TLE7368 – Frequently Asked Questions

Multi Voltage Power Supply System

Z8F52274263

Application Note

Rev. 1.01, 2015-09-21

Automotive Power

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1 Abstract

Note: The following information is given as a hint for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.

This Application Note is intended to provide additional information for implementing the TLE7368 as a multiple voltage supply into new applications. Frequently asked questions by designers are listed here, which occurred during design-in of the TLE7368. This application note is a summary of these questions and will be updated, please look for the latest revision.

2 Introduction

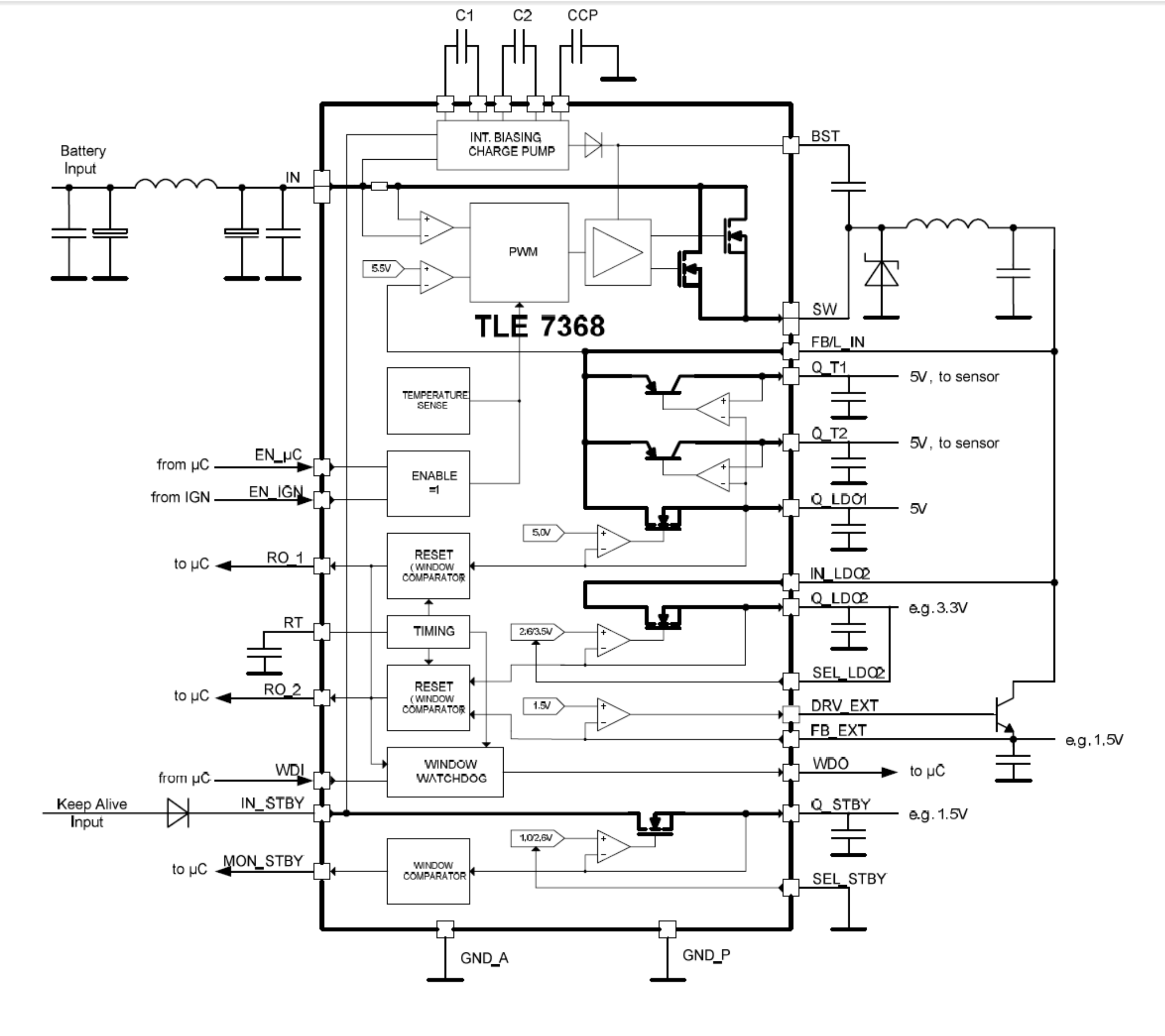

Figure 1 TLE7368 Application Circuit

The TLE7368 is a microcontroller power supply system. A step down converter operates as pre-regulator at a fixed switching frequency of 370 kHz. The pre-regulator supplies:

Table 1 Output Capability of the Regulators

Regulator	Output Voltage	Max. Output Current
LDO_1 Linear Voltage Regulator	5.0 V ± 2%	800 mA
LDO_2 Linear Voltage Regulator	3.3 V or 2.6 V, selectable, ±2%	700 mA
LDO_3 Linear Voltage Regulator with external power stage	1.5 V ±2% (TLE7368) 1.2 V ±2% (TLE7368-2) 1.3 V ±2% (TLE7368-3)	–
T1 Tracker, following LDO_1	5.0 V	105 mA
T2 Tracker, following LDO_2	5.0 V	50 mA
Standby Linear Regulator, e.g. for memory modules	1.0 V or 2.6 V, selectable	30 mA

All regulators are fully overcurrent protected.

LDOs 1 to 3 are monitored by two reset signals; a window watchdog is included to supervise the microcontroller.

For further details please refer to the data sheet.

3 Questions and Answers

3.1 Input voltage, Quiescent current etc.

Q: The minimum Ignition pull-down current is -100 µA, what is the maximum?

Assuming a variation of the pull down resistor of 30%, the maximum value is assumed to be -130µA.

Q: What is the test level of the Enable inputs?

The Enable signals "EN_IGN" and "EN_µC" are tested according to the following table:

Table 2 Result: Injection @ VBAT_IGN

TEST PULSE	Max Test Level VS	Functional Status	Pulse Duration	Pulse Cycle Time and Generator Impedance
1	-200 V (10 min)	C	2 ms	500 ms; 10 Ω
2a	+200 V (10 min)	C	50 µs	500 ms; 10 Ω
3a	-300 V (10 min)	C	100 ns	100 ms; 50 Ω
3b	+200 V (5 min)	C	100 ns	100 ms; 50 Ω

Functional status C means, that the function might be interrupted, but the device has to operate without any degradation after being restarted.

Q: What is the use of the recommended 10 kΩ resistor at the Enable inputs?

This resistor is necessary to limit incoming current (ESD-pulses applied to the connectors) during ESD testing of the device to protect the structure.

Q: What is the maximum current consumption of IN_STBY?

Measurements have shown, that with rising V_IN (at around 3.0 V, starting from 0 V) the current consumption of IN_STBY increases up to 2–3 mA, with a further increase of V_IN the current consumption reduces to around 120 µA.

The expected quiescent currents are:

120 µA = I_IN_STBY-I_Q_STBY, if EN_IGN = L, EN_µC = L and MONSTBY = H

130 µA = I_IN_STBY-I_Q_STBY, if EN_IGN = L, EN_µC = L, MONSTBY = H and SEL_STBY = GND.

If one Enable signal or both Enable signals are high, and V_BAT = 13.5 V (at IN_STBY), the device is on (meaning pre-regulator is active, charge pump is active, LDOs and trackers are on but with no load). In this case the expected current consumption is 18 to 22 mA. The higher current consumption occurring only at low input voltage (1.5 to 2.0 V, which is far below the operating range) is due to the fact, that the internal power supplies and control electronics, but mostly the Standby regulator, are activated. These circuits do not have a power on reset. Therefore the increased current consumption will not occur at higher input voltages which are within the specified operating range.

3.2 DC/DC regulator (pre-regulator)

Q: Is it possible to use the bootstrap voltage to drive an additional MOSFET?

No, it is not recommended to use the bootstrap voltage otherwise than to supply the TLE7368 itself. The internal charge pump is not designed (or capable) to drive loads other than the internal transistor. If the bootstrap voltage will be used for additional loads, this mode is outside specification and has to be evaluated by the user.

Q: What is the recommended value for the bootstrap capacitor?

The bootstrap capacitor is used to supply the pre-regulator driver. A higher value will stabilize the voltage supply and thus ensure a proper ramp up. The minimum value recommended is 100 nF. During start up the capacitor is charged with 3 mA.

Q: How does the input FB/L_IN behave during change to 100% duty cycle (Switch mode >constant on)?

The voltage at FB/L_IN will always stay within the specified range from 5.4 to 6.4 V. There might be a slight increase between switch mode and constant on. This will not be visible at the LDO outputs, however.

3.3 LDOs (Linear regulators)

Q: What should be considered choosing an external transistor for LDO_3?

This regulator was developed for quick response to load variation, especially for fast load current increase to avoid a reset at the µC due to a related voltage decrease. The regulator response time Δt is approximately 400 ns (tolerance +/- 20%); the Reset headroom is ≥ 40 mV. At a nominal output voltage of 1.530 V the tolerance of the output voltage is only +/- 1.7%, the minimum Reset threshold is 1.425 V. To achieve these values a very fast transistor (like the types mentioned in the data sheet) has to be used. The data sheet gives the values for transit frequency and current gain.

Q: How do the LDOs 1 to 3 behave in short circuit or overload condition? Do LDOs 1 and 2 have an individual temperature sensor?

Output currents are limited to the specified values. The LDOs do not have individual temperature sensors, there is a central temperature sensor, the position is shown in **Chapter 3.9**.

3.4 Voltage Trackers

Q: What happens, if one or both Trackers are shorted to Ground?

The tracker current will be limited to the maximum current. Depending on the location of the short circuit the tracker voltage may be reduced to zero. The function of the LDOs and the other trackers will not be degraded; no Reset signal will be applied. However, that additional power dissipation heating the TLE7368 must be considered. The maximum power dissipation allowed is the intermediate circuit voltage multiplied by the maximum current of the tracker.

Q: What happens if one or both Trackers are shorted to Battery Voltage?

The tracker is short circuit proof against battery voltage. A small current of some hundred microamperes to some milliamperes may flow into the pin, but will not affect the pre-regulator nor degrade the function of the other LDOs and the other tracker. No Reset signal will be applied.

Q: If one or both Trackers are shorted to Battery Voltage, battery voltage is switched off at Pins IN, but present at IN_STBY and EN_µC and EN_IGN are off, will the LDOs supply voltage?

No. If the device is switched off, neither the LDOs nor the trackers could be enabled by so called reverse charging.

Q: If one or both Trackers are used to supply lower current than the maximum specified, is it possible to decrease the size of the output capacitors accordingly?

For the tracker output capacitors the data sheet specifies a minimum value of 4.7 µF and a maximum ESR of 3 Ω. This value ensures the stability of the tracker under all conditions. For the application a smaller capacitor might be sufficient, but the user has to evaluate the stability on his own responsibility.

Q: If one or both Trackers are shorted to ground, do they have their own temperature sensing?

No, there is only one temperature sensor on the chip. The temperature sensor is located such, that any overtemperature might be detected. In case of overtemperature the pre-regulator (DC/DC-stage) is disabled. It will restart as soon as the chip temperature has decreased below the specified values. The position of the temperature sensor is shown in **Chapter 3.9**.

Q: What is the Test Level of the tracker outputs?

Trackers 1 and 2 are tested according to the following table:

Table 3 Result: Injection @ VBAT_IGN

TEST PULSE	Max Test Level VS	Functional Status	Pulse Duration	Pulse Cycle Time and Generator Impedance
1	-200 V (10 min)	C	2 ms	500 ms;10 Ω
2a	+200 V (10 min)	C	50 µs	500 ms; 10 Ω
3a	-300 V (10 min)	C	100 ns	100 ms; 50 Ω
3b	+200 V (5 min)	C	100 ns	100 ms; 50 Ω

Functional status C means, that the function might be interrupted, but the device has to operate without any degradation after being restarted.

3.5 Standby Regulator

Q: Signal MON_STBY: How does this signal behave if the input voltage decreases?

If the Input voltage at pins IN and IN_STDBY is continuously lowered from 4 V to 0 V, the MON_STBY detects undervoltage. If the input voltage is further lowered, the signal gets “high” (current value of V_IN) again below 1.25 V . This behavior is shown in **Figure 2**.

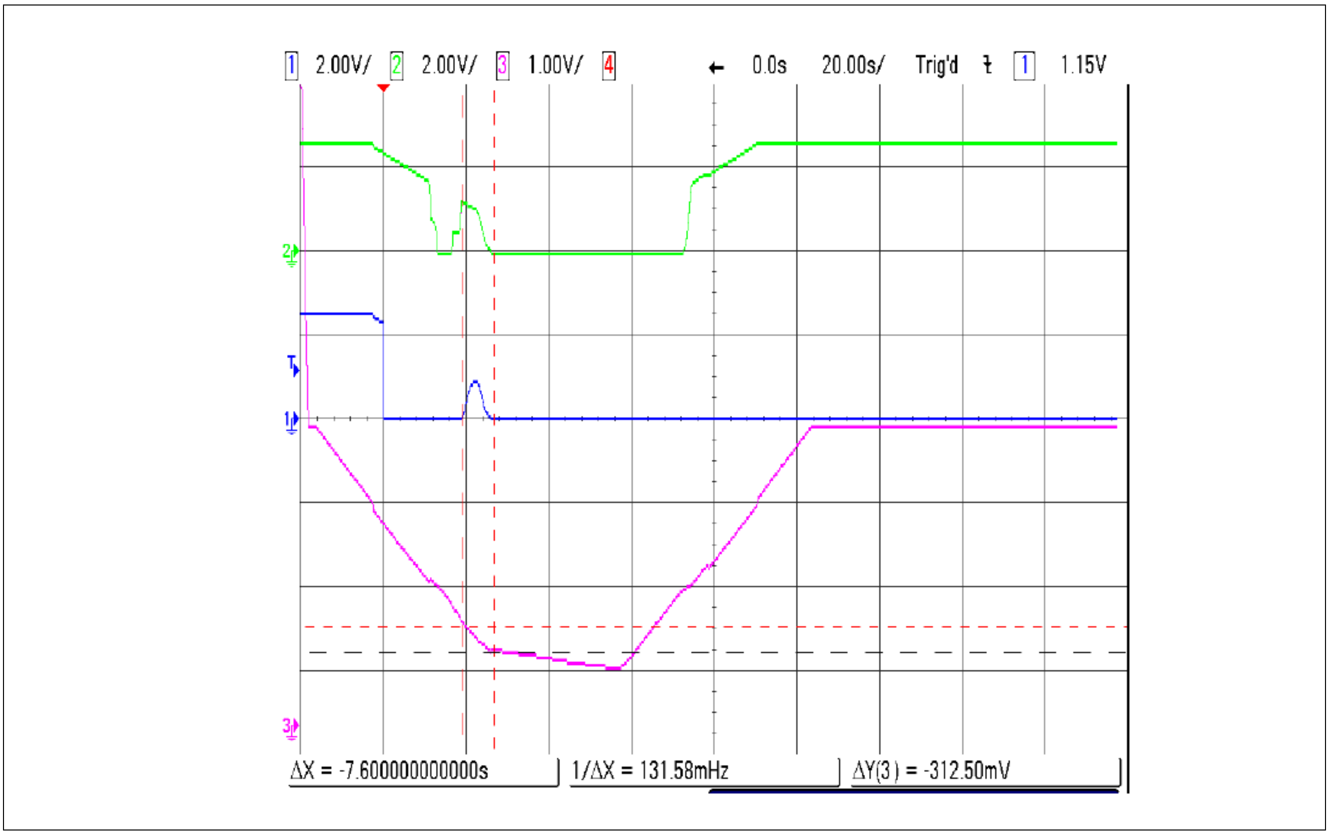

Figure 2 Behavior of the MON_STBY at decreasing input voltage (Q_STBY = 2.6 V)

Channel 1 (blue): MON_STBY

Channel 2 (green): Q_STBY

Channel 3 (pink): V_IN

The operating range of the regulator is between 3.0 and 45 V. Within these thresholds the output voltage is in the specified range, therefore between 2.75 and 3.00 V undervoltage detection is activated. Undervoltage detection is done via an open-drain structure pulling the output to ground. The device used is a DMOS with a threshold of about 1.4 V. Below 1.4 V the behavior strongly depends on the external pull-up resistor. The Standby regulator has its own bandgap, but at very low input voltage the bandgap will not work properly. The effect of the opening open drain structure (MON_STDBY goes high again) depends on this.

3.6 Reset Signals

Q: Reset Signals RO_1 and RO_2: At which input voltage or at deactivating the TLE7368 via EN_µC? Or EN_IGN will the signal be inactive again?

The signals RO_1 and RO_2 only depend on the values of the output voltages. If they are within the specified range (please refer to data sheet lines 4.4.75 to 4.4.114), the signals will be inactive.

3.7 Window Watchdog

Q: Is there additional information available on the function of the window watchdog?

Please refer to the dedicated Application Note “AN-Z8F52274263-TLE7368-Window_Watchdog”.

For further information please contact your local Infineon representative, he will be glad to support you.

3.8 Electromagnetic Compatibility (EMC)

Q: Is there an EMC test report available?

The EMC test report is available on request. Please contact your local Infineon representative.

Q: Where can I get additional support for designing an EMC appropriate layout?

There is an Application Note available about filter design, which provides EMC information. In addition you may take the demo board as a reference. The EMC test report contains details about filtering and emission levels.

3.9 Internal Architecture

Q: Where is the temperature sensor located?

The following figure shows the location of the temperature sensor between LDOs 1 and 2 and close to the trackers, where the maximum power dissipation is expected:

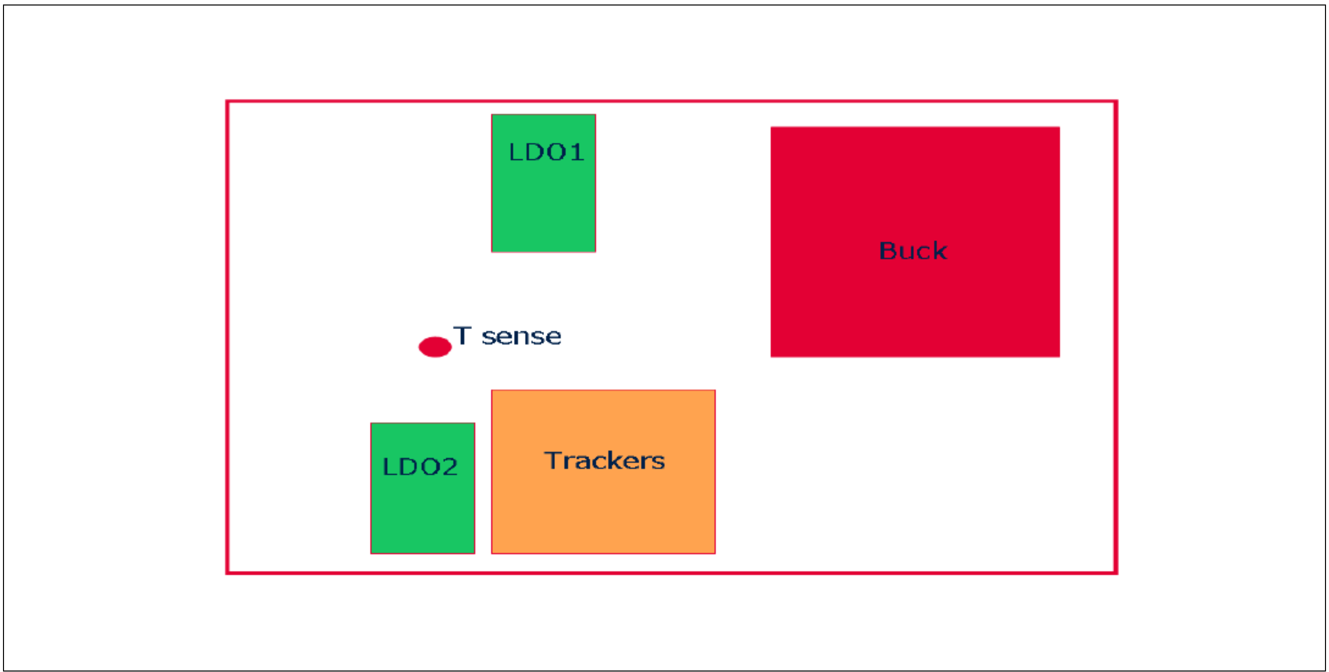

Figure 3 Location of temperature sensor

Q: How many bandgaps are in the TLE7368?

The TLE7368 has one central bandgap, which is temperature compensated. All reference voltages for the regulators and reset signals are derived from this bandgap.

Q: How is ensured, that at ramping up the overvoltage (reset) references will not be effected?

Please refer to the following block diagram showing how the references for the LDOs 1 to 3 are derived:

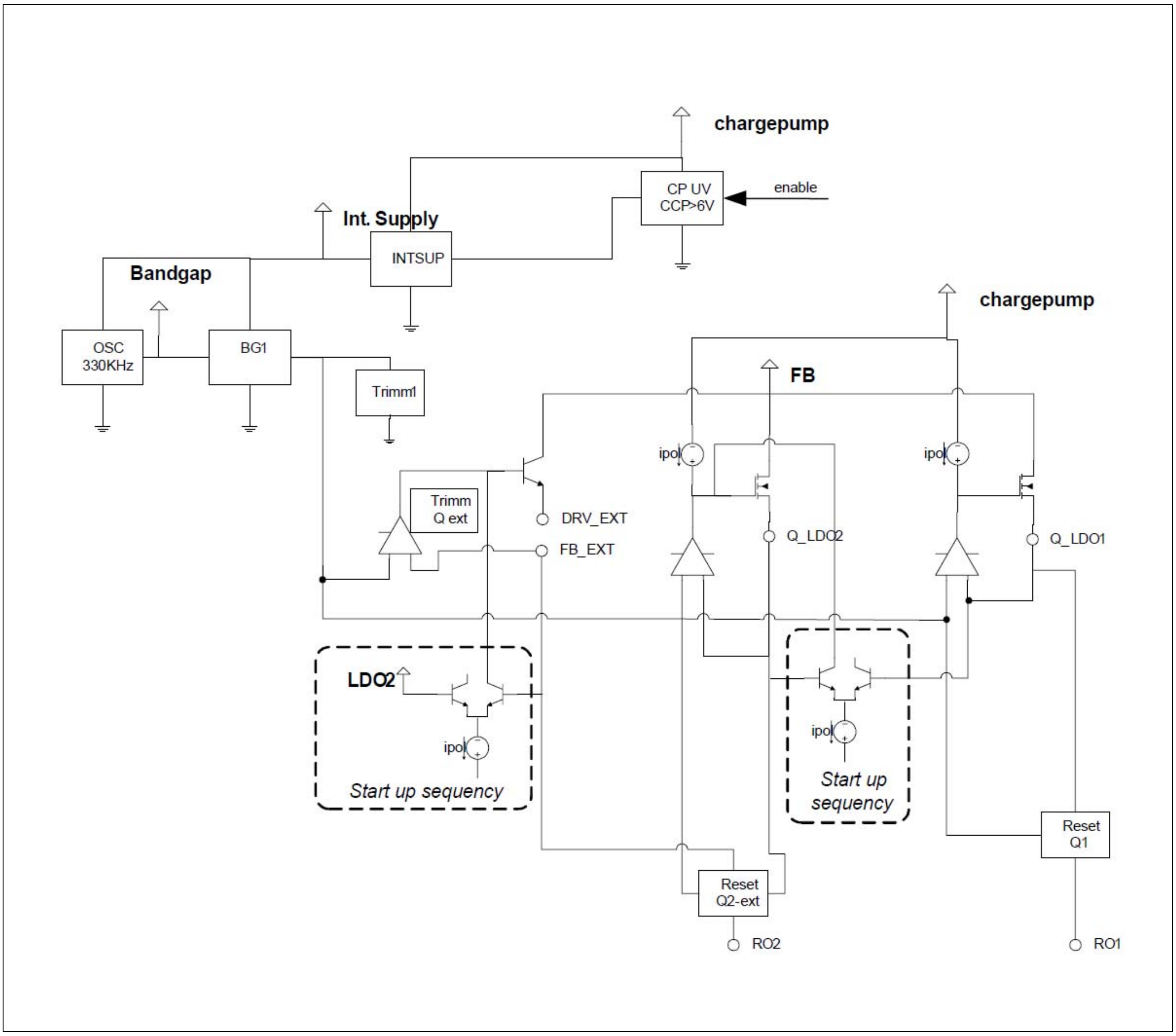

Figure 4

LDO_1 has its own reset block. LDO_2 and the external LDO_3 are monitored together. An additional monitoring of the bandgap is not included in the TLE7368. During the design of the bandgap special attention was paid to the stability to avoid an overshoot during ramping up. The function was verified by several simulations as well as by testing.

All reference voltages are derived from one single bandgap, thus it is ensured that during ramping up no LDO or tracker voltage will rise faster than another or the relating reset threshold (Power sequencing).

4 Additional Information

- Please contact your local Infineon representative for further assistance and additional information
- For further information you may contact **http://www.infineon.com/**

5 Revision History

Revision	Date	Changes
1.01	2015-09-22	Infineon Style Guide update (EDD41). Editorial changes.
1.0	2008-09-30	Application Note created.

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