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PMIC5020 Power Management IC Standard

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PMIC5020 POWER MANAGEMENT IC STANDARD

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PMIC5020 POWER MANAGEMENT IC STANDARD

From JEDEC Board Ballot JCB-24-05, formulated under the cognizance of the JC-40.1 subcommittee on Digital Logic Families and Applications, item number 325.39A.

1 Definition of PMIC5020 Voltage Regulator Device for Memory Module Applications

1.1 Scope

This standard defines the specifications of interface parameters, signaling protocols, and features for PMIC device as used for memory module applications. The designation PMIC5020 refers to the device specified by this document.

The purpose is to provide a standard for the PMIC5020 device for uniformity, multiplicity of sources, elimination of confusion, ease of device specification, and ease of use.

Unless otherwise noted in the document, any illegal operation is not allowed and device operation is not guaranteed.

NOTE: The designation PMIC5020 refers to a portion of the part number designation of a series of commercial logic devices common in the industry. This number is normally preceded by a series of manufacturer specific characters to make up a complete part designation.

1.2 Device Standard

1.2.1 Description

The PMIC5020 is designed for typical Gen1 DDR5 MRDIMM. The PMIC features four step down switching regulators and three LDO regulators.

The PMIC is designed to support approximately 30 Watts of power. The PMIC is powered from VIN_Bulk input for switching regulators and VIN_Mgmt input for the rest of the PMIC. The PMIC supports selectable interface (I²C or I3C Basic) to fit various application environment. The PMIC device is intended to operate up to 12.5 MHz on a 1.0 V I3C Basic bus or up to 1 MHz on a 1.0 V to 3.3 V I²C bus.

1.2.2 Common Features Summary

Table 1 — PMIC Device Type Summary

Device Type	SWA	SWB	SWC	SWD	Unit
PMIC5020 - Current Capability per Phase	8.5	8.5	10	3	A

- VIN_Bulk input supply range: 4.25 V to 15.0 V
- VIN_Mgmt input supply range: 3.0 V to 3.6 V
- Four step down switching regulators: SWA, SWB, SWC, and SWD
- Programmable dual phase and single phase regulator for SWA and SWB
- 3 LDO regulators: VBias, VOUT_1.8V, VOUT_1.0V
- Automatic switchover from VIN_Mgmt input supply to VIN_Bulk input supply
- Error injection capability
- Persistent Error log registers
- Write protect mode and programmable of operation
- Independently programmable output voltages, power up and power down sequence for switch regulators
- Input and output power good status reporting mechanism
- VIN_Bulk input supply protection feature: Input over voltage
- Output switch regulators protection feature: Output over voltage, output under voltage, output current limiter
- Output current and power measurement, output current threshold mechanism
- Temperature measurement, temperature warning threshold, critical temperature shutdown
- Multi Time Programmable Non-Volatile Memory
- Programmable and DIMM specific registers for customization
- General Status Interrupt Function
- Flexible Open Drain IO (I²C) and Push Pull (I3C Basic) IO Support

1.3 Input Supply and Output Regulator Electrical Characteristics

1.3.1 Input Supply Electrical Characteristics

Table 2 — Input Supply DC + AC Specification

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Bulk Input Supply Voltage DC Voltage	VIN_Bulk	4.25	12	15	V	1,2,3
Bulk Input Supply Maximum AC Voltage	VIN_Bulk_AC	-	-	18	V	
Bulk Input Supply Maximum Voltage Start up Overshoot	VIN_Bulk_OS_Startup	-	-	33	V* μ s	4
Bulk Input Supply Voltage Ramp Up Rate	VIN_Bulk_Ramp_Up	0.1	-	3.0	V/ms	5
Bulk Input Supply Voltage Ramp Down Rate	VIN_Bulk_Ramp_Down	-	-	1.0	V/ms	6
Management Input Supply Voltage	VIN_Mgmt	3.0	3.3	3.6	V	7
Management Input Supply Ramp Up and Down Rate	VIN_Mgmt_Ramp	0.15		3	V/ms	
Minimum Management Input Supply Current	I _{VIN_Mgmt}	110	-	-	mA	8
Bulk Input Supply Current	I _{VIN_Bulk}		-	4.0	A	9
NOTE 1	During first power on, the input voltage supply must reach minimum value based on default from register Table 112, “Register 0x1A” [7:5] + 1.0V for PMIC to detect valid input supply.					
NOTE 2	The PMIC efficiency is optimized for nominal input supply of 12 V or lower. The PMIC efficiency above 13.8 V is degraded and thermal impact must be considered. The PMIC operation above 14.2 V should not be greater than 20% duty cycle at any time and should be limited to a maximum contiguous period of 10 minutes.					
NOTE 3	In general, at low input supply voltage, the PMIC cannot guarantee to deliver the maximum output current load on all rails as the input supply current is limited.					
NOTE 4	The area under the curve above VIN_Bulk = 15V. VIN_Bulk_AC spec must also be satisfied.					
NOTE 5	The ramp up rate between 300 mV and 8.0 V.					
NOTE 6	The ramp down rate between 8.0 V and 300 mV.					
NOTE 7	During first power on, the input voltage supply must reach minimum value of 2.8 V for PMIC to detect valid input supply.					
NOTE 8	This is a platform spec. The minimum input current delivered by the platform through the DIMM gold finger to deliver the maximum load on LDO outputs (1.8 V LDO output + 1.0 V LDO output = 25 mA + 20 mA) plus the current required by the PMIC for its own usage.					
NOTE 9	This is a platform spec. The maximum input current delivered by the platform through the DIMM gold finger. The platform should target minimum of 3.5 A on bulk input supply current to the PMIC in order for PMIC to deliver maximum output load current simultaneously on all four rails at typical bulk input supply voltage. If the bulk input supply voltage is lowered, the platform is required to deliver higher input current to the PMIC.					

Table 3 — SWA, SWB¹ - Single Phase Regulator; PMIC5020; DC + AC Specification

Table 4 — SWA + SWB¹ - Dual Phase Regulator; PMIC5020; DC + AC Specification

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Output Voltage	V _{out}		1.1		V	2
Maximum Continuous DC Current Load	I _{tdc}	0	-	17	A	3
Maximum Peak Instantaneous Current	I _{peakmax}	-	-	20	A	4
Maximum Load Transient	dI/dt	-	-	10	A/μs	5
Regulator Output DC + AC Voltage Tolerance	Reg_DC_AC_Tol	-2.5%		2.5%		6
Regulator Feedback Set Point Accuracy	FB_Set_Point	-0.75%		0.75%		7
NOTE 1	Only applicable if Table 162, “Register 0x4F” [0], = ‘1’.					
NOTE 2	Typical voltage configured in the register Table 119, “Register 0x21 ^{1,2} ” [7:1].					
NOTE 3	Measured over long period of time. Typically 1 second.					
NOTE 4	Measured over short period of time. Typically ≥ 20 μs but less than 50 μs.					
NOTE 5	This parameter is applied to measure output voltage regulator DC+AC tolerance.					
NOTE 6	The percentage applies to typical voltage configured in the register. Applies across entire PMIC operating temperature range. The PMIC bulk input supply voltage VIN_Bulk can vary from minimum to maximum value specified in Table 2, “Input Supply DC + AC Specification”. The regulator output current load can vary maximum dI/dt value. The output ripple is inclusive in this parameter and not to exceed TBD mV.					
NOTE 7	The percentage applies to typical voltage configured in the register and at a given temperature within operating temperature range. The PMIC bulk input supply voltage VIN_Bulk is fixed at nominal voltage of 12.0 V. The regulator output current load I _{tdc} = 0 A.					

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Output Voltage	V _{out}		1.8		V	2
Maximum Continuous DC Current Load	I _{tdc}	0	-	3	A	3
Maximum Peak Instantaneous Current	I _{peakmax}	-	-	3.5	A	4
Maximum Load Transient	dI/dt	-	-	5	A/μs	5
Regulator Output DC + AC Voltage Tolerance	Reg_DC_AC_Tol	-2.5%		2.5%		6
Regulator Feedback Set Point Accuracy	FB_Set_Point	-0.75%		0.75%		7
NOTE 1	There is no note. This is intentional.					
NOTE 2	Typical voltage configured in the register Table 125, “Register 0x27 ^{1,2} ” [7:1].					
NOTE 3	Measured over long period of time. Typically 1 second.					
NOTE 4	Measured over short period of time. Typically ≥ 20 μs but less than 50 μs.					
NOTE 5	This parameter is applied to measure output voltage regulator DC+AC tolerance.					
NOTE 6	The percentage applies to typical voltage configured in the register. Applies across entire PMIC operating temperature range. The PMIC bulk input supply voltage VIN_Bulk can vary from minimum to maximum value specified in Table 2, “Input Supply DC + AC Specification”. The regulator output current load can vary maximum dI/dt value. The output ripple is inclusive in this parameter and not to exceed TBD mV.					
NOTE 7	The percentage applies to typical voltage configured in the register and at a given temperature within operating temperature range. The PMIC bulk input supply voltage VIN_Bulk is fixed at nominal voltage of 12.0V. The regulator output current load I _{tdc} = 0 A.					

1.3.3 Switch Regulator Efficiency

The PMIC efficiency spec is defined for the reference test board only and it is not applicable for any DIMM application board which varies from the reference test board. The reference test board includes the inductor and the PCB characteristics which complies with the footnote 6 in Table 7. The efficiency spec is only measured for one switch regulator at a time; all other switch regulators must be disabled. The PMIC switching frequency must comply with the footnote 9 in Table 7. The typical DIMM application environment which deviates from the reference test board, all buck regulator are turned on simultaneously, carries external load on LDOs and signal interface pins may not be held static will have lower efficiency than defined in Table 7. The combination of all variation for application environment is not subject to the efficiency spec as defined in Table 7.

Table 7 — Efficiency Characteristics; PMIC5020

Switch Node Output	Efficiency (% of Max I _{tdc} Load)			Unit	Notes
	25%	50%	100%		
SWA or SWB (Single Phase Regulator Mode)	≥ 90	≥ 92	≥ 87	%	1,2,3,4,5, 6,7,8,9,10
SWA + SWB (Dual Phase Regulator Mode)	≥ 90	≥ 92	≥ 87	%	
SWC	≥ 90	≥ 92	≥ 87	%	
SWD	≥ 90	≥ 92	≥ 87	%	
NOTE 1	VIN_Bulk = 12 V; VIN_Mgmt = 3.3 V				
NOTE 2	The maximum I _{tdc} as specified in appropriate Tables above.				
NOTE 3	When the efficiency of any given output regulator is being measured, all other switching output regulators are disabled.				
NOTE 4	No external load on VOUT_1.8V, VOUT_1.0V LDO is applied.				
NOTE 5	I ² C/I ³ C Basic bus is pulled High and held static. CAMP and GSI_n signals are pulled High and held static.				
NOTE 6	The efficiency includes the buck regulator loss, the PCB loss (≤ 2.5 mΩ from the SWx output pin of the PMIC to VOUTx bulk capacitors after inductor) and see Section 1.15 for inductor specification assumption for DCR and ACR.				
NOTE 7	Efficiency calculation equation: (V _{OUT} * I _{OUT}) / [(V _{IN_Bulk} * I _{IN_Bulk}) + (V _{IN_Mgmt} * I _{IN_Mgmt})]; where V _{OUT} , I _{OUT} , V _{IN_Mgmt} , I _{IN_Mgmt} , V _{IN_Bulk} , I _{IN_Bulk} parameters are actual measured values.				
NOTE 8	Applies at maximum ambient temperature of 65 °C (PMIC Junction temperature of 105 °C). The inductor characteristics noted above applies inductor temperature of 105 °C.				
NOTE 9	The output buck regulator switching frequency must be set to 500 KHz for SWA/SWB/SWC and 750 KHz for SWD. The device under test (DUT) must also comply with all PMIC's electrical characteristics (DC+AC) specifications. The efficiency spec for switching frequency greater than 500 KHz for SWA/SWB/SWC and 750 KHz for SWD is not specified and it is vendor specific.				
NOTE 10	For input supply rails, probing is done at the input high frequency filter cap (0.1 μF) to PMIC pin. For output rail, probing is done at the output cap location at the inductor load side.				

1.3.4 LDO Output Regulator Characteristics

Table 8 — LDO Output Regulator DC + AC Specification

Parameter	Symbol	Min	Typ	Max	Unit	Notes
1.8 V LDO Output Voltage	VOUT_1.8V		1.8		V	1
1.8 V LDO Output - Maximum Output Current	I _{tdc_VOUT_1.8V}	-	-	25	mA	2
1.0 V LDO Output Voltage	VOUT_1.0V		1.0		V	3
1.0 V LDO Output - Maximum Output Current	I _{tdc_VOUT_1.0V}	-	-	20	mA	4
NOTE 1	Typical voltage is configured in register Table 129, “Register 0x2B ^{1,2} ” [7:6]. The min and max values are guaranteed to be within ± 100 mV of programmed value.					
NOTE 2	The maximum output current represents the external load and excludes PMIC’s own internal current consumption. The specified maximum output current is only applicable after PMIC’s 1.8V LDO Power Good status is good (i.e., t1.8V_Ready timing parameter is satisfied). Prior to PMIC’s 1.8V LDO Power Good status (i.e., while PMIC is still ramping up the 1.8 V LDO, the maximum output current load shall be limited to maximum of 10 mA.					
NOTE 3	Typical voltage is configured in register Table 129, “Register 0x2B ^{1,2} ” [2:1]. The min and max values are guaranteed to be within ± 50 mV of programmed value.					
NOTE 4	The maximum output current represents the external load and excludes PMIC’s own internal current consumption. The specified maximum output current is only applicable after PMIC’s 1.0V LDO Power Good status is good (i.e., t1.0V_Ready timing parameter is satisfied). Prior to PMIC’s 1.0V LDO Power Good status (i.e., while PMIC is still ramping up the 1.0 V LDO), the maximum output current load shall be limited to maximum of 5 mA.					

Symbol	Min
--------	-----

[illegible]

1.4 I²C, I3C Basic and Interface DC and AC Electrical Characteristics

Table 10 — I²C, I3C, and Interface DC Electrical Specification

Parameter	Symbol	Min	Max	Unit	Notes
Input Low Voltage (CAMP, SDA, SCL, VR_EN)	V _{IL}	-0.3	0.3	V	
Input High Voltage (SDA, SCL)	V _{IH}	0.7	3.6	V	
Input High Voltage (CAMP, VR_EN)	V _{IH}	1.26	3.6	V	
Output Low Voltage (SDA, GSI_n)	V _{OL}	-	0.3	V	1
Output High Voltage (SDA)	V _{OH}	0.75	-	V	
Output Low Current (SDA, GSI_n, CAMP)	I _{OL}	3		mA	
Output High Current (SDA)	I _{OH}	-	-3	mA	
Output Low Voltage (CAMP)	V _{OL_CAMP}	-	0.3	V	2
Rising Output Slew Rate (SDA)	Slew_Rate	0.1	1	V/ns	3
Falling Output Slew Rate (SDA)		0.1	3	V/ns	
Input Leakage Current	I _{LI}	-	+5	μA	
Output Leakage Current	I _{LO}	-	+5	μA	
NOTE 1 The pullup resistor for GSI_n signal may vary and is typically 1K Ohm.					
NOTE 2 CAMP output is Open Drain output. There is an external pullup resistor to 3.3 V motherboard for standard DDR5 RDIMM/LRDIMM. For other DIMM environment, the external pullup resistor may be pulled to either 1.8 V or 2.5 V or 3.3 V on either on DIMM or on the motherboard.					
NOTE 3 Output slew rate is guaranteed by design and/or characterization. The output slew rate reference load is shown in Figure 4 and Figure 5 shows the timing measurement points. For slew rate measurement, the VOH level shown in Figure 5 is a function of R _{on} value; VOH = {1.0/(R _{on} + 50)} * 50.					

Table 11 — Input Capacitance Spec

Parameter	Symbol	Min	Max	Unit	Notes
Input Capacitance (CAMP, SCL, SDA, VR_EN)	C _{IN}	-	5	pF	

Table 12 — Input Spike Filter Spec

Parameter	Symbol	Test Condition	Min	Max	Unit	Notes
Pulse width of spikes which must be suppressed by the input filter in I ² C mode	t _{SP}	Single glitch, f ≤ 100 KHz	-	-	ns	
		Single glitch, f > 100 KHz	0	50	ns	1
NOTE 1 T _A = 25 °C; f = 400 KHz. Verified by design and characterization only.						

Table 13 — Output Ron

Parameter	Symbol	Min	Max	Unit	Notes
SDA Output Pullup and Pulldown Driver Impedance	R _{ON}	20	100	Ω	1
GSI_n, CAMP Output Pulldown Driver Impedance		40	100	Ω	1
NOTE 1 Pulldown Ron = Vout/Iout. Pullup Ron = (VOUT_1.0V - Vout)/Iout.					

1.4 I²C, I3C Basic and Interface DC and AC Electrical Characteristics (cont'd)

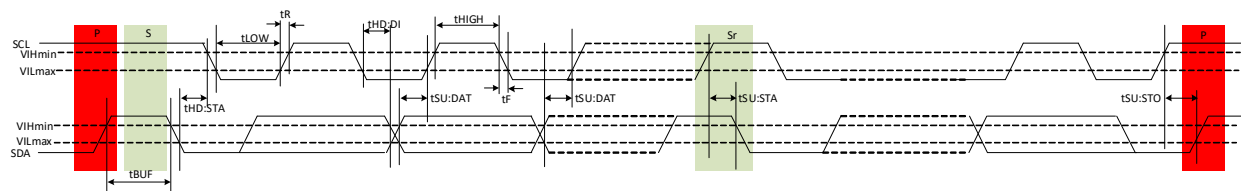
Table 14 — I²C and I3C Interface AC Characteristics

Parameter	Symbol	I ² C Mode - Open Drain		I3C Basic Mode Push-Pull ¹		Unit	Notes
		Min	Max	Min	Max		
Clock Frequency	f _{SCL}	0.01	1	0.01	12.5	MHz	
Clock High Pulse Width Time	t _{High}	260		35		ns	
Clock Low Pulse Width Time	t _{Low}	500		35		ns	
Detect Clock Input Low Time	t _{TIMEOUT}	10	50	10	50	ms	
Rise Time	t _R	-	120	-	5	ns	2,3
Fall time	t _F	-	120	0	5	ns	2,3
Data in Setup Time	t _{SU:DAT}	50	-	8	-	ns	2,4
Data in Hold Time	t _{HD:DI}	0	-	3	-	ns	2,4
Start Condition Setup Time	t _{SU:STA}	260	-	12	-	ns	2
Start Condition Hold Time	t _{HD:STA}	260	-	30	-	ns	2
Stop Condition Setup Time	t _{SU:STO}	260	-	12	-	ns	2
Time between Stop Condition and next Start Condition	t _{BUF}	500	-	500	-	ns	2,5
SDA Data Out Hold Time	t _{HD:DAT}	0.5	350	N/A	N/A	ns	6
SCL Falling Clock In to Valid SDA Data Out Time	t _{DOUT}	N/A	N/A	0.5	12	ns	7,8
SCL Rising Clock In to Target SDA Output Off	t _{DOFFT}	N/A	N/A	0.5	12	ns	7,8,9
SCL Rising Clock In to Controller SDA Output Off	t _{DOFFC}	N/A	N/A	0.5	30	ns	7,8,10
SCL Rising Clock In to Controller Driving Data Signal Low	t _{CL_r_DAT_f}	N/A	N/A	40	-	ns	11
Bus Available Time (no edges seen on SCL and SDA)	t _{AVAIL}	N/A	N/A	1	-	μs	
Time to issue IBI after an event is detected when Bus is available	t _{IBI_ISSUE}	N/A	N/A	-	15	μs	
Time from Clear Register Status to any I3C Basic operation with Start condition to avoid false IBI generation; PEC disabled	t _{CLR_I3C_CMD_Delay}	N/A	N/A	4	-	μs	
Time from Clear Register Status to any I3C Basic operation with Start condition to avoid false IBI generation; PEC enabled		N/A	N/A	15	-	μs	
DEVCTRL CCC Followed by DEVCTRL CCC or Register Read/Write Command Delay	t _{DEVCTRLCCC_DELAY_PEC_DIS}	3	-	3	-	μs	12,13, 14
Register Write Command Followed by Register Read Command Delay in PEC Enabled Mode	t _{WR_RD_DELAY_PEC_EN}	N/A	N/A	8	-	μs	15,16,17
SETHID CCC or SETAASA CCC followed by any other CCC or Read/Write Command Delay	t _{I2C_CCC_Update_Delay}	2.5	-	-	-	μs	
RSTDAA CCC or ENEC CCC or DISEC CCC to any other CCC or Read/Write Command Delay	t _{I3C_CCC_Update_Delay}	-	-	2.5	-	μs	
Any CCC followed by RSTDAA CCC delay	t _{CCC_Delay}	N/A	N/A	2.5	-	μs	

Table 14 — I²C and I3C Interface AC Characteristics (cont'd)

Parameter	Symbol	I ² C Mode - Open Drain		I3C Basic Mode Push-Pull ¹		Unit	Notes
		Min	Max	Min	Max		
NOTE 1	I3C mode with Open Drain operation follows timing values as shown in I ² C Mode - Open Drain column.						
NOTE 2	See Figure 1 for PMIC's input timing definition.						
NOTE 3	See Figure 6 for voltage threshold definition for rise and fall times.						
NOTE 4	The input setup time is referenced from SDA VIL or VIH threshold as shown in Figure 1 to SCL VIH threshold as shown in Figure 1. The input hold time is referenced from SCL VIL threshold as shown in Figure 1 to SDA VIL or VIH threshold as shown in Figure 1.						
NOTE 5	If PEC is enabled, t _{WR_RD_DELAY_PEC_EN} timing parameter applies.						
NOTE 6	The PMIC device guarantees t _{HD:DAT} value in I ² C mode of operation. See Figure 3 for PMIC's output timing definitions as well as SCL clock input threshold level and SDA data output threshold levels.						
NOTE 7	The PMIC device must be configured in I3C Basic mode to guarantee t _{DOUT} or t _{DOFFT} or t _{DOFFC} value. See Figure 2 for PMIC's output timing definition as well as SCL clock input threshold level and SDA data output threshold levels.						
NOTE 8	This timing parameter is guaranteed into output timing reference load as shown in Figure 4.						
NOTE 9	The PMIC device must be configured in I3C Basic mode to guarantee t _{DOFFT} value. See Figure 20.						
NOTE 10	The PMIC device must be configured in I3C Basic mode to guarantee t _{DOFFC} value. See Figure 21.						
NOTE 11	See Figure 23.						
NOTE 12	From STOP condition of DEVCTRL CCC to START condition for Register Read or Register Write Command Data Packet delay.						
NOTE 13	The PMIC sends NACK if Host does not satisfy t _{DEVCTRLCCC_DELAY_PEC_DIS} timing parameter.						
NOTE 14	This timing parameter restriction is only applicable when PEC function is disabled in PMIC. If PEC is enabled, this timing parameter does not apply.						
NOTE 15	From STOP condition for Register Write Command Data Packet to START condition for Register Read Command Data Packet delay.						
NOTE 16	This timing parameter restriction is only applicable when PEC function is enabled in PMIC. If PEC is disabled, this timing parameter does not apply.						
NOTE 17	The PMIC sends NACK if Host does not satisfy t _{WR_RD_DELAY_PEC_EN} timing parameter.						

The PMIC device follows the I²C or I3C Basic bus timing requirements. Figure 1, Figure 2, and Figure 3 show the timing diagram for Data bus Input and Data Output parameters.

**Figure 1 — I²C or I3C Basic Bus AC Input Timing Parameter Definition**

1.4 I²C, I³C Basic and Interface DC and AC Electrical Characteristics (cont'd)

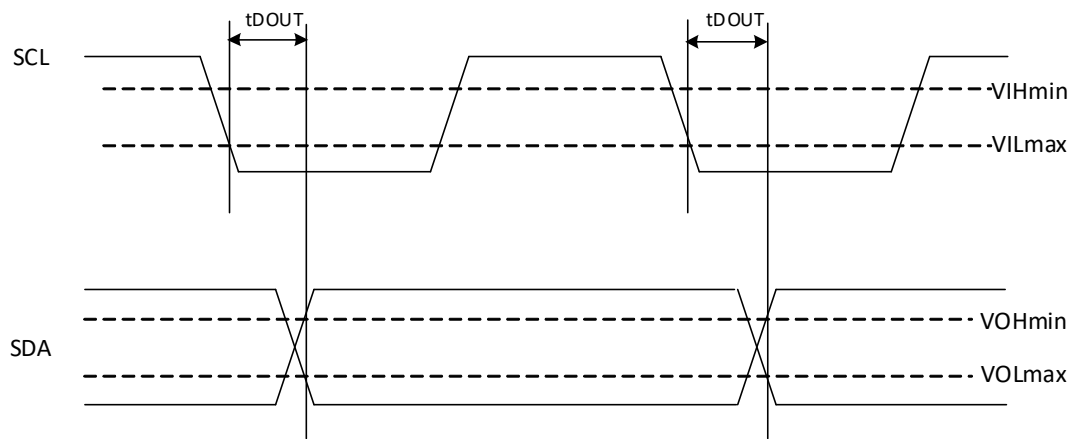


Figure 2 — I³C Basic Bus AC Data Output Timing Parameter Definition

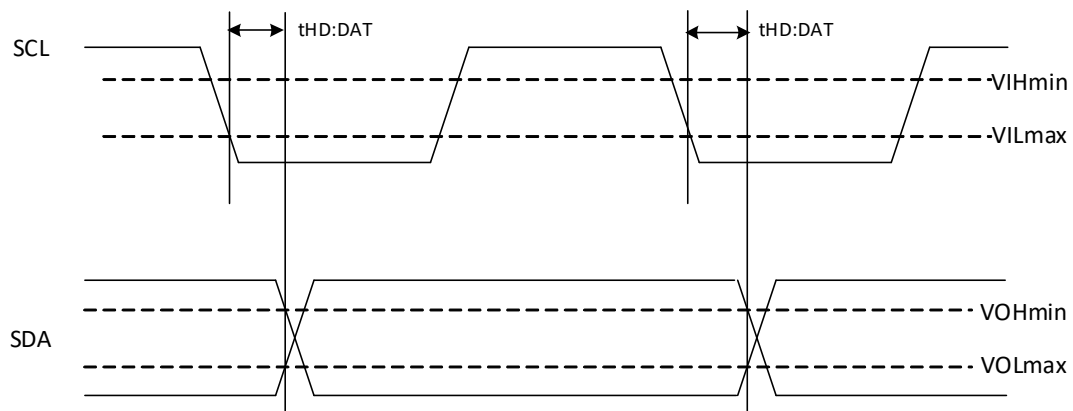


Figure 3 — I²C Bus AC Data Output Timing Parameter Definition

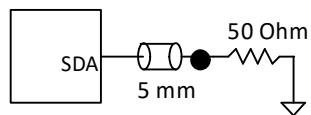


Figure 4 — Output Slew Rate and Output Timing Reference Load

1.4 I²C, I³C Basic and Interface DC and AC Electrical Characteristics (cont'd)

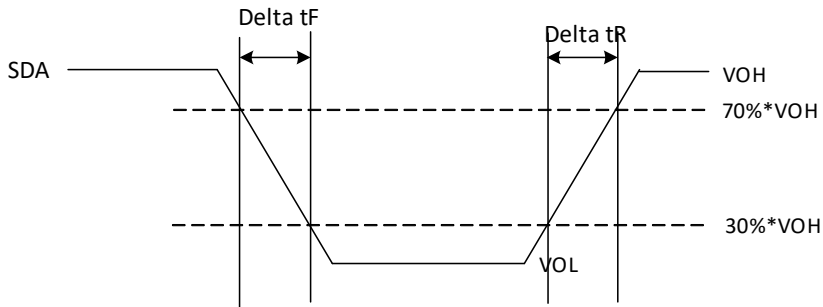


Figure 5 — Output Slew Rate Measurement Points

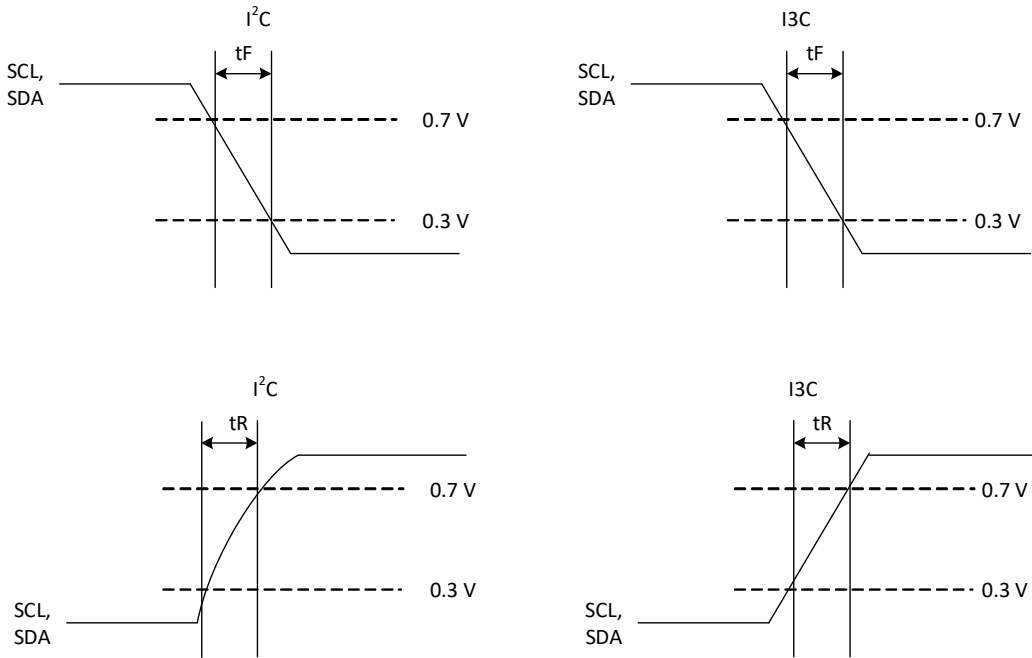


Figure 6 — Rise and Fall Timing Parameter Definition

Table 15 — AC Measurement Conditions¹

Symbol	Parameter	Min	Max	Units
C _L	Load capacitance		40	pF
	Input rise & Fall times - Open Drain	-	TBD	ns
	Input rise and fall times - Push Pull	-	TBD	ns
	Input signal swing levels	0.2 to 0.8		V
	Input and Output timing reference levels	0.3 to 0.7		V
NOTE 1	This AC measurement condition (Table 15 and Figure 7) is only for the test purpose in lab.			

1.4 I²C, I³C Basic and Interface DC and AC Electrical Characteristics (cont'd)

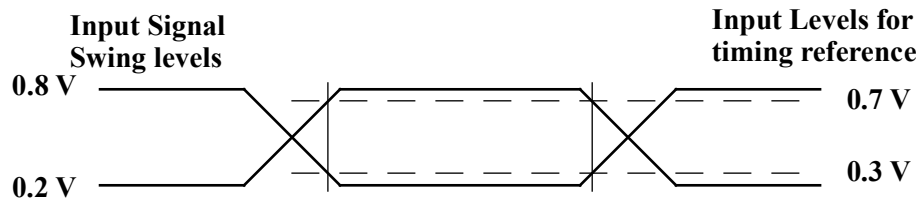


Figure 7 — AC Measurement Waveform

1.5 Thermal Characteristics

Table 16 — Thermal Characteristics

Parameter	Symbol	Maximum Rating	Unit	Notes
Thermal resistance junction to case	Θ_{JC}	TBD	$^{\circ}\text{C}/\text{W}$	1,2,3
Junction operating temperature	T_J	-10 to 125	$^{\circ}\text{C}$	
Case operating temperature	T_C	-10 to TBD	$^{\circ}\text{C}$	4
Storage temperature	T_{STG3}	-55 to 150	$^{\circ}\text{C}$	4
Lead temperature (soldering, 10s)	T_{LEAD}	300	$^{\circ}\text{C}$	4
NOTE 1 The maximum power dissipation is $P_{D(MAX)} = (T_{JMAX} - T_C) / \Theta_{JC}$. Exceeding the maximum allowable power dissipation results in excessive die temperature and the device will enter thermal shutdown.				
NOTE 2 This thermal rating was calculated on JEDEC 51 standard 4 layer board with dimensions 3" x 4.5" in still air conditions. Actual thermal resistance is affected by PCB size, solder joint quality, layer count, copper thickness, air flow, altitude and other unlisted variables.				
NOTE 3 This specification is compliant with JESD402-1 Temperature Grade and Measurement Specification for Components and Modules, operating temperature range MT, storage temperature T_{STG3} . See JESD402-1 for details, including measurement point.				
NOTE 4 Soldering temperature, 10 s.				

1.6 Absolute Maximum Rating

The absolute maximum ratings are stress ratings only. Stresses greater than those listed in Table 17, "Absolute Maximum Rating", Table 18, "ESD Requirement", and Table 19, "EOS Requirement" may cause permanent damage to the device. Functional operation of the PMIC at absolute maximum ratings is not implied. Exposure to absolute maximum rating condition for extended periods may affect long term reliability.

1.6 Absolute Maximum Rating (cont'd)

Table 17 — Absolute Maximum Rating

Pin	Maximum Rating		Unit
	DC	AC	
VIN_BULK	-0.3 to 16.2	TBD (Duration \leq 25 ns)	V
VIN_Mgmt, VBIAS	-0.3 to 6.0	-	V
VOUT_1.8V, VOUT_1.0V	-0.3 to 2.2	-	V
SWA, SWB, SWC, SWD	-0.3 to 16.2	-4.5 to 20 (Duration < 25 ns)	V
SWA_BOOT, SWB_BOOT, SWC_BOOT, SWD_BOOT (to GND)	-0.3 to 21.0	-0.3 to 24 (Duration < 25 ns)	V
SWA_BOOT, SWB_BOOT, SWC_BOOT, SWD_BOOT (to SWx)	-0.3 to 6.0	TBD	V
SWAB_FB_P, SWB_FB_P, SWC_FB_P, SWD_FB_P (to AGND)	-0.3 to 2.2	-	V
SWAB_FB_N, SWC_FB_N, SWD_FB_N/PID	-0.3 to 2.2	-	V
CAMP ¹ , GSI_n, VR_EN	-0.3 to 5.0	-	V
SCL, SDA; I ² C Mode only	-0.3 to 5.0	TBD	V
SCL, SDA; I ³ C Mode only	-0.3 to 2.1	TBD	V
AGND, PGND	-0.3 to 0.3	-	V
NOTE 1 CAMP pins shall withstand the stress when connected to maximum of 15 V DC source through 250 Ohm series resistor for 10 seconds.			

Table 18 — ESD Requirement

Test Model	Pin	Maximum Rating	Unit
HBM	All	± 2000	V
CDM	All	± 500	V

Table 19 — EOS Requirement

Pin	Maximum Rating	Unit	Notes
VIN_BULK	37	V	1,2,3,4
VIN_Mgmt	10	V	
NOTE 1	The test is performed on DDR5 DIMM module without any input capacitor on VIN_BULK and VIN_Mgmt		
NOTE 2	The input source needs to follow the waveform and condition as shown in Figure 8 and Table 20.		
NOTE 3	Probing is performed at the VIN_BULK and VIN_Mgmt pin of PMIC.		
NOTE 4	Each net test is performed individually.		

Table 20 — Input Source Condition

Item	Value	Notes
T (rise from 30% to 90% of peak)	0.72 μ s (+ 30%)	T1 = 1.67*T
T1 (rise time)	1.2 μ s (+ 30%)	
T2 (duration time to half value)	50 μ s (+ 20%)	
Output Impedance	2 Ω	
V_UNDERSHOOT Voltage	30% Max	

1.6 Absolute Maximum Rating (cont'd)

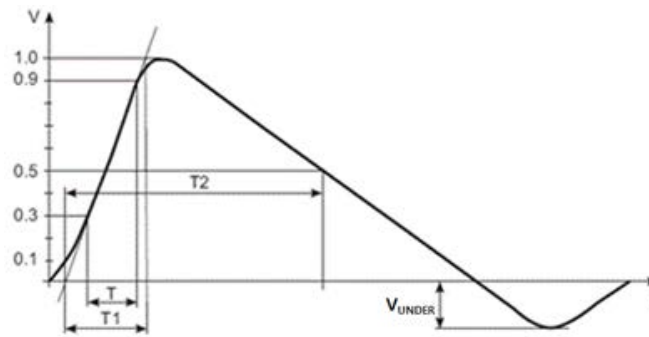


Figure 8 — Impulse Waveform for EOS Test (IEC 61000-4-5)

1.7 Example Schematic

Figure 9 shows an example schematic when PMIC is configured in dual phase regulator mode. Table 21, “PMIC Schematic Values” shows all component details shown in the schematics. Note that capacitors C25, C26, C27, C29, C30, and C31 represent the lump sum of distributed capacitance across the entire DIMM.

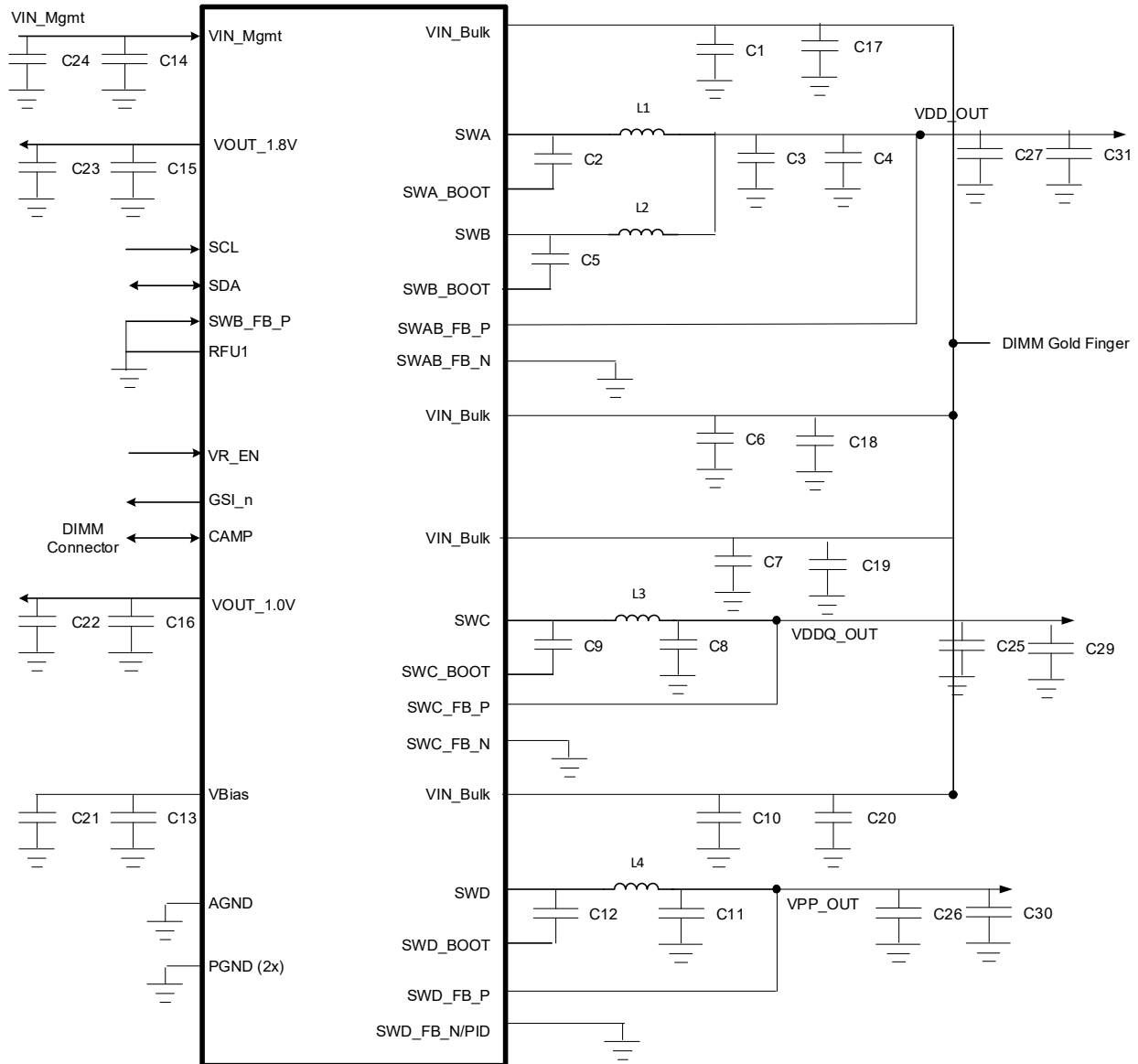


Figure 9 — Dual Phase Regulator Example Schematic

1.7 Example Schematic (cont'd)

Figure 10 shows an example schematic when PMIC is configured in single phase regulator mode. Table 21, “PMIC Schematic Values” shows all component details shown in the schematics. Note that capacitors C25, C26, C27, C28, C29, C30, C31 and C32 represents the lump sum of distributed capacitance across the entire DIMM.

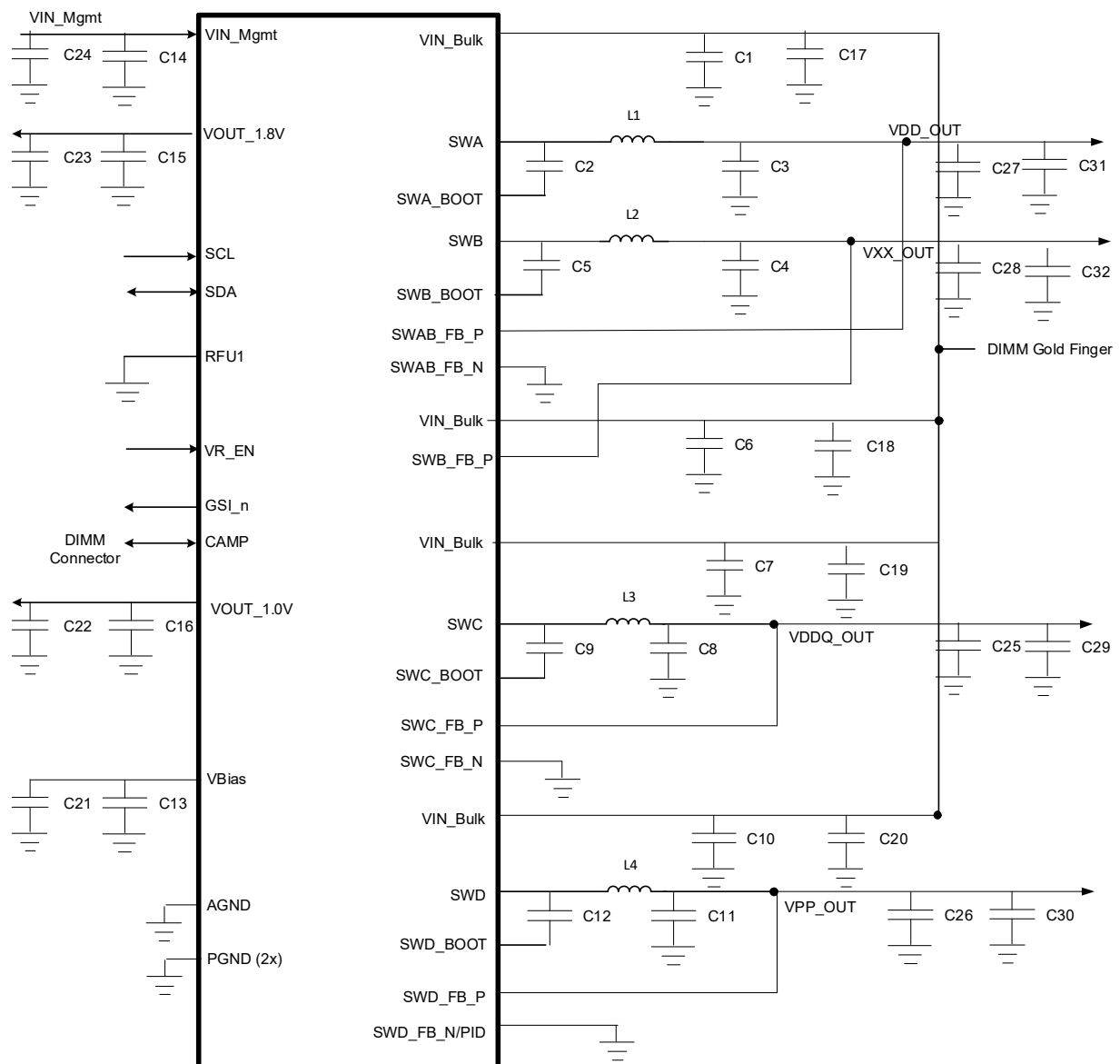


Figure 10 — Single Phase Regulator Example Schematic

1.7 Example Schematic (cont'd)

Table 21 — PMIC Schematic Values

Component	Dual Phase Regulator Mode		Single Phase Regulator Mode		Unit	Comment
	Value	Physical Size/Rating	Value	Physical Size/Rating		
L1	0.47	4.0 x 4.0 x 2.0	0.47	4.0 x 4.0 x 2.0	μH	
L2	0.47	4.0 x 4.0 x 2.0	0.47	4.0 x 4.0 x 2.0	μH	
L3	0.47	4.0 x 4.0 x 2.0	0.47	4.0 x 4.0 x 2.0	μH	
L4	1.0	4.0 x 4.0 x 2.0	1.0	4.0 x 4.0 x 2.0	μH	
C1	2x; 22	25V	2x; 22	25V	μF	
C2	0.1	16V; 0201	0.1	16V; 0201	μF	
C3	4x; 47	6.3V; 0805	4x; 47	6.3V; 0805	μF	
C4	4x; 47	6.3V; 0805	4x; 47	6.3V; 0805	μF	
C5	0.1	16V; 0201	0.1	16V; 0201	μF	
C6	2x; 22	25V	2x; 22	25V	μF	
C7	2x; 22	25V	2x; 22	25V	μF	
C8	4x; 47	6.3V; 0805	4x; 47	6.3V; 0805	μF	
C9	0.1	16V; 0201	0.1	16V; 0201	μF	
C10	2x; 22	25V	2x; 22	25V	μF	
C11	3x; 47	6.3V; 0805	3x; 47	6.3V; 0805	μF	
C12	0.1	16V; 0201	0.1	16V; 0201	μF	
C13	4.7	6.3V; 0402	4.7	6.3V; 0402	μF	
C14	4.7	6.3V; 0402	4.7	6.3V; 0402	μF	
C15	4.7	6.3V; 0402	4.7	6.3V; 0402	μF	
C16	4.7	6.3V; 0402	4.7	6.3V; 0402	μF	
C17	0.1	25V, X6S; 0201	0.1	25V, X6S; 0201	μF	
C18	0.1	25V, X6S; 0201	0.1	25V, X6S; 0201	μF	
C19	0.1	25V, X6S; 0201	0.1	25V, X6S; 0201	μF	
C20	0.1	25V, X6S; 0201	0.1	25V, X6S; 0201	μF	
C21	0.1	6.3V; 0201	0.1	6.3V; 0201	μF	
C22	0.1	6.3V; 0201	0.1	6.3V; 0201	μF	
C23	0.1	6.3V; 0201	0.1	6.3V; 0201	μF	
C24	0.1	6.3V; 0201	0.1	6.3V; 0201	μF	
C25	175	6.3V	175	6.3V	μF	1
C26	175	6.3V	175	6.3V	μF	
C27	350	6.3V	175	6.3V	μF	
C28	N/A	N/A	175	6.3V	μF	
C29	175	6.3V	175	6.3V	μF	1
C30	175	6.3V	175	6.3V	μF	
C31	350	6.3V	175	6.3V	μF	
C32	N/A		175	6.3V	μF	

NOTE 1 These capacitor values represent the distributed capacitance for the entire DIMM assuming max I_{tdc} and $I_{peakmax}$ defined in Electrical characteristics for each SWx. For a given DIMM design, the distributed capacitance for each SWx varies and is a function of I_{tdc} and $I_{peakmax}$ current requirement for that DIMM design. See actual DIMM design for total distributed capacitance.

1.8 Functional Operation

1.8.1 PMIC Input Voltage Supplies and Ramp Condition

The DDR5 PMIC has two input supplies from the platform: VIN_Bulk and VIN_Mgmt.

The VIN_Bulk supply is used by the PMIC for all output regulators except for the VOUT_1.8V & VOUT_1.0V LDO outputs regulators when not in switchover mode. The VIN_Bulk input supply may also be used to generate the internal bias voltage. Note that the VOUT_1.8V LDO output is separate and independent from SWD output, which is for the DRAM VPP rail. The VOUT_1.0V LDO output is separate and independent from SWA, SWB or SWC.

The PMIC internally generates on its own bias voltage (VBias). At first power on, the VIN_Bulk input supply shall reach a minimum threshold voltage value per register Table 112, “Register 0x1A” [7:5] plus 1.0V offset before it can be detected as a valid input supply to the PMIC. The PMIC filters any non-monotonic noise after this threshold. After power on, with valid VIN_Mgmt input supply while PMIC is operating in non write protect mode of operation, if VIN_Bulk input supply is removed and re-applied, it must reach the same threshold voltage value per Table 112, “Register 0x1A” [7:5] plus 1.0V offset.

The VIN_Mgmt supply is used to read out its internal non-volatile memory content and to supply VOUT_1.8V and VOUT_1.0V to other devices such as SPD, TS and RCD on the DIMM. At first power on, the VIN_Mgmt supply shall reach a minimum of 2.8 V before it can be detected as a valid input supply to the PMIC. At power on, the PMIC floats CAMP signal and then drives CAMP output signal low only when VIN_Mgmt input supply reaches minimum of 2.8V & PMIC VOUT_1.8V and VOUT_1.0V LDO outputs are valid. VIN_Bulk input supply does not trigger PMIC to drive CAMP output signal low at power on. The VIN_Mgmt supply is strictly a voltage input.

The CAMP output is pulled up to either 1.8 V or 3.3 V on the platform or on the host controller. The CAMP pullup voltage (either 1.8 V or 3.3 V) can be available before or after either VIN_Bulk or VIN_Mgmt is valid and stable. If CAMP pullup voltage is available before VIN_Mgmt or VIN_Bulk is applied, the CAMP signal is high and remains High with no leakage path or damage to the PMIC. When VIN_Mgmt is applied to the PMIC and after VOUT_1.8V and VOUT_1.0V LDO outputs are valid, the PMIC asserts CAMP output low.

Figure 11 and Figure 12 show PMIC power up sequence when power is first applied. The platform can power up VIN_Bulk and VIN_Mgmt supply in any sequence. Figure 11 shows VIN_Mgmt supply ramps up first prior to VIN_Bulk supply. Figure 12 shows VIN_Bulk supply ramps up first prior to VIN_Mgmt supply. The PMIC does not mandate any specific timing relationship between VIN_Bulk and VIN_Mgmt supply.

The PMIC updates register Table 94, “Register 0x08” [7] when VIN_Bulk input supply status is valid.

1.8.2 Power Up Initialization Sequence

During power on, the host shall:

1. Ramp up VIN_Mgmt supply; Ramp up VIN_Bulk supply; (No timing relationship between two supplies)
2. Hold VIN_Mgmt supply stable for a minimum of tVIN_Mgmt_to_Enable time
3. Hold VIN_Bulk supply stable for a minimum of tVIN_Bulk_to_Enable time
4. Query the status of the PMIC status register to determine if it is safe to enable VR.
5. If it is safe to enable, send VR Enable command by setting register Table 136, “Register 0x32” [7] = ‘1’ or by issuing DEVCTRL CCC.

1.8.2 Power Up Initialization Sequence (cont'd)

Once the VIN_Mgmt supply is valid and stable, the PMIC shall drive VOUT_1.8V and VOUT_1.0V supply within t1.8V_Ready and t1.0V_Ready time. The PMIC shall enable I²C/I3C Basic bus interface function within tManagement_Ready. The host shall not attempt to access the PMIC's memory registers until tManagement_Ready timing requirement is satisfied. Further the host shall not attempt to issue VR Enable command until tVIN_Mgmt_to_Enable and tVIN_Bulk_to_Enable timing requirement is satisfied. In Figure 11, the PMIC allows access to its memory registers for indefinite period of time as long as VIN_Mgmt input supply is valid and PMIC does not require VIN_Bulk input supply.

The host may read PMIC's own internal memory content prior to ramping VIN_Bulk supply.

The host, prior to issuing VR Enable command, must keep VIN_Mgmt input supply valid as long as VOUT_1.8V and VOUT_1.0V LDO output are required. If VIN_Mgmt input supply is removed or drops below 2.8 V, the PMIC does not guarantee any operation including VOUT_1.8V & VOUT_1.0V LDO output as well as access to its I²C/I3C Basic interface regardless of VIN_Bulk input supply status.

After host issues VR Enable command to the PMIC, the PMIC offers the input supply switchover function. The PMIC has an automatic internal input supply switchover function from VIN_Mgmt input supply to VIN_Bulk input supply. The PMIC triggers the switchover to VIN_Bulk input supply when VIN_Mgmt input supply drops below the threshold set in register Table 133, "Register 0x2F" [7]. The internal input supply switchover is for PMIC's VOUT_1.8V & VOUT_1.0V LDO output. The PMIC's I²C/I3C Basic interfaces (SCL/SDA) are kept alive when PMIC switches over to VIN_Bulk input supply. Figure 13 shows automatic internal switchover function when VIN_Mgmt input supply drops below the threshold while maintaining its LDO outputs as well as I²C/I3C Basic interfaces. Under the switchover conditions VIN_Mgmt back-feed voltage shall be less than 0.2 V. While PMIC is in switchover mode to VIN_Bulk, the VIN_Mgmt input supply can re-power backup at any time and PMIC switches back to VIN_Mgmt input supply for its LDO outputs and I²C/I3C interface continues to operate as normal.

The PMIC shall power up its output switch regulators when it registers VR Enable command.

After VR Enable command is registered, the PMIC shall complete the following steps within tPMIC_PWR_GOOD_OUT:

1. Check VIN_Bulk, VIN_Mgmt and VBIAS Power Good status is valid.
2. Power up itself - PMIC executes Power On Sequence Config 0 to Power On Sequence Config 3 registers and configures PMIC internal registers as programmed in DIMM vendor memory space registers.
3. Power up all enabled output switch regulators and ready for normal operation
4. Update status registers Table 94, "Register 0x08" [5:2] and floats CAMP signal.

If PMIC CAMP signal is not pulled High within tPMIC_PWR_GOOD_OUT time, the host can access the PMIC status registers for detailed information after tPMIC_PWR_GOOD_OUT time. The PMIC may NACK for any host request on I²C or I3C bus after VR Enable command until tPMIC_PWR_GOOD_OUT time expires.

Note that in Figure 11 and Figure 12, the specific sequence of ramping the output regulators (VOUT_A, VOUT_B, VOUT_C and VOUT_D) is for example purpose only. The specific ramp up sequence is configurable through the registers.

Once PMIC's output regulators are running, the PMIC allows VIN_Bulk input supply to vary. Figure 14 shows that VIN_Bulk can go as low as VIN_Bulk Min value (4.25 V) and PMIC output regulators will continue to operate as normal. The VIN_Mgmt input supply can drop and may re-power back up at any time.

1.8.3 Power Up Sequence

Figure 11 shows the power up initialization sequence.

After VIN_Bulk supply is valid and stable, the PMIC powers up its output regulators when the system host sends VR Enable command. The PMIC generates its bias voltage (VBias) on its own using VIN_Bulk input supply. Further it executes Power On Sequence Config0 to Config3 as configured in register Table 148, “Register 0x40¹” to Table 151, “Register 0x43^{1,2}” to enable its output regulators in the sequence as specified. The PMIC also follows the settings as specified in register 0x44 to register 0x6F for each of the enabled output. The PMIC ensures CAMP signal is floated within maximum of tPMIC_PWR_GOOD_OUT after registering VR Enable command.

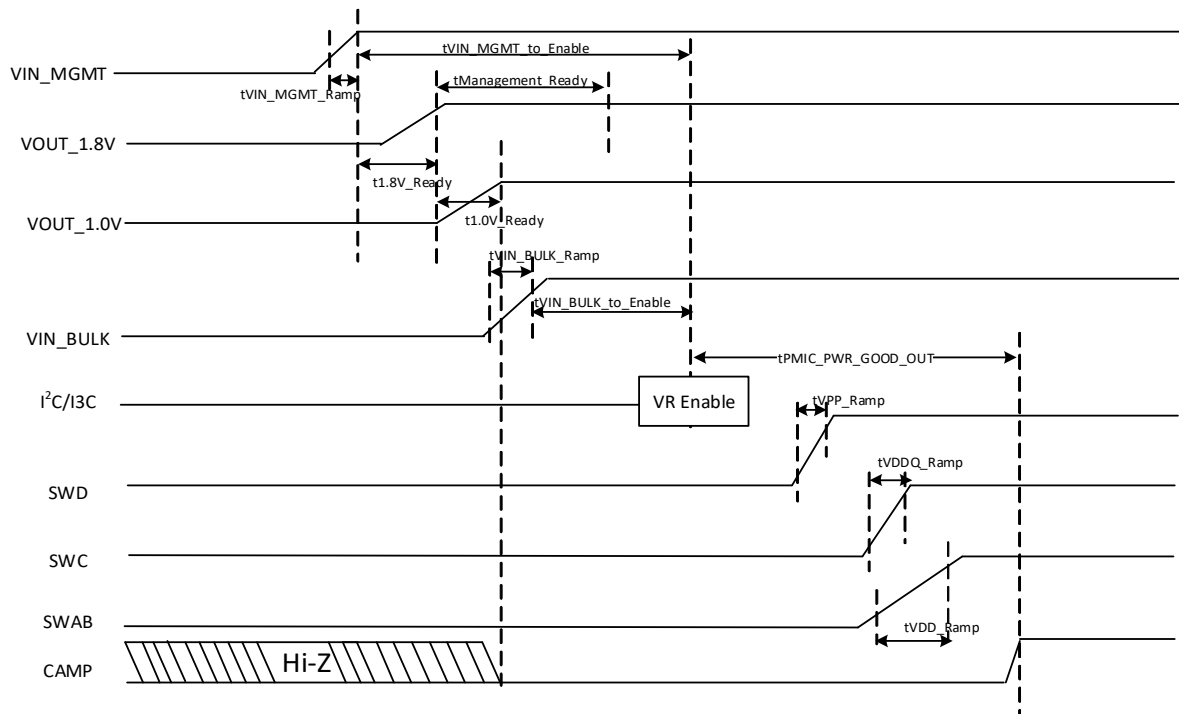


Figure 11 — PMIC Power Up Sequence; VIN_Mgmt followed by VIN_Bulk

1.8.3 Power Up Sequence (cont'd)

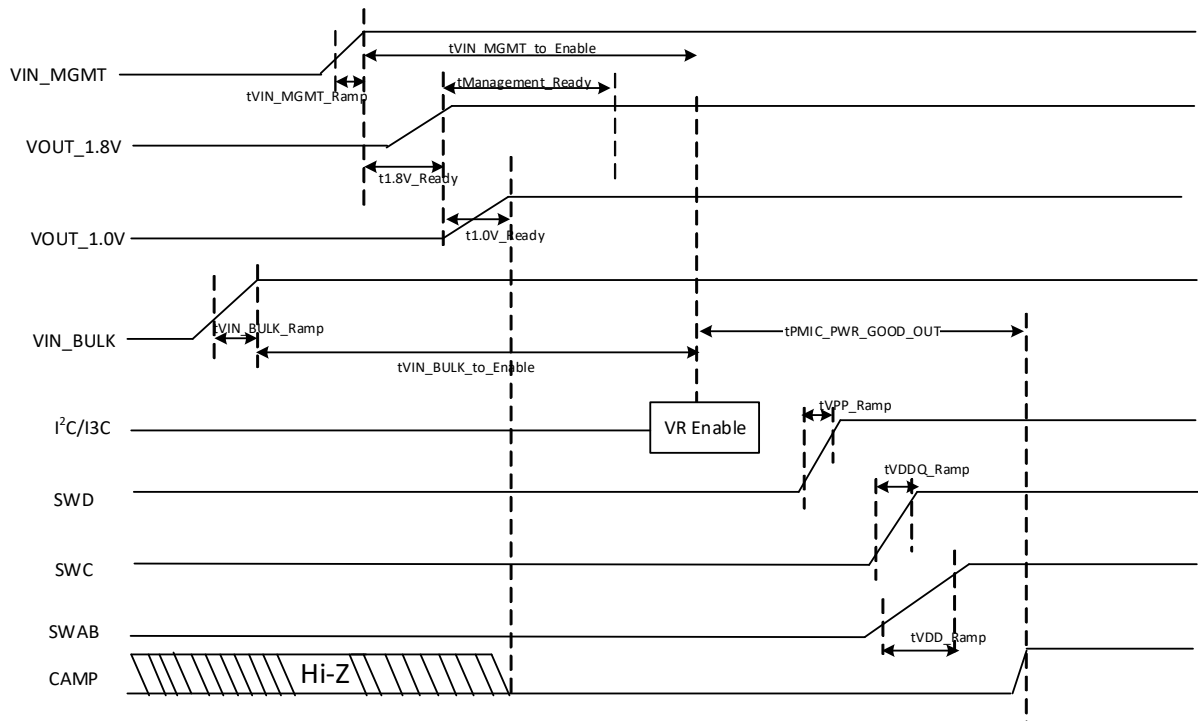


Figure 12 — PMIC Power Up Sequence; VIN_Bulk followed by VIN_Mgmt

1.8.3 Power Up Sequence (cont'd)

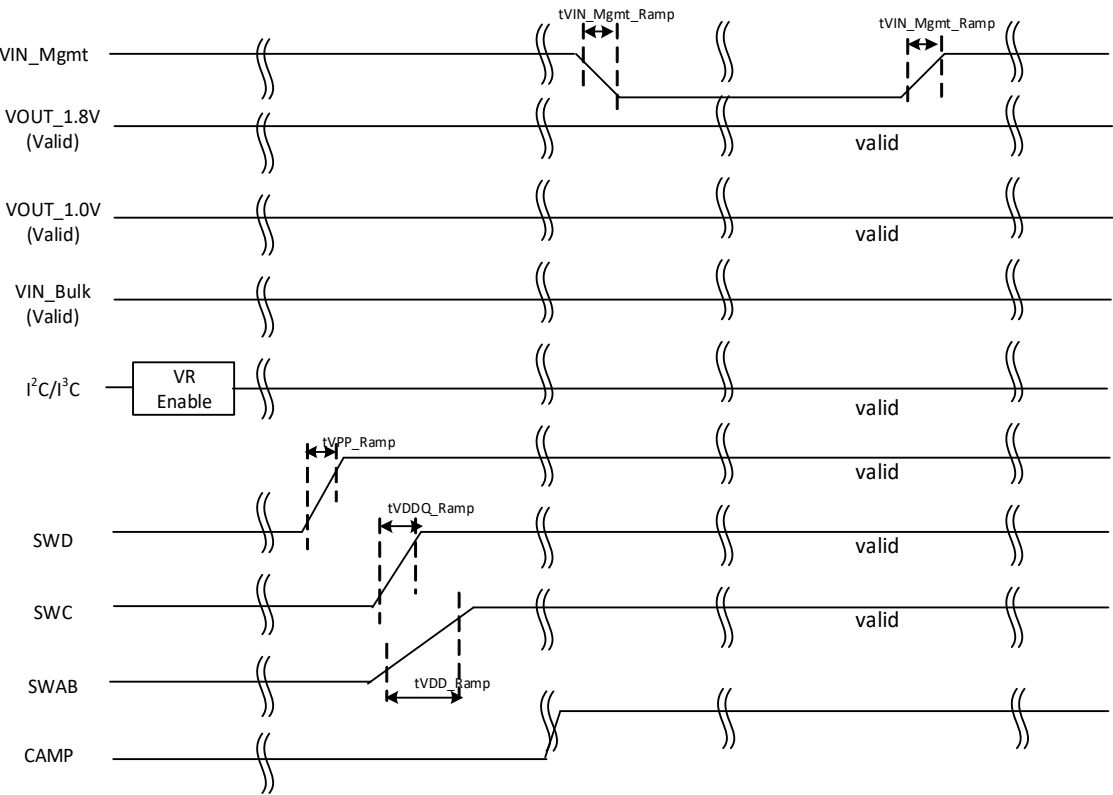


Figure 13 — VIN_Mgmt Input Supply to VIN_Bulk Input Supply Switchover Function

1.8.3 Power Up Sequence (cont'd)

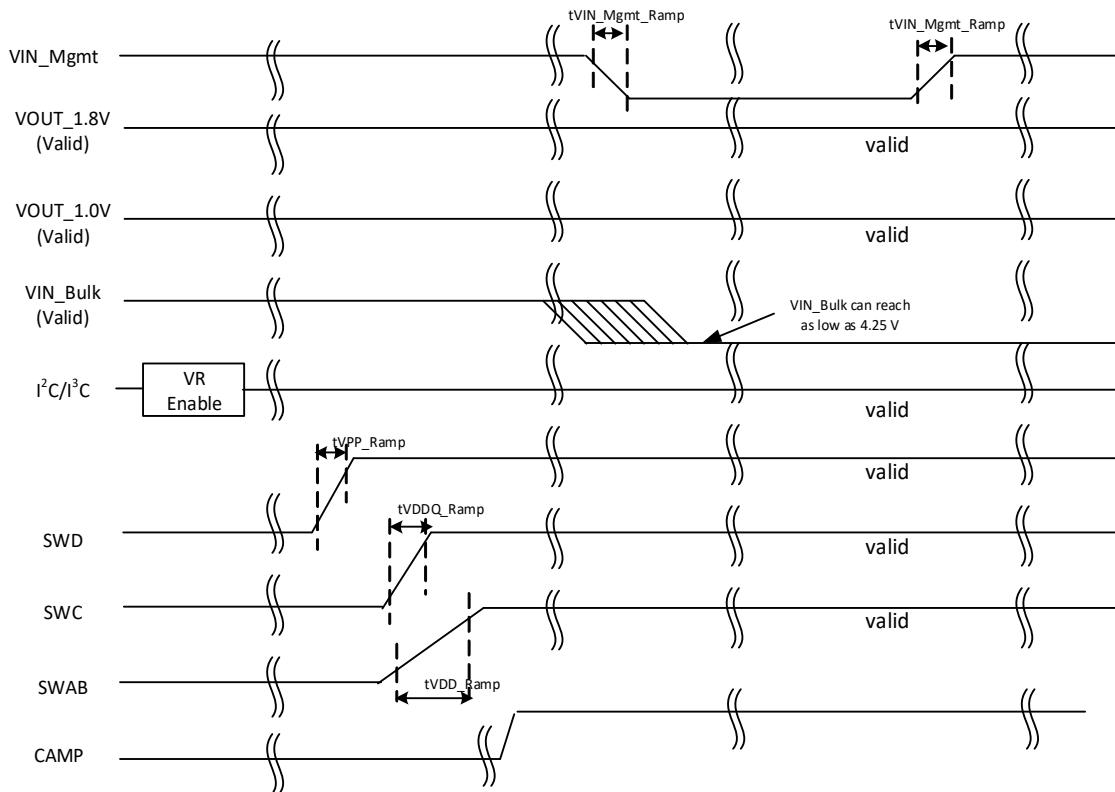


Figure 14 — VIN_Bulk Transition

The timing waveform example in Figure 14 assumes VIN_Bulk threshold is set to 4.25V in Table 112, “Register 0x1A” [7:5] and hence CAMP signal remains at valid High level.

1.8.4 Enabling PMIC Output Switch Voltage Regulators

After first power on, the PMIC automatically enables VOUT_1.8V and VOUT_1.0V LDO output regulators and primary I²C/I³C Basic port based on valid VIN_Mgmt input.

Figure 15 shows the timing relationship once the PMIC receives VR Enable command and when it floats CAMP output signal; timing parameter tPMIC_PWR_GOOD_OUT applies. This timing parameter is a sum of maximum soft start time and configured delay for each power on sequence config registers that are executed plus additional 5 ms timing margin error. The waveform shows each buck regulator output soft start time and delay time once the soft start time expires for each power on sequence config0 to power on sequence config3 registers. Note that if more than one regulators are enabled in a power on sequence config register and if those regulators have different soft start time programmed, then the larger value of that soft start time is used as a reference for delay timer to start. Each regulator will still follow different soft start time to turn on the buck regulator.

The specific example in Figure 15 uses only three power on sequence config0 to config2 registers and only one buck regulator is enabled in power on sequence config 0 register and power on sequence config 1 register. The power on sequence config 2 register enables dual phase regulator for SWA and SWB.

1.8.4 Enabling PMIC Output Switch Voltage Regulators (cont'd)

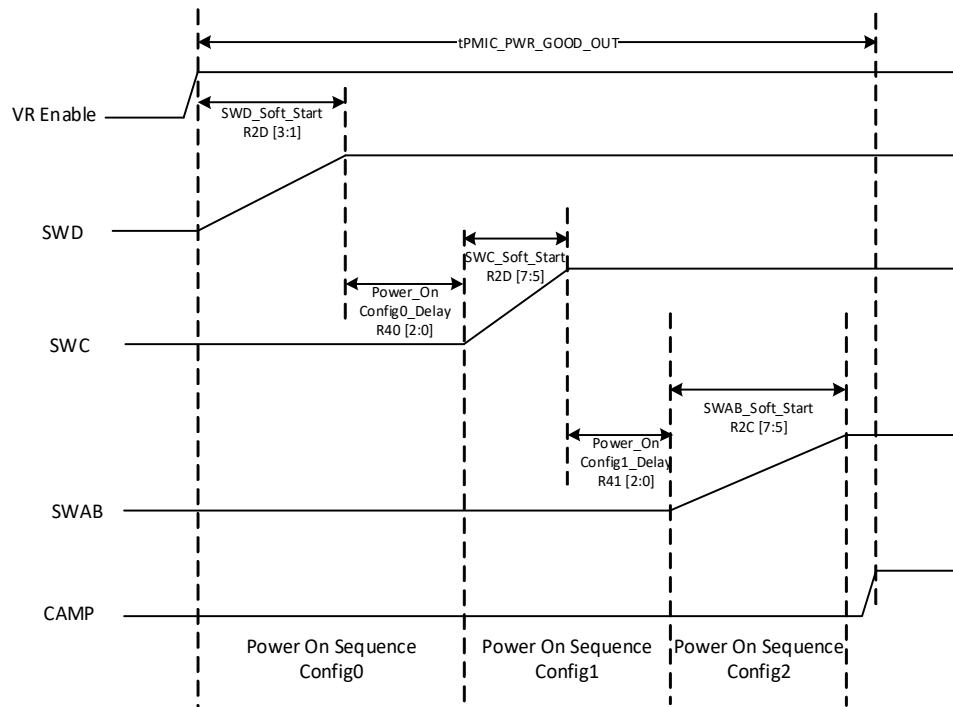


Figure 15 — PMIC Power On Timing

1.8.5 Auto Power On

The PMIC offers auto power on feature by setting Table 171, “Register 0x5F” [6] = ‘1’. When this feature is enabled, the PMIC automatically executes the VR Enable command (i.e., Table 136, “Register 0x32” [7] = ‘1’) after both VIN_Bulk and VIN_Mgmt input supplies reach at stable valid levels. The PMIC executes power on sequence configuration registers (Table 148, “Register 0x40”¹ to Table 151, “Register 0x43”^{1,2}) and floats CAMP signal. Figure 16 shows an example of Auto Power on. Once the auto power on is complete, it shows an example of VIN_Bulk fault event followed by re-enabling the output regulators with a VR Enable command on I²C bus once the VIN_Bulk is valid. VR Enable pin is a don’t care.

When the Table 171, “Register 0x5F” [6] = ‘1’ is burned in the DIMM vendor region, the PMIC requires valid stable VIN_Bulk and VIN_Mgmt input supplies. However, first time when this register is burned, the PMIC does not execute the VR Enable command (i.e., Table 136, “Register 0x32” [7] = ‘1’) even though valid VIN_Bulk and VIN_Mgmt input supply is present. The PMIC requires complete power cycle in order to take the effect of burning the Table 171, “Register 0x5F” [6] = ‘1’.

The PMIC considers the setting of Table 171, “Register 0x5F” [6:5] = ‘11’ as illegal.

1.8.5 Auto Power On (cont'd)

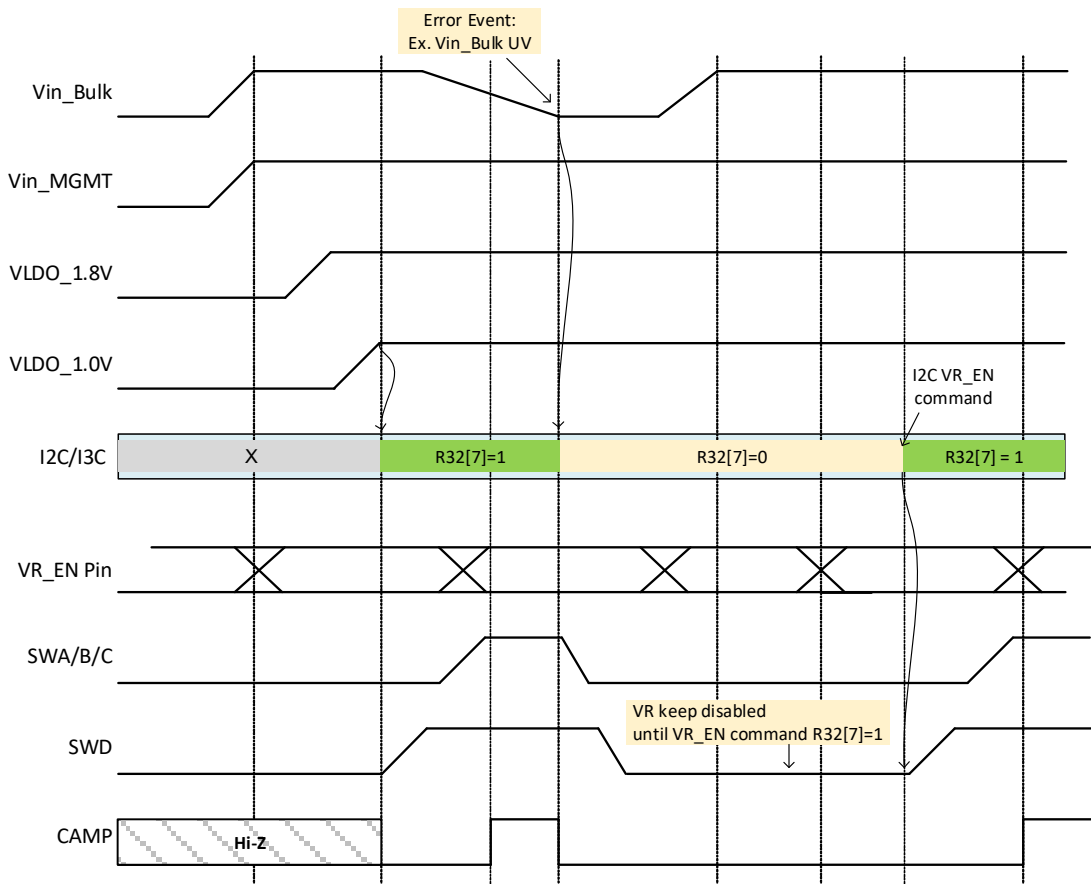


Figure 16 — PMIC Auto Power On Timing

1.8.6 Power On with VR_EN Pin

The PMIC offers a feature to turn on the output regulators with a dedicated pin by setting Table 171, “Register 0x5F” [5] = ‘1’. When this feature is enabled and when valid stable VIN_Bulk and VIN_Mgmt input supplies are present, the PMIC executes VR Enable command (i.e., sets Table 136, “Register 0x32” [7] = ‘1’) when VR_EN input pin is asserted to High. The PMIC executes power on sequence configuration registers (Table 148, “Register 0x40”¹ to Table 151, “Register 0x43”^{1,2}) and floats CAMP signal and enters in write protect mode if Table 133, “Register 0x2F” [2] = ‘0’.

The PMIC executes VR Disable command (i.e., clears Table 136, “Register 0x32” [7] = ‘0’), when VR_EN input pin is de-asserted to Low. The PMIC executes power off sequence configuration registers (Table 165, “Register 0x58”¹ to Table 168, “Register 0x5B”^{1,2}), asserts CAMP signal low and PMIC returns to non-write protect mode.

The PMIC does allow to use the combination of VR_EN pin to execute VR Enable command to turn on the regulators and I2C/I3C bus command (if PMIC is in non-write protect mode prior to VR_EN pin assertion) to execute VR Disable command to turn off the regulators.

1.8.6 Power On with VR_EN Pin (cont'd)

Figure 17 shows an example of Power On and Off with VR_En pin along with a command on I²C or I3C bus.

The VR_EN pin must be held at Low while VIN_Bulk and VIN_Mgmt input supplies are ramping up as shown.

When Table 171, “Register 0x5F” [5] = ‘1’ is burned in the DIMM vendor region, the PMIC requires valid stable VIN_Bulk and VIN_Mgmt input supplies. However, first time when this register is burned, the VR_EN pin shall be held low. The PMIC requires complete power cycle in order to take the effect of burning the Table 171, “Register 0x5F” [5] = ‘1’.

The PMIC considers the setting of Table 171, “Register 0x5F” [6:5] = ‘11’ as illegal.

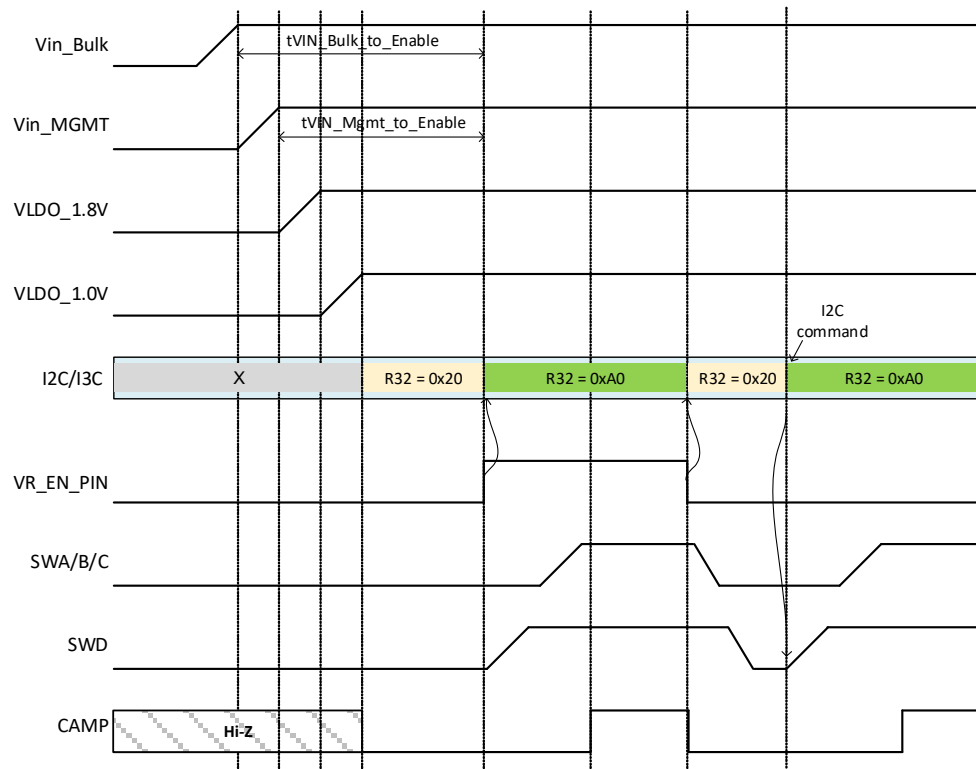


Figure 17 — VR Enable Pin Power On and Off Timing

1.8.7 Power Down Output Regulators

Regardless of how PMIC's output regulators are turned on, the PMIC's output regulators are powered down as described below depending on mode of operation.

In non write protect mode of operation, the PMIC allows host to power down any or all output regulators in non write protect mode. The host can disable PMIC's any or all output regulators by any of the three methods below.

1. The VR Disable command (Table 136, "Register 0x32" [7] = '0'). The PMIC executes power off sequence config0 (Table 165, "Register 0x58¹") to power off sequence config3 (Table 168, "Register 0x5B^{1,2}") to preserve the appropriate voltage relationship as configured by the DIMM vendors. The PMIC keeps the CAMP signal floating (i.e., it remains High) because this is an intentional command from the host and not a fault condition. Note that host can re-enable the PMIC's output regulator by issuing VR Enable command. The PMIC executes power on sequence config 0 to config 3 registers and keeps the CAMP signal floating (i.e., it remains High).
2. Configuring one or more bits in Table 133, "Register 0x2F" [6:3] to '0' in any specific sequence that is desired by the host. The PMIC does not execute power off sequence config0 (Table 165, "Register 0x58¹") to power off sequence config3 (Table 168, "Register 0x5B^{1,2}") on its own. The PMIC keeps the CAMP signal floating (i.e., it remains High) because this is intentional command from the host and not a fault condition. Note that host can re-enable any of disabled output regulators by configuring one or more bits in Table 133, "Register 0x2F" [6:3] to '1' in any specific sequence that is desired by the host. The PMIC keeps the CAMP signal floating (i.e., it remains High).
3. By driving CAMP input low. The PMIC executes power off sequence config0 (Table 165, "Register 0x58¹") to power off sequence config3 (Table 168, "Register 0x5B^{1,2}") to preserve the appropriate voltage relationship as configured by the DIMM vendors.

In write protect mode of operation, the host can disable PMIC's all enabled output regulators by any of the two methods below.

1. Power cycle the PMIC.
2. By driving CAMP input low. The PMIC executes power off sequence config0 (Table 165, "Register 0x58¹") to power off sequence config3 (Table 168, "Register 0x5B^{1,2}") to preserve the appropriate voltage relationship as configured by the DIMM vendors.

Regardless of the either mode of the operation, the PMIC, on its own, can generate VR Disable command at any time due to one or more events listed in Table 23 under column "Trigger VR Disable". The PMIC executes power off sequence config0 (Table 165, "Register 0x58¹") to power off sequence config3 (Table 168, "Register 0x5B^{1,2}") to preserve the appropriate voltage relationship as configured by the DIMM vendors. The PMIC may also reset its Vbias LDO regulator.

Figure 18 shows the timing relationship once the PMIC registers VR Disable command internally due to fault. The waveform shows each buck regulator output soft stop time and delay time once the soft stop time expires from each power off sequence config0 to power off sequence config3 registers. Note that if more than one regulators are disabled in a power off sequence config register and if those regulators have different soft stop time programmed, then the larger value of that soft stop time is used as a reference for delay timer to start. Each regulator will still follow different soft stop time to turn off the buck regulator.

The specific example in Figure 18 uses only three power off sequence config0 to config2 registers and only one buck regulator is disabled in power off sequence config 1 register and power off sequence config 2 register. The power off sequence config 0 register disables dual phase regulator for SWA and SWB.

1.8.7 Power Down Output Regulators (cont'd)

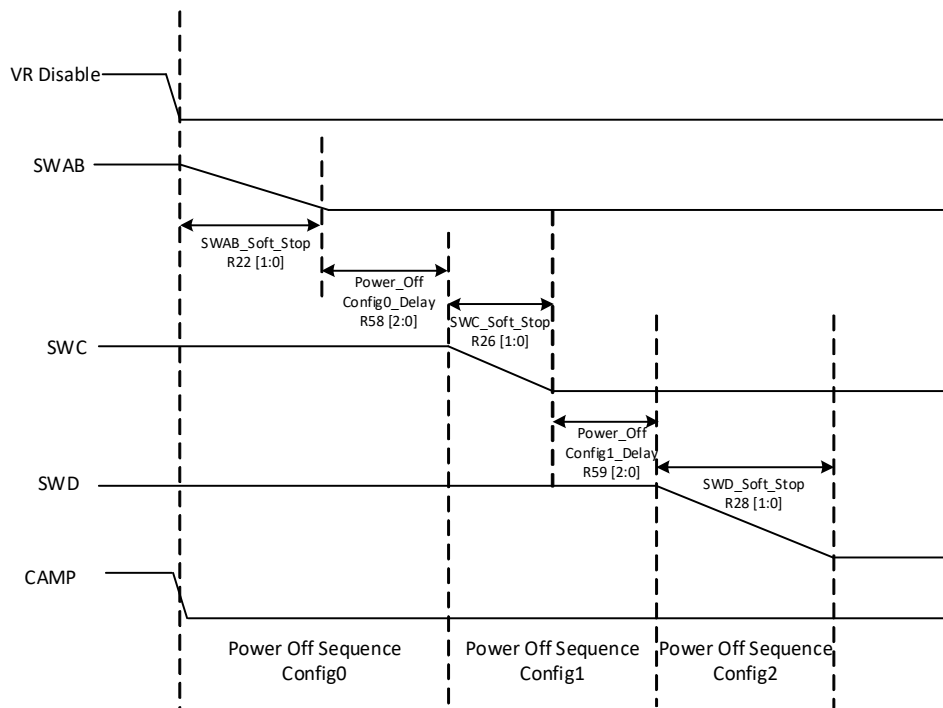


Figure 18 — PMIC Power Off Timing Due to Internal Fault Condition

1.8.8 Power Down Output Regulators During Power On Sequence

During power on as described in Section 1.8.2 it is possible that PMIC can trigger VR Disable command on its own as described in Table 23, “Events Interrupt Summary” when one or more regulators are already turned on even while other remaining output regulators are not yet turned on because PMIC has not completed the power on sequence config registers. For these type of cases, the PMIC will not execute the remaining power on sequence config registers and will immediately jump to executing the power off sequence config0 to power off sequence config3 registers. The PMIC will update the status registers and error log registers appropriately as normal because it generated VR Disable command on its own. The CAMP output signal would remain low.

1.8.9 CAMP Signal

The CAMP (Control AND Monitor Port) signal provides three different functions.

1. Register write protect function
2. Fail_n function
3. Status function

1.8.9.1 Register Write Protect Function

By default, PMIC register write protect function is enabled (i.e., Table 133, “Register 0x2F” [2] = ‘0’). The CAMP input signal level determines when PMIC enters or exits the write protect mode. The PMIC enters the write protect mode when CAMP signal is at logic level High and Table 133, “Register 0x2F” [2] = ‘0’. PMIC exits the write protect mode when CAMP signal is at logic level Low. When PMIC is in write protect mode, the PMIC does not allow to modify registers Table 107, “Register 0x15” to Table 133, “Register 0x2F”, Table 136, “Register 0x32”, Table 139, “Register 0x35” in the host region as well as Table 148, “Register 0x40” to Register 0x6F in the DIMM vendor region. These registers are write protected marked with RED color cells in “Register” column in Table 89, “Host Region - Register Map”. The PMIC simply ignores the host request for write operation in write protect mode. PMIC allows all register read access in write protect mode.

Once PMIC is in write protect mode, there are 3 ways PMIC can exit write protect mode:

1. PMIC sees CAMP input signal Low (Section 1.8.9.2)
2. PMIC triggers internal fault event (VIN_Bulk OV, VIN_Bulk UV, SWx_OV, SWx_UV) and asserts CAMP signal low.
3. PMIC goes through power cycle or power down cycle (i.e., simultaneous removal of VIN_Bulk and VIN_Mgmt input supplies)

If Table 133, “Register 0x2F” [2] = ‘1’, the PMIC does not enter write protect mode. The PMIC CAMP input signal has no effect on write protect function. The PMIC allows write and read access to all registers. Caution: The operation of non-write protect mode should be limited to lab and debug environment instead of normal system operation.

1.8.9.2 Fail_n Function

By default, PMIC Fail_n function is enabled (Table 136, “Register 0x32” [4] = ‘0’). When PMIC CAMP input signal transitions from High to Low, the PMIC executes VR Disable command (i.e., execute power off sequence config0 to config3 registers), asserts CAMP signal low (if Table 136, “Register 0x32” [3] = ‘0’), exits the write protect mode and clears Table 136, “Register 0x32” [7] to ‘0’.

If Table 136, “Register 0x32” [4] = ‘1’, the PMIC Fail_n function is disabled. When CAMP signal transition from High to Low, The PMIC does not execute VR Disable command (i.e., does not execute power off sequence config0 to config3 registers), does not assert CAMP signal low, exits the write protect mode and does not clear Table 136, “Register 0x32” [7] to ‘0’.

The Fail_n function is independent of PMIC’s write protect function.

1.8.9.3 Status Function

The PMIC CAMP PWR_GOOD output signal indicates status of VIN_Bulk input supply and all output regulators (VOUT_A, VOUT_B, VOUT_C, VOUT_D, VOUT_1.8V, VOUT_1.0V, VBias). Once PMIC receives VR Enable command, the PMIC floats CAMP pin when VIN_Bulk input supply is valid and all enabled output regulator's (VOUT_A, VOUT_B, VOUT_C, VOUT_D, VOUT_1.8V, VOUT_1.0V, VBias) tolerances are maintained as configured in the appropriate register space. Note that CAMP pin is not affected based on VIN_Mgmt input supply.

At first power up, with stable & valid input supply VIN_Mgmt as well as VOUT_1.8V & VOUT_1.0V LDO outputs, the PMIC asserts CAMP pin low however PMIC updates corresponding status register. Once PMIC receives VR Enable command from the host, the PMIC enables all appropriate output regulators and updates corresponding status registers and enters state called as "Regulation". At this point, PMIC floats CAMP PWR_GOOD output and the external board pullup resistor pulls the CAMP pin high. Once the CAMP pin is pulled high (i.e., no other PMIC is driving the CAMP pin low), the PMIC enters state stated called as "online" state.

Once the CAMP pin is high, if PMIC detects any condition either on VIN_Bulk input supply or any of the output regulators (VOUT_A, VOUT_B, VOUT_C, VOUT_D, VOUT_1.8V, VOUT_1.0V, VBias) that causes the PMIC to update its status registers to indicate the power status is not good, then PMIC asserts CAMP pin low and keeps it asserted until the host explicitly takes a specific action corresponding to it. The PMIC does not automatically let the CAMP pin float even if the condition that triggered the PMIC to assert the CAMP pin no longer exists. In other words, the PMIC's CAMP pin is latched and once latched, it must be explicitly addressed by the host.

Regardless of whether PMIC is operating in write protect mode or not, the PMIC always asserts CAMP signal low to indicate the status if there is a fault event.

1.8.10 GSI_n Signal

General Status Interrupt (GSI_n) is an Open Drain output signal. By default at power on, GSI_n output is disabled. The host can enable the GSI_n output by setting Table 113, "Register 0x1B" [3] = '1'. Typically, GSI_n output is pulled up to 1 K Ω resistor to 1.8 V or 3.3 V. The PMIC asserts GSI_n output for the events as described in Table 23.

1.8.11 State Transition Diagram

Following is a summary of high level description of basic PMIC states.

Offline State:

- VIN_Mgmt is invalid and VIN_Bulk = X (valid or invalid); LDOs are invalid
- All registers are reset to specified default values
- CAMP is Hi-Z

Configuration (non write protect) state:

- At initial configuration state, all registers follow the register attributes as defined and read/write accessible.
- The I²C/I³C bus interface is alive and running.
- LDOs are valid; switch regulators are off
- CAMP is low

1.8.11 State Transition Diagram (cont'd)

Regulation (non write protect) state:

- All registers are read/write accessible.
- All enabled output rails are active
- Internal power good is floated; external CAMP is low

Online (write protect) state:

- All registers are readable. All non protect registers are writable.
- All enabled output rails are active (i.e., PMIC has registered VR Enable command with Table 133, “Register 0x2F” [2] = ‘0’.
- CAMP is high
- Note: Prior to PMIC registering VR Enable command, PMIC may be configured to not execute VR Enable command and float its CAMP PWR_GOOD output signal (Table 136, “Register 0x32” [7:0] = 0x08) with default configuration of Table 133, “Register 0x2F” [2] = ‘0’. In this configuration, PMIC also enters write protect state when CAMP signal is pulled high.

Figure 19 shows high level simplified state diagram. Specific transition details are function of PMIC’s configuration register settings (e.g., R2F, R32, etc., as well as CAMP signal and input/output supplies). Please refer to detail functional description and configuration register definition for PMIC operation. Consider an example of a valid PMIC operation: When the PMIC first powers up from an offline state, the PMIC register Table 133, “Register 0x2F” [2] can be configured to ‘1’ followed by VR Enable command. After PMIC turns on all regulators and floats CAMP signal such that it is pulled up High, PMIC is in online state but allows all register write/read access as PMIC is not in write protect state. In this state, the PMIC does allow to clear Table 133, “Register 0x2F” [2] to ‘0’ which will cause PMIC to enter in write protect state as the CAMP signal was already pulled up High and the PMIC was in regulation.

Table 22, “State Transitions with VR Enable Pin” shows the high level state transition with using VR Enable pin. The table only shows the transition with using the VR Enable pin to turn on and turn off the regulators along with CAMP signal transition. The PMIC LDOs must be valid to turn on the rails with the VR Enable pin. The failure in LDOs returns PMIC in offline state regardless of the VR Enable pin level.

Table 22 — State Transitions with VR Enable Pin

Start State	Activity	Register Setting			End State	CAMP Output ¹	Power Cycle Required?	Note
		R2F[2]	R32[5]	R32[4]				
Offline	Valid VIN_Bulk and VIN_Mgmt	N/A	N/A	N/A	Configuration	Low	N/A	
Configuration State	VR_EN Pin; Low to High	X	0	X	Configuration	Low	No	
		X	1	X	Regulation --> Online	Hi-Z	No	2
Online	VR_EN Pin; High to Low	X	X	X	Configuration	Low	No	3
Online	CAMP Input; High to Low	X	X	0	Configuration	Low	No	4
		X	X	1	Regulation	Hi-Z	No	5
	Internal VR Disable Event or VIN_Bulk Invalid	X	X	X	Configuration	Low	No	
	Invalid VIN_Bulk and VIN_Mgmt	X	X	X	Offline	Undefined	N/A	
NOTE 1	This represents PMIC's CAMP output signal.							
NOTE 2	The PMIC transitions to regulation state first and then to online state when CAMP signal is pulled up high. The Table 133, "Register 0x2F" [2] decides whether PMIC is in write protect state or non-write protect state. The PMIC updates the Table 136, "Register 0x32" [7] to '1' when it transitions to regulation state.							
NOTE 3	The PMIC updates the Table 136, "Register 0x32" [7] to '0' when it transitions to configuration state.							
NOTE 4	The PMIC returns to non-write protect configuration state.							
NOTE 5	The PMIC returns to non-write protect regulation state.							

1.8.12 State Transition with VR Enable Pin (cont'd)

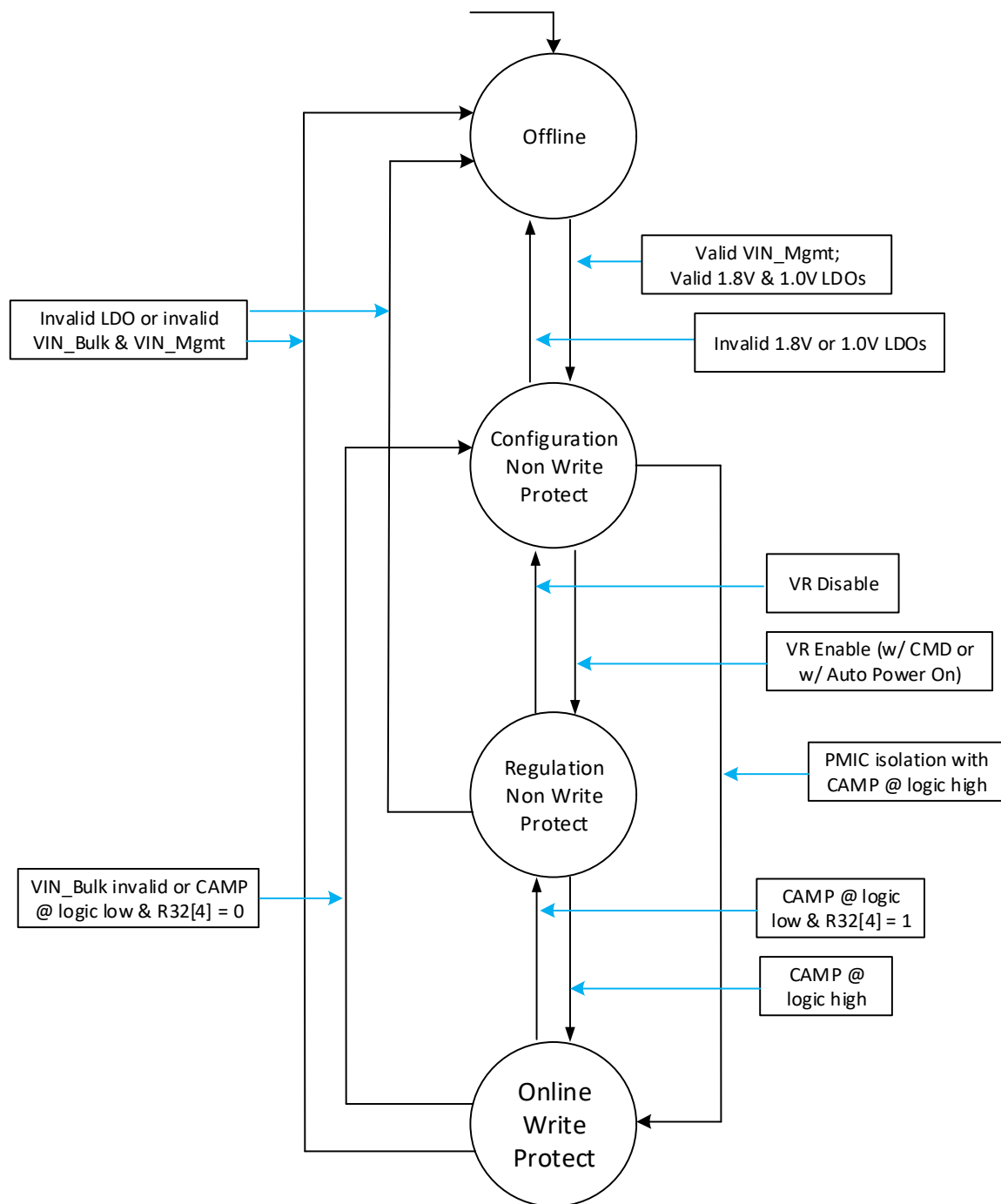


Figure 19 — High Level State Transitions

1.8.13 Function Interrupt - CAMP and GSI_n Output Signals

This section defined the output functionality of GSI_n pin and CAMP pin.

When mask register bits are not set, the PMIC asserts its GSI_n output and CAMP output signals as shown in Table 23 when any event occurs. The table also highlights 11 events that causes PMIC to generate internally VR Disable command. For remaining events that does not trigger internal VR Disable command, the PMIC continues to operate as normal.

Table 23 — Events Interrupt Summary

Event	Status Bit	Clear Bit	Mask Bit	Threshold Bits	Trigger VR Disable?	CAMP Output	GSI_n Output
VIN_Bulk Power Good	R08 [7]	R10 [7]	R15 [7]	R1A [7:5]	No	Low	Low
VIN_Bulk Over Voltage	R08 [0]	R10 [0]	R15 [0]	R1B [7]	Yes	Low	Low
VIN_Mgmt Over Voltage	R08 [1]	R10 [1]	R15 [1]	R1B [5]	No	High	Low
SWA Output Power Good	R08 [5]	R10 [5]	R15 [5]	R21 [0]; R22 [7:6]	No	Low	Low
SWB Output Power Good	R08 [4]	R10 [4]	R15 [4]	R23 [0]; R24 [7:6]	No	Low	Low
SWC Output Power Good	R08 [3]	R10 [3]	R15 [3]	R25 [0]; R26 [7:6]	No	Low	Low
SWD Output Power Good	R08 [2]	R10 [2]	R15 [2]	R27 [0]; R28 [7:6]	No	Low	Low
1.8 V LDO Power Good	R09 [5]	R11 [5]	R16 [5]	R1A [2]	No	Low	Low
1.0 V LDO Power Good	R33 [2]	R14 [2]	R19 [2]	R1A [0]	No	Low	Low
VBias LDO Power Good	R09 [6]	R11 [6]	R16 [6]	R1A [3]	No	Low	Low
SWA Output Over Voltage	R0A [7]	R12 [7]	R17 [7]	R22 [5:4]	Yes	Low	Low
SWB Output Over Voltage	R0A [6]	R12 [6]	R17 [6]	R24 [5:4]	Yes	Low	Low
SWC Output Over Voltage	R0A [5]	R12 [5]	R17 [5]	R26 [5:4]	Yes	Low	Low
SWD Output Over Voltage	R0A [4]	R12 [4]	R17 [4]	R28 [5:4]	Yes	Low	Low
SWA Output Under Voltage	R0B [3]	R13 [3]	R18 [3]	R22 [3:2]	Yes	Low	Low
SWB Output Under Voltage	R0B [2]	R13 [2]	R18 [2]	R24 [3:2]	Yes	Low	Low
SWC Output Under Voltage	R0B [1]	R13 [1]	R18 [1]	R26 [3:2]	Yes	Low	Low
SWD Output Under Voltage	R0B [0]	R13 [0]	R18 [0]	R28 [3:2]	Yes	Low	Low
VBias LDO Output or VIN_Bulk Input Under Voltage	R33 [3]	R14 [3]	R19 [3]	Vendor Specific	Yes	Low	Low
SWA Output Current Limit	R0B [7]	R13 [7]	R18 [7]	R20 [7:6]	No	High	Low
SWB Output Current Limit	R0B [6]	R13 [6]	R18 [6]	R20 [5:4]	No	High	Low
SWC Output Current Limit	R0B [5]	R13 [5]	R18 [5]	R20 [3:2]	No	High	Low
SWD Output Current Limit	R0B [4]	R13 [4]	R18 [4]	R20 [1:0]	No	High	Low
SWA Output High Current/Power	R09 [3]	R11 [3]	R16 [3]	R1C [7:0]	No	High	Low
SWB Output High Current/Power	R09 [2]	R11 [2]	R16 [2]	R1D [7:0]	No	High	Low
SWC Output High Current/Power	R09 [1]	R11 [1]	R16 [1]	R1E [7:0]	No	High	Low
SWD Output High Current/Power	R09 [0]	R11 [0]	R16 [0]	R1F [7:0]	No	High	Low
High Temperature Warning	R09 [7]	R11 [7]	R16 [7]	R1B [2:0]	No	High	Low
Critical Temperature	R08[6]	N/A	N/A	R2E [2:0]	Yes	Low	Low
VIN_Mgmt to VIN_Bulk Switchover	R09 [4]	R11 [4]	R16 [4]	R2F [7]	No	High	Low
Valid VIN_Mgmt in Switchover State	R33 [4]	R14 [4]	R19 [4]	N/A	No	High	Low
PEC Error	R0A [3]	R12 [3]	R17 [3]	N/A	No	High	Low
Parity Error	R0A [2]	R12 [2]	R17 [2]	N/A	No	High	Low

The host is expected to read appropriate status registers to determine and isolate the cause of the GSI_n signal assertion or CAMP signal assertion. The host may attempt to clear or mask the appropriate corresponding interrupt event. The PMIC keeps the GSI_n signal asserted or CAMP signal asserted until the appropriate corresponding registers are explicitly cleared or masked by the host. Table 24 and Table 25 show the PMIC's response of GSI_n signal and CAMP output signal for each event before and after host issues the Clear command. Table 24 and Table 25 assume that all mask bits are either '0' or '1' for simplicity.

1.8.13 Function Interrupt - CAMP and GSI_n Output Signals (cont'd)

Table 24 — PMIC Response for Clear Command by Host - 1

Event	Event Occurred; All Mask Bits = '0'		Clear Command; Event Not Present; All Mask Bits = '0'		Event Occurred; All Mask Bits = '1'		Clear Command; Event Not Present; All Mask Bits = '1'	
	R2F [1:0] = '00' or '01' or '10'		R2F [1:0] = '00' or '01' or '10'		R2F [1:0] = '00'		R2F [1:0] = '00'	
	CAMP Output	GSI_n Output	CAMP Output	GSI_n Output	CAMP Output	GSI_n Output	CAMP Output	GSI_n Output
VIN_Bulk Power Good	Low	Low	High	High	Low	High	High	High
VIN_Bulk Over Voltage	Low	Low	Low	High	Low	High	Low	High
VIN_Mgmt Over Voltage	High	Low	High	High	High	High	High	High
SWA Output Power Good	Low	Low	High	High	Low	High	High	High
SWB Output Power Good	Low	Low	High	High	Low	High	High	High
SWC Output Power Good	Low	Low	High	High	Low	High	High	High
SWD Output Power Good	Low	Low	High	High	Low	High	High	High
1.8 V LDO Power Good	Low	Low	High	High	Low	High	High	High
1.0 V LDO Power Good	Low	Low	High	High	Low	High	High	High
VBias LDO Power Good	Low	Low	High	High	Low	High	High	High
SWA Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWB Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWC Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWD Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWA Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWB Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWC Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWD Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
VBias LDO Output or VIN_Bulk Input Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWA Output Current Limit	High	Low	High	High	High	High	High	High
SWB Output Current Limit	High	Low	High	High	High	High	High	High
SWC Output Current Limit	High	Low	High	High	High	High	High	High
SWD Output Current Limit	High	Low	High	High	High	High	High	High
SWA Output High Current/Power	High	Low	High	High	High	High	High	High
SWB Output High Current/Power	High	Low	High	High	High	High	High	High
SWC Output High Current/Power	High	Low	High	High	High	High	High	High
SWD Output High Current/Power	High	Low	High	High	High	High	High	High
High Temperature Warning	High	Low	High	High	High	High	High	High
Critical Temperature	Low	Low	P/C ¹	P/C ¹	Low	Low	P/C ¹	P/C ¹
VIN_Mgmt to VIN_Bulk Switchover	High	Low	High	High	High	High	High	High
Valid VIN_Mgmt in Switchover	High	Low	High	High	High	High	High	High
PEC Error	High	Low	High	High	High	High	High	High
Parity Error	High	Low	High	High	High	High	High	High

NOTE 1 P/C = Power Cycle

1.8.13 Function Interrupt - CAMP and GSI_n Output Signals (cont'd)

Table 25 — PMIC Response for Clear Command by Host - 2

Event	Event Occurred; All Mask Bits = '1'		Clear Command; Event Not Present; All Mask Bits = '1'		Event Occurred; All Mask Bits = '1'		Clear Command; Event Not Present; All Mask Bits = '1'	
	R2F [1:0] = '01'		R2F [1:0] = '01'		R2F [1:0] = '10'		R2F [1:0] = '10'	
	CAMP Output	GSI_n Output	CAMP Output	GSI_n Output	CAMP Output	GSI_n Output	CAMP Output	GSI_n Output
VIN_Bulk Power Good	High	Low	High	High	High	High	High	High
VIN_Bulk Over Voltage	Low	Low	Low	High	Low	High	Low	High
VIN_Mgmt Over Voltage	High	Low	High	High	High	High	High	High
SWA Output Power Good	High	Low	High	High	High	High	High	High
SWB Output Power Good	High	Low	High	High	High	High	High	High
SWC Output Power Good	High	Low	High	High	High	High	High	High
SWD Output Power Good	High	Low	High	High	High	High	High	High
1.8 V LDO Power Good	High	Low	High	High	High	High	High	High
1.0 V LDO Power Good	High	Low	High	High	High	High	High	High
VBias LDO Power Good	High	Low	High	High	High	High	High	High
SWA Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWB Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWC Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWD Output Over Voltage	Low	Low	Low	High	Low	High	Low	High
SWA Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWB Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWC Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWD Output Under Voltage	Low	Low	Low	High	Low	High	Low	High
VBias LDO Output or VIN_Bulk Input Under Voltage	Low	Low	Low	High	Low	High	Low	High
SWA Output Current Limit	High	Low	High	High	High	High	High	High
SWB Output Current Limit	High	Low	High	High	High	High	High	High
SWC Output Current Limit	High	Low	High	High	High	High	High	High
SWD Output Current Limit	High	Low	High	High	High	High	High	High
SWA Output High Current/Power	High	Low	High	High	High	High	High	High
SWB Output High Current/Power	High	Low	High	High	High	High	High	High
SWC Output High Current/Power	High	Low	High	High	High	High	High	High
SWD Output High Current/Power	High	Low	High	High	High	High	High	High
High Temperature Warning	High	Low	High	High	High	High	High	High
Critical Temperature	Low	Low	P/C ¹	P/C ¹	Low	Low	P/C ¹	P/C ¹
VIN_Mgmt to VIN_Bulk Switchover	High	Low	High	High	High	High	High	High
Valid VIN_Mgmt in Switchover	High	Low	High	High	High	High	High	High
PEC Error	High	Low	High	High	High	High	High	High
Parity Error	High	Low	High	High	High	High	High	High
NOTE 1 P/C = Power Cycle								

Note that when host masks any of the event in appropriate register, it only masks the assertion of GSI_n output signal or assertion of CAMP output signal. The PMIC functional behavior remains the same as noted for each event other than assertion of GSI_n output signal and assertion of CAMP output signal.

1.8.14 Input Power Good Status

There is one possibility where PMIC recognizes the input supply fail.

1. VIN_Bulk goes below the threshold set in register Table 112, “Register 0x1A” [7:5].

When this event occurs for a period longer than tInput_PWR_GOOD_GSI_Assertion time then PMIC sets the register Table 94, “Register 0x08” [7] and drives GSI_n and CAMP output signal as shown in Table 23 at the same time. The PMIC allows access to all registers and PMIC continues to operate as normal as long as VIN_Bulk input remains above 4.25 V. See also Section 1.8.18. The host is responsible for taking any specific action. The host may clear the VIN_Bulk input power good status register by writing ‘1’ to register Table 94, “Register 0x08” [7] or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0]. If the input power not good condition is still present then PMIC will continue to drive GSI_n and CAMP output signal as in Table 23 and the status register Table 94, “Register 0x08” [7] will remain at ‘1’. If the input power not good condition persists, the host may set the appropriate mask register to remove GSI_n or CAMP output signal as shown in Table 24 and Table 25.

Note that after VR enable command, when VIN_Mgmt input goes below the threshold set in register Table 133, “Register 0x2F” [7], it is reported as switchover event as described in Section 1.8.23. Prior to VR Enable command, the VIN_Mgmt is always required to be above 2.8 V to guarantee PMIC’s functionality as described in Section 1.8.2.

1.8.15 Input Over Voltage Protection

An input over voltage protection mechanism is implemented to limit the voltages to the PMIC. The PMIC actively monitors the input voltage VIN_Bulk and VIN_Mgmt rail.

There are two possibilities where PMIC recognizes the input over voltage event.

1. VIN_Mgmt input goes above the threshold set in register Table 113, “Register 0x1B” [5].
2. VIN_Bulk input goes above the threshold set in register Table 113, “Register 0x1B” [7].

When either one or both event occurs for a period longer than tInput_OV_GSI_Assertion time then PMIC sets the register Table 94, “Register 0x08” [1:0] accordingly and drives GSI_n output signal as shown in Table 23 at the same time. Note that at this point, the PMIC does not assert CAMP output signal. The PMIC allows access to all registers and PMIC continues to operate as normal. The host is responsible for taking any specific action. The host may clear the VIN_Mgmt or VIN_Bulk input over voltage status register by writing ‘1’ to register Table 102, “Register 0x10” [1:0] appropriately or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0]. If the input over voltage condition is still present then PMIC will continue to assert GSI_n output signal and the status register Table 94, “Register 0x08” [1:0] will remain at ‘1’.

In non write protect mode, if VIN_Bulk input supply over voltage condition persists greater than tInput_OV_VR_Disable time then PMIC internally generates VR Disable command and disables all of its switching output regulators and asserts CAMP signal. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the CAMP signal assertion and GSI_n signal assertion. Once host determines the cause, the host must first clear the VIN_Bulk input over voltage status register as well as any other relevant status registers individually or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. If the input over voltage condition is still present then PMIC will continue to assert GSI_n output signal and the status register Table 94, “Register 0x08” [0] will remain at ‘1’. Once the status register is cleared and GSI_n output signal is de-asserted, the host may re-enable the PMIC’s output switching regulator by issuing VR Enable command. The PMIC enables output switching regulators and ensures CAMP signal is floated when all of its output regulators are normal and input over voltage condition is no longer present.

1.8.15 Input Over Voltage Protection (cont'd)

In write protect mode, if VIN_Bulk input supply over voltage condition persists greater than tInput_OV_VR_Disable time then PMIC internally generates VR Disable command and disables all of its switching output regulators by executing Power Off Sequence configuration registers, asserts CAMP signal low and returns to configuration mode. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active.

1.8.16 Output Power Good Status

The PMIC provides the voltage tolerance information to host that its output regulator may have crossed the desired voltage tolerance from its nominal programmed setting. The nominal programmed setting for output regulator SWA, SWB, SWC and SWD is programmed in register Table 119, “Register 0x21^{1,2}” [7:1], Table 121, “Register 0x23^{1,2,3}” [7:1], Table 123, “Register 0x25^{1,2}” [7:1], and Table 125, “Register 0x27^{1,2}” [7:1] respectively. The PMIC offers the CAMP condition to be set independently for low side and high side.

In addition, PMIC has three LDO regulators: VBias, VOUT_1.8V and VOUT_1.0V

There are five possibilities where PMIC recognizes the output power good event for any output regulator.

1. Output voltage goes below the threshold set in register Table 119, “Register 0x21^{1,2}” [0] for SWA or Table 121, “Register 0x23^{1,2,3}” [0] for SWB or Table 123, “Register 0x25^{1,2}” [0] for SWC or Table 125, “Register 0x27^{1,2}” [0] for SWD.
2. Output voltage goes above the threshold set in register Table 120, “Register 0x22^{1,2}” [7:6] for SWA or Table 122, “Register 0x24^{1,2,3}” [7:6] for SWB or Table 124, “Register 0x26^{1,2}” [7:6] for SWC or Table 126, “Register 0x28^{1,2}” [7:6] for SWD.
3. LDO output VBias goes below the threshold set in register Table 112, “Register 0x1A” [3].
4. LDO output VOUT_1.8V goes below the threshold set in register Table 112, “Register 0x1A” [2].
5. LDO output VOUT_1.0V goes below the threshold set in register Table 112, “Register 0x1A” [0].

When either event occurs for a period longer than Output_PWR_GOOD_GSI_Assertion time then PMIC sets the register Table 94, “Register 0x08” [5:2] or Table 95, “Register 0x09” [6:5] or Table 137, “Register 0x33” [2] appropriately and drives CAMP and GSI_n output signal as shown in Table 23 at the same time. The PMIC may continue to operate but DDR5 DIMM functionality may not be guaranteed. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine and identify the cause of the CAMP signal assertion and GSI_n signal assertion. Once host determines the cause, the host may clear the appropriate status register individually or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted and CAMP signal to be de-asserted. If the output power not good condition is still present then PMIC will continue to assert GSI_n output signal and assert CAMP signal and the appropriate status register Table 94, “Register 0x08” [5:2] or Table 95, “Register 0x09” [6:5] or Table 137, “Register 0x33” [2] will remain at ‘1’. If the output power not good condition persists, the host may set the appropriate mask register to remove GSI_n or CAMP output signal as shown in Table 24 and Table 25.

1.8.17 Output Over Voltage Protection

An output over voltage protection mechanism is implemented to limit the voltages on the PMIC output regulators. The PMIC actively monitors the output voltage on each enabled regulators.

There are four possibilities where PMIC recognizes the over voltage event.

1. SWA output regulator goes above the threshold set in register Table 120, “Register 0x22^{1,2}” [5:4].
2. SWB output regulator goes above the threshold set in register Table 122, “Register 0x24^{1,2,3}” [5:4].
3. SWC output regulator goes above the threshold set in register Table 124, “Register 0x26^{1,2}” [5:4].
4. SWD output regulator goes above the threshold set in register Table 126, “Register 0x28^{1,2}” [5:4].

1.8.17.1 DDR5 RDIMM/LRDIMM Environment - Table 162, “Register 0x4F” [7] = ‘0’:

In non write protect mode, if any output over voltage condition persists greater than tOutput_OV_VR_Disable time then PMIC internally generates VR Disable command and disables all of its switching output regulators, sets register Table 96, “Register 0x0A” [7:4] appropriately, asserts CAMP and asserts GSI_n output signal. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the CAMP signal assertion and GSI_n signal assertion. Once host determines the cause, the host must first clear the appropriate output over voltage status register as well as any other relevant status registers individually or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. Once the status register is cleared and GSI_n output signal is de-asserted, the host may re-enable the PMIC’s output switching regulator by issuing VR Enable command. The PMIC enables output switching regulators and ensures CAMP signal is floated when all of its output regulators are normal.

In write protect mode, if any output over voltage condition persists greater than tOutput_OV_VR_Disable time then PMIC internally generates VR Disable command and disables all of its switching output regulators by executing Power Off Sequence configuration registers, asserts CAMP signal low and returns to configuration mode. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active.

1.8.17.2 DDR5 NVDIMM or Other Custom Environment - Table 162, “Register 0x4F” [7] = ‘1’

In non write protect mode, if any output over voltage condition persists greater than tOutput_OV_VR_Disable time then PMIC internally generates VR Disable command to disable only the affected switching output regulator, sets register Table 96, “Register 0x0A” [7:4] appropriately, asserts CAMP and asserts GSI_n output signal and continues to operate normal on other output regulators. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the CAMP signal assertion and GSI_n signal assertion. Once host determines the cause, the host must first clear the appropriate output over voltage status register as well as any other relevant status registers individually or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. Once the status register is cleared and GSI_n output signal is de-asserted, the host may re-enable the PMIC’s output switching regulator by issuing VR Enable command. The PMIC enables output switching regulator and floats CAMP signal when all of its output regulators are normal. Note that in this case, though Host issues VR Enable command, it only turns on the only affected regulator that was disabled.

The write protect mode is not allowed when Table 162, “Register 0x4F” [7] = ‘1’.

1.8.18 Output Under Voltage and VIN_Bulk Under Voltage Lockout Protection

An output under voltage lockout protection mechanism is implemented to limit the voltages on the PMIC output regulators. The PMIC actively monitors the output voltage on each enabled regulators.

There are five possibilities where PMIC recognizes the under voltage lockout event.

1. SWA output regulator goes below the threshold set in register Table 120, “Register 0x22^{1,2}” [3:2].
2. SWB output regulator goes below the threshold set in register Table 122, “Register 0x24^{1,2,3}” [3:2].
3. SWC output regulator goes below the threshold set in register Table 124, “Register 0x26^{1,2}” [3:2].
4. SWD output regulator goes below the threshold set in register Table 126, “Register 0x28^{1,2}” [3:2].
5. VBias LDO output regulator goes below the vendor specific threshold or VIN_Bulk Input Voltage goes below vendor specific threshold.

1.8.18.1 DDR5 RDIMM/LRDIMM Environment - Table 162, “Register 0x4F” [7] = ‘0’:

In non write protect mode, if any output under voltage condition (among five possibilities listed above) or VIN_Bulk input voltage condition as listed above persists greater than tOutput_UV_VR_Disable time then PMIC internally generates VR Disable command and disables all of its switching output regulators, sets register Table 97, “Register 0x0B” [3:0], Table 137, “Register 0x33” [3] appropriately, asserts CAMP and asserts GSI_n output signal. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the CAMP signal assertion and GSI_n signal assertion. Once host determines the cause, the host must first clear the appropriate output under voltage status register as well as any other relevant status registers individually or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. Once the status register is cleared and GSI_n output signal is de-asserted, the host may re-enable the PMIC’s output switching regulator by issuing VR Enable command assuming valid VIN_Bulk input voltage. The PMIC enables output switching regulators and floats CAMP signal when all of its output regulators are normal.

In write protect mode, if any output under voltage condition (among five possibilities listed above) or VIN_Bulk input voltage condition as listed above persists greater than tOutput_UV_VR_Disable time then PMIC internally generates VR Disable command and disables all of its switching output regulators by executing Power Off Sequence configuration registers, asserts CAMP signal low and returns to configuration mode. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active.

1.8.18.2 DDR5 NVDIMM or Other Custom Environment - Table 162, “Register 0x4F” [7] = ‘1’

In non write protect mode, if any output under voltage condition (First four possibilities listed above) as listed above persists greater than tOutput_UV_VR_Disable time then PMIC internally generates VR Disable command to disable only the affected switching output regulator, sets register Table 97, “Register 0x0B” [3:0] appropriately, asserts CAMP and asserts GSI_n output signal and continues to operate normal on other output regulators. Note that if the fifth condition (VBias LDO output goes below vendor specific threshold or VIN_Bulk input goes below vendor specific threshold) listed above persists greater than tOutput_UV_VR_Disable time, then the PMIC internally generates VR Disable command and disables all of its switching output regulators, sets register Table 97, “Register 0x0B” [3:0] and Table 137, “Register 0x33” [3] appropriately, asserts CAMP and asserts GSI_n output signal. The PMIC keeps its VOUT_1.8V and VOUT_1.0V LDO output regulators active. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the CAMP signal assertion and GSI_n signal assertion. Once host determines the cause, the host must first clear the appropriate output under voltage status register as well as any other relevant status registers individually or by writing ‘1’ to global status clear register Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. Once the status register is cleared and GSI_n output signal is de-asserted, the host may re-enable the PMIC’s output switching regulator by issuing VR Enable command. The PMIC enables output switching regulator and ensures CAMP signal is floated when all of its output regulators are normal. Note that in this case, though Host issues VR Enable command, it only turns on the only affected regulator that was disabled.

The write protect mode is not allowed when Table 162, “Register 0x4F” [7] = ‘1’.

1.8.19 Output Current Limiter Warning Event

The PMIC has output current limiter mechanism to limit the current on the PMIC output voltage regulators.

There are four possibilities where PMIC recognizes the current limiter event.

1. SWA output regulator current goes above the threshold set in register Table 118, “Register 0x20¹” [7:6].
2. SWB output regulator current goes above the threshold set in register Table 118, “Register 0x20¹” [5:4].
3. SWC output regulator current goes above the threshold set in register Table 118, “Register 0x20¹” [3:2].
4. SWD output regulator current goes above the threshold set in register Table 118, “Register 0x20¹” [1:0].

1.8.19 Output Current Limiter Warning Event (cont'd)

When either event occurs for a period longer than `tOutput_Current_Limiter` time then PMIC sets the register Table 97, “Register 0x0B” [7:4] appropriately, drives GSI_n output signal as shown in Table 23 at the same time. The PMIC continues to operate as normal. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the GSI_n signal assertion. Once host determine the cause, the host may clear the appropriate output current limiter status register as well as any other status registers individually or by writing ‘1’ to global status clear register in Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. If the output current limiter condition is still present then PMIC will continue to assert GSI_n output signal and the appropriate status register in Table 97, “Register 0x0B” [7:4] will remain at ‘1’. If the output current limiter condition persists, the host may set the appropriate mask register to remove the GSI_n output signal as shown in Table 24 and Table 25.

1.8.20 Output High Current Consumption Warning Event

The PMIC supports high output current consumption warning mechanism for each of its regulator output. If enabled, the PMIC actively monitors the average output current of the regulator.

There are four possibilities where PMIC recognizes the high output current consumption.

1. SWA output regulator average current goes above the threshold set in register Table 114, “Register 0x1C” [7:2].
2. SWB output regulator average current goes above the threshold set in register Table 115, “Register 0x1D” [7:2].
3. SWC output regulator average current goes above the threshold set in register Table 116, “Register 0x1E” [7:2].
4. SWD output regulator average current goes above the threshold set in register Table 117, “Register 0x1F” [7:2].

When either event occurs then PMIC sets the register Table 95, “Register 0x09” [3:0] appropriately, drives GSI_n output signal as shown in Table 23 at the same time. The PMIC continues to operate as normal. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the GSI_n signal assertion. Once host determines the cause, the host may clear the appropriate output current consumption warning status register as well as any other status registers individually or by writing ‘1’ to global status clear register in Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. If the output current consumption warning condition is still present then PMIC will continue to assert GSI_n output signal and the appropriate status register in Table 95, “Register 0x09” [3:0] will remain at ‘1’. If the output current consumption warning condition persists, the host may set the appropriate mask register to remove GSI_n output signal as shown in Table 24 and Table 25.

1.8.21 PMIC LDO Output Failure

In the event where PMIC LDO outputs (VOUT_1.8V or VOUT_1.0V) failure occurs and PMIC cannot reliably support external communication, the PMIC has no control of CAMP signal and it is floated. The PMIC returns to “offline” state.

Note that the PMIC operation itself may not be guaranteed as PMIC internally may use the LDO output voltages for its own internal operation.

1.8.22 PMIC High Temperature Warning and Critical Temperature Protection

The PMIC provides a high temperature warning mechanism as well as critical temperature shutdown. There are two registers associated with PMIC temperature: The high temperature warning threshold register Table 113, “Register 0x1B” [2:0] and shutdown temperature threshold register Table 132, “Register 0x2E” [2:0]. The value programmed in the shutdown temperature register must be equal or greater than value programmed in a warning threshold register.

There is one possibility where PMIC recognizes the high temperature event.

1. The PMIC temperature goes above the threshold set in register Table 113, “Register 0x1B” [2:0].

When the above event occurs for a period longer than tHigh_Temp_Warning time, the PMIC sets the register Table 95, “Register 0x09” [7] and drives GSI_n output signal as shown in Table 23 at the same time. The PMIC continues to operate as normal. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the GSI_n signal assertion. Once host determines the cause, the host may clear the temperature warning status register as well as any other status registers individually or by writing ‘1’ to global status clear register in Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. If the high temperature warning condition is still present then PMIC will continue to assert GSI_n output signal and the appropriate status register in Table 95, “Register 0x09” [7] will remain at ‘1’. If the high temperature warning condition persists, the host may set the appropriate mask register to remove GSI_n output signal as shown in Table 24 and Table 25.

If the PMIC temperature goes above the threshold set in register Table 132, “Register 0x2E” [2:0] for a period longer than tShut_Down_Temp time, the PMIC internally generates VR Disable command and disables all of its switching output regulators as well as Vbias voltage regulator (optional), sets the code in register Table 91, “Register 0x05” [2:0], updates Table 94, “Register 0x08” [6], drives GSI_n and CAMP output signal as shown in Table 23 at the same time. The PMIC keeps its VOUT_1.8V LDO and VOUT_1.0V LDO output regulator active. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host is expected to monitor the temperature status registers. When the temperature drops below the threshold, the host must re-start the PMIC by going through the power cycle of the VIN_Mgmt and VIN_Bulk input supply. If the PMIC is in VIN_Bulk input supply switchover state, the host must re-start the PMIC by going through the power cycle of the VIN_Bulk input supply.

1.8.23 VIN_Mgmt to VIN_Bulk Input Supply Switchover Event

After VR Enable command is registered, the PMIC automatically switches over from VIN_Mgmt to VIN_Bulk input supply under following condition.

1. VIN_Mgmt goes below the threshold set in register Table 133, “Register 0x2F” [7].

When the above event occurs for a period longer than tInput_PWR_GOOD_GSI_Assertion time then PMIC sets the register Table 95, “Register 0x09” [4] and drives GSI_n output signal as shown in Table 23 at the same time. The PMIC continues to operate as normal. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the GSI_n signal assertion. Once host determines the cause, the host may clear the status register individually or by writing ‘1’ to global status clear register in Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. No further action is needed by the host or the PMIC at this point.

Note that this event is treated differently by the PMIC. When host clears this event, the PMIC must remove the GSI_n signal assertion even though PMIC does not see valid VIN_Mgmt. This is to simplify host because host knows that there is no VIN_Mgmt and yet host expects the PMIC (as well as system) to continue to run normal and host should not have to worry about masking this event in PMIC. It is assumed that at some point VIN_Mgmt supply will come back up again, PMIC will detect it and assert GSI_n output signal as described in Section 1.8.24. At this point, PMIC will be ready to assert GSI_n output signal again if VIN_Mgmt input supply goes below the threshold set in register Table 133, “Register 0x2F” [7].

1.8.24 Valid VIN_Mgmt Supply Detection in Switchover Mode

When PMIC is in switchover mode as described in Section 1.8.23, the VIN_Mgmt input supply may power back up at any time. When VIN_Mgmt input supply re-powers backup, the PMIC sets the register Table 137, “Register 0x33” [4] and drives GSI_n output signal as shown in Table 23 at the same time. The PMIC continues to operate as normal and automatically switches back to VIN_Mgmt input supply. The PMIC allows access to all registers. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the GSI_n signal assertion. Once host determines the cause, the host may clear the status register individually or by writing ‘1’ to global status clear register in Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. No further action is needed by the host or the PMIC at this point.

Note that this event is treated differently by the PMIC. When host clears this event, the PMIC must remove the GSI_n signal assertion even though PMIC still sees valid VIN_Mgmt. This is to simplify host because host knows that VIN_Mgmt input supply is back and so host expects the PMIC (as well as system) to continue to run normal and host should not have to worry about masking this event in PMIC. It is assumed that if at some point VIN_Mgmt supply goes below the threshold again, PMIC will detect it and assert GSI_n output signal as described in Section 1.8.23. At this point, PMIC will be ready to assert GSI_n output signal again if VIN_Mgmt input supply re-powers back up again.

1.8.25 Packet Error Code (PEC) and Parity Error Event

In I3C Basic mode, on PMIC’s primary management interface, PEC function and Parity function can be enabled. If enabled, when PMIC detects either PEC error or Parity Error, the PMIC sets the register Table 96, “Register 0x0A” [3:2] appropriately, drives GSI_n output signal as shown in Table 23 and it continues to operate as normal and allows access to all registers. See Section 1.13.8 to 1.13.9 for additional details. The host is responsible for taking any specific action. The host may query the PMIC register space to determine the cause of the GSI_n signal assertion. Once host determines the cause, the host may clear the status register individually or by writing ‘1’ to global status clear register in Table 106, “Register 0x14” [0] which triggers the GSI_n signal to be de-asserted. No further action is needed by the host from this point on.

1.9 Analog to Digital Converter (ADC)

The PMIC supports analog to digital converter (ADC) to monitor input supply voltages (VIN_Bulk and VIN_Mgmt) as well as output voltage regulator voltage (SWA, SWB, SWC, SWD, VBias, VOUT_1.8V and VOUT_1.0V). The register Table 134, “Register 0x30” [7:3] allows to enable the ADC and select the desire input supply voltage or output supply voltage. The register Table 135, “Register 0x31” [7:0] provides the actual voltage measurement. The accuracy of the voltage measurement is as follows:

- Switch Output Voltage Regulator SWA, SWB, SWC (Output Voltage Range: 1050 mV to 1160 mV): ± 1 LSB
- Switch Output Voltage Regulator SWA, SWB, SWC (Output Voltage Range outside of 1050 mV to 1160 mV): ± 3 LSB
- Switch Output Voltage Regulator SWD (Output Voltage Range: 1750 mV to 1850 mV): ± 1 LSB
- Switch Output Voltage Regulator SWD (Output Voltage Range outside of 1750 mV to 1850 mV): ± 3 LSB
- VOUT_1.8V, VOUT_1.0V: ± 3 LSB
- VBias Output Voltage, VIN_Bulk, VIN_Mgmt Input Voltage: ± 6 LSB

1.9 Analog to Digital Converter (ADC) (cont'd)

The PMIC also monitors output voltage regulator current or power (SWA, SWB, SWC and SWD) and updates registers Table 98, “Register 0x0C” [7:0] for SWA, Table 99, “Register 0x0D” [7:0] for SWB, Table 100, “Register 0x0E” [7:0] for SWC and Table 101, “Register 0x0F” [7:0] for SWD. The register Table 113, “Register 0x1B” [6] allows host to select whether PMIC should report current measurements or power measurements. The current or power measurement reported in this registers are an average measurement over time period defined in register Table 134, “Register 0x30” [1:0]. If Table 113, “Register 0x1B” [6] = ‘1’, the register Table 112, “Register 0x1A” [1] allows host to select whether PMIC should report individual rail power or total power in Table 98, “Register 0x0C” [7:0]. The register update frequency of this register is configured in Table 134, “Register 0x30” [1:0]. The internal sampling rate of the PMIC is vendor specific. The accuracy of the current (≥ 0.5 A) or corresponding power measurement is ± 3 LSB or ± 6 LSB respectively. The accuracy of the current measurement (< 0.5 A) is ± 4 LSB or corresponding power measurement is ± 7 LSB respectively.

If register Table 112, “Register 0x1A” [1] = ‘1’, the accuracy of total power reported in register Table 98, “Register 0x0C” = ± 12 LSB.

1.10 PMIC Address ID (PID)

The PMIC has PID input pin which allows to assign up to three different unique ID for I²C and I3C Basic protocol. The PID input pin is shared with SWD_FB_N pin.

At first power on, when VIN_Mgmt input is applied, the PMIC automatically senses its ID. The PMIC also checks the configuration register Table 162, “Register 0x4F” [1].

If SWD output regulator is enabled and intended to operate in a single ended remote sensing mode, the PMIC offers three different ID as shown in Table 26. If SWD output regulator is not enabled, the PMIC still offers three different ID as shown in Table 26.

If SWD output regulator is enabled and intended to operate in a differential remote sensing mode, there is only one default ID for the PMIC as shown in Table 26. This means, there can be only one PMIC on the DIMM (or I²C and I3C Basic bus).

Table 26 — PMIC ID

R4F [1] =	PID Pin Connection on DIMM Board	PMIC ID	Comment
‘0’	short to GND	PID = 1001	PMIC can be configured
	Floating	PID = 1000	
	short to 1.8	PID = 1100	Connected to PMIC’s VOUT_1.8V Rail
‘1’	Connect to Differential Sensing GND	PID = 1001	SWD differential sensing

1.11 Error Injection

The PMIC offers error injection function for the purpose of debug, test and validation at various stages.

Error Injection Function Usage prior to VR Enable:

- Prior to VR Enable command, the Error injection function may be invoked by setting error injection enable bit Table 139, “Register 0x35” [7] = ‘1’ during the configuration state. If any of either VIN_Bulk UV/OV or SWx OV/OV or Critical Temp Shutdown error is injected prior to VR Enable command, the PMIC shall not execute power on sequence and shall not enable PMIC output regulators when PMIC receives VR Enable command (either via I2C/I3C bus command or via VR_EN pin assertion). The PMIC shall not update error log registers (Table 90, “Register 0x04” to Table 92, “Register 0x06”). The PMIC shall update appropriate status registers (Table 94, “Register 0x08” to Table 97, “Register 0x0B”, Table 137, “Register 0x33”) accordingly when error is injected.

1.11 Error Injection (cont'd)

Error Injection Function Usage after VR Enable:

- After PMIC output regulators are enabled with VR Enable command (either via I2C/I3C bus command or via VR_EN pin assertion) and PMIC is in non write protect mode, the error injection function may be invoked by setting error injection enable bit Table 139, “Register 0x35” [7] = ‘1’. If any of either VIN_Bulk UV/OV or SWx OV/OV or Critical Temp Shutdown error is injected the PMIC shall execute Power Off Sequence to disable PMIC output regulators and shall update the error log registers (Table 90, “Register 0x04” to Table 92, “Register 0x06”) as well as status registers (Table 94, “Register 0x08” to Table 97, “Register 0x0B”, Table 137, “Register 0x33”) accordingly. Note that if any of the output rails are not enabled through power on sequence configuration registers, the error injection on that output rail does not apply.
- After PMIC output regulators are enabled with VR Enable command (either via I2C/I3C bus command or via VR_EN pin assertion) and PMIC is in write protect mode, the error injection enabling Table 139, “Register 0x35” [7] = ‘1’ is disallowed. The PMIC shall ignore any attempts to inject any error and shall not execute Power Off Sequence to disable PMIC output regulators and shall not update any error log or status registers.

To exit the error injection function, the host shall power cycle VIN_Bulk and VIN_Mgmt input supply.

1.12 I²C and I3C Basic Interface Operation

At power on, by default, the PMIC device comes up in legacy I²C mode of operation. Following applies in I²C mode:

1. The max operation speed is limited to 1 MHz
2. In-band interrupts are not supported
3. Bus reset is supported.
4. Parity check is not supported except for supported CCCs.
5. Packet Error check is not supported.

The PMIC device shall operate in the legacy I²C mode until put into I3C Basic mode via command.

The host may put the PMIC device in I3C Basic mode by issuing SETAASA CCC.

Following applies in I3C Basic mode.

1. The max operation speed is up to 12.5 MHz
2. In-band interrupts are supported
3. Bus reset is supported.
4. Parity check is always enabled by default.
5. Packet error check is supported and by default is disabled.

1.13 Device Interface - Protocol

The 7-bit serial address of the PMIC device applies to both I²C and I3C Basic mode of operation identically.

1.13.1 Serial Address of PMIC Device

The PMIC device 4-bit binary value (LID) is:

- If PID pin is connected to GND on PCB: ‘1001’
- If PID pin is tied to 1.8 V on PCB: ‘1100’
- If PID pin is floating on PCB: ‘1000’

The PMIC device samples the status of the PID pin on power up. The sampled status of the PID pin is used to select one of the three possible unique LID code for the device. The selected LID code either ‘1001’ or ‘1100’ or ‘1000’ is merged with a 3 bit HID code Table 138, “Register 0x34” [3:1] to establish the 7-bit address code the device. For example, with the default setting in Table 138, “Register 0x34” [3:1] = ‘111’; if the PID pin is connected to GND, the device address shall be ‘1001 111’.

Table 27 — 7-bit Address of PMIC Device

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	x	0	x	1	1	1	R/W
PMIC Device Type ID (LID)				Host ID (HID)			Read/ Write

1.13.2 Switch from I²C Mode to I3C Basic Mode

By default when PMIC first powers on, it operates in legacy I²C mode. The PMIC device shall operate in I²C mode until put into I3C Basic mode via command.

In I²C mode, the host is allowed to issued only 3 CCCs (DEVCTRL, SETHID, SETAASA). All other CCCs are not supported and the PMIC device may simply ignore it. The Host must issue DEVCTRL & SETHID CCC first (if required) followed by SETAASA CCC.

The Host puts the PMIC device in I3C Basic mode by issuing SETAASA CCC.

When SETAASA CCC is registered by the PMIC device, it updates the Table 136, “Register 0x32” [6] to ‘1’.

When SETHID CCC is registered by the PMIC device, it updates the Table 138, “Register 0x34” [3:1].

1.13.3 Switch from I3C Basic Mode to I²C Mode

The Host can put the PMIC device back in I²C mode from I3C Basic mode at any time by issuing RSTDAA CCC.

When RSTDAA CCC is registered by the PMIC device, it updates the Table 136, “Register 0x32” [6] to ‘0’.

1.13.4 I²C Target Protocol

The PMIC device operate on a standard I²C serial interface. Transactions where the PMIC device is the targeted target device begin with the Host issuing a START condition followed by a 7-bit PMIC device address then a read or write bit, RW. All data are transmitted with the most significant bit MSB first. During the address followed by R/W bit transmission, the PMIC device typically replies with an ACK unless there are exceptional conditions when it may passively assert a NACK.

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N	Stop
S or Sr ¹	1	X	0	X	HID			W=0	A	
	Address [7:0]								A	
Sr	1	X	0	X	HID			R=1	A ²	
	Data								A	
	...								A	
	Data								N ³	P

NOTE 1 In I²C mode, Start or Repeat Start operation followed by 7'h7E with W=0 is only allowed for the purpose of issuing CCCs that are allowed in I²C mode. Any other operation including another Repeat Start is considered an illegal operation.

NOTE 2 If target device NACKs during Repeat Start for any reason, the host may re-try Repeat Start again. The host can do the Repeat Start as many times it may desire. The PMIC may eventually ACK.

NOTE 3 When PMIC device reaches last byte within the region (either Host region or DIMM vendor region), it will continue to return data but returned data will be 0x00 if there is no valid password for DIMM vendor region or Vendor specific region. Once the address counter reaches R255, it will reset to address R00 and it will continue to return the data. Only Host can perform STOP operation.

1.13.4.3 Default Read Address Pointer Mode

During normal operation of the DDR5 DIMM, the host periodically may poll critical information from the same location. An example may be the PMIC device's status registers or current or power measurement register readout. To help improve the efficiency of the I²C bus protocol, the PMIC offers a default read address pointer mode so that whenever the PMIC device sees the STOP operation on its SCL and SDA bus, its read address pointer is always resets to default address. The default read pointer address mode is enabled through register Table 143, "Register 0x3A" [6] and default starting address for read operation is selectable through register Table 143, "Register 0x3A" [5:4]. This allows host to read the read command data packet as shown in Table 30. The default read address pointer reduces the packet overhead by 2 bytes. The host typically enables this mode at last after VR Enable command when the normal operation of the DDR5 DIMM begins.

Table 30 — Read Command Data Packet with Default Address Pointer Mode

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N	Stop
S or Sr	1	X	0	X	HID			R=1	A	
	Data								A	
	...								A	
	Data								N ¹	P
NOTE 1	When PMIC device reaches last byte within the region (either Host region or DIMM vendor region), it will continue to return data but returned data will be 0x00 if there is no valid password for DIMM vendor region or Vendor specific region. Once the address counter reaches R255, it will reset to address R00 and it will continue to return the data. Only Host can perform STOP operation.									

1.13.5 I3C Basic Target Protocol

The PMIC device operate on a standard I3C Basic serial interface. Transactions where the PMIC device is the targeted target device begin with the Host issuing a START condition followed by a 7-bit PMIC device address then a read or write bit, RW. All data are transmitted with the most significant bit MSB first. During the address followed by R/W bit transmission, the PMIC device typically replies with an ACK unless there are exceptional conditions when it may passively assert a NACK. See Table 31. The "T" bit carries Parity information from the Host for each byte.

The PMIC device host region registers that are write protected in write protect mode of operation, the PMIC does not execute the operation internally.

Similarly, regardless of write protect mode or non write protect mode of operation, without the correct password, all DIMM vendor and vendor specific region registers are write protected and PMIC does not execute the operation internally.

The Packet Error Code (PEC) function is disabled by default when the PMIC device is put in I3C Basic mode. The host may optionally enable this function through Table 138, "Register 0x34" [7] or DEVCTRL CCC. If enabled, the PEC is appended at the end of all transactions. If PEC is enabled, the host must complete the burst length as indicated in CMD field. In other words, the host must not interrupt the burst length pre-maturely for Write operation.

1.13.5.1 Write Operation - Data Packet

Table 31 — Write Command Data Packet; PEC Disabled

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	X	0	X	HID			W=0	A ^{1,2,3}	
	Address [7:0]								T	
	Data								T	
	...								T	
	Data								T	
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC device NACKs if there is a parity error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	The PMIC device does not check for parity error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 4	Repeat Start or Repeat Start with 7'h7E.									

Table 32 — Write Command Data Packet; PEC Enabled

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	X	0	X	HID			W=0	A ^{1,2,3}	
	Address [7:0]								T	
	CMD			W=0	0000			T		
	Data								T	
	...								T	
	Data								T	
	PEC								T	
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC device NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	The PMIC device does not check for parity or PEC error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 4	Repeat Start or Repeat Start with 7'h7E.									

The host may optionally allow PMIC device to request IBI. For this case, the transactions to the PMIC device begin with the I3C host issuing a START condition followed by 7'h7E and then write bit. If PMIC device has a pending IBI, it transmits its 7-bit device select code followed by R=1. If PMIC device has no pending IBI, there is no action taken by PMIC. Table 33 and Table 34 show the I3C Basic bus write command data packet with optional IBI header for PEC disabled and PEC enabled case respectively. Note that in Table 34, PEC calculation does not include IBI header byte (7'h7E followed by W=0).

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ^{1,2}	
Sr	1	X	0	X	HID			W=0	A ^{2,3,4}	
	Address [7:0]								T	Sr ⁵ or P
	CMD			W=0	0000			T		
	Data								T	
	...								T	
	Data								T	
	PEC								T	
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (Repeat Start)									
NOTE 2	The PMIC device NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK) and see Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 4	The PMIC device does not check for parity or PEC error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 5	Repeat Start or Repeat Start with 7'h7E.									

NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).
NOTE 2	The PMIC device NACKs if there is a parity error in a previous transaction when host performs consecutive transactions with Repeat Start.
NOTE 3	The PMIC device does not check for parity error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.
NOTE 4	If target device NACKs during Repeat Start for any reason, the host may re-try Repeat Start again. The host can do the Repeat Start as many times it may desire. If target device NACKs due to parity error in previous bytes, it will always NACK regardless of how many times the Host tries Repeat Start. If there were no parity errors, the PMIC may eventually ACK.
NOTE 5	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK).
NOTE 6	See Figure 23 to see how Host ends target device operation.
NOTE 7	When PMIC device reaches last byte within the region (either Host region or DIMM vendor region), it will continue to return data but returned data will be 0x00 if there is no valid password for DIMM vendor region or Vendor specific region. Once the address counter reaches R255, it will reset to address R00 and it will continue to return the data. Only Host can perform STOP operation.
NOTE 8	Repeat Start or Repeat Start with 7'h7E.

1.13.5.2 Read Operation - Data Packet (cont'd)

Table 36 — Read Command Data Packet; PEC Enabled

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	X	0	X	HID			W=0	A ^{1,2,3}	
	Address [7:0]								T	
	CMD			R=1	0000			T		
	PEC								T	
Sr	1	X	0	X	HID			R=1	A/N ^{4,5}	
	Data								T=1	
	...								T=1	
	Data								T=1	
	PEC								T=0 ⁶	Sr ⁷ or P
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC device NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	The PMIC device does not check for parity or PEC error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 4	If target device NACKs during Repeat Start for any reason, the host may re-try Repeat Start again. The host can do the Repeat Start as many times it may desire. If target device NACKs due to PEC error or parity error in previous bytes, it will always NACK regardless of how many times the Host tries Repeat Start. If there were no parity or PEC errors, the PMIC may eventually ACK. The PEC calculation by the target device only includes device select code of the ACK response of the Repeat start operation. In other words, if there are more than one Repeat Start operation, the target device includes device select of only the last Repeat Start from the Host when it ACKs in PEC calculation and all other NACK responses of the device select code of the Repeat Start are not included in PEC calculation.									
NOTE 5	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK).									
NOTE 6	See Figure 24 to see how target device ends the operation followed by Host STOP operation.									
NOTE 7	Repeat Start or Repeat Start with 7'h7E.									

The host may optionally allow PMIC device to request IBI. For this case, the transactions to the PMIC device begin with the I3C Basic host issuing a START condition followed by 7'h7E and then write bit. If PMIC device has a pending IBI, it transmits its 7-bit device select code followed by R=1. If PMIC device has no pending IBI, there is no action taken by PMIC. Table 37 and Table 38 show the I3C Basic bus read command data packet with optional IBI header for PEC disabled and PEC enabled case respectively. Note that in Table 38, PEC calculation does not include IBI header byte (7'h7E followed by W=0).

•

Table 37 — Read Command Data Packet with IBI Header; No Pending IBI, PEC Disabled

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ^{1,2}	
Sr	1	X	0	X	HID			W=0	A ^{2,3,4}	
	Address [7:0]								T	
Sr	1	X	0	X	HID			R=1	A/N ^{5,6}	
	Data								T=1	
	...								T=1	
	Data								T=1 ^{7,8}	Sr ⁹ or P
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC device NACKs if there is a parity error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK) and See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 4	The PMIC device does not check for parity error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 5	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK).									
NOTE 6	If target device NACKs during Repeat Start for any reason, the host may re-try Repeat Start again. The host can do the Repeat Start as many times it may desire. If target device NACKs due to parity error in previous bytes, it will always NACK regardless of how many times the Host tries Repeat Start.									
NOTE 7	See Figure 23 to see how Host ends target device operation.									
NOTE 8	When PMIC device reaches last byte within the region (either Host region or DIMM vendor region), it will continue to return data but returned data will be 0x00 if there is no valid password for DIMM vendor region or Vendor specific region. Once the address counter reaches R255, it will reset to address R00 and it will continue to return the data. Only Host can perform STOP operation.									
NOTE 9	Repeat Start or Repeat Start with 7'h7E.									

[illegible]

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ^{1,2}	
Sr	1	X	0	X	HID			W=0	A ^{2,3,4}	
	Address [7:0]								T	
	CMD			R=1	0000				T	
	PEC								T	
Sr	1	X	0	X	HID			R=1	A/N ^{5,6}	
	Data								T=1	
	...								T=1	
	Data								T=1	
	PEC								T=0 ⁷	Sr ⁸ or P
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC device NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK) and See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 4	The PMIC device does not check for parity or PEC error in subsequent bytes when it determines the 7-bit device select code issued by the host does not match with its own device code. The PMIC device ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 5	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK).									
NOTE 6	If target device NACKs during Repeat Start for any reason, the host may re-try Repeat Start again. The host can do the Repeat Start as many times it may desire. If target device NACKs due to PEC error or parity error in previous bytes, it will always NACK regardless of how many times the Host tries Repeat Start. If there were no parity or PEC errors, the PMIC may eventually ACK. The PEC calculation by the target device only includes device select code of the ACK response of the Repeat start operation. In other words, if there are more than one Repeat Start operation, the target device includes device select of only the last Repeat Start from the Host when it ACKs in PEC calculation and all other NACK responses of the device select code of the Repeat Start are not included in PEC calculation.									
NOTE 7	See Figure 24 to see how target device ends the operation followed by Host STOP operation.									
NOTE 8	Repeat Start or Repeat Start with 7'h7E.									

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	X	0	X	HID			R=1	A ¹	
	Data								T=1	
	...								T=1	
	Data								T=1	
	PEC								T=0 ²	
NOTE 1	The PMIC device NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	See Figure 24 to see how target device ends the operation followed by STOP operation.									
NOTE 3	Repeat Start or Repeat Start with 7'h7E.									

[illegible]

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ^{1,2}	
Sr	1	X	0	X	HID			R=1	A/N ^{2,3}	
	Data								T=1	
	...								T=1	
	Data								T=1 ^{4,5}	Sr ⁶ or P

[illegible]

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ^{1,2}	
Sr	1	X	0	X	HID			R=1	A/N ^{2,3}	
	Data								T=1	
	...								T=1	
	Data								T=1	
	PEC								T=0 ⁴	Sr ⁵ or P

1.13.5.3 Default Read Address Pointer Mode (cont'd)

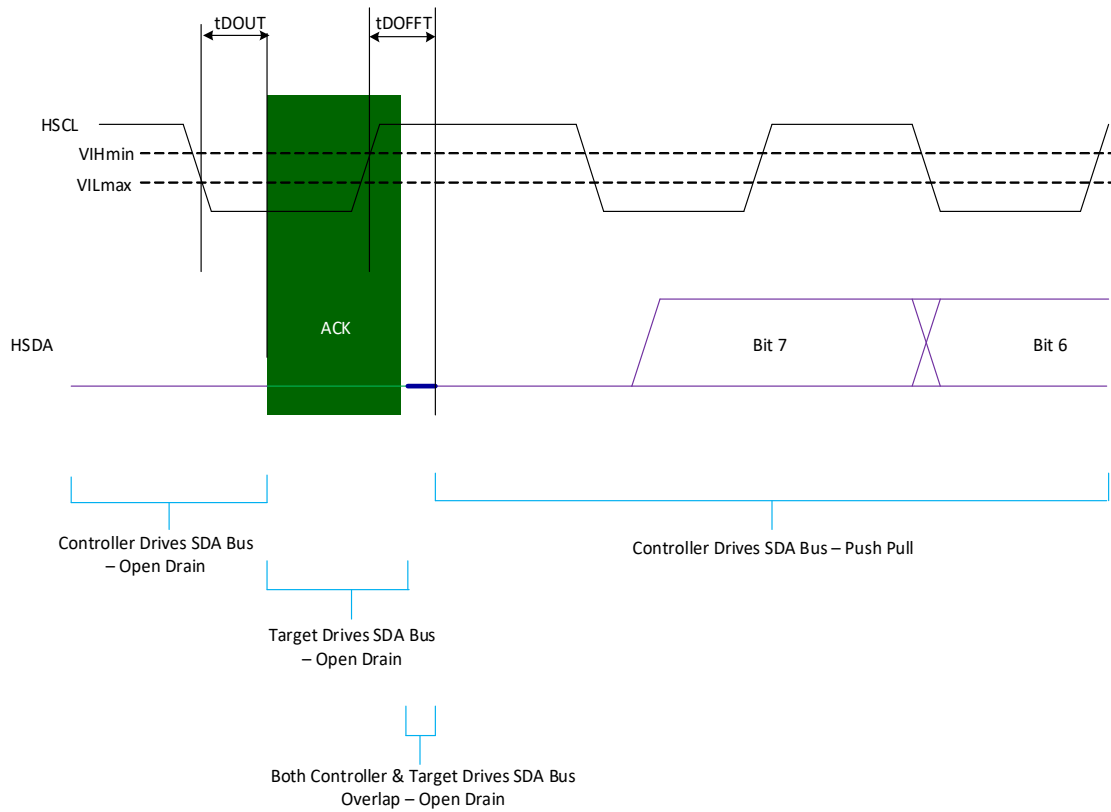


Figure 20 — Target Open Drain to Controller Push Pull Hand Off Operation

1.13.5.3 Default Read Address Pointer Mode (cont'd)

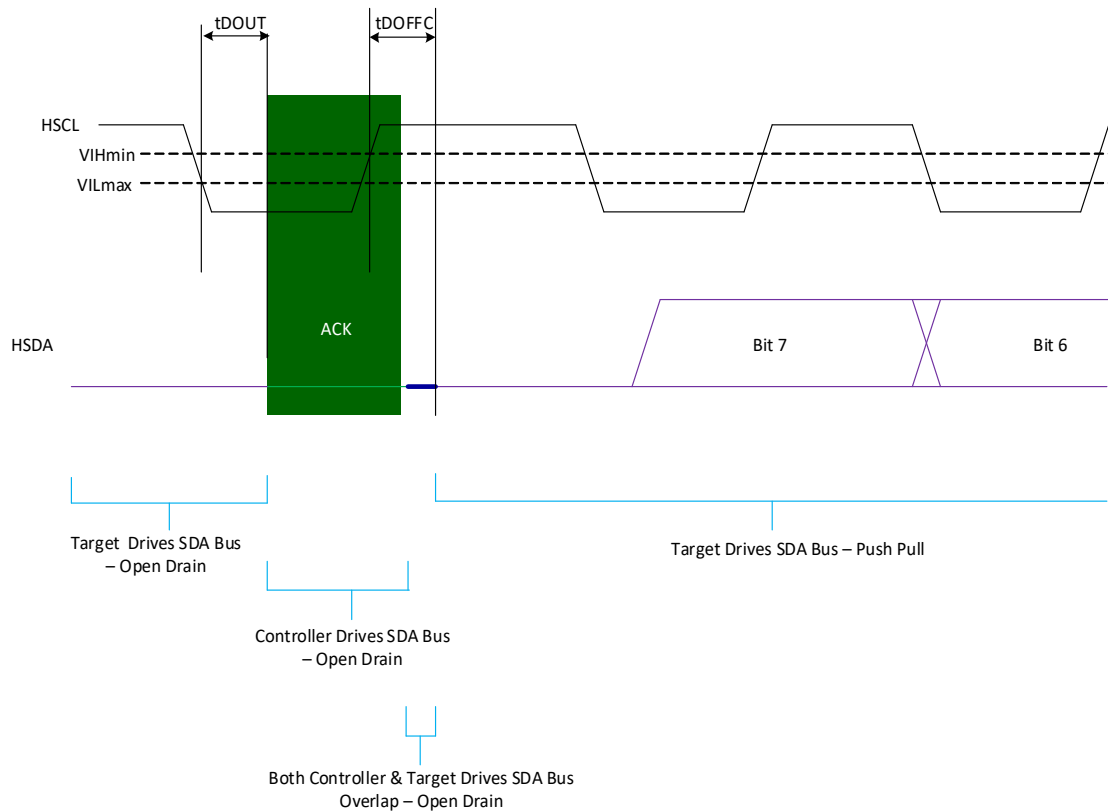


Figure 21 — Controller Open Drain (ACK) to Target Push Pull Hand Off Operation

1.13.5.3 Default Read Address Pointer Mode (cont'd)

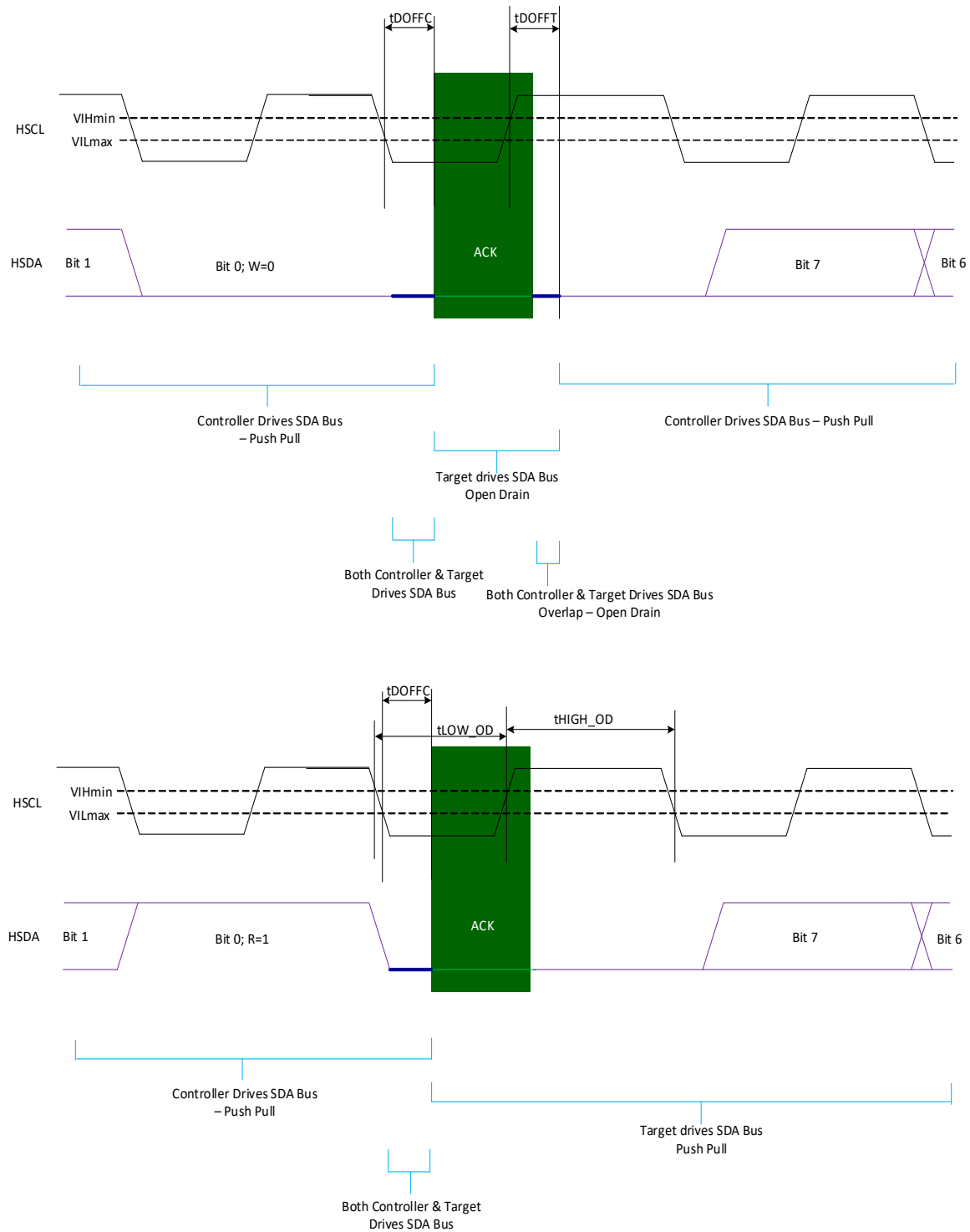


Figure 22 — Controller Push Pull to Target Open Drain Hand Off Operation

1.13.5.3 Default Read Address Pointer Mode (cont'd)

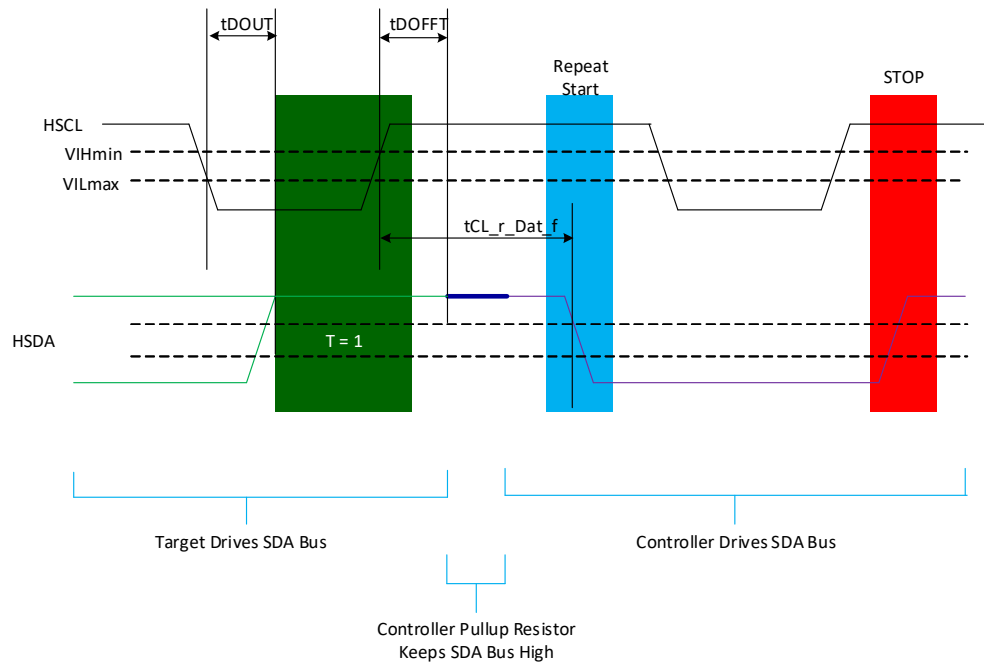


Figure 23 — T=1; Controller Ends Read with Repeated START and STOP Waveform

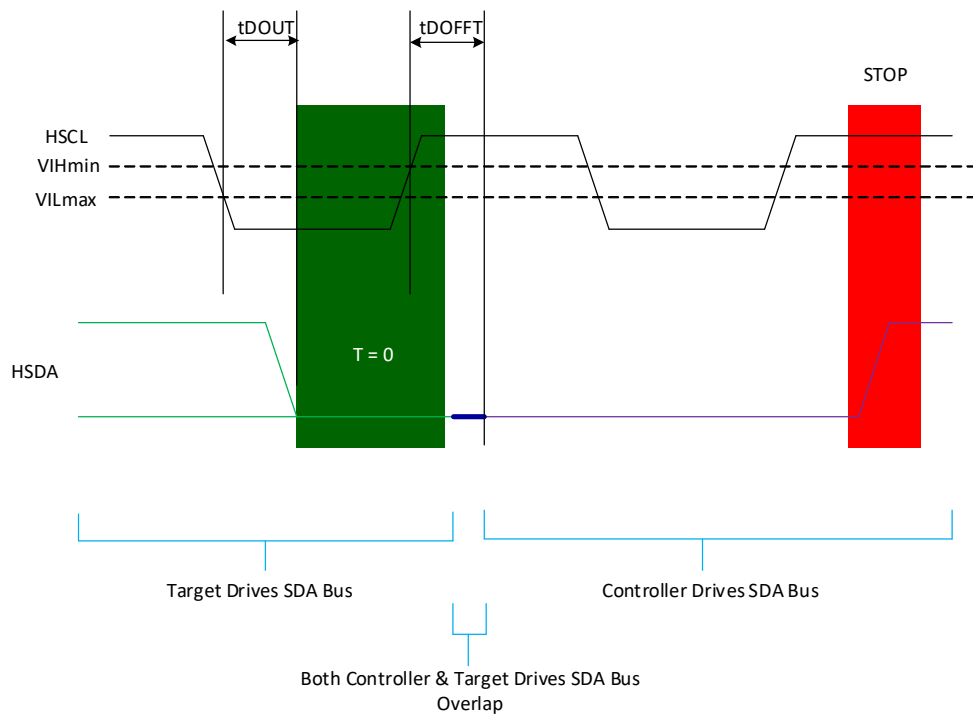


Figure 24 — T=0; Target Ends Read; Controller Generates STOP

1.13.6 In Band Interrupt (IBI)

In I²C mode, in band interrupt function is not supported. Only I3C Basic mode supports in band interrupt function.

1.13.6.1 Enabling and Disabling In Band Interrupt Function

By default, IBI function is disabled. The PMIC device enables the IBI when it registers ENEC CCC. Once enabled, the PMIC device sends an IBI when an event occurs.

- When Table 138, “Register 0x34” [6] = ‘1’, the device sends the IBI at next available opportunity when any of the register bits in Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:2], Table 97, “Register 0x0B” [7:0] and Table 137, “Register 0x33” [4:2] is set to ‘1’. The device also sets Table 96, “Register 0x0A” [1] to ‘1’ and updates Pending Interrupt Bits [3:0] = ‘0001’ for GETSTATUS CCC.
- When Table 138, “Register 0x34” [6] = ‘0’, the device does not send the IBI regardless of the register bits in Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:2], Table 97, “Register 0x0B” [7:0] and Table 137, “Register 0x33” [4:2]. However, the device set Table 96, “Register 0x0A” [1] to ‘1’ and updates Pending Interrupt Bits [3:0] = ‘0001’ for GETSTATUS CCC.

1.13.6.2 Mechanics of Interrupt Generation

Event interrupts may be generated by the local device if IBI is enabled. When there is a pending interrupt (i.e., Table 96, “Register 0x0A” [1] = ‘1’) and if IBI is enabled (i.e., Table 138, “Register 0x34” [6] = ‘1’) the PMIC device requests an interrupt after detecting START condition by transmitting its 7-bit binary address (LID bits followed by HID bits) followed by R/W = ‘1’ on the SDA bus serially (synchronized by SCL falling transitions).

If PMIC device detects no START condition but if the I3C bus (SDA and SCL) has been inactive (no edges seen) for t_{AVAL} period, then PMIC device may assert SDA low by $t_{\text{IBI_ISSUE}}$ time to request an interrupt. When the PMIC device requests an interrupt, the Host toggles the SCL. The PMIC device transmits its 7-bit binary address (LID bits followed by HID bits) followed by R/W bit = ‘1’ to the Host.

When the PMIC device requests an interrupt, the host may take one of the two actions below.

- The Host sends ACK on 9th bit to accept the interrupt request. At this point, if the PMIC device confirms that it has won the arbitration, the PMIC device transmits the IBI payload as shown in Table 43 and Table 44 for PEC disabled and PEC enabled configuration respectively. See Figure 25. Figure 25 just shows only first two data bits of the MDB byte to illustrate the timing. The interrupt payload contains MDB followed by Table 94, “Register 0x08”, Table 95, “Register 0x09”, Table 96, “Register 0x0A”, Table 97, “Register 0x0B”, and Table 137, “Register 0x33” bytes. The host then issues the STOP command. Note the timing waveform in Figure 25. The host then accepts the IBI payload if it sends an ACK on 9th bit to accept the interrupt request. The host can interrupt the IBI payload at T bit. If host stops the IBI payload at T bit in the middle of payload, the PMIC retains the IBI status flag (Table 96, “Register 0x0A” [1]) and Pending Interrupt Bits [3:0] internally and waits for the next opportunity to request an interrupt. If the PMIC device successfully transmits the entire IBI payload, it then clears IBI status flag (Table 96, “Register 0x0A” [1] = ‘0’) and Pending Interrupt Bits [3:0] = ‘0000’ on its own and does not request for an IBI again unless there is another different event occurs; for another same event, the device does not request for an IBI.

- The Host sends NACK on the 9th bit as shown in Figure 26 followed by a STOP command. In this case, the PMIC device does not transmit the IBI payload and waits for the next opportunity to request an interrupt. At this point, though Host sent an NACK, it does have a knowledge of which PMIC device sent the IBI request. The PMIC device retains the IBI status flag (Table 96, “Register 0x0A” [1] = ‘1’) and Pending Interrupt Bits [3:0] = ‘0001’

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/T	Stop
S	1	X	0	X	HID			R=1	A ¹	
	MDB = 0x00								T=1	
	R08 [7:0]								T=1	
	R09 [7:0]								T=1	
	R0A [7:0]								T=1	
	R0B [7:0]								T=1	
	R33 [7:0]								T=0 ²	
NOTE 1	See Figure 21 to see how the transition occurs from Host Open Drain (ACK) to Target Push Pull Operation (1st bit of MDB Byte bit [7]).									
NOTE 2	See Figure 24 to see how target device ends the operation followed by Host STOP operation.									

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/T	Stop
S	1	X	0	X	HID			R=1	A ¹	
	MDB 0x00								T=1	
	R08 [7:0]								T=1	
	R09 [7:0]								T=1	
	R0A [7:0]								T=1	
	R0B [7:0]								T=1	
	R33 [7:0]								T=1	
	PEC								T=0 ²	P
NOTE 1	See Figure 21 to see how the transition occurs from Host Open Drain (ACK) to Target Push Pull Operation (1st bit of MDB Byte bit [7]).									
NOTE 2	See Figure 24 to see how target device ends the operation followed by Host STOP operation.									

1.13.6.2 Mechanics of Interrupt Generation (cont'd)

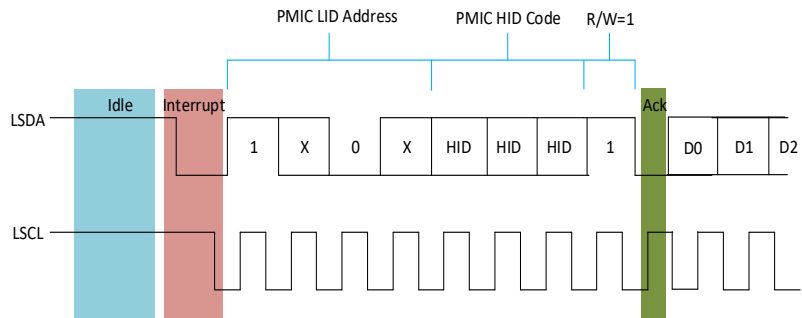


Figure 25 — PMIC Requests Interrupt, Host Ack followed by PMIC Device IBI Payload

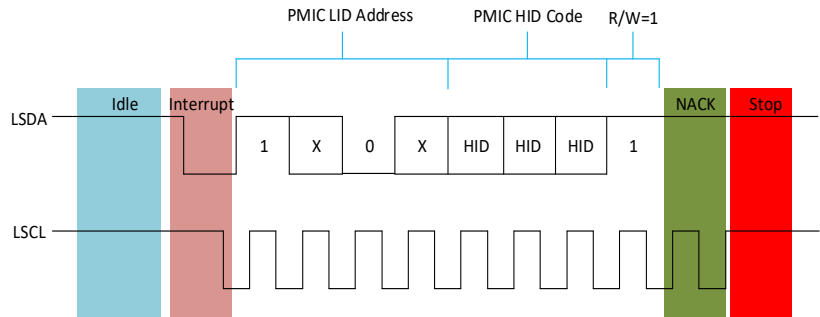


Figure 26 — PMIC Requests Interrupt; Host NACK followed by STOP

1.13.6.3 Interrupt Arbitration

As there are multiple devices I3C Basic bus, multiple device may request an interrupt when the Host I3C Basic bus is inactive for t_{AVAL} period. Arbitration process is required.

For DDR5 DIMM application environment, there could be up to total of 13 difference devices including the PMIC on I3C bus.

On a typical DDR5 DIMM application environment, all devices have the same 3-bit HID code. Hence the arbitration is always won by the lowest 4-bit LID code. For example, if one target device has LID code of '0010' and other device (PMIC) has a LID code of '1001', through the arbitration process, the target device LID code of '0010' wins. The PMIC device with a LID code of '1001' must release the bus and wait for next opportunity to request an interrupt. Table 45 shows the arbitration priority based on the LID code for all devices. The Green color cells in Table 45 are the likely devices that will be on a standard DDR5 RDIMM or DDR5 LRDIMM. The olive-colored cells in Table 45 do not apply.

1.13.6.3 Interrupt Arbitration (cont'd)

Table 45 — Interrupt Arbitration - Among All Devices

Device	LID Code	HID Code = '111'	Arbitration Priority
N/A	0000	N/A	N/A
RFU	0001	111	1
TS0	0010	111	2
RFU	0011	111	3
RFU	0100	111	4
RFU	0101	111	5
TS1	0110	111	6
RFU	0111	111	7
PMIC1	1000	111	8
PMIC0	1001	111	9
SPD Hub	1010	N/A	N/A
RCD	1011	111	10
PMIC2	1100	111	11
RFU	1101	111	12
RFU	1110	111	13
N/A	1111	N/A	N/A

In an uncommon but possible scenario would be that at the exact same time as when the Hub or local target devices (i.e., PMIC) are requesting an interrupt, the host is starting an operation to the Hub or local target devices (i.e., PMIC). When this happens, Host also gets involved in the arbitration process along with the Hub or the local target devices (PMIC). During the arbitration phase, there will be always only one winning device and it could be either Hub or the local target device (i.e., PMIC) or the Host.

If the host wins during the arbitration phase, it continues with normal operation. The losing Hub or local target device (i.e., PMIC) waits for next opportunity to send an interrupt.

If the host loses during the arbitration phase, it host must let go of the bus. When Host loses during the arbitration, the host must let the Hub or local target device (i.e., PMIC) finish sending their 4-bit LID code followed by 3-bit HID code followed by R/W = '1'. At this point, during the 9th bit, the host has two options to take the action as noted below:

- Host sends an ACK to accept the interrupt and hence accepts the IBI payload from the winning Hub or local target device (i.e., PMIC). After the IBI payload, the host issues STOP operation.
- Host sends an NACK followed by STOP operation.

In a rare but still possible scenario would be that at the exact same time as when the PMIC is requesting an interrupt, the host is starting an operation to the same PMIC. When this happens, neither Host or nor the PMIC knows it is a winner until the 8th bit and Host always wins. This is because, the PMIC sends R=1 (8th bit) during the interrupt. The host sets W=0 (8th bit) during the operation. As a result, the host wins and the PMIC must let go of the bus and wait for the next opportunity to send an interrupt.

1.13.6.3 Interrupt Arbitration (cont'd)

In an extremely rare but still possible scenario would be that at the same exact time as when PMIC device is requesting an interrupt, the host is requesting a read operation with the default read address pointer mode to the PMIC device. When this happens, there is no winning device. This is the only time there is no winning device. This is because, the PMIC device sends R=1 (8th bit) during the interrupt and Host also sends R=1 for read request with default read address pointer mode. As a result, there is no winner because Host is waiting for PMIC to ACK and PMIC is waiting for Host to ACK. In this case, neither Host nor PMIC will ACK. Since there is no ACK (i.e., NACK) by either device, the Host must time out and repeat the read request with Repeat Start. When Host repeats the read request with Repeat Start, the PMIC does not send an interrupt because of Repeat Start.

1.13.6.4 Clearing Device Status and IBI Status Registers

The PMIC device provides the IBI status in Table 96, “Register 0x0A” [1] by setting it to ‘1’. The PMIC device clears the IBI status register Table 96, “Register 0x0A” [1] to ‘0’ automatically when it sends a complete IBI (including payload and without interruption) and it also clears Pending Interrupt Bits [3:0] to ‘0000’. Once IBI status register is cleared, the PMIC does not request for an IBI again unless another event occurs.

The PMIC device provides the device status in Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:2], Table 97, “Register 0x0B” [7:0], and Table 137, “Register 0x33” [4:2] registers. The status information in Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:2], Table 97, “Register 0x0B” [7:0], and Table 137, “Register 0x33” [4:2] registers are latched and remains set even after the PMIC device sends IBI payload and clears the IBI status register Table 96, “Register 0x0A” [1] to ‘0’. The host must explicitly clear the status register through Clear command by writing ‘1’ for appropriate status or by issuing a Global clear command.

After Host issues clear command, if the condition is no longer present, the PMIC device clears the appropriate status register, clears the IBI status register to ‘0’ and Pending Interrupt Bits [3:0] to ‘0000’ even if the PMIC device has not sent the IBI. After Host issues clear command, if the condition is still present, the device will again set the appropriate status register, sets the IBI status register to ‘1’ and Pending Interrupt Bits [3:0] to ‘0001’ even if the device has already sent the IBI and entire IBI payload.

1.13.7 Packet Error Check (PEC) Function

In I²C mode, packet error checking is not supported. Only I3C Basic mode supports packet error checking.

The PMIC device implement an 8-bit Packet Error Code (PEC) which is appended at the end of all transactions if PECs is enabled through DEVCTRL CCC or by directly writing ‘1’ to Table 138, “Register 0x34” [7]. The PEC is a CRC-8 value calculated on all the messages bytes except for START, STOP, REPEATED START conditions or T-bits, ACK and NACK and IBI header (7’h7E followed W=0) bits.

The polynomial for CRC-8 calculations is:

$$\bullet C(X) = X^8 + X^2 + X^1 + 1$$

The seed value for PEC function is all zero.

When Host calculates PEC for PMIC device, it includes LID and HID bits followed by R/W bit.

1.13.8 Parity Error Check Function

In I²C mode, parity error checking is not supported except for supported CCCs. Only I3C Basic mode supports parity error checking.

By default, when PMIC device is put in I3C Basic mode, parity function is automatically enabled. The host can disable the function after it is enabled. Host can also disable the parity function with DEVCTRL CCC or by directly writing '1' to Table 138, "Register 0x34" [5]. When parity function is disabled, the PMIC device simply ignores the "T" bit information from the Host. The host may actually choose to compute the parity and send that information during "T" bit or simply drive static low or high in "T" bit.

The PMIC device implements ODD parity. If an odd number of bits in the byte are '1', the parity bit value is '0'. If even number of bits in the byte are '1', the parity bit value is '1'. The host computes the parity and sends during "T" bit.

1.13.9 Packet Error Check and Parity Error Handling

There are two types of error checking done by the PMIC device. Parity error checking and Packet Error checking. By default, the parity error checking is always enabled and packet error checking is disabled. The host may enable the packet error checking at any time. The parity error is checked for each byte in a packet except for the device select code byte from the host. The host sends parity error information in "T" bit.

I3C Basic defines TE0, TE1, TE2, TE3, TE4, TE5, TE6 error detection for target devices. Only TE1 and TE2 error detection is supported by the PMIC for parity checking. All other errors are not supported and not applicable.

1.13.9.1 Write Command Data Packet Error Handling - PEC Disabled

The PMIC device checks for the parity error for each byte in a packet that it receives from the host except for the device select code byte that it receives from the host as shown in Table 46.

Table 46 — Write Command Data Packet; PEC Disabled

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	X	0	X	HID			W=0	A ^{1,2,3}	
	Address [7:0]								T	
	Data								T	
	...								T	
	Data								T	Sr ⁴ or P
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC NACKs if there is a parity error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	The PMIC does not check for parity error in subsequent bytes when it determines the 7-bit device select code issues by the host does not match with its own device code. The PMIC ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 4	Repeat Start or Repeat Start with 7'h7E.									

Write command - if no parity error:

- The PMIC device executes the command.

Read Command - If no parity error:

1.13.9.3 Write Command Data Packet Error Handling - PEC Is Enabled (cont'd)

Write command - if no parity error:

- The PMIC device waits for the entire packet. If no error in packet, the PMIC device executes the command. If there is an error in the packet, the PMIC device discards the entire packet and does not execute the packet and waits for STOP; sets the Table 96, “Register 0x0A” [3,1] to ‘11’; PEC_Err in GETSTATUS CCC to ‘1’; updates Pending Interrupt Bits [3:0] in GETSTATUS CCC to ‘0001’; asserts GSI_n pin if enabled and waits for the next opportunity to send an in band interrupt if IBI is enabled.

Write command - if parity error:

- The PMIC device discards that byte and the entire packet until STOP operation.
- The PMIC device sets the Table 96, “Register 0x0A” [2:1] to ‘11’; P_Err in GETSTATUS CCC to ‘1’; updates Pending Interrupt Bits [3:0] in GETSTATUS CCC to ‘0001’; asserts GSI_n pin if enabled and waits for the next opportunity to send an in band interrupt if IBI is enabled.
- The PMIC device may or may not check the error for the packet. If the PMIC device checks for the packet error, likely it will detect an error in the packet and the device may also set Table 96, “Register 0x0A” [3] and PEC_Err in GETSTATUS CCC as well.

1.13.9.4 Read Command Data Packet Error Handling - PEC Is Enabled

The PMIC device checks for parity error for each byte in a packet except for the device select code byte that it receives from the host prior to Repeat Start as shown in Table 49.

The PMIC device does not compute the parity when it sends the data to the Host. The does not check for parity error for the bytes shown in Table 49. The device sends Continuous (‘1’) or Stop (‘0’) information during “T” bit when PMIC device is sending the read data.

The PMIC device checks for the PEC error in a packet that it receives from Host from Start condition to Repeat Start (from first device select code followed by the address offset and CMD byte).

The PMIC device computes the packet error code for the entire packet starting with Repeat Start (device select code and the data PMIC device transmits back to Host).

1.13.9.4 Read Command Data Packet Error Handling - PEC Is Enabled (cont'd)**Table 49 — Read Command Data Packet; PEC Enabled**

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	X	0	X	HID			W=0	A ^{1,2,3}	
	Address [7:0]								T	
	CMD			R=1	0	0	0	0	T	
	PEC								T	
Sr	1	X	0	X	HID			R=1	A/N ^{4,5}	
	Data								T=1	
	...								T=1	
	Data								T=1	
	PEC								T=0 ⁶	
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation (1st bit of Addr, bit [7]).									
NOTE 2	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	The PMIC does not check for parity or PEC error in subsequent bytes when it determines the 7-bit device select code issues by the host does not match with its own device code. The PMIC ignores the entire packet until STOP or next Repeat Start operation.									
NOTE 4	If target device NACKs during Repeat Start for any reason, the host may re-try Repeat Start again. The host can do the Repeat Start as many times it may desire. If target device NACKs due to PEC error or parity error in previous bytes, it will always NACK regardless of how many times the Host tries Repeat Start. If there were no parity or PEC errors, the PMIC may eventually ACK. The PEC calculation by the target device only includes device select code of the ACK response of the Repeat start operation. In other words, if there are more than one Repeat Start operation, the target device includes device select of only the last Repeat Start from the Host when it ACKs in PEC calculation and all other NACK responses of the device select code of the Repeat Start are not included in PEC calculation.									
NOTE 5	See Figure 22 to see how the transition occurs from Host Push Pull Operation to Target Open Drain (ACK).									
NOTE 6	See Figure 24 to see how target device ends the operation followed by Host STOP operation.									
NOTE 7	Repeat Start or Repeat Start with 7'h7E.									

Read command - If no parity error and no PEC error

- The PMIC device sends ACK back to the host when Host perform a Start Repeat operation.
- The PMIC device executes the command and sends the data as shown in Table 49.
- The PMIC computes PEC for the bytes (from Start condition to PEC byte prior to Repeat Start) shown in the cells in Table 49.

Read command - if parity error or PEC error

- The PMIC device discards the byte in the packet that had a parity error.
- The PMIC device discards second byte in that packet if a parity error occurred in first byte. The PMIC device may or may not check parity for the second byte in that packet.
- The PMIC device discards the packet if there is a PEC error.

1.13.9.4 Read Command Data Packet Error Handling - PEC Is Enabled (cont'd)

- The PMIC sends NACK back to the host when Host perform Start Repeat operation. This is shown in the **RED color** cell in Table 49. The NACK represents either PEC error or a parity error in one of the three bytes or that PMIC is not able to start the read operation. The host may re-try Repeat Start again. The host may do the Repeat Start as many times it may desire. The PEC calculation by PMIC device only includes device select code of the ACK responses of the Repeat Start operation. In other words, if there are more than one Repeat Start operation, the PMIC device includes the device select of only the last Repeat Start from the Host when it ACKs in PEC calculation and other NACK responses of the device select codes of the Repeat Start are not included in PEC calculation. If the PMIC target device NACKs due to PEC error or a parity error in a previous bytes from Host, it will always NACK regardless of how many times Host tries Repeat Start.
- The PMIC device does not send any data shown in Table 49 and instead expects Host to perform STOP operation.
- The PMIC device sets Table 96, “Register 0x0A” [3:2] accordingly and Table 96, “Register 0x0A” [1] to ‘1’; P_Err, PEC_Err in GETSTATUS CCC to ‘1’ accordingly; updates Pending Interrupt Bits [3:0] in GETSTATUS CCC to ‘0001’; asserts GSI_n pin if enabled and waits for the next opportunity to send an in band interrupt if IBI is enabled.

1.13.10 CCC Packet Error Handling

Parity error and PEC error detected in a CCC packet are handled the same way as described for normal Read/Write operations.

1.13.11 Error Reporting

All error conditions detected by the PMIC devices are captured in Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:1] Table 97, “Register 0x0B” [7:0], and Table 137, “Register 0x33” [4:2] registers.

There are four different possible ways error information can be communicated to the host.

1. The host makes the read request to Table 94, “Register 0x08”, Table 95, “Register 0x09”, Table 96, “Register 0x0A”, Table 97, “Register 0x0B”, and Table 137, “Register 0x33” registers.
2. The host starts any transactions with Start condition followed by 7'h7E IBI header (Only applicable in I3C Basic mode).
3. The PMIC device sends in band interrupt if enabled, when its SCL and SDA input has been idle for t_{AVAL} time (Only applicable in I3C Basic mode).
4. The PMIC device asserts GSI_n pin if enabled.

1.13.12 I3C Basic Common Command Codes (CCC)

The I3C Basic spec lists large number of Common Command Codes (CCC). Not all CCC are required to be supported. The PMIC device NACKs for all unsupported CCC. The PMIC supports CCC as listed in Table 50.

1.13.12 I3C Basic Common Command Codes (CCC) (cont'd)

The PMIC device requires STOP operation in between when switching from CCC operation to private device specific Write or Read or Default Read Address Pointer mode operation and vice versa. In other words, any CCC operation must be followed by STOP operation before continuing to any device specific Write or Read or Default Read Address Pointer mode operation. Similarly, any device specific Write or Read or Default Read Address Pointer mode operation must be followed by STOP operation before continuing to any CCC operation. The PMIC device also requires STOP operation between any direct CCC to broadcast CCC.

The PMIC device does allow Repeat Start operation between any direct CCC to any other direct CCC or between any broadcast CCC to any other broadcast CCC or between any private Write or Read or Default Read Address Pointer mode operation to any other private Write or Read or Default Read Address Pointer mode operation.

Table 50 — PMIC CCC Support Requirement

CCC	Mode	Code	Description	Note
ENEC	Broadcast	0x00	Enable Event Interrupts	
	Direct	0x80		
DISEC	Broadcast	0x01	Disable Event Interrupts	
	Direct	0x81		
RSTDAA	Broadcast	0x06	Put the device in I ² C Mode (aka: Reset Dynamic Address Assignment)	
SETAASA	Broadcast	0x29	Put the device in I3C Basic Mode (aka: Set All Addresses to Static Address)	
GETSTATUS	Direct	0x90	Get Device Status	
DEVCAP	Direct	0xE0	Get Device Capability	1
SETHID	Broadcast	0x61	PMIC updates 3-bit HID field	1
DEVCTRL	Broadcast	0x62	Configure SPD Hub and all devices behind Hub	1
NOTE 1 JEDEC specific CCC.				

1.13.12.1 ENEC CCC

The ENEC CCC is only supported after device is put in I3C Basic mode. In I²C mode, it is illegal for host to issue this CCC. When ENEC CCC is registered by the PMIC, it updates Table 138, “Register 0x34” [6] = ‘1’ and it takes in effect at the next Start operation (i.e., after STOP operation). Table 51 to Table 54 show an example of a single ENEC CCC. Table 55 shows the encoding definition for ENEC CCC.

If PEC function is enabled, the PEC calculation starts with Start or Repeat Start operation but does not include 7'h7E with W=0 byte in PEC calculation.

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x80 (Direct)								T	
Sr	DevID[6:0]							W=0	A ^{1,2}	
	0x00							ENINT	T	Sr3 or P
NOTE 1	The PMIC NACKs if there is a parity error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	The PMIC device does not check for parity error in subsequent bytes when it determines 7-bit device select code issued by the Host does not match with its own device code. The PMIC device ignores the entire packet until STOP operation or next Repeat Start operation.									
NOTE 3	Repeat Start or Repeat Start with 7'h7E.									

Table 54 — ENEC CCC - Direct with PEC

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x80 (Direct)								T	
	PEC								T	
Sr	DevID[6:0]							W=0	A ^{1,2}	
	0x00							ENINT	T	
	PEC							T	Sr ³ or P	
NOTE 1	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	The PMIC device does not check for parity error in subsequent bytes when it determines 7-bit device select code issued by the Host does not match with its own device code. The PMIC device ignores the entire packet until STOP operation or next Repeat Start operation.									
NOTE 3	Repeat Start or Repeat Start with 7'h7E.									

Table 55 — ENEC CCC Byte Encoding

Bit	Encoding	Notes
ENINT	0 = No Action 1 = Enable IBI Interrupt	It is illegal for Host to issue ENEC CCC with ENINT bit = '0'

1.13.12.2 DISEC CCC

The DISEC CCC is only supported after device is put in I3C Basic mode. In I²C mode, it is illegal for host to issue this CCC. When DISEC CCC is registered by the PMIC, it updates Table 138, “Register 0x34” [6] = ‘0’ and it takes in effect at the next Start operation (i.e., after STOP operation). Table 56 to Table 59 show an example of a single DISEC CCC. Table 60 shows the encoding definition for DISEC CCC.

If PEC function is enabled, the PEC calculation starts with Start or Repeat Start operation but does not include 7'h7E with W=0 byte in PEC calculation.

Table 56 — DISEC CCC - Broadcast

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x01 (Broadcast)								T	
	7'h00							DISINT	T	
NOTE 1	The PMIC NACKs if there is a parity error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	Repeat Start or Repeat Start with 7'h7E.									

Table 57 — DISEC CCC - Broadcast with PEC

Table 58 — DISEC CCC - Direct

Table 59 — DISEC CCC - Direct with PEC

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x81 (Direct)								T	
	PEC								T	
Sr	DevID[6:0]							W=0	A ^{1,2}	
	0x00							DISINT	T	
	PEC								T	Sr ³ or P
NOTE 1	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	The PMIC device does not check for parity error in subsequent bytes when it determines 7-bit device select code issued by the Host does not match with its own device code. The PMIC device ignores the entire packet until STOP operation or next Repeat Start operation.									
NOTE 3	Repeat Start or Repeat Start with 7'h7E.									

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x06 (Broadcast)								T	
	PEC								T	
NOTE 1	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									

NOTE 2 Repeat Start or Repeat Start with 7'h7E.

1.13.12.5 GETSTATUS CCC (cont'd)**Table 65 — GETSTATUS CCC - Direct with PEC**

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ¹	
	0x90 (Direct)								T	
	PEC								T	
Sr	DevID[6:0]							R=1	A	
	PEC_Err	0	0	0	0	0	0	0	T	
	0	0	P_Err	R32[3]	Pending Interrupt				T	
	PEC								T	Sr ² or P
NOTE 1	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	Repeat Start or Repeat Start with 7'h7E.									

Table 66 — GETSTATUS CCC Byte Encoding

Bit	Encoding	Notes
PEC_Err	0 = No Error 1 = PEC Error Occurred	This register is cleared when Host issues clear command to Table 104, "Register 0x12" [3] for PEC error
P_Err	0 = No Error 1 = Protocol Error; Parity Error occurred	This register is cleared when Host issues clear command to Table 104, "Register 0x12" [2] for Parity error.
R32[3]	See Table 136, "Register 0x32" for encoding.	PMIC reflects the register status of R32[3] in this bit.
Pending Interrupt	0000 = No Pending Interrupt or No New Global Status Event 0001 = Pending Interrupt or New Global Status Event All other encodings are reserved	This register is cleared when Host issues clear command to any appropriate device status register that causes IBI status register to get cleared.

When the PMIC device responds to GETSTATUS CCC, after it completes the response, the PEC_Err, P_Err and Pending Interrupt Bits [3:0] do not automatically get cleared. The host must explicitly clear the appropriate status register through Clear command by writing '1' to corresponding register or by issuing Global Clear command. Once the PMIC device clears the appropriate status register, only then PEC_Err, P_err and Pending Interrupt Bits [3:0] gets cleared.

After host issues clear command, if the condition is still present, the device will again set the appropriate status register, sets the IBI status register to '1' and Pending Interrupt Bits [3:0] to '0001'.

Table 68 — DEVCAP CCC - Direct with PEC

1.13.12.6 DEVCAP CCC (cont'd)**Table 69 — DEVCAP CCC Byte Encoding**

Bit	Encoding	Notes
MSB [7]	RFU	Coded as '0'
MSB[6]	RFU	Coded as '0'
MSB[5]	RFU	Coded as '0'
MSB[4]	RFU	Coded as '0'
MSB[3]	RFU	Coded as '0'
MSB[2]	0 = No Support for Timer based Reset 1 = Supports Timer based Reset	Coded as '1'
MSB[1:0]	RFU	Coded as '00'
LSB[7:0]	RFU	Coded as '0x00'

1.13.12.7 SETHID CCC

The SETHID CCC is supported only when device is in I²C mode. In I²C mode, when host issues this CCC, to guarantee that this CCC is registered by the device without any error, the host shall limit the maximum speed operation for this CCC to 1 MHz. In I3C Basic mode, it is illegal for host to issue this CCC. When SETHID CCC is registered by the PMIC, it updates Table 138, "Register 0x34" [3:1] with the HID code received by the PMIC and it takes in effect at the next Start operation (i.e., after STOP operation). Table 70 shows an example of a single SETHID CCC. As the device is in I²C mode when SETHID CCC is issued, the PEC function is not supported.

Once PMIC receives SETHID CCC and updates its 3-bit HID code, after the Stop operation, PMIC device only responds to updated 7-bit address. The 4-bit LID code of the PMIC device remains as is.

The Host may issue SETHID CCC more than one time.

Table 70 — SETHID CCC - Broadcast

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A	
	0x61 (Broadcast)								T	
	0	0	0	0	HID[2:0]		0		T	P

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	AddrMask[2:0]			StartOffset[1:0]		PEC BL[1:0]		RegMod	T	
	DevID[6:0]							0	T ²	
	Byte 0 Data Payload								T	
	Byte 1 Data Payload								T	
	Byte 2 Data Payload								T	
	Byte 3 Data Payload								T	Sr ³ or P
NOTE 1	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 2	An exception is made for DEVCTRL CCC. The PMIC does not report parity error when it determines 7-bit device select code issues by the host does not match with its own device code. If 7-bit device select code does not match but if parity is still valid, the device does not check for parity error in subsequent bytes; ignores the entire packet and waits until STOP or Repeat Start operation.									
NOTE 3	Repeat Start or Repeat Start with 7'h7E.									

Table 72 — DEVCTRL CCC - Broadcast with PEC¹

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S or Sr	1	1	1	1	1	1	0	W=0	A ²	
	0x62 (Broadcast)								T	
	AddrMask[2:0]			StartOffset[1:0]		PEC BL[1:0]		RegMod	T	
	DevID[6:0]							0	T ³	
	Byte 0 Data Payload								T	
	Byte 1 Data Payload								T	
	Byte 2 Data Payload								T	
	Byte 3 Data Payload								T	
	PEC								T	Sr ⁴ or P
NOTE 1	DEVCTRL CCC with PEC check is only supported in I3C mode.									
NOTE 2	The PMIC NACKs if there is a parity or PEC error in a previous transaction when host performs consecutive transactions with Repeat Start.									
NOTE 3	An exception is made for DEVCTRL CCC. The PMIC does not report parity error when it determines 7-bit device select code issues by the host does not match with its own device code. The device does not check for PEC as all subsequent bytes are discarded due to parity error. If 7-bit device select code does not match but if parity is still valid, the device does not check for parity error in subsequent bytes; ignores the entire packet and waits until STOP or Repeat Start operation.									
NOTE 4	Repeat Start or Repeat Start with 7'h7E.									

1.13.12.8 DEVCTRL CCC (cont'd)**Table 73 — DEVCTRL CCC Command Definition**

Parameter	Definition
AddrMask[2:0]	<p>Broadcast, Unicast or Multicast Command Selection</p> <p>000 = Unicast Command; PMIC device responds if DevID[6:0] field matches with PMIC device's own 7-bit address (4-bit LID + 3-bit HID)</p> <p>011 = Multicast Command; PMIC device and possible other device responds if DevID[6:3] field matches with PMIC device's own 4-bit LID address</p> <p>111 = Broadcast Command; All devices responds to this command</p> <p>All other encodings are reserved</p>
StartOffset[1:0]	<p>Only applicable if RegMod = '0'</p> <p>Identifies the starting Byte (Byte 0 or Byte 1 or Byte 2 or Byte 3) for DEVCTRL CCC. Host can start at any Byte (from Byte 0 to Byte 3) and has continuous access to next byte until STOP operation. If Byte 3 is reached, the host is responsible for applying STOP operation.</p> <p>00 = Byte 0 01 = Byte 1 10 = Byte 2 11 = Byte 3</p>
PEC BL[1:0]	<p>Only applicable if RegMod = '0' and PEC function is enabled.</p> <p>Identifies the burst length just for this DEVCTRL CCC. The device uses the setting in this field to know when the PEC byte is expected after the data bytes.</p> <p>00 = 1 Byte 01 = 2 Byte 10 = 3 Byte 11 = 4 Byte</p>
RegMod	<p>Identifies if DEVCTRL is going to be used for General Registers as identified in Byte 0 to Byte 3 or device specific address offset register.</p> <p>0 = Access to General Registers in Byte 0 to Byte 3 (i.e., StartOffset[1:0] = Valid) 1 = Device Specific Offset Address (i.e., StartOffset[1:0] and PECBL[1:0] is a don't care and does not apply). The Host shall NOT use RegMod = '1' with Broadcast Command if there are different types of devices on the I3C Basic bus.</p>
DevID[6:0]	<p>Identifies 7-bit device address. Device responds to DEVCTRL CCC data packet depending on AddrMask[2:0].</p> <p>If AddrMask[2:0] = '111', DevID[6:0] is a don't care and device always responds. If AddrMask[2:0] = '000', DevID[6:0] must match for device to respond If AddrMask[2:0] = '011', DevID[6:3] must match for device to respond. DevID[2:0] is don't care. For any other codes for AddrMask[2:0], the device always NACKs.</p>

1.13.12.8 DEVCTRL CCC (cont'd)**Table 74 — DEVCTRL CCC Data Payload Definition**

Byte #	Bit #	Function	Definition	Comment
Byte 0	[7]	PEC Enable	0 = Disable 1 = Enable	Table 138, “Register 0x34” [7] is updated
	[6]	Parity Disable	0 = Enable 1 = Disable	Table 138, “Register 0x34” [5] is updated
	[5:2]	RFU	RFU	
	[1]	VR Enable	0 = VR Disable 1 = VR Enable	Table 136, “Register 0x32” [7] is updated.
	[0]	RFU	RFU	
Byte 1	[7:4]	RFU	RFU	
	[3]	Global & IBI Clear	0 = No Action 1 = Clear All Event and pending IBI ¹	Table 106, “Register 0x14” [0] is updated.
	[2:0]	RFU	RFU	
Byte 2	[7:0]	RFU	RFU	
Byte 3	[7:0]	RFU	RFU	
NOTE 1 After target device clears the event, the device can still have certain registers set to ‘1’ if the event is still present in which case, the device will generate an IBI again at the next opportunity.				

1.13.12.8.1 DEVCTRL CCC Examples - RegMod = ‘0’

Table 75 shows an example of DEVCTRL CCC data packet. It assumes that all devices on the bus are already in I3C Basic mode with PEC function disabled and parity function enabled. In this example, the Host uses DEVCTRL CCC as Multicast command. Host sends Multicast command to all devices with 4-bit LID code of ‘1001’ on I3C Basic bus to do VR Enable followed by all devices with 4-bit LID code of ‘0110’ to disable parity function. The host sends AddrMask = ‘011’ to indicate Multicast command with DevID[6:3] match; StartOffset = ‘00’ to indicate starting Byte 0 and RegMod = ‘0’ to indicates general register. Upon receiving this command, all devices with DevID[6:3] that matches to ‘1001’ will do the VR Enable command and DevID[6:3] that matches to ‘0110’ with disable the parity function.

1.13.12.8.1 DEVCTRL CCC Examples - RegMod = '0' (cont'd)**Table 75 — DEVCTRL CCC Example - Multicast Command to '1001' and '0110' Devices**

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	011			00		00		0	T	
	1001 000							0	T	
	0000 0010								T	
Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	011			00		00		0	T	
	0110 000							0	T	
	0100 0000								T	P
NOTE 1 See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation.										

Table 76 shows an example of DEVCTRL CCC data packet. It assumes that all devices on the bus are already in I3C Basic mode with PEC function disabled and parity function enabled. In this example, the Host uses DEVCTRL CCC as Broadcast command to enable PEC function. The host sends AddrMask = '111' to indicate Broadcast command; StartOffset = '00' to indicate starting Byte 0 and RegMod = '0' to indicates general register. Upon receiving this command, all devices will enable PEC function.

Table 76 — DEVCTRL CCC Example - Broadcast Command to All Devices

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	111			00		00		0	T	
	0000 000							0	T	
	1000 0000								T	
NOTE 1 See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation.										

Table 77 shows an example of DEVCTRL CCC data packet. It assumes that all devices on the bus are already in I3C Basic mode with PEC function disabled and parity function enabled. In this example, the Host uses DEVCTRL CCC as Unitcast command to enable VR on DIMM5. The host sends AddrMask = '000' to indicate Unicast command; StartOffset = '00' to indicate starting Byte 0 and RegMod = '0' to indicates general register. Upon receiving this command, PMIC on DIMM5 will enable its regulator.

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	000			00		00		0	T	
	1001 101							0	T	
	0000 0010								T	
NOTE 1	See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation.									

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	011			00		00		1	T	
	0010 000							0	T	
	0001 1100 (address offset 0x1C)								T	
	0010 0000 (CMD field = 2 bytes of data)								T	
	1111 1111 (data)								T	
	0101 0101 (data)								T	
	PEC								T	
Sr	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	011			00		00		1	T	
	1001 000							0	T	
	0001 0101 (address offset 0x15)								T	
	0000 0000 (CMD field = 1 byte of data)								T	
	0111 1000 (data)								T	
	PEC								T	

NOTE 1 See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation.

1.13.12.8.2 DEVCTRL CCC Examples - RegMod = '1' (cont'd)

Table 79 shows an example of DEVCTRL CCC data packet for the purpose of configuring device specific address offset register. It assumes that all devices on the bus are already in I3C Basic mode with PEC function disabled and parity function enabled. In this example, the Host sends Multicast command to all devices with 4-bit LID code of '1001' on the I3C Basic bus to write to address offset of 0x13 with data 0xFF and it continues to write data 0x01 to the next address.

Table 79 — DEVCTRL CCC Example - Multicast Command to '1001' Devices

Start	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	A/N/T	Stop
S	1	1	1	1	1	1	0	W=0	A ¹	
	0x62 (Broadcast)								T	
	011			00		00		1	T	
	1001 000							0	T	
	0001 0011 (address offset 0x13)								T	
	1111 1111 (data)								T	
	0000 0001 (data)								T	P
NOTE 1 See Figure 20 to see how the transition occurs from Target Open Drain (ACK) to Host Push Pull Operation.										

1.13.13 IO Operation

At power on, by default, the PMIC device comes up in legacy I²C mode of operation with Open Drain IO for its interface. The maximum speed is limited to 1 MHz and supported IO voltage levels are from 1.0 V to 3.3 V.

After power on, the host may put the PMIC device in I3C Basic mode of operation.

In I3C Basic mode, the host may drive the SCL clock input of the PMIC device using either Push-Pull output driver or using the open-drain output driver. It is expected that for all DDR5 DIMM family environment, the host may always drive the SCL clock input using a Push-Pull output driver.

To support in band interrupt, the PMIC device supports dynamic switching between Open Drain mode and Push Pull mode on its SCL and SDA bus for various event. Table 80 describes the different mode of operation by the PMIC device for each cycle.

1.13.13 IO Operation (cont'd)

Table 80 — PMIC Device Dynamic IO Operation Mode Switching

	Open Drain Mode	Push Pull Mode
START + Device Select Code	Yes	No
START + 7'h7E IBI Header Byte	Yes	No
REPEAT START + Device Select Code	No	Yes
REPEAT START + 7'h7E Header Byte	No	Yes
CCC Bytes (i.e., after 7'h7E+W=0+ACK)	No	Yes
STOP	No	Yes
ACK/NACK Responses	Yes	No
Command, Block Address, Address Operation	No	Yes
Interrupt Request by Target + Device Select Code	Yes	No
IBI Payload	No	Yes
Write Data, T-bit sequence	No	Yes
Read Data, T-bit sequence	No	Yes
PEC, T-bit sequence	No	Yes

1.13.14 Bus Clear

The PMIC device supports the following described Bus Clear feature in I²C mode only. Any attempt by host to perform I²C Bus clear on a target device in I³C mode may result in an active drive bus contention on the SDA data line.

There may be abnormal circumstances when the host abruptly stops clocking SCL while the target device is in the middle of outputting data for read operation. For these type of events, the SDA data line may appear as stuck low as the device is expecting to receive more clock pulses from the host. Eventually when the host has control of the SCL clock, the host may optionally clear the device that is stuck low on the SDA data line by sending continuous 18 clock pulses without driving the SDA data line followed by STOP operation. The device floats the SDA line within 18 clock pulses and returns to the Idle state. The device is ready for normal new transaction with Start condition.

1.13.15 Bus Reset

To prevent a malfunctioning device from locking up the I²C bus or I³C Basic bus, a bus reset mechanism is defined. It uses a timeout mechanism on SCL as shown in Figure 27 to force a device bus reset. All devices on a I²C or I³C Basic bus reset simultaneously. Bus reset operation works same way regardless of whether device is operating in I²C or I³C Basic mode.

To guarantee the device resets I²C bus or I³C Basic bus, the SCL clock input Low time has to be greater than or equal to $t_{\text{TIMEOUT(Max)}}$.

The PMIC device does not reset I²C bus or I³C Basic bus if the SCL clock input Low time is less than $t_{\text{TIMEOUT(Min)}}$.

1.13.15 Bus Reset (cont'd)

If the SCL clock input Low time is between $t_{\text{TIMEOUT(Min)}}$ and $t_{\text{TIMEOUT(Max)}}$, the PMIC device does not guarantee and it may or may not reset the I²C bus or I3C Basic bus.

When RESET, the PMIC device takes following action.

1. Interface and any pending command or transactions are cleared
2. All internal register values are preserved unless noted otherwise in item # 3 below.
3. Device returns to I²C mode of operation; Table 138, “Register 0x34” [3:1] resets to ‘111’; Table 138, “Register 0x34” [7:5] resets to ‘000’; Table 136, “Register 0x32” [6] to ‘0’; Table 96, “Register 0x0A” [3:2] to ‘00’.
4. Device does not re-sample PID pin.
5. Device floats the SDA pin such that it gets pulled High by external/other device pullup.
6. Device treats bus reset as STOP operation.

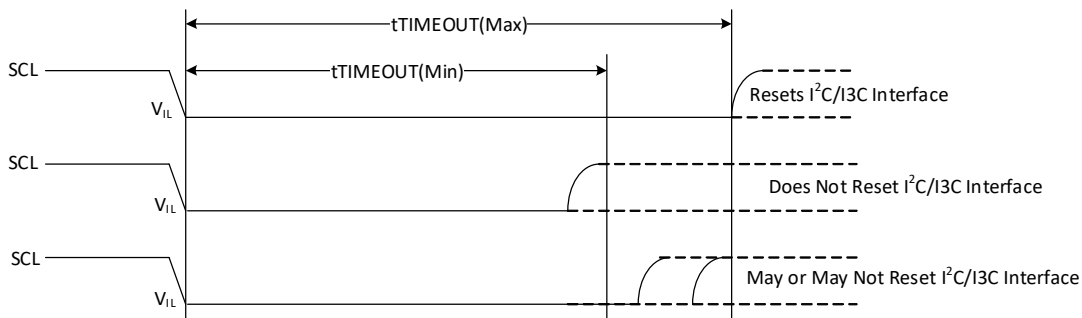


Figure 27 — I²C or I3C Basic Bus Reset - PMIC Device

1.13.16 Command Truth Table

The command truth table as shown in Table 81 only applies in I3C Basic mode with PEC enabled. In I²C mode and I3C Basic mode with PEC disabled, the command truth table does not apply.

Table 81 — For I3C Mode only with PEC Enabled - Command Truth Table

TS5 Command	Command Name	CMD Code	RW	Address
		2nd Byte Bits [7:5]	2nd Byte Bit [4]	1st Byte Bits [7:0]
Write 1 Byte to Register	W1R	000	0	V
Read 1 Byte from Register	R1R		1	V
Write 2 Byte to Register	W2R	001	0	V
Read 2 Byte from Register	R2R		1	V
Write 4 Byte to Register	W4R	010	0	V
Read 4 Byte from Register	R4R		1	V
Write 16 Byte to Register	W16R	011	0	V
Read 16 Byte from Register	R16R		1	V
Reserved	RSVD	100 to 111	RSVD	RSVD

1.14 Device Package and Pinout

The PMIC device is packaged in 5 mm x 5 mm FCQFN.

1.14.1 Package Pinout

The PMIC pinout is shown in Figure 28 and Figure 29 for TOP view and BOTTOM view, respectively.

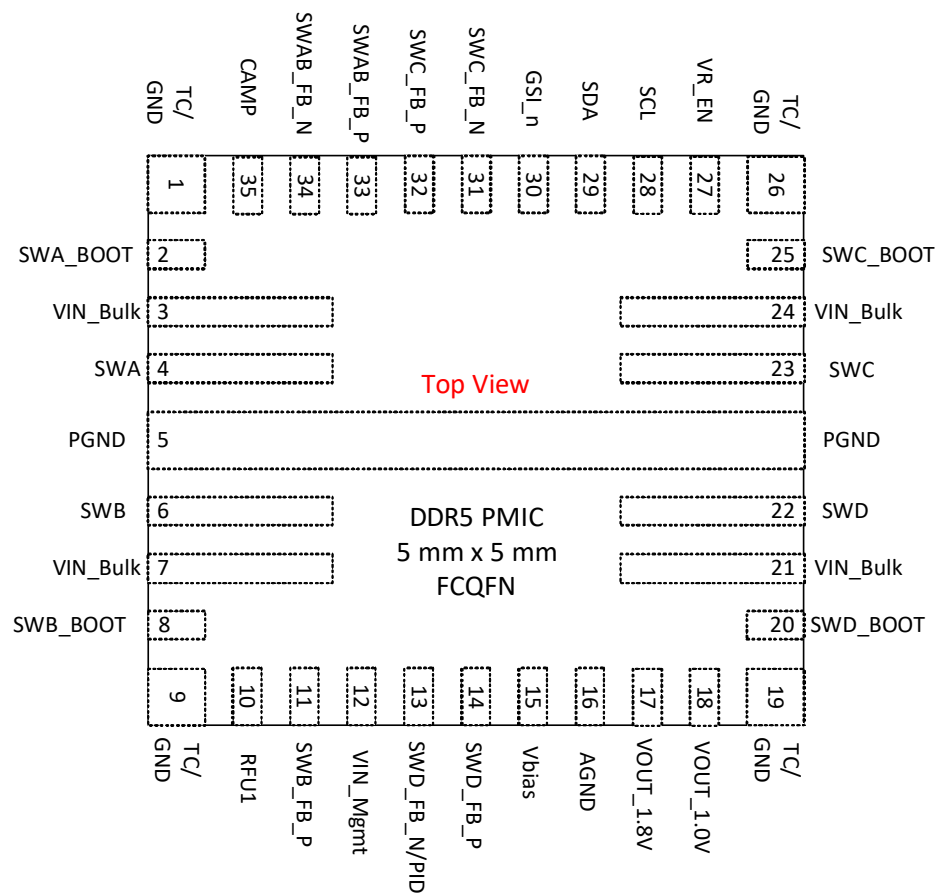


Figure 28 — PMIC Pinout - TOP View

1.14.1 Package Pinout (cont'd)

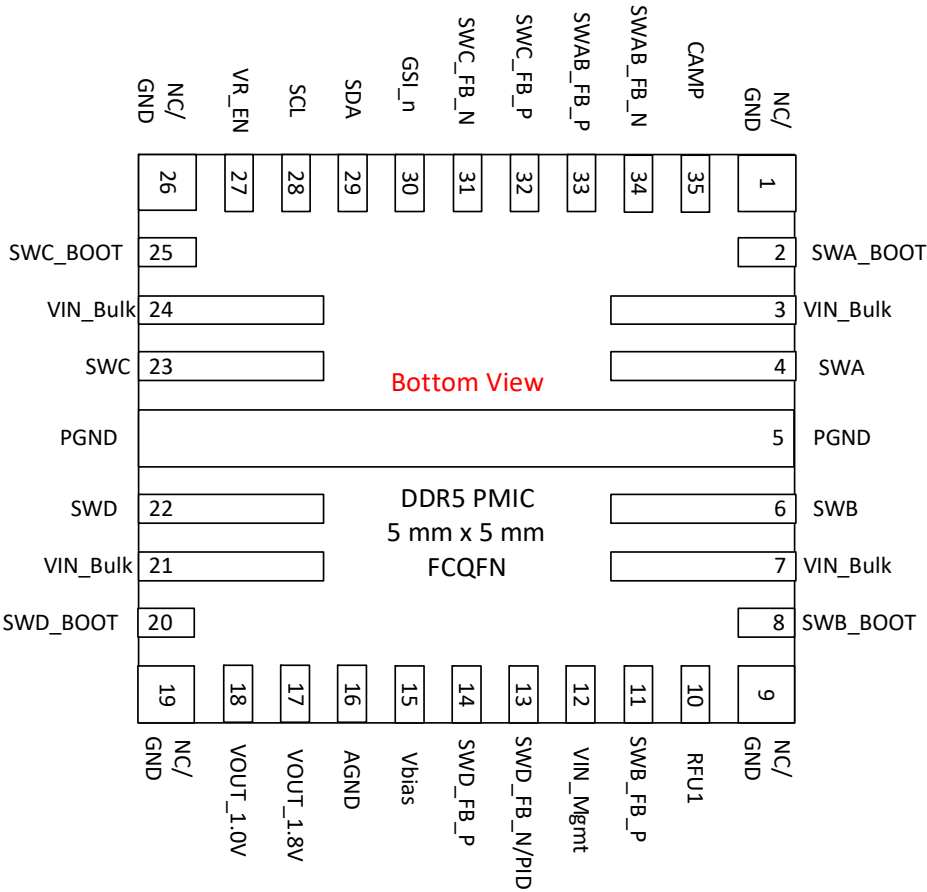


Figure 29 — PMIC Pinout - BOTTOM View

1.14.2 PMIC Package Pin List

Table 82 — PMIC Pin Description

Pin Name	Type	Description
VIN_Bulk (4x)	I	12 V power input supply pin to the PMIC. All four VIN_Bulk input pins must be connected to the 12 V input supply even if one or more output regulators are not intended to be used.
VIN_Mgmt	I	3.3 V power input supply pin to the PMIC for VOUT_1.8V & VOUT_1.0V LDO output, side band management access, internal memory read operation. Vendor usage of 3.3 V input supply may vary.
CAMP	IO	Control and Monitor Port. Open drain output. The PMIC floats this pin when VIN_Bulk input supply, as well as all enabled output buck regulators and all LDO regulators tolerance threshold is maintained as configured in the appropriate register. The PMIC drives this pin low when VIN_Bulk input goes below the threshold or when any of the enabled output buck regulator exceeds the thresholds configured in the appropriate register or when any LDO output regulator exceeds the threshold configured in the appropriate register. Input: The PMIC disables its output regulator when this pin transitions from high to low. The LDO outputs shall remain on. Input: The PMIC enters write protect mode when it is high and configuration mode when it is low.
GSI_n	O	General Status Interrupt. Open drain output. The PMIC asserts this pin low to communicate any one or more critical event to host. This pin stays asserted until the appropriate registers are explicitly cleared.
VBias	PWR	Vbias Voltage generated by PMIC.
SCL	I	I ² C/I ³ C Basic Clock Input for management bus.
SDA	IO	I ² C/I ³ C Basic Data Input/Output for management bus.
SWA	O	Output switch node A buck regulator. This pin connects to L1 power inductor. In single phase regulator mode of operation, the SWA output must not be connected to either SWB or SWC output even if they are configured as same exact output voltage.
SWA_BOOT	PWR	Bootstrap node for SWA high side NMOS driver. This pin connects to SWA through a high quality capacitor.
SWAB_FB_P	I	In single phase regulator mode or dual phase regulator mode of operation, this pin connects to DIMM power plane load.
SWAB_FB_N	I	In single phase regulator mode or dual phase regulator mode of operation, this pin connects to DIMM ground plane.
SWB	O	Output switch node B buck regulator. This pin connects to L2 power inductor. In single phase regulator mode of operation, the SWB output must not be connected to either SWA or SWC output even if they are configured as same exact output voltage.
SWB_BOOT	PWR	Bootstrap node for SWB high side NMOS driver. This pin connects to SWB through a high quality capacitor.
SWB_FB_P	I	In single phase regulator mode of operation, this pin connects to DIMM power plane load. If not used, this pin must be connected to GND. In dual phase regulator mode of operation, this pin must be connected to GND.

Table 82 — PMIC Pin Description (cont'd)

Pin Name	Type	Description
SWC	O	Output switch node C buck regulator. This pin connects to L3 power inductor. The output of SWC must not be connected to the output of either SWA or SWB or SWA+SWB even if they are configured as same exact output voltage.
SWC_BOOT	PWR	Bootstrap node for SWC high NMOS driver. This pin connects to SWC through a high quality capacitor.
SWC_FB_P	I	This pin connects to DIMM power plane load.
SWC_FB_N	I	This pin connects to DIMM ground plane.
SWD	O	Output switch node D buck regulator. This pin connects to L4 power inductor.
SWD_BOOT	PWR	Bootstrap node for SWD high side NMOS driver. This pin connects to SWD through a high quality capacitor.
SWD_FB_P	I	This pin connects to DIMM power plane load.
SWD_FB_N/ PID	I	This pin connects to DIMM ground plane when PMIC is used in differential remote sensing mode of operation. This pin connects to DIMM ground plane or VOUT_1.8V rail or left floating when PMIC is used in a single ended remote sensing mode of operation.
VOUT_1.8V	O	1.8V LDO Output.
VOUT_1.0V	O	1.0 V LDO Output.
AGND	PWR	Analog Ground. Connects to DIMM ground plane.
PGND	PWR	Power Ground. Connects to DIMM ground plane.
RFU1		This pins must be connected to GND.
TC/GND		Thermal connection to GND. This pin is connected to GND on the PCB and may or may not be connected to GND on the die.
VR_EN	I	PMIC VR Enable. If VR_EN pin function is enabled: When this pin is high, the PMIC executes VR Enable command (i.e., R32[7] = '1'). When this pin is low, the PMIC executes VR Disable command (i.e., R32[7] = '0'). This pin shall not be left floating. If VR_EN pin function is disabled: This pin shall be tied to GND. Asserting VR_EN pin has no effect on PMIC.

1.14.3 Package Mechanical Drawing

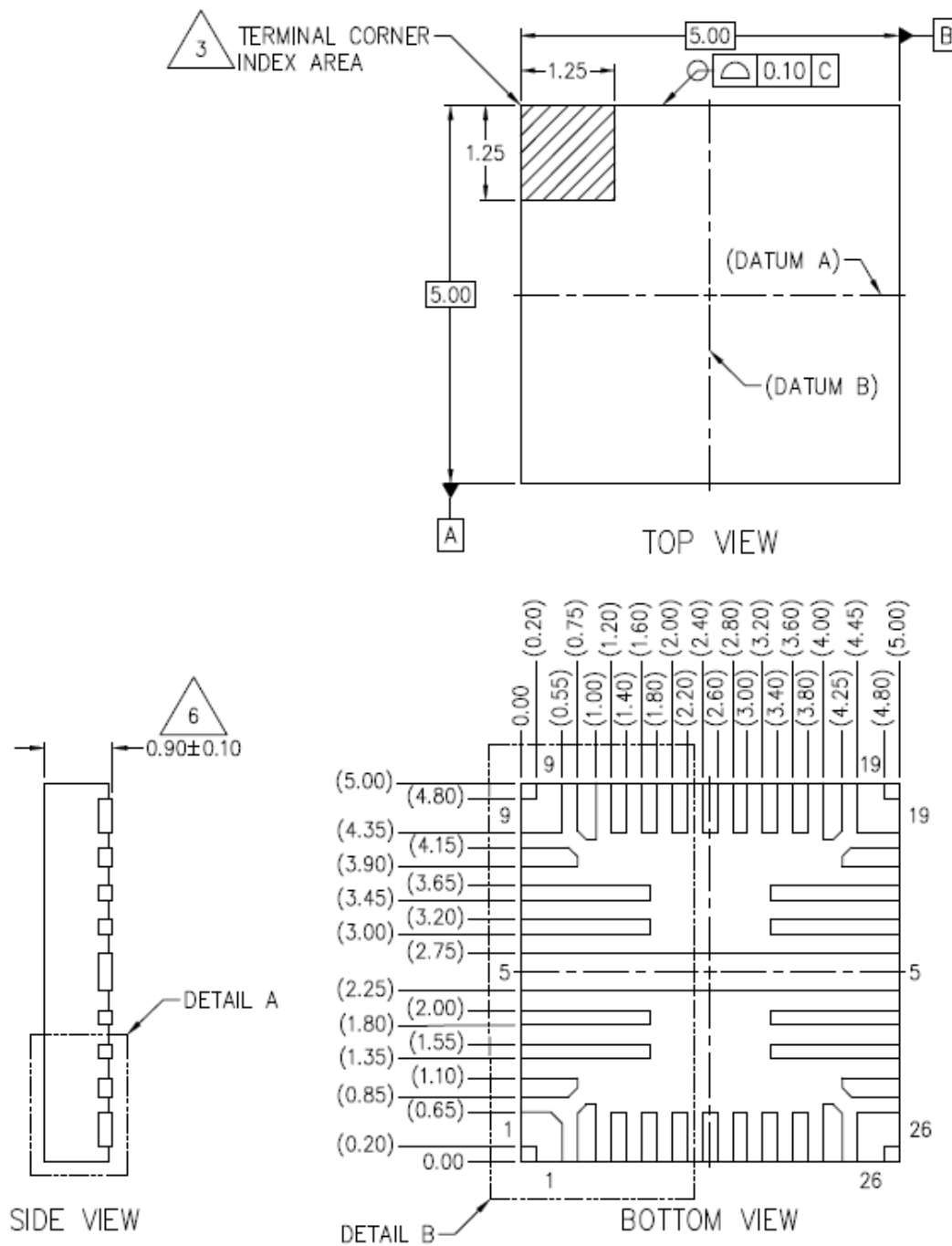


Figure 30 — Package Mechanical Outline

1.14.3 Package Mechanical Drawing (cont'd)

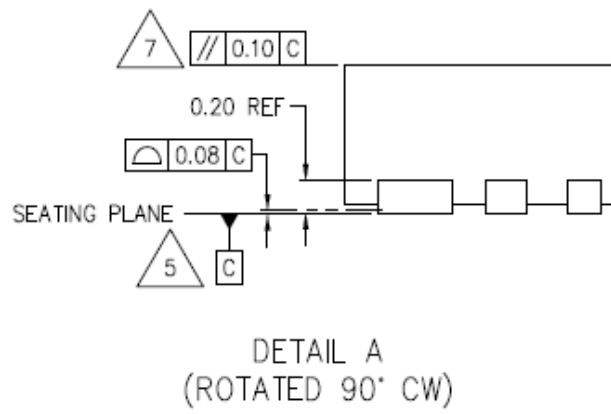


Figure 31 — Detail A Drawing

Technical drawing of Detail B, showing a cross-section of a mechanical assembly. The drawing includes various dimensions and tolerances:

- Top dimensions: $8X 1.70 \pm 0.10$, $4X 0.20 \pm 0.05$, $4X 0.55 \pm 0.05$, $4X 0.75^{+0.10}_{-0.20}$.
- Left dimensions: $4X 0.65 \pm 0.05$, $4X 0.20 \pm 0.05$.
- Right dimensions: $8X C0.15 \times 0.15 \text{ MAX}$, $4X 0.20 \text{ MIN}$.
- Internal dimensions: $4X 0.25 \pm 0.05$, $8X 0.20 \pm 0.05$, $4X 0.45$, $4X 0.475$, $4X 0.975$, $4X 0.875$, $4X 0.425$.
- Bottom dimensions: $4X 0.75 \pm 0.10$, $14X 0.65 \pm 0.10$, $14X 0.20 \pm 0.05$, $12X 0.40$.
- Surface finish symbols (triangles with '4') are present at several locations.
- Feature control frames are used to specify tolerances and surface finish requirements.

DETAIL B

Figure 32 — Detail B Drawing

1.14.3 Package Mechanical Drawing (cont'd)

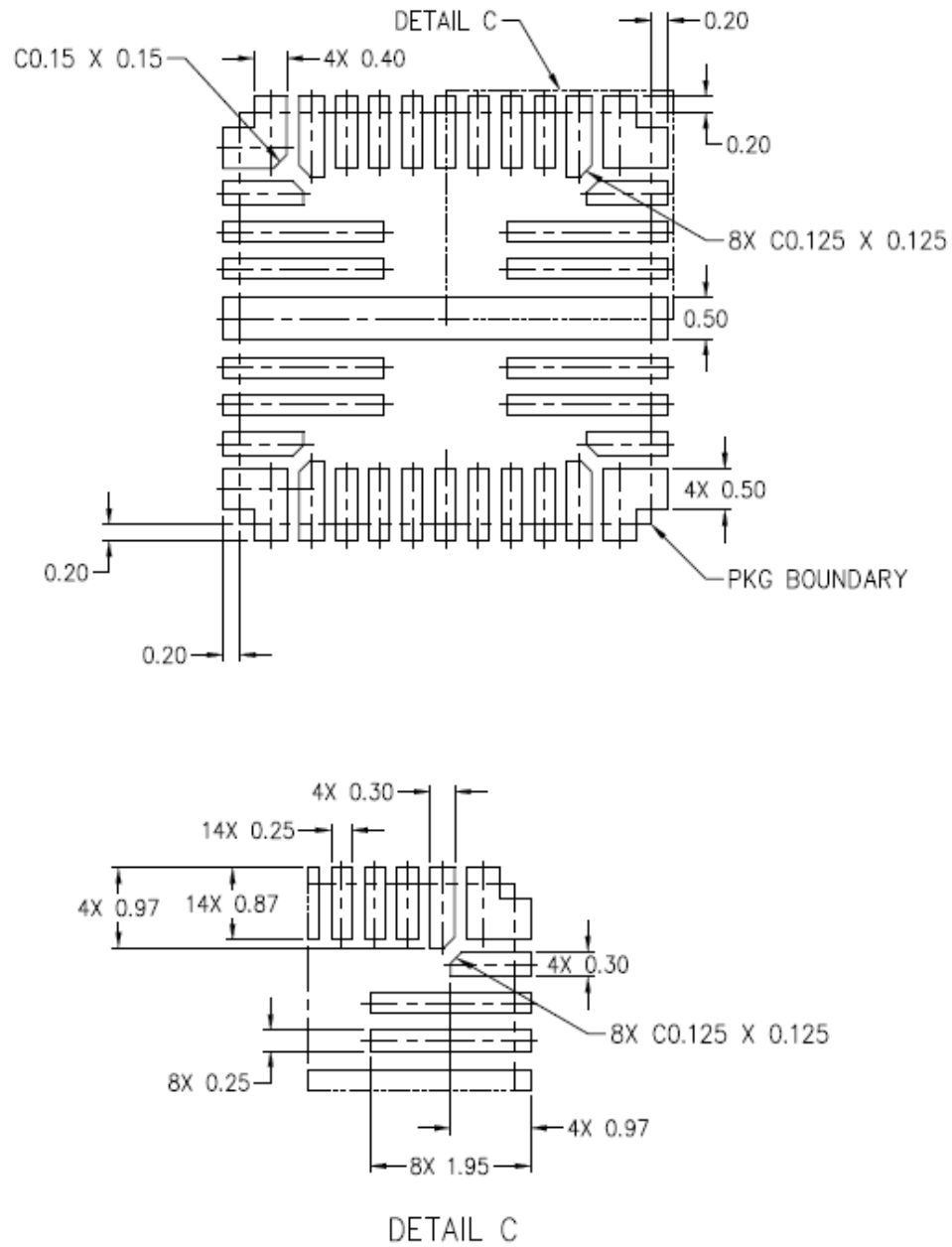


Figure 33 — Reference PCB Land Pattern

1.15 Inductor Specification

1.15.1 Mechanical Specification

The inductor package dimensions and its recommended land patterns are defined in Table 83.

Table 83 — Inductor Mechanical Specification

Package Size		Reference Drawing	Recommended Land Pattern
L (mm)	4.3 Max	Figure 34 (Left Picture)	Figure 34 (Right Picture)
W (mm)	4.3 Max		
H (mm)	2.0 Max		

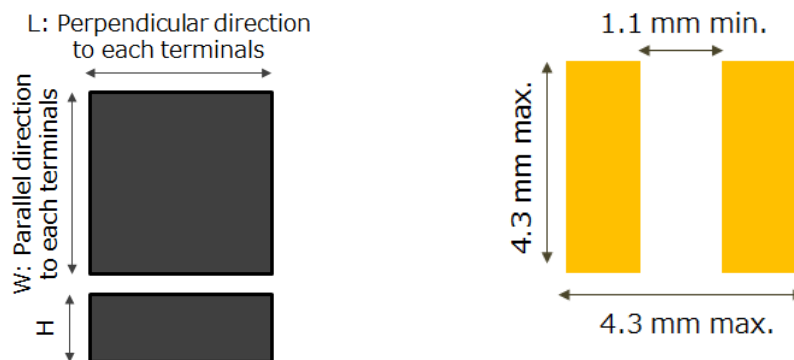


Figure 34 — Reference Drawing and Recommended Land Pattern

1.15.2 Electrical Specification

The inductor electrical specifications are defined in Table 84.

Table 84 — Inductor Electrical Specification¹

L @ 0.5-1 MHz; 0 Bias $\pm 20\%$ (μH)	Max DCR (m Ω)	Max ACR @ 1 MHz ^{2,3} (m Ω)	I _{peakmax} (A)	Min L @ (I _{peakmax} of PMIC5020) ⁴ (μH)	Max L @ I _{peakmax} (μH)	Switch Rail Target
0.47	4.9	90	10	0.27	0.47	SWA, SWB,
			11.5	0.25	0.45	SWC
1.0	15.5	250	3.5	0.56	N/A	SWD

NOTE 1 Test condition: Ambient Temperature = 20 ± 2 °C; Ambient Humidity = $65 \pm 5\%$ Rh

NOTE 2 ACR definition: $\text{ACR} = R_s @ 1 \text{ MHz} - \text{DCR}$. Measured current (1 MHz/sinusoidal): 0.52A rms for 0.47 μH and 0.25A rms for 1.0 μH ; with no DC Bias for both cases.

NOTE 3 For R_s measurement, it is recommended to measure by Iwatsu SY-8218 (BH Analyzer, with NF IE-1125B), its upper compatible instruments or other instruments which is guaranteed on the measurement accuracy by inductor vendors.

NOTE 4 Minimum and Maximum inductance is defined at DC bias current given by definition in I_{peakmax} of PMIC5020; Table 3, Table 5, and Table 6.

1.16 Application Notes

1.16.1 Method to Identify and Map Out DIMM with a PMIC Fault in Shared CAMP Topology

Typical DDR5 server platform may have up to 32 DDR5 DIMM sockets. Server platform implementation may vary however it is possible to have up to 8 DDR5 DIMMs may share CAMP signal. The exact number of DDR5 DIMMs that share CAMP signal is beyond the scope of this application note. It is assumed that CAMP signal is pulled up on the platform or on the controller via 1K Ohm pullup resistor to either 3.3 V or 1.8 V.

In a DDR5 server platform, it is possible that one or more DDR5 DIMM may have encountered a PMIC fault, as listed below, that has generated VR Disable event. Also refer to Table 23.

- SWx Over Voltage
- SWx Under Voltage
- VIN_Bulk Over Voltage
- VIN_Bulk Under Voltage
- Critical Temperature

In this environment, it is desired to let the platform continue to power up and that faulty PMIC does not interfere with the platform operation. This application note describes a BIOS or appropriate software method to identify the faulty PMIC/DDR5 DIMM and then to map out the faulty PMIC/DDR5 DIMM from the memory subsystem. The fault scenario noted here is one example of fault scenario. Note that initial failure may occur during operation, hence BIOS needs to determine and log fault condition and then execute the map out routine.

Faulty PMIC Identification:

1. Power up the platform (i.e., DDR5 DIMMs) by applying VIN_Bulk and VIN_Mgmt input supplies.
2. Broadcast VR Enable command to all PMICs.
3. If all PMICs power up the their regulators successfully, all PMICs float the CAMP signal and the pullup resistor pulls the CAMP signal high indicating that all PMICs (i.e., DDR5 DIMMs) have powered up successfully.
4. However, if one or more PMIC fails to power up their regulators then that PMIC continues to hold the CAMP signal low while other PMICs that do power up their regulators successfully floats the CAMP signal. The net effect is CAMP signal remains low.
5. BIOS eventually times out as the CAMP signal is not pulled up high and interrogates all PMIC's status registers one at a time. The interrogation process of PMIC status registers allows BIOS to identify which PMICs regulators are successfully powered up and which PMICs are faulty.

Once BIOS identifies faulty PMIC, BIOS stores the faulty PMIC (DDR5 DIMM) identification in its non-volatile memory. Isolating and Securing Faulted PMIC:

1. Once the faulty PMIC is identified, the platform may re-cycle the power by simultaneously removing VIN_Bulk and VIN_Mgmt input supply and then re-applying VIN_Bulk and VIN_Mgmt input supplies. This puts PMIC in configuration mode,
 - a. The BIOS reads PMIC error log registers to determine 'bad' PMIC. The BIOS also has a prior knowledge of a faulty PMIC.
2. BIOS performs following steps to the faulty PMIC.
 - a. Write R32 = 0x08 (Floats CAMP signal; prevents PMIC interference)
 - b. Ensure R2F[2] = '0'.

1.16.1 Method to Identify and Map Out DIMM with a PMIC Fault in Shared CAMP Topology (cont'd)

3. Broadcast VR Enable command to all PMICs.
4. All good PMIC executes Power On Sequence and floats the CAMP signal. The faulty PMIC is already floating the CAMP signal and does not execute Power On Sequence.
5. At this point, BIOS sees CAMP signal is pulled High and moves to the next operation.
6. By the above process, the faulty PMIC is mapped out of the memory system in a secure state and it does not interfere with platform operation. The good PMICs allow server system to power up normally and operate in a secure state.

1.16.2 Error Injection Test Methodology

The PMIC error injection feature can be used many ways to test the PMIC at either component level or at the module level or at the system level. The error injection feature can be used to debug the PMIC component itself or to simulate the DIMM module behavior in a standalone ATE environment or in the system environment or to develop/simulate the system software to ensure PMIC and DIMM component hardware and system software works in a harmonious way if there is an actual fault event in the system.

The combination matrix to test each type of error injection is very large and it is the responsibility of the PMIC provider to ensure that all combinations are tested. The PMIC component specification does not provide the list in entirety but rather provides one possible general test method for error injection feature.

At all time, the PMIC specification must be followed. The test methodology does not alter or change the meaning of the PMIC specification. The test methodology may add, remove or modify steps in any sequence as long as the PMIC component specification is followed. The test results will vary depending on the starting condition and the sequence of steps. It is the responsibility of PMIC component provider to ensure results are checked against the specific condition and sequence while following the PMIC component specification.

One example of Error injection test after VR Enable command:

1. Power cycle the PMIC; Issue R39 = 0x74 command; observe CAMP and GSI_n signal.
2. Read the PMIC registers R04 to R0B and R33 (checks all memory and status registers are cleared).
3. Issue the VR Enable command; read the PMIC registers R04 to R0B and R33 (check PMIC successfully turned on the rails without any fault); observe CAMP and GSI_n signal.
4. Inject error via R35 and select desired error type.
5. Check PMIC regulators are turned off; read the PMIC registers R04 to R0B and R33 (Check appropriate error log and status registers are set); observe CAMP and GSI_n signal.
6. Power cycle the PMIC.
7. Read the PMIC registers R04 to R07 (checks all memory).
8. Issue R39 = 0x74 command.
9. Read the PMIC registers R04 to R0B and R33.
10. Repeat another error injection test starting step # 3.

2 Registers Space

2.1 Register Attribute Definition

All volatile registers have Base Attributes as defined in Table 85. Some register attributes are further modified with Attribute Modifiers, as defined in Table 86.

Table 85 — Register Base Attributes

Attribute	Abbreviation	Description
Read Only	RO	This bit can be read by software. Writes have no effect.
Read/Write	RW	This bit can be read or written by host.
Write Only	W	This bit can only be written by host. Read from this bit returns '0'.
Reserved	RV	This bit is reserved for future expansion and its value must not be modified by host. The bit will return '0' when read. Write has no effect.

Table 86 — Register Attribute Modifier

Attribute	Abbreviation	Description
Write '1' Only	IO	This bit can only be set (i.e., write '1') but not reset (i.e., write '0'). Write '0' has no effect.
Protected	P	This bit is protected by the password registers. This bit cannot be written to unless the password code has been written into the password registers.
Persistent	E	This bit is persistent during power cycle.

2.2 Register Map Breakdown

Table 87 — Register Map Breakdown

Register Range	Region	Comments
0x00 - 0x3F	Host Region	Host Accessible Registers
0x40 - 0x6F	DIMM Vendor Region	<p>DIMM Vendor Registers - Non Volatile Memory</p> <p>Allows DIMM vendors to program the PMIC for a given DRAM/DIMM vendor designs.</p> <p>These are password protected registers and password is selected by DIMM vendor. Under normal operation, these registers are not used by any host.</p> <p>These registers require password for read access. Access to these registers without correct password will return all data as '0'.</p> <p>These registers require complete power cycle before it takes in effect.</p> <p>Changing these registers under normal operation is considered an illegal operation.</p>
0x70 - 0xFF	Vendor Specific Region	<p>Vendor Specific Registers - Non Volatile Memory</p> <p>These are vendor specific password protected registers. Under normal operation these registers are not used by any host.</p> <p>These registers require password for read access. Access to these registers without correct password will return all data as '0'.</p>

2.3 Register Memory Protection

The PMIC DIMM vendors registers (0x40 - 0x6F) are password protected registers. Both Read and Write access to DIMM vendor registers are blocked unless it is unlocked by providing the correct password. The default password for DIMM vendor registers is 0x9473. The PMIC offers DIMM vendors to select their own password for DIMM vendor registers.

2.3.1 Steps to Access DIMM Vendor Region Registers

The steps to access the DIMM vendor registers are as follows:

1. Write to register Table 140, "Register 0x37" = 8 bit password LSB code.
2. Write to register Table 141, "Register 0x38" = 8 bit password MSB code.
3. Write to register Table 142, "Register 0x39" = 0x40.
4. Perform Read operations to DIMM vendor registers as desired.
5. Write to register Table 142, "Register 0x39" = 0x00.

2.3.2 Steps to Change DIMM Vendor Region Password

By default, the DIMM vendor region register password is 0x9473. The steps to change the password from default password are as follows:

1. Write to register Table 140, "Register 0x37" = 0x73.
2. Write to register Table 141, "Register 0x38" = 0x94.
3. Write to register Table 142, "Register 0x39" = 0x40.
4. Write to register Table 140, "Register 0x37" = New 8 bit password LSB code as desired by DIMM vendor.
5. Write to register Table 141, "Register 0x38" = New 8 bit password MSB code as desired by DIMM vendor.
6. Write to register Table 142, "Register 0x39" = 0x80.
7. Wait 200 ms.
8. Write to register Table 142, "Register 0x39" = 0x00.
9. Power cycle the PMIC. (Remove VIN_Bulk and VIN_Mgmt supply from the PMIC. The new password is in effect after the power cycle.

To change the password again from this point on, repeat steps 1 to 8 but note that in steps 1 and 2 current password is required.

2.3.3 Steps to Burn or Program DIMM Vendor Region Registers

The steps to burn or to program the DIMM vendor registers are as follows:

1. Write to register Table 140, "Register 0x37" = 8 bit password LSB code.
2. Write to register Table 141, "Register 0x38" = 8 bit password MSB code.
3. Write to register Table 142, "Register 0x39" = 0x40.
4. Programming DIMM vendor registers are done at block level. Block 40 addresses: 0x40 - 0x4F; Block 50 addresses: 0x50 - 0x5F; Block 60 addresses: 0x60 - 0x6F. Perform write operation to each block as desired.
5. Burn each block one at a time: Block 40 addresses: Write register Table 142, "Register 0x39" = 0x81. Block 50 addresses: Write register Table 142, "Register 0x39" = 0x82. Block 60 addresses: Write register Table 142, "Register 0x39" = 0x85.

2.3.3 Steps to Burn or Program DIMM Vendor Region Registers (cont'd)

6. Wait time 200 ms.
7. To check if programming is complete: Perform read from register Table 142, "Register 0x39". The code 0x5A indicates it is complete. It takes 200 ms per page to program.
8. To verify if programming is done correctly: Perform read operation from appropriate block addresses.
9. Write to register Table 142, "Register 0x39" = 0x00.

2.3.4 Host Region Register Map

Table 88 — Register Color Coding Scheme

Region	Register Range	Restriction
Host Region + DIMM Vendor Region + Vendor specific Region	Table 107, "Register 0x15" to Table 133, "Register 0x2F" Table 136, "Register 0x32" [7,5:0], Table 139, "Register 0x35" Table 148, "Register 0x40" ¹ to Register 0x6F Register 0x70 to Register 0xFF	Register Modification is NOT allowed in write protect mode
Host Region	Table 118, "Register 0x20" ¹ to Table 131, "Register 0x2D" ^{1,2}	Registers are copied from DIMM Vendor Region Setting at power on

Table 89 — Host Region - Register Map

Register	Attribute	Description
0x00 to 0x03	RV	R00 [7:0] to R03 [7:0] - Reserved
Table 90, "Register 0x04"	ROE	R04 [7] Global Error Count R04 [6:4] Global Error History Log R04 [3:0] Reserved
Table 91, "Register 0x05"	ROE	R05 [7] Reserved R05 [6:3] Power On Reset - SWA, SWB, SWC & SWD Power Not Good R05 [2:0] Power On Reset - High Level Status Code
Table 92, "Register 0x06"	ROE	R06 [7:4] Power On Reset - SWA, SWB, SWC & SWD Under Voltage Lockout R06 [3:0] Power On Reset - SWA, SWB, SWC & SWD Over Voltage
Table 93, "Register 0x07"	ROE	R07 [7:0] Reserved
Table 94, "Register 0x08"	RO	R08 [7] VIN_Bulk Input Power Good Status R08[6] Critical Temperature Shutdown Status R08 [5:2] SWA, SWB, SWC, SWD Output Power Good Status R08 [1] VIN_Mgmt Input Over Voltage Status R08 [0] VIN_Bulk Input Over Voltage Status

Table 89 — Host Region - Register Map (cont'd)

Register	Attribute	Description
Table 95, “Register 0x09”	RO	R09 [7] PMIC High Temperature Warning Status R09 [6] VBias Power Good Status R09 [5] VOUT_1.8V Output Power Good Status R09 [4] VIN_Mgmt to VIN_Bulk Input Supply Switchover Status R09 [3:0] SWA, SWB, SWC & SWD High Output Current Consumption Warning Status
Table 96, “Register 0x0A”	RO	R0A [7:4] SWA, SWB, SWC, SWD Output Over Voltage Status R0A [3] PEC Error Status R0A [2] Parity Error Status R0A [1] IBI Status R0A [0] Reserved
Table 97, “Register 0x0B”	RO	R0B [7:4] SWA, SWB, SWC & SWD Output Current Limiter Warning Status R0B [3:0] SWA, SWB, SWC & SWD Output Under Voltage Lockout Status
Table 98, “Register 0x0C”	RO	R0C [7:0] SWA Output Current or Power or Total Output Power Measurement
Table 99, “Register 0x0D”	RO	R0D [7:0] SWB Output Current or Power Measurement
Table 100, “Register 0x0E”	RO	R0E [7:0] SWC Output Current or Power Measurement
Table 101, “Register 0x0F”	RO	R0F [7:0] SWD Output Current or Power Measurement
Table 102, “Register 0x10”	IO	R10 [7] Clear VIN_Bulk Input Power Good Status R10 [6] Reserved R10 [5:2] Clear SWA, SWB, SWC & SWD Output Power Good Status R10 [1] Clear VIN_Mgmt Input Over Voltage Status R10 [0] Clear VIN_Bulk Input Over Voltage Status
Table 103, “Register 0x11”	IO	R11 [7] Clear PMIC High Temperature Warning Status R11 [6] Clear VBias Power Good Status R11 [5] Clear VOUT_1.8V Output Power Good Status R11 [4] Clear VIN_Mgmt to VIN_Bulk Input Supply Switchover Status R11 [3:0] Clear SWA, SWB, SWC & SWD High Output Current Consumption Warning Status
Table 104, “Register 0x12”	IO	R12 [7:4] Clear SWA, SWB, SWC, SWD Output Over Voltage Status R12 [3] Clear PEC Error R12 [2] Clear Parity Error R12 [1:0] Reserved
Table 105, “Register 0x13”	IO	R13 [7:4] Clear SWA, SWB, SWC & SWD Output Current Limiter Warning Status R13 [3:0] Clear SWA, SWB, SWC & SWD Output Under Voltage Lockout Status
Table 106, “Register 0x14”	IO	R14 [7:5] Reserved R14 [4] Clear VIN_Mgmt Power Good Status in Switchover Mode R14 [3] Clear VBias Output or VIN_Bulk Input Under Voltage Lockout Status R14 [2] Clear VOUT_1.0V Output Power Good Status R14 [1] Reserved R14 [0] Clear Global Status

Table 89 — Host Region - Register Map (cont'd)

Register	Attribute	Description
Table 107, “Register 0x15”	RW	R15 [7] Mask VIN_Bulk Input Power Good Status R15 [6] Reserved R15 [5:2] Mask SWA, SWB, SWC & SWD Output Power Good Status R15 [1] Mask VIN_Mgmt Input Over Voltage Status R15 [0] Mask VIN_Bulk Input Over Voltage Status
Table 108, “Register 0x16”	RW	R16 [7] Mask PMIC High Temperature Warning Status R16 [6] Mask VBias Power Good Status R16 [5] Mask VOUT_1.8V Output Power Good Status R16 [4] Mask VIN_Mgmt to VIN_Bulk Input Supply Switchover Status R16 [3:0] Mask SWA, SWB, SWC & SWD High Output Current Consumption Warning Status
Table 109, “Register 0x17”	RW	R17 [7:4] Mask SWA, SWB, SWC, SWD Output Over Voltage R17 [3] Mask PEC Error Status R17 [2] Mask Parity Error Status R17 [1:0] Reserved
Table 110, “Register 0x18”	RW	R18 [7:4] Mask SWA, SWB, SWC & SWD Output Current Limiter Warning Status R18 [3:0] Mask SWA, SWB, SWC & SWD Output Under Voltage Lockout Status
Table 111, “Register 0x19”	RW	R19 [7:5] Reserved R19 [4] Mask VIN_Mgmt Power Good Status Switchover Mode R19 [3] Mask Vbias Output or VIN_Bulk Input Under Voltage Lockout Status R19 [2] Mask VOUT_1.0V Output Power Good Status R19 [1:0] Reserved
Table 112, “Register 0x1A”	RW	R1A [7:5] VIN_Bulk Input Power Good Threshold Voltage R1A [4] Reserved R1A [3] VBias Power Good Threshold Voltage R1A [2] VOUT_1.8 V Power Good Threshold Voltage R1A [1] Output Power Measurement Select R1A [0] VOUT_1.0 V Power Good Threshold Voltage
Table 113, “Register 0x1B”	RW	R1B [7] VIN_Bulk Input Over Voltage Threshold R1B [6] Current or Power Meter Select R1B [5] VIN_Mgmt Input Over Voltage Threshold R1B [4] Global Mask Control for PWR_GOOD Output Pin R1B [3] GSI_n Pin Enable R1B [2:0] PMIC High Temperature Warning Threshold
Table 114, “Register 0x1C”	RW	R1C [7:2] SWA Output High Current Threshold R1C [1:0] Reserved
Table 115, “Register 0x1D”	RW	R1D [7:2] SWB Output High Current Threshold R1D [1:0] Reserved
Table 116, “Register 0x1E”	RW	R1E [7:2] SWC Output High Current Threshold R1E [1:0] Reserved
Table 117, “Register 0x1F”	RW	R1F [7:2] SWD Output High Current Threshold R1F [1:0] Reserved
Table 118, “Register 0x20 ¹ ”	RW	R20 [7:6] SWA Output Current Limiter Warning Threshold R20 [5:4] SWB Output Current Limiter Warning Threshold R20 [3:2] SWC Output Current Limiter Warning Threshold R20 [1:0] SWD Output Current Limiter Warning Threshold

Table 89 — Host Region - Register Map (cont'd)

Register	Attribute	Description
Table 119, “Register 0x21 ^{1,2} ”	RW	R21 [7:1] SWA Voltage Setting R21 [0] SWA Power Good Low Side Threshold
Table 120, “Register 0x22 ^{1,2} ”	RW	R22 [7:6] SWA Power Good High Side Threshold R22 [5:4] SWA Over Voltage Threshold R22 [3:2] SWA Under Voltage Lockout Threshold R22 [1:0] SWA Soft Stop Time
Table 121, “Register 0x23 ^{1,2,3} ”	RW	R23 [7:1] SWB Voltage Setting R23 [0] SWB Power Good Low Side Threshold
Table 122, “Register 0x24 ^{1,2,3} ”	RW	R24 [7:6] SWB Power Good High Side Threshold R24 [5:4] SWB Over Voltage Threshold R24 [3:2] SWB Under Voltage Lockout Threshold R24 [1:0] SWB Soft Stop Time
Table 123, “Register 0x25 ^{1,2} ”	RW	R25 [7:1] SWC Voltage Setting R25 [0] SWC Power Good Low Side Threshold
Table 124, “Register 0x26 ^{1,2} ”	RW	R26 [7:6] SWC Power Good High Side Threshold R26 [5:4] SWC Over Voltage Threshold R26 [3:2] SWC Under Voltage Lockout Threshold R26 [1:0] SWC Soft Stop Time
Table 125, “Register 0x27 ^{1,2} ”	RW	R27 [7:1] SWD Voltage Setting R27 [0] SWD Power Good Low Side Threshold
Table 126, “Register 0x28 ^{1,2} ”	RW	R28 [7:6] SWD Power Good High Side Threshold R28 [5:4] SWD Over Voltage Threshold R28 [3:2] SWD Under Voltage Lockout Threshold R28 [1:0] SWD Soft Stop Time
Table 127, “Register 0x29 ^{1,2} ”	RW	R29 [7:6] SWA Mode Select R29 [5:4] SWA Switching Frequency R29 [3:2] SWB Mode Select R29 [1:0] SWB Switching Frequency
Table 128, “Register 0x2A ^{1,2} ”	RW	R2A [7:6] SWC Mode Select R2A [5:4] SWC Switching Frequency R2A [3:2] SWD Mode Select R2A [1:0] SWD Switching Frequency
Table 129, “Register 0x2B ^{1,2} ”	RW	R2B [7:6] VOUT_1.8V LDO Setting R2B [5:3] Voltage Range Selection for SWA, SWB and SWC R2B [2:1] VOUT_1.0V LDO Setting R2B [0] Voltage Range Selection for SWD
Table 130, “Register 0x2C ^{1,2} ”	RW	R2C [7:5] SWA Soft Start Time R2C [4] Reserved R2C [3:1] SWB Soft Start Time R2C [0] Reserved
Table 131, “Register 0x2D ^{1,2} ”	RW	R2D [7:5] SWC Soft Start Time R2D [4] Reserved R2D [3:1] SWD Soft Start Time R2D [0] Reserved
Table 132, “Register 0x2E”	RW	R2E [7:3] Reserved R2E [2:0] PMIC Shutdown temperature threshold

Table 89 — Host Region - Register Map (cont'd)

Register	Attribute	Description
Table 133, “Register 0x2F”	RW	R2F [7] VIN_Mgmt Input Supply Switchover Threshold Voltage R2F [6:3] SWA, SWB, SWC & SWD Enable R2F [2] Write Protect Function Control R2F [1:0] Mask Bits Register Control
Table 134, “Register 0x30”	RW	R30 [7] ADC Enable R30 [6:3] ADC Select R30 [2] Reserved R30 [1:0] ADC Register Update Frequency
Table 135, “Register 0x31”	RO	R31 [7:0] ADC Read Out
Table 136, “Register 0x32”	RW, RO	R32 [7] VR Enable R32 [6] Management Interface Selection R32 [5] Execute VR Enable Control R32 [4] Execute CAMP Fail_n Function Control R32 [3] PMIC CAMP Power Good Output Signal Control R32 [2:0] Reserved
Table 137, “Register 0x33”	RO	R33 [7:5] Temperature Measurement R33 [4] VIN_Mgmt Power Good Status in Switchover Mode Only R33 [3] VBias Output or VIN_Bulk Input Under Voltage Lockout Status R33 [2] VOUT_1.0V Output Power Good Status R33 [1:0] Reserved
Table 138, “Register 0x34”	RW, RO	R34 [7] PEC Enable R34 [6] IBI Enable R34 [5] Parity Disable R34 [4] Reserved R34 [3:1] HID_CODE R34 [0] Reserved
Table 139, “Register 0x35”	RW	R35 [7] Error Injection Enable R35 [6:4] Output Rail Selection R35 [3] Over and Under Voltage Select R35 [2:0] Misc. Error Injection Type
0x36	RV	R36 [7:0] Reserved
Table 140, “Register 0x37”	WO	R37 [7:0] Password Lower Byte 0
Table 141, “Register 0x38”	WO	R38 [7:0] Password Upper Byte 1
Table 142, “Register 0x39”	RW	R39 [7:0] Command Codes
Table 143, “Register 0x3A”	RW	R3A [7] Reserved R3A [6] Default Read Address Pointer Enable R3A [5:4] Default Read Address Pointer Selection R3A [3:2] Burst Length for Default Read Address Pointer Mode in PEC Enabled Mode R3A [1:0] Reserved
Table 144, “Register 0x3B”	ROE	R3B [7:6] PMIC Current Capability Extension R3B [5:4] Major Revision ID R3B [3:1] Minor Revision ID R3B [0] PMIC Current Capability
Table 145, “Register 0x3C”	ROE	R3C [7:0] VENDOR_ID_BYTE0
Table 146, “Register 0x3D”	ROE	R3D [7:0] VENDOR_ID_BYTE1
0x3E to 0x3F	RV	R3E [7:0] to 0x3F Reserved

2.3.5 Host Region Registers

2.3.5.1 Status Registers

The PMIC offers status registers that are grouped into four different categories.

1. Global History of Error Log Register (Table 90, “Register 0x04” [7:4])
2. Error Log Registers (Table 91, “Register 0x05” [6:0], Table 92, “Register 0x06” [7:0], Table 93, “Register 0x07” [7:0]; Table 93, “Register 0x07” [7:0] is currently defined as Reserved)
3. Real time Status Registers (Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:1], Table 97, “Register 0x0B” [7:0], Table 137, “Register 0x33” [4:2])
4. Periodic Status Registers (Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [7:0], Table 100, “Register 0x0E” [7:0], Table 101, “Register 0x0F” [7:0], Table 137, “Register 0x33” [7:5])

Global History of Error Log Registers (Table 90, “Register 0x04” [7:4]) - This register records the PMIC state at each abnormal power down cycle. This register reports the cumulative error of each abnormal power down sequence. The PMIC writes this register on its own when it internally generates VR Disable command on its own due to failure. The host can erase this register in MTP memory and clear the status register by writing the code 0x74 in Table 142, “Register 0x39”.

Error Log Registers (Table 91, “Register 0x05” [6:0], Table 92, “Register 0x06” [7:0] to Table 93, “Register 0x07” [7:0]) - These registers record the PMIC state at each power down sequence. The PMIC may report abnormal power down sequence or normal power down sequence. The PMIC writes this register on its own when it internally generates VR Disable command on its own due to failure. These registers are updated at power down cycle, if update is needed by the PMIC on its own. The host can clear the status register by writing the code 0x74 in Table 142, “Register 0x39”. See Figure 35 for illustration. The top waveform illustrates how PMIC captures Error Log Registers (R05 to R07) when there is a fault or a no fault and how PMIC reports error log registers when PMIC goes through power cycle. The bottom waveform illustrates same as top waveform with one exception. It shows no fault condition when CAMP is asserted to turn off switch regulator outputs with power down sequence.

Note that word Power Cycle is used interchangeably with Power Down Cycle as illustrated in both figures and it means both VIN_Bulk and VIN_Mgmt input supplies are removed and re-applied. Power Down Sequence means execution of Power Off Sequence configuration registers (Table 165, “Register 0x58”¹ to Table 168, “Register 0x5B”^{1,2}).

2.3.5.1 Status Registers (cont'd)

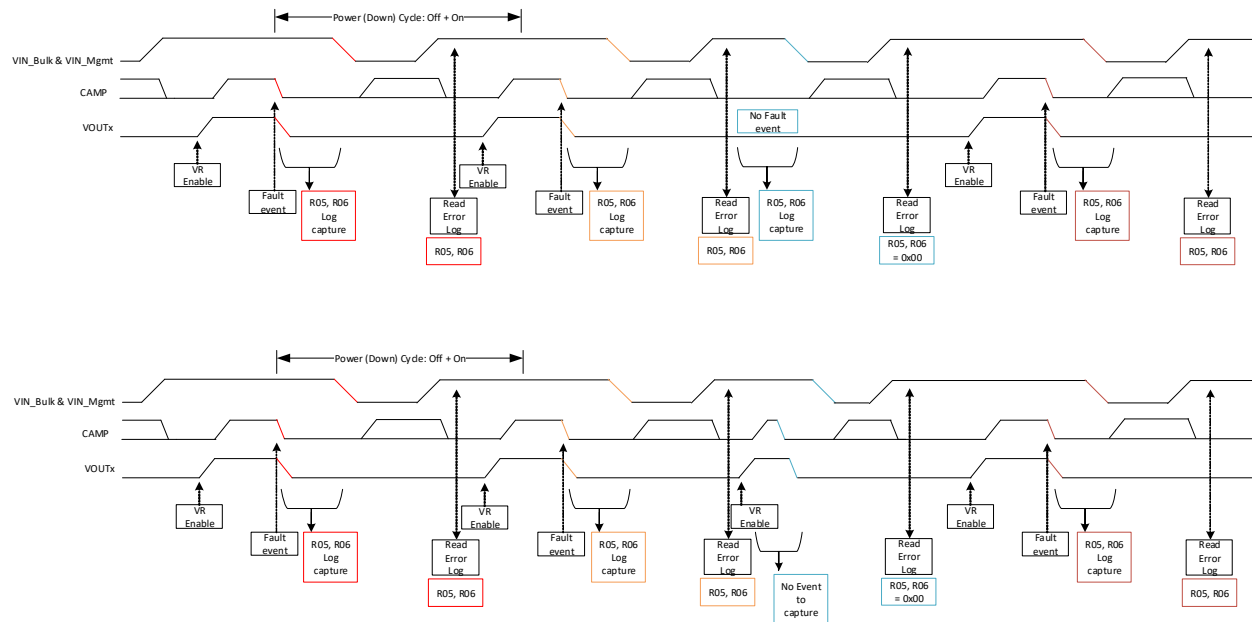


Figure 35 — Error Log (R05 to R07) Registers Behavior with Power Cycle

Real Time Status Registers (Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:1], to Table 97, “Register 0x0B” [7:0], Table 137, “Register 0x33” [4:2]): These registers are updated to ‘1’ any time based on any event that occurs. The status registers will remain at ‘1’ even if the failing condition is no longer present until the Clear Register command is received by the PMIC. Note that any switch regulator related status registers are only applicable after VR Enable command is registered by the PMIC. The PMIC updates switch regulators related status registers after VR Enable command is registered within tPMIC_PWR_GOOD_OUT time if there is any issue and host shall check these status registers after tPMIC_PWR_GOOD_OUT time. The PMIC updates these status registers if there is any event related to switch regulators in future. The GSI_n interrupt or PWR_GOOD interrupt may be generated by the PMIC at the same time depending on the type of event. The interrupts are only generated if they are not masked. The status registers Table 94, “Register 0x08” [7], Table 95, “Register 0x09” [5] and Table 137, “Register 0x33” [2] is only valid once valid VIN_Bulk and VIN_Mgmt input supply is valid at the PMIC input pin. The remaining status registers are valid after VR Enable command is registered.

Periodic Status Registers (Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [7:0], Table 100, “Register 0x0E” [7:0], Table 101, “Register 0x0F” [7:0], Table 137, “Register 0x33” [7:5]) - These registers are updated periodically. These registers are only valid after VR Enable command is registers.

All Read Only (RO) registers except for registers Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [5:0], Table 100, “Register 0x0E” [5:0] & Table 101, “Register 0x0F” [5:0] are one time latched registers. In other words, once PMIC sets those register flag, the host must explicitly clear those registers appropriately. The PMIC does not automatically update the registers on its own even if the event that triggered the status is no longer present. The registers Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [7:0], Table 100, “Register 0x0E” [7:0] and Table 101, “Register 0x0F” [7:0] are dynamically updated by the PMIC at certain frequency and they represent the status at that point.

2.3.5.1 Status Registers (cont'd)**Table 90 — Register 0x04**

R04			
Bits	Attribute	Default	Description^{1,2}
7	ROE	0	R04 [7]: GLOBAL_ERROR_COUNT Global Error Count Since Last Erase Operation ^{3,4} 0 = No Error or Only 1 Error since last Erase operation 1 = > 1 Error Count since last Erase operation
6	ROE	0	R04 [6]: GLOBAL_ERROR_LOG_BUCK_OV_OR_UV Global Error Log History for Buck Regulator Output Over or Under Voltage ⁵ 0 = No Error Occurred 1 = Error Occurred
5	ROE	0	R04 [5]: GLOBAL_ERROR_LOG_VIN_BULK_OVER_VOLTAGE Global Error Log History for VIN_Bulk Over Voltage ⁵ 0 = No Error Occurred 1 = Error Occurred
4	ROE	0	R04 [4]: GLOBAL_ERROR_LOG_CRITICAL_TEMPERATURE Global Error Log History for Critical Temperature ⁵ 0 = No Error Occurred 1 = Error Occurred
3:0	RV	0	R04 [3:0]: Reserved
<p>NOTE 1 The PMIC always attempts to write this register into its non-volatile memory. However, it may not be guaranteed depending on how fast the host may shut off the input power to the PMIC. The PMIC needs minimum of 5.0 V for VIN_Bulk voltage and 200 ms duration from PWR_GOOD signal assertion to guarantee the write operation into non-volatile memory.</p> <p>NOTE 2 Host must explicitly perform Erase operation to erase this entire register Table 90, “Register 0x04” [7:0] via Table 142, “Register 0x39”. The PMIC needs minimum of 200 ms for Erase operation.</p> <p>NOTE 3 PMIC counts the error since last erase operation and if more than one error occurs, it sets this bit to ‘1’. Host must explicitly perform Erase operation to erase this entire register Table 90, “Register 0x04” [7:0].</p> <p>NOTE 4 VIN_BULK UV fault is not counted in Global Error Count.</p> <p>NOTE 5 PMIC sets the bit when error occurs.</p>			

2.3.5.1 Status Registers (cont'd)

Table 91 — Register 0x05

R05			
Bits	Attribute	Default	Description ^{1,2}
7	RV	0	R05 [7]: Reserved
6	ROE	0	R05 [6]: SWA_POWER_GOOD PMIC Power On - SWA Power Not Good ³ 0 = Normal Power On 1 = SWA Power Not Good
5	ROE	0	R05 [5]: SWB_POWER_GOOD PMIC Power On - SWB Power Not Good ^{3,4} 0 = Normal Power On 1 = SWB Power Not Good
4	ROE	0	R05 [4]: SWC_POWER_GOOD PMIC Power On - SWC Power Not Good ³ 0 = Normal Power On 1 = SWC Power Not Good
3	ROE	0	R05 [3]: SWD_POWER_GOOD PMIC Power On - SWD Power Not Good ³ 0 = Normal Power On 1 = SWD Power Not Good
2:0	ROE	0	R05 [2:0]: PMIC_ERROR_LOG PMIC Power On - High Level Status Bit to Previous Last Known Power Cycle 000 = Normal Power On 001 = Reserved 010 = Buck Regulator Output Over or Under Voltage ⁵ 011 = Critical Temperature 100 = VIN_Bulk Input Over Voltage 101 = Reserved 110 = Reserved 111 = VIN_Bulk Under Voltage ⁶
<p>NOTE 1 The PMIC always attempts to write this register into its non-volatile memory. However, it may not be guaranteed depending on how fast the host may shut off the input power to the PMIC. The PMIC needs minimum of 5.0 V for VIN_Bulk voltage and 200 ms duration from PWR_GOOD signal assertion to guarantee the write operation into non-volatile memory.</p> <p>NOTE 2 This entire register status reflects previous power down cycle of the PMIC and is updated by the PMIC on its own at each power cycle, if update is needed. Because this register is updated only if there is an update needed, there is no NVM life time impact. This register is cleared when host issues the erase command via Table 142, “Register 0x39”. The PMIC needs minimum of 200 ms for Erase operation.</p> <p>NOTE 3 This register is set only if PMIC generates internal VR Disable command due to fault condition.</p> <p>NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.</p> <p>NOTE 5 This code is a logical OR function of Table 92, “Register 0x06” [7:0] register bits.</p> <p>NOTE 6 The PMIC shall attempt to write the error log for VIN_Bulk Under Voltage event, but it may not be reliable because a minimum of 5 V is required at VIN_Bulk to update the error log register.</p>			

2.3.5.1 Status Registers (cont'd)

Table 92 — Register 0x06

R06			
Bits	Attribute	Default	Description ^{1,2}
7	ROE	0	R06 [7]: SWA_UNDER_VOLTAGE_LOCKOUT PMIC Power On - SWA Under Voltage Lockout 0 = Normal Power On 1 = SWA Under Voltage Lockout
6	ROE	0	R06 [6]: SWB_UNDER_VOLTAGE_LOCKOUT PMIC Power On - SWB Under Voltage Lockout ³ 0 = Normal Power On 1 = SWB Under Voltage Lockout
5	ROE	0	R06 [5]: SWC_UNDER_VOLTAGE_LOCKOUT PMIC Power On - SWC Under Voltage Lockout 0 = Normal Power On 1 = SWC Under Voltage Lockout
4	ROE	0	R06 [4]: SWD_UNDER_VOLTAGE_LOCKOUT PMIC Power On - SWD Under Voltage Lockout 0 = Normal Power On 1 = SWD Under Voltage Lockout
3	ROE	0	R06 [3]: SWA_OVER_VOLTAGE PMIC Power On - SWA Over Voltage 0 = Normal Power On 1 = SWA Over Voltage
2	ROE	0	R06 [2]: SWB_OVER_VOLTAGE PMIC Power On - SWB Over Voltage ³ 0 = Normal Power On 1 = SWB Over Voltage
1	ROE	0	R06 [1]: SWC_OVER_VOLTAGE PMIC Power On - SWC Over Voltage 0 = Normal Power On 1 = SWC Over Voltage
0	ROE	0	R06 [0]: SWD_OVER_VOLTAGE PMIC Power On - SWD Over Voltage 0 = Normal Power On 1 = SWD Over Voltage
<p>NOTE 1 The PMIC always attempts to write this register into its non-volatile memory. However, it may not be guaranteed depending on how fast the host may shut off the input power to the PMIC. The PMIC needs minimum of 5.0 V for VIN_Bulk voltage and 200 ms duration from PWR_GOOD signal assertion to guarantee the write operation into non-volatile memory.</p> <p>NOTE 2 This entire register status reflects previous power down cycle of the PMIC and is updated by the PMIC on its own at each power cycle, if update is needed. Because this register is updated only if there is an update needed, there is no NVM life time impact. This register is cleared when host issues the erase command via Table 142, “Register 0x39”. The PMIC needs minimum of 200 ms for Erase operation.</p> <p>NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.</p>			

2.3.5.1 Status Registers (cont'd)

Table 93 — Register 0x07

R07			
Bits	Attribute	Default	Description^{1,2}
7:0	ROE	0	R07 [7:0]: Reserved
NOTE 1	The PMIC always attempts to write this register into its non-volatile memory. However, it may not be guaranteed depending on how fast the host may shut off the input power to the PMIC. The PMIC needs minimum of 5.0 V for VIN_Bulk voltage and 200 ms duration from PWR_GOOD signal assertion to guarantee the write operation into non-volatile memory.		
NOTE 2	This entire register status reflects previous power down cycle of the PMIC and is updated by the PMIC on its own at each power cycle, if update is needed. Because this register is updated only if there is an update needed, there is no NVM life time impact. This register is cleared when host issues the erase command via Table 142, “Register 0x39”. The PMIC needs minimum of 200 ms for Erase operation.		

2.3.5.1 Status Registers (cont'd)

Table 94 — Register 0x08

R08			
Bits	Attribute	Default	Description
7	RO	0	R08 [7]: VIN_BULK_INPUT_POWER_GOOD_STATUS VIN_Bulk Input Power Good Status ¹ 0 = Power Good 1 = Power Not Good
6	RO	0	R08 [6]: CRITICAL_TEMP_SHUTDOWN_STATUS Critical Temperature Shutdown Status ² 0 = No Critical Temperature Shutdown 1 = Critical Temperature Shutdown
5	RO	0	R08 [5]: SWA_OUTPUT_POWER_GOOD_STATUS Switch Node A Output Power Good Status ³ 0 = Power Good 1 = Power Not Good
4	RO	0	R08 [4]: SWB_OUTPUT_POWER_GOOD_STATUS Switch Node B Output Power Good Status ⁴ 0 = Power Good 1 = Power Not Good
3	RO	0	R08 [3]: SWC_OUTPUT_POWER_GOOD_STATUS Switch Node C Output Power Good Status ⁵ 0 = Power Good 1 = Power Not Good
2	RO	0	R08 [2]: SWD_OUTPUT_POWER_GOOD_STATUS Switch Node D Output Power Good Status ⁶ 0 = Power Good 1 = Power Not Good
1	RO	0	R08 [1]: VIN_MGMT_INPUT_OVER_VOLTAGE_STATUS VIN_Mgmt Input Supply Over Voltage Status ⁷ 0 = No Over Voltage 1 = Over Voltage
0	RO	0	R08 [0]: VIN_BULK_INPUT_OVER_VOLTAGE_STATUS VIN_Bulk Input Supply Over Voltage Status ⁸ 0 = No Over Voltage 1 = Over Voltage

NOTE 1 This register is set when VIN_Bulk input goes below the threshold setting in register Table 112, “Register 0x1A” [7:5].

NOTE 2 This register is set when PMIC temperature goes above the threshold setting in register Table 132, “Register 0x2E” [2:0].

NOTE 3 This register is set when SWA output voltage goes either below the threshold setting in register Table 119, “Register 0x21^{1,2}” [1:0] or above the threshold setting in register Table 120, “Register 0x22^{1,2}” [7:6].

NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This register is set when SWB output goes either below the threshold setting in register Table 121, “Register 0x23^{1,2,3}” [1:0] or above the threshold setting in register Table 122, “Register 0x24^{1,2,3}” [7:6].

NOTE 5 This register is set when SWC output goes either below the threshold setting in register Table 123, “Register 0x25^{1,2}” [1:0] or above the threshold setting in register Table 124, “Register 0x26^{1,2}” [7:6].

NOTE 6 This register is set when SWD output goes either below the threshold setting in register Table 125, “Register 0x27^{1,2}” [1:0] or above the threshold setting in register Table 126, “Register 0x28^{1,2}” [7:6].

NOTE 7 This register is set when VIN_Mgmt input voltage goes above the threshold setting in register Table 113, “Register 0x1B” [5].

NOTE 8 This register is set when VIN_Bulk input voltage goes above the threshold setting in register Table 113, “Register 0x1B” [7].

2.3.5.1 Status Registers (cont'd)

Table 95 — Register 0x09

R09			
Bits	Attribute	Default	Description
7	RO	0	R09 [7]: PMIC_HIGH_TEMP_WARNING_STATUS PMIC High Temperature Warning Status ¹ 0 = Temperature Below the Warning Threshold 1 = Temperature Exceeded the Warning Threshold
6	RO	0	R09 [6]: VBIAS_POWER_GOOD_STATUS VBias Power Good Status ² 0 = Power Good 1 = Power Not Good
5	RO	0	R09 [5]: VOUT_1.8V_OUTPUT_POWER_GOOD_STATUS VOUT_1.8V LDO Output Power Good Status ³ 0 = Power Good 1 = Power Not Good
4	RO	0	R09 [4]: VIN_MGMT_TO_VIN_BULK_INPUT_SUPPLY_SWITCHOVER_STATUS VIN_Mgmt to VIN_Bulk Input Supply Automatic Switchover Status ⁴ 0 = VIN_Mgmt Input Supply is Present 1 = VIN_Mgmt Input Supply is Removed (i.e., using VIN_Bulk Input Supply)
3	RO	0	R09 [3]: SWA_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Switch Node A High Output Current Consumption Warning Status ⁵ 0 = No High Current Consumption Warning 1 = High Current Consumption Warning
2	RO	0	R09 [2]: SWB_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Switch Node B High Output Current Consumption Warning Status ^{6,7} 0 = No High Current Consumption Warning 1 = High Current Consumption Warning
1	RO	0	R09 [1]: SWC_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Switch Node C High Output Current Consumption Warning Status ⁸ 0 = No High Current Consumption Warning 1 = High Current Consumption Warning
0	RO	0	R09 [0]: SWD_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Switch Node D High Output Current Consumption Warning Status ⁹ 0 = No High Current Consumption Warning 1 = High Current Consumption Warning
<p>NOTE 1 This register is set when PMIC temperature goes above the threshold setting in Table 113, “Register 0x1B” [2:0].</p> <p>NOTE 2 This register is set when VBias voltage goes below the threshold setting in register Table 112, “Register 0x1A” [3].</p> <p>NOTE 3 This register is set when VOUT_1.8V output goes below the threshold setting in register Table 112, “Register 0x1A” [2].</p> <p>NOTE 4 This register is set when VIN_Mgmt input supply goes below the threshold setting in register Table 133, “Register 0x2F” [7].</p> <p>NOTE 5 This register is set when SWA output current consumption goes above the threshold setting in Table 114, “Register 0x1C” [7:2].</p> <p>NOTE 6 This register is set when SWB output current consumption goes above the threshold setting in Table 115, “Register 0x1D” [7:2]. If Table 162, “Register 0x4F” [0] = ‘1’, the setting in Table 115, “Register 0x1D” [7:2] must be identical as Table 114, “Register 0x1C” [7:2].</p> <p>NOTE 7 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0].</p> <p>NOTE 8 This register is set when SWC output current consumption goes above the threshold setting in Table 116, “Register 0x1E” [7:2].</p> <p>NOTE 9 This register is set when SWD output current consumption goes above the threshold setting in Table 117, “Register 0x1F” [7:2].</p>			

2.3.5.1 Status Registers (cont'd)**Table 96 — Register 0x0A**

R0A			
Bits	Attribute	Default	Description
7	RO	0	R0A [7]: SWA_OUTPUT_OVER_VOLTAGE_STATUS Switch Node A Output Over Voltage Status ¹ 0 = No Over Voltage 1 = Over Voltage
6	RO	0	R0A [6]: SWB_OUTPUT_OVER_VOLTAGE_STATUS Switch Node B Output Over Voltage Status ² 0 = No Over Voltage 1 = Over Voltage
5	RO	0	R0A [5]: SWC_OUTPUT_OVER_VOLTAGE_STATUS Switch Node C Output Over Voltage Status ³ 0 = No Over Voltage 1 = Over Voltage
4	RO	0	R0A [4]: SWD_OUTPUT_OVER_VOLTAGE_STATUS Switch Node D Output Over Voltage Status ⁴ 0 = No Over Voltage 1 = Over Voltage
3	RO	0	R0A [3]: PEC_ERROR_STATUS Packet Error Code Status ^{5,6} 0 = No PEC Error 1 = PEC Error
2	RO	0	R0A [2]: PARITY_ERROR_STATUS T Bit Parity Error Status ^{6,7} 0 = No Parity Error 1 = Parity Error
1	RO	0	R0A [1]: IBI_AND_GLOBAL_STATUS In Band Interrupt and Global Status ⁸ 0 = No Pending IBI or Outstanding Status 1 = Pending IBI or Outstanding Status
0	RV	0	R0A [0]: Reserved

NOTE 1 This register is set when SWA output voltage goes above the threshold setting in Table 120, “Register 0x22^{1,2}” [5:4].

NOTE 2 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This register is set when SWB output voltage goes above the threshold setting in Table 122, “Register 0x24^{1,2,3}” [5:4]. If Table 162, “Register 0x4F” [0] = ‘1’, the setting in Table 122, “Register 0x24^{1,2,3}” [5:4] must be identical as Table 120, “Register 0x22^{1,2}” [5:4].

NOTE 3 This register is set when SWC output voltage goes above the threshold setting in Table 124, “Register 0x26^{1,2}” [5:4].

NOTE 4 This register is set when SWD output voltage goes above the threshold setting in Table 126, “Register 0x28^{1,2}” [5:4].

NOTE 5 Applicable in I3C Basic Mode Only and if enabled in register Table 138, “Register 0x34” [7].

NOTE 6 This register is updated when PMIC device goes through bus reset as described in Section 1.13.15.

NOTE 7 Applicable in I3C Basic Mode and if enabled in register Table 138, “Register 0x34” [5]. Also applicable in I²C mode for supported CCC.

NOTE 8 This register can be used as Global Status in addition to IBI status. When IBI function is enabled, this register is automatically cleared when PMIC transmits IBI payload; however individual status registers still require an explicit clear command from host.

2.3.5.1 Status Registers (cont'd)

Table 97 — Register 0x0B

R0B			
Bits	Attribute	Default	Description
7	RO	0	R0B [7]: SWA_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Switch Node A Output Current Limiter Warning Status ¹ 0 = No Current Limiter Event 1 = Current Limiter Event
6	RO	0	R0B [6]: SWB_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Switch Node B Output Current Limiter Warning Status ² 0 = No Current Limiter Event 1 = Current Limiter Event
5	RO	0	R0B [5]: SWC_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Switch Node C Output Current Limiter Warning Status ³ 0 = No Current Limiter Event 1 = Current Limiter Event
4	RO	0	R0B [4]: SWD_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Switch Node D Output Current Limiter Warning Status ⁴ 0 = No Current Limiter Event 1 = Current Limiter Event
3	RO	0	R0B [3]: SWA_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Switch Node A Output Under Voltage Lockout Status ⁵ 0 = No Under Voltage Lockout 1 = Under Voltage Lockout
2	RO	0	R0B [2]: SWB_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Switch Node B Output Under Voltage Lockout Status ⁶ 0 = No Under Voltage Lockout 1 = Under Voltage Lockout
1	RO	0	R0B [1]: SWC_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Switch Node C Output Under Voltage Lockout Status ⁷ 0 = No Under Voltage Lockout 1 = Under Voltage Lockout
0	RO	0	R0B [0]: SWD_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Switch Node D Output Under Voltage Lockout Status ⁸ 0 = No Under Voltage Lockout 1 = Under Voltage Lockout

Table 97 — Register 0x0B (cont'd)

R0B			
Bits	Attribute	Default	Description
NOTE 1	This register is set when SWA output current goes above the threshold setting in Table 118, “Register 0x20 ¹ ” [7:6].		
NOTE 2	This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0]. This register is set when SWB output current goes above the threshold setting in Table 118, “Register 0x20 ¹ ” [5:4]. If Table 162, “Register 0x4F” [0] = ‘1’, the setting in Table 118, “Register 0x20 ¹ ” [5:4] must be identical as Table 118, “Register 0x20 ¹ ” [7:6].		
NOTE 3	This register is set when SWC output current goes above the threshold setting in Table 118, “Register 0x20 ¹ ” [3:2].		
NOTE 4	This register is set when SWD output current goes above the threshold setting in Table 118, “Register 0x20 ¹ ” [1:0].		
NOTE 5	This register is set when SWA output voltage goes below the threshold setting in Table 120, “Register 0x22 ^{1,2} ” [3:2].		
NOTE 6	Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This register is set when SWB output voltage goes below the threshold setting in Table 122, “Register 0x24 ^{1,2,3} ” [3:2]. If Table 162, “Register 0x4F” [0] = ‘1’, the setting in Table 122, “Register 0x24 ^{1,2,3} ” [3:2] must be identical as Table 120, “Register 0x22 ^{1,2} ” [3:2].		
NOTE 7	This register is set when SWC output voltage goes below the threshold setting in Table 124, “Register 0x26 ^{1,2} ” [3:2].		
NOTE 8	This register is set when SWD output voltage goes below the threshold setting in Table 126, “Register 0x28 ^{1,2} ” [3:2].		

Table 98 — Register 0x0C

R0C			
Bits	Attribute	Default	Description ¹
7:0	RO	0	<p>R0C [7:0]: SWA_OUTPUT_CURRENT_POWER_MEASUREMENT</p> <p>If Table 112, “Register 0x1A”[1] = ‘0’: Switch Node A Output Current or Output Power² Measurement³</p> <p>0000 0000 = Undefined</p> <p>0000 0001 = 0.125 A or 125 mW</p> <p>0000 0010 = 0.25 A or 250 mW</p> <p>0000 0011 = 0.375 A or 375 mW</p> <p>0000 0100 = 0.5 A or 500 mW</p> <p>...</p> <p>1111 1111 >= 31.875 A or 31.875 W</p> <p>If Table 112, “Register 0x1A”[1] = ‘1’: Sum of SWA, SWB, SWC and SWD Output Power⁴</p> <p>0000 0000 = Undefined</p> <p>0000 0001 = 125 mW</p> <p>0000 0010 = 250 mW</p> <p>0000 0011 = 375 mW</p> <p>0000 0100 = 500 mW</p> <p>...</p> <p>1111 1111 >= 31.875 W</p>
NOTE 1	The PMIC reports current or power measurement as long as there is no output over voltage or output under voltage lockout event that triggers the VR Disable command. If PMIC triggers VR Disable command, PMIC does not report current or power measurement and register content may have stale data. For all other events that causes PMIC’s power good status as Not Good, the PMIC continues to provide current or power measurement.		
NOTE 2	If Table 113, “Register 0x1B” [6] = ‘0’, the PMIC reports current measurement. If Table 113, “Register 0x1B” [6] = ‘1’, the PMIC reports power measurement.		
NOTE 3	If Table 162, “Register 0x4F” [0] = ‘1’, host adds the current or power reported in Table 98, “Register 0x0C” [7:0] and Table 99, “Register 0x0D” [7:0] for total current or power consumption.		
NOTE 4	Register Table 113, “Register 0x1B” [6] must be configured as ‘1’.		

2.3.5.1 Status Registers (cont'd)

Table 99 — Register 0x0D

R0D			
Bits	Attribute	Default	Description ¹
7:0	RO	0	R0D [7:0]: SWB_OUTPUT_CURRENT_POWER_MEASUREMENT Switch Node B Output Current or Output Power ² Measurement ³ 0000 0000 = Undefined 0000 0001 = 0.125 A or 125 mW 0000 0010 = 0.25 A or 250 mW 0000 0011 = 0.375 A or 375 mW 0000 0100 = 0.5 A or 500 mW ... 1111 1111 >= 31.875 A or 31.875 W
NOTE 1 The PMIC reports current or power measurement as long as there is no output over voltage or output under voltage lockout event that triggers the VR Disable command. If PMIC triggers VR Disable command, PMIC does not report current or power measurement and register content may have stale data. For all other events that causes PMIC's power good status as Not Good, the PMIC continues to provide current or power measurement.			
NOTE 2 If Table 113, "Register 0x1B" [6] = '0', the PMIC reports current measurement. If Table 113, "Register 0x1B" [6] = '1', the PMIC reports power measurement.			
NOTE 3 If Table 162, "Register 0x4F" [0] = '1', host adds the current or power reported in Table 98, "Register 0x0C" [7:0] and Table 99, "Register 0x0D" [7:0] for total current or power consumption.			

Table 100 — Register 0x0E

R0E			
Bits	Attribute	Default	Description ¹
7:0	RO	0	R0E [7:0]: SWC_OUTPUT_CURRENT_POWER_MEASUREMENT Switch Node C Output Current or Output Power ² Measurement 0000 0000 = Undefined 0000 0001 = 0.125 A or 125 mW 0000 0010 = 0.25 A or 250 mW 0000 0011 = 0.375 A or 375 mW 0000 0100 = 0.5 A or 500 mW ... 1111 1111 >= 31.875 A or 31.875 W
NOTE 1 The PMIC reports current or power measurement as long as there is no output over voltage or output under voltage lockout event that triggers the VR Disable command. If PMIC triggers VR Disable command, PMIC does not report current or power measurement and register content may have stale data. For all other events that causes PMIC's power good status as Not Good, the PMIC continues to provide current or power measurement.			
NOTE 2 If Table 113, "Register 0x1B" [6] = '0', the PMIC reports current measurement. If Table 113, "Register 0x1B" [6] = '1', the PMIC reports power measurement.			

2.3.5.1 Status Registers (cont'd)

Table 101 — Register 0x0F

R0F			
Bits	Attribute	Default	Description ¹
7:0	RO	0	R0F [7:0]: SWD_OUTPUT_CURRENT_POWER_MEASUREMENT Switch Node D Output Current or Output Power ² Measurement 0000 0000 = Undefined 0000 0001 = 0.125 A or 125 mW 0000 0010 = 0.25 A or 250 mW 0000 0011 = 0.375 A or 375 mW 0000 0100 = 0.5 A or 500 mW ... 1111 1111 >= 31.875 A or 31.875 W
NOTE 1 The PMIC reports current or power measurement as long as there is no output over voltage or output under voltage lockout event that triggers the VR Disable command. If PMIC triggers VR Disable command, PMIC does not report current or power measurement and register content may have stale data. For all other events that causes PMIC's power good status as Not Good, the PMIC continues to provide current or power measurement.			
NOTE 2 If Table 113, "Register 0x1B" [6] = '0', the PMIC reports current measurement. If Table 113, "Register 0x1B" [6] = '1', the PMIC reports power measurement.			

2.3.5.2 Clear Registers

For each Real Time Status Registers (Table 94, "Register 0x08" [7:0], Table 95, "Register 0x09" [7:0], Table 96, "Register 0x0A" [7:1], Table 97, "Register 0x0B" [7:0], and Table 137, "Register 0x33" [4:2]), the PMIC offers a way to clear the status of each event. The clear registers are Table 102, "Register 0x10" [7,5:0], Table 103, "Register 0x11" [7:0], Table 104, "Register 0x12" [7:2], Table 105, "Register 0x13" [7:0] and to Table 106, "Register 0x14" [4:2,0] respectively. All clear registers are Write '1' only registers. When '1' is written to any of the clear registers, the PMIC updates the status registers to default state and removes the interrupt condition on GSI_n and PWR_GOOD output signal assuming that event is no longer present. If the failing condition is still present, the status register will still remain at '1'. Note that GSI_n and PWR_GOOD interrupt is only applicable if that event is not masked. GSI_n output signal can be disabled.

When '1' is written to any of the clear registers, there are three categories of response by the PMIC.

1. PMIC removes GSI_n interrupt (PWR_GOOD interrupt is not applicable. Related status registers are: Table 102, "Register 0x10" [1], Table 103, "Register 0x11" [7,4:0], Table 105, "Register 0x13" [7:4], Table 106, "Register 0x14" [4].
2. PMIC removes GSI_n and PWR_GOOD interrupt. Related status registers are: Table 102, "Register 0x10" [7,5:2], Table 103, "Register 0x11" [6:5], Table 106, "Register 0x14" [2].
3. PMIC only removes GSI_n interrupt and does not remove PWR_GOOD interrupt. Related status registers are: Table 102, "Register 0x10" [0], Table 104, "Register 0x12" [7:4], Table 105, "Register 0x13" [3:0], Table 106, "Register 0x14" [3]. The host is expected to either power cycle the PMIC or re-issue the VR Enable command if PMIC is in non write protect mode.

The PMIC offers a Global Clear command by writing '1' to registers Table 106, "Register 0x14" [0]. This command works same way as individual clear command. This command can alternatively be used by the host if more than one clear command is required to different registers.

2.3.5.2 Clear Registers (cont'd)

Table 102 — Register 0x10

R10			
Bits	Attribute	Default	Description ¹
7	IO	0	R10 [7]: CLEAR_VIN_BULK_INPUT_POWER_GOOD_STATUS Clear VIN_Bulk Input Power Good Status. 1 = Clear Register Table 94, “Register 0x08” [7] ²
6	RV	0	R10 [6]: Reserved
5	IO	0	R10 [5]: CLEAR_SWA_OUTPUT_POWER_GOOD_STATUS Clear SWA Output Power Good Status. 1 = Clear Register Table 94, “Register 0x08” [5] ²
4	IO	0	R10 [4]: CLEAR_SWB_OUTPUT_POWER_GOOD_STATUS Clear SWB Output Power Good Status. ³ 1 = Clear Register Table 94, “Register 0x08” [4] ²
3	IO	0	R10 [3]: CLEAR_SWC_OUTPUT_POWER_GOOD_STATUS Clear SWC Output Power Good Status. 1 = Clear Register Table 94, “Register 0x08” [3] ²
2	IO	0	R10 [2]: CLEAR_SWD_OUTPUT_POWER_GOOD_STATUS Clear SWD Output Power Good Status. 1 = Clear Register Table 94, “Register 0x08” [2] ²
1	IO	0	R10 [1]: CLEAR_VIN_MGMT_INPUT_OVER_VOLTAGE_STATUS Clear VIN_Mgmt Input Supply Over Voltage Status. 1 = Clear Register Table 94, “Register 0x08” [1] ²
0	IO	0	R10 [0]: CLEAR_VIN_BULK_INPUT_OVER_VOLTAGE_STATUS Clear VIN_Bulk Input Supply Over Voltage Status. 1 = Clear Register Table 94, “Register 0x08” [0] ²
NOTE 1 Table 102, “Register 0x10” [7:0] are self clearing bits.			
NOTE 2 See Table 24 and Table 25 for GSI_n and POWER_GOOD output signal status change.			
NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			

2.3.5.2 Clear Registers (cont'd)**Table 103 — Register 0x11**

R11			
Bits	Attribute	Default	Description¹
7	1O	0	R11 [7]: CLEAR_PMIC_HIGH_TEMP_WARNING_STATUS Clear PMIC High Temperature Warning Status. 1 = Clear Register Table 95, “Register 0x09” [7] ²
6	1O	0	R11 [6]: CLEAR_VBIAS_POWER_GOOD_STATUS Clear VBias Power Good Status. 1 = Clear Register Table 95, “Register 0x09” [6] ²
5	1O	0	R11 [5]: CLEAR_VOUT_1.8V_OUTPUT_POWER_GOOD_STATUS Clear VOUT_1.8V Output Power Good Status. 1 = Clear Register Table 95, “Register 0x09” [5] ²
4	1O	0	R11 [4]: CLEAR_VIN_MGMT_TO_VIN_BULK_INPUT_SWITCHOVER_STATUS Clear VIN_Mgmt to VIN_Bulk Input Supply Switchover Status. 1 = Clear Register Table 95, “Register 0x09” [4] ²
3	1O	0	R11 [3]: CLEAR_SWA_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNIN G_STATUS Clear Switch Node A High Output Current Consumption Warning Status. 1 = Clear Register Table 95, “Register 0x09” [3] ²
2	1O	0	R11 [2]: CLEAR_SWB_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNIN G_STATUS Clear Switch Node B High Output Current Consumption Warning Status. ³ Clear Register Table 95, “Register 0x09” [2] ²
1	1O	0	R11 [1]: CLEAR_SWC_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNIN G_STATUS Clear Switch Node C High Output Current Consumption Warning Status. 1 = Clear Register Table 95, “Register 0x09” [1] ²
0	1O	0	R11 [0]: CLEAR_SWD_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNIN G_STATUS Clear Switch Node D High Output Current Consumption Warning Status. 1 = Clear Register Table 95, “Register 0x09” [0] ²
NOTE 1 Table 103, “Register 0x11” [7:0] are self clearing bits.			
NOTE 2 See Table 24 and Table 25 for GSI_n and POWER_GOOD output signal status change.			
NOTE 3 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0].			

2.3.5.2 Clear Registers (cont'd)

Table 104 — Register 0x12

R12			
Bits	Attribute	Default	Description ¹
7	IO	0	R12 [7]: CLEAR_SWA_OUTPUT_OVER_VOLTAGE_STATUS Clear Switch Node A Output Over Voltage Status. 1 = Clear Register Table 96, “Register 0x0A” [7] ²
6	IO	0	R12 [6]: CLEAR_SWB_OUTPUT_OVER_VOLTAGE_STATUS Clear Switch Node B Output Over Voltage Status. ³ 1 = Clear Register Table 96, “Register 0x0A” [6] ²
5	IO	0	R12 [5]: CLEAR_SWC_OUTPUT_OVER_VOLTAGE_STATUS Clear Switch Node C Output Over Voltage Status. 1 = Clear Register Table 96, “Register 0x0A” [5] ²
4	IO	0	R12 [4]: CLEAR_SWD_OUTPUT_OVER_VOLTAGE_STATUS Clear Switch Node D Output Over Voltage Status. 1 = Clear Register Table 96, “Register 0x0A” [4] ²
3	IO	0	R12 [3]: CLEAR_PER_ERROR_STATUS Clear PEC Error Status. 1 = Clear Register Table 96, “Register 0x0A” [3]
2	IO	0	R12 [2]: CLEAR_PARITY_ERROR_STATUS Clear Parity Error Status. 1 = Clear Register Table 96, “Register 0x0A” [2]
1:0	RV	0	R12 [1:0]: Reserved
NOTE 1 Table 104, “Register 0x12” [7:0] are self clearing bits.			
NOTE 2 See Table 24 and Table 25 for GSI_n and POWER_GOOD output signal status change.			
NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			

2.3.5.2 Clear Registers (cont'd)**Table 105 — Register 0x13**

R13			
Bits	Attribute	Default	Description¹
7	1O	0	R13 [7]: CLEAR_SWA_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Clear Switch Node A Output Current Limiter Warning Status. 1 = Clear Register Table 97, “Register 0x0B” [7] ²
6	1O	0	R13 [6]: CLEAR_SWB_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Clear Switch Node B Output Current Limiter Warning Status. ³ 1 = Clear Register Table 97, “Register 0x0B” [6] ²
5	1O	0	R13 [5]: CLEAR_SWC_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Clear Switch Node C Output Current Limiter Warning Status. 1 = Clear Register Table 97, “Register 0x0B” [5] ²
4	1O	0	R13 [4]: CLEAR_SWD_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Clear Switch Node D Output Current Limiter Warning Status. 1 = Clear Register Table 97, “Register 0x0B” [4] ²
3	1O	0	R13 [3]: CLEAR_SWA_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Clear Switch Node A Output Under Voltage Lockout Status. 1 = Clear Register Table 97, “Register 0x0B” [3] ²
2	1O	0	R13 [2]: CLEAR_SWB_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Clear Switch Node B Output Under Voltage Lockout Status. ⁴ 1 = Clear Register Table 97, “Register 0x0B” [2] ²
1	1O	0	R13 [1]: CLEAR_SWC_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Clear Switch Node C Output Under Voltage Lockout Status. 1 = Clear Register Table 97, “Register 0x0B” [1] ²
0	1O	0	R13 [0]: CLEAR_SWD_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Clear Switch Node D Output Under Voltage Lockout Status. 1 = Clear Register Table 97, “Register 0x0B” [0] ²
NOTE 1 Table 105, “Register 0x13” [7:0] are self clearing bits.			
NOTE 2 See Table 24 and Table 25 for GSI_n and POWER_GOOD output signal status change.			
NOTE 3 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0].			
NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			

2.3.5.2 Clear Registers (cont'd)

Table 106 — Register 0x14

R14			
Bits	Attribute	Default	Description¹
7:5	RV	0	R14 [7:5]: Reserved
4	1O	0	R14 [4]: CLEAR_VIN_MGMT_POWER_GOOD_STATUS_SWITCHOVER_MODE Clear Valid VIN_Mgmt Power Good Status in Switchover Mode. 1 = Clear Register Table 137, “Register 0x33” [4] ²
3	1O	0	R14 [3]: CLEAR_VBIAS_OUTPUT_OR_VIN_BULK_UNDER_VOLTAGE_LOCKOUT_STATUS Clear VBias Output or VIN_Bulk Input Under Voltage Lockout Status. 1 = Clear Register Table 137, “Register 0x33” [3] ²
2	1O	0	R14 [2]: CLEAR_VOUT_1.0V_OUTPUT_POWER_GOOD_STATUS Clear VOUT_1.0V Output Power Good Status. 1 = Clear Register Table 137, “Register 0x33” [2] ²
1	RV	0	R14 [1]: Reserved
0	1O	0	R14 [0]: GLOBAL_CLEAR_STATUS Clear all ³ status bits. 1 = Clear all status bits ⁴
NOTE 1 Table 106, “Register 0x14” [4:2, 0] are self clearing bits.			
NOTE 2 See Table 24 and Table 25 for GSI_n and POWER_GOOD output signal status change.			
NOTE 3 All status bits in register Table 102, “Register 0x10” [7,5:0], Table 103, “Register 0x11” [7:0], Table 104, “Register 0x12” [7:2], Table 105, “Register 0x13” [7:0], and Table 106, “Register 0x14” [4:2].			
NOTE 4 See Table 24 and Table 25 for GSI_n and POWER_GOOD output signal status change.			

2.3.5.3 Mask Registers

For each Real Time Status Registers (Table 94, “Register 0x08” [7:0], Table 95, “Register 0x09” [7:0], Table 96, “Register 0x0A” [7:1], Table 97, “Register 0x0B” [7:0], Table 137, “Register 0x33” [4:2]), the PMIC offers a way to mask the status of each event interrupt. The mask registers are Table 107, “Register 0x15” [7,5:0], Table 108, “Register 0x16” [7:0], Table 109, “Register 0x17” [7:2], Table 110, “Register 0x18” [7:0] and Table 111, “Register 0x19” [4:2] respectively. The mask registers only masks the event interrupt on GSI_n and PWR_GOOD signal.

There is also a global mask bits register control Table 133, “Register 0x2F” [1:0] to control the GSI_n and PWR_GOOD output signal. When all mask registers are Table 107, “Register 0x15” [7,5:0], Table 108, “Register 0x16” [7:0], Table 109, “Register 0x17” [7:2], Table 110, “Register 0x18” [7:0], Table 111, “Register 0x19” [4:2] configured as ‘0’, the setting in Table 133, “Register 0x2F” [1:0] does not matter. The setting in Table 133, “Register 0x2F” [1:0] only matters when one or more mask registers Table 107, “Register 0x15” [7,5:0], Table 108, “Register 0x16” [7:0], Table 109, “Register 0x17” [7:2], Table 110, “Register 0x18” [7:0], Table 111, “Register 0x19” [4:2] are configured to ‘1’.

For any failure events that cause the PMIC to generate VR Disable command on its own, the mask register bits (Table 107, “Register 0x15” [0], Table 109, “Register 0x17” [7:4], Table 110, “Register 0x18” [3:0], Table 111, “Register 0x19” [3], Table 133, “Register 0x2F” [1:0]) do not apply and PMIC will assert PWR_GOOD output signal regardless of the setting in mask registers. The PMIC still updates the status registers appropriately when any event occurs. When masked, the host is expected to read the status registers periodically to learn if any of the event has occurred or not. The host can mask or unmask each event individually. The host can mask or unmask at any time in non write protect mode. In write protect mode of operation, the mask registers are locked.

2.3.5.3 Mask Registers (cont'd)

Table 107 — Register 0x15

R15			
Bits	Attribute	Default	Description
7	RW	1	R15 [7]: MASK_VIN_BULK_INPUT_POWER_GOOD_STATUS Mask VIN_Bulk Input Power Good Status Event. 0 = Do Not Mask VIN_Bulk Input Power Good Status Event 1 = Mask VIN_Bulk Input Power Good Status Event ¹
6	RV	0	R15 [6]: Reserved
5	RW	1	R15 [5]: MASK_SWA_OUTPUT_POWER_GOOD_STATUS Mask SWA Output Power Good Status Event. 0 = Do Not Mask SWA Output Power Good Status Event 1 = Mask SWA Output Power Good Status Event ¹
4	RW	1	R15 [4]: MASK_SWB_OUTPUT_POWER_GOOD_STATUS Mask SWB Output Power Good Status Event. ² 0 = Do Not Mask SWB Output Power Good Status Event 1 = Mask SWB Output Power Good Status Event ¹
3	RW	1	R15 [3]: MASK_SWC_OUTPUT_POWER_GOOD_STATUS Mask SWC Output Power Good Status Event. 0 = Do Not Mask SWC Output Power Good Status Event 1 = Mask SWC Output Power Good Status Event ¹
2	RW	1	R15 [2]: MASK_SWD_OUTPUT_POWER_GOOD_STATUS Mask SWD Output Power Good Status Event. 0 = Do Not Mask SWD Output Power Good Status Event 1 = Mask SWD Output Power Good Status Event ¹
1	RW	0	R15 [1]: MASK_VIN_MGMT_INPUT_OVER_VOLTAGE_STATUS Mask VIN_Mgmt Input Supply Over Voltage Status Event. 0 = Do Not Mask VIN_Mgmt Input Supply Over Voltage Status Event 1 = Mask VIN_Mgmt Input Supply Over Voltage Status Event ³
0	RW	0	R15 [0]: MASK_VIN_BULK_INPUT_OVER_VOLTAGE_STATUS Mask VIN_Bulk Input Supply Over Voltage Status Event. 0 = Do Not Mask VIN_Bulk Input Supply Over Voltage Status Event 1 = Mask VIN_Bulk Input Supply Over Voltage Status Event ³
NOTE 1 Not assert GSI_n or assert POWER_GOOD output signal.			
NOTE 2 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			
NOTE 3 Not assert GSI_n output signal.			

2.3.5.3 Mask Registers (cont'd)**Table 108 — Register 0x16**

R16			
Bits	Attribute	Default	Description
7	RW	0	R16 [7]: MASK_PMIC_HIGH_TEMP_WARNING_STATUS Mask PMIC High Temperature Warning Status Event. 0 = Do Not Mask PMIC High Temperature Warning Status Event 1 = Mask PMIC High Temperature Warning Status Event ¹
6	RW	0	R16 [6]: MASK_VBIAS_POWER_GOOD_STATUS Mask VBIAS Power Good Status Event. 0 = Do Not Mask VBIAS Power Good Status Event 1 = Mask VBIAS Power Good Status Event ²
5	RW	1	R16 [5]: MASK_VOUT_1.8V_OUTPUT_POWER_GOOD_STATUS Mask VOUT_1.8V Output Power Good Status Event. 0 = Do Not Mask 1.8V Output Power Good Status Event 1 = Mask 1.8V Output Power Good Status Event ²
4	RW	0	R16 [4]: MASK_VIN_MGMT_TO_VIN_BULK_SWITCHOVER_STATUS Mask VIN_Mgmt to VIN_Bulk Input Supply Switchover Status Event. 0 = Do Not Mask VIN_Mgmt to VIN_Bulk Input Supply Switchover Status Event 1 = Mask VIN_Mgmt to VIN_Bulk Input Supply Switchover Status Event ¹
3	RW	0	R16 [3]: MASK_SWA_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Mask SWA High Output Current Consumption Warning Status Event. 0 = Do Not Mask SWA Output Current Consumption Warning Status Event 1 = Mask SWA Output Current Consumption Warning Status Event ¹
2	RW	0	R16 [2]: MASK_SWB_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Mask SWB High Output Current Consumption Warning Status Event. ³ 0 = Do Not Mask SWB Output Current Consumption Warning Status Event 1 = Mask SWB Output Current Consumption Warning Status Event ¹
1	RW	0	R16 [1]: MASK_SWC_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Mask SWC High Output Current Consumption Warning Status Event. 0 = Do Not Mask SWC Output Current Consumption Warning Status Event 1 = Mask SWC Output Current Consumption Warning Status Event ¹
0	RW	0	R16 [0]: MASK_SWD_HIGH_OUTPUT_CURRENT_CONSUMPTION_WARNING_STATUS Mask SWD High Output Current Consumption Warning Status Event. 0 = Do Not Mask SWD Output Current Consumption Warning Status Event 1 = Mask SWD Output Current Consumption Warning Status Event ¹
NOTE 1 Not assert GSI_n output signal.			
NOTE 2 Not assert GSI_n or assert POWER_GOOD output signal			
NOTE 3 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0].			

2.3.5.3 Mask Registers (cont'd)

Table 109 — Register 0x17

R17			
Bits	Attribute	Default	Description
7	RW	0	R17 [7]: MASK_SWA_OUTPUT_OVER_VOLTAGE_STATUS Mask SWA Output Over Voltage Status Event. 0 = Do Not Mask SWA Output Over Voltage Status Event 1 = Mask SWA Output Over Voltage Status Event ¹
6	RW	0	R17 [6]: MASK_SWB_OUTPUT_OVER_VOLTAGE_STATUS Mask SWB Output Over Voltage Status Event. ² 0 = Do Not Mask SWB Output Over Voltage Status Event 1 = Mask SWB Output Over Voltage Status Event ¹
5	RW	0	R17 [5]: MASK_SWC_OUTPUT_OVER_VOLTAGE_STATUS Mask SWC Output Over Voltage Status Event. 0 = Do Not Mask SWC Output Over Voltage Status Event 1 = Mask SWC Output Over Voltage Status Event ¹
4	RW	0	R17 [4]: MASK_SWD_OUTPUT_OVER_VOLTAGE_STATUS Mask SWD Output Over Voltage Status Event. 0 = Do Not Mask SWD Output Over Voltage Status Event 1 = Mask SWD Output Over Voltage Status Event ¹
3	RW	0	R17 [3]: MASK_PEC_ERROR_STATUS Mask PEC Error Event for GSI_n output Only ³ 0 = Do Not Mask PEC Error Status Event 1 = Mask PEC Error Status
2	RW	0	R17 [2]: MASK_PARITY_ERROR_STATUS Mask Parity Error Event for GSI_n output Only ³ 0 = Do Not Mask Parity Error Status Event 1 = Mask Parity Error Status
1:0	RV	0	R17 [1:0]: Reserved
NOTE 1 Not assert GSI_n output signal.			
NOTE 2 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			
NOTE 3 Only applicable when PMIC is in I3C Basic Mode. This Mask register only masks the GSI_n output. Does not apply to IBI.			

2.3.5.3 Mask Registers (cont'd)**Table 110 — Register 0x18**

R18			
Bits	Attribute	Default	Description
7	RW	0	R18 [7]: MASK_SWA_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Mask SWA Output Current Limiter Warning Status Event. 0 = Do Not Mask SWA Output Current Limiter Warning Status Event 1 = Mask SWA Output Current Limiter Warning Status Event ¹
6	RW	0	R18 [6]: MASK_SWB_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Mask SWB Output Current Limiter Warning Status Event. ² 0 = Do Not Mask SWB Output Current Limiter Warning Status Event 1 = Mask SWB Output Current Limiter Warning Status Event ¹
5	RW	0	R18 [5]: MASK_SWC_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Mask SWC Output Current Limiter Warning Status Event. 0 = Do Not Mask SWC Output Current Limiter Warning Status Event 1 = Mask SWC Output Current Limiter Warning Status Event ¹
4	RW	0	R18 [4]: MASK_SWD_OUTPUT_CURRENT_LIMITER_WARNING_STATUS Mask SWD Output Current Limiter Warning Status Event. 0 = Do Not Mask SWD Output Current Limiter Warning Status Event 1 = Mask SWD Output Current Limiter Warning Status Event ¹
3	RW	0	R18 [3]: MASK_SWA_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Mask SWA Output Under Voltage Lockout Status Event. 0 = Do Not Mask SWA Output Under Voltage Lockout Status Event 1 = Mask SWA Output Under Voltage Lockout Status Event ¹
2	RW	0	R18 [2]: MASK_SWB_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Mask SWB Output Under Voltage Lockout Status Event. ³ 0 = Do Not Mask SWB Output Under Voltage Lockout Status Event 1 = Mask SWB Output Under Voltage Lockout Status Event ¹
1	RW	0	R18 [1]: MASK_SWC_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Mask SWC Output Under Voltage Lockout Status Event. 0 = Do Not Mask SWC Output Under Voltage Lockout Status Event 1 = Mask SWC Output Under Voltage Lockout Status Event ¹
0	RW	0	R18 [0]: MASK_SWD_OUTPUT_UNDER_VOLTAGE_LOCKOUT_STATUS Mask SWD Output Under Voltage Lockout Status Event. 0 = Do Not Mask SWD Output Under Voltage Lockout Status Event 1 = Mask SWD Output Under Voltage Lockout Status Event ¹

NOTE 1 Not assert GSI_n output signal.

NOTE 2 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0].

NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.

2.3.5.3 Mask Registers (cont'd)

Table 111 — Register 0x19

R19			
Bits	Attribute	Default	Description
7:5	RV	0	R19 [7:5]: Reserved
4	RW	0	R19 [4]: MASK_VIN_MGMT_POWER_GOOD_STATUS_SWITCHOVER_MODE Mask VIN_Mgmt Input Supply Power Good Status in Switchover Mode Only 0 = Do Not Mask VIN_Mgmt Input Power Supply Power Good Status Event in Switchover Mode 1 = Mask VIN_Mgmt Input Power Supply Power Good Status Event in Switchover Mode ¹
3	RW	0	R19 [3]: MASK_VBIAS_OUTPUT_OR_VIN_BULK_UNDER_VOLTAGE_LOCKOUT_STATUS Mask VBias Output or VIN_Bulk Input Under Voltage Lockout Event 0 = Do Not Mask Vbias Output or VIN_Bulk Input Under Voltage Lockout Event 1 = Mask Vbias Output or VIN_Bulk Input Under Voltage Lockout Event ¹
2	RW	1	R19 [2]: MASK_VOUT_1.0V_OUTPUT_POWER_GOOD_STATUS Mask VOUT_1.0V Output Power Good Status Event. 0 = Do Not Mask VOUT_1.0V Output Power Good Status Event 1 = Mask VOUT_1.0V Output Power Good Status Event ²
1:0	RV	0	R19 [1:0]: Reserved
NOTE 1 Not assert GSI_n output signal.			
NOTE 2 Not assert GSI_n or POWER_GOOD output signal.			

2.3.5.4 Threshold and Configuration Registers

Table 112 — Register 0x1A

R1A			
Bits	Attribute	Default	Description
7:5	RW	110	R1A [7:5]: VIN_BULK_POWER_GOOD_THRESHOLD_VOLTAGE VIN Bulk Input Threshold Voltage for Input Power Good Status for input supply 000 = Reserved 001 = 9.5 V 010 = 8.5 V 011 = 7.5 V 100 = 6.5 V 101 = 5.5 V 110 = 4.25 V ^{1,2,3} 111 = Reserved
4	RV	0	R1A [4]: Reserved
3	RW	0	R1A [3]: VBIAS_POWER_GOOD_THRESHOLD_VOLTAGE VBias LDO Output Threshold Voltage for Power Good Status 0 = Vendor Specific 1 = Reserved
2	RW	0	R1A [2]: VOUT_1.8V_POWER_GOOD_THRESHOLD_VOLTAGE VOUT 1.8V LDO Output Threshold Voltage for Power Good Status 0 = 1.6 V 1 = Reserved
1	RW	0	R1A [1]: OUTPUT_POWER_SELECT Switch Regulator Output Power Select ⁴ 0 = Report individual power for each rail in R0C, R0D, R0E, and R0F 1 = Report total power of each rail in R0C ⁵
0	RW	0	R1A [0]: VOUT_1.0V_POWER_GOOD_THRESHOLD_VOLTAGE VOUT 1.0V LDO Output Threshold Voltage for Power Good Status 0 = -10% from the setting in Table 129, “Register 0x2B ^{1,2} ” [2:1] 1 = -15% from the setting in Table 129, “Register 0x2B ^{1,2} ” [2:1]
NOTE 1 If VIN_Bulk input voltage falls below this threshold, the PMIC may not guarantee the operation.			
NOTE 2 If VIN_Bulk voltage continues to fall below vendor specific UVLO, the PMIC triggers an VR Disable command and executes power down sequence.			
NOTE 3 If VIN_Bulk voltage threshold is higher than default setting of this register, the PMIC continues to operate but updates its PWR_GOOD status register and GSI_n/PWR_GOOD signal is asserted when VIN_Bulk falls below the threshold setting.			
NOTE 4 This register is only applicable if Table 113, “Register 0x1B” [6] = ‘1’.			
NOTE 5 Host should only read Table 98, “Register 0x0C” [7:0] for total power. The register contents of Table 99, “Register 0x0D”, Table 100, “Register 0x0E”, and Table 101, “Register 0x0F” may not be valid.			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 113 — Register 0x1B

R1B			
Bits	Attribute	Default	Description
7	RW	0	R1B [7]: VIN_BULK_OVER_VOLTAGE_THRESHOLD VIN_Bulk Input Over Voltage Threshold Setting 0 = 14.5 V 1 = 16.0 V
6	RW	0	R1B [6]: CURRENT_OR_POWER_METER_SELECT PMIC Output Regulator Measurement - Current or Power Meter 0 = Report Current Measurements in registers: ¹ 1 = Report Power Measurements in registers ¹
5	RW	0	R1B [5]: VIN_MGMT_OVER_VOLTAGE_THRESHOLD VIN_Mgmt Input Over Voltage Threshold 0 = 3.8 V 1 = 3.7 V
4	RW	0	R1B [4]: GLOBAL_PWR_GOOD_PIN_STATUS_MASK Global Mask PWR_GOOD Output Pin ² 0 = Not Masked 1 = Masked
3	RW	0	R1B [3]: GSI_N_PIN_ENABLE Enable GSI_n Pin ³ 0 = Disable GSI_n Pin 1 = Enable GSI_n Pin
2:0	RW	101	R1B [2:0]: PMIC_HIGH_TEMPERATURE_WARNING_THRESHOLD PMIC High Temperature Warning Threshold ⁴ 000 = Reserved 001 = PMIC temperature $\geq 85^{\circ}\text{C}$ 010 = PMIC temperature $\geq 95^{\circ}\text{C}$ 011 = PMIC temperature $\geq 105^{\circ}\text{C}$ 100 = PMIC temperature $\geq 115^{\circ}\text{C}$ 101 = PMIC temperature $\geq 125^{\circ}\text{C}$ 110 = PMIC temperature $\geq 135^{\circ}\text{C}$ 111 = Reserved
NOTE 1 Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [7:0], Table 100, “Register 0x0E” [7:0], Table 101, “Register 0x0F” [7:0].			
NOTE 2 Mask POWER_GOOD output signal for all appropriate register bits in Table 107, “Register 0x15” [7:5:0], Table 108, “Register 0x16” [7:0], Table 109, “Register 0x17” [7:4], Table 110, “Register 0x18” [7:0] and Table 111, “Register 0x19” [4:2]. Mask Register Control Table 133, “Register 0x2F” [1:0] still applies when Global PWR_GOOD output Mask register is set to ‘1’.			
NOTE 3 This register can be used as Global Mask Function for GSI_n pin. If disabled, this masks GSI_n output signal for all register bits in Table 107, “Register 0x15” [7, 5:0], Table 108, “Register 0x16” [7:0], Table 109, “Register 0x17” [7:2], Table 110, “Register 0x18” [7:0], and Table 111, “Register 0x19” [4:2].			
NOTE 4 The tolerance of the temperature warning threshold is $\pm 5^{\circ}\text{C}$ from the selected setting.			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 114 — Register 0x1C

R1C			
Bits	Attribute	Default	Description
7:0	RW	0100 1000	R1C [7:0]: SWA_OUTPUT_HIGH_CURRENT_CONSUMPTION_WARNING_THRE SHOLD SWA Output High Current Consumption Warning Threshold 0000 0000 = Undefined 0000 0001 = > 0.125 A 0000 0010 = > 0.25 A 0000 0011 = > 0.375 A ... 1111 1111 = > 31.875 A

Table 115 — Register 0x1D

R1D			
Bits	Attribute	Default	Description
7:0	RW	0100 1000	R1D [7:0]: SWB_OUTPUT_HIGH_CURRENT_CONSUMPTION_WARNING_THRE SHOLD SWB Output High Current Consumption Warning Threshold ¹ 0000 0000 = Undefined 0000 0001 = > 0.125 A 0000 0010 = > 0.25 A 0000 0011 = > 0.375 A ... 1111 1111 = > 31.875 A
NOTE 1 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0]. For dual phase operation, this register should be configured identically as Table 114, “Register 0x1C” [7:0].			

Table 116 — Register 0x1E

R1E			
Bits	Attribute	Default	Description
7:0	RW	0101 0000	R1E [7:0]: SWC_OUTPUT_HIGH_CURRENT_CONSUMPTION_WARNING_THRE SHOLD SWC Output High Current Consumption Warning Threshold 0000 0000 = Undefined 0000 0001 = > 0.125 A 0000 0010 = > 0.25 A 0000 0011 = > 0.375 A ... 1111 1111 = > 31.875 A

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 117 — Register 0x1F

R1F			
Bits	Attribute	Default	Description
7:0	RW	0001 1000	R1F [7:0]: SWD_OUTPUT_HIGH_CURRENT_CONSUMPTION_WARNING_THRESHO LD SWD Output High Current Consumption Warning Threshold 0000 0000 = Undefined 0000 0001 = > 0.125 A 0000 0010 = > 0.25 A 0000 0011 = > 0.375 A ... 1111 1111 = > 31.875 A

Table 118 — Register 0x20¹

R20			
Bits	Attribute	Default	Description
7:6	RW	01	R20 [7:6]: SWA_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING PMIC5020, COT Ivalley_limit 00 = 7.0 A 01 = 8.0 A 10 = 9.0 A 11 = 10.0 A
5:4	RW	01	R20 [5:4]: SWB_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING PMIC5020, COT Ivalley_limit: ² 00 = 7.0 A 01 = 8.0 A 10 = 9.0 A 11 = 10.0 A
3:2	RW	01	R20 [3:2]: SWC_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING PMIC5020, COT Ivalley_limit: 00 = 8.0 A 01 = 9.0 A 10 = 10.0 A 11 = 11.0 A
1:0	RW	00	R20 [1:0]: SWD_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING PMIC5020, COT Ivalley_limit: 00 = 3.0 A 01 = 3.5 A 10 = 4.0 A 11 = 4.5 A
NOTE 1 At first power on, this register is automatically configured identically by PMIC on its own as Table 163, “Register 0x50”.			
NOTE 2 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0]. If Table 162, “Register 0x4F” [0] = ‘1’, this register must be configured identically as bits [7:6].			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 119 — Register 0x21^{1,2}

R21			
Bits	Attribute	Default	Description
7:1	RW	011 1100	R21 [7:1]: SWA_VOLTAGE_SETTING SWA Output Regulator Voltage Setting ^{3,4} 000 0000 = 800 mV ⁵ or 600 mV ⁶ 000 0001 = 805 mV or 605 mV 000 0010 = 810 mV or 610 mV ... 011 1100 = 1100 mV or 900 mV ... 111 1101 = 1425 mV or 1225 mV 111 1110 = 1430 mV or 1230 mV 111 1111 = 1435 mV or 1235 mV
0	RW	0	R21 [0]: SWA_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWA Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 1 = -7.5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1]
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 152, “Register 0x45”.		
NOTE 2	If required, the host must update the settings in register Table 119, “Register 0x21 ^{1,2} ” [0], Table 120, “Register 0x22 ^{1,2} ” [7:2] and Table 118, “Register 0x20 ¹ ” [7:6] first prior to updating the settings in the register Table 119, “Register 0x21 ^{1,2} ” [7:1].		
NOTE 3	PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1050 mV to 1160 mV.		
NOTE 4	After VR is enabled, the host may update this register to any new setting that it may desire. However to prevent false error trigger, the PMIC internally will increment the SWA output voltage setting by 5 mV at a time. The time it takes for PMIC to adjust the output voltage is 5 μ s for each 5 mV increment. The host must wait sufficient time for PMIC to adjust to final value. As an example, if host adjusts the output voltage by 50 mV from the original value, the host must wait minimum of 50 μ s before PMIC can guarantee the new output voltage. During this time, PMIC masks the PWR_GOOD output signal assertion to prevent any artificial error due to the crossing of the output voltage threshold setting. However, PMIC does assert PWR_GOOD output signal if there is any abnormal issues that triggers VR Disable command as described in Table 23. Further, PMIC does monitor PWR_GOOD input signal and executes power off config sequence registers if it is registered low when Table 136, “Register 0x32” [5] = ‘1’.		
NOTE 5	Table 129, “Register 0x2B ^{1,2} ” [5] = ‘0’; 5 mV step size.		
NOTE 6	Table 129, “Register 0x2B ^{1,2} ” [5] = ‘1’; 5 mV step size		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 120 — Register 0x22^{1,2}

R22			
Bits	Attribute	Default	Description
7:6	RW	01	R22 [7:6]: SWA_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWA Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 01 = +7.5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 10 = +10% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 11 = Reserved
5:4	RW	10	R22 [5:4]: SWA_OVER_VOLTAGE_THRESHOLD_SETTING SWA Output Regulator Threshold For Over Voltage Status ³ 00 = +7.5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 01 = +10% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 10 = +12.5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 11 = Reserved
3:2	RW	00	R22 [3:2]: SWA_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWA Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 01 = -12.5% from the setting in Table 119, “Register 0x21 ^{1,2} ” [7:1] 10 = Reserved 11 = Reserved
1:0	RW	00	R22 [1:0]: SWA_OUTPUT_SOFT_STOP_TIME SWA Output Regulator Soft Stop Time After VR Disable ⁴ 00 = 0.5 ms 01 = 1 ms 10 = 2 ms 11 = 4 ms
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 153, “Register 0x46,”.		
NOTE 2	If required, the host must update the setting in register Table 119, “Register 0x21,” [0], Table 120, “Register 0x22,” [7:2] and Table 118, “Register 0x20” [7:6] first prior to updating the settings in the register Table 119, “Register 0x21,” [7:1].		
NOTE 3	The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 120, “Register 0x22 ^{1,2} ” [7:6].		
NOTE 4	This is the time it takes for buck regulator to go from steady state voltage to 0 V.		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 121 — Register 0x23^{1,2,3}

R23			
Bits	Attribute	Default	Description
7:1	RW	011 1100	R23 [7:1]: SWB_VOLTAGE_SETTING SWB Output Regulator Voltage Setting ^{4,5} 000 0000 = 800 mV ⁶ or 600 mV ⁷ 000 0001 = 805 mV or 605 mV 000 0010 = 810 mV or 610 mV ... 011 1100 = 1100 mV or 900 mV ... 111 1101 = 1425 mV or 1225 mV 111 1110 = 1430 mV or 1230 mV 111 1111 = 1435 mV or 1235 mV
0	RW	0	R23 [0]: SWB_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWB Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 1 = -7.5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1]
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 154, “Register 0x47”.		
NOTE 2	If required, the host must update the settings in register Table 121, “Register 0x23 ^{1,2,3} ” [0], Table 122, “Register 0x24 ^{1,2,3} ” [7:2], and Table 118, “Register 0x20 ¹ ” [5:4] first prior to updating the settings in the register Table 121, “Register 0x23 ^{1,2,3} ” [7:1].		
NOTE 3	Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.		
NOTE 4	PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1050 mV to 1160 mV.		
NOTE 5	After VR is enabled, the host may update this register to any new setting that it may desire. However to prevent false error trigger, the PMIC internally will increment the SWB output voltage setting by 5 mV at a time. The time it takes for PMIC to adjust the output voltage is 5 μs for each 5 mV increment. The host must wait sufficient time for PMIC to adjust to final value. As an example, if host adjusts the output voltage by 50 mV from the original value, the host must wait minimum of 50 μs before PMIC can guarantee the new output voltage. During this time, PMIC masks the PWR_GOOD output signal assertion to prevent any artificial error due to the crossing of the output voltage threshold setting. However, PMIC does assert PWR_GOOD output signal if there is any abnormal issues that triggers VR Disable command as described in Table 23. Further, PMIC does monitor PWR_GOOD input signal and executes power off config sequence registers if it is registered low when Table 136, “Register 0x32” [5] = ‘1’.		
NOTE 6	Table 129, “Register 0x2B ^{1,2} ” [4] = ‘0’; 5 mV step size.		
NOTE 7	Table 129, “Register 0x2B ^{1,2} ” [4] = ‘1’; 5 mV step size		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 122 — Register 0x24^{1,2,3}

R24			
Bits	Attribute	Default	Description
7:6	RW	01	R24 [7:6]: SWB_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWB Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 01 = +7.5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 10 = +10% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 11 = Reserved
5:4	RW	10	R24 [5:4]: SWB_OVER_VOLTAGE_THRESHOLD_SETTING SWB Output Regulator Threshold For Over Voltage Status ⁴ 00 = +7.5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 01 = +10% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 10 = +12.5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 11 = Reserved
3:2	RW	00	R24 [3:2]: SWB_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWB Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 01 = -12.5% from the setting in Table 121, “Register 0x23 ^{1,2,3} ” [7:1] 10 = Reserved 11 = Reserved
1:0	RW	00	R24 [1:0]: SWB_OUTPUT_SOFT_STOP_TIME SWB Output Regulator Soft Stop Time After VR Disable ⁵ 00 = 0.5 ms 01 = 1 ms 10 = 2 ms 11 = 4 ms
NOTE 1 At first power on, this register is automatically configured identically by PMIC on its own as Table 155, “Register 0x48”. NOTE 2 If required, the host must update the settings in register Table 121, “Register 0x23 ^{1,2,3} ” [0], Table 122, “Register 0x24 ^{1,2,3} ” [7:2] and Table 118, “Register 0x20 ¹ ” [5:4] first prior to updating the settings in the register Table 121, “Register 0x23 ^{1,2,3} ” [7:1]. NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. NOTE 4 The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 122, “Register 0x24 ^{1,2,3} ” [7:6]. NOTE 5 This is the time it takes for buck regulator to go from steady state voltage to 0 V.			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 123 — Register 0x25^{1,2}

R25			
Bits	Attribute	Default	Description
7:1	RW	011 1100	R25 [7:1]: SWC_VOLTAGE_SETTING SWC Output Regulator Voltage Setting ^{3,4} 000 0000 = 800 mV ⁵ or 600 mV ⁶ 000 0001 = 805 mV or 605 mV 000 0010 = 810 mV or 610 mV ... 011 1100 = 1100 mV or 900 mV ... 111 1101 = 1425 mV or 1225 mV 111 1110 = 1430 mV or 1230 mV 111 1111 = 1435 mV or 1235 mV
0	RW	0	R25 [0]: SWC_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWC Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 1 = -7.5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1]
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 156, “Register 0x49”.		
NOTE 2	If required, the host must update the settings in register Table 123, “Register 0x25 ^{1,2} ” [0], Table 124, “Register 0x26 ^{1,2} ” [7:2] and Table 118, “Register 0x20 ¹ ” [3:2] first prior to updating the settings in the register Table 123, “Register 0x25 ^{1,2} ” [7:1].		
NOTE 3	PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1050 mV to 1160 mV.		
NOTE 4	After VR is enabled, the host may update this register to any new setting that it may desire. However to prevent false error trigger, the PMIC internally will increment the SWC output voltage setting by 5 mV at a time. The time it takes for PMIC to adjust the output voltage is 5 μs for each 5 mV increment. The host must wait sufficient time for PMIC to adjust to final value. As an example, if host adjusts the output voltage by 50 mV from the original value, the host must wait minimum of 50 μs before PMIC can guarantee the new output voltage. During this time, PMIC masks the PWR_GOOD output signal assertion to prevent any artificial error due to the crossing of the output voltage threshold setting. However, PMIC does assert PWR_GOOD output signal if there is any abnormal issues that triggers VR Disable command as described in Table 23. Further, PMIC does monitor PWR_GOOD input signal and executes power off config sequence registers if it is registered low when Table 136, “Register 0x32” [5] = ‘1’.		
NOTE 5	Table 129, “Register 0x2B ^{1,2} ” [3] = ‘0’; 5 mV step size.		
NOTE 6	Table 129, “Register 0x2B ^{1,2} ” [3] = ‘1’; 5 mV step size		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 124 — Register 0x26^{1,2}

R26			
Bits	Attribute	Default	Description
7:6	RW	01	R26 [7:6]: SWC_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWC Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 01 = +7.5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 10 = +10% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 11 = Reserved
5:4	RW	10	R26 [5:4]: SWC_OVER_VOLTAGE_THRESHOLD_SETTING SWC Output Regulator Threshold For Over Voltage Status ³ 00 = +7.5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 01 = +10% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 10 = +12.5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 11 = Reserved
3:2	RW	00	R26 [3:2]: SWC_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWC Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 01 = -12.5% from the setting in Table 123, “Register 0x25 ^{1,2} ” [7:1] 10 = Reserved 11 = Reserved
1:0	RW	00	R26 [1:0]: SWC_OUTPUT_SOFT_STOP_TIME SWC Output Regulator Soft Stop Time After VR Disable ⁴ 00 = 0.5 ms 01 = 1 ms 10 = 2 ms 11 = 4 ms
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 157, “Register 0x4A”.		
NOTE 2	If required, the host must update the settings in register Table 123, “Register 0x25 ^{1,2} ” [0], Table 124, “Register 0x26 ^{1,2} ” [7:2] and Table 118, “Register 0x20 ¹ ” [3:2] first prior to updating the settings in the register Table 123, “Register 0x25 ^{1,2} ” [7:1].		
NOTE 3	The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 124, “Register 0x26 ^{1,2} ” [7:6].		
NOTE 4	This is the time it takes for buck regulator to go from steady state voltage to 0 V.		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 125 — Register 0x27^{1,2}

R27			
Bits	Attribute	Default	Description
7:1	RW	011 1100	R27 [7:1]: SWD_VOLTAGE_SETTING SWD Output Regulator Voltage Setting ^{3,4} 000 0000 = 1500 mV ⁵ or 2200 mV ⁶ 000 0001 = 1505 mV or 2205 mV 000 0010 = 1510 mV or 2210 mV ... 011 1100 = 1800 mV or 2500 mV ... 111 1101 = 2125 mV or 2825 mV 111 1110 = 2130 mV or 2830 mV 111 1111 = 2135 mV or 2835 mV
0	RW	0	R27 [0]: SWD_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWD Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 1 = -7.5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1]
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 158, “Register 0x4B”.		
NOTE 2	If required, the host must update the settings in register Table 125, “Register 0x27 ^{1,2} ” [0], Table 126, “Register 0x28 ^{1,2} ” [7:2] and Table 118, “Register 0x20 ¹ ” [1:0] first prior to updating the settings in the register Table 125, “Register 0x27 ^{1,2} ” [7:1].		
NOTE 3	PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1750 mV to 1850 mV.		
NOTE 4	After VR is enabled, the host may update this register to any new setting that it may desire. However to prevent false error trigger, the PMIC internally will increment the SWD output voltage setting by 5 mV at a time. The time it takes for PMIC to adjust the output voltage is 5 μ s for each 5 mV increment. The host must wait sufficient time for PMIC to adjust to final value. As an example, if host adjusts the output voltage by 50 mV from the original value, the host must wait minimum of 50 μ s before PMIC can guarantee the new output voltage. During this time, PMIC masks the PWR_GOOD output signal assertion to prevent any artificial error due to the crossing of the output voltage threshold setting. However, PMIC does assert PWR_GOOD output signal if there is any abnormal issues that triggers VR Disable command as described in Table 23. Further, PMIC does monitor PWR_GOOD input signal and executes power off config sequence registers if it is registered low when Table 136, “Register 0x32” [5] = ‘1’.		
NOTE 5	Table 129, “Register 0x2B ^{1,2} ” [0] = ‘0’; 5 mV step size.		
NOTE 6	Table 129, “Register 0x2B ^{1,2} ” [0] = ‘1’; 5 mV step size.		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 126 — Register 0x28^{1,2}

R28			
Bits	Attribute	Default	Description
7:6	RW	01	R28 [7:6]: SWD_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWD Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 01 = +7.5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 10 = +10% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 11 = Reserved
5:4	RW	10	R28 [5:4]: SWD_OVER_VOLTAGE_THRESHOLD_SETTING SWD Output Regulator Threshold For Over Voltage Status ³ 00 = +7.5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 01 = +10% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 10 = +12.5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 11 = Reserved
3:2	RW	00	R28 [3:2]: SWD_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWD Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 01 = -12.5% from the setting in Table 125, “Register 0x27 ^{1,2} ” [7:1] 10 = Reserved 11 = Reserved
1:0	RW	00	R28 [1:0]: SWD_OUTPUT_SOFT_STOP_TIME SWD Output Regulator Soft Stop Time After VR Disable ⁴ 00 = 1 ms 01 = 2 ms 10 = 4 ms 11 = 8 ms
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 159, “Register 0x4C”.		
NOTE 2	If required, the host must update the settings in register Table 125, “Register 0x27 ^{1,2} ” [0], Table 126, “Register 0x28 ^{1,2} ” [7:2] and Table 118, “Register 0x20 ¹ ” [1:0] first prior to updating the settings in the register Table 125, “Register 0x27 ^{1,2} ” [7:1].		
NOTE 3	The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 126, “Register 0x28 ^{1,2} ” [7:6].		
NOTE 4	This is the time it takes for buck regulator to go from steady state voltage to 0 V.		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 127 — Register 0x29^{1,2}

R29			
Bits	Attribute	Default	Description
7:6	RW	10	R29 [7:6]: SWA_MODE_SELECT SWA Output Regulator Mode Selection 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; Forced CCM (Constant on Time; Continuous Current Mode)
5:4	RW	01	R29 [5:4]: SWA_SWITCHING_FREQ SWA Output Regulator Switching Frequency 00 = 500 KHz 01 = 750 KHz 10 = Reserved 11 = Reserved
3:2	RW	10	R29 [1:0]: SWB_MODE_SELECT SWB Output Regulator Mode Selection ³ 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; Forced CCM (Constant on Time; Continuous Current Mode)
1:0	RW	01	R29 [1:0]: SWB_SWITCHING_FREQ SWB Output Regulator Switching Frequency ³ 00 = 500 KHz 01 = 750 KHz 10 = Reserved 11 = Reserved
NOTE 1 At first power on, this register is automatically configured identically by PMIC on its own as Table 160, “Register 0x4D”.			
NOTE 2 If required, the host must adjust this register first before issuing VR Enable command in Table 136, “Register 0x32” [7].			
NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 128 — Register 0x2A^{1,2}

R2A			
Bits	Attribute	Default	Description
7:6	RW	10	R2A [7:6]: SWC_MODE_SELECT Switch Node C Output Regulator Mode Selection 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; Forced CCM (Constant on Time; Continuous Current Mode)
5:4	RW	01	R2A [5:4]: SWC_SWITCHING_FREQ Switch Node C Output Regulator Switching Frequency 00 = 500 KHz 01 = 750 KHz 10 = Reserved 11 = Reserved
3:2	RW	10	R2A [3:2]: SWD_MODE_SELECT Switch Node D Output Regulator Mode Selection 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; Forced CCM (Constant on Time; Continuous Current Mode)
1:0	RW	01	R2A [1:0]: SWD_SWITCHING_FREQ Switch Node D Output Regulator Switching Frequency 00 = Reserved 01 = 750 KHz 10 = 1000 KHz 11 = Reserved
NOTE 1	At first power on, this register is automatically configured identically by PMIC on its own as Table 161, “Register 0x4E”.		
NOTE 2	If required, the host must adjust this register first before issuing VR Enable command in Table 136, “Register 0x32” [7].		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 129 — Register 0x2B^{1,2}

R2B			
Bits	Attribute	Default	Description
7:6	RW	01	R2B [7:6]: VOUT_1.8V_VOLTAGE_SETTING VOUT 1.8 V LDO Output Voltage Setting ³ 00 = 1.7 V 01 = 1.8 V 10 = 1.9 V 11 = Reserved
5	RW	0	R2B [5]: SWA_VOLTAGE_RANGE SWA Output Voltage Range Selection ⁴ 0 = Range: 800 mV to 1435 mV for SWA; 5 mV step size 1 = Range: 600 mV to 1235 mV for SWA; 5 mV step size
4	RW	0	R2B [4]: SWB_VOLTAGE_RANGE SWB Output Voltage Range Selection ^{5,6} 0 = Range: 800 mV to 1435 mV for SWB; 5 mV step size 1 = Range: 600 mV to 1235 mV for SWB; 5 mV step size
3	RW	0	R2B [3]: SWC_VOLTAGE_RANGE SWC Output Voltage Range Selection ⁷ 0 = Range: 800 mV to 1435 mV for SWC; 5 mV step size 1 = Range: 600 mV to 1235 mV for SWC; 5 mV step size
2:1	RW	01	R2B [2:1]: VOUT_1.0V_VOLTAGE_SETTING VOUT 1.0 V LDO Voltage Setting ⁸ 00 = 0.9 V 01 = 1.0 V 10 = 1.1 V 11 = 1.2 V
0	RW	0	R2B [0]: SWD_VOLTAGE_RANGE SWD Output Voltage Range Selection ⁹ 0 = Range: 1500 mV to 2135 mV for SWD; 5 mV step size 1 = Range: 2200 mV to 2835 mV for SWD; 5 mV step size
NOTE 1 At first power on, this register is automatically configured identically by PMIC on its own as Table 164, “Register 0x51”.			
NOTE 2 If required, the host must adjust this register first before issuing VR Enable command in Table 136, “Register 0x32” [7]. The host must also wait minimum of 5 μ s after the adjustment before issuing VR Enable command.			
NOTE 3 The VOUT_1.8V Power Good threshold in register Table 112, “Register 0x1A” [2] is always fixed regardless of the setting in this register.			
NOTE 4 Range and resolution selection applies to register Table 119 [7:1].			
NOTE 5 Range and resolution selection applies to register Table 121 [7:1].			
NOTE 6 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			
NOTE 7 Range and resolution selection applies to register Table 123 [7:1].			
NOTE 8 If required, the host must adjust this register one step at a time (0.1 V increment or decrement) to prevent false trigger of power good status and PWR_GOOD pin assertion. In other words, host should not increment or decrement 0.2 V or 0.3 V from its current setting.			
NOTE 9 Range & resolution selection applies to register Table 125 [7:1].			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 130 — Register 0x2C^{1,2}

R2C			
Bits	Attribute	Default	Description
7:5	RW	001	R2C [7:5]: SWA_OUTPUT_SOFT_START_TIME SWA Output Regulator Soft Start Time After VR Enable ³ 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
4	RV	0	R2C [4]: Reserved
3:1	RW	001	R2C [3:1]: SWB_OUTPUT_SOFT_START_TIME SWB Output Regulator Soft Start Time After VR Enable ^{3,4} 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
0	RV	0	R2C [0]: Reserved
<p>NOTE 1 At first power on, this register is automatically configured identically by PMIC on its own as Table 169, “Register 0x5D”.</p> <p>NOTE 2 If required, the host must adjust this register first before issuing VR Enable command in Table 136, “Register 0x32” [7].</p> <p>NOTE 3 This is the time it takes for buck regulator to go from 0 V to steady state voltage (the actual voltage varies based on pre-programmed voltage).</p> <p>NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.</p>			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 131 — Register 0x2D^{1,2}

R2D			
Bits	Attribute	Default	Description
7:5	RW	001	R2D [7:5]: SWC_OUTPUT_SOFT_START_TIME SWC Output Regulator Soft Start Time After VR Enable ³ 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
4	RV	0	R2D [4]: Reserved
3:1	RW	001	R2D [3:1]: SWD_OUTPUT_SOFT_START_TIME SWD Output Regulator Soft Start Time After VR Enable ³ 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
0	RV	0	R2D [0]: Reserved
NOTE 1 At first power on, this register is automatically configured identically by PMIC on its own as Table 170, “Register 0x5E”.			
NOTE 2 If required, the host must adjust this register first before issuing VR Enable command in Table 136, “Register 0x32” [7].			
NOTE 3 This is the time it takes for buck regulator to go from 0 V to steady state voltage (the actual voltage varies based on pre-programmed voltage)			

Table 132 — Register 0x2E

R2E			
Bits	Attribute	Default	Description
7:3	RV	0	R2E [7:3]: Reserved
2:0	RW	100	R2E [2:0]: PMIC_SHUTDOWN_TEMPERATURE_THRESHOLD PMIC Shutdown Temperature Threshold 000 = PMIC Temperature $\geq 105^{\circ}\text{C}$ 001 = PMIC Temperature $\geq 115^{\circ}\text{C}$ 010 = PMIC Temperature $\geq 125^{\circ}\text{C}$ 011 = PMIC Temperature $\geq 135^{\circ}\text{C}$ 100 = PMIC Temperature $\geq 145^{\circ}\text{C}$ 101 = Reserved 110 = Reserved 111 = Reserved

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 133 — Register 0x2F

R2F			
Bits	Attribute	Default	Description
7	RW	0	R2F [7]: VIN_MGMT_INPUT_SUPPLY_SWITCHOVER_THRESHOLD VIN_Mgmt Input Supply Switchover Voltage Threshold to VIN_Bulk Input Supply 0 = Vendor Specific ¹ 1 = Reserved
6	RW	0	R2F [6]: SWA_REGULATOR_CONTROL Disable SWA Regulator Output ^{2,3} 0 = Disable Switch Node A Output Regulator 1 = Enable Switch Node A Output Regulator
5	RW	0	R2F [5]: SWB_REGULATOR_CONTROL Disable SWB Regulator Output ^{2,3,4} 0 = Disable Switch Node B Output Regulator 1 = Enable Switch Node B Output Regulator
4	RW	0	R2F [4]: SWC_REGULATOR_CONTROL Disable SWC Regulator Output ^{2,3} 0 = Disable Switch Node C Output Regulator 1 = Enable Switch Node C Output Regulator
3	RW	0	R2F [3]: SWD_REGULATOR_CONTROL Disable SWD Regulator Output ^{2,3} 0 = Disable Switch Node D Output Regulator 1 = Enable Switch Node D Output Regulator
2	RW	0	R2F [2]: WRITE_PROTECT_FUNCTION_CONTROL PMIC Write Protect Function Control ⁵ 0 = CAMP input signal determines the Write Protect Function as noted in Section 1.8.9.1 1 = Write Protect Function is disabled; All register write access is allowed independent of CAMP input signal as noted in Section 1.8.9.1.
1:0	RW	10	R2F [1:0]: MASK_BITS_REGISTER_CONTROL Mask Bits Register Control ⁶ 00 = Mask GSI_n Signal Only (PWR_GOOD Signal will assert) 01 = Mask PWR_GOOD Signal Only (GSI_n Signal will assert) 10 = Mask GSI_n and PWR_GOOD Signals (neither PWR_GOOD assert or GSI_n signal will assert) 11 = Reserved

Table 133 — Register 0x2F (cont'd)

R2F			
Bits	Attribute	Default	Description
NOTE 1	The VIN_Mgmt input switchover voltage threshold range is vendor specific and can vary between 2.6 V to 2.9 V max.		
NOTE 2	This bit must be used only after power up sequence (after VR Enable command). At first power up, PMIC automatically updates the status of this register to '1' after VR Enable command. When VR Enable command is registered, the PMIC updates this register based on Power On Sequence Configuration (0 to 3) setting. If enabled in Power On Sequence Configuration 0 to 3 registers, only then, under non write protect mode of operation, the PMIC's output regulator can be disabled by clearing this bit and they can be re-enabled again by setting this bit. The PMIC does not alter its Power Good output signal and keeps it asserted High. If any regulator is not enabled in Power on Sequence Configuration 0 to 3, it cannot be enabled using this register. For example, if only SWA is enabled and SWB, SWC & SWD is not enabled in Table 148, "Register 0x40 ¹ " [7:0] to Table 151, "Register 0x43 ^{1,2} " [7:0] then only SWA can be disabled and then re-enabled again but SWB, SWC and SWD cannot be enabled using Table 133, "Register 0x2F" [6:3].		
NOTE 3	In non write protect mode, after VR enable command, if any output regulators are disabled by clearing Table 133, "Register 0x2F" [6:3] and then if host issues VR Disable command or PMIC internally triggers VR Disable command, the PMIC keeps the disabled output regulator in Table 133, "Register 0x2F"[6:3] off and remaining output regulators are disabled by following the Power Off Sequence Configuration 0 to 3 settings.		
NOTE 4	Only applicable if Table 162, "Register 0x4F" [0] = '0'.		
NOTE 5	At first power on, this register is automatically configured identically by the PMIC on its own as Table 171, "Register 0x5F" [7].		
NOTE 6	Applies to Mask Registers Table 107, "Register 0x15" [7,5:0], Table 108, "Register 0x16" [7:0], Table 109, "Register 0x17" [7:2], Table 110, "Register 0x18" [7:0], Table 111, "Register 0x19" [4:2] when any one or more Mask registers are set to '1'. If all Mask registers are configured as '0', the setting in this register (Table 133, "Register 0x2F" [1:0]) does not matter.		

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 134 — Register 0x30

R30			
Bits	Attribute	Default	Description
7	RW	0	R30 [7]: ADC_ENABLE Enable ADC (Analog to Digital Conversion) 0 = Disable ¹ 1 = Enable
6:3	RW	0	R30 [6:3]: ADC_SELECT Input Selection for ADC Readout ² 0000 = SWA Output Voltage 0001 = SWB Output Voltage ³ 0010 = SWC Output Voltage 0011 = SWD Output Voltage 0100 = Reserved 0101 = VIN_Bulk Input Voltage 0110 = VIN_Mgmt Input Voltage 0111 = VBias Output Voltage 1000 = VOUT_1.8V Output Voltage 1001 = VOUT_1.0V Output Voltage All other encodings are reserved.
2	RV	0	R30 [2]: Reserved
1:0	RW	0	R30 [1:0]: ADC_REGISTER_UPDATE_FREQUENCY ADC Current or Power Measurement Update Frequency ^{4,5} 00 = 1 ms 01 = 2 ms 10 = 4 ms 11 = 8 ms
NOTE 1 Disables the ADC function completely. Applies to voltage readout in Table 135, “Register 0x31” [7:0] as well as current or power readout in Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [7:0], Table 100, “Register 0x0E” [7:0] and Table 101, “Register 0x0F” [7:0]. Does not apply to thermal sensor temperature readout in Table 137, “Register 0x33” [7:5] as well as high temperature warning and critical temperature shutdown.			
NOTE 2 The host shall wait minimum of 9 ms delay after the input selection for ADC readout and the actual readout from Table 135, “Register 0x31” to get the latest reading			
NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’			
NOTE 4 For average output current or power measurement in registers Table 98, “Register 0x0C” [7:0], Table 99, “Register 0x0D” [7:0], Table 100, “Register 0x0E” [7:0] and Table 101, “Register 0x0F” [7:0].			
NOTE 5 This register represents how often the registers are updated. The internal sampling rate is vendor specific.			

2.3.5.4 Threshold and Configuration Registers (cont'd)**Table 135 — Register 0x31**

R31			
Bits	Attribute	Default	Description
7:0	RO	0	<p>R31 [7:0]: ADC_READ</p> <p>ADC Output Voltage Reading¹ (Applies to SW[A:D], VOUT_1.8V, VOUT_1.0V, VIN_Mgmt)</p> <p>0000 0000 = Undefined</p> <p>0000 0001 = 15 mV</p> <p>0000 0010 = 30 mV</p> <p>..</p> <p>1111 1111 > = 3825 mV</p> <p>ADC Output Voltage Reading² (Applies to VIN_Bulk Input Voltage)</p> <p>0000 0000 = Undefined</p> <p>0000 0001 = 70 mV</p> <p>0000 0010 = 140 mV</p> <p>..</p> <p>1111 1111 > = 17850 mV</p> <p>ADC Output Voltage Reading³ (Applies to VBias Output Voltage)</p> <p>0000 0000 = Undefined</p> <p>0000 0001 = 25 mV</p> <p>0000 0010 = 50 mV</p> <p>..</p> <p>1111 1111 > = 6375 mV</p>
NOTE 1 Only valid when Table 134, “Register 0x30” [6:3] = ‘0000’ or ‘0001’ or ‘0010’ or ‘0011’ or ‘0110’ or ‘1000’ or ‘1001’.			
NOTE 2 Only valid when Table 134, “Register 0x30” [6:3] = ‘0101’.			
NOTE 3 Only valid when Table 134, “Register 0x30” [6:3] = ‘0111’.			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 136 — Register 0x32

R32			
Bits	Attribute	Default	Description
7	RW	0	R32 [7]: VR_ENABLE PMIC Enable ^{1,2,3,4} 0 = PMIC Disable 1 = PMIC Enable
6	RO	0	R32 [6]: MANAGEMENT_INTERFACE_SELECTION PMIC Management Bus Interface Protocol Selection ⁵ 0 = I ² C Protocol (Max speed 1 MHz) 1 = I3C Basic Protocol
5	RW	1	R32 [5]: EXECUTE_VR_ENABLE_CONTROL_ PMIC VR Enable Command Execution Control over I ² C/I3C Bus ⁴ 0 = Do Not Execute VR Enable Command; i.e., ignore bit [7] = '1' and keep it as '0'. 1 = Execute VR Enable Command
4	RW	0	R32 [4]: EXECUTE_CAMP_FAIL_N_FUNCTION_CONTROL PMIC CAMP Fail_n function (Transition from High to Low) Control ⁶ 0 = Execute VR Disable Command 1 = Do Not Execute VR Disable Command
3	RW	0	R32 [3]: CAMP_PWR_GOOD_OUTPUT_SIGNAL_CONTROL PMIC CAMP PWR_GOOD Output Signal Control 0 = PMIC controls PWR_GOOD output on its own based on internal status 1 = PWR_GOOD Output Float ⁷
2:0	RV	00	R32 [2:0]: Reserved
<p>NOTE 1 Host sets this bit at first power on. After this bit is set, the PMIC executes Power On Sequence configuration 0 (Table 148, "Register 0x40¹") to Power On Sequence configuration 3 (Table 151, "Register 0x43^{1,2}") registers. At least one bit in Table 148, "Register 0x40¹" [6:3] must be set to '1' to issue VR Enable command.</p> <p>NOTE 2 The host shall ensure that prior to issuing VR Enable command, there is no pending IBI interrupt (i.e., Table 96, "Register 0x0A" [1] = '1') status. After host issues VR Enable command, the PMIC may NACK any I²C or I3C Basic bus transaction by host until tPMIC_PWR_GOOD_OUT timing parameter is satisfied. The host shall not access any device specific registers or issue any CCCs until tPMIC_PWR_GOOD_OUT parameter is satisfied. The PMIC device may request for an IBI during power up sequence (i.e., during tPMIC_PWR_GOOD_OUT time) if there is any event.</p> <p>NOTE 3 After host issues VR Enable command, the PMIC may NACK any I2C or I3C Basic bus transactions by host until tPMIC_PWR_GOOD_OUT timing parameter is satisfied.</p> <p>NOTE 4 Once Table 136, "Register 0x32" [7] is set to '1' via VR Enable command, the subsequent write to register Table 136, "Register 0x32" [5] = '0' is ignored by the PMIC. If there is a simultaneous write to register Table 136, "Register 0x32" [7,5] = '10', the PMIC prioritizes bit [5] and does not execute VR Enable command.</p> <p>NOTE 5 This register is automatically updated when SETAASA CCC or RSTDAA CCC is registered by the PMIC device or when PMIC device goes through bus reset as described in Section 1.13.15 regardless of whether PMIC is in write protect mode or non write protect mode of operation. This register can be read by the Host through normal Read operation but it cannot be written with normal write operation either in I²C mode or I3C Basic mode of operation. When this register is updated, it takes in effect where there is a next START operation (i.e., after STOP operation).</p> <p>NOTE 6 At first power on, this register is automatically configured identically by the PMIC on its own as Table 171, "Register 0x5F" [4].</p> <p>NOTE 7 When this encoding is set, the PMIC always floats the PWR_GOOD output signal even when there is an internal VR Disable command due to fault condition.</p>			

2.3.5.4 Threshold and Configuration Registers (cont'd)**Table 137 — Register 0x33**

R33			
Bits	Attribute	Default	Description
7:5	RO	0	R33 [7:5]: TEMPERATURE_MEASUREMENT PMIC Temperature ¹ 000 = $\leq 85^{\circ}\text{C}$ 001 = 85°C 010 = 95°C 011 = 105°C 100 = 115°C 101 = 125°C 110 = 135°C 111 = $> 140^{\circ}\text{C}$
4	RO	0	R33 [4]: VIN_MGMT_POWER_GOOD_STATUS_SWITCHOVER_MODE VIN_Mgmt Input Supply Power Good Status in Switchover Mode Only ² 0 = Power Not Good 1 = Power Good
3	RO	0	R33 [3]: VBIAS_OR_VIN_BULK_UNDER_VOLTAGE_LOCKOUT_STATUS VBias or VIN_Bulk Under Voltage Lockout Status ³ 0 = No Under Voltage Lockout 1 = Under Voltage Lockout
2	RO	0	R33 [2]: VOUT_1.0V_OUTPUT_POWER_GOOD_STATUS VOUT_1.0V LDO Output Power Good Status ⁴ 0 = Power Good 1 = Power Not Good
1:0	RV	0	R33 [1:0]: Reserved
<p>NOTE 1 The accuracy of the temperature readout code is $\pm 5^{\circ}\text{C}$.</p> <p>NOTE 2 This register has no meaning when PMIC is NOT in switchover mode. In switchover mode only, when PMIC detects VIN_Mgmt input supply from the platform, this bit is set to indicate that PMIC now recognizes valid VIN_Mgmt input power supply.</p> <p>NOTE 3 This register is set when VBias LDO output goes below vendor specific threshold or VIN_Bulk input goes below vendor-specific threshold.</p> <p>NOTE 4 This register is set when VOUT_1.0V output drops below the threshold setting in register Table 112, “Register 0x1A” [0].</p>			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 138 — Register 0x34

R34			
Bits	Attribute	Default	Description ¹
7	RO	0	R34 [7]: PEC_ENABLE Packet Error Code Enable ² (Applicable Only if R32 [6] = '1') 0 = Disable 1 = Enable
6	RO	0	R34 [6]: IBI_ENABLE In Band Interrupt Enable ³ (Applicable Only if R32 [6] = '1') 0 = Disable 1 = Enable
5	RO	0	R34 [5]: PARITY_DISABLE T Bit Parity Code Disable ² (Applicable Only if R32 [6] = '1'.) 0 = Enable 1 = Disable ⁴
4	RV	0	R34 [4]: Reserved
3:1	RO	111	R34 [3:1]: HID_CODE PMIC's 3-bit HID Code ⁵ 000 001 010 011 100 101 110 111
0	RV	0	R34 [0]: Reserved
<p>NOTE 1 The write (or update) transaction to this register must be followed by STOP operation to allow the PMIC device to update the setting.</p> <p>NOTE 2 This register is automatically updated when RSTDAA CCC is registered by the PMIC device or when PMIC device goes through bus reset as described in Section 1.13.15. This register cannot be written by the Host through normal write operation either in I²C mode or I3C mode of operation. This register is updated with DEVCTRL CCC with RegMod='0' only. This register cannot be written with DEVCTRL CCC with RegMod='1'.</p> <p>NOTE 3 This register is automatically updated when ENEC CCC or DISEC CCC or RSTDAA CCC is registered by the PMIC device or when PMIC device goes through bus reset as described in Section 1.13.15. This register can be read by the Host through normal Read operation but it cannot be written with normal write operation either in I²C mode or I3C mode of operation. This register cannot be written with DEVCTRL CCC with RegMod='1'.</p> <p>NOTE 4 When Parity function is disabled, the PMIC simply ignores the "T" bit information from the Host. The host may actually choose to compute the parity and send that information in "T" bit or simply drive static low or high in "T" bit.</p> <p>NOTE 5 This register is updated when PMIC device receives SETHID CCC or when PMIC device goes through bus reset as described in Section 1.13.15. This register cannot be written with DEVCTRL CCC with RegMod='1'.</p>			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 139 — Register 0x35

R35			
Bits	Attribute	Default	Description ^{1,2}
7	RW	0	R35 [7]: ERROR_INJECTION_ENABLE Error Injection Enable ³ 0 = Disable 1 = Enable
6:4	RW	0	R35 [6:4]: ERROR_INJECTION_RAIL_SELECTION Error Injection - Input Rail and Output Rail Selection ^{4,5} 000 = Undefined 001 = SWA Output Only 010 = SWB Output Only 011 = SWC Output Only 100 = SWD Output Only 101 = VIN_Bulk Input Only 110 = VIN_Mgmt Input Only 111 = Do Not Use
3	RW	0	R35 [3]: OVER_VOLTAGE_UNDER_VOLTAGE_SELECT Over Voltage or Under Voltage Selection for Bits [6:4] ⁶ 0 = Over Voltage 1 = Under Voltage ⁷
2:0	RW	0	R35[2:0]: MISC_ERROR_INJECTION_TYPE Miscellaneous Error Injection Type ⁸ 000 = Undefined 001 = VIN_Mgmt to VIN_Bulk Switchover 010 = Critical Temperature Shutdown 011 = High Temperature Warning Threshold 100 = VOUT_1.8V LDO Power Good 101 = High Current Consumption Warning ⁹ 110 = Reserved 111 = Current Limiter Warning ⁹
NOTE 1 Refer to Section 1.11 for error function usage model. The host can erase the error log registers (Table 90, “Register 0x04” to Table 92, “Register 0x06”) by writing 0x74 to Table 142, “Register 0x39”.			
NOTE 2 To exit from Error Injection Mode, the PMIC must go through power cycle of both VIN_Bulk and VIN_Mgmt input supply.			
NOTE 3 When error function is invoked by setting bit [7] = ‘1’, the setting of bits [6:4, 2:0] = ‘000 000’ is considered an illegal setting.			
NOTE 4 This register Table 139, “Register 0x35” [6:4] is only applicable if Table 139, “Register 0x35” [2:0] is ‘000’. Any value other than ‘000’ in both Table 139, “Register 0x35” [6:4] and Table 139, “Register 0x35” [2:0] is considered an illegal setting and PMIC operation is not guaranteed.			
NOTE 5 If dual phase regulator is selected, use SWA encoding to inject the error. Register bit [3] selects either over voltage or under voltage condition for the setting selected in this register.			
NOTE 6 This register Table 139, “Register 0x35” [3] is only applicable if bits [6:4] is anything other than ‘000’.			
NOTE 7 The under voltage selection only applies to SWx output rails and VIN_Bulk input. Does not apply to VIN_Mgmt input.			
NOTE 8 This register Table 139, “Register 0x35” [2:0] is only applicable if Table 139, “Register 0x35” [6:3] is ‘0000’. Any value other than ‘000’ in both Table 139, “Register 0x35” [6:4] and Table 139, “Register 0x35” [2:0] is considered an illegal setting and PMIC operation is not guaranteed.			
NOTE 9 Applies to all enabled SWx output regulators at the same time.			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 140 — Register 0x37

R37			
Bits	Attribute	Default	Description
7:0	WO	-	R37 [7:0]: DIMM_VENDOR_MEMORY_REGION_PASSWORD_LOWER_BYTE DIMM Vendor Memory Region (0x40 - 0x6F) Password - Lower Byte [7:0] = Code

Table 141 — Register 0x38

R38			
Bits	Attribute	Default	Description
7:0	WO	-	R38 [7:0]: DIMM_VENDOR_MEMORY_REGION_PASSWORD_UPPER_BYTE DIMM Vendor Memory Region (0x40 - 0x6F) Password - Upper Byte [7:0] = Code

Table 142 — Register 0x39

R39			
Bits	Attribute	Default	Description
7:0	RW	0x00	<p>R39 Codes: Host Region Codes: 0x74: Clear Registers R04 to R07; Erase MTP memory for R04 to R07.</p> <p>DIMM Vendor Region (0x40 to 0x6F) Write Codes: 0x40: Unlock DIMM Vendor Region. Password needs to be present in R37 and R38 registers. 0x00: Lock DIMM Vendor Region. 0x80: Burn DIMM Vendor Region Password. New password needs to be present in R37 & R38. 0x81: Burn DIMM Vendor Region - 0x40 to 0x4F 0x82: Burn DIMM Vendor Region - 0x50 to 0x5F 0x85: Burn DIMM Vendor Region - 0x60 to 0x6F</p> <p>DIMM Vendor Region (0x40 to 0x6F) Read Codes: 0x5A: Burning is complete in DIMM Vendor region.</p>

2.3.5.4 Threshold and Configuration Registers (cont'd)**Table 143 — Register 0x3A**

R3A			
Bits	Attribute	Default	Description¹
7	RV	0	R3A [7]: Reserved
6	RW	0	R3A [6]: DEFAULT_READ_ADDRESS_POINTER_ENABLE Enable Default Address Read Pointer when PMIC sees STOP operation 0 = Disable Default Address Pointer (address pointer is set by Host) ² 1 = Enable Default Address Pointer; Address selected by register bits [5:4] ³
5:4	RW	0	R3A [5:4]: DEFAULT_READ_STARTING_ADDRESS Default Read Address Pointer Selection when PMIC sees STOP operation ⁴ 00 = R08 01 = R0C 10 = Reserved 11 = Reserved
3:2	RW	0	R3A [3:2]: BURST_LENGTH_FOR_READ_DEFAULT_ADDR_POINTER Burst Length (# of Bytes) to be transferred for Read Default Address Pointer Mode ⁵ 00 = 2 Bytes 01 = 4 Bytes 10 = Reserved 11 = 16 Bytes
1:0	RV	0	R3A [1:0]: Reserved
<p>NOTE 1 The write (or update) transaction to this register must be followed by STOP operation to allow the PMIC device to update the setting.</p> <p>NOTE 2 The register setting in R3A [5:4] is a don't care.</p> <p>NOTE 3 This mode is only allowed when PEC function is disabled (i.e., register R34 [7] = '0').</p> <p>NOTE 4 This register is only applicable if R3A [6] = '1'.</p> <p>NOTE 5 This register is only applicable if R3A [6] = '1' and R34 [7] = '1'.</p>			

2.3.5.4 Threshold and Configuration Registers (cont'd)

Table 144 — Register 0x3B

R3B			
Bits	Attribute	Default	Description
7:6	ROE	01	R3B [7:6]: PMIC_PART_CAPABILITY_EXT PMIC Current Capability Extension. This register bits [7:6] and bit [0] provides 3 bit encoding as following: 000 = Small PMIC (Low Current) 001 = Big PMIC (High Current) 01x = Extreme PMIC (Extreme Current) All other encodings are reserved.
5:4	ROE	-	R3B [5:4]: REVISION_ID_MAJOR_STEPPING Major Revision Stepping 00 = Revision 1 01 = Revision 2 10 = Revision 3 11 = Revision 4
3:1	ROE	-	R3B [3:1]: REVISION_ID_MINOR_STEPPING Minor Revision Stepping 000 = Revision 0 001 = Revision 1 010 = Revision 2 011 = Revision 3 All other encodings are reserved.
0	ROE	-	R3B [0]: PMIC_PART_CAPABILITY PMIC Current Capability. See also bits [7:6] definition. 0 = Small PMIC (Low Current) 1 = Big PMIC (High Current)

Table 145 — Register 0x3C

R3C			
Bits	Attribute	Default	Description
7:0	ROE	-	R3C [7:0]: VENDOR_ID_BYTE0 Vendor Identification Register Byte 0.

Table 146 — Register 0x3D

R3D			
Bits	Attribute	Default	Description
7:0	ROE	-	R3D [7:0]: VENDOR_ID_BYTE1 Vendor Identification Register Byte 1.

2.3.6 DIMM Vendor Region Registers

Table 147 — DIMM Vendor Region - Register Map

Register	Attribute	Description
Table 148, “Register 0x40 ¹ ”	RWPE	R40 [7:0] Power On Sequence Config 0
Table 149, “Register 0x41 ^{1,2} ”	RWPE	R41 [7:0] Power On Sequence Config 1
Table 150, “Register 0x42 ^{1,2} ”	RWPE	R42 [7:0] Power On Sequence Config 2
Table 151, “Register 0x43 ^{1,2} ”	RWPE	R43 [7:0] Power On Sequence Config 3
0x44	RV	R44 [7:0] Reserved
Table 152, “Register 0x45”	RWPE	R45 [7:1] SWA Voltage Setting R45 [0] SWA Power Good Low Side Threshold
Table 153, “Register 0x46”	RWPE	R46 [7:6] SWA Power Good High Side Threshold R46 [5:4] SWA Over Voltage Threshold R46 [3:2] SWA Under Voltage Lockout Threshold R46 [1:0] SWA Soft Stop Time
Table 154, “Register 0x47”	RWPE	R47 [7:1] SWB Voltage Setting R47 [0] SWB Power Good Low Side Threshold
Table 155, “Register 0x48”	RWPE	R48 [7:6] SWB Power Good High Side Threshold R48 [5:4] SWB Over Voltage Threshold R48 [3:2] SWB Under Voltage Lockout Threshold R48 [1:0] SWB Soft Stop Time
Table 156, “Register 0x49”	RWPE	R49 [7:1] SWC Voltage Setting R49 [0] SWC Power Good Low Side Threshold
Table 157, “Register 0x4A”	RWPE	R4A [7:6] SWC Power Good High Side Threshold R4A [5:4] SWC Over Voltage Threshold R4A [3:2] SWC Under Voltage Lockout Threshold R4A [1:0] SWC Soft Stop Time
Table 158, “Register 0x4B”	RWPE	R4B [7:1] SWD Voltage Setting R4B [0] SWD Power Good Low Side Threshold
Table 159, “Register 0x4C”	RWPE	R4C [7:6] SWD Power Good High Side Threshold R4C [5:4] SWD Over Voltage Threshold R4C [3:2] SWD Under Voltage Lockout Threshold R4C [1:0] SWD Soft Stop Time
Table 160, “Register 0x4D”	RWPE	R4D [7:6] SWA Mode Select R4D [5:4] SWA Switching Frequency R4D [3:2] SWB Mode Select R4D [1:0] SWB Switching Frequency
Table 161, “Register 0x4E”	RWPE	R4E [7:6] SWC Mode Select R4E [5:4] SWC Switching Frequency R4E [3:2] SWD Mode Select R4E [1:0] SWD Switching Frequency
Table 162, “Register 0x4F”	RWPE	R4F [7] Output Regulator Disable Control R4F [6:5] Reserved R4F [4] SWA Remote Sensing Scheme R4F [3] Reserved R4F [2] SWC Remote Sensing Scheme R4F [1] SWD Remote Sensing Scheme R4F [0] SWA, SWB Single or Dual Phase Regulator Select

Table 147 — DIMM Vendor Region - Register Map (cont'd)

Register	Attribute	Description
Table 163, “Register 0x50”	RWPE	R50 [7:6] SWA Current Limit Warning Threshold R50 [5:4] SWB Current Limit Warning Threshold R50 [3:2] SWC Current Limit Warning Threshold R50 [1:0] SWD Current Limit Warning Threshold
Table 164, “Register 0x51”	RWPE	R51 [7:6] VOUT_1.8V LDO Setting R51 [5:3] Voltage Range Selection for SWA, SWB and SWC R51 [2:1] VOUT_1.0V LDO Setting R51 [0] Voltage Range Selection for SWD
0x52 to 0x57	RV	R52 [7:0] to R57 [7:0] Reserved
Table 165, “Register 0x58 ¹ ”	RWPE	R58 [7:0] Power Off Sequence Config 0
Table 166, “Register 0x59 ^{1,2} ”	RWPE	R59 [7:0] Power Off Sequence Config 1
Table 167, “Register 0x5A ^{1,2} ”	RWPE	R5A [7:0] Power Off Sequence Config 2
Table 168, “Register 0x5B ^{1,2} ”	RWPE	R5B [7:0] Power Off Sequence Config 3
0x5C	RV	R5C [7:0] Reserved
Table 169, “Register 0x5D”	RWPE	R5D [7:5] SWA Soft Start Time R5D [4] Reserved R5D [3:1] SWB Soft Start Time R5D [0] Reserved
Table 170, “Register 0x5E”	RWPE	R5E [7:5] SWC Soft Start Time R5E [4] Reserved R5E [3:1] SWD Soft Start Time R5E [0] Reserved
Table 171, “Register 0x5F”	RWPE	R5F [7] R2F[2] Control R5F [6] Auto Power On Enable R5F [5] VR Enable Pin Enable R5F [4] R32[4] Control R5F [3:0] Reserved
0x50 to 0x6F	RV	R60 [7:0] to R6F [7:0] Reserved

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 148 — Register 0x40¹

R40			
Bits	Attribute	Default	Description
7	RWPE	0	R40 [7]: POWER_ON_SEQUENCE_CONFIG0 PMIC Power On Sequence Config 0 ² 0 = Do Not Execute Config 0 1 = Execute Config 0
6	RWPE	0	R40 [6]: POWER_ON_SEQUENCE_CONFIG0_SWA_ENABLE Enable SWA Output Regulator. 0 = Disable SWA Output Regulator 1 = Enable SWA Output Regulator
5	RWPE	0	R40 [5]: POWER_ON_SEQUENCE_CONFIG0_SWB_ENABLE Enable SWB Output Regulator. ³ 0 = Disable SWB Output Regulator 1 = Enable SWB Output Regulator
4	RWPE	0	R40 [4]: POWER_ON_SEQUENCE_CONFIG0_SWC_ENABLE Enable SWC Output Regulator. 0 = Disable SWC Output Regulator 1 = Enable SWC Output Regulator
3	RWPE	0	R40 [3]: POWER_ON_SEQUENCE_CONFIG0_SWD_ENABLE Enable SWD Output Regulator. 0 = Disable SWD Output Regulator 1 = Enable SWD Output Regulator
2:0	RWPE	001	R40 [2:0]: POWER_ON_SEQUENCE_CONFIG0_IDLE Idle time after Power On Sequence Config 0 ⁴ 000 = 0 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms 100 = 8 ms 101 = 10 ms 110 = 12 ms 111 = 24 ms
<p>NOTE 1 If more than one configuration register is used for power on sequence, first register must start at Table 148, “Register 0x40¹” and it must go in sequential order to Table 151, “Register 0x43^{1,2}” to turn on all desired regulators. In other words, there must not be any gap of the register that is used for power on sequence.</p> <p>NOTE 2 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.</p> <p>NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This bit is a don’t care when Table 162, “Register 0x4F” [0] = ‘1’.</p> <p>NOTE 4 Idle time is the additional time after soft-start time expires. The PMIC waits sum of Soft Start time and Idle time before it executes the next power on sequence configuration register. If more than one regulators are enabled, the PMIC uses the largest value of the soft start time among the regulators that are enabled in this configuration register.</p>			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 149 — Register 0x41^{1,2}

R41			
Bits	Attribute	Default	Description
7	RWPE	0	R41 [7]: POWER_ON_SEQUENCE_CONFIG1 PMIC Power On Sequence Config 1 0 = Do Not Execute Config ³ 1 = Execute Config 1
6	RWPE	0	R41 [6]: POWER_ON_SEQUENCE_CONFIG1_SWA_ENABLE Enable SWA Output Regulator. 0 = Disable SWA Output Regulator 1 = Enable SWA Output Regulator
5	RWPE	0	R41 [5]: POWER_ON_SEQUENCE_CONFIG1_SWB_ENABLE Enable SWB Output Regulator. ⁴ 0 = Disable SWB Output Regulator 1 = Enable SWB Output Regulator
4	RWPE	0	R41 [4]: POWER_ON_SEQUENCE_CONFIG1_SWC_ENABLE Enable Switch Node C Output Regulator. 0 = Disable SWC Output Regulator 1 = Enable SWC Output Regulator
3	RWPE	0	R41 [3]: POWER_ON_SEQUENCE_CONFIG1_SWD_ENABLE Enable Switch Node D Output Regulator. 0 = Disable SWD Output Regulator 1 = Enable SWD Output Regulator
2:0	RWPE	001	R41 [2:0]: POWER_ON_SEQUENCE_CONFIG1_IDLE Idle time after Power On Sequence Config 1 ⁵ 000 = 0 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms 100 = 8 ms 101 = 10 ms 110 = 12 ms 111 = 24 ms
NOTE 1 If any regulators are enabled in Table 148, “Register 0x40 ¹ ” [6:3], those regulators must be configured as ‘1’ in this sequence.			
NOTE 2 If more than one configuration register is used for power on sequence, first register must start at Table 148, “Register 0x40 ¹ ” and it must go in sequential order to Table 151, “Register 0x43 ^{1,2} ” to turn on all desired regulators. In other words, there must not be any gap of the register that is used for power on sequence.			
NOTE 3 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.			
NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This bit is a don’t care when Table 162, “Register 0x4F” [0] = ‘1’.			
NOTE 5 Idle time is the additional time after soft-start time expires. The PMIC waits sum of Soft Start time and Idle time before it executes the next power on sequence configuration register. If more than one regulators are enabled, the PMIC uses the largest value of the soft start time among the regulators that are enabled in this configuration register.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 150 — Register 0x42^{1,2}

R42			
Bits	Attribute	Default	Description
7	RWPE	0	R42 [7]: POWER_ON_SEQUENCE_CONFIG2 PMIC Power On Sequence Config 2 ³ 0 = Do Not Execute Config 2 1 = Execute Config 2
6	RWPE	0	R42 [6]: POWER_ON_SEQUENCE_CONFIG2_SWA_ENABLE Enable Switch Node A Output Regulator. 0 = Disable Switch Node A Output Regulator 1 = Enable Switch Node A Output Regulator
5	RWPE	0	R42 [5]: POWER_ON_SEQUENCE_CONFIG2_SWB_ENABLE Enable Switch Node B Output Regulator. ⁴ 0 = Disable Switch Node B Output Regulator 1 = Enable Switch Node B Output Regulator
4	RWPE	0	R42 [4]: POWER_ON_SEQUENCE_CONFIG2_SWC_ENABLE Enable Switch Node C Output Regulator. 0 = Disable Switch Node C Output Regulator 1 = Enable Switch Node C Output Regulator
3	RWPE	0	R42 [3]: POWER_ON_SEQUENCE_CONFIG2_SWD_ENABLE Enable Switch Node D Output Regulator. 0 = Disable Switch Node D Output Regulator 1 = Enable Switch Node D Output Regulator
2:0	RWPE	001	R42 [2:0]: POWER_ON_SEQUENCE_CONFIG2_IDLE Idle time after Power On Sequence Config 2 ⁵ 000 = 0 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms 100 = 8 ms 101 = 10 ms 110 = 12 ms 111 = 24 ms
<p>NOTE 1 If any regulators are enabled in Table 148, “Register 0x40¹” [6:3] and Table 149, “Register 0x41^{1,2}” [6:3], those regulators must be configured as ‘1’ in this sequence.</p> <p>NOTE 2 If more than one configuration register is used for power on sequence, first register must start at Table 148, “Register 0x40¹” and it must go in sequential order to Table 151, “Register 0x43^{1,2}” to turn on all desired regulators. In other words, there must not be any gap of the register that is used for power on sequence.</p> <p>NOTE 3 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.</p> <p>NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This bit is a don’t care when Table 162, “Register 0x4F” [0] = ‘1’.</p> <p>NOTE 5 Idle time is the additional time after soft-start time expires. The PMIC waits sum of Soft Start time and Idle time before it executes the next power on sequence configuration register. If more than one regulators are enabled, the PMIC uses the largest value of the soft start time among the regulators that are enabled in this configuration register.</p>			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 151 — Register 0x43^{1,2}

R43			
Bits	Attribute	Default	Description
7	RWPE	0	R43 [7]: POWER_ON_SEQUENCE_CONFIG3 PMIC Power On Sequence Config 3 0 = Do Not Execute Config 3 ³ 1 = Execute Config 3
6	RWPE	0	R43 [6]: POWER_ON_SEQUENCE_CONFIG3_SWA_ENABLE Enable Switch Node A Output Regulator. 0 = Disable Switch Node A Output Regulator 1 = Enable Switch Node A Output Regulator
5	RWPE	0	R43 [5]: POWER_ON_SEQUENCE_CONFIG3_SWB_ENABLE Enable Switch Node B Output Regulator. ⁴ 0 = Disable Switch Node B Output Regulator 1 = Enable Switch Node B Output Regulator
4	RWPE	0	R43 [4]: POWER_ON_SEQUENCE_CONFIG3_SWC_ENABLE Enable Switch Node C Output Regulator. 0 = Disable Switch Node C Output Regulator 1 = Enable Switch Node C Output Regulator
3	RWPE	0	R43 [3]: POWER_ON_SEQUENCE_CONFIG3_SWD_ENABLE Enable Switch Node D Output Regulator. 0 = Disable Switch Node D Output Regulator 1 = Enable Switch Node D Output Regulator
2:0	RWPE	001	R43 [2:0]: POWER_ON_SEQUENCE_CONFIG3_IDLE Idle time after Power On Sequence Config 3 ⁵ 000 = 0 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms 100 = 8 ms 101 = 10 ms 110 = 12 ms 111 = 24 ms

NOTE 1 If any regulators are enabled in Table 148, “Register 0x40¹” [6:3], Table 149, “Register 0x41^{1,2}” [6:3] and Table 150, “Register 0x42^{1,2}” [6:3], those regulators must be configured as ‘1’ in this sequence.

NOTE 2 If more than one configuration register is used for power on sequence, first register must start at Table 148, “Register 0x40¹” and it must go in sequential order to Table 151, “Register 0x43^{1,2}” to turn on all desired regulators. In other words, there must not be any gap of the register that is used for power on sequence.

NOTE 3 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.

NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. This bit is a don’t care when Table 162, “Register 0x4F” [0] = ‘1’.

NOTE 5 Idle time is the additional time after soft-start time expires. The PMIC waits sum of Soft Start time and Idle time before it executes the next event. If more than one regulators are enabled, the PMIC uses the largest value of the soft start time among the regulators that are enabled in this configuration register.

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 152 — Register 0x45

R45			
Bits	Attribute	Default	Description
7:1	RWPE	011 1100	R45 [7:1]: SWA_VOLTAGE_SETTING SWA Output Regulator Voltage Setting ¹ 000 0000 = 800 mV ² or 600 mV ³ 000 0001 = 805 mV or 605 mV 000 0010 = 810 mV or 610 mV ... 011 1100 = 1100 mV or 900 mV ... 111 1101 = 1425 mV or 1225 mV 111 1110 = 1430 mV or 1230 mV 111 1111 = 1435 mV or 1235 mV
0	RWPE	0	R45 [1:0]: SWA_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWA Output Threshold Low Side Voltage For Power Good Status 0 = - 5% from the setting in Table 152, “Register 0x45” [7:1] 1 = - 7.5% from the setting in Table 152, “Register 0x45” [7:1]
NOTE 1 PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1050 mV to 1160 mV.			
NOTE 2 Table 164, “Register 0x51” [5] = ‘0’; 5 mV step size.			
NOTE 3 Table 164, “Register 0x51” [5] = ‘1’; 5 mV step size.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 153 — Register 0x46

R46			
Bits	Attribute	Default	Description
7:6	RWPE	01	R46 [7:6]: SWA_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING Switch Node A Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 152, “Register 0x45” [7:1] 01 = +7.5% from the setting in Table 152, “Register 0x45” [7:1] 10 = +10% from the setting in Table 152, “Register 0x45” [7:1] 11 = Reserved
5:4	RWPE	10	R46 [5:4]: SWA_OVER_VOLTAGE_THRESHOLD_SETTING Switch Node A Output Regulator Threshold For Over Voltage Status ¹ 00 = +7.5% from the setting in Table 152, “Register 0x45” [7:1] 01 = +10% from the setting in Table 152, “Register 0x45” [7:1] 10 = +12.5% from the setting in Table 152, “Register 0x45” [7:1] 11 = Reserved
3:2	RWPE	00	R46 [3:2]: SWA_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING Switch Node A Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 152, “Register 0x45” [7:1] 01 = -12.5% from the setting in Table 152, “Register 0x45” [7:1] 10 = Reserved 11 = Reserved
1:0	RWPE	00	R46 [1:0]: SWA_OUTPUT_SOFT_STOP_TIME SWA Output Regulator Soft Stop Time After VR Disable ² 00 = 0.5 ms 01 = 1 ms 10 = 2 ms 11 = 4 ms
NOTE 1 The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 153, “Register 0x46”[7:6].			
NOTE 2 This is the time it takes for buck regulator to go from steady state voltage to 0 V.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 154 — Register 0x47

R47			
Bits	Attribute	Default	Description ¹
7:1	RWPE	011 1100	R47 [7:1]: SWB_VOLTAGE_SETTING SWB Output Regulator Voltage Setting ² 000 0000 = 800 mV ³ or 600 mV ⁴ 000 0001 = 805 mV or 605 mV 000 0010 = 810 mV or 610 mV ... 011 1100 = 1100 mV or 900 mV ... 111 1101 = 1425 mV or 1225 mV 111 1110 = 1430 mV or 1230 mV 111 1111 = 1435 mV or 1235 mV
0	RWPE	0	R47 [1]: SWB_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWB Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 154, “Register 0x47” [7:1] 1 = -7.5% from the setting in Table 154, “Register 0x47” [7:1]
NOTE 1 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’. NOTE 2 PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1050 mV to 1160 mV. NOTE 3 Table 164, “Register 0x51” [4] = ‘0’; 5mV step size. NOTE 4 Table 164, “Register 0x51” [4] = ‘1’; 5 mV step size.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 155 — Register 0x48

R48			
Bits	Attribute	Default	Description ¹
7:6	RWPE	01	R48 [7:6]: SWB_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWB Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 154, “Register 0x47” [7:1] 01 = +7.5% from the setting in Table 154, “Register 0x47” [7:1] 10 = +10% from the setting in Table 154, “Register 0x47” [7:1] 11 = Reserved
5:4	RWPE	10	R48 [5:4]: SWB_OVER_VOLTAGE_THRESHOLD_SETTING SWB Output Regulator Threshold For Over Voltage Status ² 00 = +7.5% from the setting in Table 154, “Register 0x47” [7:1] 01 = +10% from the setting in Table 154, “Register 0x47” [7:1] 10 = +12.5% from the setting in Table 154, “Register 0x47” [7:1] 11 = Reserved
3:2	RWPE	00	R48 [3:2]: SWB_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWB Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 154, “Register 0x47” [7:1] 01 = -12.5% from the setting in Table 154, “Register 0x47” [7:1] 10 = Reserved 11 = Reserved
1:0	RWPE	00	R48 [1:0]: SWB_OUTPUT_SOFT_STOP_TIME SWB Output Regulator Soft Stop Time After VR Disable ³ 00 = 0.5 ms 01 = 1 ms 10 = 2 ms 11 = 4 ms
NOTE 1 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			
NOTE 2 The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 155, “Register 0x48”[7:6].			
NOTE 3 This is the time it takes for buck regulator to go from steady state voltage to 0 V.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 156 — Register 0x49

R49			
Bits	Attribute	Default	Description
7:1	RWPE	011 1100	R49 [7:1]: SWC_VOLTAGE_SETTING SWC Output Regulator Voltage Setting ¹ 000 0000 = 800 mV ² or 600 mV ³ 000 0001 = 805 mV or 605 mV 000 0010 = 810 mV or 610 mV ... 011 1100 = 1100 mV or 900 mV ... 111 1101 = 1425 mV or 1225 mV 111 1110 = 1430 mV or 1230 mV 111 1111 = 1435 mV or 1235 mV
0	RWPE	0	R49 [0]: SWC_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING Switch Node C Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 156, “Register 0x49” [7:1] 1 = -7.5 from the setting in Table 156, “Register 0x49” [7:1]
NOTE 1 PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1050 mV to 1160 mV. NOTE 2 Table 164, “Register 0x51” [3] = ‘0’; 5 mV step size. NOTE 3 Table 164, “Register 0x51” [3] = ‘1’; 5 mV step size.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 157 — Register 0x4A

R4A			
Bits	Attribute	Default	Description
7:6	RWPE	01	R4A [7:6]: SWC_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWC Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 156, “Register 0x49” [7:1] 01 = +7.5% from the setting in Table 156, “Register 0x49” [7:1] 10 = +10% from the setting in Table 156, “Register 0x49” [7:1] 11 = Reserved
5:4	RWPE	10	R4A [5:4]: SWC_OVER_VOLTAGE_THRESHOLD_SETTING SWC Output Regulator Threshold For Over Voltage Status ¹ 00 = +7.5% from the setting in Table 156, “Register 0x49” [7:1] 01 = +10% from the setting in Table 156, “Register 0x49” [7:1] 10 = +12.5% from the setting in Table 156, “Register 0x49” [7:1] 11 = Reserved
3:2	RWPE	00	R4A [3:2]: SWC_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWC Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 156, “Register 0x49” [7:1] 01 = -12.5% from the setting in Table 156, “Register 0x49” [7:1] 10 = Reserved 11 = Reserved
1:0	RWPE	00	R4A [1:0]: SWC_OUTPUT_SOFT_STOP_TIME SWC Output Regulator Soft Stop Time After VR Disable ² 00 = 0.5 ms 01 = 1 ms 10 = 2 ms 11 = 4 ms
NOTE 1 The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 157, “Register 0x4A”[7:6].			
NOTE 2 This is the time it takes for buck regulator to go from steady state voltage to 0 V.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 158 — Register 0x4B

R4B			
Bits	Attribute	Default	Description
7:1	RWPE	011 1100	R4B [7:1]: SWD_VOLTAGE_SETTING SWD Output Regulator Voltage Setting ¹ 000 0000 = 1500 mV ² or 2200 mV ³ 000 0001 = 1505 mV or 2205 mV 000 0010 = 1510 mV or 2210 mV ... 011 1100 = 1800 mV or 2500 mV ... 111 1101 = 2125 mV or 2825 mV 111 1110 = 2130 mV or 2830 mV 111 1111 = 2135 mV or 2835 mV
0	RWPE	0	R4B [0]: SWD_POWER_GOOD_THRESHOLD_LOW_SIDE_VOLTAGE_SETTING SWD Output Threshold Low Side Voltage For Power Good Status 0 = -5% from the setting in Table 158, “Register 0x4B” [7:1] 1 = -7.5% from the setting in Table 158, “Register 0x4B” [7:1]
NOTE 1 PMIC guarantees efficiency spec and all electrical characteristics spec within a range of 1750 mV to 1850 mV. NOTE 2 Table 164, “Register 0x51” [0] = ‘0’; 5 mV step size. NOTE 3 Table 164, “Register 0x51” [0] = ‘1’; 5 mV step size.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 159 — Register 0x4C

R4C			
Bits	Attribute	Default	Description
7:6	RWPE	01	R4C [7:6]: SWD_POWER_GOOD_THRESHOLD_HIGH_SIDE_VOLTAGE_SETTING SWD Output Threshold High Side Voltage For Power Good Status 00 = +5% from the setting in Table 158, “Register 0x4B” [7:1] 01 = +7.5% from the setting in Table 158, “Register 0x4B” [7:1] 10 = Reserved 11 = Reserved
5:4	RWPE	10	R4C [5:4]: SWD_OVER_VOLTAGE_THRESHOLD_SETTING SWD Output Regulator Threshold For Over Voltage Status ¹ 00 = +7.5% from the setting in Table 158, “Register 0x4B” [7:1] 01 = +10% from the setting in Table 158, “Register 0x4B” [7:1] 10 = +12.5% from the setting in Table 158, “Register 0x4B” [7:1] 11 = Reserved
3:2	RWPE	00	R4C [3:2]: SWD_UNDER_VOLTAGE_LOCKOUT_THRESHOLD_SETTING SWD Output Regulator Threshold For Under Voltage Lockout Status 00 = -10% from the setting in Table 158, “Register 0x4B” [7:1] 01 = -12.5% from the setting in Table 158, “Register 0x4B” [7:1] 10 = Reserved 11 = Reserved
1:0	RWPE	00	R4C [1:0]: SWD_OUTPUT_SOFT_STOP_TIME SWD Output Regulator Soft Stop Time After VR Disable ² 00 = 1 ms 01 = 2 ms 10 = 4 ms 11 = 8 ms
NOTE 1 The setting for the Over Voltage must be higher than Power Good High Side Voltage threshold in Table 159, “Register 0x4C”[7:6].			
NOTE 2 This is the time it takes for buck regulator to go from steady state voltage to 0 V.			

2.3.6 DIMM Vendor Region Registers (cont'd)**Table 160 — Register 0x4D**

R4D			
Bits	Attribute	Default	Description
7:6	RWPE	10	R4D [7:6]: SWA_MODE_SELECT Switch Node A Output Regulator Mode Selection 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; CCM (Constant on Time; Continuous Current Mode)
5:4	RWPE	01	R4D [5:4]: SWA_SWITCHING_FREQ Switch Node A Output Regulator Switching Frequency 00 = 500 KHz 01 = 750 KHz 10 = Reserved 11 = Reserved
3:2	RWPE	10	R4D [1:0]: SWB_MODE_SELECT Switch Node B Output Regulator Mode Selection ¹ 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; CCM (Constant on Time; Continuous Current Mode)
1:0	RWPE	01	R4D [1:0]: SWB_SWITCHING_FREQ Switch Node B Output Regulator Switching Frequency ¹ 00 = 500 KHz 01 = 750 KHz 10 = Reserved 11 = Reserved
NOTE 1 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 161 — Register 0x4E

R4E			
Bits	Attribute	Default	Description
7:6	RWPE	10	R4E [7:6]: SWC_MODE_SELECT Switch Node C Output Regulator Mode Selection 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; CCM (Constant on Time; Continuous Current Mode)
5:4	RWPE	01	R4E [5:4]: SWC_SWITCHING_FREQ Switch Node C Output Regulator Switching Frequency 00 = 500 KHz 01 = 750 KHz 10 = Reserved 11 = Reserved
3:2	RWPE	10	R4E [3:2]: SWD_MODE_SELECT Switch Node D Output Regulator Mode Selection 00 = Reserved 01 = Reserved 10 = COT; DCM (Constant on Time; Discontinuous Current Mode) 11 = COT; CCM (Constant on Time; Continuous Current Mode)
1:0	RWPE	01	R4E [1:0]: SWD_SWITCHING_FREQ Switch Node D Output Regulator Switching Frequency 00 = Reserved 01 = 750 KHz 10 = 1000 KHz 11 = Reserved

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 162 — Register 0x4F

R4F			
Bits	Attribute	Default	Description
7	RWPE	0	R4F [7]: OUTPUT_REGULATORS_DISABLE_CONTROL ¹ Output Regulator SWA, SWB, SWC and SWD Disable Control for OV and UV. 0 = Disable all switching regulators of PMIC ² 1 = Disable only the affected switching output regulator; Rest of the PMIC's switching regulators remains operations ³
6:5	RWPE	0	R4F [6:5]: Reserved
4	RWPE	0	R4F [4]: SWA_OUTPUT_REGULATOR_REMOTE_SENSING SWA Output Regulator Remote Sensing Scheme on DIMM 0 = Single Ended Remote Sensing on DIMM. 1 = Differential Remote Sensing on DIMM
3	RV	0	R4F [3]: Reserved
2	RWPE	0	R4F [2]: SWC_OUTPUT_REGULATOR_REMOTE_SENSING SWC Output Regulator Remote Sensing Scheme on DIMM 0 = Single Ended Remote Sensing on DIMM. 1 = Differential Remote Sensing on DIMM
1	RWPE	0	R4F [1]: SWD_OUTPUT_REGULATOR_REMOTE_SENSING SWD Output Regulator Remote Sensing Scheme on DIMM 0 = Single Ended Remote Sensing on DIMM; Use SWD_FB_N pin as PID input pin to determine the PMIC's ID ⁴ 1 = Differential Remote Sensing on DIMM ⁵ .
0	RWPE	1	R4F [0]: SWA_SWB_PHASE_MODE_SELECT Switch Node A and Switch Node B Phase Regulator Mode Selection. 0 = Single Phase Regulator Mode 1 = Dual Phase Regulator Mode
<p>NOTE 1 Applicable to Output Over Voltage and Output Under Voltage. For VIN_Bulk input over voltage or VBIAS under voltage or VIN_Bulk Input under voltage, this bit does not apply and the PMIC always disables all switching regulators.</p> <p>NOTE 2 For standard DDR5 RDIMM and DDR5 LRDIMM, this bit must be always configured to '0'.</p> <p>NOTE 3 For DDR5 NVDIMM or any other custom DIMM, this bit can be configured to either '0' or '1' as desired. This is applicable only after VR_ENABLE bit is set to '1'. Prior to VR_ENABLE bit is set to '1', PMIC keeps all buck regulator off,</p> <p>NOTE 4 Up to three different PMIC can be placed on DIMM module.</p> <p>NOTE 5 Only one PMIC can be placed on DIMM module.</p>			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 163 — Register 0x50

R50			
Bits	Attribute	Default	Description
7:6	RWPE	01	<p>R50 [7:6]: SWA_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING</p> <p>PMIC5020 COT Mode, Ivalley_limit:</p> <p>00 = 7.0 A 01 = 8.0 A 10 = 9.0 A 11 = 10.0 A</p>
5:4	RWPE	01	<p>R50 [5:4]: SWB_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING</p> <p>PMIC5020 COT Mode, Ivalley_limit¹:</p> <p>00 = 7.0 A 01 = 8.0 A 10 = 9.0 A 11 = 10.0 A</p>
3:2	RWPE	01	<p>R50 [3:2]: SWC_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING</p> <p>PMIC5020 COT Mode, Ivalley_limit:</p> <p>00 = 8.0 A 01 = 9.0 A 10 = 10.0 A 11 = 11.0 A</p>
1:0	RWPE	00	<p>R50 [1:0]: SWD_OUTPUT_CURRENT_LIMITER_WARNING_THRESHOLD_SETTING</p> <p>PMIC5020 COT Mode, Ivalley_limit:</p> <p>00 = 3.0 A 01 = 3.5 A 10 = 4.0 A 11 = 4.5 A</p>
<p>NOTE 1 This register is applicable regardless of the setting in Table 162, “Register 0x4F” [0]. If Table 162, “Register 0x4F” [0] = ‘1’, this register must be configured identically as bits [7:6].</p>			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 164 — Register 0x51

R51			
Bits	Attribute	Default	Description
7:6	RWPE	01	R51 [7:6]: VOUT_1.8V_VOLTAGE_SETTING VOUT 1.8 V LDO Output Voltage Setting ¹ 00 = 1.7 V 01 = 1.8 V 10 = 1.9 V 11 = Reserved
5	RWPE	0	R51 [5]: SWA_VOLTAGE_RANGE SWA Output Voltage Range Selection ² 0 = Range: 800 mV to 1435 mV for SWA; 5 mV step size. 1 = Range: 600 mV to 1235 mV for SWA; 5 mV step size
4	RWPE	0	R51 [4]: SWB_VOLTAGE_RANGE SWB Output Voltage Range Selection ^{3,4} 0 = Range: 800 mV to 1435 mV for SWB; 5 mV step size 1 = Range: 600 mV to 1235 mV for SWB; 5 mV step size
3	RWPE	0	R51 [3]: SWC_VOLTAGE_RANGE SWC Output Voltage Range Selection ⁵ 0 = Range: 800 mV to 1435 mV for SWC; 5 mV step size 1 = Range: 600 mV to 1235 mV for SWC; 5 mV step size
2:1	RWPE	01	R51 [2:1]: VOUT_1.0V_VOLTAGE_SETTING VOUT 1.0 V LDO Voltage Setting 00 = 0.9 V 01 = 1.0 V 10 = 1.1 V 11 = 1.2 V
0	RWPE	0	R51 [0]: SWD_VOLTAGE_RANGE SWD Output Voltage Range Selection ⁶ 0 = Range: 1500 mV to 2135 mV for SWD; 5 mV step size 1 = Range: 2200 mV to 2835 mV for SWD; 5 mV step size
NOTE 1 The VOUT_1.8V Power Good threshold in register Table 112, “Register 0x1A” [2] is always fixed regardless of the setting in this register.			
NOTE 2 Range and resolution selection applies to registers Table 152, “Register 0x45” [7:1].			
NOTE 3 Range and resolution selection applies to registers Table 154, “Register 0x47” [7:1].			
NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			
NOTE 5 Range and resolution selection applies to registers Table 156, “Register 0x49” [7:1].			
NOTE 6 Range and resolution selection applies to registers Table 158, “Register 0x4B” [7:1].			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 165 — Register 0x58¹

R58			
Bits	Attribute	Default	Description
7	RWPE	0	R58 [7]: POWER_OFF_SEQUENCE_CONFIG0 PMIC Power Off Sequence Config 0 0 = Do Not Execute Config 0 ² 1 = Execute Config 0
6	RWPE	0	R58 [6]: POWER_OFF_SEQUENCE_CONFIG0_SWA_DISABLE Disable SWA Output Regulator. 0 = Do Not Disable SWA Output Regulator 1 = Disable SWA Output Regulator
5	RWPE	0	R58 [5]: POWER_OFF_SEQUENCE_CONFIG0_SWB_DISABLE Disable Switch Node B Output Regulator. ³ 0 = Do Not Disable SWB Output Regulator 1 = Disable SWB Output Regulator
4	RWPE	0	R58 [4]: POWER_OFF_SEQUENCE_CONFIG0_SWC_DISABLE Disable Switch Node C Output Regulator. 0 = Do Not Disable SWC Output Regulator 1 = Disable SWC Output Regulator
3	RWPE	0	R58 [3]: POWER_OFF_SEQUENCE_CONFIG0_SWD_DISABLE Disable SWD Output Regulator. 0 = Do Not Disable SWD Output Regulator 1 = Disable SWD Output Regulator
2:0	RWPE	0	R58 [2:0]: POWER_OFF_SEQUENCE_CONFIG0_IDLE Idle time after Power Off Sequence Config 0 ⁴ 000 = 0 ms 001 = 1 ms 010 = 2 ms 011 = 3 ms 100 = 4 ms 101 = 5 ms 110 = 6 ms 111 = 7 ms

NOTE 1 If more than one configuration register is used for power off sequence, first register must start at Table 165, “Register 0x58¹,” and it must go in sequential order to Table 168, “Register 0x5B^{1,2},” to turn off all regulators. In other words, there must not be any gap of the register that is used for power off sequence.

NOTE 2 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.

NOTE 3 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.

NOTE 4 Idle time is the additional time after soft-stop time expires. The PMIC waits sum of soft stop time and idle time before it executes the next power off sequence configuration register. If more than one regulators are disabled, the PMIC uses the largest value of the soft stop time among the regulators that are disabled in this configuration register.

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 166 — Register 0x59^{1,2}

R59			
Bits	Attribute	Default	Description
7	RWPE	0	R59 [7]: POWER_OFF_SEQUENCE_CONFIG1 PMIC Power Off Sequence Config1 ³ 0 = Do Not Execute Config 1 1 = Execute Config 1
6	RWPE	0	R59 [6]: POWER_OFF_SEQUENCE_CONFIG1_SWA_DISABLE Disable SWA Output Regulator. 0 = Do Not Disable SWA Output Regulator 1 = Disable SWA Output Regulator
5	RWPE	0	R59 [5]: POWER_OFF_SEQUENCE_CONFIG1_SWB_DISABLE Disable Switch Node B Output Regulator. ⁴ 0 = Do Not Disable SWB Output Regulator 1 = Disable SWB Output Regulator
4	RWPE	0	R59 [4]: POWER_OFF_SEQUENCE_CONFIG1_SWC_DISABLE Disable Switch Node C Output Regulator. 0 = Do Not Disable SWC Output Regulator 1 = Disable SWC Output Regulator
3	RWPE	0	R59 [3]: POWER_OFF_SEQUENCE_CONFIG1_SWD_DISABLE Disable Switch Node D Output Regulator. 0 = Do Not Disable SWD Output Regulator 1 = Disable SWD Output Regulator
2:0	RWPE	0	R59 [2:0]: POWER_OFF_SEQUENCE_CONFIG1_IDLE Idle time after Power Off Sequence Config 1 ⁵ 000 = 0 ms 001 = 1 ms 010 = 2 ms 011 = 3 ms 100 = 4 ms 101 = 5 ms 110 = 6 ms 111 = 7 ms
NOTE 1 If any regulators are disabled in Table 165, “Register 0x58 ¹ ” [6:3], those regulators must be configured as ‘1’ in this sequence.			
NOTE 2 If more than one configuration register is used for power off sequence, first register must start at Table 165, “Register 0x58 ¹ ” and it must go in sequential order to Table 168, “Register 0x5B ^{1,2} ” to turn off all regulators. In other words, there must not be any gap of the register that is used for power off sequence.			
NOTE 3 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.			
NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.			
NOTE 5 Idle time is the additional time after soft-stop time expires. The PMIC waits sum of soft stop time and idle time before it executes the next power off sequence configuration register. If more than one regulators are disabled, the PMIC uses the largest value of the soft stop time among the regulators that are disabled in this configuration register.			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 167 — Register 0x5A^{1,2}

R5A			
Bits	Attribute	Default	Description
7	RWPE	0	R5A [7]: POWER_OFF_SEQUENCE_CONFIG2 PMIC Power Off Sequence Config 2 ³ 0 = Do Not Execute Config 2 1 = Execute Config 2
6	RWPE	0	R5A [6]: POWER_OFF_SEQUENCE_CONFIG2_SWA_DISABLE Disable SWA Output Regulator. 0 = Do Not Disable SWA Output Regulator 1 = Disable SWA Output Regulator
5	RWPE	0	R5A [5]: POWER_OFF_SEQUENCE_CONFIG2_SWB_DISABLE Disable Switch Node B Output Regulator. ⁴ 0 = Do Not Disable SWB Output Regulator 1 = Disable SWB Output Regulator
4	RWPE	0	R5A [4]: POWER_OFF_SEQUENCE_CONFIG2_SWC_DISABLE Disable Switch Node C Output Regulator. 0 = Do Not Disable SWC Output Regulator 1 = Disable SWC Output Regulator
3	RWPE	0	R5A [3]: POWER_OFF_SEQUENCE_CONFIG2_SWD_DISABLE Disable Switch Node D Output Regulator. 0 = Do Not Disable SWD Output Regulator 1 = Disable SWD Output Regulator
2:0	RWPE	0	R5A [2:0]: POWER_OFF_SEQUENCE_CONFIG2_IDLE Idle time after Power Off Sequence Config 2 ⁵ 000 = 0 ms 001 = 1 ms 010 = 2 ms 011 = 3 ms 100 = 4 ms 101 = 5 ms 110 = 6 ms 111 = 7 ms
<p>NOTE 1 If any regulators are disabled in Table 165, “Register 0x58¹” [6:3], and Table 166, “Register 0x59^{1,2}” [6:3] those regulators must be configured as ‘1’ in this sequence.</p> <p>NOTE 2 If more than one configuration register is used for power off sequence, first register must start at Table 165, “Register 0x58¹” and it must go in sequential order to Table 168, “Register 0x5B^{1,2}” to turn off all regulators. In other words, there must not be any gap of the register that is used for power off sequence.</p> <p>NOTE 3 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.</p> <p>NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.</p> <p>NOTE 5 Idle time is the additional time after soft-stop time expires. The PMIC waits sum of soft stop time and idle time before it executes the next power off sequence configuration register. If more than one regulators are disabled, the PMIC uses the largest value of the soft stop time among the regulators that are disabled in this configuration register.</p>			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 168 — Register 0x5B^{1,2}

R5B			
Bits	Attribute	Default	Description
7	RWPE	0	R5B [7]: POWER_OFF_SEQUENCE_CONFIG3 PMIC Power Off Sequence Config 3 ³ 0 = Do Not Execute Config 3 1 = Execute Config 3
6	RWPE	0	R5B [6]: POWER_OFF_SEQUENCE_CONFIG3_SWA_DISABLE Disable SWA Output Regulator. 0 = Do Not Disable SWA Output Regulator 1 = Disable SWA Output Regulator
5	RWPE	0	R5B [5]: POWER_OFF_SEQUENCE_CONFIG3_SWB_DISABLE Disable SWB Output Regulator. ⁴ 0 = Do Not Disable SWB Output Regulator 1 = Disable SWB Output Regulator
4	RWPE	0	R5B [4]: POWER_OFF_SEQUENCE_CONFIG3_SWC_DISABLE Disable Switch Node C Output Regulator. 0 = Do Not Disable SWC Output Regulator 1 = Disable SWC Output Regulator
3	RWPE	0	R5B [3]: POWER_OFF_SEQUENCE_CONFIG3_SWD_DISABLE Disable Switch Node D Output Regulator. 0 = Do Not Disable SWD Output Regulator 1 = Disable SWD Output Regulator
2:0	RV	0	R5B [2:0]: Reserved
<p>NOTE 1 If any regulators are disabled in Table 165, “Register 0x58¹” [6:3], Table 166, “Register 0x59^{1,2}” [6:3] and Table 167, “Register 0x5A^{1,2}” [6:3], those regulators must be configured as ‘1’ in this sequence.</p> <p>NOTE 2 If more than one configuration register is used for power off sequence, first register must start at Table 165, “Register 0x58¹” and it must go in sequential order to Table 168, “Register 0x5B^{1,2}” to turn off all regulators. In other words, there must not be any gap of the register that is used for power off sequence.</p> <p>NOTE 3 If bit [7] = ‘0’, bits [6:3] must be programmed as ‘0000’. If bit [7] = ‘1’, at least one of the bits [6:3] must be programmed as ‘1’.</p> <p>NOTE 4 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.</p>			

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 169 — Register 0x5D

R5D			
Bits	Attribute	Default	Description
7:5	RWPE	001	R5D [7:5]: SWA_OUTPUT_SOFT_START_TIME SWA Output Regulator Soft Start Time After VR Enable ¹ 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
4	RV	0	R5D [4]: Reserved
3:1	RWPE	001	R5D [3:1]: SWB_OUTPUT_SOFT_START_TIME SWB Output Regulator Soft Start Time After VR Enable ^{1,2} 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
0	RV	0	R5D [0]: Reserved

NOTE 1 This is the time it takes for buck regulator to go from 0 V to steady state voltage (the actual voltage varies based on pre-programmed voltage).

NOTE 2 Only applicable if Table 162, “Register 0x4F” [0] = ‘0’.

Table 170 — Register 0x5E

R5E			
Bits	Attribute	Default	Description
7:5	RWPE	001	R5E [7:5]: SWC_OUTPUT_SOFT_START_TIME SWC Output Regulator Soft Start Time After VR Enable ¹ 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
4	RV	0	R5E [4]: Reserved
3:1	RWPE	001	R5E [3:1]: SWD_OUTPUT_SOFT_START_TIME SWD Output Regulator Soft Start Time After VR Enable ¹ 000 = 1 ms 001 = 2 ms 010 = 4 ms 011 = 6 ms ... 111 = 14 ms
0	RV	0	R5E [0]: Reserved

NOTE 1 This is the time it takes for buck regulator to go from 0 V to steady state voltage (the actual voltage varies based on pre-programmed voltage)

2.3.6 DIMM Vendor Region Registers (cont'd)

Table 171 — Register 0x5F

R5F			
Bits	Attribute	Default	Description
7	RWPE	0	R5F [7]: R2F_2_CONTROL Host Region R2F[2] Register Setting at First Power On 0 = R2F[2] = '0' 1 = R2F[2] = '1'
6	RWPE	0	R5F [6]: PMIC_AUTO_POWER_EN PMIC Auto Power On Control ^{1,2} 0 = PMIC Requires VR_EN command on I2C/I3C bus or via VR Enable pin to turn on output rails 1 = PMIC automatically powers on output rails as soon as it detects valid VIN_Bulk and VIN_Mgmt input supplies ³
5	RWPE	0	R5F [5]: VR_EN_PIN_ENABLE VR Enable Pin Enable ^{1,4} 0 = VR Enable pin is disabled (i.e., the pin acts as RFU) 1 = VR Enable pin is enabled. PMIC turns on SWx when VR_EN pin is asserted ⁵
4	RWPE	0	R5F [4]: R32_4_CONTROL Host Region R32[4] Register Setting at First Power On 0 = R32[4] = '0' 1 = R32[4] = '1'
3:0	RV	0	R5F [3:0]: Reserved
NOTE 1 The PMIC considers the setting of bits [6:5] = '11' as illegal.			
NOTE 2 When this feature is enabled, it takes in effect at next power cycle.			
NOTE 3 Once the PMIC output rails are powered up, if there is a subsequent VR Disable command or a fault event, the PMIC output regulators remains off until subsequent VR Enable command.			
NOTE 4 When this feature is enabled, the VR_EN input pin must be held low. The enable function takes in effect at next power cycle.			
NOTE 5 At initial power on, the VR Enable pin must be held low while VIN_Bulk and VIN_Mgmt input supplies are ramping up.			



Standard Improvement Form**JEDEC Standard JESD301-4**

The purpose of this form is to provide the Technical Committees of JEDEC with input from the industry regarding usage of the subject standard. Individuals or companies are invited to submit comments to JEDEC. All comments will be collected and dispersed to the appropriate committee(s).

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1. I recommend changes to the following:

☐ Requirement, clause number _____

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The referenced clause number has proven to be:

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