

# OPTIREG™ PMIC TLF4D985QVV01R1

## Multi-rail power management IC for systems up to ASIL D



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Simulation



Family overview



Support



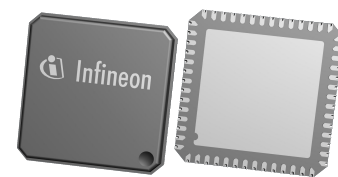
RoHS



ISO 26262 compliant

## Features

- AEC-Q100 Grade 0 for high temperature mission profiles
- Wide input voltage range 3.8 V to 60 V
- 5.0 V, 30 mA low drop voltage regulator for standby supply
- 5.5 V, 4.0 V, 10 A pre-regulator
- 7 A multiphase synchronous buck converter for microcontroller supply, configurable from 0.7 V to 1.1 V in 12.5 mV steps
- 3.3 V, 1.2 A buck post-regulator for high-speed communication interface
- 5.0 V, 600 mA low drop regulator for microcontroller IO supply
- 5.0 V, 600 mA low drop regulator for low speed communication supply
- 5.0 V  $\pm 1\%$ , 150 mA voltage reference for ADC supply
- Control circuit for external MOSFETs for safety switch and reverse battery
- Voltage monitoring with reset and interrupt functions, built-in self-test
- Input voltage monitoring with overvoltage shutdown
- Two safe state control outputs, configurable functional watchdog and window watchdog
- Internal state machine with support for CPU and system virtualization
- 32 bit SPI with CRC
- ISO 26262 Safety Element out of Context (SEooC) for safety requirements up to ASIL D
- Infineon automotive quality
- Green Product (RoHS compliant)



## Potential applications

- Car powertrain and transmission applications: inverter, engine management
- Truck applications, CAV applications
- Sensor fusion
- Domain controller, zone controller
- Connected gateway

## Product validation

Qualified for automotive applications with higher temperature requirements. Product validation according to AEC-Q100, Grade 0.

# OPTIREG™ PMIC TLF4D985QVV01R1

## Multi-rail power management IC for systems up to ASIL D



### Description

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## Description

The OPTIREG™ PMIC TLF4D985QVV01R1 is a highly efficient Functional Safety PMIC (Power management integrated circuit).

Type	Package	Marking (Line 1 / Line 2)
TLF4D985QVV01R1	PG-VQFN-56	TLF4D985 V01R1

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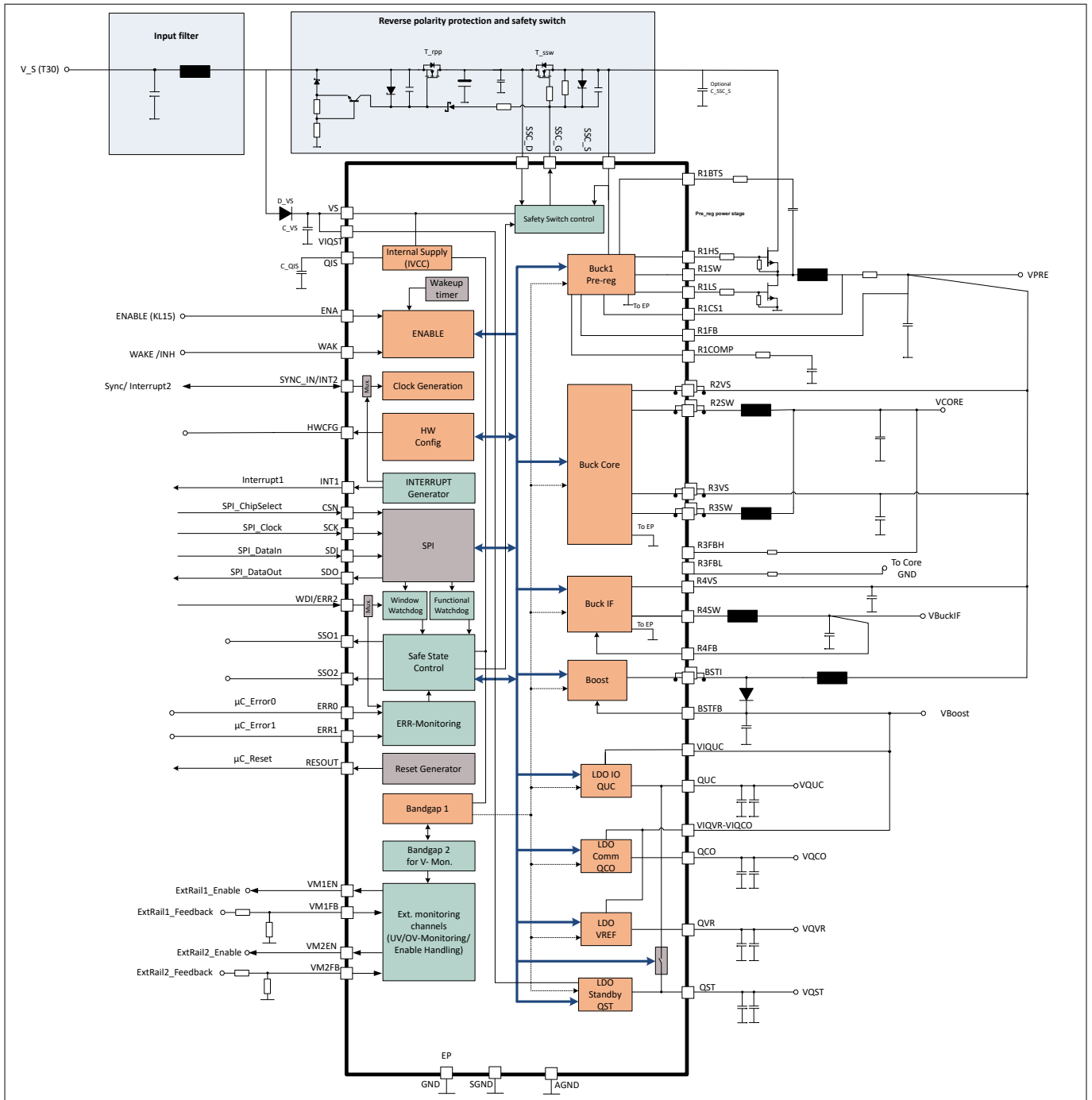


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**1 Block diagram**

**1 Block diagram**

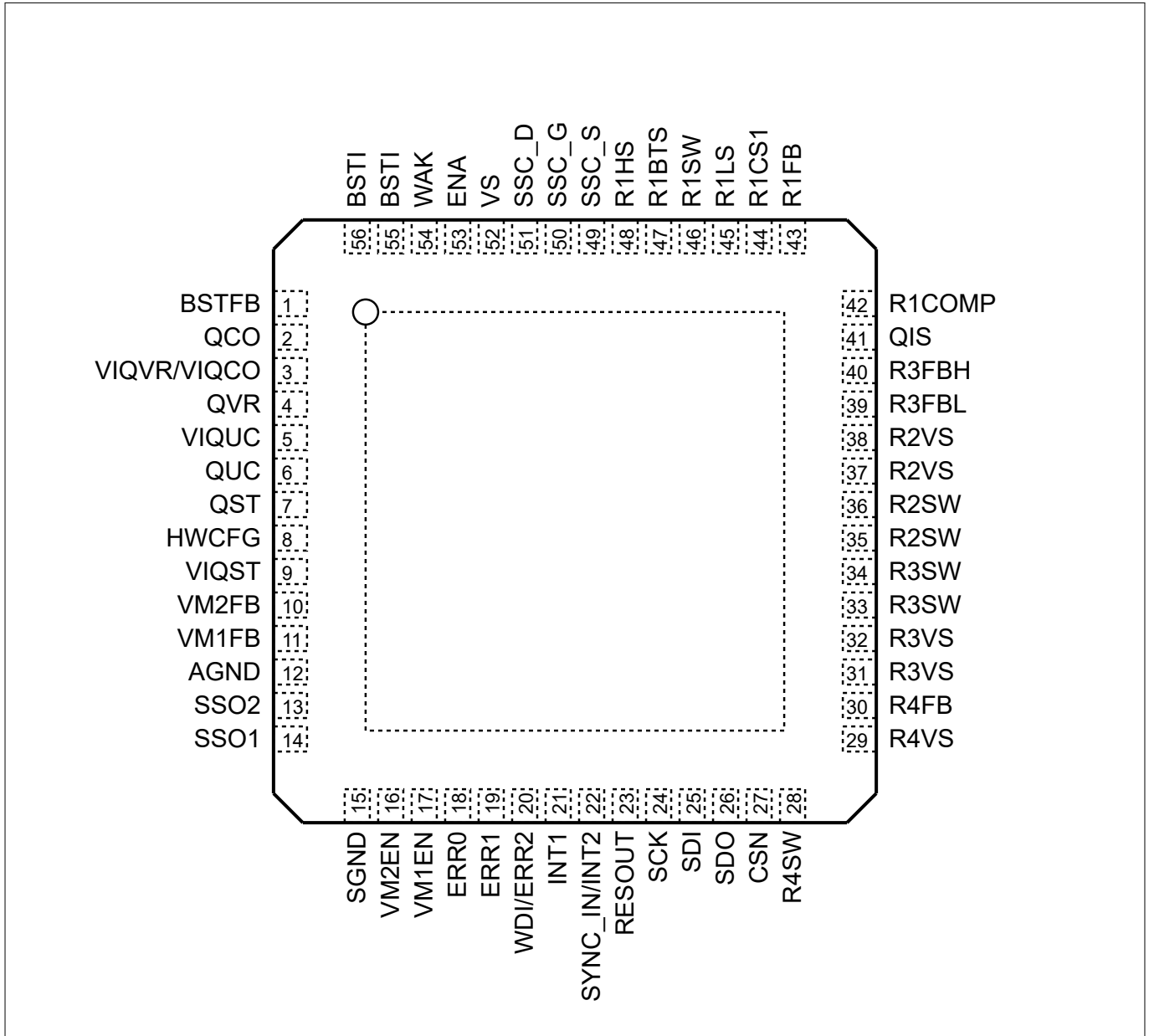


**Figure 1 Block diagram**

**2 Pin configuration**

**2 Pin configuration**

**2.1 Pin assignment**



**Figure 2 PIN assignment PG-VQFN-56 package**

**2.2 Pin definitions and functions**

**Table 1 Pin definitions and functions**

Pin	Name	Type	Function
1	BSTFB	AI	Boost voltage feedback (connect to R1FB if BOOST not used)
2	QCO	SO	Communication supply voltage

**(table continues...)**

**2 Pin configuration**

**Table 1 (continued) Pin definitions and functions**

3	VIQVR - VIQCO	SI	Input voltage for voltage reference regulator (QVR) and communication supply regulator (QCO)
4	QVR	SO	ADC reference supply voltage
5	VIQUC	SI	Input voltage for microcontroller IO regulator
6	QUC	SO	Microcontroller IO supply voltage
7	QST	SO	Standby regulator output voltage
8	HWCFG	AO	Hardware configuration setting
9	VIQST	SI	Input voltage for standby regulator and internal peripherals
10	VM2FB	AI	Feedback for external voltage monitoring 2
11	VM1FB	AI	Feedback for external voltage monitoring 1
12	AGND	GND	Analog ground connection
13	SSO2	AO	Safe state control output 2
14	SSO1	AO	Safe state control output 1
15	SGND	GND	Safety ground connection (ground for safety corner SSO1 and SSO2)
16	VM2EN	DIO	Enable for external voltage monitoring 2
17	VM1EN	DIO	Enable for external voltage monitoring 1
18	ERR0	DI	Error monitoring 0 input
19	ERR1	DI	Error monitoring 1 input
20	WDI/ ERR2	DI	Watchdog input/ Error monitoring 2 input WDI option is the default function If REDUCED OPERATION is enabled, the integrator must ensure to use the functionality correctly and exclusively use WDI/ERR2 for either one of the watchdogs or ERR2
21	INT1	DO	Interrupt 1 output
22	SYNC_IN/ INT2	DIO	Synchronization input/ Interrupt 2 output
23	RESOUT	DO	Reset output
24	SCK	DI	SPI clock input
25	SDI	DI	SPI data input
26	SDO	DO	SPI data output
27	CSN	DI	SPI chip select input
28	R4SW	AO	Switching node buck interface
29	R4VS	SI	Input voltage buck interface
30	R4FB	AI	Feedback voltage buck interface regulator
31	R3VS	SI	Input voltage buck core regulator

**(table continues...)**

## 2 Pin configuration

**Table 1 (continued) Pin definitions and functions**

32	R3VS	SI	Input voltage buck core regulator
33	R3SW	AO	Switching node buck core
34	R3SW	AO	Switching node buck core
35	R2SW	AO	Switching node buck core
36	R2SW	AO	Switching node buck core
37	R2VS	SI	Input voltage buck core regulator
38	R2VS	SI	Input voltage buck core regulator
39	R3FBL	AI	Feedback BUCKCORE regulator: Remote ground GND
40	R3FBH	AI	Feedback buck core regulator
41	QIS	SO	Buffer capacitor for internal supply
42	R1COMP	AO	Buck pre-regulator compensation
43	R1FB	AI	Feedback voltage buck pre regulator
44	R1CS1	AI	Current feedback shunt positive
45	R1LS	AO	Gate external low side FET for buck pre-regulator
46	R1SW	AI	Switch node pre-regulator
47	R1BTS	SI	Bootstrap input voltage
48	R1HS	AO	Gate external high side FET for buck pre-regulator
49	SSC_S	AI	Safety switch source (If the safety switch is not used, connect to the input of PREREG)
50	SSC_G	AO	Safety switch gate (If the safety switch is not used, connect to the input of PREREG)
51	SSC_D	SI	Safety switch drain (If the safety switch is not used, connect to GND)
52	VS	SI	Main supply voltage
53	ENA	AI	Enable - edge sensitive
54	WAK	AI	Wake - level sensitive
55	BSTI	AO	Switch node boost regulator (connect to GND if BOOST not used)
56	BSTI	AO	Switch node boost regulator (connect to GND if BOOST not used)
-	Exposed pad	-	Connect the exposed pad to GND. It is recommended to connect the exposed pad to a heat sink.

**Notes:**

AI: Analog input  
 AO: Analog output  
 AIO: Analog input output  
 SI: Supply input  
 SO: Supply output  
 DI: Digital input

## **2 Pin configuration**

DO: Digital output

DIO: Digital input output

**3 General product characteristics**

**3 General product characteristics**

- Note:**
- Stresses above the ones listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
  - Integrated protection functions are designed to prevent IC destruction under fault conditions described in the datasheet. Fault conditions are considered as outside the normal operating range. Protection functions are not designed for continuous repetitive operation.

**3.1 Absolute maximum ratings**

**Table 2 Absolute maximum ratings**

$T_j = -40^{\circ}\text{C}$  to  $+175^{\circ}\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
<b>Pins</b>							
Input voltage for standby regulator QST	$V_{VIQST}$	-0.3	-	60	V	-	DS-1661
Safety switch drain	$V_{SSC\_D}$	-0.3	-	60	V	-	DS-1662
Safety switch gate	$V_{SSC\_G}$	-0.3	-	60	V	-	DS-1663
Safety switch source	$V_{SSC\_S}$	-0.3	-	60	V	-	DS-1664
Main supply voltage	$V_{VS}$	-0.3	-	60	V	-	DS-1665
Enable	$V_{ENA}$	-0.3	-	60	V	-	DS-1666
Wake	$V_{WAK}$	-0.3	-	60	V	-	DS-1667
Switch node BUCK PREREG	$V_{R1SW}$	-2	-	60	V	-	DS-1668
Bootstrap input voltage	$V_{R1BTS}$	-0.3	-	60	V	-	DS-1669
Gate external high-side FET for BUCK PREREG	$V_{R1HS}$	-0.3	-	60	V	-	DS-1670
Switch node BOOST regulator	$V_{BSTI}$	-0.3	-	7	V	-	DS-1671
Current feedback shunt positive	$V_{R1CS1}$	-0.3	-	7	V	-	DS-1672
Feedback voltage BUCK PREREG	$V_{R1FB}$	-0.3	-	7	V	-	DS-1673
Input voltage BUCK IF regulator	$V_{R4VS}$	-0.3	-	7	V	-	DS-1674
Feedback for BUCK IF regulator	$V_{R4FB}$	-0.3	-	7	V	-	DS-1675
Input voltage BUCK CORE 2 regulator	$V_{R3VS}$	-0.3	-	7	V	-	DS-1676

**(table continues...)**

**3 General product characteristics**

**Table 2 (continued) Absolute maximum ratings**

$T_j = -40^\circ\text{C}$  to  $+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Switch node BUCK CORE 2 regulator	$V_{R3SW}$	-0.3	-	7	V	-	DS-1677
Switch node BUCK CORE 1 regulator	$V_{R2SW}$	-0.3	-	7	V	-	DS-1678
Input voltage BUCK CORE 1 regulator	$V_{R2VS}$	-0.3	-	7	V	-	DS-1679
Compensation	$V_{R1COMP}$	-0.3	-	7	V	-	DS-1680
Buffer capacitor for internal supply	$V_{QIS}$	-0.3	-	7	V	-	DS-1681
Feedback BUCK CORE 2 regulator	$V_{R3FBH}$	-0.3	-	7	V	-	DS-1682
Switch node BUCK IF regulator	$V_{R4SW}$	-0.3	-	7	V	-	DS-1683
SPI chip select input	$V_{CSN}$	-0.3	-	6	V	-	DS-1684
Feedback for external voltage monitoring 2	$V_{VM2FB}$	-0.3	-	60	V	-	DS-1685
Feedback for external voltage monitoring 1	$V_{VM1FB}$	-0.3	-	6	V	-	DS-1686
SPI data output	$V_{SDO}$	-0.3	-	6	V	-	DS-1687
SPI data input	$V_{SDI}$	-0.3	-	6	V	-	DS-1688
SPI clock input	$V_{SCK}$	-0.3	-	6	V	-	DS-1689
Hardware configuration setting	$V_{HWCFG}$	-0.3	-	60	V	-	DS-1690
Output voltage for standby regulator QST	$V_{QST}$	-0.3	-	6	V	Max value increases to 7 V if QUC is OFF and QST is ON	DS-1691
Microcontroller IO supply voltage	$V_{QUC}$	-0.3	-	6	V	-	DS-1692
Input voltage for microcontroller IO regulator	$V_{VIQUC}$	-0.3	-	7	V	-	DS-1693
ADC reference supply voltage	$V_{QVR}$	-0.3	-	6	V	-	DS-1694
Input voltage reference and communication regulator	$V_{VIQVR-}$ $V_{IQCO}$	-0.3	-	7	V	-	DS-1695
Communication supply voltage	$V_{QCO}$	-0.3	-	6	V	-	DS-1696

**(table continues...)**

**3 General product characteristics**

**Table 2 (continued) Absolute maximum ratings**

$T_j = -40^{\circ}\text{C}$  to  $+175^{\circ}\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Boost voltage feedback	$V_{BSTFB}$	-0.3	-	7	V	-	DS-1697
Safe state control output 1	$V_{SSO1}$	-0.3	-	60	V	-	DS-1698
Safe state control output 2	$V_{SSO2}$	-0.3	-	60	V	-	DS-1699
Reset output	$V_{RESOUT}$	-0.3	-	6	V	-	DS-1700
Synchronization input / interrupt output 2	$V_{SYNC\_IN/INT2}$	-0.3	-	6	V	-	DS-1701
Interrupt output 1	$V_{INT1}$	-0.3	-	6	V	-	DS-1702
Watchdog input / error input 2	$V_{WDI/ERR2}$	-0.3	-	6	V	-	DS-1703
Error input 0	$V_{ERR0}$	-0.3	-	6	V	-	DS-1704
Error input 1	$V_{ERR1}$	-0.3	-	6	V	-	DS-1705
Enable for external voltage monitoring 1	$V_{VM1EN}$	-0.3	-	6	V	-	DS-1706
Enable for external voltage monitoring 2	$V_{VM2EN}$	-0.3	-	6	V	-	DS-1707
Safety ground connection	$V_{SGND}$	-0.3	-	0.3	V	AGND, SGND and EP are internally connected	DS-1708
Power ground - exposed pad	$V_{EP}$	-0.3	-	0.3	V	AGND, SGND and EP are internally connected	DS-1709
Analog ground connection	$V_{AGND}$	-0.3	-	0.3	V	AGND, SGND and EP are internally connected	DS-1710
Connection to buck core ground	$V_{R3FBL}$	-0.3	-	0.3	V	Respect to AGND	DS-1711
Gate external low-side FET for BUCK PREREG	$V_{R1LS}$	-0.3	-	7	V	Respect to AGND	DS-1712

**ESD robustness**

ESD voltage HBM parameter	$V_{ESD\_HBM}$	-2	-	2	kV	<sup>2)</sup> HBM	DS-1732
ESD robustness not corner pins (CDM)	$V_{ESD\_CDM}$	-500	-	500	V	<sup>3)</sup> CDM	DS-1733
ESD robustness corner pins (CDM)	$V_{ESD\_CDM\_Corner}$	-750	-	750	V	<sup>3)</sup> CDM	DS-1734

**Differential parameters**

Differential voltage between R1BTS - R1SW	$\Delta V_{R1BTS-R1SW}$	-0.3	-	7	V	$\Delta V_{R1BTS-R1SW} = V_{R1BTS} - V_{R1SW}$	DS-2060
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**(table continues...)**

### 3 General product characteristics

**Table 2 (continued) Absolute maximum ratings**

$T_j = -40^\circ\text{C}$  to  $+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Differential voltage between R1HS- R1SW	$\Delta V_{R1HS-R1SW}$	-0.3	-	7	V	$\Delta V_{R1HS-R1SW} = V_{R1HS} - V_{R1SW}$	DS-2061
Differential voltage between SSC_G - SSC_S	$\Delta V_{SSC_G-SSC_S}$	-0.3	-	7	V	$\Delta V_{SSC_G-SSC_S_{max}} = V_{SSC_G} - V_{SSC_S}$	DS-2062

1) Not subject to production test, specified by design.

2) Human Body Model (HBM) according to JEDEC HBM Human Body Model ANSI/ESDA/JEDEC JS001 (1.5 k $\Omega$ , 100 pF).

3) Charged Device Model (CDM) according to ESDA STM5.3.1 or ANSI/ESD S.5.3.1.

## 3.2 Functional range

### 3.2.1 Functional range description

**Note:** *Within the functional or operating range, the device operates as described in the circuit description. The electrical characteristics are specified within the conditions given in the Electrical Characteristics table.*

### 3.2.2 Electrical characteristics functional range

**Table 3 Functional range**

$V_{VS} = 6.0\text{ V}$  to  $36\text{ V}$ ,  $T_j = -40^\circ\text{C}$  to  $+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Supply voltage for normal operation of internal blocks with BOOST	$V_S$	3.8	-	36	V	For $V_{VS} < 6\text{ V}$ , max temp is $105^\circ\text{C}$ ; Same voltage applied to VS and VIQST pins; Device must already be operating 1)	DS-2143
Supply voltage for normal operation of internal blocks without BOOST	$V_S$	6	-	36	V	Same voltage applied to VS and VIQST pins 1)	DS-1932

(table continues...)

**3 General product characteristics**

**Table 3 (continued) Functional range**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Device start-up time	$t_{\text{start\_up}}$	–	–	11	ms	From first battery connection to release of microcontroller reset RESOUT; Default reset delay time $t_{RD} = 2\text{ms}$ ; $V_{SSC\_S} < 1\text{V}$ at startup; Capacitance at SSC_S pin = $1\mu\text{F}[\text{Max}]$ <sup>1)</sup>	DS-2084
Supply voltage range, load dump	$V_{VS\_LD}$			$V_{VS\_OV}$	V	Load dump condition, device transitions to FAILSAFE mode if severe overvoltage is detected on VS pin; Same voltage applied to VS and VIQST pins; <sup>1)</sup>	DS-2132
PREREG input voltage with boost	$V_{SSC\_S}$	3.8	–	36	V	For $V_{SSC\_S} \leq 6.5\text{ V}$ : $T_j = -40^\circ\text{C to }25^\circ\text{C}$ ; BOOST max load: 650 mA; PREREG max load: 3.5 A (including BOOST load); $dV_{SSC\_S}/dt \leq 8\text{ V/ms}$ ; PREREG efficiency $\geq 88\%$ <sup>1)</sup>	DS-2070
PREREG input voltage with boost, high temp	$V_{SSC\_S}$	4.3	–	36	V	For $V_{SSC\_S} \leq 6.5\text{ V}$ : $T_j = -40^\circ\text{C to }105^\circ\text{C}$ ; BOOST max load: 650 mA; PREREG max load: 3.5 A (including BOOST load); $dV_{SSC\_S}/dt \leq 8\text{ V/ms}$ ; PREREG efficiency $\geq 88\%$ <sup>1)</sup>	DS-2158
PREREG input voltage without boost	$V_{SSC\_S\_PREREG\_noBOOST}$	6.6	–	36	V	$V_{SSC\_S} > 6.6\text{V}$ needed for startup without boost; <sup>1)</sup>	DS-2157

**(table continues...)**

### 3 General product characteristics

**Table 3 (continued) Functional range**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
<b>Temperatures</b>							
Junction temperature	$T_j$	-40	-	175	°C	Continuous operation; <sup>1)</sup>	DS-1931
Storage temperature	$T_{stg}$	-55	-	175	°C	<sup>1)</sup>	DS-2069

<sup>1)</sup> Not subject to production test, specified by design

### 3.3 Thermal resistance

**Table 4 Thermal resistance**

$V_{VS} = 6.0\text{ V to }40\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Junction to case	$R_{thJC}$	-	2.6	-	K/W	Fixed temperature for bottom <sup>1)</sup>	DS-2019
Junction to top	$R_{thJTop}$	-	12.8	-	K/W	Fixed temperature for top side <sup>1)</sup>	DS-2021
Junction to ambient - 2s2p	$R_{thJA\_2s2p}$	-	22.5	-	K/W	JEDEC 2s2p PCB <sup>1) 2)</sup>	DS-2023
Junction to ambient - 2s4p	$R_{thJA\_2s4p}$	-	17.2	-	K/W	2s4p PCB <sup>1) 3)</sup>	DS-2025

<sup>1)</sup> Not subject to production test, specified by design

<sup>2)</sup> Specified  $R_{thJA}$  value is according to JEDEC JESD51-2,-5,-7 at natural convection on FR4 2s2p board; the product (chip and package) was simulated on a  $76.2 \times 114.3 \times 1.5\text{ mm}^3$  board with two outside signal Cu traces ( $2 \times 70\mu\text{m}$ ) and two inner copper layers ( $2 \times 35\mu\text{m}$ ). Where applicable, a thermal via array next to the package contacted the first inner copper layer.

<sup>3)</sup> Specified  $R_{thJA}$  value is according to internal application board at a natural convection on FR4 2s4p board; the product (chip and package) was simulated on a  $74.2 \times 74.2 \times 1.688\text{ mm}^3$  board with two outside copper layers ( $2 \times 53\mu\text{m}$ ) and four inner copper layers ( $4 \times 33\mu\text{m}$  Cu). Thermal via array contacted the second and third inner copper layer.

**4 DCDC Switching frequency generation and clock synchronization**

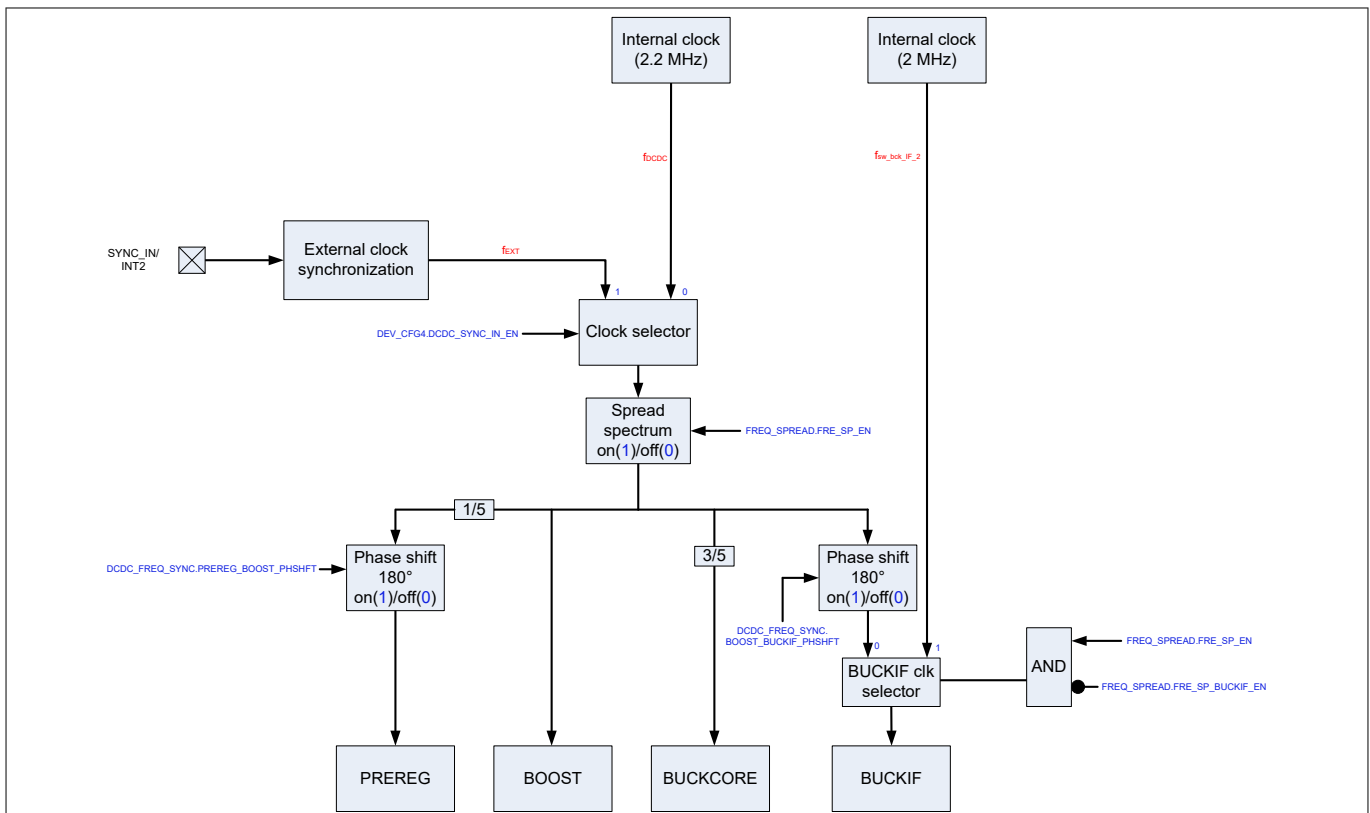
**4 DCDC Switching frequency generation and clock synchronization**

**Table 5 Electrical characteristics DCDC Switching frequency generation and clock synchronization**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
DCDC switching frequency default	$f_{DCDC}$	$2.2 + f_{DCDC\_acc[MIN]}$	2.2	$2.2 + f_{DCDC\_acc[MAX]}$	MHz	-	DS-1719
DCDC switching frequency accuracy	$f_{DCDC\_acc}$	-10	-	+10	%	-	DS-1720

**4.1 Functional description**



**Figure 3 DCDC clock generation and clock manager**

The switching frequencies for the different integrated DCDC converters are generated by an integrated clock generator or an external synchronization frequency signal.

The main switching frequency ( $f_{DCDC}$ ) is adjustable via SPI bitfield **DCDC\_FREQ\_SYNC.DCDC\_FREQSEL**, in the range of 1.8 MHz to 2.4 MHz with 100 kHz step resolution.

**External clock synchronization**

## **4 DCDC Switching frequency generation and clock synchronization**

The device provides an external synchronization of the DC-DC switching frequency  $f_{\text{DCDC}}$  to an external clock source within the range 1.6 MHz to 2.6 MHz at the SYNC\_IN/INT2 pin, to improve the EMC/EMI performance and reduce the cross-talk to the loads.

Synchronization can be enabled or disabled via SPI bit DEV\_CFG4.DCDC\_SYNC\_IN\_EN, default is disabled (DEV\_CFG4.DCDC\_SYNC\_IN\_EN = 0).

The device handles a change of 100 kHz in the external clock source frequency with a settling time of 50  $\mu\text{s}$  on the switching frequency.

### **4.1.1 EMC features**

#### **Spread spectrum**

The device incorporates spread-spectrum modulation to improve EMC/EMI performance. The spread spectrum modulation is applied to the main clock source, hence affects all power converters.

The spread spectrum modulation is disabled by default and can be enabled via SPI bit **FREQ\_SPREAD.FRE\_SP\_EN**.

After enabling the spread spectrum (**FREQ\_SPREAD.FRE\_SP\_EN = 1**), the device allows to configure the spread spectrum functionality to be applied also to the Buck IF regulator via SPI bit **FREQ\_SPREAD.FRE\_SP\_BUCKIF\_EN**.

The configuration of the spread spectrum modulation method, modulation frequency and amplitude can be selected via SPI register **FREQ\_SPREAD**.

#### **Phase shift**

To further improve the EMC performance, the device allows to configure phase relationship between BUCK PREREG and BOOST regulator and between BUCK IF and BOOST regulator via SPI:

- The device enables 180° phase shift between BOOST and BUCK IF if SPI **DCDC\_FREQ\_SYNC.BOOST\_BUCKIF\_PHSFT** is set to 1.
- The device enables 180° phase shift between BOOST and PREREG if SPI **DCDC\_FREQ\_SYNC.PREREG\_BOOST\_PHSFT** is set to 1.

#### **Slew rate control**

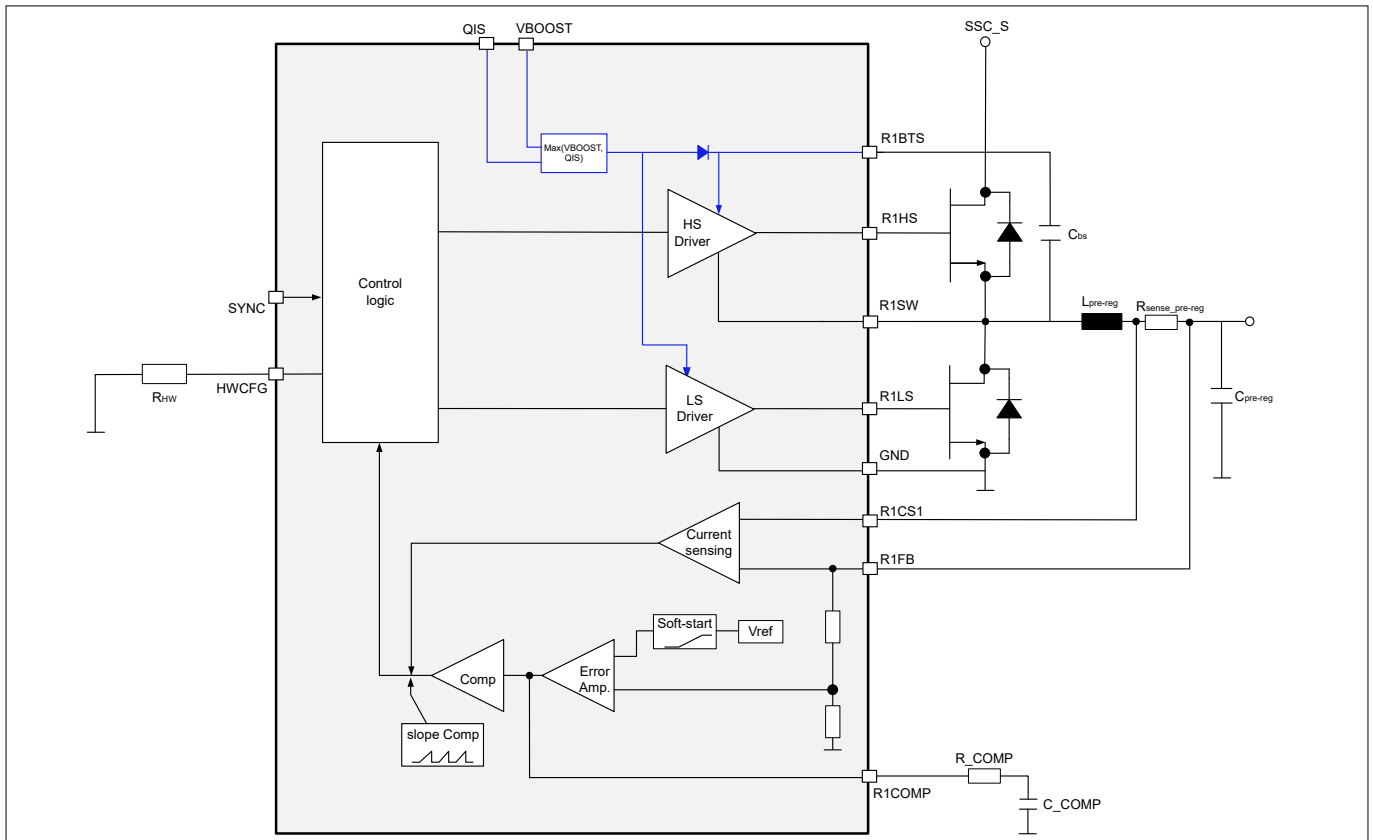
Device also provides configurability of switching slew rate for all power converters via SPI register **DCDC\_FREQ\_SYNC**

**5 Power supply function**

**5 Power supply function**

**5.1 BUCK PREREG (buck pre-regulator)**

**5.1.1 Functional description BUCK PREREG**



**Figure 4 Block diagram PREREG**

The pre-regulator is a synchronous buck controller with two external power switches (NMOS, enhanced type) to supply internal circuitry, buck, boost, LDOs and other external loads.

The pre-regulator converts the input voltage at pin SSC\_S to an output voltage  $V_{R1FB}$  with  $I_{bck\_prereg}$  output current.

The output voltage of the pre-regulator is configurable by hardware.

Depending on the value of the external resistor on pin HWCFG, the output voltage  $V_{R1FB} = V_{R1FB\_4V0}$  or  $V_{R1FB} = V_{R1FB\_5V5}$ .

The pre-regulator operates in PWM mode with peak current control and outer voltage control loop.

The output current is sensed via an external shunt resistor ( $R_{sense}$ ) in series with the inductor and the maximum current capability is defined by the external components (NMOS gate charge, inductor, shunt resistor), the gate driver current capability and the switching frequency. An overcurrent detection is implemented to protect the external MOSFETs. If an overcurrent is detected after the HS minimum TON time, the HS is turned OFF and will be turned ON again at the next rising edge of the switching clock. The overcurrent induces a duty cycle reduction that could lead to the output voltage gradually dropping.

The BUCK PREREG operates with external compensation for external component-references according to the table given below:

**5 Power supply function**

**Table 6 External filter component buck pre-regulator**

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
External inductor	$L_{PR}$	-20 %	6.8	20%	μH	–	DS-1890
External inductor series resistance	$DCRL_{PR}$	–	8	10	mΩ	Max value to guarantee the efficiency	DS-1891
External capacitor	$C_{PR}$	-20 %	66	20%	μF	–	DS-1892
External capacitor series resistance	$R_{C\_PR}$	–	10	20	mΩ	Max value to guarantee the efficiency and the stability	DS-1893
External bootstrap capacitor	$C_{R1BTS}$	-20 %	100	20%	nF	–	DS-1894
External bootstrap capacitor resistance	$R_{C\_R1BTS}$	–	50	–	mΩ	–	DS-1895
External sense resistor	$R_{sense}$	-1%	10	+1%	mΩ	For 10 A current capability	DS-1896
External sense resistor	$R_{sense}$	-1%	20	+1%	mΩ	For 5 A current capability	DS-1897
External compensation capacitor	$C_{comp}$	-20 %	1.5	+20 %	nF	For 5 A current capability	DS-1898
External compensation capacitor	$C_{comp}$	-20 %	2.7	+20 %	nF	For 10 A current capability	DS-1899
External compensation resistance	$R_{comp}$	-1%	25	+1%	kΩ	For 5 A current capability	DS-1900
External compensation resistance	$R_{comp}$	-1%	12	+1%	kΩ	For 10 A current capability	DS-1901

1) Not subject to production test

**5.1.2 Electrical characteristics BUCK PREREG**

**Table 7 Electrical characteristics BUCK PREREG**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
4.0 V output voltage	$V_{R1FB\_4V0}$	3.6	4	4.4	V	$V_{SSC\_S} \geq 5.5\text{ V}$ ; $dI/dt \leq 390\text{ A/ms}$ ; Output voltage is set to 4 V by <a href="#">HWCFG</a>	DS-1407

(table continues...)

**5 Power supply function**

**Table 7 (continued) Electrical characteristics BUCK PREREG**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
4.0 V output voltage accuracy	$V_{R1FB\_4V0\_acc}$	3.88	–	4.08	V	Static; $V_{SSC\_S} \geq 5.5\text{ V}$	DS-2151
5.5 V output voltage	$V_{R1FB\_5V5}$	4.95	5.5	6.05	V	$V_{SSC\_S} \geq 6.5\text{ V}$ ; $di/dt \leq 390\text{ A/ms}$ ; Output voltage is set to 5V5 by <a href="#">HWCFG</a>	DS-2154
5.5 V output voltage accuracy	$V_{R1FB\_5V5\_acc}$	5.34	–	5.61	V	Static; $V_{SSC\_S} \geq 6.5\text{ V}$	DS-2152
Maximum output current	$I_{bck\_prereg}$	5	–	10	A	Max = 10 A with $R_{sense} = 10\text{ m}\Omega$ ; Max = 5 A with $R_{sense} = 20\text{ m}\Omega$ ; $I_{bck\_prereg} < 5\text{ A}$ if $V_{SSC\_S} \leq 8\text{ V}$	DS-2155
Sense input current high side	$I_{R1CS1}$			100	$\mu\text{A}$	$V_{SSC\_S} > 3.6\text{ V}$ ; $I_{bck\_prereg} = 0$ <a href="#">1)</a>	DS-1410
Sense input current low-side	$I_{R1FB}$			100	$\mu\text{A}$	$V_{SSC\_S} > 3.6\text{ V}$ ; $I_{bck\_prereg} = 0$ <a href="#">1)</a>	DS-1411
Overcurrent peak detection threshold	$V_{shunt\_R1FB\_OC}$	120	150	180	mV	Overcurrent case not including $R_{sense}$ tolerance	DS-1412
Switching frequency	$f_{sw\_bck\_prereg}$	$f_{DCDC}$ [MIN]/5	$f_{DCDC}$ /5	$f_{DCDC}$ [MAX]/5	MHz	$f_{sw\_bck\_prereg} = f_{DCDC}/5$	DS-1413
Soft-start time	$t_{ss\_bck\_prereg}$	–	400	715	$\mu\text{s}$	Voltage at pin $V_{R1FB}$ ramps up from 10% to 90% of $V_{R1FB}$	DS-1414
Maximum duty cycle	$D_{max\_bck\_prereg}$			98	%		DS-1415
High-side peak sourcing current	$I_{R1HS\_SRC}$	200 * X	–	850 * X	mA	$V_{R1HS} - V_{R1SW}$ from 1 V to 4 V $V_{QIS} = 5.5\text{ V}$ $I_{R1HS\_SRC}$ is programmable by SPI in $DCDC\_FREQ\_SYNC.PREREG\_DRIVER\_CONFIG$ ; x:1,2/3,1/3; Default value: 1; <a href="#">1)</a>	DS-2087

**(table continues...)**

**5 Power supply function**

**Table 7 (continued) Electrical characteristics BUCK PREREG**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
High-side peak sinking current	$I_{R1HS\_SNK}$	200 * X		850 * X	mA	$V_{R1HS} - V_{R1SW}$ from 4 V to 1 V; $V_{QIS} = 5.5\text{ V}$ $I_{R1HS\_SNK}$ is programmable by SPI in DCDC_FREQ_SYNC.PREREG_DRIVER_CONFIG; x:1,2/3,1/3; Default value: 1; <sup>1)</sup>	DS-2088
Low-side peak sourcing current	$I_{R1LS\_SRC}$	200 * X	-	850 * X	mA	$V_{R1LS}$ from 1 V to 4 V; $V_{QIS} = 5.5\text{ V}$ ; $I_{R1LS\_SRC}$ is programmable by SPI in DCDC_FREQ_SYNC.PREREG_DRIVER_CONFIG; x:1,2/3,1/3; Default value: 1; <sup>1)</sup>	DS-2089
Low-side peak sinking current	$I_{R1LS\_SNK}$	200 * X		850 * X	mA	$V_{R1LS}$ from 4 V to 1 V; $V_{QIS} = 5.5\text{ V}$ $I_{R1LS\_SNK}$ is programmable by SPI in DCDC_FREQ_SYNC.PREREG_DRIVER_CONFIG; x:1,2/3,1/3; Default value: 1; <sup>1)</sup>	DS-2090
Low-side high level gate output voltage vs. source	$\Delta V_{R1LS}$	3.5	4.5	6	V	$\Delta V_{R1LS} = V_{R1LS} - V_{GND}$ ; $V_{VS} = V_{VIQST} > 6\text{ V}$ <sup>1)</sup>	DS-1514
High-side high level gate output voltage vs. source	$\Delta V_{HS\_R1HS\_R1SW}$	3.5	4.5	6	V	$\Delta V_{HS\_R1HS\_R1SW} = V_{R1HS} - V_{R1SW}$ ; $V_{VS} = V_{VQST} > 6\text{ V}$ <sup>1)</sup>	DS-1515
High-side gate rise time	$t_{R1HS\_r}$	23	-	55	ns	$V_{R1HS}$ from 10% to 90%; $C_{R1HS} = 3\text{ nF}$ <sup>1)</sup>	DS-1516
High-side gate fall time	$t_{R1HS\_f}$	24	-	51	ns	$V_{R1HS}$ from 90% to 10%; $C_{R1HS} = 3\text{ nF}$ <sup>1)</sup>	DS-1517

**(table continues...)**

**5 Power supply function**

**Table 7 (continued) Electrical characteristics BUCK PREREG**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

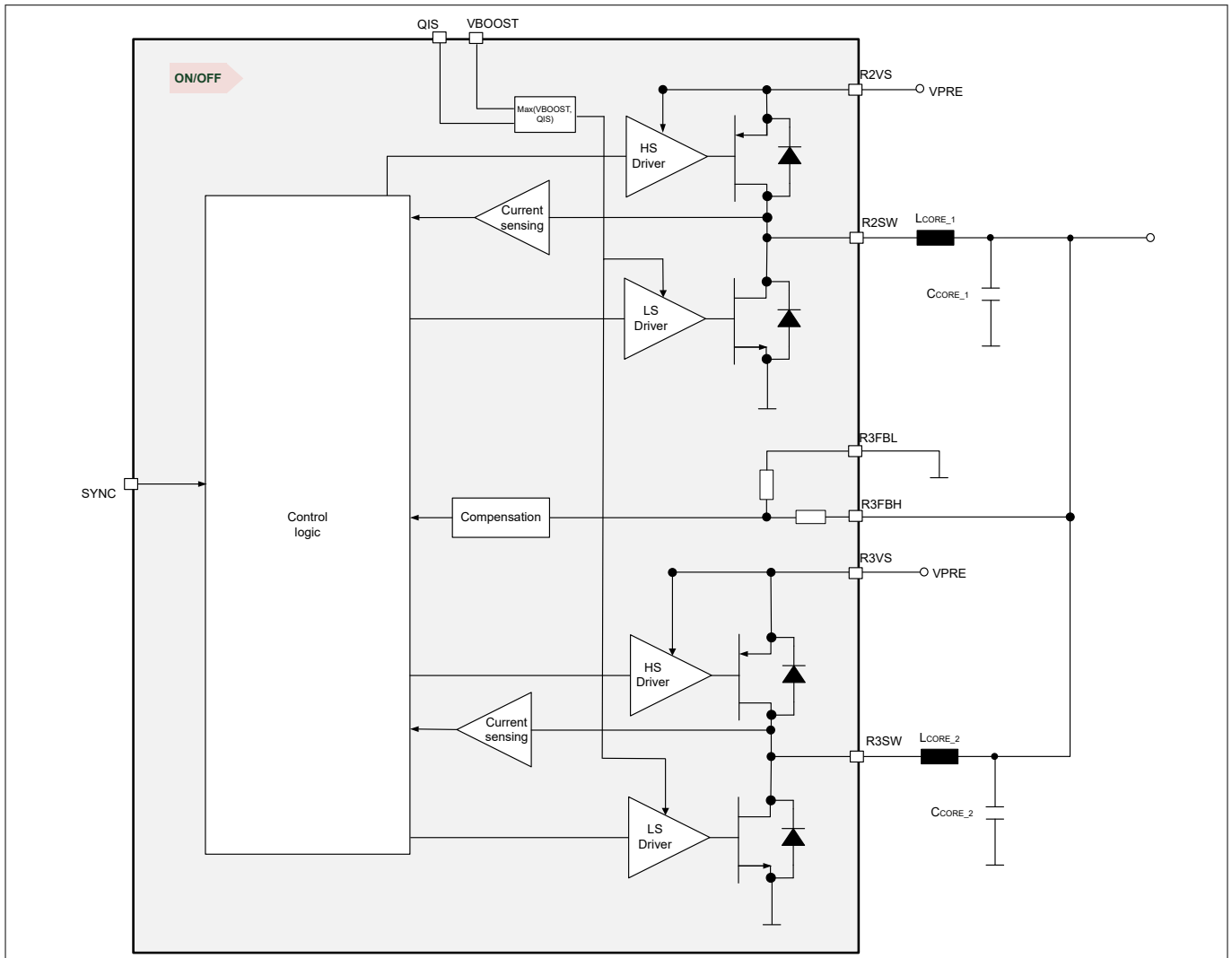
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Low-side gate rise time	$t_{R1LS\_r}$	23	–	55	ns	$V_{R1LS}$ from 10% to 90%; $C_{R1LS} = 3\text{ nF}$ <i>1)</i>	DS-1518
Low-side gate fall time	$t_{R1LS\_f}$	24	–	51	ns	$V_{R1LS}$ from 90% to 10%; $C_{R1LS} = 3\text{ nF}$ <i>1)</i>	DS-1519

*1)* Not subject to production test, specified by design

**5.2 BUCK CORE (buck core regulator)**

**5 Power supply function**

**5.2.1 Functional description BUCK CORE**



**Figure 5 Block diagram BUCK CORE regulator**

The device provides a dual phases buck regulator, which generates an output voltage between  $V_{R3FBH}$  and  $V_{R3FBL}$  with  $I_{bck\_core}$  output current to supply the microcontroller core.

The default output voltage of the buck core can be read in the SPI register bitfield **VCORESTAT.VOUT**.

The output voltage of the buck core can be adjusted via SPI register bitfield **BUCK\_CORE\_PW\_VSEL.VSEL**.

The device provides voltage scaling based on the request from the SPI interface in the range of  $V_{R3FBH\_rg}$  with the unit step of  $V_{R3FBH\_step}$ . When starting up or recovering from a R1 reset class event (see [Reset classes](#)) the regulator starts up with its default value of 1.025 V.

Further default OTP (One Time Programmable) values are available as default options:

0.7 V, 0.8 V, 0.9 V, 0.95 V, 0.9625 V, 0.975 V, 0.9875 V, 1.0 V, 1.0125 V, 1.025 V, 1.0375 V, 1.05 V, 1.15 V

**Note:** *The reset value of the respective registers for configuring the output voltage of BUCKCORE (BUCK\_CORE\_PW\_VSEL, BUCK\_CORE\_RS\_VSEL, VCORESTAT, VCOREMONSTAT) does not correspond with the value a user will read upon the device's start-up or recovering from reset event. During the start-up, this register is overwritten with the pre-set default value.*

The undervoltage and overvoltage monitoring thresholds of the buck core are adjusted according to the chosen regulator set point during static voltage scaling.

An overcurrent protection of maximum  $I_{OC\_bck\_core}$  in cycle-by-cycle limitation mode is implemented.

## 5 Power supply function

The buck core regulator is implemented with an overload protection in the low-side MOSFET with  $I_{OL\_bck\_core}$  limit in source-drain direction.

The buck core regulator operates with internal compensation for external component-references according to the table given below:

**Table 8 External filter component (BOM) buck core regulator**

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
External inductor 1	$L_{buck\_core\_1}$	-20 %	1	20%	μH	–	DS-1902
External inductor series resistance 1	$DCR_{L\_buck\_core\_1}$	–	30	37	mΩ	–	DS-1903
External inductor 2	$L_{buck\_core\_2}$	-20 %	1	20%	μH	–	DS-1904
External inductor series resistance 2	$DCR_{L\_buck\_core\_2}$	–	30	37	mΩ	–	DS-1905
External capacitor 1	$C_{buck\_core\_1}$	-20 %	47	20%	μF	–	DS-1906
External capacitor series resistance 1	$ESR_{C\_buck\_core\_1}$	–	–	5	mΩ	–	DS-1907
External capacitor 2	$C_{buck\_core\_2}$	-20 %	47	20%	μF	–	DS-1908
External capacitor series resistance 2	$ESR_{C\_buck\_core\_2}$	–	–	5	mΩ	–	DS-1909

1) Not subject to production test

### 5.2.2 Electrical characteristics BUCK CORE

**Table 9 Electrical characteristics BUCK CORE**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Input voltage	$V_{R^*VS}$	$V_{R1FB\_4V0}$	–	$V_{R1FB\_5V5}$	V	$V_{R^*VS} = V_{R2VS} = V_{R3VS}$	DS-1418
Default output voltage	$V_{R3FBH}$	–	1.025	–	V	–	DS-2085
Maximum output current	$I_{bck\_core\_ph}$	–	–	3.5	A	Per phase	DS-1421

(table continues...)

**5 Power supply function**

**Table 9 (continued) Electrical characteristics BUCK CORE**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Minimum output current	$I_{\text{bck\_core\_min}}$	1	–	–	mA	<sup>1)</sup>	DS-1428
Overcurrent limitation	$I_{\text{OC\_bck\_core\_ph}}$	4.3	–	5.3	A	Per phase	DS-1423
Overload limitation	$I_{\text{OL\_bck\_core\_ph}}$	4.3	–	5.3	A	Per phase	DS-1529
Static voltage range	$V_{\text{R3FBH\_rg}}$	0.7	–	1.1	V	$V_{\text{R3FBH\_rg}}$ is programmable (6 bits) between 0.7V and 1.1V via SPI with a default value $V_{\text{R3FBH}}$  From 0.7V to 0.8875V: $V_{\text{R2VS}} = V_{\text{R3VS}} = V_{\text{R1FB\_4V0}}$	DS-1419
Static voltage steps	$V_{\text{R3FBH\_step}}$	–	12.5	–	mV	–	DS-1530
Switching frequency	$f_{\text{sw\_bck\_core}}$	$(f_{\text{DCDC}}[\text{MIN}]/5) \times 3$	$(f_{\text{DCDC}}[\text{C}/5]) \times 3$	$(f_{\text{DCDC}}[\text{MAX}]/5) \times 3$	MHz	–	DS-1531
Static tolerance including ripple	$dV_{\text{R3FBHL\_stat}}$	-2	–	+2	%	Under static output load.	DS-1420
Response time for static voltage scaling	$T_{\text{R\_TO\_SVS}}$	$0.9 * T_{\text{R\_TO\_SVS}}[\text{typ}]$	$20 + 50 * ((V_{\text{R3FBH\_end}} - V_{\text{R3FBH\_start}}) / dV_{\text{R3FBH\_step}}) + 20$	$1.1 * T_{\text{R\_TO\_SVS}}[\text{typ}]$	us	$V_{\text{R3FBH\_end}}$ is the target $V_{\text{R3FBH}}$ output voltage; $V_{\text{R3FBH\_start}}$ is the starting $V_{\text{R3FBH}}$ output voltage; $I_{\text{bck\_core}} \geq 200\text{ mA}$ to guarantee the BUCK_CORE response time for static voltage scaling <sup>1)</sup>	DS-1422

**(table continues...)**

**5 Power supply function**

**Table 9 (continued) Electrical characteristics BUCK CORE**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Peak efficiency	$P_{eff\_bck\_core}$	83	87	–	%	50% of max load ( $I_{bck\_core}/2$ ) including typical external components and excluding board parasitics at RT <sup>1)</sup>	DS-1424
Soft-start time	$t_{ss\_bck\_core}$	–	0.5	–	ms	Voltage at pin $V_{R3FBH}$ ramps up from 10% to 90% of $V_{R3FBH}$	DS-1425
Load step response for high load	$dV_{R3FBH\_HL}$	-0.04 * $V_{R3FBH}$	–	0.04 * $V_{R3FBH}$	mV	(1) $0.7\text{ V} \leq V_{R3FBH} \leq 0.9\text{ V}$ ; $V_{R2VS} = V_{R3VS} = 4\text{ V}$ ; (2) $0.9\text{ V} < V_{R3FBH} \leq 1.1\text{ V}$ ; $V_{R2VS} = V_{R3VS} = 5.5\text{ V}$ or $V_{R2VS} = V_{R3VS} = 4\text{ V}$ ; $dI_{buck\_core} < 1200\text{ mA}$ ; $100\text{ mA} \leq I_{bck\_core} \leq 5000\text{ mA}$ ; load step rise/fall time = 100 ns; $t_{settling} = 10\text{ }\mu\text{s}$ $dI_{buck\_core} > -1200\text{ mA}$ ; $2100\text{ mA} \leq I_{bck\_core} \leq 7000\text{ mA}$ ; load step rise/fall time = 100 ns; $t_{settling} = 10\text{ }\mu\text{s}$ series resistance 10mOhm between R3FBH and load (VDD supply pin MCU); series resistance 5 mΩ between R3FBL and load ground (supply ground pin of MCU); Including static output voltage accuracy <sup>1)</sup>	DS-2147

(table continues...)

**5 Power supply function**

**Table 9 (continued) Electrical characteristics BUCK CORE**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Load step response for medium load	$dV_{R3FBH\_ML}$	-0.03 $5 \cdot V_{R3FBH}$	–	0.03 $5 \cdot V_{R3FBH}$	mV	(1) $0.7 \leq V_{R3FBH} \leq 0.9$ ; $V_{R3VS} = 4\text{V}$ (2) $0.9 < V_{R3FBH} \leq 1.1\text{V}$ ; $V_{R3VS} = 5.5\text{V}$ or $V_{R3VS} = 4\text{V}$ $dI_{buck\_core} < 500\text{mA}$ ; $100\text{mA} \leq I_{bck\_core} \leq 6500\text{mA}$ ; load step rise/fall time = $100\text{ns}$ ; $t_{settling} = 10\mu\text{s}$ $dI_{buck\_core} > -500\text{mA}$ ; $600\text{mA} \leq I_{bck\_core} \leq 7000\text{mA}$ ; load step rise/fall time = $100\text{ns}$ ; $t_{settling} = 10\mu\text{s}$ series resistance $10\text{m}\Omega$ between R3FBH and load (VDD supply pin MCU); series resistance $5\text{m}\Omega$ between R3FBL and load ground (supply ground pin of MCU); Including static output voltage accuracy <sup>1)</sup>	DS-2148
Line step response	$dV_{R3FBH\_line}$	-0.01 $5 \cdot V_{R3FBH}$	–	0.01 $5 \cdot V_{R3FBH}$	mV	(1) Maximum load: $dV/dT = 50\text{ V/ms}$ ; step on $V_{R2VS} = V_{R3VS}$ from $3.6\text{ V}$ to $4.4\text{ V}$ if $V_{R1FB} = V_{R1FB\_4V0}$ ; $100\text{ mA} \leq I_{bck\_core} \leq 7000\text{ mA}$ (2) Maximum load: $dV/dT = 50\text{ V/ms}$ ; step on $V_{R2VS} = V_{R3VS}$ from $4.95\text{ V}$ to $6.05\text{ V}$ if $V_{R1FB} = V_{R1FB\_5V5}$ ; $100\text{ mA} \leq I_{bck\_core} \leq 7000\text{ mA}$ <sup>1)</sup>	DS-1429
Internal pull-down resistor	$R_{R3FBH\_PD}$	2.5	–	8.5	$\Omega$	$V_{R3FBH} = 1\text{ V}$	DS-1532
BUCKCORE high side on-resistance (4V0)	$R_{DS(on)\_HS\_BUCKCORE\_4V0}$	–	67	118	$\text{m}\Omega$	$V_{R1FB} = V_{R1FB\_4V0}$ <sup>1)</sup>	DS-2053
BUCKCORE high side on-resistance (5V5)	$R_{DS(on)\_HS\_BUCKCORE\_5V5}$	–	58	101	$\text{m}\Omega$	$V_{R1FB} = V_{R1FB\_5V5}$	DS-2063
BUCKCORE low side on-resistance	$R_{DS(on)\_LS\_BUCKCORE}$	–	33	63	$\text{m}\Omega$	–	DS-2146

**(table continues...)**

**5 Power supply function**

**Table 9 (continued) Electrical characteristics BUCK CORE**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Switching output slew rate	$SR_{\text{bck\_core\_5V5}}$	4.2	–	6.3	V/ns	$V_{R2VS} = V_{R3VS} = 5.5\text{ V}$ $SR_{\text{bck\_core\_5V5}} = 0.8 * V_{R2VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90%. DCDC_FREQ_SYNC.BUCKCORE_DRIVER_CONFIG = 00 <sub>b</sub> 1)	DS-2094
Switching output slew rate	$SR_{\text{bck\_core\_5V5}}$	2.8		5.9	V/ns	$V_{R2VS} = V_{R3VS} = 5.5\text{ V}$ $SR_{\text{bck\_core\_5V5}} = 0.8 * V_{R2VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90%. DCDC_FREQ_SYNC.BUCKCORE_DRIVER_CONFIG = 01 <sub>b</sub> 1)	DS-2099
Switching output slew rate	$SR_{\text{bck\_core\_5V5}}$	1.1	–	3.6	V/ns	$V_{R2VS} = V_{R3VS} = 5.5\text{ V}$ $SR_{\text{bck\_core\_5V5}} = 0.8 * V_{R2VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90%. DCDC_FREQ_SYNC.BUCKCORE_DRIVER_CONFIG = 10 <sub>b</sub> 1)	DS-2098
Switching output slew rate	$SR_{\text{bck\_core\_4V}}$	2.8	–	4.9	V/ns	$V_{R2VS} = V_{R3VS} = 4\text{ V}$ $SR_{\text{bck\_core\_4V}} = 0.8 * V_{R2VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKCORE_DRIVER_CONFIG = 00 <sub>b</sub> 1)	DS-2097

(table continues...)

**5 Power supply function**

**Table 9 (continued) Electrical characteristics BUCK CORE**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

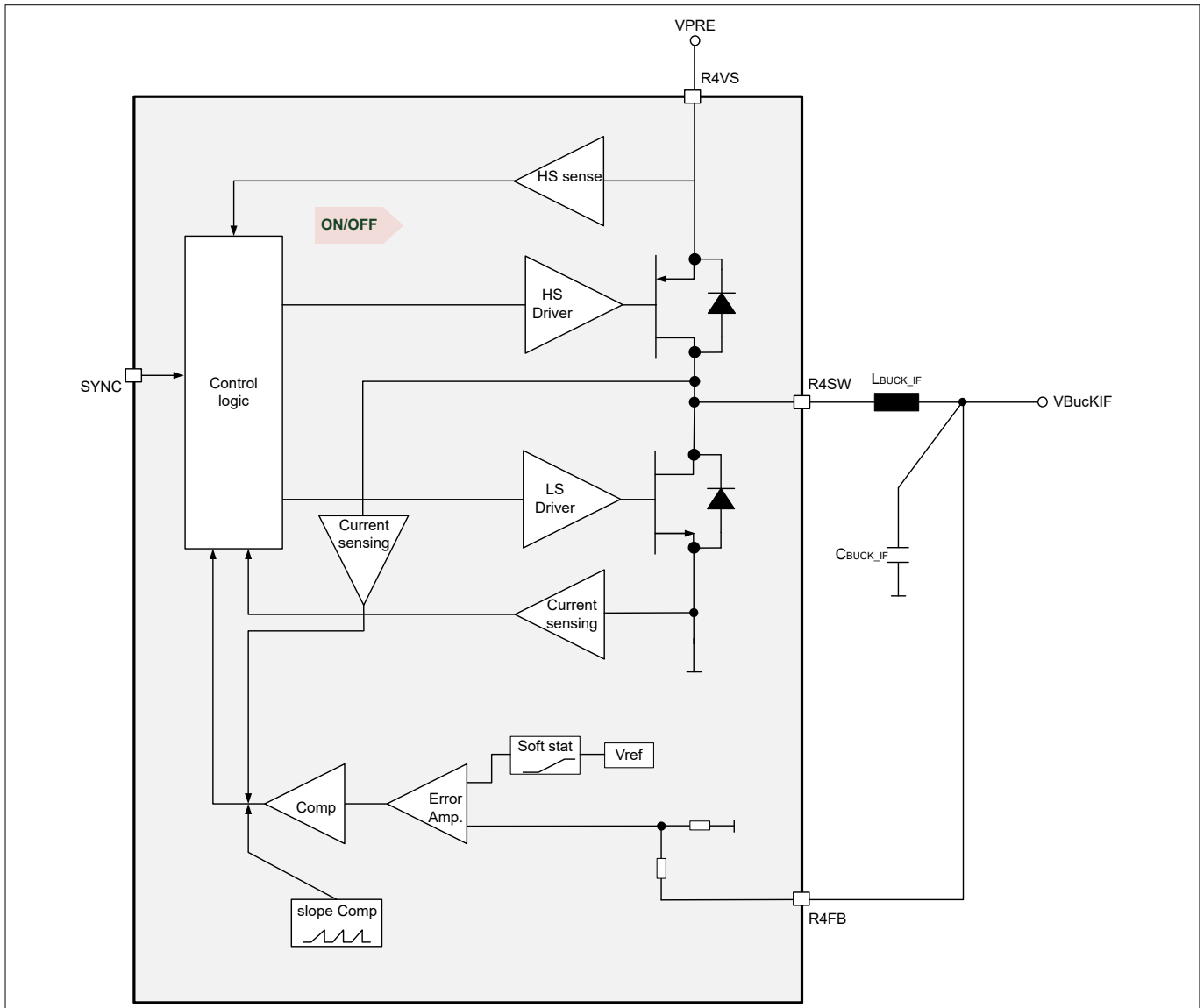
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Switching output slew rate	$SR_{\text{bck\_core\_4V}}$	1		4.4	V/ns	$V_{R2VS} = V_{R3VS} = 4\text{ V}$ $SR_{\text{bck\_core\_4V}} = 0.8 * V_{R2VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKCORE_DRIVER_CONFIG = 01 <sub>b</sub> 1)	DS-2096
Switching output slew rate	$SR_{\text{bck\_core\_4V}}$	0.38	–	1.3	V/ns	$V_{R2VS} = V_{R3VS} = 4\text{ V}$ $SR_{\text{bck\_core\_4V}} = 0.8 * V_{R2VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKCORE_DRIVER_CONFIG = 10 <sub>b</sub> 1)	DS-2095

1) Not subject to production test, specified by design

**5.3 BUCK IF (interface regulator)**

**5 Power supply function**

**5.3.1 Functional description BUCK IF**



**Figure 6 Block diagram BUCKIF**

The device provides buck interface regulator which steps down the PREREG output voltage VPRES to an output voltage VBuckIF with  $I_{bck\_if}$  output current at pin R4FB.

**Note:** This voltage can be used to supply the high speed interfaces.

The BUCK IF regulator is implemented with an overcurrent protection of maximum  $I_{OC\_bck\_if}$  in cycle-by-cycle limitation mode.

The BUCK IF regulator is implemented with an overload protection in the low-side MOSFET with  $I_{OL\_bck\_if}$  limit in source-drain direction.

The device provides an auto detection during start-up if the BUCK IF regulator is used within the application. If not used the pins of BUCKIF must be connected according to the following configuration:

- R4VS: connect to GND
- R4FB: leave open
- R4SW: leave open

**5 Power supply function**

**Note:** BUCK IF is excluded from the power sequencing if not used.

The BUCK IF regulator operates with internal compensation for external component-references according to the table given below:

**Table 10 External filter component (BOM) BUCK IF**

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
External inductor	$L_{BUCK\_IF}$	-20 %	2.2	20%	μH	–	DS-1910
External inductor series resistance	$D_{CRL\_BUCK\_IF}$		20	80	mΩ	Max value to guarantee the efficiency	DS-1911
External capacitor	$C_{BUCK\_IF}$	25	47	(+20 %)	μF	–	DS-1912
External capacitor series resistance	$ESR_{C\_BUCK\_IF}$		8	15	mΩ	Max value to guarantee the efficiency	DS-1913

1) Not subject to production test

**5.3.2 Electrical characteristics BUCK IF**

**Table 11 Electrical characteristics BUCK IF**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Input voltage	$V_{R4VS}$	$V_{R1FB\_4V0}$	–	$V_{R1FB\_5V5}$	V	–	DS-1431
Output voltage excluding ripple	$V_{R4FB}$	3.23 4	3.3	3.36 6	V	Static output voltage excluding ripple minimum load: $I_{bck\_if} \geq 20\text{mA}$ 1)	DS-1432
Maximum output current	$I_{bck\_if}$	–	–	1.2	A	1)	DS-1434
Minimum output current	$I_{buck\_if\_min}$	200	–	–	μA	1)	DS-2042
Overcurrent limitation	$I_{OC\_bck\_if}$	1.5	–	2.6	A	–	DS-1435
Peak efficiency	$P_{eff\_bck\_if}$	80	88	–	%	$I_{buck\_if}$ from 0.2 A up to 1 A, including typical external components at RT 1)	DS-1436

(table continues...)

**5 Power supply function**

**Table 11 (continued) Electrical characteristics BUCK IF**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Switching frequency	$f_{sw\_bck\_IF}$	$f_{DCDC}$ [MIN ]	$f_{DCDC}$	$f_{DCDC}$ [MAX ]	MHz	-	DS-1523
Switching frequency 2	$f_{sw\_bck\_IF\_2}$	0.9 * $f_{sw\_bck\_IF\_2}$ [typ ]	2	1.1 * $f_{sw\_bck\_IF\_2}$ [typ ]	MHz	Only applicable if: FREQ_SPREAD.FRE_SP_EN = 1 AND FREQ_SPREAD.FRE_SP_BUCKIF_EN = 0	DS-2050
Soft-start time	$t_{ss\_bck\_if}$	-	430	800	$\mu\text{s}$	Voltage at pin $V_{R4FB}$ ramps up from 10% to 90% of $V_{R4FB}$ $5\text{ mA} < I_{R4FB} < 500\text{ mA}$	DS-2167
Load step response	$\Delta V_{R4FB\_load}$	-82	-	82	mV	$\Delta I_{bck\_if} < 500\text{ mA}$ ; $20\text{ mA} \leq I_{bck\_if} \leq 500\text{ mA}$ ; load step rise/fall time = 100 ns; $\Delta I_{bck\_if} > -500\text{ mA}$ ; $520\text{ mA} \leq I_{bck\_if} \leq 1000\text{ mA}$ ; load step rise/fall time = 100 ns 1)	DS-1438
Load step response max dynamic range	$\Delta V_{R4FB\_mdr\_load}$	-116	-	116	mV	$\Delta I_{bck\_if} > -700\text{ mA}$ ; $I_{bck\_if} = 1000\text{ mA}$ ; load step rise/fall time = 100 ns; $t_{settling} = 10\ \mu\text{s}$ 1)	DS-1440
Line step response	$\Delta V_{R4FB\_line}$	-116	-	116	mV	Step on $V_{R4VS}$ from 3.88 V to 3.66 V in 10 $\mu\text{s}$ and from 3.66 V to 3.88 V in 10 $\mu\text{s}$ if $V_{R1FB} = V_{R1FB\_4V0}$ ; Step on $V_{R4VS}$ from 5.61 V to 5.97 V in 10 $\mu\text{s}$ and from 5.97 V to 5.61 V in 10 $\mu\text{s}$ if $V_{R1FB} = V_{R1FB\_5V5}$ ; $20\text{ mA} \leq I_{bck\_if} \leq 1000\text{ mA}$	DS-1442
Overload limitation	$I_{OL\ bck\ if}$	1.5	-	2.1	A	-	DS-1522
Internal pull-down resistor	$R_{R4FB\_PD}$	3.2	-	21	$\Omega$	-	DS-1524
BUCKIF high side on-resistance (4V0)	$R_{DS(on)\_HS\_BUCKIF\_4V0}$	-	214	372	m $\Omega$	$V_{R1FB} = V_{R1FB\_4V0}$ 1)	DS-2055

**(table continues...)**

**5 Power supply function**

**Table 11 (continued) Electrical characteristics BUCK IF**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
BUCKIF high side on-resistance (5V5)	$R_{DS(on)_{HS\_BUCKIF\_5V5}}$	–	181	309	mΩ	$V_{R1FB} = V_{R1FB\_5V5}$	DS-2065
BUCKIF low side on-resistance (4V0)	$R_{DS(on)_{LS\_BUCKIF\_4V0}}$	–	92	158	mΩ	$V_{R1FB} = V_{R1FB\_4V0}$ <sup>1)</sup>	DS-2056
BUCKIF low side on-resistance (5V5)	$R_{DS(on)_{LS\_BUCKIF\_5V5}}$	–	82	139	mΩ	$R_{DS(on)_{HS\_BUCKIF\_5V5}}$	DS-2066
Switching output slew rate	$SR_{bck\_if\_5V5}$	1.8	–	3.5	V/ns	$V_{R4VS} = 5.5\text{ V}$ $SR_{bck\_if\_5V5} = 0.8 * V_{R4VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKIF_D RIVER_CONFIG = 00 <sub>b</sub> <sup>1)</sup>	DS-2100
Switching output slew rate	$SR_{bck\_if\_5V5}$	1.8	–	3.5	V/ns	$V_{R4VS} = 5.5\text{ V}$ $SR_{bck\_if\_5V5} = 0.8 * V_{R4VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKIF_D RIVER_CONFIG = 01 <sub>b</sub> <sup>1)</sup>	DS-2101
Switching output slew rate	$SR_{bck\_if\_5V5}$	1.8	–	3.5	V/ns	$V_{R4VS} = 5.5\text{ V}$ $SR_{bck\_if\_5V5} = 0.8 * V_{R4VS} / \text{trise}$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKIF_D RIVER_CONFIG = 10 <sub>b</sub> <sup>1)</sup>	DS-2102

**(table continues...)**

**5 Power supply function**

**Table 11 (continued) Electrical characteristics BUCK IF**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

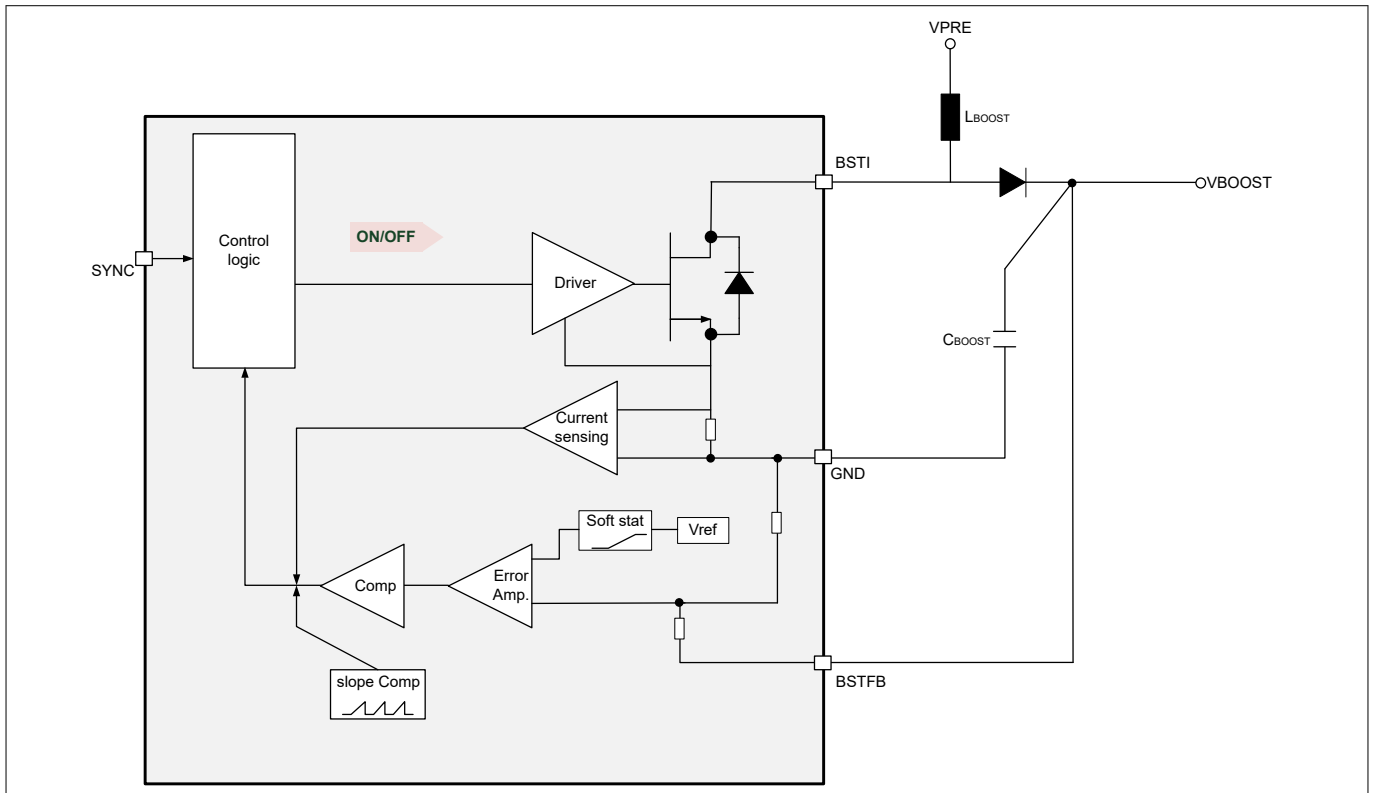
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Switching output slew rate	$SR_{bck\_if\_4V}$	1.3	–	2.6	V/ns	$V_{R4VS} = 4V$ $SR_{bck\_if\_4V} = 0.8 * V_{R4VS} / trise$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKIF_D RIVER_CONFIG = 00 <sub>b</sub> 1)	DS-2103
Switching output slew rate	$SR_{bck\_if\_4V}$	1.3	–	2.6	V/ns	$V_{R4VS} = 4V$ $SR_{bck\_if\_4V} = 0.8 * V_{R4VS} / trise$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKIF_D RIVER_CONFIG = 01 <sub>b</sub> 1)	DS-2104
Switching output slew rate	$SR_{bck\_if\_4V}$	1.1	–	2.1	V/ns	$V_{R4VS} = 4V$ $SR_{bck\_if\_4V} = 0.8 * V_{R4VS} / trise$ , where trise is the rise time measured between 10% and 90% DCDC_FREQ_SYNC.BUCKIF_D RIVER_CONFIG = 10 <sub>b</sub> 1)	DS-2105

1) Not subject to production test, specified by design

**5.4 BOOST (boost regulator)**

**5 Power supply function**

**5.4.1 Functional description BOOST**



**Figure 7 Block diagram BOOST**

The device provides a boost regulator which steps up the PREREG output voltage VPRE to an output voltage VBOOST with an external diode to ensure post power blocks.

The device provides an auto detection during start-up if the boost regulator is used within the application. If the BOOST is not used in the application make sure that the following connections of pins BSTI and BSTFB are made:

- BSTI: connect to GND
- BSTFB: connect to R1FB

The boost regulator operates with internal compensation for external component-references according to the table given below:

**Table 12 External filter component BOOST**

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
External inductor	$L_{bst}$	-20 %	3.3	20%	$\mu\text{H}$	-	DS-1914
External inductor series resistance	$DCR_{L_{bst}}$	-	20	50	$\text{m}\Omega$	-	DS-1915
External capacitor	$C_{bst}$	-20 %	10	20%	$\mu\text{F}$	-	DS-1916

**(table continues...)**

**5 Power supply function**

**Table 12 (continued) External filter component BOOST**

1)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
External capacitor series resistance	$ESR_{C\_bst}$	-	10	20	mΩ	-	DS-1917
External Schottky diode forward voltage	$V_{Dbst}$	-	0.4	0.52	V	@ $I_{D\_boost} = 1$ A	DS-1951

1) Not subject to production test

**5.4.2 Electrical characteristics BOOST**

**Table 13 Electrical characteristics BOOST**

$V_{VS} = 6.0$  V to 36 V,  $T_j = -40^\circ\text{C}$  to  $+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Input voltage	$V_{in\_boost}$	2.7	-	5.61	V	1)	DS-2150
Output voltage	$V_{BSTFB}$	5.63	5.8	5.97	V	$I_{LOAD\_BOOST} < 1$ A: $3.9$ V $\leq$ $V_{R1FB\_4V0} \leq 4.1$ V, $5.33$ V $\leq$ $V_{R1FB\_5V5} \leq 5.61$ V; $I_{LOAD\_BOOST} < 0.650$ A; $2.59$ V $\leq$ $V_{R1FB} \leq 2.71$ V	DS-1447
Load current	$I_{LOAD\_BOOST}$	-	-	1	A	Total load (internal and external load)	DS-1509
Switching frequency	$f_{sw\_bst}$	$f_{DCDC}$ [MIN]	$f_{DCDC}$	$f_{DCDC}$ [MAX]	MHZ	-	DS-1526
Overcurrent limitation	$I_{OC\_BSTI}$	3.5	4	4.5	A	-	DS-1448
Efficiency	$P_{eff\_bst}$	81	85	-	%	Including typical BOM; @27°C; $150$ mA $\leq I_{LOAD\_BOOST} \leq 950$ mA 1)	DS-1449
Soft-start time	$t_{ss\_boost}$	-	650	1000	μs	Voltage at pin $V_{BSTFB}$ ramps up from 10% to 90% of $V_{BSTFB}$	DS-1450
Pull-down resistor	$R_{BSTFB\_PD}$	12	-	76	Ω	-	DS-1527
BOOST low side on-resistance	$R_{DS(on)\_LS\_BOOST}$	-	114	221	mΩ	-	DS-2057

(table continues...)

**5 Power supply function**

**Table 13 (continued) Electrical characteristics BOOST**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

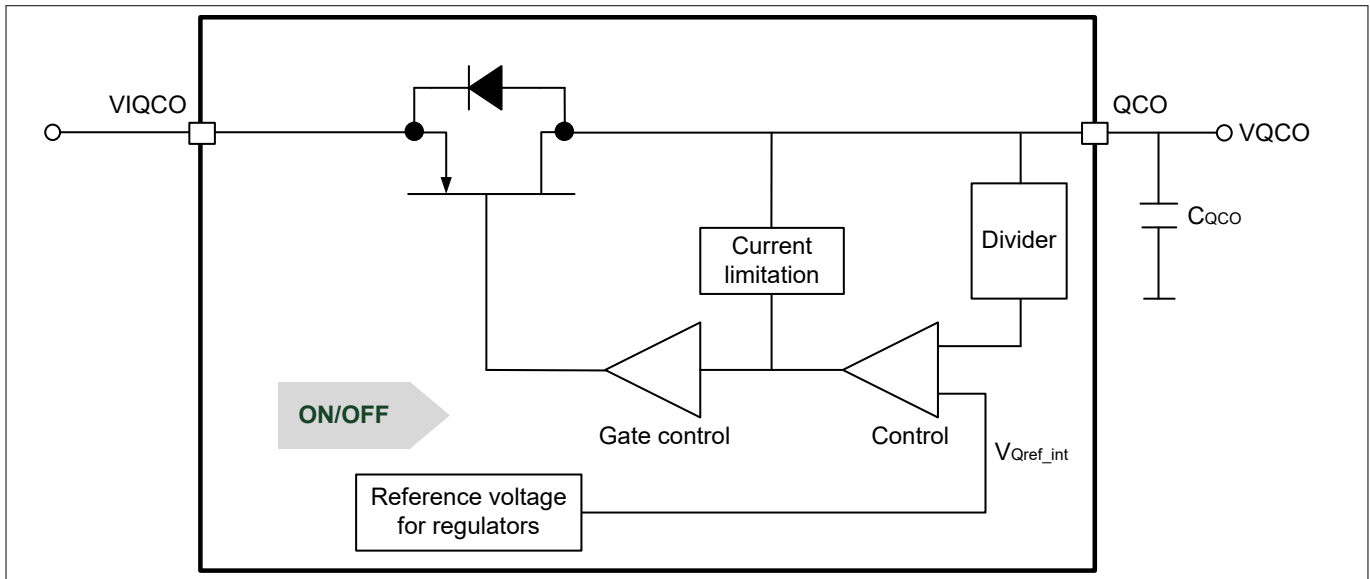
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Switching output slew rate	$SR_{bst}$	0.50		2.2	V/ns	$SR_{bst} = 0.8 * V_{BSTI} / t_{fall}$ , where $t_{fall}$ is the fall time measured between 10% and 90%. $100\text{mA} < I_{bst} < 1\text{A}$ DCDC_FREQ_SYNC.BOOST_D RIVER_CONFIG = 00 <sub>b</sub> 1)	DS-2091
Switching output slew rate	$SR_{bst}$	0.4		1.5	V/ns	$S_{R\_bst} = 0.8 * V_{BSTI} / t_{fall}$ , where $t_{fall}$ is the fall time measured between 10% and 90%. $100\text{mA} < I_{bst} < 1\text{A}$ DCDC_FREQ_SYNC.BOOST_D RIVER_CONFIG = 01 <sub>b</sub> 1)	DS-2092
Switching output slew rate	$SR_{bst}$	0.15		0.8	V/ns	$S_{R\_bst} = 0.8 * V_{BSTI} / t_{fall}$ , where $t_{fall}$ is the fall time measured between 10% and 90%. $100\text{mA} < I_{bst} < 1\text{A}$ DCDC_FREQ_SYNC.BOOST_D RIVER_CONFIG = 10 <sub>b</sub> 1)	DS-2093

1) Not subject to production test, specified by design

**5.5 Communication LDO (QCO)**

**5 Power supply function**

**5.5.1 Functional description communication LDO (QCO)**



**Figure 8 Block diagram LDO-QCO**

The device provides a low-dropout-regulator LDO-QCO which generates a regulated output voltage  $V_{QCO}$  with  $I_{QCO}$  output current to supply the microcontroller. The regulator is supplied from the boost regulator output. As a configuration option, the regulator can also be supplied directly from the pre-regulator output.

The stability of the control loop depends on the load current, the characteristics of the output capacitor and the chip junction temperature. A stable operation is ensured by the output capacitance chosen according to the specified electrical characteristics table below (capacitance value  $C_{QCO}$  and equivalent series resistance  $ESR_{C_{QCO}}$ ). The output capacitance is either one capacitor or a set of capacitors following the capacitance range as a whole.

**Note:** This voltage can be used to supply the communication device, e.g. CAN transceiver.

To protect the communication supply from overstress the current limitation limits the output current  $I_{QCO}$  to the specified limit  $I_{QCO\_max}$ .

**5.5.2 Electrical characteristics communication LDO (QCO)**

**Table 14 Electrical characteristics communication LDO (QCO)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output voltage	$V_{QCO}$	4.9	5	5.1	V	$0\text{ mA} < I_{QCO} < 600\text{ mA}$	DS-1453
Output current	$I_{QCO}$	0	-	600	mA	-	DS-1454
Output current limitation	$I_{QCO\_max}$	650	-	1100	mA	-	DS-1455

**(table continues...)**

**5 Power supply function**

**Table 14 (continued) Electrical characteristics communication LDO (QCO)**

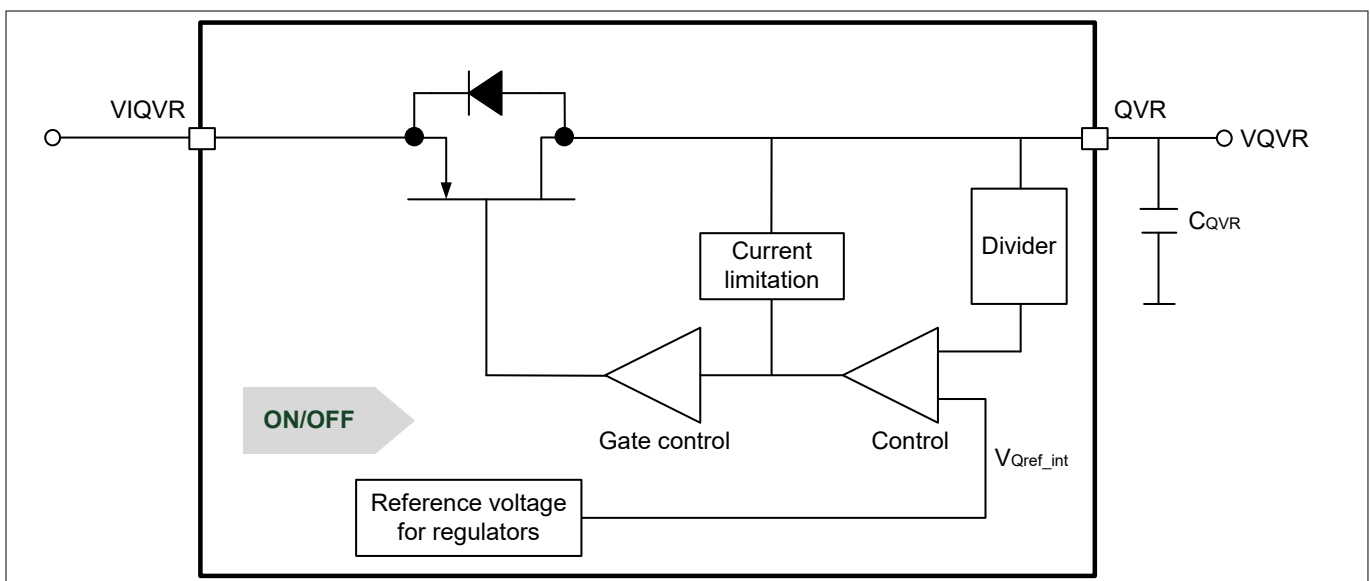
$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Drop voltage	$V_{dr\_QCO}$	-	-	500	mV	$I_{QCO} < 600\text{ mA}$	DS-1456
Power supply ripple rejection	$PSRR_{QCO}$	26	-	-	dB	$V_{VIQVR\_VIQCO} = 5.8\text{V}$ with $100\text{mVpp}$ at $2.2\text{ MHz}$ and $I_{load} \leq I_{QCO}$ $ESR_{C\_QCO} \leq 50\text{m}\Omega$ <sup>1)</sup>	DS-1457
Load regulation	$\Delta V_{QCO}$	-	40	70	mV	$100\ \mu\text{A} < I_{QCO} < 600\text{ mA}$	DS-1458
Output capacitor	$C_{QCO}$	1	-	47	$\mu\text{F}$	<sup>1)</sup>	DS-1459
Output capacitor equivalent series resistance	$ESR_{C\_QCO}$	-	-	100	$\text{m}\Omega$	<sup>1)</sup>	DS-1460
Soft-start time	$t_{ss\_QCO}$	-	290	500	$\mu\text{s}$	Voltage at pin QCO ramps up from 10% to 90% of $V_{QCO}$ ; $-60\text{ mA} < I_{QCO} < -5\text{ mA}$ ; $C_{QCO} = 4.7\ \mu\text{F}$	DS-2046

1) Not subject to production test, specified by design

**5.6 Reference LDO (QVR)**

**5.6.1 Functional description reference LDO (QVR)**



**Figure 9 Block diagram LDO-QVR**

## 5 Power supply function

The device provides a low dropout regulator LDO-VREF which generates a regulated output voltage  $V_{QVR}$  with  $I_{QVR}$  output current to supply the microcontroller. The regulator is supplied from the boost regulator output. As a configuration option, the regulator can also be supplied directly from the pre-regulator output.

The stability of the control loop depends on the load current, the characteristics of the output capacitor and the chip junction temperature. A stable operation is ensured by the output capacitance chosen according to the specified electrical characteristics table below (capacitance value  $C_{VREF}$  and equivalent series resistance  $ESR_{C\_QVR}$ ). The output capacitance is either one capacitor or a set of capacitors following as a whole the capacitance range.

**Note:** This voltage can be used as reference voltage for the ADC in the microcontroller.

To protect the communication supply from overstress the current limitation limits the output current  $I_{QVR}$  to the specified limit  $I_{QVR\_max}$ .

The status of OC fault can be read via register and can be cleared on write command via SPI once the OC fault is expired.

### 5.6.2 Electrical characteristics reference LDO (QVR)

**Table 15** Electrical characteristics reference LDO (QVR)

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

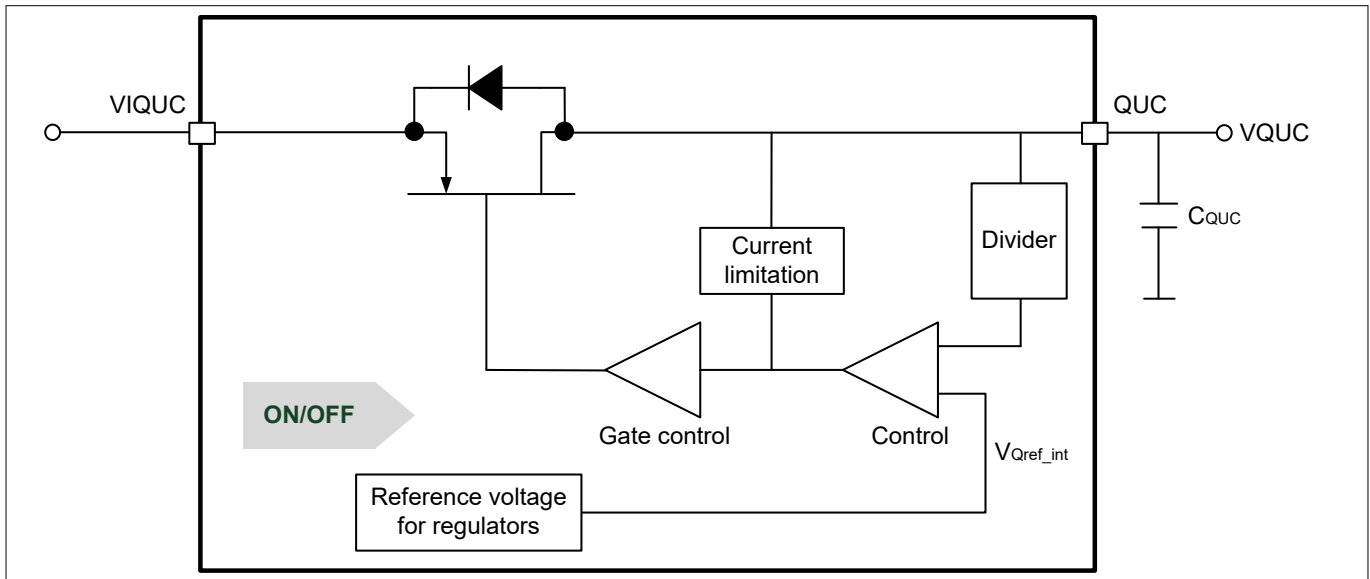
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output voltage	$V_{QVR}$	4.95	5	5.05	V	$0\text{ mA} < I_{QVR} < 150\text{ mA}$	DS-1462
Output current	$I_{QVR}$	0	-	150	mA	-	DS-1463
Output current limitation	$I_{QVR\_max}$	170	-	345	mA	-	DS-1464
Drop voltage	$V_{dr\_QVR}$	-	-	400	mV	$I_{QVR} < 150\text{ mA}$	DS-1465
Load regulation	$\Delta V_{QVR}$	-	4.5	9	mV	$100\ \mu\text{A} < I_{QVR} < 150\text{ mA}$	DS-1466
Power supply ripple rejection	$PSRR_{QVR}$	26	-	-	dB	$V_{I_{QVR\_VIQCO}} = 5.8\text{V}$ with 100mVpp at 2.2 MHz and $I_{load} \leq I_{QVR}$ $ESR_{C\_QVR} \leq 50\text{m}\Omega$ 1)	DS-1467
Output capacitor	$C_{QVR}$	1	-	10	$\mu\text{F}$	1)	DS-1468
Output capacitor equivalent series resistance	$ESR_{C\_QVR}$	-	-	100	$\text{m}\Omega$	1)	DS-1469
Soft-start time	$t_{ss\_QVR}$	-	280	520	$\mu\text{s}$	Voltage at pin QVR ramps up from 10% to 90% of $V_{QVR}$ ; $-15\text{ mA} < I_{QVR} < -5\text{ mA}$ ; $C_{QVR} = 4.7\ \mu\text{F}$	DS-2048

1) Not subject to production test, specified by design

## 5.7 MCU-LDO (QUC)

**5 Power supply function**

**5.7.1 Functional description MCU-LDO (QUC)**



**Figure 10 Block diagram LDO-QUC**

The device provides a low drop out regulator LDO-QUC which generates a regulated output voltage  $V_{QUC}$  with  $I_{QUC}$  output current to supply the microcontroller. The regulator is supplied from the boost regulator output. As a configuration option, the regulator can also be supplied directly from the pre-regulator output.

The stability of the control loop depends on the load current, the characteristics of the output capacitor and the chip junction temperature. A stable operation is ensured by the output capacitance chosen according to the specified electrical characteristics table below (capacitance value  $C_{QUC}$  and equivalent series resistance  $ESR_{C_{QUC}}$ ). The output capacitance is either one capacitor or a set of capacitors following the capacitance range as a whole.

To protect the QUC supply from overstress the current limitation limits the output current  $I_{QUC}$  to the specified limit  $I_{QUC\_max}$ .

**Note:** When the current, sunk from the output pin QUC, is limited, the output voltage  $V_{QUC}$  will decrease.

**5.7.2 Electrical characteristics MCU-LDO (QUC)**

**Table 16 Electrical characteristics MCU-LDO (QUC)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output voltage	$V_{QUC}$	4.9	5	5.1	V	$0\text{ mA} < I_{QUC} < 600\text{ mA}$	DS-1471
Output current	$I_{QUC}$	0	-	600	mA	-	DS-1473
Output current limitation	$I_{QUC\_max}$	650	-	1100	mA	-	DS-1474
Drop voltage	$\Delta V_{QUC}$	-	-	450	mV	$I_{QUC} < 600\text{ mA}$	DS-1475
Load regulation	$\Delta V_{QUC\_load}$	-	45	81	mV	$100\ \mu\text{A} < I_{QUC} < 600\text{ mA}$	DS-1477

(table continues...)

**5 Power supply function**

**Table 16 (continued) Electrical characteristics MCU-LDO (QUC)**

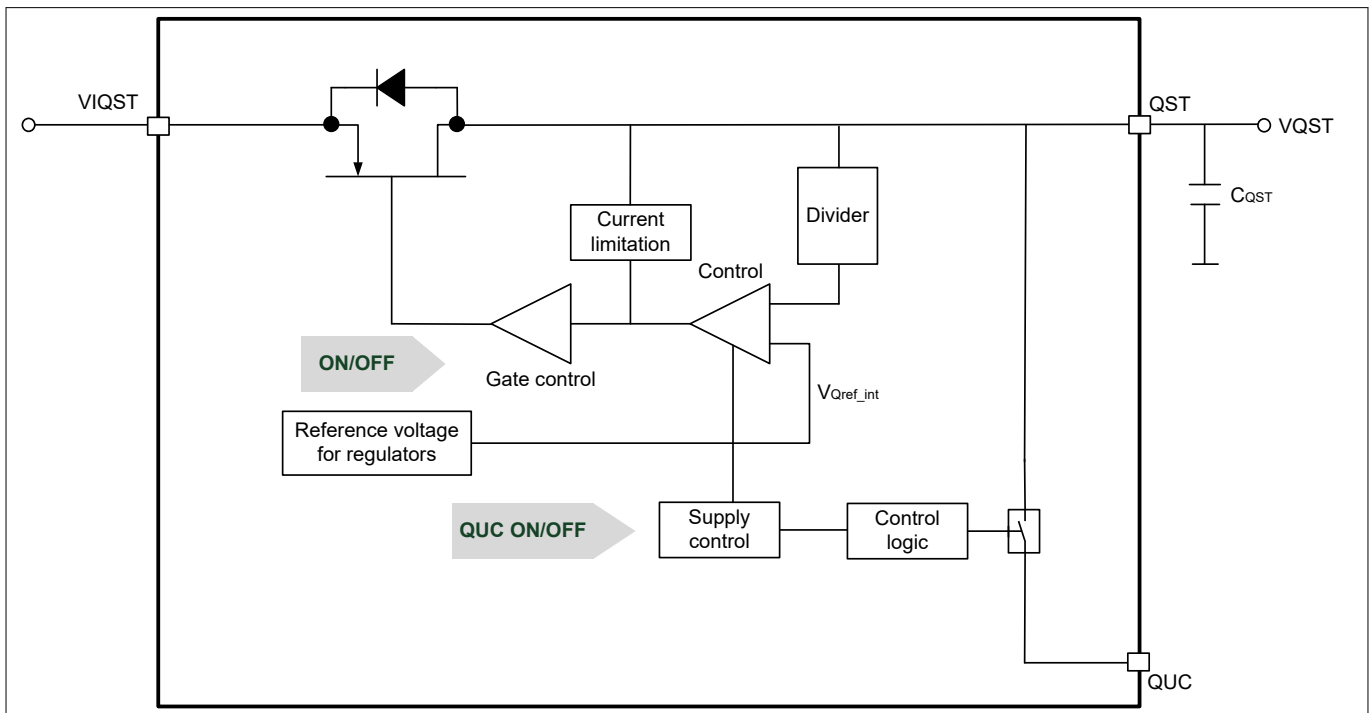
$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output capacitor	$C_{QUC}$	2.2	4.7	22	$\mu\text{F}$	1)	DS-1479
Output capacitor equivalent series resistance	$ESR_{C_{QUC}}$	-	-	100	$\text{m}\Omega$	1)	DS-1480
Power supply ripple rejection	$PSRR_{QUC}$	26	-	-	dB	$V_{IQUC} = 5.8\text{ V}$ with 100 mVpp at 2.2 MHz and $I_{load} \leq I_{QUC}$ $ESR_{C_{QUC}} \leq 50\text{ m}\Omega$ 1)	DS-1481
Soft-start time	$t_{ss\_QUC}$	-	290	500	$\mu\text{s}$	Voltage at pin QUC ramps up from 10% to 90% of $V_{QUC}$ ; $-60\text{ mA} < I_{QUC} < -5\text{ mA}$ ; $C_{QUC} = 4.7\text{ }\mu\text{F}$ 1)	DS-2047

1) Not subject to production test, specified by design

**5.8 Standby LDO (QST)**

**5.8.1 Functional descriptions standby LDO (QST)**



**Figure 11 Block diagram LDO QST**

**5 Power supply function**

The device provides a linear low dropout regulator LDO-QST witch generated a regulated output voltage  $V_{QST}$  with  $I_{QST}$  output current.

The output voltage  $V_{QST}$  at pin QST is generated from the input voltage  $V_{IQST}$  after starting up the device. In case LDO-QUC is enabled, the output voltage  $V_{QST}$  is supplied from the input voltage  $V_{QUC}$  at pin QUC to optimize the supply topology for higher efficiency.

The stability of the control loop depends on the load current, the characteristics of the output capacitor and the chip junction temperature. A stable operation is ensured by the output capacitance chosen according to the specified electrical characteristics table below (capacitance value  $C_{QST}$  and equivalent series resistance  $ESR_{C_{QST}}$ ). The output capacitance is either one capacitor or a set of capacitors following as a whole the capacitance range.

The QST regulator can be enabled or disabled by protected SPI communication.

To protect the standby supply from overstress the current limitation limits the output current  $I_{QST}$  to the specified limit  $I_{QST\_max}$ .

The status of OC fault can be read via register and can be cleared on write command via SPI once the OC fault is expired.

**Note:** When the current sunk from the output pin QST is limited, the output voltage  $V_{QST}$  will decrease.

**5.8.2 Electrical characteristics standby LDO (QST)**

**Table 17 Electrical characteristics standby LDO (QST)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output voltage	$V_{QST}$	4.8	5	5.2	V	$0\text{ mA} < I_{QST} < 30\text{ mA}$ static; $5.6\text{ V} < V_{VIQST} < 40\text{ V}$	DS-1486
Output current	$I_{QST}$	0	–	30	mA	QUC OFF	DS-1498
Output current limitation	$I_{QST\_max}$	40	60	90	mA	QUC OFF	DS-1488
Soft-start time	$t_{ss\_QST}$	–	255	–	$\mu\text{s}$	Voltage at pin QST ramps up from 10% to 90% of $V_{QST}$ ; $-5\text{ mA} < I_{QST} < -1\text{ mA}$ ; $C_{QUC} = 4.7\ \mu\text{F}$	DS-1497
Transient line regulation 1	$\Delta V_{QST\_tr\_line1}$	–	–	70	mV	$I_{QST} < 30\text{ mA}$ ; $V_{IQST}$ from 10 V to 14 V voltage step in $\Delta t = 30\ \mu\text{s}$ ; QUC OFF	DS-1490
Transient line regulation 2	$\Delta V_{QST\_tr\_line2}$	–	–	140	mV	$I_{QST} < 30\text{ mA}$ ; $V_{IQST}$ from 6 V to 14 V voltage step in $\Delta t = 500\ \mu\text{s}$ ; QUC OFF	DS-1491

**(table continues...)**

**5 Power supply function**

**Table 17 (continued) Electrical characteristics standby LDO (QST)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Load regulation	$\Delta V_{QST\_load}$	-	25	40	mV	$100\ \mu\text{A} < I_{QST} < 15\ \text{mA}$ ; QUC OFF	DS-1492
Power supply ripple rejection	$PSRR_{QST}$	30	-	-	dB	$V_{batt} = 13.5\ \text{V}$ , 100 mVpp, ESR $\leq 50\ \text{m}\Omega$ , $f = 100\ \text{Hz}$ and $f = 100\ \text{kHz}$ <sup>1)</sup>	DS-1496
Output capacitor	$C_{QST}$	0.47	-	10	$\mu\text{F}$	<sup>1)</sup>	DS-1494
Output capacitor equivalent series resistance	$ESR_{C\_QST}$	-	-	200	m $\Omega$	<sup>1)</sup>	DS-1495
Drop voltage RT	$\Delta V_{QST\_RT}$	-	-	380	mV	$I_{QST} < 30\ \text{mA}$ ; at $T_j = 27^\circ\text{C}$	DS-1721
Drop voltage HT	$\Delta V_{QST\_HT}$	-	-	600	mV	$I_{QST} < 30\ \text{mA}$ ; at $T_j = 155^\circ\text{C}$	DS-1489
Dropout voltage when QUC ON	$\Delta V_{QUC\_QST}$	-	-	300	mV	$I_{QST} = 30\ \text{mA}$	DS-2003

1) Not subject to production test, specified by design

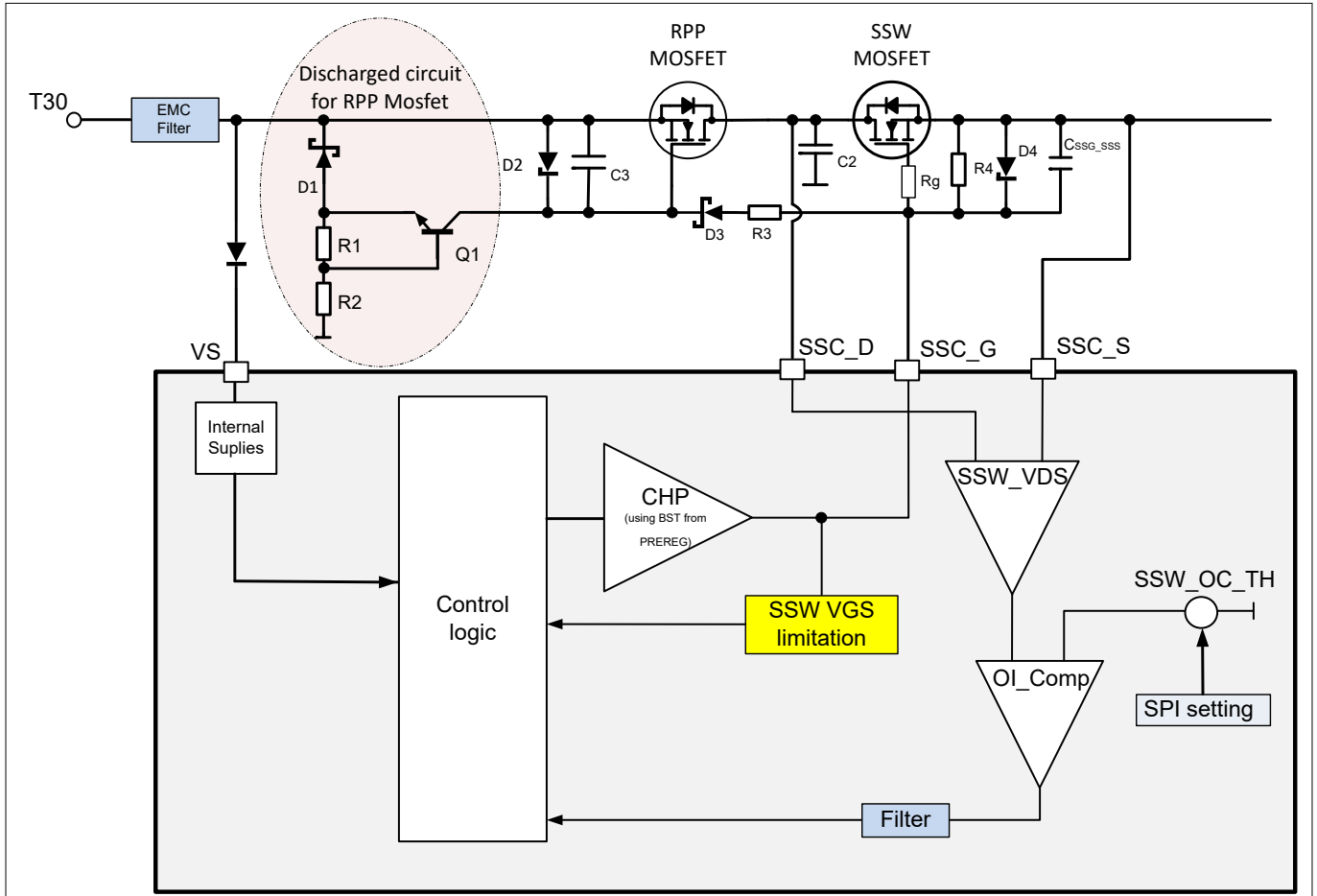
**5.9 Active discharge**

Each of the output rails generated by one of the device's regulators, incorporate an active discharge function. This discharge function consists of an internal pull-down resistor. Whenever a regulator is disabled via SPI or switched off due to reaction on detected faults (this also includes state transitions into FAILSAFE), the discharge path is activated and discharges the corresponding output rail. Except for Boost regulator, this discharge feature remains also active while being in SLEEP or STANDBY state if a regulator is not used during this time.

**6 Safety switch (SSW)**

**6 Safety switch (SSW)**

**6.1 Functional description safety switch (SSW)**



**Figure 12 Block diagram SSW & RPP**

The device provides a driver to control the external n-channel power MOSFETs (the reverse polarity protection (RPP) MOSFET and the safety switch (SSW) MOSFET).

The gate of both MOSFETs is connected to SSC\_G.

The activation of the external power MOSFET is driven according to the failure reaction table and the operation mode.

In case of reverse battery, the Gate of the RPP MOSFET is discharged through the external circuitry.

The source of the SSW MOSFET is connected to pin SSC\_S and the drain is connected to SSC\_D pin.

The driver circuit includes an over current detection on the SSW MOSFET (Sensing the voltage drop between source and drain).

The threshold for the over current detection is programmable via SPI register bitfield **DEV\_PW\_CFG2.SSW\_OC\_TH**.

The overcurrent is detected if the drain source voltage exceeds the detection threshold ( $SSW_{OC\_TH}$ ) for a time longer than the over current detection time ( $t_{fil\_OC}$ ).

The device autodetects at start-up the usage of the input side safety switch protection MOSFET and store the autodetection result into a status register. If the safety switch is not used the corresponding pins must be connected according to the following configuration:

- SSC\_D: connect to GND

**6 Safety switch (SSW)**

- SSC\_G: connect to input of PREREG
- SSC\_S: connect to input of PREREG

**6.2 Electrical characteristics safety switch (SSW)**

**Table 18 Electrical characteristics safety switch**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
High level gate output voltage vs. source	$\Delta V_{SSG\_SSS}$	4	4.5	-	V	$\Delta V_{SSG\_SSS} = V_{SSC\_G} - V_{SSC\_S}$ ; $C_{BTS} > 20 \times C_{SSG\_SSS}$ ; BUCK PREREG in CCM; $I_{bck\_prereg} \geq 1\text{ A}$ 1)	DS-1500
[SSW] High level Gate output voltage vs. Source (light load)	$\Delta V_{SSG\_SSS}$	3.4	4.5	-	V	$\Delta V_{SSG\_SSS} = V_{SSC\_G} - V_{SSC\_S}$ ; $C_{BTS} > 20 \times C_{SSG\_SSS}$ ; BUCK PREREG in CCM; $I_{bck\_prereg} < 1\text{ A}$ 1)	DS-2041
Gate rise time	$t_{SSC\_G\_r}$	-	-	320	$\mu\text{s}$	$\Delta V_{SSG\_SSS}$ from 0 V to 4 V $V_{VS} > V_{VS}[\text{MIN}]$ $C_{SSG\_SSS} = 3\text{ nF}$ From R1SW rising edge 1)	DS-1501
Gate fall time	$t_{SSC\_G\_f}$	-	-	3	$\mu\text{s}$	$\Delta V_{SSG\_SSS} = V_{SSC\_G} - V_{SSC\_S}$ ; $\Delta V_{SSG\_SSS}$ from 4.0V to 0.7V $C_{SSG\_SSS} = 1\text{ nF}$ $V_{VS} > V_{VS}[\text{MIN}]$ 1)	DS-2141
Over current detection threshold for SSW	$SSW_{OC\_TH}$	x * 0.63	x	x * 1.73	V	$SSW_{OC\_TH}$ is programmable by SPI; x: 0.755 V, 0.944 V, 1.04 V, 1.22 V; Default value: 0.755V; $V_{SSC\_D} \geq 5\text{V}$ , for x: 0.755V $V_{SSC\_D} \geq 6.5\text{V}$ , for x: 0.944V, 1.04V, 1.22V $V_{VS} > V_{VS}[\text{MIN}]$	DS-2136
Filter time for over current detection	$t_{fil\_OC}$	-	60	-	ns	$V_{VS} > V_{VS}[\text{MIN}]$ 1)	DS-1947

**(table continues...)**

**6 Safety switch (SSW)**

**Table 18 (continued) Electrical characteristics safety switch**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

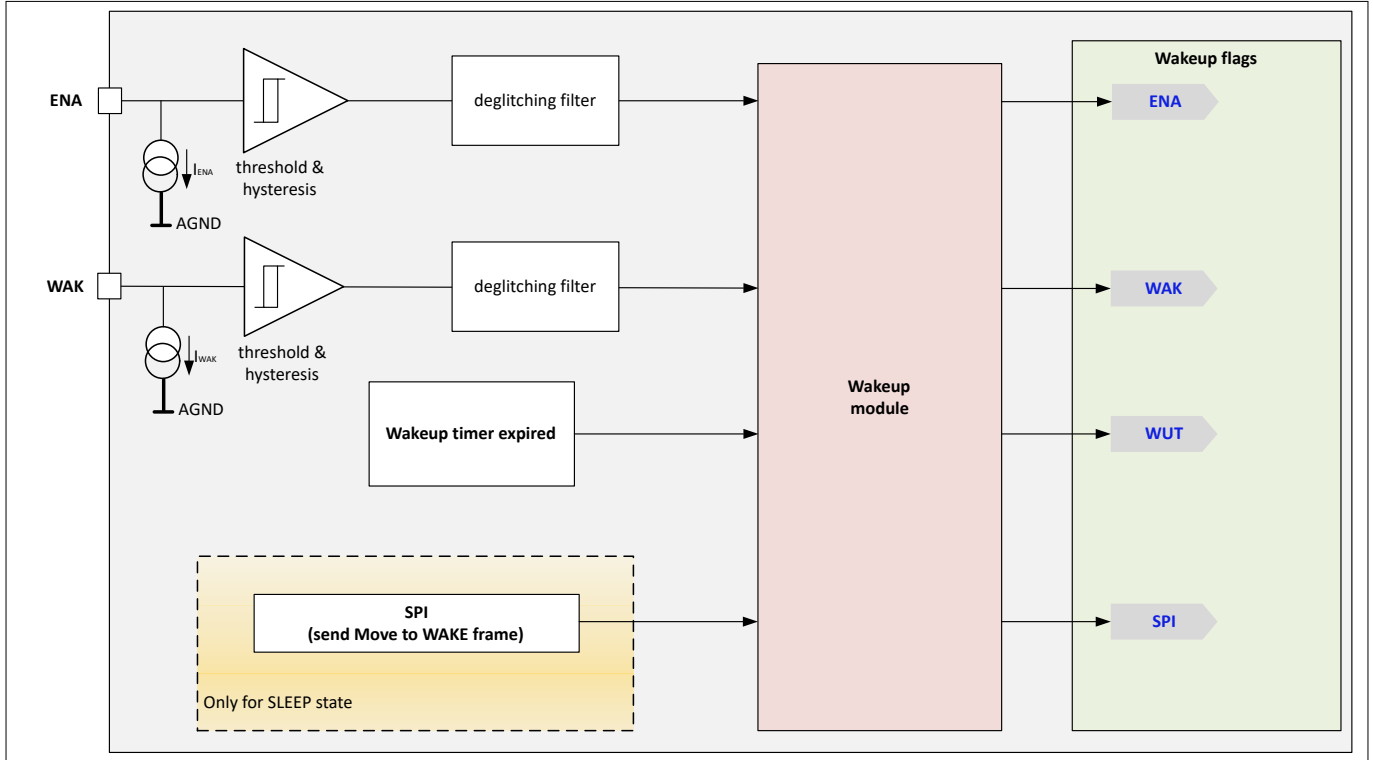
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SSW over current detection and reaction time	$t_{SSW\_OC\_SD}$	-	500	-	ns	$V_{SSG\_SSS}$ is off $V_{VS} > V_{VS}[MIN]$ <sup>1)</sup>	DS-1948

1) Not subject to production test, specified by design

**7 Wakeup functions**

**7 Wakeup functions**

**7.1 Introduction**



**Figure 13 Functional block diagram wakeup functions**

The module provides the following wakeup sources:

- ENA pin (edge sensitive input)
- WAK pin (level sensitive input)
- Internal wakeup timer (WUT)
- SPI

To determine which wake-up event caused the device to start-up, the registers **WAKE\_STAT\_APP1/2** store the following wakeup events:

- ENA
- WAK
- WUT
- SPI

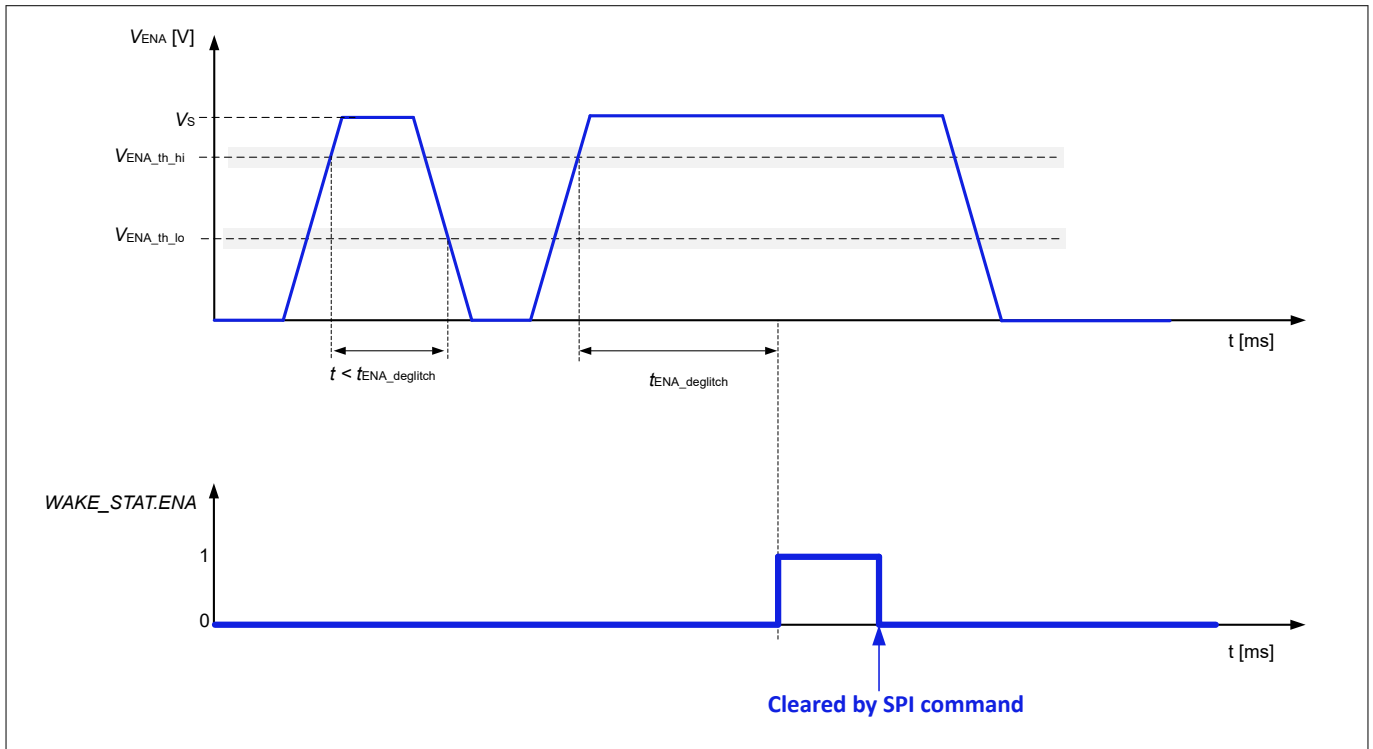
Any wakeup event may trigger a state transition and an interrupt event, see [Chapter 9](#) and [interrupt \[AutoNumbering\]](#).

The ENA wakeup signal is typically a signal from the vehicle ignition switch. The WAK wakeup signal is typically a signal from a transceiver.

**7.2 Enable (ENA)**

**7 Wakeup functions**

**7.2.1 Functional description enable (ENA)**



**Figure 14 Enable (ENA) signal diagram**

The ENA pin is edge sensitive.

**Rising edge detection**

If the voltage at the ENA pin exceeds the threshold  $V_{ENA\_th\_lo}$  and it also exceeds the threshold  $V_{ENA\_th\_hi}$  for longer than the deglitch filter time  $t_{ENA\_deglitch}$ , then the device detects a rising edge.

**ENA bit setting**

The device sets the **WAKE\_STAT\_APPx.ENA** bit if an FSM state transition is caused by a rising edge detection at the ENA pin.

The **WAKE\_STAT\_APPx.ENA** bit can be cleared via SPI, independently of the voltage level at the ENA pin.

**7.2.2 Electrical characteristics enable (ENA)**

**Table 19 Electrical characteristics enable (ENA)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
ENA threshold "high" voltage	$V_{ENA\_th\_hi}$	1.3	1.65	2.0	V	$V_{ENA}$ increasing; $V_S \geq 6\text{ V}$	DS-1971
ENA threshold "low" voltage	$V_{ENA\_th\_lo}$	1	1.2	1.4	V	$V_{ENA}$ decreasing; $V_S \geq 6\text{ V}$	DS-1972

(table continues...)

**7 Wakeup functions**

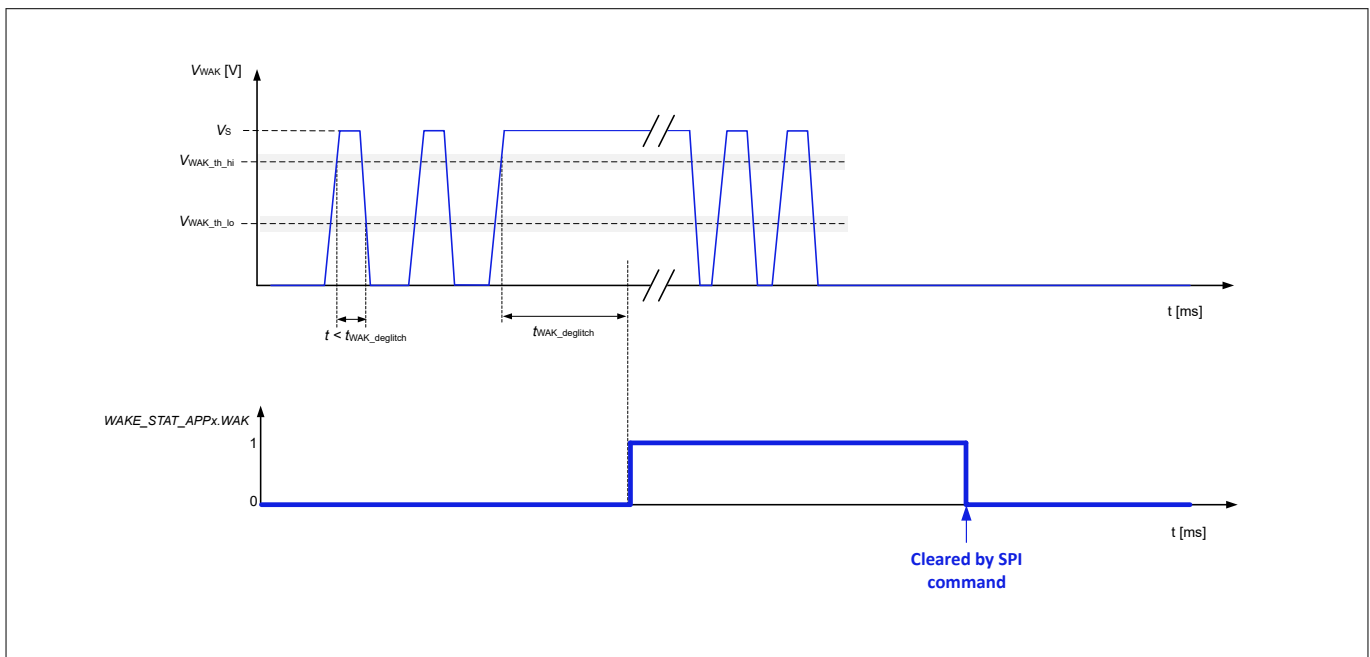
**Table 19 (continued) Electrical characteristics enable (ENA)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
ENA deglitch filter time	$t_{ENA\_deglitch}$	20	30	40	$\mu\text{s}$	$V_S \geq 6\text{ V}$	DS-1973
ENA pin "high" input current	$I_{ENA\_hi}$	-	-	5	$\mu\text{A}$	$V_{ENA} \geq 2\text{ V}$	DS-1974
ENA pin "low" input current	$I_{ENA\_lo}$	-	0.1	2	$\mu\text{A}$	$V_{ENA} \leq 1\text{ V}$	DS-1975
ENA threshold hysteresis	$V_{ENA\_HYST}$	200	400	550	mV	$V_S \geq 6\text{ V}$	DS-1976

**7.3 Wake (WAK)**

**7.3.1 Functional description wake (WAK)**



**Figure 15 Wake(WAK) signal diagram**

The WAK pin is level sensitive.

**Level definition**

If the voltage level at the WAK pin is below the threshold  $V_{WAK\_th\_lo}$  for longer than the deglitch filter time  $t_{WAK\_deglitch}$ , then it detects a valid "low" signal.

If the voltage level at the WAK pin is above the threshold  $V_{WAK\_th\_hi}$  for longer than the deglitch filter time  $t_{WAK\_deglitch}$ , then it detects a valid "high" signal.

**WAK bit setting**

The device sets an **WAKE\_STAT\_APPx.WAK** bit if a wake-up is caused by a valid "high" level detection at the WAK pin

The **WAKE\_STAT\_APPx.WAK** bit can be cleared via SPI.

**7 Wakeup functions**

**7.3.2 Electrical characteristics wake (WAK)**

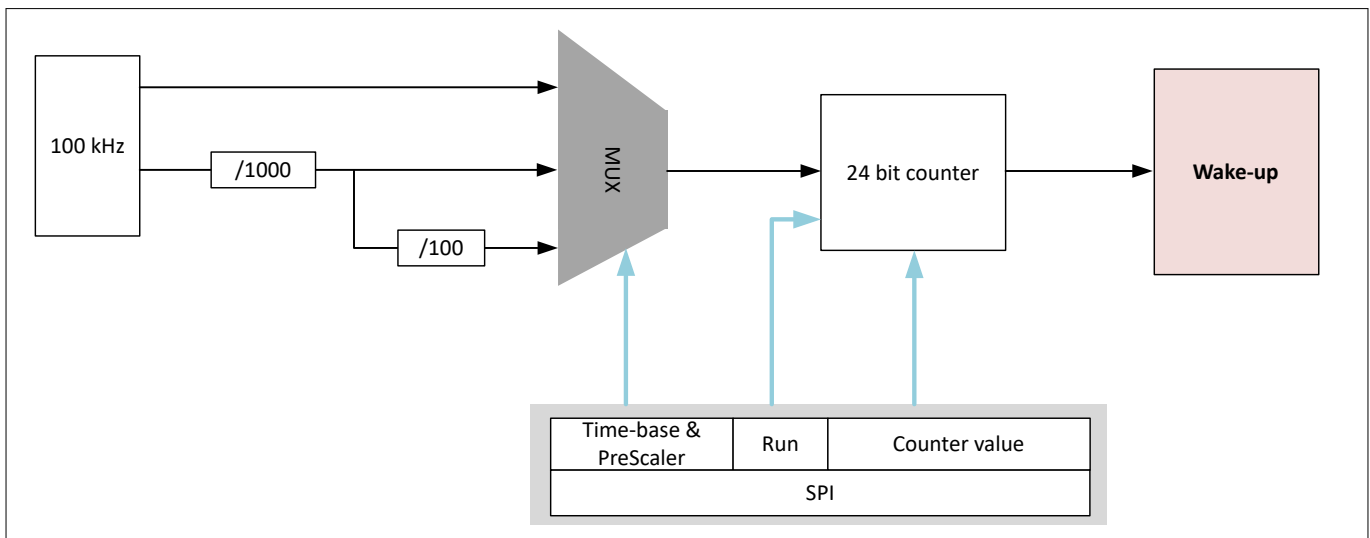
**Table 20 Electrical characteristics wake (WAK)**

$V_{S} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^{\circ}\text{C to }+175^{\circ}\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
WAK threshold "high" voltage	$V_{WAK\_th\_hi}$	1.3	1.65	2.0	V	$V_{WAK}$ increasing; $V_S \geq 6\text{ V}$	DS-1977
WAK threshold "low" voltage	$V_{WAK\_th\_lo}$	1.0	1.2	1.4	V	$V_{WAK}$ decreasing; $V_S \geq 6\text{ V}$	DS-1978
WAK deglitch filter time	$t_{WAK\_deglit\ ch}$	20	30	40	$\mu\text{s}$	$V_S \geq 6\text{ V}$	DS-1979
WAK pin "high" input current	$I_{WAK\_hi}$	-	-	5	$\mu\text{A}$	$V_{WAK} \geq 2\text{ V}$	DS-1980
WAK pin "low" input current	$I_{WAK\_lo}$	-	0.1	2	$\mu\text{A}$	$V_{WAK} \leq 1\text{ V}$	DS-1981
WAK threshold hysteresis	$V_{WAK\_HYST}$	200	400	550	mV	$V_S \geq 6\text{ V}$	DS-1982

**7.4 Wake-up timer (WUT)**

**7.4.1 Functional description wake-up timer (WUT)**



**Figure 16 Functional block diagram wake-up timer**

**Wake-up timer configuration**

The wake-up timer value can be configured via SPI in the 24-bit wide wake-up timer registers **WUT\_CFG0** and **WUT\_CFG1** and the time base can be configured via **DEV\_CFG4** register.

The wake-up timer is a 24-bit counter, which operates at a selectable clock frequency of 100 kHz, 1 kHz, 100 Hz or 1 Hz (timebase).

**7 Wakeup functions**

**Table 21** Wake-up timer configuration

Timebase		Clock	Timer resolution	Timer range (timebase resolution × timer value)
WUT_CYC	WUT_PRESC			
0	0	100 kHz	10 μs	10 μs to 168 s
0	1	1 kHz	1 ms	1 ms to 4.6 h
1	0	100Hz	10 ms	10 ms to 1.9 days
1	1	1 Hz	1 s	1 s to 194 days

The device allows enabling and disabling the wake-up timer via **DEV\_CFG4.WUT\_EN**.

**Wake-up timer start and stop**

On entering STANDBY state or SLEEP state with DEV\_CFG4.WUT\_EN=1, the counter is loaded with the value of the wake-up timer register and starts decrementing.

The device stops the timer under any of the following conditions:

- The wake-up timer expires
- The device exits SLEEP state or STANDBY state. The remaining timer value can be read back via SPI in order to evaluate the theoretical time left and the corresponding time elapsed (**WUT\_STAT0.TIMVALL**, **WUT\_STAT1.TIMVALH**, **WUT\_STAT1.PRESC**, **WUT\_STAT1.CYC**)

**Wake-up timer bit**

If the wake-up timer expires, the device sets the wake-up timer bit **WAKE\_STAT\_APPx.WUT = 1**.

The WUT bit can be cleared via SPI.

**7.4.2 Electrical characteristic wake-up timer**

**Table 22** Electrical characteristic wake-up timer

V<sub>VS</sub> = 6.0 V to 36 V, T<sub>j</sub> = -40°C to +175°C, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Wake-up timer accuracy	d <sub>acc_WUT</sub>	-10	-	10	%	-	DS-2059

**7.5 Wake-up via SPI frame**

A wake-up via SPI is only available if the device is in SLEEP state and BUCKCORE and QUC are enabled. Only then the device can be woken up by sending a state transition request to WAKE state by writing **DEV\_PW\_CFG3.FSM\_STATEREQ = WAKE** accordingly. Writing any other register that is not involved in a state transition request does not result in a wake-up of the device.

**8 Hardware configuration (HWCFG)**

**8 Hardware configuration (HWCFG)**

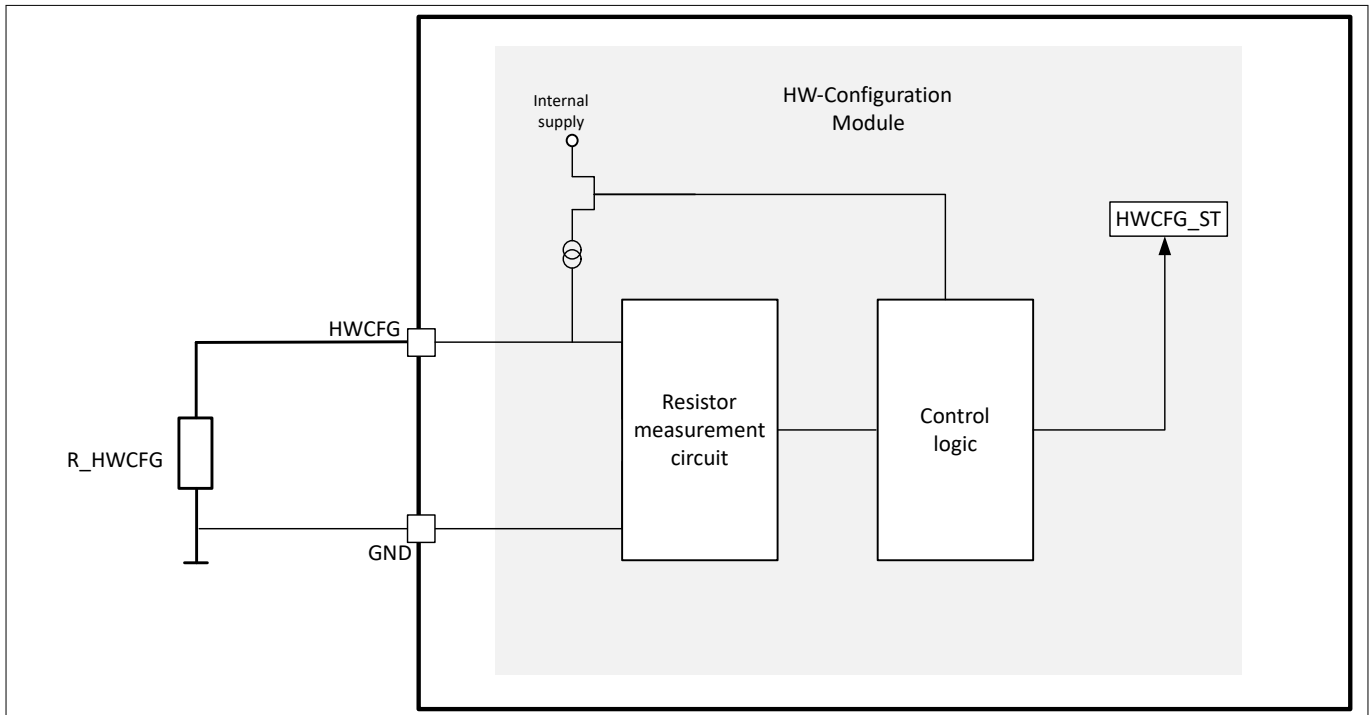
**Table 23 Electrical characteristics hardware configuration resistor**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
External resistor accuracy	$R_{HWCFG\_ac}$ c	-5	-	+5	%	1)	DS-2017

1) Not subject to production test, specified by design

**8.1 Functional description**



**Figure 17 Hardware configuration blockdiagramm**

The device provides a hardware configuration module. The external resistor ( $R_{HWCFG}$ ) connected on pin (HWCFG) is used to:

- Define the start-up sequence of the internal regulators
- Define the pre-regulator output voltage
- Define the default value of the reset delay time
- Activate the MPS mode

According to the table below.

**8 Hardware configuration (HWCFG)**

**Table 24 Hardware configuration (HWCFG)**

<b>HWCFG resistor setting kΩ, 5% tolerance</b>	<b>RESOUT start-up delay</b>	<b>Pre-regulator output voltage (V<sub>PRE</sub>)</b>	<b>Start-up sequence of the regulator</b>	<b>MPS mode activation</b>	<b>SPI bits readout DEV_CFG1.HWC FG_STAT</b>
	2 ms/10 ms (TBD)	4V/5V5	Schema (A)/ Schema (B)	ON/OFF	
< 1.0 or GND	10 ms	4V	A	OFF	0000
2.2	2 ms	4V	A	OFF	0001
3.3	2 ms	4V	B	OFF	0010
4.7	10 ms	4V	B	OFF	0011
6.8	2 ms	5V5	A	OFF	0100
10	10 ms	5V5	A	OFF	0101
15	2 ms	5V5	B	OFF	0110
22	2 ms	5V5	B	ON	1001
33	2 ms	5V5	A	ON	1010
47	10 ms	4V	B	ON	1011
68	2 ms	4V	B	ON	1100
100	2 ms	4V	A	ON	1101
150	10 ms	4V	A	ON	1110
> 200 or open	10 ms	4V	A	OFF	1111

After starting up the device, microcontroller can verify the selected setting by reading the SPI status register **DEV\_CFG1.HWC\_CFG\_STAT** where the HWCFG resistor value is stored

9 State machine (FSM)

9 State machine (FSM)

9.1 Functional description state machine (FSM)

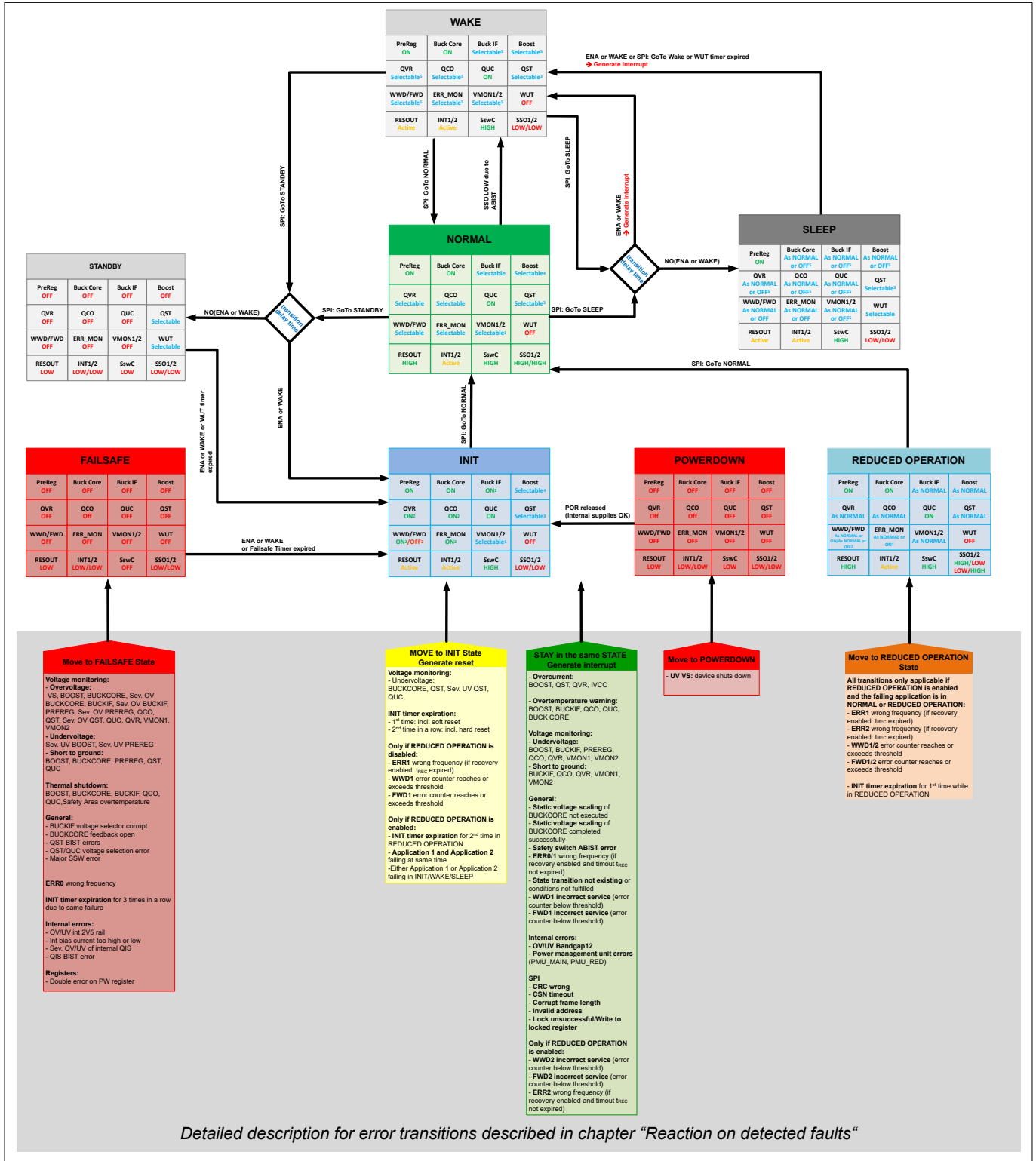


Figure 18 State machine flow diagram

(1): Selectable function during the start-up via VMxEN; can be switched off via SPI. Restarts on entering INIT

**9 State machine (FSM)**

- (2): Switched ON or OFF at entering the INIT or the REDUCED OPERATION state, then configurable via SPI.
- (3): QST supply is on or off, can be configured by SPI when QST\_MODE is configured as USER\_MODE else QST is on independently of QST\_EN when QST\_MODE is configured as PMIC\_MODE (Default)
- (4): Selectable with start-up autodetect only if VPREREG=5V5 nominal. Otherwise it is ON
- (5): WD: Can be configured to remain active in SLEEP; all other modules have to be disabled within the same SPI frame that contains the move to SLEEP command; Upon wake-up the modules are restored to the states as they were before the move to SLEEP

**9.1.1 Description of the states**

The device provides the following states:

- INITIALIZATION states:
  - INIT
  - WAKE
- OPERATIONAL state:
  - NORMAL
- LOW QUIESCENT states:
  - SLEEP
  - STANDBY
- ERROR states
  - FAILSAFE
  - REDUCED OPERATION

**9.1.1.1 POWERDOWN state**

The POWERDOWN state represents the unpowered condition of the device. The voltage at VS pin is not available.

<b>POWERDOWN</b>			
<b>PreReg</b> OFF	<b>Buck Core</b> OFF	<b>Buck IF</b> OFF	<b>Boost</b> OFF
<b>QVR</b> Off	<b>QCO</b> Off	<b>QUC</b> OFF	<b>QST</b> OFF
<b>WWD/FWD</b> OFF	<b>ERR_MON</b> OFF	<b>VMON1/2</b> OFF	<b>WUT</b> OFF
<b>RESOUT</b> LOW	<b>INT1/2</b> LOW/LOW	<b>SswC</b> LOW	<b>SSO1/2</b> LOW/LOW

**Figure 19 POWERDOWN state**

**9 State machine (FSM)**

**Table 25 POWERDOWN state**

Part/Function	Value	Description
PreReg	OFF	Pre-regulator is off
Buck Core	OFF	Core supply is off
Buck IF	OFF	Buck regulator for interface supply is off
Boost	OFF	Boost regulator is off
QVR	OFF	Voltage reference is off
QCO	OFF	Communication supply is off
QUC	OFF	Microcontroller supply is off
QST	OFF	Standby supply is off
WWD/FWD	OFF	Watchdog is off
ERR_MON	OFF	Error monitoring function ERR MON is off
VMON1/2	OFF	External voltage monitoring VMON1/2 is off
WUT	OFF	Wake up timer (WUT) is off
RESOUT	LOW	RESOUT output is low
INT1/2	LOW	Interrupt outputs are low
SswC	LOW	External safety switch is off
SSO1/2	LOW	Safe state outputs are low

**9.1.1.2 INIT state**

In INIT state the device starts up its internal supplies, as well as the external voltage rails as configured. Upon every entry RESOUT will be pulled low for  $t_{RD\_2ms}/t_{RD\_10ms}$  or to its configured value and released again after the power-up sequence was executed. If rails are still at their nominal voltage upon entry, they are skipped in the power-up sequence. Internal checks are being performed and the device waits for [successful initialization](#) by the microcontroller before the INIT timer  $t_{INIT}$  expires.

**9 State machine (FSM)**

INIT			
PreReg <b>ON</b>	Buck Core <b>ON</b>	Buck IF <b>ON<sup>2</sup></b>	Boost <b>Selectable<sup>4</sup></b>
QVR <b>ON<sup>2</sup></b>	QCO <b>ON<sup>2</sup></b>	QUC <b>ON</b>	QST <b>Selectable<sup>3</sup></b>
WWD/FWD <b>ON<sup>2</sup>/OFF<sup>2</sup></b>	ERR_MON <b>ON<sup>2</sup></b>	VMON1/2 <b>Selectable<sup>1</sup></b>	WUT <b>OFF</b>
RESOUT <b>Active</b>	INT1/2 <b>Active</b>	SswC <b>HIGH</b>	SSO1/2 <b>LOW/LOW</b>

**Figure 20** INIT state

**Table 26** INIT state

Part/Function	Value	Description
PreReg	ON	Pre-regulator is on
Buck Core	ON	Core supply is on
Buck IF	ON	Buck regulator for interface supply is on, if automated use-detection identified the usage; then configurable via SPI
Boost	Selectable	Boost regulator is selectable with start-up autodetect only if $V_{OUT\_PreReg} = 5V5$ nominal otherwise, it is on.
QVR	ON	Voltage reference is on; then configurable via SPI
QCO	ON	Communication supply is on; then configurable via SPI
QUC	ON	Microcontroller supply is on
QST	Selectable	Standby supply is selectable when QST_MODE is configured as USER_MODE otherwise, it is on when QST_MODE is configured as PMIC_MODE (default)
WWD	ON	Window watchdog is on; then configurable via SPI
FWD	OFF	Functional Watchdog is off; then configurable via SPI
ERR_MON	ON	Error monitoring function ERR MON is on; then configurable via SPI
VMON1/2	Selectable	External voltage monitoring VMON1/2 is on, if automated use-detection identified the usage; can be switched off by SPI
WUT	OFF	Wake-up timer (WUT) is off
RESOUT	Active	RESOUT output released ("high") after power-up sequence has finished and reset delay time has expired

**(table continues...)**

**9 State machine (FSM)**

**Table 26 (continued) INIT state**

Part/Function	Value	Description
INT1/2	Active	Interrupt outputs are active (INT2 only active if "REDUCED OPERATION" is enabled)
SswC	High	External safety switch is on
SSO1/2	LOW	Safe state outputs are low

**Note:**

*The Move to NORMAL SPI command is not executed:*

- 900µs after move to INIT because of execution of auto detection
- Until all enabled voltage rails are in regulation (above UV threshold). Note: all regulators are switched on again at move to INIT (if disabled before)

*In general the application is not exposed to this limitation due to RESOUT at low level but with the following exceptions:*

- with low tRD values (<1ms)
- in case MPS is ON (the RESOUT stays high for WDs/ERRs monitoring faults and therefore the application can be exposed to such limitation).

**9.1.1.3 NORMAL state**

Device has a NORMAL state and the only state where safe state outputs (SSO1/2) are high.

**Note:** In this state the device is supplying the microcontroller and the peripheral blocks in the application.

<b>NORMAL</b>			
<b>PreReg</b> ON	<b>Buck Core</b> ON	<b>Buck IF</b> Selectable	<b>Boost</b> Selectable <sup>4</sup>
<b>QVR</b> Selectable	<b>QCO</b> Selectable	<b>QUC</b> ON	<b>QST</b> Selectable <sup>3</sup>
<b>WWD/FWD</b> Selectable	<b>ERR_MON</b> Selectable	<b>VMON1/2</b> Selectable <sup>1</sup>	<b>WUT</b> OFF
<b>RESOUT</b> HIGH	<b>INT1/2</b> Active	<b>SswC</b> HIGH	<b>SSO1/2</b> HIGH/HIGH

**Figure 21 NORMAL state**

**9 State machine (FSM)**

**Table 27          NORMAL state**

<b>Part/Function</b>	<b>Value</b>	<b>Description</b>
PreReg	ON	Pre-regulator is on
Buck Core	ON	Core supply is on
Buck IF	Selectable	Buck regulator for interface supply can be switched on or off, if it has been detected via automated use detection during start-up
Boost	Selectable	Boost regulator is selectable with start-up autodetect only if $V_{R1FB} = 5V5$ nominal. Otherwise it is on
QVR	Selectable	Voltage reference can be selected by SPI to be on or off
QCO	Selectable	Communication supply can be selected by SPI to be on or off
QUC	ON	Microcontroller supply is on
QST	Selectable	Standby supply is selectable when QST_MODE is configured as USER_MODE otherwise, it is on when QST_MODE is configured as PMIC_MODE (default)
WWD/FWD	Selectable	Watchdog can be selected by SPI to be on or off
ERR_MON	Selectable	Error monitoring function ERR MON can be selected by SPI to be on or off
VMON1/2	Selectable	External voltage monitoring VMON1/2 is on, if automated use-detection identified the usage; can be switched off by SPI
WUT	OFF	Wake-up timer (WUT) is off
RESOUT	High	RESOUT output is high
INT1/2	Active	Interrupt outputs are active (INT2 only active if "REDUCED OPERATION" is enabled)
SswC	High	External safety switch is on
SSO1/2	High/High	Safe state outputs are high

**9.1.1.4          WAKE state**

When the device enters WAKE from SLEEP, the modules are restored to the states as they were before the move to SLEEP. If in SLEEP RESOUT was low, in WAKE state the device waits for successful initialization by the microcontroller before the INIT timer tINIT expires.

**9 State machine (FSM)**

<b>WAKE</b>			
<b>PreReg</b> ON	<b>Buck Core</b> ON	<b>Buck IF</b> Selectable <sup>5</sup>	<b>Boost</b> Selectable <sup>5</sup>
<b>QVR</b> Selectable <sup>5</sup>	<b>QCO</b> Selectable <sup>5</sup>	<b>QUC</b> ON	<b>QST</b> Selectable <sup>3</sup>
<b>WWD/FWD</b> Selectable <sup>5</sup>	<b>ERR_MON</b> Selectable <sup>5</sup>	<b>VMON1/2</b> Selectable <sup>5</sup>	<b>WUT</b> OFF
<b>RESOUT</b> Active	<b>INT1/2</b> Active	<b>SswC</b> HIGH	<b>SSO1/2</b> LOW/LOW

**Figure 22** WAKE state

**Table 28** WAKE state

Part/Function	Value	Description
PreReg	ON	Pre-regulator is on
Buck Core	ON	Core supply is on
Buck IF	Selectable	Buck regulator for interface supply is configurable, if it has been detected via automated use detection during start-up
Boost	Selectable	Boost regulator is configurable with start-up autodetect only if VR1FB =5V5 nominal otherwise, it is on
QVR	Selectable	Voltage reference is configurable via SPI
QCO	Selectable	Communication supply is configurable via SPI
QUC	ON	Microcontroller supply is on
QST	Selectable	Standby supply is selectable when QST_MODE is configured as USER_MODE otherwise, it is on when QST_MODE is configured as PMIC_MODE (default)
WWD/FWD	Selectable	Watchdog is configurable via SPI
ERR_MON	Selectable	Error monitoring function ERR MON is configurable via SPI
VMON1/2	Selectable	External voltage monitoring VMON1/2 is on, if automated use-detection identified the usage; can be switched off by SPI
WUT	OFF	Wake-up timer (WUT) is off
RESOUT	Active	RESOUT output is active
INT1/2	Active	Interrupt outputs are active
SswC	HIGH	External safety switch is on
SSO1/2	LOW	Safe state outputs are low

**9 State machine (FSM)**

**9.1.1.5 REDUCED OPERATION state**

The device provides a REDUCED OPERATION state to allow severe safety reactions only on sub-parts of the application, when the device is either in NORMAL state or REDUCED OPERATION state itself. In addition, a [successful initialization](#) by the microcontroller must be done before the INIT timer  $t_{INIT}$  expires. If REDUCED OPERATION is enabled (**REDOP\_RS\_CFG1.EN = 1**) the device shows a differentiated reaction to specific events. In particular an additional Application Reset function is introduced. This Application Reset differs in its configurable pulse width compared to a normal reset and it is issued at the outputs INT1/2 accordingly (**REDOP\_RS\_CFG2.REDOP\_RESOUT\_APP1\_DUR, REDOP\_RS\_CFG2.REDOP\_RESOUT\_APP2\_DUR**). By enabling this state ERR2 and WD2 are automatically enabled, too. Events that are detected at ERR1 or WD1 are reported with an Application Reset at INT1 and events that are detected at ERR2 and WD2 are reported with an Application Reset at INT2. In addition a normal interrupt is issued at INT1 if ERR2 or WD2 report an error and vice versa at INT2 if ERR1 or WD1 report an error. This cross application notification however can be disabled by using the configuration in **REDOP\_RS\_CFG1.INT1\_DIS** and **REDOP\_RS\_CFG1.INT2\_DIS**. For further information on initialization in REDUCED OPERATION, failure reaction, interrupt generation and Application Reset the following chapter provide more details:

- [INIT timer function](#)
- [Reaction on faults](#)
- [Interrupt function \(INT\)](#)
- [Application Reset \(REDUCED OPERATION ENABLE\)](#)

<b>REDUCED OPERATION</b>			
PreReg <b>ON</b>	Buck Core <b>ON</b>	Buck IF As NORMAL	Boost As NORMAL
QVR As NORMAL	QCO As NORMAL	QUC <b>ON</b>	QST As NORMAL
WWD/FWD As NORMAL or ON/As NORMAL or OFF <sup>2</sup>	ERR_MON As NORMAL or ON <sup>2</sup>	VMON1/2 As NORMAL	WUT <b>OFF</b>
RESOUT <b>HIGH</b>	INT1/2 <b>Active</b>	SswC <b>HIGH</b>	SSO1/2 <b>HIGH/LOW</b> <b>LOW/HIGH</b>

**Figure 23 REDUCED OPERATION state**

**Table 29 REDUCED OPERATION state**

Part/Function	Value	Description
PreReg	ON	Pre-regulator is on
Buck Core	ON	Core supply is on
Buck IF	As NORMAL	Buck regulator for interface supply has same configuration as in NORMAL state
Boost	As NORMAL	Boost regulator has the same configuration as in NORMAL
QVR	As NORMAL	Voltage reference has same configuration as in NORMAL state
QCO	As NORMAL	Communication supply has same configuration as in NORMAL state

**(table continues...)**

**9 State machine (FSM)**

**Table 29 (continued) REDUCED OPERATION state**

<b>Part/Function</b>	<b>Value</b>	<b>Description</b>
QUC	ON	Microcontroller supply is on
QST	As NORMAL	Standby supply has same configuration as in NORMAL state
WWD	Failing application: ON Configuration registers reset Non failing application: As NORMAL	Failing application: Configuration registers reset and remains ON. Waits for trigger and/or configuration via SPI. Non failing application: Keeps configuration as for NORMAL state and needs to be serviced as in NORMAL state.
FWD	Failing application: OFF Configuration registers reset Non failing application: As NORMAL	Failing application: Configuration registers reset and OFF. Non failing application: Keeps configuration and stays ON as in NORMAL. Trigger must be done accordingly.
ERR_MON	Failing application: ON Configuration registers reset Non failing application: As NORMAL	Failing application: Configuration registers reset and remains ON. Waits for correct ERR pin signal and/or configuration via SPI. Non failing application: Keeps configuration as for NORMAL state and needs to be serviced as in NORMAL state.
VMON1/2	As NORMAL	External voltage monitoring VMON1/2 have same configuration as in NORMAL state
WUT	OFF	Wake-up timer (WUT) is off
RESOUT	High	RESOUT output is high
INT1/2	Active	Interrupt outputs are active
SswC	High	External safety switch is on
SSO1/2	High/Low or Low/High	Safe state outputs are low or high depending on the failing cluster/application

**Note:** *While being in REDUCED OPERATION state it must be ensured by the integrator, that except for triggering the watchdog and reconfiguring the application specific monitoring ERR1/2 or WD1/2, no other configuration of the device is being made, like disabling or enabling voltage rails. This could interfere with the internal monitoring of the device and cause incorrect error reporting while being in REDUCED OPERATION. In addition it must be mentioned, that upon the release of the related INTx, the corresponding WWDx and ERRx function is re-enabled, whereas the FWD is disabled.*

**9.1.1.6 FAILSAFE state**

In FAILSAFE state all generated voltage rails are being switched off.  
 The failsafe timer is started when entering the FAILSAFE state.

**9 State machine (FSM)**

<b>FAILSAFE</b>			
<b>PreReg</b> OFF	<b>Buck Core</b> OFF	<b>Buck IF</b> OFF	<b>Boost</b> OFF
<b>QVR</b> OFF	<b>QCO</b> Off	<b>QUC</b> OFF	<b>QST</b> OFF
<b>WWD/FWD</b> OFF	<b>ERR_MON</b> OFF	<b>VMON1/2</b> OFF	<b>WUT</b> OFF
<b>RESOUT</b> LOW	<b>INT1/2</b> LOW/LOW	<b>SswC</b> OFF	<b>SSO1/2</b> LOW/LOW

**Figure 24** FAILSAFE state

**Table 30** FAILSAFE state

<b>Part/Function</b>	<b>Value</b>	<b>Description</b>
PreReg	OFF	Pre-regulator is off
Buck Core	OFF	Core supply is off
Buck IF	OFF	Buck regulator for interface supply is off
Boost	OFF	Boost regulator is off
QVR	OFF	Voltage reference is off
QCO	OFF	Communication supply is off
QUC	OFF	Microcontroller supply is off
QST	OFF	Standby supply is off
WWD/FWD	OFF	Watchdog is off
ERR_MON	OFF	Error monitoring function ERR MON block is off
VMON1/2	OFF	External voltage monitoring VMON1/2 are off
WUT	OFF	Wake-up timer (WUT) is off
RESOUT	LOW	RESOUT output is low
INT1/2	LOW	Interrupt outputs are low
SswC	LOW	External safety switch is off
SSO1/2	LOW	Safe state outputs are low

**9.1.1.7 SLEEP state**

For minimized operation constraints in the application the device can be moved into a SLEEP state which provides a configuration to only operate selected modules of the device. This enables a state for reduced function sets while consuming less energy in the application compared to the NORMAL state.

**9 State machine (FSM)**

<b>SLEEP</b>			
<b>PreReg</b> <b>ON</b>	<b>Buck Core</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>	<b>Buck IF</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>	<b>Boost</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>
<b>QVR</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>	<b>QCO</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>	<b>QUC</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>	<b>QST</b> Selectable <sup>3</sup>
<b>WWD/FWD</b> As <b>NORMAL</b> or <b>OFF</b>	<b>ERR_MON</b> As <b>NORMAL</b> or <b>OFF</b>	<b>VMON1/2</b> As <b>NORMAL</b> or <b>OFF</b> <sup>5</sup>	<b>WUT</b> Selectable
<b>RESOUT</b> <b>Active</b>	<b>INT1/2</b> <b>Active</b>	<b>SswC</b> <b>HIGH</b>	<b>SSO1/2</b> <b>LOW/LOW</b>

**Figure 25 SLEEP state**

**Table 31 SLEEP state**

<b>Part/Function</b>	<b>Value</b>	<b>Description</b>
PreReg	ON	Pre-regulator is on
Buck Core	As NORMAL or OFF	Buck core regulator has same configuration as in NORMAL state or is off if configured
Buck IF	As NORMAL or OFF	Buck regulator for interface supply has same configuration as in NORMAL state or is off if configured
Boost	As NORMAL or OFF	Boost regulator has same configuration as in NORMAL state or is off if configured
QVR	As NORMAL or OFF	Voltage reference has same configuration as in NORMAL state or is off if configured
QCO	As NORMAL or OFF	Communication supply has same configuration as in NORMAL state or is off if configured
QUC	As NORMAL or OFF	Microcontroller supply has same configuration as in NORMAL state or is off if configured
QST	Selectable	Standby supply is selectable when QST_MODE is configured as USER_MODE otherwise, it is on when QST_MODE is configured as PMIC_MODE (default)
WWD/FWD	As NORMAL or OFF	Watchdog has same configuration as in NORMAL state or is off if configured
ERR_MON	As NORMAL or OFF	Error monitoring function ERR MON has same configuration as in NORMAL state or is off if configured
VMON1/2	As NORMAL or OFF	External voltage monitoring VMON1/2 have same configuration as in NORMAL state or they are off if configured

**(table continues...)**

**9 State machine (FSM)**

**Table 31 (continued) SLEEP state**

Part/Function	Value	Description
WUT	Selectable	Wake-up timer (WUT) is selectable to be on or off
RESOUT	Active	RESOUT output is active (LOW if either BUCKCORE or QUC are OFF)
INT1/2	Active	Interrupt outputs are active (LOW if QUC is OFF)
SswC	HIGH	External safety switch is on
SSO1/2	LOW	SSO1 and SSO2 are low

**Note:** While being in SLEEP state it must be ensured by the integrator, that except for servicing the watchdog no other configuration of the device is being made, like disabling or enabling voltage rails or changing the configuration of WD1/2 or ERR1/2. This could interfere with the internal monitoring of the device and cause incorrect error reporting while being in SLEEP.

**9.1.1.8 STANDBY state**

The STANDBY state represents the low current mode of the device.

STANDBY				
PreReg	Buck Core	Buck IF	Boost	
OFF	OFF	OFF	OFF	
QVR	QCO	QUC	QST	
OFF	OFF	OFF	Selectable	
WWD/FWD	ERR_MON	VMON1/2	WUT	
OFF	OFF	OFF	Selectable	
RESOUT	INT1/2	SswC	SSO1/2	
LOW	LOW/LOW	LOW	LOW/LOW	

**Figure 26 STANDBY state**

**Table 32 STANDBY state**

Part/Function	Value	Description
PreReg	OFF	Pre-regulator is off
Buck Core	OFF	Core supply is off
Buck IF	OFF	Buck regulator for interface supply is off
Boost	OFF	Boost regulator is off
QVR	OFF	Voltage reference is off
QCO	OFF	Communication supply is off

**(table continues...)**

**9 State machine (FSM)**

**Table 32 (continued) STANDBY state**

Part/Function	Value	Description
QUC	OFF	Microcontroller supply is off
QST	Selectable	Standby supply is on or off, can be configurable by SPI
WWD/FWD	OFF	Watchdog interface is off
ERR_MON	OFF	Error monitoring block is off
VMON1/2	OFF	Monitoring blocks are off
WUT	Selectable	Wake block is selected to be on or off
RESOUT	LOW	Control reset output is low
INT1/2	LOW	Interrupt outputs are low
SswC	LOW	External safety switch is off
SSO1/2	LOW	Safe state outputs are low

**Note:** *Lowest quiescent current can only be reached if WUT and QST are both OFF. This allows the device to switch off all internal voltage rails that are not required.*

**9.1.2 INIT timer function**

The INIT timer provides an extended time window for the microcontroller to properly start-up and synchronize itself with the PMIC. Upon release of the reset output elementary supervision functions have be established or disabled before  $t_{INIT}$  expires. The following paragraphs refine the general operation of the INIT timer.

**Start INIT timer**

- The INIT timer starts on the rising edge of the application reset pulse of the corresponding INT1/2 pin if the device is in REDUCED OPERATION state.
- The INIT timer starts on the rising edge of RESOUT pin if the device is in INIT or in WAKE state.

**STOP INIT timer**

The device stops the INIT timer and resets its expiration counter if all of the following conditions are fulfilled:

- WD1/2 is properly triggered or is disabled via SPI, see [Watchdog functions](#).
- ERRMON0/1/2 signal is applied correctly or is disabled via SPI, see [Error monitoring](#)

**INIT TIMER FAULT**

The device detects an INIT\_TIMER\_FAULT if the INIT timer is not successfully stopped before it expires.

**Note:** *WD2 and ERR2 only need to be initialized if REDUCED OPERATION is enabled (**REDOP\_RS\_CFG1.EN = 1**).*

If the INIT timer elapses **once** in INIT state, the device:

- generates an INIT\_TIMER\_FAULT,
- activates a soft reset
- stores the fault
- resets registers belonging to the reset class R3
- moves to INIT state, see [state machine](#)

If the INIT timer elapses **twice** in INIT state, the device

- generates an INIT\_TIMER\_FAULT
- activates a hard reset
- stores the fault

## 9 State machine (FSM)

- resets registers belonging to the reset class R3
- performs configured power-down sequence
- restarts configured power sequence
- moves to INIT state, see [state machine](#)

If the INIT timer elapses **a third time** in INIT state, the device

- stores the fault
- resets registers belonging to the reset class R2
- moves to FAILSAFE state, see [state machine](#)

If the INIT timer elapses **once** in REDUCED OPERATION state, the device:

- generates an INIT\_TIMER\_FAULT
- activates a new application reset corresponding to the application that has failed
- sets the bit **INIT\_ERR\_APPx.REDOP\_RES1**

If the INIT timer elapses **twice** in REDUCED OPERATION state, the device

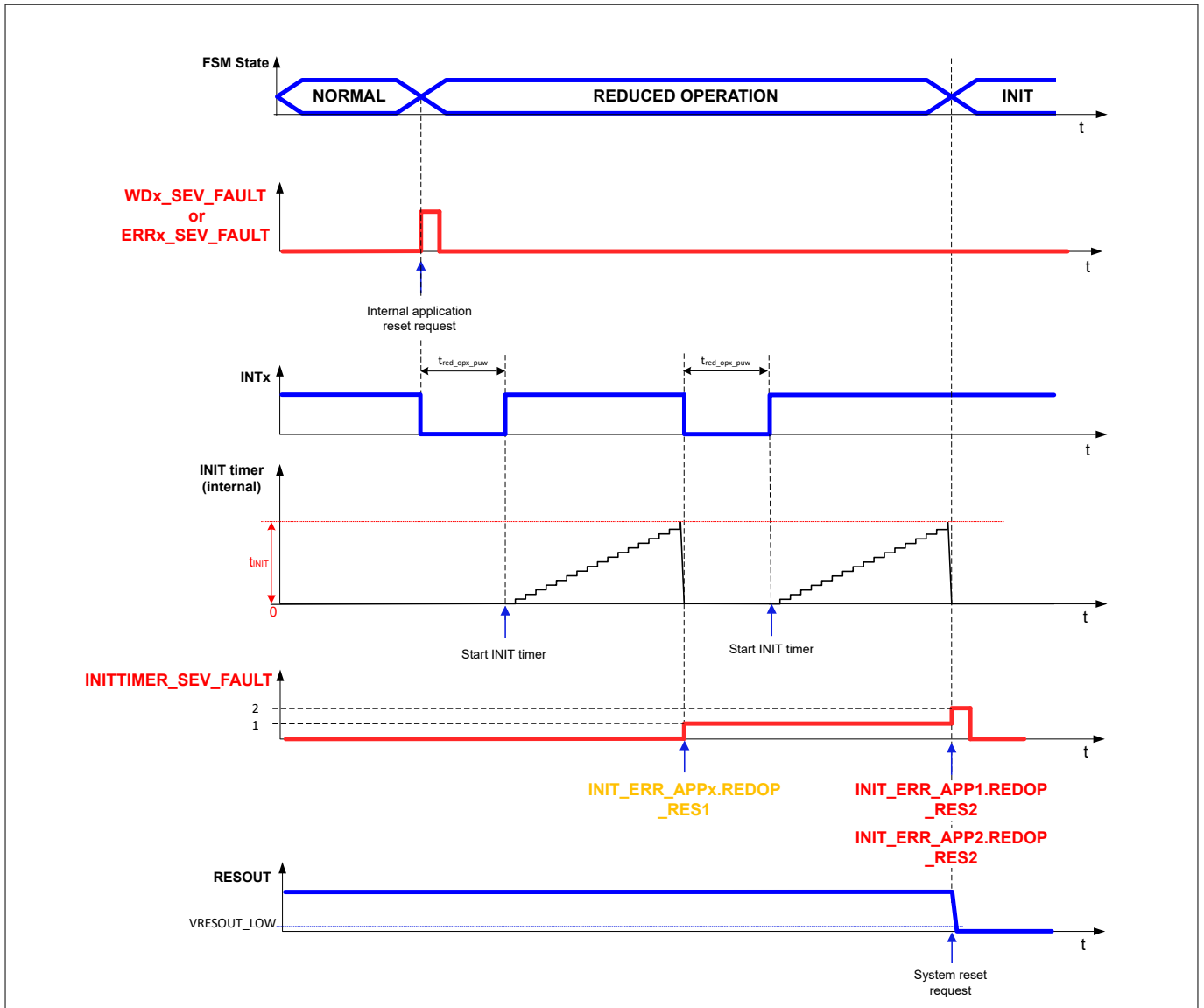
- generates an INIT\_TIMER\_FAULT,
- activates a soft reset
- sets the error bit **INIT\_ERR\_APPx.REDOP\_RES2**
- moves to INIT state, see [state machine](#)

If the INIT timer elapses **once** in WAKE state, the device

- generates an INIT\_TIMER\_FAULT,
- activates a soft reset
- stores the fault
- resets registers belonging to the reset class R3
- moves to INIT state, see [state machine](#)

Note: *The first expiration in WAKE already counts as first as if it had happened in INIT.*

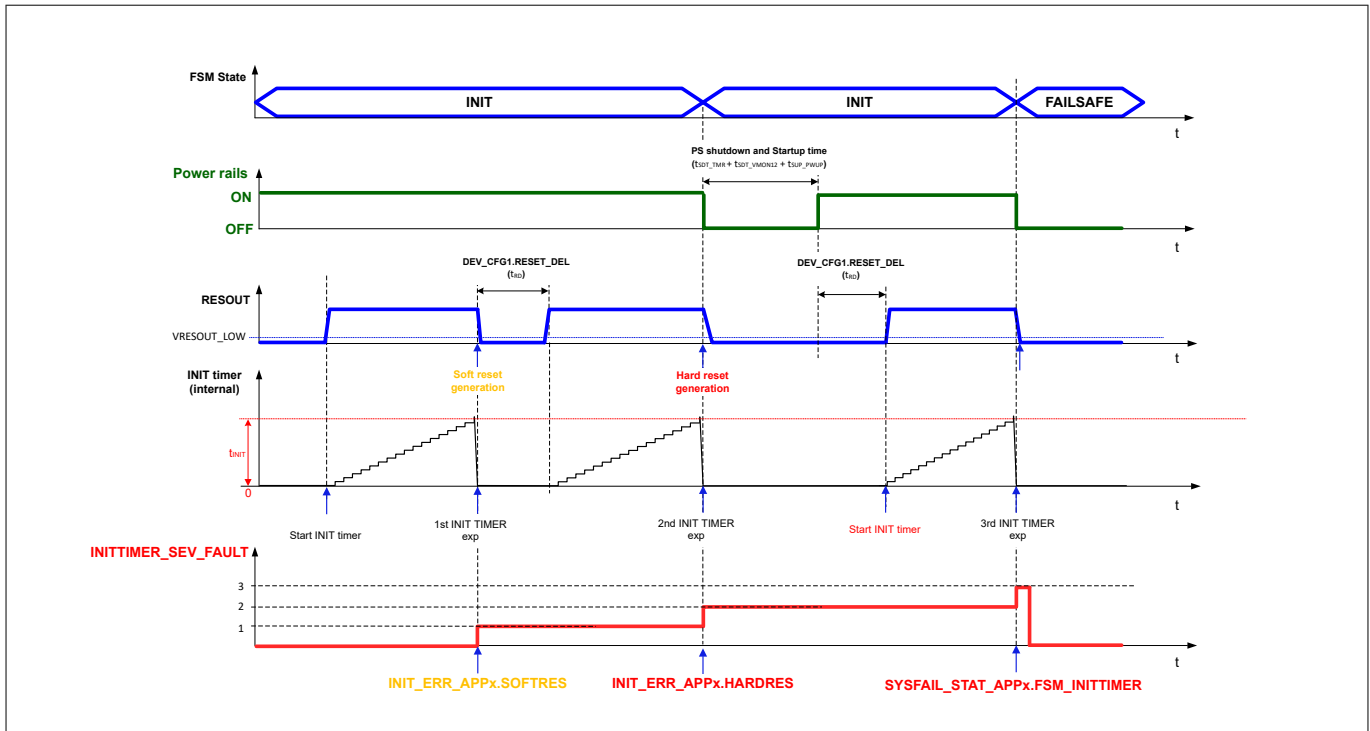
**9 State machine (FSM)**



**Figure 27** Signal diagram system reset activation in REDUCED OPERATION state

x = 1, 2

**9 State machine (FSM)**



**Figure 28** Signal diagram system shutdown due to 3xINIT timer elapse in INIT state

x = 1, 2

**9.1.3 State transition**

A state transition is requested by writing the bitfield **DEV\_PW\_CFG3.FSM\_STATEREQ**. Made changes will take effect upon successful completion of the SPI communication and locking the protected write registers again. This happens upon release of CSN after **PROT\_CFG.KEY** has been written with the lock key. If a state transition originated in NORMAL is requested, the release of CSN after writing the lock key also marks the moment when the outputs SSOx will be pulled low. Possible configured delay times between SSO1 and SSO2 will still be respected.

If a state request is received while the device executes a power-up or power-down sequence, the state transition is rejected and the bit **SYS\_STAT\_APP1.FSM\_NOOP** is set while at the same time an interrupt is issued (if REDUCED OPERATION is enabled, also **SYS\_STAT\_APP2.FSM\_NOOP** is set). The same reaction also takes place if a state transition is requested which is not listed in the state transition table (invalid state transition request). If a valid state transition is requested while already being in a transition delay into SLEEP or STANDBY, the current delay will be aborted and a transition takes place as if ENA or WAK signal would have been detected instead. Transitions from one state into itself are allowed.

In case a WAK, ENA takes places after the delay time has expired, the already started power-down sequence will be finished and a wake-up takes place directly afterwards.

(x = 1,2)

**9.1.3.1 State transition table**

Old State	New state	Conditions	Comments
POWERDOWN	INIT	Internal POR (internal supplies OK)	The configured power sequencing is applied, see <a href="#">Hardware configuration (HWCFG)</a>

**9 State machine (FSM)**

INIT	NORMAL	(SPI command: Move to NORMAL) AND (Disable or successful service within $t_{INIT}$ : - WWD1/2 - FWD1/2 - ERR0/1/2 pin monitoring )	-
NORMAL	SLEEP	(SPI command: Move to SLEEP) AND (No ENA) AND (No WAK)	- If a move to SLEEP is unsuccessful an interrupt is issued and the device moves into WAKE - The configured power sequencing is applied, see <a href="#">Hardware configuration (HWCFG)</a>
NORMAL	STANDBY	(SPI command: Move to STANDBY) AND (No ENA) AND (No WAK)	- If a move to STANDBY is unsuccessful an interrupt is issued and the device moves into INIT - The configured power sequencing is applied, see <a href="#">Hardware configuration (HWCFG)</a>
SLEEP	WAKE	ENA OR WAK OR WUT timer expired OR (SPI command: Move to WAKE)	- Upon wake-up from SLEEP an interrupt is issued, if QUC was on in SLEEP - The wake-up information is stored - Restores regulator configuration as it has been before entering SLEEP, following the power-up sequence and skipping the respective regulators, see <a href="#">Hardware configuration (HWCFG)</a>
WAKE	NORMAL	(SPI command: Move to NORMAL) AND (Disable or successful service within $t_{INIT}$ : - WWD1/2 - FWD1/2 - ERR0/1/2 pin monitoring)	-

**9 State machine (FSM)**

WAKE	SLEEP	(SPI command: Move to SLEEP) AND (No ENA) AND (No WAK)	- If a move to SLEEP is unsuccessful an interrupt is issued and the device moves into WAKE - The configured power sequencing is applied, see <a href="#">Hardware configuration (HWCFG)</a>
WAKE	STANDBY	(SPI command: Move to STANDBY) AND (No ENA) AND (No WAK)	- If a move to STANDBY is unsuccessful an interrupt is issued and the device moves into INIT - The configured power sequencing is applied, see <a href="#">Hardware configuration (HWCFG)</a>
STANDBY	INIT	ENA OR WAK OR WUT timer expired	The configured power sequencing is applied
FAILSAFE	INIT	ENA OR WAK OR Failsafe Timer expired	- The automated wake-up from FAILSAFE upon expiration of the failsafe timer only works if FAILSAFE has not been entered three times consecutively caused by the same failure - The configured power sequencing is applied
REDUCED OPERATION	NORMAL	(SPI command: Move to NORMAL) AND (Disable or successful service within $t_{INIT}$ : - WWD1/2 - FWD1/2 - ERR0/1/2 pin monitoring )	-

**Note:** When requesting a state transition into SLEEP or STANDBY, all configurations of the destination state must be done before sending the state transition request.

**9.1.3.2 Programmable transition delay time**

For the transitions from NORMAL to SLEEP, from NORMAL to STANDBY, from WAKE to SLEEP and from WAKE to STANDBY a configurable transition delay time exists. Once one of the mentioned state transitions have been requested by the microcontroller, the transition takes place after the expiration of the transition delay time

## 9 State machine (FSM)

$t_{TR\_DEL}$ . The transition is unsuccessful and moves to INIT or WAKE respectively, if a state request is received within the transition delay time.

The configuration is done in **DEV\_CFG4.FSM\_TRDEL**.

### 9.1.3.3 Automated wake-up from FAILSAFE

Upon entering FAILSAFE the device remains in it for  $t_{FAILSAFE\_min}^*$ . Afterwards it runs an automated restart attempt unless FAILSAFE was entered 3 times consecutively caused by the same error source, in which case the device remains in FAILSAFE and waits for ENA or WAK to run another restart attempt. In case it is unsuccessful, the device follows the same sequence as above.

\*) If an overtemperature event was the cause for entering FAILSAFE the device remains in it for  $t_{TSD\_min}$ .

### 9.1.4 Power sequencing

BUCK PREREG and QST are the first regulators to ramp up when the internal power on reset (POR) was released. However QST output voltage level has no impact on the power sequencing and is not gating for other rails to start up. Also the UV events for a regulator is masked until the output has exceeded its undervoltage threshold.

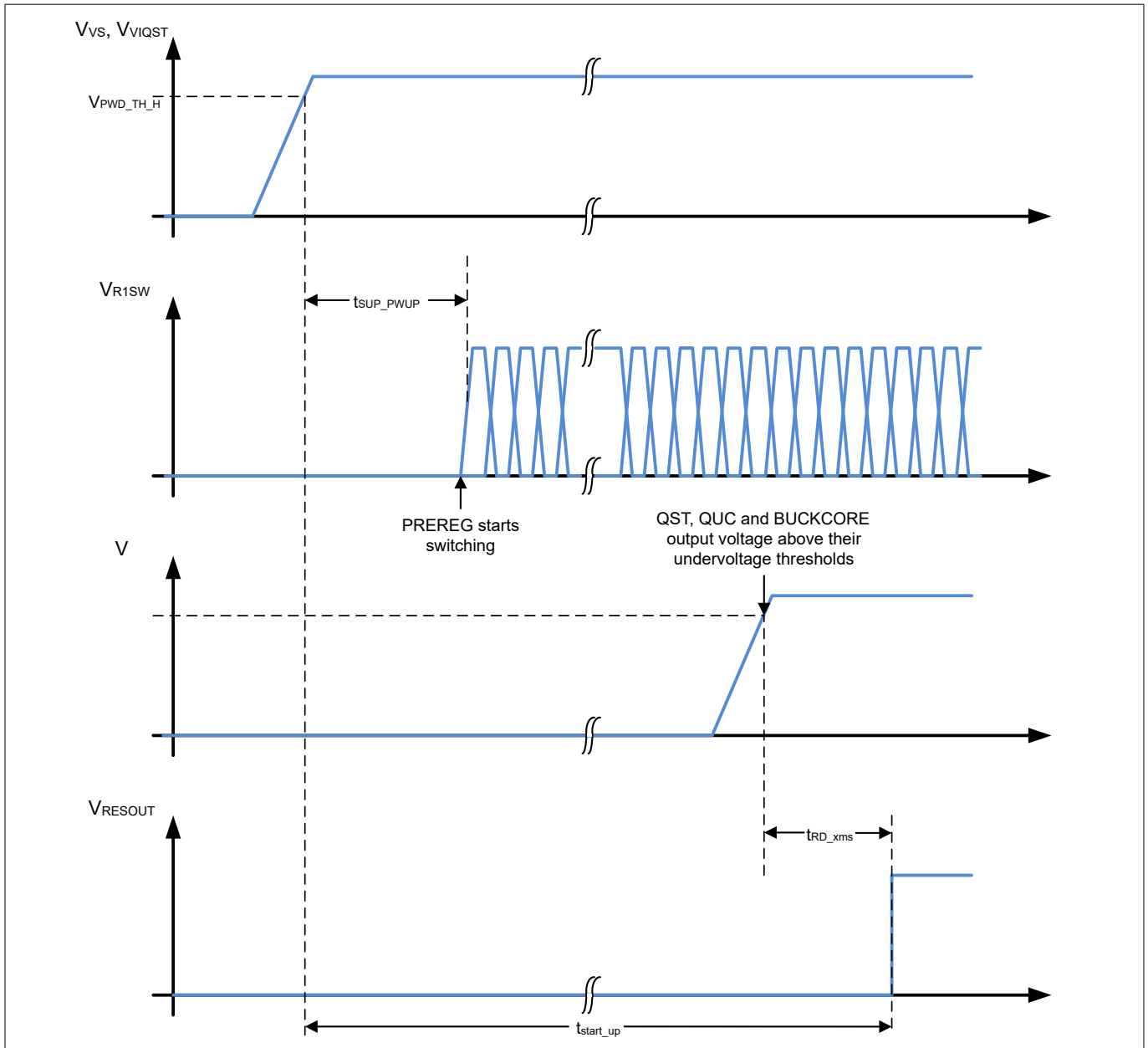
If a regulator does not succeed to establish a voltage above its undervoltage threshold before  $t_{StG}$  expires, one of the following scenarios apply:

1. Move to FAILSAFE:
  - BUCK PREREG
  - BOOST (if usage detected)
  - QUC
  - BUCK CORE
  - QST
2. Skips the start-up of the respective regulator and disables it. Issues an interrupt according to the reaction on detected faults for short to GND detection in [Reaction on faults](#) (non-blocking for power sequence)
  - BUCK IF (if usage detected)
  - VMON1 (if usage detected)
  - QVR
  - QCO
  - VMON2 (if usage detected)

The initial reset release (RESOUT going "high") after a power-up sequence has taken place, occurs when QUC, QST and BUCKCORE have surpassed their undervoltage thresholds. Further details for the reset function see [Reset function \(RESOUT\)](#)

PREREG starts switching after the input voltage at the pins VS and VIQST is above  $V_{PVD\_TH\_H}$  and the time  $t_{SUP\_PWUP}$  has passed.

**9 State machine (FSM)**



**Figure 29 System start-up timings**

If a state transition request is placed while the device performs a power-down or power-up sequence the following points apply:

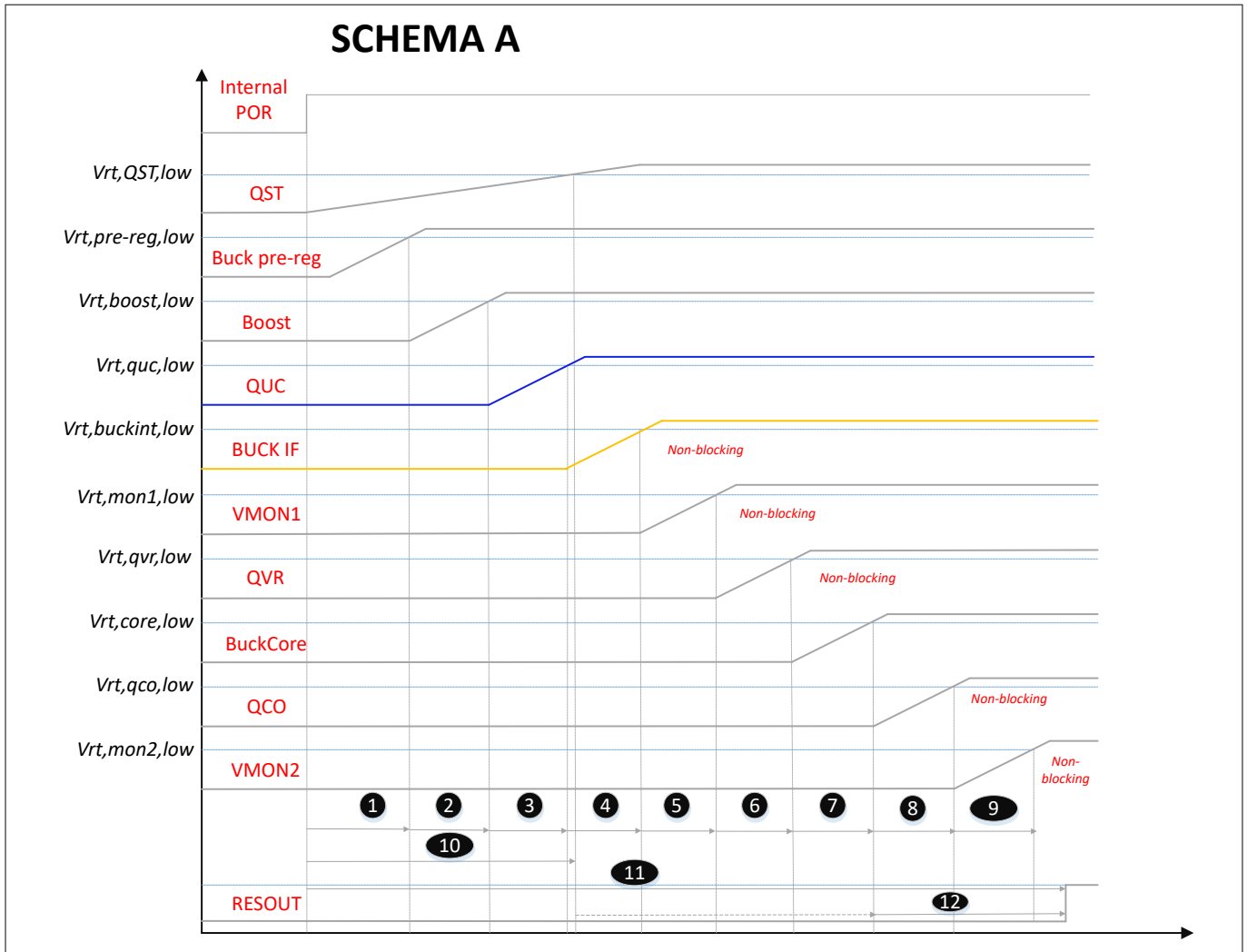
- The command is ignored
- An interrupt is triggered
- The fault is stored in a dedicated register

The device provides status information for static configurations (active regulators) via register status flags in DEV\_STAT.

**9.1.4.1 Power up sequence schema A**

The hardware configuration (HWCFG) determines the start up sequence to be either schema A or schema B. If the power up sequence schema A is selected, the sequence as described below is executed. Thereby the next voltage rail is only ramped up if the previous output voltage rail has exceeded its undervoltage threshold. QST starts up independently from the other voltage regulators and is not a precondition for another regulator.

**9 State machine (FSM)**



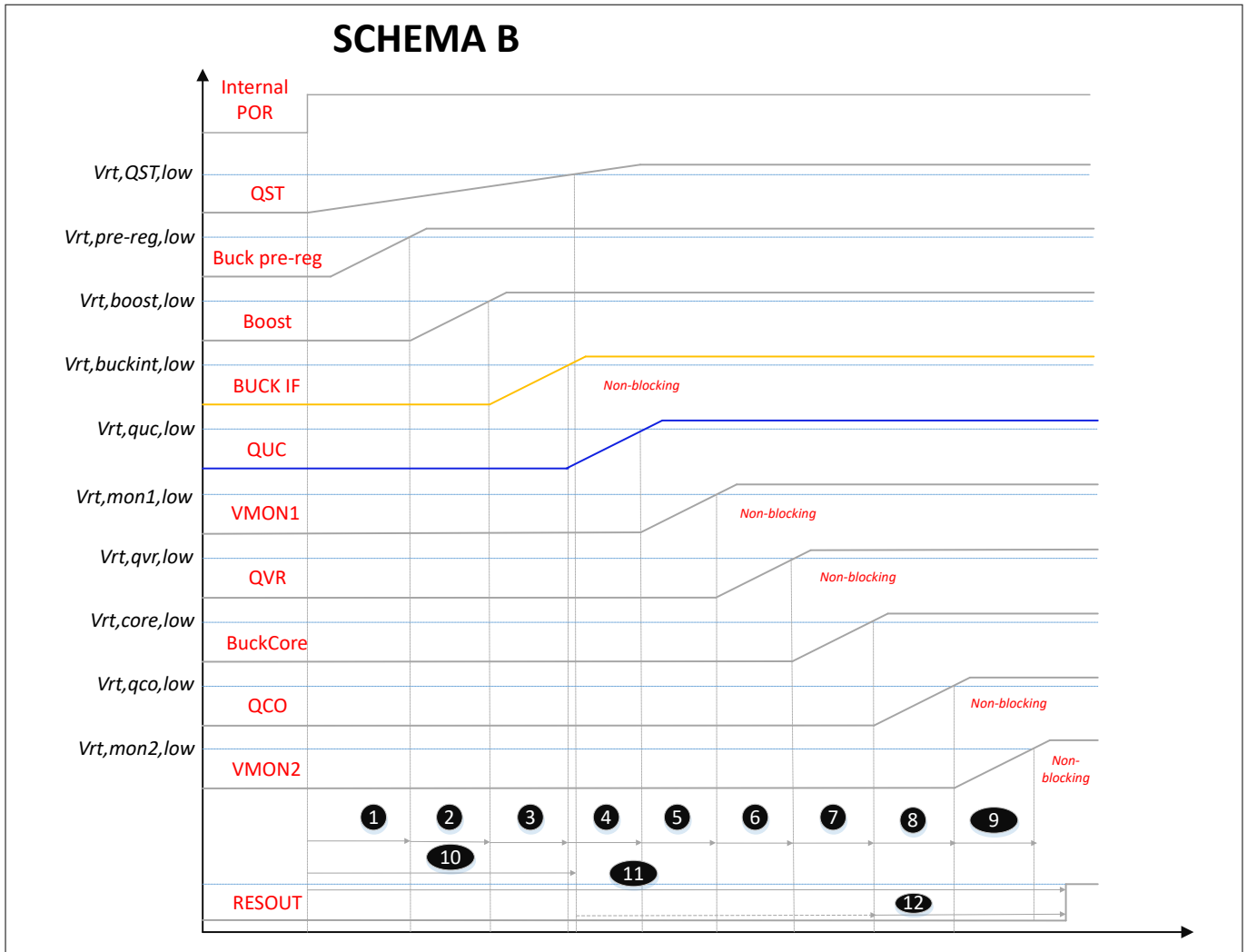
**Figure 30 Power-up sequencing schema A**

- 1 -> PREREG starts up
- 2 -> BOOST starts up (only if autodetected)
- 3 -> QUC starts up
- 4 -> BUCKIF starts up (only if autodetected during first power up sequence)
- 5 -> VMON1 starts up (only if autodetected during first power up sequence)
- 6 -> QVR starts up
- 7 -> BUCK CORE starts up
- 8 -> QCO starts up
- 9 -> VMON2 starts up(only if autodetected during first power up sequence)
- 10 -> QST starts up
- 11 -> Duration of complete start-up:  $t_{start\_up}$
- 12 -> RESOUT delay time (further information in [Reset function \(RESOUT\)](#))

**9.1.4.2 Power up sequence schema B**

If the power up sequence schema B is selected, the sequence as described below is executed. Thereby the next voltage rail is only ramped up if the previous output voltage rail has exceeded its undervoltage threshold. QST starts up independently from the other voltage regulators and is not a precondition for another regulator.

**9 State machine (FSM)**



**Figure 31 Power sequencing schema B**

- 1 -> PREREG starts up
- 2 -> BOOST starts up (only if autodetected)
- 3 -> BUCKIF starts up (only if autodetected during first power up sequence)
- 4 -> QUC starts up
- 5 -> VMON1 starts up (only if autodetected during first power up sequence)
- 6 -> QVR starts up
- 7 -> BUCK CORE starts up
- 8 -> QCO starts up
- 9 -> VMON2 (only if autodetected during first power up sequence)
- 10 -> QST starts up
- 11 -> Duration of complete start-up:  $t_{start\_up}$
- 12 -> RESOUT delay time (further information in [Reset function \(RESOUT\)](#))

**9.1.4.3 Power down sequencing**

The device disables the output voltage rail(s) following the corresponding power down sequences if it transitions into STANDBY or SLEEP. When transitioning into SLEEP the sequence will leave out the rails and the associated delays, that are configured to stay on.

## 9 State machine (FSM)

If power up sequence schema A was selected

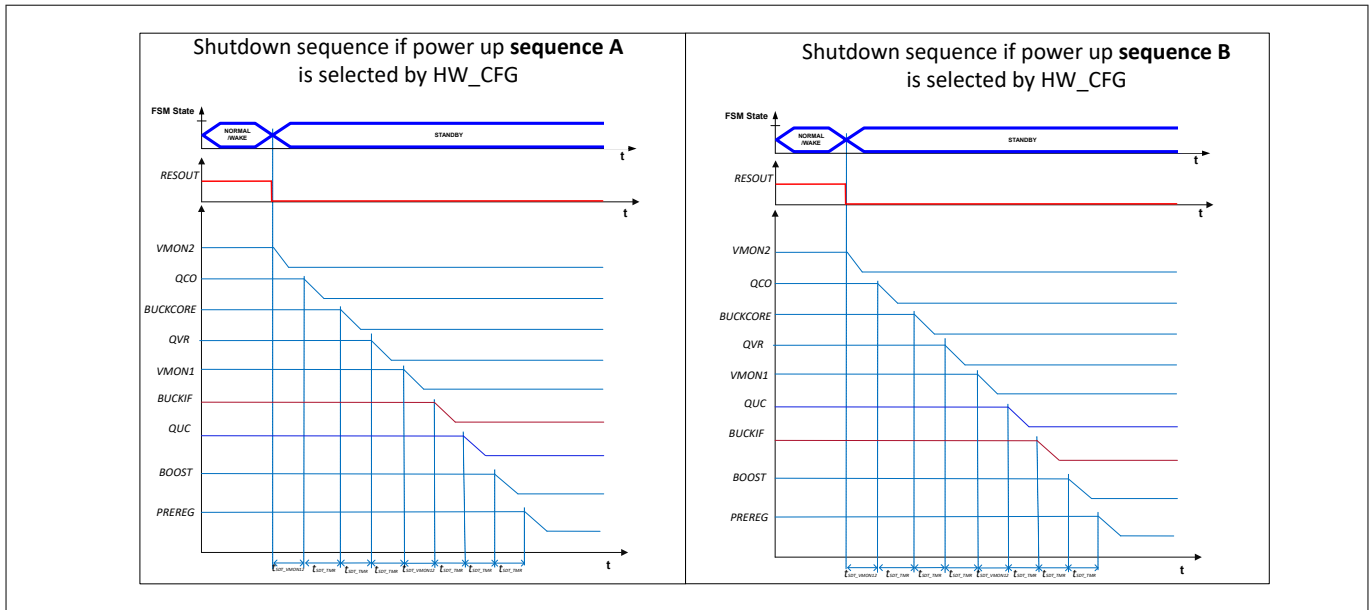
1. disable VMON2
2. wait for  $t_{SDT\_VMON12}$
3. disable QCO
4. wait for  $t_{SDT\_TMR}$
5. disable BUCK CORE
6. wait for  $t_{SDT\_TMR}$
7. disable QVR
8. wait for  $t_{SDT\_TMR}$
9. disable VMON1
10. wait for  $t_{SDT\_VMON12}$
11. disable BUCK IF
12. wait for  $t_{SDT\_TMR}$
13. disable QUC
14. wait for  $t_{SDT\_TMR}$
15. disable BOOST
16. wait for  $t_{SDT\_TMR}$
17. disable BUCK PREREG
18. wait for  $t_{SDT\_TMR}$

If power up sequence schema B was selected

1. disable VMON2
2. wait for  $t_{SDT\_VMON12}$
3. disable QCO
4. wait for  $t_{SDT\_TMR}$
5. disable BUCK CORE
6. wait for  $t_{SDT\_TMR}$
7. disable QVR
8. wait for  $t_{SDT\_TMR}$
9. disable VMON1
10. wait for  $t_{SDT\_VMON12}$
11. disable QUC
12. wait for  $t_{SDT\_TMR}$
13. disable BUCK IF
14. wait for  $t_{SDT\_TMR}$
15. disable BOOST
16. wait for  $t_{SDT\_TMR}$
17. disable BUCK PREREG
18. wait for  $t_{SDT\_TMR}$

The device disables the output voltage rail(s) following the corresponding power down sequencing.

**9 State machine (FSM)**



**Figure 32 Power down sequencing**

**Note:** The parameter  $t_{SDT\_TMR}$  and  $t_{SDT\_VMON12}$  represent an internal delay and is not gated by external conditions.

**9.2 Electrical characteristics state machine (FSM)**

**Table 33 Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Supplies start-up time	$t_{SUP\_PWUP}$	-	4	6	ms	<ul style="list-style-type: none"> <li><math>V_{VS}</math> and <math>V_{VIQST} \geq V_{PWD\_TH\_H}</math> (<math>V_S</math> and <math>V_{IQST}</math> pins assumed to be connected together externally)</li> <li><math>V_{SSC\_S} &lt; 1\text{V}</math> at startup</li> <li>Max. Capacitance at SSC_S pin is 1uF</li> </ul>	DS-2083
Power up threshold	$V_{PWD\_TH\_H}$	-	-	6	V	$V_{VS}$ increasing	DS-2156
Power down threshold low	$V_{PWD\_TH\_L}$	2.5	-	5.5	V	$V_{VS}$ decreasing BOOST not used	DS-1555
System shutdown time	$t_{SDT}$	-	-	15	ms	-	DS-1536
Thermal shutdown time	$t_{TSD\_min}$	0.9	1	1.1	s	-	DS-1548

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Internal voltage rails shutdown delay	$t_{SDT\_TMR}$	0.9*t <sub>SDT_TMR</sub>	t <sub>SDT_TMR</sub>	1.1*t <sub>SDT_TMR</sub>	μs	t <sub>SDT_TMR</sub> : Programmable via SPI in DEV_CFG4.FSM_SDT_TMR	DS-1936
VMON1/2 shutdown time	$t_{SDT\_VMON12}$	0.9*t <sub>SDT_VMON12</sub>	t <sub>SDT_VMON12</sub>	1.1*t <sub>SDT_VMON12</sub>	μs	t <sub>SDT_VMON12</sub> : Programmable via SPI in DEV_CFG4.FSM_SDT_VMON12	DS-1937
Short to ground detection time for internal regulators except QST	$t_{STG}$	0.9	1	1.1	ms	–	DS-1538
Short to ground detection time for QST regulator	$t_{STG\_QST}$	1.8	2	2.2	ms	–	DS-1537
FAILSAFE time	$t_{FAILSAFE\_min}$	18	20	22	ms	–	DS-1547
INIT timer	$t_{INIT}$	540	600	660	ms	–	DS-1549
Low power state transition time	$t_{TR\_DEL}$	100	–	1600	μs	t <sub>TR_DEL</sub> is programmable between 100 μs and 1.6 ms via SPI The default value is set to 900 μs	DS-1503
Accuracy for low power state transition time	$t_{TR\_DEL\_ACC}$	-20	–	20	%	–	DS-1550
State transition time	$t_{TR}$	–	–	200	μs	–	DS-1551
State transition time to Initialization state	$t_{TR\_INIT}$	–	–	3	ms	Transition from STANDBY/ FAILSAFE to INIT state: Measured from rising edge of ENA/WAKE to R1SW rising edge; Move to INIT faults: Measured from RESOUT falling edge to QVR enable or R1SW rising edge	DS-1552

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
<b>Current consumption</b>							
SLEEP state current consumption	$I_{q\_SLEEP}$	–	12.9	20	mA	Current consumptions are measured from $V_S(T30)$ without load current applied to post regulators: <ul style="list-style-type: none"> <li>• BUCK PREREG, QUC, BUCK IF, QCO and QST are enabled</li> <li>• BUCK CORE and QVR are switched off;</li> <li>• BOOST is not populated;</li> <li>• <math>V_{R1FB} = V_{R1FB\_5V5}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2128

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	7.9	12.3	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG enabled</li> <li>• BOOST, BUCK CORE, QUC, BUCK IF, QCO and QST and QVR are switched off;</li> <li>• <math>V_{R1FB} = V_{R1FB\_4V}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2107

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	6	9.3	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG and BOOST are enabled</li> <li>• BUCK CORE, QUC, BUCK IF, QCO and QST and QVR are switched off;</li> <li>• <math>V_{R1FB} = V_{R1FB\_4V}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2109

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	6.9	10.7	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BOOST and QUC are enabled</li> <li>• BUCK CORE, BUCK IF, QCO and QST and QVR are switched off;</li> <li>• <math>V_{R1FB} = V_{R1FB\_4V}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2111

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	10.4	16.2	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BOOST, BUCK IF and QUC are enabled</li> <li>• BUCK CORE, QCO, QST and QVR are switched off;</li> <li>• <math>V_{R1FB} = V_{R1FB\_4V}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2113

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	11.4	17.7	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BOOST, BUCK IF, QVR and QUC are enabled</li> <li>• BUCK CORE, QCO, QST are switched off;</li> <li>• <math>V_{R1FB} = V_{R1FB\_4V}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2115

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	12.9	20	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BOOST, BUCK IF, QVR, BUCK CORE, QCO and QUC are enabled</li> <li>• QST is switched off;</li> <li>• <math>V_{R1FB} = V_{R1FB\_4V}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2117

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	6	9.3	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG is enabled</li> <li>• BUCK IF, QVR, BUCK CORE, QCO, QUC and QST are switched off;</li> <li>• BOOST is not populated;</li> <li>• <math>V_{R1FB} = V_{R1FB\_5V5}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2119

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	6.1	9.5	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG and QUC are enabled</li> <li>• BUCK IF, QVR, BUCK CORE, QCO and QST are switched off;</li> <li>• BOOST is not populated;</li> <li>• <math>V_{R1FB} = V_{R1FB\_5V5}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2121

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	13.4	20.8	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BUCK IF and QUC are enabled</li> <li>• QVR, BUCK CORE, QCO and QST are switched off;</li> <li>• BOOST is not populated;</li> <li>• <math>V_{R1FB} = V_{R1FB\_5V5}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2123

(table continues...)

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	14	21.7	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BUCK IF, QVR and QUC are enabled</li> <li>• BUCK CORE, QCO and QST are switched off;</li> <li>• BOOST is not populated;</li> <li>• <math>V_{R1FB} = V_{R1FB\_5V5}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2125

(table continues...)

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SLEEP state current consumption	$I_{q\_SLEEP}$	–	15.2	23.6	mA	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• BUCK PREREG, BUCK IF, QVR, BUCK CORE, QCO and QUC are enabled</li> <li>• QST is switched off;</li> <li>• BOOST is not populated;</li> <li>• <math>V_{R1FB} = V_{R1FB\_5V5}</math>;</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math>;</li> <li>• VMON1 and VMON2 are disabled;</li> <li>• Error pin monitoring and all watchdog channels are disabled;</li> <li>• wakeup timer is disabled;</li> <li>• <math>V_{VS}/V_{VIQST} = 13.5\text{ V}</math>;</li> <li>• MOSFET IPG20N06S2L-35A for SSW, MOSFET IPG20N06S4L-26A for PREREG Half-bridge</li> <li>• BUCK CORE Load = 1mA, BUCK IF Load = 200uA</li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2127

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
STANDBY state current consumption	$I_{q\_STANDBY\ OFF}$	–	20	24	$\mu\text{A}$	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>All output voltage rails (BUCK PREREG, BUCK CORE, BUCK IF, BOOST, QUC, QVR, QST, QCO) are switched off</li> <li>VMON1 and VMON2 are disabled</li> <li>Error pin monitoring and all watchdog channels are disabled</li> <li>Wakeup timer is disabled</li> <li>Pin ENA and pin WAK are monitored for wakeup events</li> <li><math>10\text{ V} \leq V_{VS}/V_{VIQST} \leq 28\text{ V}</math></li> <li><math>T_j \leq 85^\circ\text{C}</math></li> <li>Quiescent current also depending on the leakage of diode D3</li> </ul>	DS-2079

(table continues...)

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
STANDBY state current consumption with QST ON	$I_{q\_STANDBY\_ON}$	–	54	70	$\mu\text{A}$	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• QST is switched ON</li> <li>• All output voltage rails (BUCK PREREG, BUCK CORE, BUCK IF, BOOST, QUC, QVR, QCO) are switched off</li> <li>• ERRx pin monitoring, WWD and FWD are disabled</li> <li>• VMON1 and VMON2 are disabled</li> <li>• Wakeup timer is disabled</li> <li>• Pin ENA and pin WAK are monitored for wakeup events</li> <li>• <math>10\text{ V} \leq V_{VS}/V_{VIQST} \leq 28\text{ V}</math></li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> <li>• Quiescent current also depending on the leakage of diode D3</li> </ul>	DS-1544

**(table continues...)**

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
STANDBY state current consumption with WUT ON	$I_{q\_WUT\_ON}$	–	–	50	$\mu\text{A}$	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• QST is switched OFF</li> <li>• All output voltage rails (BUCK PREREG, BUCK CORE, BUCK IF, BOOST, QUC, QVR, QCO) are switched off</li> <li>• ERRx pin monitoring, WWD and FWD are disabled</li> <li>• VMON1 and VMON2 are disabled</li> <li>• Wakeup timer is enabled</li> <li>• Pin ENA and pin WAK are monitored for wakeup events</li> <li>• <math>10\text{ V} \leq V_{VS}/V_{VIQST} \leq 28\text{ V}</math></li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> <li>• Quiescent current also depending on the leakage of diode D3</li> </ul>	DS-2052

(table continues...)

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
STANDBY state current consumption with QST and WUT ON	$I_{q\_STANDBY\_WUT\_ON}$	–	–	70	$\mu\text{A}$	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>• QST is switched ON</li> <li>• All output voltage rails (BUCK PREREG, BUCK CORE, BUCK IF, BOOST, QUC, QVR, QCO) are switched off</li> <li>• ERRx pin monitoring, WWD and FWD are disabled</li> <li>• VMON1 and VMON2 are disabled</li> <li>• Wakeup timer is enabled</li> <li>• Pin ENA and pin WAK are monitored for wakeup events</li> <li>• <math>10\text{ V} \leq V_{VS}/V_{VIQST} \leq 28\text{ V}</math></li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> <li>• Quiescent current also depending on the leakage of diode D3</li> </ul>	DS-2051
Operational state current consumption	$I_{q\_Operational}$	–	20	30	$\text{mA}$	Current consumptions are measured from $V_{S(T30)}$ without load current applied to post regulators: <ul style="list-style-type: none"> <li>• All output voltage rails (BUCK PREREG, BUCK CORE, BUCK IF, BOOST, QUC, QTS, QVR, QCO) are switched on</li> <li>• ERRx pin monitoring, WWD and FWD are disabled</li> <li>• VMON1 and VMON2 are disabled</li> <li>• Wakeup timer is disabled</li> <li>• <math>f_{DCDC} = 2.2\text{ MHz}</math></li> <li>• <math>10\text{ V} \leq V_{VS}/V_{VIQST} \leq 28\text{ V}</math></li> <li>• <math>T_j \leq 85^\circ\text{C}</math></li> </ul>	DS-2080

(table continues...)

**9 State machine (FSM)**

**Table 33 (continued) Electrical characteristics state machine (FSM)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)<sup>1)</sup>

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
FAILSAFE state current consumption	$I_{q\_FAILSAFE}$	–	120	200	$\mu\text{A}$	Current consumptions are measured from $V_{S(T30)}$ : <ul style="list-style-type: none"> <li>All output voltage rails (BUCK PREREG, BUCK CORE, BUCK IF, BOOST, QUC, QVR, QST, QCO) are switched off</li> <li>ERRx pin monitoring, WWD and FWD are disabled</li> <li>VMON1 and VMON2 are disabled</li> <li>Wakeup timer is disabled</li> <li>Pin ENA and pin WAK are monitored for wakeup events</li> <li><math>10\text{ V} \leq V_{VS}/V_{VIQST} \leq 18\text{ V}</math></li> <li><math>T_j \leq 40^\circ\text{C}</math></li> <li><math>t_{FAILSAFE} &gt; t_{FAILSAFE\_min}</math></li> <li>Quiescent current also depending on the leakage of diode D3</li> </ul>	DS-1546

1) Not subject to production test, specified by design

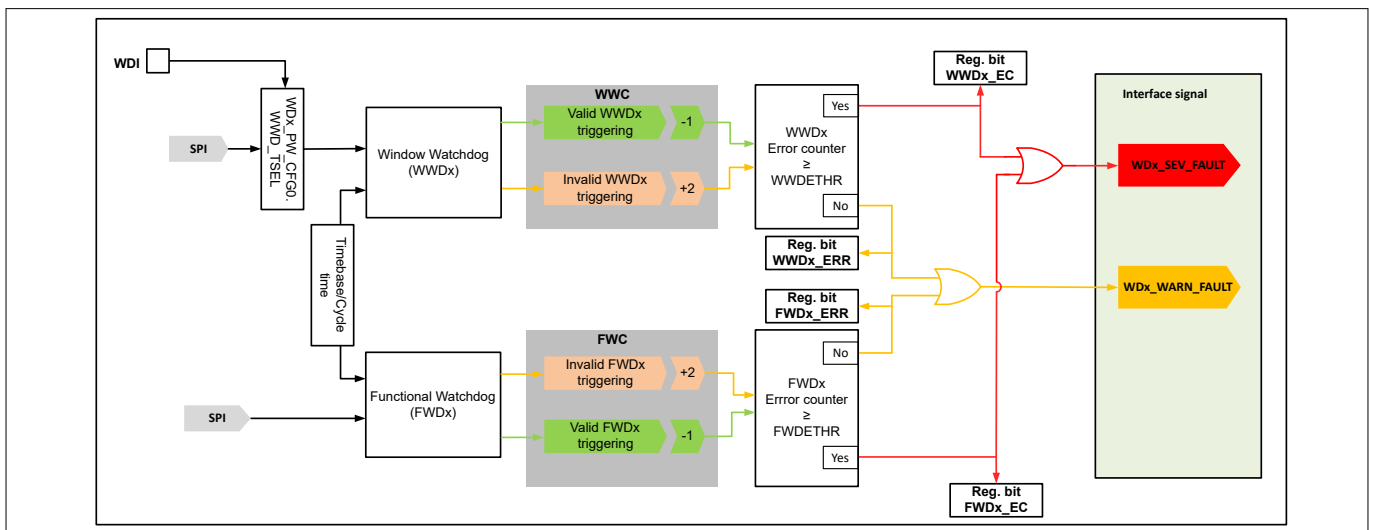
**10 Monitoring functions**

**10 Monitoring functions**

**10.1 Watchdog functions (WD)**

**10.1.1 Introduction watchdog functions (WD)**

The purpose of a watchdog is to provide a monitoring mechanism for the application microcontroller by means of temporal and logical program sequence monitoring. A watchdog may detect defective MCU program sequence, where individual program elements (e.g. software modules, subprograms, or commands) are processed in the wrong sequence or period of time, or if the clock of the processor is faulty.



**Figure 33 Functional block diagram watchdog functions**

(x = 1; 2)

The device incorporates two independent watchdog instances(WD). Each of them consisting of one window watchdog module (WWD) and one functional watchdog module (FWD):

- WD1: Consisting of WWD1 and FWD1
- WD2: Consisting of WWD2 and FWD2

**Note:** Watchdog instance 2 can only be used if REDUCED OPERATION is enabled (**REDOP\_RS\_CFG1.EN = 1**).

The watchdog modules differentiate between the following services:

- "Valid WWDx triggering" or "Invalid WWDx triggering"
- "Valid FWDx triggering" or "Invalid FWDx triggering"

Each WWD module and each FWD module has its own error counters assigned and monitors the watchdog triggers. This allows an operation of a WWD and FWD in parallel. A WWDx shares the same time base with its corresponding FWDx.

The basic time base configuration is done with the register bit WDX\_PW\_CFG0.CYC. For shortening the time base even further an additional divider by 10 can be enabled which results in a time base as depicted:

$$time\ base = \frac{WDX\_RS\_CFG0.CYC}{WDX\_RS\_CFG1.CYC\_DIV} \text{ (interpreted value)}$$

**Equation 1**

**Configuration**

**10 Monitoring functions**

Each watchdog module can be activated and deactivated independently in the register bits **WDx\_PW\_CFG0.WWD\_EN** and **WDx\_PW\_CFG0.FWD\_EN**.

Automatic deactivation of the watchdogs on entering SLEEP state can be configured in the register bits **WDx\_PW\_CFG1.SLP\_EN**.

**10.1.2 Window watchdog (WWD)**

**10.1.2.1 Functional description window watchdog (WWD)**

The window watchdogs (WWDx) can be configured in **WDx\_PW\_CFG0.WWD\_TSEL** to be triggered by one of the following events:

- Falling edge at the digital input pin WDI
- Writing WWD1\_TRIG.TRIG via SPI. In order to trigger the watchdog:
  - Read the last internal service value (**WWDx\_TRIG.TRIG\_STAT**) received via SPI
  - Write the inverted value of the (**WWDx\_TRIG.TRIG\_STAT**) to the **WWDx\_TRIG.TRIG** bitfield

If the trigger event occurs during the open window period (OW), then the device detects a **"valid WWDx triggering"**. The open window is closed immediately and the closed window starts.

If no trigger event occurs during the open window period or if the trigger event occurs during the closed window period (CW), then the device detects an **"invalid WWDx triggering"**.

The duration of the open window  $t_{OW}$  and the closed window  $t_{CW}$  can be calculated with the following formulas:

$$t_{OW} = (WWDx\_PW\_OW\_CFG.OW + 1) \times 50 \times \textit{time base}$$

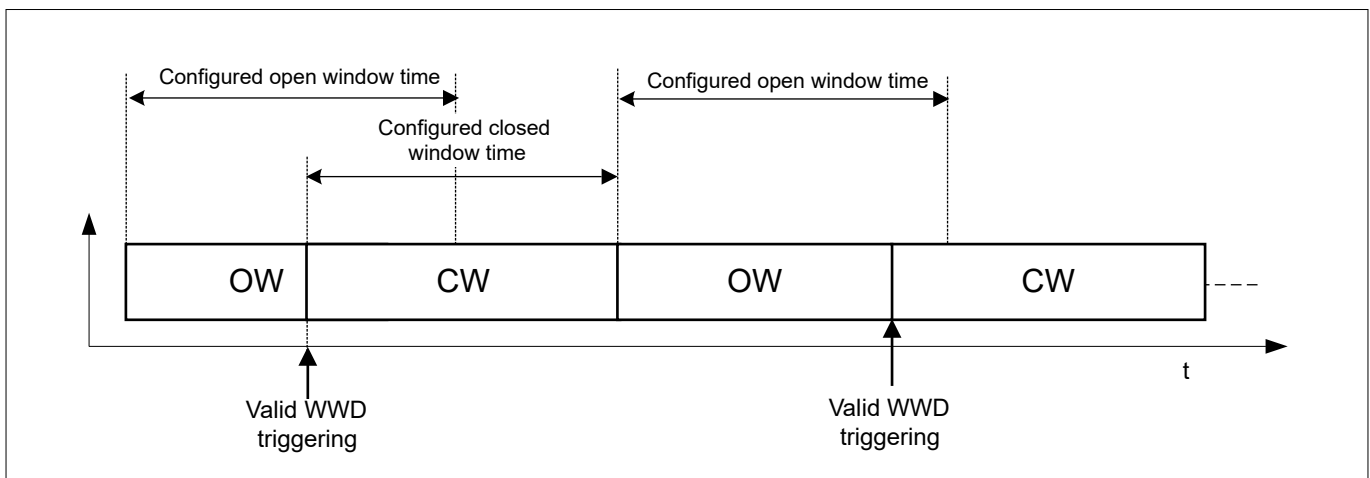
**Equation 2**

$$t_{CW} = (WWDx\_PW\_CW\_CFG.CW + 1) \times 50 \times \textit{time base}$$

**Equation 3**

The duration of the closed window of the window watchdog is also configurable to be set to 0. If this setting is used (**WWDx\_PW\_CW\_CFG.CW\_DIS = 1**), a successful trigger within the open window will immediately initialize a new open window again.

**10.1.2.1.1 Valid triggering of the window watchdog**

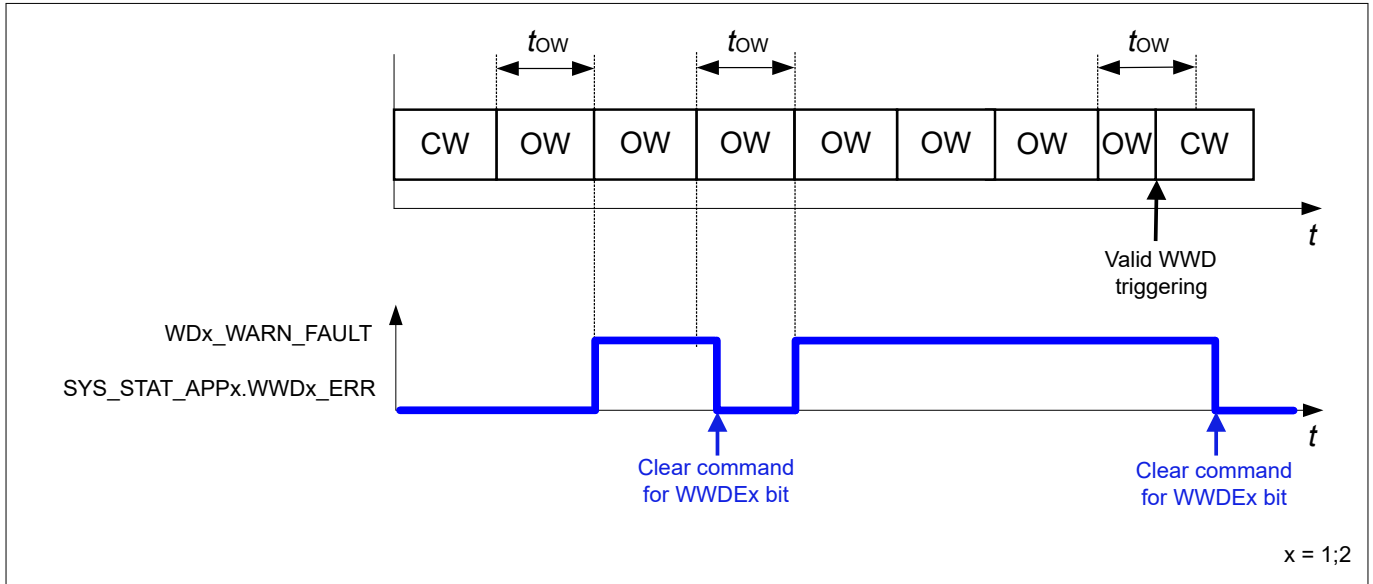


**Figure 34 Valid triggering of the window watchdog**

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Initially the window watchdog starts with an open window. If successfully triggered, the open window closes immediately and a closed window is started. After the closed window was active for the configured time, an open window is started again. After reconfiguration the window watchdog starts with the configured open window and its corresponding error counter is reset.

**10.1.2.1.2 Invalid triggering due to missing trigger during open window**



**Figure 35 Invalid service due to missing trigger during open window assuming error counter remains smaller than threshold**

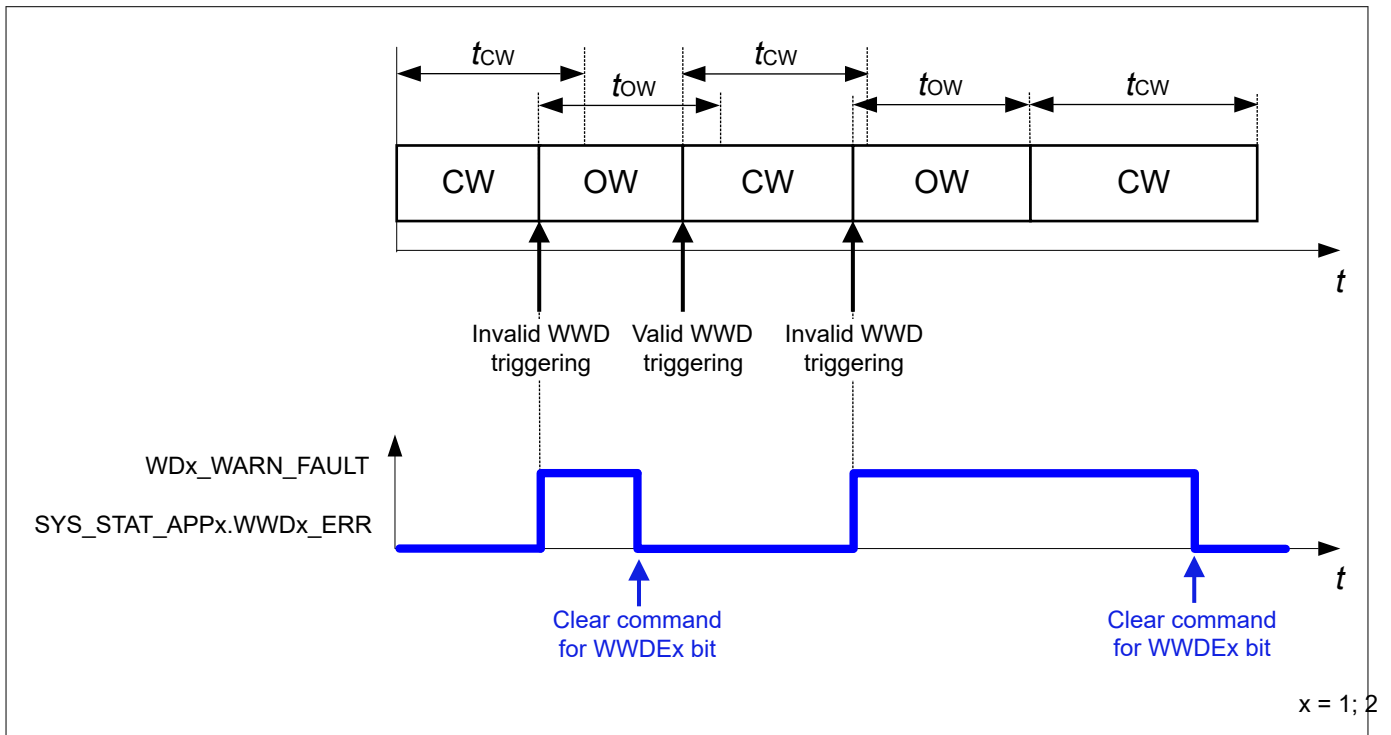
If the open window expires without any trigger, then the watchdog starts a new timing sequence with an open window and the device performs the following actions:

1. Increment the corresponding error counter value by 2, see [Chapter 10.1.2.1.5](#)
2. If the error counter remains below the configured threshold:
  - then:
    - Generate a watchdog warning fault  $WDx\_WARN\_FAULT$
    - Set the corresponding error bit  $SYS\_STAT\_APPx.WWDx\_ERR$ , which can be cleared via SPI
  - else:
    - Generate a watchdog severe fault  $WDx\_SEV\_FAULT$

(x = 1; 2)

**10 Monitoring functions**

**10.1.2.1.3 Invalid triggering due to trigger during closed window**



**Figure 36 Invalid triggering due to trigger during closed window assuming error counter remains smaller than threshold**

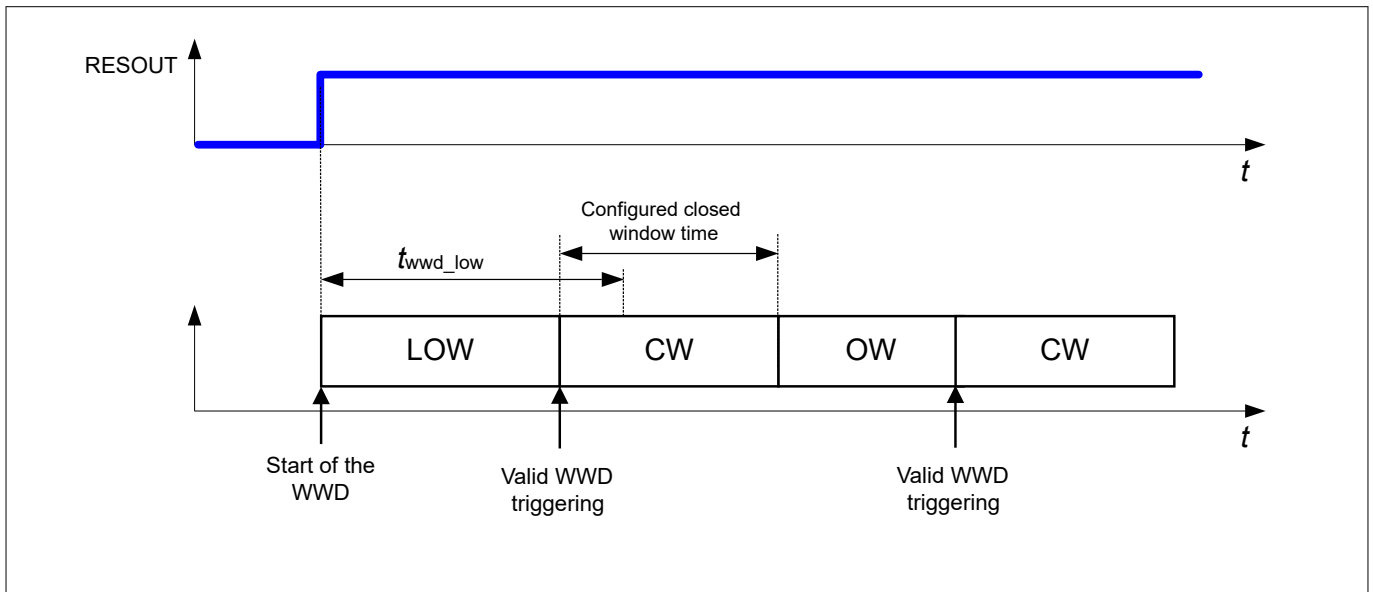
If the watchdog is triggered during the closed window, then it starts a new watchdog timing sequence with an open window and the device performs the following actions:

1. Increment the corresponding error counter value by 2, see [Chapter 10.1.2.1.5](#)
2. If the error counter remains below the configured threshold:
  - then:
    - Generate a watchdog warning fault  $WDDx\_WARN\_FAULT$
    - Set the corresponding error bit  $SYS\_STAT\_APPx.WWDx\_ERR$ , which can be cleared via SPI
  - else:
    - Generate a watchdog severe fault  $WDDx\_SEV\_FAULT$

(x = 1; 2)

**10 Monitoring functions**

**10.1.2.1.4 Watchdog startup behavior (enable and reset)**

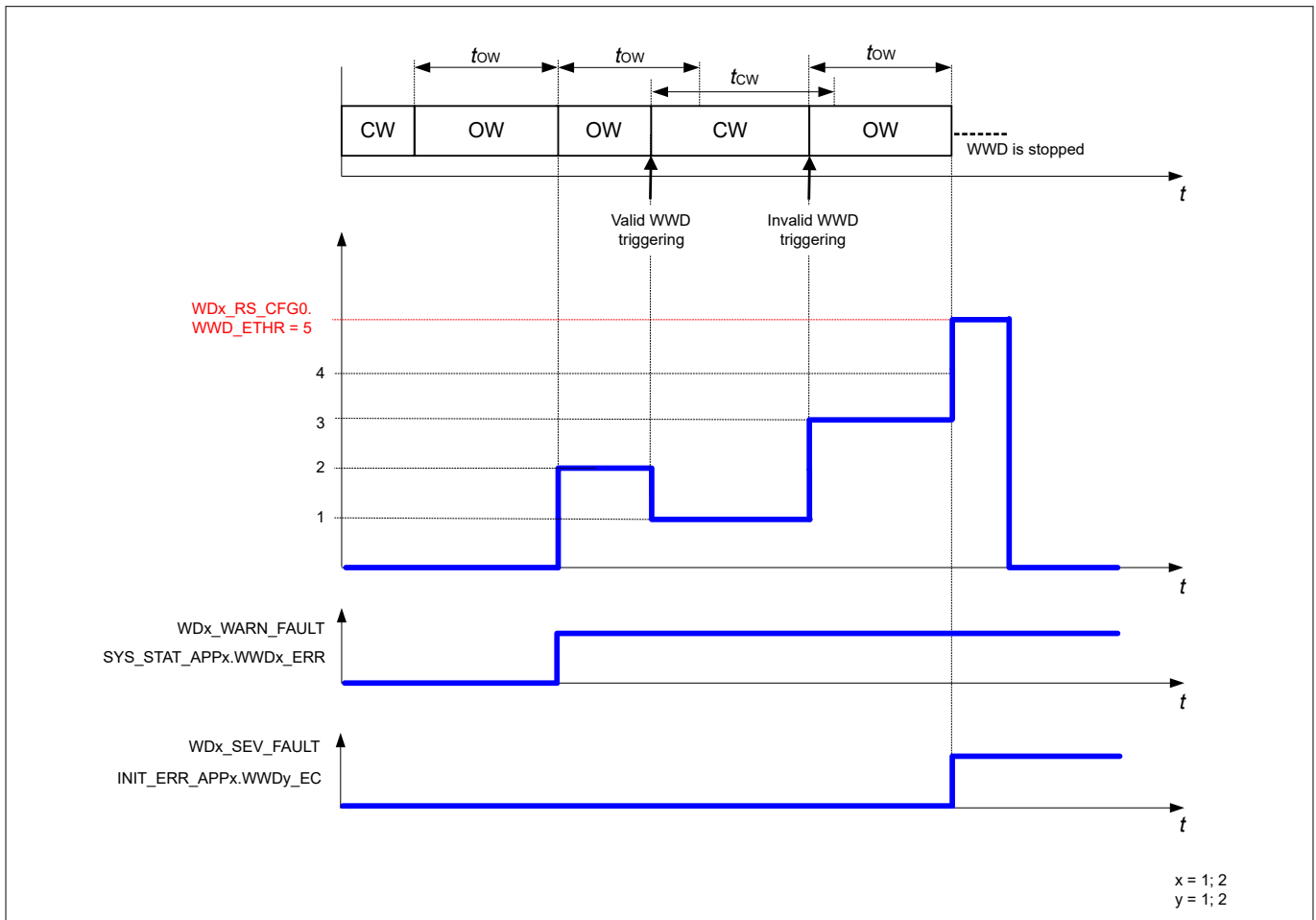


**Figure 37 Watchdog initialization phase**

Whenever INIT state is entered and RESOUT was released (pin RESOUT goes "high"), the watchdog is enabled and starts the first watchdog timing window sequence with a long open window. The long open window time  $t_{\text{WWD\_LOW}}$  matches the INIT timer duration  $t_{\text{INIT}}$ . If a valid trigger is provided within  $t_{\text{WWD\_LOW}}$  the WWD starts operating as described in this chapter, else the watchdog long open window expires together with the INIT timer and an INIT\_TIMER\_FAULT is generated.

**10 Monitoring functions**

**10.1.2.1.5 Windows watchdog error counter**



**Figure 38 Window watchdog error counter**

If the device detects an invalid triggering, it increments the value of **WWDx\_ECNT\_STAT.ECNT** by 2.

If the device detects a valid triggering, it decrements **WWDx\_ECNT\_STAT.ECNT** by 1.

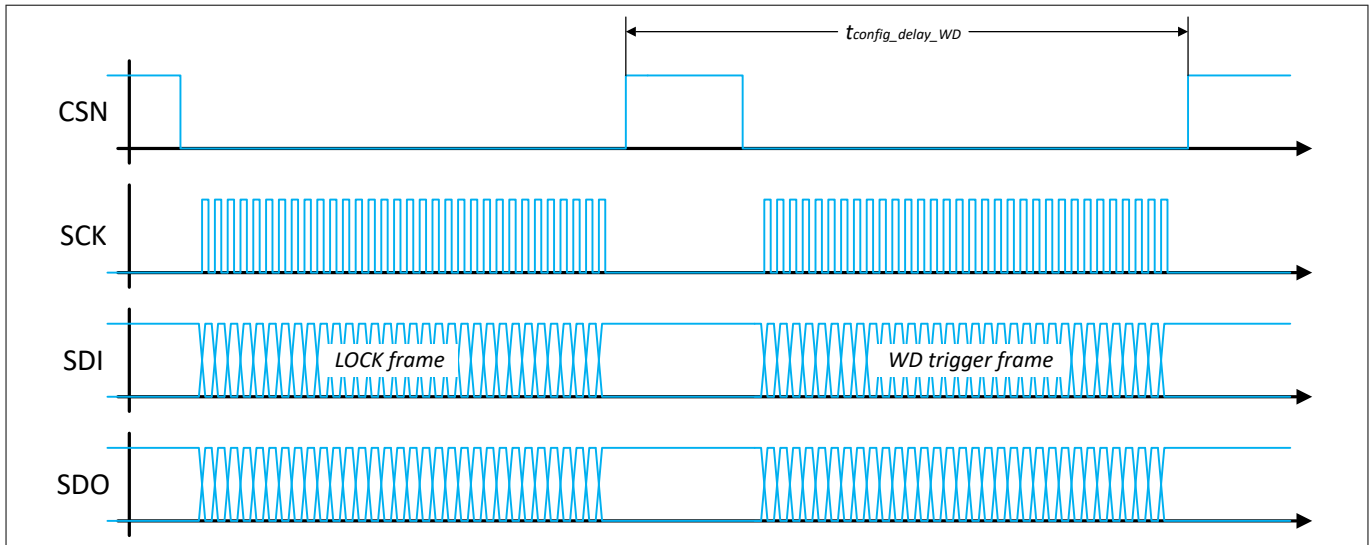
If the value of the ECNT bitfield reaches the value of the configured WWD error counter threshold **WDx\_RS\_CFG0.WWD\_ETHR**, the device performs the following actions:

- Generate a watchdog severe fault **WDx\_SEV\_FAULT**
- Set the corresponding error bit **INIT\_ERR\_APPx.WWDy\_EC**, which can be cleared via SPI
- Clear the error counter

**10.1.2.1.6 Timing constraints and behavior after configuring the watchdog**

After configuring the watchdog and before first service there is a timing constraint, which needs to be respected. New configurations of the watchdog, such as open/closed window time, made by the microcontroller can take up to  $t_{config\_delay\_wd}$  before they become active.. Because the watchdog configuration registers belong to the protected registers, an unlock and lock command must be sent. Only upon successfully receiving the lock command changes, made to the watchdog configuration, are mirrored to the corresponding reflected status registers and hereby made available for the PMICs modules. Hence the lock command marks the start of the timing before a first trigger can be received via SPI and applied to the new configuration. This timing limitation does however not apply to a trigger via WDI pin, since the combination of sample time  $t_{WDI\_spl}$  and filter criteria will always be longer than  $t_{config\_delay\_wd}$ .

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**Figure 39** Watchdog trigger delay after configuration of watchdog module

**10.1.2.2 Electrical characteristics window watchdog (WWD)**

**Table 34** Electrical characteristics window watchdog (WWD)

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Cycle time	$t_{\text{wwd\_cycle\_0}}$	90	100	110	$\mu\text{s}$	Selectable via SPI	DS-1660
Cycle time, default	$t_{\text{wwd\_cycle\_1}}$	900	1000	1100	$\mu\text{s}$	Selectable via SPI	DS-1659
Long open window time	$t_{\text{wwd\_low}}$	540	600	660	ms	Used for the initial WWD activation, or after each WWD restart due to recovery from a fault condition	DS-1653
WDI sample time	$t_{\text{WDI\_spl}}$	45	50	55	$\mu\text{s}$	<sup>2)</sup> <sup>1)</sup>	DS-2166
WD configuration-trigger delay	$t_{\text{config\_delay\_wd}}$	–	–	22	$\mu\text{s}$	<sup>2)</sup>	DS-2068

1) Since ERR2 and WDI share the same pin, they also share the electrical characteristic for voltage levels, hysteresis and current specification. Therefore it is being referred to table [Electrical characteristics error monitoring \(ERR MON\) \[EC-Table-P\]](#)

2) Not subject to production test, specified by design

## 10 Monitoring functions

### 10.1.3 Functional watchdog (FWD)

#### 10.1.3.1 Functional description functional watchdog (FWD)

The functional watchdog (FWD, also called question/answer watchdog) generates a question taken from a table and starts the heartbeat counter from zero. To trigger the functional watchdog correctly, the correct response bytes to each question must be written to an answer register, in a specific order, within the heartbeat period.

The heartbeat timer increments until it reaches its configured heart beat timer period. This period is configured via the register **FWDx\_PW\_HBTP\_CFG.HBTP**. The length of the period follows the following formula for the heart beat timer:

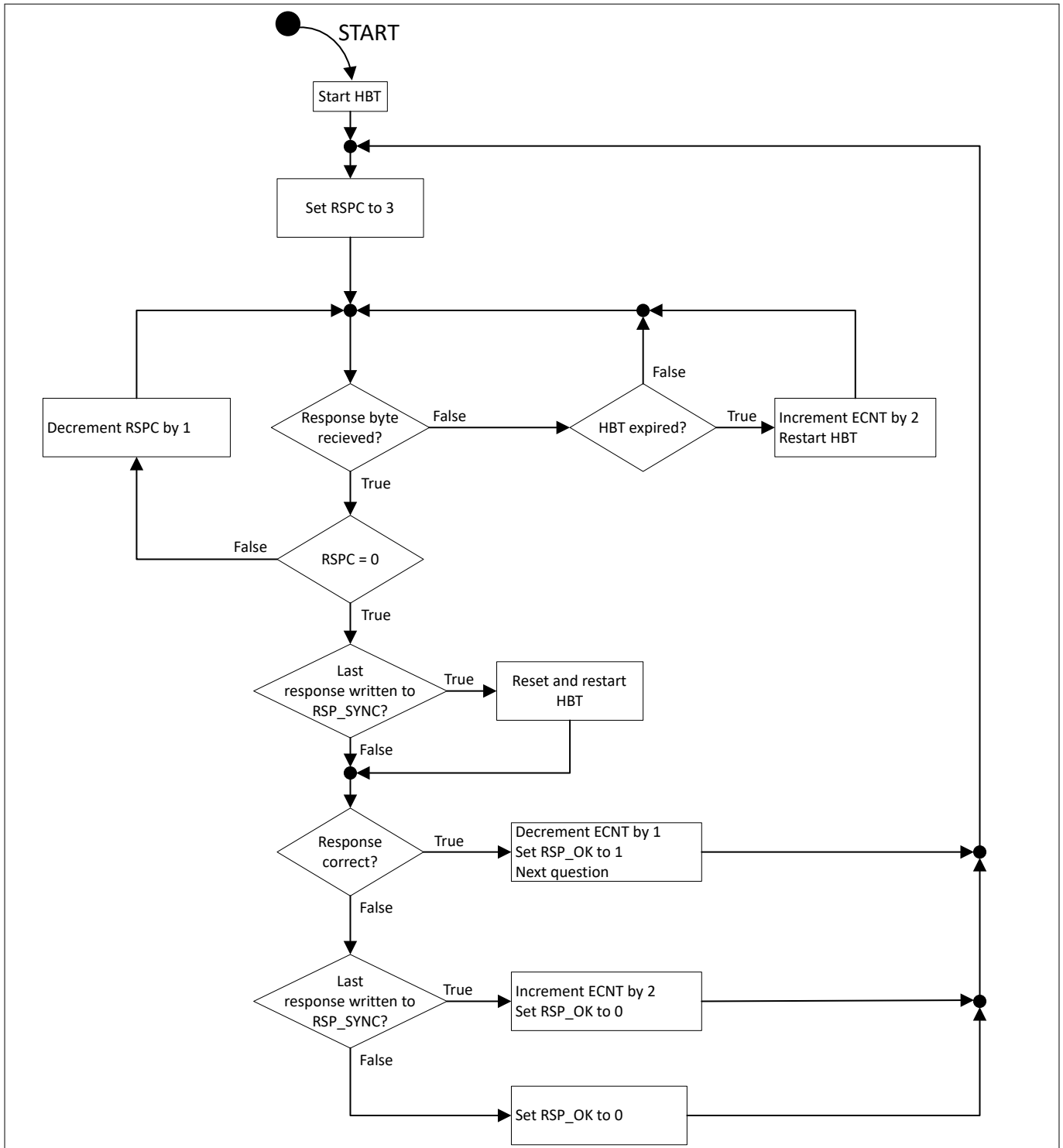
$$\text{heartbeat time} = (\text{FWDx_RS_HBTP_CFG.HBTP} + 1) \times 50 \times \text{time base} \quad (\text{interpreted value})$$

#### Equation 4

##### 10.1.3.1.1 Functional watchdog service

Upon enabling or reconfiguration of the FWD its corresponding HBT starts running. It waits for 4 bytes being written to FWDx\_RSP.RSP or FWDx\_RSP\_SYNC.RSP\_SYNC consecutively. The response bytes have to match the question which is read from FWDx\_STAT.QUEST. If all bytes are written correctly before the HBT expires, the service was successful, which decrements the error counter and starts a new sequence with the next question in FWDx\_STAT.QUEST. After having received the 4th response byte, the received byte is checked for correctness. If the response was incorrect and the last byte was written to FWDx\_RSP\_SYNC.RSP\_SYNC the error counter of FWDx is incremented. Also, if the HBT expires the corresponding error counter is incremented. Status register FWDx\_STAT is reset upon reconfiguration of the FWD.

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**Figure 40 FWD flow chart**

**Valid triggering of the functional watchdog**

The question consists of 4 bits, the corresponding answer consists of four consecutive response bytes. The answer to each question in the register **FWDx\_STAT.QUEST** needs to be written to the response register **FWDx\_RSP.RSP** or **FWDx\_RSP\_SYNC.RSP\_SYNC**.

**10 Monitoring functions**

**Table 35**                    **Functional watchdog questions and responses**

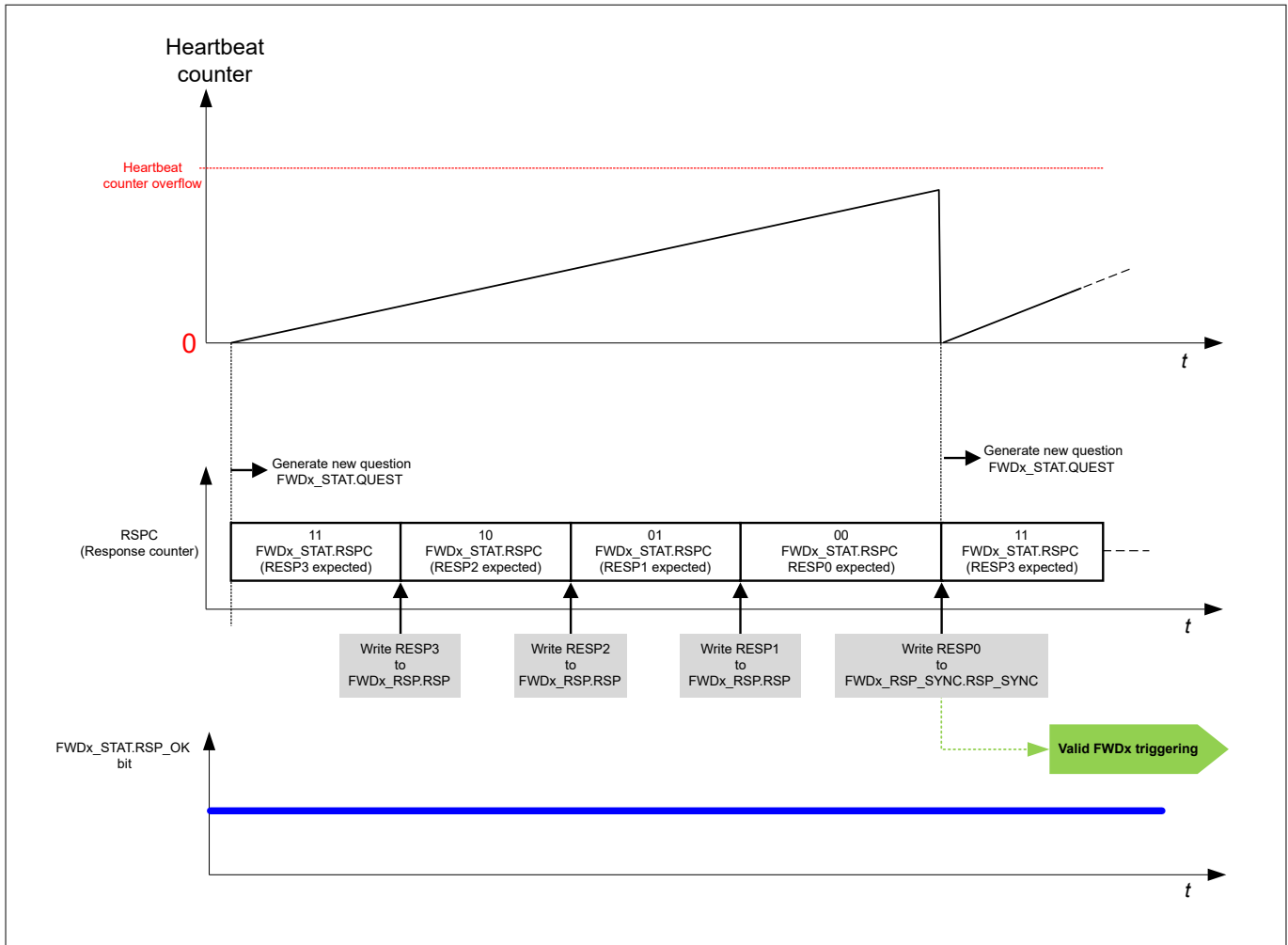
<b>QUEST[3:0]</b>	<b>RESP3</b>	<b>RESP2</b>	<b>RESP1</b>	<b>RESP0</b>
0	FF	0F	F0	00
1	B0	40	BF	4F
2	E9	19	E6	16
3	A6	56	A9	59
4	75	85	7A	8A
5	3A	CA	35	C5
6	63	93	6C	9C
7	2C	DC	23	D3
8	D2	22	DD	2D
9	9D	6D	92	62
A	C4	34	CB	3B
B	8B	7B	84	74
C	58	A8	57	A7
D	17	E7	18	E8
E	4E	BE	41	B1
F	01	F1	0E	FE

If all of the following conditions are fulfilled for a question, the FWD is triggered correctly (valid trigger):

- The four response bytes are in the correct order from RESP3 to RESP0
- All four responses are correctly written to the response registers

To reset the heartbeat counter, the last response (RESP0) must be written to the synchronization response register **FWDx\_RSP\_SYNC.RSP\_SYNC**.

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**Figure 41 Example FWD: Possible valid triggering**

Upon detection of a valid triggering, the device performs the following actions:

- Generate a new question
- Resets the response counter RSPC to 3
- Decrements the corresponding error counter value by 1 if not already at 0, see [Chapter 10.1.2.1.5](#)
- Sets the corresponding status bit of the response bytes **FWDx\_STAT.RSP\_OK** to 1
- If the last byte has been written to **FWDx\_RSP\_SYNC.RSP\_SYNC** also the HBT periode is reset and restarted

**Invalid triggering of the functional watchdog**

If any of the following conditions is fulfilled, the FWD is triggered incorrectly (invalid trigger):

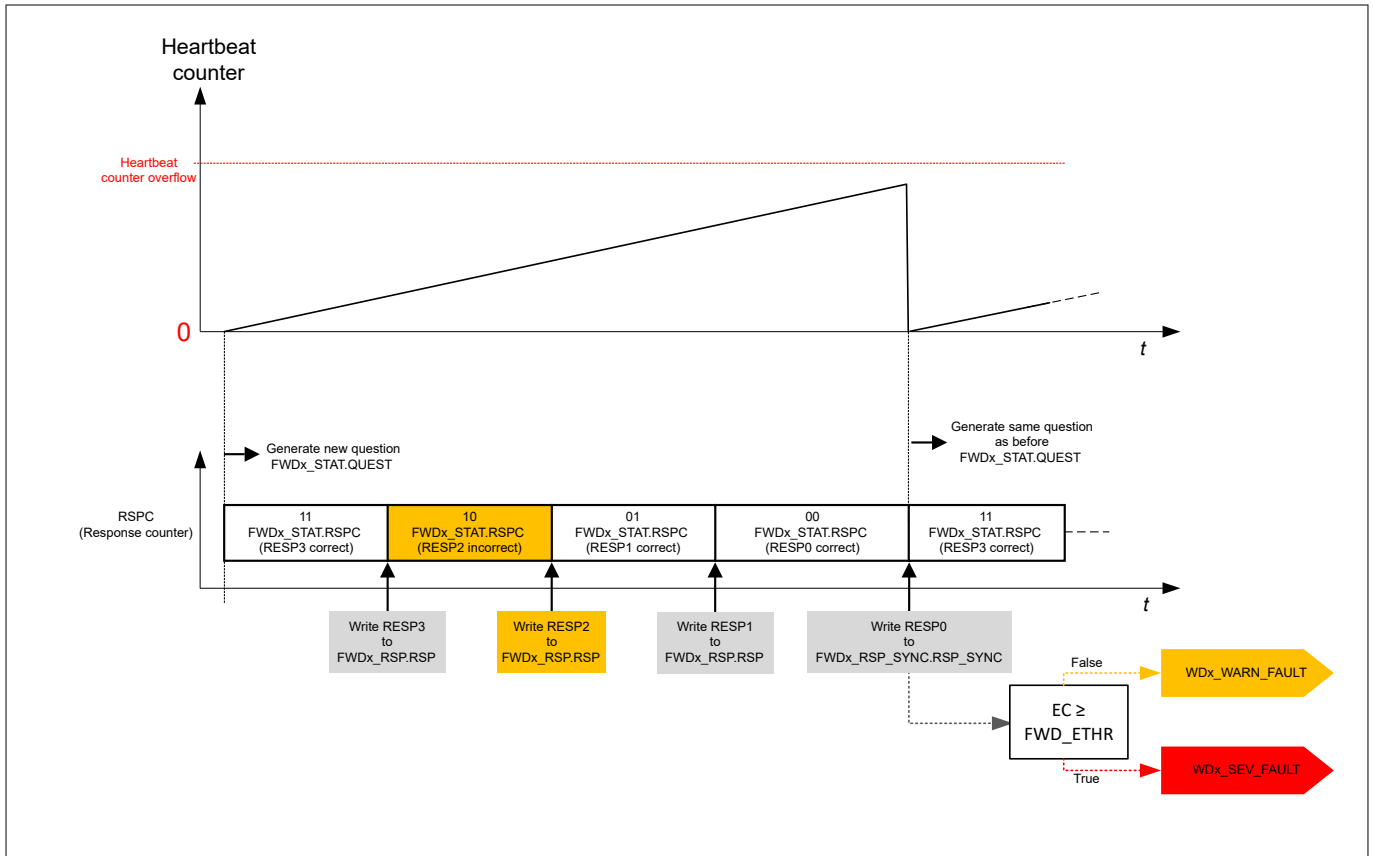
- Wrong order or content of the four response bytes
- Heartbeat period expires (heartbeat counter overflow)

Upon detection of an invalid trigger, the device performs the following actions:

- HBT expiration:
  - Increment error counter **FWDx\_STAT.ECNT** by 2, see [Chapter 10.1.3.1.2](#)
  - Reset and restart HBT
- If the 4<sup>th</sup> byte was written to **FWDx\_RSP\_SYNC.RSP\_SYNC**:
  - Reset and restart HBT

**10 Monitoring functions**

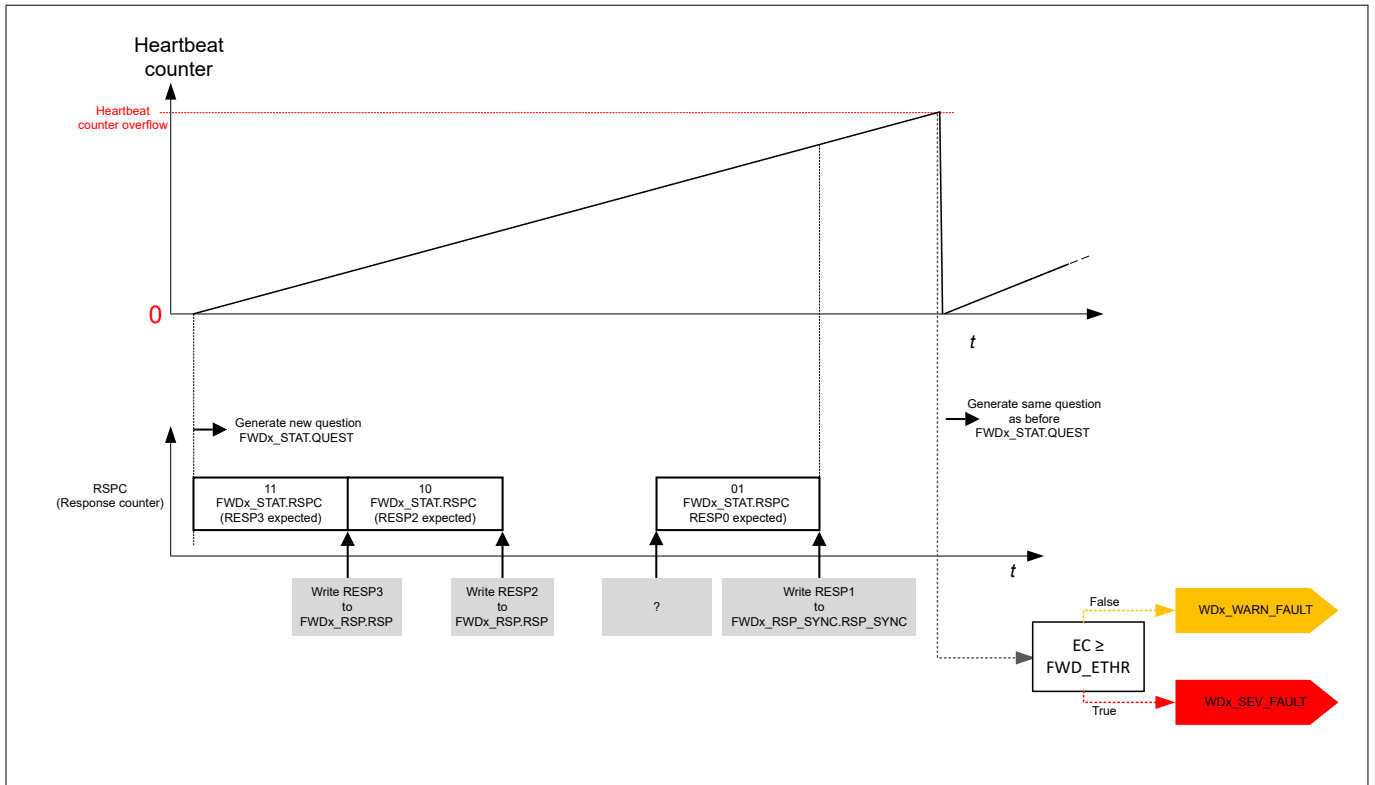
- Set the status bit **FWDx\_STAT.RSP\_OK** to 0
- Increment the error counter **FWDx\_STAT.ECNT** by 2, see [Chapter 10.1.3.1.2](#)
- If the 4<sup>th</sup> byte was written to **FWDx\_RSP.RSP**:
  - Set the status bit **FWDx\_STAT.RSP\_OK** to 0
- If error counter **FWDx\_STAT.ECNT** was incremented (see [Reaction on faults](#)):
  - Generate a watchdog warning fault **WDx\_WARN\_FAULT** if error counter is still below configured error threshold, see [Chapter 9](#)
  - Sets the corresponding error bit **SYS\_STAT\_APPx.FWDx\_ERR**, which can be cleared via SPI



**Figure 42 FWD: Wrong response (RESP2) timing diagram**

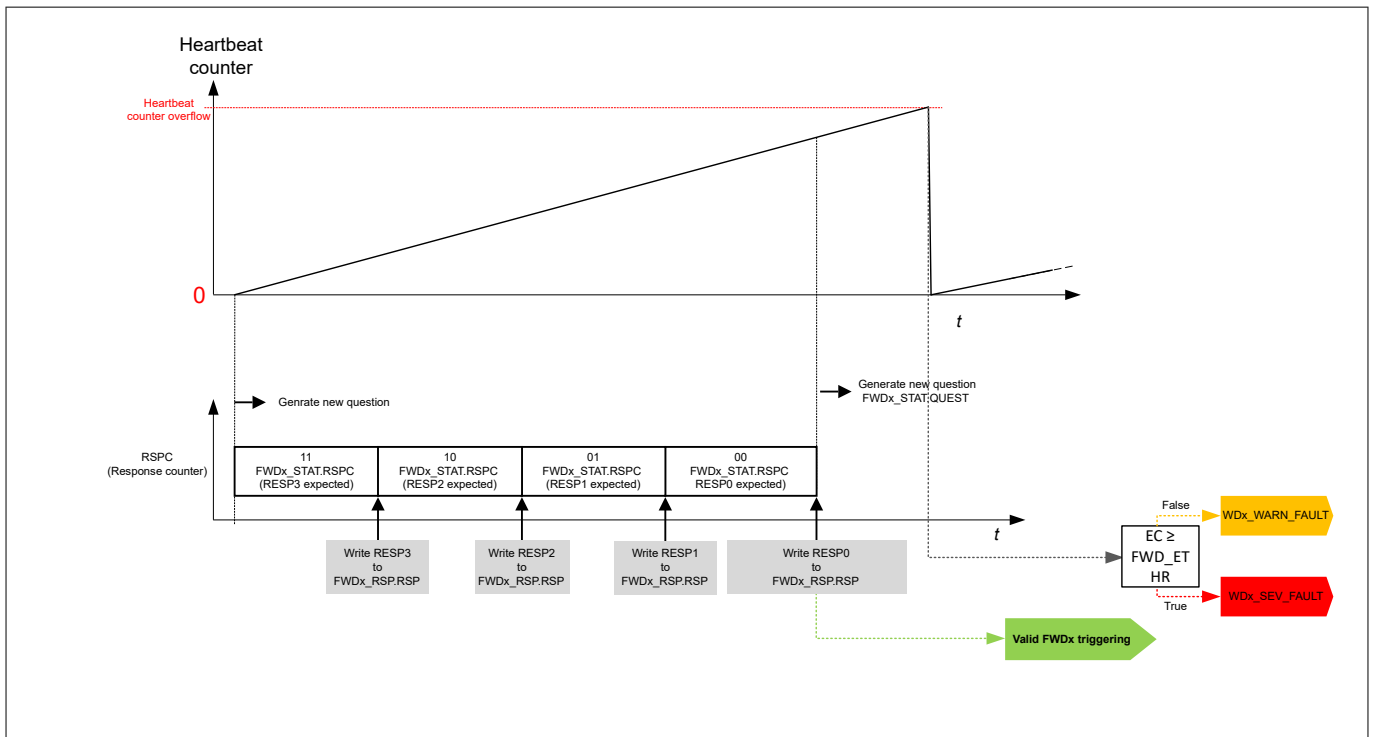
(x = 1, 2)

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**Figure 43** Missing response timing diagram

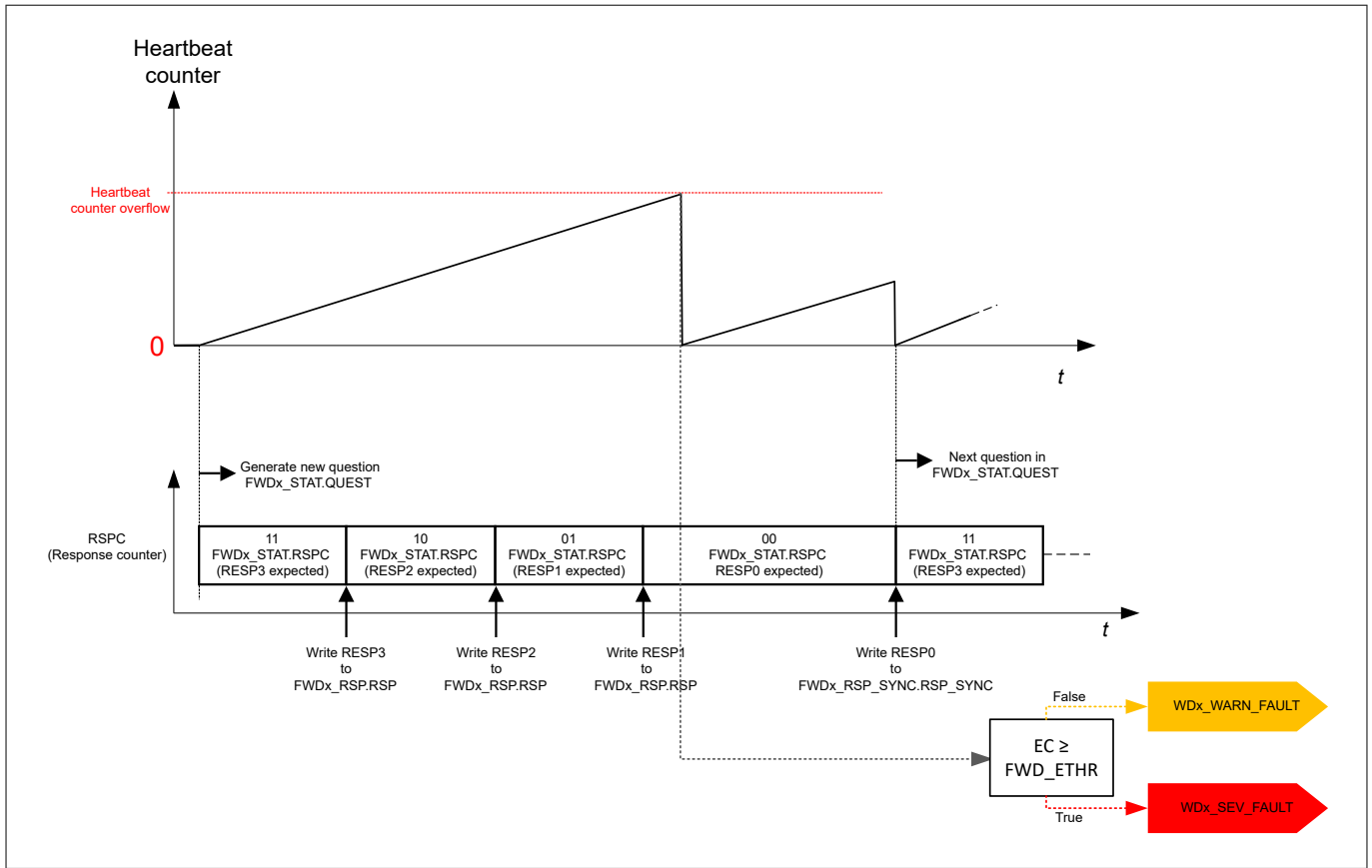
(x = 1, 2)



**Figure 44** Missing synchronization timing diagram

(x = 1, 2)

**10 Monitoring functions**



**Figure 45 Heartbeat counter overflow**

(x = 1, 2)

**10.1.3.1.2 Functional watchdog error counter overflow**

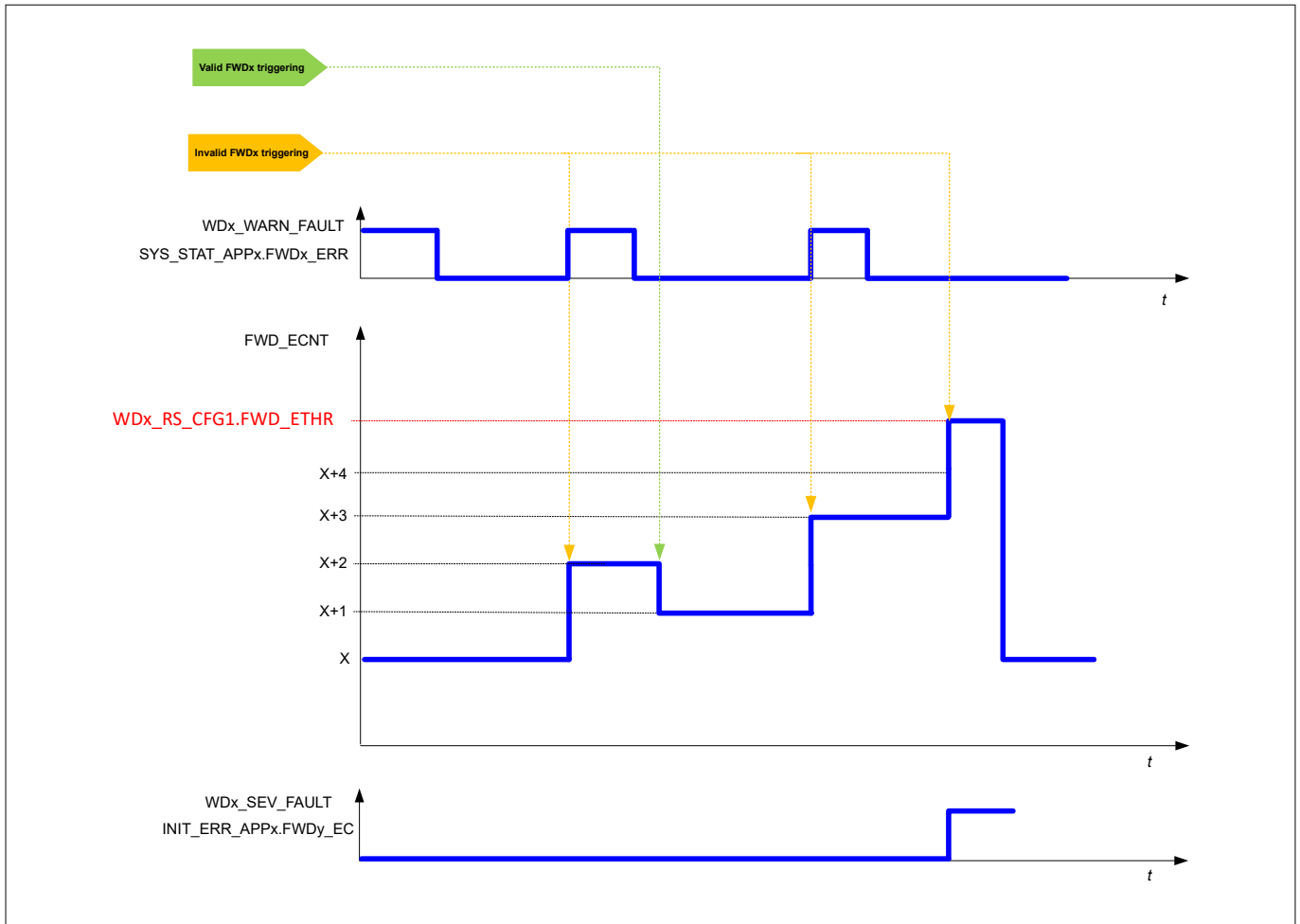
If the device detects valid FWDx triggering, then it decrements the value of the ECNT bitfield in the **FWDx\_STAT** register by 1 if greater than 0.

If the device detects invalid FWDx triggering, then it increments the value of the ECNT bitfield in the **FWDx\_STAT** register by 2.

If the value of the ECNT bitfield reaches or exceeds the value of the configured FWD error counter threshold **WDx\_PW\_CFG1.FWD\_ETHR**, the device performs the following actions (see [Reaction on faults](#)):

- Generate a watchdog severe fault **WDx\_SEV\_FAULT**, see [Chapter 9](#)
- Set the corresponding failure bit (register **INIT\_ERR\_APPx.FWDy\_EC**), which can be cleared via SPI
- Clear the FWD error counter

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**Figure 46 Error counter (ECNT) overflow timing diagram**

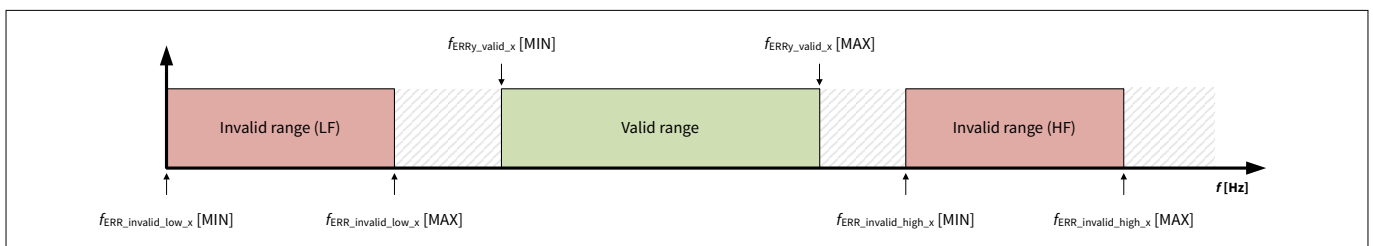
(x = 1, 2)  
 (y = 1, 2)

**10.2 Error monitoring (ERR MON)**

**10.2.1 Introduction**

The error monitoring (ERR MON) function is a safety mechanism that supervises the safety management unit (SMU) of the application's microcontroller. There are three independent ERRx inputs. If one of the error monitors detects a signal frequency at its input which is outside of the valid frequency range, the device reacts accordingly (see [Reaction on faults](#)).

(x=0, 1, 2)

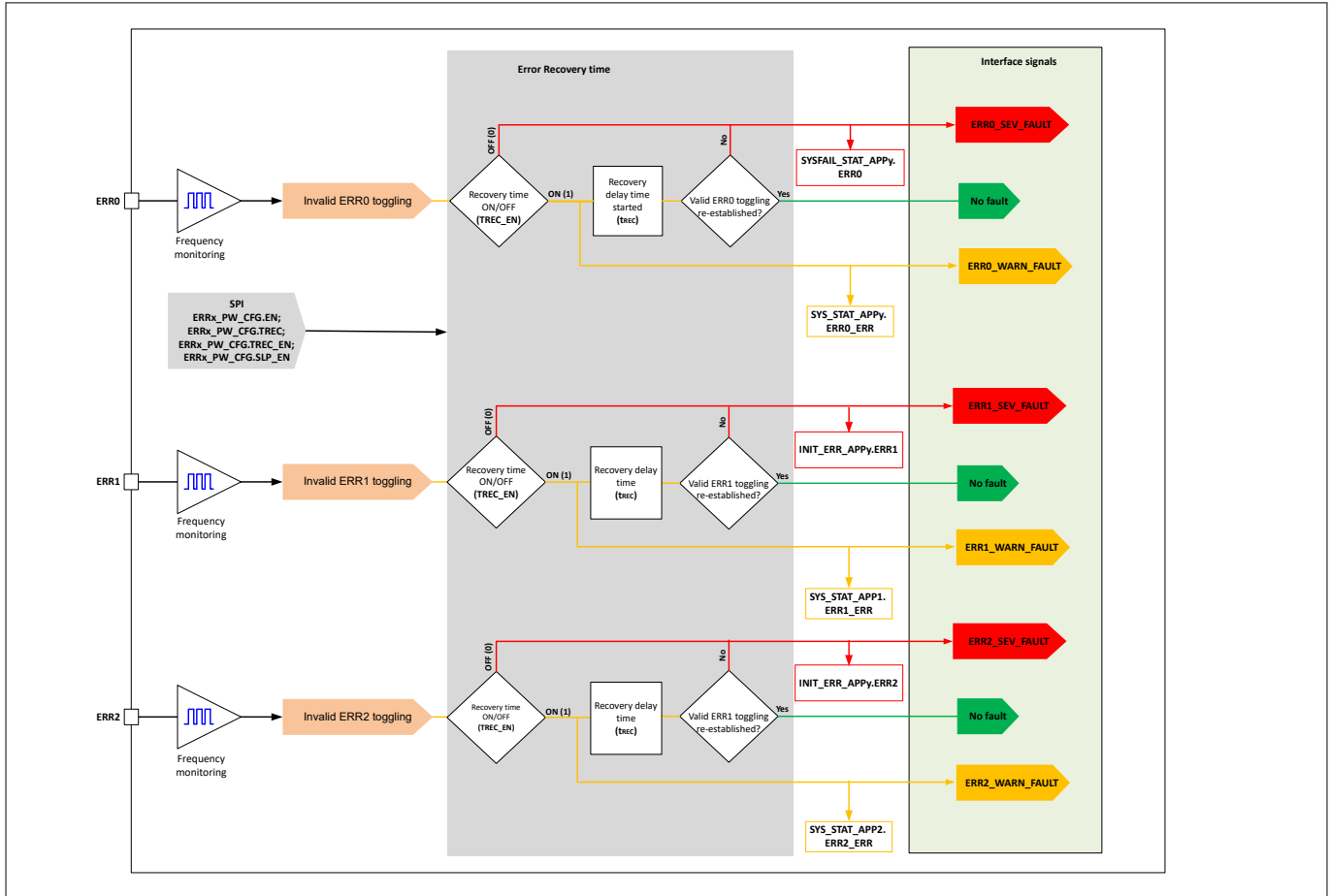


**Figure 47 Toggling frequency signal applied on ERRy monitoring inputs**

(x = LF; HF)

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(y = 0; 1; 2)



**Figure 48 Functional block diagram error monitoring functions**

(x = 1, 2, 3; y = 1, 2)

The device provides the following error monitoring channels:

- ERR MON0 for the ERR0 pin
- ERR MON1 for the ERR1 pin
- ERR MON2 for the ERR2 pin

**10.2.2 Functional description error monitoring (ERR MON)**

**10.2.2.1 Error monitoring initialization**

The error monitoring module can be properly triggered either using a low or a high frequency:

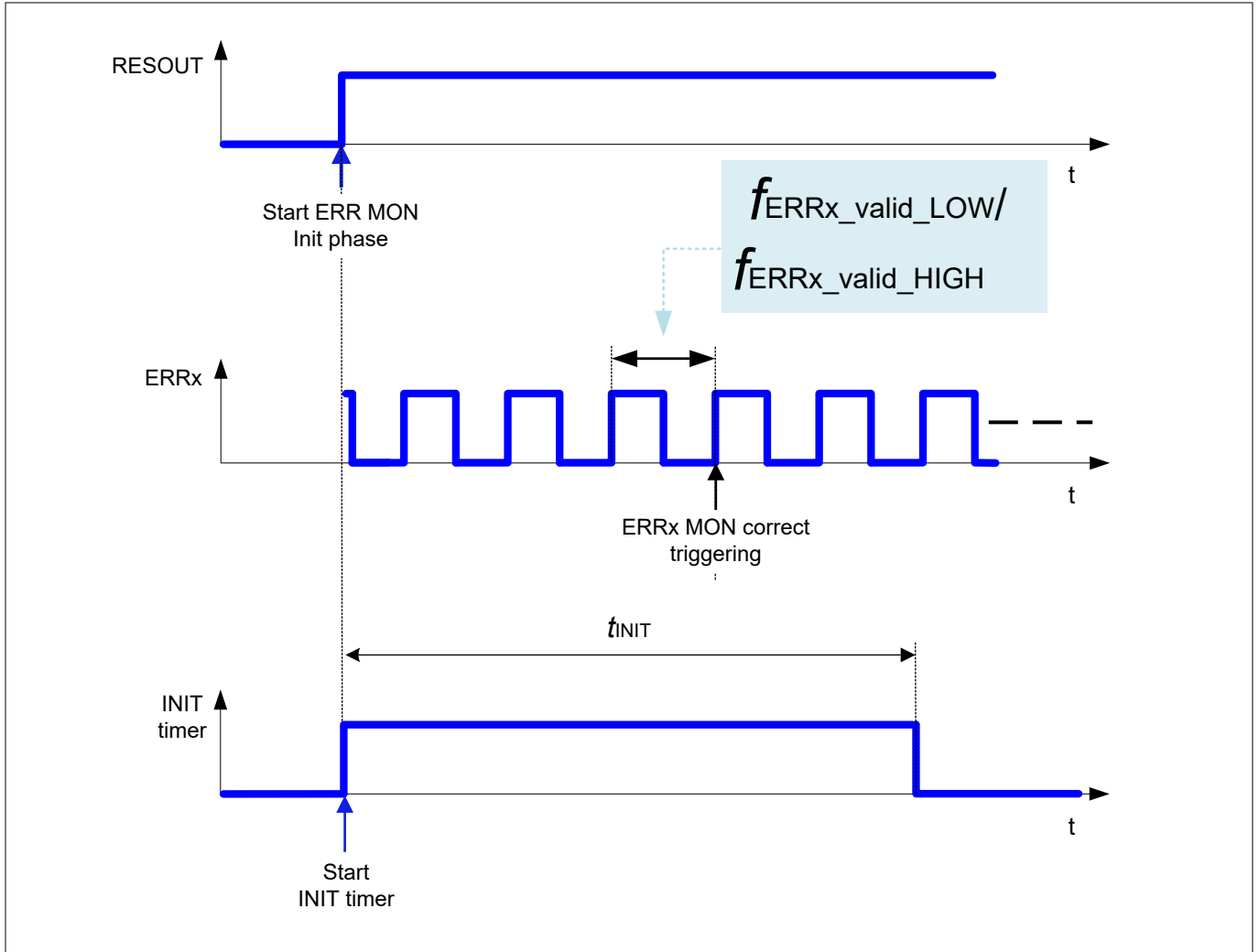
- Valid input signal frequency low ( $f_{ERRx\_valid\_LOW}$ )
- Valid input signal frequency high ( $f_{ERRx\_valid\_HIGH}$ )

Upon applying the error monitoring signal at ERRx, the device ignores the first six edges of the signal to allow stabilization of the external signal. Next the device automatically detects the frequency range among the allowed ranges. If no correct frequency range can be detected, it reacts accordingly (see [Reaction on faults](#)). While operating, the ERRx module continuously monitors the applied signal. This procedure is always executed whenever the ERRx module experiences a reset condition and reinitialization is required. Reset conditions are:

- RESOUT showed a reset
- Starting from POWERDOWN
- Recovering from FAILSAFE, STANDBY or SLEEP with QUC or BUCKCORE disabled
- Exiting form SLEEP with **ERRx\_RS\_CFG.EN = 1** and **ERRx\_RS\_CFG.SLP\_EN = 0**

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(x = 0; 1; 2)



**Figure 49 Error monitoring correct triggering**

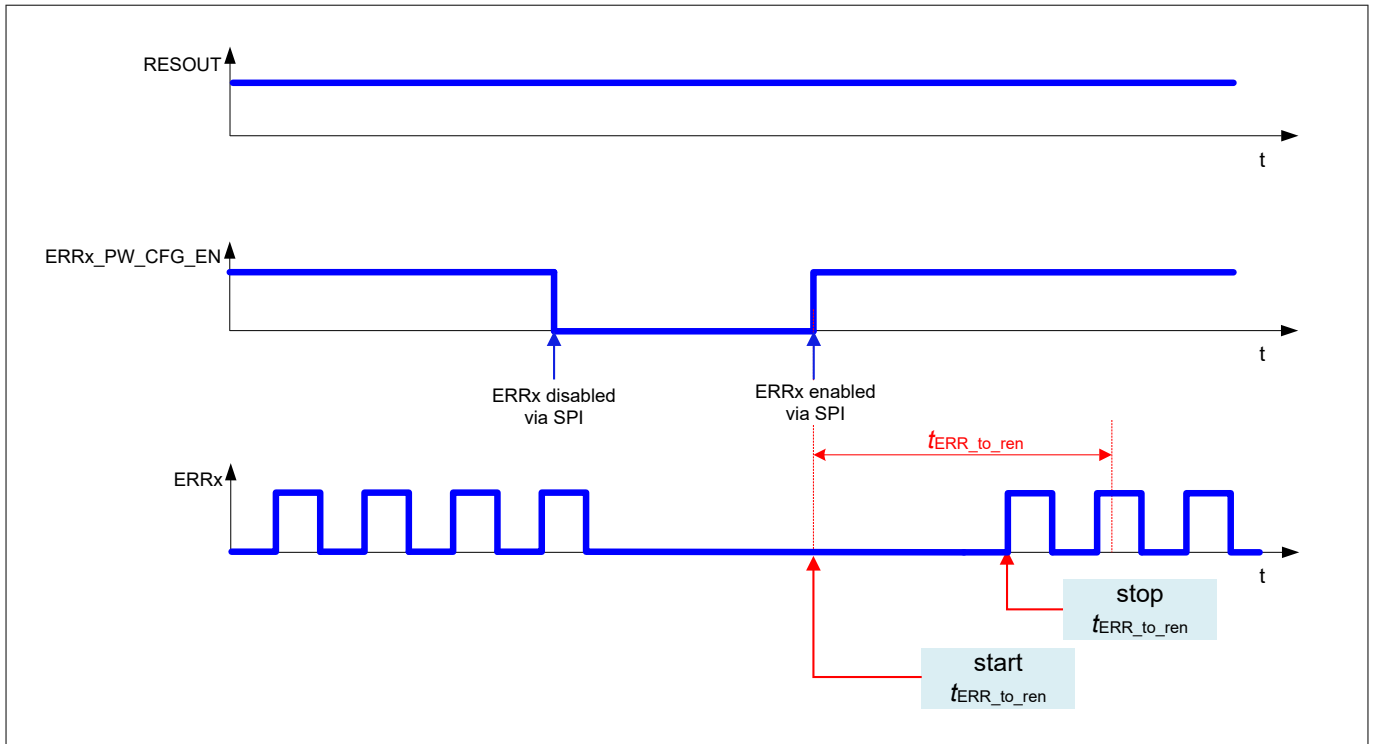
(x = 0; 1; 2)

**10.2.2.2 Error monitoring configuration**

Each error monitoring channel can be activated or deactivated independently in the register bit **ERRx\_PW\_CFG.EN**.

On reactivating the error monitoring channel via SPI, the device starts the reactivation timeout after reenabling  $t_{ERR\_to\_ren}$ . When the device detects an edge on the ERRx pin, it stops  $t_{ERR\_to\_ren}$ . If  $t_{ERR\_to\_ren}$  expires without detecting an edge, a severe fault is thrown.

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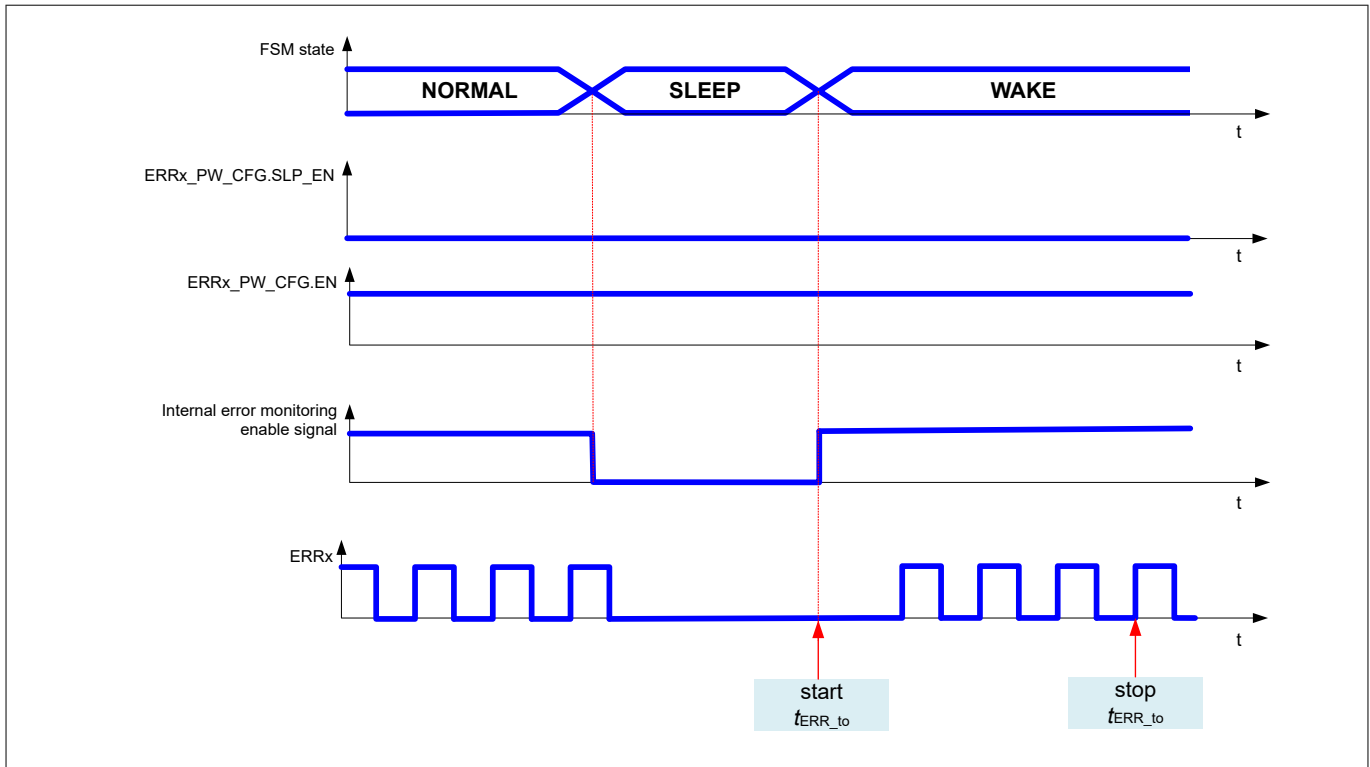
**Figure 50** ERRx reactivation timeout

(x = 0; 1; 2)

The error monitoring channels can be enabled and disabled independently from each other by writing the respective **ERRx\_PW\_CFG.EN** bit. In addition each error monitoring channel can be configured to remain active while being in SLEEP state with the respective bit **ERRx\_PW\_CFG.SLP.EN**. If the error monitoring has not been configured to remain active while being in SLEEP state and it has already been running before entering SLEEP state, the function will re-enable upon transition into WAKE state and starts the reactivation timeout  $t_{ERR\_to}$ . This provides an additional time budget to apply an error monitoring signal again or disable the function. If no error monitoring is applied within  $t_{ERR\_to}$  an **ERRx\_SEV\_FAULT** is issued (see [Interrupt function \(INT\)](#) and [Reset function \(RESOUT\)](#)). The ERR timeout is a global timer and is only stopped, if either all ERRx channels are disabled or all enabled ERRx channels are properly serviced within  $t_{ERR\_to}$ .

**Note:** ERR2 can only be used if REDUCED OPERATION is enabled (**REDOP\_RS\_CFG1.EN = 1**).

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**Figure 51** ERRx reactivation timeout from SLEEP state

(x = 0; 1; 2;  
y = 1; 2)

**10.2.2.3 Error monitoring recovery timers**

Each error monitoring channel provides a recovery timer. On detection of an invalid ERRx toggling signal period, the corresponding recovery timer grants the application some time to recover and to resume valid error frequency generation.

The recovery timer of each error monitoring channel can be activated or deactivated independently in the register bit **ERRx\_PW\_CFG.TREC\_EN**.

For an activated recovery timer, the duration of the recovery time  $t_{REC}$  can be configured in the bitfield **ERRx\_PW\_CFG.TREC**.

**10.2.2.4 Invalid error toggling**

If any of the following conditions is fulfilled, then the device detects "invalid ERRx toggling":

- The ERR signal stops toggling and remains "low" or "high"
- The ERR signal starts toggling with a too high frequency ( $f_{ERR\_invalid\_high\_x}$ )
- The ERR signal starts toggling with a too low frequency ( $f_{ERR\_invalid\_low\_x}$ )

(x = LF; HF)

**Recovery time disabled**

On detection of an invalid ERRx triggering, the device performs the following actions:

- Generate an error monitoring severe fault **ERRx\_SEV\_FAULT**, see [Reaction on faults](#)
- Set the corresponding failure bit (**SYSFAIL\_STAT\_APPy.ERR0**, **INIT\_ERR\_APPy.ERRx**)

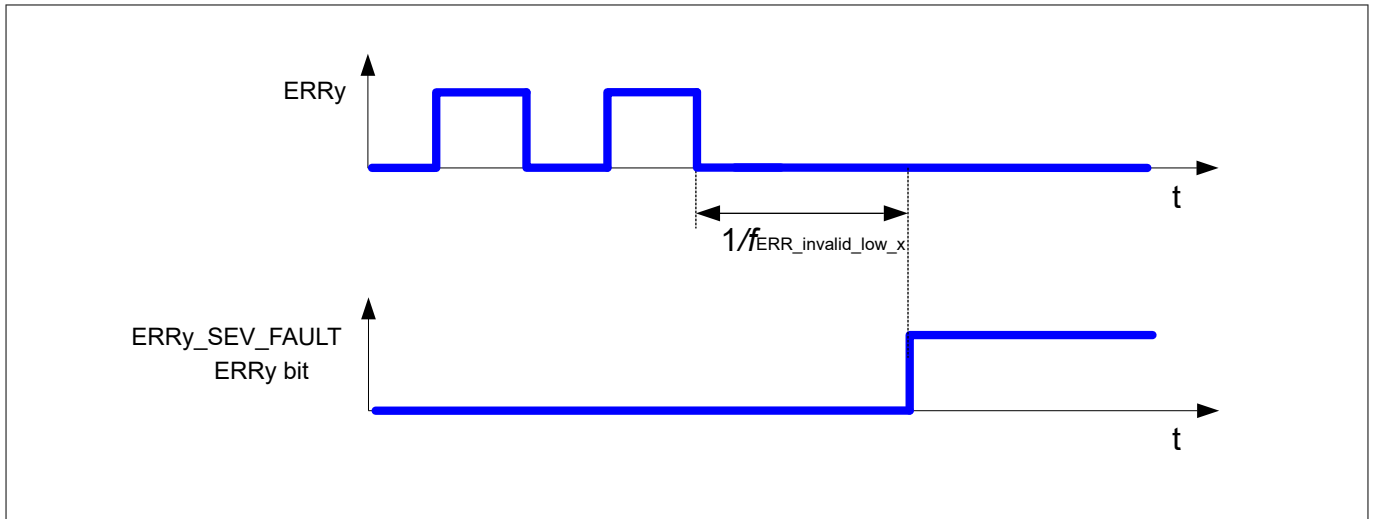
**Recovery time enabled**

On detection of invalid ERRx triggering, the device performs the following actions:

- Generate an error monitoring warning fault **ERRx\_WARN\_FAULT**, see [Reaction on faults](#)
- Set the corresponding failure bits (**SYS\_STAT\_APPy.ERRx\_ERR**), which can be cleared via SPI

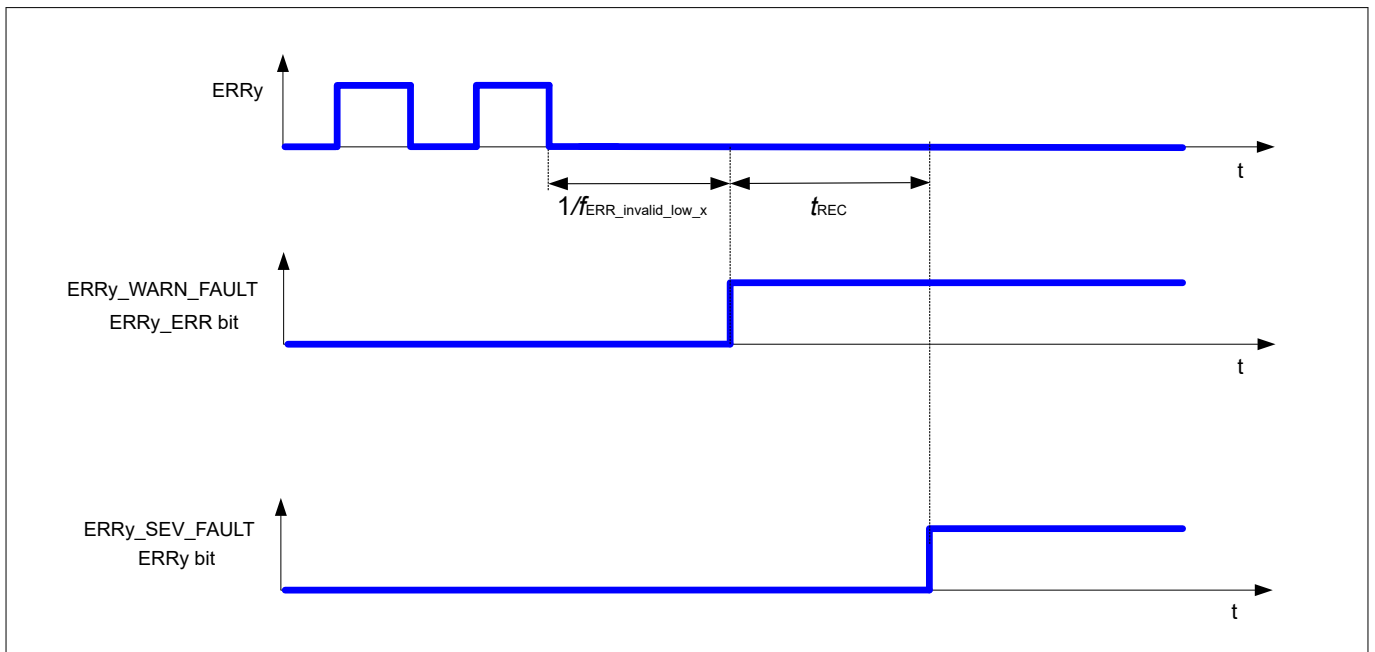
**10 Monitoring functions**

- Start the recovery timer
- If correct signal has been re-established before  $t_{REC}$  has expired, timer is stopped and no further actions take place
- Generate an error monitoring severe fault  $ERR_x\_SEV\_FAULT$  after the recovery time  $t_{REC}$  has expired and no valid error signal has been re-established in time, see [Reaction on faults](#)
- Set the corresponding failure bit (**SYSFAIL\_STAT\_APPy.ERR0, INIT\_ERR\_APPy.ERRx**), which can be cleared via SPI



**Figure 52** ERRy capture with too low frequency or stops toggling (recovery time disabled)

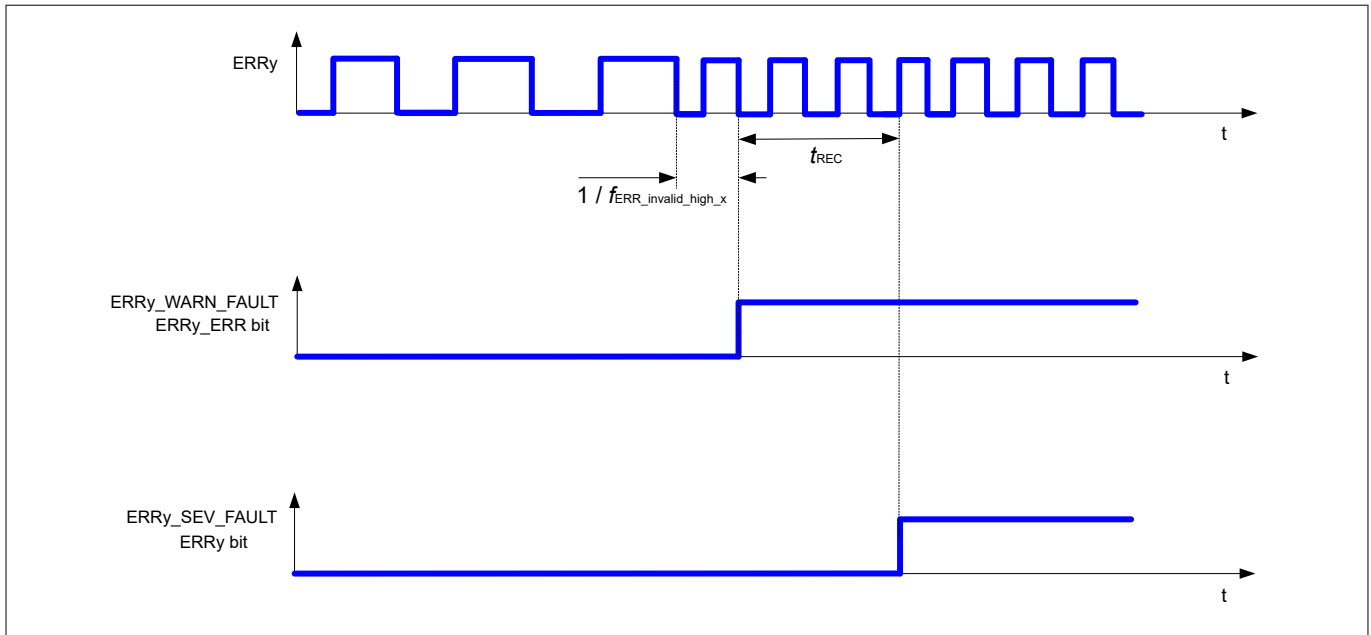
(x = LF; HF)  
 (y = 0; 1; 2)



**Figure 53** ERRy capture with too low frequency or stops toggling (recovery time enabled)

(x = LF; HF)  
 (y = 0; 1; 2)

**10 Monitoring functions**



**Figure 54** ERRy capture with too high frequency (recovery time enabled)

(x = LF; HF)  
 (y = 0; 1; 2)

**10.2.3 Electrical characteristics error monitoring (ERR MON)**

**Table 36** Electrical characteristics error monitoring (ERR MON)

V<sub>VS</sub> = 6.0 V to 36 V, T<sub>j</sub> = -40°C to +175°C, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
ERRx pin valid "high" voltage	V <sub>ERRx_HIG</sub> H	3.15	-	V <sub>QUC</sub>	V	V <sub>ERRx</sub> increasing; V <sub>QUC</sub> ≥ V <sub>QUC</sub> [Min.]	DS-1623
ERRx pin valid "low" voltage	V <sub>ERRx_LOW</sub>	0	-	0.8	V	V <sub>ERRx</sub> decreasing	DS-1625
ERRx pin hysteresis	V <sub>ERRx_HYS</sub> T	-	300	-	mV	V <sub>QUC</sub> = V <sub>QUC</sub> [Typ.]	DS-1626
ERRx pin pull-down current	I <sub>ERRx</sub>	-	135	330	µA	V <sub>ERRx</sub> = V <sub>QUC</sub>	DS-1628
ERRx pin input capacitance	C <sub>ERRx</sub>	-	4	15	pF	<sup>1)</sup>	DS-1629
Valid ERRx input signal frequency low	f <sub>ERRx_valid_LOW</sub>	10	-	45	kHz	-	DS-1630
Valid ERRx input signal frequency high	f <sub>ERRx_valid_HIGH</sub>	1000	-	2000	kHz	-	DS-1631
ERRx invalid input signal - too low frequency LF	f <sub>ERR_invali</sub> d_low_LF	0	-	5	kHz	<sup>1)</sup>	DS-1632
ERRx invalid input signal - too high frequency LF	f <sub>ERR_invali</sub> d_high_LF	96.2	-	1000 0	kHz	<sup>1)</sup>	DS-1633

**(table continues...)**

## 10 Monitoring functions

**Table 36 (continued) Electrical characteristics error monitoring (ERR MON)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
ERRx invalid input signal - too low frequency HF	$f_{ERR\_invalid\_low\_HF}$	0	–	0.5	MHz	<sup>1)</sup>	DS-1634
ERRx invalid input signal - too high frequency HF	$f_{ERR\_invalid\_high\_HF}$	4	–	10	MHz	<sup>1)</sup>	DS-1635
Reactivation timeout	$t_{ERR\_to}$	9	–	11	ms	After SLEEP with RESOUT=1 and ERRx_RS_CFG.EN=1 and ERRx_RS_CFG.SLP_EN=0 <sup>1)</sup>	DS-1636
Reactivation timeout after reenabling	$t_{ERR\_to\_ren}$	90	100	110	µs	After reenabling via SPI <sup>1)</sup>	DS-1637
ERRx recovery time	$t_{REC}$	0.9 · t	t	1.1 · t	ms	t configurable to be 1 ms, 2.5 ms, 5 ms, 10 ms; Configuration done via SPI <sup>1)</sup>	DS-1998

<sup>1)</sup> Not subject to production test, specified by design

## 10.3 Voltage monitoring

### 10.3.1 Introduction

The voltage monitoring (VMON) function is a safety mechanism that supervises the internal and external supply rails. If the monitoring voltage rail is outside of the defined operational range, then the device reacts accordingly.

The voltage monitoring module provides following voltage monitoring channels:

- The Battery voltage monitoring
- The internal voltage monitoring for each internal regulator or supply rail
- Two external voltage monitoring channels

The voltage monitoring for the corresponding voltage rail is active whenever the regulator is enabled.

Only when a regulator is being ramped up, an undervoltage is ignored until the output voltage is within the monitoring range defined by his undervoltage and overvoltage thresholds.

A short to ground detection remains active while being ramped up.

The device integrates also internal voltage supplies and bias currents necessary to operate all functions, including regulators, monitoring and digital logic. These internal supplies are monitored to ensure proper device functionality.

The following internal supplies are monitored in the device:

- internal supply voltages
- bias currents
- bandgap to bandgap variation

*Note: These voltages and current sources are not directly available externally to the device*

**10 Monitoring functions**

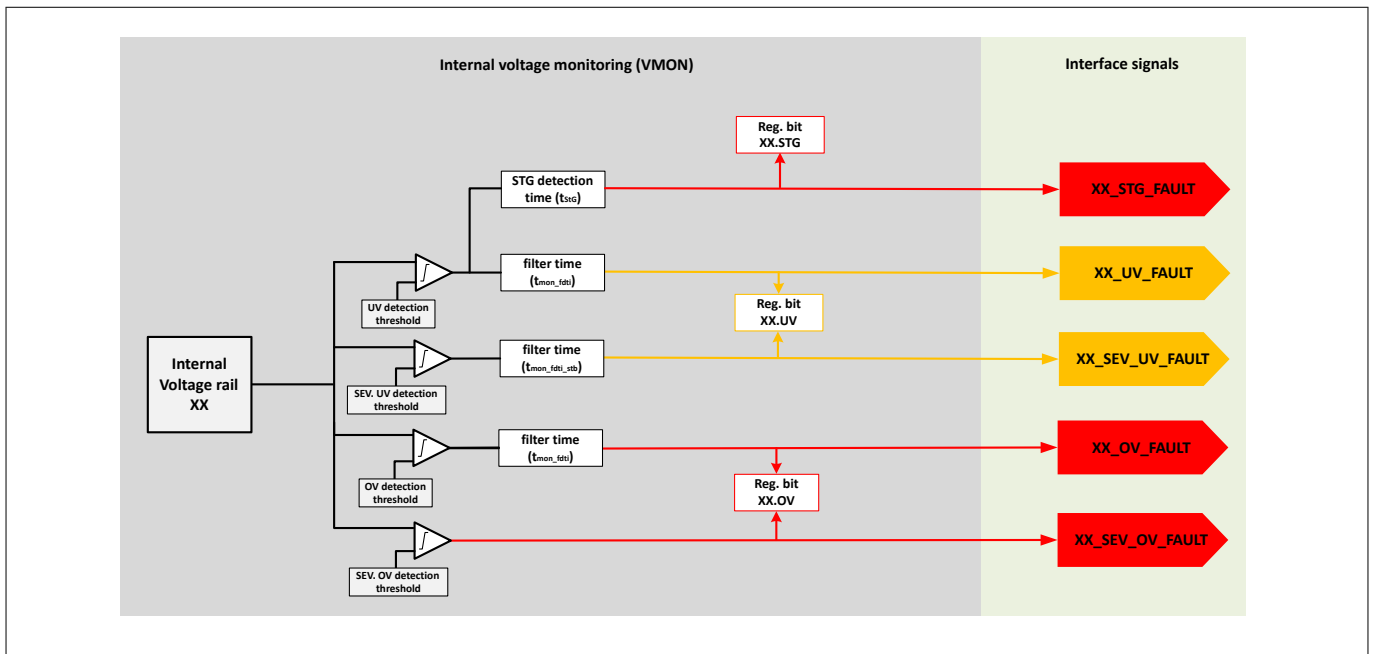
**10.3.2 Battery voltage monitoring**

The voltage on Vs pin is monitored to protect the device for unexpected overvoltage.

If the voltage ( $V_{VS}$ ) on Vs pin exceeds the overvoltage threshold  $V_{VS\_OV}$ , the device performs the following actions:

- Generate an VBAT monitoring severe fault VBAT\_SEV\_FAULT, see [Chapter 9](#)
- Set the corresponding failure bit INTSUP\_STAT\_APPx.VBAT\_OV, which can be cleared via SPI.

**10.3.3 Internal voltage monitoring**



**Figure 55 Functional block diagram internal voltage monitoring**

The table below shows the corresponding monitoring type for each regulator rail (XX)

Monitoring rail (XX)	severe OV detection	OV detection	UV detection	severe UV Detection	Short to Ground
<b>BUCK PREREG</b>	X	X	X	x (BOOST not used) *	X
<b>BUCKIF</b>	X	X	X		X
<b>BUCKCORE</b>	X	X	X		X
<b>BOOST</b>		X	X	x (BOOST used) *	X
<b>QUC</b>		X	X		X
<b>QCO</b>		X	X		X
<b>QVR</b>		X	X		X
<b>QST</b>	X	X	X		X
<b>QST (STANDBY)</b>	X			X	X
<b>Int. Supply</b>	X	X	X		X
<b>BG12</b>		X	X		

\* Severe undervoltage monitoring is performed at BSTFB pin with following cases:

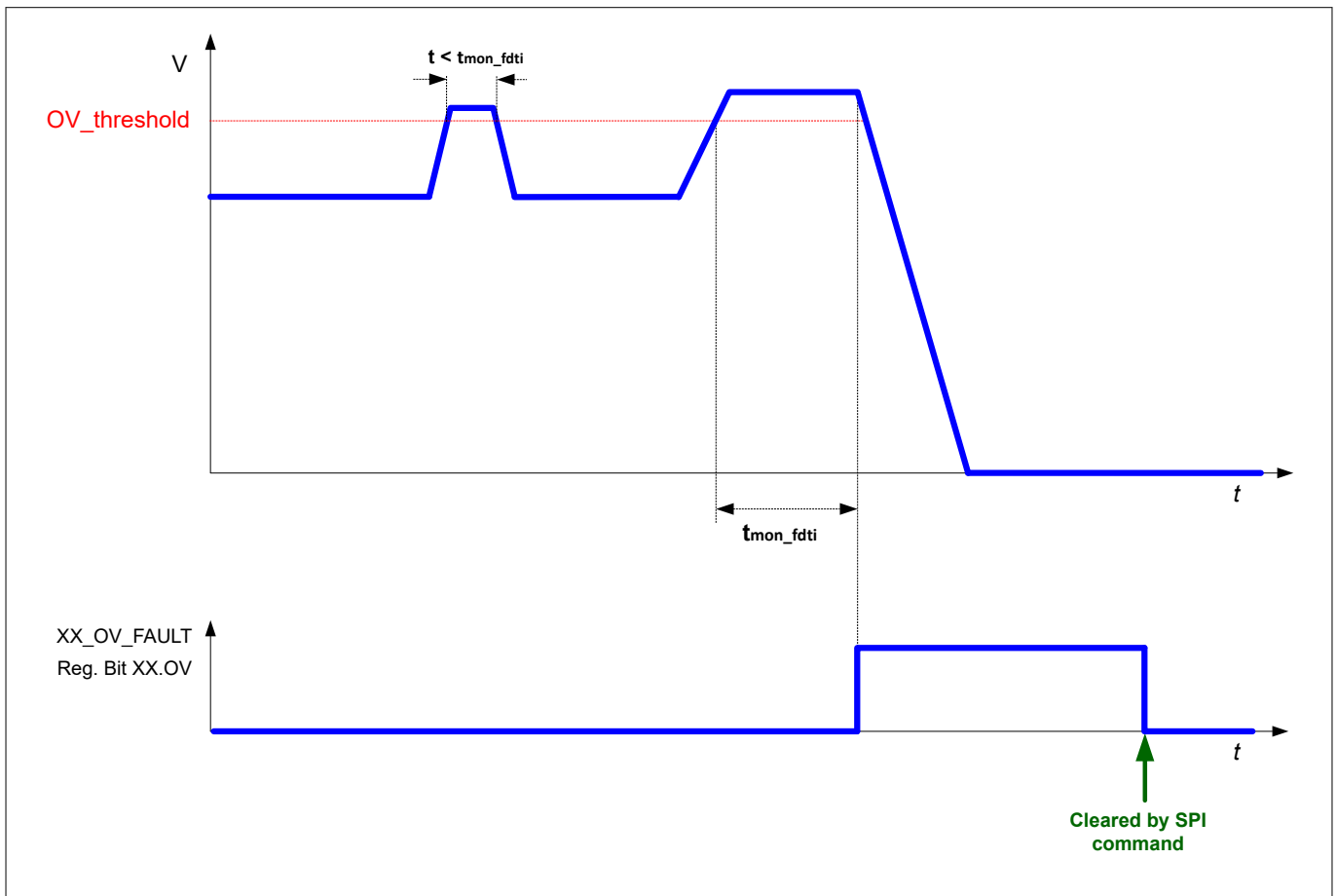
**10 Monitoring functions**

- If BOOST is mounted and switched on, it is considered as BOOST severe undervoltage and it is indicated in the SPI bitfield STG\_STAT\_APPx.BOOST
- If BOOST is not mounted or switched off in Sleep state, it is considered as BUCK PREREG severe undervoltage and is indicated in the SPI bitfield STG\_STAT\_APPx.PREREG

**Overvoltage detection:**

If the output voltage of internal supply rail XX exceeds the defined overvoltage threshold  $V_{XX\_OV}$  for a timer longer than the monitoring reaction time of  $t_{mon\_fdti}$ , the device performs the following actions:

- Generate an internal overvoltage fault XX\_OV\_FAULT (see [Reaction on detected fault](#))
- Set the corresponding failure bits (register **OV\_STAT\_APPx.XX**), which can only be cleared via SPI after the voltage returns to normal operation range.



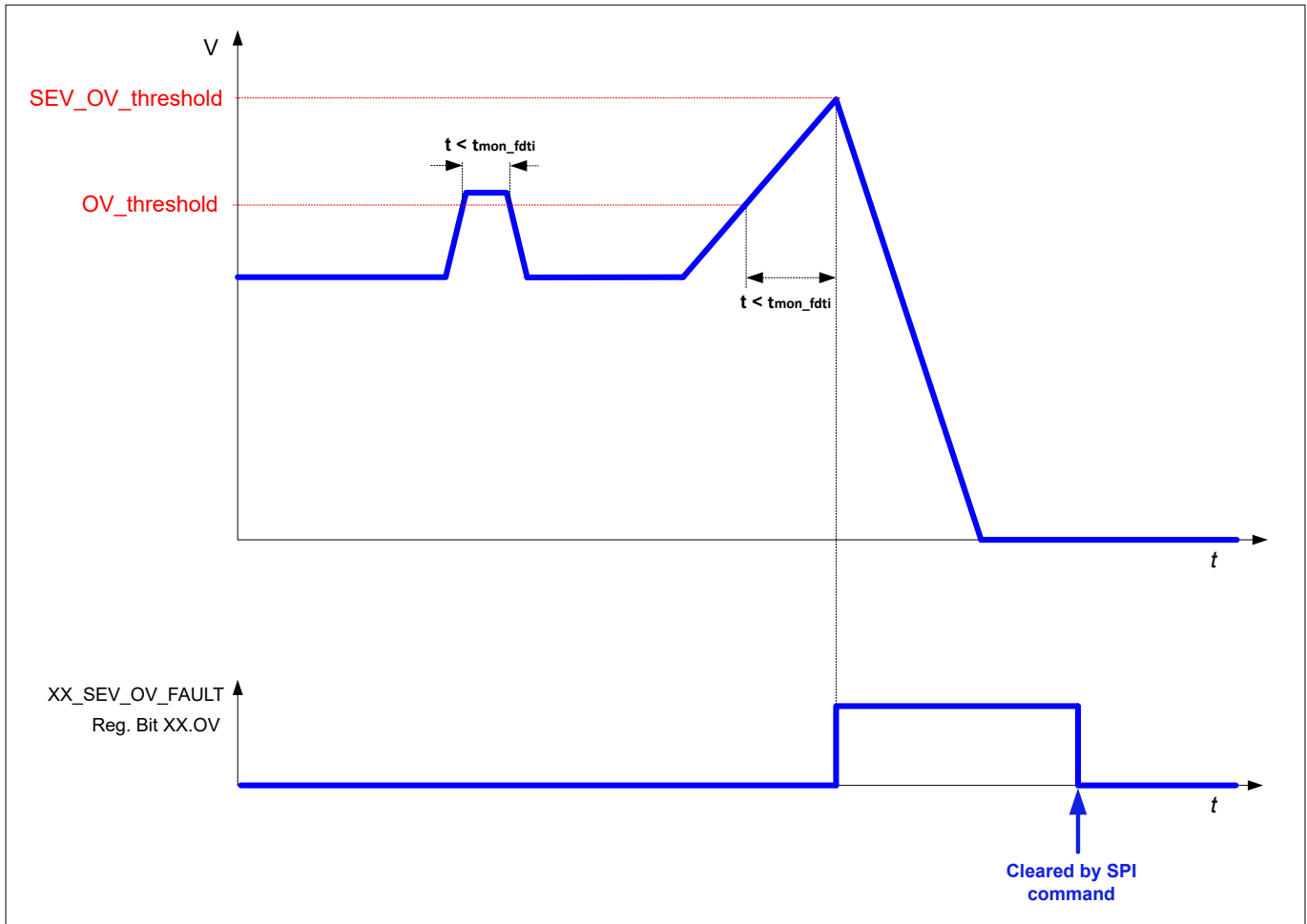
**Figure 56**      **Timing diagram overvoltage detection**

**Severe overvoltage detection:**

If the output voltage of internal supply rail XX rapidly increases and reach the severe overvoltage threshold  $V_{XX\_SEV\_OV}$ ,

the device immediately switches off the correspondent regulator. In general the severe overvoltage reaction is the same as for the overvoltage detection with the difference, that the threshold is set higher compared to the overvoltage and the filter time is not applied.

**10 Monitoring functions**



**Figure 57**      **Timing diagram severe overvoltage detection**

If the device enters STANDBY state and the output voltage of the standby regulator (QST) drops below the severe undervoltage threshold  $V_{QST\_SEV\_UV}$  for a timer longer than the monitoring reaction time in standby  $t_{mon\_fdti\_stb}$ ,

the device performs the following actions:

- Generate an internal undervoltage fault QST\_SEV\_UV\_FAULT (see [Reaction on detected fault](#))
- Set the corresponding failure bits (register **UV\_STAT\_APPx.XX**), which can only be cleared via SPI after the voltage returns to normal operation range.

**Short to Ground detection:**

If the output voltage of the internal supply rail XX drops below the defined undervoltage threshold  $V_{XX\_UV}$  for a timer longer than the short to ground detection time of  $t_{STG}$ ,

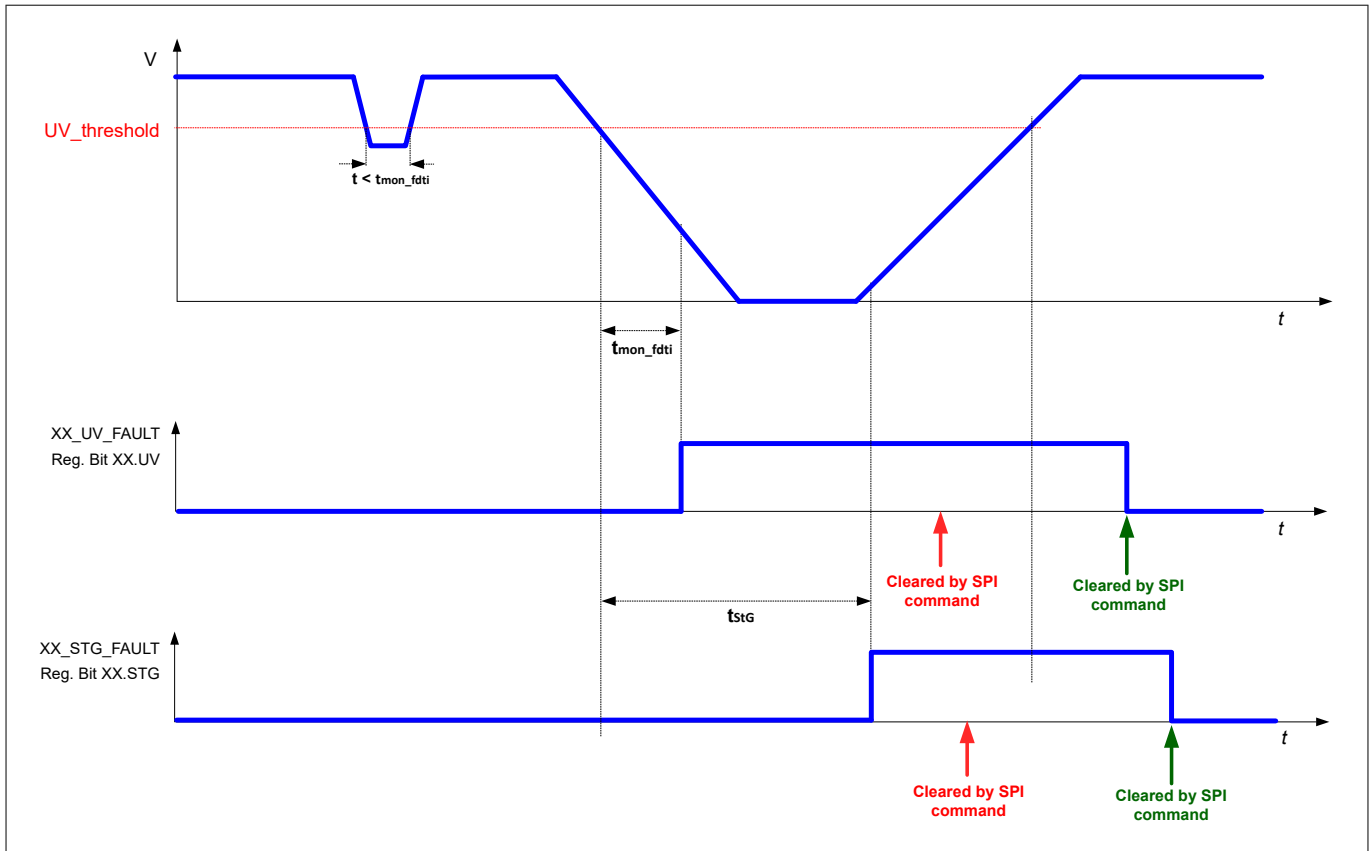
the device performs the following actions:

- Generate an internal short to ground fault XX\_STG\_FAULT, see [Chapter 9](#)
- Set the corresponding failure bit (register **STG\_STAT\_APPx.XX**), which can only be cleared via SPI after the voltage returns to normal operation range.

The device detects a short to ground (StG) on the BOOST regulator switched node, if the voltage at pin  $V_{BSTI}$  does not recover above the threshold  $V_{BSTI\_UV}$  between the switching cycles.

The device detects an short to ground (StG) at pin QST if the voltage  $V_{QST}$  drops below the undervoltage threshold  $V_{QST\_UV}$  for a timer longer than the QST short to ground detection time  $t_{StG\_QST}$ .

**10 Monitoring functions**



**Figure 58** Timing diagram UV and STG detection

**10.3.4 Electrical characteristics monitoring functions**

**Table 37** Electrical characteristics monitoring functions

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
<b>Overvoltage monitoring</b>							
Vbat overvoltage shutdown threshold	$V_{VS\_OV}$	49	52	55	V	-	DS-1355
Severe overvoltage threshold Pre-reg	$V_{R1FB\_SEV\_OV}$	6.66	6.8	6.94	V	-	DS-1356
5V5 overvoltage threshold Pre-reg	$V_{R1FB\_5V5\_OV}$	6.15	6.3	6.43	V	-	DS-1357
4V0 overvoltage threshold Pre-reg	$V_{R1FB\_4V0\_OV}$	5.10	5.2	5.3	V	-	DS-1358

**(table continues...)**

**10 Monitoring functions**

**Table 37 (continued) Electrical characteristics monitoring functions**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Severe overvoltage threshold BUCK CORE	$V_{R3FB\_sev\_OV}$	y * 1.19	–	y * 1.56	V	y: Configured nominal BUCKCORE output voltage; y = 0.7 + x*12.5 mV; x: 0,1,...32 (register value); y = 1.15 V for x = 33	DS-2043
Overvoltage threshold BUCK CORE	$V_{R3FBH\_OV}$	y * 1.06 8	y * 1.09	y * 1.11 2	V	y: Configured nominal BUCKCORE output voltage; y = 0.7 + x*12.5 mV; x: 0,1,...32 (register value BUCK_CORE_PW_VSEL); y = 1.15 V for x = 33	DS-1359
Overvoltage hysteresis BUCK CORE	$V_{R3FBH\_OV\_HYS}$	5	15	25	mV	–	DS-1360
Severe overvoltage threshold BUCK IF	$V_{R4FB\_SEV\_OV}$	4.21	4.3	4.39	V	–	DS-1361
Overvoltage threshold BUCK IF	$V_{R4FB\_OV}$	3.49	3.56	3.63	V	–	DS-1363
Overvoltage threshold BOOST	$V_{BSTFB\_OV}$	6.37	6.5	6.63	V	–	DS-1365
Overvoltage hysteresis BOOST	$V_{BSTFB\_OV\_HYS}$	35	–	115	mV	–	DS-1366
Overvoltage threshold QUC	$V_{QUC\_OV}$	5.3	5.4	5.5	V	–	DS-1367
Overvoltage hysteresis QUC	$V_{QUC\_OV\_HYS}$	34	–	102	mV	–	DS-1368
Overvoltage threshold QCO	$V_{QCO\_OV}$	5.3	5.4	5.5	V	–	DS-1371
Overvoltage hysteresis QCO	$V_{QCO\_OV\_HYS}$	25	–	102	mV	–	DS-2153
Severe overvoltage threshold QST	$V_{QST\_SEV\_OV}$	5.95	6.25	6.5	V	–	DS-1373
Overvoltage threshold QST	$V_{QST\_OV}$	5.3	5.4	5.5	V	–	DS-1374
Overvoltage hysteresis QST	$V_{QST\_OV\_HYS}$	34	–	102	mV	–	DS-1377
Overvoltage threshold QVR	$V_{QVR\_OV}$	5.24	5.35	5.46	V	–	DS-1378
Overvoltage hysteresis QVR	$V_{QVR\_OV\_HYS}$	30	–	100	mV	–	DS-1379

**(table continues...)**

**10 Monitoring functions**

**Table 37 (continued) Electrical characteristics monitoring functions**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
<b>Undervoltage monitoring</b>							
Undervoltage threshold Pre-reg	$V_{R1FB\_UV}$	2.59	2.65	2.71	V	–	DS-1380
Undervoltage hysteresis Pre-reg	$V_{R1FB\_UV\_HYS}$	15	–	50	mV	–	DS-1381
Undervoltage threshold BUCK CORE	$V_{R3FBH\_UV}$	y * 0.89 1	y * 0.91	y * 0.92 9	V	y: Configured nominal BUCKCORE output voltage; y = 0.7 + x*12.5 mV; x: 0,1,...32 (register value BUCK_CORE_PW_VSEL); y = 1.15 V for x = 33	DS-1382
Undervoltage hysteresis BUCK CORE	$V_{R3FBH\_UV\_HYS}$	3	15	25	mV	–	DS-1383
Undervoltage threshold BUCK IF	$V_{R4FB\_UV}$	2.9	2.97	3.03 6	V	–	DS-1385
Undervoltage hysteresis BUCK IF	$V_{R4FB\_UV\_HYS}$	15	–	55	mV	–	DS-1387
Undervoltage threshold BOOST	$V_{BSTFB\_UV}$	4.9	5	5.10	V	–	DS-1388
Severe undervoltage threshold BOOST	$V_{BSTFB\_SE\_UV}$	1.96	2	2.04	V	If BOOST is not used, it is interpreted as BUCK PREREG severe undervoltage threshold	DS-2161
Undervoltage hysteresis BOOST	$V_{BSTFB\_UV\_HYS}$	30	–	90	mV	–	DS-1389
Boost short to ground threshold	$V_{BSTI\_UV}$	1.84	2.0	2.16	V	$V_{BSTI}$ decreasing	DS-1955
Boost short to ground threshold hysteresis	$V_{BSTI\_UV\_HYS}$	13 <sup>1)</sup>	25	37	mV	$V_{BSTI}$ increasing	DS-1956
Undervoltage threshold QCO	$V_{QCO\_UV}$	4.5	4.6	4.7	V	–	DS-1390
Undervoltage hysteresis QCO	$V_{QCO\_UV\_HYS}$	25	–	80	mV	–	DS-1391
Undervoltage threshold QUC	$V_{QUC\_UV}$	4.4	4.5	4.6	V	–	DS-1392

**(table continues...)**

**10 Monitoring functions**

**Table 37 (continued) Electrical characteristics monitoring functions**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

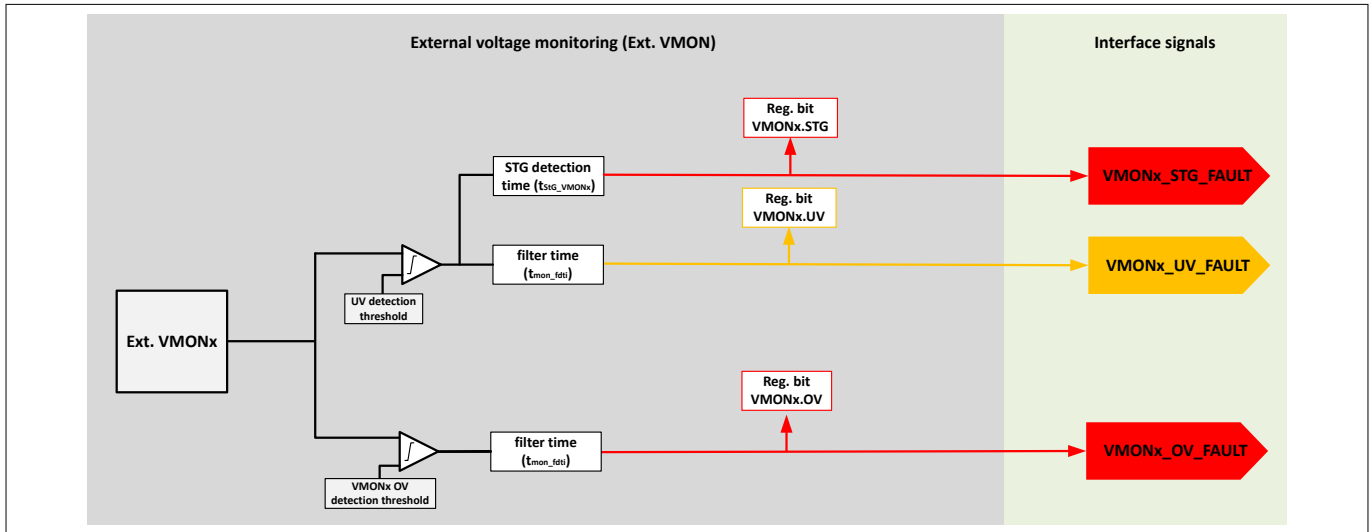
Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Undervoltage hysteresis QUC	$V_{QUC\_UV\_HYS}$	25	–	80	mV	–	DS-1393
Undervoltage threshold QVR	$V_{QVR\_UV}$	4.5	4.6	4.7	V	–	DS-1396
Undervoltage hysteresis QVR	$V_{QVR\_UV\_HYS}$	25	–	80	mV	–	DS-1397
Undervoltage threshold QST	$V_{QST\_UV}$	4.3	4.4	4.5	V	–	DS-1398
Undervoltage hysteresis QST	$V_{QST\_UV\_HYS}$	25	–	80	mV	–	DS-1400
Severe undervoltage threshold QST	$V_{QST\_SEV\_UV}$	2.6	2.72	2.78	V	–	DS-2007
Internal Supply undervoltage threshold	$V_{int\_sup\_UV}$	4.4	4.5	4.6	V	$V_{QIS}$ decreasing	DS-1966
Internal Supply overvoltage threshold	$V_{int\_sup\_OV}$	6.37	6.5	6.63	V	$V_{QIS}$ increasing	DS-2008
Voltage monitoring fault detection time	$t_{mon\_fdti}$	6		12	$\mu\text{s}$	–	DS-2001
Voltage monitoring fault detection time standby	$t_{mon\_fdti\_sb}$	8		50	$\mu\text{s}$	–	DS-2002

1) Not subject to production test, specified by design

**10.3.5 Ext. monitoring channels (VMON)**

**10 Monitoring functions**

**10.3.5.1 Functional description ext. monitoring channels (VMON)**



**Figure 59 Functional block diagram external voltage monitoring**

The device includes two channels (VMON1 or VMON2), each consists of two pins VMxFB and VMxEN. The external voltage rail is compared against a predefined threshold on the pins VM1FB and VM2FB. An external resistor divider must be used to scale the voltage that shall be monitored to the mid point of the monitoring window (typ: 0.8 V). The pins VM1EN and VM2EN are outputs to the corresponding monitoring inputs VM1FB and VM2FB. They provide a high level  $V_{VMxEN\_H}$  if the automatic use detection during start-up detects the usage of the channel or, after that, if they are disabled and re-enabled via SPI. They can be used to enable and embed an external voltage regulator into the start-up and shut-down sequence of the device.

When a signal exceeds the thresholds for a duration longer than the fault detection time  $t_{mon\_fdti}$ , an undervoltage or an overvoltage event is generated.

During start-up, the device detects if the external monitoring channels VMON1 or VMON2 are used within the application. If the respective external voltage monitor shall not be used in the application, the pin VMxEN must be connected to ground in order to enable the device to reliably determine whether a voltage monitor is used. For this case VMxFB can be left open. If an external voltage monitoring channel is used, VMxEN must be connected to the external regulator's enable pin. This properly integrates the start-up of the voltage rail into the start-up sequence.

**Note:** *VMON1 and VMON2 are excluded from the power sequencing if not used.*

The device detects a short to ground (StG) at one of the external monitoring channels, if the output voltage at pin  $V_{VMxFB}$  stays below the undervoltage threshold  $V_{MONx\_UV}$  for a time longer than the short to ground detection time  $t_{StG\_VMONx}$ .

The short to ground detection times for each external monitoring channel  $t_{StG\_VMONx}$  is programmable via SPI register Bitfield **DEV\_PW\_CFG2.VMONx\_STG\_TIME**

(x = 1; 2)

**10 Monitoring functions**

**10.3.5.2 Electrical characteristics ext. monitoring channels (VMON)**

**Table 38 Electrical characteristics ext. monitoring channels (VMON)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output voltage high level (x=1 or 2)	$V_{VMxEN\_H}$	3.15	-	-	V	$V_{QUC} \geq V_{QUC}[\text{Min}]$ ; $I_{VMxEN} = -7\text{ mA}$	DS-1655
Output voltage low level (X = 1 or 2)	$V_{VMxEN\_L}$	-	-	0.7	V	$I_{VMxEN} = 5\text{ mA}$	DS-1657
Short to ground detection time for VMON1	$t_{STG\_VMON1}$	1		6	ms	$t_{STG\_VMON1}$ is programmable between 1ms, 2ms, 4ms and 6ms via SPI with a default value of 6ms	DS-1942
accuracy of the short to ground detection time for VMON1	$t_{STG\_VMON1\_acc}$	$t_{STG\_VMON1^-}$ (10%* $t_S$ TG_VMON1)	$t_{STG\_VMON1}$	$t_{STG\_VMON1^+}$ (10%* $t_S$ TG_VMON1)	ms		DS-1943
Short to ground detection time for VMON2	$t_{STG\_VMON2}$	1		6	ms	$t_{STG\_VMON2}$ is programmable between 1 ms, 2 ms, 4 ms and 6 ms via SPI with a default value of 6 ms	DS-1939
Accuracy of the short to ground detection time for VMON2	$t_{STG\_VMON2\_acc}$	$t_{STG\_VMON2^-}$ (10%* $t_S$ TG_VMON2)	$t_{STG\_VMON2}$	$t_{STG\_VMON2^+}$ (10%* $t_S$ TG_VMON2)	ms		DS-1938
VMON1 overvoltage threshold	$V_{mon\_MON1\_OV}$	858	872	886	mV	$V_{VM1FB}$ increasing	DS-1957
VMON1 overvoltage hysteresis	$V_{mon\_MON1\_OV\_HYS}$	5 <sup>1)</sup>		15	mV	$V_{VM1FB}$ decreasing	DS-1958
VMON1 undervoltage threshold	$V_{mon\_MON1\_UV}$	716	728	740	mV	$V_{VM1FB}$ decreasing	DS-1959
VMON1 undervoltage hysteresis	$V_{mon\_MON1\_UV\_HYS}$	5 <sup>1)</sup>		15	mV	$V_{VM1FB}$ increasing	DS-1960

**(table continues...)**

**10 Monitoring functions**

**Table 38 (continued) Electrical characteristics ext. monitoring channels (VMON)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
VMON2 overvoltage threshold	$V_{\text{mon\_MON}2\_OV}$	858	872	895	mV	$V_{VM2FB}$ increasing	DS-1961
VMON2 overvoltage hysteresis	$V_{\text{mon\_MON}2\_OV\_HYS}$	5 <sup>1)</sup>		15	mV	$V_{VM2FB}$ decreasing	DS-2009
VMON2 undervoltage threshold	$V_{\text{mon\_MON}2\_UV}$	716	728	750	mV	$V_{VM2FB}$ decreasing	DS-2010
VMON2 undervoltage hysteresis	$V_{\text{mon\_MON}2\_UV\_HYS}$	5 <sup>1)</sup>		15	mV	$V_{VM2FB}$ increasing	DS-2011

1) Not subject to production test, specified by design

**10.4 Overcurrent and overtemperature monitoring**

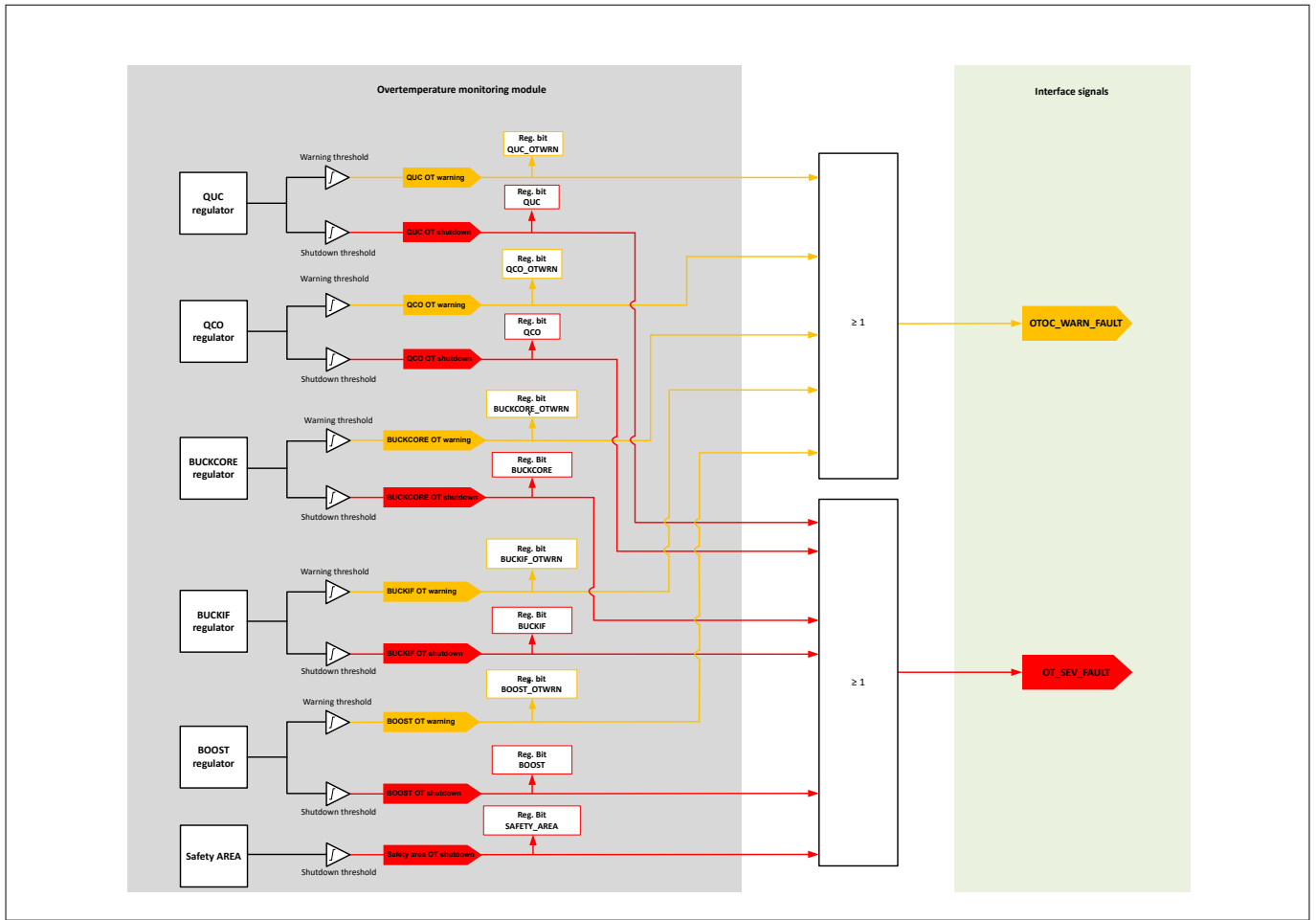
**10.4.1 Introduction**

The overtemperature or overcurrent monitoring function protects the device for transient overtemperature (e.g. load dump or short circuit).

**Overtemperature monitoring**

The device provides an overtemperature monitoring sensor for the safety area and for all post regulators except the Standby (QST) and the reference (QVR) regulator.

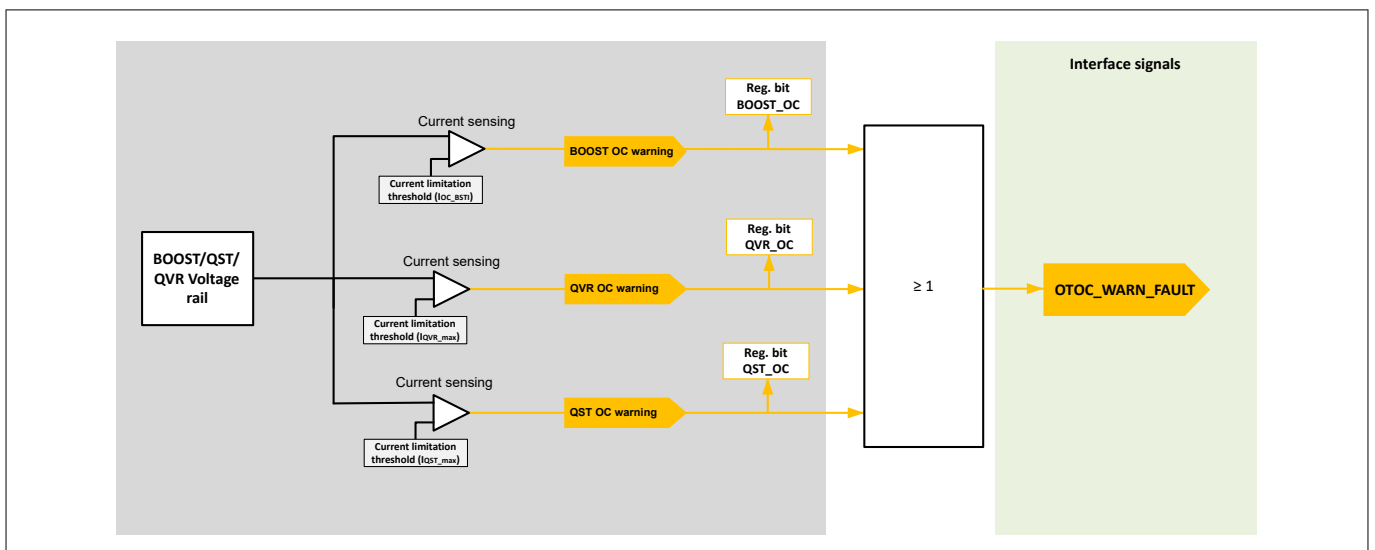
**10 Monitoring functions**



**Figure 60 Functional block diagram overtemperature monitoring function**

**Overcurrent monitoring**

The device provides overcurrent monitoring sensors for the boost regulator, the Standby regulator (QST), the internal supply (IVCC) and the reference voltage regulator (QVR).



**Figure 61 Functional block diagram overcurrent monitoring**

**10 Monitoring functions**

**10.4.2 Functional description overtemperature monitoring**

Two overtemperature detection thresholds are implemented:

**Overtemperature warning**

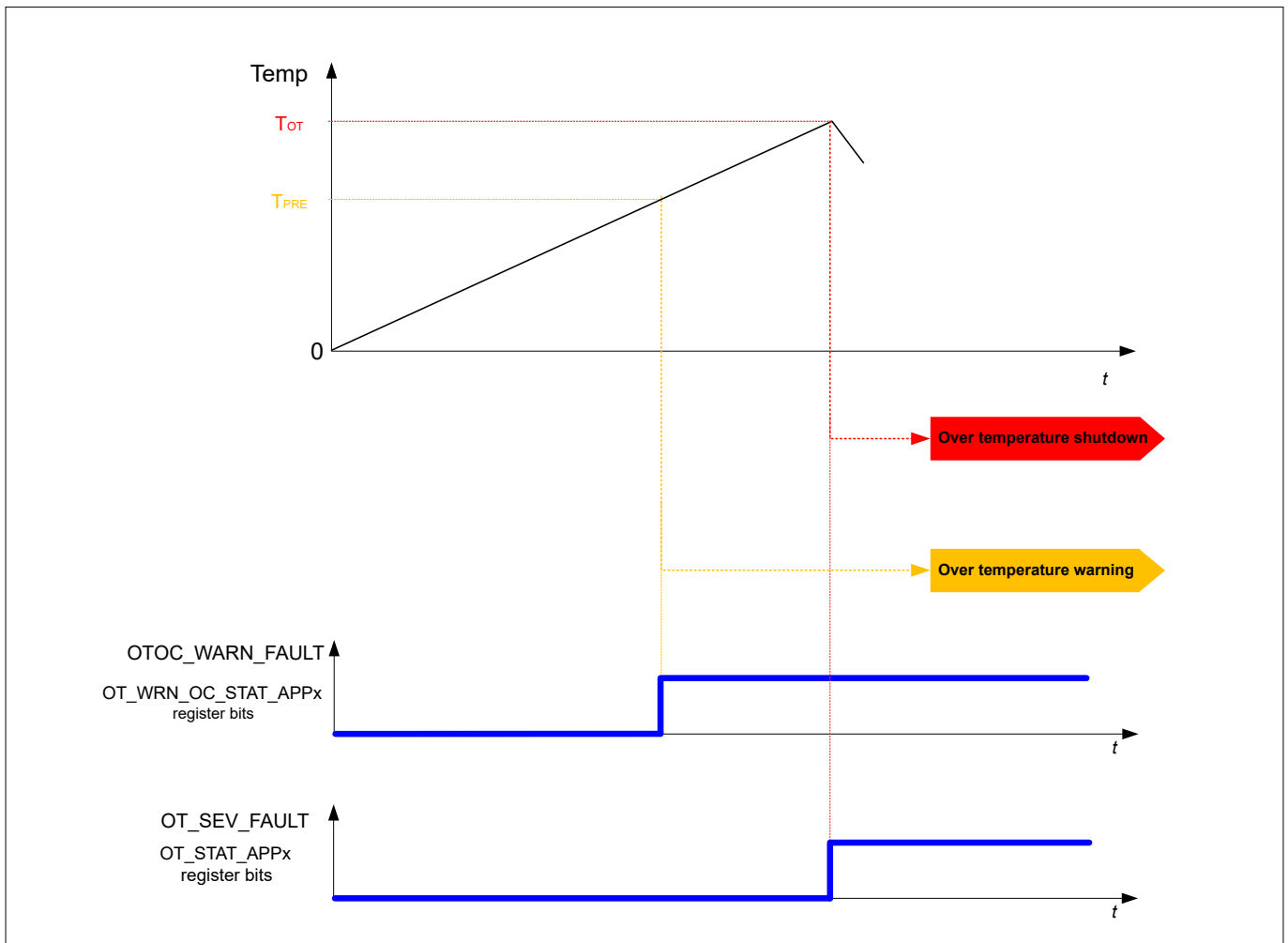
If the temperature of the monitoring block exceeds the first threshold (overtemperature warning threshold ( $t_{PRE}$ )), the device:

- sets the correspondent overtemperature warning bit, which can be cleared via SPI if the temperature drops below the warning threshold
- generates an overtemperature warning fault OTOC\_WARN\_FAULT, see [Chapter 9](#)

**Overtemperature shutdown**

If the temperature of the monitoring block continues to rise and exceeds the second threshold (overtemperature shutdown threshold ( $t_{OT}$ )), the device:

- sets the correspondent overtemperature shutdown bit, which can be cleared via SPI if the temperature drops below the shutdown threshold
- generates an overtemperature severe fault OT\_SEV\_FAULT, see [Chapter 9](#)



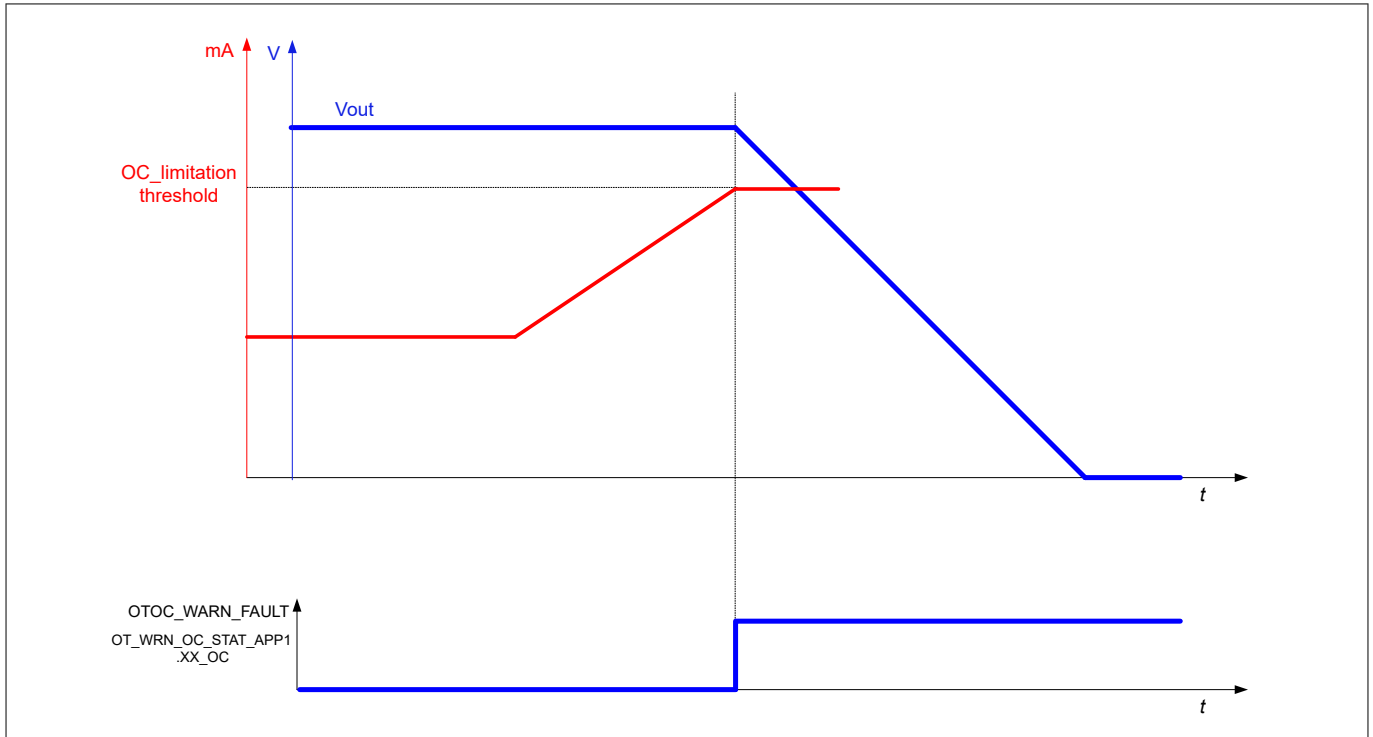
**Figure 62 Signal diagram overtemperature monitoring**

**10.4.3 Functional description current monitoring**

If the output current of the monitoring regulator reaches the overcurrent limitation threshold, the device:

**10 Monitoring functions**

- Sets the correspondent overcurrent warning bit, which can be cleared via SPI if the current drops below warning threshold
- Generates an overcurrent warning fault OTOC\_WARN\_FAULT, see [Chapter 9](#)
- The output voltage of the correspondent regulator starts to decrease immediately as consequence



**Figure 63** Signal diagram overcurrent monitoring

**10.4.4 Electrical characteristics overtemperature monitoring**

**Table 39** Electrical characteristics overtemperature monitoring

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Overtemperature pre-warning threshold	$T_{PRE}$	136	146	156	°C	$T_j$ increasing <sup>1)</sup>	DS-1402
Overtemperature threshold	$T_{OT}$	177	187	197	°C	$T_j$ increasing <sup>1)</sup>	DS-1403

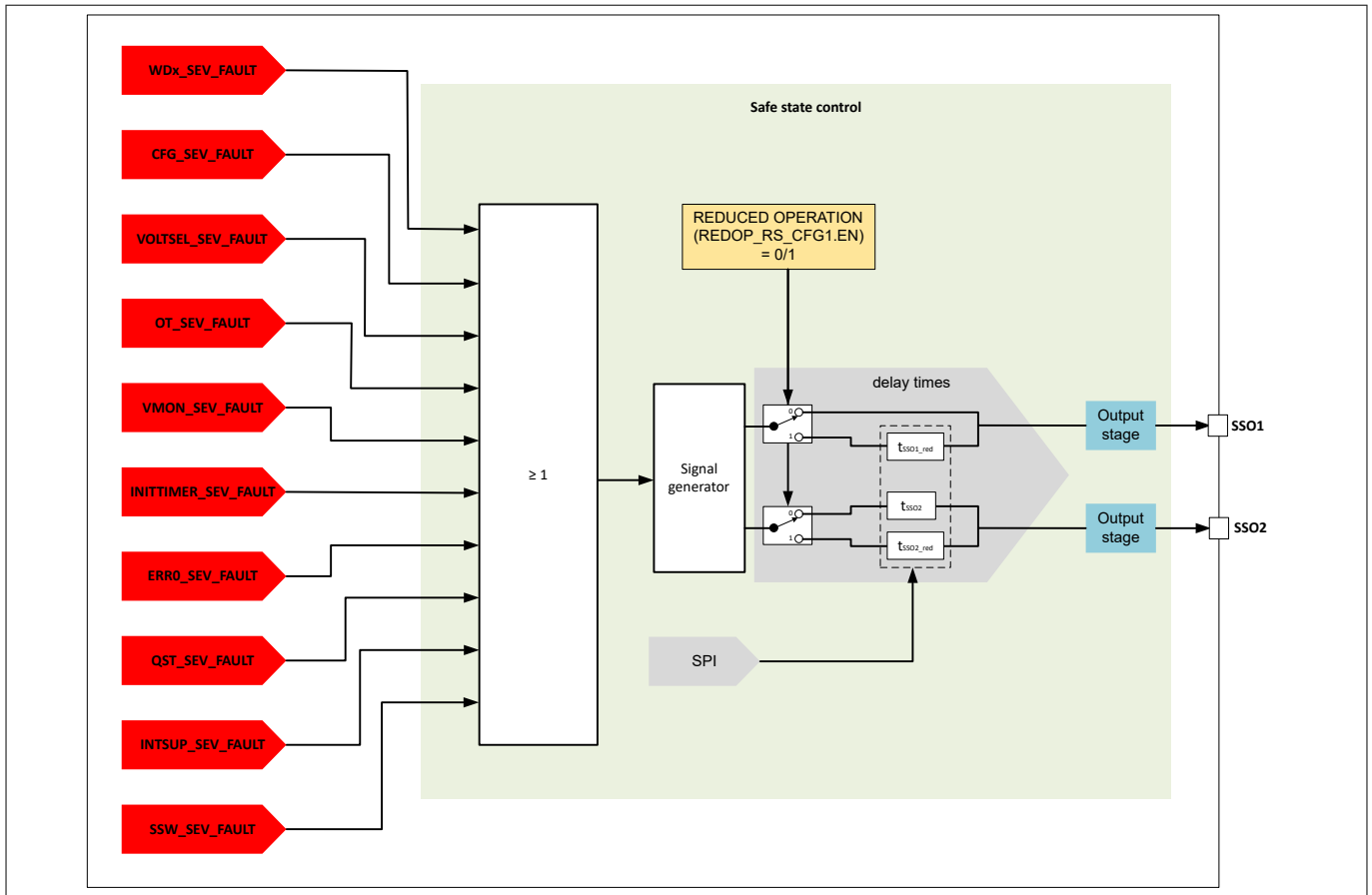
1) Not subject to production test, specified by design

**10.5 Safe state control (SSOx)**

**10.5.1 Introduction**

The Safe State Control module monitors the safety related signals and controls the safe state outputs. The following description summarizes the contributors to the Safe State Control function and the possibilities to adjust them.

**10 Monitoring functions**



**Figure 64 Functional block diagram safe state control**

The safe state control module provides two safe state output control channels:

- The safe state control channel 1 which generates a safe state output signal on pin SS01
- The safe state control channel 2 which generates a safe state output signal on pin SS02

The safe state control module is designed to be independent of the device power supply parts by circuitry, signals, and layout.

**10.5.2 Functional descriptions shutdown path (SSOx)**

The device activates the shutdown path (SSOx output LOW) in any state but NORMAL. Respectively any fault or state transition command that causes the device to leave NORMAL state, results in SS01 or SS02 or both to be pulled low, depending on the fault. Also refer to [Reaction on detected fault](#).

**10.5.2.1 Delay times and reaction on detected faults**

The safe state control is implemented with optional delay time. these functions gives the application the possibility to generate two separate safe state output signals dependent on the application uses cases:

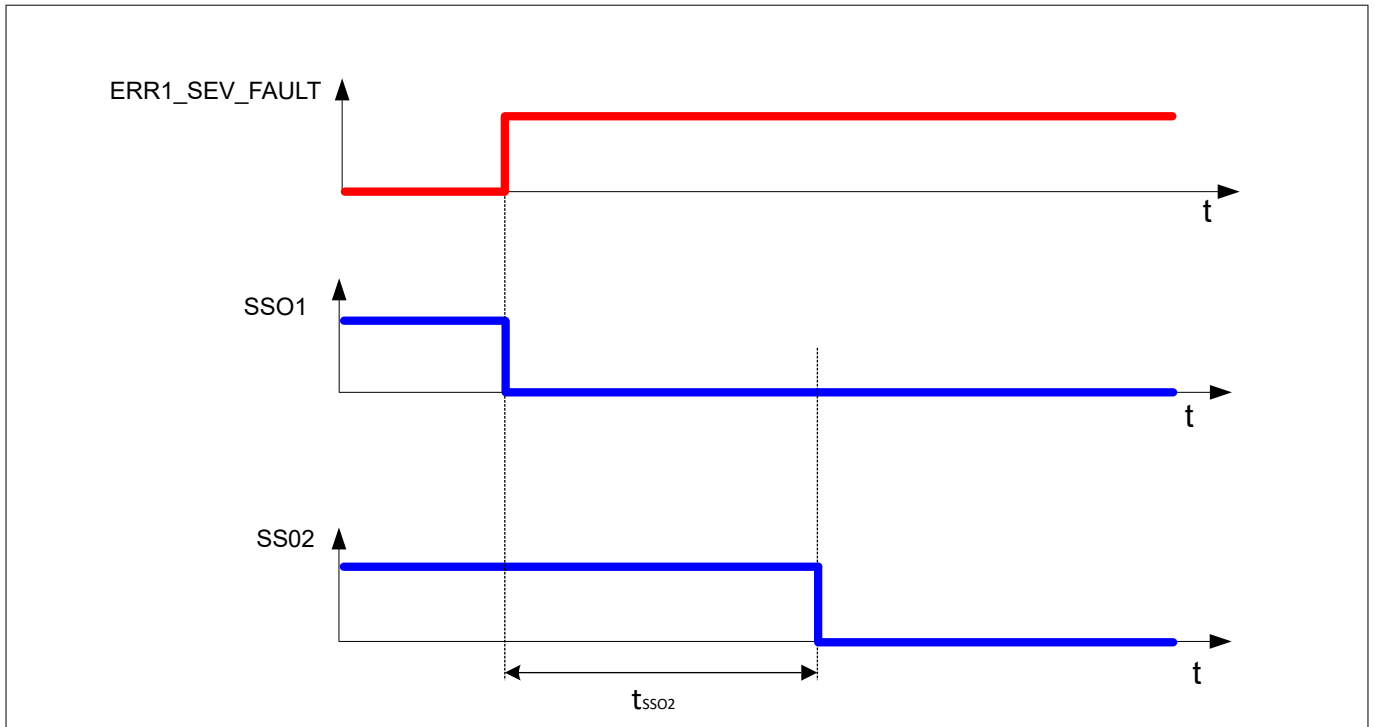
**Single application use case:**

Single application is activated by setting the register bit **REDOP\_PW\_CFG1.EN** to 0.

After detection of any severe fault, the device sets immediately the output signal on SS01 pin to "low", while the output signal on SS02 pin is pulled "low" after a delay time ( $t_{SSO2}$ ).

The delay time ( $t_{SSO2}$ ) can be configured in the register bitfield **REDOP\_PW\_CFG1.SSO1TOSSO2\_DEL**.

**10 Monitoring functions**



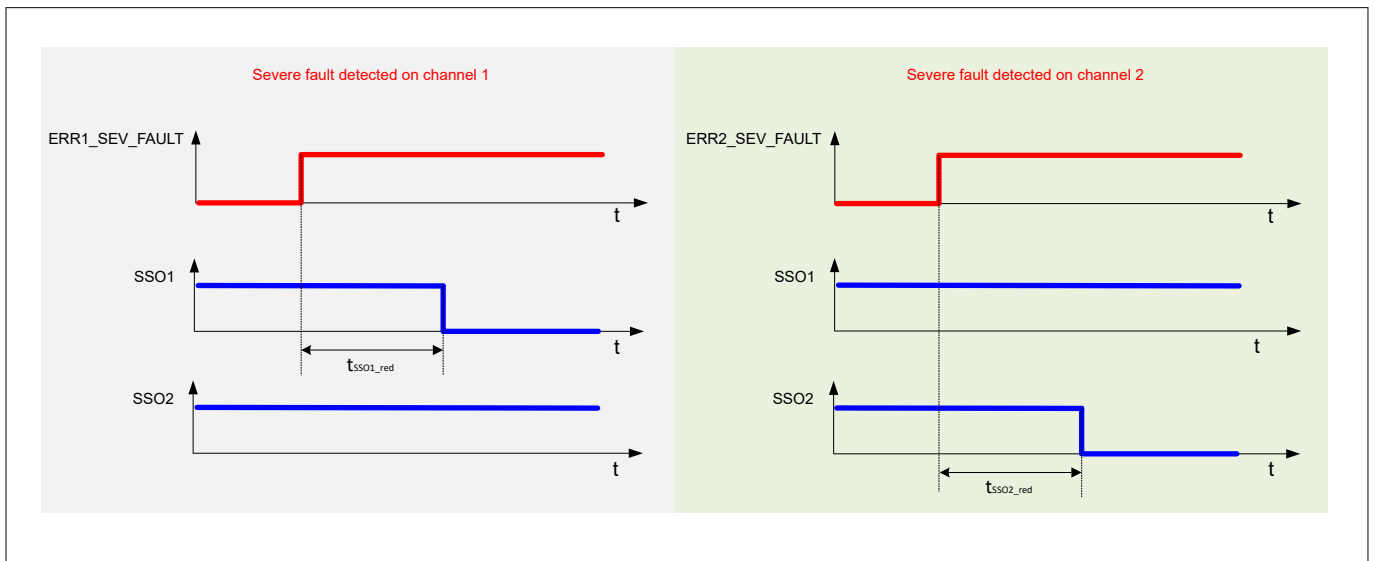
**Figure 65** Flow diagram SSOx generation by single application use case, if ERR1 is the error source

(x = 1, 2)

**Dual application use case:**

Dual application is activated by setting the register bit **REDOP\_PW\_CFG1.EN** to 1.

The device sets the output signal on pin SSO1 or SSO2 "low" upon detection of any severe fault. In case the severe fault is originated in only one of the two applications, the related SSOx pin is set low. This activation can be delayed by configuring the delay times ( $t_{SSOx\_red}$ ) in the register bitfields **REDOP\_PW\_CFG1.SSOx\_DEL**.



**Figure 66** Flow diagram SSOx generation by dual application use case (**REDOP\_PW\_CFG1.EN = 1**)

**Note:** The delay time as described in the paragraphs above is only applied for faults that do not have a move to FAILSAFE as state transition. In other words if FAILSAFE is entered the delay times for SSO1/2 are not applied.

**10 Monitoring functions**

**10.5.3 Electrical characteristics shutdown path (SSOx)**

**Table 40 Electrical characteristics shutdown path (SSOx)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output high level 1 mA	$V_{SSOx\_HIG\ H}$	3.6	4.8	$V_{QUC}$	V	$I_{SSOx} \geq -1\text{ mA}$ ; $V_{QUC} = V_{QUC} [\text{Min}]$	DS-1612
[SSOx] Output high level 3.75 mA	$V_{SSOx\_HIG\ H\_3mA}$	3.0	4.3	$V_{QUC}$	V	$I_{SSOx} \geq -3.75\text{ mA}$ ; $V_{QUC} = V_{QUC} [\text{Min}]$	DS-1614
Pull-down resistor	$R_{SSOx}$	70	100	130	k $\Omega$	–	DS-1616
Output low level	$V_{SSOx\_LO}$	–	0	0.3	V	$R_{SSOx\_PD\_EXT} \leq 100\text{ k}\Omega$ ; $I_{SSOx} \leq 1.2\text{ mA}$ ; QUC active; $V_{QUC} \geq 2.9\text{ V}$ ; $-40^\circ\text{C} \leq T_j \leq 175^\circ\text{C}$	DS-2081
SSO2 reaction delay time	$t_{SSO2}$	0	–	250	ms	Timebase accuracy is $t_{SSC}$	DS-1618
SSO1 reaction delay time for REDUCED OPERATION	$t_{SSO1\_red}$	0	–	250	ms	Timebase accuracy is $t_{SSC}$	DS-1619
SSO2 reaction delay time for REDUCED OPERATION	$t_{SSO2\_red}$	0	–	250	ms	Timebase accuracy is $t_{SSC}$	DS-1620
Timebase accuracy	$t_{SSC}$	-10	-	10	%		DS-1999

**10.6 Reaction on faults**

**10.6.1 Reaction on detected fault**

**Table 41 Reaction on detected events of regulators**

Module	Event description	REDUCED OPERATION ON/OFF	State transition	IO reaction	Register name	Bitfield name
Battery Monitoring	VS OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	INTSUP_STAT_APP1	VBAT_OV
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	INTSUP_STAT_APP2	VBAT_OV
BOOST	BOOST OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP1	BOOST

(table continues...)

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	BOOST
BOOST overcurrent		off	No transition	INT1	OT_WRN_OC_STAT_APP1	BOOST_OC
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	BOOST_OC
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	BOOST_OC
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	BOOST_OC
BOOST overtemperature warning		off	No transition	INT1	OT_WRN_OC_STAT_APP1	BOOST_OT WRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	BOOST_OT WRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	BOOST_OT WRN
BOOST short to ground or Severe undervoltage or undervoltage at BSTI pin		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P1	BOOST
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P2	BOOST
BOOST thermal shutdown		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 1	BOOST
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 2	BOOST
Undervoltage at BOOST		off	No transition	INT1	UV_STAT_APP 1	BOOST
		on	No transition	INT1, INT2	UV_STAT_APP 1	BOOST
		on	No transition	INT1, INT2	UV_STAT_APP 2	BOOST
BUCKCORE	BUCKCORE overtemperature warning	off	No transition	INT1	OT_WRN_OC_STAT_APP1	BUCKCORE_OTWRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	BUCKCORE_OTWRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	BUCKCORE_OTWRN
	BUCKCORE short to ground	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P1	BUCKCORE
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P2	BUCKCORE
			on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P2

**(table continues...)**

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

	BUCKCORE thermal shutdown	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 1	BUCKCORE
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 2	BUCKCORE
	BUCKCORE undervoltage	any	Move to INIT	RESOUT, SSO1, SSO2	UV_STAT_APP 1	BUCKCORE
		on	Move to INIT	RESOUT, SSO1, SSO2	UV_STAT_APP 1	BUCKCORE
	Feedback open	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	BUCKCORE_FB_OPEN
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	BUCKCORE_FB_OPEN
	Severe overvoltage at BUCKCORE or BUCKCORE OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	BUCKCORE
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	BUCKCORE
	Static voltage scaling completed successfully.	off	No transition	INT1	SYS_STAT_AP P1	BUCKCORE_SVS_OK
		on	No transition	INT1, INT2	SYS_STAT_AP P1	BUCKCORE_SVS_OK
		on	No transition	INT1, INT2	SYS_STAT_AP P2	BUCKCORE_SVS_OK
	Static voltage scaling not performed due to: - Device being not in INIT or NORMAL - BUCKCORE voltage set to 1.15 V - Invalid SPI value	off	No transition	INT1	SYS_STAT_AP P1	BUCKCORE_SVS_NOK
		on	No transition	INT1, INT2	SYS_STAT_AP P1	BUCKCORE_SVS_NOK
		on	No transition	INT1, INT2	SYS_STAT_AP P2	SBUCKCORE_SVS_NOK
	Voltage selection error. Core voltage might be corrupt.	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP1	BUCK_CORE_VOLTSEL
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP2	BUCK_CORE_VOLTSEL
BUCKIF	BUCKIF overtemperature warning	off	No transition	INT1	OT_WRN_OC_STAT_APP1	BUCKIF_OT_WRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	BUCKIF_OT_WRN

**(table continues...)**

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	BUCKIF_OT WRN
BUCKIF thermal shutdown		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 1	BUCKIF
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 2	BUCKIF
Severe overvoltage at BUCKIF or BUCKIF OV		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	BUCKIF
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	BUCKIF
Undervoltage at BUCKIF		off	No transition	INT1	UV_STAT_APP 1	BUCKIF
		on	No transition	INT1, INT2	UV_STAT_APP 1	BUCKIF
		on	No transition	INT1, INT2	UV_STAT_APP 2	BUCKIF
Voltage selection error. 1.8 or 3.3 V might be corrupt and not correctly selected.		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP1	BUCKIF_VOL TSEL
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP2	BUCKIF_VOL TSEL
Short to ground at BUCKIF		off	No transition	INT1	STG_STAT_AP P1	BUCKIF
		on	No transition	INT1, INT2	STG_STAT_AP P1	BUCKIF
		on	No transition	INT1, INT2	STG_STAT_AP P2	BUCKIF
PREREG	PREREG short to ground	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P1	PREREG
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_AP P2	PREREG
	Severe overvoltage at PREREG & PREREG OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	PREREG
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	PREREG
	Undervoltage at PREREG	off	No transition	INT1	UV_STAT_APP 1	PREREG
		on	No transition	INT1, INT2	UV_STAT_APP 1	PREREG
		on	No transition	INT1, INT2	UV_STAT_APP 2	PREREG

**(table continues...)**

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

QCO	QCO OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	QCO
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	QCO
	QCO overtemperature warning	off	No transition	INT1	OT_WRN_OC_STAT_APP1	QCO_OTWRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	QCO_OTWRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	QCO_OTWRN
	QCO thermal shutdown	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 1	QCO
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP 2	QCO
	Undervoltage at QCO	off	No transition	INT1	UV_STAT_APP 1	QCO
		on	No transition	INT1, INT2	UV_STAT_APP 1	QCO
		on	No transition	INT1, INT2	UV_STAT_APP 2	QCO
	Short to ground at QCO	off	No transition	INT1	STG_STAT_APP1	QCO
		on	No transition	INT1, INT2	STG_STAT_APP1	QCO
on		No transition	INT1, INT2	STG_STAT_APP2	QCO	
QST	QST OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	QST
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	QST
	QST overcurrent	off	No transition	INT1	OT_WRN_OC_STAT_APP1	QST_OC
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	QST_OC
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	QST_OC
	QST undervoltage or Severe undervoltage	any	Move to INIT	RESOUT, SSO1, SSO2	UV_STAT_APP 1	QST
on		Move to INIT	RESOUT, SSO1, SSO2	UV_STAT_APP 1	QST	

**(table continues...)**

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

	QST short to ground	on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_APP2	QST
	QST BIST errors, severe overvoltage	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP1	QST
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP2	QST
	QST short to ground	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_APP1	QST
QST/QUC	Voltage selection error. 5 V or 3.3 V might be corrupt and not correctly selected.	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP1	QST_QUC_VOLTSEL
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP2	QST_QUC_VOLTSEL
QUC	QUC OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP1	QUC
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP2	QUC
	QUC overtemperature warning	off	No transition	INT1	OT_WRN_OC_STAT_APP1	QUC_OTWRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	QUC_OTWRN
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	QUC_OTWRN
	QUC short to ground	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_APP1	QUC
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	STG_STAT_APP2	QUC
	QUC thermal shutdown	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP1	QUC
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP2	QUC
	QUC undervoltage	any	Move to INIT	RESOUT, SSO1, SSO2	UV_STAT_APP1	QUC
on		Move to INIT	RESOUT, SSO1, SSO2	UV_STAT_APP1	QUC	
QVR	QVR OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP1	QVR
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP2	QVR
	QVR overcurrent	off	No transition	INT1	OT_WRN_OC_STAT_APP1	QVR_OC

(table continues...)

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP1	QVR_OC
		on	No transition	INT1, INT2	OT_WRN_OC_STAT_APP2	QVR_OC
	Undervoltage at QVR	off	No transition	INT1	UV_STAT_APP 1	QVRUV
		on	No transition	INT1, INT2	UV_STAT_APP 1	QVRUV
		on	No transition	INT1, INT2	UV_STAT_APP 2	QVR
	QVR short to ground	off	No transition	INT1	STG_STAT_AP P1	QVR
		on	No transition	INT1, INT2	STG_STAT_AP P1	QVR
		on	No transition	INT1, INT2	STG_STAT_AP P2	QVR
	VMON1	Undervoltage at VMON1	off	No transition	INT1	UV_STAT_APP 1
on			No transition	INT1, INT2	UV_STAT_APP 1	VMON1
on			No transition	INT1, INT2	UV_STAT_APP 2	VMON1
VMON1 OV		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	VMON1
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 2	VMON1
Short to ground at VMON1		off	No transition	INT1	STG_STAT_AP P1	VMON1
		on	No transition	INT1, INT2	STG_STAT_AP P1	VMON1
		on	No transition	INT1, INT2	STG_STAT_AP P2	VMON1
VMON2		Undervoltage at VMON2	off	No transition	INT1	UV_STAT_APP 1
	on		No transition	INT1, INT2	UV_STAT_APP 1	VMON2
	on		No transition	INT1, INT2	UV_STAT_APP 2	VMON2
	VMON2 OV	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP 1	VMON2

**(table continues...)**

**10 Monitoring functions**

**Table 41 (continued) Reaction on detected events of regulators**

		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_APP2	VMON2
	Short to ground at VMON2	off	No transition	INT1	STG_STAT_APP1	VMON2
		on	No transition	INT1, INT2	STG_STAT_APP1	VMON2
		on	No transition	INT1, INT2	STG_STAT_APP2	VMON2

1) Only for move to INIT

2) Due to move to FAILSAFE also INTx will go low (QUC switched off in FAILSAFE)

(x = 1; 2)

**Table 42 Reaction on detected events of the system**

Module	Event description	REDUCED OPERATION ON/OFF	State transition	IO reaction	Register name	Bitfield name
SSW	Major error detected during SSW BIST or SSW was activated during normal operation	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP1	PREREG_COSW
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP2	PREREG_COSW
ENA	ENA signal detected (only when waking up from FAILSAFE, STANDBY or SLEEP)	on	Move into WAKE if device is in SLEEP or within the transition into this state. Else no transition takes place.	INT1 <sup>3)</sup> , INT2 <sup>3)</sup>	WAKE_STAT_APP1	ENA
		on	Move into WAKE if device is in SLEEP or within the transition into this state. Else no transition takes place.	INT1 <sup>3)</sup> , INT2 <sup>3)</sup>	WAKE_STAT_APP2	ENA

(table continues...)

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

		off	Move into WAKE or INIT if device is in STANDBY or SLEEP or within the transition into those states. Else no transition takes place.	INT1 <sup>3)</sup>	WAKE_STAT_APP1	ENA
WAK	WAK signal detected (only when waking up from FAILSAFE, STANDBY or SLEEP)	on	Move into WAKE if device is in SLEEP or within the transition into this state. Else no transition takes place.	INT1 <sup>3)</sup> , INT2 <sup>3)</sup>	WAKE_STAT_APP2	WAK
		on	Move into WAKE if device is in SLEEP or within the transition into this state. Else no transition takes place.	INT1 <sup>3)</sup> , INT2 <sup>3)</sup>	WAKE_STAT_APP1	WAK
		off	Move into WAKE or INIT if device is in STANDBY or SLEEP or within the transition into those states. Else no transition takes place.	INT1 <sup>3)</sup>	WAKE_STAT_APP1	WAK
WUT	Wake-up timer (WUT) expired and woke up the device (only when waking up from STANDBY or SLEEP)	on	Move into WAKE if device is in SLEEP. Else no transition takes place.	INT2	WAKE_STAT_APP2	WUT
		on	Move into WAKE if device is in SLEEP. Else no transition takes place.	INT1, INT2	WAKE_STAT_APP1	WUT

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

		off	Move into WAKE or INIT if device is in STANDBY or SLEEP. Else no transition takes place.	INT1	WAKE_STAT_APP1	WUT
ERR0	ERR0 monitoring error AND ERR0 recovery is enabled	on	No transition	INT1, INT2	SYS_STAT_APP2	ERR0_ERR
		on	No transition	INT1, INT2	SYS_STAT_APP1	ERR0_ERR
		off	No transition	INT1	SYS_STAT_APP1	ERR0_ERR
	FAILSAFE was entered after ERR0 reported invalid frequency (No recovery enabled or recovery expired)	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP1	ERR0
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_STAT_APP2	ERR0
ERR1	ERR1 monitoring error AND ERR1 recovery is enabled (less than $t_{REC}$ )	any	No transition	INT1	SYS_STAT_APP1	ERR1_ERR
	ERR1 signal is outside of valid frequencies (if recovery enabled: longer than $t_{REC}$ before being set)	off	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP1	ERR1
		on	Move to REDUCED OPERATION	INT2 <sup>4)</sup>	INIT_ERR_APP2	ERR1
		on	Move to REDUCED OPERATION	INT1 <sup>6)</sup> , SSO1	INIT_ERR_APP1	ERR1
ERR2	ERR2 monitoring error AND ERR2 recovery is enabled (less than $t_{REC}$ )	on	No transition	INT2	SYS_STAT_APP2	ERR2_ERR
	ERR2 signal is outside of valid frequencies (if recovery enabled: longer than $t_{REC}$ before being set)	on	Move to REDUCED OPERATION	INT2 <sup>6)</sup> , SSO2	INIT_ERR_APP2	ERR2
		on	Move to REDUCED OPERATION	INT1 <sup>4)</sup>	INIT_ERR_APP1	ERR2

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

FSM	FAILSAFE was entered because INIT timer expired a 3rd time in a row without successful initialization.	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_ST AT_APP1	FSM_INITTIMER
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_ST AT_APP2	FSM_INITTIMER
	INIT timer expires 1st time Soft reset issued	off/on	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP1	SOFTRES
		on	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP2	SOFTRES
	INIT timer expires 2nd time in a row Hard reset issued	off/on	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP1	HARDRES
		on	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP2	HARDRES
	State transition into low power state (STANDBY or SLEEP) failed/ interrupted (e.g. by WAK or ENA)	off	Move into WAKE or INIT (depending on the transition)	INT1, RESOUT <sup>1)</sup> , SSO1, SSO2	SYS_STAT_APP1	FSM_TRFAIL
	State transition into low power state (STANDBY or SLEEP) failed/ interrupted (e.g. by WAK or ENA)	on	Move into WAKE or INIT (depending on the transition)	INT1, INT2, RESOUT <sup>1)</sup> , SSO1, SSO2	SYS_STAT_APP1	FSM_TRFAIL
		on	Move into WAKE or INIT (depending on the transition)	INT1, INT2, RESOUT <sup>1)</sup> , SSO1, SSO2	SYS_STAT_APP2	FSM_TRFAIL
	State transition not existing or transition conditions not fulfilled.	off	No transition	INT1	SYS_STAT_APP1	FSM_NOOP
		on	No transition	INT1, INT2	SYS_STAT_APP1	FSM_NOOP
		on	No transition	INT1, INT2	SYS_STAT_APP2	FSM_NOOP
	WWD1 incorrectly triggered and error counter reaches or exceeds threshold	off	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP1	WWD1_EC
		on	Move to REDUCED OPERATION	INT2 <sup>4)</sup>	INIT_ERR_APP2	WWD1_EC
on		Move to REDUCED OPERATION	INT1 <sup>6)</sup> , SSO1	INIT_ERR_APP1	WWD1_EC	

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

	WWD1 missed or incorrect service (error counter below threshold)	any	No transition	INT1	SYS_STAT_APP1	WWD1_ERR
WWD2	WWD2 incorrectly triggered and error counter reaches threshold	on	Move to REDUCED OPERATION	INT2 <sup>6)</sup> , SSO2	INIT_ERR_APP2	WWD2_EC
		on	Move to REDUCED OPERATION	INT1 <sup>4)</sup>	INIT_ERR_APP1	WWD2_EC
	WWD2 missed or incorrect service (error counter below threshold)	on	No transition	INT2	SYS_STAT_APP2	WWD2_ERR
FWD1	FWD1 incorrectly triggered and error counter reaches threshold	off	Move to INIT	RESOUT, SSO1, SSO2	INIT_ERR_APP1	FWD1_EC
		on	Move to REDUCED OPERATION	INT2 <sup>4)</sup>	INIT_ERR_APP2	FWD1_EC
		on	Move to REDUCED OPERATION	INT1 <sup>6)</sup> , SSO1	INIT_ERR_APP1	FWD1_EC
	FWD1 response missed or incorrectly triggered (error counter below threshold)	any	No transition	INT1	SYS_STAT_APP1	FWD1_ERR
FWD2	FWD2 response missed or incorrectly triggered (error counter below threshold)	on	No transition	INT2	SYS_STAT_APP2	FWD2_ERR
	FWD2 incorrectly triggered and error counter reaches threshold	on	Move to REDUCED OPERATION	INT2 <sup>6)</sup> , SSO2	INIT_ERR_APP2	FWD2_EC
		on	Move to REDUCED OPERATION	INT1 <sup>4)</sup>	INIT_ERR_APP1	FWD2_EC
INT	Interrupt flags not cleared after $t_{INTx\_to}$	any	No transition	-	IF1	INTMISS
		on	No transition	-	IF2	INTMISS

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

Internal Element	Internal 2V5 rail overvoltage	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_A PP1	INTSUP_VDD2V5
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_A PP2	INTSUP_VDD2V5
	Internal 2V5 rail undervoltage	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	UV_STAT_A PP1	INTSUP_VDD2V5_UV
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	UV_STAT_A PP2	INTSUP_VDD2V5_UV
	Internal bias current too high	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	INTSUP_ST AT_APP1	BIAS_HI
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	INTSUP_ST AT_APP2	BIAS_HI
	Internal bias current too low	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	INTSUP_ST AT_APP1	BIAS_LOW
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	INTSUP_ST AT_APP2	BIAS_LOW
	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_AP Px can be set)	off	No transition	INT1	INTSUP_ST AT_APP1	BG12_OV
		off	No transition	INT1	INTSUP_ST AT_APP1	BG12_UV
		off	No transition	INT1	INTSUP_ST AT_APP1	PMU_MAIN
		off	No transition	INT1	INTSUP_ST AT_APP1	PMU_RED
		on	No transition	INT1, INT2	INTSUP_ST AT_APP1	BG12_OV
		on	No transition	INT1, INT2	INTSUP_ST AT_APP1	BG12_UV
		on	No transition	INT1, INT2	INTSUP_ST AT_APP1	PMU_MAIN
		on	No transition	INT1, INT2	INTSUP_ST AT_APP1	PMU_RED
		on	No transition	INT1, INT2	INTSUP_ST AT_APP2	BG12_OV

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

		on	No transition	INT1, INT2	INTSUP_ST AT_APP2	BG12_UV
		on	No transition	INT1, INT2	INTSUP_ST AT_APP2	PMU_MAIN
		on	No transition	INT1, INT2	INTSUP_ST AT_APP2	PMU_RED
Internal IVCC overvoltage		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_A PP1	INTSUP_IVCC
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OV_STAT_A PP2	INTSUP_IVCC
Internal IVCC undervoltage or short to ground		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	UV_STAT_A PP1	INTSUP_IVCC_ UV
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	UV_STAT_A PP2	INTSUP_IVCC_ UV
Internal IVCC overcurrent		off	No transition	INT1	OT_WRN_O C_STAT_AP P1	IVCC_OC
		on	No transition	INT1, INT2	OT_WRN_O C_STAT_AP P1	IVCC_OC
		on	No transition	INT1, INT2	OT_WRN_O C_STAT_AP P2	IVCC_OC
Interval IVCC BIST errors, severe overvoltage		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_ST AT_APP1	INTSUP_IVCC
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_ST AT_APP2	INTSUP_IVCC
Double Error detected on a protected register		any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_ST AT_APP1	CFGE
		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	SYSFAIL_ST AT_APP2	CFGE
Safety Area	Overtemperature of safety area	any	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_A PP1	SAFETY_AREA

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

		on	Move to FAILSAFE	RESOUT, SSO1, SSO2 <sup>2)</sup>	OT_STAT_APP2	SAFETY_AREA
SPI	CRC wrong	off	No transition	INT1	SPI_FAIL_STAT_APP1	CRC
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP1	CRC
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP2	CRC
	CSN timeout after 2 ms	off	No transition	INT1	SPI_FAIL_STAT_APP1	CS_TO
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP1	CS_TO
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP2	CS_TO
	Frame length wrong	off	No transition	INT1	SPI_FAIL_STAT_APP1	FR_LEN
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP1	FR_LEN
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP2	FR_LEN
	Invalid address	off	No transition	INT1	SPI_FAIL_STAT_APP1	ADR
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP1	ADR
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP2	ADR
	Lock of protected registers was unsuccessful (will cause the registers to be locked again and made changes are ignored)	off	No transition	INT1	SPI_FAIL_STAT_APP1	LOCK
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP1	LOCK
		on	No transition	INT1, INT2	SPI_FAIL_STAT_APP2	LOCK
SPI command woke up the device while in sleep	on	Move into WAKE if device is in SLEEP. Else no transition takes place.	INT1, INT2	WAKE_STAT_APP2	SPI	

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

		on	Move into WAKE if device is in SLEEP. Else no transition takes place.	INT1, INT2	WAKE_STAT_APP1	SPI
		off	Move into WAKE if device is in SLEEP. Else no transition takes place.	INT1	WAKE_STAT_APP1	SPI
ABIST	ABIST finished execution	off	No transition	INT1	IF1	ABIST
		on	No transition	INT1, INT2	IF1	ABIST
		on	No transition	INT1, INT2	IF2	ABIST
	Any error that moves the device to FAILSAFE or INIT during an ABIST execution aborts the on-going ABIST and sets this bit.	any	No transition	RESOUT, SSO1, SSO2	SYSFAIL_ST_AT_APP1	ABIST
		on	No transition	RESOUT, SSO1, SSO2	SYSFAIL_ST_AT_APP2	ABIST
Application1	Application 1 was reason for entering REDUCED OPERATION	on	Move to REDUCED OPERATION	INT2 <sup>4)</sup>	SYS_STAT_APP2	APP1_FAIL
	INIT timer expired a second time in RED. OP. due to application 1 not being able to reinitialize	on	Move to INIT	RESOUT, SSO2	INIT_ERR_APP1	REDOP_RES2
	INIT timer expired the first time in RED. OP. due to application 1 not being able to reinitialize	on	Move to REDUCED OPERATION	INT1	INIT_ERR_APP1	REDOP_RES1
Application2	Application 2 was reason for entering REDUCED OPERATION	on	Move to REDUCED OPERATION	INT1 <sup>4)</sup>	SYS_STAT_APP1	APP2_FAIL

**(table continues...)**

**10 Monitoring functions**

**Table 42 (continued) Reaction on detected events of the system**

INIT timer expired a second time in RED. OP. due to application 2 not being able to reinitialize	on	Move to INIT	RESOUT, SSO1	INIT_ERR_A PP2	REDOP_RES2
INIT timer expired the first time in RED. OP. due to application 2 not being able to reinitialize	on	Move to REDUCED OPERATION	INT2	INIT_ERR_A PP2	REDOP_RES1

- 1) Only for move to INIT
  - 2) Due to move to FAILSAFE also INTx will go low (QUC switched off in FAILSAFE)
  - 3) Only if BUCKCORE and QUC are on
  - 4) Configurable via SPI
  - 5) Only if REDUCED OPERATION is enabled
  - 6) Application reset
- (x = 1; 2)

**10.7 Analog built-in self test (ABIST)**

**10.7.1 Analog built-in self test (ABIST) - overview**

The device contains an analog built in self-test function that can be triggered by the microcontroller. It serves the purpose to test the overvoltage and undervoltage comparators for the external and internal voltage rails, as well as the corresponding safety logic. By performing these tests, it can be ensured, that the monitoring works correctly and the warning and safety paths in the system are intact. The device differentiates between the following main configuration for the ABIST:

- Comparators Only (no deglitching)
- Full path including deglitching logic and interrupt generation (INTx)
- Full path including deglitching logic and secondary shutdown path (SSOx)

(x = 1;2)

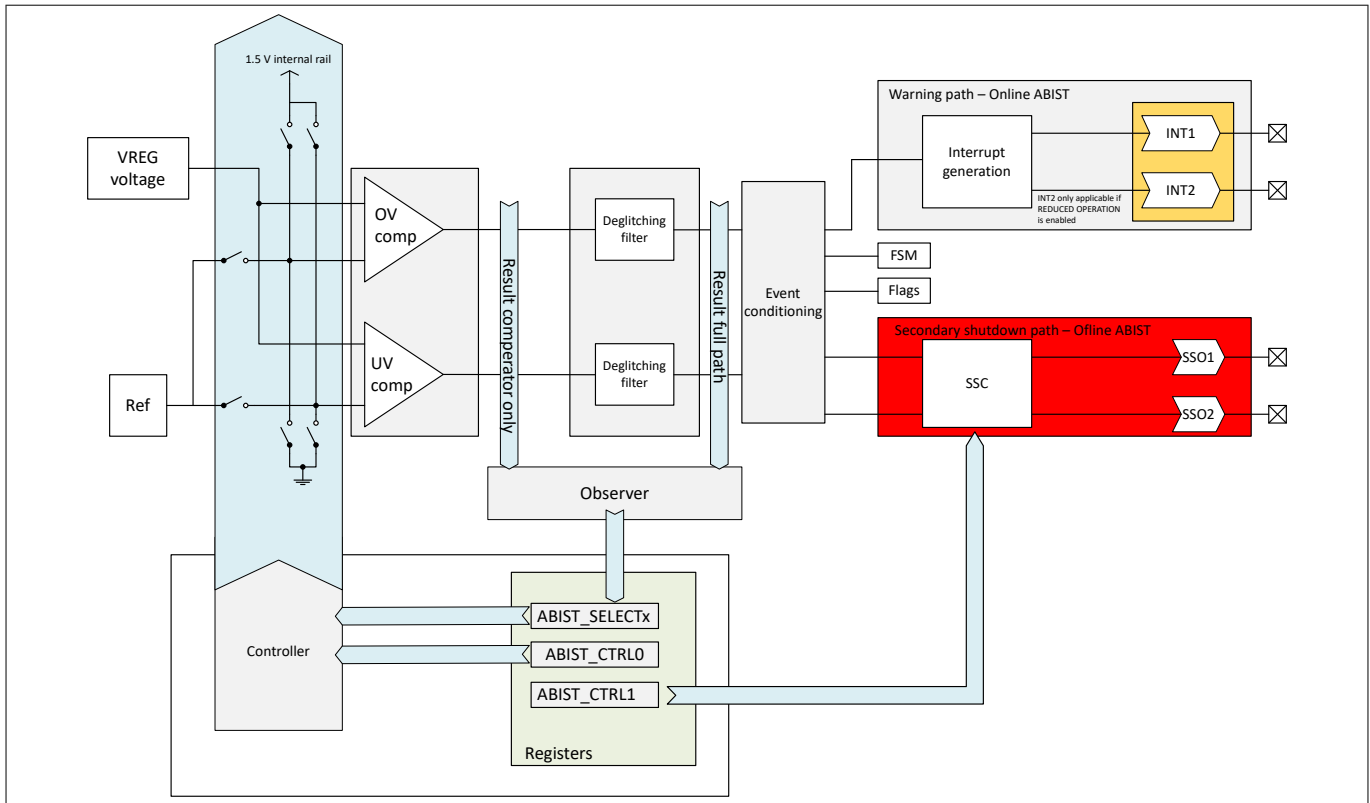
The configuration for the mentioned tests is done in the registers:

- ABIST\_CTRL0
- ABIST\_SELECT0
- ABIST\_SELECT1
- ABIST\_SELECT2

In addition, the device allows specific analog tests, that affect the safety logic directly. For that the register

- ABIST\_CTRL1
- must be written accordingly.

**10 Monitoring functions**



**Figure 67 ABIST block diagram**

**10.7.2 ABIST - comparators only**

The device provides the functionality to only test the comparators without the deglitching logic. During the test the overvoltage and undervoltage comparators are forced into error condition, by either connecting the reference input to ground or internal 1.5 V. This condition will only be applied for a time which does not exceed the deglitching logic filter time. Hence the remaining path (warning path, secondary shutdown path) is not tested any further.

**10.7.3 ABIST - full path**

The device provides the functionality to test the internal overvoltage and undervoltage comparators including the corresponding deglitching logic. This will consequently issue the respective full path as well (warning path, secondary shutdown path). When the full path to test to check SSO1/2 is started, the device must be in NORMAL state. For all other full path test executions the device can also be started in INIT or WAKE. Following the comparators are forced into error condition which is maintained for a time long enough to also trigger the deglitching logic. This will result in a corresponding event for the remaining path. If the test is started in NORMAL a state transition into WAKE will also occur (only for secondary shutdown path comparators, else no transition). Whether an interrupt at INT1/2 or a secondary shutdown path at SSO1/2 is issued, depends on the selection of the comparators, that has been made before the test was started. An overview of the corresponding comparator assignment can be found in the following table:

**Table 43 ABIST - Comparator assignment to secondary shutdown path or warning path**

Comparator	Secondary shutdown path	Interrupt
PREREG OV	X	
QST OV	X	
QUC OV	X	

(table continues...)

**10 Monitoring functions**

**Table 43** (continued) **ABIST - Comparator assignment to secondary shutdown path or warning path**

BUCKCORE OV	X	
QCO OV	X	
QVR OV	X	
BUCKIF OV	X	
BOOST OV	X	
VMON1 OV	X	
VMON2 OV	X	
IVCC OV	X	
VDD2V5 OV	*	
PREREG SEVOV	*	
BUCKCORE SEVOV	*	
BUCKIF SEVOV	*	
R3FBL_OPEN	*	
PREREG UV		X
QST UV	X	
QUC UV	X	
BUCKCORE UV	X	
QCO UV		X
QVR UV		X
BUCKIF UV		X
BOOST UV		X
VMON1 UV		X
VMON2 UV		X
IVCC UV	X	
VDD2V5 UV	*	
BSTI UV	*	
BST_DEEP_UV	X	
VBAT OV	X	
BG12 UV		X
BG12 OV		X
BIASLOW	X	
BIASHI	X	
VDD1V5 UV	*	
VDD1V5 OV	*	

**(table continues...)**

**10 Monitoring functions**

**Table 43 (continued) ABIST - Comparator assignment to secondary shutdown path or warning path**

VDD5V0 UV	*	
VDD5V0 OV	*	

\*) Comparators contribute to the secondary shutdown path but are not testable in full path by the ABIST.

**Note:** *An interrupt for a single test execution (only one comparator tested) will show two interrupts at the device. One for the comparator test and one for the completion of the test execution. If multiple comparators are tested only one interrupt for test completion will be issued. The SSO1/2 event, as well as the state transition into WAKE from NORMAL takes only place once for each test execution. Meaning, that if a test sequence is being run for the full path, only the first comparator will trigger the state transition and its corresponding full path reaction (secondary shutdown path). All others will simply test the deglitching logic and set the corresponding flags.*

**Note:** *To see the entire reaction chain for the full path, which includes the trigger of the INT pin or SSO1/2 pin (depending on the selected comparators) as well as the flagging of the respective error or status bits, it must be ensured by the integrator that all affected regulators that shall be tested are also enabled.*

**10.7.4 ABIST - configuration and execution**

To execute the ABIST the following selections and configurations must be made:

- ABIST\_CTRL0:
  - START: Starts the ABIST
  - PATH: determines whether the full path or only the comparators are being tested
  - SINGLE: determines whether only a single comparator or an entire sequence (only the selected comparators in ABIST\_SELECT0/1/2) is executed
  - INT: must be configured to select the test either for the warning path (interrupt related comparators) or the secondary shutdown path (SSO1/2 related comparators)
  - STATUS: indicates whether the ABIST has finished with or without errors
  - ALL: if set, all comparators in ABIST\_SELECT0/1/2 are automatically selected and the test is executed with PATH = 0 and SINGLE = 0 except BSTI UV comparator
- ABIST\_SELECT0/1/2: determines which comparators shall be tested during execution

**Note:** Integrator must ensure that the bit ABIST\_SELECT1.BSTIUV is set to 0, especially before starting any ABIST operation in case an error in BSTI UV is reported

When the execution of the ABIST has finished:

1. An interrupt is issued
2. Check if ABIST\_CTRL0.START = 0
3. ABIST without errors: ABIST\_CTRL0.STATUS = 0x5
4. ABIST with errors: ABIST\_CTRL0.STATUS = 0xA
5. Read ABIST\_SELECT0/1/2:
  - 0: Comparator intact
  - 1: Comparator failed test

**10.7.5 ABIST - testing the secondary shutdown path logic**

In addition to the above described comparator tests, the device provides the option to directly force and hereby test the activation of the secondary shutdown path. This can be done for each SSO1/2 separately and is applied immediately once the register ABIST\_CTRL1 is written.

The following tests can be applied by writing ABIST\_CTRL1:

## **10 Monitoring functions**

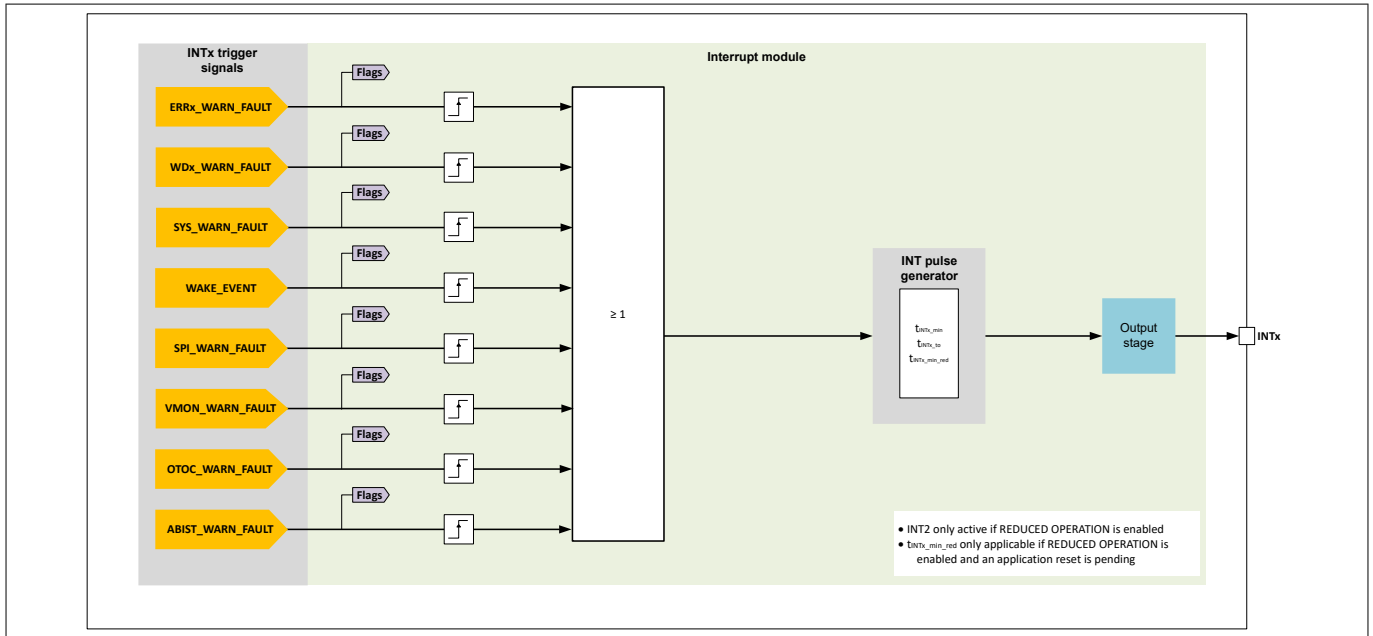
- **OV\_1V5\_TRIG:** forces an overvoltage at the internal 1.5 V supply of the secondary shutdown path logic
  - Expected result: SSO1/2 must be activated (pulled low)
- **ABIST\_CLK\_EN:** enables the internal clock signal for the SSOx reaction
  - Must be used in combination with the other bits in ABIST\_CTRL1. For further references the Safety Manual provides more information.
- **SS1\_EN\_BIST:** interrupts the safety clock signal only for SS1
  - Expected result: SSO1 must be activated (pulled low)
- **SS2\_EN\_BIST:** interrupts the safety clock signal only for SS2
  - Expected result: SSO2 must be activated (pulled low)

**11 Interrupt function (INT)**

**11 Interrupt function (INT)**

**11.1 Introduction**

The interrupt module is used to inform the microcontroller that a system event has been detected by the device. It is a request to the microcontroller to perform a diagnostic of the device.



**Figure 68 Functional block diagram Interrupt function**

The interrupt module provides two interrupt channels.

General occurrences are reported on INT1. If REDUCED OPERATION is enabled, INT1 and INT2 are additionally activated for their application specific error cases (see [Reaction on faults](#)).

Each interrupt pin INTx (x = 1 or 2) is a push-pull stage.

The device can be configured for single application or dual application use cases.

**Single Application use case (default configuration):**

In this case, any interrupt-triggered signal detection activates the interrupt on the output pin INT1.

**Dual Application use case:**

Dual applications use case can be activated via SPI by setting the bit **REDOP\_PW\_CFG1.EN** to 1.

In this case (see [Reaction on faults](#)):

- The detection of the Interrupt-triggered signal on application 1 activates the interrupt on the output pin INT1
- The detection of the Interrupt-triggered signal on application 2 activates the interrupt on the output pin INT2
- The detection of general events is reported at both interrupt lines INT1 and INT2
- The detection of a severe fault (**WD1\_SEV\_FAULT** or **ERR1\_SEV\_FAULT**) on application 1 activates an interrupt on the application 2 if SPI bit **REDOP\_RS\_CFG1.INT2\_DIS** is set to 0 (Condition: Device must be in NORMAL or REDUCED OPERATION state)
- The detection of a severe fault (**WD2\_SEV\_FAULT** or **ERR2\_SEV\_FAULT**) on application 2 activates an interrupt on the application 1 if SPI bit **REDOP\_RS\_CFG1.INT1\_DIS** is set to 0 (Condition: Device must be in NORMAL or REDUCED OPERATION state)

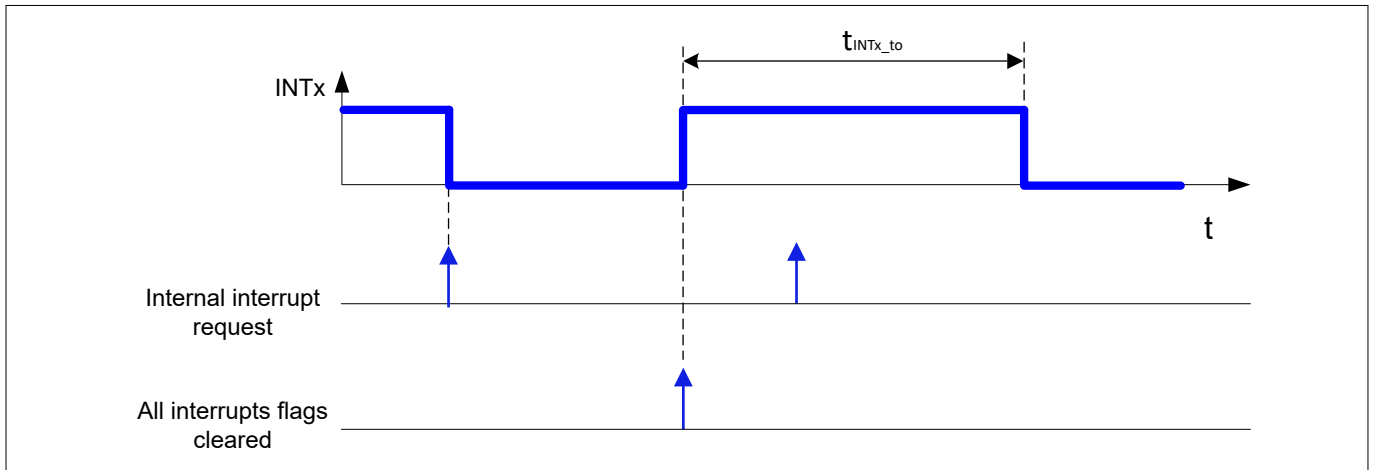
**11 Interrupt function (INT)**

**11.2 Interrupt activation**

The default output value of the interrupt pin is logical high (no interrupt pending). The device activates an interrupt by setting the related interrupt pin to "low".

After the interrupt pin becomes inactive (Interrupt signal transition from "low" to "high"), a minimum active time  $t_{INTx\_to}$  has to elapse before new interrupt requests can reactivate the pin. The  $t_{INTx\_to}$  time starts with the next rising edge of the interrupt pin.

The occurrence of an interrupt is latched in a status register and can be read and cleared on a write command via SPI after removing the failure.



**Figure 69**      **Activation of the interrupt pin INTx (set interrupt pin to logical low)**

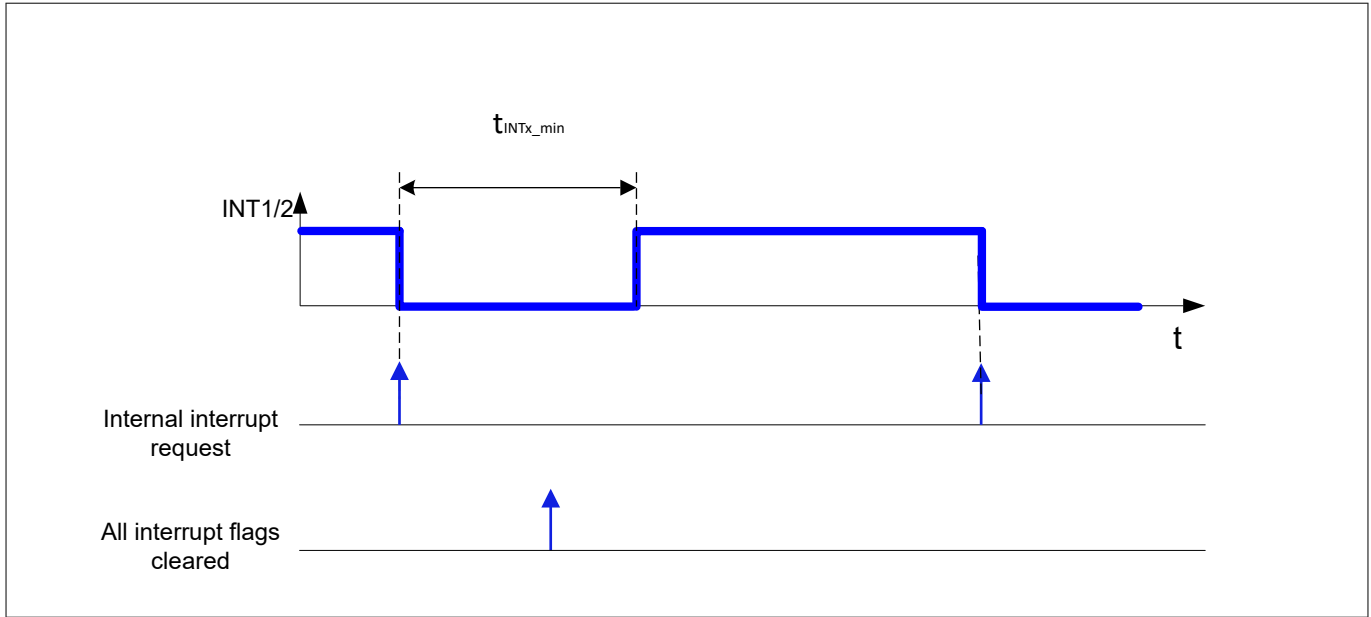
**11.3 Interrupt deactivation**

The interrupt will be deactivated and set to logical "high" under the following conditions:

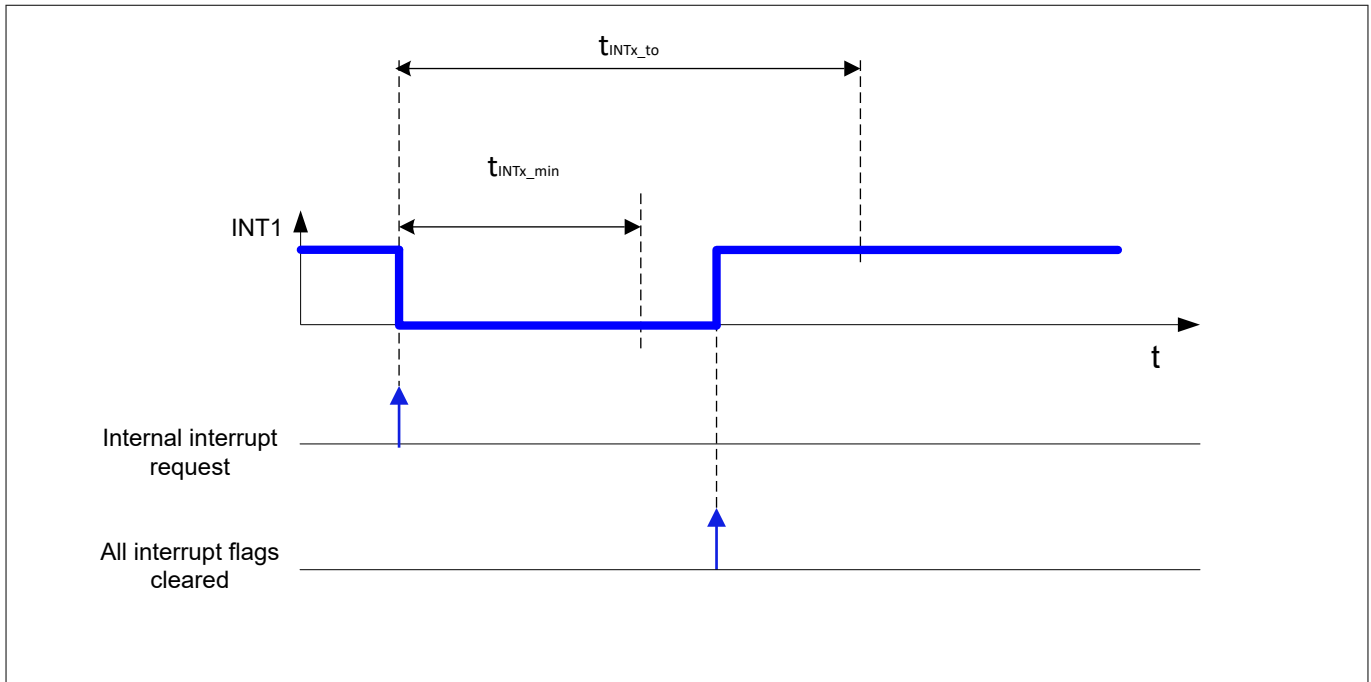
- If all dedicated interrupt flags are cleared after the minimum interrupt pulse width  $t_{INTx\_min}$  AND before  $t_{INTx\_to}$  is expired (see figure [deactivating of interrupt by clearing all dedicated interrupt flags](#)).
- If  $t_{INTx\_min}$  expires, and all interrupt flags have been cleared in time(see figure [deactivating of interrupt by the minimum pulse width if interrupt flags are cleared too early](#))
- If  $t_{INTx\_min\_red}$  expires and REDUCED OPERATION is enabled while an application reset is pending
- If  $t_{INTx\_to}$  expires and not all interrupt flags have been cleared in time(see figure [deactivating of interrupt by t\\_{INTx\\\_to} if interrupt flags cleared too late](#)). In this case a missing interrupt is detected, the bit **IFx.INTMISS** is set and can be clear via SPI

(x=1,2)

**11 Interrupt function (INT)**

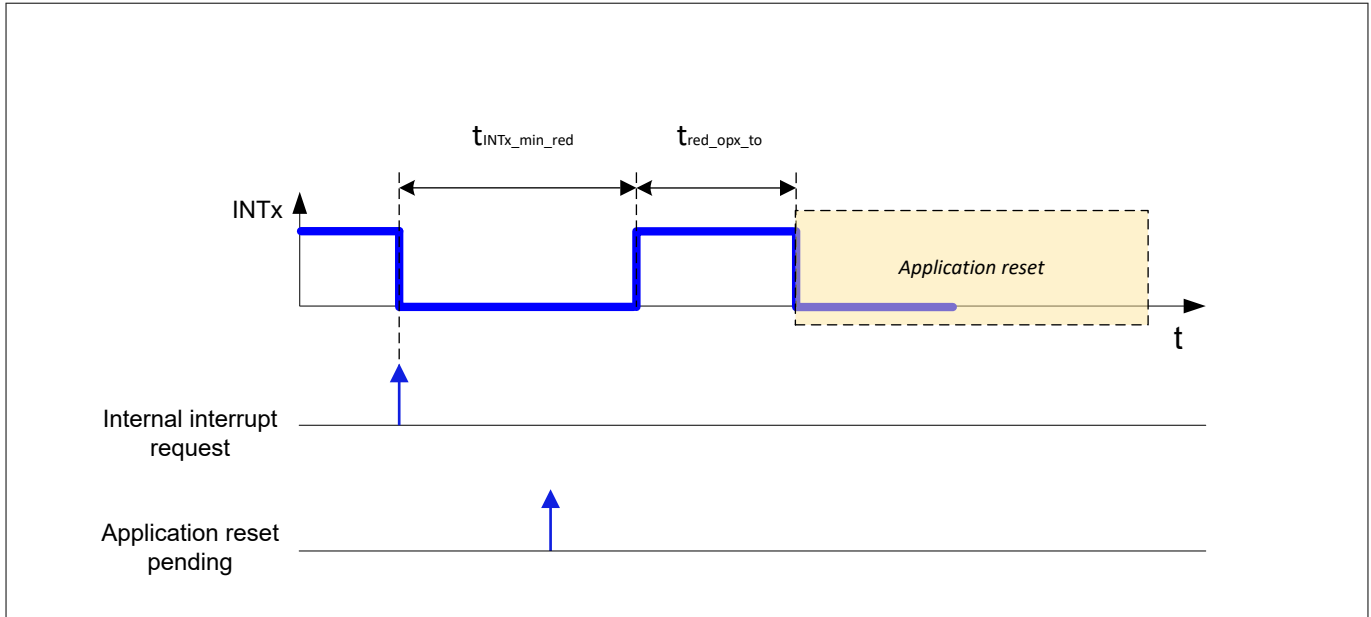


**Figure 70** Deactivating of interrupt by the minimum pulse width if interrupt flags are cleared before expiration of  $t_{INTx\_min}$

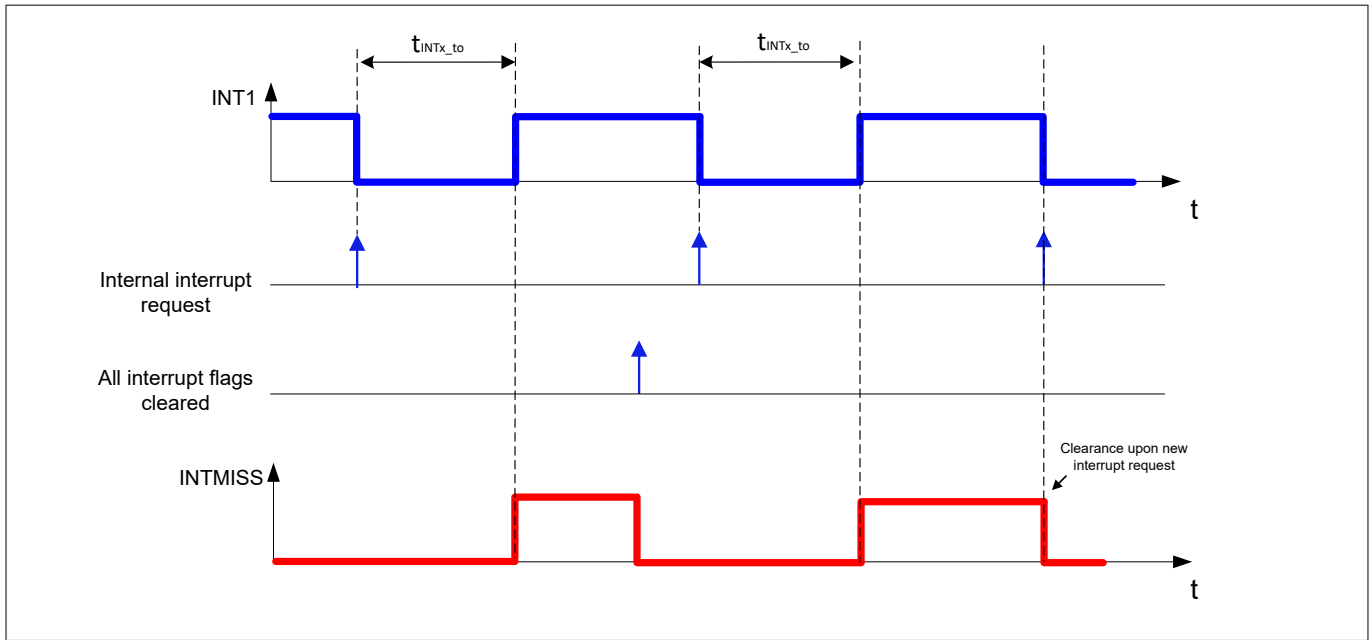


**Figure 71** Deactivating of interrupt by clearing all dedicated interrupt flags

**11 Interrupt function (INT)**



**Figure 72 Deactivation of interrupt by pending application reset**



**Figure 73 Missed interrupt (Deactivating of interrupt by timeout ( $t_{INTx\_to}$ ) if interrupt flags cleared too late)**

**11 Interrupt function (INT)**

**11.4 Electrical characteristics interrupt (INT)**

**Table 44 Electrical characteristics interrupt (INT)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
Output voltage high level	$V_{INT\_H}$	3.15	-	-	V	$V_{QUC} \geq V_{QUC}[\text{Min}]$ ; $I_{INT} = -7\text{ mA}$ ; Parameter applicable to INT1 and SYNC_IN/INT2	DS-1641
Output voltage low level	$V_{INT\_L}$	-	-	0.7	V	$I_{INT} = 5.5\text{ mA}$ ; Parameter applicable to INT1 and SYNC_IN/INT2	DS-1643
Pin output rise time	$t_{INT\_RISE}$	-	-	25	ns	$C_{INT,load} = 50\text{ pF}^{1)}$	DS-1644
Pin output fall time	$t_{INT\_FALL}$	-	-	25	ns	$C_{INT,load} = 50\text{ pF}^{1)}$	DS-1645
Minimum interrupt pulse width for single application use case	$t_{INTx\_min}$	90	100	150	$\mu\text{s}$	<sup>1)</sup>	DS-1646
Interrupt pulse timeout	$t_{INTx\_to}$	270	300	350	$\mu\text{s}$	<sup>1)</sup>	DS-1647
Minimum interrupt pulse width for dual application used case - application reset pending	$t_{INTx\_min\_red}$	50	55	60	$\mu\text{s}$	<sup>1)</sup>	DS-1649

<sup>1)</sup> Not subject to production test, specified by design

## **12 Reset function (RESOUT)**

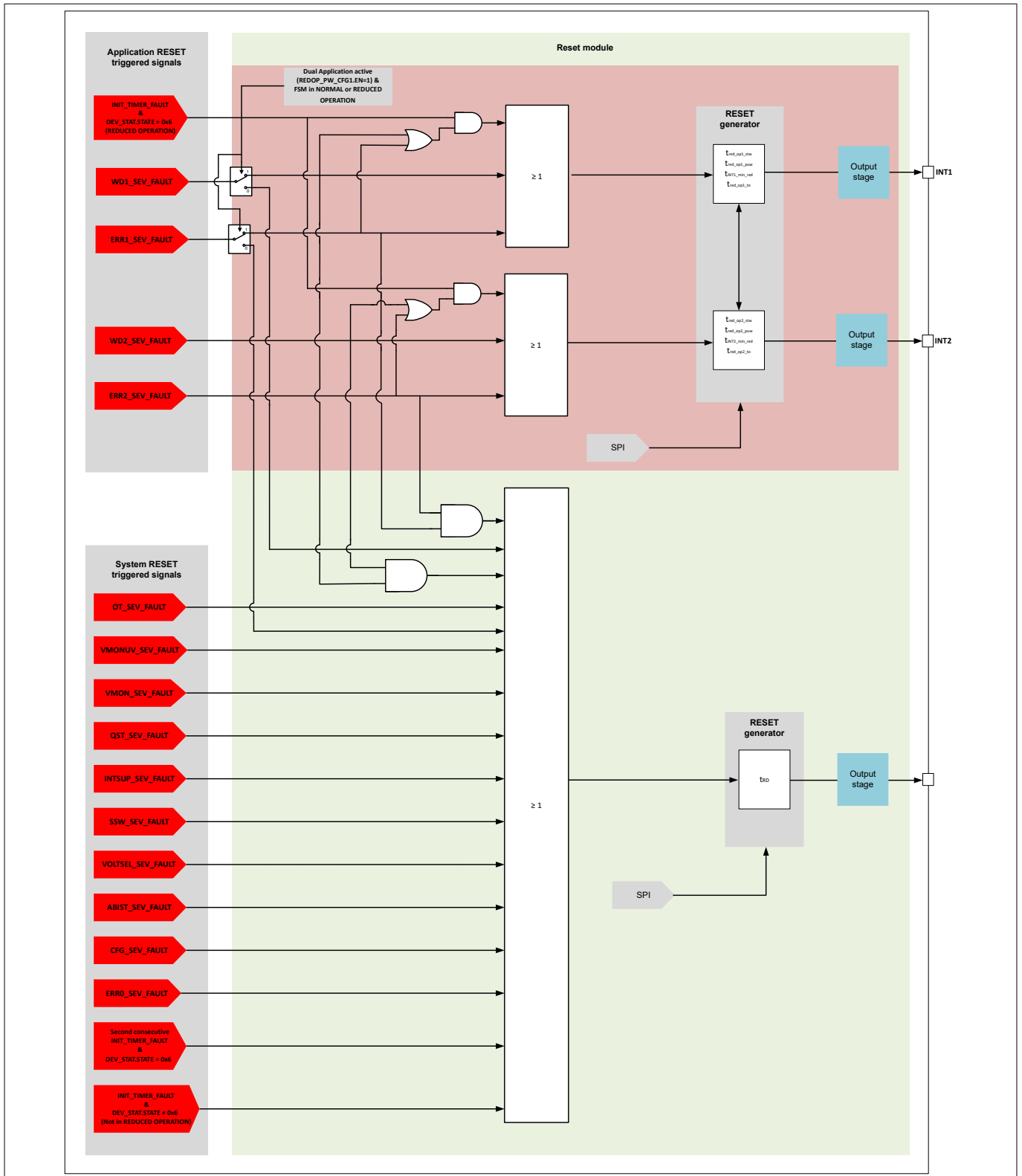
### **12 Reset function (RESOUT)**

#### **12.1 Functional description reset function (RESOUT)**

##### **12.1.1 Introduction**

The Reset module is used to reset a group of applications (Application Reset) or to reset the total system (System Reset) based on the configuration and the source of the reset. An application reset is only active if REDUCED OPERATION is enabled.

**12 Reset function (RESOUT)**



**Figure 74 Functional block diagram reset function**

The reset module provides following reset channels:

**12 Reset function (RESOUT)**

- Two channels for application reset. The application reset is activated on the output pins INTx (x = 1 or 2) if an application reset-triggered signal is detected on the related application (valid only for dual application use case (bit **REDOP\_PW\_CFG1.EN** = 1))
- One channel for system reset. The system reset is activated on the output pin RESOUT if:
  - a system reset-triggered signal is detected
  - an application reset-triggered signal is detected on both applications (valid only for dual application use case **REDOP\_PW\_CFG1.EN** = 1)

**12.1.2 Application Reset (REDUCED OPERATION ENABLE)**

**12.1.2.1 Activation**

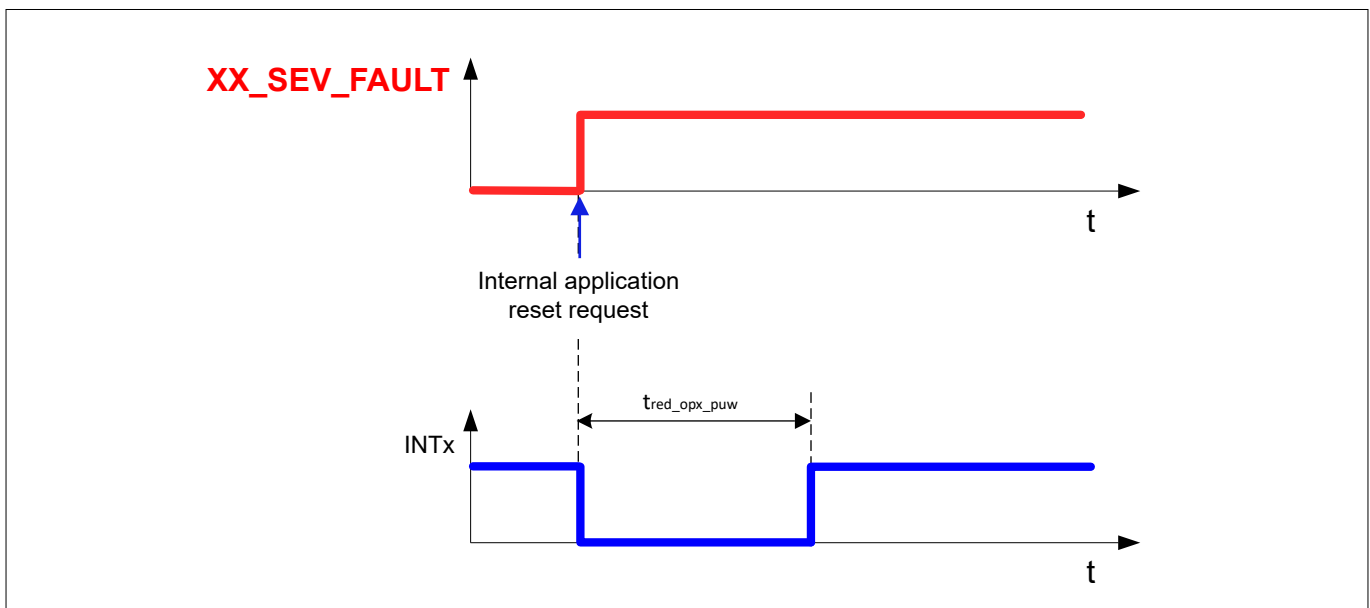
The device activates an application reset by generating a "low" pulse on the related interrupt pin (INTx) if one of the following application-reset-triggered signals is detected on the corresponding application:

- A severe fault of the WD or ERRx monitoring(WDx\_SEV\_FAULT or ERRx\_SEV\_FAULT), see [application reset activation](#)
- The INIT timer elapses once (INIT\_TIMER\_FAULT) when the device is in REDUCED OPERATION state (SPI Bitfield **DEV\_STAT.STATE** = **0x6**), see [application reset activation INIT timer fault](#).

The duration of the pulse length ( $t_{red\_opx\_puw}$ ) is configurable via SPI and can be calculated with following formula:

	Calculation	$t_{red\_opx\_stw}$	STEP
Pulse type 1 (default):	$t_{red\_opx\_puw} = STEP \times t_{red\_opx\_stw}$	10 $\mu$ s (TYP)	1 ... 8
Pulse type 2:	$t_{red\_opx\_puw} = STEP \times t_{red\_opx\_stw}$ ;	100 $\mu$ s (TYP)	1 ... 8

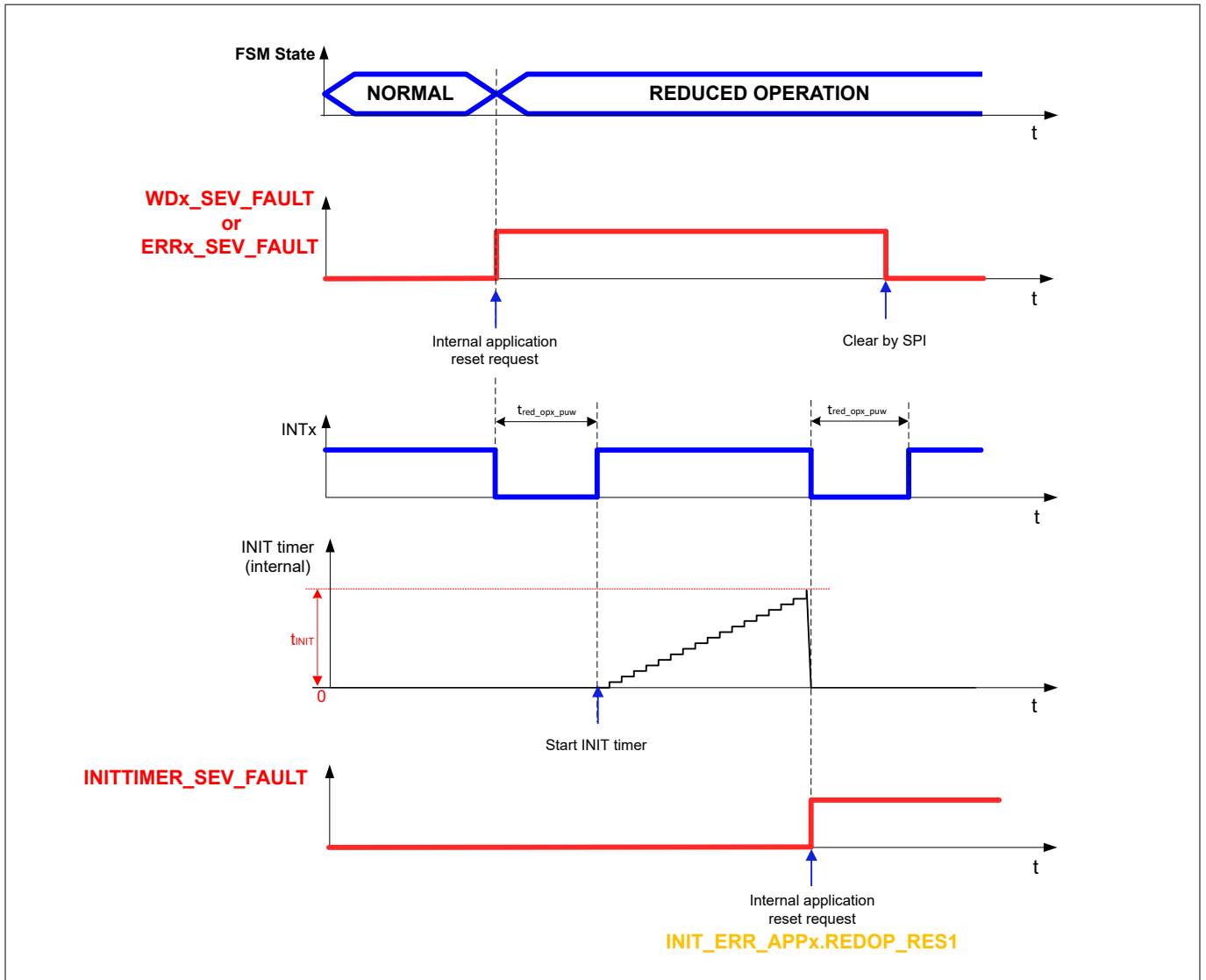
$t_{red\_opx\_stw}$  can be configured via SPI bit **REDOP\_RS\_CFG2.REDOP\_RESOUT\_APP\_TB**, the default value is 10  $\mu$ s and STEP can be configured via SPI bit **REDOP\_RS\_CFG2.REDOP\_RESOUT\_APPx\_DUR**.



**Figure 75 Activation of the application reset due to a severe fault**

(xx: ERR1/2 or WD1/2 or INIT timer expiration in combination with one of the modules ERR1/2 or WD1/2)

**12 Reset function (RESOUT)**



**Figure 76 Activation of the application reset due to INIT\_TIMER\_FAULT**

(x = 1; 2)

If the application reset is activated when the interrupt is active, the device sequentially:

1. Waits for the minimum interrupt pulse width  $t_{INTx\_min\_red}$
2. Releases the interrupt line and waits for  $t_{red\_opx\_to}$
3. Generates the interrupt pulse with its configurable width  $t_{red\_opx\_puw}$

12 Reset function (RESOUT)

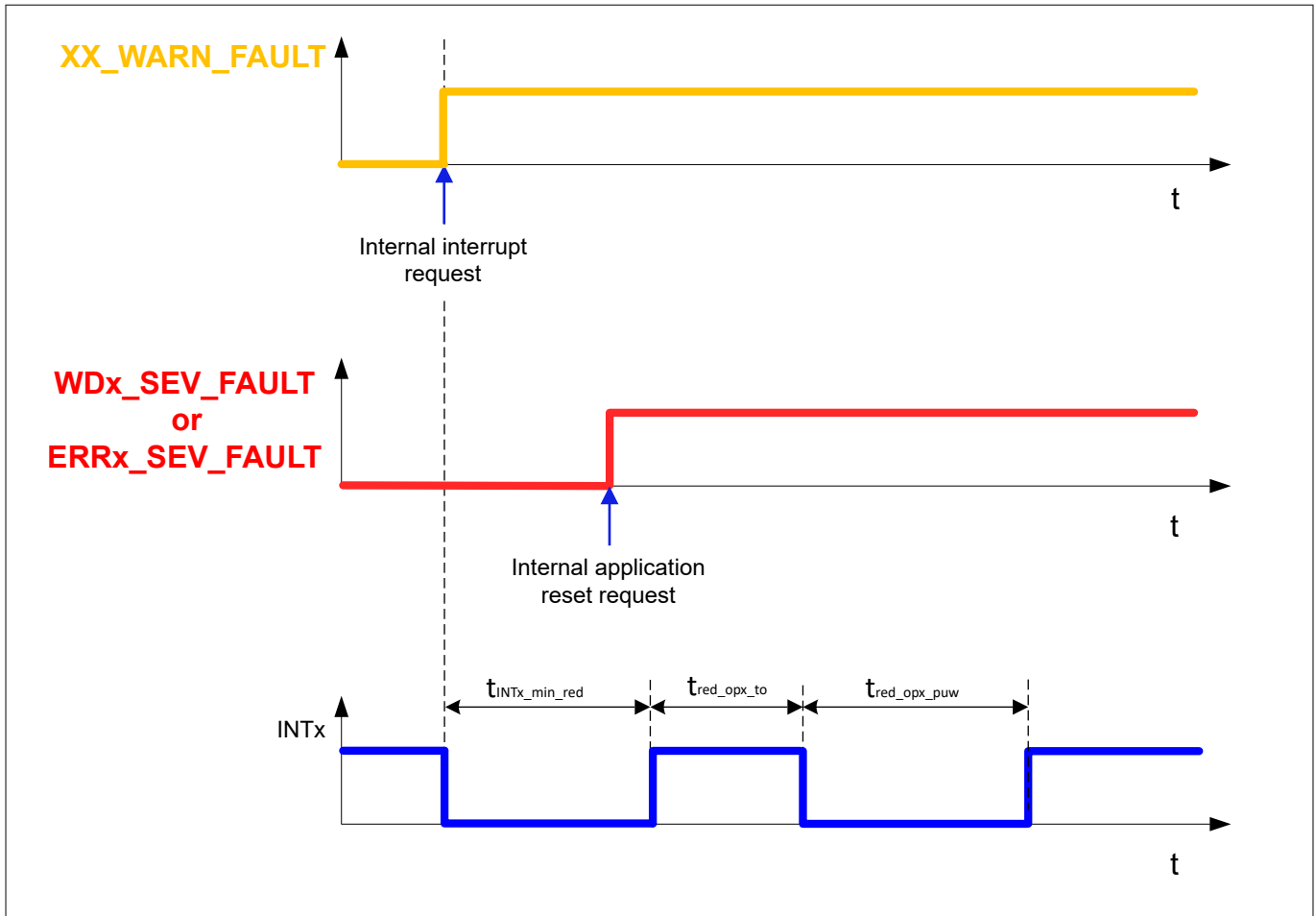


Figure 77 Application reset activation with interrupt active

If the INIT timer elapses **once** in REDUCED OPERATION state, the device:

- generates an INIT\_TIMER\_FAULT,
- activates a new application reset,
- sets the bit **INIT\_ERR\_APPx.REDOP\_RES1**; which can be clear by SPI after removing the fault.
- remains in REDUCED OPERATION

If the INIT timer elapses **twice** in REDUCED OPERATION state, the device

- generates an INIT\_TIMER\_FAULT
- activates a system reset
- sets the error bits **INIT\_ERR\_APP1.REDOP\_RES2** and **INIT\_ERR\_APP2.REDOP\_RES2**; which can be clear by SPI after removing the fault.
- moves to INIT state, see [Chapter 9](#).

### 12.1.3 System Reset

#### 12.1.3.1 Activation

The reset output pin RESOUT is an open drain structure. An internal pull up current ( $I_{RESOUT\_PU}$ ) is pulling the output towards  $V_{QUC}$ . As soon as a system reset condition occurs, the device triggers a reset by pulling pin RESOUT below  $V_{RESOUT\_LOW}$ .

An additional external pull-up resistor can be connected between the RESOUT and  $V_{QUC}$  pins to speed up the low-to-high transition.

12 Reset function (RESOUT)

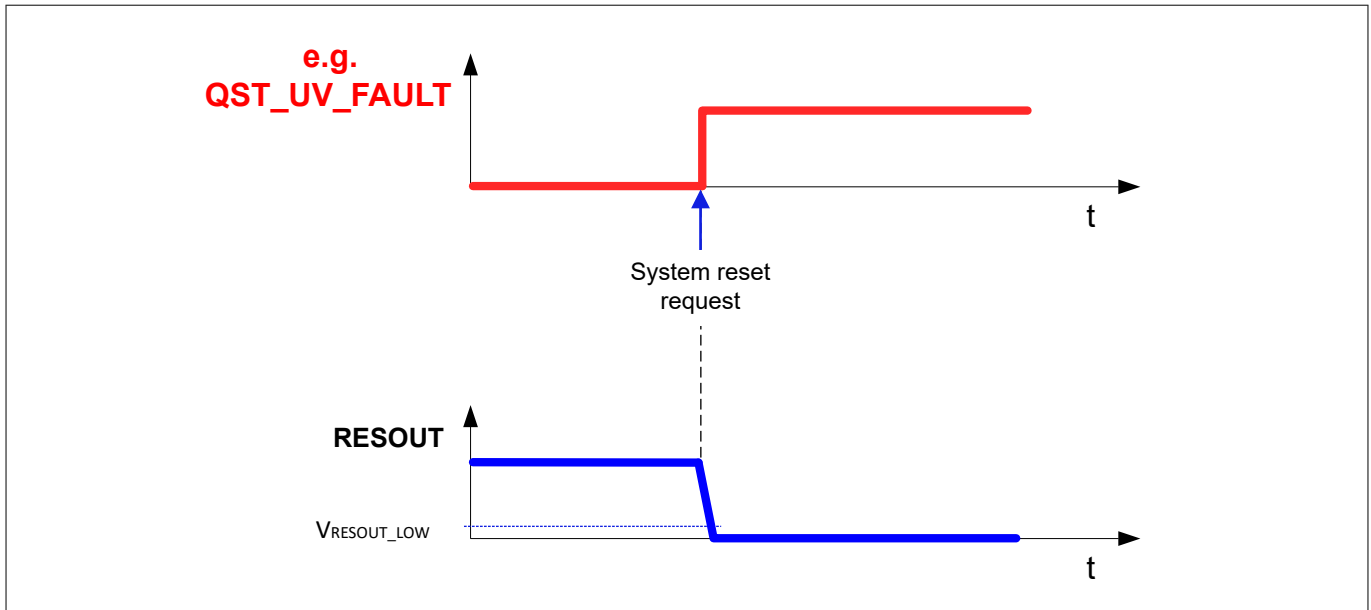


Figure 78 Activation of a system reset

12.1.3.2 Hard and Soft reset

Definition

Based on the detected system fault, the device generates a "Soft Reset" (WARM RESET) or a "Hard Reset" (COLD RESET) after entering INIT state, see Chapter 9.

- It is called a "Soft Reset" if pin RESOUT goes below  $V_{RESOUT\_LOW}$ , but the pre and post regulator output voltages are not switched off.
- It is called a "Hard Reset" if pin RESOUT goes below  $V_{RESOUT\_LOW}$ , and all regulator output voltages are switched off.

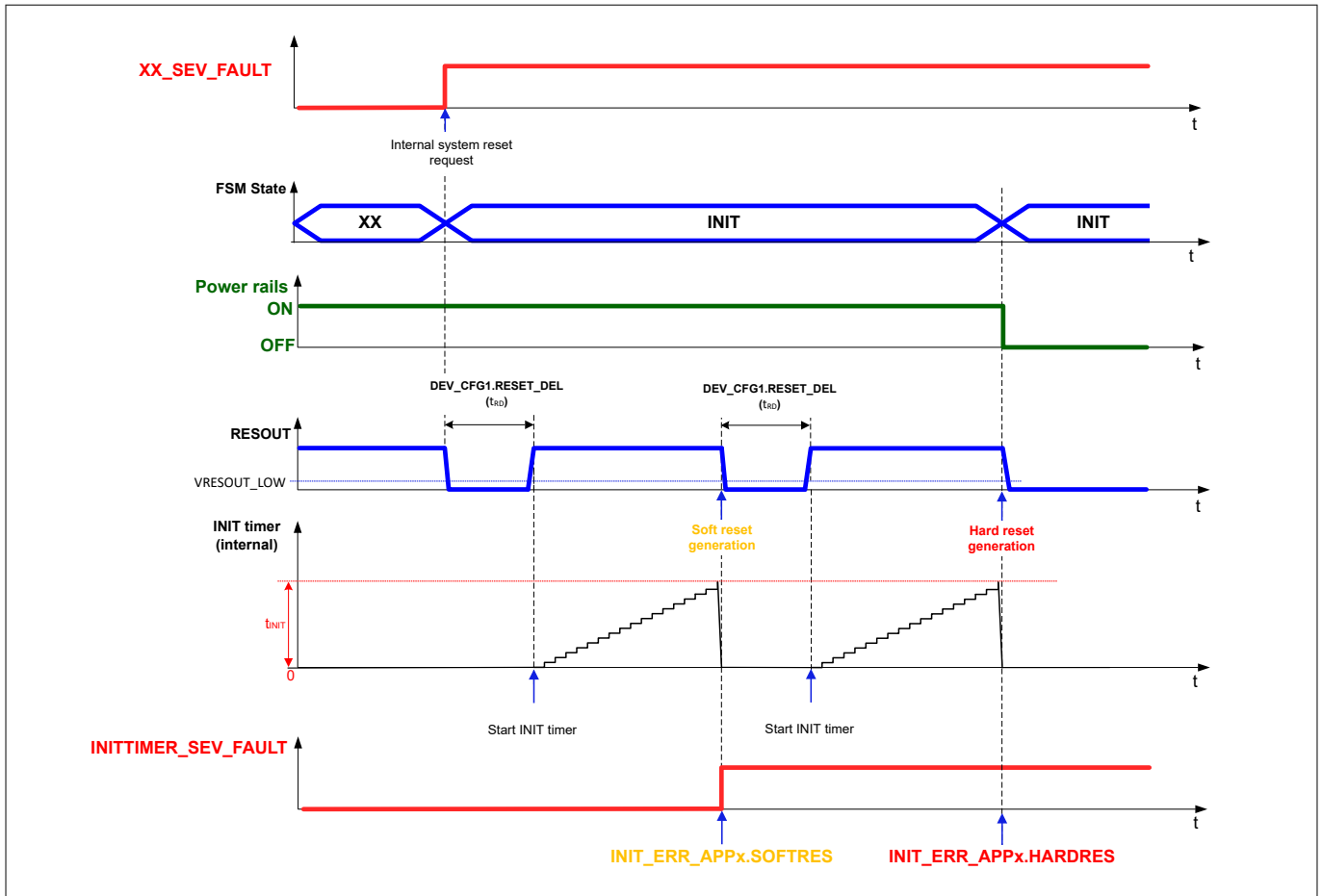
If the INIT timer elapses **once** in INIT or in WAKE state, the device:

- activates a soft reset
- generates an INIT\_TIMER\_FAULT
- set the bit **INIT\_ERR\_APPx.SOFTRES**; which can be clear by SPI
- moves into INIT state, see Chapter 9

If the INIT timer elapses **second time** in a row in INIT state, the device

- activates a hard reset, all regulator output voltages are switched off
- generates INIT\_TIMER\_FAULT
- sets the error bit **INIT\_ERR\_APPx.HARDRES**; which can be clear by SPI after removing the fault
- moves into INIT state, see Chapter 9

**12 Reset function (RESOUT)**



**Figure 79 Signal diagram Soft and Hard reset activation**

**Reset release**

After a soft reset generation, the device releases the reset by setting the output pin RESOUT "high" after the reset delay time ( $t_{RD}$ ).

After a hard reset generation, the device waits for QST, QUC and BUCKCORE to reached their undervoltage threshold during the [power up sequencing schema A](#) or the [power up sequencing schema B](#). Only if this was successful, the device:

1. Waits for the reset delay time  $t_{RD}$
2. Sets the output pin RESOUT "high"

**Reset Delay time configuration**

Upon starting up from POWERDOWN or STANDBY with WUT and QST disabled, the default value of the reset delay time can be set by hardware, see [HWCFG](#).

The configuration of the reset delay time  $t_{RD}$  is configurable during runtime in the register **DEV\_CFG1.RESET\_DEL**.

**12 Reset function (RESOUT)**

**12.2 Electrical characteristics reset function (RESOUT)**

**Table 45 Electrical characteristics reset function (RESOUT)**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
RESOUT start up delay time 2ms	$t_{RD\_2ms}$	1.8	2	2.2	ms	RESOUT start up delay time is set to 2ms by <a href="#">HWCFG</a> <sup>1)</sup>	DS-1539
RESOUT start up delay time 10ms	$t_{RD\_10ms}$	9	10	11	ms	RESOUT start up delay time is set to 10ms by <a href="#">HWCFG</a> <sup>1)</sup>	DS-1540
Pull-up current	$I_{RESOUT\_PU}$	-180	-55	-15	$\mu\text{A}$	$V_{RESOUT} \leq 2.0\text{ V}$	DS-2131
Low level	$V_{RESOUT\_LOW}$	-	-	0.4	V	$V_{QUC} = V_{QUC} [\text{Typ}]$ ; $I_{RESOUT} = 3.5\text{ mA}$	DS-1558
REDUCED OPERATION configurable reset step (default)	$t_{red\_opx\_step}$	9	10	11	$\mu\text{s}$	Default configuration <sup>1)</sup>	DS-1648
REDUCED OPERATION reset timeout	$t_{red\_opx\_to}$	9	10	11	$\mu\text{s}$	<sup>1)</sup>	DS-1650
Output fall time	$t_{RESOUT\_FALL}$	-	-	25	ns	$C_{RESOUT,load} = 50\text{ pF}$ <sup>1)</sup>	DS-1559

<sup>1)</sup> Not subject to production test, specified by design

## **13 Microcontroller programming support (MPS)**

The device includes a Microcontroller Programming Support (MPS) function, during which the following events are masked:

- MCU reset events (RESOUT) due to ERR1/2 pin monitoring reactions
- MCU reset events (RESOUT) due to watchdog reactions
- MCU reset events (RESOUT) due to all INIT timers (including REDUCED OPERATION) expiration reactions (INIT timer is stopped or not started)
- Transition to FAILSAFE due to ERR0 pin monitoring reaction. In case ERR0 is triggered, the device will move to INIT state without generating a reset events

This allows for example a programming of the  $\mu$ C without interruptions.

**Note:** *All other faults generates their respective response and other behaviors of the device remain the same.*

The MPS mode can be configured:

- Via hardware by setting the correspondent resistor value as describe in the [HWCFG](#) table
  - The MPS mode selection is refreshed only after a power cycle has been performed
- Via SPI command
  - MPS mode can be enable or disable in all FSM modes (**DEV\_CFG1.MPS\_EN**).

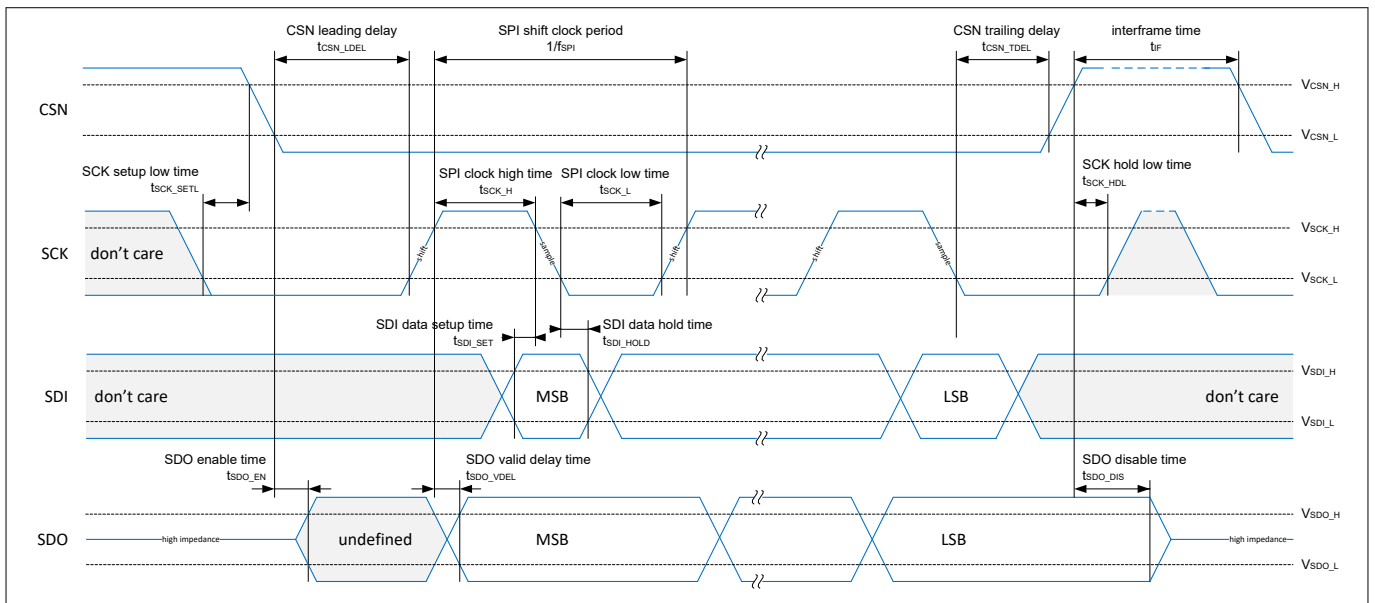
**14 SPI**

**14 SPI**

The Serial Peripheral Interface (SPI) is the communication link between the device and the microcontroller and supports multi-slave operation in full-duplex mode with 32 bit data access. The data transmission starts with the MSB. The clock polarity (CPOL) is 0 and the clock phase (CPHA) is 1.

The SPI uses 4 interface signals for synchronization and data transfer:

- CSN: SPI chip select (active low)
- SCK: SPI clock
- SDI: SPI data input
- SDO: SPI data output

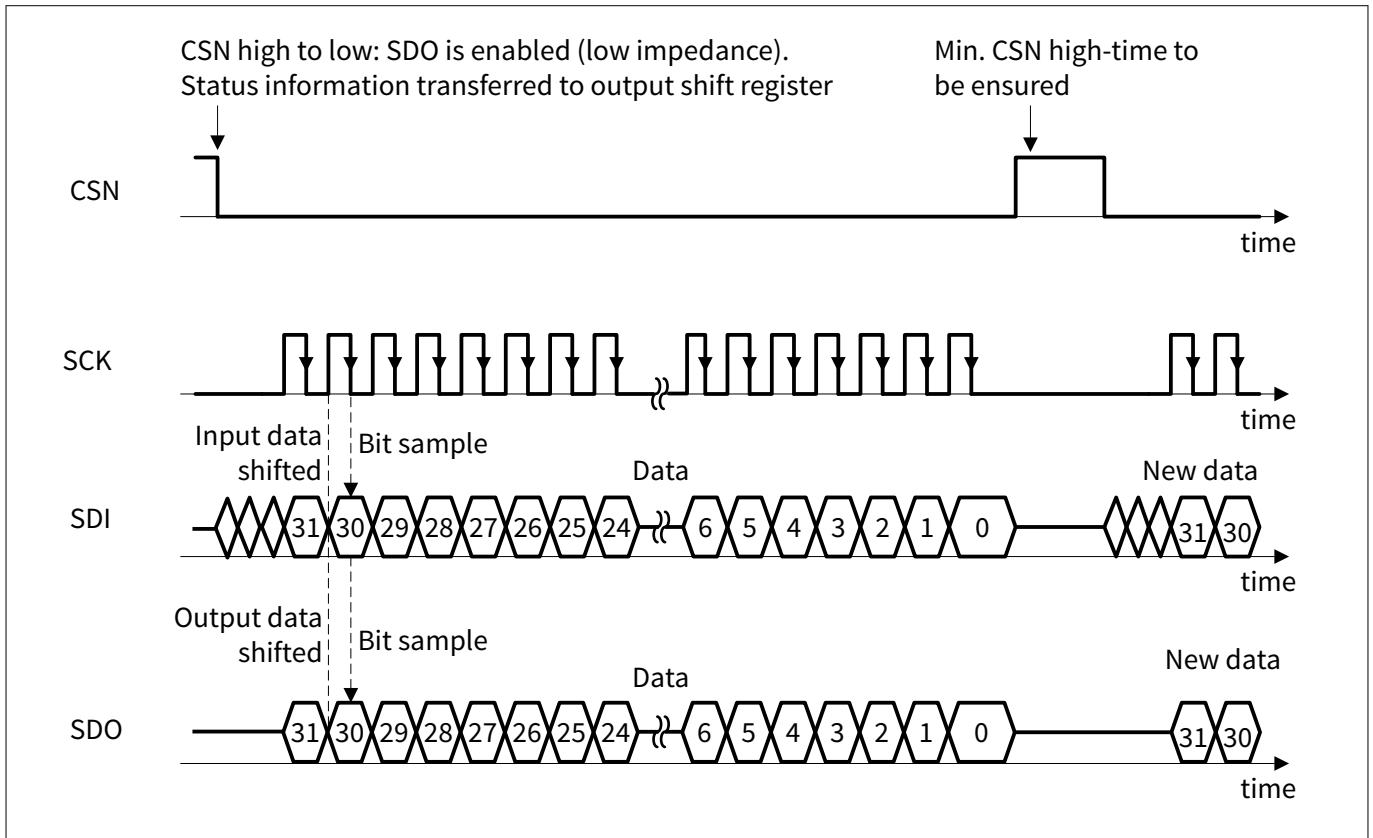


**Figure 80 SPI signals**

**14.1 Functional description SPI**

**14 SPI**

**14.1.1 SPI data transfer**



**Figure 81 SPI data transfer**

The SPI transfer begins when the device is selected by setting the CSN pin to "low". On every SCK rising edge data is shifted in on SDI (MSB first) and respectively shifted out on SDO (MSB first). The data on SDI is sampled on every falling edge of SCK. The SPI transfer is terminated by detecting a "high" signal at CSN. While CSN is at "high" level, SDO is set to high impedance.

The SPI does not support daisy chaining.

**14.1.2 SPI frame format**

The following section defines the SPI frame formats and defines the SPI service.

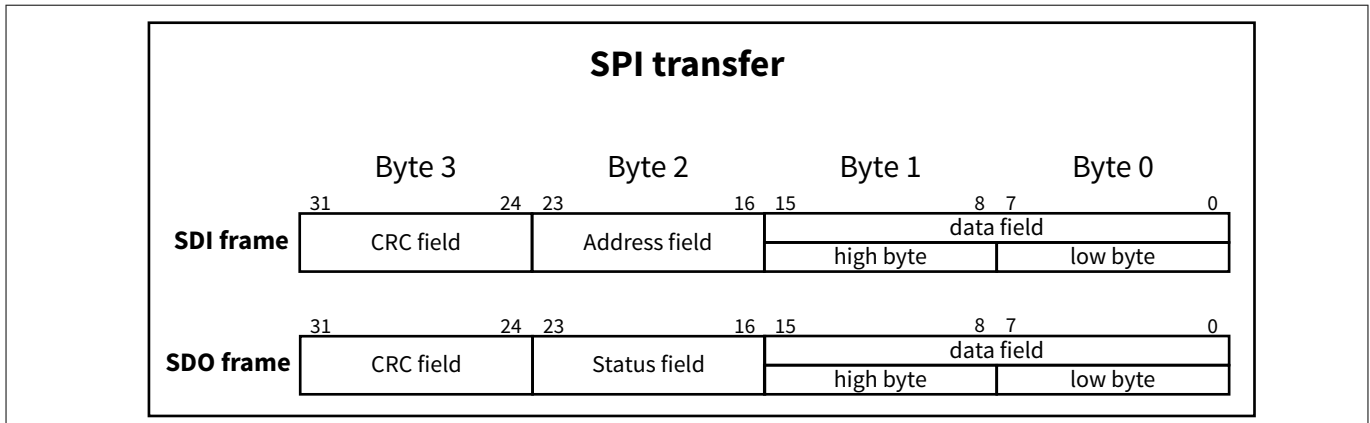
**14.1.2.1 SPI transfer**

An SPI transfer consists of the following frames:

- SDI frame
- SDO frame

After 32 shift clock cycles the device has received the SDI frame and the master (microcontroller) has received the SDO frame. [Figure 82](#) illustrates the structure of an SPI transfer.

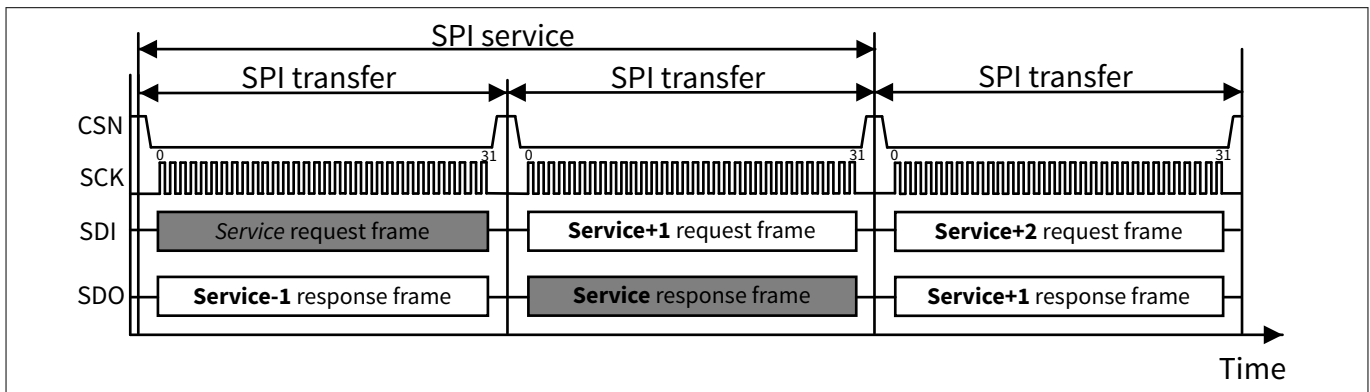
**14 SPI**



**Figure 82 SPI transfer structure**

**14.1.2.2 SPI service**

An SPI service can be a write service or a read service and consists of two SPI transfers. The first SPI transfer (request) contains the request information in the SDI frame which the master (microcontroller) sends to the device. The SDO frame of the first SPI transfer (request) contains the response information of the previous service and is not relevant for the current service. The second SPI transfer (response) contains the response information in the SDO frame. The SDI frame contains the request information of the next service and is not relevant for the current service. [Figure 83](#) shows the structure of the SPI service.



**Figure 83 SPI service and transfer definition**

**14.1.2.3 SPI read service**

A read service consists of two SPI transfers (request SPI transfer and response SPI transfer). [Figure 84](#) illustrates the structure of the read service.

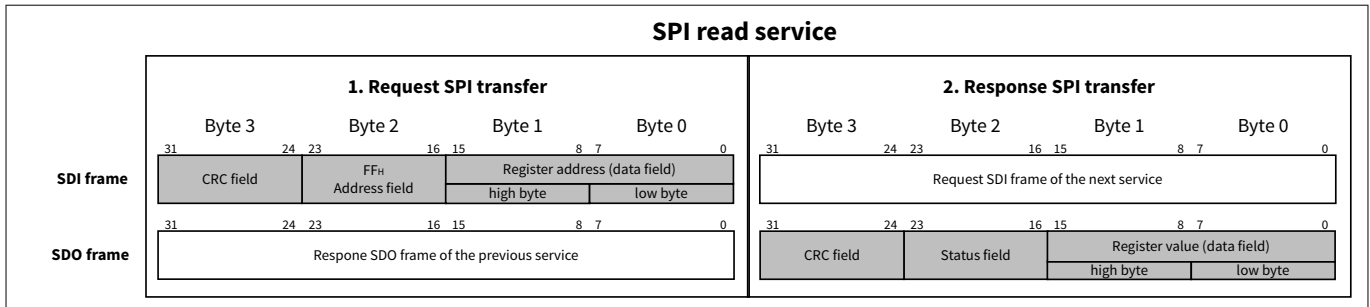
**Request SPI transfer SDI frame**

- CRC field: The calculation process of the CRC value is described in [Chapter 14.1.2.5](#)
- Address field: The value of the address field must be FF<sub>H</sub>, which defines a read service
- Data field: The data field contains the address of the register which shall be read

**Response SPI transfer SDO frame**

- CRC field: The calculation process of the CRC value is described in [Chapter 14.1.2.5](#)
- Status field: The status field is described in [Chapter 14.1.2.6](#)
- Data field: The data field contains the value of the register which was addressed in the request SPI transfer SDI frame

**14 SPI**



**Figure 84**                    **Structure of the read service**

**14.1.2.4**                    **SPI write service**

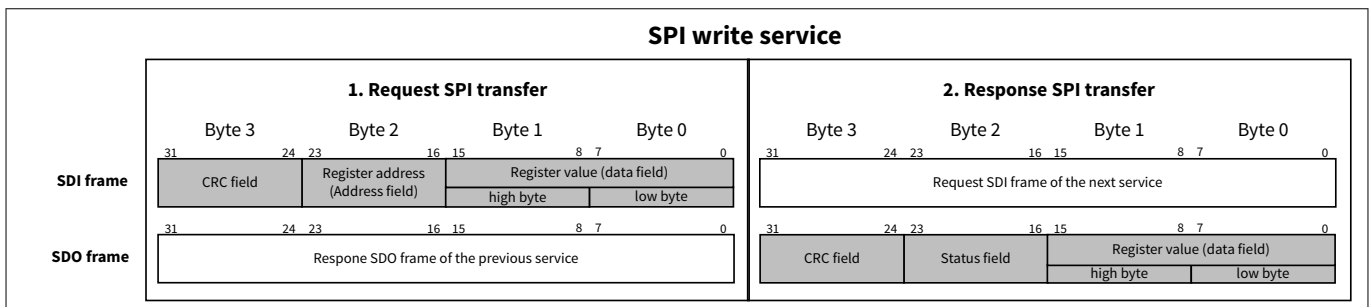
A write service consist of two SPI transfers (request SPI transfer and response SPI transfer). [Figure 85](#) illustrates the structure of the read service.

**Request SPI transfer SDI frame**

- CRC field: The calculation process of the CRC value is described in [Chapter 14.1.2.5](#)
- Address field: The address field contains the address to the register which shall be written
- Data field: The data field contains the value which shall be written to the register

**Response SPI transfer SDO Frame**

- CRC field: The calculation process of the CRC value is described in [Chapter 14.1.2.5](#)
- Status field: The status field is described in [Chapter 14.1.2.6](#)
- Data field: The data field contains the new value of the register after it was written



**Figure 85**                    **Structure of the SPI write service**

**14.1.2.5**                    **CRC field**

This chapter describes the CRC calculation from the point of view of the microcontroller and of the device. The CRC calculation uses the CRC8 of SAE J1850 standard.

**14 SPI**

The mathematical background for the CRC8 calculation and algorithm is described in the CRC AUTOSAR specification Version 4.3.1. The following C# example code explains the algorithm for calculating the CRC8.

```

Byte crc8(Byte[] data ,uint length) {
    Byte crc;
    uint i,bit;

    //Inital value must be 0xFF
    crc = 0xFF;
    for ( i=0 ; i<length ; i++ ) {
        crc ^= data[i];
        for ( bit=0 ; bit<8 ; bit++ ) {
            if ( (crc & 0x80)!=0 ) {
                crc <<= 1;
                crc ^= 0x1D; //Polynomial is 0x1D
            }
            else {
                crc <<= 1;
            }
        }
    }

    return (Byte)~crc;
}
    
```

The microcontroller calculates the CRC in the SDI frame (see [Chapter](#) ) and must checks the CRC in the SDO frame (see [Chapter](#) ).

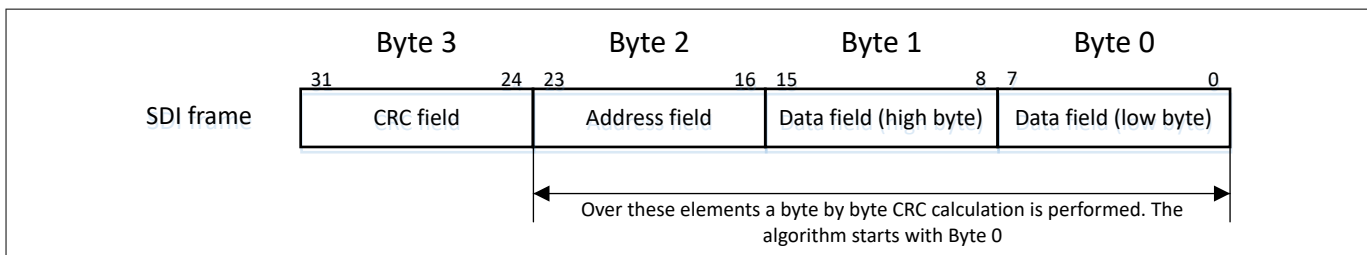
The device calculates the CRC in the SDO frame (see [Chapter](#) ) and must check the CRC in the SDI frame (see [Chapter](#) ).

**14.1.2.5.1 CRC microcontroller handling**

**CRC calculation**

The CRC calculation includes the following SDI frame elements ([Figure 86](#)):

- Low byte of the data field
- High byte of the data field
- Address field



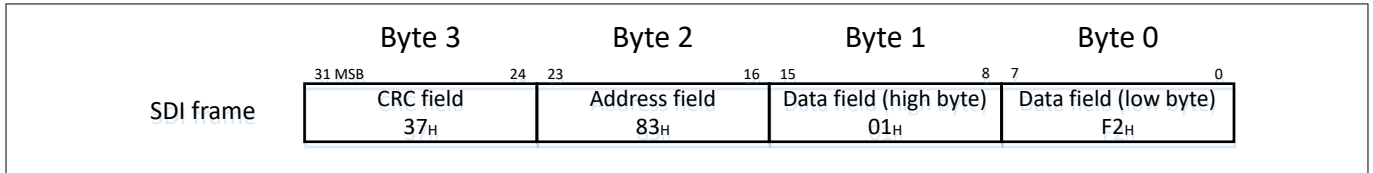
**Figure 86 Byte order for SAE J1850 CRC calculation**

To write to the register address 83<sub>H</sub> the register value 01F2<sub>H</sub>, the CRC algorithm (see [Chapter 14.1.2.5](#)) requires the following input parameters:

**14 SPI**

- Input bytefield parameter data: {F2<sub>H</sub>, 01<sub>H</sub>, 83<sub>H</sub>}
- Input parameter length: 3

The result of the CRC calculation is 37<sub>H</sub>. The SDI frame which must be sent from the microcontroller shows [Figure 87](#).

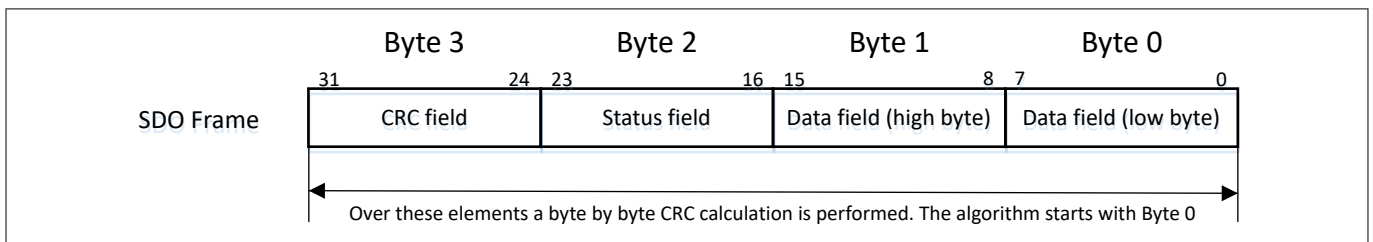


**Figure 87 SDI frame example**

**CRC check**

The CRC check includes the following SDO frame elements ([Figure 88](#)):

- Low byte of the data field
- High byte of the data field
- Status field
- CRC field



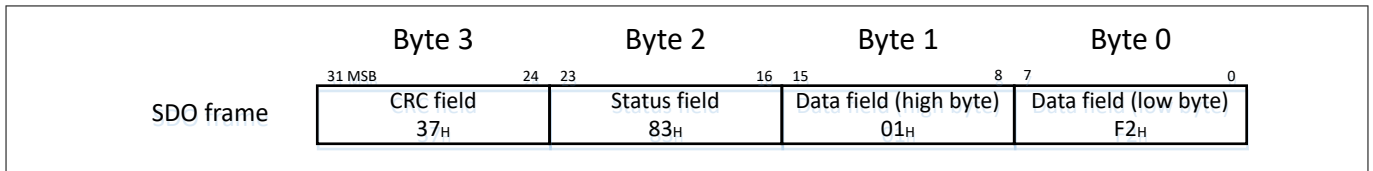
**Figure 88 Byte order for SAE J1850 CRC check**

**Example:**

If the microcontroller receives the frame in [Figure 89](#), then the CRC algorithm (see [Chapter 14.1.2.5](#)) requires the following input parameter:

- Input bytefield parameter data: {F2<sub>H</sub>, 01<sub>H</sub>, 83<sub>H</sub>, 37<sub>H</sub>}
- Input parameter length: 4

The result of the CRC check must always be 3B<sub>H</sub>. Any other value means that the frame is corrupt. The value 3B<sub>H</sub> is called magic number in the AUTOSAR CRC specification.



**Figure 89 SDO frame example**

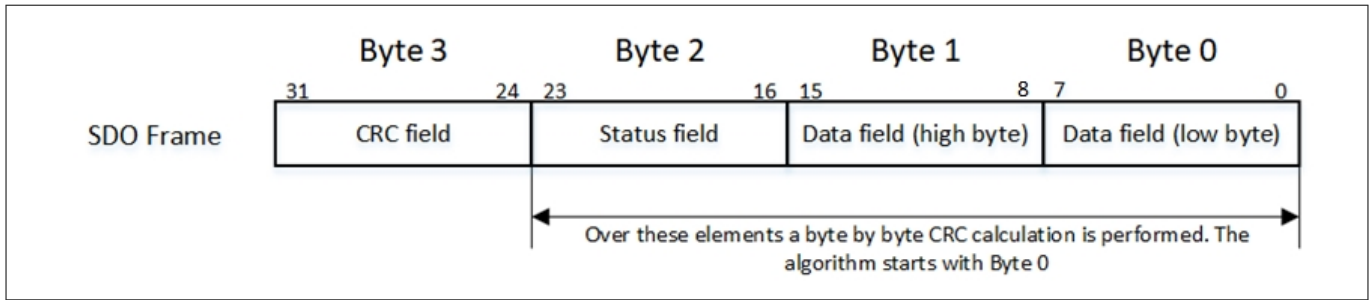
**14.1.2.5.2 CRC device handling**

**CRC calculation**

The CRC calculation includes the following SDO frame elements ([Figure 90](#)):

- Low byte of the data field
- High byte of the data field
- Status field

**14 SPI**

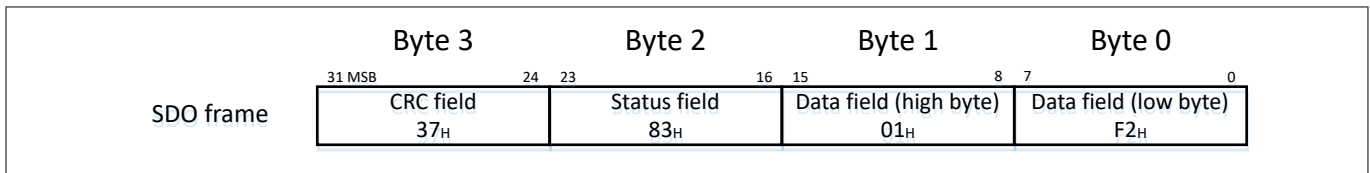


**Figure 90** Byte order for SAE J1850 CRC calculation

If the status field has the value 83<sub>H</sub> and the data field has the value 01F2<sub>H</sub>, the CRC algorithm (see [Chapter 14.1.2.5](#)) requires the following input parameters:

- Input bytefield parameter data: {F2<sub>H</sub>, 01<sub>H</sub>, 83<sub>H</sub>}
- Input parameter length: 3

The result of the CRC calculation is 37<sub>H</sub>.

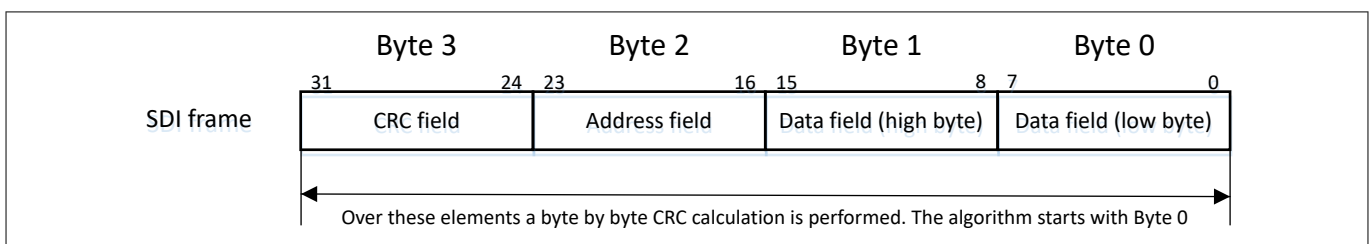


**Figure 91** SDO frame example

**CRC check**

The CRC check includes the following SDI frame elements ([Figure 92](#)):

- Low byte of the data field
- High byte of the data field
- Address field
- CRC field



**Figure 92** Byte order for SAE J1850 CRC calculation

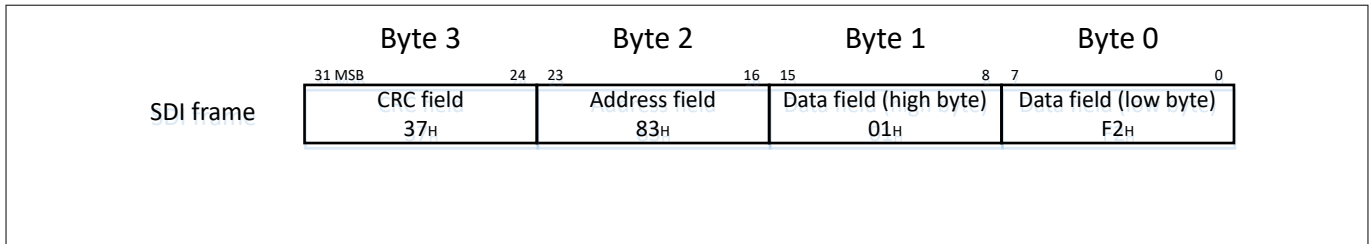
**Example:**

If the device receives the frame in [Figure 93](#), then the CRC algorithm (see [Chapter 14.1.2.5](#)) requires the following input parameter:

- Input bytefield parameter data: {F2<sub>H</sub>, 01<sub>H</sub>, 83<sub>H</sub>, 37<sub>H</sub>}
- Input parameter length: 4

The result of the CRC check is always 3B<sub>H</sub>. A different value implies that the frame is corrupt. The value 3B<sub>H</sub> is called magic number in the AUTOSAR CRC specification.

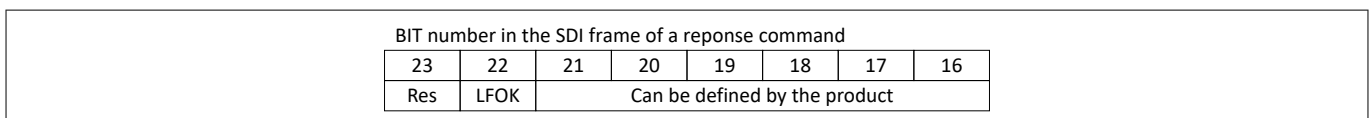
**14 SPI**



**Figure 93 SDI frame example**

**14.1.2.6 Status field**

Figure 94 shows the structure of the status field. The following chapters defines the functionality of the status field bits in detail.



**Figure 94 Structure of the status field**

The device implements the following bit fields in the SDO frame status field bits 21 to 16:

**Table 46 Device specific status field**

Bit number referred to SDO frame	Bit number referred to status field	Function
[21]	[5]	<b>INTMISS:</b> Flag for interrupt not serviced in time $t_{INTx\_to}$
[20]	[4]	<b>MON:</b> Flag for monitor interrupt (IF1.MON)
[19]	[3]	<b>OTW:</b> Flag for overtemperature warning interrupt (IF1.OTW)
[18]	[2]	<b>CL2ERR:</b> Flag for fault detected on WWD2, FWD2 or ERR2
[17]	[1]	<b>CL1ERR:</b> Flag for fault detected on WWD1, FWD1 or ERR1
[16]	[0]	<b>ERRMISS:</b> Flag for fault detected on any ERR[x]

**Note:**

The status flag only is updated upon arrival/request of the last frame.

**14.1.2.6.1 Last frame OK (LFOK)**

**Table 47 Last frame OK**

Encoding	Description
0 <sub>b</sub>	Error encountered in the SDI frame of last request frame
1 <sub>b</sub>	Read service or write service successfully executed

The error handling and the reason for an LFOK = 0 are described in [Chapter 14.1.2.7](#).

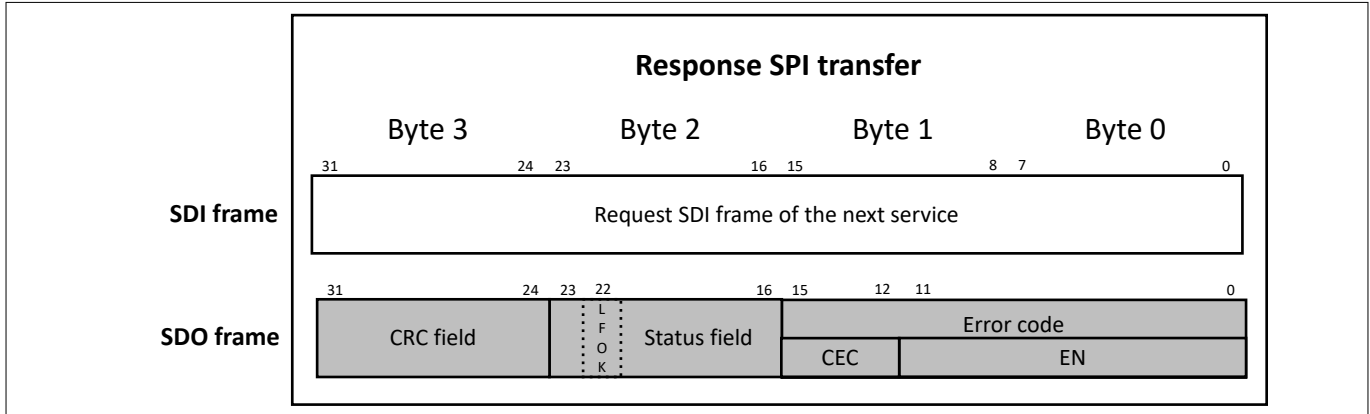
**Note:**

It is recommended to check the status of LFOK before processing SPI frame independent of INT

**14 SPI**

**14.1.2.7 Error mechanism**

In case a failure happens in the SPI communication (see Table 48), the LFOK bit is set to "0" (see Table 47). In this case the response SPI transfer contains a error code. Figure 95 shows the structure of the response SPI transfer.



**Figure 95 Error response SPI transfer**

The error code consists of the following items:

- Communication error code (CEC)
- Error number (EN which is only used for internal usage)

**Table 48 SPI communication failure**

CEC	Description
0x0	reserved
0x1	Frame error detected - frame frame length invalid of previous SPI communication - frame ignored
0x2	CRC error detected - frame ignored
0x3	reserved
0x4	Access to none existing register (if SPI interframe is >5.2 us) If SPI interframe is <5.2 us an error frame of 0xF1000000 can be responded instead
0x5	reserved
0x6	reserved
0x7	Internal error while accessing a register

**Note:** In case a communication error code is received which is not listed, contact customer support, please.

**14.1.2.8 SPI response with MPS ON**

If MPS is enabled and MCU fails servicing ERRs/WDs, the device moves to INIT and performs the initialization sequence with RESOUT high.

Due to the initialization activity after the move to INIT event, there is a window of maximum 75µs, in which the SDO response needs longer (2.5 µs) to be available. If the SPI interframe space is shorter, the response on SDO has a 0xF1000000 error frame ("no data available") when the next SPI frame is transferred, even though the request is executed. Software can implement one out of the following countermeasures to avoid the error frame condition:

- Increase interframe space to 2.5 µs (typ.)

## 14 SPI

- Make SPI handler robust on receiving the error frame
- If there is a fault injection test on ERRs and WDs it is suggested to avoid SPI communication from the point of fault injection until 75µs after SSO1 decreases. Due to analog delays SSO1 decreases up to 30 µs after the actual move to INIT event.

### 14.2 Electrical characteristics SPI

**Table 49 Electrical characteristics SPI**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
<b>SPI timing</b>							
SPI frequency	$f_{SPI}$	–	–	10	MHz	<sup>1)</sup>	DS-1577
CSN leading delay	$t_{CSN\_LDEL}$	200	–	–	ns	<sup>1)</sup>	DS-2075
CSN trailing delay	$t_{CSN\_TDEL}$	100	–	–	ns	<sup>1)</sup>	DS-1579
Interframe time	$t_{IF}$	1	–	–	µs	CSN rising to CSN falling edge <sup>1)</sup>	DS-1580
SCK setup low time	$t_{SCK\_SETL}$	100	–	–	ns	<sup>1)</sup>	DS-1581
SCK clock high time	$t_{SCK\_H}$	45	–	–	ns	<sup>1)</sup>	DS-1582
SCK clock low time	$t_{SCK\_L}$	45	–	–	ns	<sup>1)</sup>	DS-1583
SCK hold low time	$t_{SCK\_HDL}$	100	–	–	ns	<sup>1)</sup>	DS-1584
SDI data setup time	$t_{SDI\_SET}$	10	–	–	ns	<sup>1)</sup>	DS-1585
SDI data hold time	$t_{SDI\_HOLD}$	10	–	–	ns	<sup>1)</sup>	DS-1586
SDO enable time	$t_{SDO\_EN}$	–	–	50	ns	<sup>1)</sup>	DS-1587
SDO valid delay time (high frequency)	$t_{SDO\_VDEL}$	–	–	136	ns	$C_{SDO,load} = 50\text{ pF}$ ; $f_{SPI} < 1\text{ MHz}$ <sup>1)</sup>	DS-1588
SDO valid delay time (high frequency)	$t_{SDO\_VDEL}$	–	–	$36 + 0.1/f_{SPI}$	ns	$C_{SDO,load} = 50\text{ pF}$ ; $1\text{ MHz} \leq f_{SPI} \leq 10\text{ MHz}$ <sup>1)</sup>	DS-1589
SDO disable time	$t_{SDO\_DIS}$	–	–	100	ns	<sup>1)</sup>	DS-1590
SPI input signal rise time (SDI, SCK, CSN)	$t_{SPI,r}$	–	–	100	ns	$f_{SPI} < 1\text{ MHz}$ ; Parameter applicable to all SPI input pins SDI, SCK and CSN <sup>1)</sup>	DS-1591
SPI input signal rise time (SDI, SCK, CSN)	$t_{SPI,r}$	–	–	$0.1/f_{SPI}$	ns	$1\text{ MHz} \leq f_{SPI} \leq 10\text{ MHz}$ ; Parameter applicable to all SPI input pins SDI, SCK and CSN <sup>1)</sup>	DS-1592
SPI input signal fall time (SDI, SCK, CSN)	$t_{SPI,f}$	–	–	100	ns	$f_{SPI} < 1\text{ MHz}$ ; Parameter applicable to all SPI input pins SDI, SCK and CSN <sup>1)</sup>	DS-1593

(table continues...)

**14 SPI**

**Table 49 (continued) Electrical characteristics SPI**

$V_{VS} = 6.0\text{ V to }36\text{ V}$ ,  $T_j = -40^\circ\text{C to }+175^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or condition	P-Number
		Min.	Typ.	Max.			
SPI input signal fall time (SDI, SCK, CSN)	$t_{SPI,f}$	-	-	0.1/ $f_{SPI}$	ns	$1\text{ MHz} \leq f_{SPI} \leq 10\text{ MHz}$ ; Parameter applicable to all SPI input pins SDI, SCK and CSN <sup>1)</sup>	DS-1594
<b>SPI microcontroller interface</b>							
SPI input voltage high level	$V_{SPI,H}$	3.15	-	$V_{QUC}$	V	$V_{SPI}$ increasing; $V_{QUC} \geq V_{QUC}$ [Min]; Parameter applicable to all SPI input pins SDI, SCK and CSN	DS-1595
SPI input voltage low level	$V_{SPI,L}$	0	-	0.8	V	$V_{SPI}$ decreasing; Parameter applicable to all SPI input pins SDI, SCK and CSN	DS-1597
SPI input voltage hysteresis	$V_{SPI,HYS}$	-	300	-	mV	$V_{QUC} = V_{QUC}$ [Typ]; Parameter applicable to all SPI input pins SDI, SCK and CSN	DS-1598
SPI input capacitance	$C_{SPI}$	-	4	15	pF	Parameter applicable to all SPI input pins SDI, SCK and CSN <sup>1)</sup>	DS-1600
CSN pull-up current	$I_{CSN}$	-180	-55	-	$\mu\text{A}$	$V_{CSN} \leq V_{QUC}$ [Typ] <sup>1)</sup>	DS-1601
SCK pull-down current	$I_{SCK}$	-	135	330	$\mu\text{A}$	$V_{SCK} \leq V_{QUC}$ [Typ] <sup>1)</sup>	DS-1602
SDI pull-down current	$I_{SDI}$	-	135	330	$\mu\text{A}$	$V_{SDI} = V_{QUC}$ <sup>1)</sup>	DS-1603
SDO output voltage high level	$V_{SDO,H}$	3.15	-	-	V	$V_{QUC} \geq V_{QUC}$ [Min]; $I_{SDO} = -7\text{ mA}$ <sup>1)</sup>	DS-1604
SDO output voltage low level	$V_{SDO,L}$	-	-	0.7	V	$I_{SDO} = 5.5\text{ mA}$ <sup>1)</sup>	DS-1606
SDO tristate capacitance	$C_{SDO}$	-	4	15	pF	<sup>1)</sup>	DS-1607
SDO tristate leakage current	$I_{SDO,leak}$	-10	-	10	$\mu\text{A}$	<sup>1)</sup>	DS-1608

1) Not subject to production test, specified by design

## 15 Reset classes

### 15 Reset classes

There are in total 6 reset classes. Each bitfield is assigned to one of these six reset classes and is reset to its reset value accordingly upon an occurrence of the events listed in the reset class. The reset classes are set up in a way so that the next higher reset class fully includes the lower reset class (for example: R3 contains R2, R2 contains R1,...).

#### 15.1 R0 - Reset class

Bitfields assigned to reset class R0 are reset to their reset value upon occurrence of the following events:

- POR (power on reset, disconnect battery)
- STANDBY no WUT AND no QST active (entering STANDBY state without activating the wake-up timer nor using the standby voltage regulator QST)

#### 15.2 R1 - Reset class

Bitfields assigned to reset class R1 are reset to their reset value upon occurrence of the following events:

- POR
- STANDBY no WUT AND no QST active
- STANDBY

#### 15.3 R2 - Reset class

Bitfields assigned to reset class R2 are reset to their reset value upon occurrence of the following events:

- POR
- STANDBY no WUT AND no QST active
- STANDBY
- FAILSAFE

#### 15.4 R3 - Reset class

Bitfields assigned to reset class R3 are reset to their reset value upon occurrence of the following events:

- POR
- STANDBY no WUT AND no QST active
- STANDBY
- FAILSAFE
- RESOUT pulled low
- INIT (entering INIT state)

#### 15.5 R3\_C1 - Reset class

Bitfields assigned to reset class R3\_C1 are reset to their reset value upon occurrence of the following events:

- POR
- STANDBY no WUT AND no QST active
- STANDBY
- FAILSAFE
- RESOUT pulled low
- INIT
- REDUCED OPERATION (entering REDUCED OPERATION caused by a application 1 fault)

Registers and bitfields that belong to this reset class are:

- ERR1\_RS\_CFG

## 15 Reset classes

- WD1\_RS\_CFG0
- WD1\_RS\_CFG1
- FWD1\_RS\_HBTP\_CFG
- WWD1\_RS\_CW\_CFG
- WWD1\_RS\_OW\_CFG
- FWD1\_STAT
- WWD1\_ECNT\_STAT

### 15.6 R3\_C2 - Reset class

Bitfields assigned to reset class R3\_C2 are reset to their reset value upon occurrence of the following events:

- POR
- STANDBY no WUT AND no QST active
- STANDBY
- FAILSAFE
- RESOUT pulled low
- INIT
- REDUCED OPERATION (entering REDUCED OPERATION caused by a application 2 fault)

Registers and bitfields that belong to this reset class are:

- ERR2\_RS\_CFG
- WD2\_RS\_CFG0
- WD2\_RS\_CFG1
- FWD2\_RS\_HBTP\_CFG
- WWD2\_RS\_CW\_CFG
- WWD2\_RS\_OW\_CFG
- FWD2\_STAT
- WWD2\_ECNT\_STAT

## 16 Collection registers, error reporting and clearance of bitfields

The device provides error registers that are being set if respective error events occur (see [Reaction on faults](#)). To simplify the diagnosis procedure collection registers are implemented which bundle a group of error registers and only set one bit in the collection registers. By providing this piece of information it allows the integrator in a first step to only read the collection registers and follow the path of the error report, instead of always reading all error registers. The entire set up is available in a doubled up structure in case REDUCED OPERATION is enabled and two application threads access the information. If REDUCED OPERATION is not used, these doubled up registers are inactive and won't feedback any reliable result.

Failure and error bits are cleared by writing the respective bit with "1". Any other read and write access stays without effect.

In addition, the overview of the error reporting provides the assignment to the error classes used. In general, there is a distinction between a severe fault (xx\_SEV\_FAULT) and a warning fault (xx\_WARN\_FAULT).

### Severe fault:

A severe fault is associated with a critical event in either the device or the system parameters monitored by the device, that could have caused the application to become unreliable and already is unreliable and must not be allowed to enter normal operation. Depending on the fault several recovery attempts such as a soft reset, a hard reset or a move to FAILSAFE will take place. In any case the signals SSO1/2 will be issued to indicate that the application cannot be assumed to be fully functional and must be brought into a safe state.

### Warning fault:

A warning is associated with an event in either the device or the system parameters monitored by the device, which do not directly jeopardise the normal functionality of the application. A warning fault is indicated by issuing an interrupt. The application, however, remains in a normal functionality and no safe state is indicated via SSO1/2.

### 16.1 Error reporting generating an interrupt

Errors that trigger an interrupt (INT) are collected in the IFx register. Events that are bundled in this registers are listed in the following table.

**Table 50 Errors generating an interrupt - Collection register: IF1**

IF1 bitfield	Error register	Error class	Error bitfield	Description
SYSFAIL_ERR	SYS_STAT_APP1	ERRx_WARN_FAULT	ERR0_ERR	ERR0 monitoring error AND ERR0 recovery is enabled
			ERR1_ERR	ERR1 monitoring error AND ERR1 recovery is enabled
		WDx_WARN_FAULT	WWD1_ERR	WWD1 missed or incorrect service (error counter below threshold)
			FWD1_ERR	FWD1 response missed or incorrectly triggered (error counter below threshold)
	SYS_WARN_FAULT			

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 50 (continued) Errors generating an interrupt - Collection register: IF1**

IF1 bitfield	Error register	Error class	Error bitfield	Description
			FSM_NOOP	State transition not existing or transition conditions not fulfilled.
			FSM_TRFAIL	State transition into low power state (STANDBY or SLEEP) failed/interrupted (e.g. by WAK or ENA)
			BUCKCORE_SVS_NO K	Static voltage scaling not performed due to: - Device being no in INIT or NORMAL - BUCKCORE voltage set to 1.15 V
			BUCKCORE_SVS_OK	Static voltage scaling completed successfully.
			APP2_FAIL	Application 2 was reason for entering REDUCED OPERATION
WUT_EVT	WAKE_STAT_APP1	WAKE_EVENT	ENA	ENA signal detected
			WAK	WAK signal detected
			WUT	Wake-up timer (WUT) expired and woke up the device
			SPI	SPI command woke up the device
SPI_FAIL	SPI_FAIL_STAT_APP1	SPI_WARN_FAULT	LOCK	Lock of protected registers was unsuccessful
			CRC	CRC wrong
			FR_LEN	Frame length wrong
			ADR	Invalid address
			CS_TO	CSN timeout after 2 ms
MON	STG_STAT_APP1	VMON_WARN_FAULT	BUCKIF	Short to ground at BUCKIF BUCKIF is switched off

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 50 (continued) Errors generating an interrupt - Collection register: IF1**

IF1 bitfield	Error register	Error class	Error bitfield	Description
			QCO	Short to ground at QCO QCO is switched off
			QVR	Short to ground at QVR QVR is switched off
			VMON1	Short to ground at VMON1 VMON1 rail is disabled
			VMON2	Short to ground at VMON2 VMON2 rail is disabled
	UV_STAT_APP1		PREREG	Undervoltage at PREREG
	UV_STAT_APP1		BOOST	Undervoltage at BOOST
	UV_STAT_APP1		QCO	Undervoltage at QCO
	UV_STAT_APP1		BUCKIF	Undervoltage at BUCKIF
	UV_STAT_APP1		QVRUV	Undervoltage at QVR
	UV_STAT_APP1		VMON1	Undervoltage at VMON1
	UV_STAT_APP1		VMON2	Undervoltage at VMON2
	INTSUP_STAT_APP1		PMU_RED	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
	INTSUP_STAT_APP1		PMU_MAIN	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 50 (continued) Errors generating an interrupt - Collection register: IF1**

IF1 bitfield	Error register	Error class	Error bitfield	Description
			BG12_OV	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
			BG12_UV	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
OT_WRN_OC_ERR	OT_WRN_OC_STAT_APP1	OTOC_WARN_FAULT	IVCC_OC	Internal error
			QST_OC	QST overcurrent
			BUCKCORE_OTWRN	BUCKCORE overtemperature warning
			BUCKIF_OTWRN	BUCKIF overtemperature warning
			BOOST_OTWRN	BOOST overtemperature warning
			BOOST_OC	BOOST overcurrent
			QUC_OTWRN	QUC overtemperature warning
			QCO_OTWRN	QCO overtemperature warning
			QVR_OC	QVR overcurrent
ABIST	-	ABIST_WARN_FAULT	-	ABIST finished execution
INTMISS	-	-	-	Interrupt flags not cleared after tINTx_to

(x = 1; 2)

If REDUCED OPERATION is enabled, also the following bits are set:

**16 Collection registers, error reporting and clearance of bitfields**

**Table 51 Errors generating an interrupt - Reduced Operation - Collection register: IF2**

IF2 bitfield	Error register	Error class	Error bitfield	Description	
SYSFAIL_ERR	SYS_STAT_APP2	ERRx_WARN_FAULT	ERR0_ERR	ERR0 monitoring error	
			ERR2_ERR	ERR2 monitoring error AND ERR2 recovery is enabled	
		WDx_WARN_FAULT	WWD2_ERR	WWD2 missed or incorrect service (error counter below threshold)	
			FWD2_ERR	FWD2 response missed or incorrectly triggered (error counter below threshold)	
		SYS_WARN_FAULT		FSM_NOOP	State transition not existing or transition conditions not fulfilled.
				FSM_TRFAIL	State transition into low power state (STANDBY or SLEEP) failed/interrupted (e.g. by WAK or ENA)
				BUCKCORE_SVS_NO K	Static voltage scaling not performed due to: - Device being not in INIT or NORMAL - BUCKCORE voltage set to 1.15 V
				BUCKCORE_SVS_OK	Static voltage scaling completed successfully.
				APP1_FAIL	Cluster 1 was reason for entering REDUCED OPERATION
		WUT_EVT	WAKE_STAT_APP2	WAKE_EVENT	ENA
WAK	WAK signal detected				
WUT	Wake-up timer (WUT) expired and woke up the device				

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 51 (continued) Errors generating an interrupt - Reduced Operation - Collection register: IF2**

IF2 bitfield	Error register	Error class	Error bitfield	Description
			SPI	SPI command woke up the device
SPI_FAIL	SPI_FAIL_STAT_APP2	SPI_WARN_FAULT	LOCK	Lock of protected registers was unsuccessful
			CRC	CRC wrong
			FR_LEN	Frame length wrong
			ADR	Invalid address
			CS_TO	CSN timeout after 2 ms
MON	STG_STAT_APP2	VMON_WARN_FAULT	BUCKIF	Short to ground at BUCKIF BUCKIF is switched off
			QCO	Short to ground at QCO QCO is switched off
			QVR	Short to ground at QVR QVR is switched off
			VMON1	Short to ground at VMON1 VMON1 rail is disabled
			VMON2	Short to ground at VMON2 VMON2 rail is disabled
			UV_STAT_APP2	PREREG
	UV_STAT_APP2	BOOST	Undervoltage at BOOST	
	UV_STAT_APP2	QCO	Undervoltage at QCO	
	UV_STAT_APP2	BUCKIF	Undervoltage at BUCKIF	
	UV_STAT_APP2	QVR	Undervoltage at QVR	
	UV_STAT_APP2	VMON1	Undervoltage at VMON1	
	UV_STAT_APP2	VMON2	Undervoltage at VMON2	

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 51 (continued) Errors generating an interrupt - Reduced Operation - Collection register: IF2**

IF2 bitfield	Error register	Error class	Error bitfield	Description
	INTSUP_STAT_APP2		PMU_RED	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
			PMU_MAIN	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
			BG12_OV	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
			BG12_UV	Internal error; Always needs to be read when waking up from FAILSAFE (IF register is not being set in FAILSAFE but INTSUP_STAT_APPx could have been set)
OT_WRN_OC_ERR	OT_WRN_OC_STAT_APP2	OTOC_WARN_FAULT	IVCC_OC	Internal error
			QST_OC	QST overcurrent
			BUCKCORE_OTWRN	BUCKCORE overtemperature warning
			BUCKIF_OTWRN	BUCKIF overtemperature warning
			BOOST_OTWRN	BOOST overtemperature warning

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 51 (continued) Errors generating an interrupt - Reduced Operation - Collection register: IF2**

IF2 bitfield	Error register	Error class	Error bitfield	Description
			BOOST_OC	BOOST overcurrent
			QUC_OTWRN	QUC overtemperature warning
			QCO_OTWRN	QCO overtemperature warning
			QVR_OTWRN	QVR overcurrent
ABIST	-	ABIST_WARN_FAULT	-	ABIST finished execution
INTMISS	-	-	-	Interrupt flags not cleared after tINTx_to

(x = 1; 2)

**16.2 Error reporting causing a move to INIT or REDUCED OPERATION**

Errors that trigger a move to INIT usually also trigger a reset (RESOUT) and are collected in the INIT\_ERR\_APPx register. Events that are bundled in this registers are listed in the following table. For MPS (see [Microcontroller programming support \(MPS\)](#)) enabled, some move to INITs do not issue an reset.

**Table 52 Errors causing a move to INIT - Collection register: INIT\_ERR\_APP1**

INIT_ERR_APP1 bitfield	Error class	Error register	Error bitfield	Description
VMONF	VMONUV_SEV_FAULT	UV_STAT_APP1	BUCKCORE	BUCKCORE undervoltage
			QUC	QUC undervoltage
			QST	QST undervoltage
WWD1_EC	WDx_SEV_FAULT	-	-	WWD1 incorrectly triggered and error counter reaches threshold
WWD2_EC		-	-	WWD2 incorrectly triggered and error counter reaches threshold
FWD1_EC		-	-	FWD1 incorrectly triggered and error counter reaches threshold

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 52 (continued) Errors causing a move to INIT - Collection register: INIT\_ERR\_APP1**

<b>INIT_ERR_APP1 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>
FWD2_EC		-	-	FWD2 incorrectly triggered and error counter reaches threshold
ERR1	ERRx_SEV_FAULT	-	-	ERR1 signal is outside of valid frequencies (if recovery enabled: longer than tREC before being set)
ERR2		-	-	ERR2 signal is outside of valid frequencies (if recovery enabled: longer than tREC before being set)
REDOP_RES1	INITTIMER_SEV_FAULT	-	-	INIT timer expired the first time in RED. OP. due to application 1 not being able to reinitialize
REDOP_RES2		-	-	INIT timer expired a second time in RED. OP.
SOFTRES		-	-	INIT timer expires 1st time → Soft reset issued
HARDRES		-	-	INIT timer expires 2nd time consecutively → Hard reset issued

(x = 1; 2)

If REDUCED OPERATION is enabled, also the following bits are set:

**Table 53 Errors causing a move to INIT - Reduced Operation - Collection register: INIT\_ERR\_APP2**

<b>INIT_ERR_APP2 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>
VMONF	VMONUV_SEV_FAULT	UV_STAT_APP1	BUCKCORE	BUCKCORE undervoltage
			QUC	QUC undervoltage

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 53 (continued) Errors causing a move to INIT - Reduced Operation - Collection register: INIT\_ERR\_APP2**

INIT_ERR_APP2 bitfield	Error class	Error register	Error bitfield	Description
			QST	QST undervoltage
WWD1_EC	WDx_SEV_FAULT	—	—	WWD1 incorrectly triggered and error counter reaches threshold
WWD2_EC		—	—	WWD2 incorrectly triggered and error counter reaches threshold
FWD1_EC		—	—	FWD1 incorrectly triggered and error counter reaches threshold
FWD2_EC		—	—	FWD2 incorrectly triggered and error counter reaches threshold
ERR1		ERRx_SEV_FAULT	—	—
ERR2	—		—	ERR2 signal is outside of valid frequencies (if recovery enabled: longer than tREC before being set)
REDOP_RES1	INITTIMER_SEV_FAULT	—	—	INIT timer expired the first time in RED. OP. due to application 2 not being able to reinitialize
REDOP_RES2		—	—	INIT timer expired a second time in RED. OP.
SOFTRES		—	—	INIT timer expires 1st time → Soft reset issued

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 53 (continued) Errors causing a move to INIT - Reduced Operation - Collection register: INIT\_ERR\_APP2**

INIT_ERR_APP2 bitfield	Error class	Error register	Error bitfield	Description
HARDRES		—	—	INIT timer expires 2nd time consecutively → Hard reset issued

(x = 1; 2)

**16.3 Error reporting causing a move to FAILSAFE**

Errors that trigger a move to FAILSAFE are collected in the register. Only exception is the bit ABIST. It is being set only, if during an ABIST execution an error occurs that moves the device into INIT or FAILSAFE and is by itself no trigger for a state transition.

**Table 54 Errors causing a move to FAILSAFE - Collection register: SYSFAIL\_STAT\_APP1**

SYSFAIL_STAT_APP1 bitfield	Error class	Error register	Error bitfield	Description
QST_QUC_VOLTSEL	VOLTSEL_SEV_FAULT	-	-	Voltage selection error. 5 V or 3.3 V might be corrupt and not correctly selected.
BUCKIF_VOLTSEL		-	-	Voltage selection error. 1.8 or 3.3 V might be corrupt and not correctly selected.
BUCK_CORE_VOLTSEL		-	-	Voltage selection error. Core voltage might be corrupt.
OT	OT_SEV_FAULT	OT_STAT_APP1	BUCKCORE	BUCKCORE thermal shutdown
			BUCKIF	BUCKIF thermal shutdown
			BOOST	BOOST thermal shutdown
			QUC	QUC thermal shutdown
			QCO	QCO thermal shutdown
			SAFETY_AREA	Overtemperature of safety area

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 54 (continued) Errors causing a move to FAILSAFE - Collection register: SYSFAIL\_STAT\_APP1**

<b>SYSFAIL_STAT_APP1 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>	
VMON	VMON_SEV_FAULT	STG_STAT_APP1	BUCKCORE	BUCKCORE short to ground	
			BOOST	BOOST short to ground & Severe undervoltage	
			QUC	QUC short to ground	
			QST	QST short to ground	
			PREREG	PREREG short to ground & Severe undervoltage	
		OV_STAT_APP1		BUCKCORE	Severe overvoltage at BUCKCORE & BUCKCORE OV
				BUCKCORE_FB_OPEN	Feedback open
				PREREG	Severe overvoltage at PREREG & PREREG OV
				BUCKIF	Severe overvoltage at BUCKIF & BUCKIF OV
				BOOST	BOOST OV
				QUC	QUC OV
				QCO	QCO OV
				QVR	QVR OV
				QST	QST OV
				VMON1	VMON1 OV
	VMON2			VMON2 OV	
	INTSUP_VDD2V5			Internal 2V5 rail overvoltage	
	INTSUP_IVCC			Internal IVCC overvoltage	
	UV_STAT_APP1		INTSUP_VDD2V5_UV	Internal 2V5 rail undervoltage	
			INTSUP_IVCC_UV	Internal IVCC undervoltage	

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 54 (continued) Errors causing a move to FAILSAFE - Collection register: SYSFAIL\_STAT\_APP1**

<b>SYSFAIL_STAT_APP1 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>
		INTSUP_STAT_APP1	BIAS_HI	Internal bias current too high
			BIAS_LOW	Internal bias current too low
			VBAT_OV	VS OV
FSM_INITTIMER	INITTIMER_SEV_FAULT	-	-	FAILSAFE was entered because INIT timer expired a 3rd time without successful initialization.
ERR0	ERR0_SEV_FAULT	-	-	FAILSAFE was entered after ERR0 reported invalid frequency.
QST	QST_SEV_FAULT	-	-	Set for: QST BIST errors, severe overvoltage
INTSUP_IVCC	INTSUP_SEV_FAULT	-	-	Set for: QIS BIST errors, severe overvoltage
PREREG_COSW	SSW_SEV_FAULT	-	-	BIST major error SSC or SSW was activated during normal operation
CFGE	CFG_SEV_FAULT	-	-	Double Error detected on a protected register
ABIST	ABIST_SEV_FAULT	-	-	Any error that moves the device to FAILSAFE or INIT and is not part of the ABIST routine will abort the on-going ABIST and set this bit.

(x = 1; 2)

If REDUCED OPERATION is enabled, also the following bits are set:

**16 Collection registers, error reporting and clearance of bitfields**

**Table 55**                    **Errors causing a move to FAILSAFE - Reduced Operation - Collection register:**  
**SYSFAIL\_STAT\_APP2**

<b>SYSFAIL_STAT_APP2 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>
QST_QUC_VOLTSEL	VOLTSEL_SEV_FAULT	-	-	Voltage selection error. 5 V or 3.3 V might be corrupt and not correctly selected.
BUCKIF_VOLTSEL		-	-	Voltage selection error. 1.8 V or 3.3 V might be corrupt and not correctly selected.
BUCK_CORE_VOLTSEL		-	-	Voltage selection error. Core voltage might be corrupt.
OT	OT_SEV_FAULT	OT_STAT_APP2	BUCKCORE	BUCKCORE thermal shutdown
			BUCKIF	BUCKIF thermal shutdown
			BOOST	BOOST thermal shutdown
			QUC	QUC thermal shutdown
			QCO	QCO thermal shutdown
			SAFETY_AREA	Overtemperature of safety area
VMON	VMON_SEV_FAULT	STG_STAT_APP2	BUCKCORE	BUCKCORE short to ground
			BOOST	BOOST short to ground & severe undervoltage
			QUC	QUC short to ground
			QST	QST short to ground
			PREREG	PREREG short to ground & severe undervoltage
		OV_STAT_APP2	BUCKCORE	Severe overvoltage at BUCKCORE & BUCKCORE OV

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 55 (continued) Errors causing a move to FAILSAFE - Reduced Operation - Collection register: SYSFAIL\_STAT\_APP2**

<b>SYSFAIL_STAT_APP2 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>		
			BUCKCORE_FB_OPEN	Feedback open		
			PREREG	Severe overvoltage at PREREG & PREREG OV		
			BUCKIF	Severe overvoltage at BUCKIF & BUCKIF OV		
			BOOST	BOOST OV		
			QUC	QUC OV		
			QCO	QCO OV		
			QVR	QVR OV		
			QST	QST OV		
			VMON1	VMON1 OV		
			VMON2	VMON2 OV		
			INTSUP_VDD2V5	Internal 2V5 rail overvoltage		
			INTSUP_IVCC	Internal IVCC overvoltage		
			UV_STAT_APP2		INTSUP_VDD2V5_UV	Internal 2V5 rail undervoltage
					INTSUP_IVCC_UV	Internal IVCC undervoltage
			INTSUP_STAT_APP2		BIAS_HI	Internal bias current too high
BIAS_LOW	Internal bias current too low					
VBAT_OV	VS OV					
FSM_INITTIMER	INITTIMER_SEV_FAULT	-	-	FAILSAFE was entered because INIT timer expired a 3rd time without successful initialization.		
ERR0	ERR0_SEV_FAULT	-	-	FAILSAFE was entered after ERR0 reported invalid frequency.		

**(table continues...)**

**16 Collection registers, error reporting and clearance of bitfields**

**Table 55 (continued) Errors causing a move to FAILSAFE - Reduced Operation - Collection register: SYSFAIL\_STAT\_APP2**

<b>SYSFAIL_STAT_APP2 bitfield</b>	<b>Error class</b>	<b>Error register</b>	<b>Error bitfield</b>	<b>Description</b>
QST	QST_SEV_FAULT	-	-	Set for: QST BIST errors, severe overvoltage
INTSUP_IVCC	INTSUP_SEV_FAULT	-	-	Set for: QIS BIST errors, severe overvoltage
PREREG_COSW	SSW_SEV_FAULT	-	-	BIST major error SSC or SSW was activated during normal operation
CFGE	CFG_SEV_FAULT	-	-	Double error detected on a protected register
ABIST	ABIST_SEV_FAULT	-	-	Any error that moves the device to FAILSAFE or INIT and is not part of the ABIST routine will abort the on-going ABIST and set this bit.

(x = 1; 2)

**16.4 Status reporting - Miscellaneous registers**

Device status information are collected in VMON\_STAT and DEV\_STAT.

	<b>Status bitfield</b>	<b>Description</b>
VMON_STAT	all	Indicates whether voltage regulators are within range or outside of it. If a regulator is switched off the bits read as 0.
DEV_STAT	all	Provides an overview of the devices general state (e.g. Enabled regulators, State, Autodetection)

**17 Protected registers - Protected write and reflected status registers**

## **17 Protected registers - Protected write and reflected status registers**

The device contains protected registers to avoid unintentional access to safety related parameters. A protected register always consists of a pair of a configurable "protected write" register and its corresponding "reflected status" shadow register. These registers first need to be unlocked before new content can be written. New content must always be written to the protected write register. In order for new changes take effect, the registers have to be locked again. With the lock sequence new content is transferred to the reflected status registers.

Registers that belong to the class of protected registers are labeled as below in their names:

---

Protected write	<i>&lt;registername&gt;_PW_&lt;registername&gt;</i>
Reflected status	<i>&lt;registername&gt;_RS_&lt;registername&gt;</i>

---

### **17.1 Unlock/lock sequence**

To unlock and lock protected register, the following steps must be executed:

- 1. Unlock registers: Write 0xB5CA to register **PROT\_CFG.KEY****
- 2. Write changes to protected write registers**
- 3. Lock registers: Write 0xD396 to register **PROT\_CFG.KEY****

Before writing changes to protected write registers and checking whether changes took effect by reading reflected status registers, the current lock status of the protected registers can be read in **PROT\_STAT.LOCK**. In addition the error bit **SPI\_FAIL\_STAT\_APP1.LOCK** is set in case something went wrong during the unlock/lock sequence. In such case written values will not become effective and RS registers are not updated. If **REDUCED OPERATION** is enabled also **SPI\_FAIL\_STAT\_APP2.LOCK** is set.

**18 Registers description**

**18 Registers description**

**18.1 Registers overview - OTHERSR2 (ascending offset address)**

**Table 56 Registers overview - OTHERSR2 (ascending offset address)**

Short name	Long name	Offset address	See
<a href="#">DEV_CFG4</a>	Device configuration 4 *R2)	000 <sub>H</sub>	<a href="#">210</a>
<a href="#">REDOP_RS_CFG2</a>	Reduced operation reflected status configuration 2 register - *R2)	001 <sub>H</sub>	<a href="#">212</a>
<a href="#">PROT_CFG</a>	Protection configuration register - *R2)	002 <sub>H</sub>	<a href="#">213</a>
<a href="#">DEV_RS_CFG3</a>	Device reflected status configuration Register *R2)	003 <sub>H</sub>	<a href="#">214</a>
<a href="#">WUT_CFG0</a>	Wake up timer LSB Value (*R2)	004 <sub>H</sub>	<a href="#">216</a>
<a href="#">WUP_CFG1</a>	Wake up timer MSB Value (*R2)	005 <sub>H</sub>	<a href="#">217</a>
<a href="#">WAKE_STAT_APP1</a>	Wakeup status flags for Application 1 *R2)	006 <sub>H</sub>	<a href="#">218</a>
<a href="#">WAKE_STAT_APP2</a>	Wakeup status flags for Application 2 *R2)	007 <sub>H</sub>	<a href="#">219</a>
<a href="#">INIT_ERR_APP1</a>	INIT and REDUCED OPERATION Error Status flags for Application 1 *R2)	008 <sub>H</sub>	<a href="#">220</a>
<a href="#">INIT_ERR_APP2</a>	INIT and REDUCED OPERATION Error Status flags for Application 2 *R2)	009 <sub>H</sub>	<a href="#">222</a>
<a href="#">IF1</a>	Interrupt flags for Application 1 that trigger INT1 *R2)	00A <sub>H</sub>	<a href="#">224</a>
<a href="#">IF2</a>	Interrupt flags for Application 2 that trigger INT2 *R2)	00B <sub>H</sub>	<a href="#">226</a>
<a href="#">SYS_STAT_APP1</a>	System status flags for Application 1 that trigger INT1 *R2)	00C <sub>H</sub>	<a href="#">228</a>
<a href="#">SYS_STAT_APP2</a>	System status flags for Application 2 that trigger INT2 *R2)	00D <sub>H</sub>	<a href="#">230</a>
<a href="#">SPI_FAIL_STAT_APP1</a>	SPI failure status flags that triggers INT1 *R2)	00E <sub>H</sub>	<a href="#">232</a>
<a href="#">SPI_FAIL_STAT_APP2</a>	SPI status flags for Application 2 that trigger INT2 *R2)	00F <sub>H</sub>	<a href="#">233</a>
<a href="#">UV_STAT_APP1</a>	Monitor status flags register 2 for Application 1 *R2)	010 <sub>H</sub>	<a href="#">234</a>
<a href="#">UV_STAT_APP2</a>	Monitor status flags register 2 for Application 2 *R2)	011 <sub>H</sub>	<a href="#">236</a>
<a href="#">OT_WRN_OC_STAT_APP1</a>	Over temperature warning and over current status flags *R2)	012 <sub>H</sub>	<a href="#">238</a>
<a href="#">OT_WRN_OC_STAT_APP2</a>	Over temperature warning /Over current status flags for Application 2 *R2)	013 <sub>H</sub>	<a href="#">240</a>
<a href="#">VMON_STAT</a>	Voltage monitor status *R2)	014 <sub>H</sub>	<a href="#">242</a>
<a href="#">DEV_STAT</a>	Device status register *R2)	015 <sub>H</sub>	<a href="#">244</a>
<a href="#">DCDC_FREQ_SYNC</a>	DC-DC switching frequency change *R2)	016 <sub>H</sub>	<a href="#">246</a>
<a href="#">FREQ_SPREAD</a>	DC-DC Frequency spread-spectrum control register *R2)	017 <sub>H</sub>	<a href="#">248</a>
<a href="#">ABIST_CTRL0</a>	ABIST control 0 *R2)	018 <sub>H</sub>	<a href="#">250</a>
<a href="#">ABIST_CTRL1</a>	ABIST control 1 *R2)	019 <sub>H</sub>	<a href="#">251</a>
<a href="#">ABIST_SELECT0</a>	ABIST select 0 *R2)	01A <sub>H</sub>	<a href="#">252</a>
<a href="#">ABIST_SELECT1</a>	ABIST select 1 *R2)	01B <sub>H</sub>	<a href="#">254</a>
<a href="#">ABIST_SELECT2</a>	ABIST select 2 *R2)	01C <sub>H</sub>	<a href="#">256</a>

**(table continues...)**

**18 Registers description**

**Table 56 (continued) Registers overview - OTHERSR2 (ascending offset address)**

Short name	Long name	Offset address	See
GTM	Global testmode *R2)	01D <sub>H</sub>	<a href="#">258</a>
REDOP_RS_CFG1	Reduced operation reflected status configuration 1 register - *R2)	01E <sub>H</sub>	<a href="#">259</a>

**18.2 Registers overview - ERR (ascending offset address)**

**Table 57 Registers overview - ERR (ascending offset address)**

Short name	Long name	Offset address	See
ERR0_PW_CFG	ERR0 protection write configuration register *R2)	01F <sub>H</sub>	<a href="#">261</a>
ERR0_RS_CFG	ERR0 reflected status configuration register *R3)	020 <sub>H</sub>	<a href="#">262</a>
ERR1_PW_CFG	ERR1 protection write configuration register *R2)	021 <sub>H</sub>	<a href="#">263</a>
ERR1_RS_CFG	ERR1 reflected status configuration register *R3_C1)	022 <sub>H</sub>	<a href="#">264</a>
ERR2_PW_CFG	ERR2 protection write configuration register *R2)	023 <sub>H</sub>	<a href="#">265</a>
ERR2_RS_CFG	ERR2 reflected status configuration register *R3_C2)	024 <sub>H</sub>	<a href="#">266</a>

**18.3 Registers overview - OTHERSR0 (ascending offset address)**

**Table 58 Registers overview - OTHERSR0 (ascending offset address)**

Short name	Long name	Offset address	See
DEV_CFG1	Device configuration 1 register *R0)	025 <sub>H</sub>	<a href="#">267</a>
DEV_PW_CFG2	Device protected write configuration 2 register *R0)	026 <sub>H</sub>	<a href="#">269</a>
DEV_RS_CFG2	Device reflected status configuration 2 register *R0)	027 <sub>H</sub>	<a href="#">270</a>

**18.4 Registers overview - OTHERSR1 (ascending offset address)**

**Table 59 Registers overview - OTHERSR1 (ascending offset address)**

Short name	Long name	Offset address	See
SYSFAIL_STAT_APP1	System failure status register for application 1 *R1)	029 <sub>H</sub>	<a href="#">271</a>
SYSFAIL_STAT_APP2	System failure status flags for application 2 *R1)	02A <sub>H</sub>	<a href="#">273</a>
STG_STAT_APP1	Short to ground status register for application 1 *R1)	02B <sub>H</sub>	<a href="#">275</a>
STG_STAT_APP2	Short to ground status register for application 2 *R1)	02C <sub>H</sub>	<a href="#">277</a>
OV_STAT_APP1	Overvoltage status register for application 1 *R1)	02D <sub>H</sub>	<a href="#">279</a>
OV_STAT_APP2	Overvoltage status register for application 2 *R1)	02E <sub>H</sub>	<a href="#">281</a>
INTSUP_STAT_APP1	Internal supply status register for application 1 *R1)	02F <sub>H</sub>	<a href="#">283</a>
INTSUP_STAT_APP2	Internal supply status register for application 2 *R1)	030 <sub>H</sub>	<a href="#">284</a>

**(table continues...)**

**18 Registers description**

**Table 59 (continued) Registers overview - OTHERSR1 (ascending offset address)**

Short name	Long name	Offset address	See
OT_STAT_APP1	Over temperature status register for application 1 *R1)	031 <sub>H</sub>	<a href="#">285</a>
OT_STAT_APP2	Over temperature status register for application 2 *R1)	032 <sub>H</sub>	<a href="#">286</a>
PROT_STAT	Protection status *R1)	033 <sub>H</sub>	<a href="#">287</a>
REDOP_PW_CFG1	Reduced operation protected write configuration 1 register - *R1)	034 <sub>H</sub>	<a href="#">288</a>
REDOP_PW_CFG2	Reduced operation protected write configuration 2 register - *R1)	035 <sub>H</sub>	<a href="#">290</a>
DEV_PW_CFG3	Device protected write configuration 3 register *R1)	036 <sub>H</sub>	<a href="#">291</a>

**18.5 Registers overview - WATCHDOG (ascending offset address)**

**Table 60 Registers overview - WATCHDOG (ascending offset address)**

Short name	Long name	Offset address	See
WD1_PW_CFG0	Watchdog 1 protected write configuration 0 register *R2)	037 <sub>H</sub>	<a href="#">293</a>
WD1_RS_CFG0	Watchdog 1 reflected status configuration 0 register - *R3_C1	038 <sub>H</sub>	<a href="#">294</a>
WD1_PW_CFG1	Watchdog 1 protected write configuration 1 register *R2)	039 <sub>H</sub>	<a href="#">295</a>
WD1_RS_CFG1	Watchdog 1 reflected status configuration 1 register- *R3_C1	03A <sub>H</sub>	<a href="#">296</a>
FWD1_PW_HBTP_CFG	Functional watchdog 1 protected write heart beat timer period configuration register - *R2)	03B <sub>H</sub>	<a href="#">297</a>
FWD1_RS_HBTP_CFG	Functional watchdog 1 reflected status heart beat timer period configuration register *R3_C1	03C <sub>H</sub>	<a href="#">298</a>
WWD1_PW_CW_CFG	Window watchdog 1 protected write closed window configuration register - *R2)	03D <sub>H</sub>	<a href="#">299</a>
WWD1_RS_CW_CFG	Window watchdog 1 reflected status closed window configuration register *R3_C1)	03E <sub>H</sub>	<a href="#">300</a>
WWD1_PW_OW_CFG	Window watchdog 1 protected write open window configuration register - *R2)	03F <sub>H</sub>	<a href="#">301</a>
WWD1_RS_OW_CFG	Window watchdog 1 reflected status open window configuration register - *R3_C1)	040 <sub>H</sub>	<a href="#">302</a>
WWD1_TRIG	Window watchdog 1 trigger- *R2)	041 <sub>H</sub>	<a href="#">303</a>
FWD1_RSP	Functional watchdog 1 response register - *R2)	042 <sub>H</sub>	<a href="#">304</a>
FWD1_RSP_SYNC	Functional watchdog 1 response register with synchronization of the heartbeat timer - *R2)	043 <sub>H</sub>	<a href="#">305</a>
FWD1_STAT	Functional watchdog 1 status register - *R3_C1)	044 <sub>H</sub>	<a href="#">306</a>
WWD1_ECNT_STAT	Window watchdog 1 error counter status register - *R3_C1)	045 <sub>H</sub>	<a href="#">307</a>
WD2_PW_CFG0	Watchdog 2 protected write configuration 0 register - *R2)	046 <sub>H</sub>	<a href="#">308</a>
WD2_RS_CFG0	Watchdog 2 reflected status configuration 0 register- *R3_C2)	047 <sub>H</sub>	<a href="#">309</a>

**(table continues...)**

**18 Registers description**

**Table 60 (continued) Registers overview - WATCHDOG (ascending offset address)**

Short name	Long name	Offset address	See
<a href="#">WD2_PW_CFG1</a>	Watchdog 2 protected write configuration 1 - *R2)	048 <sub>H</sub>	<a href="#">310</a>
<a href="#">WD2_RS_CFG1</a>	Watchdog 2 reflected status configuration 1 register - *R3_C2)	049 <sub>H</sub>	<a href="#">311</a>
<a href="#">FWD2_PW_HBTP_CFG</a>	Functional watchdog 2 protected write heart beat timer period configuration register - *R2)	04A <sub>H</sub>	<a href="#">312</a>
<a href="#">FWD2_RS_HBTP_CFG</a>	Functional watchdog 2 reflected status heart beat timer period configuration register *R3_C2)	04B <sub>H</sub>	<a href="#">313</a>
<a href="#">WWD2_PW_CW_CFG</a>	Window watchdog 2 protected write closed window configuration register - *R2)	04C <sub>H</sub>	<a href="#">314</a>
<a href="#">WWD2_RS_CW_CFG</a>	Window watchdog 2 reflected status closed window configuration register *R3_C2)	04D <sub>H</sub>	<a href="#">315</a>
<a href="#">WWD2_PW_OW_CFG</a>	Window watchdog 2 protected write open window configuration register - *R2)	04E <sub>H</sub>	<a href="#">316</a>
<a href="#">WWD2_RS_OW_CFG</a>	Window watchdog 2 reflected status open window configuration register *R3_C2)	04F <sub>H</sub>	<a href="#">317</a>
<a href="#">WWD2_TRIG</a>	Window watchdog 2 service - *R2)	050 <sub>H</sub>	<a href="#">318</a>
<a href="#">FWD2_RSP</a>	Functional watchdog 2 response register - *R2)	051 <sub>H</sub>	<a href="#">319</a>
<a href="#">FWD2_RSP_SYNC</a>	Functional watchdog 2 response register with synchronization - *R2)	052 <sub>H</sub>	<a href="#">320</a>
<a href="#">FWD2_STAT</a>	Functional watchdog 2 status register - *R3_C2)	053 <sub>H</sub>	<a href="#">321</a>
<a href="#">WWD2_ECNT_STAT</a>	Window watchdog 2 status register - *R3_C2)	054 <sub>H</sub>	<a href="#">322</a>

**18.6 Register overview - MISC (ascending offset address)**

**Table 61 Register overview - MISC (ascending offset address)**

Short name	Long name	Offset address	See
<a href="#">SSW_DIAG</a>	Safety switch diagnostics, *R1)	055 <sub>H</sub>	<a href="#">323</a>
<a href="#">BUCK_CORE_PW_VSEL</a>	BUCK CORE protected write voltage selection register *R1)	056 <sub>H</sub>	<a href="#">324</a>
<a href="#">BUCK_CORE_RS_VSEL</a>	BUCK CORE reflected status voltage selection register *R2)	057 <sub>H</sub>	<a href="#">325</a>
<a href="#">VCORESTAT</a>	Buck core voltage selection stat, *R2)	058 <sub>H</sub>	<a href="#">326</a>
<a href="#">VCOREMONSTAT</a>	Buck core voltage selection monitors stat, *R2)	059 <sub>H</sub>	<a href="#">327</a>
<a href="#">WUT_STAT0</a>	Wake Up Timer value after exiting from STANDBY or SLEEP (lower 16 bits)	05A <sub>H</sub>	<a href="#">328</a>
<a href="#">WUT_STAT1</a>	Wake Up Timer value after exiting from STANDBY or SLEEP (upper 8 bits)	05B <sub>H</sub>	<a href="#">329</a>

**18 Registers description**

**18.7 Registers overview - DEVICEID (ascending offset address)**

**Table 62 Registers overview - DEVICEID (ascending offset address)**

<b>Short name</b>	<b>Long name</b>	<b>Offset address</b>	<b>See</b>
<a href="#">CHPID</a>	Chip product identifier	1F0 <sub>H</sub>	<a href="#">330</a>
<a href="#">CHREV</a>	Chip product version and revision	1F1 <sub>H</sub>	<a href="#">331</a>
<a href="#">MANID</a>	Manufacturer ID	1F2 <sub>H</sub>	<a href="#">332</a>

**18 Registers description**

**18.8 Device configuration 4 \*R2)**

**DEV\_CFG4**

Device configuration 4 \*R2)

Offset address: 000<sub>H</sub>

Reset values see: [Table 63](#)

15	14	13	12	11	10	9	8
<b>FSM_SDT_VMON12</b>		<b>Res</b>				<b>DCDC_SYN C_IN_EN</b>	<b>WUT_EN</b>
rw		r				rw	rw
7	6	5	4	3	2	1	0
<b>WUT_CYC</b>	<b>WUT_PRESC</b> <b>C</b>	<b>FSM_SDT_TMR</b>		<b>FSM_TRDEL</b>			
rw	rw	rw		rw			

Field	Bits	Type	Description
FSM_TRDEL	3:0	rw	<b>Transition delay (TRDEL) into low power states (STANDBY, SLEEP)</b> 0 <sub>H</sub> 100 μs 1 <sub>H</sub> 200 μs 2 <sub>H</sub> 300 μs 3 <sub>H</sub> 400 μs 4 <sub>H</sub> 500 μs 5 <sub>H</sub> 600 μs 6 <sub>H</sub> 700 μs 7 <sub>H</sub> 800 μs 8 <sub>H</sub> 900 μs 9 <sub>H</sub> 1000 μs A <sub>H</sub> 1100 μs B <sub>H</sub> 1200 μs C <sub>H</sub> 1300 μs D <sub>H</sub> 1400 μs E <sub>H</sub> 1500 μs F <sub>H</sub> 1600 μs
FSM_SDT_TMR	5:4	rw	<b>Shut down timer (tSDT_TMR) for internal regulators of power down sequencing</b> 00 <sub>B</sub> 0 01 <sub>B</sub> 500 μs 10 <sub>B</sub> 1000 μs 11 <sub>B</sub> 1500 μs
WUT_PRESC	6	rw	<b>Wake up timer cycle period pre-scaler</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WUT_CYC	7	rw	<b>Wake timer cycle period</b> 0 <sub>B</sub> 10 μs 1 <sub>B</sub> 10 ms

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
WUT_EN	8	rw	<b>Wake timer enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
DCDC_SYNC_I N_EN	9	rw	<b>Enable synchronization input (only applicable when REDUCED OPERATION is disabled, since it uses SYNC_IN pin shared with INT2)</b> 0 <sub>B</sub> Disable 1 <sub>B</sub> Enable
FSM_SDT_VM ON12	15:14	rw	<b>Shut down timer for VMON1 and VMON2 of power down sequencing</b> 00 <sub>B</sub> 0 μs 01 <sub>B</sub> 500 μs 10 <sub>B</sub> 1 ms 11 <sub>B</sub> 1.5 ms

**Table 63**      **Reset values of DEV\_CFG4**

Reset	Reset value	Note
	C038 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.9 Reduced operation reflected status configuration 2 register - \*R2)**

**REDOP\_RS\_CFG2**

Reduced operation reflected status configuration 2 register - \*R2)

Offset address: 001<sub>H</sub>

Reset values see: [Table 64](#)

15	14	13	12	11	10	9	8
<b>REDOP_RESOUT_APP2_DUR</b>			<b>REDOP_RESOUT_APP1_DUR</b>			<b>REDOP_RESOUT_APP_TB</b>	<b>Res</b>
r			r			r	r
7	6	5	4	3	2	1	0
<b>Res</b>							
r							

Field	Bits	Type	Description
REDOP_RESOUT_APP_TB	9	r	<b>Partial reset timer step, selectable between 10 μs or 100 μs</b> 0 <sub>B</sub> 10 μs 1 <sub>B</sub> 100 μs
REDOP_RESOUT_APP1_DUR	12:10	r	<b>Application reset pulse duration duration for INT1</b> 000 <sub>B</sub> (0 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((0 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1 ... 111 <sub>B</sub> (7 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((7 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1
REDOP_RESOUT_APP2_DUR	15:13	r	<b>Application reset pulse duration duration for INT2</b> 000 <sub>B</sub> (0 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((0 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1 ... 111 <sub>B</sub> (7 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((7 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1

**Table 64 Reset values of REDOP\_RS\_CFG2**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.10 Protection configuration register - \*R2)**

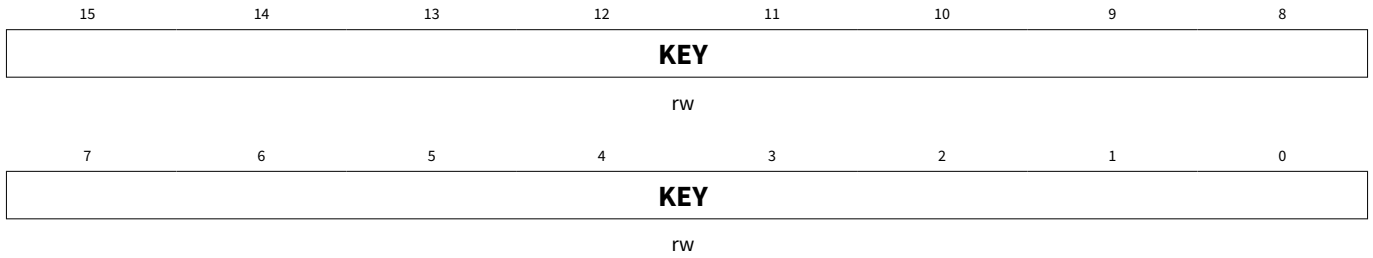
Controls UNLOCK/LOCK mechanism for password protected registers. UNLOCK allows to program registers, LOCK updates effective content of programmed ones. Any other value lead to LOCKed state, discarding pending changes if any.

**PROT\_CFG**

Offset address: 002<sub>H</sub>

Protection configuration register - \*R2)

Reset values see: [Table 65](#)



Field	Bits	Type	Description
KEY	15:0	rw	<b>KEY value</b> B5CA <sub>H</sub> Registers unlocked D396 <sub>H</sub> Registers locked

**Table 65** Reset values of **PROT\_CFG**

Reset	Reset value	Note
	D396 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.11 Device reflected status configuration Register \*R2)**

**DEV\_RS\_CFG3**

Offset address: 003<sub>H</sub>

Device reflected status configuration Register \*R2)

Reset values see: [Table 66](#)

15	14	13	12	11	10	9	8
<b>Res</b>					<b>VMON2_EN</b>	<b>VMON1_EN</b>	<b>BOOST_EN</b>
r					r	r	r
7	6	5	4	3	2	1	0
<b>BUCKINT_EN</b>	<b>QUC_EN</b>	<b>BUCKCORE_EN</b>	<b>QCO_EN</b>	<b>QVR_EN</b>	<b>FSM_STATEREQ</b>		
r	r	r	r	r	r		

Field	Bits	Type	Description
FSM_STATEREQ	2:0	r	<b>Request for device state transition.</b> 000 <sub>B</sub> NONE 001 <sub>B</sub> INIT 010 <sub>B</sub> NORMAL 011 <sub>B</sub> SLEEP 100 <sub>B</sub> STANDBY 101 <sub>B</sub> WAKE 110 <sub>B</sub> NONE 111 <sub>B</sub> NONE
QVR_EN	3	r	<b>Enable request for reference voltage.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
QCO_EN	4	r	<b>Enable request for communication LDO.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BUCKCORE_EN	5	r	<b>Enable request for BUCKCORE</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
QUC_EN	6	r	<b>Enable request for QUC</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BUCKINT_EN	7	r	<b>Enable request for BUCK interface</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BOOST_EN	8	r	<b>Enable request for Boost</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
VMON1_EN	9	r	<b>Enable request for External Monitoring1</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
VMON2_EN	10	r	<b>Enable request for External Monitoring2</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**Table 66**      **Reset values of DEV\_RS\_CFG3**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

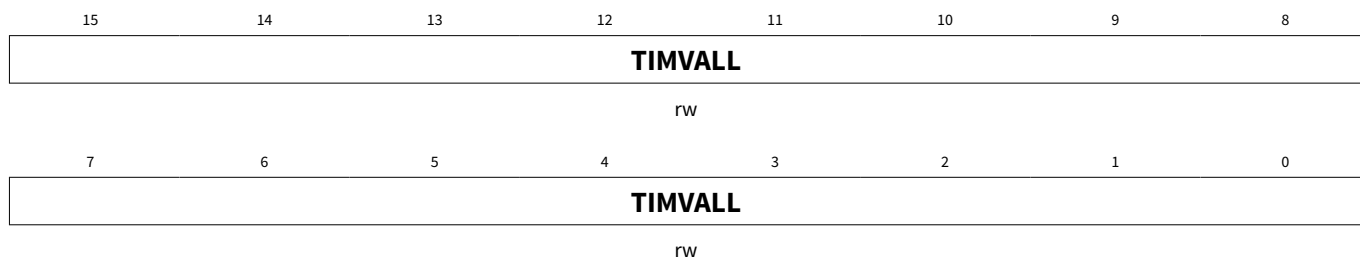
**18.12 Wake up timer LSB Value (\*R2)**

**WUT\_CFG0**

Wake up timer LSB Value [\*R2)

Offset address: 004<sub>H</sub>

Reset values see: [Table 67](#)



Field	Bits	Type	Description
TIMVALL	15:0	rw	Wake timer compare value, 16bit lsb

**Table 67** Reset values of [WUT\\_CFG0](#)

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

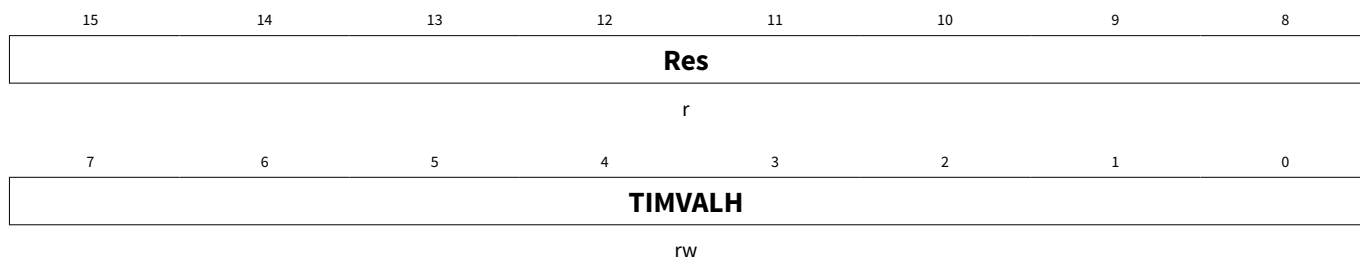
**18.13 Wake up timer MSB Value (\*R2)**

**WUP\_CFG1**

Wake up timer MSB Value [\*R2)

Offset address: 005<sub>H</sub>

Reset values see: [Table 68](#)



Field	Bits	Type	Description
TIMVALH	7:0	rw	Wake timer compare value (23:16) (msb)

**Table 68** Reset values of [WUP\\_CFG1](#)

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

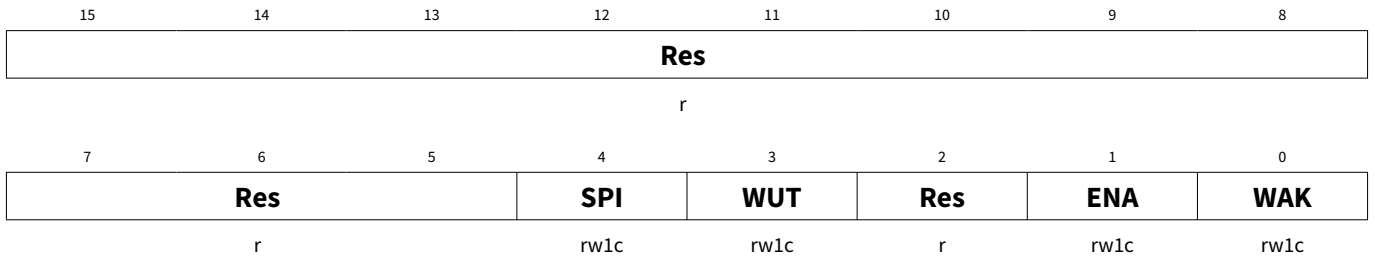
**18.14 Wakeup status flags for Application 1 \*R2)**

**WAKE\_STAT\_APP1**

Offset address: 006<sub>H</sub>

Wakeup status flags for Application 1 \*R2)

Reset values see: [Table 69](#)



Field	Bits	Type	Description
WAK	0	rw1c	<b>Wakeup by WAK signal, bit is set if SLEEP, FAILSAFE or STANDBY state left because of WAK</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
ENA	1	rw1c	<b>Wake by ENA signal, bit is set if SLEEP, FAILSAFE or STANDBY state left because of ENA</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
WUT	3	rw1c	<b>Wakeup by wake timer</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
SPI	4	rw1c	<b>Wakeup by SPI</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected

**Table 69 Reset values of [WAKE\\_STAT\\_APP1](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

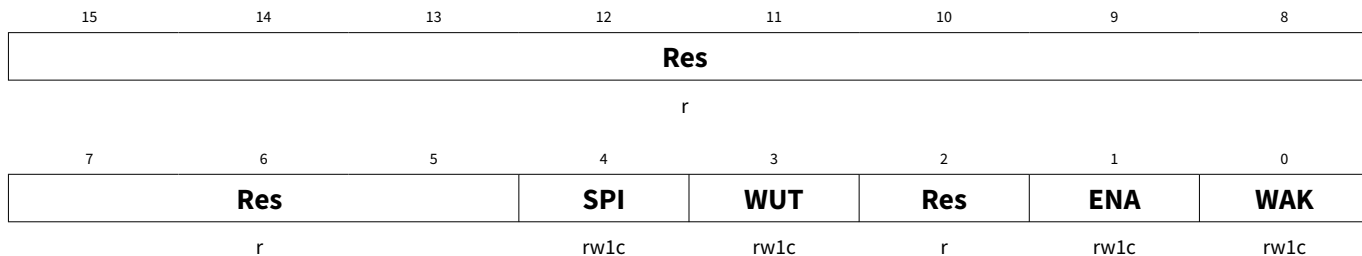
**18.15 Wakeup status flags for Application 2 \*R2)**

**WAKE\_STAT\_APP2**

Offset address: 007<sub>H</sub>

Wakeup status flags for Application 2 \*R2)

Reset values see: [Table 70](#)



Field	Bits	Type	Description
WAK	0	rw1c	<b>Wakeup by WAK signal, bit is set if SLEEP, FAILSAFE or STANDBY state left because of WAK</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
ENA	1	rw1c	<b>Wake by ENA signal, bit is set if SLEEP, FAILSAFE or STANDBY state left because of ENA</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
WUT	3	rw1c	<b>Wakeup by wake timer, bit will also be set if device leaves STANDBY state because of wakeup timer expired</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
SPI	4	rw1c	<b>Wakeup by SPI from SLEEP state</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected

**Table 70** Reset values of **WAKE\_STAT\_APP2**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.16 INIT and REDUCED OPERATION Error Status flags for Application 1 \*R2)**

**INIT\_ERR\_APP1**

INIT and REDUCED OPERATION Error Status flags for Application 1 \*R2)

Offset address: 008<sub>H</sub>

Reset values see: [Table 71](#)

15	14	13	12	11	10	9	8
<b>HARDRES</b>	<b>SOFTRES</b>	<b>Res</b>		<b>REDOP_RE S2</b>	<b>REDOP_RE S1</b>	<b>Res</b>	
rw1c	rw1c	r		rw1c	rw1c	r	
7	6	5	4	3	2	1	0
<b>ERR2</b>	<b>ERR1</b>	<b>Res</b>	<b>FWD2_EC</b>	<b>FWD1_EC</b>	<b>WWD2_EC</b>	<b>WWD1_EC</b>	<b>VMONF</b>
rw1c	rw1c	r	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
VMONF	0	rw1c	<b>Voltage monitor failure which lead to INIT (see chapter: Collection registers)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
WWD1_EC	1	rw1c	<b>Window watchdog1 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
WWD2_EC	2	rw1c	<b>Window watchdog2 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
FWD1_EC	3	rw1c	<b>Functional watchdog1 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
FWD2_EC	4	rw1c	<b>Functional watchdog2 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
ERR1	6	rw1c	<b>ERR1 failure</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
ERR2	7	rw1c	<b>ERR2 failure</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
REDOP_RES1	10	rw1c	<b>REDUCED OPERATION reset has been generated because REDUCED OPERATION timer expired once (same timer as INIT timer)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
REDOP_RES2	11	rw1c	<b>REDUCED OPERATION reset has been generated because REDUCED OPERATION timer expired twice (same timer as INIT timer); Move to INIT is triggered</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
SOFTRES	14	rw1c	<b>Soft reset generated</b> 0 <sub>B</sub> No soft reset occurred 1 <sub>B</sub> Soft reset occurred
HARDRES	15	rw1c	<b>Hard reset generated because INIT timer expired twice</b> 0 <sub>B</sub> No hard reset occurred 1 <sub>B</sub> Hard reset occurred

**Table 71** Reset values of **INIT\_ERR\_APP1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.17 INIT and REDUCED OPERATION Error Status flags for Application 2 \*R2)**

**INIT\_ERR\_APP2**

Offset address: 009<sub>H</sub>

INIT and REDUCED OPERATION Error Status flags for Application 2 \*R2)

Reset values see: [Table 72](#)

15	14	13	12	11	10	9	8
<b>HARDRES</b>	<b>SOFTRES</b>	<b>Res</b>		<b>REDOP_RE S2</b>	<b>REDOP_RE S1</b>	<b>Res</b>	
rw1c	rw1c	r		rw1c	rw1c	r	
7	6	5	4	3	2	1	0
<b>ERR2</b>	<b>ERR1</b>	<b>Res</b>	<b>FWD2_EC</b>	<b>FWD1_EC</b>	<b>WWD2_EC</b>	<b>WWD1_EC</b>	<b>VMONF</b>
rw1c	rw1c	r	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
VMONF	0	rw1c	<b>Voltage monitor failure which lead to INIT (see chapter: Collection registers)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
WWD1_EC	1	rw1c	<b>Window watchdog1 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
WWD2_EC	2	rw1c	<b>Window watchdog2 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
FWD1_EC	3	rw1c	<b>Functional watchdog1 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
FWD2_EC	4	rw1c	<b>Functional watchdog2 error counter reached the error threshold</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
ERR1	6	rw1c	<b>error1 monitor failure</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
ERR2	7	rw1c	<b>error2 monitor failure</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
REDOP_RES1	10	rw1c	<b>REDUCED OPERATION reset has been generated because REDUCED OPERATION timer expired once</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
REDOP_RES2	11	rw1c	<b>REDUCED OPERATION reset has been generated because REDUCED OPERATION timer expired twice</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
SOFTRES	14	rw1c	<b>Soft reset generated because the Init timer expired once</b> 0 <sub>B</sub> No soft reset occurred 1 <sub>B</sub> Soft reset occurred
HARDRES	15	rw1c	<b>Hard reset generated because Init timer expired twice</b> 0 <sub>B</sub> No hard reset occurred 1 <sub>B</sub> Hard reset occurred

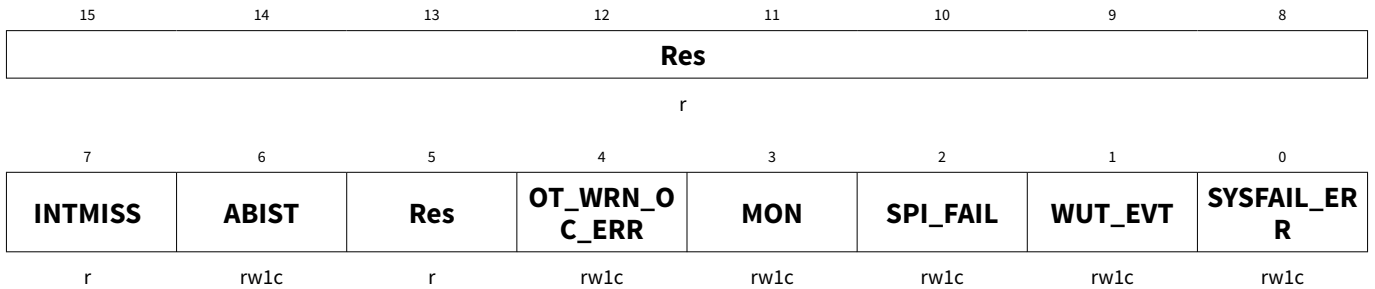
**Table 72**      **Reset values of [INIT\\_ERR\\_APP2](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.18 Interrupt flags for Application 1 that trigger INT1 \*R2)**

**IF1** Offset address: 00A<sub>H</sub>  
 Interrupt flags for Application 1 that trigger INT1 \*R2) Reset values see: [Table 73](#)



Field	Bits	Type	Description
SYSFAIL_ERR	0	rw1c	<b>INT1 is triggered, because a system event has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
WUT_EVT	1	rw1c	<b>INT1 is triggered, because a wake up event has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
SPI_FAIL	2	rw1c	<b>INT1 is triggered, because a SPI_FAIL has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
MON	3	rw1c	<b>INT1 is triggered, because a monitoring event has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
OT_WRN_OC_ERR	4	rw1c	<b>INT1 is triggered, because a overtemperature warning or overcurrent has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
ABIST	6	rw1c	<b>Requested ABIST operation performed or interrupted. ABIST is not continued automatically.</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
INTMISS	7	r	<b>Interrupt INT1 has not been serviced within tINTTO time</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred

**18 Registers description**

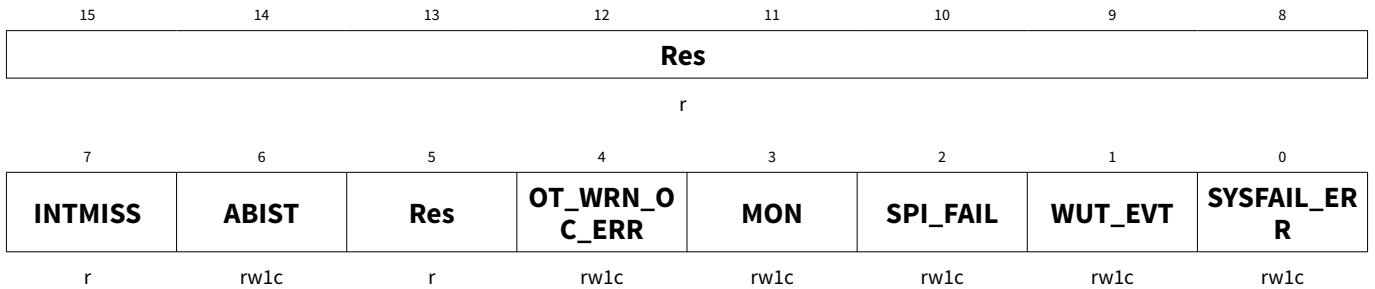
**Table 73**      **Reset values of IF1**

<b>Reset</b>	<b>Reset value</b>	<b>Note</b>
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.19 Interrupt flags for Application 2 that trigger INT2 \*R2)**

**IF2** Offset address: 00B<sub>H</sub>  
 Interrupt flags for Application 2 that trigger INT2 \*R2) Reset values see: [Table 74](#)



Field	Bits	Type	Description
SYSFAIL_ERR	0	rw1c	<b>INT2 is triggered, because a system event has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
WUT_EVT	1	rw1c	<b>INT2 is triggered, because a wake up event has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
SPI_FAIL	2	rw1c	<b>INT2 is triggered, because a SPI_FAIL has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
MON	3	rw1c	<b>INT2 is triggered, because a monitoring event has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
OT_WRN_OC_ERR	4	rw1c	<b>INT2 is triggered, because a overtemperature warning or overcurrent has occurred (see chapter: Collection registers)</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
ABIST	6	rw1c	<b>Requested ABIST operation performed or interrupted. ABIST is not continued automatically.</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred
INTMISS	7	r	<b>Interrupt INT2 has not been serviced within tINTTO time</b> 0 <sub>B</sub> No interrupt 1 <sub>B</sub> Interrupt occurred

**18 Registers description**

**Table 74**      **Reset values of IF2**

<b>Reset</b>	<b>Reset value</b>	<b>Note</b>
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.20 System status flags for Application 1 that trigger INT1 \*R2)**

**SYS\_STAT\_APP1**

System status flags for Application 1 that trigger INT1 \*R2)

Offset address: 00C<sub>H</sub>

Reset values see: [Table 75](#)

<b>Res</b>								<b>BUCKCORE _SVS_NOK</b>	<b>BUCKCORE _SVS_OK</b>
r								rw1c	rw1c
<b>APP2_FAIL</b>	<b>ERR1_ERR</b>	<b>ERR0_ERR</b>	<b>FSM_NOOP</b>	<b>FSM_TRFAI L</b>	<b>FWD1_ERR</b>	<b>WWD1_ERR</b>	<b>Res</b>		
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	r		

Field	Bits	Type	Description
WWD1_ERR	1	rw1c	<b>Window watchdog 1 error interrupt flag. Service was incorrect or missed.</b> 0 <sub>B</sub> No event occurred 1 <sub>B</sub> Event detected
FWD1_ERR	2	rw1c	<b>Functional watchdog 1 error interrupt flag. Service was incorrect or missed.</b> 0 <sub>B</sub> No event occurred 1 <sub>B</sub> Event occurred
FSM_TRFAIL	3	rw1c	<b>Transition to low power state (STANDBY/SLEEP) failed</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Transition unsuccessful
FSM_NOOP	4	rw1c	<b>Requested state transition via DEVCTRL could not be performed because either path between current state and requested state does not exist (eg. INIT to SLEEP), or paths exists but pre-conditions are not satisfied (e.g. INIT to NORMAL, but WWD enabled and not serviced).</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Transition was not executed
ERR0_ERR	5	rw1c	<b>ERR0 error status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Invalid frequency - recovery time started
ERR1_ERR	6	rw1c	<b>ERR1 error status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Invalid frequency - recovery time started
APP2_FAIL	7	rw1c	<b>Application 2 entered REDUCED OPERATION</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Application 2 fault occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BUCKCORE_SV S_OK	8	rw1c	<b>BUCK CORE static voltage scaling procedure completed successfully.</b> 0 <sub>B</sub> Not completed 1 <sub>B</sub> Completed successfully
BUCKCORE_SV S_NOK	9	rw1c	<b>BUCK CORE static voltage scaling procedure was unsuccessful, because the device is not in state NORMAL or INIT or BUCKCORE output voltage is set to 1.15 V.</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> BUCK CORE voltage scaling was unsuccessful

**Table 75**      **Reset values of [SYS\\_STAT\\_APP1](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.21 System status flags for Application 2 that trigger INT2 \*R2)**

**SYS\_STAT\_APP2**

System status flags for Application 2 that trigger INT2 \*R2)

Offset address: 00D<sub>H</sub>

Reset values see: [Table 76](#)

Res								BUCKCORE _SVS_NOK	BUCKCORE _SVS_OK
r								rw1c	rw1c
7	6	5	4	3	2	1	0		
<b>APP1_FAIL</b>	<b>ERR2_ERR</b>	<b>ERR0_ERR</b>	<b>FSM_NOOP</b>	<b>FSM_TRFAI L</b>	<b>FWD2_ERR</b>	<b>WWD2_ERR</b>	<b>Res</b>		
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	r		

Field	Bits	Type	Description
WWD2_ERR	1	rw1c	<b>Window watchdog 2 error interrupt flag. Service was incorrect or missed.</b> 0 <sub>B</sub> No event occurred 1 <sub>B</sub> Event detected
FWD2_ERR	2	rw1c	<b>Functional watchdog 1 error interrupt flag. Service was incorrect or missed.</b> 0 <sub>B</sub> No event detected 1 <sub>B</sub> Event detected
FSM_TRFAIL	3	rw1c	<b>Transition to low power state (STANDBY/SLEEP) failed</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Transition unsuccessful
FSM_NOOP	4	rw1c	<b>Requested state transition via DEVCTRL could not be performed because either path between current state and requested state does not exist (eg. INIT to SLEEP), or paths exists but pre-conditions are not satisfied (e.g. INIT to NORMAL, but WWD enabled and not serviced).</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Transition was not executed
ERR0_ERR	5	rw1c	<b>ERR0 error status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Invalid frequency - recovery time started
ERR2_ERR	6	rw1c	<b>ERR2 error status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Invalid frequency - recovery time started
APP1_FAIL	7	rw1c	<b>Application 1 entered REDUCED OPERATION</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Application 1 fault occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BUCKCORE_SV S_OK	8	rw1c	<b>BUCK CORE static voltage scaling procedure completed successfully.</b> 0 <sub>B</sub> Not completed 1 <sub>B</sub> Completed successfully
BUCKCORE_SV S_NOK	9	rw1c	<b>BUCK CORE static voltage scaling procedure was unsuccessful, because the device is not in state NORMAL or INIT or BUCKCORE output voltage is set to 1.15 V.</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> BUCK CORE voltage scaling was unsuccessful

**Table 76**      **Reset values of [SYS\\_STAT\\_APP2](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

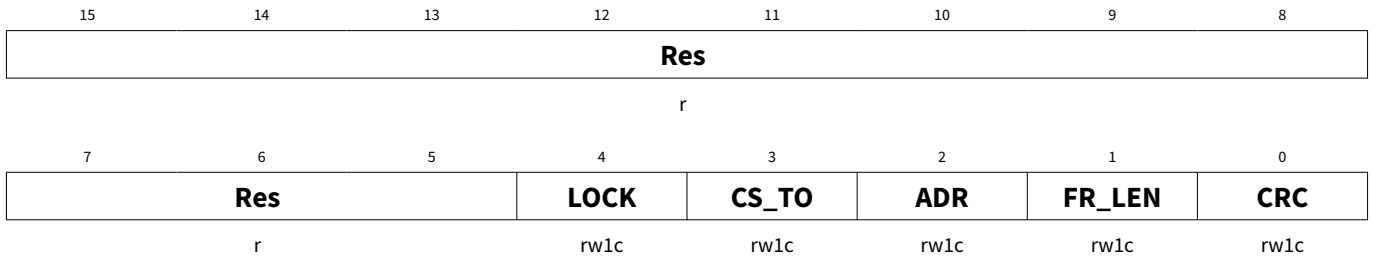
**18.22 SPI failure status flags that triggers INT1 \*R2)**

**SPI\_FAIL\_STAT\_APP1**

Offset address: 00E<sub>H</sub>

SPI failure status flags that triggers INT1 \*R2)

Reset values see: [Table 77](#)



Field	Bits	Type	Description
CRC	0	rw1c	<b>CRC error in SPI frame</b> 0 <sub>B</sub> No error 1 <sub>B</sub> CRC wrong
FR_LEN	1	rw1c	<b>Invalid frame length, number of detected SPI clock cycles different than 32</b> 0 <sub>B</sub> Frame length ok 1 <sub>B</sub> Frame length incorrect
ADR	2	rw1c	<b>Invalid address in SPI frame</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Address not existing
CS_TO	3	rw1c	<b>Error in duration of SPI transaction, nCS low for more than 2 ms</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> CSN timeout
LOCK	4	rw1c	<b>Error during LOCK/UNLOCK procedure or write attempts to locked registers</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> LOCK/UNLOCK sequence failed

**Table 77 Reset values of SPI\_FAIL\_STAT\_APP1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

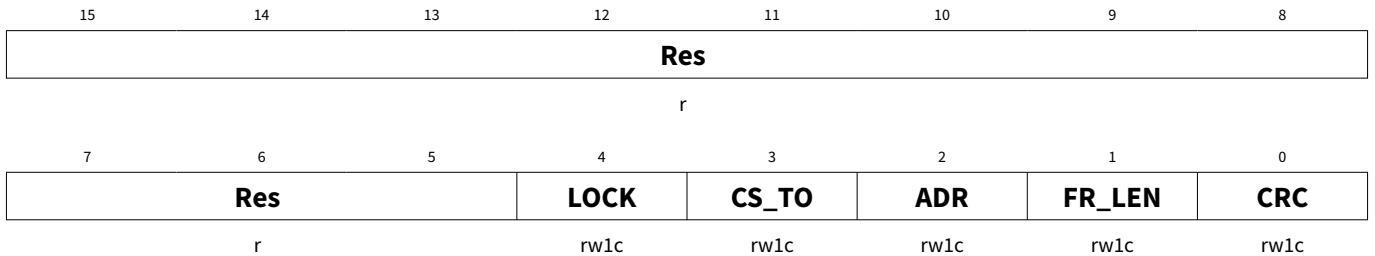
**18.23 SPI status flags for Application 2 that trigger INT2 \*R2)**

**SPI\_FAIL\_STAT\_APP2**

Offset address: 00F<sub>H</sub>

SPI status flags for Application 2 that trigger INT2 \*R2)

Reset values see: [Table 78](#)



Field	Bits	Type	Description
CRC	0	rw1c	<b>CRC error in SPI frame</b> 0 <sub>B</sub> No error 1 <sub>B</sub> CRC wrong
FR_LEN	1	rw1c	<b>Invalid frame length, number of detected SPI clock cycles different than 32</b> 0 <sub>B</sub> Frame length ok 1 <sub>B</sub> Frame length incorrect
ADR	2	rw1c	<b>Invalid address in SPI frame</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Address not existing
CS_TO	3	rw1c	<b>Error in duration of SPI transaction, nCS low for more than 2 ms</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> CSN timeout
LOCK	4	rw1c	<b>Error during LOCK/UNLOCK procedure or write attempts to locked registers</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> LOCK/UNLOCK sequence failed

**Table 78 Reset values of SPI\_FAIL\_STAT\_APP2**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.24 Monitor status flags register 2 for Application 1 \*R2)**

**UV\_STAT\_APP1**

Monitor status flags register 2 for Application 1 \*R2)

Offset address: 010<sub>H</sub>

Reset values see: [Table 79](#)

15	14	13	12	11	10	9	8
<b>Res</b>				<b>INTSUP_VD D2V5_UV</b>	<b>INTSUP_IV CC_UV</b>	<b>BUCKIF</b>	<b>VMON2</b>
r				rw1c	rw1c	rw1c	rw1c
7	6	5	4	3	2	1	0
<b>VMON1</b>	<b>BOOST</b>	<b>QVR</b>	<b>QCO</b>	<b>BUCKCORE</b>	<b>QST</b>	<b>QUC</b>	<b>PREREG</b>
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
PREREG	0	rw1c	<b>Pre-regulator voltage under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QUC	1	rw1c	<b>QUC under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QST	2	rw1c	<b>QST under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
BUCKCORE	3	rw1c	<b>BUCKCORE under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QCO	4	rw1c	<b>QCO under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QVR	5	rw1c	<b>QVR under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
BOOST	6	rw1c	<b>BOOST under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
VMON1	7	rw1c	<b>VMON1 under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
VMON2	8	rw1c	<b>VMON2 under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BUCKIF	9	rw1c	<b>BUCKIF under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
INTSUP_IVCC_UV	10	rw1c	<b>Internal supply IVCC under voltage status flag, *R1)</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
INTSUP_VDD2 V5_UV	11	rw1c	<b>Internal supply VDD 2.5 V under voltage status flag, *R1)</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred

**Table 79**      **Reset values of [UV\\_STAT\\_APP1](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.25 Monitor status flags register 2 for Application 2 \*R2)**

**UV\_STAT\_APP2**

Monitor status flags register 2 for Application 2 \*R2)

Offset address: 011<sub>H</sub>

Reset values see: [Table 80](#)

15	14	13	12	11	10	9	8
<b>Res</b>				<b>INTSUP_2V 5_UV</b>	<b>INTSUP_IV CC_UV</b>	<b>BUCKIF</b>	<b>VMON2</b>
r				rw1c	rw1c	rw1c	rw1c
7	6	5	4	3	2	1	0
<b>VMON1</b>	<b>BOOST</b>	<b>QVR</b>	<b>QCO</b>	<b>BUCKCORE</b>	<b>QST</b>	<b>QUC</b>	<b>PREREG</b>
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
PREREG	0	rw1c	<b>Pre-regulator voltage under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QUC	1	rw1c	<b>QUC under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QST	2	rw1c	<b>QST under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
BUCKCORE	3	rw1c	<b>BUCKCORE under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QCO	4	rw1c	<b>QCO under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
QVR	5	rw1c	<b>QVR under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
BOOST	6	rw1c	<b>Boost voltage under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
VMON1	7	rw1c	<b>VMON1 voltage under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurrence
VMON2	8	rw1c	<b>Mon2 voltage under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BUCKIF	9	rw1c	<b>BUCKIF under voltage status flag</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
INTSUP_IVCC_UV	10	rw1c	<b>IVCC voltage under voltage status flag *R1)</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred
INTSUP_2V5_UV	11	rw1c	<b>2V5 voltage under voltage status flag *R1)</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Undervoltage occurred

**Table 80**      **Reset values of UV\_STAT\_APP2**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.26 Over temperature warning and over current status flags \*R2)**

**OT\_WRN\_OC\_STAT\_APP1**

Offset address: 012<sub>H</sub>

Over temperature warning and over current status flags \*R2)

Reset values see: [Table 81](#)

Res							BOOST_OC
r							rw1c
IVCC_OC	QUC_OTWRN	BOOST_OTWRN	BUCKIF_OTWRN	BUCKCORE_OTWRN	QVR_OC	QCO_OTWRN	QST_OC
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
QST_OC	0	rw1c	<b>QST over current</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred
QCO_OTWRN	1	rw1c	<b>QCO over temperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
QVR_OC	2	rw1c	<b>QVR over current</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred
BUCKCORE_OTWRN	3	rw1c	<b>BUCKCORE overtemperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
BUCKIF_OTWRN	4	rw1c	<b>BUCKIF overtemperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
BOOST_OTWRN	5	rw1c	<b>BOOST overtemperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
QUC_OTWRN	6	rw1c	<b>QUC over temperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
IVCC_OC	7	rw1c	<b>IVCC over current warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred
BOOST_OC	8	rw1c	<b>BOOST over current</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred

**18 Registers description**

**Table 81**      **Reset values of [OT\\_WRN\\_OC\\_STAT\\_APP1](#)**

<b>Reset</b>	<b>Reset value</b>	<b>Note</b>
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

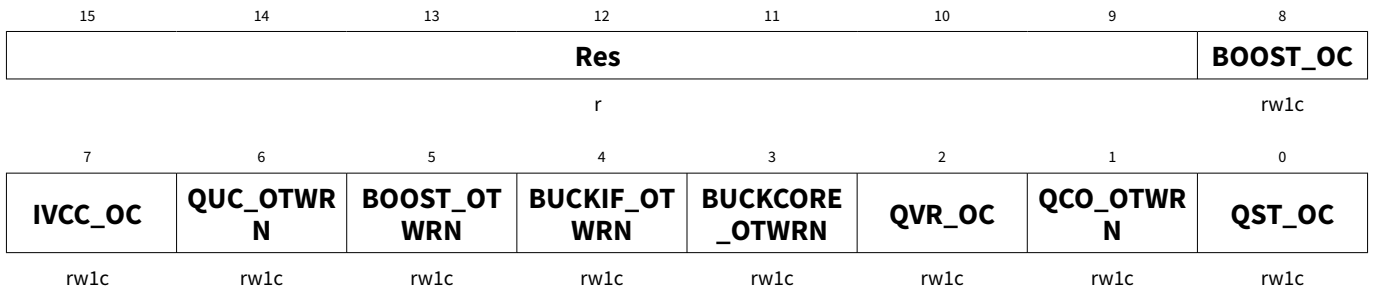
**18.27 Over temperature warning /Over current status flags for Application 2 \*R2)**

**OT\_WRN\_OC\_STAT\_APP2**

Offset address: 013<sub>H</sub>

Over temperature warning /Over current status flags for Application 2 \*R2)

Reset values see: [Table 82](#)



Field	Bits	Type	Description
QST_OC	0	rw1c	<b>QST over current</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred
QCO_OTWRN	1	rw1c	<b>QCO over temperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
QVR_OC	2	rw1c	<b>QVR over current</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred
BUCKCORE_OTWRN	3	rw1c	<b>BUCKCORE overtemperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
BUCKIF_OTWRN	4	rw1c	<b>BUCKIF overtemperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
BOOST_OTWRN	5	rw1c	<b>BOOST overtemperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
QUC_OTWRN	6	rw1c	<b>QUC over temperature warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Overtemperature warning
IVCC_OC	7	rw1c	<b>IVCC over current warning</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred
BOOST_OC	8	rw1c	<b>BOOST over current</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Over current occurred

**18 Registers description**

**Table 82**      **Reset values of [OT\\_WRN\\_OC\\_STAT\\_APP2](#)**

<b>Reset</b>	<b>Reset value</b>	<b>Note</b>
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.28 Voltage monitor status \*R2)**

**VMON\_STAT**

Voltage monitor status \*R2)

Offset address: 014<sub>H</sub>

Reset values see: [Table 83](#)

15				14				13				12				11				10				9				8			
<b>Res</b>												<b>VMON2_ST</b>				<b>VMON1_ST</b>				<b>IVCC_ST</b>											
r												r				r				r											
7				6				5				4				3				2				1				0			
<b>QUC_ST</b>				<b>PREREG_ST</b>				<b>BOOST_ST</b>				<b>BUCKINT_S T</b>				<b>QVR_ST</b>				<b>QCO_ST</b>				<b>BUCKCORE _ST</b>				<b>QST_ST</b>			
r				r				r				r				r				r				r							

Field	Bits	Type	Description
QST_ST	0	r	<b>Standby LDO voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
BUCKCORE_ST	1	r	<b>Core voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
QCO_ST	2	r	<b>Communication voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
QVR_ST	3	r	<b>Reference voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
BUCKINT_ST	4	r	<b>Buckint voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
BOOST_ST	5	r	<b>Boost voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
PREREG_ST	6	r	<b>Prereg voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
QUC_ST	7	r	<b>QUC voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
IVCC_ST	8	r	<b>IVCC voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
VMON1_ST	9	r	<b>MON1 voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK
VMON2_ST	10	r	<b>MON2 voltage status</b> 0 <sub>B</sub> Voltage is out of range or not enabled 1 <sub>B</sub> Voltage is OK

**Table 83**      **Reset values of VMON\_STAT**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.29 Device status register \*R2)**

**DEV\_STAT**

Device status register \*R2)

Offset address: 015<sub>H</sub>

Reset values see: [Table 84](#)

15	14	13	12	11	10	9	8
<b>VMON2_AUTO_DET</b>	<b>VMON1_AUTO_DET</b>	<b>BOOST_AUTO_DET</b>	<b>BUCKINT_AUTO_DET</b>	<b>SSW_AUTO_DET</b>	<b>VMON2_EN</b>	<b>VMON1_EN</b>	<b>BOOST_EN</b>
r	r	r	r	r	r	r	r
7	6	5	4	3	2	1	0
<b>BUCKIF_EN</b>	<b>QUC_EN</b>	<b>BUCKCORE_EN</b>	<b>QCO_EN</b>	<b>QVR_EN</b>	<b>STATE</b>		
r	r	r	r	r	r		

Field	Bits	Type	Description
STATE	2:0	r	<b>Current device state</b> 000 <sub>B</sub> reserved 001 <sub>B</sub> INIT 010 <sub>B</sub> NORMAL 011 <sub>B</sub> SLEEP 100 <sub>B</sub> STANDBY 101 <sub>B</sub> WAKE 110 <sub>B</sub> REDUCED_OPERATION 111 <sub>B</sub> reserved
QVR_EN	3	r	<b>QVR status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
QCO_EN	4	r	<b>QCO status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BUCKCORE_EN	5	r	<b>BUCKCORE status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
QUC_EN	6	r	<b>QUC status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BUCKIF_EN	7	r	<b>BUCKIF status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BOOST_EN	8	r	<b>BOOST status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
VMON1_EN	9	r	<b>External voltage monitor channel 1 status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
VMON2_EN	10	r	<b>External voltage monitor channel 2 status</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SSW_AUTO_DETECT	11	r	<b>Safety switch auto detect</b> 0 <sub>B</sub> not detected 1 <sub>B</sub> detected
BUCKINT_AUTO_DET	12	r	<b>BUCKINT autodetection result: 0 not detected, 1 detected</b> 0 <sub>B</sub> not detected 1 <sub>B</sub> detected
BOOST_AUTO_DET	13	r	<b>BOOST autodetection result: 0 not detected, 1 detected</b> 0 <sub>B</sub> not detected 1 <sub>B</sub> detected
VMON1_AUTO_DET	14	r	<b>VMON1 autodetection result: 0 not detected, 1 detected</b> 0 <sub>B</sub> not detected 1 <sub>B</sub> detected
VMON2_AUTO_DET	15	r	<b>VMON2 autodetection result: 0 not detected, 1 detected</b> 0 <sub>B</sub> not detected 1 <sub>B</sub> detected

**Table 84**      **Reset values of DEV\_STAT**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.30 DC-DC switching frequency change \*R2)**

**DCDC\_FREQ\_SYNC**

DC-DC switching frequency change \*R2)

Offset address: 016<sub>H</sub>

Reset values see: [Table 85](#)

15	14	13	12	11	10	9	8
<b>PREREG_BOOST_PHSHT</b>	<b>BOOST_BUCKIF_PHSHT</b>	<b>Res</b>			<b>BOOST_DRIVER_CONFIG</b>		<b>BUCKIF_DRIVER_CONFIG</b>
rw	rw	r			rw		rw
7	6	5	4	3	2	1	0
<b>BUCKIF_DRIVER_CONFIG</b>	<b>BUCKCORE_DRIVER_CONFIG</b>		<b>PREREG_DRIVER_CONFIG</b>		<b>DCDC_FREQSEL</b>		
rw	rw		rw		rw		

Field	Bits	Type	Description
DCDC_FREQSEL	2:0	rw	<b>DC-DC switching frequency (fDCDC) change</b> 000 <sub>B</sub> 1.8 MHz 001 <sub>B</sub> 1.9 MHz 010 <sub>B</sub> 2.0 MHz 011 <sub>B</sub> 2.1 MHz 100 <sub>B</sub> 2.2 MHz - default/center value 101 <sub>B</sub> 2.3 MHz 110 <sub>B</sub> 2.4 MHz 111 <sub>B</sub> 2.4 MHz
PREREG_DRIVER_CONFIG	4:3	rw	<b>Drive strength configuration for BUCK PREREG</b> 00 <sub>B</sub> Full strength 01 <sub>B</sub> 66% of full strength 10 <sub>B</sub> 33% of full strength 11 <sub>B</sub> <b>RESERVED:</b> Do not use, currently selects 33% strength
BUCKCORE_DRIVER_CONFIG	6:5	rw	<b>Drive strength configuration for BUCK CORE</b> 00 <sub>B</sub> Full strength 01 <sub>B</sub> 50% of full strength 10 <sub>B</sub> 25% of full strength 11 <sub>B</sub> Do not use, currently selects 25% strength
BUCKIF_DRIVER_CONFIG	8:7	rw	<b>Drive strength configuration for BUCK IF</b> 00 <sub>B</sub> Full strength 01 <sub>B</sub> 50% of full strength 10 <sub>B</sub> 25% of full strength 11 <sub>B</sub> <b>RESERVED:</b> Do not use, currently selects 25% strength

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BOOST_DRIVE R_CONFIG	10:9	rw	<b>Drive strength configuration for BOOST</b> 00 <sub>B</sub> Full strenght 01 <sub>B</sub> 50% of full strength 10 <sub>B</sub> 25% of full strength 11 <sub>B</sub> <b>RESERVED:</b> Do not use, currently selects 25% strength
BOOST_BUCKI F_PHSFT	14	rw	<b>180 degree phase shift between BOOST and BUCKIF</b> 0 <sub>B</sub> Disable phase shift 1 <sub>B</sub> Enable phase shift
PREREG_BOO ST_PHSFT	15	rw	<b>180 degree phase shift between BOOST and PREREG</b> 0 <sub>B</sub> Disable Phase Shift 1 <sub>B</sub> Enable Phase Shift

**Table 85**      **Reset values of [DCDC\\_FREQ\\_SYNC](#)**

Reset	Reset value	Note
	0004 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.31 DC-DC Frequency spread-spectrum control register \*R2)**

**FREQ\_SPREAD**

DC-DC Frequency spread-spectrum control register \*R2)

Offset address: 017<sub>H</sub>

Reset values see: [Table 86](#)

15	14	13	12	11	10	9	8
<b>Res</b>		<b>FRE_SP_AMPLITUDE</b>				<b>FRE_SP_FSTEP</b>	
r		rw				rw	
7	6	5	4	3	2	1	0
<b>FRE_SP_TIMEBASE</b>			<b>FRE_SP_METH</b>			<b>FRE_SP_BUCK_IF_EN</b>	<b>FRE_SP_EN</b>
rw			rw			rw	rw

Field	Bits	Type	Description
FRE_SP_EN	0	rw	<b>Enable spread spectrum</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
FRE_SP_BUCK_IF_EN	1	rw	<b>Enable spread spectrum for BUCKIF (ignored when FRE_SP_EN is 0)</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
FRE_SP_METH	4:2	rw	<b>These bits define the method for vary the frequency spectrum</b> 000 <sub>B</sub> Triangle 001 <sub>B</sub> Triangle with dithering 010 <sub>B</sub> Triangle with pseudorandom period 011 <sub>B</sub> Triangle with pseudorandom period and dithering 100 <sub>B</sub> Triangle with pseudorandom half-period 101 <sub>B</sub> Triangle with pseudorandom half-period and dithering 110 <sub>B</sub> Triangle with pseudorandom ramp 111 <sub>B</sub> Triangle with pseudorandom ramp and dithering
FRE_SP_TIMEBASE	7:5	rw	<b>These bits define the timings for varying the frequency spectrum</b> 000 <sub>B</sub> Frequency changes every 3.5 us 001 <sub>B</sub> Frequency changes every 7 us 010 <sub>B</sub> Frequency changes every 10.5 us 011 <sub>B</sub> Frequency changes every 14 us 100 <sub>B</sub> Frequency changes every 17.5 us 101 <sub>B</sub> Frequency changes every 21 us 110 <sub>B</sub> Frequency changes every 24.5 us 111 <sub>B</sub> Frequency changes every 28 us
FRE_SP_FSTEP	9:8	rw	<b>These bits define the frequency step for varying the frequency spectrum</b> 00 <sub>B</sub> 0.625% variation 01 <sub>B</sub> 1.25% variation 10 <sub>B</sub> 2.5% variation 11 <sub>B</sub> <b>RESERVED:</b> Do not use. Currently maps to 2.5% variation

(table continues...)

**18 Registers description**

(continued)

Field	Bits	Type	Description
FRE_SP_AMPL ITUDE	13:10	rw	<p><b>Defines the maximum width of the triangular ramp with respect to the center value</b></p> <p>0<sub>H</sub> 12 frequency steps            1<sub>H</sub> 1 frequency step            2<sub>H</sub> 2 frequency steps            3<sub>H</sub> 3 frequency steps            4<sub>H</sub> 4 frequency steps            5<sub>H</sub> 5 frequency steps            6<sub>H</sub> 6 frequency steps            7<sub>H</sub> 7 frequency steps            8<sub>H</sub> 8 frequency steps            9<sub>H</sub> 9 frequency steps            A<sub>H</sub> 10 frequency steps            B<sub>H</sub> 11 frequency steps            C<sub>H</sub> 12 frequency steps            D<sub>H</sub> 13 frequency steps            E<sub>H</sub> 14 frequency steps            F<sub>H</sub> 15 frequency steps</p>

**Table 86**      **Reset values of [FREQ\\_SPREAD](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.32 ABIST control 0 \*R2)**

**ABIST\_CTRL0**

ABIST control 0 \*R2)

Offset address: 018<sub>H</sub>

Reset values see: [Table 87](#)

15	14	13	12	11	10	9	8
<b>Res</b>							<b>ALL</b>
r							rwh
7	6	5	4	3	2	1	0
<b>STATUS</b>			<b>INT</b>	<b>SINGLE</b>	<b>PATH</b>	<b>START</b>	
r			rw	rw	rwh	rwh	

Field	Bits	Type	Description
START	0	rwh	<b>Start ABIST operation, the operation itself will be started. This bit is cleared after ABIST operation has been performed</b> 0 <sub>B</sub> Operation done or not started 1 <sub>B</sub> Start operation
PATH	1	rwh	<b>Select the path which should be covered by ABIST operation</b> 0 <sub>B</sub> Comparator only 1 <sub>B</sub> Comparator and correspondig deglitching logic
SINGLE	2	rw	<b>Select whether a single comparator shall be tested or all comparators in predefined sequence</b> 0 <sub>B</sub> Predefined sequence 1 <sub>B</sub> Single comparator test
INT	3	rw	<b>Selection for safe state related comparators or interrupt related comparators</b> 0 <sub>B</sub> Safe state related comparators 1 <sub>B</sub> Interrupt related comparators
STATUS	7:4	r	<b>ABIST global status information after requested operation has been performed, information shall only be considered valid, once START bit is cleared</b> 5 <sub>H</sub> Selected ABIST operation performed without errors A <sub>H</sub> Selected ABIST operation performed with errors, check respective ABIST_SELECTx registers
ALL	8	rwh	<b>When set to '1' all comparators are automatically selected.</b> 0 <sub>B</sub> Comparators executed as selected in ABIST_CTRL0 and ABIST_SELECT0/1/2 1 <sub>B</sub> All comparators are tested with PATH = 0 and SINGLE = 0

**Table 87 Reset values of ABIST\_CTRL0**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

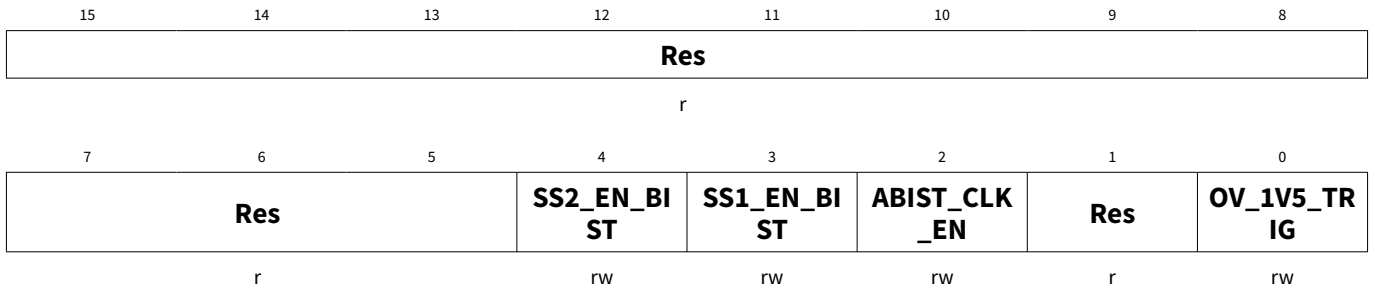
**18.33 ABIST control 1 \*R2)**

**ABIST\_CTRL1**

ABIST control 1 \*R2)

Offset address: 019<sub>H</sub>

Reset values see: [Table 88](#)



Field	Bits	Type	Description
OV_1V5_TRIG	0	rw	<b>Enable overvoltage trigger for protected 1.5 V comparator for analog safe state control</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
ABIST_CLK_EN	2	rw	<b>Select ABIST clock to generate local 2 MHz clock</b> 0 <sub>B</sub> Disable 1 <sub>B</sub> Enable
SS1_EN_BIST	3	rw	<b>Enables ABIST for SSO1. Requires ABIST_CTRL1.ABIST_CLK_EN=1 and ABIST_CTRL1.OV_1V5_TRIG=1</b> 0 <sub>B</sub> Disable 1 <sub>B</sub> Enable
SS2_EN_BIST	4	rw	<b>Enables ABIST for SSO2. Requires ABIST_CTRL1.ABIST_CLK_EN=1 and ABIST_CTRL1.OV_1V5_TRIG=1</b> 0 <sub>B</sub> Disable 1 <sub>B</sub> Enable

**Table 88** Reset values of **ABIST\_CTRL1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.34 ABIST select 0 \*R2)**

**ABIST\_SELECT0**

ABIST select 0 \*R2)

Offset address: 01A<sub>H</sub>

Reset values see: [Table 89](#)

15	14	13	12	11	10	9	8
<b>R3FBL_OPEN</b>	<b>BUCKIF_SEVOV</b>	<b>BUCKCORE_SEVOV</b>	<b>PREREG_SEVOV</b>	<b>VDD2V5OV</b>	<b>IVCCOV</b>	<b>VMON2OV</b>	<b>VMON1OV</b>
rwh	rwh	rwh	rwh	rwh	rwh	rwh	rwh
7	6	5	4	3	2	1	0
<b>BOOSTOV</b>	<b>BUCKIFOV</b>	<b>QVROV</b>	<b>QCOOV</b>	<b>BUCKCOREOV</b>	<b>QSTOV</b>	<b>QUCOV</b>	<b>PREREGOV</b>
rwh	rwh	rwh	rwh	rwh	rwh	rwh	rwh

Field	Bits	Type	Description
PREREGOV	0	rwh	<b>Select Pre-regulator OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QUCOV	1	rwh	<b>Select uC LDO OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QSTOV	2	rwh	<b>Select Standby LDO OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BUCKCOREOV	3	rwh	<b>Select Core voltage OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QCOOV	4	rwh	<b>Select COM OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QVROV	5	rwh	<b>Select VREF OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BUCKIFOV	6	rwh	<b>Buck_int OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BOOSTOV	7	rwh	<b>BOOST OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VMON1OV	8	rwh	<b>VMON1 OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VMON2OV	9	rwh	<b>VMON2 OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
IVCCOV	10	rwh	<b>IVCCOV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VDD2V5OV	11	rwh	<b>VDD2V5 OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
PREREG_SEVO V	12	rwh	<b>Select Pre-regulator Severe OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BUCKCORE_SE VOV	13	rwh	<b>Select BUCKCORE Severe OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BUCKIF_SEVO V	14	rwh	<b>Select BUCKINT Severe OV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
R3FBL_OPEN	15	rwh	<b>Select R3FBL comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator

**Table 89**      **Reset values of [ABIST\\_SELECT0](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.35 ABIST select 1 \*R2)**

**ABIST\_SELECT1**  
 ABIST select 1 \*R2)

Offset address: 01B<sub>H</sub>  
 Reset values see: [Table 90](#)

15	14	13	12	11	10	9	8
<b>Res</b>	<b>BST_DEEP_UV</b>		<b>BSTIUV</b>	<b>VDD2V5UV</b>	<b>IVCCUV</b>	<b>VMON2UV</b>	<b>VMON1UV</b>
r	rwh		rwh	rwh	rwh	rwh	rwh
7	6	5	4	3	2	1	0
<b>BOOSTUV</b>	<b>BUCKINTUV</b>	<b>QVRUV</b>	<b>QCOUV</b>	<b>BUCKCORE UV</b>	<b>QSTUV</b>	<b>QUCUV</b>	<b>PREREGUV</b>
rwh	rwh	rwh	rwh	rwh	rwh	rwh	rwh

Field	Bits	Type	Description
PREREGUV	0	rwh	<b>Select pre regulator UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QUCUV	1	rwh	<b>Select uC UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QSTUV	2	rwh	<b>Select STBY UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BUCKCOREUV	3	rwh	<b>Select VCORE UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QCOUV	4	rwh	<b>Select COM UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
QVRUV	5	rwh	<b>Select VREF UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BUCKINTUV	6	rwh	<b>Select Buck_int UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BOOSTUV	7	rwh	<b>Select Boost UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VMON1UV	8	rwh	<b>Select VMON1 UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VMON2UV	9	rwh	<b>Select VMON2 UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
IVCCUV	10	rwh	<b>Select IVCC UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VDD2V5UV	11	rwh	<b>Select VDD2V5 UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BSTIUV	12	rwh	<b>BSTI UV comparator for ABIST operation</b> 0 <sub>B</sub> No error detected 1 <sub>B</sub> Error detected (during internal checks)
BST_DEEP_UV	13	rwh	<b>Select BST_DEEP_UV comparator for ABIST operation</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator

**Table 90**      **Reset values of [ABIST\\_SELECT1](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.36 ABIST select 2 \*R2)**

**ABIST\_SELECT2**  
 ABIST select 2 \*R2)

Offset address: 01C<sub>H</sub>  
 Reset values see: [Table 91](#)

15	14	13	12	11	10	9	8
<b>Res</b>							<b>VDD5V0OV</b>
r							rwh
7	6	5	4	3	2	1	0
<b>VDD5V0UV</b>	<b>VDD1V5OV</b>	<b>VDD1V5UV</b>	<b>BIASHI</b>	<b>BIASLOW</b>	<b>BG12OV</b>	<b>BG12UV</b>	<b>VBATOV</b>
rwh	rwh	rwh	rwh	rwh	rwh	rwh	rwh

Field	Bits	Type	Description
VBATOV	0	rwh	<b>Supply voltage VS1/2 is too high</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BG12UV	1	rwh	<b>Bandgap comparator UV condition</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BG12OV	2	rwh	<b>Bandgap comparator OV condition</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BIASLOW	3	rwh	<b>Bias current too low</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
BIASHI	4	rwh	<b>Bias current too high</b> 0 <sub>B</sub> Not selected 1 <sub>B</sub> Selected; Bit will be cleared upon successful ABIST operation on comparator, bit will be set in case of ABIST fail for this comparator
VDD1V5UV	5	rwh	<b>Select internal 1.5 V domain undervoltage comparator</b> 0 <sub>B</sub> Comparator test not selected 1 <sub>B</sub> Comparator test selected
VDD1V5OV	6	rwh	<b>Select internal 1.5 V domain overvoltage comparator</b> 0 <sub>B</sub> Comparator test not selected 1 <sub>B</sub> Comparator test selected
VDD5V0UV	7	rwh	<b>Select internal 2.5 V domain undervoltage comparator</b> 0 <sub>B</sub> Comparator test not selected 1 <sub>B</sub> Comparator test selected

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
VDD5V0OV	8	rwh	<b>Select internal 2.5 V domain overvoltage comparator</b> 0 <sub>B</sub> Comparator test not selected 1 <sub>B</sub> Comparator test selected

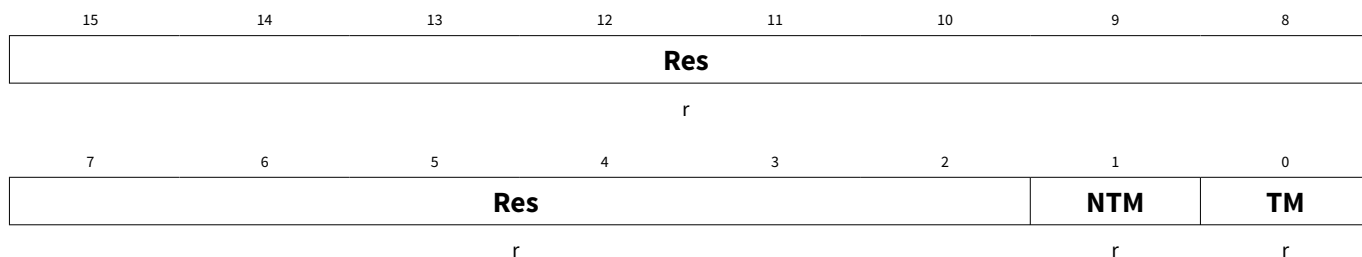
**Table 91**      **Reset values of [ABIST\\_SELECT2](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.37 Global testmode \*R2)**

**GTM** Offset address: 01D<sub>H</sub>  
 Global testmode \*R2) Reset values see: [Table 92](#)



Field	Bits	Type	Description
TM	0	r	<b>Test mode status</b> 0 <sub>B</sub> Device is in normal mode 1 <sub>B</sub> Device is in test mode
NTM	1	r	<b>Test mode status inverted</b> 0 <sub>B</sub> Device is in test mode 1 <sub>B</sub> Device is in normal mode

**Table 92 Reset values of GTM**

Reset	Reset value	Note
	0002 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.38 Reduced operation reflected status configuration 1 register - \*R2)**

**REDOP\_RS\_CFG1**

Reduced operation reflected status configuration 1 register - \*R2)

Offset address: 01E<sub>H</sub>

Reset values see: [Table 93](#)

15	14	13	12	11	10	9	8
<b>Res</b>	<b>SSO1TOSSO2_DEL</b>			<b>Res</b>	<b>INT2_DIS</b>	<b>INT1_DIS</b>	
r	r			r	r	r	
7	6	5	4	3	2	1	0
<b>SSO2_DEL</b>			<b>SSO1_DEL</b>			<b>Res</b>	<b>EN</b>
r			r			r	r

Field	Bits	Type	Description
EN	0	r	<b>Enable reduced operation - *R3)</b> 0 <sub>B</sub> Disable 1 <sub>B</sub> Enable
SSO1_DEL	4:2	r	<b>Safe state output 1 delay (tSSO1_red) - only active if REDUCED OPERATION is enabled</b> 000 <sub>B</sub> 0 ms 001 <sub>B</sub> 10 ms 010 <sub>B</sub> 50 ms 011 <sub>B</sub> 100 ms 100 <sub>B</sub> 250 ms 101 <sub>B</sub> Do not use. Maps to 0 ms ... 111 <sub>B</sub> Do not use. Maps to 0 ms
SSO2_DEL	7:5	r	<b>Safe state output 2 delay (tSSO2_red) - only active if REDUCED OPERATION is enabled</b> 000 <sub>B</sub> 0 ms 001 <sub>B</sub> 10 ms 010 <sub>B</sub> 50 ms 011 <sub>B</sub> 100 ms 100 <sub>B</sub> 250 ms 101 <sub>B</sub> Do not use. Maps to 0 ms ... 111 <sub>B</sub> Do not use. Maps to 0 ms
INT1_DIS	8	r	<b>Disable generation of INT1 due to Cluster 2 entering REDUCED OPERATION</b> 0 <sub>B</sub> Allow generation of INT1 when application 2 enters REDUCED OPERATION 1 <sub>B</sub> Disable generation of INT1 related to application 2 entering REDUCED OPERATION

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
INT2_DIS	9	r	<p><b>Disable generation of INT2 due to Cluster 1 entering REDUCED OPERATION</b></p> <p>0<sub>B</sub> Allow generation of INT2 when application 1 enters REDUCED OPERATION</p> <p>1<sub>B</sub> Disable generation of INT2 related to application 1 entering REDUCED OPERATION</p>
SSO1TOSSO2_DEL	14:12	r	<p><b>Safe state output 2 delay to Safe state output 1 (tSSO2) when REDUCED OPERATION is disabled</b></p> <p>000<sub>B</sub> 0 ms</p> <p>001<sub>B</sub> 10 ms</p> <p>010<sub>B</sub> 50 ms</p> <p>011<sub>B</sub> 100 ms</p> <p>100<sub>B</sub> 250 ms</p> <p>101<sub>B</sub> Do not use. Maps to 0 ms</p> <p>...</p> <p>111<sub>B</sub> Do not use. Maps to 0 ms</p>

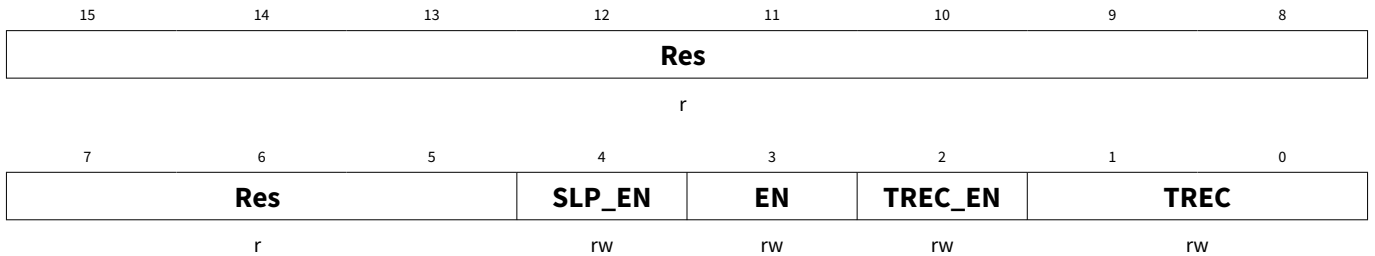
**Table 93** Reset values of **REDOP\_RS\_CFG1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.39      ERR0 protection write configuration register \*R2)**

**ERR0\_PW\_CFG**      Offset address:      01F<sub>H</sub>  
 ERR0 protection write configuration register \*R2)      Reset values see:      [Table 94](#)



Field	Bits	Type	Description
TREC	1:0	rw	<b>ERR0 pin monitor recovery time</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2.5 ms 10 <sub>B</sub> 5 ms 11 <sub>B</sub> 10 ms
TREC_EN	2	rw	<b>Enabling of recovery time functionality for ERR0 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
EN	3	rw	<b>Enable ERR0 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SLP_EN	4	rw	<b>Enabling of ERR0 pin monitor functionality while the system is in SLEEP state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

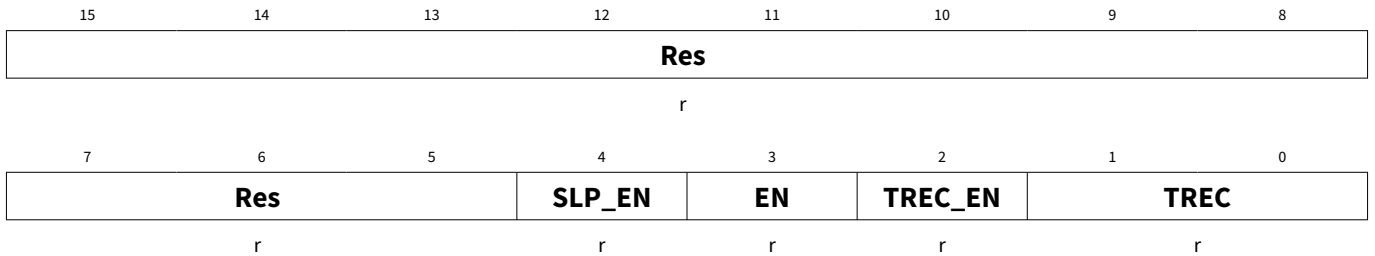
**Table 94      Reset values of [ERR0\\_PW\\_CFG](#)**

Reset	Reset value	Note
	0008 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.40 ERR0 reflected status configuration register \*R3)**

**ERR0\_RS\_CFG** Offset address: 020<sub>H</sub>  
 ERR0 reflected status configuration register \*R3) Reset values see: [Table 95](#)



Field	Bits	Type	Description
TREC	1:0	r	<b>ERR0 pin monitor recovery time</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2.5 ms 10 <sub>B</sub> 5 ms 11 <sub>B</sub> 10 ms
TREC_EN	2	r	<b>Enabling of recovery time functionality for ERR0 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
EN	3	r	<b>Enable ERR0 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SLP_EN	4	r	<b>Enabling of ERR0 pin monitor functionality while the system is in SLEEP state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

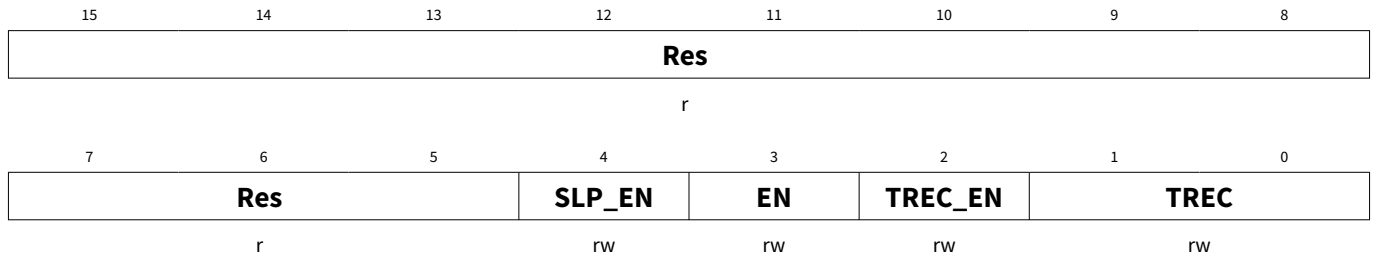
**Table 95** Reset values of **ERR0\_RS\_CFG**

Reset	Reset value	Note
	0008 <sub>H</sub>	Reset class R3) C1

**18 Registers description**

**18.41 ERR1 protection write configuration register \*R2)**

**ERR1\_PW\_CFG** Offset address: 021<sub>H</sub>  
 ERR1 protection write configuration register \*R2) Reset values see: [Table 96](#)



Field	Bits	Type	Description
TREC	1:0	rw	<b>ERR1 pin monitor recovery time</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2.5 ms 10 <sub>B</sub> 5 ms 11 <sub>B</sub> 10 ms
TREC_EN	2	rw	<b>Enabling of recovery time functionality for ERR1 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
EN	3	rw	<b>Enable ERR1 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SLP_EN	4	rw	<b>Enabling of ERR1 pin monitor functionality while the system is in SLEEP state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

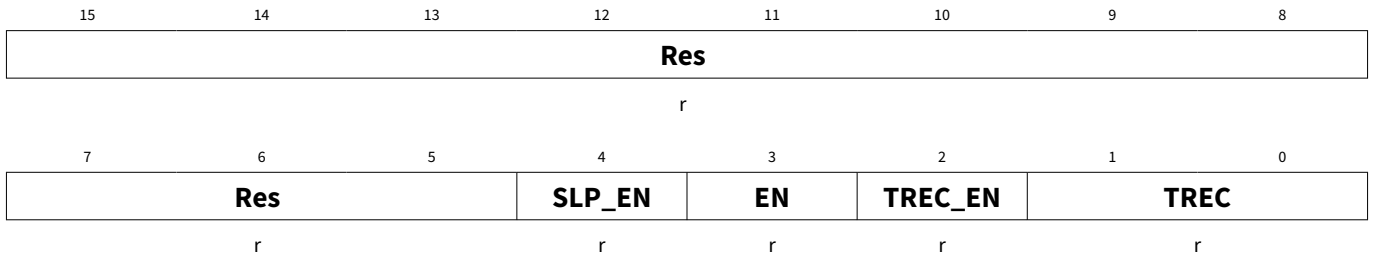
**Table 96** Reset values of [ERR1\\_PW\\_CFG](#)

Reset	Reset value	Note
	0008 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.42 ERR1 reflected status configuration register \*R3\_C1)**

**ERR1\_RS\_CFG** Offset address: 022<sub>H</sub>  
 ERR1 reflected status configuration register \*R3\_C1) Reset values see: [Table 97](#)



Field	Bits	Type	Description
TREC	1:0	r	<b>ERR1 pin monitor recovery time</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2.5 ms 10 <sub>B</sub> 5 ms 11 <sub>B</sub> 10 ms
TREC_EN	2	r	<b>Enabling of recovery time functionality for ERR1 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
EN	3	r	<b>Enable ERR1 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SLP_EN	4	r	<b>Enabling of ERR1 pin monitor functionality while the system is in SLEEP state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

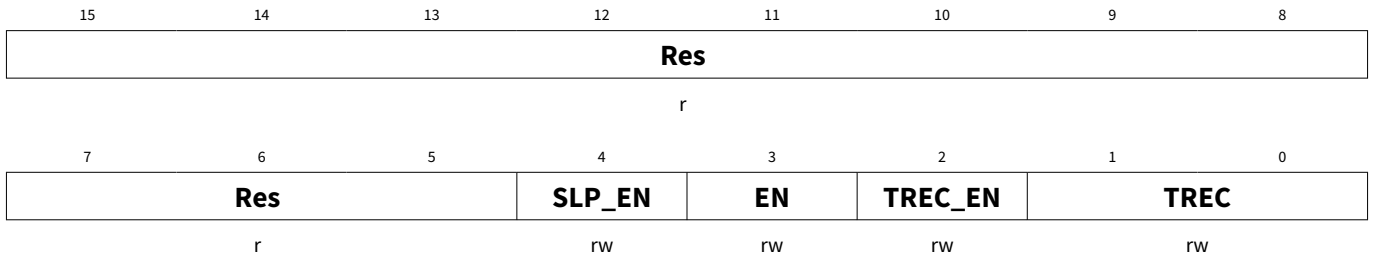
**Table 97** Reset values of **ERR1\_RS\_CFG**

Reset	Reset value	Note
	0008 <sub>H</sub>	Reset class R3) C1

**18 Registers description**

**18.43 ERR2 protection write configuration register \*R2)**

**ERR2\_PW\_CFG** Offset address: 023<sub>H</sub>  
 ERR2 protection write configuration register \*R2) Reset values see: [Table 98](#)



Field	Bits	Type	Description
TREC	1:0	rw	<b>ERR2 pin monitor recovery time</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2.5 ms 10 <sub>B</sub> 5 ms 11 <sub>B</sub> 10 ms
TREC_EN	2	rw	<b>Enabling of recovery time functionality for ERR2 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
EN	3	rw	<b>Enable ERR2 pin monitor</b> This bit has only an effect if REDOP_RS_CFG1.EN is 1 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SLP_EN	4	rw	<b>Enabling of ERR2 pin monitor functionality while the system is in SLEEP state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

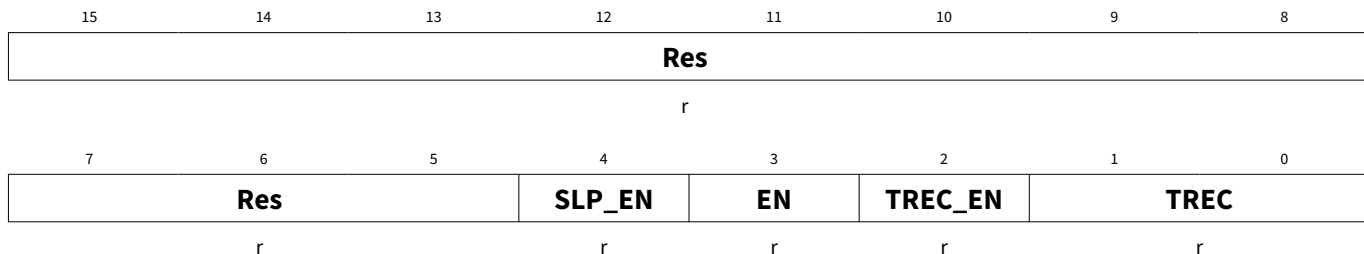
**Table 98 Reset values of ERR2\_PW\_CFG**

Reset	Reset value	Note
	0008 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.44 ERR2 reflected status configuration register \*R3\_C2)**

**ERR2\_RS\_CFG** Offset address: 024<sub>H</sub>  
 ERR2 reflected status configuration register \*R3\_C2) Reset values see: [Table 99](#)



Field	Bits	Type	Description
TREC	1:0	r	<b>ERR2 pin monitor recovery time</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2.5 ms 10 <sub>B</sub> 5 ms 11 <sub>B</sub> 10 ms
TREC_EN	2	r	<b>Enabling of recovery time functionality for ERR2 pin monitor</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
EN	3	r	<b>Enable ERR2 pin monitor</b> This bit has only an effect if REDOP_RS_CFG1.EN is 1 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SLP_EN	4	r	<b>Enabling of ERR2 pin monitor functionality while the system is in SLEEP state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**Table 99 Reset values of [ERR2\\_RS\\_CFG](#)**

Reset	Reset value	Note
	0008 <sub>H</sub>	Reset class R3) C2

**18 Registers description**

**18.45 Device configuration 1 register \*R0)**

**DEV\_CFG1**

Device configuration 1 register \*R0)

Offset address: 025<sub>H</sub>

value: 0206<sub>H</sub>

15	14	13	12	11	10	9	8
<b>Res</b>						<b>ABIST_EN</b>	<b>Res</b>
r						rw	r
7	6	5	4	3	2	1	0
<b>HWCFG_STAT</b>				<b>MPS_EN</b>	<b>RESET_DEL</b>		
r				rwh	rwh		

Field	Bits	Type	Description
RESET_DEL	2:0	rwh	<b>Reset delay time (tRD); Starts upon QST, QUC and BUCKCORE are above their UV thresholds.</b> 000 <sub>B</sub> 200 μs 001 <sub>B</sub> 400 μs 010 <sub>B</sub> 800 μs 011 <sub>B</sub> 1 ms 100 <sub>B</sub> 2 ms 101 <sub>B</sub> 4 ms 110 <sub>B</sub> 10 ms 111 <sub>B</sub> 20 ms
MPS_EN	3	rwh	<b>Microcontroller programming support enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
HWCFG_STAT	7:4	r	<b>This bit reflects the status of the hardware configuration pin</b> 0 <sub>H</sub> 1 kOhm 1 <sub>H</sub> 2.2 kOhm 2 <sub>H</sub> 3.3 kOhm 3 <sub>H</sub> 4.7 kOhm 4 <sub>H</sub> 6.8 kOhm 5 <sub>H</sub> 10 kOhm 6 <sub>H</sub> 15 kOhm 7 <sub>H</sub> Reserved value 8 <sub>H</sub> Reserved value 9 <sub>H</sub> 22 kOhm A <sub>H</sub> 33 kOhm B <sub>H</sub> 47 kOhm C <sub>H</sub> 68 kOhm D <sub>H</sub> 100 kOhm E <sub>H</sub> 150 kOhm F <sub>H</sub> 200 kOhm

(table continues...)

**18 Registers description**

(continued)

Field	Bits	Type	Description
ABIST_EN	9	rw	<b>Autostart of analog built in self test for voltage monitoring when waking up from FAILSAFE, STANDBY and POWERDOWN.</b> 0 <sub>B</sub> ABIST only executed when waking up from STANDBY (if WUT and QST are both OFF) or from POWERDOWN 1 <sub>B</sub> ABIST executed when waking up from STANDBY or from POWERDOWN or from FAILSAFE

**18 Registers description**

**18.46 Device protected write configuration 2 register \*R0)**

**DEV\_PW\_CFG2** Offset address: 026<sub>H</sub>  
 Device protected write configuration 2 register \*R0) value: F001<sub>H</sub>

15	14	13	12	11	10	9	8
<b>VMON2_STG_TIME</b>		<b>VMON1_STG_TIME</b>		<b>Res</b>			
rw		rw		r			
7	6	5	4	3	2	1	0
<b>Res</b>				<b>QST_MODE</b>	<b>SSW_OC_TH</b>		<b>QST_EN</b>
r				rw	rw		rw

Field	Bits	Type	Description
QST_EN	0	rw	<b>Activation of standby LDO</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SSW_OC_TH	2:1	rw	<b>Safety switch overcurrent detection threshold.</b> 00 <sub>B</sub> 0.755 V 01 <sub>B</sub> 0.944 V 10 <sub>B</sub> 1.04 V 11 <sub>B</sub> 1.22 V
QST_MODE	3	rw	<b>Selects between 2 different modes of controlling standby LDO via QSTEN</b> 0 <sub>B</sub> <b>PMIC_MODE:</b> QST is selectable only when the device is moving to STANDBY. QST is on in all other states, independently of QST_EN. 1 <sub>B</sub> <b>USER_MODE:</b> QST supply on or off, can be configured by QST_EN
VMON1_STG_TIME	13:12	rw	<b>Filter time to detect a short-to-ground on external voltage monitor channel 1</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2 ms 10 <sub>B</sub> 4 ms 11 <sub>B</sub> 6 ms
VMON2_STG_TIME	15:14	rw	<b>Filter time to detect a short-to-ground on external voltage monitor channel 2</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2 ms 10 <sub>B</sub> 4 ms 11 <sub>B</sub> 6 ms

**18 Registers description**

**18.47 Device reflected status configuration 2 register \*R0)**

**DEV\_RS\_CFG2** Offset address: 027<sub>H</sub>  
 Device reflected status configuration 2 register \*R0) value: F001<sub>H</sub>

15	14	13	12	11	10	9	8
<b>VMON2_STG_TIME</b>		<b>VMON1_STG_TIME</b>		<b>Res</b>			
r		r		r			
7	6	5	4	3	2	1	0
<b>Res</b>				<b>QST_MODE</b>	<b>SSW_OC_TH</b>		<b>QST_EN</b>
r				r	r		r

Field	Bits	Type	Description
QST_EN	0	r	<b>Activation of standby LDO</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SSW_OC_TH	2:1	r	<b>Safety switch overcurrent detection threshold.</b> 00 <sub>B</sub> 0.755 V 01 <sub>B</sub> 0.944 V 10 <sub>B</sub> 1.04 V 11 <sub>B</sub> 1.22 V
QST_MODE	3	r	<b>Selects between 2 different modes of controlling standby LDO via QSTEN</b> 0 <sub>B</sub> <b>PMIC_MODE:</b> QST is selectable only when the device is moving to STANDBY. QST is on in all other states, independently of QST_EN. 1 <sub>B</sub> <b>USER_MODE:</b> QST supply on or off, can be configured by QST_EN
VMON1_STG_TIME	13:12	r	<b>Time to detect a short-to-ground on external voltage monitor channel 1</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2 ms 10 <sub>B</sub> 4 ms 11 <sub>B</sub> 6 ms
VMON2_STG_TIME	15:14	r	<b>Time to detect a short-to-ground on external voltage monitor channel 2</b> 00 <sub>B</sub> 1 ms 01 <sub>B</sub> 2 ms 10 <sub>B</sub> 4 ms 11 <sub>B</sub> 6 ms

**18 Registers description**

**18.48 System failure status register for application 1 \*R1)**

**SYSFAIL\_STAT\_APP1**

System failure status register for application 1 \*R1)

Offset address: 029<sub>H</sub>

Reset values see: [Table 100](#)

15		14		13		12		11		10		9		8	
<b>Res</b>						<b>ABIST</b>		<b>CFGE</b>		<b>PREREG_C OSW</b>		<b>INTSUP_IV CC</b>			
r						rw1c		rw1c		rw1c		rw1c			
7		6		5		4		3		2		1		0	
<b>QST</b>		<b>ERRO</b>		<b>FSM_INITTIME MER</b>		<b>VMON</b>		<b>OT</b>		<b>BUCK_CORE_VOLTSEL</b>		<b>BUCKIF_VOLTSEL</b>		<b>QST_QUC_VOLTSEL</b>	
rw1c		rw1c		rw1c		rw1c		rw1c		rw1c		rw1c		rw1c	

Field	Bits	Type	Description
QST_QUC_VOLTSEL	0	rw1c	<b>QST and QUC voltage selection error. Nominal voltage of QST and QUC might be corrupt (3.3 V or 5 V).</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
BUCKIF_VOLTSEL	1	rw1c	<b>BUCK IF voltage selection error. Nominal voltage of BUCKIF might be corrupt (1.8 V or 3.3 V).</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
BUCK_CORE_VOLTSEL	2	rw1c	<b>BUCK CORE voltage selection error. Nominal voltage of BUCKCORE might be corrupt.</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
OT	3	rw1c	<b>Over temperature failure. (see chapter: Collection registers)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON	4	rw1c	<b>Voltage monitor failure (see chapter: Collection registers)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
FSM_INITTIME R	5	rw1c	<b>Init timer failure due to the third INIT failure in row. The device moved to FAILSAFE state.</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
ERRO	6	rw1c	<b>ERRO failure</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QST	7	rw1c	<b>Standby LDO (QST) failure; Also set if BIST of QST returned an error</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

(table continues...)

**18 Registers description**

(continued)

Field	Bits	Type	Description
INTSUP_IVCC	8	rw1c	<b>Internal supply IVCC failure; Also set if BIST of QIS returned an error</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PREREG_COS W	9	rw1c	<b>Reports major faults detected during SSW BIST and overcurrent on SSW</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
CFGE	10	rw1c	<b>DED for Cluster1 config registers</b> 0 <sub>B</sub> Write 0 - no action 1 <sub>B</sub> Event detected, write 1 to clear the flag
ABIST	11	rw1c	<b>ABIST operation interrupted by move to INIT or move to FAILSAFE fault</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 100**      **Reset values of [SYSFAIL\\_STAT\\_APP1](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.49 System failure status flags for application 2 \*R1)**

**SYSFAIL\_STAT\_APP2**

System failure status flags for application 2 \*R1)

Offset address: 02A<sub>H</sub>

Reset values see: [Table 101](#)

15		14		13		12		11		10		9		8	
<b>Res</b>						<b>ABIST</b>		<b>CFGE</b>		<b>PREREG_C OSW</b>		<b>INTSUP_IV CC</b>			
r						rw1c		rw1c		rw1c		rw1c			
7		6		5		4		3		2		1		0	
<b>QST</b>		<b>ERRO</b>		<b>FSM_INITTIME MER</b>		<b>VMON</b>		<b>OT</b>		<b>BUCK_CORE_VOLTSEL</b>		<b>BUCKIF_VOLTSEL</b>		<b>QST_QUC_VOLTSEL</b>	
rw1c		rw1c		rw1c		rw1c		rw1c		rw1c		rw1c		rw1c	

Field	Bits	Type	Description
QST_QUC_VOLTSEL	0	rw1c	<b>QST and QUC voltage selection error. Nominal voltage of QST and QUC might be corrupt (3.3 V or 5 V).</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
BUCKIF_VOLTSEL	1	rw1c	<b>BUCK IF voltage selection error. Nominal voltage of BUCKIF might be corrupt (1.8 V or 3.3 V).</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
BUCK_CORE_VOLTSEL	2	rw1c	<b>BUCK CORE voltage selection error. Nominal voltage of BUCKCORE might be corrupt.</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
OT	3	rw1c	<b>Over temperature failure (see chapter: Collection registers)</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
VMON	4	rw1c	<b>Voltage monitor failure (see chapter: Collection registers)</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
FSM_INITTIME R	5	rw1c	<b>Init timer failure due to the third INIT failure in row. The device moved to FAILSAFE state.</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
ERRO	6	rw1c	<b>ERRO failure</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
QST	7	rw1c	<b>Standby LDO (QST) failure</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred

(table continues...)

**18 Registers description**

(continued)

Field	Bits	Type	Description
INTSUP_IVCC	8	rw1c	<b>Internal supply IVCC failure</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
PREREG_COS W	9	rw1c	<b>Reports severe faults detected during SSW BIST</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred
CFGE	10	rw1c	<b>DED for Cluster 2 config registers</b> 0 <sub>B</sub> Write 0 - no action 1 <sub>B</sub> Event detected, write 1 to clear the flag
ABIST	11	rw1c	<b>ABIST operation interrupted by move to INIT or move to FAILSAFE fault</b> 0 <sub>B</sub> No occurrence 1 <sub>B</sub> Fault occurred

**Table 101**      **Reset values of [SYSFAIL\\_STAT\\_APP2](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.50 Short to ground status register for application 1 \*R1)**

**STG\_STAT\_APP1**

Offset address: 02B<sub>H</sub>

Short to ground status register for application 1 \*R1)

Reset values see: [Table 102](#)

15	14	13	12	11	10	9	8
<b>Res</b>						<b>VMON2</b>	<b>VMON1</b>
r						rw1c	rw1c
7	6	5	4	3	2	1	0
<b>BOOST</b>	<b>BUCKIF</b>	<b>QVR</b>	<b>QCO</b>	<b>BUCKCORE</b>	<b>QST</b>	<b>QUC</b>	<b>PREREG</b>
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
PREREG	0	rw1c	<b>Pre-regulator voltage short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QUC	1	rw1c	<b>MCU LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QST	2	rw1c	<b>Standby LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE	3	rw1c	<b>Buckcore voltage short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QCO	4	rw1c	<b>Communication LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QVR	5	rw1c	<b>Reference LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKIF	6	rw1c	<b>Buck interface short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BOOST	7	rw1c	<b>Boost short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Event detected
VMON1	8	rw1c	<b>VMON1 short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON2	9	rw1c	<b>VMON2 short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**18 Registers description**

**Table 102**      **Reset values of [STG\\_STAT\\_APP1](#)**

<b>Reset</b>	<b>Reset value</b>	<b>Note</b>
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.51 Short to ground status register for application 2 \*R1)**

**STG\_STAT\_APP2**

Offset address: 02C<sub>H</sub>

Short to ground status register for application 2 \*R1)

Reset values see: [Table 103](#)

Res								VMON2	VMON1
r								rw1c	rw1c
7	6	5	4	3	2	1	0		
<b>BOOST</b>	<b>BUCKIF</b>	<b>QVR</b>	<b>QCO</b>	<b>BUCKCORE</b>	<b>QST</b>	<b>QUC</b>	<b>PREREG</b>		
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c		

Field	Bits	Type	Description
PREREG	0	rw1c	<b>Pre-regulator voltage short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QUC	1	rw1c	<b>MCU LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QST	2	rw1c	<b>Standby LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE	3	rw1c	<b>Buckcore voltage short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QCO	4	rw1c	<b>Communication LDO short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QVR	5	rw1c	<b>Voltage reference short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKIF	6	rw1c	<b>Buckint short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BOOST	7	rw1c	<b>Boost short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON1	8	rw1c	<b>VMON1 short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON2	9	rw1c	<b>VMON2 short to ground status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**18 Registers description**

**Table 103**      **Reset values of [STG\\_STAT\\_APP2](#)**

<b>Reset</b>	<b>Reset value</b>	<b>Note</b>
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.52 Overvoltage status register for application 1 \*R1)**

**OV\_STAT\_APP1**

Offset address: 02D<sub>H</sub>

Overvoltage status register for application 1 \*R1)

Reset values see: [Table 104](#)

15	14	13	12	11	10	9	8
<b>Res</b>			<b>BUCKCORE _FB_OPEN</b>	<b>INTSUP_VD D2V5</b>	<b>INTSUP_IV CC</b>	<b>BUCKIF</b>	<b>PREREG</b>
r			rw1c	rw1c	rw1c	rw1c	rw1c
7	6	5	4	3	2	1	0
<b>VMON2</b>	<b>VMON1</b>	<b>BOOST</b>	<b>QVR</b>	<b>QCO</b>	<b>BUCKCORE</b>	<b>QST</b>	<b>QUC</b>
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
QUC	0	rw1c	<b>QUC over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QST	1	rw1c	<b>Standby LDO QST over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE	2	rw1c	<b>BUCKCORE over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QCO	3	rw1c	<b>QCO over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QVR	4	rw1c	<b>QVR over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BOOST	5	rw1c	<b>BOOST over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON1	6	rw1c	<b>External volatage monitor channel 1 over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON2	7	rw1c	<b>External volatage monitor channel 2 over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PREREG	8	rw1c	<b>Pre-regulator over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BUCKIF	9	rw1c	<b>Buck interface over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
INTSUP_IVCC	10	rw1c	<b>Internal supply IVCC LDO over voltage status flag (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
INTSUP_VDD2 V5	11	rw1c	<b>Internal supply VDD 2V5 LDO over voltage status flag (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE_F B_OPEN	12	rw1c	<b>BUCKCORE feedback open status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 104**      **Reset values of [OV\\_STAT\\_APP1](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.53 Overvoltage status register for application 2 \*R1)**

**OV\_STAT\_APP2**

Offset address: 02E<sub>H</sub>

Overvoltage status register for application 2 \*R1)

Reset values see: [Table 105](#)

15	14	13	12	11	10	9	8
<b>Res</b>			<b>BUCKCORE _GND_OPE N</b>	<b>VDD2V5OV</b>	<b>INTSUP_IV CC</b>	<b>BUCKIF</b>	<b>PREREG</b>
r			rw1c	rw1c	rw1c	rw1c	rw1c
7	6	5	4	3	2	1	0
<b>VMON2</b>	<b>VMON1</b>	<b>BOOST</b>	<b>QVR</b>	<b>QCO</b>	<b>BUCKCORE</b>	<b>QST</b>	<b>QUC</b>
rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
QUC	0	rw1c	<b>MCU LDO over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QST	1	rw1c	<b>Standby LDO QST over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE	2	rw1c	<b>BUCKCORE over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QCO	3	rw1c	<b>QCO over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QVR	4	rw1c	<b>QVR over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BOOST	5	rw1c	<b>BOOST over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON1	6	rw1c	<b>External volatage monitor channel 1 over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VMON2	7	rw1c	<b>External volatage monitor channel 2 over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PREREG	8	rw1c	<b>Pre-regulator over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
BUCKIF	9	rw1c	<b>BUCKIF over voltage status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
INTSUP_IVCC	10	rw1c	<b>Internal supply IVCC LDO over voltage status flag (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
VDD2V5OV	11	rw1c	<b>Internal supply VDD 2V5 LDO over voltage status flag (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE_G ND_OPEN	12	rw1c	<b>Buckcore ground open status flag</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 105**      **Reset values of [OV\\_STAT\\_APP2](#)**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.54 Internal supply status register for application 1 \*R1)**

**INTSUP\_STAT\_APP1**

Offset address: 02F<sub>H</sub>

Internal supply status register for application 1 \*R1)

Reset values see: [Table 106](#)

15	14	13	12	11	10	9	8
<b>Res</b>							
r							
7	6	5	4	3	2	1	0
<b>Res</b>	<b>PMU_RED</b>	<b>PMU_MAIN</b>	<b>BIAS_HI</b>	<b>BIAS_LOW</b>	<b>BG12_OV</b>	<b>BG12_UV</b>	<b>VBAT_OV</b>
r	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
VBAT_OV	0	rw1c	<b>Battery voltage supply (VS) over voltage</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BG12_UV	1	rw1c	<b>Internal bandgap comparator detected UV condition (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BG12_OV	2	rw1c	<b>Internal bandgap comparator detected OV condition (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BIAS_LOW	3	rw1c	<b>Internal bias current too low (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BIAS_HI	4	rw1c	<b>Internal bias current too high (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PMU_MAIN	5	rw1c	<b>PMU main pass element fail (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PMU_RED	6	rw1c	<b>PMU redundant pass element fail (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 106** Reset values of **INTSUP\_STAT\_APP1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.55 Internal supply status register for application 2 \*R1)**

**INTSUP\_STAT\_APP2**

Offset address: 030<sub>H</sub>

Internal supply status register for application 2 \*R1)

Reset values see: [Table 107](#)

15	14	13	12	11	10	9	8
<b>Res</b>							
r							
7	6	5	4	3	2	1	0
<b>Res</b>	<b>PMU_RED</b>	<b>PMU_MAIN</b>	<b>BIAS_HI</b>	<b>BIAS_LOW</b>	<b>BG12_OV</b>	<b>BG12_UV</b>	<b>VBAT_OV</b>
r	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c	rw1c

Field	Bits	Type	Description
VBAT_OV	0	rw1c	<b>Battery voltage supply (VS) over voltage</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BG12_UV	1	rw1c	<b>Internal bandgap comparator detected UV condition (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BG12_OV	2	rw1c	<b>Internal bandgap comparator detected OV condition (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BIAS_LOW	3	rw1c	<b>Internal bias current too low (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BIAS_HI	4	rw1c	<b>Internal bias current too high (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PMU_MAIN	5	rw1c	<b>PMU main pass element fail (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
PMU_RED	6	rw1c	<b>PMU redundant pass element fail (Internal monitoring)</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 107** Reset values of [INTSUP\\_STAT\\_APP2](#)

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

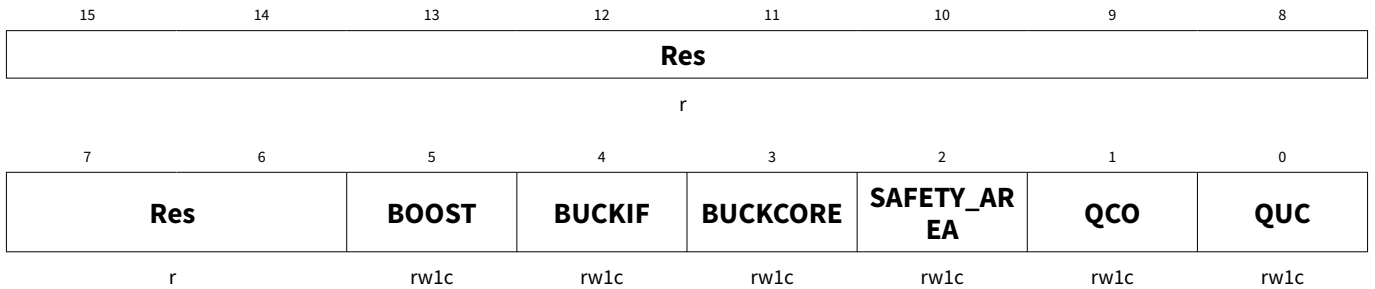
**18.56 Over temperature status register for application 1 \*R1)**

**OT\_STAT\_APP1**

Offset address: 031<sub>H</sub>

Over temperature status register for application 1 \*R1)

Reset values see: [Table 108](#)



Field	Bits	Type	Description
QUC	0	rw1c	<b>QUC over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QCO	1	rw1c	<b>QCO over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
SAFETY_AREA	2	rw1c	<b>Over temperature of Safety area temperature sensor</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE	3	rw1c	<b>Buckcore over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKIF	4	rw1c	<b>BUCKIF over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BOOST	5	rw1c	<b>BOOST over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 108** Reset values of **OT\_STAT\_APP1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

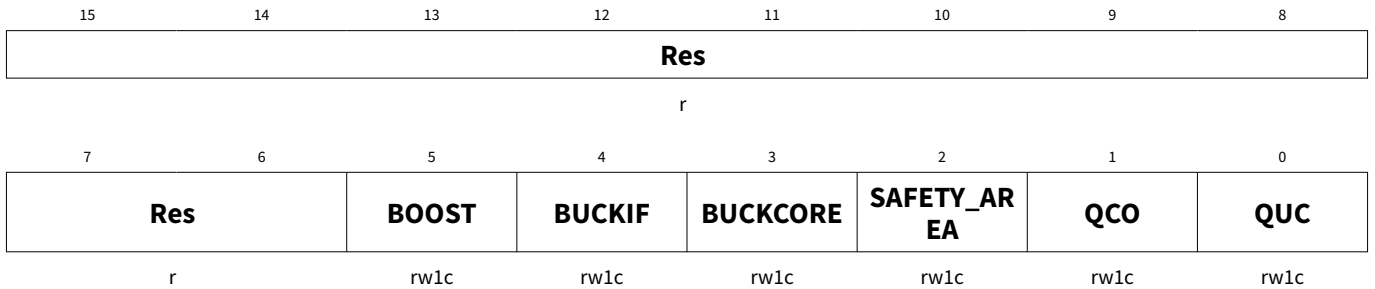
**18.57 Over temperature status register for application 2 \*R1)**

**OT\_STAT\_APP2**

Offset address: 032<sub>H</sub>

Over temperature status register for application 2 \*R1)

Reset values see: [Table 109](#)



Field	Bits	Type	Description
QUC	0	rw1c	<b>QUC over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
QCO	1	rw1c	<b>QCO over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
SAFETY_AREA	2	rw1c	<b>Over temperature of Safety area temperature sensor</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKCORE	3	rw1c	<b>BUCKCORE over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BUCKIF	4	rw1c	<b>BUCKIF over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred
BOOST	5	rw1c	<b>BOOST over temperature</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Fault occurred

**Table 109 Reset values of OT\_STAT\_APP2**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

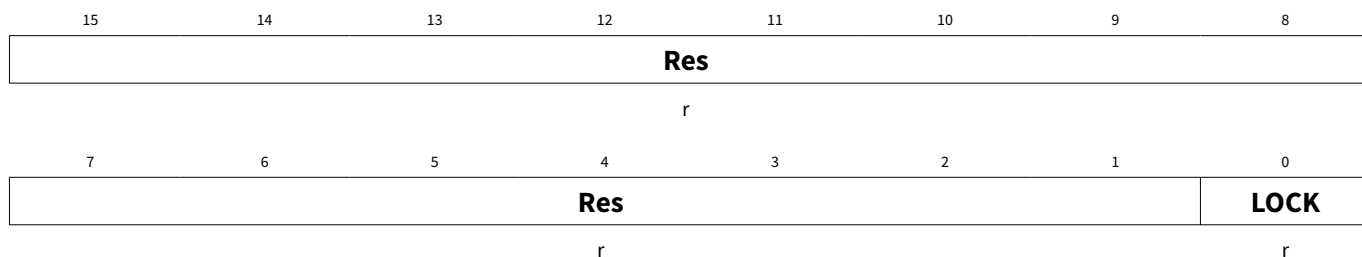
**18.58 Protection status \*R1)**

**PROT\_STAT**

Protection status \*R1)

Offset address: 033<sub>H</sub>

Reset values see: [Table 110](#)



Field	Bits	Type	Description
LOCK	0	r	<b>Protected register password status</b> 0 <sub>B</sub> Registers unlocked 1 <sub>B</sub> Registers locked

**Table 110** Reset values of **PROT\_STAT**

Reset	Reset value	Note
	0001 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.59 Reduced operation protected write configuration 1 register - \*R1)**

This register contains configuration related to the reduce operation mode. All setting will be applied if reduce operation mode is enabled (EN = 1).

**REDOP\_PW\_CFG1**

Reduced operation protected write configuration 1 register - \*R1)

Offset address: 034<sub>H</sub>

Reset values see: [Table 111](#)

15	14	13	12	11	10	9	8
<b>Res</b>	<b>SSO1TOSSO2_DEL</b>			<b>Res</b>	<b>INT2_DIS</b>	<b>INT1_DIS</b>	
r	rw			r	rw	rw	
7	6	5	4	3	2	1	0
<b>SSO2_DEL</b>			<b>SSO1_DEL</b>			<b>Res</b>	<b>EN</b>
rw			rw			r	rw

Field	Bits	Type	Description
EN	0	rw	<b>Enable reduced operation *R2)</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
SSO1_DEL	4:2	rw	<b>Safe state output 1 delay (tSSO1_red)</b> 000 <sub>B</sub> 0 ms 001 <sub>B</sub> 10 ms 010 <sub>B</sub> 50 ms 011 <sub>B</sub> 100 ms 100 <sub>B</sub> 250 ms 101 <sub>B</sub> Do not use. Maps to 0 ms ... 111 <sub>B</sub> Do not use. Maps to 0 ms
SSO2_DEL	7:5	rw	<b>Safe state output 2 delay (tSSO2_red)</b> 000 <sub>B</sub> 0 ms 001 <sub>B</sub> 10 ms 010 <sub>B</sub> 50 ms 011 <sub>B</sub> 100 ms 100 <sub>B</sub> 250 ms 101 <sub>B</sub> Do not use. Maps to 0 ms ... 111 <sub>B</sub> Do not use. Maps to 0 ms
INT1_DIS	8	rw	<b>Disable generation of INT1 due to Cluster 2 entering REDUCED OPERATION</b> 0 <sub>B</sub> Allow generation of INT1 when Cluster 2 enters REDUCED OPERATION 1 <sub>B</sub> Disable generation of INT1 related to Cluster 2 entering REDUCED OPERATION

(table continues...)

**18 Registers description**

(continued)

Field	Bits	Type	Description
INT2_DIS	9	rw	<b>Disable generation of INT2 due to Cluster 1 entering REDUCED OPERATION</b> 0 <sub>B</sub> Allow generation of INT2 when Cluster 1 enters REDUCED OPERATION 1 <sub>B</sub> Disable generation of INT2 related to Cluster 1 entering REDUCED OPERATION
SSO1TOSSO2_DEL	14:12	rw	<b>Safe state output 2 delay to Safe state output 1 (tSSO2) when REDUCED OPERATION is disabled</b> 000 <sub>B</sub> 0 ms 001 <sub>B</sub> 10 ms 010 <sub>B</sub> 50 ms 011 <sub>B</sub> 100 ms 100 <sub>B</sub> 250 ms 101 <sub>B</sub> Do not use. Maps to 0 ms ... 111 <sub>B</sub> Do not use. Maps to 0 ms

**Table 111** Reset values of **REDOP\_PW\_CFG1**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.60 Reduced operation protected write configuration 2 register - \*R1)**

This register contains configuration related to the reduce operation mode. All setting will be applied if reduce operation mode is enabled (EN = 1).

**REDOP\_PW\_CFG2**

Offset address: 035<sub>H</sub>

Reduced operation protected write configuration 2 register - \*R1)

Reset values see: [Table 112](#)

15	14	13	12	11	10	9	8
<b>REDOP_RESOUT_APP2_DUR</b>			<b>REDOP_RESOUT_APP1_DUR</b>			<b>REDOP_RESOUT_APP_TB</b>	<b>Res</b>
rw			rw			rw	r
7	6	5	4	3	2	1	0
<b>Res</b>							
r							

Field	Bits	Type	Description
REDOP_RESOUT_APP_TB	9	rw	<b>Reset timer time base for application reset pulse</b> 0 <sub>B</sub> 10 μs 1 <sub>B</sub> 100 μs
REDOP_RESOUT_APP1_DUR	12:10	rw	<b>Application reset pulse duration for INT1</b> 000 <sub>B</sub> (0 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((0 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1 ... 111 <sub>B</sub> (7 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((7 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1
REDOP_RESOUT_APP2_DUR	15:13	rw	<b>Application reset pulse duration for INT2</b> 000 <sub>B</sub> (0 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((0 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1 ... 111 <sub>B</sub> (7 + 1)*10 μs for REDOP_RESOUT_APP_TB = 0; ((7 + 1)*100 + 50) μs for REDOP_RESOUT_APP_TB = 1

**Table 112 Reset values of REDOP\_PW\_CFG2**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

**18.61 Device protected write configuration 3 register \*R1)**

**DEV\_PW\_CFG3**

Device protected write configuration 3 register \*R1)

Offset address: 036<sub>H</sub>

Reset values see: [Table 113](#)

15	14	13	12	11	10	9	8
<b>Res</b>					<b>VMON2_EN</b>	<b>VMON1_EN</b>	<b>BOOST_EN</b>
r					rw	rw	rw
7	6	5	4	3	2	1	0
<b>BUCKIF_EN</b>	<b>QUCEN</b>	<b>BUCKCORE_EN</b>	<b>QCO_EN</b>	<b>QVR_EN</b>	<b>FSM_STATEREQ</b>		
rw	rw	rw	rw	rw	rw		

Field	Bits	Type	Description
FSM_STATEREQ	2:0	rw	<b>Request for device state transition.</b> 000 <sub>B</sub> NONE 001 <sub>B</sub> INIT 010 <sub>B</sub> NORMAL 011 <sub>B</sub> SLEEP 100 <sub>B</sub> STANDBY 101 <sub>B</sub> WAKE 110 <sub>B</sub> NONE 111 <sub>B</sub> NONE
QVR_EN	3	rw	<b>Enable request for reference voltage.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
QCO_EN	4	rw	<b>Enable request for communication LDO.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BUCKCORE_EN	5	rw	<b>Enable request for BUCKCORE.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
QUCEN	6	rw	<b>Enable request for QUC.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BUCKIF_EN	7	rw	<b>Enable request for Buck interface.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
BOOST_EN	8	rw	<b>Enable request for Boost.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**(table continues...)**

**18 Registers description**

(continued)

Field	Bits	Type	Description
VMON1_EN	9	rw	<b>Enable request for external voltage monitoring channel 1.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
VMON2_EN	10	rw	<b>Enable request for external voltage monitoring channel 2.</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**Table 113**      **Reset values of DEV\_PW\_CFG3**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

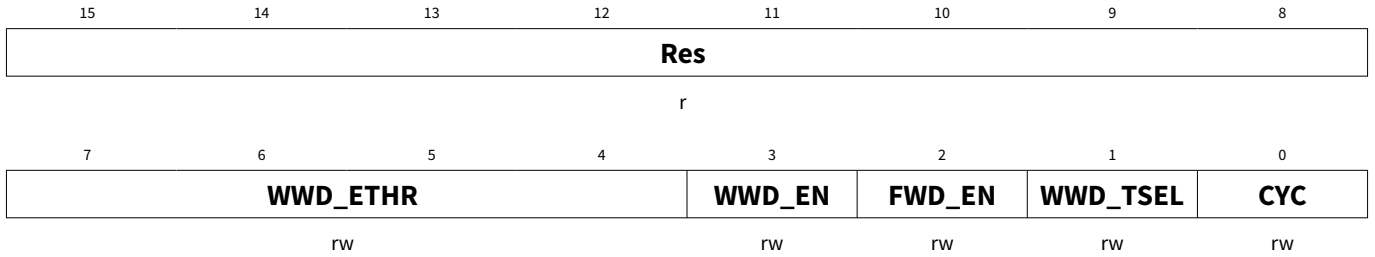
**18.62 Watchdog 1 protected write configuration 0 register \*R2)**

**WD1\_PW\_CFG0**

Offset address: 037<sub>H</sub>

Watchdog 1 protected write configuration 0 register  
 \*R2)

Reset values see: [Table 114](#)



Field	Bits	Type	Description
CYC	0	rw	<b>Watchdog 1 cycle time</b> 0 <sub>B</sub> 0.1 ms tick period 1 <sub>B</sub> 1 ms tick period
WWD_TSEL	1	rw	<b>Window watchdog (WWD1) trigger selection</b> 0 <sub>B</sub> External WDI input used as a WWD trigger 1 <sub>B</sub> WWD is triggered by SPI
FWD_EN	2	rw	<b>Functional watchdog (FWD1) enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_EN	3	rw	<b>Window watchdog (WWD1) enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_ETHR	7:4	rw	<b>Window watchdog error counter threshold.</b>

**Table 114** Reset values of **WD1\_PW\_CFG0**

Reset	Reset value	Note
	009B <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.63 Watchdog 1 reflected status configuration 0 register - \*R3\_C1**

**WD1\_RS\_CFG0**

Offset address: 038<sub>H</sub>

Watchdog 1 reflected status configuration 0 register - \*R3\_C1

Reset values see: [Table 115](#)



Field	Bits	Type	Description
CYC	0	r	<b>Watchdog 1 cycle time</b> 0 <sub>B</sub> 0.1 ms tick period 1 <sub>B</sub> 1 ms tick period
WWD_TSEL	1	r	<b>Window watchdog (WWD1) trigger selection.</b> 0 <sub>B</sub> External WDI input used as a WWD trigger 1 <sub>B</sub> WWD is triggered by SPI
FWD_EN	2	r	<b>Functional watchdog enable (FWD1)</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_EN	3	r	<b>Window watchdog enable (WWD1)</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_ETHR	7:4	r	<b>Window watchdog error threshold.</b>

**Table 115** Reset values of [WD1\\_RS\\_CFG0](#)

Reset	Reset value	Note
	009B <sub>H</sub>	Reset class R3) C1

**18 Registers description**

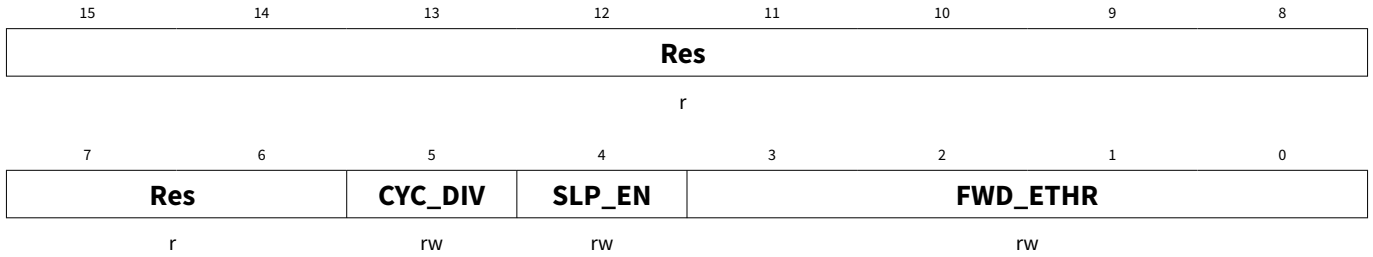
**18.64 Watchdog 1 protected write configuration 1 register \*R2)**

**WD1\_PW\_CFG1**

Offset address: 039<sub>H</sub>

Watchdog 1 protected write configuration 1 register  
 \*R2)

Reset values see: [Table 116](#)



Field	Bits	Type	Description
FWD_ETHR	3:0	rw	<b>Functional watchdog error threshold.</b>
SLP_EN	4	rw	<b>Watchdog1 is active in sleep state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
CYC_DIV	5	rw	<b>Apply an additional divider of 10 to the cycle time</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**Table 116**      **Reset values of [WD1\\_PW\\_CFG1](#)**

Reset	Reset value	Note
	0009 <sub>H</sub>	Reset class R2)

**18 Registers description**

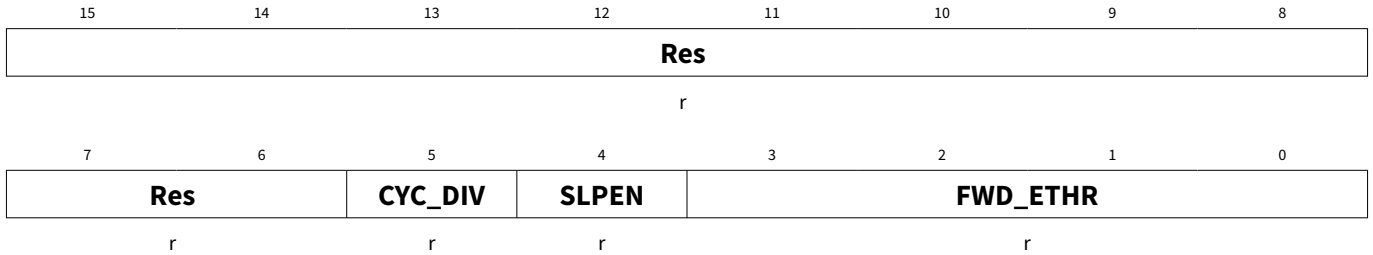
**18.65 Watchdog 1 reflected status configuration 1 register- \*R3\_C1**

**WD1\_RS\_CFG1**

Offset address: 03A<sub>H</sub>

Watchdog 1 reflected status configuration 1 register-  
 \*R3\_C1

Reset values see: [Table 117](#)



Field	Bits	Type	Description
FWD_ETHR	3:0	r	<b>Functional watchdog error threshold.</b>
SLPEN	4	r	<b>Watchdog1 is active in sleep state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
CYC_DIV	5	r	<b>Additional divider of 10 to the cycle time is applied</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**Table 117 Reset values of [WD1\\_RS\\_CFG1](#)**

Reset	Reset value	Note
	0009 <sub>H</sub>	Reset class R3) C1

**18 Registers description**

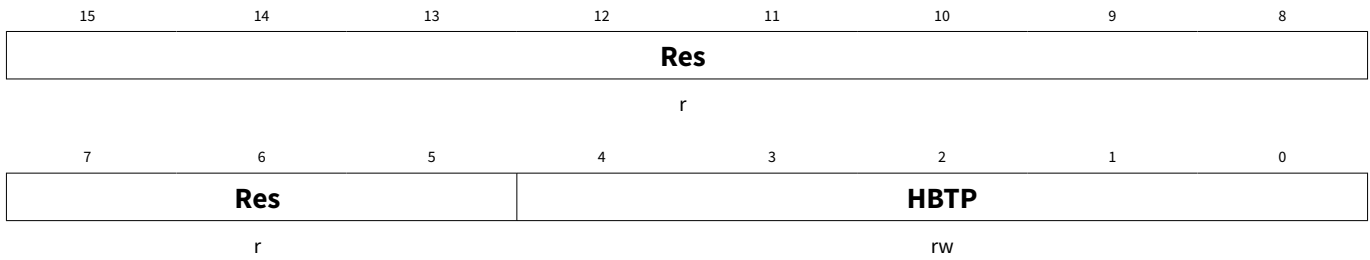
**18.66 Functional watchdog 1 protected write heart beat timer period configuration register - \*R2)**

**FWD1\_PW\_HBTP\_CFG**

Offset address: 03B<sub>H</sub>

Functional watchdog 1 protected write heart beat timer period configuration register - \*R2)

Reset values see: [Table 118](#)



Field	Bits	Type	Description
HBTP	4:0	rw	<b>Functional watchdog 1 heartbeat timer period</b> 00 <sub>H</sub> (0 * 50 + 50) * time base ... 1F <sub>H</sub> (31 * 50 + 50) * time base

**Table 118** Reset values of [FWD1\\_PW\\_HBTP\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R2)

**18 Registers description**

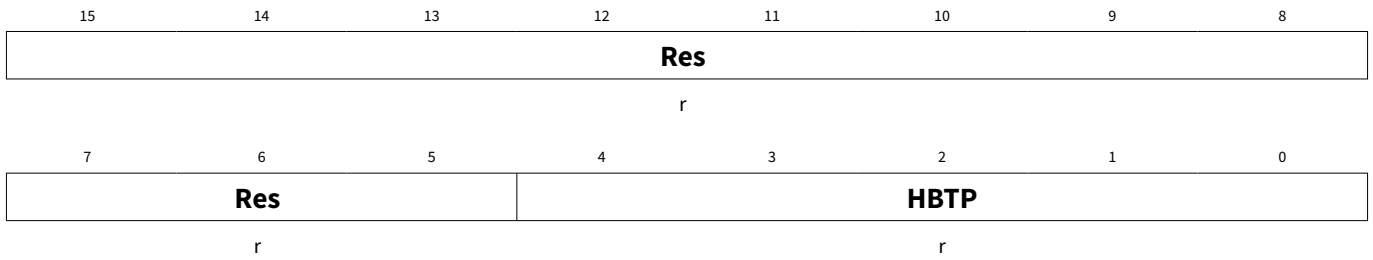
**18.67 Functional watchdog 1 reflected status heart beat timer period configuration register \*R3\_C1**

**FWD1\_RS\_HBTP\_CFG**

Offset address: 03C<sub>H</sub>

Functional watchdog 1 reflected status heart beat timer period configuration register \*R3\_C1

Reset values see: [Table 119](#)



Field	Bits	Type	Description
HBTP	4:0	r	<b>Functional watchdog 1 heartbeat timer period</b> 00 <sub>H</sub> (0 * 50 + 50) * time base ... 1F <sub>H</sub> (31 * 50 + 50) * time base

**Table 119** Reset values of [FWD1\\_RS\\_HBTP\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R3) C1

**18 Registers description**

**18.68 Window watchdog 1 protected write closed window configuration register - \*R2)**

**WWD1\_PW\_CW\_CFG**

Offset address: 03D<sub>H</sub>

Window watchdog 1 protected write closed window configuration register - \*R2)

Reset values see: [Table 120](#)

15	14	13	12	11	10	9	8
<b>CW_DIS</b>		<b>Res</b>					
rw		r					
7	6	5	4	3	2	1	0
<b>Res</b>				<b>CW</b>			
r				rw			

Field	Bits	Type	Description
CW	4:0	rw	<b>Closed window time</b> 00 <sub>H</sub> (0 * 50 + 50) * time base ... 1F <sub>H</sub> (31 * 50 + 50) * time base
CW_DIS	15	rw	<b>Disable the closed window (CW) of the window watchdog (WWD)</b> 0 <sub>B</sub> Closed window enabled 1 <sub>B</sub> Closed window disabled

**Table 120** Reset values of **WWD1\_PW\_CW\_CFG**

Reset	Reset value	Note
	0006 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.69 Window watchdog 1 reflected status closed window configuration register \*R3\_C1)**

**WWD1\_RS\_CW\_CFG**

Offset address: 03E<sub>H</sub>

Window watchdog 1 reflected status closed window configuration register \*R3\_C1)

Reset values see: [Table 121](#)

15	14	13	12	11	10	9	8
<b>CW_DIS</b>		<b>Res</b>					
r		r					
7	6	5	4	3	2	1	0
<b>Res</b>				<b>CW</b>			
r				r			

Field	Bits	Type	Description
CW	4:0	r	<b>Closed window time</b> 00 <sub>H</sub> (0 * 50 + 50) * time base ... 1F <sub>H</sub> (31 * 50 + 50) * time base
CW_DIS	15	r	<b>Disable the closed window (CW) of the window watchdog (WWD)</b> 0 <sub>B</sub> Closed window enabled 1 <sub>B</sub> Closed window disabled

**Table 121** Reset values of [WWD1\\_RS\\_CW\\_CFG](#)

Reset	Reset value	Note
	0006 <sub>H</sub>	Reset class R3) C1

**18 Registers description**

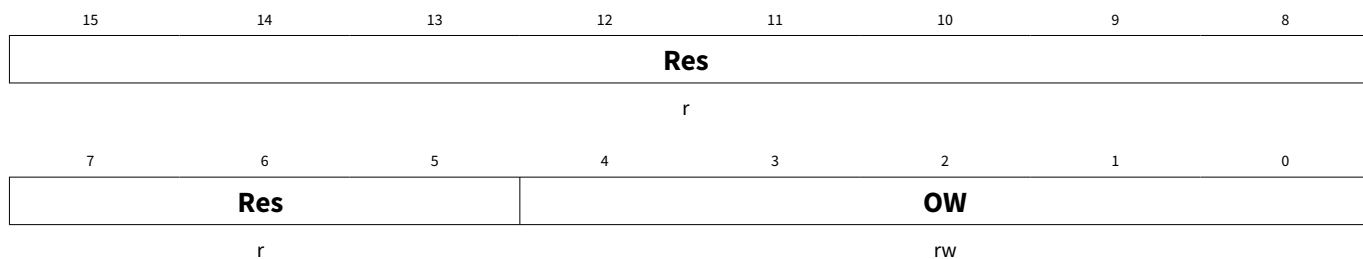
**18.70 Window watchdog 1 protected write open window configuration register - \*R2)**

**WWD1\_PW\_OW\_CFG**

Offset address: 03F<sub>H</sub>

Window watchdog 1 protected write open window configuration register - \*R2)

Reset values see: [Table 122](#)



Field	Bits	Type	Description
OW	4:0	rw	<b>Open window time</b> 00 <sub>H</sub> (0 * 50 + 50) * time base ... 1F <sub>H</sub> (31 * 50 + 50) * time base

**Table 122** Reset values of [WWD1\\_PW\\_OW\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R2)

**18 Registers description**

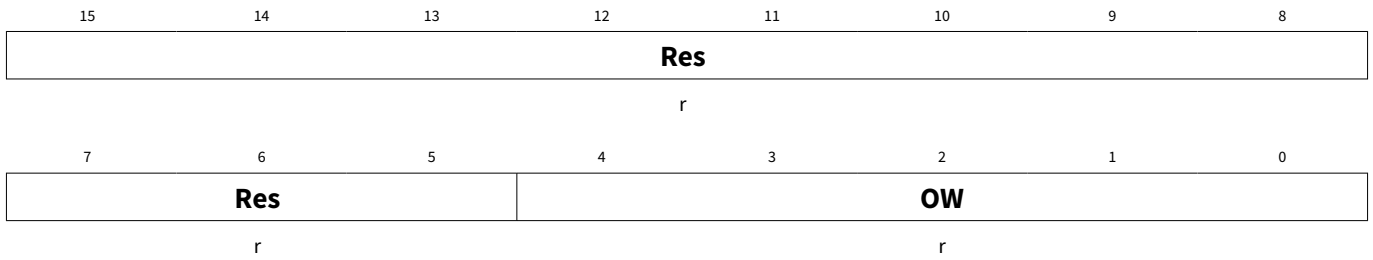
**18.71 Window watchdog 1 reflected status open window configuration register - \*R3\_C1)**

**WWD1\_RS\_OW\_CFG**

Offset address: 040<sub>H</sub>

Window watchdog 1 reflected status open window configuration register - \*R3\_C1)

Reset values see: [Table 123](#)



Field	Bits	Type	Description
OW	4:0	r	<b>Open window time</b> 00 <sub>H</sub> (0 * 50 + 50) * time base ... 1F <sub>H</sub> (31 * 50 + 50) * time base

**Table 123** Reset values of [WWD1\\_RS\\_OW\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R3) C1

**18 Registers description**

**18.72 Window watchdog 1 trigger- \*R2)**

**WWD1\_TRIG**

Offset address: 041<sub>H</sub>

Window watchdog 1 trigger- \*R2)

Reset values see: [Table 124](#)

15	14	13	12	11	10	9	8
<b>TRIG_STAT</b>		<b>Res</b>					
r		r					
7	6	5	4	3	2	1	0
<b>Res</b>							<b>TRIG</b>
r							rw

Field	Bits	Type	Description
TRIG	0	rw	<b>This bit triggers the window watchdog 1. For successful trigger, inverted value must be written.</b>
TRIG_STAT	15	r	<b>Last internal trigger value (TRIG bit) received via SPI.</b>

**Table 124** Reset values of **WWD1\_TRIG**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

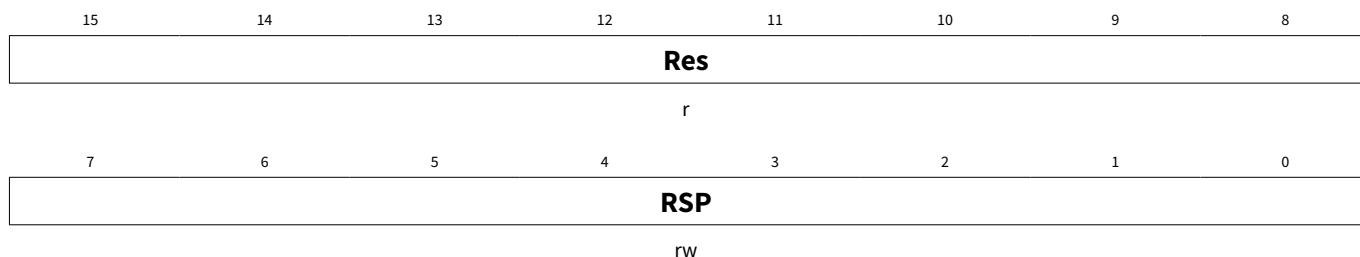
**18.73 Functional watchdog 1 response register - \*R2)**

**FWD1\_RSP**

Offset address: 042<sub>H</sub>

Functional watchdog 1 response register - \*R2)

Reset values see: [Table 125](#)



Field	Bits	Type	Description
RSP	7:0	rw	Response byte

**Table 125** Reset values of **FWD1\_RSP**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

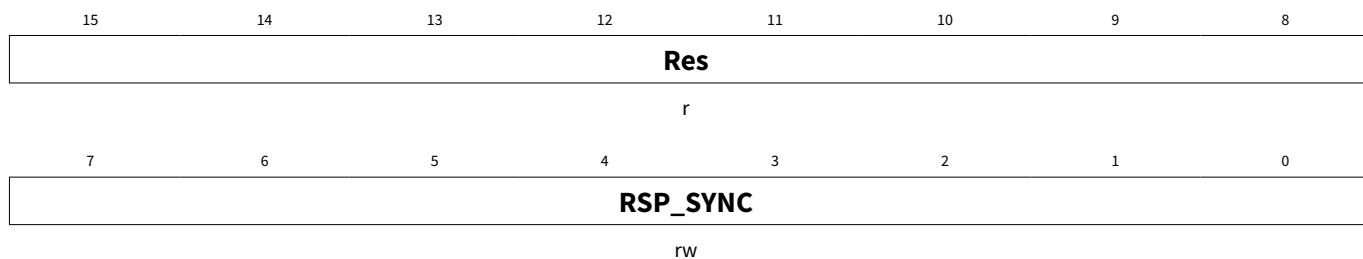
**18.74 Functional watchdog 1 response register with synchronization of the heartbeat timer - \*R2)**

**FWD1\_RSP\_SYNC**

Functional watchdog 1 response register with synchronization of the heartbeat timer - \*R2)

Offset address: 043<sub>H</sub>

Reset values see: [Table 126](#)



Field	Bits	Type	Description
RSP_SYNC	7:0	rw	Functional watchdog response byte and heartbeat timer synchronization

**Table 126** Reset values of **FWD1\_RSP\_SYNC**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.75 Functional watchdog 1 status register - \*R3\_C1)**

**FWD1\_STAT**

Offset address: 044<sub>H</sub>

Functional watchdog 1 status register - \*R3\_C1)

Reset values see: [Table 127](#)

15	14	13	12	11	10	9	8
<b>Res</b>						<b>ECNT</b>	
r						r	
7	6	5	4	3	2	1	0
<b>ECNT</b>	<b>RSP_OK</b>	<b>RSPC</b>		<b>QUEST</b>			
r	r	r		r			

Field	Bits	Type	Description
QUEST	3:0	r	<b>Functional watchdog question. Represents the value of the question, that is currently being asked.</b>
RSPC	5:4	r	<b>Functional watchdog response counter value. Represents the response which is currently expected (RESP3/2/1/0).</b>
RSP_OK	6	r	<b>Functional watchdog response status</b> 0 <sub>B</sub> Response message is wrong 1 <sub>B</sub> All received bytes in response message are correct
ECNT	10:7	r	<b>Functional watchdog error counter value</b>

**Table 127** Reset values of **FWD1\_STAT**

Reset	Reset value	Note
	0030 <sub>H</sub>	Reset class R3) C1

**18 Registers description**

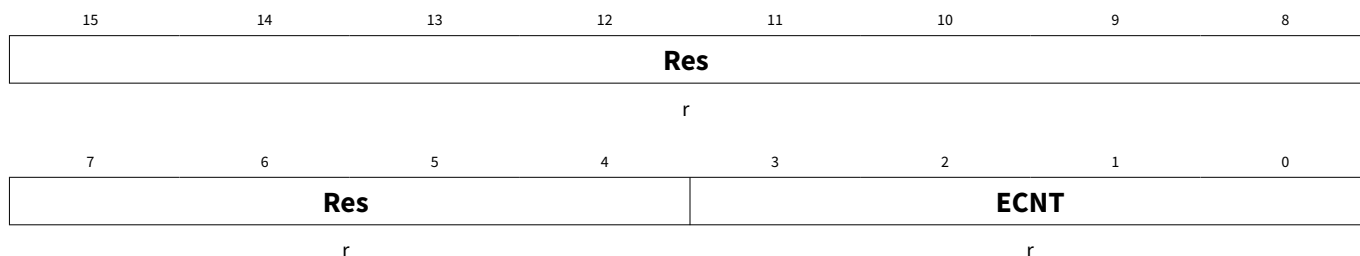
**18.76 Window watchdog 1 error counter status register - \*R3\_C1)**

**WWD1\_ECNT\_STAT**

Offset address: 045<sub>H</sub>

Window watchdog 1 error counter status register -  
 \*R3\_C1)

Reset values see: [Table 128](#)



Field	Bits	Type	Description
ECNT	3:0	r	Error counter value

**Table 128** Reset values of [WWD1\\_ECNT\\_STAT](#)

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R3) C1

**18 Registers description**

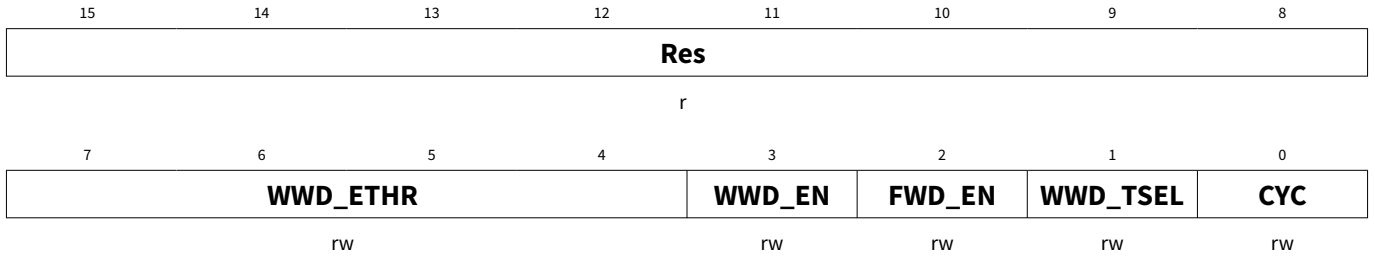
**18.77 Watchdog 2 protected write configuration 0 register - \*R2)**

**WD2\_PW\_CFG0**

Offset address: 046<sub>H</sub>

Watchdog 2 protected write configuration 0 register - \*R2)

Reset values see: [Table 129](#)



Field	Bits	Type	Description
CYC	0	rw	<b>Watchdog 2 cycle time</b> 0 <sub>B</sub> 0.1 ms tick period 1 <sub>B</sub> 1 ms tick period
WWD_TSEL	1	rw	<b>Window watchdog (WWD2) trigger selection.</b> 0 <sub>B</sub> External WDI input used as a WWD trigger 1 <sub>B</sub> WWD is triggered by SPI
FWD_EN	2	rw	<b>Functional watchdog (FWD2) enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_EN	3	rw	<b>Window watchdog (WWD2) enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_ETHR	7:4	rw	<b>Window watchdog error threshold.</b>

**Table 129** Reset values of **WD2\_PW\_CFG0**

Reset	Reset value	Note
	009B <sub>H</sub>	Reset class R2)

**18 Registers description**

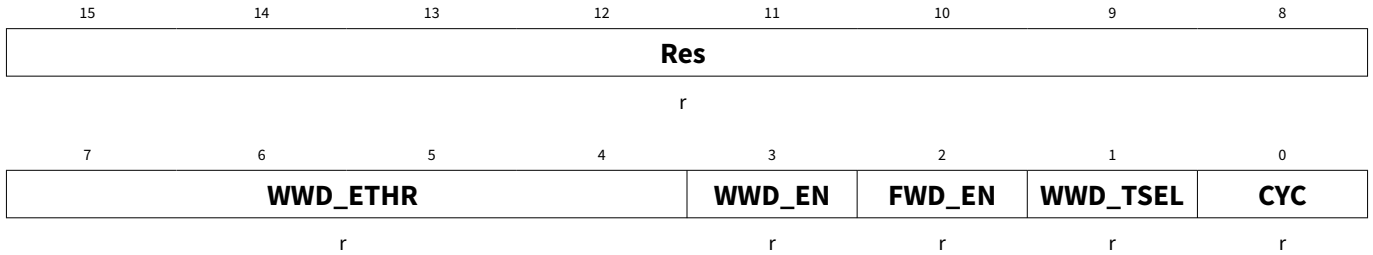
**18.78 Watchdog 2 reflected status configuration 0 register- \*R3\_C2)**

**WD2\_RS\_CFG0**

Offset address: 047<sub>H</sub>

Watchdog 2 reflected status configuration 0 register-  
 \*R3\_C2)

Reset values see: [Table 130](#)



Field	Bits	Type	Description
CYC	0	r	<b>Watchdog 2 cycle time</b> 0 <sub>B</sub> 0.1 ms tick period 1 <sub>B</sub> 1 ms tick period
WWD_TSEL	1	r	<b>Window watchdog (WWD2) trigger selection.</b> 0 <sub>B</sub> External WDI input used as a WWD trigger 1 <sub>B</sub> WWD is triggered by SPI write to WWDSCMD register
FWD_EN	2	r	<b>Functional watchdog (FWD2) enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_EN	3	r	<b>Window watchdog (WWD2) enable</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
WWD_ETHR	7:4	r	<b>Window watchdog error threshold.</b>

**Table 130** Reset values of [WD2\\_RS\\_CFG0](#)

Reset	Reset value	Note
	009B <sub>H</sub>	Reset class R3) C2

**18 Registers description**

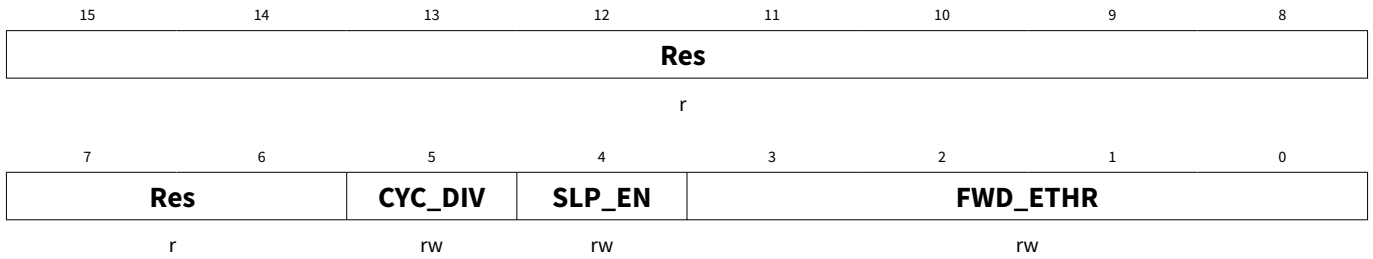
**18.79 Watchdog 2 protected write configuration 1 - \*R2)**

**WD2\_PW\_CFG1**

Offset address: 048<sub>H</sub>

Watchdog 2 protected write configuration 1 - \*R2)

Reset values see: [Table 131](#)



Field	Bits	Type	Description
FWD_ETHR	3:0	rw	<b>Functional watchdog error threshold.</b>
SLP_EN	4	rw	<b>Watchdog 2 is active in sleep state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
CYC_DIV	5	rw	<b>Apply an additional divider of 10 to the cycle time</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled, additional divider

**Table 131** Reset values of [WD2\\_PW\\_CFG1](#)

Reset	Reset value	Note
	0009 <sub>H</sub>	Reset class R2)

**18 Registers description**

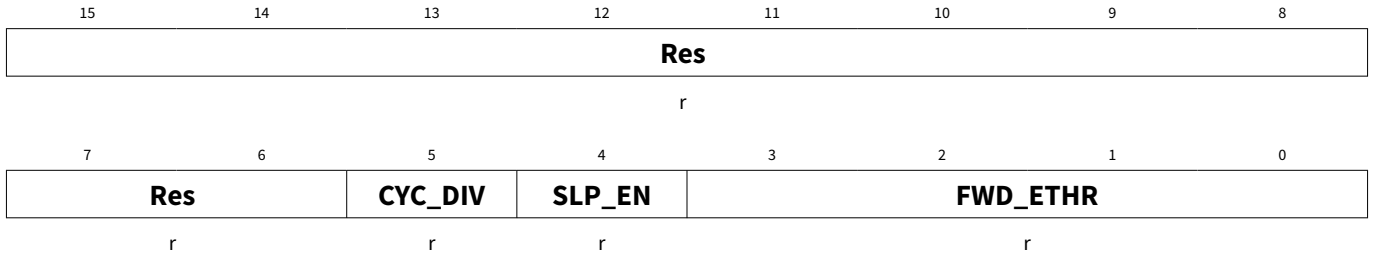
**18.80 Watchdog 2 reflected status configuration 1 register - \*R3\_C2)**

**WD2\_RS\_CFG1**

Offset address: 049<sub>H</sub>

Watchdog 2 reflected status configuration 1 register - \*R3\_C2)

Reset values see: [Table 132](#)



Field	Bits	Type	Description
FWD_ETHR	3:0	r	<b>Functional watchdog error threshold.</b>
SLP_EN	4	r	<b>Watchdog 2 is active in sleep state</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
CYC_DIV	5	r	<b>Additional divider of 10 to the cycle time is applied</b> 0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled

**Table 132 Reset values of [WD2\\_RS\\_CFG1](#)**

Reset	Reset value	Note
	0009 <sub>H</sub>	Reset class R3) C2

**18 Registers description**

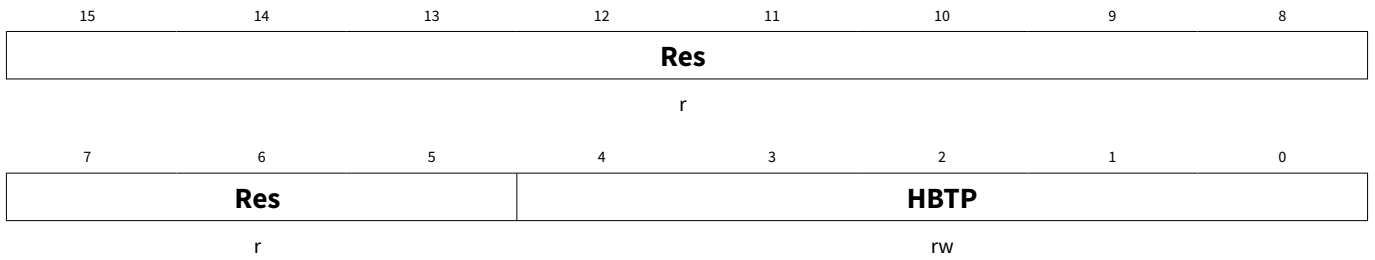
**18.81 Functional watchdog 2 protected write heart beat timer period configuration register - \*R2)**

**FWD2\_PW\_HBTP\_CFG**

Offset address: 04A<sub>H</sub>

Functional watchdog 2 protected write heart beat timer period configuration register - \*R2)

Reset values see: [Table 133](#)



Field	Bits	Type	Description
HBTP	4:0	rw	<b>Functional watchdog 2 heartbeat timer period</b> 00 <sub>H</sub> (0 * 50 + 50) wd time base ... 1F <sub>H</sub> (31 * 50 + 50) wd time base

**Table 133** Reset values of [FWD2\\_PW\\_HBTP\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R2)

**18 Registers description**

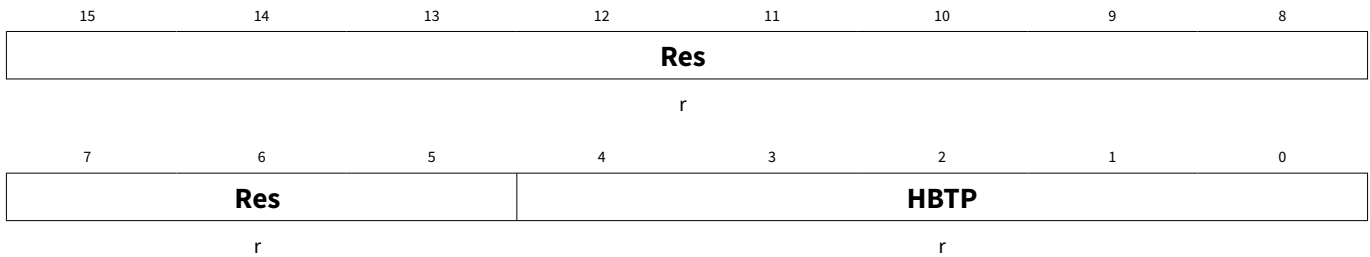
**18.82 Functional watchdog 2 reflected status heart beat timer period configuration register \*R3\_C2)**

**FWD2\_RS\_HBTP\_CFG**

Offset address: 04B<sub>H</sub>

Functional watchdog 2 reflected status heart beat timer period configuration register \*R3\_C2)

Reset values see: [Table 134](#)



Field	Bits	Type	Description
HBTP	4:0	r	<b>Functional watchdog 2 heartbeat timer period</b> 00 <sub>H</sub> (0 * 50 + 50) wd time base ... 1F <sub>H</sub> (31 * 50 + 50) wd time base

**Table 134** Reset values of [FWD2\\_RS\\_HBTP\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R3) C2

**18 Registers description**

**18.83 Window watchdog 2 protected write closed window configuration register - \*R2)**

**WWD2\_PW\_CW\_CFG**

Offset address: 04C<sub>H</sub>

Window watchdog 2 protected write closed window configuration register - \*R2)

Reset values see: [Table 135](#)

15	14	13	12	11	10	9	8
<b>CW_DIS</b>		<b>Res</b>					
rw		r					
7	6	5	4	3	2	1	0
<b>Res</b>				<b>CW</b>			
r				rw			

Field	Bits	Type	Description
CW	4:0	rw	<b>Closed window time</b> 00 <sub>H</sub> (0 * 50 + 50) wd time base ... 1F <sub>H</sub> (31 * 50 + 50) wd time base
CW_DIS	15	rw	<b>Disable the closed window (CW) of the window watchdog (WWD)</b> 0 <sub>B</sub> Closed window enabled 1 <sub>B</sub> Closed window disabled

**Table 135 Reset values of WWD2\_PW\_CW\_CFG**

Reset	Reset value	Note
	0006 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.84 Window watchdog 2 reflected status closed window configuration register \*R3\_C2)**

**WWD2\_RS\_CW\_CFG**

Offset address: 04D<sub>H</sub>

Window watchdog 2 reflected status closed window configuration register \*R3\_C2)

Reset values see: [Table 136](#)

15	14	13	12	11	10	9	8
<b>CW_DIS</b>		<b>Res</b>					
r		r					
7	6	5	4	3	2	1	0
<b>Res</b>				<b>CW</b>			
r				r			

Field	Bits	Type	Description
CW	4:0	r	<b>Closed window time</b> 00 <sub>H</sub> (0 * 50 + 50) wd time base ... 1F <sub>H</sub> (31 * 50 + 50) wd time base
CW_DIS	15	r	<b>Disable the closed window (CW) of the window watchdog (WWD)</b> 0 <sub>B</sub> Closed window enabled 1 <sub>B</sub> Closed window disabled

**Table 136** Reset values of [WWD2\\_RS\\_CW\\_CFG](#)

Reset	Reset value	Note
	0006 <sub>H</sub>	Reset class R3) C2

**18 Registers description**

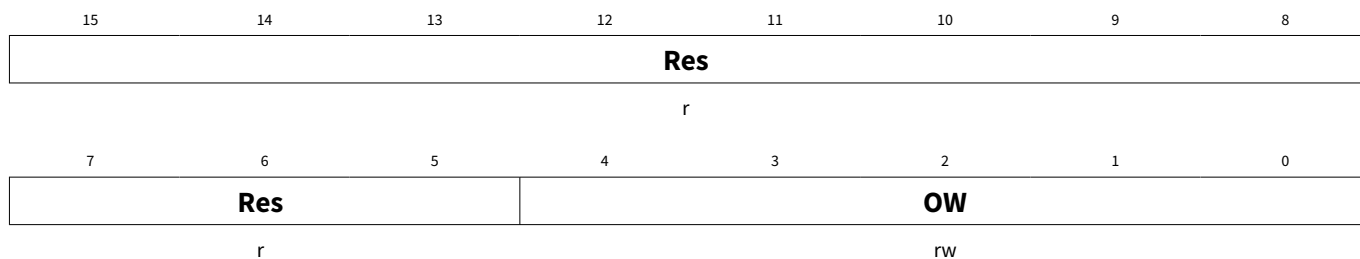
**18.85 Window watchdog 2 protected write open window configuration register - \*R2)**

**WWD2\_PW\_OW\_CFG**

Offset address: 04E<sub>H</sub>

Window watchdog 2 protected write open window configuration register - \*R2)

Reset values see: [Table 137](#)



Field	Bits	Type	Description
OW	4:0	rw	<b>Open window time</b> 00 <sub>H</sub> (0 * 50 + 50) wd time base ... 1F <sub>H</sub> (31 * 50 + 50) wd time base

**Table 137** Reset values of [WWD2\\_PW\\_OW\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R2)

**18 Registers description**

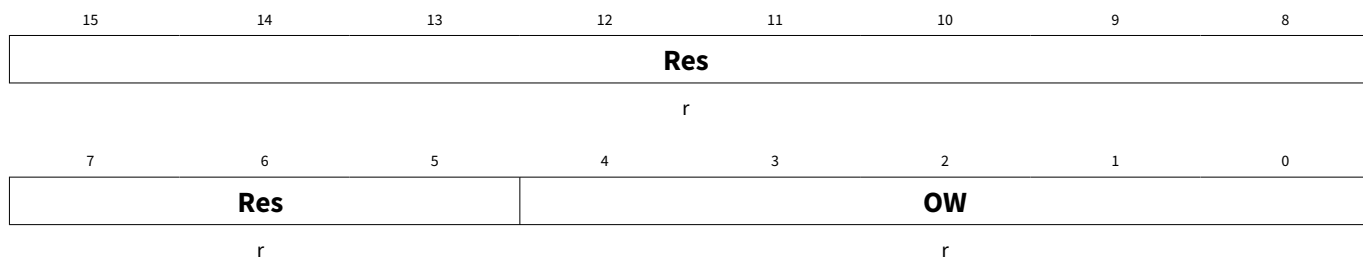
**18.86 Window watchdog 2 reflected status open window configuration register \*R3\_C2)**

**WWD2\_RS\_OW\_CFG**

Offset address: 04F<sub>H</sub>

Window watchdog 2 reflected status open window configuration register \*R3\_C2)

Reset values see: [Table 138](#)



Field	Bits	Type	Description
OW	4:0	r	<b>Open window time</b> 00 <sub>H</sub> (0 * 50 + 50) wd time base ... 1F <sub>H</sub> (31 * 50 + 50) wd time base

**Table 138** Reset values of [WWD2\\_RS\\_OW\\_CFG](#)

Reset	Reset value	Note
	000B <sub>H</sub>	Reset class R3) C2

**18 Registers description**

**18.87 Window watchdog 2 service - \*R2)**

**WWD2\_TRIG**

Offset address: 050<sub>H</sub>

Window watchdog 2 service - \*R2)

Reset values see: [Table 139](#)

15	14	13	12	11	10	9	8
<b>TRIG_STAT</b>		<b>Res</b>					
r		r					
7	6	5	4	3	2	1	0
<b>Res</b>							<b>TRIG</b>
r							rw

Field	Bits	Type	Description
TRIG	0	rw	<b>This bit triggers the window watchdog 2. For successful trigger, inverted value must be written.</b>
TRIG_STAT	15	r	<b>Last internal service value (TRIG bit) received via SPI.</b>

**Table 139** Reset values of **WWD2\_TRIG**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

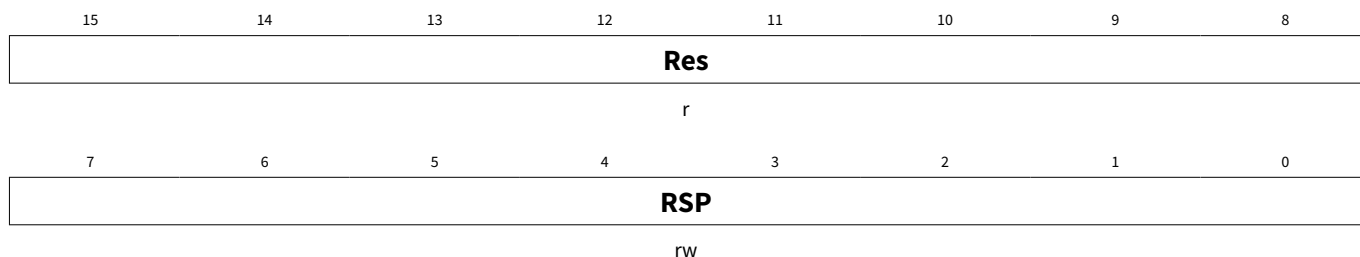
**18.88 Functional watchdog 2 response register - \*R2)**

**FWD2\_RSP**

Offset address: 051<sub>H</sub>

Functional watchdog 2 response register - \*R2)

Reset values see: [Table 140](#)



Field	Bits	Type	Description
RSP	7:0	rw	Response byte

**Table 140** Reset values of **FWD2\_RSP**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

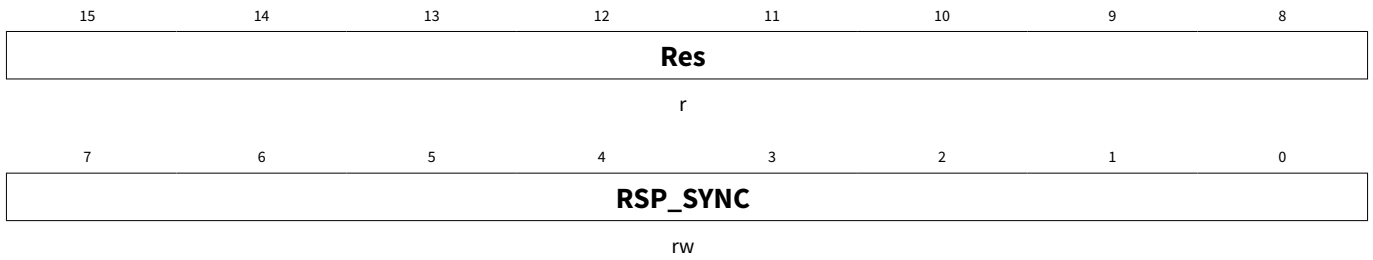
**18.89 Functional watchdog 2 response register with synchronization - \*R2)**

**FWD2\_RSP\_SYNC**

Functional watchdog 2 response register with synchronization - \*R2)

Offset address: 052<sub>H</sub>

Reset values see: [Table 141](#)



Field	Bits	Type	Description
RSP_SYNC	7:0	rw	Functional watchdog response byte and heartbeat timer synchronization

**Table 141** Reset values of **FWD2\_RSP\_SYNC**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.90 Functional watchdog 2 status register - \*R3\_C2)**

**FWD2\_STAT**

Offset address: 053<sub>H</sub>

Functional watchdog 2 status register - \*R3\_C2)

Reset values see: [Table 142](#)

15	14	13	12	11	10	9	8
<b>Res</b>						<b>ECNT</b>	
r						r	
7	6	5	4	3	2	1	0
<b>ECNT</b>	<b>RSP_OK</b>	<b>RSPC</b>		<b>QUEST</b>			
r	r	r		r			

Field	Bits	Type	Description
QUEST	3:0	r	<b>Functional watchdog question</b>
RSPC	5:4	r	<b>Functional watchdog response counter value</b>
RSP_OK	6	r	<b>Functional watchdog response status</b> 0 <sub>B</sub> Response message is wrong 1 <sub>B</sub> All received bytes in response message are correct
ECNT	10:7	r	<b>Functional watchdog error counter value</b>

**Table 142** Reset values of [FWD2\\_STAT](#)

Reset	Reset value	Note
	0030 <sub>H</sub>	Reset class R3) C2

**18 Registers description**

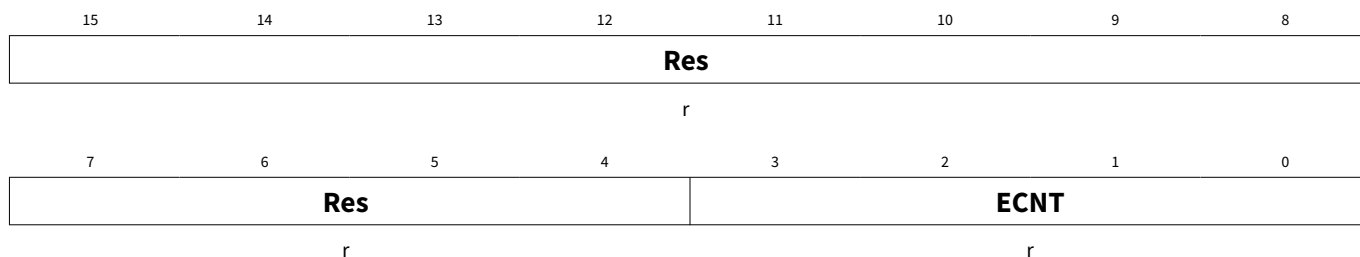
**18.91 Window watchdog 2 status register - \*R3\_C2)**

**WWD2\_ECNT\_STAT**

Offset address: 054<sub>H</sub>

Window watchdog 2 status register - \*R3\_C2)

Reset values see: [Table 143](#)



Field	Bits	Type	Description
ECNT	3:0	r	<b>Error counter value</b>

**Table 143** Reset values of [WWD2\\_ECNT\\_STAT](#)

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R3) C2

**18 Registers description**

**18.92 Safety switch diagnostics, \*R1)**

**SSW\_DIAG**

Safety switch diagnostics, \*R1)

Offset address: 055<sub>H</sub>

Reset values see: [Table 144](#)



Field	Bits	Type	Description
EBIST0	0	r	<b>Indicates if SSW is intact</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> SSW check not passed
EBIST1	1	r	<b>Indicates if high side switch at PREREG is intact</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> HS switch of PREREG defect
EBIST2	2	r	<b>Indicates if SSW gate can be discharged</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> SSW gate could not be discharged
EBIST3	3	r	<b>Indicates if low side switch of PREREG is intact</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> LS switch of PREREG defect
EBIST4	4	r	<b>Sanity check on SSW charge pump chain</b> 0 <sub>B</sub> No fault 1 <sub>B</sub> Sanity check unsuccessful

**Table 144** Reset values of **SSW\_DIAG**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R1)

**18 Registers description**

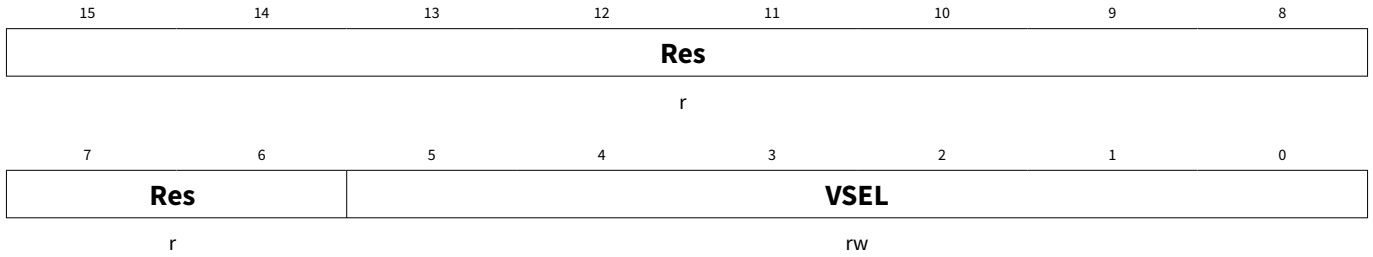
**18.93 BUCK CORE protected write voltage selection register \*R1)**

**BUCK\_CORE\_PW\_VSEL**

Offset address: 056<sub>H</sub>

BUCK CORE protected write voltage selection register  
 \*R1)

Reset values see: [Table 145](#)



Field	Bits	Type	Description
VSEL	5:0	rw	<b>Voltage selection (0.7 V to 1.1 V; 12.5 mV steps)</b> 00 <sub>H</sub> BUCKCORE output voltage: 0.7 V + 0*12.5 mV ... 20 <sub>H</sub> BUCKCORE output voltage: 0.7 V + 32*12.5 mV <b>others, reserved</b>

**Table 145** Reset values of **BUCK\_CORE\_PW\_VSEL**

Reset	Reset value	Note
	0000 <sub>H</sub>	

**18 Registers description**

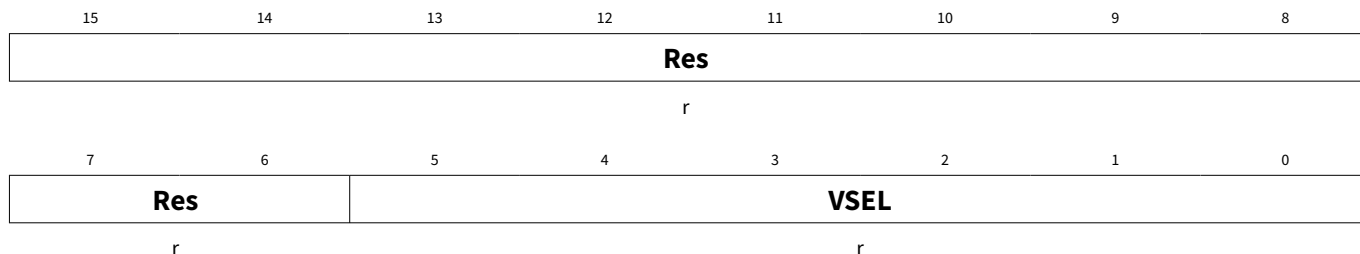
**18.94 BUCK CORE reflected status voltage selection register \*R2)**

**BUCK\_CORE\_RS\_VSEL**

Offset address: 057<sub>H</sub>

BUCK CORE reflected status voltage selection register  
 \*R2)

Reset values see: [Table 146](#)



Field	Bits	Type	Description
VSEL	5:0	r	<b>Voltage selection status register (0.7 V to 1.1 V; 12.5 mV steps)</b> 00 <sub>H</sub> BUCKCORE output voltage: 0.7 V + 0*12.5 mV ... 20 <sub>H</sub> BUCKCORE output voltage: 0.7 V + 32*12.5 mV <b>others, reserved</b>

**Table 146** Reset values of [BUCK\\_CORE\\_RS\\_VSEL](#)

Reset	Reset value	Note
	001A <sub>H</sub>	Reset class R2)

**18 Registers description**

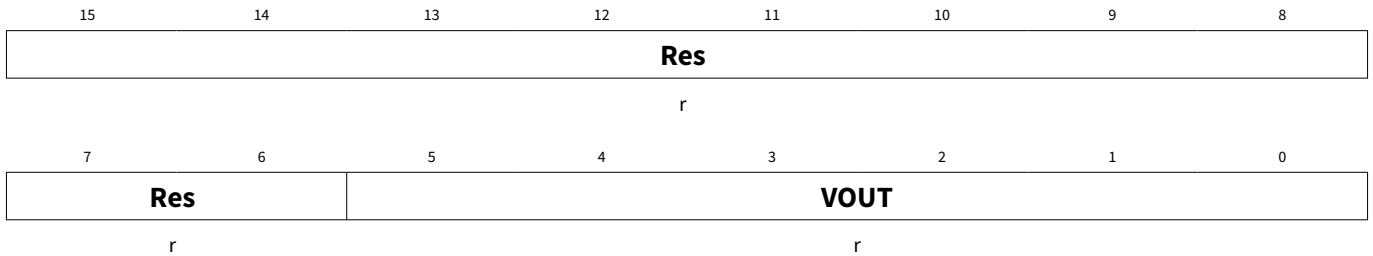
**18.95 Buck core voltage selection stat, \*R2)**

**VCORESTAT**

Buck core voltage selection stat, \*R2)

Offset address: 058<sub>H</sub>

Reset values see: [Table 147](#)



Field	Bits	Type	Description
VOUT	5:0	r	<p><b>Current voltage out for buckcore, *R2)</b></p> <p>00<sub>H</sub> BUCKCORE output voltage set to 0.7 V + 0*12.5 mV</p> <p>...</p> <p>20<sub>H</sub> BUCKCORE output voltage set to 0.7 V + 32*12.5 mV</p> <p>21<sub>H</sub> BUCKCORE output voltage set to 1.15 V; Not allowed to be used for static voltage scaling!</p> <p><b>others, reserved</b></p>

**Table 147 Reset values of VCORESTAT**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.96 Buck core voltage selection monitors stat, \*R2)**

**VCOREMONSTAT**

Offset address: 059<sub>H</sub>

Buck core voltage selection monitors stat, \*R2)

Reset values see: [Table 148](#)

15	14	13	12	11	10	9	8
<b>Res</b>		<b>OVTH</b>					
r		r					
7	6	5	4	3	2	1	0
<b>Res</b>		<b>UVTH</b>					
r		r					

Field	Bits	Type	Description
UVTH	5:0	r	<b>Under voltage thresholds for buckcore voltage selection, *R2)</b> 00 <sub>H</sub> BUCKCORE undervoltage threshold for VOUT = 0.7 V + 0*12.5 mV ... 20 <sub>H</sub> BUCKCORE undervoltage threshold for VOUT = 0.7 V + 32*12.5 mV 21 <sub>H</sub> BUCKCORE undervoltage threshold for VOUT = 1.15 V <b>others, reserved</b>
OVTH	13:8	r	<b>Over voltage thresholds for buckcore voltage selection, *R2)</b> 00 <sub>H</sub> BUCKCORE overvoltage threshold for VOUT = 0.7 V + 0*12.5 mV ... 20 <sub>H</sub> BUCKCORE overvoltage threshold for VOUT = 0.7 V + 32*12.5 mV 21 <sub>H</sub> BUCKCORE overvoltage threshold for VOUT = 1.15 V <b>others, reserved</b>

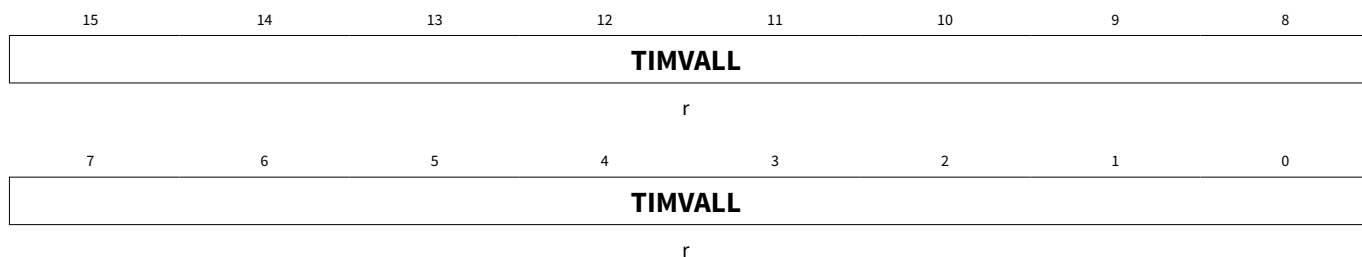
**Table 148 Reset values of VCOREMONSTAT**

Reset	Reset value	Note
	0000 <sub>H</sub>	Reset class R2)

**18 Registers description**

**18.97 Wake Up Timer value after exiting from STANDBY or SLEEP (lower 16 bits)**

**WUT\_STAT0** Offset address: 05A<sub>H</sub>  
 Wake Up Timer value after exiting from STANDBY or SLEEP [lower 16 bits] value: 0000<sub>H</sub>



Field	Bits	Type	Description
TIMVALL	15:0	r	Lower 16 bit of wake-up timer value: LSB bit 0; MSB bit15

**18 Registers description**

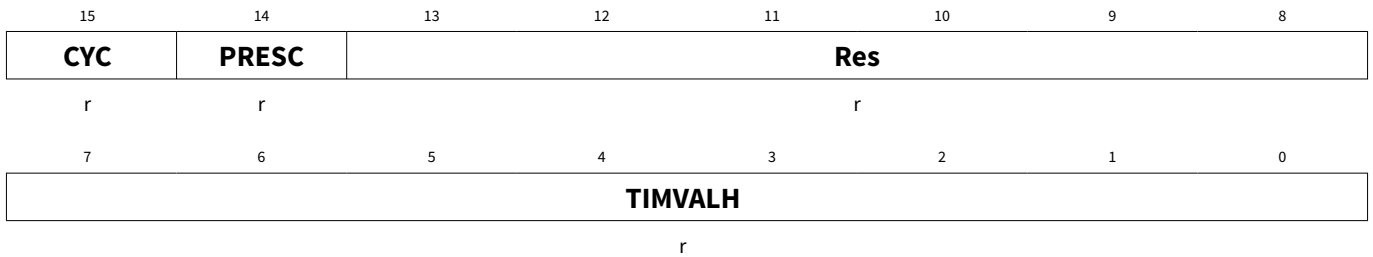
**18.98 Wake Up Timer value after exiting from STANDBY or SLEEP (upper 8 bits)**

**WUT\_STAT1**

Offset address: 05B<sub>H</sub>

Wake Up Timer value after exiting from STANDBY or SLEEP [upper 8 bits)

value: 0000<sub>H</sub>

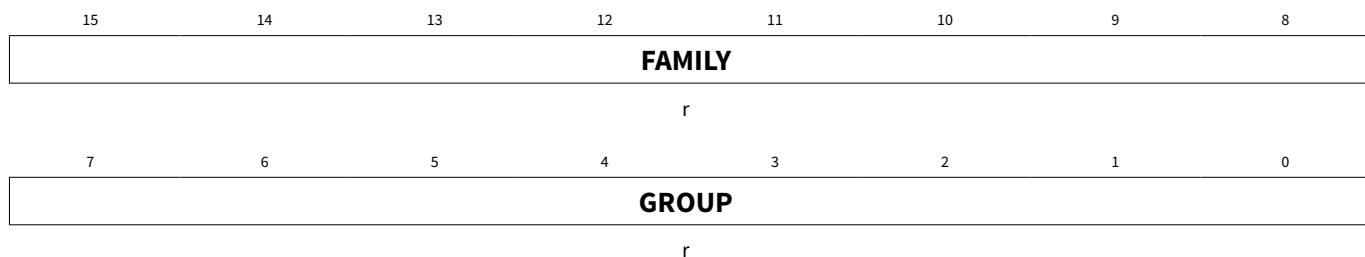


Field	Bits	Type	Description
TIMVALH	7:0	r	<b>Higher 8 bits of wake-up timer value: LSB bit0; MSB bit 7</b>
PRESC	14	r	0 <sub>B</sub> Disabled 1 <sub>B</sub> Enabled
CYC	15	r	0 <sub>B</sub> 10 μs 1 <sub>B</sub> 10 ms

**18 Registers description**

**18.99 Chip product identifier**

**CHPID** Offset address: 1F0<sub>H</sub>  
 Chip product identifier value: 0201<sub>H</sub>



Field	Bits	Type	Description
GROUP	7:0	r	<b>Chip product group</b> 01 <sub>H</sub> GP_PMIC
FAMILY	15:8	r	<b>Chip family</b> 02 <sub>H</sub> TLF4D985

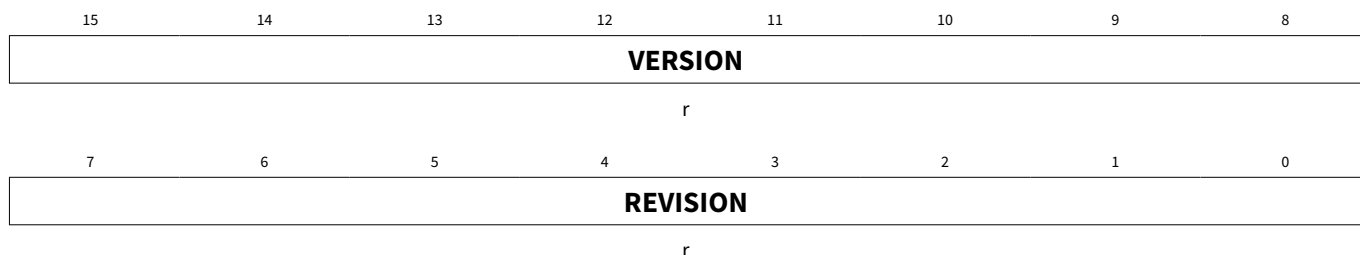
**18 Registers description**

**18.100 Chip product version and revision**

**CHREV**

Chip product version and revision

Offset address: 1F1<sub>H</sub>  
 value: 0003<sub>H</sub>

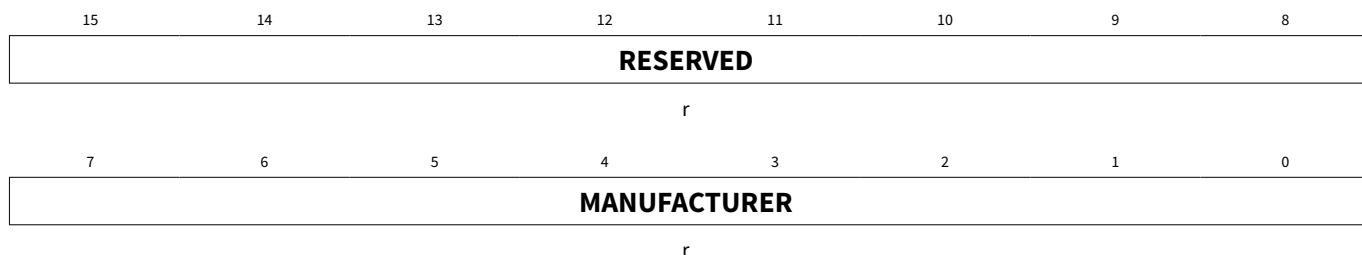


Field	Bits	Type	Description
REVISION	7:0	r	<b>Chip revision</b> 01 <sub>H</sub> A11 02 <sub>H</sub> A21 03 <sub>H</sub> A31 (TLF4D985QxV0xR1)
VERSION	15:8	r	<b>Chip product version</b> 01 <sub>H</sub> TLF4D985QxV01 02 <sub>H</sub> TLF4D985QxV02 03 <sub>H</sub> TLF4D985QxV03

**18 Registers description**

**18.101 Manufacturer ID**

**MANID** Offset address: 1F2<sub>H</sub>  
 Manufacturer ID value: 00C1<sub>H</sub>

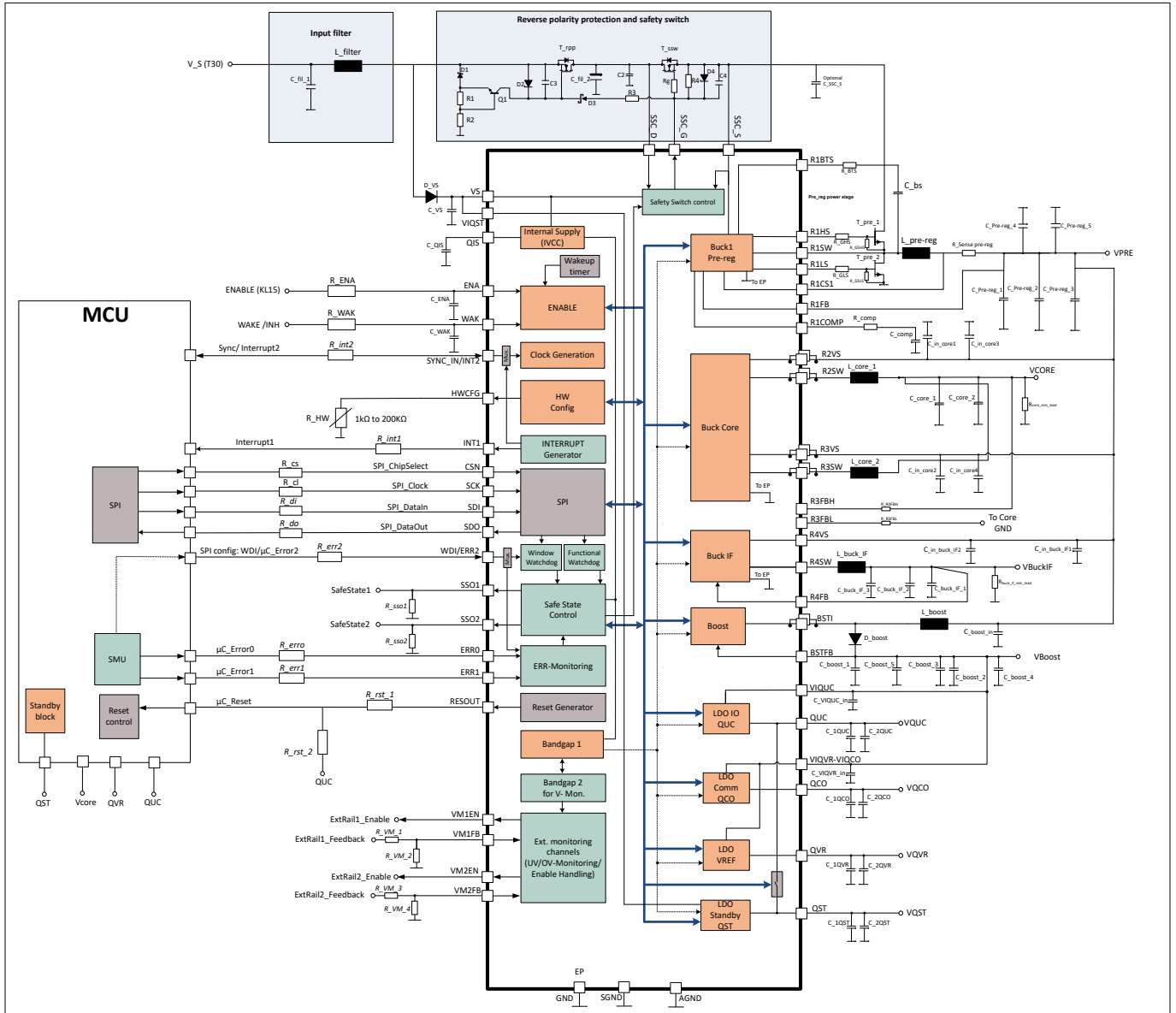


Field	Bits	Type	Description
MANUFACTURER	7:0	r	<b>MANUFACTURER</b> C1 <sub>H</sub> Infineon technologies AG
RESERVED	15:8	r	<b>RESERVED</b>

**19 Application information**

**19 Application information**

**19.1 Application diagram**



**Figure 96 Application diagram**

**19 Application information**

**19.2 BOM recommendation**

**Table 149 BOM recommendation**

Block	Symbol	Value	Description	Note
Input Filter	C_fil_1	10 µF	Surface mount ceramic capacitor	Max voltage depending on application (50 V for 12 V application and 100 V for 24 V application)
	C_fil_2	220 µF	Electrolytic capacitor	Max voltage depending on application (50 V for 12 V application and 100 V for 24 V application)
	L_filter	4.7 µH	Shielded filter Power Inductor	Inductor selection depending on EMC requirement
QIS & Input voltage	C_QIS	1 µF	Surface mount ceramic capacitor	–
	C_VS	4.7 µF	Surface mount ceramic capacitors	–
	D_VS	d_schottky	reverse polarity protection diode for low current path	–
Reverse battery protection (RPP) and safety switch (SSC)	C2	10 µF	Surface mount ceramic capacitor	Max voltage depending on application (50 V for 12 V application and 100 V for 24 V application)
	C3	1 nF	Surface mount ceramic capacitor	–
	C4	1 nF	Surface mount ceramic capacitor	–
	T_rpp	RPP + SSC MOSFET	N-Channel MOSFETs (logic level)	IPG20N06S2L-35A (dual MOSFET) or IAUZ40N06S5L050 (single) or similar
	T_ssw			
	D1	VBD = 60 V	Schottky diode to prevent current flowing via R1 and R2 in normal supply condition	–

**(table continues...)**

**19 Application information**

**Table 149 (continued) BOM recommendation**

Block	Symbol	Value	Description	Note
	D2	VZ = 10 V	Zener diode to protect gate of RPP MOSFET	–
	D3	VBD = 60 V	Schottky diode to prevent current bypassing RPP and SSW via R4 and R5 in normal supply condition	RB558VYM150FH
	D4	VZ = 6.2 V	Zener diode to protect the PMIC VGS driver	–
	Q1	npn	Low leakage npn transistor, to discharge the RPP MOSFET when the battery voltage is below ground	Recommended low leakage at VCB = 40 V at hot
	R1	47 kΩ	Standard thick film chip resistor	–
	R2	47 kΩ	Standard thick film chip resistor	–
	R3	300 kΩ	Standard thick film chip resistor	–
	R4	300 kΩ	Standard thick film chip resistor	–
	Rg	10 Ω	Gate resistor for the control of the external safety switch	–
	C_SSC_S	1 μF (Max)	Surface mount ceramic capacitors	optional: To improve EMC performance. However dimension the capacitance to meet safety goals as it might have an effect on system's response to fault conditions.
PREREG	C_Pre_reg_1	3 × 22 μF	Surface mount ceramic capacitors	Nominal values of capacitances are recommended taking into account
	C_Pre_reg_2			

**(table continues...)**

**19 Application information**

**Table 149 (continued) BOM recommendation**

Block	Symbol	Value	Description	Note
	C_Pre_reg_3			all derating factors (voltage, temperature and aging)
	C_Pre_reg_4	1 $\mu$ F	Surface mount ceramic capacitor	–
	C_Pre_reg_5	100 nF	Surface mount ceramic capacitor	–
	L_pre_reg	6.8 $\mu$ H	Shielded power inductor	Select inductor according to the over current limitation
	T_pre_1	External MOSFETs	N-Channel MOSFETs (logic level)	IPG20N06S4L-26A (dual MOSFET) or IAUZ40N06S5L050 (single) or similar
	T_pre_2			IPG20N06S4L-26A (dual MOSFET) or IAUZ40N06S5L050 (single) or similar
	R_COMP	12 k $\Omega$	Standard thick film chip resistor	For 10 A current capability
		25 k $\Omega$	Standard thick film chip resistor	For 5 A current capability
	C_COMP	1.5 nF	Surface mount ceramic capacitor	For 5 A current capability
		2.7 nF	Surface mount ceramic capacitor	For 10 A current capability
	R_Sense_pre-reg	10 m $\Omega$	Standard thick film chip resistor, tol. $\pm$ 1%	For 10 A current capability
		20 m $\Omega$	Standard thick film chip resistor, tol. $\pm$ 1%	For 5 A current capability
	C_bs	100 nF	Surface mount ceramic capacitor	–
	R_BTS	–	Boot strap line resistance for limiting inrush currents	If EMC does not require it, set it to 0 $\Omega$

**(table continues...)**

**19 Application information**

**Table 149 (continued) BOM recommendation**

Block	Symbol	Value	Description	Note
	R_GHS	–	Gate resistor for limiting gate currents	If EMC does not require it, set it to 0 Ω
	R_GSHS	–	–	optional: Only if use case assumption requires it for safety reasons
	R_GSLS	–	–	optional Only if use case assumption requires it for safety reasons
	R_GLS	–	Gate resistor for limiting gate currents	If EMC does not require it, set it to 0 Ω
BOOST	C_boost_in	100 nF	Surface mount ceramic capacitor	–
	C_boost_1	100 nF	Surface mount ceramic capacitor	–
	C_boost_2	1 μF	Surface mount ceramic capacitor	–
	C_boost_3	10 μF	Surface mount ceramic capacitor	–
	C_boost_4	100 nF	Surface mount ceramic capacitor	–
	C_boost_5	47 nF	Surface mount ceramic capacitor	–
	D_boost	d_schottky	Schottky Rectifier	MSS2P3 or similar
	L_boost	3.3 μH	Shielded Power Inductor	Select inductance according to the over current limitation
BUCK CORE	C_in_core1	2 × 4.7 μF	Surface mount ceramic capacitors	–
	C_in_core2			
	C_in_core3	2 × 100 nF	Surface mount ceramic capacitors	–
	C_in_core4			
	C_core_1	2 × 47 μF	Surface mount ceramic capacitors	consider to use additional capacitance in case it is necessary.
	C_core_2			

**(table continues...)**

**19 Application information**

**Table 149 (continued) BOM recommendation**

<b>Block</b>	<b>Symbol</b>	<b>Value</b>	<b>Description</b>	<b>Note</b>
	L_core_1	1 $\mu$ H	Shielded power inductor	Select inductor according to the over current limitation
	L_core_2	1 $\mu$ H	Shielded power inductor	Select inductor according to the over current limitation
	R_core_min_load	–	–	Pick accordingly to fulfill Minimum output current - BUCK CORE
	R_R3FBH	10 - 100 $\Omega$	–	optional: Only required if use case assumption requires it for safety reasons
	R_R3FBL	10 - 100 $\Omega$	–	optional: Only required if use case assumption requires it for safety reasons
BUCK IF	C_in_buck_IF1	1 $\mu$ F	Surface mount ceramic capacitors	–
	C_in_buck_IF2	100 nF	Surface mount ceramic capacitors	–
	C_buck_IF_1	47 $\mu$ F	Surface mount ceramic capacitors	–
	C_buck_IF_2	1 $\mu$ F	Surface mount ceramic capacitor	–
	C_buck_IF_3	100 nF	Surface mount ceramic capacitor	–
	L_buck_IF	2.2 $\mu$ H	Shielded power inductor	Select inductor according to the over current limitation
	R_buck_if_min_load	–	–	Pick accordingly to fulfill Minimum output current - BUCK IF
LDO_Capacitors	C_1QCO	4.7 $\mu$ F	Surface mount ceramic capacitor	–

**(table continues...)**

**19 Application information**

**Table 149 (continued) BOM recommendation**

Block	Symbol	Value	Description	Note
	C_2QCO	–	Surface mount ceramic capacitor	Redundant setup might be required for safety context. Dimension according to EC table of QCO.
	C_1QST	4.7 $\mu$ F	Surface mount ceramic capacitor	–
	C_2QST	–	Surface mount ceramic capacitor	Redundant setup might be required for safety context. Dimension according to EC table of QST.
	C_1QUC	4.7 $\mu$ F	Surface mount ceramic capacitor	–
	C_2QUC	–	Surface mount ceramic capacitor	Redundant setup might be required for safety context. Dimension according to EC table of QUC.
	C_1QVR	4.7 $\mu$ F	Surface mount ceramic capacitor	–
	C_2QVR	–	Surface mount ceramic capacitor	Redundant setup might be required for safety context. Dimension according to EC table of QVR.
	C_IQUC_in	100 nF	Surface mount ceramic capacitor	optional
	C_IQVR_in	100 nF	Surface mount ceramic capacitor	optional
ENA/WAK	C_ENA	10 nF	Surface mount ceramic capacitor	optional
	C_WAK	10 nF	Surface mount ceramic capacitor	optional
	R_ENA	10 k $\Omega$	Standard thick film chip resistor	optional
	R_WAK	10 k $\Omega$	Standard thick film chip resistor	optional

**19 Application information**

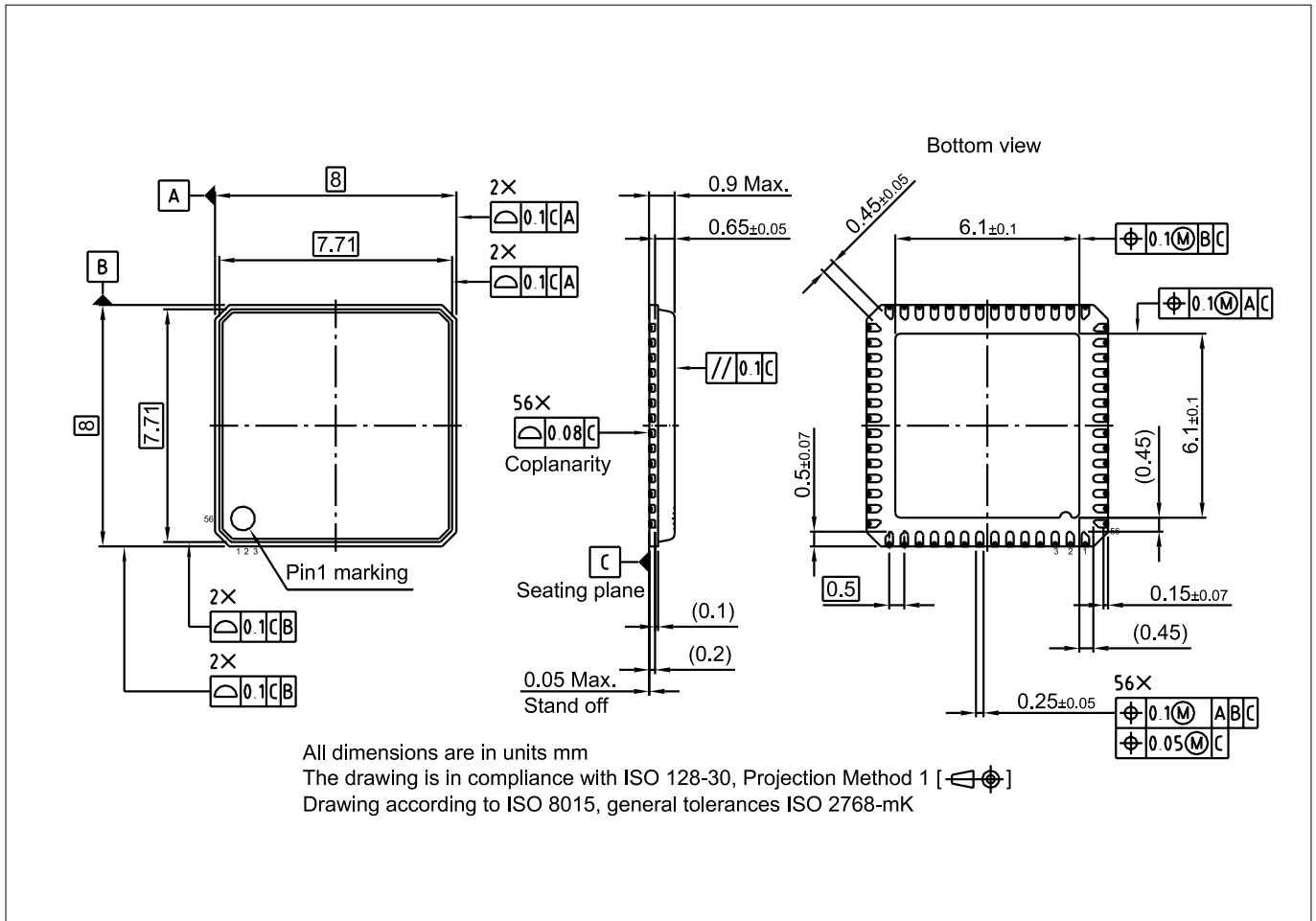
**Table 150 BOM deviation for output capacitances of switch mode power supplies**

<b>SMPS</b>	<b>Effective capacitance</b>	<b>Deviation</b>
PREREG	$C_{PR}[typ]$	-40%
BUCKCORE	$C_{buck\_core\_1/2}[typ]$	-30%
BUCKIF	$C_{BUCK\_IF}[typ]$	-40%
BOOST	$C_{bst}[typ]$	-40%

**Note:** *When deviating to the values, as specified in the table above, for the output capacitances of the switch mode regulators, the dynamic performance as specified in the datasheet can be impacted and it would require a dedicated assessment of the behavior in the application's context.*

**20 Package information**

**20 Package information**



**Figure 97 PG-VQFN-56**

**Green Product (RoHS compliant)**

To meet the world-wide customer requirements for environmentally friendly products and to be compliant with government regulations, the device is available as a Green Product. Green Products are RoHS compliant (Pb-free finish on leads and suitable for Pb-free soldering according to IPC/JEDEC J-STD-020).

**Information on packages**

For more information on packages, such as recommendations on assembly, refer to [www.infineon.com/packages](http://www.infineon.com/packages).

**21 Revision history**

**21 Revision history**

Revision	Date	Changes
1.00	2026-01-09	Datasheet created

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