

Integrated Power Management Unit Top Specification

Check for

Samples: [TPS65910](#), [TPS65910A](#), [TPS65910A3](#), [TPS659101](#), [TPS659102](#), [TPS659103](#), [TPS659104](#), [TPS659105](#), [TPS659106](#), [TPS659107](#), [TPS659108](#), [TPS659109](#)

FEATURES

The purpose of the TPS65910 device is to provide the following resources:

- Embedded power controller
- Two efficient step-down dc-dc converters for processor cores
- One efficient step-down dc-dc converter for I/O power
- One efficient step-up 5-V dc-dc converter
- SmartReflex™ compliant dynamic voltage management for processor cores
- 8 LDO voltage regulators and one RTC LDO (internal purpose)
- One high-speed I²C interface for general-purpose control commands (CTL-I²C)
- One high-speed I²C interface for SmartReflex Class 3 control and command (SR-I²C)
- Two enable signals multiplexed with SR-I²C, configurable to control any supply state and processor cores supply voltage
- Thermal shutdown protection and hot-die detection
- A real-time clock (RTC) resource with:
 - Oscillator for 32.768-kHz crystal or 32-kHz built-in RC oscillator
 - Date, time and calendar
 - Alarm capability
- One configurable GPIO
- DC-DC switching synchronization through internal or external 3-MHz clock

APPLICATIONS

- Portable and handheld systems
- OMAP3 power management

DESCRIPTION

The TPS65910 is an integrated power-management IC available in 48-QFN package and dedicated to applications powered by one Li-Ion or Li-Ion polymer battery cell or 3-series Ni-MH cells, or by a 5-V input; it requires multiple power rails. The device provides three step-down converters, one step-up converter, and eight LDOs and is designed to support the specific power requirements of OMAP-based applications.

Two of the step-down converters provide power for dual processor cores and are controllable by a dedicated class-3 SmartReflex interface for optimum power savings. The third converter provides power for the I/Os and memory in the system.

The device includes eight general-purpose LDOs providing a wide range of voltage and current capabilities; they are fully controllable by the I²C interface. The use of the LDOs is flexible; they are intended to be used as follows: Two LDOs are designated to power the PLL and video DAC supply rails on the OMAP based processors, four general-purpose auxiliary LDOs are available to provide power to other devices in the system, and two LDOs are provided to power DDR memory supplies in applications requiring these memories.

In addition to the power resources, the device contains an embedded power controller (EPC) to manage the power sequencing requirements of the OMAP systems and an (RTC).

[Figure 1](#) shows the top-level diagram of the device.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

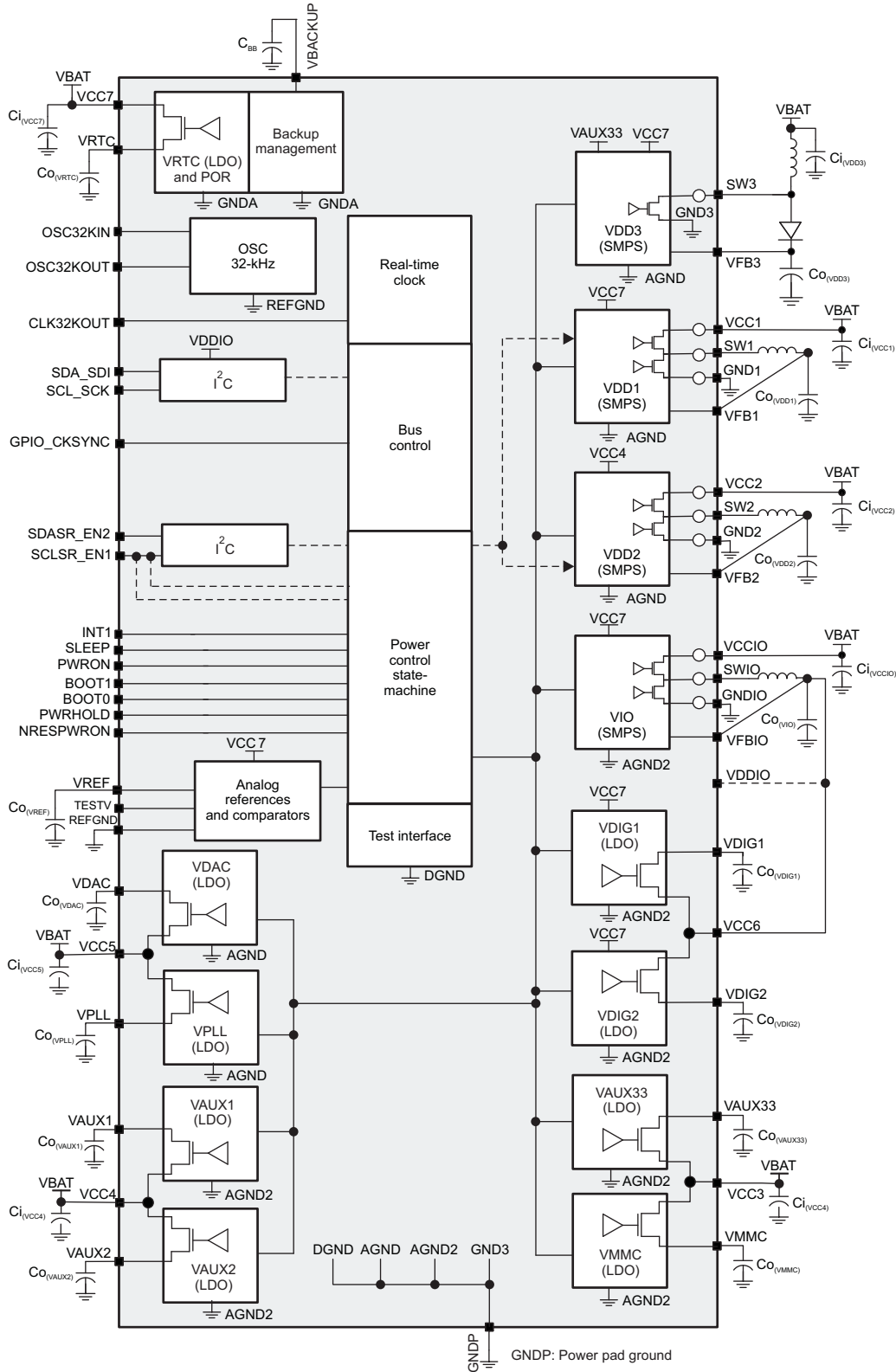


Figure 1. 48-QFN Top-Level Diagram

SWCS046-001

Table 1. SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS

| Compatible Processor ⁽¹⁾ | Part Number ⁽¹⁾ |
|---|----------------------------|
| TI processor - AM335x with DDR2 | TPS65910AA1RSL |
| TI processor - AM335x with DDR3 | TPS65910A3A1RSL |
| TI processor - AM335x with DDR3 ⁽²⁾ | TPS65910A31A1RSL |
| TI processors - AM1705/07, AM1806/08, AM3505/17, AM3703/15, DM3730/25, OMAP-L137/38, OMAP3503/15/25/30, TMS320C6742/6/8 | TPS65910A1RSL |
| Samsung - S5PV210, S5PC110 | TPS659101A1RSL |
| Rockchip - RK29xx, RK30xx | TPS659102A1RSL |
| Samsung - S5PC100 | TPS659103A1RSL |
| Samsung - S5P6440 | TPS659104A1RSL |
| TI processors - DM643x, DM644x | TPS659105A1RSL |
| Reserved | TPS659106A1RSL |
| Freescale - i.MX27, Freescale - i.MX35 | TPS659107A1RSL |
| Freescale - i.MX508 | TPS659108A1RSL |
| Freescale - i.MX51 | TPS659109A1RSL |

(1) The RSL package is available in tape and reel. See for details for corresponding part numbers, quantities and ordering information.

(2) Refer to SWCU093 document.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)

Stresses beyond those listed under below may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated below are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

The absolute maximum ratings for the TPS65910 device are listed below:

| PARAMETER | MIN | MAX | UNIT |
|---|------|----------------------------|------|
| Voltage range on pins/balls VCC1, VCC2, VCCIO, VCC3, VCC4, VCC5, VCC6, VCC7 | -0.3 | 7 | V |
| Voltage range on pins/balls VDDIO | -0.3 | 3.6 | V |
| Voltage range on pins/balls OSC32KIN, OSC32KOUT, BOOT1, BOOT0 | -0.3 | VRTC _{MAX} + 0.3 | V |
| Voltage range on pins/balls SDA_SDI, SCL_SCK, SDASR_EN2, SCLSR_EN1, SLEEP, INT1, CLK32KOUT, NRESPWRON | -0.3 | VDDIO _{MAX} + 0.3 | V |
| Voltage range on pins/balls PWRON | -0.3 | 7 | V |
| Voltage range on pins/balls PWRHOLD ⁽¹⁾ GPIO_CKSYNC ⁽²⁾ | -0.3 | 7 | V |
| Functional junction temperature range | -45 | 150 | °C |
| Peak output current on all other terminals than power resources | -5 | 5 | mA |

(1) I/O supplied from VDDIO but which can be driven from to a VBAT voltage level

(2) I/O supplied from VRTC but can be driven to a VBAT voltage level

THERMAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

| Package | R _{θja} (°C/W) | TA < 25°C Power Rating (W) | DERATING FACTOR ABOVE 25 °C (mW/°C) | TA = 70°C Power (W) | TA = 85°C Power Rating (W) |
|------------|-------------------------|----------------------------|-------------------------------------|---------------------|----------------------------|
| RSL 48-QFN | 37 | 2.6 | 37 | 1.48 | 1 |

The thermal resistance R_{θJP} junction-to-power PAD of the RSL package is 1.1°C/W

The value of thermal resistance R_{θJA} junction-to-ambient was measured on a high K.

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

Lists of the recommended operating maximum ratings for the TPS65910 device are given below.

Note1: VCC7 should be connected to the highest supply that is connected to the device VCCx pin. The exception is that VCC2 and VCC4 can be higher than VCC7.

Note2: VCC2 and VCC4 must be connected together (to the same voltage).

Note3: If VDD3 boost is used, VAUX33 must be set to 2.8 V or higher and enabled before VDD3.

| PARAMETER | TEST CONDITIONS | MIN | NOM | MAX | UNIT |
|---|-------------------------------|------|---------|------|------|
| V _{CC} : Input voltage range on pins/balls VCC1, VCC2, VCCIO, VCC3, VCC4, VCC5, VCC7 | | 2.7 | 3.6 | 5.5 | V |
| V _{CCP} : Input voltage range on pins/balls VCC6 | | 1.7 | 3.6 | 5.5 | V |
| Input voltage range on pins/balls VDDIO | | 1.65 | 1.8/3.3 | 3.45 | V |
| Input voltage range on pins/balls PWRON | | 0 | 3.6 | 5.5 | V |
| Input voltage range on pins/balls SDA_SDI, SCL_SCK, SDASR_EN2, SCLSR_EN1, SLEEP | | 1.65 | VDDIO | 3.45 | V |
| Input voltage range on pins/balls PWRHOLD, GPIO_CKSYNC | | 1.65 | VDDIO | 5.5 | V |
| Input voltage range on balls BOOT1, BOOT0, OSC32KIN | | 1.65 | VRTC | 1.95 | V |
| Operating free-air temperature, T _A | | -40 | 27 | 85 | °C |
| Junction temperature T _J | | -40 | 27 | 125 | °C |
| Storage temperature range | | -65 | 27 | 150 | °C |
| Lead temperature (soldering, 10 s) | | | 260 | | °C |
| Power References | | | | | |
| VREF filtering capacitor C _{O(VREF)} | Connected from VREF to REFGND | | 100 | | nF |
| VDD1 SMPS | | | | | |
| Input capacitor C _{I(VCC1)} | X5R or X7R dielectric | | 10 | | μF |
| Filter capacitor C _{O(VDD1)} | X5R or X7R dielectric | 4 | 10 | 12 | μF |
| C _O filter capacitor ESR | f = 3 MHz | | 10 | 300 | mΩ |
| Inductor L _{O(VDD1)} | | | 2.2 | | μH |
| L _O inductor dc resistor DCR _L | | | | 125 | mΩ |
| VDD2 SMPS | | | | | |
| Input capacitor C _{I(VCC2)} | X5R or X7R dielectric | | 10 | | μF |
| Filter capacitor C _{O(VDD2)} | X5R or X7R dielectric | 4 | 10 | 12 | μF |
| C _O filter capacitor ESR | f = 3 MHz | | 10 | 300 | mΩ |
| Inductor L _{O(VDD2)} | | | 2.2 | | μH |
| L _O inductor dc resistor DCR _L | | | | 125 | mΩ |
| VIO SMPS | | | | | |
| Input capacitor C _{I(VIO)} | X5R or X7R dielectric | | 10 | | μF |
| Filter capacitor C _{O(VIO)} | X5R or X7R dielectric | 4 | 10 | 12 | μF |
| C _O filter capacitor ESR | f = 3 MHz | | 10 | 300 | mΩ |
| Inductor L _{O(VIO)} | | | 2.2 | | μH |
| L _O inductor dc resistor DCR _L | | | | 125 | mΩ |
| VDIG1 LDO | | | | | |
| Input capacitor C _{I(VCC6)} | X5R or X7R dielectric | | 4.7 | | μF |
| Filtering capacitor C _{O(VDIG1)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VDIG2 LDO | | | | | |
| Filtering capacitor C _{O(VDIG2)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VPLL LDO | | | | | |
| Input capacitor C _{I(VCC5)} | X5R or X7R dielectric | | 4.7 | | μF |
| Filtering capacitor C _{O(VPLL)} | | 0.8 | 2.2 | 2.64 | μF |

RECOMMENDED OPERATING CONDITIONS (continued)

over operating free-air temperature range (unless otherwise noted)

Lists of the recommended operating maximum ratings for the TPS65910 device are given below.

Note1: VCC7 should be connected to the highest supply that is connected to the device VCCx pin. The exception is that VCC2 and VCC4 can be higher than VCC7.

Note2: VCC2 and VCC4 must be connected together (to the same voltage).

Note3: If VDD3 boost is used, VAUX33 must be set to 2.8 V or higher and enabled before VDD3.

| PARAMETER | TEST CONDITIONS | MIN | NOM | MAX | UNIT |
|--|---|-------|--------|-------|---------------------|
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VDAC LDO | | | | | |
| Filtering capacitor C _{O(VDAC)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VMMC LDO | | | | | |
| Input capacitor C _{I(VCC4)} | X5R or X7R dielectric | | 4.7 | | μF |
| Filtering capacitor C _{O(VMMC)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VAUX33 LDO | | | | | |
| Filtering capacitor C _{O(VAUX33)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VAUX1 LDO | | | | | |
| Input capacitor C _{I(VCC3)} | X5R or X7R dielectric | | 4.7 | | μF |
| Filtering capacitor C _{O(VAUX1)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VAUX2 LDO | | | | | |
| Filtering capacitor C _{O(VAUX2)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VRTC LDO | | | | | |
| Input capacitor C _{I(VCC7)} | X5R or X7R dielectric | | 4.7 | | μF |
| Filtering capacitor C _{O(VRTC)} | | 0.8 | 2.2 | 2.64 | μF |
| C _O filtering capacitor ESR | | 0 | | 500 | mΩ |
| VDD3 SMPS | | | | | |
| Input capacitor C _{I(VDD3)} | X5R or X7R dielectric | | 4.7 | | μF |
| Filter capacitor C _{O(VDD3)} | X5R or X7R dielectric | 4 | 10 | 12 | μF |
| C _O filter capacitor ESR | f = 1 MHz | | 10 | 300 | mΩ |
| Inductor L _{O(VDD3)} | | 2.8 | 4.7 | 6.6 | μH |
| L _O inductor DC resistor DCR _L | | | 50 | 500 | mΩ |
| Backup Battery | | | | | |
| Backup battery capacitor C _{BB} | Battery or superCap supplying VBACKUP | 5 | 10 | 2000 | mF |
| | Capacitor supplying VBACKUP | 1 | | 40 | μF |
| Series resistors | 5 to 15 mF | 10 | | 1500 | Ω |
| | 100 to 2000 mF | 5 | | 15 | |
| I²C Interfaces | | | | | |
| SDA_SDI, SCL_SCK, SDASR_EN2, SCLSR_EN1 external pull-up resistor | Connected to VDDIO | | 1.2 | | kΩ |
| Crystal Oscillator (connected from OSC32KIN to OSC32KOUT) | | | | | |
| Crystal frequency | @ specified load cap value | | 32.768 | | kHz |
| Crystal tolerance | @ 27°C | -20 | 0 | 20 | ppm |
| Frequency Temperature coefficient. | Oscillator contribution (not including crystal variation) | -0.5 | | 0.5 | ppm/°C |
| Secondary temperature coefficient | | -0.04 | -0.035 | -0.03 | ppm/°C ² |
| Voltage coefficient | | -2 | | 2 | ppm/V |

RECOMMENDED OPERATING CONDITIONS (continued)

over operating free-air temperature range (unless otherwise noted)

Lists of the recommended operating maximum ratings for the TPS65910 device are given below.

Note1: VCC7 should be connected to the highest supply that is connected to the device VCCx pin. The exception is that VCC2 and VCC4 can be higher than VCC7.

Note2: VCC2 and VCC4 must be connected together (to the same voltage).

Note3: If VDD3 boost is used, VAUX33 must be set to 2.8 V or higher and enabled before VDD3.

| PARAMETER | TEST CONDITIONS | MIN | NOM | MAX | UNIT |
|---|---|------|-----|-------|------|
| Max crystal series resistor | @ Fundamental frequency | | | 90 | kΩ |
| Crystal load capacitor | According to crystal data sheet | 6 | | 12.5 | pF |
| Load crystal oscillator Coscin, Coscout | parallel mode Including parasitic PCB capacitor | 12 | | 25 | pF |
| Quality factor | | 8000 | | 80000 | |

ESD SPECIFICATIONS

over operating free-air temperature range (unless otherwise noted)

| ESD METHOD | STANDARD REFERENCE | PERFORMANCE | TI STANDARD REQUIREMENTS |
|---------------------------|--------------------|-------------|--------------------------|
| Human body model (HBM) | EIA/JESD22-A114D | 2000 V | 2000 V |
| Charge device model (CDM) | EIA/JESD22-C101C | 500 V | 500 V |

I/O PULLUP AND PULLDOWN CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|-------------------------------------|------|-----|------|------|
| SDA_SDI, SCL_SCK, SDASR_EN2, SCLSR_EN1 Programmable pullup (DFT, default inactive) | Grounded, VDDIO = 1.8 V | -45% | 8 | +45% | kΩ |
| SLEEP programmable pulldown (default active) | @ 1.8 V, VRTC = 1.8 V | 2 | 4.5 | 10 | μA |
| PWRHOLD programmable pulldown (default active) | @ 1.8 V, VRTC = 1.8 V, VCC7 = 2.7 V | 2 | 4.5 | 10 | μA |
| | @ 5.5 V, VRTC = 1.8 V, VCC7 = 5.5 V | 7 | 14 | 30 | |
| BOOT0, BOOT1 programmable pulldown (default active) | @ 1.8 V, VRTC = 1.8 V | 2 | 4.5 | 10 | μA |
| NRESPWRON pulldown | @ 1.8 V, VCC7 = 5.5 V, OFF state | 2 | 4.5 | 10 | μA |
| 32KCLKOUT pulldown (disabled in Active-sleep state) | @ 1.8 V, VRTC = 1.8 V, OFF state | 2 | 4.5 | 10 | μA |
| PWRON programmable pullup (default active) | Grounded, VCC7 = 5.5 V | -40 | -31 | -15 | μA |
| GPIO_CKSYNC programmable pullup (default active) | Grounded, VRTC = 1.8 V | -27 | -18 | -9 | μA |

- (1) The internal pullups on the CTL-I²C and SR-I²C balls are used for test purposes or when the SR-I²C interface is not used. Discrete pullups to the VIO supply must be mounted on the board in order to use the I²C interfaces. The internal I²C pullups must not be used for functional applications

DIGITAL I/O VOLTAGE ELECTRICAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | | MIN | TYP | MAX | UNIT |
|---|----------------------------|--------------|---------------|--------------|------|
| Related I/O: PWRON | | | | | |
| Low-level input voltage V_{IL} | | | | 0.3 x VCC7 | V |
| High-level input voltage V_{IH} | | 0.7 x VCC7 | | | V |
| Related I/Os: PWRHOLD, GPIO_CKSYNC | | | | | |
| Low-level input voltage V_{IL} | | | | 0.45 | V |
| High-level input voltage V_{IH} | | 1.3 | VDDIO/ CC7 | VCC7 | V |
| Related I/Os: BOOT0, BOOT1, OSC32KIN | | | | | |
| Low-level input voltage V_{IL} | | | | 0.35 x VRTC | V |
| High-level input voltage V_{IH} | | 0.65 x VRTC | | | V |
| Related I/Os: SLEEP | | | | | |
| Low-level input voltage V_{IL} | | | | 0.35 x VDDIO | V |
| High-level input voltage V_{IH} | | 0.65 x VDDIO | | | V |
| Related I/Os: NRESPWRON, INT1, 32KCLKOUT | | | | | |
| Low-level output voltage V_{OL} | $I_{OL} = 100 \mu\text{A}$ | | | 0.2 | V |
| | $I_{OL} = 2 \text{ mA}$ | | | 0.45 | V |
| High-level output voltage V_{OH} | $I_{OH} = 100 \mu\text{A}$ | VDDIO – 0.2 | | | V |
| | $I_{OH} = 2 \text{ mA}$ | VDDIO – 0.45 | | | V |
| Related Open-Drain I/Os: GPIO0 | | | | | |
| Low-level output voltage V_{OL} | $I_{OL} = 100 \mu\text{A}$ | | | 0.2 | V |
| | $I_{OL} = 2 \text{ mA}$ | | | 0.45 | V |
| I²C-Specific Related I/Os: SCL, SDA, SCLSR_EN1, SDASR_EN2 | | | | | |
| Low-level input voltage V_{IL} | | –0.5 | | 0.3 x VDDIO | V |
| High-level input voltage V_{IH} | | 0.7 x VDDIO | | | V |
| Hysteresis | | 0.1 x VDDIO | | | V |
| Low-level output voltage V_{OL} @ 3mA (sink current), VDDIO = 1.8 V | | | | 0.2 x VDDIO | V |
| Low-level output voltage V_{OL} @ 3mA (sink current), VDDIO = 3.3 V | | | | 0.4 x VDDIO | V |

I²C INTERFACE AND CONTROL SIGNALS

over operating free-air temperature range (unless otherwise noted)

| NO. | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX |
|----------------------------------|---------------------|--|--------------------------|-----|---------|
| | | INT1 rise and fall times, $C_L = 5$ to 35 pF | 5 | 10 | ns |
| | | NRESPWRON rise and fall times, $C_L = 5$ to 35 pF | 5 | 10 | ns |
| SLAVE HIGH-SPEED MODE | | | | | |
| | | SCL/SCLSR_EN1 and SDA/SDASR_EN2 rise and fall time, $C_L = 10$ to 100 pF | 10 | 80 | ns |
| | | Data rate | | 3.4 | Mbps |
| I3 | $t_{su}(SDA-SCLH)$ | Setup time, SDA valid to SCL high | 10 | | ns |
| I4 | $t_h(SCLL-SDA)$ | Hold time, SDA valid from SCL low | 0 | 70 | ns |
| I7 | $t_{su}(SCLH-SDAL)$ | Setup time, SCL high to SDA low | 160 | | ns |
| I8 | $t_h(SDAL-SCLL)$ | Hold time, SCL low from SDA low | 160 | | ns |
| I9 | $t_{su}(SDAH-SCLH)$ | Setup time, SDA high to SCL high | 160 | | ns |
| SLAVE FAST MODE | | | | | |
| | | SCL/SCLSR_EN1 and SDA/SDASR_EN2 rise and fall time, $C_L = 10$ to 400 pF | 20 + $0.1 \times C_L$ | 250 | ns |
| | | Data rate | | 400 | Kbps |
| I3 | $t_{su}(SDA-SCLH)$ | Setup time, SDA valid to SCL high | 100 | | ns |
| I4 | $t_h(SCLL-SDA)$ | Hold time, SDA valid from SCL low | 0 | 0.9 | μ s |
| I7 | $t_{su}(SCLH-SDAL)$ | Setup time, SCL high to SDA low | 0.6 | | μ s |
| I8 | $t_h(SDAL-SCLL)$ | Hold time, SCL low from SDA low | 0.6 | | μ s |
| I9 | $t_{su}(SDAH-SCLH)$ | Setup time, SDA high to SCL high | 0.6 | | μ s |
| SLAVE STANDARD MODE | | | | | |
| | | SCL/SCLSR_EN1 and SDA/SDASR_EN2 rise and fall time, $C_L = 10$ to 400 pF | | 250 | ns |
| | | Data rate | | 100 | Kbps |
| I3 | $t_{su}(SDA-SCLH)$ | Setup time, SDA valid to SCL high | 250 | | ns |
| I4 | $t_h(SCLL-SDA)$ | Hold time, SDA valid from SCL low | 0 | | μ s |
| I7 | $t_{su}(SCLH-SDAL)$ | Setup time, SCL high to SDA low | 4.7 | | μ s |
| I8 | $t_h(SDAL-SCLL)$ | Hold time, SCL low from SDA low | 4 | | μ s |
| I9 | $t_{su}(SDAH-SCLH)$ | Setup time, SDA high to SCL high | 4 | | μ s |
| SWITCHING CHARACTERISTICS | | | | | |
| SLAVE HIGH-SPEED MODE | | | | | |
| I1 | $t_w(SCLL)$ | Pulse duration, SCL low | 160 | | ns |
| I2 | $t_w(SCLH)$ | Pulse duration, SCL high | 60 | | ns |
| SLAVE FAST MODE | | | | | |
| I1 | $t_w(SCLL)$ | Pulse duration, SCL low | 1.3 | | μ s |
| I2 | $t_w(SCLH)$ | Pulse duration, SCL high | 0.6 | | μ s |
| SLAVE STANDARD MODE | | | | | |
| I1 | $t_w(SCLL)$ | Pulse duration, SCL low | 4.7 | | μ s |
| I2 | $t_w(SCLH)$ | Pulse duration, SCL high | 4 | | μ s |

POWER CONSUMPTION

over operating free-air temperature range (unless otherwise noted)

All current consumption measurements are relative to the FULL chip, all VCC inputs set to VBAT voltage.

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------|--|-----|------------------------|----------------------|------|
| Device BACKUP state | VBAT = 2.4 V, VBACKUP = 0 V, VBAT = 0 V, VBACKUP = 3.2 V | | 11 6 | 16 9 | μA |
| Device OFF state | VBAT = 3.6 V, CK32K clock running BOOT[1:0] = 00: 32-kHz RC oscillator BOOT[1:0] = 01: 32-kHz quartz or bypass oscillator, BOOT0P = 0 BOOT[1:0] = 01, Backup Battery Charger on, VBACKUP = 3.2 V VBAT = 5 V, CK32K clock running: BOOT[1:0] = 00: RC oscillator | | 16.5 15 32 20 | 23 20 42 28 | μA |
| Device SLEEP state | VBAT = 3.6 V, CK32K clock running, PWRHOLDP = 0 BOOT[1:0] = 00, 3 DC-DCs on, 5 LDOs and VRTC on, no load BOOT[1:0] = 01, 3 DC-DCs on, 3 LDOs and VRTC on, no load, BOOT0P = 0 | | 295 279 | | μA |
| Device ACTIVE state | VBAT = 3.6 V, CK32K clock running, PWRHOLDP = 0 BOOT[1:0] = 00, 3 DC-DCs on, 5 LDOs and VRTC on, no load BOOT[1:0] = 01, 3 DC-DCs on, 3 LDOs and VRTC on, no load, BOOT0P = 0 BOOT[1:0] = 00, 3 DC-DCs on PWM mode (VDD1_PSKIP = VDD2_PSKIP = VIO_PSKIP = 0), 5 LDOs and VRTC on, no load | | 1 0.9 21 | | mA |

POWER REFERENCES AND THRESHOLDS

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|------------|-----------------------------|--------|------|
| Output reference voltage (VREF terminal) | Device in active or low-power mode | -1% | 0.85 | +1% | V |
| Main battery charged threshold VMBCH (programmable) | Measured on VCC7 terminal Triggering monitored through NRESRWON VMBCH_VSEL = 11, BOOT[1:0] = 11 or 00 VMBCH_VSEL = 10 VMBCH_VSEL = 01 VMBCH_VSEL = 00 | | 3 2.9 2.8 bypassed | | V |
| Main battery discharged threshold VMBDCH (programmable) | Measured on VCC7 terminal (MTL prg) Triggering monitored through INT1 | | VMBCH – 100 mV | | V |
| Main battery low threshold VMBLO (MB comparator) | Measured on VCC7 terminal (Triggering monitored on terminal NRESRWON) | 2.5 | 2.6 | 2.7 | V |
| Main battery high threshold VMBHI | VBACKUP = 0 V, measured on terminal VCC7 (MB comparator) VBACKUP = 3.2 V, measured on terminal VCC7 | 2.6 2.5 | 2.75 2.55 | 3 3 | V |
| Main battery not present threshold VBNPR | Measured on terminal VCC7 (Triggering monitored on terminal VRTC) | 1.9 | 2.1 | 2.2 | V |
| Ground current (analog references + comparators + backup battery switch) | VCC = 3.6 V Device in OFF state Device in ACTIVE or SLEEP state | | 8 20 | | μA |

THERMAL MONITORING AND SHUTDOWN

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|-----|-----|-----|------|
| Hot-die temperature rising threshold | THERM_HDSEL[1:0] = 00 | | 117 | | °C |
| | THERM_HDSEL[1:0] = 01 | | 121 | | |
| | THERM_HDSEL[1:0] = 10 | 113 | 125 | 136 | |
| | THERM_HDSEL[1:0] = 11 | | 130 | | |
| Hot-die temperature hysteresis | | | 10 | | °C |
| Thermal shutdown temperature rising threshold | | 136 | 148 | 160 | °C |
| Thermal shutdown temperature hysteresis | | | 10 | | °C |
| Ground current | Device in ACTIVE state, Temp = 27°C, VCC7 = 3.6 V | | 6 | | µA |

32-kHz RTC CLOCK

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--------------------------------|------|--------|------|------|
| CLK32KOUT rise and fall time | C _L = 35 pF | | | 10 | ns |
| Bypass Clock (OSC32KIN: input, OSC32KOUT floating) | | | | | |
| Input bypass clock frequency | OSCKIN input | | 32 | | kHz |
| Input bypass clock duty cycle | OSCKIN input | 40% | | 60% | |
| Input bypass clock rise and fall time | 10% – 90%, OSC32KIN input, | | 10 | 20 | ns |
| CLK32KOUT duty cycle | Logic output signal | 40% | | 60% | |
| Bypass clock setup time | 32KCLKOUT output | | | 1 | ms |
| Ground current | Bypass mode | | | 1.5 | µA |
| Crystal oscillator (connected from OSC32KIN to OSC32KOUT) | | | | | |
| Output frequency | CK32KOUT output | | 32.768 | | kHz |
| Oscillator startup time | On power on | | | 2 | s |
| Ground current | | | 1.5 | | µA |
| RC oscillator (OSC32KIN: grounded, OSC32KOUT floating) | | | | | |
| Output frequency | CK32KOUT output | | 32 | | kHz |
| Output frequency accuracy | @ 25°C | –15% | 0% | +15% | |
| Cycle jitter (RMS) | Oscillator contribution | | | +10% | |
| Output duty cycle | | +40% | +50% | +60% | |
| Settling time | | | | 150 | µs |
| Ground current | Active @ fundamental frequency | | 4 | | µA |

BACKUP BATTERY CHARGER

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|----------------------------------|--------------|------|------|------|
| Backup battery charging current | VBACKUP = 0 to 2.4 V, BBCHEN = 1 | 350 | 500 | 700 | μA |
| End-of-charge backup battery voltage ⁽¹⁾ | VCC7 = 3.6 V, BBSEL = 10 | -3% | 3.15 | +3% | V |
| | VCC7 = 3.6 V, BBSEL = 00 | -3% | 3 | +3% | |
| | VCC7 = 3.6 V, BBSEL = 01 | -3% | 2.52 | +3% | |
| | VCC7 = 3.6 V, BBSEL = 11 | VBAT – 0.3 V | | VBAT | |
| Ground current | On mode | | 10 | | μA |

(1) Note:

- (a) BBSEL = 10, 00, or 01 intended to charge battery or superCap
- (b) BBSEL = 11 intended to charge capacitor

VRTC LDO

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------------------------|---|------|------|-------------------|------|
| Input voltage V_{IN} | On mode | 2.5 | | 5.5 | V |
| | Back-up mode | 1.9 | | 5.5 | |
| DC output voltage V_{OUT} | On mode, $3.0\text{ V} < V_{IN} < 5.5\text{ V}$ | 1.78 | 1.83 | 1.88 | V |
| | Back-up mode, $2.3\text{ V} \leq V_{IN} \leq 2.6\text{ V}$ | 1.72 | 1.78 | 1.84 | |
| Rated output current I_{OUTmax} | On mode | 20 | | | mA |
| | Back-up mode | 0.1 | | | |
| DC load regulation | On mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 50 | mV |
| | Back-up mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 50 | |
| DC line regulation | On mode, $V_{IN} = 3.0\text{ V}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}$ | | | 2.5 | mV |
| | Back-up mode, $V_{IN} = 2.3\text{ V}$ to 5.5 V @ $I_{OUT} = I_{OUTmax}$ | | | 25 | |
| Transient load regulation | On mode, $V_{IN} = V_{INmin} + 0.2\text{ V}$ to V_{INmax} | | | 50 ⁽¹⁾ | mV |
| | $I_{OUT} = I_{OUTmax}/2$ to I_{OUTmax} in $5\text{ }\mu\text{s}$ and $I_{OUT} = I_{OUTmax}$ to $I_{OUTmax}/2$ in $5\text{ }\mu\text{s}$ | | | | |
| Transient line regulation | On mode, $V_{IN} = V_{INmin} + 0.5\text{ V}$ to V_{INmin} in $30\text{ }\mu\text{s}$ | | | 25 ⁽¹⁾ | mV |
| | And $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5\text{ V}$ in $30\text{ }\mu\text{s}$, $I_{OUT} = I_{OUTmax}/2$ | | | | |
| Turn-on time | $I_{OUT} = 0$, V_{IN} rising from 0 up to 3.6 V, @ $V_{OUT} = 0.1\text{ V}$ up to V_{OUTmin} | | 2.2 | | ms |
| Ripple rejection | $V_{IN} = V_{INDC} + 100\text{ mV}_{pp}$ tone, $V_{INDC+} = V_{INmin} + 0.1\text{ V}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}/2$ $f = 217\text{ Hz}$ $f = 50\text{ kHz}$ | | 55 | | dB |
| | | | 35 | | |
| | | | | | |
| Ground current | Device in ACTIVE state | | 23 | | μA |
| | Device in BACKUP or OFF state | | 3 | | |

(1) These parameters are not tested. They are used for design specification only.

VIO SMPS

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|--|-------------------------------|--------------------------|------------|
| Input voltage (VCCIO and VCC7) V_{IN} | $I_{OUT} \leq 800$ mA $V_{OUT} = 1.5$ V or 1.8 V, $I_{OUT} > 800$ mA $V_{OUT} = 2.5$ V, $I_{OUT} > 800$ mA $V_{OUT} = 3.3$ V, $I_{OUT} > 800$ mA | 2.7 3.2 4.0 4.4 | | 5.5 5.5 5.5 5.5 | V |
| DC output voltage (V_{OUT}) | PWM mode (VIO_PSKIP = 0) or pulse skip mode I_{OUT} to I_{MAX} VSEL=00 VSEL = 01, default BOOT[1:0] = 00 and 01 VSEL = 10 VSEL = 11 Power down | -3% -3% -3% -3% | 1.5 1.8 2.5 3.3 0 | +3% +3% +3% +3% | V |
| Rated output current I_{OUTmax} | ILMAX[1:0] = 00, default ILMAX[1:0] = 01 | 500 1000 | | | mA |
| P-channel MOSFET On-resistance $R_{DS(ON)_PMOS}$ | $V_{IN} = V_{INmin}$ $V_{IN} = 3.8$ V | | 300 250 | 400 | m Ω |
| P-channel leakage current I_{LK_PMOS} | $V_{IN} = V_{INmax}$, SWIO = 0 V | | | 2 | μ A |
| N-channel MOSFET On-resistance $R_{DS(ON)_NMOS}$ | $V_{IN} = V_{MIN}$ $V_{IN} = 3.8$ V | | 300 250 | 400 | m Ω |
| N-channel leakage current I_{LK_NMOS} | $V_{IN} = V_{INmax}$, SWIO = V_{INmax} | | | 2 | μ A |
| PMOS current limit (high-side) | $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 00 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 01 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 10 | 650 1200 1700 | | | mA |
| NMOS current limit (low-side) | Source current load: $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 00 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 01 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 10 Sink current load: $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 00 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 01 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX[1:0] = 10 | 650 1200 1700 800 1200 1700 | | | mA |
| DC load regulation | On mode, $I_{OUT} = 0$ to I_{OUTmax} | | | 20 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} | | | 20 | mV |
| Transient load regulation | $V_{IN} = 3.8$ V, $V_{OUT} = 1.8$ V $I_{OUT} = 0$ to 500 mA, Max slew = 100 mA/ μ s $I_{OUT} = 700$ to 1200 mA, Max slew = 100 mA/ μ s | | | 50 | mV |
| t on, off to on | $I_{OUT} = 200$ mA | | 350 | | μ s |
| Overshoot | SMPS turned on | | 3% | | |
| Power-save mode Ripple voltage | Pulse skipping mode, $I_{OUT} = 1$ mA | | $0.025 \times V_{OUT}$ | | V_{PP} |
| Switching frequency | | | 3 | | MHz |
| Duty cycle | | | | 100 | % |
| Minimum On Time $T_{ON(MIN)}$ P-channel MOSFET | | | 35 | | ns |
| VFBI0 internal resistance | | 0.5 | 1 | | M Ω |
| Discharge resistor for power-down sequence R_{DIS} | During device switch-off sequence Note: No discharge resistor is applied if VIO is turned off while the device is on. | | 30 | 50 | Ω |

VIO SMPS (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------------|--|-----|------|-----|---------|
| Ground current (I_Q) | Off | | | 1 | |
| | PWM mode, $I_{OUT} = 0$ mA, $V_{IN} = 3.8$ V, $VIO_PSKIP = 0$ | | 7500 | | |
| | Pulse skipping mode, no switching, 3-MHz clock on | | 250 | | μ A |
| | Low-power (pulse skipping) mode, no switching $ST[1:0]=11$ | | 63 | | |
| Conversion efficiency | PWM mode, $DCR_L < 50$ m Ω , $V_{OUT} = 1.8$ V, V_{IN} $= 3.6$ V: | | | | |
| | $I_{OUT} = 10$ mA | | 44% | | |
| | $I_{OUT} = 100$ mA | | 87% | | |
| | $I_{OUT} = 400$ mA | | 86% | | |
| | $I_{OUT} = 800$ mA | | 76% | | |
| | $I_{OUT} = 1000$ mA | | 72% | | |
| | Pulse Skipping mode, $DCR_L < 50$ m Ω , $V_{OUT} =$ 1.8 V, $V_{IN} = 3.6$ V: | | | | |
| | $I_{OUT} = 1$ mA | | 71% | | |
| | $I_{OUT} = 10$ mA | | 80% | | |
| $I_{OUT} = 200$ mA | | 87% | | | |

VDD1 SMPS

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|--------------------------------------|-------------------------------|-----------------------|-----------------|
| Input voltage (VCC1 and VCC7) V_{IN} | $I_{OUT} \leq 1200$ mA $V_{OUT} = 0.6$ V to 1.5 V, VGAIN_SEL = 00, $I_{OUT} > 1200$ mA 2.5 V $\leq V_{OUT} \leq 3.3$ V, VGAIN_SEL = 10 or 11, $I_{OUT} > 1200$ mA | 2.7 $V_{OUT} + 2$ V 4.5 | | 5.5 5.5 5.5 | V |
| DC output voltage (V_{OUT}) | VGAIN_SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} : max programmable voltage, SEL[6:0] = 1001011 default voltage, BOOT[1:0] = 00 default voltage, BOOT[1:0] = 01 min programmable voltage, SEL[6:0] = 0000011 SEL[6:0] = 0000000: power down VGAIN_SEL = 10, SEL = 0101011 = 43, $I_{OUT} = 0$ to I_{OUTmax} VGAIN_SEL = 11, SEL = 0101000 = 40, $I_{OUT} = 0$ to I_{OUTmax} | | 1.5 1.2 1.2 0.6 0 | | V |
| DC output voltage programmable step ($V_{OUTSTEP}$) | VGAIN_SEL = 00, 72 steps | | 12.5 | | mV |
| Rated output current I_{OUTmax} | ILMAX = 0, default ILMAX = 1 | 1000 1500 | | | mA |
| P-channel MOSFET On-resistance $R_{DS(ON)}_{PMOS}$ | $V_{IN} = V_{INmin}$ $V_{IN} = 3.8$ V | | 300 250 | 400 | m Ω |
| P-channel leakage current I_{LK_PMOS} | $V_{IN} = V_{INmax}$, SW1 = 0 V | | | 2 | μ A |
| N-channel MOSFET On-resistance $R_{DS(ON)}_{NMOS}$ | $V_{IN} = V_{MIN}$ $V_{IN} = 3.8$ V | | 300 250 | 400 | m Ω |
| N-channel leakage current I_{LK_NMOS} | $V_{IN} = V_{INmax}$, SW1 = V_{INmax} | | | 2 | μ A |
| PMOS current limit (high-side) | $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX = 0 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX = 1 | 1150 2000 | | | mA |
| NMOS current limit (low-side) | Source current load: $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX = 0 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX = 1 Sink current load: $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX = 0 $V_{IN} = V_{INmin}$ to V_{INmax} , ILMAX = 1 | 1150 2000 1200 2000 | | | mA |
| DC load regulation | On mode, $I_{OUT} = 0$ to I_{OUTmax} | | | 20 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} | | | 20 | mV |
| Transient load regulation | $V_{IN} = 3.8$ V, $V_{OUT} = 1.2$ V $I_{OUT} = 0$ to 500 mA, Max slew = 100 mA/ μ s $I_{OUT} = 700$ mA to 1.2A, Max slew = 100 mA/ μ s | | | 50 | mV |
| t on, off to on | $I_{OUT} = 200$ mA | | 350 | | μ s |
| Output voltage transition rate | From $V_{OUT} = 0.6$ V to 1.5 V and $V_{OUT} = 1.5$ V to 0.6 V $I_{OUT} = 500$ mA TSTEP[2:0] = 001 TSTEP[2:0] = 011 (default) TSTEP[2:0] = 111 | | 12.5 7.5 2.5 | | mV/ μ s |
| Overshoot | SMPS turned on | | 3% | | |
| Power-save mode ripple voltage | Pulse skipping mode, $I_{OUT} = 1$ mA | | $0.025 \times$ V_{OUT} | | V _{PP} |
| Switching frequency | | | 3 | | MHz |

VDD1 SMPS (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|-----|--|-----|------------|
| Duty cycle | | | | 100 | % |
| Minimum on time $t_{ON(MIN)}$ P-channel MOSFET | | | 35 | | ns |
| VFB1 internal resistance | | 0.5 | 1 | | M Ω |
| Discharge resistor for power-down sequence R_{DIS} | | | 30 | 50 | Ω |
| Ground current (I_Q) | Off PWM mode, $I_{OUT} = 0$ mA, $V_{IN} = 3.8$ V, $VDD1_PSKIP = 0$ Pulse skipping mode, no switching Low-power (pulse skipping) mode, no switching $ST[1:0] = 11$ | | 7500 78 63 | 1 | μ A |
| Conversion efficiency | PWM mode, $DCR_L < 0.1$ Ω , $V_{OUT} = 1.2$ V, $V_{IN} = 3.6$ V: $I_{OUT} = 10$ mA $I_{OUT} = 200$ mA $I_{OUT} = 400$ mA $I_{OUT} = 800$ mA $I_{OUT} = 1500$ mA Pulse skipping mode, $DCR_L < 0.1\Omega$, $V_{OUT} = 1.2$ V, $V_{IN} = 3.6$ V: $I_{OUT} = 1$ mA $I_{OUT} = 10$ mA $I_{OUT} = 200$ mA | | 35% 82% 81% 74% 62% 59% 70% 82% | | |

VDD2 SMPS

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|----------------------------------|------------------------|-------------------|------------|
| Input voltage (VCC2 and VCC4) V_{IN} | $I_{OUT} \leq 1200$ mA $V_{OUT} = 0.6$ V to 1.5 V, $VGAIN_SEL = 00$, $I_{OUT} > 1200$ mA 2.5 V $\leq V_{OUT} \leq 3.3$ V, $VGAIN_SEL = 10$ or 11 , $I_{OUT} > 1200$ mA | 2.7 $V_{OUT} + 2$ V 4.5 | | 5.5 5.5 5.5 | V |
| DC output voltage (V_{OUT}) | $VGAIN_SEL = 00$, $I_{OUT} = 0$ to I_{OUTmax} : max programmable voltage, $SEL[6:0] = 1001011$ default, $BOOT[1:0] = 01$ min programmable voltage, $SEL[6:0] = 0000011$ $SEL[6:0] = 0000000$: power down $VGAIN_SEL = 10$, $SEL = 0101011 = 43$ $VGAIN_SEL = 11$, default, $BOOT[1:0] = 00$ | -3% | 1.5 1.2 0.6 0 | +3% | V |
| DC output voltage programmable step ($V_{OUTSTEP}$) | $VGAIN_SEL = 00$, 72 steps | | 12.5 | | mV |
| Rated output current I_{OUTmax} | $ILMAX = 0$, default $ILMAX = 1$ | 1000 1500 | | | mA |
| P-channel MOSFET On-resistance $R_{DS(ON)_PMOS}$ | $V_{IN} = V_{INmin}$ $V_{IN} = 3.8$ V | | 300 250 | 400 | m Ω |
| P-channel leakage current I_{LK_PMOS} | $V_{IN} = V_{INmax}$, $SW2 = 0$ V | | | 2 | μ A |
| N-channel MOSFET On-resistance $R_{DS(ON)_NMOS}$ | $V_{IN} = V_{MIN}$ $V_{IN} = 3.8$ V | | 300 250 | 400 | m Ω |
| N-channel leakage current I_{LK_NMOS} | $V_{IN} = V_{INmax}$, $SW2 = V_{INmax}$ | | | 2 | μ A |
| PMOS current limit (high-side) | $V_{IN} = V_{INmin}$ to V_{INmax} , $ILMAX = 0$ $V_{IN} = V_{INmin}$ to V_{INmax} , $ILMAX = 1$ | 1150 2200 | | | mA |
| NMOS current limit (low-side) | Source current load: $V_{IN} = V_{INmin}$ to V_{INmax} , $ILMAX = 0$ $V_{IN} = V_{INmin}$ to V_{INmax} , $ILMAX = 1$ Sink current load: $V_{IN} = V_{INmin}$ to V_{INmax} , $ILMAX = 0$ $V_{IN} = V_{INmin}$ to V_{INmax} , $ILMAX = 1$ | 1150 2000 1200 2000 | | | mA |
| DC load regulation | On mode, $I_{OUT} = 0$ to I_{OUTmax} | | | 20 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}$ | | | 20 | mV |
| Transient load regulation | $V_{IN} = 3.8$ V, $V_{OUT} = 1.2$ V $I_{OUT} = 0$ to 500 mA, Max slew = 100 mA/ μ s $I_{OUT} = 700$ mA to 1.2 A, Max slew = 100 mA/ μ s | | | 50 | mV |
| t on, Off to on | $I_{OUT} = 200$ mA | | 350 | | μ s |
| Output voltage transition rate | From $V_{OUT} = 0.6$ V to 1.5 V and $V_{OUT} = 1.5$ V to 0.6 V $I_{OUT} = 500$ mA $TSTEP[2:0] = 001$ $TSTEP[2:0] = 011$ (default) $TSTEP[2:0] = 111$ | | 12.5 7.5 2.5 | | μ s |
| Power-save mode ripple voltage | Pulse skipping mode, $I_{OUT} = 1$ mA | | 0.025 V_{OUT} | | V_{PP} |
| Overshoot | | | 3% | | |
| Switching frequency | | | 3 | | MHz |
| Duty cycle | | | | 100 | % |
| Minimum On time P-Channel MOSFET | | | 35 | | ns |

VDD2 SMPS (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----|--|-----|------|
| VFB2 internal resistance | | 0.5 | 1 | | MΩ |
| Discharge resistor for power-down sequence R_{DIS} | | | 30 | 50 | Ω |
| Ground current (I_Q) | Off PWM mode, $I_{OUT} = 0$ mA, $V_{IN} = 3.8$ V, $VDD2_PSKIP = 0$ Pulse skipping mode, no switching Low-power (pulse skipping) mode, no switching $ST[1:0] = 11$ | | 7500 78 63 | 1 | μA |
| Conversion efficiency | PWM mode, $DCR_L < 50$ mΩ, $V_{OUT} = 1.2$ V, $V_{IN} = 3.6$ V: $I_{OUT} = 10$ mA $I_{OUT} = 200$ mA $I_{OUT} = 400$ mA $I_{OUT} = 800$ mA $I_{OUT} = 1200$ mA $I_{OUT} = 1500$ mA Pulse skipping mode mode, $DCR_L < 50$ mΩ, $V_{OUT} = 1.2$ V, $V_{IN} = 3.6$ V: $I_{OUT} = 1$ mA $I_{OUT} = 10$ mA $I_{OUT} = 200$ mA PWM mode, $DCR_L < 50$ mΩ, $V_{OUT} = 3.3$ V, $V_{IN} = 5$ V: $I_{OUT} = 10$ mA $I_{OUT} = 200$ mA $I_{OUT} = 400$ mA $I_{OUT} = 800$ mA $I_{OUT} = 1200$ mA $I_{OUT} = 1500$ mA Pulse skipping mode mode, $DCR_L < 50$ mΩ, $V_{OUT} = 3.3$ V, $V_{IN} = 5$ V: $I_{OUT} = 1$ mA $I_{OUT} = 10$ mA $I_{OUT} = 200$ mA | | 35% 82% 81% 74% 66% 62% 59% 70% 82% 44% 90% 91% 88% 84% 81% 75% 83% 90% | | |

VDD3 SMPS

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|------|-------------------|------|---------------|
| Input voltage V_{IN} | | 3 | | 5.5 | V |
| DC output voltage (V_{OUT}) | | 4.65 | 5 | 5.25 | V |
| Rated output current I_{OUTmax} | | 100 | | | mA |
| N-channel MOSFET On-resistance $R_{DS(ON)_NMOS}$ | $V_{IN} = 3.6\text{ V}$ | | 500 | | m Ω |
| N-channel MOSFET leakage current I_{LK_NMOS} | $V_{IN} = V_{INmax}$, $SW3 = V_{INmax}$ | | | 2 | μA |
| N-channel MOSFET DC current limit | $V_{IN} = V_{INmin}$ to V_{INmax} , sink current load | 430 | 550 | | mA |
| Turn-on inrush current | $V_{IN} = V_{INmin}$ to V_{INmax} | | | 850 | mA |
| Ripple voltage | | | 20 | | mV |
| DC load regulation | On mode, $I_{OUT} = 0$ to I_{OUTmax} | | | 100 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to 5 V @ $I_{OUT} = I_{OUTmax}$ | | | 100 | mV |
| Turn-on time | $I_{OUT} = 8\text{ mA}$, $V_{OUT} = 0$ to 4.4 V | | 200 | | μs |
| Overshoot | | | 3% | | |
| Switching frequency | | | 1 | | MHz |
| VFB3 internal resistance | | | 088 | | M Ω |
| Ground current (I_Q) | Off $I_{OUT} = 0\text{ mA}$ to I_{OUTmax} , $V_{IN} = 3.6\text{ V}$ | | 360 | 1 | μA |
| Conversion efficiency | $V_{IN} = 3.6\text{ V}$: $I_{OUT} = 10\text{ mA}$ $I_{OUT} = 50\text{ mA}$ $I_{OUT} = 100\text{ mA}$ | | 81% 85% 85% | | |

VDIG1 AND VDIG2 LDO

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----|------|-----|---------------|
| Input voltage (VCC6) V_{IN} | V_{OUT} (VDIG1) = 1.2 V @ 300 mA / 1.5 V @ 100 mA and | | | | V |
| | V_{OUT} (VDIG2) = 1.2 V / 1.1 V / 1.0 V @ 300 mA | 1.7 | | 5.5 | |
| | V_{OUT} (VDIG1) = 1.5 V and V_{OUT} (VDIG2) = 1.8 V @ 200mA | 2.1 | | 5.5 | |
| | V_{OUT} (VDIG1) = 1.8 V and V_{OUT} (VDIG2) = 1.8 V | 2.7 | | 5.5 | |
| | V_{OUT} (VDIG1) = 2.7 V | 3.2 | | 5 | |
| VDIG1 | | | | | |
| DC output voltage V_{OUT} | ON and Low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.7 | +3% | V |
| | SEL = 10 $I_{OUT} = 0$ to I_{OUTmax} | -3% | 1.8 | +3% | |
| | SEL = 01 $I_{OUT} = 0$ to 100 mA/ I_{OUTmax} | -3% | 1.5 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} , $V_{IN} = V_{INmin}$ to 4 V, default BOOT[1:0] = 00 or 01 | -3% | 1.2 | +3% | |
| Rated output current I_{OUTmax} | On mode | 300 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100$ mV | 350 | 600 | | mA |
| Dropout voltage V_{DO} | ON mode, $V_{DO} = V_{IN} - V_{OUT}$ $V_{OUTtyp} = 2.7$ V, $V_{IN} = 2.8$ V, $I_{OUT} = I_{OUTmax}$, $T = 25^{\circ}\text{C}$ | | 150 | | mV |
| | $V_{OUTtyp} = 1.5$ V, $V_{IN} = 1.7$ V, $I_{OUT} = I_{OUTmax}$, $T = 25^{\circ}\text{C}$ | | 300 | | |
| DC load regulation | On mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 25 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}$ | | | 3 | mV |
| Transient load regulation | ON mode, $V_{IN} = 3.8$ V $I_{OUT} = 20$ mA to 180 mA in 5 μs and $I_{OUT} = 180$ mA to 20 mA in 5 μs | | 10 | | mV |
| Transient line regulation | On mode, $V_{IN} = 2.7 + 0.5$ V to 2.7 in 30 μs , And $V_{IN} = 2.7$ to 2.7 + 0.5 V in 30 μs , $I_{OUT} = I_{OUTmax}/2$ | | 2 | | mV |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1$ V up to V_{OUTmin} | | 100 | | μs |
| Turn-on inrush current | | | 300 | | mA |
| Ripple rejection | $V_{IN} = V_{INDC} + 100$ mV _{pp} tone, $V_{INDC+} = 3.8$ V, $I_{OUT} = I_{OUTmax}/2$ $f = 217$ Hz $f = 50$ kHz | | 70 | | dB |
| | | | 40 | | |
| | | | | | |
| VDIG1 internal resistance | LDO off | | 400 | | Ω |
| Ground current | On mode, $I_{OUT} = 0$, VCC6 = VBAT, $V_{OUT} = 2.7$ V | | 54 | | μA |
| | On mode, $I_{OUT} = 0$, VCC6 = 1.8 V, $V_{OUT} = 1.2$ V | | 67 | | |
| | On mode, $I_{OUT} = I_{OUTmax}$, VCC6 = VBAT, $V_{OUT} = 2.7$ V | | 1870 | | |
| | On mode, $I_{OUT} = I_{OUTmax}$, VCC6 = 1.8 V, $V_{OUT} = 1.2$ V | | 1300 | | |
| | Low-power mode, VCC6 = VBAT, $V_{OUT} = 2.7$ V | | 13 | | |
| | Low-power mode, VCC6 = 1.8 V, $V_{OUT} = 1.2$ V | | 10 | | |
| | Off mode | | | 1 | |
| VDIG2 | | | | | |
| DC output voltage V_{OUT} | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} | | | | |

VDIG1 AND VDIG2 LDO (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----|----------|-----|------|
| | SEL = 11, I _{OUT} = 0 to I _{OUTmax} | –3% | 1.8 | +3% | V |
| | SEL = 10 I _{OUT} = 0 to I _{OUTmax} , V _{IN} = V _{INmin} to 4 V | –3% | 1.2 | +3% | |
| | SEL = 01 I _{OUT} = 0 to 100 mA/I _{OUTmax} , V _{IN} = V _{INmin} to 4 V | –3% | 1.1 | +3% | |
| | SEL = 00, I _{OUT} = 0 to I _{OUTmax} , V _{IN} = V _{INmin} to 4 V, default BOOT[1:0] = 00 or 01 | –3% | 1 | +3% | |
| Rated output current I _{OUTmax} | On mode | 300 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, V _{OUT} = V _{OUTmin} – 100 mV | 350 | 600 | | mA |
| Dropout voltage V _{DO} | ON mode, V _{DO} = V _{IN} – V _{OUT} , V _{OUTtyp} = 1.8 V, V _{IN} = 2.1 V, I _{OUT} = I _{OUTmax} , T = 25°C | | 250 | | mV |
| DC load regulation | On mode, I _{OUT} = I _{OUTmax} to 0 | | | 25 | mV |
| DC line regulation | On mode, V _{IN} = V _{INmin} to V _{INmax} @ I _{OUT} = I _{OUTmax} | | | 3 | mV |
| Transient load regulation | ON mode, V _{IN} = 3.8 V I _{OUT} = 20 mA to 180 mA in 5µs and I _{OUT} = 180 mA to 20 mA in 5 µs | | 10 | | mV |
| Transient line regulation | On mode, V _{IN} = 2.7 + 0.5 V to 2.7 in 30 µs, And V _{IN} = 2.7 to 2.7 + 0.5 V in 30 µs, I _{OUT} = I _{OUTmax} /2 | | 2 | | mV |
| Turn-on time | I _{OUT} = 0, @ V _{OUT} = 0.1 V up to V _{OUTmin} | | 100 | | µs |
| Turn-on inrush current | | | 300 | | mA |
| Ripple rejection | V _{IN} = V _{INDC} + 100 mV _{pp} tone, V _{INDC+} = 3.8 V, I _{OUT} = I _{OUTmax} /2 f = 217 Hz f = 50 kHz | | 70 40 | | dB |
| VDIG2 internal resistance | LDO off | | 400 | | Ω |
| Ground current | On mode, I _{OUT} = 0, VCC6 = VBAT, V _{OUT} = 1.8 V | | 52 | | µA |
| | On mode, I _{OUT} = 0, VCC6 = 1.8 V, V _{OUT} = 1.0 V | | 67 | | |
| | On mode, I _{OUT} = I _{OUTmax} , VCC6 = VBAT, V _{OUT} = 1.8 V | | 1750 | | |
| | On mode, I _{OUT} = I _{OUTmax} , VCC6 = 1.8 V, V _{OUT} = 1.0 V | | 1300 | | |
| | Low-power mode, VCC6 = VBAT, V _{OUT} = 1.8 V | | 11 | | |
| | Low-power mode, VCC6 = 1.8 V, V _{OUT} = 1.0 V | | 10 | | |
| | Off mode | | | 1 | |

VAUX33 AND VMMC LDO

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|---|-----|------|-----|---------------|
| Input voltage (VCC3) V_{IN} | V_{OUT} (VAUX33) = 1.8 V / 2 V and V_{OUT} (VMMC) = 1.8 V | 2.7 | | 5.5 | V |
| | V_{OUT} (VAUX33) = 2.8 V | 3.2 | | 5.5 | |
| | V_{OUT} (VAUX33) = 3.3 V | 3.6 | | 5.5 | |
| | V_{OUT} (VMMC) = 2.8 V @ 200 mA | 3.2 | | 5.5 | |
| | V_{OUT} (VMMC) = 3.0 V | 3.6 | | 5.5 | |
| | V_{OUT} (VMMC) = 3.3 V @ 200 mA | 3.6 | | 5.5 | |
| VAUX33 | | | | | |
| DC output voltage V_{OUT} | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to I_{OUTmax} , Default BOOT[1:0] = 01 | -3% | 3.3 | +3% | V |
| | SEL = 10, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.8 | +3% | |
| | SEL = 01, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.0 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} , default BOOT[1:0] = 00 | -3% | 1.8 | +3% | |
| Rated output current I_{OUTmax} | On mode | 150 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100$ mV | 350 | 500 | | mA |
| Dropout Voltage V_{DO} | On mode, $V_{OUTtyp} = 2.8$ V, $V_{DO} = V_{IN} - V_{OUT}$, $V_{IN} = 2.9$ V, $I_{OUT} = I_{OUTmax}$, $T = 25^{\circ}\text{C}$ | | 150 | | mV |
| DC load regulation | On mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 20 | mV |
| DC line regulation | On mode, $I_{OUT} = I_{OUTmax}$ | | | 3 | mV |
| Transient load regulation | On mode, $V_{IN} = 3.8$ V $I_{OUT} = 0.1 \times I_{OUTmax}$ to $0.9 \times I_{OUTmax}$ in 5 μs and $I_{OUT} = 0.9 \times I_{OUTmax}$ to $0.1 \times I_{OUTmax}$ in 5 μs | | 12 | | mV |
| Transient line regulation | On mode, $I_{OUT} = I_{OUTmax}$, $V_{IN} = V_{INmin} + 0.5$ V to V_{INmin} in 30 μs and $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5$ V in 30 μs , $I_{OUT} =$ $I_{OUTmax}/2$ | | 2 | | mV |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1$ V up to V_{OUTmin} | | 100 | | μs |
| Turn-on inrush current | | | 600 | | mA |
| Ripple Rejection | $V_{IN} = V_{INDC} + 100$ mV _{pp} tone, $V_{INDC+} = 3.8$ V, $I_{OUT} =$ $I_{OUTmax}/2$ $f = 217$ Hz $f = 50$ kHz | | 70 | | dB |
| | | | 40 | | |
| | | | | | |
| VAUX33 internal resistance | LDO off | | 70 | | Ω |
| Ground current | On mode, $I_{OUT} = 0$ | | 55 | | μA |
| | On mode, $I_{OUT} = I_{OUTmax}$ | | 1600 | | |
| | Low-power mode | | 15 | | |
| | Off mode | | | 1 | |
| VMMC | | | | | |
| DC output voltage V_{OUT} | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to 200 mA, default BOOT[1:0] = 00 | -3% | 3.3 | +3% | V |
| | SEL = 10, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 3.0 | +3% | |
| | SEL = 01, $I_{OUT} = 0$ to 200 mA | -3% | 2.8 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} , default BOOT[1:0] = 01 | -3% | 1.8 | +3% | |

VAUX33 AND VMMC LDO (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----|------|-----|---------------|
| Rated output current I_{OUTmax} | On mode | 300 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100\text{ mV}$ | 350 | 500 | | mA |
| Dropout voltage V_{DO} | Dropout voltage V_{DO} | | | | mV |
| | $V_{IN} = 3.0\text{ V}$, $I_{OUT} = 200\text{ mA}$, $T = 25^\circ\text{C}$ | | 200 | | |
| DC load regulation | On mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 25 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}$ | | | 3 | mV |
| Transient load regulation | On mode, $V_{IN} = 3.8\text{ V}$ | | 12 | | mV |
| | $I_{OUT} = 20\text{ mA}$ to 180 mA in $5\text{ }\mu\text{s}$ and $I_{OUT} = 180\text{ mA}$ to 20 mA in $5\text{ }\mu\text{s}$ | | | | |
| Transient line regulation | On mode, $I_{OUT} = 200\text{ mA}$, $V_{IN} = V_{INmin} + 0.5\text{ V}$ to V_{INmin} in $30\text{ }\mu\text{s}$ | | 2 | | mV |
| | And $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5\text{ V}$ in $30\text{ }\mu\text{s}$, $I_{OUT} = I_{OUTmax}/2$ | | | | |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1\text{ V}$ up to V_{OUTmin} | | 100 | | μs |
| Ripple rejection | $V_{IN} = V_{INDC} + 100\text{ mV}_{pp}$ tone, $V_{INDC+} = 3.8\text{ V}$, $I_{OUT} = I_{OUTmax}/2$ $f = 217\text{ Hz}$ $f = 50\text{ kHz}$ | | 70 | | dB |
| | | | 40 | | |
| | | | | | |
| VMMC internal resistance | LDO Off | | 70 | | Ω |
| Ground current | On mode, $I_{OUT} = 0$ | | 55 | | μA |
| | On mode, $I_{OUT} = I_{OUTmax}$ | | 2700 | | |
| | Low-power mode | | 15 | | |
| | Off mode | | | 1 | |

VAUX1 AND VAUX2 LDO

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|---|-----|------|-----|----------|
| Input voltage (VCC4) V_{IN} | V_{OUT} (VAUX1) = 1.8 V and V_{OUT} (AUX2) = 1.8 V | 2.7 | | 5.5 | V |
| | V_{OUT} (VAUX1) = 2.5 V | 3.2 | | 5.5 | |
| | V_{OUT} (VAUX1) = 2.8 V @ $I_{load} = 200$ mA and 2.85 V @ $I_{load} = 200$ mA | 3.2 | | 5.5 | |
| | V_{OUT} (VAUX2) = 2.8 V | 3.2 | | 5.5 | |
| | V_{OUT} (VAUX2) = 2.9 V @ $I_{load} = 100$ mA | 3.2 | | 5.5 | |
| | V_{OUT} (VAUX2) = 3.3 V | 3.6 | | 5.5 | |
| VAUX1 | | | | | |
| DC output voltage V_{OUT} | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to 200 mA | -3% | 2.85 | +3% | V |
| | SEL = 10, $I_{OUT} = 0$ to 200 mA | -3% | 2.8 | +3% | |
| | SEL = 01, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.5 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} , default BOOT[1:0] = 00 or 01 | -3% | 1.8 | +3% | |
| Rated output current I_{OUTmax} | On mode | 300 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100$ mV | 350 | 500 | | mA |
| Dropout voltage V_{DO} | On mode, $V_{OUTtyp} = 2.8$ V, $V_{DO} = V_{IN} - V_{OUT}$, $V_{IN} = 3.0$ V, $I_{OUT} = 200$ mA, $T = 25^{\circ}C$ | | 200 | | mV |
| DC load regulation | On mode, $I_{OUT} = 200$ mA to 0 | | | 15 | mA |
| DC line regulation | On mode, $I_{OUT} = 200$ mA | | | 5 | V |
| Transient load regulation | On mode, $V_{IN} = 3.8$ V, $I_{OUT} = 20$ mA to 180 mA in 5 μ s and $I_{OUT} = 180$ mA to 20 mA in 5 μ s | | 15 | | mV |
| Transient line regulation | On mode, $I_{OUT} = 200$ mA, $V_{IN} = V_{INmin} + 0.5$ V to V_{INmin} in 30 μ s and $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5$ V in 30 μ s, $I_{OUT} = I_{OUTmax}/2$ | | 2 | | mV |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1$ V up to V_{OUTmin} , no load | | 100 | | μ s |
| Turn-on inrush current | | | 600 | | mA |
| Ripple Rejection | $V_{IN} = V_{INDC} + 100$ mV _{pp} tone, $V_{INDC+} = 3.8$ V, $I_{OUT} = I_{OUTmax}/2$ $f = 217$ Hz $f = 50$ kHz | | 70 | | dB |
| | | | 40 | | |
| | | | | | |
| VAUX1 internal resistance | LDO Off | | 80 | | Ω |
| Ground current | On mode, $I_{OUT} = 0$ | | 60 | | μ A |
| | On mode, $I_{OUT} = I_{OUTmax}$ | | 2700 | | |
| | Low-power mode | | 12 | | |
| | Off mode | | | 1 | |
| VAUX2 | | | | | |
| | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 3.3 | +3% | V |
| | SEL = 10, $I_{OUT} = 0$ to 100 mA | -3% | 2.9 | +3% | |
| | SEL = 01, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.8 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} , default BOOT[1:0] = 00 or 01 | -3% | 1.8 | +3% | |
| Rated output current I_{OUTmax} | On mode | 300 | | | mA |
| | Low-power mode | 1 | | | |

VAUX1 AND VAUX2 LDO (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|---|-----|------------------|-----|---------------|
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100 \text{ mV}$ | 350 | 500 | | mA |
| Dropout voltage V_{DO} | On mode, $V_{OUTtyp} = 2.8 \text{ V}$, $V_{DO} = V_{IN} - V_{OUT}$ $V_{IN} = 2.9 \text{ V}$, $I_{OUT} = I_{OUTmax}$, $T = 25^\circ\text{C}$ | | 150 | | mV |
| DC load regulation | On mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 15 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}$ | | | 2 | mV |
| Transient load regulation | On mode, $V_{IN} = 3.8 \text{ V}$, $I_{OUT} = 0.1 \times I_{OUTmax}$ to $0.9 \times I_{OUTmax}$ in $5\mu\text{s}$ And $I_{OUT} = 0.9 \times I_{OUTmax}$ to $0.1 \times I_{OUTmax}$ in $5\mu\text{s}$ | | 12 | | mV |
| Transient line regulation | On mode, $I_{OUT} = I_{OUTmax}$, $V_{IN} = V_{INmin} + 0.5 \text{ V}$ to V_{INmin} in $30 \mu\text{s}$ And $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5 \text{ V}$ in $30 \mu\text{s}$, $I_{OUT} = I_{OUTmax}/2$ | | 2 | | mV |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1 \text{ V}$ up to V_{OUTmin} | | 100 | | μs |
| Turn-on Inrush current | | | 600 | | mA |
| Ripple rejection | $V_{IN} = V_{INDC} + 100 \text{ mV}_{pp}$ tone, $V_{INDC+} = 3.8 \text{ V}$, $I_{OUT} = I_{OUTmax}/2$ $f = 217 \text{ Hz}$ $f = 50 \text{ kHz}$ | | 70 40 | | dB |
| VAUX2 internal resistance | LDO off | | 80 | | Ω |
| Ground current | On mode, $I_{OUT} = 0$ On mode, $I_{OUT} = I_{OUTmax}$ Low-power mode Off mode | | 60 1600 12 | | μA |
| | | | | 1 | |

VDAC AND VPLL LDO

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----|------|-----|---------------|
| Input voltage (VCC5) V_{IN} | $V_{OUT}(VDAC) = 1.8\text{ V}$ and $V_{OUT}(VPLL) = 1.8\text{ V} / 1.1\text{ V} / 1.0\text{ V}$ | 2.7 | | 5.5 | V |
| | $V_{OUT}(VDAC) = 2.6\text{ V}$ and $V_{OUT}(VPLL) = 2.5\text{ V}$ | 3.0 | | 5.5 | |
| | $V_{OUT}(VDAC) = 2.8\text{ V} / 2.85\text{ V}$ | 3.2 | | 5.5 | |
| VDAC | | | | | |
| DC Output voltage V_{OUT} | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.85 | +3% | V |
| | SEL = 10, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.8 | +3% | |
| | SEL = 01, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.6 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} , default BOOT[1:0] = 00 or 01 | -3% | 1.8 | +3% | |
| Rated output current I_{OUTmax} | On mode | 150 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100\text{ mV}$ | 350 | 500 | | mA |
| Dropout Voltage V_{DO} | On mode, $V_{OUTtyp} = 2.8\text{ V}$, $V_{DO} = V_{IN} - V_{OUT}$, $V_{IN} = 2.9\text{ V}$, $I_{OUT} = I_{OUTmax}$, $T = 25^\circ\text{C}$ | | 150 | | mV |
| DC load regulation | On mode, $V_{OUT} = V_{OUTmin} - 100\text{ mV}$ | | | 15 | mV |
| DC line regulation | On mode, $V_{OUT} = 1.8\text{ V}$, $I_{OUT} = I_{OUTmax}$ | | | 2 | mV |
| Transient load regulation | On mode, $V_{IN} = 3.8\text{ V}$, $I_{OUT} = 0.1 \times I_{OUTmax}$ to $0.9 \times I_{OUTmax}$ in $5\ \mu\text{s}$ | | 15 | | mV |
| | And $I_{OUT} = 0.9 \times I_{OUTmax}$ to $0.1 \times I_{OUTmax}$ in $5\ \mu\text{s}$ | | | | |
| Transient line regulation | On mode, $I_{OUT} = I_{OUTmax}$, $V_{IN} = V_{INmin} + 0.5\text{ V}$ to V_{INmin} in $30\ \mu\text{s}$ | | 0.5 | | mV |
| | And $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5\text{ V}$ in $30\ \mu\text{s}$, $I_{OUT} = I_{OUTmax}/2$ | | | | |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1\text{ V}$ up to V_{OUTmin} | | 100 | | μs |
| Turn-on Inrush current | | | 600 | | mA |
| Ripple Rejection | $V_{IN} = V_{INDC} + 100\text{ mV}_{pp}$ tone, $V_{INDC+} = 3.8\text{ V}$, $I_{OUT} = I_{OUTmax}/2$ $f = 217\text{ Hz}$ $f = 50\text{ kHz}$ | | 70 | | dB |
| | | | 40 | | |
| | | | | | |
| VDAC internal resistance | LDO off | | 360 | | k Ω |
| Ground current | On mode, $I_{OUT} = 0$ | | 60 | | μA |
| | On mode, $I_{OUT} = I_{OUTmax}$ | | 1600 | | |
| | Low-power mode | | 12 | | |
| | Off mode | | | 1 | |
| VPLL | | | | | |
| DC output voltage V_{OUT} | On and low-power mode, $V_{IN} = V_{INmin}$ to V_{INmax} SEL = 11, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 2.5 | +3% | V |
| | SEL = 10, $I_{OUT} = 0$ to I_{OUTmax} , default BOOT[1:0] = 00 or 01 | -3% | 1.8 | +3% | |
| | SEL = 01, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 1.1 | +3% | |
| | SEL = 00, $I_{OUT} = 0$ to I_{OUTmax} | -3% | 1.0 | +3% | |
| Rated output current I_{OUTmax} | On mode | 50 | | | mA |
| | Low-power mode | 1 | | | |
| Load current limitation (short-circuit protection) | On mode, $V_{OUT} = V_{OUTmin} - 100\text{ mV}$ | 200 | 400 | | mA |
| Dropout voltage V_{DO} | On mode, $V_{OUTtyp} = 2.5\text{ V}$, $V_{DO} = V_{IN} - V_{OUT}$, | | 100 | | mV |

VDAC AND VPLL LDO (continued)

over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------------|---|-----|------------------|-----|---------------|
| | $V_{IN} = 2.5\text{ V}$, $I_{OUT} = I_{OUTmax}$, $T = 25^\circ\text{C}$ | | | | |
| DC load regulation | On mode, $I_{OUT} = I_{OUTmax}$ to 0 | | | 10 | mV |
| DC line regulation | On mode, $V_{IN} = V_{INmin}$ to V_{INmax} @ $I_{OUT} = I_{OUTmax}$ | | | 1 | mV |
| Transient load regulation | On mode, $V_{IN} = 3.8\text{ V}$, $I_{OUT} = 0.1 \times I_{OUTmax}$ to $0.9 \times I_{OUTmax}$ in $5\ \mu\text{s}$ And $I_{OUT} = 0.9 \times I_{OUTmax}$ to $0.1 \times I_{OUTmax}$ in $5\ \mu\text{s}$ | | 9 | | mV |
| Transient line regulation | On mode, $V_{IN} = V_{INmin} + 0.5\text{ V}$ to V_{INmin} in $30\ \mu\text{s}$ And $V_{IN} = V_{INmin}$ to $V_{INmin} + 0.5\text{ V}$ in $30\ \mu\text{s}$, $I_{OUT} = I_{OUTmax}/2$ | | 0.5 | | mV |
| Turn-on time | $I_{OUT} = 0$, @ $V_{OUT} = 0.1\text{ V}$ up to V_{OUTmin} | | 100 | | μs |
| Turn-on inrush current | | | 300 | | mA |
| Ripple rejection | $V_{IN} = V_{INDC} + 100\text{ mV}_{pp}$ tone, $V_{INDC+} = 3.8\text{ V}$, $I_{OUT} = I_{OUTmax}/2$ $f = 217\text{ Hz}$ $f = 50\text{ kHz}$ | | 70 40 | | dB |
| VPLL internal resistance | LDO off | | 535 | | k Ω |
| Ground current | On mode, $I_{OUT} = 0$ On mode, $I_{OUT} = I_{OUTmax}$ Low-power mode Off mode | | 60 1600 12 | | μA |
| | | | | 1 | |

SWITCH-ON/OFF SEQUENCES AND TIMING

Time slot length can be selected to be 0.5 ms or 2 ms through the EEPROM for an OFF-to-ACTIVE transition or through the value programmed in the register DEVCTRL2_REG for a SLEEP-to-ACTIVE transition.

BOOT1 = 0, BOOT0 = 0

Table 2 provides details about the EEPROM setting for the BOOT modes. The power-up sequence for this boot mode is provided in Figure 2.

Table 2. Fixed Boot Mode: 00

| Register | Bit | Description | TPS65910 Boot 00 |
|-------------------------|------------|---------------------------------------|------------------|
| VDD1_OP_REG | SEL | VDD1 voltage level selection for boot | 1.2 V |
| VDD1_REG | VGAIN_SEL | VDD1 Gain selection, x1 or x2 | x1 |
| EEPROM | | VDD1 time slot selection | 3 |
| DCDCCTRL_REG | VDD1_PSKIP | VDD1 pulse skip mode enable | skip enabled |
| VDD2_OP_REG/VDD2_SR_REG | SEL | VDD2 voltage level selection for boot | 1.1 V |
| VDD2_REG | VGAIN_SEL | VDD2 Gain selection, x1 or x3 | x3 |
| EEPROM | | VDD2 time slot selection | 2 |
| DCDCCTRL_REG | VDD2_PSKIP | VDD2 pulse skip mode enable | skip enabled |
| VIO_REG | SEL | VIO voltage selection | 1.8 V |
| EEPROM | | VIO time slot selection | 1 |
| DCDCCTRL_REG | VIO_PSKIP | VIO pulse skip mode enable | skip enabled |
| EEPROM | | VDD3 time slot | OFF |
| VDIG1_REG | SEL | LDO voltage selection | 1.2 V |
| EEPROM | | LDO time slot | OFF |
| VDIG2_REG | SEL | LDO voltage selection | 1.0 V |

SWITCH-ON/OFF SEQUENCES AND TIMING (continued)

Table 2. Fixed Boot Mode: 00 (continued)

| | | | |
|---------------|-----------------|--|--|
| EEPROM | | LDO time slot | OFF |
| VDAC_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | 5 |
| VPLL_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | 4 |
| VAUX1_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | 1 |
| VMMC_REG | SEL | LDO voltage selection | 3.3 V |
| EEPROM | | LDO time slot | 6 |
| VAUX33_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | OFF |
| VAUX2_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | 5 |
| CLK32KOUT pin | | CLK32KOUT time slot | 7 |
| NRESPWRON pin | | NRESPWRON time slot | 7 + 1 |
| VRTC_REG | VRTC_OFFMASK | 0: VRTC LDO will be in low-power mode during OFF state 1: VRC LDO will be in full-power mode during OFF state | Low-power mode |
| DEVCTRL_REG | RTC_PWDN | 0: RTC in normal power mode 1: Clock gating of RTC register and logic, low-power mode | 1 |
| DEVCTRL_REG | CK32K_CTRL | 0: Clock source is crystal/external clock 1: Clock source is internal RC oscillator | RC |
| DEVCTRL2_REG | TSLOT_LENGTH[0] | Boot sequence time slot duration: 0: 0.5 ms 1: 2 ms | 2 ms |
| DEVCTRL2_REG | IT_POL | 0: INT1 signal will be active-low 1: INT1 signal will be active-high | Active-low |
| INT_MSK_REG | VMBHI_IT_MSK | 0: Device will automatically switch-on at NOSUPPLY to OFF or BACKUP to OFF transition 1: Startup reason required before switch-on | 0: Automatic switch-on from supply insertion |
| VMBCH_REG | VMBCH_SEL[1:0] | Select threshold for main battery comparator threshold VMBCH. | 3 V |

Figure 2 shows the 00 Boot mode timing characteristics.

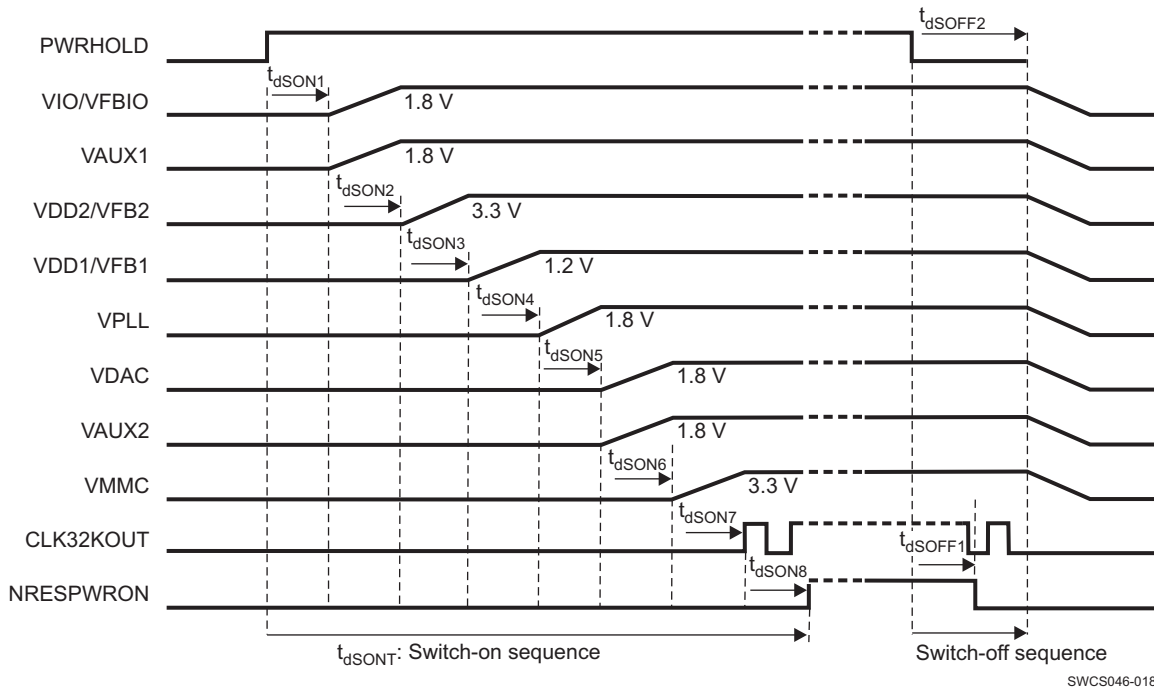


Figure 2. Boot Mode: BOOT1 = 0, BOOT0 = 0

Table 3 lists the 00 Boot mode timing characteristics.

Table 3. Boot Mode: BOOT1 = 0, BOOT0 = 0 Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------|--|-----|------------------------------|-----|---------|
| t_{dSON1} | PWRHOLD rising edge to VIO, VAUX1 enable delay | | $66 \times t_{CK32k} = 2060$ | | μs |
| t_{dSON2} | VIO to VDD2 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON3} | VDD2 to VDD1 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON4} | VDD1 to VPLL enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON5} | VPLL to VDAC, VAUX2 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON6} | VDAC to VMMC enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON7} | VMMC to CLK32KOUT rising edge delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON8} | CLK32KOUT to NRESPWRON rising edge delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSONT} | Total switch-on delay | | 16 | | ms |
| t_{dSOFF1} | PWRHOLD falling edge to NRESPWRON falling edge delay | | $2 \times t_{CK32k} = 62.5$ | | μs |
| $t_{dSOFF1B}$ | NRESPWRON falling edge to CLK32KOUT low delay | | $3 \times t_{CK32k} = 92$ | | μs |
| t_{dSOFF2} | PWRHOLD falling edge to supplies and reference disable delay | | $5 \times t_{CK32k} = 154$ | | μs |

Registers default setting: CK32K_CTRL = 1 (32-kHz RC oscillator is used), RTC_PWDN = 1 (RTC domain off), IT_POL = 0 (INT2 interrupt flag active low), VMBHI_IT_MSK = 0 (automatic switch-on on Battery plug), VMBCH_SEL = 11.

BOOT1 = 0, BOOT0 = 1

Table 4 provides details about the EEPROM setting for the BOOT modes. The power-up sequence for this boot mode is provided in Figure 3.

Table 4. Fixed Boot Mode: 01

| Register | Bit | Description | TPS65910 Boot 01 |
|-------------------------|---------------------|--|--|
| VDD1_OP_REG | SEL | VDD1 voltage level selection for boot | 1.2 V |
| VDD1_REG | VGAIN_SEL | VDD1 Gain selection, x1 or x2 | x1 |
| EEPROM | | VDD1 time slot selection | 3 |
| DCDCCTRL_REG | VDD1_PSKIP | VDD1 pulse skip mode enable | Skip enabled |
| VDD2_OP_REG/VDD2_SR_REG | SEL | VDD2 voltage level selection for boot | 1.2 V |
| VDD2_REG | VGAIN_SEL | VDD2 Gain selection, x1 or x3 | x1 |
| EEPROM | | VDD2 time slot selection | 4 |
| DCDCCTRL_REG | VDD2_PSKIP | VDD2 pulse skip mode enable | Skip enabled |
| VIO_REG | SEL | VIO voltage selection | 1.8 V |
| EEPROM | | VIO time slot selection | 1 |
| DCDCCTRL_REG | VIO_PSKIP | VIO pulse skip mode enable | Skip enabled |
| EEPROM | | VDD3 time slot | OFF |
| VDIG1_REG | SEL | LDO voltage selection | 1.2 V |
| EEPROM | | LDO time slot | OFF |
| VDIG2_REG | SEL | LDO voltage selection | 1.0 V |
| EEPROM | | LDO time slot | OFF |
| VDAC_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | OFF |
| VPLL_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | 2 |
| VAUX1_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | OFF |
| VMMC_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | OFF |
| VAUX33_REG | SEL | LDO voltage selection | 3.3 V |
| EEPROM | | LDO time slot | 6 |
| VAUX2_REG | SEL | LDO voltage selection | 1.8 V |
| EEPROM | | LDO time slot | 5 |
| CLK32KOUT pin | | CLK32KOUT time slot | 7 |
| NRESPWRON pin | | NRESPWRON time slot | 7+1 |
| VRTC_REG | VRTC_OFFMAS K | 0: VRTC LDO will be in low-power mode during OFF state 1: VRC LDO will be in full-power mode during OFF state | low-power mode |
| DEVCTRL_REG | RTC_PWDN | 0: RTC in normal power mode 1: Clock gating of RTC register and logic, low-power mode | 1 |
| DEVCTRL_REG | CK32K_CTRL | 0: Clock source is crystal/external clock 1: Clock source is internal RC oscillator | Crystal |
| DEVCTRL2_REG | TSLOT_LENGTH [0] | Boot sequence time slot duration: 0: 0.5 ms 1: 2 ms | 2 ms |
| DEVCTRL2_REG | IT_POL | 0: INT1 signal will be active-low 1: INT1 signal will be active-high | Active-low |
| INT_MSK_REG | VMBHI_IT_MSK | 0: Device will automatically switch-on at NOSUPPLY to OFF or BACKUP to OFF transition 1: Startup reason required before switch-on | 0: Automatic switch-on from supply insertion |
| VMBCH_REG | VMBCH_SEL[1:0] | Select threshold for main battery comparator threshold VMBCH. | 3 V |

Figure 3 shows the 01 Boot mode timing characteristics.

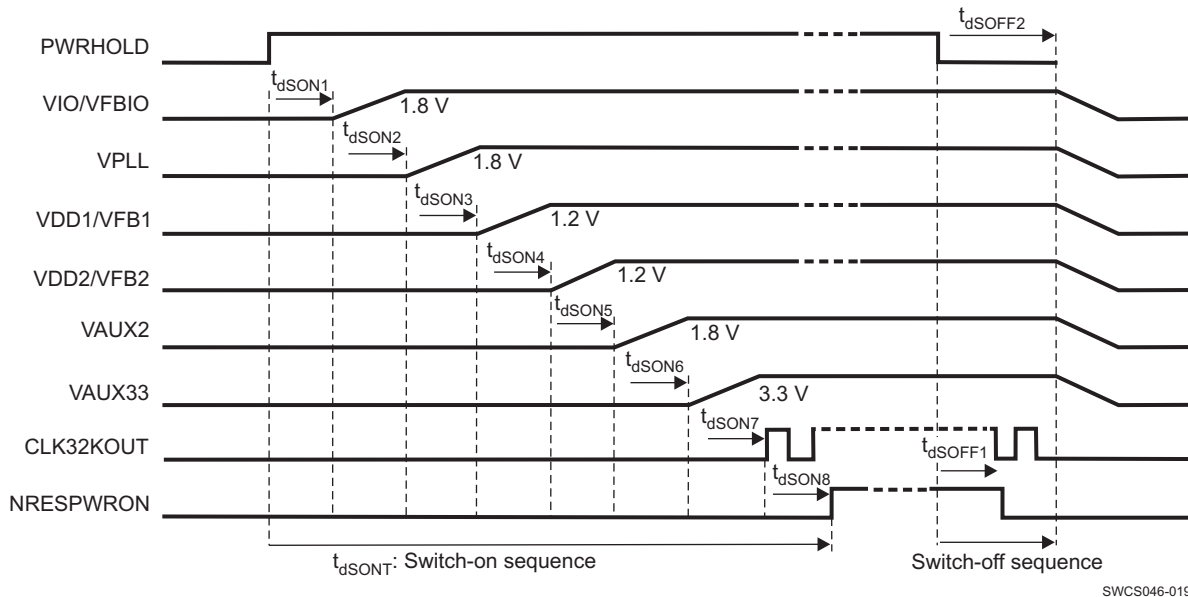


Figure 3. Boot Mode: BOOT1 = 0, BOOT0 = 1

Table 5 lists the 01 Boot mode timing characteristics.

Table 5. Boot Mode: BOOT1 = 0, BOOT0 = 1 Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------|--|-----|------------------------------|-----|---------|
| t_{dSON1} | PWRHOLD rising edge to VIO enable delay | | $66 \times t_{CK32k} = 2060$ | | μs |
| t_{dSON2} | VIO to VPLL enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON3} | VPLL to VDD1 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON4} | VDD1 to VDD2 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON5} | VDD2 to VAUX2 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| | VAUX2 to VAUX33 enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON7} | VAUX33 to CLK32KOUT enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSON8} | CLK32KOUT to NRESPWRON enable delay | | $64 \times t_{CK32k} = 2000$ | | μs |
| t_{dSONT} | Total switch-on delay | | 16 | | ms |
| t_{dSOFF1} | PWRHOLD falling edge to NRESPWRON falling edge | | $2 \times t_{CK32k} = 62.5$ | | μs |
| $t_{dSOFF1B}$ | NRESPWRON falling edge to CLK32KOUT low delay | | $3 \times t_{CK32k} = 92$ | | μs |
| t_{dSOFF2} | PWRHOLD falling edge to supplies disable delay | | $5 \times t_{CK32k} = 154$ | | μs |

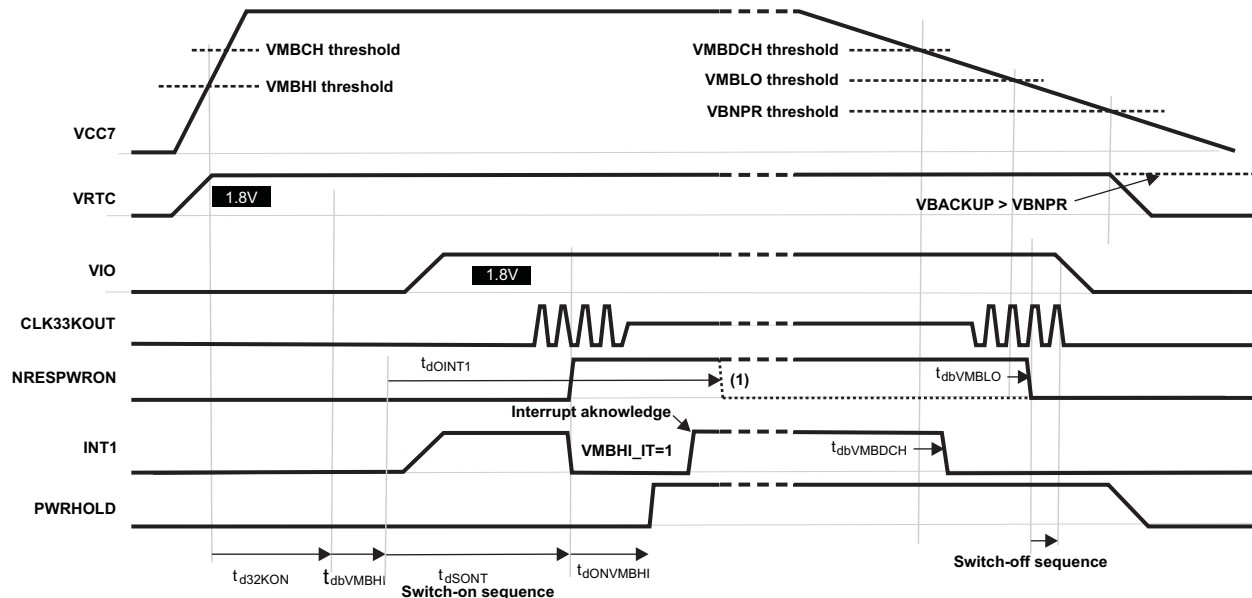
Registers default setting: CK32K_CTRL = 0 (32-kHz quartz or external bypass clock is used), RTC_PWDN = 1 (RTC domain off), IT_POL = 0 (INT2 interrupt flag active low), VMBHI_IT_MSK = 0 (automatic switch-on on battery plug), VMBCH_SEL = 11.

POWER CONTROL TIMING

Device Turn-On/Off With Rising/Falling Input Voltage

Figure 4 shows the device turn-on/-off with rising/falling input voltage.

POWER CONTROL TIMING (continued)



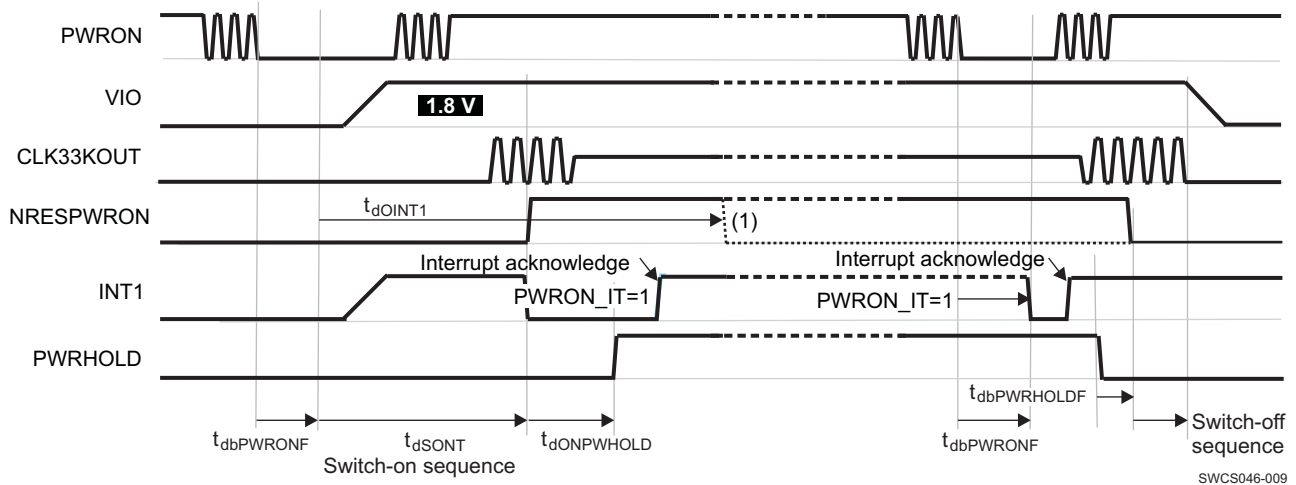
SWCS046-022

NOTE: (1) The DEV_ON control bit (set to 1) or the PWRHOLD signal (set high) can be used to maintain supplies on after the switch-on sequence. If none of these device Power On enable conditions is set, the supplies will be turned off after t_{dOINT1} delay.

Figure 4. Device Turn-On/Off with Rising/Falling Input Voltage

Device State Control Through PWRON Signal

Figure 5 shows the device state control through PWRON signal.

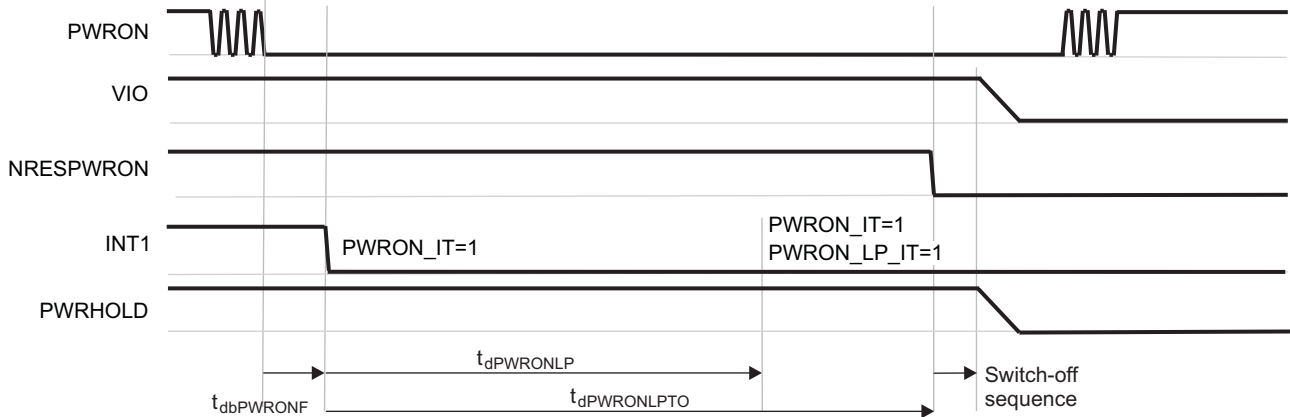


SWCS046-009

NOTE: (1) The DEV_ON control bit (set to 1) or the PWRHOLD signal (set high) can be used to maintain supplies on after switch-on sequence. If none of these device POWER ON enable condition is set the supplies will be turned off after T_{dOINT1} delay.

Figure 5. PWRON Turn-On/Turn-Off

Figure 6 shows the long-press turn-off timing characteristics.

POWER CONTROL TIMING (continued)


SWCS046-010

NOTE: If the DEV_ON control bit is set to 1 or PWRHOLD is kept high, the device will be turned on again after PWRON long press turn-off and PWRON released.

Figure 6. PWRON Long-Press Turn-Off

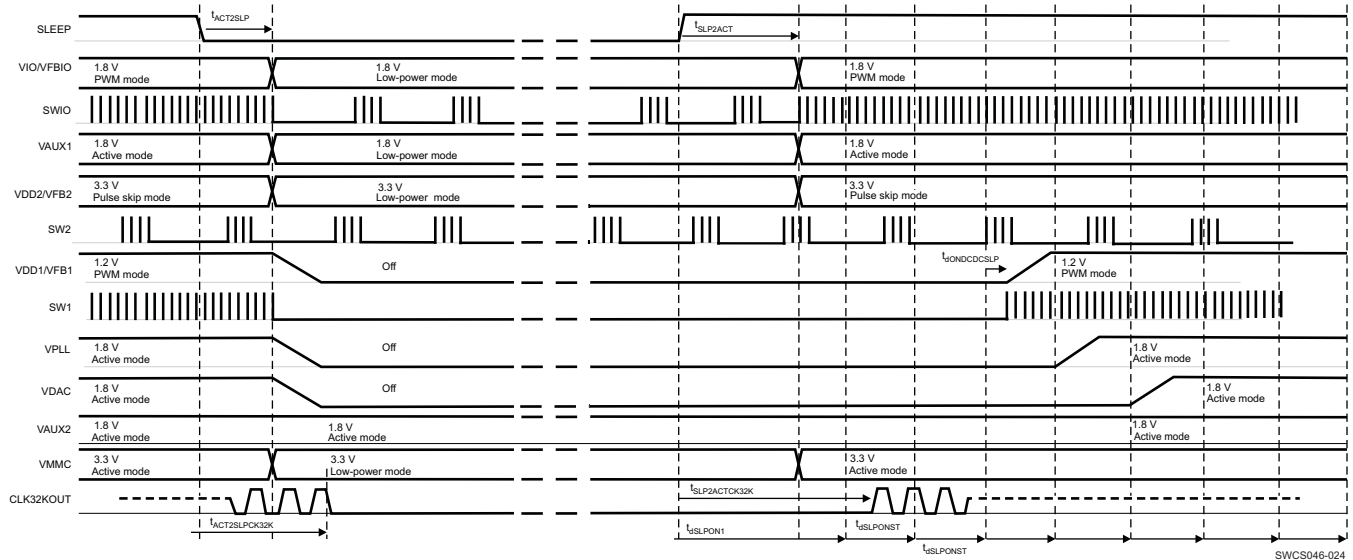
Table 6 lists the power control timing characteristics.

Table 6. Power Control Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|---------------------------|-------------------|----------------------------|---------|
| t_{d32KON} : 32-kHz Oscillator turn-on time | BOOT[1:0] = 00, RC oscillator BOOT[1:0] = 01, Quartz oscillator BOOT[1:0] = 01, Bypass clock | | 0.1 400 0.1 | 2000 | ms |
| $t_{dbVMBHI}$: VMBHI rising-edge debouncing delay | | $3 \times t_{CK32k} = 94$ | | $4 \times t_{CK32k} = 125$ | μ s |
| $t_{dbVMBDCH}$: Main Battery voltage = VMBDCH threshold to INT1 falling-edge delay | | $3 \times t_{CK32k} = 94$ | | $4 \times t_{CK32k} = 125$ | s |
| $t_{dbVMBLO}$: Main Battery voltage = VMBLO threshold to NRESPWRON falling-edge delay | | $3 \times t_{CK32k} = 94$ | | $4 \times t_{CK32k} = 125$ | s |
| $t_{dbPWRONF}$: PWRON falling-edge debouncing delay | | 500 | | 550 | ms |
| $t_{dbPWRONR}$: PWRON rising-edge debouncing delay | | $3 \times t_{CK32k} = 94$ | | $4 \times t_{CK32k} = 125$ | μ s |
| $t_{dbPWRHOLD}$: PWRON rising-edge debouncing delay | | $2 \times t_{CK32k} = 63$ | | $3 \times t_{CK32k} = 94$ | μ s |
| t_{dOINT} : INT1 (internal) Power-on pulse duration after PWRON low-level (debounced) event | | | 1 | | s |
| $t_{dONPWHOLD}$: delay to set high PWRHOLD signal or DEV_ON control bit after NRESPWRON released to keep on the supplies | | | 984 | | ms |
| $t_{dPWRONLP}$: PWRON long-press delay to interrupt | PWRON falling edge to PWON_LP_IT = 1 | | 6 | | s |
| $t_{dPWRONLPTO}$: PWRON long-press delay to turn-off | PWRON falling edge to NRESPWRON falling edge | | 8 | | s |

Device SLEEP State Control

Figure 7 shows the device SLEEP state control timing characteristics.



NOTE: Registers programming: VIO_PSKIP = 0, VDD1_PSKIP = 0, VDD1_SETOFF = 1, VDAC_SETOFF = 1, VPLL_SETOFF = 1, VAUX2_KEEPPON = 1

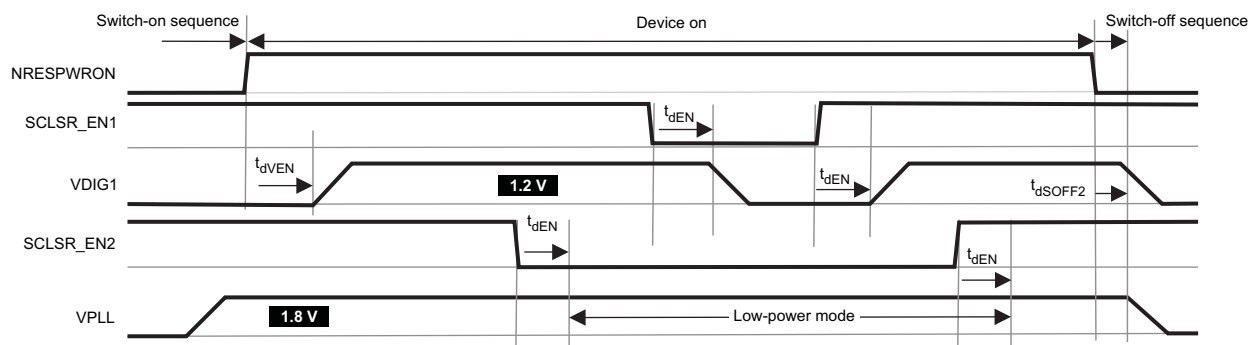
Figure 7. Device SLEEP State Control

Table 7. Device SLEEP State Control Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|--|----------------------------|------------------------------------|----------------------------|---------|
| $t_{ACT2SLP}$ | SLEEP falling edge to supply in low power mode (SLEEP resynchronization delay) | $2 \times t_{CK32k} = 62$ | | $3 \times t_{CK32k} = 94$ | μs |
| $t_{ACT2SLP}$ | SLEEP falling edge to CLK32KOUT low | 156 | $t_{ACT2SLP} + 3 \times t_{CK32k}$ | 188 | μs |
| $t_{SLP2ACT}$ | SLEEP rising edge to supply in high power mode | $8 \times t_{CK32k} = 250$ | | $9 \times t_{CK32k} = 281$ | μs |
| $t_{SLP2ACTCK32K}$ | SLEEP rising edge to CLK32KOUT running | 344 | $t_{SLP2ACT} + 3 \times t_{CK32k}$ | 375 | μs |
| $t_{dSLPON1}$ | SLEEP rising edge to time step 1 of the tun-on sequence from SLEEP state | 281 | $t_{SLP2ACT} + 1 \times t_{CK32k}$ | 312 | μs |
| $t_{dSLPONST}$ | turn-on sequence step duration, from SLEEP state | | | | μs |
| | TSLOT_LENGTH[1:0] = 00 | | 0 | | |
| | TSLOT_LENGTH[1:0] = 01 | | 200 | | |
| | TSLOT_LENGTH[1:0] = 11 | | 2000 | | |
| $t_{dSLPONDCDC}$ | VDD1, VDD2 or VIO tun-on delay from tun-on sequence time step | | $2 \times t_{CK32k} = 62$ | | μs |

Power Supplies State Control Through the SCLSR_EN1 and SDASR_EN2 Signals

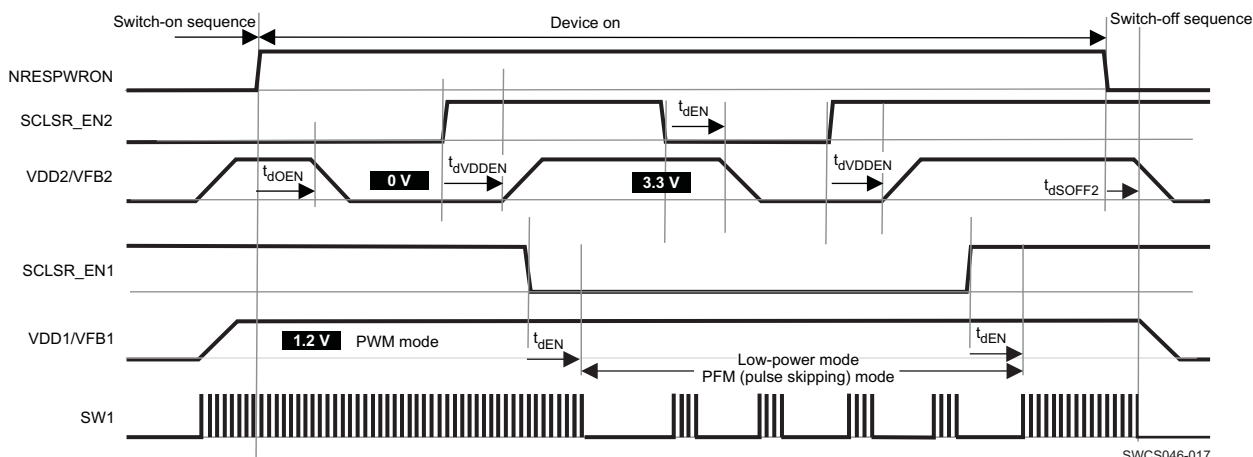
Figure 8 and Figure 9 show the power supplies state control through the SCLSR_EN1 and SDASR_EN2 signals timing characteristics.



SWCS046-016

NOTE: Register setting: VDIG1_EN1 = 1, VPLL_EN2 = 1, and VPLL_KEEPON = 1

Figure 8. LDO Type Supplies State Control Through SCLSR_EN1 and SCLSR_EN2



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NOTE: Register setting: VDD2_EN2 = 1, VDD1_EN1 = 1, VDD1_KEEPON = 1, VDD1_PSKIP = 0, and SEL[6:0] = hex00 in VDD2_SR_REG

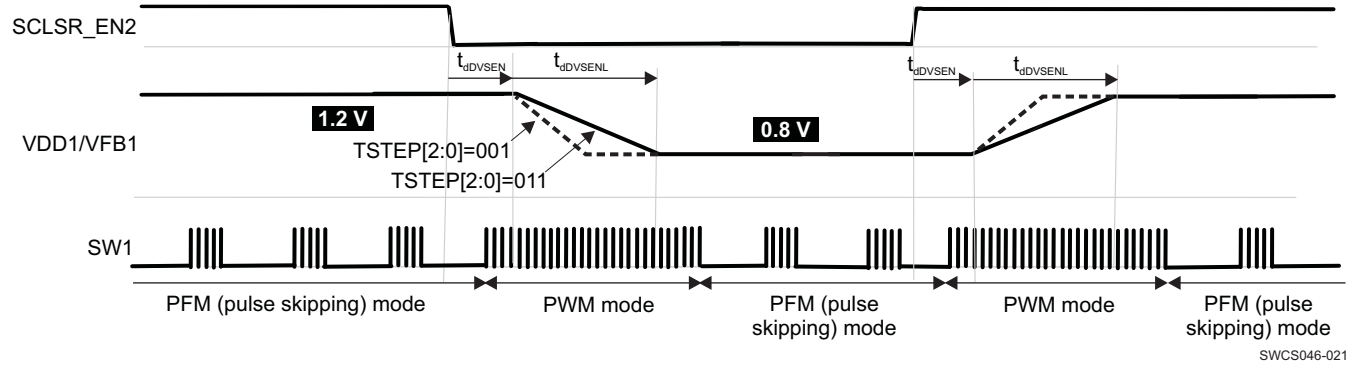
Figure 9. VDD1 and VDD2 Supplies State Control Through SCLSR_EN1 and SCLSR_EN2

Table 8. Supplies State Control Through SCLSR_EN1 and SCLSR_EN2 Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|-----------------|-----|---------------------------|-----|---------|
| t_{dEN} : NRESPWRON to supply state change delay, SCLSR_EN1 or SCLSR_EN2 driven | | | 0 | | ms |
| t_{dEN} : SCLSR_EN1 or SCLSR_EN2 edge to supply state change delay | | | $1 \times t_{CK32k} = 31$ | | μ s |
| t_{dVDDEN} : SCLSR_EN1 or SCLSR_EN2 edge to VDD1 or VDD2 dc-dc turn on delay | | | $3 \times t_{CK32k} = 63$ | | μ s |

VDD1 and VDD2 Voltage Control Through SCLSR_EN1 and SDASR_EN2 Signals

Figure 10 shows the VDD1 and VDD2 voltage control through the SCLSR_EN1 and SDASR_EN2 signals timing characteristics.



NOTE: Register setting: VDD1_EN1 = 1, SEL[6:0] = hex13 in VDD1_SR_REG

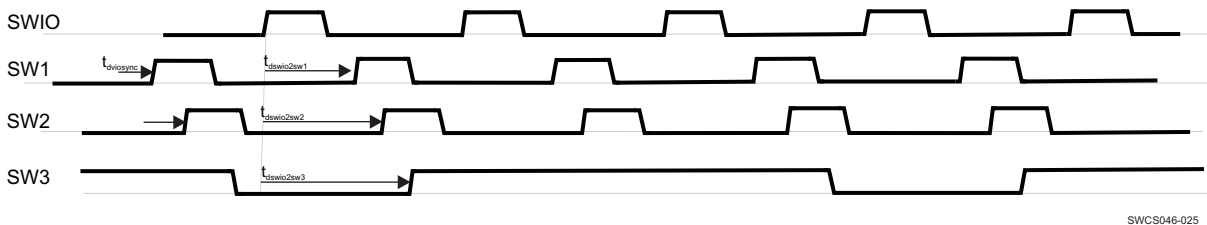
Figure 10. VDD1 Supply Voltage Control Through SCLSR_EN1

Table 9. VDD1 Supply Voltage Control Through SCLSR_EN1 Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----|---------------------------|-----|---------|
| t_{dVSEN} : SCLSR_EN1 or SCLSR_EN2 edge to VDD1 or VDD2 voltage change delay | | | $2 \times t_{CK32k} = 62$ | | μs |
| t_{dVSENL} : VDD1 or VDD2 voltage settling delay | TSTEP[2:0] = 001 TSTEP[2:0] = 011 (default) TSTEP[2:0] = 111 | | 32 0.4/7.5 = 53 160 | | μs |

SMPS Switching Synchronization

Figure 11 shows the SMPS switching synchronization timing characteristics.



NOTE: VDD1 or VDD2 switching synchronization is available in PWM mode (VDD1_PSKIP = 0 or VDD2_PSKIP = 0). SMPS external clock (GPIO_CKSYNC) synchronization is available when VIO PWM mode is set (VIO_PSKIP = 0).

Figure 11. SMPS Switching Synchronization

Table 10. SMPS Switching Synchronization Timing Characteristics

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|---|-----|------------|-----|------|
| $t_{dSWIO2SW1}$: delay from SWIO rising edge to SW1 rising edge | VDD1_PSKIP = 0, DCDCCKSYNC[1:0] = 11 DCDCCKSYNC[1:0] = 01 | | 160 220 | | ns |
| $t_{dSWIO2SW2}$: delay from SWIO rising edge to SW2 rising edge | VDD2_PSKIP = 0, DCDCCKSYNC[1:0] = 11 DCDCCKSYNC[1:0] = 01 | | 160 290 | | ns |

Table 10. SMPS Switching Synchronization Timing Characteristics (continued)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|-----------------|-----|-----|-----|------|
| $t_{dSWIO2SW3}$: delay from SWIO rising edge to SW3 rising edge | | | 206 | | ns |

DEVICE INFORMATION

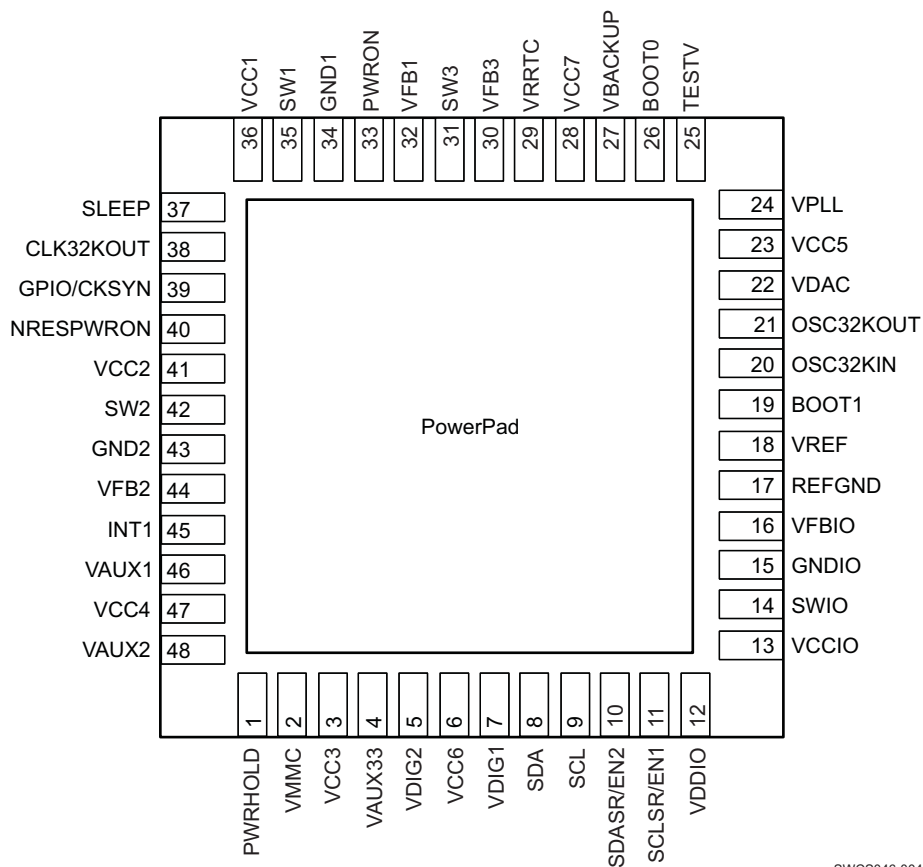
Table 11. Terminal Functions

| NAME | QFN PIN | SUPPLIES | TYPE | I/O | DESCRIPTION | PU/PD |
|-------------|---------|--------------|---------|-----|---|-------------------------------------|
| VDDIO | | VDDIO/DGND | Power | I | Digital I/Os supply | No |
| SDA_SDI | | VDDIO/DGND | Digital | I/O | I ² C bidirectional data signal/serial peripheral interface data input (multiplexed) | External PU |
| SCL_SCK | | VDDIO/DGND | Digital | I/O | I ² C bidirectional clock signal/serial peripheral interface Clock Input (multiplexed) | External PU |
| SDASR_EN2 | | VDDIO/DGND | Digital | I/O | I ² C SmartReflex bidirectional data signal/enable of supplies (multiplexed) | External PU |
| SCLSR_EN1 | | VDDIO/DGND | Digital | I/O | I ² C SmartReflex bidirectional clock signal/enable of supplies (multiplexed) | External PU |
| SLEEP | | VDDIO/DGND | Digital | I | Active-sleep state transition control signal | Programmable PD (default active) |
| GPIO_CKSYNC | | VDDIO/DGND | Digital | I/O | Configurable general-purpose I/O or DC-DCs synchronization clock input signal | Programmable PD (default active) |
| PWRHOLD | | VRTC/DGND | Digital | I | Switch-on/-off control signal | Programmable PD (default active) |
| PWRON | | VBAT/DGND | Digital | I | External switch-on control (ON button) | Programmable PU (default active) |
| NRESPWRON | | VDDIO/DGND | Digital | O | Power off reset | PD active during device OFF state |
| INT1 | | VDDIO/DGND | Digital | O | Interrupt flag | No |
| BOOT0 | | VRTC/DGND | Digital | I | Power-up sequence selection | Programmable PD (default active) |
| BOOT1 | | VRTC/DGND | Digital | I | Power-up sequence selection | Programmable PD (default active) |
| CLK32KOUT | | VDDIO/DGND | Digital | O | 32-kHz clock output | PD disable in ACTIVE or SLEEP state |
| OSC32KIN | | VRTC/REFGND | Analog | I | 32-kHz crystal oscillator | No |
| OSC32KOUT | | VRTC/REFGND | Analog | I | 32-kHz crystal oscillator | No |
| VREF | | VCC7/REFGND | Analog | O | Bandgap voltage | No |
| REFGND | | REFGND | Analog | I/O | Reference ground | No |
| TESTV | | VCC7/AGND | Analog | O | Analog test output (DFT) | No |
| VBACKUP | | VBACKUP/AGND | Power | I | Backup battery input (short to VCC5 if not used) | No |
| VCC1 | | VCC1/GND1 | Power | I | VDD1 dc-dc power input | No |
| GND1 | | VCC1/GND1 | Power | I/O | VDD1 dc-dc power ground | No |
| SW1 | | VCC1/GND1 | Power | O | VDD1 dc-dc switched output | No |
| VFB1 | | VCC7/AGND | Analog | I | VDD1 feedback voltage | PD |
| VCC2 | | VCC2/GND2 | Power | I | VDD2 dc-dc power input | No |
| GND2 | | VCC2/GND2 | Power | I/O | VDD2 dc-dc power ground | No |
| SW2 | | VCC2/GND2 | Power | O | VDD2 dc-dc switched output | No |
| VFB2 | | VCC4/AGND2 | Analog | I | VDD2 dc-dc feedback voltage | PD |
| VCCIO | | VCCIO/GNDIO | Power | I | VIO dc-dc power input | No |
| GNDIO | | VCCIO/GNDIO | Power | I/O | VIO dc-dc power ground | No |
| SWIO | | VCCIO/GNDIO | Power | O | VIO dc-dc switched output | No |
| VFBIO | | VCC7/AGND | Analog | I | VIO feedback voltage | PD |
| VCC3 | | VCC3/AGND2 | Power | I | VMMC VAUX33 power input | No |
| VMMC | | VCC3/REFGND | Power | O | LDO regulator output | PD |

Table 11. Terminal Functions (continued)

| NAME | QFN PIN | SUPPLIES | TYPE | I/O | DESCRIPTION | PU/PD |
|--------|-----------|-------------|--------|-----|--|-------|
| VAUX33 | | VCC3/REFGND | Power | O | LDO regulator output, VDD3 internal regulated supply | PD |
| VCC4 | | VCC4/AGND2 | Power | I | VAUX1, VAUX2 power input | No |
| VAUX1 | | VCC4/REFGND | Power | O | LDO regulator output | PD |
| VAUX2 | | VCC4/REFGND | Power | O | LDO regulator output | PD |
| VCC5 | | VCC5/AGND | Power | I | VDAC, VPLL power input | No |
| VDAC | | VCC5/REFGND | Power | O | LDO regulator output | PD |
| VPLL | | VCC5/REFGND | Power | O | LDO regulator output | PD |
| VRTC | | VCC7/REFGND | Power | O | LDO regulator output | PD |
| VCC6 | | VCC6/AGND2 | Power | I | VDIG1, VDIG2 power input | No |
| VDIG1 | | VCC6/REFGND | Power | O | LDO regulator output | No |
| VDIG2 | | VCC6/REFGND | Power | O | LDO regulator output | No |
| VCC7 | | VCC7/REFGND | Power | I | VRTC power input, VDD3 internal and analog references supply | No |
| VFB3 | | VCC7/AGND | Analog | I | VDD3 feedback voltage | No |
| SW3 | | VCC7/GND3 | Power | O | VDD3 dc-dc switched output | No |
| GND3 | Power PAD | AGND | Power | I/O | VDD3 dc-dc power ground | No |
| AGND | Power PAD | AGND | Power | I/O | Analog ground | No |
| AGND2 | Power PAD | AGND | Power | I/O | Analog ground | No |
| DGND | Power PAD | DGND | Power | I/O | Digital ground | No |

PIN ASSIGNMENT (TOP VIEW)



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Figure 12. 48-QFN Top View Pin Assignment

DETAILED DESCRIPTION

POWER REFERENCE

The bandgap voltage reference is filtered by using an external capacitor connected across the VREF output and the analog ground REFGND (see [RECOMMENDED OPERATING CONDITIONS](#), Recommended Operating Conditions). The VREF voltage is distributed and buffered inside the device.

POWER SOURCES

The power resources provided by the TPS65910 device include inductor-based switched mode power supplies (SMPS) and linear low drop-out voltage regulators (LDOs). These supply resources provide the required power to the external processor cores and external components, and to modules embedded in the TPS65910 device.

Two of these SMPS have DVS capability SmartReflex Class 3 compatible. These SMPS provide independent core voltage domains to the host processor. The remaining SMPS provides supply voltage for the host processor I/Os.

[Table 12](#) lists the power sources provided by the TPS65910 device.

Table 12. Power Sources

| RESOURCE | TYPE | VOLTAGES | POWER |
|----------|------|--|---------|
| VIO | SMPS | 1.5 V / 1.8 V / 2.5 V / 3.3 V | 1000 mA |
| VDD1 | SMPS | 0.6 ... 1.5 in 12.5-mV steps Programmable multiplication factor: x2, x3 | 1500 mA |
| VDD2 | SMPS | 0.6 ... 1.5 in 12.5-mV steps Programmable multiplication factor: x2, x3 | 1500 mA |
| VDD3 | SMPS | 5 V | 100 mA |
| VDIG1 | LDO | 1.2 V, 1.5 V, 1.8 V, 2.7 V | 300 mA |
| VDIG2 | LDO | 1 V, 1.1 V, 1.2 V, 1.8 V | 300 mA |
| VPLL | LDO | 1.0 V, 1.1 V, 1.8 V, 2.5 V | 50 mA |
| VDAC | LDO | 1.8 V, 2.6 V, 2.8 V, 2.85 V | 150 mA |
| VAUX1 | LDO | 1.8 V, 2.5 V, 2.8 V, 2.85 V | 300 mA |
| VAUX2 | LDO | 1.8 V, 2.8 V, 2.9 V, 3.3 V | 150 mA |
| VAUX33 | LDO | 1.8 V, 2.0 V, 2.8 V, 3.3 V | 150 mA |
| VMMC | LDO | 1.8 V, 2.8 V, 3.0 V, 3.3 V | 300 mA |

EMBEDED POWER CONTROLLER

The embedded power controller manages the state of the device and controls the power-up sequence.

STATE-MACHINE

The EPC supports the following states:

No supply: The main battery supply voltage is not high enough to power the VRTC regulator. A global reset is asserted in this case. Everything on the device is off.

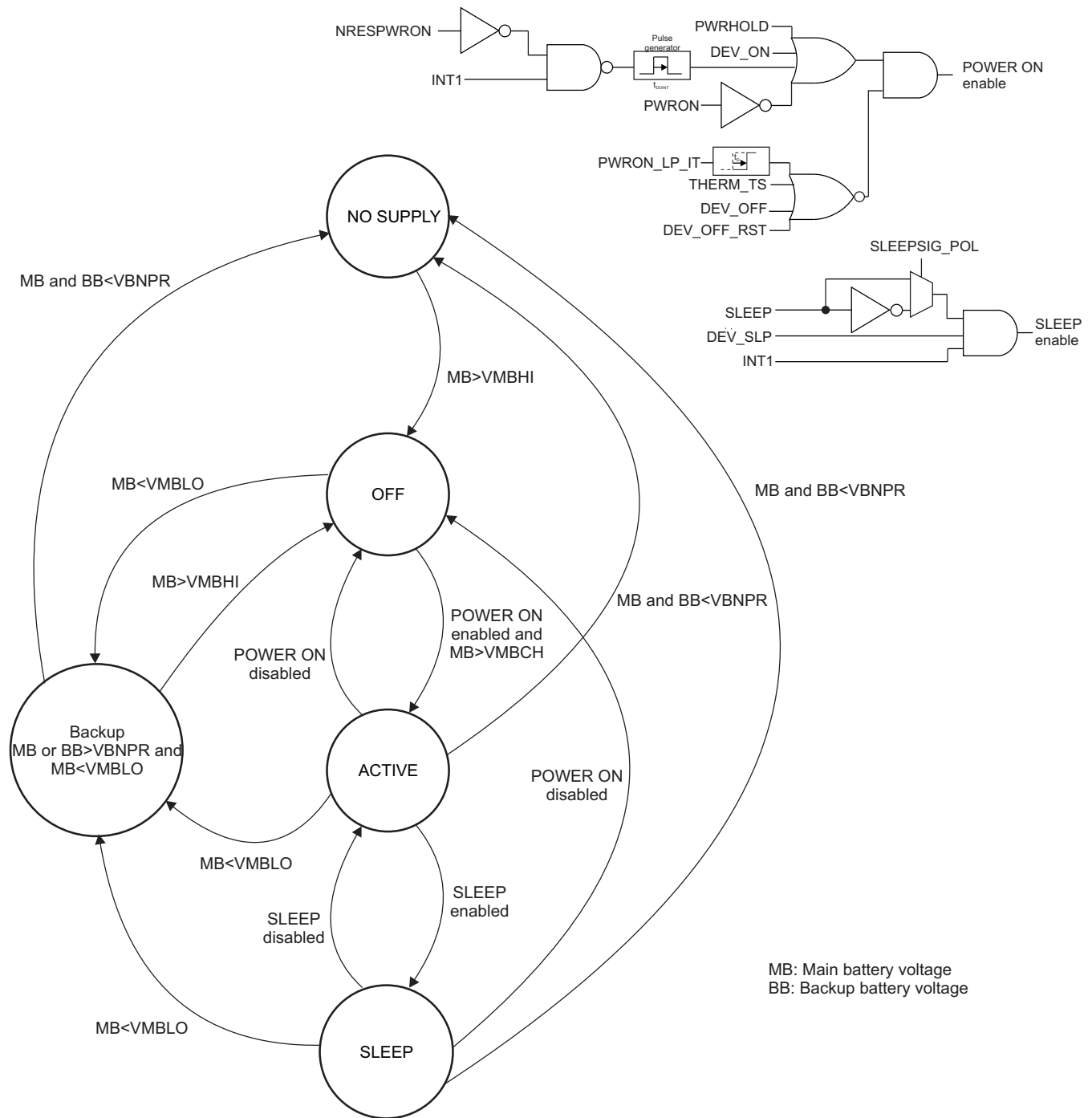
Backup: The main battery supply voltage is high enough to enable the VRTC domain but not enough to switch on all the resources. In this state, the VRTC regulator is in backup mode and only the 32-K oscillator and RTC module are operating (if enabled). All other resources are off or under reset.

Off: The main battery supply voltage is high enough to start the power-up sequence but device power on is not enabled. All power supplies are in OFF state except VRTC.

Active: Device power-on enable conditions are met and regulated power supplies are on or can be enabled with full current capability.

Sleep: Device SLEEP enable conditions are met and some selected regulated power supplies are in low-power mode.

Figure 13 shows the transitions of the state-machine.



MB: Main battery voltage
 BB: Backup battery voltage

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Figure 13. Embedded Power Control State-Machine

Device power-on enable conditions:

If none of the device power-on disable conditions is met, the following conditions are available to turn on and/or maintain the ON state of the device:

- PWRON signal low level.
- Or PWRHOLD signal high level.
- Or DEV_ON control bit set to 1 (default inactive).

- Or interrupt flag active (default INT1 low) while the device is off (NRESPWRON = 0) generates a power-on enable condition during a fixed delay (T_{DOINT1} pulse duration defined in [POWER CONTROL TIMING](#), Power Control Timing).

The power-on enable condition pulse occurs only if the interrupt status bit is initially low (no previous identical interrupt pending in the status register).

The Interrupt sources expected when the device is off are:

- PWRON low-level interrupt (PWRON_IT = 1 in INT_STS_REG register)
- PWRHOLD rising-edge interrupt (PWRHOLD_IT = 1 in INT_STS_REG register)

The Interrupt sources expected if enabled when the device is off are:

- RTC Alarm interrupt (RTC_ALARM_IT = 1 or RTC_PERIOD_IT = 1 in INT_STS_REG register)
- First-time input voltage rising above VMBHI threshold (Boot mode or EEPROM dependent) and input voltage > VMBCH threshold (VMBCH_IT = 1 in INT_STS_REG register).

GPIO_CKSYNC cannot be used to turn on the device (OFF-to-ACTIVE state transition), even if its associated interrupt is not masked, but can be used as an interrupt source to wake up the device from SLEEP-to-ACTIVE state.

Device power-on disable conditions:

- PWRON signal low level during more than the long-press delay: $t_{dPWRONLP}$ (can be disabled though register programming). The interrupt corresponding to this condition is PWRON_LP_IT in the INT_STS_REG register.
- Or Die temperature has reached the thermal shutdown threshold.
- Or DEV_OFF or DEV_OFF_RST control bit set to 1 (value of DEV_OFF is cleared when the device is in OFF state).

Device SLEEP enable conditions:

- SLEEP signal low level (default, or high level depending on the programmed polarity)
- And DEV_SLP control bit set to 1
- And interrupt flag inactive (default INT1 high): no nonmasked interrupt pending

The SLEEP state can be controlled by programming DEV_SLP and keeping the SLEEP signal in the active polarity state, or it can be controlled through the SLEEP signal setting the DEV_SLP bit to 1 once, after device turn-on.

SWITCH-ON/OFF SEQUENCES

The power sequence is the automated switching on of the device resources when an off-to-active transition takes place.

The device supports three embedded power sequences selectable by the device BOOT pins.

| BOOT0 | BOOT1 | Processor Supported |
|-------|-------|------------------------------------|
| 0 | 0 | AM3517, AM3505 |
| 1 | 0 | OMAP3 Family, AM3715/03, DM3730/25 |
| 0 | 1 | EEPROM sequence |

Details of the boot sequence timing are given in [SWITCH-ON/OFF SEQUENCES AND TIMING](#). EEPROM sequences can be used for specific power up sequence for corresponding application processor. For details of EEPROM sequence refer to the user guides on the product folder: <http://focus.ti.com/docs/prod/folders/print/tps65910.html>.

CONTROL SIGNALS

SLEEP

When none of the device sleep-disable conditions are met, a falling edge (default, or rising edge, depending on the programmed polarity) of this signal causes an ACTIVE-to-SLEEP state transition of the device. A rising edge (default, or falling edge, depending on the programmed polarity) causes a transition back to ACTIVE state. This input signal is level sensitive and no debouncing is applied.

While the device is in SLEEP state, predefined resources are automatically set in their low-power mode or off. Resources can be kept in their active mode: (full-load capability), programming the SLEEP_KEEP_LDO_ON and the SLEEP_KEEP_RES_ON registers. These registers contain 1 bit per power resource. If the bit is set to 1, then that resource stays in active mode when the device is in SLEEP state. 32KCLKOUT is also included in the SLEEP_KEEP_RES_ON register and the 32-kHz clock output is maintained in SLEEP state if the corresponding mask bit is set.

PWRHOLD

When none of the device power-on disable conditions are met, a rising edge of this signal causes an OFF-to-ACTIVE state transition of the device and a falling edge causes a transition back to OFF state. Typically, this signal is used to control the device in a slave configuration. It can be connected to the SYSEN output signal from other TPS659xx devices, or the NRESPWRON signal of another TPS65910 device. This input signal is level sensitive and no debouncing is applied.

A rising edge of PWRHOLD is highlighted though an associated interrupt.

BOOT0/BOOT1

These signals determine which processor the device is working with and hence which power-up sequence is needed. See [SWITCH-ON/OFF SEQUENCES AND TIMING](#) for more details. There is no debouncing on this input signal.

NRESPWRON

This signal is used as the reset to the processor. It is held low until the ACTIVE state is reached. See [POWER CONTROL TIMING](#) to get detailed timing.

CLK32KOUT

This signal is the output of the 32K oscillator, which can be enabled or not during the power-on sequence, depending on the Boot mode. It can be enabled and disabled by register bit, during ACTIVE state of the device. CLK32KOUT output can also be enabled or not during SLEEP state of the device depending on the SLEEPMASK register programming.

PWRON

A falling edge on this signal causes after $t_{dbPWRONF}$ debouncing delay (defined in [Figure 5](#) and [Table 6](#)) an OFF-to-ACTIVE state or SLEEP-to-ACTIVE state transition of the device and makes the corresponding interrupt (PWRON_IT) active. The PWRON input is connected to an external push-button. The built-in debouncing time defines a minimum button press duration that is required for button press detection. Any button press duration which is lower than this value is ignored, considered an accidental touch.

After an OFF-to-ACTIVE state transition, the PMIC maintains ACTIVE during t_{dOINT} delay, if the button is released. After this delay if none of the device enabling conditions is set by the processor supplied, the PMIC automatically turns off. If the button is not released, the PMIC maintains ACTIVE up to $t_{dPWRONLPTO}$, because PWRON low is a device enabling condition. After a SLEEP-to-ACTIVE state transition, the PMIC maintains ACTIVE as long as an interrupt is pending.

If the device is already in ACTIVE state, a PWRON low level makes the corresponding interrupt (PWRON_IT) active.

When the PMIC is in ACTIVE mode, if the button is pressed for longer time than $t_{dPWRONLP}$, the PMIC generates the PWON_LP_IT interrupt. If the processor does not acknowledge the long press interrupt within a period of $t_{dPWRONLPTO} - t_{dPWRONLP}$, the PMIC goes to OFF mode and shuts down the DCDCs and LDOs.

INT1

INT1 signal (default active low) warns the host processor of any event that occurred on the TPS65910 device. The host processor can then poll the interrupt from the interrupt status register through I²C to identify the interrupt source. A low level (default setting) indicates an active interrupt, highlighted in the INT_STS_REG register. The polarity of INT1 can be set by programming the IT_POL control bit.

Any (not masked or masked) interrupt detection causes a POWER ON enable condition during a fixed delay t_{DOINT1} (only) when the device is in OFF state (when NRESPWON signal is low). Any (not masked) interrupt detection is causing a device wakeup from SLEEP state up to acknowledge of the pending interrupt. Any of the interrupt sources can be masked by programming the INT_MSK_REG register. When an interrupt is masked, its corresponding interrupt status bit is still updated, but the INT1 flag is not activated.

Interrupt source masking can be used to mask a device switch-on event. Because interrupt flag active is a POWER ON enable condition during t_{DOINT1} delay, any interrupt not masked must be cleared to allow turn off of the device after the t_{DOINT1} POWER ON enable pulse duration.. See section: Interrupts, for interrupt sources definition.

SDASR_EN2 and SCLSR_EN1

SDASR_EN2 and SCLSR_EN1 are the data and clock signals of the serial control interface (SR-I²C) dedicated to SmartReflex applications. These signals can also be programmed to be used as enable signals of one or several supplies, when the device is on (NRESPWRON high). A resource assigned to SDASR_EN2 or SCLSR_EN1 control automatically disables the serial control interface.

Programming EN1_LDO_ASS_REG, EN2_LDO_REG, and SLEEP_KEEP_LDO_ON_REG registers: SCLSR_EN1 and SDASR_EN2 signals can be used to control the turn on/off or sleep state of any LDO type supplies.

Programming EN1_SMPS_ASS_REG, EN2_SMPS_ASS_REG, and SLEEP_KEEP_RES_ON registers: SCLSR_EN1 and SDASR_EN2 signals can be used to control the turn on/off or low-power state (PFM mode) of SMPS type supplies.

SDASR_EN2 and SCLSR_EN1 can be used to set output voltage of VDD1 and VDD2 SMPS from a roof to a floor value, preprogrammed in the VDD1_OP_REG, VDD2_OP_REG, and teh VDD1_SR_REG, VDD2_SR_REG registers. Tun-off of VDD1 and VDD2 can also be programmed either in VDD1_OP_REG, VDD2_OP_REG or in VDD1_SR_REG, VDD2_SR_REG registers.

When a supply is controlled through SCLSR_EN1 or SCLSR_EN2 signals, its state is no longer driven by the device SLEEP state.

GPIO_CKSYNC

GPIO_CKSYNC is a configurable open-drain digital I/O: directivity, debouncing delay and internal pullup can be programmed in the GPIO0_REG register. GPIO_CKSYNC cannot be used to turn on the device (OFF-to-ACTIVE state transition), even if its associated interrupt is not masked, but can be used as an interrupt source to wake up the device from SLEEP-to-ACTIVE state.

Programming DCDCCKEXT = 1, VDD1, VDD2, VIO, and VDD3 dc-dc switching can be synchronized using a 3-MHz clock set though the GPIO_CKSYNC pin.

DYNAMIC VOLTAGE FREQUENCY SCALING AND ADAPTIVE VOLTAGE SCALING OPERATION

Dynamic voltage frequency scaling (DVFS) operation: a supply voltage value corresponding to a targeted frequency of the digital core supplied is programmed in VDD1_OP_REG or VDD2_OP_REG registers.

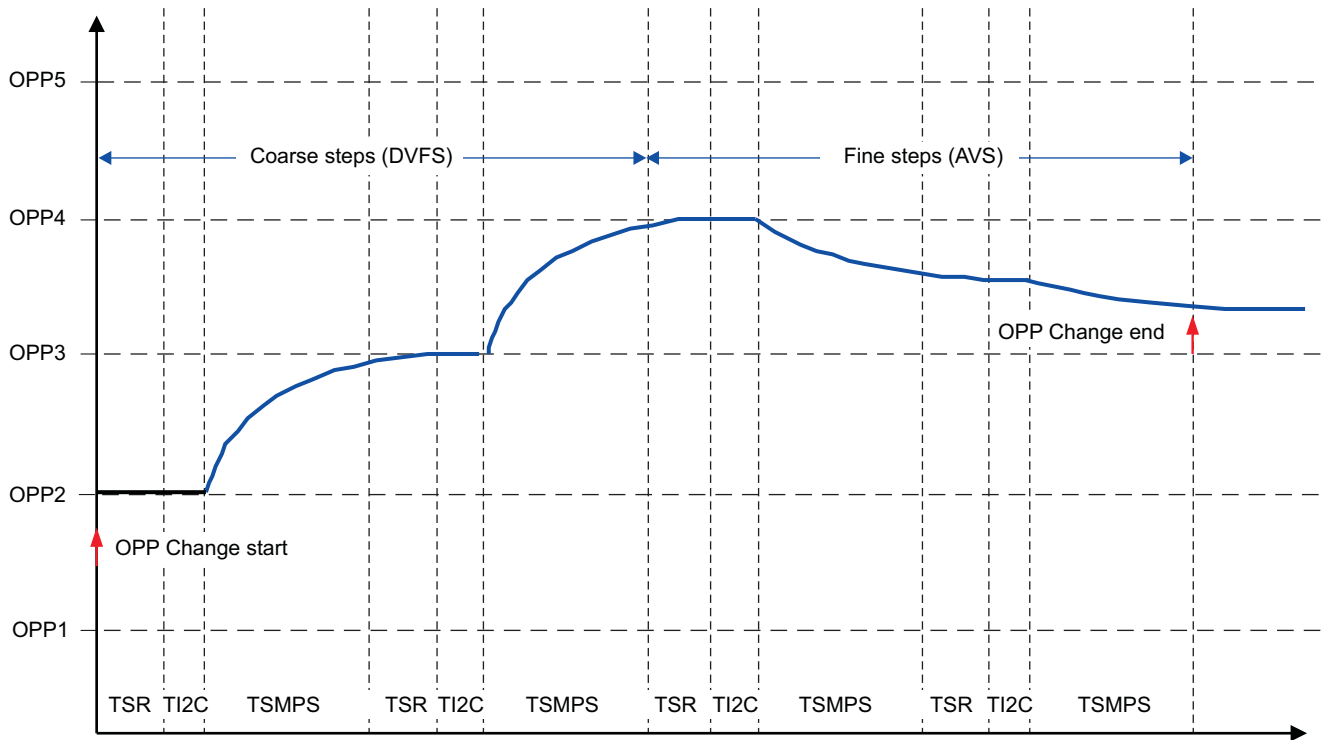
The slew rate of the voltage supply reaching a new VDD1_OP_REG or VDD2_OP_REG programmed value is limited to 12.5 mV/ μ s, fixed value. Adaptative voltage scaling (AVS) operation: a supply voltage value corresponding to a supply voltage adjustment is programmed in VDD1_SR_REG or VDD2_SR_REG registers. The supply voltage is then intended to be tuned by the digital core supplied, based its performance self-evaluation. The slew rate of VDD1 or VDD2 voltage supply reaching a new programmed value is programmable though the VDD1_REG or VDD2_REG register, respectively.

A serial control interface (SR-I²C) is dedicated to SmartReflex applications such as DVFS and class 3 AVS, and thus gives access to the VDD1_OP_REG, VDD1_SR_REG, and VDD2_OP_REG, VDD2_SR_REG register.

A general-purpose serial control interface (CTL-I²C) also gives access to these registers, if SR_CTL_I2C_SEL control bit is set to 1 in the DEVCTRL_REG register (default inactive).

Both control interfaces are compliant with HS-I²C specification (100 kbps, 400 kbps, or 3.4 Mbps).

Figure 14 shows an example of a SmartReflex operation. To optimize power efficiency, the voltage domains of the host processor uses the DVFS and AVS features provided by SmartReflex.



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- (1) T_{SR} : Time used by the SmartReflex controller
- (2) T_{I2C} : Time used for data transfer through the I²C interface
- (3) T_{SMPS} : Time required by the SMPS to converge to new voltage value

Figure 14. SmartReflex Operation Example

32-kHz RTC CLOCK

The TPS65910 device can provide a 32-kHz clock to the platform through the CLK32KOUT output, the source of this 32-kHz clock can be:

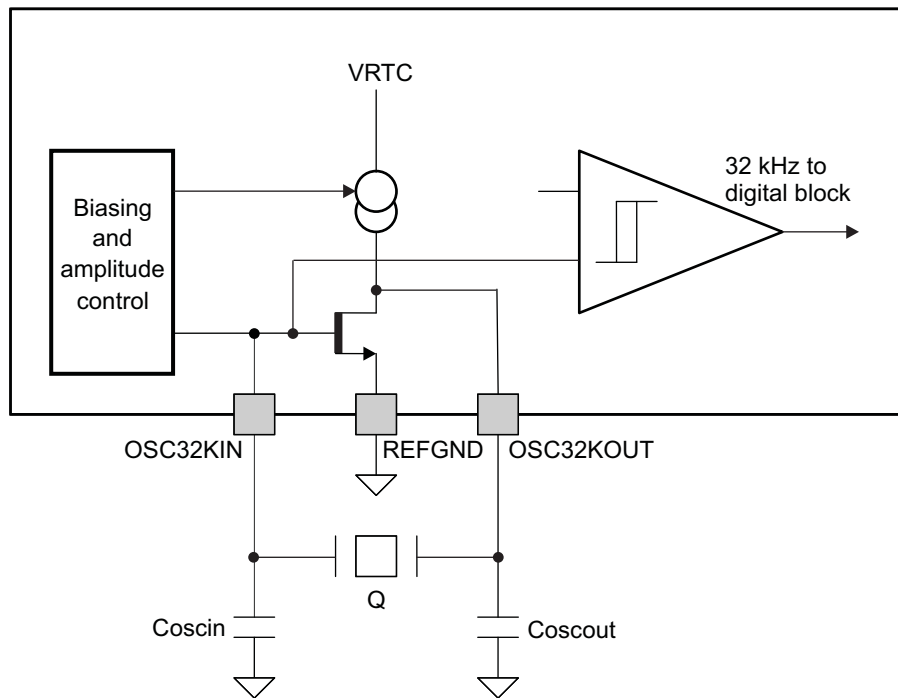
- 32-kHz crystal connected from OSC32IN to OSC32KOUT pins
- A square-wave 32-kHz clock signal applied to OSC32IN input (OSC32KOUT kept floating).
- Internal 32-kHz RC oscillator, to reduce the BOM, if an accurate clock is not needed by the system.

Default selection of a 32-kHz RC oscillator versus 32-kHz crystal oscillator or external square-wave 32-kHz clock depends on the Boot mode or device version (EEPROM programming):

- BOOT1 = 0, BOOT0 = 1: quartz oscillator or external square wave 32-kHz clock default
- BOOT1 = 0, BOOT0 = 0: 32-kHz RC oscillator default

Switching from the 32-kHz RC oscillator to the 32-kHz crystal oscillator or external square-wave 32-kHz clock can also be programmed through DEVCTRL_REG register, taking benefit of the shorter turn-on time of the internal RC oscillator.

Switching from the 32-kHz crystal oscillator or external square-wave clock to the RC oscillator is not supported.



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Figure 15. Crystal Oscillator 32-kHz Clock

RTC

The RTC, which is driven by the 32-kHz clock, provides the alarm and timekeeping functions. The RTC is kept supplied when the device is in the OFF or the BACKUP state.

The main functionalities of the RTC block are:

- Time information (seconds/minutes/hours) directly in binary-coded decimal (BCD) format
- Calendar information (Day/Month/Year/Day of the week) directly in BCD code up to year 2099
- Programmable interrupts generation: The RTC can generate two interrupts: a timer interrupt RTC_PERIOD_IT periodically (1s/1m/1h/1d period) and an alarm interrupt RTC_ALARM_IT at a precise time of the day (alarm function). These interrupts are enabled using IT_ALARM and IT_TIMER control bits. Periodically interrupts can be masked during the SLEEP period to avoid host interruption and are automatically unmasked after SLEEP wakeup (using the IT_SLEEP_MASK_EN control bit).
- Oscillator frequency calibration and time correction

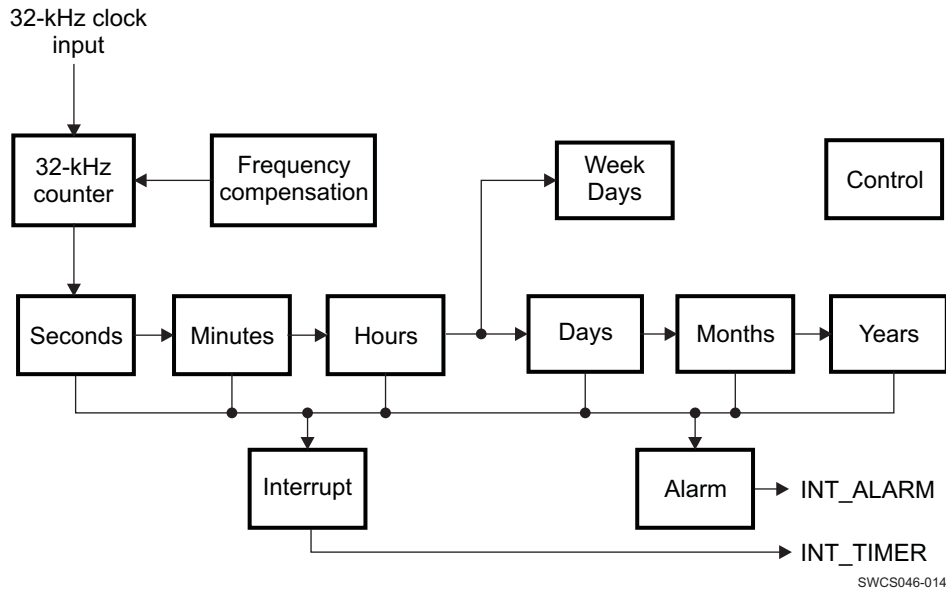


Figure 16. RTC Digital Section Block Diagram

NOTE

INT_ALARM can generate a wakeup of the platform.

INT_TIMER cannot generate a wakeup of the platform.

TIME CALENDAR REGISTERS

All the time and calendar information are available in these dedicated registers, called TC registers. Values of the TC registers are written in BCD format.

1. Year data ranges from 00 to 99
 - Leap year = Year divisible by four (2000, 2004, 2008, 2012...)
 - Common year = other years
2. Month data ranges from 01 to 12
3. Day value ranges from:
 - 1 to 31 when months are 1, 3, 5, 7, 8, 10, 12
 - 1 to 30 when months are 4, 6, 9, 11
 - 1 to 29 when month is 2 and year is a leap year
 - 1 to 28 when month is 2 and year is a common year
4. Week value ranges from 0 to 6
5. Hour value ranges from 00 to 23 in 24-hour mode and ranges from 1 to 12 in AM/PM mode
6. Minutes value ranges from 0 to 59
7. Seconds value ranges from 0 to 59

To modify the current time, software writes the new time into TC registers to fix the time/calendar information. The DBB can write into TC registers without stopping the RTC. In addition, software can stop the RTC by clearing the STOP_RTC bit of the control register and check the RUN bit of the status to be sure that the RTC is frozen. Then update TC values, and then restart the RTC by setting the STOP_RTC bit.

Example: Time is 10H54M36S PM (PM_AM mode set), 2008 September 5, previous register values are:

| Register | Value |
|-------------|-------|
| SECONDS_REG | 0x36 |
| MINUTES_REG | 0x54 |
| HOURS_REG | 0x90 |
| DAYS_REG | 0x05 |
| MONTHS_REG | 0x09 |
| YEARS_REG | 0x08 |

The user can round to the closest minute, by setting the ROUND_30S register bit. TC values are set to the closest minute value at the next second. The ROUND_30S bit is automatically cleared when the rounding time is performed.

Example:

- If current time is 10H59M45S, a round operation changes time to 11H00M00S.
- if current time is 10H59M29S, a round operation changes time to 10H59M00S.

GENERAL REGISTERS

Software can access the RTC_STATUS_REG and RTC_CTRL_REG registers at any time (except for the RTC_CTRL_REG[5] bit, which must be changed only when the RTC is stopped).

COMPENSATION REGISTERS

The RTC_COMP_MSB_REG and RTC_COMP_LSB_REG registers must respect the available access period. These registers must be updated before each compensation process. For example, software can load the compensation value into these registers after each hour event, during an available access period.

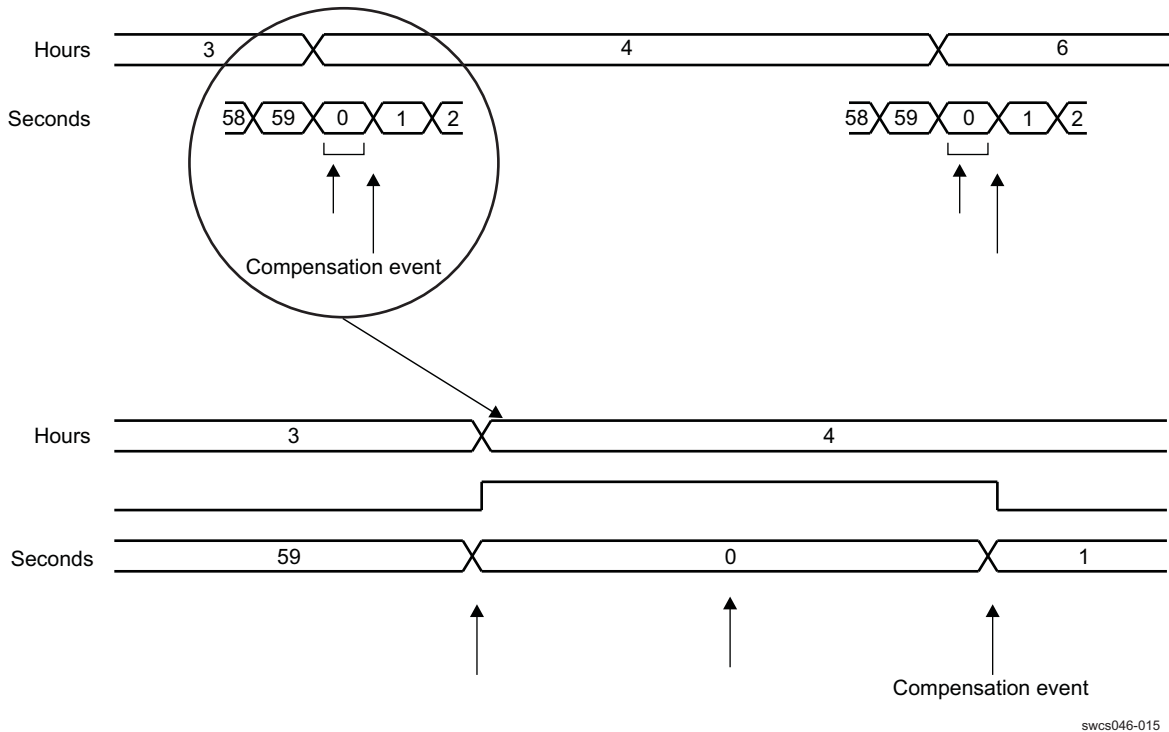


Figure 17. RTC Compensation Scheduling

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This drift can be balanced to compensate for any inaccuracy of the 32-kHz oscillator. Software must calibrate the oscillator frequency, calculate the drift compensation versus one time hour period; and then load the compensation registers with the drift compensation value. Indeed, if the AUTO_COMP_EN bit in the RTC_CTRL_REG is enabled, the value of COMP_REG (in twos-complement) is added to the RTC 32-kHz counter at each hour and one second. When COMP_REG is added to the RTC 32-kHz counter, the duration of the current second becomes $(32768 - \text{COMP_REG})/32768\text{s}$; so, the RTC can be compensated with a 1/32768 s/hour time unit accuracy.

NOTE

The compensation is considered once written into the registers.

BACKUP BATTERY MANAGEMENT

The device includes a back-up battery switch connecting the VRTC regulator input to a main battery (VCC7) or to a back-up battery (VBACKUP), depending on the batteries voltage value.

The VRTC supply can then be maintained during a BACKUP state as far as the input voltage is high enough (>VBNPR threshold). Below the VBNPR voltage threshold the digital core of the device is set under reset by internal signal POR (PowerOnReset).

The back-up domain functions which are always supplied from VRTC comprehend:

- The internal 32-kHz oscillator
- Backup registers

The back-up battery can be charged from the main battery through an embedded charger. The back-up battery charge voltage and enable is controlled through BBCH_REG register programming. This register content is maintained during the device Backup state.

Hence enabled the back-up battery charge is maintained as far as the main battery voltage is higher than the VMBLO threshold and the back-up battery voltage.

BACKUP REGISTERS

As part of the RTC the device contains five 8-bit registers which can be used for storage by the application firmware when the external host is powered down. These registers retain their content as long as the VRTC is active.

I²C INTERFACE

A general-purpose serial control interface (CTL-I²C) allows read and write access to the configuration registers of all resources of the system.

A second serial control interface (SR-I²C) is dedicated to SmartReflex applications such as DVFS or AVS.

Both control interfaces are compliant with HS-I²C specification.

These interfaces support the standard slave mode (100 Kbps), Fast mode (400 Kbps), and high-speed mode (3.4 Mbps). The general-purpose I²C module using one slave hard-coded address (ID1 = 2Dh). The SmartReflex I²C module uses one slave hard-coded address (ID0 = 12h). The master mode is not supported.

Addressing: Seven-bit mode addressing device

They do not support the following features:

- 10-bit addressing
- General call

THERMAL MONITORING AND SHUTDOWN

A thermal protection module monitors the junction temperature of the device versus two thresholds:

- Hot-die temperature threshold
- Thermal shutdown temperature threshold

When the hot-die temperature threshold is reached an interrupt is sent to software to close the noncritical running tasks.

When the thermal shutdown temperature threshold is reached, the TPS65910 device is set under reset and a transition to OFF state is initiated. Then the power-on enable conditions of the device is not considered until the die temperature has decreased below the hot-die threshold. An hysteresis is applied to the hot-die and shutdown threshold, when detecting a falling edge of temperature, and both detection are debounced to avoid any parasitic detection. The TPS65910 device allows programming of four hot-die temperature thresholds to increase the flexibility of the system.

By default, the thermal protection is enabled in ACTIVE state, but can be disabled through programming register THERM_REG. The thermal protection can be enabled in SLEEP state programming register SLEEP_KEEP_RES_ON. The thermal protection is automatically enabled during an OFF-to-ACTIVE state transition and is kept enabled in OFF state after a switch-off sequence caused by a thermal shutdown event. Transition to OFF state sequence caused by a thermal shutdown event is highlighted in the INT_STS_REG status register. Recovery from this OFF state is initiated (switch-on sequence) when the die temperature falls below the hot-die temperature threshold.

Hot-die and thermal shutdown temperature threshold detections state can be monitored or masked by reading or programming the THERM_REG register. Hot-die interrupt can be masked by programming the INT_MSK_REG register.

INTERRUPTS

Table 13. Interrupt Sources

| Interrupt | Description |
|---------------|---|
| RTC_ALARM_IT | RTC alarm event: Occurs at programmed determinate date and time (running in ACTIVE, OFF, and SLEEP state, default inactive) |
| RTC_PERIOD_IT | RTC periodic event: Occurs at programmed regular period of time (every second or minute) (running in ACTIVE, OFF, and SLEEP state, default inactive) |
| HOT_DIE_IT | The embedded thermal monitoring module has detected a die temperature above the hot-die detection threshold (running in ACTIVE and SLEEP state) Level sensitive interrupt. |
| PWRHOLD_IT | PWRHOLD signal rising edge |
| PWRON_LP_IT | PWRON is low during more than the long-press delay: $t_{dPWRONLP}$ (can be disable though register programming). |
| PWRON_IT | PWRON is low while the device is on (running in ACTIVE and SLEEP state) or PWON was low while the device was off (causing a device turn-on). Level-sensitive interrupt |
| VMBHI_IT | The battery voltage rise above the VMBHI threshold: NOSUPPLY to Off or Backup-to-Off device states transition (first battery plug or battery voltage bounce detection). This interrupt source can be disabled through EEPROM programming (VMBHI_IT_DIS). Edge-sensitive interrupt |
| VMBDCH_IT | The battery voltage falls down below the VMBDCH threshold (running in ACTIVE and SLEEP state, if enabled programming VMBCH_VSEL). Edge-sensitive interrupt |
| GPIO0_R_IT | GPIO_CKSYNC rising-edge detection (available in ACTIVE and SLEEP state) |
| GPIO0_F_IT | GPIO_CKSYNC falling-edge detection (available in ACTIVE and SLEEP state) |

INT1 signal (active low) warns the host processor of any event that occurred on the TPS65910 device. The host processor can then poll the interrupt from the interrupt status register via I²C to identify the interrupt source. Each interrupt source can be individually masked via the interrupt mask register.

PACKAGE DESCRIPTION

The following are the package descriptions of the TPS65910 PMU devices:

- Package type:

| Package | TPS65910 |
|--|-----------------------|
| Type | RSL QFN-N48 |
| Size (mm) | 6x6 |
| Substrate layers | 1 layer |
| Pitch ball array (mm) | 0.4 mm |
| ViP (via-in-pad) | No |
| Number of balls | 48 |
| Thickness (mm) (max. height including balls) | 1 |
| Others | Green, ROHS-compliant |

- Moisture sensitivity level target: JEDEC MSL3 @ 260°C

APPENDIX A: FUNCTIONAL REGISTERS

TPS65910_FUNC_REG REGISTERS MAPPING SUMMARY

Table 14. TPS65910_FUNC_REG Register Summary

| Register Name | Type | Register Width (Bits) | Register Reset | Address Offset |
|----------------------|------|-----------------------|----------------|----------------|
| SECONDS_REG | RW | 8 | 0x00 | 0x00 |
| MINUTES_REG | RW | 8 | 0x00 | 0x01 |
| HOURS_REG | RW | 8 | 0x00 | 0x02 |
| DAYS_REG | RW | 8 | 0x01 | 0x03 |
| MONTHS_REG | RW | 8 | 0x01 | 0x04 |
| YEARS_REG | RW | 8 | 0x00 | 0x05 |
| WEEKS_REG | RW | 8 | 0x00 | 0x06 |
| ALARM_SECONDS_REG | RW | 8 | 0x00 | 0x08 |
| ALARM_MINUTES_REG | RW | 8 | 0x00 | 0x09 |
| ALARM_HOURS_REG | RW | 8 | 0x00 | 0x0A |
| ALARM_DAYS_REG | RW | 8 | 0x01 | 0x0B |
| ALARM_MONTHS_REG | RW | 8 | 0x01 | 0x0C |
| ALARM_YEARS_REG | RW | 8 | 0x00 | 0x0D |
| RTC_CTRL_REG | RW | 8 | 0x00 | 0x10 |
| RTC_STATUS_REG | RW | 8 | 0x80 | 0x11 |
| RTC_INTERRUPTS_REG | RW | 8 | 0x00 | 0x12 |
| RTC_COMP_LSB_REG | RW | 8 | 0x00 | 0x13 |
| RTC_COMP_MSB_REG | RW | 8 | 0x00 | 0x14 |
| RTC_RES_PROG_REG | RW | 8 | 0x27 | 0x15 |
| RTC_RESET_STATUS_REG | RW | 8 | 0x00 | 0x16 |
| BCK1_REG | RW | 8 | 0x00 | 0x17 |
| BCK2_REG | RW | 8 | 0x00 | 0x18 |
| BCK3_REG | RW | 8 | 0x00 | 0x19 |
| BCK4_REG | RW | 8 | 0x00 | 0x1A |
| BCK5_REG | RW | 8 | 0x00 | 0x1B |
| PUADEN_REG | RW | 8 | 0x9F | 0x1C |
| REF_REG | RW | 8 | 0x01 | 0x1D |
| VRTC_REG | RW | 8 | 0x01 | 0x1E |
| VIO_REG | RW | 8 | 0x00 | 0x20 |

Table 14. TPS65910_FUNC_REG Register Summary (continued)

| Register Name | Type | Register Width (Bits) | Register Reset | Address Offset |
|-----------------------|------|-----------------------|----------------|----------------|
| VDD1_REG | RW | 8 | 0x0C | 0x21 |
| VDD1_OP_REG | RW | 8 | 0x00 | 0x22 |
| VDD1_SR_REG | RW | 8 | 0x00 | 0x23 |
| VDD2_REG | RW | 8 | 0x04 | 0x24 |
| VDD2_OP_REG | RW | 8 | 0x00 | 0x25 |
| VDD2_SR_REG | RW | 8 | 0x00 | 0x26 |
| VDD3_REG | RW | 8 | 0x04 | 0x27 |
| VDIG1_REG | RW | 8 | 0x00 | 0x30 |
| VDIG2_REG | RW | 8 | 0x00 | 0x31 |
| VAUX1_REG | RW | 8 | 0x00 | 0x32 |
| VAUX2_REG | RW | 8 | 0x00 | 0x33 |
| VAUX33_REG | RW | 8 | 0x00 | 0x34 |
| VMMC_REG | RW | 8 | 0x00 | 0x35 |
| VPLL_REG | RW | 8 | 0x00 | 0x36 |
| VDAC_REG | RW | 8 | 0x00 | 0x37 |
| THERM_REG | RW | 8 | 0x0D | 0x38 |
| BBCH_REG | RW | 8 | 0x00 | 0x39 |
| DCDCCTRL_REG | RW | 8 | 0x3B | 0x3E |
| DEVCTRL_REG | RW | 8 | 0x40 | 0x3F |
| DEVCTRL2_REG | RW | 8 | 0x34 | 0x40 |
| SLEEP_KEEP_LDO_ON_REG | RW | 8 | 0x00 | 0x41 |
| SLEEP_KEEP_RES_ON_REG | RW | 8 | 0x00 | 0x42 |
| SLEEP_SET_LDO_OFF_REG | RW | 8 | 0x00 | 0x43 |
| SLEEP_SET_RES_OFF_REG | RW | 8 | 0x00 | 0x44 |
| EN1_LDO_ASS_REG | RW | 8 | 0x00 | 0x45 |
| EN1_SMPS_ASS_REG | RW | 8 | 0x00 | 0x46 |
| EN2_LDO_ASS_REG | RW | 8 | 0x00 | 0x47 |
| EN2_SMPS_ASS_REG | RW | 8 | 0x00 | 0x48 |
| RESERVED | RW | 8 | 0x00 | 0x49 |
| RESERVED | RW | 8 | 0x00 | 0x4A |
| INT_STS_REG | RW | 8 | 0x00 | 0x50 |
| INT_MSK_REG | RW | 8 | 0x02 | 0x51 |
| INT_STS2_REG | RW | 8 | 0x00 | 0x52 |
| INT_MSK2_REG | RW | 8 | 0x00 | 0x53 |
| GPIO0_REG | RW | 8 | 0x0A | 0x60 |
| JTAGVERNUM_REG | RO | 8 | 0x00 | 0x80 |

TPS65910_FUNC_REG REGISTER DESCRIPTIONS

Table 15. SECONDS_REG

| | | |
|-------------------------|--------------------------|-----------------|
| Address Offset | 0x00 | |
| Physical Address | | Instance |
| Description | RTC register for seconds | |
| Type | RW | |

| | | | | | | | |
|----------|------|---|---|------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | SEC1 | | | SEC0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|-------|
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 6:4 | SEC1 | Second digit of seconds (range is 0 up to 5) | RW | 0x0 |
| 3:0 | SEC0 | First digit of seconds (range is 0 up to 9) | RW | 0x0 |

Table 16. MINUTES_REG

| | | |
|-------------------------|--------------------------|-----------------|
| Address Offset | 0x01 | |
| Physical Address | | Instance |
| Description | RTC register for minutes | |
| Type | RW | |

| | | | | | | | |
|----------|------|---|---|------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | MIN1 | | | MIN0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|-------|
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 6:4 | MIN1 | Second digit of minutes (range is 0 up to 5) | RW | 0x0 |
| 3:0 | MIN0 | First digit of minutes (range is 0 up to 9) | RW | 0x0 |

Table 17. HOURS_REG

| | | |
|-------------------------|------------------------|-----------------|
| Address Offset | 0x02 | |
| Physical Address | | Instance |
| Description | RTC register for hours | |
| Type | RW | |

| | | | | | | | |
|--------|----------|-------|---|-------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PM_NAM | Reserved | HOUR1 | | HOUR0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|-------|
| 7 | PM_NAM | Only used in PM_AM mode (otherwise it is set to 0) 0 is AM 1 is PM | RW | 0 |
| 6 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 5:4 | HOUR1 | Second digit of hours(range is 0 up to 2) | RW | 0x0 |
| 3:0 | HOUR0 | First digit of hours (range is 0 up to 9) | RW | 0x0 |

Table 18. DAYS_REG

| | | |
|-------------------------|-----------------------|-----------------|
| Address Offset | 0x03 | |
| Physical Address | | Instance |
| Description | RTC register for days | |
| Type | RW | |

| | | | | | | | |
|----------|---|------|---|------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | DAY1 | | DAY0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|-------|
| 7:6 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 5:4 | DAY1 | Second digit of days (range is 0 up to 3) | RW | 0x0 |
| 3:0 | DAY0 | First digit of days (range is 0 up to 9) | RW | 0x1 |

Table 19. MONTHS_REG

| | | |
|-------------------------|-------------------------|-----------------|
| Address Offset | 0x04 | |
| Physical Address | | Instance |
| Description | RTC register for months | |
| Type | RW | |

| | | | | | | | |
|----------|---|---|--------|--------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | MONTH1 | MONTH0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|-------|
| 7:5 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 4 | MONTH1 | Second digit of months (range is 0 up to 1) | RW | 0 |
| 3:0 | MONTH0 | First digit of months (range is 0 up to 9) | RW | 0x1 |

Table 20. YEARS_REG

| | | |
|-------------------------|----------------------------------|-----------------|
| Address Offset | 0x05 | |
| Physical Address | | Instance |
| Description | RTC register for day of the week | |
| Type | RW | |

| | | | | | | | |
|-------|---|---|---|-------|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| YEAR1 | | | | YEAR0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|------|-------|
| 7:4 | YEAR1 | Second digit of years (range is 0 up to 9) | RW | 0x0 |
| 3:0 | YEAR0 | First digit of years (range is 0 up to 9) | RW | 0x0 |

Table 21. WEEKS_REG

| | | |
|-------------------------|----------------------------------|-----------------|
| Address Offset | 0x06 | |
| Physical Address | | Instance |
| Description | RTC register for day of the week | |
| Type | RW | |

| | | | | | | | |
|----------|---|---|---|---|------|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | | WEEK | | |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

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| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|-------|
| 7:3 | Reserved | Reserved bit | RO R returns 0s | 0x00 |
| 2:0 | WEEK | First digit of day of the week (range is 0 up to 6) | RW | 0 |

Table 22. ALARM_SECONDS_REG

| | |
|-------------------------|--|
| Address Offset | 0x08 |
| Physical Address | Instance |
| Description | RTC register for alarm programming for seconds |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|------------|---|---|------------|---|---|---|
| Reserved | ALARM_SEC1 | | | ALARM_SEC0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|-------|
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 6:4 | ALARM_SEC1 | Second digit of alarm programming for seconds (range is 0 up to 5) | RW | 0x0 |
| 3:0 | ALARM_SEC0 | First digit of alarm programming for seconds (range is 0 up to 9) | RW | 0x0 |

Table 23. ALARM_MINUTES_REG

| | |
|-------------------------|--|
| Address Offset | 0x09 |
| Physical Address | Instance |
| Description | RTC register for alarm programming for minutes |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|------------|---|---|------------|---|---|---|
| Reserved | ALARM_MIN1 | | | ALARM_MIN0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|-------|
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 6:4 | ALARM_MIN1 | Second digit of alarm programming for minutes (range is 0 up to 5) | RW | 0x0 |
| 3:0 | ALARM_MIN0 | First digit of alarm programming for minutes (range is 0 up to 9) | RW | 0x0 |

Table 24. ALARM_HOURS_REG

| | |
|-------------------------|--|
| Address Offset | 0x0A |
| Physical Address | Instance |
| Description | RTC register for alarm programming for hours |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------|----------|-------------|---|-------------|---|---|---|
| ALARM_PM_NAM | Reserved | ALARM_HOUR1 | | ALARM_HOUR0 | | | |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|--------------|--|--------------------|-------|
| 7 | ALARM_PM_NAM | Only used in PM_AM mode for alarm programming (otherwise it is set to 0) 0 is AM 1 is PM | RW | 0 |
| 6 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 5:4 | ALARM_HOUR1 | Second digit of alarm programming for hours(range is 0 up to 2) | RW | 0x0 |
| 3:0 | ALARM_HOUR0 | First digit of alarm programming for hours (range is 0 up to 9) | RW | 0x0 |

Table 25. ALARM_DAYS_REG

| | |
|-------------------------|---|
| Address Offset | 0x0B |
| Physical Address | Instance |
| Description | RTC register for alarm programming for days |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|------------|---|------------|---|---|---|
| Reserved | | ALARM_DAY1 | | ALARM_DAY0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------|-------|
| 7:6 | Reserved | Reserved bit | RO R Special | 0x0 |
| 5:4 | ALARM_DAY1 | Second digit of alarm programming for days (range is 0 up to 3) | RW | 0x0 |
| 3:0 | ALARM_DAY0 | First digit of alarm programming for days (range is 0 up to 9) | RW | 0x1 |

Table 26. ALARM_MONTHS_REG

| | |
|-------------------------|---|
| Address Offset | 0x0C |
| Physical Address | Instance |
| Description | RTC register for alarm programming for months |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|--------------|--------------|---|---|---|
| Reserved | | | ALARM_MONTH1 | ALARM_MONTH0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|---|--------------------|-------|
| 7:5 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 4 | ALARM_MONTH1 | Second digit of alarm programming for months (range is 0 up to 1) | RW | 0 |
| 3:0 | ALARM_MONTH0 | First digit of alarm programming for months (range is 0 up to 9) | RW | 0x1 |

Table 27. ALARM_YEARS_REG

| | |
|-------------------------|--|
| Address Offset | 0x0D |
| Physical Address | Instance |
| Description | RTC register for alarm programming for years |
| Type | RW |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

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| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|---|---|---|-------------|---|---|---|
| ALARM_YEAR1 | | | | ALARM_YEAR0 | | | |

| Bits | Field Name | Description | Type | Reset |
|------|-------------|--|------|-------|
| 7:4 | ALARM_YEAR1 | Second digit of alarm programming for years (range is 0 up to 9) | RW | 0x0 |
| 3:0 | ALARM_YEAR0 | First digit of alarm programming for years (range is 0 up to 9) | RW | 0x0 |

Table 28. RTC_CTRL_REG

| | | |
|-------------------------|--|-----------------|
| Address Offset | 0x10 | Instance |
| Physical Address | | |
| Description | RTC control register: NOTES: A dummy read of this register is necessary before each I ² C read in order to update the ROUND_30S bit value. | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------|----------|----------------|-----------|------------|-----------|-----------|----------|
| RTC_V_OPT | GET_TIME | SET_32_COUNTER | TEST_MODE | MODE_12_24 | AUTO_COMP | ROUND_30S | STOP_RTC |

| Bits | Field Name | Description | Type | Reset |
|------|----------------|---|------|-------|
| 7 | RTC_V_OPT | RTC date / time register selection: 0: Read access directly to dynamic registers (SECONDS_REG, MINUTES_REG, HOURS_REG, DAYS_REG, MONTHS_REG, YEAR_REG, WEEKS_REG) 1: Read access to static shadowed registers: (see GET_TIME bit). | RW | 0 |
| 6 | GET_TIME | When writing a 1 into this register, the content of the dynamic registers (SECONDS_REG, MINUTES_REG, HOURS_REG, DAYS_REG, MONTHS_REG, YEAR_REG and WEEKS_REG) is transferred into static shadowed registers. Each update of the shadowed registers needs to be done by re-asserting GET_TIME bit to 1 (i.e.: reset it to 0 and then re-write it to 1) | RW | 0 |
| 5 | SET_32_COUNTER | 0: No action 1: set the 32-kHz counter with COMP_REG value. It must only be used when the RTC is frozen. | RW | 0 |
| 4 | TEST_MODE | 0: functional mode 1: test mode (Auto compensation is enable when the 32kHz counter reaches at its end) | RW | 0 |
| 3 | MODE_12_24 | 0: 24 hours mode 1: 12 hours mode (PM-AM mode) It is possible to switch between the two modes at any time without disturbed the RTC, read or write are always performed with the current mode. | RW | 0 |
| 2 | AUTO_COMP | 0: No auto compensation 1: Auto compensation enabled | RW | 0 |
| 1 | ROUND_30S | 0: No update 1: When a one is written, the time is rounded to the closest minute. This bit is a toggle bit, the micro-controller can only write one and RTC clears it. If the micro-controller sets the ROUND_30S bit and then read it, the micro-controller will read one until the rounded to the closet. | RW | 0 |
| 0 | STOP_RTC | 0: RTC is frozen 1: RTC is running | RW | 0 |

Table 29. RTC_STATUS_REG

| | |
|-------------------------|---|
| Address Offset | 0x11 |
| Physical Address | Instance |
| Description | RTC status register: NOTES: A dummy read of this register is necessary before each I ² C read in order to update the status register value. |
| Type | RW |

| | | | | | | | |
|----------|-------|----------|----------|----------|----------|-----|----------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| POWER_UP | ALARM | EVENT_1D | EVENT_1H | EVENT_1M | EVENT_1S | RUN | Reserved |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|--------------------|-------|
| 7 | POWER_UP | Indicates that a reset occurred (bit cleared to 0 by writing 1). POWER_UP is set by a reset, is cleared by writing one in this bit. | RW | 1 |
| 6 | ALARM | Indicates that an alarm interrupt has been generated (bit clear by writing 1). The alarm interrupt keeps its low level, until the micro-controller write 1 in the ALARM bit of the RTC_STATUS_REG register. The timer interrupt is a low-level pulse (15 µs duration). | RW | 0 |
| 5 | EVENT_1D | One day has occurred | RO | 0 |
| 4 | EVENT_1H | One hour has occurred | RO | 0 |
| 3 | EVENT_1M | One minute has occurred | RO | 0 |
| 2 | EVENT_1S | One second has occurred | RO | 0 |
| 1 | RUN | 0: RTC is frozen 1: RTC is running This bit shows the real state of the RTC, indeed because of STOP_RTC signal was resynchronized on 32-kHz clock, the action of this bit is delayed. | RO | 0 |
| 0 | Reserved | Reserved bit | RO R returns 0s | 0 |

Table 30. RTC_INTERRUPTS_REG

| | |
|-------------------------|--------------------------------|
| Address Offset | 0x12 |
| Physical Address | Instance |
| Description | RTC interrupt control register |
| Type | RW |

| | | | | | | | |
|----------|---|---|------------------|----------|----------|-------|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | IT_SLEEP_MASK_EN | IT_ALARM | IT_TIMER | EVERY | |

| Bits | Field Name | Description | Type | Reset |
|------|------------------|--|--------------------|-------|
| 7:5 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 4 | IT_SLEEP_MASK_EN | 1: Mask periodic interrupt while the TPS65910 device is in SLEEP mode. Interrupt event is back up in a register and occurred as soon as the TPS65910 device is no more in SLEEP mode. 0: Normal mode, no interrupt masked | RW | 0 |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|------|-------|
| 3 | IT_ALARM | Enable one interrupt when the alarm value is reached (TC ALARM registers) by the TC registers | RW | 0 |
| 2 | IT_TIMER | Enable periodic interrupt 0: interrupt disabled 1: interrupt enabled | RW | 0 |
| 1:0 | EVERY | Interrupt period 00: every second 01: every minute 10: every hour 11: every day | RW | 0x0 |

Table 31. RTC_COMP_LSB_REG

| | |
|-------------------------|---|
| Address Offset | 0x13 |
| Physical Address | Instance |
| Description | RTC compensation register (LSB) Notes: This register must be written in 2-complement. This means that to add one 32kHz oscillator period every hour, micro-controller needs to write FFFF into RTC_COMP_MSB_REG & RTC_COMP_LSB_REG. To remove one 32-kHz oscillator period every hour, micro-controller needs to write 0001 into RTC_COMP_MSB_REG & RTC_COMP_LSB_REG. The 7FFF value is forbidden. |
| Type | RW |

| | | | | | | | |
|--------------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RTC_COMP_LSB | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|--|------|-------|
| 7:0 | RTC_COMP_LSB | This register contains the number of 32-kHz periods to be added into the 32-kHz counter every hour [LSB] | RW | 0x00 |

Table 32. RTC_COMP_MSB_REG

| | |
|-------------------------|---|
| Address Offset | 0x14 |
| Physical Address | Instance |
| Description | RTC compensation register (MSB) Notes: See RTC_COMP_LSB_REG Notes. |
| Type | RW |

| | | | | | | | |
|--------------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RTC_COMP_MSB | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|--|------|-------|
| 7:0 | RTC_COMP_MSB | This register contains the number of 32-kHz periods to be added into the 32-kHz counter every hour [MSB] | RW | 0x00 |

Table 33. RTC_RES_PROG_REG

| | |
|-------------------------|---|
| Address Offset | 0x15 |
| Physical Address | Instance |
| Description | RTC register containing oscillator resistance value |
| Type | RW |

| | | | | | | | |
|----------|---|-------------|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | SW_RES_PROG | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|-------------|------------------------------------|-----------------------|-------|
| 7:6 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 5:0 | SW_RES_PROG | Value of the oscillator resistance | RW | 0x27 |

Table 34. RTC_RESET_STATUS_REG

| | |
|-------------------------|-------------------------------|
| Address Offset | 0x16 |
| Physical Address | Instance |
| Description | RTC register for reset status |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|---|---|---|--------------|
| Reserved | | | | | | | RESET_STATUS |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|--------------|-----------------------|-------|
| 7:1 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 0 | RESET_STATUS | | RW | 0x0 |

Table 35. BCK1_REG

| | |
|-------------------------|--|
| Address Offset | 0x17 |
| Physical Address | Instance |
| Description | Backup register which can be used for storage by the application firmware when the external host is powered down. These registers will retain their content as long as the VRTC is active. |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|---|---|---|---|---|---|---|
| BCKUP | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|-------------|------|-------|
| 7:0 | BCKUP | Backup bit | RW | 0x00 |

Table 36. BCK2_REG

| | |
|-------------------------|--|
| Address Offset | 0x18 |
| Physical Address | Instance |
| Description | Backup register which can be used for storage by the application firmware when the external host is powered down. These registers will retain their content as long as the VRTC is active. |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|---|---|---|---|---|---|---|
| BCKUP | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|-------------|------|-------|
| 7:0 | BCKUP | Backup bit | RW | 0x00 |

Table 37. BCK3_REG

| | |
|-------------------------|--|
| Address Offset | 0x19 |
| Physical Address | Instance |
| Description | Backup register which can be used for storage by the application firmware when the external host is powered down. These registers will retain their content as long as the VRTC is active. |
| Type | RW |

| | | | | | | | |
|-------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| BCKUP | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|-------------|------|-------|
| 7:0 | BCKUP | Backup bit | RW | 0x00 |

Table 38. BCK4_REG

| | |
|-------------------------|--|
| Address Offset | 0x1A |
| Physical Address | Instance |
| Description | Backup register which can be used for storage by the application firmware when the external host is powered down. These registers will retain their content as long as the VRTC is active. |
| Type | RW |

| | | | | | | | |
|-------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| BCKUP | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|-------------|------|-------|
| 7:0 | BCKUP | Backup bit | RW | 0x00 |

Table 39. BCK5_REG

| | |
|-------------------------|--|
| Address Offset | 0x1B |
| Physical Address | Instance |
| Description | Backup register which can be used for storage by the application firmware when the external host is powered down. These registers will retain their content as long as the VRTC is active. |
| Type | RW |

| | | | | | | | |
|-------|---|---|---|---|---|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| BCKUP | | | | | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|-------------|------|-------|
| 7:0 | BCKUP | Backup bit | RW | 0x00 |

Table 40. PUADEN_REG

| | |
|-------------------------|-------------------------------------|
| Address Offset | 0x1C |
| Physical Address | Instance |
| Description | Pull-up/pull-down control register. |
| Type | RW |

| | | | | | | | |
|----------|---------|---------|--------|--------|----------|--------|--------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RESERVED | I2CCTLP | I2CSRSP | PWRONP | SLEEPP | PWRHOLDP | BOOT1P | BOOT0P |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|------|-------|
| 7 | RESERVED | Reserved bit | RW | 1 |
| 6 | I2CCTLP | SDACTL and SCLCTL pull-up control: 1: Pull-up is enabled 0: Pull-up is disabled | RW | 0 |
| 5 | I2CSRSP | SDASR and SCLSR pull-up control: 1: Pull-up is enabled 0: Pull-up is disabled | RW | 0 |
| 4 | PWRONP | PWRON pad pull-up control: 1: Pull-up is enabled 0: Pull-up is disabled | RW | 1 |
| 3 | SLEEPP | SLEEP pad pull-down control: 1: Pull-down is enabled 0: Pull-down is disabled | RW | 1 |
| 2 | PWRHOLDP | PWRHOLD pad pull-down control: 1: Pull-down is enabled 0: Pull-down is disabled | RW | 1 |
| 1 | BOOT1P | BOOT1 pad control: 1: Pull-down is enabled 0: Pull-down is disabled | RW | 1 |
| 0 | BOOT0P | BOOT0 pad control: 1: Pull-down is enabled 0: Pull-down is disabled | RW | 1 |

Table 41. REF_REG

| | | |
|-------------------------|----------------------------|-----------------|
| Address Offset | 0x1D | Instance |
| Physical Address | | |
| Description | Reference control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|-----------|---|----|---|
| Reserved | | | | VMBCH_SEL | | ST | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|-------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | VMBCH_SEL | Main Battery comparator VMBCH programmable threshold (EEPROM bits): VMBCH_SEL[1:0] = 00 : bypass VMBCH_SEL[1:0] = 01 : VMBCH = 2.8 V VMBCH_SEL[1:0] = 10 : VMBCH = 2.9 V VMBCH_SEL[1:0] = 11 : VMBCH = 3.0 V | RW | 0x0 |
| 1:0 | ST | Reference state: ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Reserved ST[1:0] = 11 : On low power (SLEEP) (Write access available in test mode only) | RO | 0x1 |

Table 42. VRTC_REG

| | | |
|-------------------------|--|-----------------|
| Address Offset | 0x1E | Instance |
| Physical Address | | |
| Description | VRTC internal regulator control register | |
| Type | RW | |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

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| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|--------------|----------|----|---|
| Reserved | | | | VRTC_OFFMASK | Reserved | ST | |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|--|--------------------|-------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3 | VRTC_OFFMASK | VRTC internal regulator off mask signal: when 1, the regulator keeps its full-load capability during device OFF state. when 0, the regulator will enter in low-power mode during device OFF state.(EEPROM bit) | RW | 0 |
| 2 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 1:0 | ST | Reference state: ST[1:0] = 00 : Reserved ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Reserved ST[1:0] = 11 : On low power (SLEEP) (Write access available in test mode only) | RO | 0x1 |

Table 43. VIO_REG

| | | |
|-------------------------|----------------------|-----------------|
| Address Offset | 0x20 | Instance |
| Physical Address | | |
| Description | VIO control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------|---|----------|---|-----|---|----|---|
| ILMAX | | Reserved | | SEL | | ST | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|--------------------|--------------------|
| 7:6 | ILMAX | Select maximum load current: when 00: 0.5 A when 01: 1.0 A when 10: 1.0 A when 11: 1.0 A | RW | 0x0 |
| 5:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Output voltage selection (EEPROM bits): SEL[1:0] = 00 : 1.5 V SEL[1:0] = 01 : 1.8 V SEL[1:0] = 10 : 2.5 V SEL[1:0] = 11 : 3.3 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) (Write access available in test mode only) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 44. VDD1_REG

| | | |
|-------------------------|-----------------------|--|
| Address Offset | 0x21 | |
| Physical Address | Instance | |
| Description | VDD1 control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----------|---|-------|---|-------|---|----|---|
| VGAIN_SEL | | ILMAX | | TSTEP | | ST | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|------|-------|
| 7:6 | VGAIN_SEL | Select output voltage multiplication factor: G (EEPROM bits): when 00: x1 when 01: x1 when 10: x2 when 11: x3 | RW | 0x0 |
| 5:4 | ILMAX | Select maximum load current: when 0: 1.0 A when 1: 1.5 A | RW | 0 |
| 3:2 | TSTEP | Time step: when changing the output voltage, the new value is reached through successive 12.5 mV voltage steps (if not bypassed). The equivalent programmable slew rate of the output voltage is then: TSTEP[2:0] = 000 : step duration is 0, step function is bypassed TSTEP[2:0] = 001 : 12.5 mV/μs (sampling 3 Mhz) TSTEP[2:0] = 010 : 9.4 mV/μs (sampling 3 Mhz × 3/4) TSTEP[2:0] = 011 : 7.5 mV/μs (sampling 3 Mhz × 3/5) (default) TSTEP[2:0] = 100 : 6.25 mV/μs(sampling 3 Mhz/2) TSTEP[2:0] = 101 : 4.7 mV/μs(sampling 3 Mhz/3) TSTEP[2:0] = 110 : 3.12 mV/μs(sampling 3 Mhz/4) TSTEP[2:0] = 111 : 2.5 mV/μs(sampling 3 Mhz/5) | RW | 0x3 |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On, high power mode ST[1:0] = 10 : Off ST[1:0] = 11 : On, low power mode | RW | 0x0 |

Table 45. VDD1_OP_REG

| | | |
|-------------------------|---|--|
| Address Offset | 0x22 | |
| Physical Address | Instance | |
| Description | VDD1 voltage selection register. This register can be accessed by both control and smartreflex I ² C interfaces depending on SR_CTL_I2C_SEL register bit value. | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|---|---|---|-----|---|---|---|
| CMD | | | | SEL | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|------|--------------------|
| 7 | CMD | Smart-Reflex command: when 0: VDD1_OP_REG voltage is applied when 1: VDD1_SR_REG voltage is applied | RW | 0 |
| 6:0 | SEL | Output voltage (EEPROM bits) selection with GAIN_SEL = 00 (G = 1, 12.5 mV per LSB): SEL[6:0] = 1001011 to 1111111 : 1.5 V ... SEL[6:0] = 0111111 : 1.35 V ... SEL[6:0] = 0110011 : 1.2 V ... SEL[6:0] = 0000001 to 0000011 : 0.6 V SEL[6:0] = 0000000 : Off (0.0 V) Note: from SEL[6:0] = 3 to 75 (dec) Vout = (SEL[6:0] × 12.5 mV + 0.5625 V) × G | RW | See ⁽¹⁾ |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 46. VDD1_SR_REG

| | |
|-------------------------|---|
| Address Offset | 0x23 |
| Physical Address | Instance |
| Description | VDD1 voltage selection register for smartreflex. This register can be accessed by both control and smartreflex I ² C interfaces depending on SR_CTL_I2C_SEL register bit value. |
| Type | RW |

| | | | | | | | |
|----------|---|---|---|---|---|---|-----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | | | | SEL |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|-----------------------|--------------------|
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 6:0 | SEL | Output voltage (EEPROM bits) selection with GAIN_SEL = 00 (G = 1, 12.5 mV per LSB): SEL[6:0] = 1001011 to 1111111 : 1.5V ... SEL[6:0] = 0111111 : 1.35V ... SEL[6:0] = 0110011 : 1.2V ... SEL[6:0] = 0000001 to 0000011 : 0.6V SEL[6:0] = 0000000 : Off (0.0V) Note: from SEL[6:0] = 3 to 75 (dec) Vout = (SEL[6:0] × 12.5 mV + 0.5625 V) × G | RW | See ⁽¹⁾ |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 47. VDD2_REG

| | |
|-------------------------|-----------------------|
| Address Offset | 0x24 |
| Physical Address | Instance |
| Description | VDD2 control register |
| Type | RW |

| | | | | | | | |
|-----------|---|-------|---|-------|---|---|----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| VGAIN_SEL | | ILMAX | | TSTEP | | | ST |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|------|-------|
| 7:6 | VGAIN_SEL | Select output voltage multiplication factor: G (EEPROM bits): when 00: x1 when 01: x1 when 10: x2 when 11: x3 | RW | 0x0 |
| 5:4 | ILMAX | Select maximum load current: when 0: 1.0 A when 1: 1.5 A | RW | 0 |
| 3:2 | TSTEP | Time step: when changing the output voltage, the new value is reached through successive 12.5 mV voltage steps (if not bypassed). The equivalent programmable slew rate of the output voltage is then: TSTEP[2:0] = 000: step duration is 0, step function is bypassed TSTEP[2:0] = 001: 12.5 mV/μs (sampling 3 Mhz) TSTEP[2:0] = 010: 9.4 mV/μs (sampling 3 Mhz × 3/4) TSTEP[2:0] = 011: 7.5 mV/μs (sampling 3 Mhz × 3/5) (default) TSTEP[2:0] = 100: 6.25 mV/μs(sampling 3 Mhz/2) TSTEP[2:0] = 101: 4.7 mV/μs(sampling 3 Mhz/3) TSTEP[2:0] = 110: 3.12 mV/μs(sampling 3 Mhz/4) TSTEP[2:0] = 111: 2.5 mV/μs(sampling 3 Mhz/5) | RW | 0x1 |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On, high power mode ST[1:0] = 10 : Off ST[1:0] = 11 : On, low power mode | RW | 0x0 |

Table 48. VDD2_OP_REG

| | |
|-------------------------|---|
| Address Offset | 0x25 |
| Physical Address | Instance |
| Description | VDD2 voltage selection register. This register can be accessed by both control and smartreflex I ² C interfaces depending on SR_CTL_I2C_SEL register bit value. |
| Type | RW |

| | | | | | | | |
|-----|---|---|---|---|---|---|-----|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| CMD | | | | | | | SEL |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|------|--------------------|
| 7 | CMD | Smart-Reflex command: when 0: VDD2_OP_REG voltage is applied when 1: VDD2_SR_REG voltage is applied | RW | 0 |
| 6:0 | SEL | Output voltage (EEPROM bits) selection with GAIN_SEL = 00 (G = 1, 12.5 mV per LSB): SEL[6:0] = 1001011 to 1111111 : 1.5 V ... SEL[6:0] = 0111111 : 1.35 V ... SEL[6:0] = 0110011 : 1.2 V ... SEL[6:0] = 0000001 to 0000011 : 0.6 V SEL[6:0] = 0000000 : Off (0.0 V) Note: from SEL[6:0] = 3 to 75 (dec) Vout= (SEL[6:0] × 12.5 mV + 0.5625 V) × G | RW | See ⁽¹⁾ |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 49. VDD2_SR_REG

| | |
|-------------------------|---|
| Address Offset | 0x26 |
| Physical Address | Instance |
| Description | VDD2 voltage selection register for smartreflex. This register can be accessed by both control and smartreflex I ² C interfaces depending on SR_CTL_I2C_SEL register bit value. |

Table 49. VDD2_SR_REG (continued)

| Type | RW | | | | | | | | |
|------|------------|---|--------------------|--------------------|---|---|---|---|--|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | Reserved | | SEL | | | | | | |
| Bits | Field Name | Description | Type | Reset | | | | | |
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 | | | | | |
| 6:0 | SEL | Output voltage (EEPROM bits) selection with GAIN_SEL = 00 (G = 1, 12.5 mV per LSB): SEL[6:0] = 1001011 to 11111111: 1.5 V ... SEL[6:0] = 01111111: 1.35V ... SEL[6:0] = 0110011: 1.2V ... SEL[6:0] = 0000001 to 0000011: 0.6V SEL[6:0] = 0000000: Off (0.0V) Note: from SEL[6:0] = 3 to 75 (dec) Vout= (SEL[6:0] × 12.5 mV + 0.5625 V) ×G | RW | See ⁽¹⁾ | | | | | |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 50. VDD3_REG

| Address Offset | 0x27 | | | | | | | |
|------------------|---|---|--------------------|-------|---|--------|----|---|
| Physical Address | | Instance | | | | | | |
| Description | VDD2 voltage selection register for smartreflex. This register can be accessed by both control and smartreflex I ² C interfaces depending on SR_CTL_I2C_SEL register bit value. | | | | | | | |
| Type | RW | | | | | | | |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | Reserved | | | | | CKINEN | ST | |
| Bits | Field Name | Description | Type | Reset | | | | |
| 7:3 | Reserved | Reserved bit | RO R returns 0s | 0x00 | | | | |
| 2 | CKINEN | Enable 1Mhz clock synchronization | RW | 1 | | | | |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 | | | | |

Table 51. VDIG1_REG

| Address Offset | 0x30 | | | | | | | |
|------------------|----------------------------------|----------|---|-----|---|----|---|---|
| Physical Address | | Instance | | | | | | |
| Description | VDIG1 regulator control register | | | | | | | |
| Type | RW | | | | | | | |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | Reserved | | | SEL | | ST | | |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.2 V SEL[1:0] = 01 : 1.5 V SEL[1:0] = 10 : 1.8 V SEL[1:0] = 11 : 2.7 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 52. VDIG2_REG

| | | |
|-------------------------|----------------------------------|-----------------|
| Address Offset | 0x31 | Instance |
| Physical Address | | |
| Description | VDIG2 regulator control register | |
| Type | RW | |

| | | | | | | | |
|----------|---|---|---|-----|----|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | SEL | ST | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.0 V SEL[1:0] = 01 : 1.1 V SEL[1:0] = 10 : 1.2 V SEL[1:0] = 11 : 1.8 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 53. VAUX1_REG

| | | |
|-------------------------|----------------------------------|-----------------|
| Address Offset | 0x32 | Instance |
| Physical Address | | |
| Description | VAUX1 regulator control register | |
| Type | RW | |

| | | | | | | | |
|----------|---|---|---|-----|----|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | SEL | ST | | |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

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| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.8 V SEL[1:0] = 01 : 2.5 V SEL[1:0] = 10 : 2.8 V SEL[1:0] = 11 : 2.85 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 54. VAUX2_REG

| | |
|-------------------------|----------------------------------|
| Address Offset | 0x33 |
| Physical Address | Instance |
| Description | VAUX2 regulator control register |
| Type | RW |

| | | | | | | | |
|----------|---|---|---|-----|----|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | SEL | ST | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.8 V SEL[1:0] = 01 : 2.8 V SEL[1:0] = 10 : 2.9 V SEL[1:0] = 11 : 3.3 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 55. VAUX33_REG

| | |
|-------------------------|-----------------------------------|
| Address Offset | 0x34 |
| Physical Address | Instance |
| Description | VAUX33 regulator control register |
| Type | RW |

| | | | | | | | |
|----------|---|---|---|-----|----|---|---|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | SEL | ST | | |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.8 V SEL[1:0] = 01 : 2.0 V SEL[1:0] = 10 : 2.8 V SEL[1:0] = 11 : 3.3 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 56. VMMC_REG

| | | |
|-------------------------|---------------------------------|-----------------|
| Address Offset | 0x35 | Instance |
| Physical Address | | |
| Description | VMMC regulator control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|-----|----|---|---|
| Reserved | | | | SEL | ST | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.8 V SEL[1:0] = 01 : 2.8 V SEL[1:0] = 10 : 3.0 V SEL[1:0] = 11 : 3.3 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00: Off ST[1:0] = 01: On high power (ACTIVE) ST[1:0] = 10: Off ST[1:0] = 11: On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 57. VPLL_REG

| | | |
|-------------------------|---------------------------------|-----------------|
| Address Offset | 0x36 | Instance |
| Physical Address | | |
| Description | VPLL regulator control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|-----|----|---|---|
| Reserved | | | | SEL | ST | | |

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| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.0V SEL[1:0] = 01 : 1.1 V SEL[1:0] = 10 : 1.8 V SEL[1:0] = 11 : 2.5 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 58. VDAC_REG

| | | |
|-------------------------|---------------------------------|-----------------|
| Address Offset | 0x37 | Instance |
| Physical Address | | |
| Description | VDAC regulator control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|-----|---|----|---|
| Reserved | | | | SEL | | ST | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------------|--------------------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:2 | SEL | Supply voltage (EEPROM bits): SEL[1:0] = 00 : 1.8 V SEL[1:0] = 01 : 2.6 V SEL[1:0] = 10 : 2.8 V SEL[1:0] = 11 : 2.85 V | RW | See ⁽¹⁾ |
| 1:0 | ST | Supply state (EEPROM bits): ST[1:0] = 00 : Off ST[1:0] = 01 : On high power (ACTIVE) ST[1:0] = 10 : Off ST[1:0] = 11 : On low power (SLEEP) | RW | 0x0 |

(1) The reset value for this field varies with boot mode selection and the processor support. Please refer to the corresponding processor user guide to find the correct default value.

Table 59. Therm_REG

| | | |
|-------------------------|--------------------------|-----------------|
| Address Offset | 0x38 | Instance |
| Physical Address | | |
| Description | Thermal control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|----------|----------|-------------|---|-------|-------------|
| Reserved | | THERM_HD | THERM_TS | THERM_HDSEL | | RSVD1 | THERM_STATE |

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| Bits | Field Name | Description | Type | Reset |
|------|-------------|---|--------------------|-------|
| 7:6 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 5 | THERM_HD | Hot die detector output: when 0: the hot die threshold is not reached when 1: the hot die threshold is reached | RO | 0 |
| 4 | THERM_TS | Thermal shutdown detector output: when 0: the thermal shutdown threshold is not reached when 1: the thermal shutdown threshold is reached | RO | 0 |
| 3:2 | THERM_HDSEL | Temperature selection for Hot Die detector: when 00: Low temperature threshold ... when 11: High temperature threshold | RW | 0x3 |
| 1 | RSVD1 | Reserved bit | RW | 0 |
| 0 | THERM_STATE | Thermal shutdown module enable signal: when 0: thermal shutdown module is disable when 1: thermal shutdown module is enable | RW | 1 |

Table 60. BBCH_REG

| | |
|-------------------------|--|
| Address Offset | 0x39 |
| Physical Address | Instance |
| Description | Back-up battery charger control register |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|-------|---|--------|---|
| Reserved | | | | BBSEL | | BBCHEN | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|--------------------|-------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x00 |
| 2:1 | BBSEL | Back up battery charge voltage selection: BBSEL[1:0] = 00 : 3.0 V BBSEL[1:0] = 01 : 2.52 V BBSEL[1:0] = 10 : 3.15 V BBSEL[1:0] = 11 : VBAT | RW | 0x0 |
| 0 | BBCHEN | Back up battery charge enable | RW | 0 |

Table 61. DCDCCTRL_REG

| | |
|-------------------------|-----------------------|
| Address Offset | 0x3E |
| Physical Address | Instance |
| Description | DCDC control register |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|------------|------------|-----------|-----------|------------|---|
| Reserved | | VDD2_PSKIP | VDD1_PSKIP | VIO_PSKIP | DCDCCKEXT | DCDCCKSYNC | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|--------------------|-------|
| 7:6 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 5 | VDD2_PSKIP | VDD2 pulse skip mode enable (EEPROM bit) | RW | 1 |
| 4 | VDD1_PSKIP | VDD1 pulse skip mode enable (EEPROM bit) | RW | 1 |
| 3 | VIO_PSKIP | VIO pulse skip mode enable (EEPROM bit) | RW | 1 |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|------|-------|
| 2 | DCDCCKEXT | This signal control the muxing of the GPIO0 pad: When 0: this pad is a GPIO When 1: this pad is used as input for an external clock used for the synchronisation of the DCDCs | RW | 0 |
| 1:0 | DCDCCKSYNC | DCDC clock configuration: DCDCCKSYNC[1:0] = 00 : no synchronization of DCDC clocks DCDCCKSYNC[1:0] = 01 : DCDC synchronous clock with phase shift DCDCCKSYNC[1:0] = 10 : no synchronization of DCDC clocks DCDCCKSYNC[1:0] = 11 : DCDC synchronous clock | RW | 0x3 |

Table 62. DEVCTRL_REG

| | | |
|-------------------------|-------------------------|-----------------|
| Address Offset | 0x3F | Instance |
| Physical Address | | |
| Description | Device control register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|----------|------------|----------------|-------------|--------|---------|---------|
| Reserved | RTC_PWDN | CK32K_CTRL | SR_CTL_I2C_SEL | DEV_OFF_RST | DEV_ON | DEV_SLP | DEV_OFF |

| Bits | Field Name | Description | Type | Reset |
|------|----------------|--|-----------------------|-------|
| 7 | Reserved | Reserved bit | RO R returns 0s | 0 |
| 6 | RTC_PWDN | When 1, disable the RTC digital domain (clock gating and reset of RTC registers and logic). This register bit is not reset in BACKUP state. (EEPROM bit) | RW | 1 |
| 5 | CK32K_CTRL | Internal 32-kHz clock source control bit (EEPROM bit): when 0, the internal 32-kHz clock source is the crystal oscillator or an external 32-kHz clock in case the crystal oscillator is used in bypass mode when 1, the internal 32-kHz clock source is the RC oscillator. | RW | 0 |
| 4 | SR_CTL_I2C_SEL | Smartreflex registers access control bit: when 0: access to smartreflex registers by smartreflex I2C when 1: access to smartreflex registers by control I2C The smartreflex registers are: VDD1_OP_REG, VDD1_SR_REG, VDD2_OP_REG and VDD2_SR_REG. | RW | 0 |
| 3 | DEV_OFF_RST | Write 1 will start an ACTIVE to OFF or SLEEP to OFF device state transition (switch-off event) and activate reset of the digital core. | RW | 0 |
| 2 | DEV_ON | Write 1 will maintain the device on (ACTIVE or SLEEP device state) (if DEV_OFF = 0 and DEV_OFF_RST = 0). | RW | 0 |
| 1 | DEV_SLP | Write 1 allows SLEEP device state (if DEV_OFF = 0 and DEV_OFF_RST = 0). Write '0' will start an SLEEP to ACTIVE device state transition (wake-up event) (if DEV_OFF = 0 and DEV_OFF_RST = 0). This bit is cleared in OFF state. | RW | 0 |
| 0 | DEV_OFF | Write 1 will start an ACTIVE to OFF or SLEEP to OFF device state transition (switch-off event). This bit is cleared in OFF state. | RW | 0 |

Table 63. DEVCTRL2_REG

| | | |
|-------------------------|-------------------------|-----------------|
| Address Offset | 0x40 | Instance |
| Physical Address | | |
| Description | Device control register | |

Table 63. DEVCTRL2_REG (continued)

| Type | RW | | | | | | | |
|------|----------|---|--------------|---|--------------|--------------|--------------|--------|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | Reserved | | TSLOT_LENGTH | | SLEEPSIG_POL | PWRON_LP_OFF | PWRON_LP_RST | IT_POL |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|--|--------------------|-------|
| 7:6 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 5:4 | TSLOT_LENGTH | Time slot duration programming (EEPROM bit): When 00 : 0 μs When 01 : 200 μs When 10 : 500 μs When 11 : 2 ms | RW | 0x3 |
| 3 | SLEEPSIG_POL | When 1, SLEEP signal active high When 0, SLEEP signal active low | RW | 0 |
| 2 | PWRON_LP_OFF | When 1, allows device turn-off after a PWRON long press (signal low). | RW | 1 |
| 1 | PWRON_LP_RST | When 1, allows digital core reset when the device is OFF after a PWRON long press (signal low). | RW | 0 |
| 0 | IT_POL | INT1 interrupt pad polarity control signal (EEPROM bit): When 0, active low When 1, active high | RW | 0 |

Table 64. SLEEP_KEEP_LDO_ON_REG

| | |
|-------------------------|--|
| Address Offset | 0x41 |
| Physical Address | Instance |
| Description | <p>When corresponding control bit=0 in EN1/2_LDO_ASS register (default setting): Configuration Register keeping the full load capability of LDO regulator (ACTIVE mode) during the SLEEP state of the device. When control bit=1, LDO regulator full load capability (ACTIVE mode) is maintained during device SLEEP state.</p> <p>When control bit=0, the LDO regulator is set or stay in low power mode during device SLEEP state (but then supply state can be overwritten programming ST[1:0]). Control bit value has no effect if the LDO regulator is off.</p> <p>When corresponding control bit=1 in EN1/2_LDO_ASS register: Configuration Register setting the LDO regulator state driven by SCLSR_EN1/2 signal low level (when SCLSR_EN1/2 is high the regulator is on, full power):</p> <ul style="list-style-type: none"> - the regulator is set off if its corresponding Control bit = 0 in SLEEP_KEEP_LDO_ON register (default) - the regulator is set in low power mode if its corresponding control bit = 1 in SLEEP_KEEP_LDO_ON register |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---------------|--------------|--------------|--------------|--------------|-------------|
| VDAC_KEEPON | VPLL_KEEPON | VAUX33_KEEPON | VAUX2_KEEPON | VAUX1_KEEPON | VDIG2_KEEPON | VDIG1_KEEPON | VMMC_KEEPON |

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| Bits | Field Name | Description | Type | Reset |
|------|---------------|---|------|-------|
| 7 | VDAC_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 6 | VPLL_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 5 | VAUX33_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 4 | VAUX2_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 3 | VAUX1_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 2 | VDIG2_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 1 | VDIG1_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |
| 0 | VMMC_KEEPON | Setting supply state during device SLEEP state or when SCLSR_EN1/2 is low | RW | 0 |

Table 65. SLEEP_KEEP_RES_ON_REG

| | |
|-------------------------|---|
| Address Offset | 0x42 |
| Physical Address | Instance |
| Description | <p>Configuration Register keeping, during the SLEEP state of the device (but then supply state can be overwritten programming ST[1:0]):</p> <ul style="list-style-type: none"> - the full load capability of LDO regulator (ACTIVE mode), - The PWM mode of DCDC converter - 32KHz clock output - Register access though I2C interface (keeping the internal high speed clock on) - Die Thermal monitoring on <p>Control bit value has no effect if the resource is off.</p> |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------|------------------|-------------|--------------|-------------|-------------|-------------|------------|
| THERM_KEEPON | CLKOUT32K_KEEPON | VRTC_KEEPON | I2CHS_KEEPON | VDD3_KEEPON | VDD2_KEEPON | VDD1_KEEPON | VIO_KEEPON |

| Bits | Field Name | Description | Type | Reset |
|------|------------------|--|------|-------|
| 7 | THERM_KEEPON | When 1, thermal monitoring is maintained during device SLEEP state. When 0, thermal monitoring is turned off during device SLEEP state. | RW | 0 |
| 6 | CLKOUT32K_KEEPON | When 1, CLK32KOUT output is maintained during device SLEEP state. When 0, CLK32KOUT output is set low during device SLEEP state. | RW | 0 |
| 5 | VRTC_KEEPON | When 1, LDO regulator full load capability (ACTIVE mode) is maintained during device SLEEP state. When 0, the LDO regulator is set or stays in low power mode during device SLEEP state. | RW | 0 |
| 4 | I2CHS_KEEPON | When 1, high speed internal clock is maintained during device SLEEP state. When 0, high speed internal clock is turned off during device SLEEP state. | RW | 0 |
| 3 | VDD3_KEEPON | When 1, VDD3 SMPS high power mode is maintained during device SLEEP state. No effect if VDD3 working mode is low power. When 0, VDD3 SMPS low power mode is set during device SLEEP state. | RW | 0 |

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| Bits | Field Name | Description | Type | Reset |
|------|--------------|--|------|-------|
| 2 | VDD2_KEEPPON | If VDD2_EN1&2 control bit = 0 (default setting): When 1, VDD2 SMPS PWM mode is maintained during device SLEEP state. No effect if VDD2 working mode is PFM. When 0, VDD2 SMPS PFM mode is set during device SLEEP state. | RW | 0 |
| 1 | VDD1_KEEPPON | If VDD1_EN1&2 control bit=0 (default setting): When 1, VDD1 SMPS PWM mode is maintained during device SLEEP state. No effect if VDD1 working mode is PFM. When 0, VDD1 SMPS PFM mode is set during device SLEEP state. | RW | 0 |
| 0 | VIO_KEEPPON | If VIO_EN1&2 control bit=0 (default setting): When 1, VIO SMPS PWM mode is maintained during device SLEEP state. No effect if VIO working mode is PFM. When 0, VIO SMPS PFM mode is set during device SLEEP state. | RW | 0 |

Table 66. SLEEP_SET_LDO_OFF_REG

| | |
|-------------------------|--|
| Address Offset | 0x43 |
| Physical Address | Instance |
| Description | Configuration Register turning-off LDO regulator during the SLEEP state of the device. Corresponding *_KEEP_ON control bit in SLEEP_KEEP_RES_ON register should be 0 to make this *_SET_OFF control bit effective |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|-------------|---------------|--------------|--------------|--------------|--------------|-------------|
| VDAC_SETOFF | VPLL_SETOFF | VAUX33_SETOFF | VAUX2_SETOFF | VAUX1_SETOFF | VDIG2_SETOFF | VDIG1_SETOFF | VMMC_SETOFF |

| Bits | Field Name | Description | Type | Reset |
|------|---------------|---|------|-------|
| 7 | VDAC_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 6 | VPLL_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 5 | VAUX33_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 4 | VAUX2_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 3 | VAUX1_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 2 | VDIG2_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 1 | VDIG1_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |
| 0 | VMMC_SETOFF | When 1, LDO regulator is turned off during device SLEEP state. When 0, No effect | RW | 0 |

Table 67. SLEEP_SET_RES_OFF_REG

| | |
|-------------------------|--|
| Address Offset | 0x44 |
| Physical Address | Instance |
| Description | Configuration Register turning-off SMPS regulator during the SLEEP state of the device. Corresponding *_KEEP_ON control bit in SLEEP_KEEP_RES_ON2 register should be 0 to make this *_SET_OFF control bit effective. Supplies voltage expected after their wake-up (SLEEP to ACTIVE state transition) can also be programmed. |
| Type | RW |

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| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------|------|---|--------------|-------------|-------------|-------------|------------|
| DEFAULT_VOLT | RSVD | | SPARE_SETOFF | VDD3_SETOFF | VDD2_SETOFF | VDD1_SETOFF | VIO_SETOFF |

| Bits | Field Name | Description | Type | Reset |
|------|--------------|---|-----------------------|-------|
| 7 | DEFAULT_VOLT | When 1, default voltages (registers value after switch-on) will be used to turned-on supplies during SLEEP to ACTIVE state transition. When 0, voltages programmed before the ACTIVE to SLEEP state transition will be used to turned-on supplies during SLEEP to ACTIVE state transition. | RW | 0 |
| 6:5 | RSVD | Reserved bit | RO R returns 0s | 0x0 |
| 4 | SPARE_SETOFF | Spare bit | RW | 0 |
| 3 | VDD3_SETOFF | When 1, SMPS is turned off during device SLEEP state. When 0, No effect. | RW | 0 |
| 2 | VDD2_SETOFF | When 1, SMPS is turned off during device SLEEP state. When 0, No effect. | RW | 0 |
| 1 | VDD1_SETOFF | When 1, SMPS is turned off during device SLEEP state. When 0, No effect. | RW | 0 |
| 0 | VIO_SETOFF | When 1, SMPS is turned off during device SLEEP state. When 0, No effect. | RW | 0 |

Table 68. EN1_LDO_ASS_REG

| | |
|-------------------------|--|
| Address Offset | 0x45 |
| Physical Address | Instance |
| Description | Configuration Register setting the LDO regulators, driven by the multiplexed SCLSR_EN1 signal. When control bit = 1, LDO regulator state is driven by the SCLSR_EN1 control signal and is also defined though SLEEP_KEEP_LDO_ON register setting: When SCLSR_EN1 is high the regulator is on, When SCLSR_EN1 is low: - the regulator is off if its corresponding Control bit = 0 in SLEEP_KEEP_LDO_ON register - the regulator is working in low power mode if its corresponding control bit = 1 in SLEEP_KEEP_LDO_ON register When control bit = 0 no effect : LDO regulator state is driven though registers programming and the device state Any control bit of this register set to 1 will disable the I2C SR Interface functionality |
| Type | RW |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|----------|------------|-----------|-----------|-----------|-----------|----------|
| VDAC_EN1 | VPLL_EN1 | VAUX33_EN1 | VAUX2_EN1 | VAUX1_EN1 | VDIG2_EN1 | VDIG1_EN1 | VMMC_EN1 |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|------|-------|
| 7 | VDAC_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 6 | VPLL_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 5 | VAUX33_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 4 | VAUX2_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 3 | VAUX1_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 2 | VDIG2_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 1 | VDIG1_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |
| 0 | VMMC_EN1 | Setting supply state control though SCLSR_EN1 signal | RW | 0 |

Table 69. EN1_SMPS_ASS_REG

| | |
|-------------------------|--|
| Address Offset | 0x46 |
| Physical Address | Instance |
| Description | Configuration Register setting the SMPS Supplies driven by the multiplexed SCLSR_EN1 signal. When control bit = 1, SMPS Supply state and voltage is driven by the SCLSR_EN1 control signal and is also defined though SLEEP_KEEP_RES_ON register setting. When control bit = 0 no effect : SMPS Supply state is driven though registers programming and the device state. Any control bit of this register set to 1 will disable the I2C SR Interface functionality |
| Type | RW |

| | | | | | | | |
|------|---|---|-----------|----------|----------|----------|---------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RSVD | | | SPARE_EN1 | VDD3_EN1 | VDD2_EN1 | VDD1_EN1 | VIO_EN1 |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|------|-------|
| 7:5 | RSVD | Reserved bit | RW | 0 |
| 4 | SPARE_EN1 | Spare bit | Rw | 0 |
| 3 | VDD3_EN1 | When 1: When SCLSR_EN1 is high the supply is on. When SCLSR_EN1 is low and SLEEP_KEEP_RES_ON = '0' the supply voltage is off. When SCLSR_EN1 is low and SLEEP_KEEP_RES_ON = '1' the SMPS is working in low power mode. When control bit = 0 no effect: supply state is driven though registers programming and the device state | RW | 0 |
| 2 | VDD2_EN1 | When control bit = 1: When SCLSR_EN1 is high the supply voltage is programmed though VDD2_OP_REG register, and it can also be programmed off. When SCLSR_EN1 is low the supply voltage is programmed though VDD2_SR_REG register, and it can also be programmed off. When SCLSR_EN1 is low and VDD2_KEEPON = 1 the SMPS is working in low power mode, if not tuned off through VDD2_SR_REG register. When control bit = 0 no effect: supply state is driven though registers programming and the device state | RW | 0 |
| 1 | VDD1_EN1 | When 1: When SCLSR_EN1 is high the supply voltage is programmed though VDD1_OP_REG register, and it can also be programmed off. When SCLSR_EN1 is low the supply voltage is programmed though VDD1_SR_REG register, and it can also be programmed off. When SCLSR_EN1 is low and VDD1_KEEPON = 1 the SMPS is working in low power mode, if not tuned off though VDD1_SR_REG register. When control bit = 0 no effect: supply state is driven though registers programming and the device state | RW | 0 |
| 0 | VIO_EN1 | When control bit = 1, supply state is driven by the SCLSR_EN1 control signal and is also defined though SLEEP_KEEP_RES_ON register setting: When SCLSR_EN1 is high the supply is on, When SCLSR_EN1 is low: - the supply is off (default) or the SMPS is working in low power mode if VIO_KEEPON = 1 When control bit = 0 no effect: SMPS state is driven though registers programming and the device state | RW | 0 |

Table 70. EN2_LDO_ASS_REG

| | |
|-------------------------|---|
| Address Offset | 0x47 |
| Physical Address | Instance |
| Description | <p>Configuration Register setting the LDO regulators, driven by the multiplexed SDASR_EN2 signal. When control bit = 1, LDO regulator state is driven by the SDASR_EN2 control signal and is also defined though SLEEP_KEEP_LDO_ON register setting: When SDASR_EN2 is high the regulator is on, When SCLSR_EN2 is low: - the regulator is off if its corresponding Control bit = 0 in SLEEP_KEEP_LDO_ON register - the regulator is working in low power mode if its corresponding control bit = 1 in SLEEP_KEEP_LDO_ON register When control bit = 0 no effect: LDO regulator state is driven though registers programming and the device state Any control bit of this register set to 1 will disable the I2C SR Interface functionality</p> |
| Type | RW |

| | | | | | | | |
|----------|----------|------------|-----------|-----------|-----------|-----------|----------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| VDAC_EN2 | VPLL_EN2 | VAUX33_EN2 | VAUX2_EN2 | VAUX1_EN2 | VDIG2_EN2 | VDIG1_EN2 | VMMC_EN2 |

| Bits | Field Name | Description | Type | Reset |
|------|------------|--|------|-------|
| 7 | VDAC_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 6 | VPLL_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 5 | VAUX33_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 4 | VAUX2_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 3 | VAUX1_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 2 | VDIG2_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 1 | VDIG1_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |
| 0 | VMMC_EN2 | Setting supply state control though SDASR_EN2 signal | RW | 0 |

Table 71. EN2_SMPS_ASS_REG

| | |
|-------------------------|--|
| Address Offset | 0x48 |
| Physical Address | Instance |
| Description | <p>Configuration Register setting the SMPS Supplies driven by the multiplexed SDASR_EN2 signal. When control bit = 1, SMPS Supply state and voltage is driven by the SDASR_EN2 control signal and is also defined though SLEEP_KEEP_RES_ON register setting. When control bit = 0 no effect: SMPS Supply state is driven though registers programming and the device state Any control bit of this register set to 1 will disable the I2C SR Interface functionality</p> |
| Type | RW |

| | | | | | | | |
|------|---|---|-----------|----------|----------|----------|---------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| RSVD | | | SPARE_EN2 | VDD3_EN2 | VDD2_EN2 | VDD1_EN2 | VIO_EN2 |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|--------------------|-------|
| 7:5 | RSVD | Reserved bit | RO R returns 0s | 0x0 |
| 4 | SPARE_EN2 | Spare bit | RW | 0 |
| 3 | VDD3_EN2 | When 1: When SDASR_EN2 is high the supply is on. When SDASR_EN2 is low and SLEEP_KEEP_RES_ON = 0 the supply voltage is off. When SDASR_EN2 is low and SLEEP_KEEP_RES_ON = 1 the SMPS is working in low power mode. When control bit = 0 no effect: supply state is driven though registers programming and the device state | RW | 0 |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|------|-------|
| 2 | VDD2_EN2 | When control bit = 1: When SDASR_EN2 is high the supply voltage is programmed though VDD2_OP_REG register, and it can also be programmed off. When SDASR_EN2 is low the supply voltage is programmed though VDD2_SR_REG register, and it can also be programmed off. When SDASR_EN2 is low and and VDD2_KEEPPON = 1 the SMPS is working in low power mode, if not tuned off though VDD2_SR_REG register. When control bit = 0 no effect: supply state is driven though registers programming and the device state | RW | 0 |
| 1 | VDD1_EN2 | When control bit = 1: When SDASR_EN2 is high the supply voltage is programmed though VDD1_OP_REG register, and it can also be programmed off. When SDASR_EN2 is low the supply voltage is programmed though VDD1_SR_REG register, and it can also be programmed off. When SDASR_EN2 is low and and VDD1_KEEPPON = 1 the SMPS is working in low power mode, if not tuned off though VDD1_SR_REG register. When control bit = 0 no effect: supply state is driven though registers programming and the device state | RW | 0 |
| 0 | VIO_EN2 | When control bit = 1, supply state is driven by the SCLSR_EN2 control signal and is also defined though SLEEP_KEEP_RES_ON register setting: When SDASR_EN2 is high the supply is on, When SDASR_EN2 is low : - the supply is off (default) or the SMPS is working in low power mode if VIO_KEEPPON = 1 When control bit = 0 no effect: SMPS state is driven though registers programming and the device state | RW | 0 |

Table 72. RESERVED

| | | | | | | | | |
|-------------------------|-------------------|--------------------|---|-----------------|---|---|-------------|--------------|
| Address Offset | 0x49 | | | | | | | |
| Physical Address | | | | Instance | | | | |
| Description | Reserved register | | | | | | | |
| Type | RW | | | | | | | |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RESERVED | | | | | | | |
| Bits | Field Name | Description | | | | | Type | Reset |
| 7:0 | RESERVED | Reserved bit | | | | | RW | 0 |

Table 73. RESERVED

| | | | | | | | | |
|-------------------------|-------------------|--------------------|---|-----------------|---|---|-------------|--------------|
| Address Offset | 0x4A | | | | | | | |
| Physical Address | | | | Instance | | | | |
| Description | Reserved register | | | | | | | |
| Type | RW | | | | | | | |
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RESERVED | | | | | | | |
| Bits | Field Name | Description | | | | | Type | Reset |
| 7:0 | RESERVED | Reserved bit | | | | | RW | 0x00 |

Table 74. INT_STS_REG

| | | |
|-------------------------|---|-----------------|
| Address Offset | 0x50 | |
| Physical Address | | Instance |
| Description | Interrupt status register: The interrupt status bit is set to 1 when the associated interrupt event is detected. Interrupt status bit is cleared by writing 1. | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------|--------------|-----------|------------|-------------|----------|----------|-----------|
| RTC_PERIOD_IT | RTC_ALARM_IT | HOTDIE_IT | PWRHOLD_IT | PWRON_LP_IT | PWRON_IT | VMBHI_IT | VMBDCH_IT |

| Bits | Field Name | Description | Type | Reset |
|------|---------------|--|-----------------|-------|
| 7 | RTC_PERIOD_IT | RTC period event interrupt status. | RW W1 to Clr | 0 |
| 6 | RTC_ALARM_IT | RTC alarm event interrupt status. | RW W1 to Clr | 0 |
| 5 | HOTDIE_IT | Hot die event interrupt status. | RW W1 to Clr | 0 |
| 4 | PWRHOLD_IT | PWRHOLD event interrupt status. | RW W1 to Clr | 0 |
| 3 | PWRON_LP_IT | PWRON Long Press event interrupt status. | RW W1 to Clr | 0 |
| 2 | PWRON_IT | PWRON event interrupt status. | RW W1 to Clr | 0 |
| 1 | VMBHI_IT | VBAT > VMBHI event interrupt status | RW W1 to Clr | 0 |
| 0 | VMBDCH_IT | VBAT > VMBDCH event interrupt status. Active only if Main Battery comparator VMBCH programmable threshold is not bypassed (VMBCH_SEL[1:0] ≠ 00) | RW W1 to Clr | 0 |

Table 75. INT_MSK_REG

| | | |
|-------------------------|--|-----------------|
| Address Offset | 0x51 | |
| Physical Address | | Instance |
| Description | Interrupt mask register: When *_IT_MSK is set to 1, the associated interrupt is masked: INT1 signal is not activated, but *_IT interrupt status bit is updated. When *_IT_MSK is set to 0, the associated interrupt is enabled: INT1 signal is activated, *_IT is updated. | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------------|------------------|---------------|----------------|-----------------|--------------|--------------|---------------|
| RTC_PERIOD_IT_MSK | RTC_ALARM_IT_MSK | HOTDIE_IT_MSK | PWRHOLD_IT_MSK | PWRON_LP_IT_MSK | PWRON_IT_MSK | VMBHI_IT_MSK | VMBDCH_IT_MSK |

TPS65910, TPS65910A, TPS65910A3, TPS659101, TPS659102, TPS659103
 TPS659104, TPS659105, TPS659106, TPS659107, TPS659108, TPS659109

| Bits | Field Name | Description | Type | Reset |
|------|------------------------|--|------|-------|
| 7 | RTC_PERIOD_IT_MSK K | RTC period event interrupt mask. | RW | 0 |
| 6 | RTC_ALARM_IT_MSK K | RTC alarm event interrupt mask. | RW | 0 |
| 5 | HOTDIE_IT_MSK | Hot die event interrupt mask. | RW | 0 |
| 4 | PWRHOLD_IT_MSK | PWRHOLD rising edge event interrupt mask. | RW | 0 |
| 3 | PWRON_LP_IT_MSK | PWRON Long Press event interrupt mask. | RW | 0 |
| 2 | PWRON_IT_MSK | PWRON event interrupt mask. | RW | 0 |
| 1 | VMBHI_IT_MSK | VBAT > VMBHI event interrupt mask. When 0, enable the device automatic switch on at BACKUP to OFF or NOSUPPLY to OFF device state transition (EEPROM bit) | RW | 1 |
| 0 | VMBDCH_IT_MSK | VBAT < VMBDCH event interrupt status. Active only if the main battery comparator VMBCH programmable threshold is not bypassed (VMBCH_SEL[1:0] ≠ 00). | RW | 0 |

Table 76. INT_STS2_REG

| | | | |
|-------------------------|---|-----------------|--|
| Address Offset | 0x52 | Instance | |
| Physical Address | | | |
| Description | Interrupt status register: The interrupt status bit is set to 1 when the associated interrupt event is detected. Interrupt status bit is cleared by writing 1. | | |
| Type | RW | | |

| | | | | | | | |
|----------|---|---|---|---|---|------------|------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | | | GPIO0_F_IT | GPIO0_R_IT |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|-----------------|-------|
| 7:2 | Reserved | Reserved bit | RW W1 to Clr | 0 |
| 1 | GPIO0_F_IT | GPIO_CKSYNC falling edge detection interrupt status | RW W1 to Clr | 0 |
| 0 | GPIO0_R_IT | GPIO_CKSYNC rising edge detection interrupt status | RW W1 to Clr | 0 |

Table 77. INT_MSK2_REG

| | | | |
|-------------------------|--|-----------------|--|
| Address Offset | 0x53 | Instance | |
| Physical Address | | | |
| Description | Interrupt mask register: When *_IT_MSK is set to 1, the associated interrupt is masked: INT1 signal is not activated, but *_IT interrupt status bit is updated. When *_IT_MSK is set to 0, the associated interrupt is enabled: INT1 signal is activated, *_IT is updated. | | |
| Type | RW | | |

| | | | | | | | |
|----------|---|---|---|---|---|----------------|----------------|
| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Reserved | | | | | | GPIO0_F_IT_MSK | GPIO0_R_IT_MSK |

| Bits | Field Name | Description | Type | Reset |
|------|----------------|--|------|-------|
| 7:2 | Reserved | Reserved bit | RW | 0 |
| 1 | GPIO0_F_IT_MSK | GPIO_CKSYNC falling edge detection interrupt mask. | RW | 0 |
| 0 | GPIO0_R_IT_MSK | GPIO_CKSYNC rising edge detection interrupt mask. | RW | 0 |

Table 78. GPIO0_REG

| | | |
|-------------------------|------------------------------|-----------------|
| Address Offset | 0x60 | Instance |
| Physical Address | | |
| Description | GPIO0 configuration register | |
| Type | RW | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|----------|-----------|----------|----------|----------|
| Reserved | | | GPIO_DEB | GPIO_PUEN | GPIO_CFG | GPIO_STS | GPIO_SET |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|--------------------|-------|
| 7:5 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 4 | GPIO_DEB | GPIO_CKSYNC input debouncing time configuration: When 0, the debouncing is 91.5 μ s using a 30.5 μ s clock rate When 1, the debouncing is 150 ms using a 50 ms clock rate | RW | 0 |
| 3 | GPIO_PUEN | GPIO_CKSYNC pad pull-up control: 1: Pull-up is enabled 0: Pull-up is disabled | RW | 1 |
| 2 | GPIO_CFG | Configuration of the GPIO_CKSYNC pad direction: When 0, the pad is configured as an input When 1, the pad is configured as an output | RW | 0 |
| 1 | GPIO_STS | Status of the GPIO_CKSYNC pad | RO | 1 |
| 0 | GPIO_SET | Value set on the GPIO output when configured in output mode | RW | 0 |

Table 79. JTAGVERNUM_REG

| | | |
|-------------------------|------------------------|-----------------|
| Address Offset | 0x80 | Instance |
| Physical Address | | |
| Description | Silicon version number | |
| Type | RO | |

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---|---|---|--------|---|---|---|
| Reserved | | | | VERNUM | | | |

| Bits | Field Name | Description | Type | Reset |
|------|------------|---|--------------------|-------|
| 7:4 | Reserved | Reserved bit | RO R returns 0s | 0x0 |
| 3:0 | VERNUM | Value depending on silicon version number 0000 - Revision 1.0 | RO | 0x0 |

GLOSSARY

ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

| ACRONYM | DEFINITION |
|---------------------|---|
| DDR | Dual-Data Rate (memory) |
| ES | Engineering Sample |
| ESD | Electrostatic Discharge |
| FET | Field Effect Transistor |
| EPC | Embedded Power Controller |
| FSM | Finite State Machine |
| GND | Ground |
| GPIO | General-Purpose I/O |
| HBM | Human Body Model |
| HD | Hot-Die |
| HS-I ² C | High-Speed I ² C |
| I ² C | Inter-Integrated Circuit |
| IC | Integrated Circuit |
| ID | Identification |
| IDDQ | Quiescent supply current |
| IEEE | Institute of Electrical and Electronics Engineers |
| IR | Instruction Register |
| I/O | Input/Output |
| JEDEC | Joint Electron Device Engineering Council |
| JTAG | Joint Test Action Group |
| LBC7 | Lin Bi-CMOS 7 (360 nm) |
| LDO | Low Drop Output voltage linear regulator |
| LP | Low-Power application mode |
| LSB | Least Significant Bit |
| MMC | Multimedia Card |
| MOSFET | Metal Oxide Semiconductor Field Effect Transistor |
| NVM | Nonvolatile Memory |
| OMAP™ | Open Multimedia Application Platform™ |
| RTC | Real-Time Clock |
| SMPS | Switched Mode Power Supply |
| SPI | Serial Peripheral Interface |
| POR | Power-On Reset |

Table 80. REVISION HISTORY

| VERSION | DATE | NOTES |
|---------|---------|-----------------------|
| * | 03/2010 | See ⁽¹⁾ . |
| A | 05/2010 | See ⁽²⁾ . |
| B | 06/2010 | See ⁽³⁾ . |
| C | 06/2010 | See ⁽⁴⁾ . |
| D | 11/2010 | See ⁽⁵⁾ . |
| E | 01/2011 | See ⁽⁶⁾ . |
| F | 01/2011 | See ⁽⁷⁾ . |
| G | 05/2011 | See ⁽⁸⁾ . |
| H | 06/2011 | See ⁽⁹⁾ . |
| I | 07/2011 | See ⁽¹⁰⁾ . |
| J | 10/2011 | See ⁽¹¹⁾ . |
| K | 10/2011 | See ⁽¹²⁾ . |
| L | 01/2012 | See ⁽¹³⁾ . |
| M | 03/2012 | See ⁽¹⁴⁾ . |
| N | 04/2012 | See ⁽¹⁵⁾ . |
| O | 06/2012 | See ⁽¹⁶⁾ . |
| P | 09/2012 | See ⁽¹⁷⁾ . |
| Q | 09/2012 | See ⁽¹⁸⁾ . |
| R | 02/2013 | See ⁽¹⁹⁾ . |
| S | 08/2013 | See ⁽²⁰⁾ . |

- (1) Initial release
- (2) SWCS046A: Updated register tables VMMC_REG and VDAC_REG. Added register table VPLL_REG
- (3) SWCS046B: Update Absolute Maximum Ratings, Recommended Operating Conditions, I/O Pullup and Pulldown Characteristics, Digital I/Os Voltage Electrical Characteristics, Power Consumption, Power References and Thresholds, Thermal Monitoring and Shutdown, 32-kHz RTC Clock, VRTC LDO, VIO SMPS, VDD1 SMPS, VDD2 SMPS, VDD3 SMPS, Switch-On/-Off Sequences and Timing
- (4) SWCS046C: Associate parts; no change.
- (5) SWCS046D: Update Recommended Operating Conditions - Backup Battery, I/O Pullup and Pulldown Characteristics, Backup Battery Charger. Update Rated output current, PMOS current limit (High-Side), NMOS current limit (Low-Side), and Conversion Efficiency for VIO SMPS, VDD1/VDD2/VDD3 SMPS and VDIG1/VDIG2 LDO. Update Input Voltage for VIO/VDD1/VDD2 SMPS. Update DC and Transient Load and Line Regulation and Internal Resistance for VDIG1/VDIG2 LDO, VAUX33/VMMC LDO, VAUX1, VAUX2, LDO, and VDAC/VPLL LDO. Update DC Load Regulation for VAUX3/VMMC/VDAC. Update Power Control Timing. Add Device SLEEP State Control. Add SMPS Switching Synchronization. Update VIO_REG, VDD1_REG, and VDD2_REG.
- (6) SWCS046E: Manually added Thermal Pad Mechanical Data.
- (7) SWCS046F: Update [Table 1, SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS](#).
- (8) SWCS046G: Update [PACKAGE DESCRIPTION, RECOMMENDED OPERATING CONDITIONS, DIGITAL I/O VOLTAGE ELECTRICAL CHARACTERISTICS](#), and [PWRON](#).
- (9) SWCS046H: Update [Table 40, PUADEN_REG](#), [Table 72, RESERVED](#), and [Table 73, RESERVED](#).
- (10) SWCS046I: Update DC Output voltage V_{OUT} in [VAUX1 AND VAUX2 LDO](#).
- (11) SWCS046J: Update [Table 1, SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS](#).
- (12) SWCS046K: Update [Table 1, SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS](#) - Add AM335x.
- (13) SWCS046L: Update [Table 1, SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS](#) - Add AM335x with DDR2 and AM335x with DDR3.
- (14) SWCS046M: Update [STATE-MACHINE](#), - Update Device Sleep enable conditions control information.
- (15) SWCS046N:
 - (a) [VIO SMPS](#) - Update PMOS current limit (high side) conditions
 - (b) [Table 74](#) - Update INT_STS_REG register - VMBHI_IT description
 - (c) Update Input voltage: [VDIG1 AND VDIG2 LDO](#)
- (16) SWCS046O: Update [Table 6, Power Control Timing Characteristics](#)
 - (a) Replace unit of μ s for $t_{dbPWRONF}$ by ms
- (17) SWCS046P: Update [Table 1, SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS](#) -
 - (a) Add AM335x with DDR3 - TPS65910A31A1RSL
 - (b) Add Rockchip - RK30xx
- (18) SWCS046Q: Update [Table 1, SUPPORTED PROCESSORS AND CORRESPONDING PART NUMBERS](#) -
 - (a) Refer to SWCU093 document: Update document reference from TBD to SWCU093
- (19) SWCS046R: Update [VRTC LDO, VRTC LDO](#) - Changed Input Voltage - Back-up mode - Max from 3V to 5.5V.
- (20) SWCS046S: Update [VAUX1 AND VAUX2 LDO, VAUX1 AND VAUX2 LDO](#) - Changed VAUX2 - Rated Output Current I_{OUTmax} - On mode from 150 mA to 300 mA

Table 80. REVISION HISTORY (continued)

| VERSION | DATE | NOTES |
|---------|---------|---------------------|
| T | 09/2013 | See ⁽²¹⁾ |

(21) SWCS046T: Update

- (a) [Table 34](#), *RTC_Reset_Status_Reg*, Changed Reserved bits to 7:1 and changed RESET_STATUS's reset value to 0x0.
- (b) [Table 45](#), *VDD1_OP_REG*, Changed SEL Vout to $V_{out} = (SEL[6:0] \times 12.5 \text{ mV} + 0.5625 \text{ V}) \times G$.
- (c) [Table 46](#), *VDD1_SR_REG*, Changed SEL Vout to $V_{out} = (SEL[6:0] \times 12.5 \text{ mV} + 0.5625 \text{ V}) \times G$.
- (d) [Table 48](#), *VDD2_OP_REG*, Changed SEL Vout to $V_{out} = (SEL[6:0] \times 12.5 \text{ mV} + 0.5625 \text{ V}) \times G$.
- (e) [Table 49](#), *VDD2_SR_REG*, Changed SEL Vout to $V_{out} = (SEL[6:0] \times 12.5 \text{ mV} + 0.5625 \text{ V}) \times G$.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS659101A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659101 A1 | Samples |
| TPS659101A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659101 A1 | Samples |
| TPS659102A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659102 A1 | Samples |
| TPS659102A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659102 A1 | Samples |
| TPS659103A1RSL | PREVIEW | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659103 A1 | |
| TPS659103A1RSLR | PREVIEW | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659103 A1 | |
| TPS659104A1RSL | PREVIEW | VQFN | RSL | 48 | 60 | TBD | Call TI | Call TI | -40 to 85 | | |
| TPS659104A1RSLR | PREVIEW | VQFN | RSL | 48 | 2500 | TBD | Call TI | Call TI | -40 to 85 | | |
| TPS659105A1RSL | PREVIEW | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659105 A1 | |
| TPS659105A1RSLR | PREVIEW | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659105 A1 | |
| TPS659106A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659106 A1 | Samples |
| TPS659106A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659106 A1 | Samples |
| TPS659107A1RSL | PREVIEW | VQFN | RSL | 48 | 60 | TBD | Call TI | Call TI | -40 to 85 | | |
| TPS659107A1RSLR | PREVIEW | VQFN | RSL | 48 | 2500 | TBD | Call TI | Call TI | -40 to 85 | | |
| TPS659108A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659108 A1 | Samples |
| TPS659108A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659108 A1 | Samples |
| TPS659109A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659109 A1 | Samples |
| TPS659109A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T659109 A1 | Samples |
| TPS65910A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | TPS 65910A1 | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|-------------------|---------------|--------------|-----------------|------|-------------|-------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS65910A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | TPS65910A1 | Samples |
| TPS65910A31A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | 65910A31A1 | Samples |
| TPS65910A31A1RSLT | ACTIVE | VQFN | RSL | 48 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | 65910A31A1 | Samples |
| TPS65910A3A1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T65910A3A1 | Samples |
| TPS65910A3A1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T65910A3A1 | Samples |
| TPS65910AA1RSL | ACTIVE | VQFN | RSL | 48 | 60 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T65910AA1 | Samples |
| TPS65910AA1RSLR | ACTIVE | VQFN | RSL | 48 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-3-260C-168 HR | -40 to 85 | T65910AA1 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS659101A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.1 | 12.0 | 16.0 | Q2 |
| TPS659102A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.1 | 12.0 | 16.0 | Q2 |
| TPS659102A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS659106A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS659108A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.1 | 12.0 | 16.0 | Q2 |
| TPS659109A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.1 | 12.0 | 16.0 | Q2 |
| TPS65910A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS65910A31A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS65910A31A1RSLT | VQFN | RSL | 48 | 250 | 180.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS65910A3A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.1 | 12.0 | 16.0 | Q2 |
| TPS65910A3A1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |
| TPS65910AA1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.1 | 12.0 | 16.0 | Q2 |
| TPS65910AA1RSLR | VQFN | RSL | 48 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS

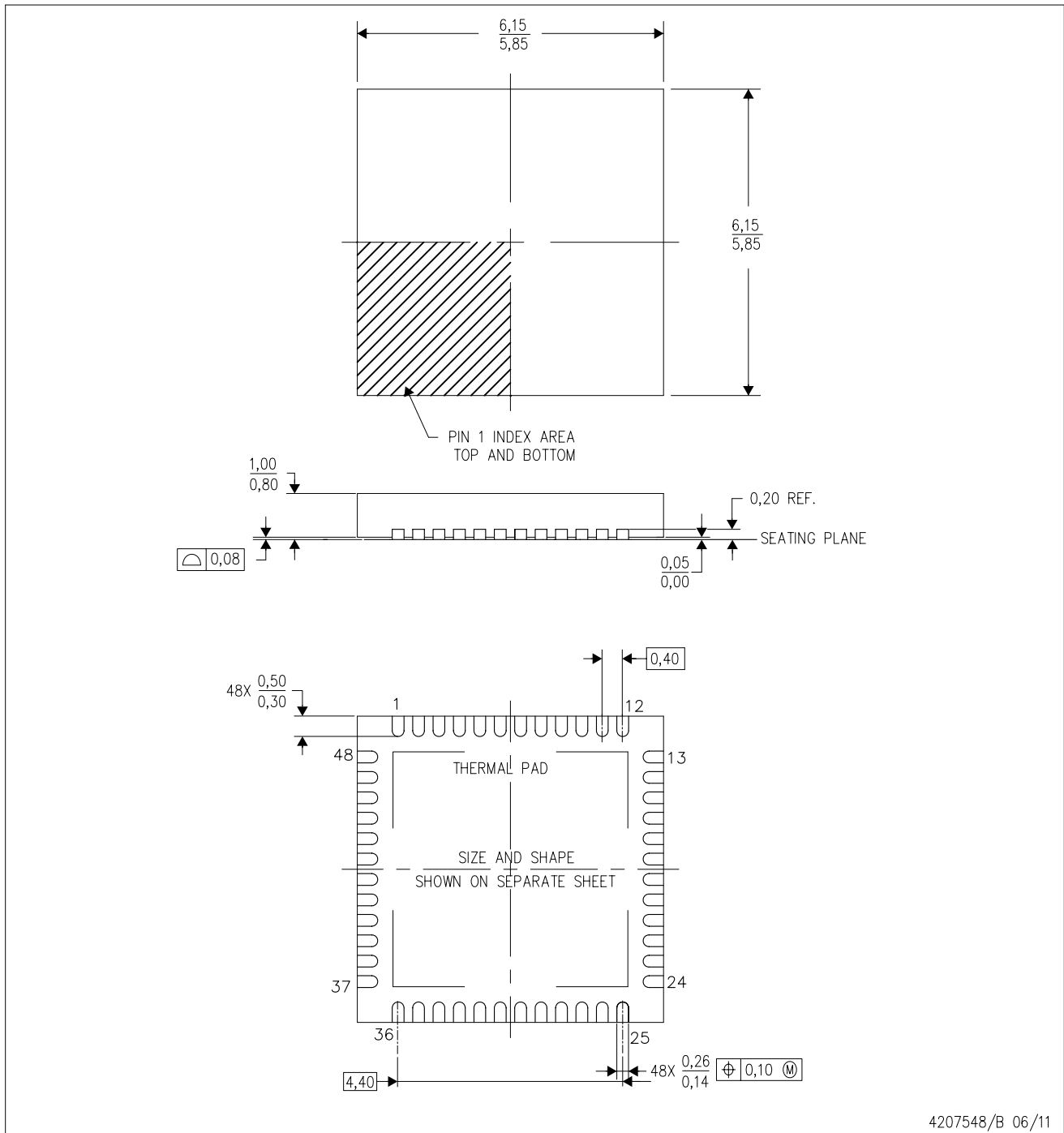

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS659101A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS659102A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS659102A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS659106A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS659108A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS659109A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS65910A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS65910A31A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS65910A31A1RSLT | VQFN | RSL | 48 | 250 | 210.0 | 185.0 | 35.0 |
| TPS65910A3A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS65910A3A1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS65910AA1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |
| TPS65910AA1RSLR | VQFN | RSL | 48 | 2500 | 367.0 | 367.0 | 38.0 |

MECHANICAL DATA

RSL (S-PVQFN-N48)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Quad Flatpack, No-leads (QFN) package configuration.
 - The package thermal pad must be soldered to the board for thermal and mechanical performance.
 - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.

THERMAL PAD MECHANICAL DATA

RSL (S-PVQFN-N48)

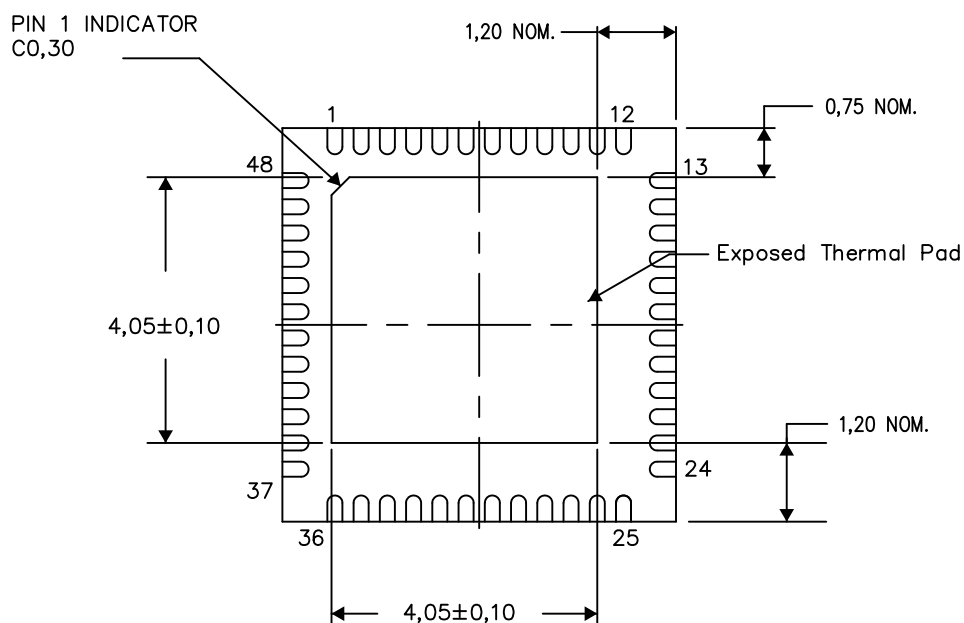
PLASTIC QUAD FLATPACK NO-LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

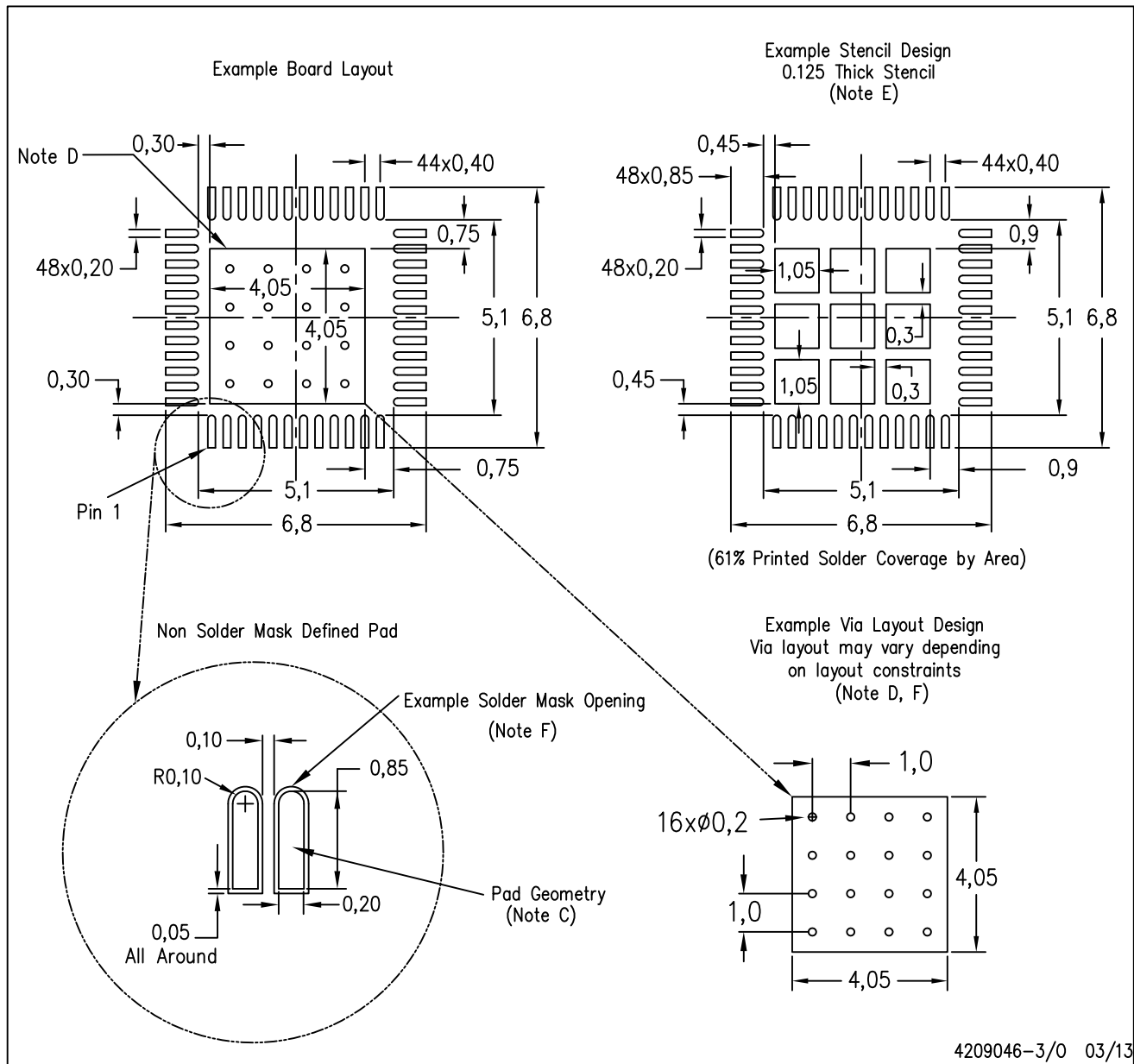
Exposed Thermal Pad Dimensions

4207841-4/P 03/13

NOTE: All linear dimensions are in millimeters

RSL (S-PVQFN-N48)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

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