Errata Sheet

TLE984xQX
Microcontroller with LIN and Power Switches for Automotive Applications

Overview

This document lists the deviations of the TLE984xQX "Microcontroller with LIN and Power Switches for Automotive Applications".

It is strongly recommended that the device behavior and possible proposed workarounds are considered for the application.

Table 1 Reference documents

Document type	Document reference	Issue Date
Data Sheet	See Table 2	
User Manual	Infineon-TLE984xQX-UM-v01_10-EN.pdf	2019-03-18

Table 2 List of affected products

Device	Reference Data Sheet	Issue Date
TLE9842-2QX	Infineon-TLE9842-2QX-DS-v01_00-EN.pdf	2016-05-06
TLE9842QX	Infineon-TLE9842QX-DS-v01_00-EN.pdf	2016-05-06
TLE9843-2QX	Infineon-TLE9843-2QX-DS-v01_00-EN.pdf	2016-05-06
TLE9843QX	Infineon-TLE9843QX-DS-v01_00-EN.pdf	2016-05-06
TLE9844-2QX	Infineon-TLE9844-2QX-DS-v01_00-EN.pdf	2016-05-06
TLE9844QX	Infineon-TLE9844QX-DS-v01_00-EN.pdf	2016-05-06
TLE9845QX	Infineon-TLE9845QX-DS-v01_00-EN.pdf	2016-05-06

Table of Contents

1 Product errata

This chapter lists the errata of the referenced products and documentation.

1.1 High-Side switch: Wrong OT_STS after wake from Stop mode without reset (0000048511-52)

Introduction

In Stop mode, the configuration of the driver is kept inside the corresponding SFR. If the driver was switched on before entering stop mode, after a wakeup its status is restored automatically. Under certain conditions it may be possible that an unintended HSx_OT_STS information will be set in the corresponding SFR.

Effects

This will lead to an automatic shutdown of the corresponding High-Side switch after Stop mode exit without reset.

1.1.1 Workaround

To avoid the described errata, the following workaround is recommended. With this workaround the unintended HSx_OT_STS information will be rese and the configuration of the driver is restored inside the corresponding SFR.

Code Listing 1: Recommended Stop mode entry with additional workaround

```
void SCU_EnterStopMode(void)
 {
  sint32 int_was_mask;
  uint32 dummy;
```

Workaround

```
  uint32 backup_HS_CTRL;

  /* backup current HS settings */
  backup_HS_CTRL = HS->CTRL.reg;

  /* disable the HSx switch)*/
  HS->CTRL.bit.HS1_EN = 0;
  HS->CTRL.bit.HS2_EN = 0;
  HS->CTRL.bit.HS1_ON = 0;
  HS->CTRL.bit.HS2_ON = 0;
```

```

  /* to remove compiler warning of unused   *
   * dummy variable                         */
  dummy = 0;
  dummy = dummy;
  /* dummy read to clr wake up status       *
   * to prevent the device from wakeing up *
   * immediately because of still set      *
```

Product errata

```
         * wake up flags                               */
        dummy = PMU->WAKE_STATUS.reg;
        /* stop WDT1 (SysTick) to prevent any          *
         * SysTick interrupt to disturb the            *
         * Sleep Mode Entry sequence                   */
        WDT1_Stop();
        /* Trigger a ShortOpenWindow on WDT1           *
         * to prevent an unserviced WDT1 by            *
         * accident                                    */
        WDT1_SOW_Service(1u);
        /* disable all interrupts                      */
        int_was_mask = CMSIS_Irq_Dis();

        /* select LP_CLK as sys clock                  */
        SCU_OpenPASSWD();
        SCU->SYSCON0.bit.SYSCLKSEL = 2U;
        SCU_ClosePASSWD();

        /* open passwd to access PMCON0 register */
        SCU_OpenPASSWD();

        /* set PowerDown flag in PMCON0              */
        SCU->PMCON0.reg = 0x04;
        __ASM("sev");
        __ASM("wfe");
        __ASM("wfe");
        __ASM("nop");
        __ASM("nop");
        __ASM("nop");
        __ASM("nop");

        /* dont do anything anymore                  *
         * device is in PowerDown Mode               */
        /***************************************/
        /********* DEVICE IN STOP MODE *********/
        /***************************************/
        /* Device has been woken up                  */
```

Workaround

Workaround

```
        /* begin: HS workaround */
        PMU->HIGHSIDE_CTRL.reg = (uint32)0;
        if (HS->IRQS.bit.HS1_OT_STS == 1)
        {
          HS->CTRL.bit.HS1_EN = 1;
          HS->IRQCLR.reg = (uint32)0x00002020;
        }

        if (HS->IRQS.bit.HS2_OT_STS == 1)
        {
          HS->CTRL.bit.HS2_EN = 1;
          HS->IRQCLR.reg = (uint32)0x20200000;
        }

        /* restore HS control register */
        HS->CTRL.reg = backup_HS_CTRL;
        /* end: HS workaround */

        /* switch fSYS back to                *
         * user configuration                 */
        SCU_OpenPASSWD();
        SCU->SYSCON0.reg = (uint8)0;
        SCU_ClosePASSWD();

        /* enable interrupts                   */
        if (int_was_mask == 0)
        {
          CMSIS_Irq_En();
        }

        /* Init SysTick                        */
        SysTick_Init();

        /* Init and service WDT1               */
        WDT1_Init();
      }
```

1.1.2 Planned fixes

Fix with product transfer planned, estimated distribution of PCN in 2022.

1.2 Temperature sensor selector not behaving as specified

Introduction

The TLE984x device contains two temperature sensors:

- lowside switch temperature sensor, measured at ADC2 - channel 5
- system/central temperature sensor, measured at ADC2 - channel 6

In normal operation, both temperature sensors show similar values.

The lowside switch temperature sensor (located near the two lowside switches) has the purpose to act as additional protection against temperature cycling (e.g. multiple switchoff relays, higher lowside currents in short time).

Description of behaviour

A selector is used to select the temperature sensor to be measured. This selector does not behave as specified. The measurement is done on the previously selected temperature sensor, not on the intended currently selected one.

The sequence of measurements in ADC2 is defined in the registers ADC2_SQ1_4 and ADC2_SQ5_8 (SQ1 up to SQ7, SQ8 is not used).

With the predefined sequences (which cannot be changed by the user), channel 5 and channel 6 are measured as follows:

- channel 5 (lowside) is measured in SQ1, SQ3, SQ5, SQ7
- channel 6 (system/central) is measured in SQ2, SQ4, SQ6

The scheduler executes the defined measurements in increasing order (SQ1 to SQ7, then wraparound). The measurements of other channels are executed as well of course, but have no influence on the temperature sensor selector.

This means that channel 5 and channel 6 are measured mainly alternately, despite of the wraparound-case, where channel 5 is measured twice in a row.

As a result, the measurement results **appear basically swapped**, only the measurement done in SQ1 shows correctly the channel 5 result, because channel 5 was already measured in SQ7.

Temperature effects at the lowside switch

Following figures based on measurements make the consequences more visible:

- Figure 1: lowside clamping, normal case (Vs = 13.5V, relay, 160 Ohm (nom.))
- Figure 2: lowside clamping, worst case (Vs maximized to reach 2mJ clamping energy, relay, 160 Ohm (nom.))
- Figure 3: lowside current, normal case (Vs = 13.5V, relay, 160 Ohm (nom.))
- reaching the max. lowside current (300mA +-10%) is unrealistic with a standard relay and has not been included in these examples, but the conclusions can be applied for this scenario as well.

Figure 1 shows the temperature effect of LS1 clamping in normal operating condition. The local heating effect caused by the clamping of the lowside can be seen in channel 6 instead of the expected channel 5, as the channels appear swapped. The short temperature increase caused by the clamping is <5Kelvin.

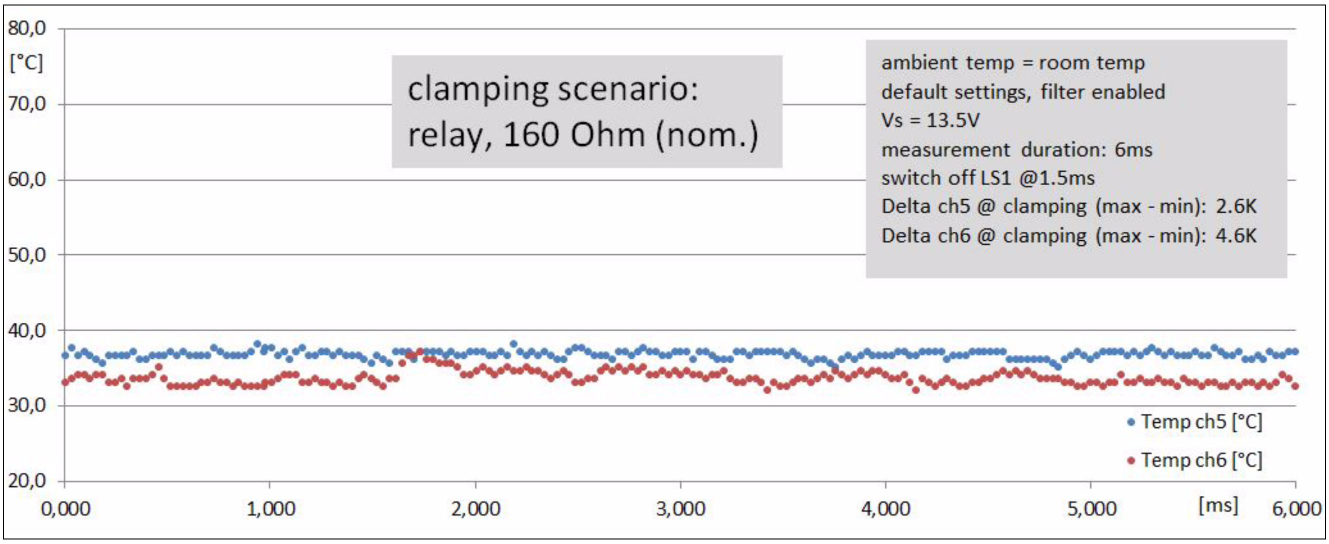

Figure 1 lowside clamping, normal case (Vs = 13.5V, relay, 160 Ohm (nom.))

Figure 2 shows the temperature effect of LS1 clamping at worst case conditions. Vs has been selected intentionally that high to reach 2mJ clamping energy as specified in P_12.1.17. Again, the short temperature increase can be seen in channel 6 instead of channel 5, and is <9Kelvin.

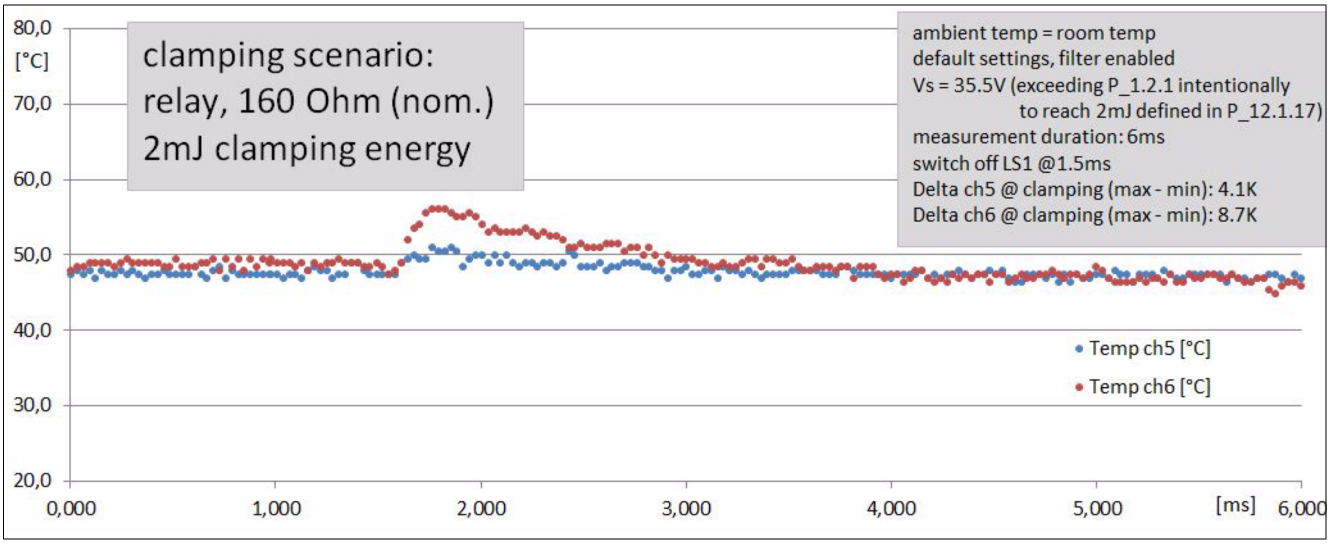

Figure 2 lowside clamping, worst case (Vs maximized to reach 2mJ clamping energy, relay, 160 Ohm (nom.))

Figure 3 shows the temperature effect of a relay current in normal operating condition. The local heating is <6Kelvin.

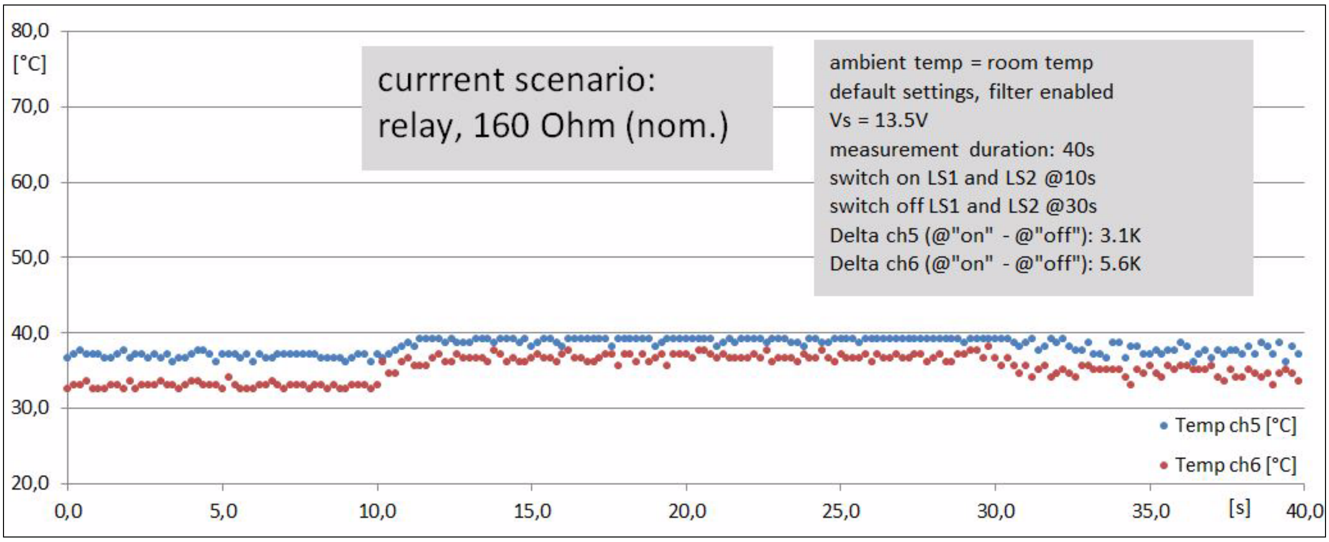

Figure 3 lowside current, normal case (Vs = 13.5V, relay, 160 Ohm (nom.))

For significantly deviating conditions (higher Vs, lower relay resistance) or other (non-relay) use-cases a separate, application-specific investigation is recommended.

Measurements at higher ambient temperatures have been done as well. The results are shifted up linearly, no additional effect (e.g. bigger delta temperature) has been observed.

Impact on protection functionality

The shutoff of the system is based on the lowside temperature, and the shutoff of the lowside is based on the system temperature, due to the swapping explained above.

System temperature shutoff and lowside temperature shutoff are both configured to 180°C (cannot be changed by the user), while T_j (max) is 150°C.

The delta temperature to trigger a wrong shutoff decision is therefore 30Kelvin. This value is never reached as the investigations above show.

Following scenarios and effects have been considered:

potential effect	scenario	based on	potential trigger
potential violation of operating range up to 150°C	system shutoff too early (below 150°C)	lowside temperature	lowside temperature more than 30Kelvin above system temperature, cannot happen (see measurements)
potential violation of operating range up to 150°C	lowside shutoff too early (below 150°C)	system temperature	system temperature more than 30Kelvin above lowside temperature, cannot happen (see measurements)
potential destruction	system shutoff too late (above destruction threshold)	lowside temperature	lowside temperature more than 30Kelvin below system temperature, cannot happen (see measurements)
potential destruction	lowside shutoff too late (above destruction threshold)	system temperature	system temperature more than 30Kelvin below lowside temperature, cannot happen (see measurements)

By default, the decision of a shutoff is taken on filtered results of the temperature measurement. This means, that a single outlier result (as caused by the wraparound from SQ7 to SQ1) crossing the threshold has no immediate effect. The filtering can be configured in the registers ADC2_FILT_UP_CTRL, ADC2_CNT4_7_UPPER.CNT_UP_CH5 and ...CH6 . It is recommended to leave the default settings unchanged.

Impact on readout of temperature values in user software

Additionally to the automated protection functions, the temperature values can also be read out by software.

This temperature readout feature has been used to generate the plots shown in **Temperature effects at the lowside switch**.

User software might take decisions based on these values. As mentioned above, the read values **appear basically swapped**. Again, in normal operation (no local lowside heating), both temperature sensors show similar values, as the plots in **Temperature effects at the lowside switch** show.

By default, the filtering is enabled (register ADC2_CTRL4.FILT_OUT_SEL_6_0). To avoid potential wrong decisions in user software based on single wrong values, it is recommended to leave the filtering enabled. As the values are not completely swapped (wraparound case), the resulting value of the system temperature deviates slightly, because with the default filter setting of 1/4 (configured in ADC2_FILTCOEFF0_7, cannot be changed by the user) sporadically lowside-results are mixed in.

If the temperature values are used in the user software, users should consider, dependent on the application, whether a change in software to cope with the swapping and with the additional deviation is necessary.

Summary

The temperature sensors for system and lowside temperature appear basically swapped.

In normal operation, both temperature sensors show similar values.

Protection functionality is not affected.

Readout functionality: If the temperature values are used in the user software, users should consider, dependent on the application, whether a change in software to cope with the swapping and with the additional deviation is necessary.

Planned Fix

No fix in silicon planned.

1.3 ADC1 accuracy

Topic

The electrical parameters listed below regarding ADC1 accuracy (i.e. covering the whole measurement chain) are valid not only in a restricted temperature range (T_j = -40°C to +125°C), but in the full temperature range (T_j = -40°C to +150°C). Therefore the restriction “Tj = -40..125°C” mentioned in the “Note” column is removed and the general condition in the table heading applies.

Deviation

Table 3 updated Data Sheet values

V_S = 5.5 V to 28 V, T_j= -40 °C to +150 °C, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Accuracy of V_{BAT_SENSE} / V_S after calibration - with IIR filter	ΔVBAT_SENSE_IIR, V_{S_IIR}	-200	–	200	mV	Vs= 5.5V to 18V, $f_{ADCI} = f_{sys\_max}$ ADC1_FILTCOEFF0_11.CHx = 11’b.	P_8.1.12
Accuracy of V_{BAT_SENSE} / V_S after calibration	ΔVBAT_SENSE, V_S	-300	–	300	mV	Vs= 5.5V to 18V, $f_{ADCI} = f_{sys\_max}$.	P_8.1.36
Accuracy of V_{MONx} sense after calibration - with IIR filter	ΔV_{MONx_IIR}	-241	–	241	mV	Vs= 5.5V to 18V, $f_{ADCI} = f_{sys\_max}$ ADC1_FILTCOEFF0_11.CHx = 11’b.	P_8.1.33
Accuracy of V_{MONx} sense after calibration - Reduced Operating Range - with IIR filter	$\Delta V_{MONx\_ROR\_IIR}$	-170	–	170	mV	[1] V_s= 5.5V to 18V, $V_{MONx,range}$= 0V to 12V, $f_{ADCI} = f_{sys\_max}$, ADC1_FILTCOEFF0_11.CHx = 11’b.	P_8.1.20
Accuracy of V_{MONx} sense after calibration	ΔV_{MONx}	-361	–	361	mV	[1] V_s= 5.5V to 18V, $f_{ADCI} = f_{sys\_max}$.	P_8.1.37
Accuracy of $V_{Port2.x}$ sense after calibration - with IIR filter	$\Delta V_{Port2.x\_IIR}$	-43	–	43	mV	Vs= 5.5V to 18V, $f_{ADCI} = f_{sys\_max}$ ADC1_FILTCOEFF0_11.CHx = 11’b.	P_8.1.34
Accuracy of $V_{Port2.x}$ sense after calibration	$\Delta V_{Port2.x}$	-67	–	67	mV	Vs= 5.5V to 18V, $f_{ADCI} = f_{sys\_max}$.	P_8.1.38

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

Planned Fix

Update in next revision of the Data Sheet.

1.4 ADC1 error (INL, Gain, TUE) and noise specification

Topic

The electrical parameters listed below regarding ADC1 error (i.e. referring to ADC1 as module - for the whole measurement chain refer to **ADC1 accuracy**) were specified inconsistantly regarding the TUE and the contributing elements in the Data Sheet.

For the definition of ADC-related electrical characteristics, please also refer to the Application Note "ADC measurement and specification", V1.1, Nov 2010 (AP32121).

1.4.1 Introductory sentence

Deviation

Introductory sentence in Chapter 28.9.2:

These parameters describe the conditions for optimum ADC performance. They already include the reference voltage V_{BG} and its variation.

(the first sentence is unchanged, the second sentence is added for clarification)

Planned Fix

Update in next revision of the Data Sheet.

1.4.2 INL error

Deviation

Table 4 A/D Converter Characteristics

V_S= 5.5 V to 28 V, , T_j= -40 °C to +150 °C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
INL error	EA_{INL}	–	–	± 1.5	LSB	–	P_9.2.9

The INL error value improves from ±3 to ±1.5 LSB.

Planned Fix

Update in next revision of the Data Sheet.

1.4.3 Gain error

Deviation

Table 5 A/D Converter Characteristics

V_S= 5.5 V to 28 V, , T_j= -40 °C to +150 °C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Gain error	EA_{GAIN}	–	–	± 0.54	% of FSR [1]	[2] calibrated; Gain Error is calibrated by implemented calibration unit	P_9.2.10

1) this Gain error is calibrated by IFX end of line
2) Not subject to production test

The gain error value improves from ±1.2% to ±0.54%.

Planned Fix

Update in next revision of the Data Sheet.

1.4.4 Total unadjusted error (TUE)

Deviation

Table 6 A/D Converter Characteristics

V_S= 5.5 V to 28 V, , T_j= -40 °C to +150 °C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Total unadjusted error	EA_{TUE}	–	–	± 8	LSB	already calibrated $f_{ADCI} = f_{sys\_max}$, ADC1_FILTCOEFF0_11.CHx = 11'b.	P_9.2.33
Total unadjusted error, without filter	EA_{TUE_nofilt}	–	–	± 12.4	LSB	already calibrated, without filter	P_9.2.35 (new)

The TUE values need to be specified in two separate parameters.

For P_9.2.33, the Note "$f_{ADCI} = f_{sys\_max}$, ADC1_FILTCOEFF0_11.CHx = 11'b." needs to be added, and the value improves from ±10 LSB to ±8 LSB. This covers the case that the averaging filter is switched on.

For the case without filter, P_9.2.35 is added.

Planned Fix

Update in next revision of the Data Sheet.

1.4.5 Input referred noise

Deviation

Table 7 A/D Converter Characteristics

V_S= 5.5 V to 28 V, , T_j= -40 °C to +150 °C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Input referred noise	V_{Noise_LSB}	–	–	1.5	LSB rms	1)	P_9.2.34

1) Not subject to production test

The Input referred noise value of 1.5LSB rms remains unchanged. Two restrictions (regarding temperature and averaging) are removed, i.e. the value is valid over the whole temperature range and without averaging.

Planned Fix

Update in next revision of the Data Sheet.

2 Application hint

2.1 ADC1 (HV-Channel) sampling switch activation

Behavior

Fast transients on the enabled ADC1 HV-Channel could activate the ADC sampling switch, which will lead to a load of 10 kΩ (+/- 20%) on the causing channel.

In case the corresponding channel will be selected (sequencter, etc.), the additional load will disappear again.

Effects

The activation will increase the input current (> 100 µA @ V_S 13.5 V) on corresponding MONx pin. This increased current can cause a voltage drop via the external resistor. Depending on the size of the resistor the voltage drop can be so high, that a wrong low signal on the MONx will be detected.

2.1.1 Workaround

To achive robustness against ISO 7637-3 pulses, the recommended R-C filter from the "Reference Data Sheet" is sufficient. To increase the robustness an additional 10nF capacitoir (C_{1MONx}) is recommended. This will lead to a C-R-C filter. See **Figure 4**.

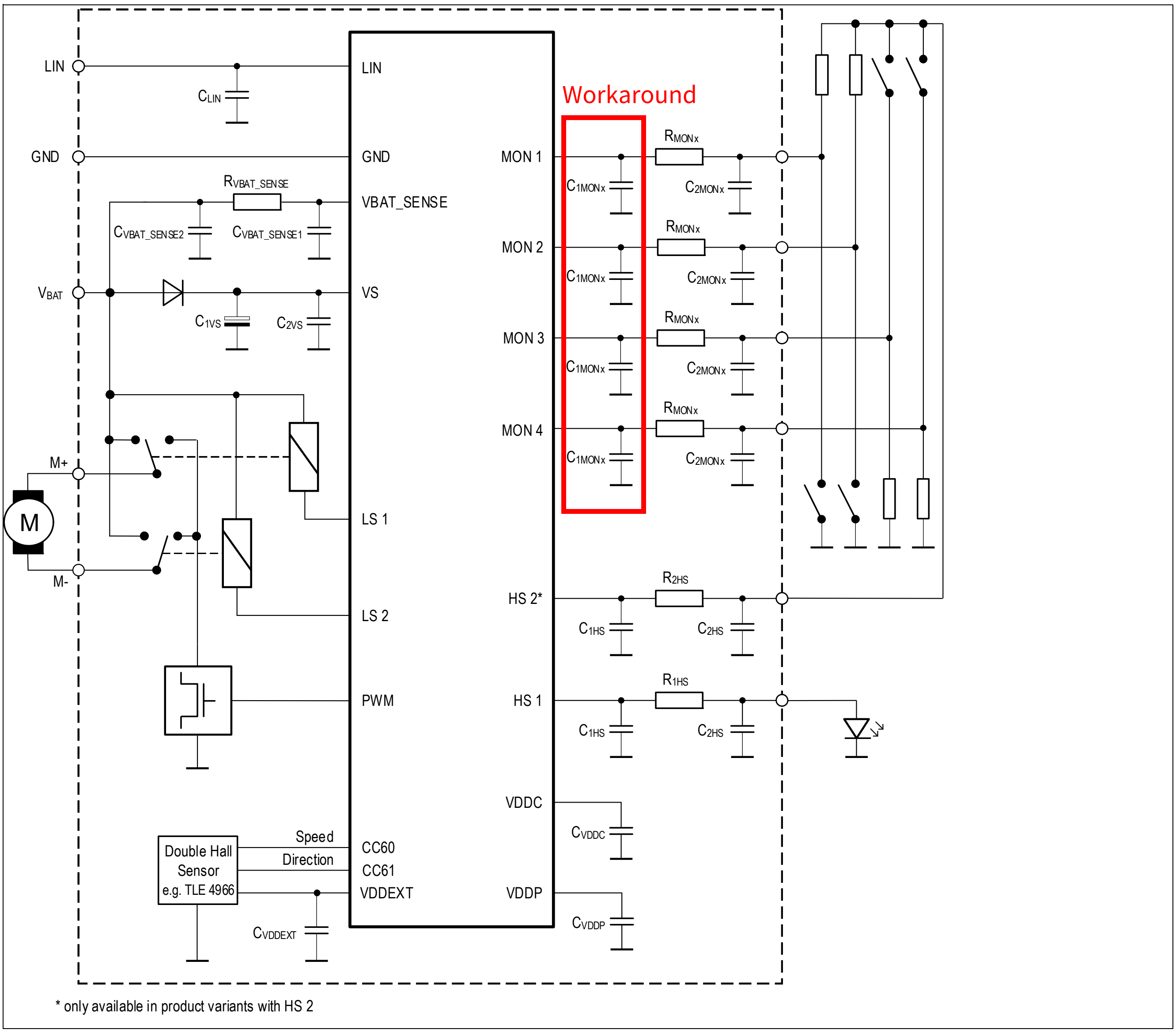

Figure 4 Updated application information

2.1.2 Planned fixes

No fix planned.

3 Revision history

Revision	Date	Changes
1.0	2017-05-26	Initial release
2.0	2020-04-20	High-Side switch: Wrong OT_STS after wake from Stop mode without reset (0000048511-52) added ADC1 (HV-Channel) sampling switch activation added

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