

TPS389C03-Q1 Multichannel Overvoltage and Undervoltage I²C Programmable Voltage Supervisor and Monitor with Q&A Watchdog

1 Features

- AEC-Q100 qualified with the following results:
 - Device temperature grade 1: –40°C to +125°C
 - Device HBM ESD classification level 2
 - Device CDM ESD classification level C7B
- **Functional Safety-Capable**
 - Documentation to aid ISO 26262 system design
 - Systematic capability up to ASIL D
 - Hardware capability up to ASIL D
- Q&A Watchdog to monitor SoC software operation
 - Programmable OPEN/CLOSE watchdog timing through I²C (1ms to 864ms)
 - Start-up delay for SoC boot up initialization (2ms to 3.46s)
 - Programmable maximum violation count (up to 7) before WDO assertion
 - Watchdog disable pin (WDE)
- Monitor state-of-the art SOCs
 - Three channels with three remote sense (TPS389C03-Q1)
 - Input voltage range: 2.6V to 5.5V
 - Undervoltage lockout (UVLO): 2.6V
 - High threshold accuracy:
 - ± 5mV (-40°C to +125°C)
 - Built-in ADC for voltage readouts
 - Fixed window threshold levels
 - 5mV steps from 0.2V to 1.475V
 - 20mV steps in other ranges
- Miniature package and minimal component cost
 - 3mm × 3mm QFN package
 - User adjustable voltage threshold levels via I²C
 - User adjustable glitch immunity and hysteresis levels via I²C
- Designed for safety applications
 - Error Signal Monitoring (ESM)
 - Programmable ESM delay via I²C (1ms to 864ms)
 - Cyclic Redundancy Checking (CRC)

- Packet Error Checking (PEC)
- Active-low open-drain NIRQ, NRST, and WDO outputs

2 Applications

- Advanced driver assistance system (ADAS)
- Sensor fusion
 - Level 3 to Level 5 Autonomous Platforms

3 Description

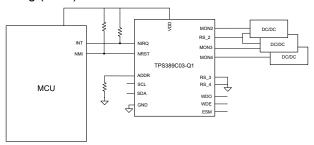
The TPS389C03-Q1 device integrated is an multichannel window monitor reset IC with three remote sense pins available in a 16-pin 3mm × 3mm QFN package.

This highly accurate multichannel voltage supervisor is designed for systems that operate on lowvoltage supply rails and have narrow margin supply tolerances. Internal glitch immunity and noise filters further eliminate false resets resulting from erroneous signals. This TPS389C03-Q1 device does not require any external resistors for setting overvoltage and undervoltage reset thresholds, which further optimizes overall accuracy, cost, size, and improves reliability for safety systems. I²C functionality gives flexibility in selecting thresholds, reset delays, glitch filters, and pin functionality. This device offers CRC error checking and a built-in ADC for voltage readouts to provide redundant error checking. The device has a built in Q&A watchdog and Error Signal monitor with independent watchdog enable and watchdog output.

Package Information

PART NUMBER	PACKAGE (1)	PACKAGE SIZE ⁽²⁾
TPS389C03-Q1	RTE (WQFN, 16)	3mm × 3mm

- For all available packages, see Section 12.
- The package size (length × width) is a nominal value and includes pins, where applicable.



TPS389C03-Q1 Typical Circuit



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4 Device Comparison

Figure 4-1 illustrates the device nomenclature. See Table 4-1 and Table 4-2 for more detailed information regarding the configuration of currently released variants. Table 10-2 provides a more in depth description of register configuration and data value stored.

Table 4-3 provides a summary of available device functions and corresponding part number. Contact TI sales representatives or go online to TI's E2E forum for details and availability of other options; minimum order quantities apply.

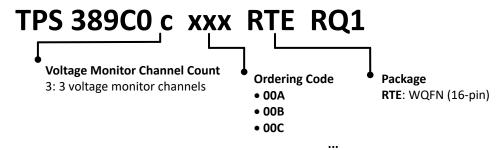


Figure 4-1. TPS389C03-Q1 Device Nomenclature

Table 4-1. TPS389C0x-Q1 Device Threshold Table

Ordering Code	Monitor Channel Count	Thresholds	VMON2 (V)	VMON3 (V)	VMON4 (V)
TPS389C0300CRTERQ1	3	UV_HF/OV_HF	4.56/5.44	3.02/3.6	0.2/1.475
TF3309C0300CKTERQT	3	UV_LF/OV_LF	4.56/5.44	3.02/3.6	0.2/1.475
TPS389C03A26RTERQ1	3	UV_HF/OV_HF	3.0/3.6	1.7/1.9	1.1/1.31
TF 3309C03AZ0INTENQT		UV_LF/OV_LF	3.16/3.44	1.72/1.88	1.145/1.25

Table 4-2. TPS389C0x-Q1 Device Configuration Table

Ordering Code	Functions	Scaling	OV/UV DEBOUNCE	LF CUTOFF	BIST	PEC	WD Open (ms)	WD Close (ms)	Max WD violation count	I2c pull- up voltage (v)
TPS389C0300CR TERQ1	Monitor LF/HF	4/4/1	102.4 us	1kHz	At POR	Disabled	30	30	2	3.3V
TPS389C03A26R TERQ1	Monitor LF/HF	4/4/1	102.4 us	1kHz	At POR	Enabled	100	100	7	3.3V



Table 4-3. Multichannel Supervisor Summary Table

0	TD000000 04	TD0000D0 04 (1)	TD000000 04 (1)	TD0000D0:- 04 (1)	TD0000000	TD000000 04 (1)
Specification	TPS38900x-Q1	1P5389R0X-Q1 (1)	1PS38800X-Q1 (1)	TPS388R0x-Q1 (1)	TPS389C0x-Q1	TPS388C0x-Q1 (1)
Hardware ASIL Rating	D	D	В	В	D	В
Monitoring Channel Count	4 to 8	4 to 7	4 to 8	4 to 7	3 to 6	3 to 6
Monitoring Range	0.2 to 5.5V	0.2 to 5.5V	0.2 to 5.5V	0.2 to 5.5V	0.2 to 5.5V	0.2 to 5.5V
Comparator Monitoring (HF Faults)	✓	✓	✓	✓	✓	✓
ADC Monitoring (LF Faults)	✓	✓	х	х	✓	х
Watchdog	х	х	х	х	Q&A	Window
Voltage Telemetry	✓	✓	х	х	✓	х
Monitor Glitch Filtering	✓	✓	✓	✓	✓	✓
Sequence Logging	✓	х	✓	х	✓	✓
NIRQ PIN	✓	✓	✓	✓	✓	✓
NRST PIN	х	✓	х	✓	✓	✓
SYNC PIN	✓	х	х	х	х	х
WDO PIN	х	х	х	х	✓	✓
WDI PIN	х	х	х	х	х	1
ESM PIN	х	х	х	х	✓	х

⁽¹⁾ Preview, contact TI sales representatives or on TI's E2E forum for details and availability of other options



5 Pin Configuration and Functions

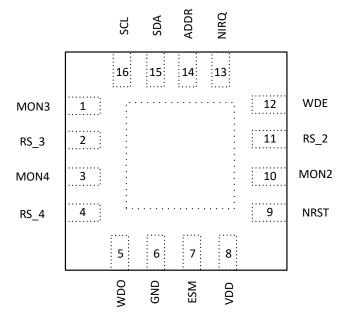


Figure 5-1. RTE Package 16-Pin WQFN TPS389C03-Q1 Top View

Table 5-1. Pin Functions

	PIN		
NO.	TPS389C03-Q1	I/O	DESCRIPTION
NO.	NAME		
1	MON3	I	Voltage monitor channel 3
2	RS_3	I	Remote sense for channel 3
3	MON4	I	Voltage monitor channel 4
4	RS_4	I	Remote sense for channel 4
5	WDO	0	Open drain pin for Watch Dog errors
6	GND	-	Power ground
7	ESM	I	Error signal monitor
8	VDD	-	Power supply rail
9	NRST	0	Open drain Reset pin
10	MON2	I	Voltage monitor channel 2
11	RS_2	I	Remote sense for channel 2
12	WDE	I	Watch dog enable
13	NIRQ	0	Active-low open-drain interrupt output
14	ADDR	I	I ² C address select pin
15	SDA	I/O	I ² C data pin
16	SCL	I	I ² C clock pin
17	GND	-	Exposed power ground pad



6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Voltage	VDD	-0.3	6	V
Voltage	NIRQ,NRST,WDO,ESM,WDE	-0.3	6	V
Voltage	SCL,SDA	-0.3	VDD+0.3	V
Voltage	ADDR	-0.3	2	V
Voltage	MONx	-0.3	6	V
Current	NIRQ,NRST,WDO		±10	mA
	Continuous total power dissipation	See the Thermal Information		
Temperature (2)	Operating junction temperature, T _J	-40	150	°C
Temperature \ /	Operating free-air temperature, T _A	-40	125	°C
	Storage temperature, T _{stg}	-65	150	°C

⁽¹⁾ Stresses beyond values listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

				VALUE	UNIT
		Human-body model (HBM), per ANSI/ESDA/JEDE	C JS-001 ⁽¹⁾	±2000	
$V_{(ESD)}$	Electrostatic discharge	Charged-device model (CDM), per AEC	All pins	±500	V
	a.ee.na.ge	Q100-011	Corner pins	±750	

⁽¹⁾ AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification

6.3 Recommended Operating Conditions

		MIN	NOM MAX	UNIT
VDD	Supply pin voltage	2.6	5.5	V
NIRQ,NRST,W DO,ESM,WDE	Pin voltage	0	5.5	V
I _{NIRQ,NRST,WDO}	Pin Currents	0	±5	mA
ADDR	Address pin voltage	0	1.8	V
MONx	Monitor Pins	0	5.5	V
SCL,SDA	Pin Voltage	0	VDD	V
R _{UP} (1)	Pull-up resistor (Open Drain config)	1	100	kΩ
T _J	Junction temperature (free-air temperature)	-40	125	°C

⁽²⁾ As a result of the low dissipated power in this device, it is assumed that $T_J = T_A$.



6.4 Thermal Information

		TPS389C03-Q1	
	THERMAL METRIC ⁽¹⁾	RTE (WQFN)	UNIT
		PINS	
R _{0JA}	Junction-to-ambient thermal resistance	53.4	°C/W
R _{0JC(top)}	Junction-to-case (top) thermal resistance	51.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	17.2	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	0.3	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	20.7	°C/W
R ₀ JC(bot)	Junction-to-case (bottom) thermal resistance	3.9	°C/W

⁽¹⁾ For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

6.5 Electrical Characteristics

At $2.6\text{V} \leq \text{VDD} \leq 5.5\text{V}$, NIRQ Voltage = $10\text{k}\Omega$ to V_{DD} , NIRQ load = 10pF, and over the operating free-air temperature range of -40°C to 125°C , unless otherwise noted. Typical values are at T_J = 25°C , typical conditions at VDD= 3.3V.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
COMMON PA	RAMETERS					
VDD	Input supply voltage		2.6		5.5	V
\ (D.D.	Rising Threshold		2.67		2.81	V
VDD _{UVLO}	Falling Threshold		2.48		2.6	V
V _{POR}	Power on Reset Voltage (2)				1.65	V
I _{DD_Active}	Supply current into VDD pin	VDD≤5.5V		1550	2000	μΑ
V _{MONX}	MON voltage range		0.2		5.5	V
I _{MONX}	Input current MONx pins	V _{MON} =5V			20	μA
WAON LE	1x mode (No scaling)		0.2		1.475	V
VMON_LF	4x mode		0.8		5.5	V
\#46\\ \\	1x mode (No scaling)		0.2		1.475	V
VMON_HF	4x mode		0.8		5.5	V
Threshold	1x mode (No scaling)			5		mV
Granularity_L F	4x mode			20		mV
Threshold Granularity_ HF	1x mode (No scaling)			5		mV
Threshold Granularity_ HF	4x mode			20		mV
		0.2V≤V _{MONX} ≤1.0V	-6		6	mV
A 001170 01/ 11F	VAACAL	1.0V <v<sub>MONX≤1.475V</v<sub>	-7.5		7.5	mV
Accuracy_HF	VIVION	1.475V <v<sub>MONX≤2.95V</v<sub>	-0.6		0.6	%
		V _{MONX} >2.95V	-0.7		0.7	%
	Hysteresis on UV,OV pin(Hysteresis is	0.2V≤V _{MONX} ≤1.475V		5	11	mV
V _{HYS_HF}	with respect of the tripoint ((UV),(OV))	1.475V <v<sub>MONX≤2.95V</v<sub>		9	16	IIIV
	(1)	VMONX>2.95V		17	28	mV
MON_OFF	OFF Voltage threshold	Monitored falling edge of V _{MON}	140		215	mV
NIRQ	On resistance- when asserted Low	Open Drain		12	17	Ω
V _{OL}	Low level output voltage-NIRQ	NIRQ, 5.5V/5mA			100	mV



6.5 Electrical Characteristics (continued)

At $2.6V \le VDD \le 5.5V$, NIRQ Voltage = $10k\Omega$ to V_{DD} , NIRQ load = 10pF, and over the operating free-air temperature range of $-40^{\circ}C$ to $125^{\circ}C$, unless otherwise noted. Typical values are at $T_{J} = 25^{\circ}C$, typical conditions at VDD= 3.3V.

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I _{lkg(OD)}	Open-Drain output leakage current-NIRQ	NIRQ pin in High Impedance,VNIRQ= 5.5, Not asserted			90	nA
NRST	On resistance- when asserted Low	Open Drain		10	15	Ω
V _{OL}	Low level output voltage-NRST	NRST, 5.5V/5mA			100	mV
I _{lkg(OD)}	Open-Drain output leakage current-NRST	NRST pin in High Impedance,VNRST= 5.5, Not asserted			600	nA
WDO	On resistance- when asserted Low	Open Drain		12	17	Ω
V _{OL}	Low level output voltage-WDO	WDO , 5.5V/5mA			100	mV
I _{lkg(OD)}	Open-Drain output leakage current-WDO	WDO pin in High Impedance,VNRST= 5.5, Not asserted			500	nA
ESM_L	Logic Low Input				0.24 x VDD	V
ESM_H	Logic High Input	VDD>4.5	0.55 x VDD			V
LOW_II	Logic Flight Input	VDD<4.5	0.6 x VDD			V
llkg(ESM)	Leakage current	ESM=5.5V			75	μΑ
WDE_L	Logic Low Input				0.36	V
WDE_H	Logic High Input		1.26			V
Ilkg(WDE)	Leakage current	WDE=5.5V			5	μA
I _{ADDR}	ADDR pin current			20		μA
		R=5.36k		0x30		
		R=16.2k		0x31		
		R=26.7k		0x32		
100 ADDD	(110) (50)	R=37.4k		0x33		
I2C ADDR	(Hex format)	R=47.5k		0x34		
		R=59.0k		0x35		
		R=69.8k		0x36		
		R=80.6k		0x37		
TSD	Thermal Shutdown			155		°C
TSD Hys	Thernal Shutdown Hysterisis			25		°C
RS	Remote sense range		-100		100	mV
ADC SPECIF	ICATION					
Vin	Input Range		0.2		5.5	V
Danalusti	1x mode	0.2V≤VMON≤1.475V		5		mV
Resolution	4x mode	VMON>1.475V		20		mV
f _S	Sample Rate			125		ksps
A	VMON,1x mode	0.2V≤VMON≤1.475V	-12		+12	mV
Accuracy_LF	VMON, 4x mode	VMON>1.475V	-40		+40	mV
I2C ELECTR	ICAL SPECIFICATIONS					
· · · · · · · · · · · · · · · · · · ·	Hysteresis LF Faults, 1x mode	0.2V≤VMON≤1.475V		10	15	mV
V_{HYS_LF}	Hysteresis LF Faults, 4x mode	VMON>1.475V		40	55	mV
C _B	Capacitive load for SDA and SCL				400	pF
SDA,SCL	Low Threshold	DEV_CONFIG.SOC_IF=0			0.84	V

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6.5 Electrical Characteristics (continued)

At $2.6V \le VDD \le 5.5V$, NIRQ Voltage = $10k\Omega$ to V_{DD} , NIRQ load = 10pF, and over the operating free-air temperature range of $-40^{\circ}C$ to $125^{\circ}C$, unless otherwise noted. Typical values are at $T_{J} = 25^{\circ}C$, typical conditions at VDD= 3.3V.

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SDA,SCL	High Threshold	DEV_CONFIG.SOC_IF=0	2.31			V

⁽¹⁾

6.6 Timing Requirements

At 2.6V ≤ VDD ≤ 5.5V, NIRQ Voltage = 10kΩ to VDD, NIRQ load = 10pF, and over the operating free-air temperature range of -40° C to 125°C, unless otherwise noted. Typical values are at T_J = 25°C, typical conditions at VDD = 3.3V.

			MIN	NOM	MAX	UNIT
COMMON F	PARAMETERS				'	
t _{BIST}	POR to ready with BIST, TEST_CFG.AT_POR=1	includes OTP load			12	ms
tNBIST	POR to ready without BIST, TEST_CFG.AT_POR=0	includes OTP load			2	ms
BIST	BIST time, TEST_CFG.AT_POR=1 or TEST_CFG.AT_SHDN=1				10	ms
t _{I2C_ACT}	I2C active from BIST complete				0	μs
t _{NRST}	Fault detection to NRST assertion latency				25	μs
t _{WDO}	Fault detection to WDO assertion latency				25	μs
t _{NIRQ}	Fault detection to NIRQ assertion latency (except OV/UV faults)				25	μs
t _{PD_NIRQ_1X}	HF fault Propagation detect delay (default deglitch filter) includes digitial delay	VIT_OV/UV +/- 100mV			650	ns
t _{PD_NIRQ_4X}	HF fault Propagation detect delay (default deglitch filter) includes digitial delay	VIT_OV/UV +/- 400mV			750	ns
		I2C Register time delay =000		200		μs
		I2C Register time delay =001		1		ms
		I2C Register time delay =010		10		ms
	DECET time delay	I2C Register time delay =011		16		ms
t _D	RESET time delay	I2C Register time delay =100		20		ms
		I2C Register time delay =101		70		ms
		I2C Register time delay =110		100		ms
		I2C Register time delay =111		200		ms

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Hysteresis is with respect of the trip point $(V_{\text{IT-(UV)}}, V_{\text{IT+(OV)}})$. V_{POR} is the minimum V_{DDX} voltage level for a controlled output state.



6.6 Timing Requirements (continued)

At $2.6\text{V} \le \text{VDD} \le 5.5\text{V}$, NIRQ Voltage = $10\text{k}\Omega$ to VDD, NIRQ load = 10pF, and over the operating free-air temperature range of -40°C to 125°C , unless otherwise noted. Typical values are at $T_J = 25^{\circ}\text{C}$, typical conditions at VDD = 3.3V.

			MIN NOM	MAX	UNIT	
		I2C Register time delay =000	1		ms	
		I2C Register time delay =001	2		ms	
		I2C Register time delay =010	5		ms	
	WDO delay	I2C Register time delay =011	10		ms	
t _{D_WD}		I2C Register time delay =100	20		ms	
		I2C Register time delay =101	50		ms	
		I2C Register time delay =110	100		ms	
		I2C Register time delay =111	200		ms	
		I2C Register time delay =00	10			
t _{debounce_ES}	Debounce time	I2C Register time delay =01	25		μs	
		I2C Register time delay =10	50			
		I2C Register time delay =11	100			
t _{GI_R}	UV & OV debounce range via I2C	FLT_HF(N)	0.1	102.4	μs	



6.6 Timing Requirements (continued)

At $2.6V \le VDD \le 5.5V$, NIRQ Voltage = $10k\Omega$ to VDD, NIRQ load = 10pF, and over the operating free-air temperature range of $-40^{\circ}C$ to $125^{\circ}C$, unless otherwise noted. Typical values are at $T_J = 25^{\circ}C$, typical conditions at VDD = 3.3V.

			MIN	NOM	MAX	UNIT
I2C TIMIN	IG CHARACTERISTICS					
f _{SCL}	Serial clock frequency	Standard mode			100	kHz
SCL	Serial clock frequency	Fast mode	,		400	kHz
SCL	Serial clock frequency	Fast mode +			1	MHz
t _{LOW}	SCL low time	Standard mode	4.7			μs
t _{LOW}	SCL low time	Fast mode	1.3			μs
Low	SCL low time	Fast mode +	0.5			μs
t _{HIGH}	SCL high time	Standard mode	4			μs
t _{HIGH}	SCL high time	Fast mode +	0.26			μs
t _{SU;DAT}	Data setup time	Standard mode	250			ns
t _{SU;DAT}	Data setup time	Fast mode	100			ns
SU;DAT	Data setup time	Fast mode +	50			ns
HD;DAT	Data hold time	Standard mode	10			ns
t _{HD;DAT}	Data hold time	Fast mode	10			ns
t _{HD;DAT}	Data hold time	Fast mode +	10			ns
t _{SU;STA}	Setup time for a Start or Repeated Start condition	Standard mode	4.7			μs
t _{SU;STA}	Setup time for a Start or Repeated Start condition	Fast mode	0.6			μs
t _{su;sta}	Setup time for a Start or Repeated Start condition	Fast mode +	0.26			μs
HD:STA	Hold time for a Start or Repeated Start condition	Standard mode	4			μs
t _{HD:STA}	Hold time for a Start or Repeated Start condition	Fast mode	0.6			μs
t _{HD:STA}	Hold time for a Start or Repeated Start condition	Fast mode +	0.26			μs
t _{BUF}	Bus free time between a STOP and START condition	Standard mode	4.7			μs
t _{BUF}	Bus free time between a STOP and START condition	Fast mode	1.3			μs
t _{BUF}	Bus free time between a STOP and START condition	Fast mode +	0.5	,		μs
t _{su;sto}	Setup time for a Stop condition	Standard mode	4			μs
t _{su;sto}	Setup time for a Stop condition	Fast mode	0.6			μs
t _{su;sto}	Setup time for a Stop condition	Fast mode +	0.26			μs
trDA	Rise time of SDA signal	Standard mode		,	1000	
trDA	Rise time of SDA signal	Fast mode	20		300	ns
trDA	Rise time of SDA signal	Fast mode +			120	ns
tfDA	Fall time of SDA signal	Standard mode			300	ns
tfDA	Fall time of SDA signal	Fast mode	1.4		300	ns
tfDA	Fall time of SDA signal	Fast mode +	6.5		120	ns
trCL	Rise time of SCL signal	Standard mode		,	1000	ns
trCL	Rise time of SCL signal	Fast mode	20		300	ns
rCL	Rise time of SCL signal	Fast mode +			120	ns
fCL	Fall time of SCL signal	Standard mode			300	ns
tfCL	Fall time of SCL signal	Fast mode	6.5		300	ns
fCL	Fall time of SCL signal	Fast mode +	6.5		120	ns
tSP	Pulse width of SCL and SDA spikes that are suppressed	Standard mode, Fast mode and Fast mode +			50	ns



7 Detailed Description

7.1 Overview

The TPS389C03-Q1 family of devices has three channels that can be configured for over voltage, under voltage or both in a window configuration. The TPS389C03-Q1 features a highly accurate window threshold voltages (up to ±5mV) and a variety voltage thresholds which can be factory configured or set on boot up by I2C commands.

The TPS389C03-Q1 includes the resistors used to set the overvoltage and undervoltage thresholds internal to the device. These internal resistors allow for lower component counts and greatly simplifies the design because no additional margins are needed to account for the accuracy of external resistors.

The TPS389C03-Q1 is designed to assert active low output signals (NIRQ and/or NRST) when the monitored voltage is outside the safe window. The default configuration has the interrupts enabled for over voltage and under voltage faults, sequence timeout set for 1ms, BIST enabled at POR, and over voltage and under voltage debounce set for 102.4µs.

7.2 Functional Block Diagram

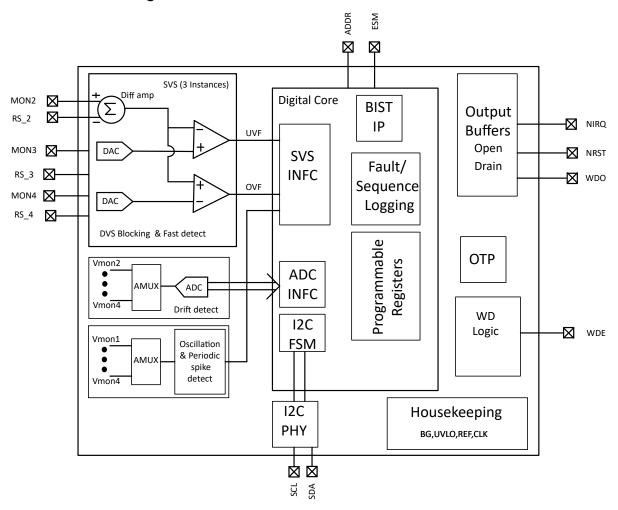


Figure 7-1. TPS389C03-Q1 Block Diagram

Product Folder Links: TPS389C03-Q1

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7.3 Feature Description

7.3.1 I²C

The TPS389C03-Q1 device follows the I^2C protocol (up to 1MHz) to manage communication with host devices such as an MCU or System on Chip (SoC). I^2C is a two wire communication protocol implemented using two signals, clock (SCL) and data (SDA). The host device is primary controller of communication. TPS389C03-Q1 device responds over the data line during read or write operation as defined by I^2C protocol. Both SCL and SDA signals are open drain topology and can be used in a wired-OR configuration with other devices to share the communication bus. Both SCL and SDA pins need an external pull up resistance to supply voltage ($10k\Omega$ recommended).

Figure 7-2 shows the timing relationship between SCL and SDA lines to transfer 1 byte of data. SCL line is always controlled by host. To transfer 1 byte data, host needs to send 9 clocks on SCL. 8 clocks for data and 1 clock for ACK or NACK. SDA line is controlled by either host or TPS389C03-Q1 device based on the read or write operation. Figure 7-3 and Figure 7-4 highlight the communication protocol flow and which device controls SDA line at various instances during active communication.

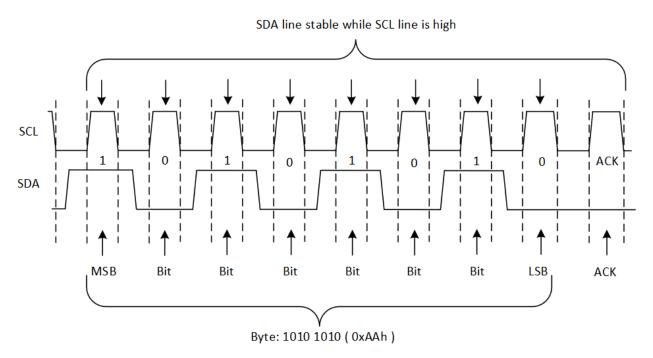


Figure 7-2. SCL to SDA timing for 1 byte data transfer



Master Controls SDA Line
Slave Controls SDA Line

Write to One Register in a Device

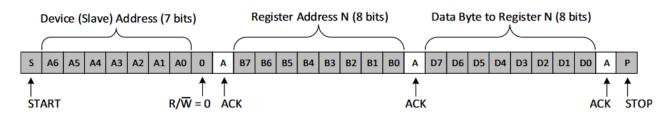


Figure 7-3. I²C write protocol

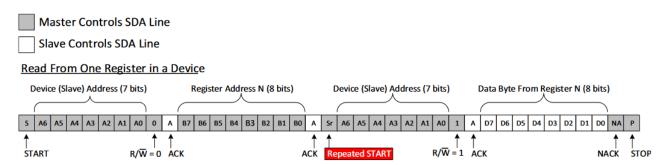


Figure 7-4. I²C read protocol

Before initiating communication over I^2C protocol, host needs to confirm the I^2C bus is available for communication. Monitor the SCL and SDA lines, if any line is pulled low, the I^2C bus is occupied. Host needs to wait until the bus is available for communication. Once the bus is available for communication, the host can initiate read or write operation by issuing a START condition. Once the I^2C communication is complete, release the bus by issuing STOP command. Figure 7-5 shows how to implement START and STOP condition.

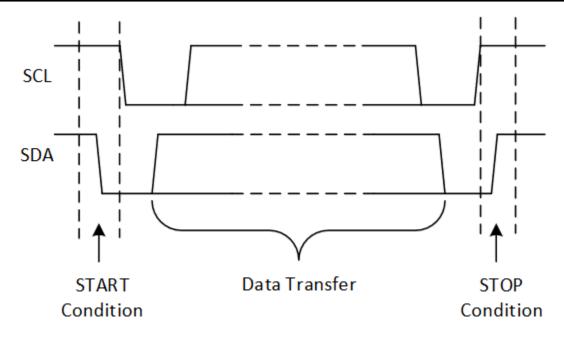


Figure 7-5. I²C START and STOP condition

The SDA line can get stuck in logic low level if required number of clocks are not provided by the host. In this scenario, the host provides multiple clocks on SCL line until the SDA line goes high. After this event, host must issue I^2C stop command. This releases the I^2C bus and other devices can use the I^2C bus.

Table 7-1 shows the different functionality available when programming with I²C.

Table 7-1. User Programmable I²C Functions

FUNCTIONS	DESCRIPTION
Thresholds for OV/UV- HF	Adjustable in 5mV steps from 0.2V to 1.475V and 20mV steps from 0.8V to 5.5V
Thresholds for OV/UV - LF	Adjustable in 5mV steps from 0.2V to 1.475V and 20mV steps from 0.8V to 5.5V
Voltage Monitoring scaling	1 or 4
Glitch immunity for OV/UV- HF	0.1 us to 102.4 us
Low Frequency Cutoff filter	250Hz to 4kHz
Enable sequence timeout	1ms to 4s
Packet error checking for I ² C	Enabling or Disabling
Force NIRQ/NRST/WDO assertion	Controlled by I ² C register
Individual channel MON	Enable or Disable
Interrupt disable functions	BIST, PEC, TSD, CRC
ESM Threshold	1ms to 864ms
ESM Debounce	10us to 100us
Reset Delay	200us to 200ms
MAX Violation Count	0 to 7
Watchdog Startup Delay Multiplier	0 to 7
Watchdog Open and Close Window Times	1ms to 864ms
Watchdog Output Delay	200us to 200ms (only applicable for non-latched WDO)
OV/UV/ESM/WDT	Mappable individually to NIRQ, NRST, and WDO



7.3.2 Maskable Interrupt (AMSK)

In the case of power up, AMSK_ON register applies. AMSK_ON masks interrupts until the MON voltage crosses the UVLF threshold or sequence timeout expires whichever is sooner. In the case of power down AMSK_OFF register applies. AMSK_ON masks interrupts until the MON voltage is below the OFF threshold and then the OVLF interrupts are active.

Table 7-2 summarizes the auto-mask operation for power up and power down.

Table 7-2. Auto-Mask Operation for the Power Up and Power Down

TRANSITION	AUTO-MASK APPLIED	AUTO-MASK APPLIES TO	AUTO-MASK INACTIVE	INTERRUPTS ACTIVE FOR MON CHANNELS NOT IN AUTO-MASK
Power Up	AMSK_ON	IEN UVLF, IEN UVHF,	SEQ_TOUT expires or rail crosses UVLF	At Power Up
Power Down	AMSK_OFF	IEN OVHE	Auto-mask active in transition until SEQ_TOUT expires	Until SEQ_TOUT expires

7.3.3 VDD

The TPS389C03-Q1 is designed to operate from an input voltage supply range between 2.6V to 5.5V. An input supply capacitor is not required for this device; however, if the input supply is noisy good analog practice is to place a 1µF capacitor between the VDD pin and the GND pin.

 V_{DD} needs to be at or above $V_{DD(MIN)}$ for at least the start-up delay $(t_{SD} + t_D)$ for the device to be fully functional.

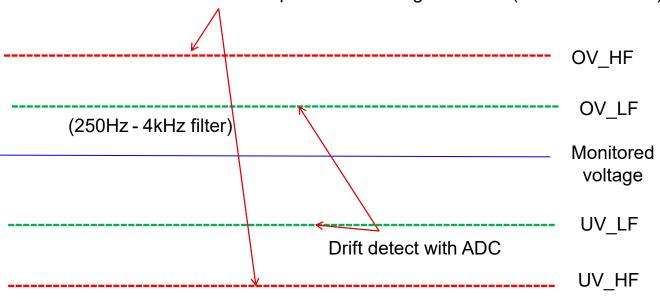
7.3.4 MON

The TPS389C03-Q1 combines two comparators with a precision reference voltage and a trimmed resistor divider per monitor (MON) channel. This configuration optimizes device accuracy because all resistor tolerances are accounted for in the accuracy and performance specifications. Both comparators also include built-in hysteresis that provides noise immunity and provides stable operation.

Each MON channel can be configured for Low Frequency (LF) and High Frequency (HF) fault detection. HF fault detection uses a comparator for UV and OV measurements referenced to the threshold voltage. A debounce filter for glitch immunity can be configured for HF faults using the FLT_HF registers in BANK1 associated with each MON channel.

LF fault detection measures the voltage through an ADC that can be used to monitor voltage drift. The LF detection thresholds can be configured for various purposes. For example, the OVLF threshold can be set lower than the OVHF threshold for drift monitoring. Alternatively, the OVLF threshold can be set to overlap with the OVHF threshold for redundancy. LF and HF faults are configured using the UV_HF, OV_HF, UV_LF, and OV_LF registers in BANK1. Each MON channel has unique UV_HF, OV_HF, UV_LF, and OV_LF registers. The diagram shown in Figure 7-6 illustrates an example of how the LF and HF faults can be configured.

Ultra fast detection with comparators with deglitch filters (0.1us to 102.4us)



ases, for noisy applications good analog design practice is to pla

Although not required in most cases, for noisy applications good analog design practice is to place a 1nF to 10nF bypass capacitor at the MON input to reduce sensitivity to transient voltages on the monitored signal. Specific debounce times or deglitch times can also be set independently for each MON via I²C registers

Figure 7-6. MON Channel State Diagram

When monitoring VDD supply voltage, the MON pin can be connected directly to VDD. The outputs NIRQ and NRST are high impedance when voltage at the MON pin is between upper and lower boundary of threshold.

The MON channel settings can be adjusted by using the associated registers listed in the register maps found in Section 8. Using the register maps, the code example in Figure 7-7 demonstrates how MON2 can be reconfigured.



```
ADDR 30
11
              Go to Bank 1
WR F0 01
11
              Check UVHF, OVHF thresholds for MON2 and MON3
RD 30 //MON2 UVHF
RD 31 //MON2 OVHF
RD 40 //MON3 UVHF
RD 41 //MON3 OVHF
               Check UVLF, OVLF thresholds for MON2 and MON3
RD 32 //MON2 UVHF
RD 33 //MON2 OVHF
RD 42 //MON3 UVHF
RD 43 //MON3 OVHF
11
              Example change OVHF threshold MON2 to 5.5V
WR 31 EB
11
              Example change OVHF threshold MON2 to 5.48V
WR 31 EA
11
              Example change OVHF threshold MON2 to 5.44V
WR 31 E8
11
          Telemetry read the voltages being monitored
11
               Go to Bank 0
WR FO 00
RD 41 // MON2 Voltage
RD 42 // MON3 Voltage
11
       Simulate an OV fault on MON2
11
               Go to Bank 1
WR F0 01
WR 31 C8 // Change OVHF threshold to 4.8V
      NIRQ, NRST asserts (depends on mapping)
11
      Clearing OVHF fault MON2
11
11
               Go to Bank 0
WR F0 00
RD 16 // 02 READ SINCE OVHF on MON2
WR 16 02 // WRITE 1(bit 2) to clear
```

Figure 7-7. MON2 Setting Software Example

7.3.5 NRST

The NRST pin features a programmable reset delay time that can be adjusted from 0.2ms to 200ms when using TI_CONTROL register. NRST is an open-drain output that must be pulled up through a $1k\Omega$ to $100k\Omega$ pullup resistor. When the device is powered up and POR is complete, NRST is asserted low until the BIST is complete. After the BIST, NRST remains high (not asserted) until triggered by a mappable fault condition. An NRST_MISMATCH fault is asserted if the NRST pin is pulled to an unexpected state. For example, if the NRST pin is in a high-impedance state (logic high) and is externally pulled low, then an NRST_MISMATCH fault asserts. During an NRST toggle NRST mismatch is active after $2\mu s$, NRST must exceed 0.6*VDD to be considered in a logic high state.

NRST is mappable to the watchdog fault, and the ESM fault when using the IEN_{VENDOR} register. If NRST is mapped to the ESM fault, the NRST pin asserts following the ESM delay and be de-asserted after the reset delay (t_D). If NRST is mapped to the watchdog fault, the NRST pin asserts during a watchdog fault and de-asserts following the reset delay (t_D).

NRST is also mappable to the OVHF and UVHF faults using the FC_LF[n] registers. If a monitored voltage falls or rises outside of the programmed OVHF and UVHF thresholds, then NRST is asserted, driving the NRST pin

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low. When the monitored voltage comes back into the valid window, a reset delay circuit is enabled that holds NRST low for a specified reset delay period (t_D). Note if NRST is un-mapped from OVHF and UVHF faults while NRST is asserted then NRST deasserts, NRST reasserts when re-mapped assuming the voltage is still outside the valid window

The t_D period is determined by the RST_DLY[2:0] value found in the TI_CONTROL register. When the reset delay has elapsed, the NRST pin goes to a high-impedance state and uses a pullup resistor to hold NRST high. The pullup resistor must be connected to the proper voltage rail to allow other devices to be connected at the correct interface voltage. To maintain proper voltage levels, give some consideration when choosing the pullup resistor values. The pullup resistor value is determined by output logic low voltage (VOL), capacitive loading, and leakage current.

7.3.6 NIRQ

NIRQ is a interrupt error ouput with latched behavior, if a monitored voltage falls or rises outside of the programmed OVHF and UVHF thresholds NIRQ is asserted. NIRQ remains in a low state until the action causing the fault is no longer present and a 1-to-clear is written to the bit signaling the fault. Un-mapping NIRQ from a fault reporting register does not de-assert the NIRQ signal. NIRQ is In a typical TPS389C03-Q1 application, the NIRQ output is connected to a reset or enable input of a processor [such as a digital signal processor (DSP) or application-specific integrated circuit (ASIC), or other processor type].

The TPS389C03-Q1 has an open drain active low output that requires a pull-up resistor to hold these lines high to the required voltage logic. Connect the pull-up resistor to the proper voltage rail to enable the output to be connected to other devices at the correct interface voltage levels. To meet proper voltage levels, give some consideration when choosing the pull-up resistor values. The pull-up resistor value is determined by V_{OL} , output capacitive loading, and output leakage current. These values are specified in Section 6. The open drain output can be connected as a wired-OR logic with other open drain signals such as another TPS389C03-Q1 NIRQ pin.

7.3.7 ADC

The ADC used in the TPS389C03Q-1 runs on a 1MHz clock with an effective sampling rate of 1/8MHz (= 125kHz). Initially, the ADC records with a resolution of 12 bits (1LSB = 0.41667mV) which is later round off to 8-bit data for I^2 C transaction. (1LSB = 5mV) The ADC uses ping-pong architecture which requires 2us for both sampling and conversion per channel with a total of 2 sampling channels. While CH0 performs coarse conversion, CH1 does fine conversion and vice verse.

Digitized 8-bit data is updated once the fine conversion is completed, which occurs once every 8µs. Each I²C transaction initiated for reading 8-bit MON_LVL data (the ADC data of a particular channel), 8-bit data is paused from updating until the I²C transaction completes.

Voltage scaling is done using a resistor ladder, but for differential mode channels, a chopping circuit is used to get the average of both of the voltages (VMON + VMON_RS)/2 since VMON_RS can be negative and can't be converted into an ADC code. VMON – VMON_RS is calculated digitally by subtracting ((VMON + VMON_RS) /2) from VMON and then multiplying by 2.

The MONX channels can be configured in 1x (0.2V to 1.475V) or 4x mode (0.8V to 5.5V). For differential mode channels configured in 1x mode, (MON1 and MON2) the ADC range is limited up to 1.7V. To configure an ADC channel above 1.7V, please use 4x mode.

Real time voltage measurements use.

$$V_{|V|} = ((ADC[7:0] * 5mV) + 0.2) * (VRANGE_MULT)$$
 (1)

- 1. ADC[7:0] is translated to a corresponding decimal value. The value of ADC[7:0] corresponding to MON2-MON4 can be read from BANK0, registers 0x41 to 0x43 found in Table 8-1.
- 2. VRANGE_MULT corresponds to the selected monitor voltage multiplier set in BANK1, register 0x1F of Table 8-26
- 3. VRANGE_MULT is set to a decimal 1 or 4 value depending on monitored value.



7.3.8 Packet Error Checking (PEC)

TPS389C03-Q1 supports Packet Error Checking (PEC) as a way to implement Cyclic Redundancy Checking (CRC). PEC is a dynamic CRC that happens only during read or write transactions if enabled. With the initial value of CRC set to 0x00, the PEC uses a CRC-8 represented by the polynomial:

$$C(x) = x^8 + x^2 + x + 1 \tag{2}$$

The polynomial is meant to catch any bit flips or noise in I2C communication which cause data and PEC byte to have a mismatch. The PEC calculation includes all bytes in the transmission, including address, command and data. The PEC calculation does not include ACK or NACK bits or START, STOP or REPEATED START conditions. If PEC is enabled, and the TPS389C03-Q1 is transmitting data, then the TPS389C03-Q1 is responsible for sending the PEC byte. If PEC is enabled, and the TPS389C03-Q1 is reveiving data from the MCU, then the MCU is responsible for sending the PEC byte. In case of faster communications needs like servicing the watchdog the required PEC feature can be effectively used to handle missing PEC information and to avoid triggering faults. Figure 7-8 and Figure 7-9 highlight the communication protocol flow when PEC is required and which device controls SDA line at various instances during active communication.

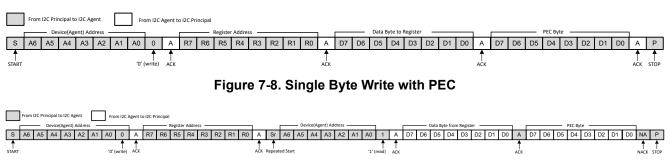


Figure 7-9. Single Byte Read with PEC

Table 7-3 summarises the registers associated with a PEC Write command and resulting device behavior. Table 7-4 summarises the registers associated with a PEC Read command and resulting device behavior.

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Table 7-3. PEC Write Summary

EN_PEC	REQ_PEC	PEC_INT	Interrupt Status
0	х	х	PEC byte is not required in write operation, NO NIRQ assertion.
1	0	х	A write command missing a PEC byte is treated as OK, the write command executes and result in a I2C ACT. A write command with an incorrect PEC is treated as an error, the write command does not execute and result in a I2C NACK. NO NIRQ assertion.
1	1	0	A missing PEC is treated as an error, a write command executes only if the correct PEC byte is provided. I2C communication still responds with an ACT although write command did not execute. A write command with an incorrect PEC is treated as an error, the write command does not execute and result in a I2C NACK. NO NIRQ assertion.
1	1	1	A missing PEC is treated as an error, a write command executes only if the correct PEC byte is provided. I2C communication still responds with an ACT although write command did not execute. A write command with an incorrect PEC is treated as an error, the write command does not

Table 7-4. PEC Read Summary

execute and result in a I2C NACK. NIRQ is asserted when a write command with a incorrect or missing PEC byte is attempted.

EN_PEC	REQ_PEC	PEC_INT	Interrupt Status
0	х	х	I2C read operation reponds with data stored in register, I2C read command does not respond with registers corresponding PEC byte.
1	х	х	I2C read operation responds with data stored in register and corresponding PEC byte.

7.3.9 Q&A Watchdog

The Question and Answer Watchdog requires specific data to be sent from the MCU to the TPS389C03-Q1 within a specific time interval.

The TPS389C03-Q1 generates questions for the MCU to read during the OPEN and CLOSE windows. Questions are read as the combination of ANSW_CNT[1:0] and TOKEN[3:0] status bits found in the WD_STAT_QA register in BANK0. After reading a question, the MCU calculates the Reference Answer using the logic equations shown in Figure 7-10 and responds by writing the 8-bit answer into the WDT_ANSWER register in BANK1. A code example for Reference Answer calculation is shown in Figure 7-13. For a typical application, changing the value of FDBK[1:0], found in the WDT_QA_CFG register in BANK1, from the default value of FDBK[1:0] = 00b is not required. However, FDBK[1:0] can be changed if a different Reference Answer calculation is needed. Question generation and answer calculations are explained in more detail in Section 7.3.9.1.



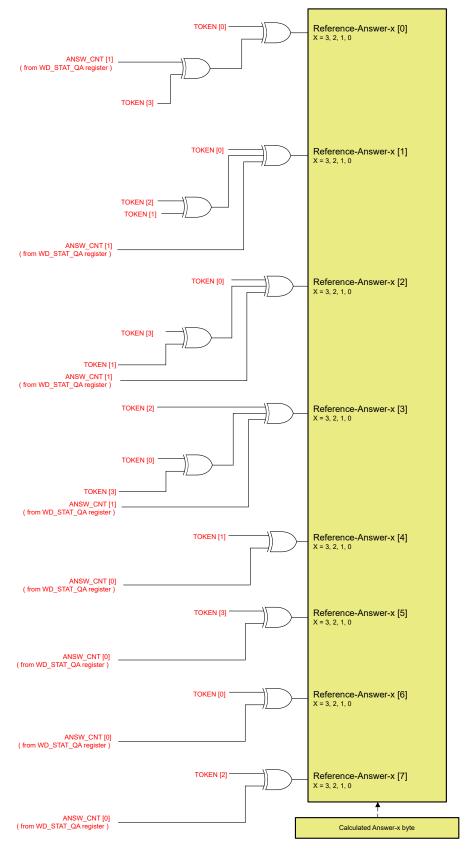


Figure 7-10. Watchdog Answer Calculation for FDBK[1:0] = 00b

During one "event," the TPS389C03-Q1 generates three questions within the CLOSE window and one question within the OPEN window. The MCU must correctly read and answer all three questions within the specified CLOSE window and the question within the specified OPEN window for a "good event" to occur. At the start of an event, ANSW_CNT[1:0] = 11b. A correctly answered question decrements ANSW_CNT[1:0] to generate the next question. Once a good event occurs, ANSW_CNT[1:0] is reset to ANSW_CNT[1:0] = 11b, and the value of TOKEN[3:0] changes to generate a new set of questions for the next event.

An incorrectly answered question increments the violation count, resets the ANSW_CNT[1:0] to ANSW_CNT[1:0] = 11b, and restarts the CLOSE window. The maxmimum violation count, MAX_VIOLATION_COUNT[2:0], is programmed using the WDT_CFG register in BANK1. When the violation count reaches the maximum value, the TPS389C03-Q1 WDO (latched) low, and asserts NIRQ and NRST low depending on the fault mapping. Note if NIRQ is un-mapped from watchdog fault reporting while NIRQ is asserted then NIRQ deasserts, NIRQ reasserts when re-mapped assuming the fault has not been cleared. A good event decrements the violation count if the violation count is not already equal to zero. When the watchdog enters the Idle state, the violation count is reset. When the the watchdog enters the suspend state, the violation count remains unchanged. The watchdog state diagram is illustrated in Figure 7-22.

Within an event, the CLOSE window time is a fixed value, and does not change if all three questions are answered faster than the set time. For example, if the CLOSE window time is set to 10ms, and the three questions are correctly answered in 5ms, then the TPS389C03-Q1 waits the remaining 5ms before transitioning to the OPEN window. During the OPEN window, if the question is answered faster than the selected OPEN window time, then the TPS389C03-Q1 automatically transitions on to the next event's CLOSE window. An incorrectly answered question within either the CLOSE or OPEN windows results in the TPS389C03-Q1 restarting the CLOSE window.

7.3.9.1 Question and Token Generation

A question is presented to the MCU as a combination of the TOKEN[3:0] and the ANSW_CNT[1:0] status bits found in the WD_STAT_WA register. ANSW_CNT[1:0] has a default value of ANSW_CNT[1:0] = 11b and is decremented when a question is answered correctly. The value of ANSW_CNT[1:0] is reset to ANSW_CNT[1:0] = 11b when a question is answered incorrectly or a good event is completed.

The watchdog uses the Token Counter (TOKEN_CNT[3:0] bits Figure 7-12) and a Linear Feedback Shift Register (LFSR) to generate the 4-bit TOKEN[3:0]. The LFSR architecture can be configured using POLY[1:0] in the WDT_QA_CFG register in BANK1 as shown in Figure 7-12. In a typical application,not necessary to change the value of POLY[1:0] from the default 00b. However, POLY[1:0] can be configured if a different LFSR architecture is required. The diagram illustrated in Figure 7-11 represents how questions are generated by the watchdog.

During the watchdog startup state, the LFSR is set with the initial value SEED[3:0], which is located in the WDT QA CFG register in BANK1. SEED[3:0] has a default value of 0000b.



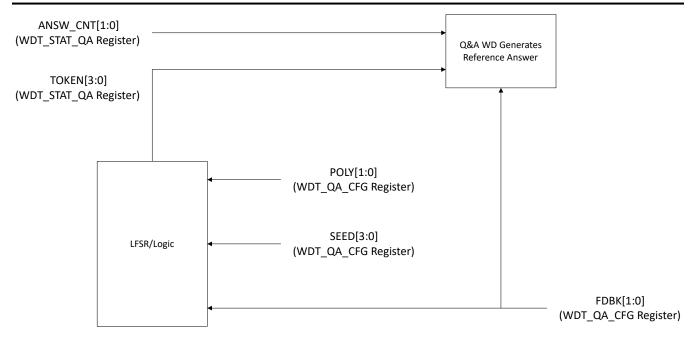
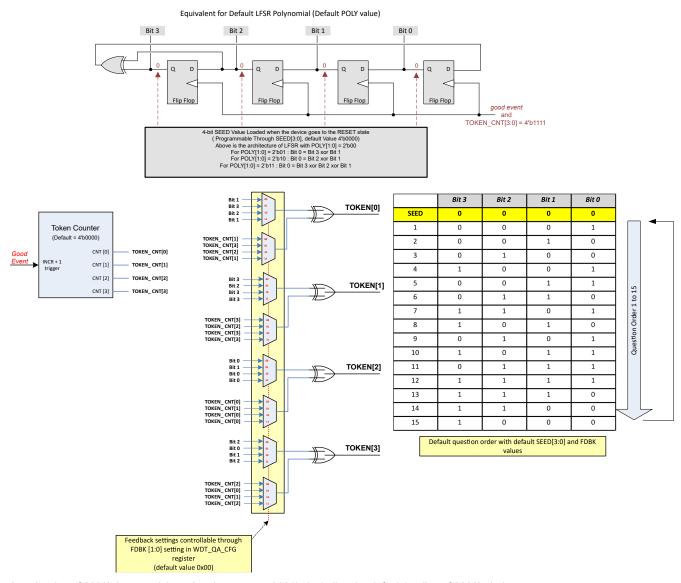


Figure 7-11. Watchdog Question Generation

At the end of a good event, the Token Counter is incremented, and the value of TOKEN[3:0] changes as a result of the mux and logic combinations shown in Figure 7-12.



A. A value of 0000b is a special seed and equates to 0001b, including the default loading of 0000b during power up.

Figure 7-12. Watchdog Question and Token Generation

Once the Token Counter has reached the maximum value of 1111b, the counter resets and provide a clock pulse to the LFSR. The clock pulse left shifts the value stored in the LFSR, which changes the value of the TOKEN[3:0]. During the special case of SEED[3:0] = 0000b, Bit 0 of the LFSR is incremented the first time the Token Counter resets. Subsequent Token Counter resets provides the typical clock pulse that left-shifts the LFSR. While left shifting, the value of seed cycles through values 1 to 15 as listed in Figure 7-12.

The mux devices that generate TOKEN[3:0] are configured using FDBK[1:0] (WDT_QA_CFG register in BANK1). Not necessary to change the value of FDBK[1:0] from the default value of 00b, and important to note that changing FDBK[1:0] also changes the logic equations required to calculate the reference answer. The different reference answer logic equations are listed below:

For FDBK[1:0] = 00b:

- Reference-Answer[0] = TOKEN[0] XOR (TOKEN[3] XOR ANSW CNT[1])
- Reference-Answer[1] = TOKEN[0] XOR (TOKEN[1] XOR TOKEN[2]) XOR ANSW CNT[1]
- Reference-Answer[2] = TOKEN[0] XOR (TOKEN[3] XOR TOKEN[1]) XOR ANSW_CNT[1]
- Reference-Answer[3] = TOKEN[2] XOR (TOKEN[0] XOR TOKEN[3]) XOR ANSW CNT[1]

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- Reference-Answer[4] = TOKEN[1] XOR ANSW_CNT[0]
- Reference-Answer[5] = TOKEN[3] XOR ANSW CNT[0]
- Reference-Answer[6] = TOKEN[0] XOR ANSW CNT[0]
- Reference-Answer[7] = TOKEN[2] XOR ANSW_CNT[0]

For FDBK[1:0] = 01b:

- Reference-Answer[0] = TOKEN[1] XOR (TOKEN[2] XOR ANSW CNT[1])
- Reference-Answer[1] = TOKEN[1] XOR (TOKEN[1] XOR TOKEN[1]) XOR ANSW CNT[1]
- Reference-Answer[2] = TOKEN[3] XOR (TOKEN[2] XOR TOKEN[1]) XOR ANSW CNT[1]
- Reference-Answer[3] = TOKEN[1] XOR (TOKEN[3] XOR TOKEN[3]) XOR ANSW_CNT[1]
- Reference-Answer[4] = TOKEN[0] XOR ANSW CNT[0]
- Reference-Answer[5] = TOKEN[2] XOR ANSW CNT[0]
- Reference-Answer[6] = TOKEN[3] XOR ANSW_CNT[0]
- Reference-Answer[7] = TOKEN[1] XOR ANSW_CNT[0]

For FDBK[1:0] = 10b :

- Reference-Answer[0] = TOKEN[2] XOR (TOKEN[1] XOR ANSW_CNT[1])
- Reference-Answer[1] = TOKEN[2] XOR (TOKEN[0] XOR TOKEN[1]) XOR ANSW_CNT[1]
- Reference-Answer[2] = TOKEN[1] XOR (TOKEN[1] XOR TOKEN[1]) XOR ANSW_CNT[1]
- Reference-Answer[3] = TOKEN[0] XOR (TOKEN[2] XOR TOKEN[3]) XOR ANSW CNT[1]
- Reference-Answer[4] = TOKEN[2] XOR ANSW_CNT[0]
- Reference-Answer[5] = TOKEN[1] XOR ANSW CNT[0]
- Reference-Answer[6] = TOKEN[2] XOR ANSW_CNT[0]
- Reference-Answer[7] = TOKEN[0] XOR ANSW CNT[0]

For FDBK[1:0] = 11b

- Reference-Answer[0] = TOKEN[3] XOR (TOKEN[0] XOR ANSW_CNT[1])
- Reference-Answer[1] = TOKEN[3] XOR (TOKEN[3] XOR TOKEN[1]) XOR ANSW_CNT[1]
- Reference-Answer[2] = TOKEN[1] XOR (TOKEN[0] XOR TOKEN[1]) XOR ANSW CNT[1]
- Reference-Answer[3] = TOKEN[3] XOR (TOKEN[1] XOR TOKEN[3]) XOR ANSW_CNT[1]
- Reference-Answer[4] = TOKEN[3] XOR ANSW CNT[0]
- Reference-Answer[5] = TOKEN[0] XOR ANSW_CNT[0]
- Reference-Answer[6] = TOKEN[1] XOR ANSW CNT[0]
- Reference-Answer[7] = TOKEN[3] XOR ANSW_CNT[0]

Example code for answer calcultion when FDBK[1:0] = 00b is included in Figure 7-13.

Expression

```
[Locals Answer[7] = Locals WDT_status_Bin[2] ^ Locals WDT_status_Bin[4],
Locals Answer[6] = Locals WDT_status_Bin[0] ^ Locals WDT_status_Bin[4],
Locals Answer[5] = Locals WDT_status_Bin[3] ^ Locals WDT_status_Bin[4],
Locals Answer[4] = Locals WDT_status_Bin[1] ^ Locals WDT_status_Bin[4],
Locals Answer[4] = Locals WDT_status_Bin[1] ^ Locals WDT_status_Bin[0] ^ Locals WDT
```

Figure 7-13. Watchdog Answer Calculation Code for FDBK[1:0] = 00b

7.3.9.2 Q&A Watchdog Open and Close Window Delay

TPS389C03-Q1 offers a Open and Close window delay accuracy of ±5%, window delay can be adjusted through register 0xAC and 0xAB respectively. During a reset event, the Open and Close window delays do not change

from the programmed value (default OTP or user changes). Table 7-5 lists delay time and associated register value.

Table 7-5. Open and Close Window Delay

Reg Value	Time	Notes
0-31	1-32ms 1ms steps	
32-63	34-96 ms	2ms steps
64-255	100-864 ms	4ms steps

The startup delay is calculated using the WDT_Startup_DLY_MULTIPLIER[2:0] (register 0xAA), Close window delay, and the Open window delay. Please note that changing either the Close window delay or the Open window delay changes the resulting startup delay. Use Equation 3 to calculate total startup delay.

$$t_{Startup} = (WDT_Startup_DLY_MULTIPLIER+1)*(WDT_OPEN+WDT_CLOSE)$$
(3)

7.3.9.3 Q&A Watchdog Status Register

Read status register 0x37 to determine watchdog state of operation. Table 7-6 provides the operating state with associated value. Bits ST_WDUV and ST_WDEXP of register 0x37 are cleared when read.

Table 7-6. Q&A Watchdog Operating State

OPERATING STATE	STATE DESCRIPTION	VALUE
IDLE	WD is wating for a fault to be cleared or WDE is low. The violation count is reset.	0x00
OPEN	WD open window.	0x01
CLOSE	WD close window.	0x02
START UP	WD startup window.	0x03
SUSPEND	WDE is high and another fault has asserted output pins unrelated to the WD, or I ² C MR bit is set to 1. Violation count remains unchanged.	0x04



7.3.9.4 Q&A Watchdog Timing

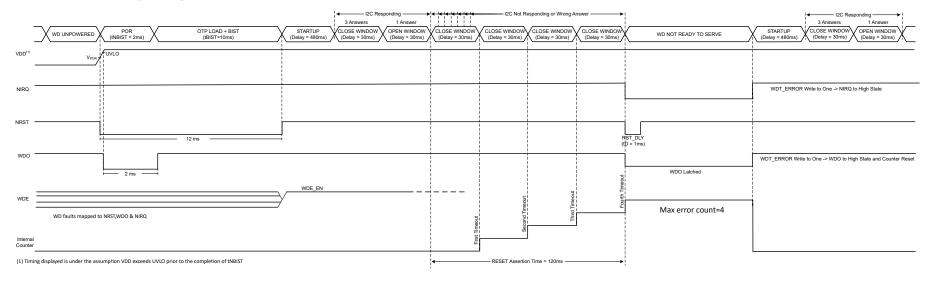


Figure 7-14. TPS389C03 CLOSE Window Error WDO Latched

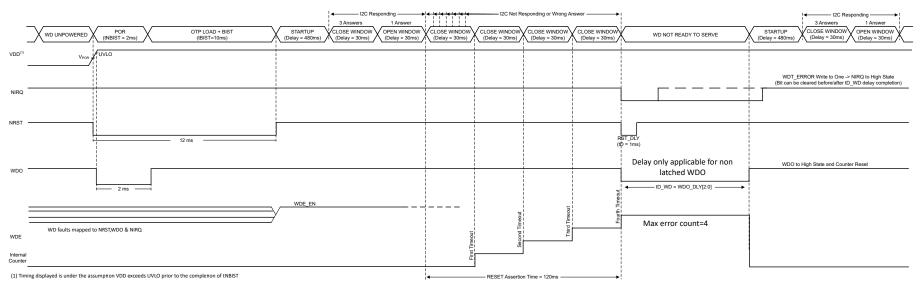


Figure 7-15. TPS389C03 CLOSE Window Error WDO Delay

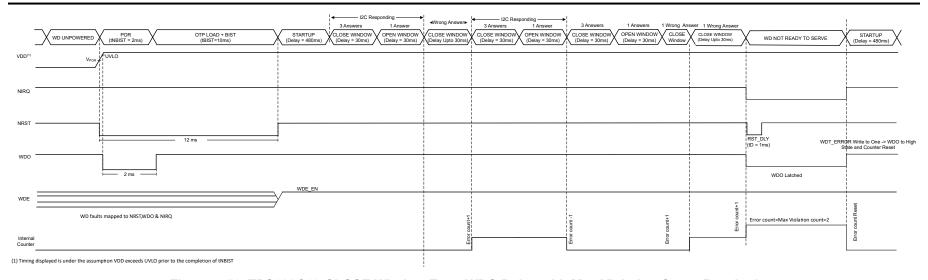


Figure 7-16. TPS389C03 CLOSE Window Error WDO Delay with Max Violation Count Reached

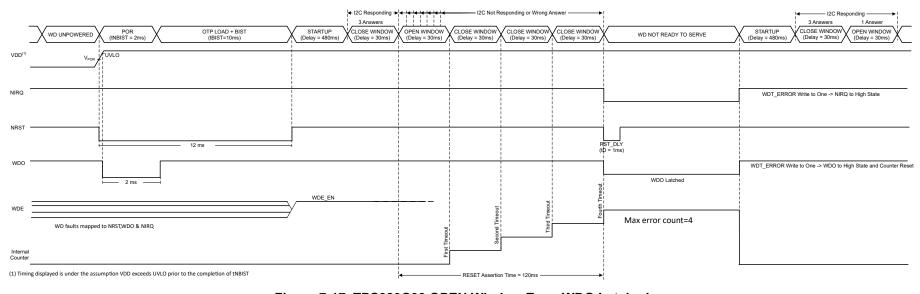


Figure 7-17. TPS389C03 OPEN Window Error WDO Latched



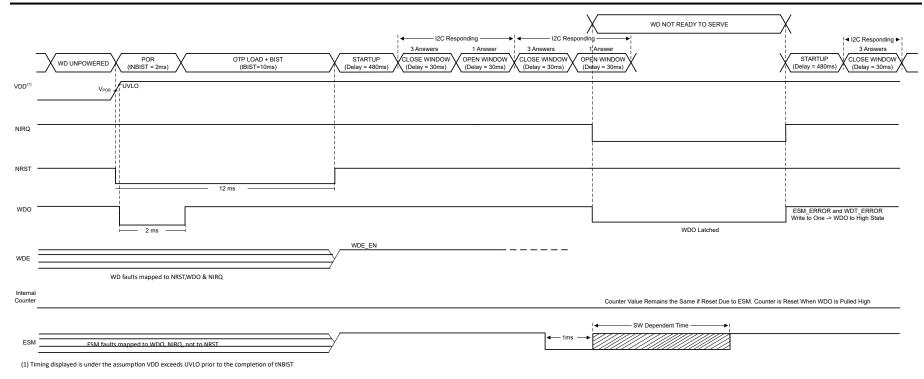


Figure 7-18. TPS389C03 ESM Error with No WD Faults

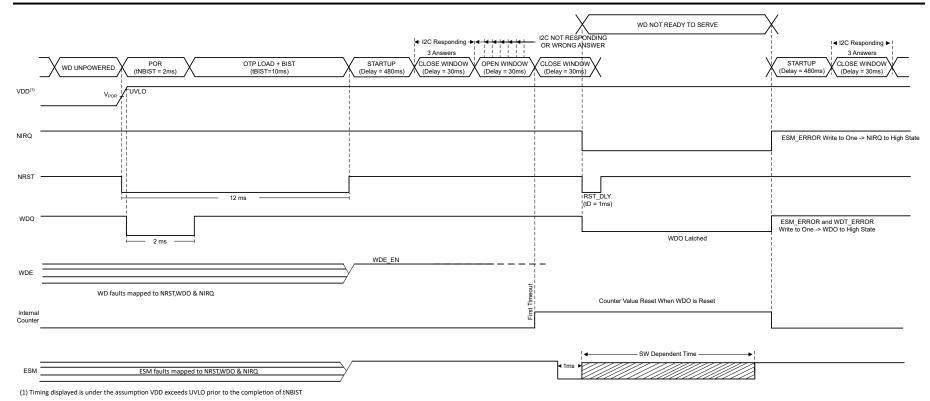


Figure 7-19. TPS389C03 ESM Error After WD Time-out

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7.3.9.5 Q&A Watchdog State Machine and Test Program

The flowchart shown in Figure 7-20 and Figure 7-21 describes the operation of the Q&A watchdog with an MCU. The associated state machine diagram drawn in Figure 7-22 is referenced to Table 7-6 and describes the transition between states for the Q&A watchdog.

The single test program in Figure 7-23 to Figure 7-25 demonstrates how the watchdog can be tested.



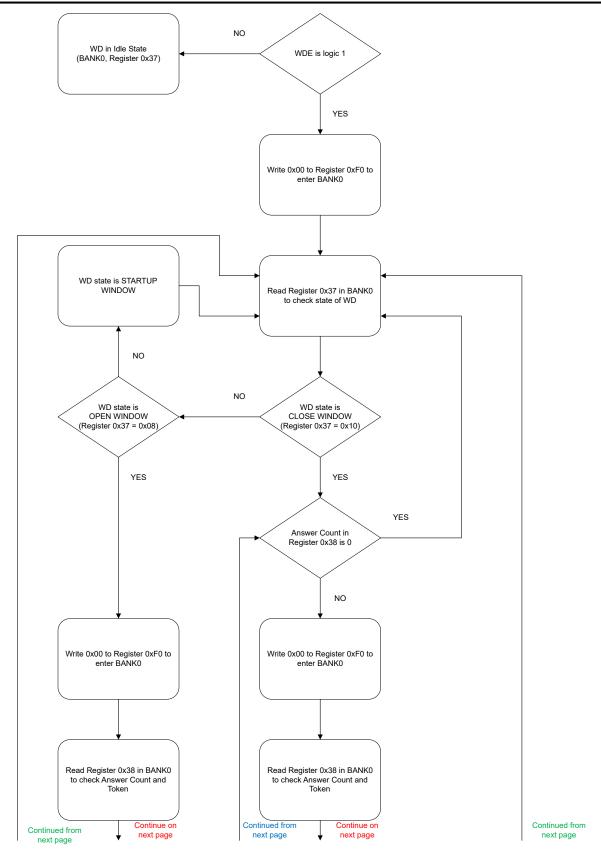


Figure 7-20. Q&A Watchdog Operation Flowchart Page 1



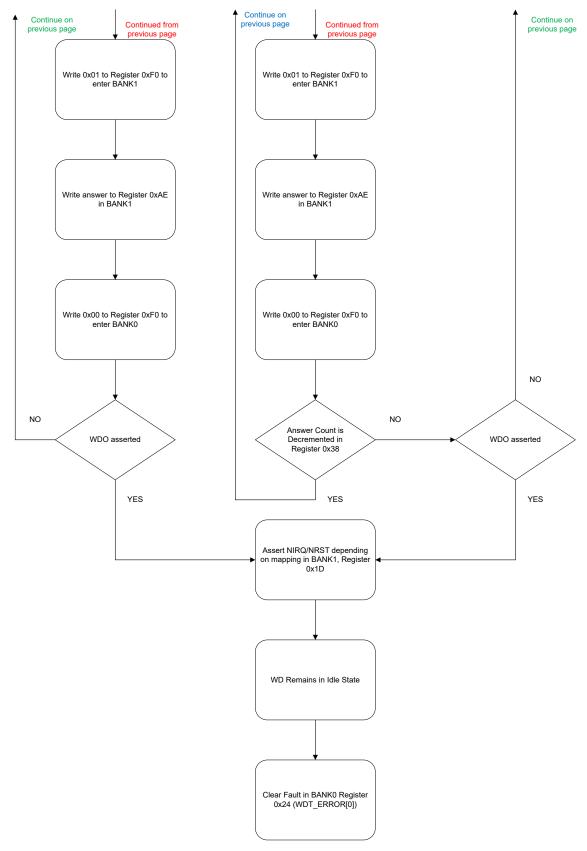


Figure 7-21. Q&A Watchdog Operation Flowchart Page 2

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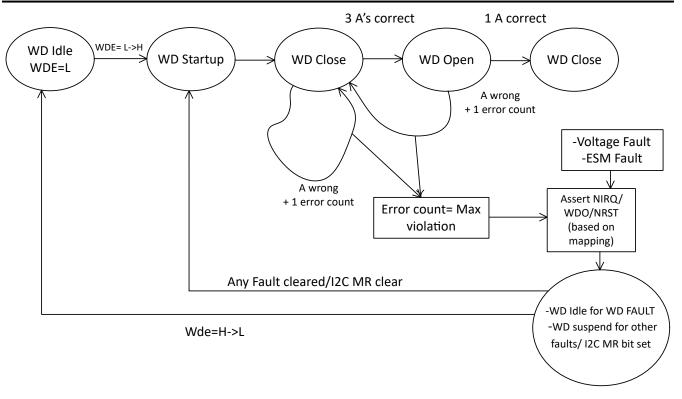


Figure 7-22. Q&A Watchdog State Diagram

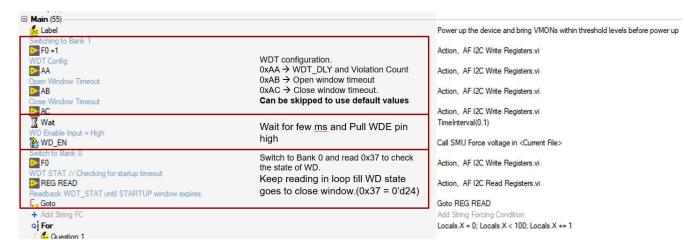


Figure 7-23. Q&A Watchdog Test Program Page 1



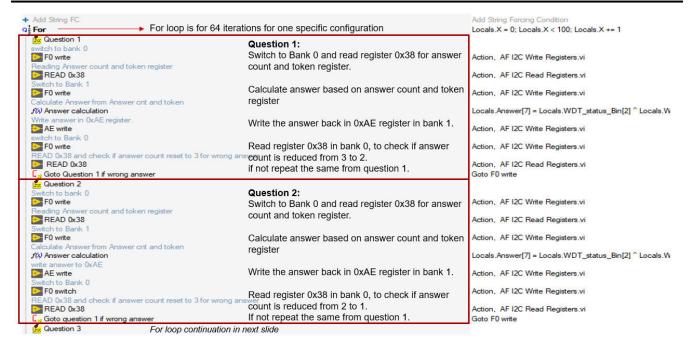


Figure 7-24. Q&A Watchdog Test Program Page 2

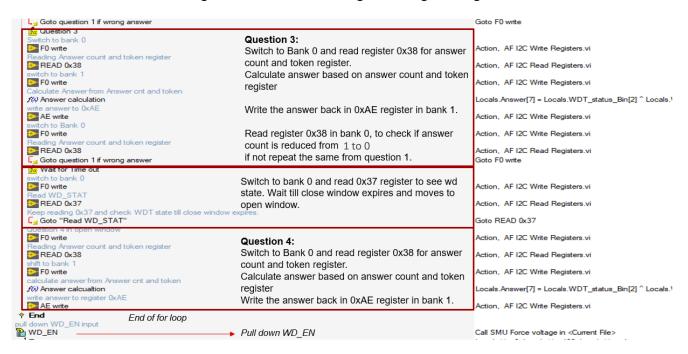


Figure 7-25. Q&A Watchdog Test Program Page 3

7.3.10 Error Signal Monitoring (ESM)

The Error Signal Monitoring (ESM) pin is used to monitor the error output of the SOC or microcontroller. The internal types of errors that need to happen to assert the ESM pin low can be configured in the microcontroller. Once the ESM pin is asserted low, the actions or results of the microcontroller cannot be relied on. The ESM pin has a programmable threshold delay (Bank 1 0x09E Threshold) to prevent unintended false trips. The ESM pin also has a configurable debounce (Bank 1 0x09F ESM DEB). When the ESM pin of TPS389C03-Q1 is asserted low an ESM ERROR is flagged by a bit located in the INT VENDOR register. The ESM pin is pulled low by default through an internal 100k pull-down resistance, thus an ESM ERROR is flagged by default if no

external source is applied to the ESM pin. Note the pull down resistor is only active when VDD has been applied, otherwise the pin is left floating.

Table 7-7. ESM Threshold Delay Time

REG VALUE	TIME	NOTES	
0-31	1-32ms	1ms steps	
32-63	34-96 ms	2ms steps	
64-255	100-864 ms	4ms steps	

The configurations listed in Table 7-8 to Table 7-14 demonstrate how TPS389C03-Q1 responds when mapped to different fault outputs such as NRST, NIRQ and WDO. Faults mapped to NIRQ are always latched behavior. Note if NIRQ is un-mapped from ESM while NIRQ is asserted (latched) then NIRQ de-asserts, NIRQ re-asserts when re-mapped assuming the ESM_ERROR bit is not cleared. Faults mapped to WDO can be latched or have an associated WDO delay based on the OTP setting. If the ESM function is being used as a reset method, mapping ESM to WDO is recommended to avoid NRST toggling. If WDE is pulled low in operation, having ESM fault mapped only to NIRQ is recommended.

When ESM is mapped to WDO, an ESM fault, with the resulting WDO assertion, is not flagged in the WDT_ERROR bit. However, write 1 to the WDT_ERROR bit and the ESM_ERROR bit found in the INT_VENDOR (Table 8-11) register to clear all of the latched outputs is recommended. The WDO output can also be de-asserted by toggling the WDE pin. Note if ESM is un-mapped from WDO while WDO is asserted (latched), WDO stays asserted until write 1 to the WDT_ERROR bit and the ESM_ERROR bit.

Table 7-8. ESM Mapped to WDO, NIRQ, and NRST

	WDE	WDO	NIRQ	NRST
	High	After ESM delay, WDO asserted and ESM fault set. I2C write to clear and deassert.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state not checked until WDO is deasserted.
ESM fault	Low	ESM fault not asserted WDO.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state checked after ESM delay. If ESM stays low, NRST toggles.

Table 7-9. ESM Mapped to NIRQ and NRST

	WDE	WDO	NIRQ	NRST
ESM fault	High	Not asserted.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state checked after ESM delay. If ESM stays low, NRST toggles.
Low fault	Low	Not asserted.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state checked after ESM delay. If ESM stays low, NRST toggles.

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Table 7-10. ESM Mapped to WDO and NIRQ

	WDE	WDO	NIRQ	NRST
	WDE	WDO	NIKQ	NKSI
ESM fault	High	After ESM delay, WDO asserted and ESM fault set. I2C write to clear and deassert.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	Not asserted.
	Low	Not asserted.	After ESM delay,NIRQ asserted and ESM fault set. I2C write to clear and deassert.	Not asserted.

Table 7-11. ESM Mapped to WDO and NRST

	WDE	WDO	NIRQ	NRST
	High	After ESM delay, WDO asserted and ESM fault set. I2C write to clear and deassert.	Not asserted.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state not checked until WDO is deasserted.
ESM fault	Low	Not asserted.	Not asserted.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state checked after ESM delay. If ESM stays low NRST toggles.

Table 7-12. ESM Mapped to NRST

	WDE	WDO	NIRQ	NRST
ESM fault	High	Not asserted.	Not asserted. Not asserted.	
Low raun	Low	Not asserted.	Not asserted.	After ESM delay, NRST asserted and deasserted after reset delay. ESM pin state checked after ESM delay. If ESM stays low NRST toggles.

Table 7-13. ESM Mapped to NIRQ

		• • • • • • • • • • • • • • • • • • • •		
	WDE	WDO	NIRQ	NRST
ESM fault	High	Not asserted.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	Not asserted.
	Low	Not asserted.	After ESM delay, NIRQ asserted and ESM fault set. I2C write to clear and deassert.	Not asserted.

Table 7-14. ESM Mapped to WDO

	WDE	WDO	NIRQ	NRST
ESM fault	High	After ESM delay, WDO asserted and ESM fault set. I2C write to clear and deassert.	Not asserted.	Not asserted.
	Low	ESM fault not asserted WDO.	Not asserted.	Not asserted.

7.3.10.1 ESM Timing

The timing diagrams starting from Figure 7-26 to Figure 7-29 show the behavior for a latched WDO fault pin. Faults mapped to NRST have an associated reset delay based on (Bank 1_0x9F_RST_DLY). For each diagram, the assumed system configuration is that once the microcontroller is reset, the microcontroller restarts with ESM fault cleared or ESM pin high.

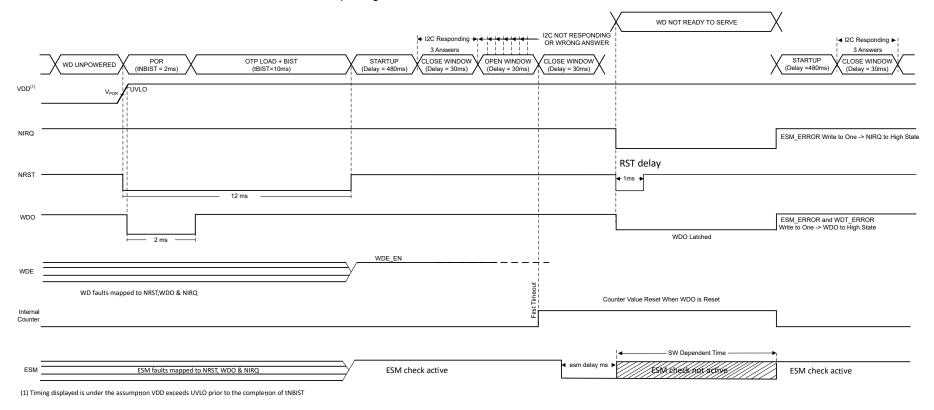


Figure 7-26. WD Error Followed by ESM Fault (WD Enabled)

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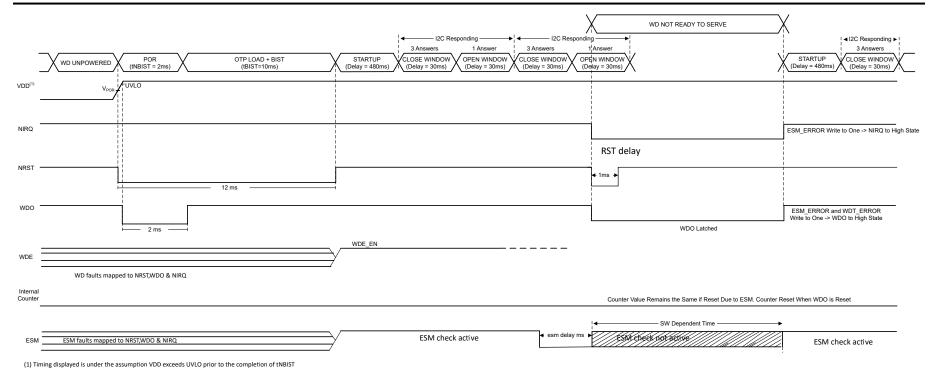
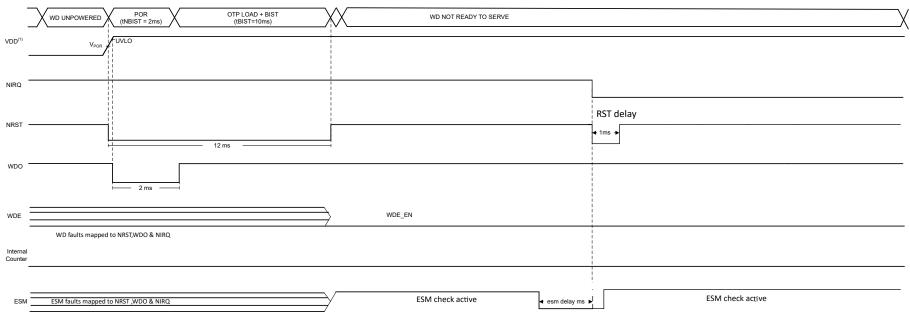


Figure 7-27. ESM Fault (WD Enabled)

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(1) Timing displayed is under the assumption VDD exceeds UVLO prior to the completion of tNBIST

Figure 7-28. Transient ESM Fault (WD Disabled)



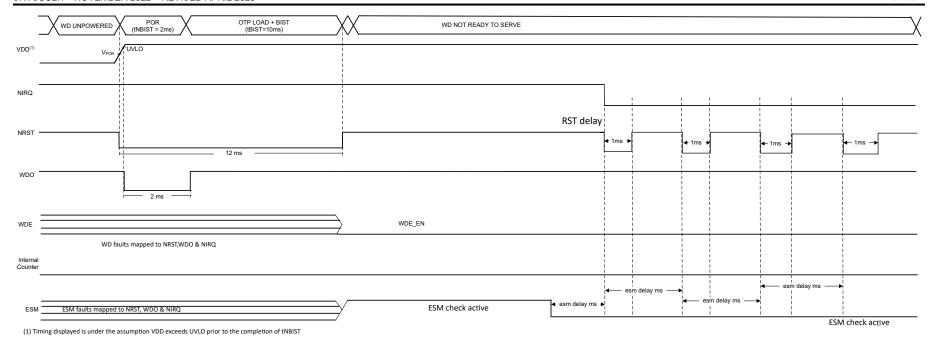


Figure 7-29. Permanent ESM Fault (WD Disabled)

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7.3.11 Register Protection

TPS389C03-Q1 features register protection enabled through registers PROT1 0xF1h and PROT2 0xF2h. Registers PROT1 and PROT2 composition is shown in table Table 7-15

Table 7-15. PROT1 Register Description

Register	Bit	7	6	5	4	3	2	1	0
PROT1 (0xF1)	R/W	RSVD	RSVD	WRKC	RSVD	CFG	IEN	MON	SEQ
PROT2 (0xF2)	R/W	RSVD	RSVD	WRKC	RSVD	CFG	IEN	MON	SEQ

To write-protect a register group, the host must set the relevant bit in both registers PROT1 and PROT2. Register groups are split up into categories as shown in Table 7-16. Register groups are only applicable to registers in Bank One. Registers concerning ESM and Watchdog are not protected by any register group as seen in Table 7-16.

Table 7-16. Write-Protect Register Group Summary

Register name	PROT group	Register name	PROT group
VMON_CTL	WRKC	ESM	N/A
VMON_MISC	CFG	TI_CONTROL	N/A
TEST_CFG	CFG	AMSK_ON	IEN
IEN_UVHP	IEN	AMSK_OFF	IEN
IEN_UVLP	IEN	SEQ_TOUT_MSB	SEQ
IEN_OVHP	IEN	SEQ_TOUT_LSB	SEQ
IEN_OVLP	IEN	SEQ_UP_THLD	SEQ
IEN_CONTROL	IEN	SEQ_DN_THLD	SEQ
IEN_TEST	IEN	WDT_CFG	N/A
IEN_VENDOR	IEN	WDT_CLOSE	N/A
VIN_CH_EN	CFG	WDT_OPEN	N/A
VRANGE_MULT	CFG	WDT_QA_CFG	N/A
MON2 settings	MON[2]	WDT_ANSWER	N/A
MON3 settings	MON[3]	BANK_SEL	N/A
MON4 settings	MON[4]		

If individual monitor protection is desired this can be achieved through the use of register PROT_MON (0xF3) as seen in figure Table 7-17.

Table 7-17. PROT MON Register Description

Register	Bit	7	6	5	4	3	2	1	0
PROT_MON (0xF3)	R/W	RSVD	RSVD	RSVD	RSVD	MON[4]	MON[3]	MON[2]	RSVD

Register PROT_MON selects the monitor channel which is protected once PROT1 AND PROT2 registers are written to protect the MON group. Register PROT_MON is set to a value of 0xFF by default, which applies protection to all monitors when MON protection is set through registers PROT1 and PROT2. If a user wishes to not apply protection to a specific monitor channel then the user must set the bit corresponding to the monitor channel in question to a value of 0 prior to PROT1 and PROT2 being set.

At start up registers PROT1 and PROT2 are set to a defult value of 0x00. Once a bit is set to 1 in PROT1 or PROT2 the bit becomes read-only and cannot be cleared by a write command. To reset PROT1 and PROT2 the user can utilize RESET_PROT, bit 3 of the VMON_CTL register. RESET_PROT is part of the WRKC register set therefore if the user desires to use RESET_PROT's functionality WRKC protection must not be included when



configuring PROT1 and PROT2 protection registers. If WRKC protection is enabled when configuring PROT1 and PROT2 then protection registers can only be reset through a device power cycle.

7.4 Device Functional Modes

The TPS389C03-Q1 has three key functional modes that the device enters over the course of operation. When no power is applied to the device, the device is in the OFF state where the monitoring channels and the watchdog is inactive. Once VDD is greater than UVLO, the device enters the ACTIVE state after the BIST and OTP loading have finished. During the ACTIVE state, the device is capable of full monitoring and the watchdog is active. If a BIST failure, double-error detect (DED) during the OTP loading, thermal shutdown, or an address pin fault occurs, the device enters the FAILSAFE mode. Once in FAILSAFE, NRST and NIRQ are asserted low. To leave the FAILSAFE state, power to the TPS389C03-Q1 must be cycled. Reading register 0x30 in BANK0 provides information on the state of the device. See Table 8-12 for details. The state diagram drawn in Figure 7-30 follows the progression through each state.

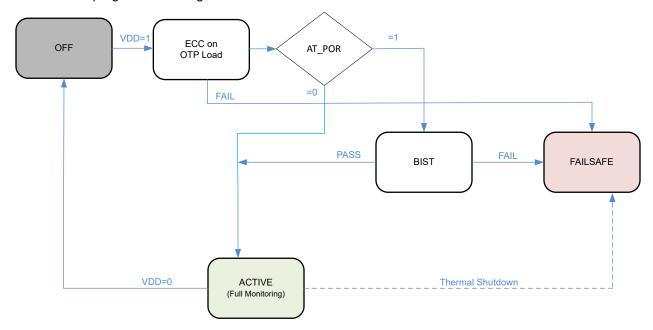


Figure 7-30. TPS389C03-Q1 State Diagram

7.4.1 Built-In Self Test and Configuration Load

Built-In Self Test (BIST) is performed at Power On Reset (POR), if TEST_CFG.AT_POR=1.

Configuration load from OTP is assisted by ECC (supporting SEC-DED). This is to protect against data integrity issues and to maximize system availability.

During BIST, NIRQ is de-asserted (asserted in case of failure), input pins are ignored, and the I²C block is inactive with SDA and SCL de-asserted. The BIST includes device testing to meet the Technical Safety Requirements. Once BIST is completed without failure, I²C is immediately active and the device enters the ACTIVE state after loading the configuration data from OTP. If BIST fails and/or ECC reports Double-Error Detection (DED), NIRQ is asserted low, NRST is asserted low, the device enters FAILSAFE state. The TEST INFO register found in Table 8-13 provides information on the test coverage and results. Additionally, Watchdog and ESM are covered in Logic BIST as well and verified in BIST L.

The detailed behavior upon success/failure of the BIST is controlled by INT TEST and IEN TEST registers. Reporting of the BIST results is carried out through:

- NIRQ pin: pulled low depending on the test result and BIST C and BIST bits in IEN TEST
- I_BIST_C and BIST bits in INT_TEST register depending on IEN_TEST settings
- VMON_STAT.ST_BIST_C register bit

TEST_INFO[3:0] register bits

7.4.1.1 Notes on BIST Execution

Upon POR the TPS389C03-Q1 needs to make a decision whether to run BIST or not, based on the value of the TEST_CFG.AT_POR register bit. Assuming that ECC on this register is performed after BIST has checked the ECC logic, data intregrity is not verified before running BIST.

BIST can be triggered manually during normal operation by writing 1 to the ENTER_BIST bit found in BANK1 Register 0x9F. Using BIST when faults are asserted by the TPS389C03-Q1 is not recommended.

7.4.2 TPS389C03-Q1 Power ON

When the TPS389C03-Q1 is powered ON, BIST is optionally executed (depending on TEST_CFG.AT_POR register bit); I²C and fault reporting (through NIRQ) become active as soon as BIST is complete and configuration is loaded from OTP (assisted by ECC, supporting SEC-DED).

The details of the configuration load ECC and BIST results are reported are reported in TEST_INFO register.

Upon detection of the VDD rising edge past UVLO, the TPS389C03-Q1 starts the sequence timeout timer. The UV faults are masked until the sequence timeout has expired.

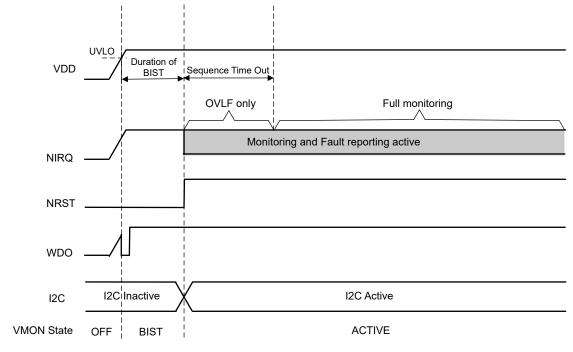


Figure 7-31. TPS389C03-Q1 Power ON Signaling and Internal States

BIST completion can be detected through interrupt or register polling:

- Interrupt: INT_TEST.I_BIST_C flag is set and NIRQ is asserted if IEN_TEST.BIST_C=1
- Polling: VMON_STAT register can be polled to read the ST_BIST_C bit



8 Register Maps

8.1 Registers Overview

The register map is designed to support up to 3 channels through register banks, with the following organization:

- Bank 0 Status Register Set Summary
 - Vendor info and usage registers (bank independent)
 - Interrupt registers
 - Status registers
 - Bank selection register (bank independent)
 - Protection registers (bank independent)
 - Device configuration registers (bank independent)
- Bank 1 Configuration Register Set Summary
 - Vendor info and usage registers (bank independent)
 - Control registers (device global registers)
 - Monitor configuration registers (channel specific registers)
 - Sequence configuration registers (both device global and channel specific registers)
 - Bank selection register (bank independent)
 - Protection registers (bank independent)
 - Device configuration registers (bank independent)

Bank independent registers are accessible at the same address irrespective of the current bank selection. Access to other registers requires the proper bank being selected.

All registers are 8-bit wide, and are loaded at boot with the default value described here or with the OTP value programmed at the factory. Unused registers addresses are reserved for future use and support up to 3 channels.

Write accesses to protected registers (see PROT1/2 details), invalid registers, or valid registers with invalid data is NACK'd.

If the default value found in the register map is listed as "X", then the value can be found in TPS389C0300CRTERQ1 OTP Configuration.

8.1.1 BANK0 Registers

Table 8-1 lists the memory-mapped registers for the BANK0 registers. All register offset addresses not listed in Table 8-1 should be considered as reserved locations and the register contents should not be modified.

Table 8-1. BANK0 Registers

Offset	Acronym	Register Name	Section
10h	INT_SRC	Global Interrupt Source Status register.	Section 8.1.1.1
11h	INT_MONITOR	Voltage Monitor Interrupt Status register.	Section 8.1.1.2
12h	INT_UVHF	High Frequency channel Under-Voltage Interrupt Status register.	Section 8.1.1.3
14h	INT_UVLF	Low Frequency channel Under-Voltage Interrupt Status register.	Section 8.1.1.4
16h	INT_OVHF	High Frequency channel Over-Voltage Interrupt Status register	Section 8.1.1.5
18h	INT_OVLF	Low Frequency channel Over-Voltage Interrupt Status register	Section 8.1.1.6
22h	INT_CONTROL	Control and Communication Interrupt Status register.	Section 8.1.1.7
23h	INT_TEST	Internal Test and Configuration Load Interrupt Status register.	Section 8.1.1.8
24h	INT_VENDOR	Vendor Specific Internal Interrupt Status register.	Section 8.1.1.9
30h	VMON_STAT	Status flags for internal operations and other non critical conditions.	Section 8.1.1.10
31h	TEST_INFO	Internal Self-Test and ECC information.	Section 8.1.1.11
32h	OFF_STAT	Channel OFF status.	Section 8.1.1.12
37h	WDT_STAT	Watchdog Status	Section 8.1.1.13
38h	WD_STAT_QA	Watchdog Answer Count and Token	Section 8.1.1.14
41h	MON_LVL[2]	Channel 2 voltage level.	Section 8.1.1.15
42h	MON_LVL[3]	Channel 3 voltage level.	Section 8.1.1.16
43h	MON_LVL[4]	Channel 4 voltage level.	Section 8.1.1.17
F0h	BANK_SEL	Bank Select.	Section 8.1.1.18
F1h	PROT1	Locks or unlocks register changes. Must match PROT2.	Section 8.1.1.19
F2h	PROT2	Locks or unlocks register changes. Must match PROT1.	Section 8.1.1.20
F3h	PROT_MON	Locks MON registers in tandem with PROT1 and PROT2.	Section 8.1.1.21
F9h	I2CADDR	I2C Address	Section 8.1.1.22
FAh	DEV_CFG	Status of I2C interface voltage levels.	Section 8.1.1.23

Complex bit access types are encoded to fit into small table cells. Table 8-2 shows the codes that are used for access types in this section.

Table 8-2. BANKO Access Type Codes

Access Type	Code	Description				
Read Type						
R	R	Read				
Write Type	Write Type					
W	W	Write				
W1C	W 1C	Write 1 to clear				
Reset or Default Value						
-n		Value after reset or the default value				



8.1.1.1 INT_SRC Register (Offset = 10h) [Reset = 00h]

INT_SRC is shown in Table 8-3.

Return to the Summary Table.

Global Interrupt Source Status register.

Table 8-3. INT_SRC Register Field Descriptions

	Tuble 6 6. INTI_SING Register Field Bescriptions					
Bit	Field	Туре	Reset	Description		
7	F_OTHER	R	0h	Vendor internal defined faults. Details reported in INT_Vendor. Represents ORed value of all bits in INT_Vendor. 0 = No Vendor defined faults detected 1 = Vendor defined faults detected		
6-3	RESERVED	R	0h	Reserved		
2	TEST	R	0h	Internal test or configuration load fault. Details reported in INT_TEST. Represents ORed value of all bits in INT_TEST. 0 = No test/configuration fault detected 1 = Test/configuration fault detected		
1	CONTROL	R	0h	Control status or communication fault. Details reported in INT_CONTROL. Represents ORed value of all bits in INT_CONTROL. 0 = No status or communication fault detected 1 = Status or communication fault detected		
0	MONITOR	R	0h	Voltage monitor fault. Details reported in INT_MONITOR. Represents ORed value of all bits in INT_MONITOR. 0 = No voltage fault detected 1 = Voltage fault detected		



8.1.1.2 INT_MONITOR Register (Offset = 11h) [Reset = 00h]

INT_MONITOR is shown in Table 8-4.

Return to the Summary Table.

Voltage Monitor Interrupt Status register.

Table 8-4. INT_MONITOR Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R	0h	Reserved
3	OVLF	R	0h	Over-Voltage Low Frequency Fault reported by ADC based measurement. Details reported in INT_OVLF. Represents ORed value of all bits in INT_OVLF. 0 = No OVLF fault detected 1 = OVLF fault detected
2	OVHF	R	0h	Over-Voltage High Frequency Fault reported by comparator based monitoring. Details reported in INT_OVHF. Represents ORed value of all bits in INT_OVHF. 0 = No OVHF fault detected 1 = OVHF fault detected
1	UVLF	R	0h	Under-Voltage Low Frequency Fault reported by ADC based measurement. Details reported in INT_UVLF. Represents ORed value of all bits in INT_UVLF. 0 = No UVLF fault detected 1 = UVLF fault detected
0	UVHF	R	0h	Under-Voltage High Frequency Fault reported by comparator based monitoring. Details reported in INT_UVHF. Represents ORed value of all bits in INT_UVHF. 0 = No UVHF fault detected 1 = UVHF fault detected



8.1.1.3 INT_UVHF Register (Offset = 12h) [Reset = 00h]

INT_UVHF is shown in Table 8-5.

Return to the Summary Table.

High Frequency channel Under-Voltage Interrupt Status register.

Table 8-5. INT UVHF Register Field Descriptions

	Table 6-3. IN 1_0 VHF Register Field Descriptions					
Bit	Field	Туре	Reset	Description		
7-4	RESERVED	R/W1C	0h	Reserved		
3	F_UVHF[4]	R/W1C	0h	Under-Voltage High Frequency Fault for MON4. Trips if MON4 High Frequency signal goes below UVHF[4]. 0 = MON4 has no UVHF fault detected (or interrupt disabled in IEN_UVHF register) 1 = MON4 has UVHF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the UVHF fault condition is also removed (MON4 High Frequency signal is above UVHF[4]).		
2	F_UVHF[3]	R/W1C	0h	Under-Voltage High Frequency Fault for MON3. Trips if MON3 High Frequency signal goes below UVHF[3]. 0 = MON3 has no UVHF fault detected (or interrupt disabled in IEN_UVHF register) 1 = MON3 has UVHF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the UVHF fault condition is also removed (MON3 High Frequency signal is above UVHF[3]).		
1	F_UVHF[2]	R/W1C	0h	Under-Voltage High Frequency Fault for MON2. Trips if MON2 High Frequency signal goes below UVHF[2]. 0 = MON2 has no UVHF fault detected (or interrupt disabled in IEN_UVHF register) 1 = MON2 has UVHF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the UVHF fault condition is also removed (MON2 High Frequency signal is above UVHF[2]).		
0	RESERVED	R/W1C	0h	Reserved		



8.1.1.4 INT_UVLF Register (Offset = 14h) [Reset = 00h]

INT_UVLF is shown in Table 8-6.

Return to the Summary Table.

Low Frequency channel Under-Voltage Interrupt Status register.

Table 8-6. INT_UVLF Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W1C	0h	Reserved
3	F_UVLF[4]	R/W1C	0h	Under-Voltage Low Frequency Fault for MON4 . Trips if MON4 Low Frequency signal goes below UVLF[4]. 0 = MON4 has no UVLF fault detected (or interrupt disabled in IEN_UVLF register) 1 = MON4 has UVLF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the UVLF fault condition is also removed (MON4 Low Frequency signal is above UVLF[4]).
2	F_UVLF[3]	R/W1C	0h	Under-Voltage Low Frequency Fault for MON3. Trips if MON3 Low Frequency signal goes below UVLF[3]. 0 = MON3 has no UVLF fault detected (or interrupt disabled in IEN_UVLF register) 1 = MON3 has UVLF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the UVLF fault condition is also removed (MON3 Low Frequency signal is above UVLF[3]).
1	F_UVLF[2]	R/W1C	0h	Under-Voltage Low Frequency Fault for MON2. Trips if MON2 Low Frequency signal goes below UVLF[2]. 0 = MON2 has no UVLF fault detected (or interrupt disabled in IEN_UVLF register) 1 = MON2 has UVLF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the UVLF fault condition is also removed (MON2 Low Frequency signal is above UVLF[2]).
0	RESERVED	R/W1C	0h	Reserved

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8.1.1.5 INT_OVHF Register (Offset = 16h) [Reset = 00h]

INT_OVHF is shown in Table 8-7.

Return to the Summary Table.

High Frequency channel Over-Voltage Interrupt Status register

Table 8-7. INT OVHF Register Field Descriptions

	Table 8-7. IN 1_OVHF Register Field Descriptions					
Bit	Field	Туре	Reset	Description		
7-4	RESERVED	R/W1C	0h	Reserved		
3	F_OVHF[4]	R/W1C	Oh	Over-Voltage High Frequency Fault for MON4. Trips if MON4 High Frequency signal goes above OVHF[4]. 0 = MON4 has noOVHF fault detected (or interrupt disabled in IEN_OVHF register) 1 = MON4 has OVHF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the OVHF fault condition is also removed (MON4 High Frequency signal is below OVHF[4])		
2	F_OVHF[3]	R/W1C	Oh	Over-Voltage High Frequency Fault for MON3. Trips if MON3 High Frequency signal goes above OVHF[3]. 0 = MON3 has no OVHF fault detected (or interrupt disabled in IEN_OVHF register) 1 = MON3 has OVHF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the OVHF fault condition is also removed (MON3 High Frequency signal is below OVHF[3])		
1	F_OVHF[2]	R/W1C	Oh	Over-Voltage High Frequency Fault for MON2. Trips if MON2 High Frequency signal goes above OVHF[2]. 0 = MON2 has no OVHF fault detected (or interrupt disabled in IEN_OVHF register) 1 = MON2 has OVHF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the OVHF fault condition is also removed (MON2 High Frequency signal is below OVHF[2])		
0	RESERVED	R/W1C	0h	Reserved		



8.1.1.6 INT_OVLF Register (Offset = 18h) [Reset = 00h]

INT_OVLF is shown in Table 8-8.

Return to the Summary Table.

Low Frequency channel Over-Voltage Interrupt Status register

Table 8-8. INT_OVLF Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W1C	0h	Reserved
3	F_OVLF[4]	R/W1C	Oh	Over-Voltage Low Frequency Fault for MON4. Trips if MON4 Low Frequency signal goes above OVLF[4]. 0 = MON4 has no OVLF fault detected (or interrupt disabled in IEN_OVLF register) 1 = MON4 has OVLF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the OVLF fault condition is also removed (MON4 Low Frequency signal is below OVLF[4]).
2	F_OVLF[3]	R/W1C	Oh	Over-Voltage Low Frequency Fault for MON3. Trips if MON3 Low Frequency signal goes above OVLF[3]. 0 = MON3 has no OVLF fault detected (or interrupt disabled in IEN_OVLF register) 1 = MON3 has OVLF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the OVLF fault condition is also removed (MON3 Low Frequency signal is below OVLF[3]).
1	F_OVLF[2]	R/W1C	Oh	Over-Voltage Low Frequency Fault for MON2. Trips if MON2 Low Frequency signal goes above OVLF[2]. 0 = MON2 has no OVLF fault detected (or interrupt disabled in IEN_OVLF register) 1 = MON2 has OVLF fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the OVLF fault condition is also removed (MON2 Low Frequency signal is below OVLF[2]).
0	RESERVED	R/W1C	0h	Reserved

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8.1.1.7 INT_CONTROL Register (Offset = 22h) [Reset = 00h]

INT_CONTROL is shown in Table 8-9.

Return to the Summary Table.

Control and Communication Interrupt Status register.

Table 8-9. INT_CONTROL Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-5	RESERVED	R/W1C	0h	Reserved
4	F_CRC	R/W1C	Oh	Runtime register CRC Fault: 0 = No fault detected (or IEN_CONTROL.RT_CRC is disabled) 1 = Register CRC fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit. The bit will be set again during next register CRC check if the same fault is detected
3	F_NIRQ	R/W1C	Oh	Interrupt pin fault (fault bit always enabled; no enable bit available): 0 = No fault detected on NIRQ pin 1 = Low resistance path to supply detected on NIRQ pin The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the NIRQ fault condition is also removed.
2	F_TSD	R/W1C	Oh	Thermal Shutdown fault: 0 = No TSD fault detected (or IEN_CONTROL.TSD is disabled) 1 = TSD fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the TSD fault condition is also removed
1	RESERVED	R/W1C	0h	Reserved
0	F_PEC	R/W1C	Oh	Packet Error Checking fault: 0 = PEC mismatch has not occurred (or IEN_CONTROL.PEC is disabled) 1 = PEC mismatch has occurred, or VMON_MISC.REQ_PEC=1 and PEC is missing in a write transaction The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit. The bit will be set again during next I2C transaction if the same fault is detected.



8.1.1.8 INT_TEST Register (Offset = 23h) [Reset = 00h]

INT_TEST is shown in Table 8-10.

Return to the Summary Table.

Internal Test and Configuration Load Interrupt Status register.

Table 8-10. INT_TEST Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W1C	0h	Reserved
3	ECC_SEC	R/W1C	0h	ECC single-error corrected on OTP configuration load: 0 = No single-error corrected (or IEN_TEST.ECC_SEC is disabled) 1 = Single-error corrected Write-1-to-clear will clear the bit. The bit will be set again during next OTP configuration load if the same fault is detected.
2	ECC_DED	R/W1C	Oh	ECC double-error detected on OTP configuration load: 0 = No double-error detected on OTP load 1 = Double-error detected on OTP load The fault bit is always enabled (there is no associated interrupt enable bit). The device will move to failsafe mode on double error detection.
1	BIST_Complete_INT	R/W1C	0h	Indication of Built-In Self-Test complete: 0 = BIST not complete (or IEN_TEST.BIST_C is disabled) 1 = BIST complete Write-1-to-clear will clear the bit. The bit will be set again on completion of next BIST execution
0	BIST_Fail_INT	R/W1C	Oh	Built-In Self-Test fault: 0 = No BIST fault detected (or IEN_TEST.BIST is disabled) 1 = BIST fault detected Write-1-to-clear will clear the bit. The bit will be set again during next BIST execution if the fault is detected

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8.1.1.9 INT_VENDOR Register (Offset = 24h) [Reset = 00h]

INT_VENDOR is shown in Table 8-11.

Return to the Summary Table.

Vendor Specific Internal Interrupt Status register.

Table 8-11. INT_VENDOR Register Field Descriptions

D:4			_	R Register Field Descriptions
Bit	Field	Туре	Reset	Description
7	Self-Test_CRC	R/W1C	Oh	Startup register CRC self-test 0 = Self-test Pass 1 = Self-test Fail Write-1-to clear
6	LDO_OV_Error	R/W1C	0h	Internal LDO Overvoltage error. 0 = No internal LDO overvoltage fault detected 1 = Internal LDO overvoltage fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the LDO fault condition is also removed.
5	NRST_MISMATCH	R/W1C	Oh	Designates error due to drive state and read back. During an NRST toggle NRST mismatch will be active after 2µs, NRST must exceed 0.6*VDD to be considered in a logic high state. 0 = No fault detected on NRST pin 1 = Error due to drive state and read back. The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the NRST fault condition is also removed.
4	Freq_DEV_Error	R/W1C	0h	Designates internal frequency errors. 0 = No internal frequency fault detected 1 = Internal frequency fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the frequency fault condition is also removed.
3	SHORT_DET	R/W1C	Oh	Address pin short detect. 0 = No address pin short fault detected 1 = Address pin short fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the address pin short fault condition is also removed.
2	OPEN_DET	R/W1C	Oh	Address pin open detect. 0 = No address pin open fault detected 1 = Address pin open fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the address pin open fault condition is also removed.
1	ESM_ERROR	R/W1C	0h	Indication of ESM fault. 0 = No ESM fault detected 1 = ESM fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the ESM fault condition is also removed.
0	WDT_ERROR	R/W1C	0h	Indication of Watchdog fault. 0 = No Watchdog fault detected 1 = Watchdog fault detected The recovery of the fault condition does NOT clear the bit. It can only be cleared by the host with a write-1-to-clear. Write-1-to-clear will clear the bit only if the Watchdog fault condition is also removed.



8.1.1.10 VMON_STAT Register (Offset = 30h) [Reset = 7Eh]

VMON_STAT is shown in Table 8-12.

Return to the Summary Table.

Status flags for internal operations and other non critical conditions.

Table 8-12. VMON_STAT Register Field Descriptions

Bit	Field	Туре	Reset	Description
7	FAILSAFE	R	0h	1 = Device in FAILSAFE state
6	ST_BIST_C	R	1h	Built-In Self-Test state: 0 = BIST not complete 1 = BIST complete
5	ST_VDD	R	1h	Status VDD
4	ST_NIRQ	R	1h	Status NIRQ pin
3	RESERVED	R	0h	Reserved
2	ACTIVE	R	1h	1 = Device in ACTIVE state
1	RESERVED	R	0h	Reserved
0	RESERVED	R	0h	Reserved



8.1.1.11 TEST_INFO Register (Offset = 31h) [Reset = 00h]

TEST_INFO is shown in Table 8-13.

Return to the Summary Table.

Internal Self-Test and ECC information.

Table 8-13. TEST_INFO Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-6	RESERVED	R	0h	Reserved
5	ECC_SEC	R	Oh	Status of ECC single-error correction on OTP configuration load. 0 = no error correction applied 1 = single-error correction applied
4	ECC_DED	R	Oh	Status of ECC double-error detection on OTP configuration load. 0 = no double-error detected 1 = double-error detected
3	BIST_VM	R	0h	Status of Volatile Memory test output from BIST. 0 = Volatile Memory test pass 1 = Volatile Memory test fail
2	BIST_NVM	R	Oh	Status of Non-Volatile Memory test output from BIST. 0 = Non-Volatile Memory test pass 1 = Non-Volatile Memory test fail
1	BIST_L	R	Oh	Status of Logic test output from BIST. 0 = Logic test pass 1 = Logic test fail
0	BIST_A	R	0h	Status of Analog test output from BIST. 0 = Analog test pass 1 = Analog test fail



8.1.1.12 OFF_STAT Register (Offset = 32h) [Reset = 00h]

OFF_STAT is shown in Table 8-14.

Return to the Summary Table.

Channel OFF status.

Table 8-14. OFF_STAT Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R	0h	Reserved
3	MON[4]	R	0h	Represents the OFF status of each channel: 0 = channel 4 is NOT OFF 1 = channel 4 is OFF (below OFF threshold)
2	MON[3]	R	0h	Represents the OFF status of each channel: 0 = channel 3 is NOT OFF 1 = channel 3 is OFF (below OFF threshold)
1	MON[2]	R	0h	Represents the OFF status of each channel: 0 = channel 2 is NOT OFF 1 = channel 2 is OFF (below OFF threshold)
0	RESERVED	R	0h	Reserved



8.1.1.13 WDT_STAT Register (Offset = 37h) [Reset = 00h]

WDT_STAT is shown in Table 8-15.

Return to the Summary Table.

Watchdog Status

Table 8-15. WDT_STAT Register Field Descriptions

	Idi	716 0-10. VV L	egister i leid bescriptions	
Bit	Field	Туре	Reset	Description
7-6	RESERVED	R	0h	Reserved
5-3	WD_STATE	R	Oh	Represents Watchdog state. 000 = WD Idle state 001 = WD Open state 010 = WD Close state 011 = WD Startup state 100 = WD suspend state
2	ST_WDEXP	R	0h	Will flag if close window expires before writing 3 answers or if open window expires. 1 = close window or open window expired (bit clears when read)
1	RESERVED	R	0h	Reserved
0	ST_WDUV	R	0h	Will flag if an extra answer in close window (4 answers in close window) OR a wrong answer in close window OR a wrong answer in open window. 1 = extra or wrong answer (bit clears when read)



8.1.1.14 WD_STAT_QA Register (Offset = 38h) [Reset = 3Ch]

WD_STAT_QA is shown in Table 8-16.

Return to the Summary Table.

Watchdog Answer Count and Token

Table 8-16. WD_STAT_QA Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-6	RESERVED	R	0h	Reserved
5-4	ANSW_CNT[1:0]	R	3h	Represents Answer count in real time
3-0	TOKEN[3:0]	R	Ch	Represents Token in real time. Enabling the watchdog sets the Token value to 0.

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8.1.1.15 MON_LVL[2] Register (Offset = 41h) [Reset = 00h]

MON_LVL[2] is shown in Table 8-17.

Return to the Summary Table.

Channel 2 voltage level.

Table 8-17. MON_LVL[2] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	ADC[7:0]	R	0h	Represents MON2 voltage telemetry value in hex



8.1.1.16 MON_LVL[3] Register (Offset = 42h) [Reset = 00h]

MON_LVL[3] is shown in Table 8-18.

Return to the Summary Table.

Channel 3 voltage level.

Table 8-18. MON_LVL[3] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	ADC[7:0]	R	0h	Represents MON3 voltage telemetry value in hex



8.1.1.17 MON_LVL[4] Register (Offset = 43h) [Reset = 00h]

MON_LVL[4] is shown in Table 8-19.

Return to the Summary Table.

Channel 4 voltage level.

Table 8-19. MON_LVL[4] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	ADC[7:0]	R	0h	Represents MON4 voltage telemetry value in hex



8.1.1.18 BANK_SEL Register (Offset = F0h) [Reset = 00h]

BANK_SEL is shown in Table 8-20.

Return to the Summary Table.

Bank Select.

Table 8-20. BANK_SEL Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-1	RESERVED	R/W	0h	Reserved
0	BANK_Select	R/W	1 -	Represents bank selection. 0 = Bank 0 1 = Bank 1



8.1.1.19 PROT1 Register (Offset = F1h) [Reset = 00h]

PROT1 is shown in Table 8-21.

Return to the Summary Table.

Locks or unlocks register changes. Must match PROT2.

Table 8-21. PROT1 Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-6	RESERVED	R/W	0h	Reserved
5	WRKC	R/W	Oh	Represents Protection from writes for WRKC group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
4	RESERVED	R/W	0h	Reserved
3	CFG	R/W	Oh	Represents Protection from writes for CFG group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
2	IEN	R/W	Oh	Represents Protection from writes for IEN group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
1	MON	R/W	Oh	Represents Protection from writes for MON group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
0	SEQ	R/W	Oh	Represents Protection from writes for SEQ group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible



8.1.1.20 PROT2 Register (Offset = F2h) [Reset = 00h]

PROT2 is shown in Table 8-22.

Return to the Summary Table.

Locks or unlocks register changes. Must match PROT1.

Table 8-22. PROT2 Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-6	RESERVED	R/W	0h	Reserved
5	WRKC	R/W	0h	Represents Protection from writes for CFG group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
4	RESERVED	R/W	0h	Reserved
3	CFG	R/W	0h	Represents Protection from writes for CFG group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
2	IEN	R/W	0h	Represents Protection from writes for IEN group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
1	MON	R/W	0h	Represents Protection from writes for MON group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible
0	SEQ	R/W	0h	Represents Protection from writes for SEQ group. Both PROT1 and PROT2 need to be set for protection. 0 = Changes to register are possible 1 = Changes to register are not possible



8.1.1.21 PROT_MON Register (Offset = F3h) [Reset = 1Fh]

PROT_MON is shown in Table 8-23.

Return to the Summary Table.

Locks MON registers in tandem with PROT1 and PROT2.

Table 8-23. PROT_MON Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	1h	Protects MON4 from writes along with PROT1 and PROT2. 0= Changes are possible 1= Changes are not possible
2	MON[3]	R/W	1h	Protects MON3 from writes along with PROT1 and PROT2. 0= Changes are possible 1= Changes are not possible
1	MON[2]	R/W	1h	Protects MON2 from writes along with PROT1 and PROT2. 0= Changes are possible 1= Changes are not possible
0	RESERVED	R/W	0h	Reserved



8.1.1.22 I2CADDR Register (Offset = F9h) [Reset = 30h]

I2CADDR is shown in Table 8-24.

Return to the Summary Table.

I2C Address

Table 8-24. I2CADDR Register Field Descriptions

	Bit	Field	Туре	Reset	Description	
	7	RESERVED	R/W	0h	Reserved	
	6-3	ADDR_NVM[3:0]	R	6h	Represents I2C address from internal OTP. Default value of 30 hex. Also the default I2C address for fail safe mode if I2C communication fails	
ĺ	2-0	ADDR_STRAP[2:0]	R	0h	Represents I2C address from resistor value on ADDR pin.	



8.1.1.23 DEV_CFG Register (Offset = FAh) [Reset = 00h]

DEV_CFG is shown in Table 8-25.

Return to the Summary Table.

Status of I2C interface voltage levels.

Table 8-25. DEV_CFG Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	RESERVED	R	0h	Reserved



8.1.2 BANK1 Registers

Table 8-26 lists the memory-mapped registers for the BANK1 registers. All register offset addresses not listed in Table 8-26 should be considered as reserved locations and the register contents should not be modified.

Table 8-26. BANK1 Registers

10h	Offset	Acronym	Register Name	Section
TEST_CFG	10h	VMON_CTL	VMON device control register.	Section 8.1.2.1
13h IEN_UVHF	11h	VMON_MISC	Miscellaneous VMON configurations.	Section 8.1.2.2
register Low Frequency channel Under-Voltage Interrupt Enable Section 8.1.2.5 register. High Frequency channel Over-Voltage Interrupt Enable Progister. High Frequency channel Over-Voltage Interrupt Enable Section 8.1.2.6 register. Low Frequency channel Over-Voltage Interrupt Enable Section 8.1.2.7 register. IBh IEN_CONTROL Control and Communication Fault Interrupt Enable Section 8.1.2.8 register. ICh IEN_TEST Internal Test and Configuration Load Fault Interrupt Section 8.1.2.9 Enable register. IDh IEN_VENDOR Vendor Specific Internal Interrupt Enable register. Section 8.1.2.10 Enable register. IPh MON_CH_EN Channel Voltage Monitoring Enable. Section 8.1.2.11 Fib. VRANGE_MULT Channel Voltage Monitoring Range/Scaling. Section 8.1.2.12 Channel 2 High Frequency channel Under-Voltage Section 8.1.2.13 treshold. JUV_HF[2] Channel 2 High Frequency channel Under-Voltage Section 8.1.2.14 threshold. JUV_LF[2] Channel 2 Low Frequency channel Under-Voltage Section 8.1.2.15 threshold. JUV_LF[2] Channel 2 Low Frequency Path (Sc) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequency Section 8.1.2.18 threshold. JUV_HF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.16 threshold. Channel 3 Low Frequency Path (Sc) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequency Section 8.1.2.20 threshold. Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. Channel 3 Low Frequency Path (Sc) Cutoff Frequency Section 8.1.2.22 threshold. Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.22 threshold. Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. Channel 3 Low Frequency Channel Over-Voltage Section 8.1.2.22 threshold. Channel 3 Low Frequency Channel Ov	12h	TEST_CFG	Built-In Self Test (BIST) execution configuration.	Section 8.1.2.3
register. 15h IEN_OVHF High Frequency channel Over-Voltage Interrupt Enable register. 16h IEN_OVLF Low Frequency channel Over-Voltage Interrupt Enable register. 16h IEN_CONTROL Control and Communication Fault Interrupt Enable register. 16h IEN_CENTROL Control and Communication Fault Interrupt Enable register. 16h IEN_TEST Internal Test and Configuration Load Fault Interrupt Section 8.1.2.9 Enable register. 16h MON_CH_EN Vendor Specific Internal Interrupt Enable register. Section 8.1.2.10 Internal Politage Monitoring Enable. Section 8.1.2.10 Internal Non_CH_EN Channel Voltage Monitoring Range/Scaling. Section 8.1.2.11 Internal Prequency channel Under-Voltage Section 8.1.2.13 Internal Prequency Channel Under-Voltage Section 8.1.2.14 Intershold. 31h OV_HF[2] Channel 2 High Frequency channel Under-Voltage Section 8.1.2.14 Intershold. 32h UV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.15 Intershold. 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.16 Intershold. 34h FLT_HF[2] Channel 2 Low Frequency Channel Over-Voltage Section 8.1.2.16 Intershold. 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.17 Intershold. 36h FLT_HF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.16 Intershold. 37h OV_LF[2] Channel 3 Light Frequency Channel Under-Voltage Section 8.1.2.16 Intershold. 38h FLT_HF[3] Channel 3 High Frequency Channel Under-Voltage Section 8.1.2.17 Intershold. 49h UV_HF[3] Channel 3 High Frequency Channel Under-Voltage Section 8.1.2.20 Intershold. 40h UV_HF[3] Channel 3 High Frequency Channel Under-Voltage Section 8.1.2.20 Intershold. 41h OV_LF[3] Channel 3 High Frequency Channel Under-Voltage Section 8.1.2.20 Intershold. 42h UV_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.20 Intershold. 43h OV_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.20 Intershold. 44h FLT_HF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.23 Intershold. 45h FC_	13h	IEN_UVHF		Section 8.1.2.4
register. 16h IEN_OVLF Low Frequency channel Over-Voltage Interrupt Enable register. 18h IEN_CONTROL Control and Communication Fault Interrupt Enable register. 10h IEN_TEST Internal Test and Configuration Load Fault Interrupt Section 8.1.2.9 Enable register. 10h IEN_VENDOR Vendor Specific Internal Interrupt Enable register. Section 8.1.2.10 Internal Test and Configuration Load Fault Interrupt Section 8.1.2.10 Internal Test and Configuration Load Fault Interrupt Section 8.1.2.10 Internal Interrupt Enable register. Section 8.1.2.10 Internal Interrupt Enable register. Section 8.1.2.11 Internal Test and Configuration Load Fault Interrupt Section 8.1.2.12 Internal Interrupt Enable register. Section 8.1.2.13 Internal Interrupt Enable register. Section 8.1.2.13 Internal Interrupt Enable register. Section 8.1.2.14 Internal Interrupt Enable register. Section 8.1.2.14 Internal Interrupt Enable register. Section 8.1.2.14 Internal Interrupt Enable register. Section 8.1.2.15 Internal Interrupt Enable register. Section 8.1.2.15 Internal Interrupt Enable register. Section 8.1.2.16 Internal Interrupt Enable register. Section 8.1.2.16 Internal Internal Interrupt Enable register Change (Section 8.1.2.15 Internal Internal Interrupt Enable Prequency Path (Section 8.1.2.16 Internal Internal Interrupt Enable Prequency Channel Internal Inter	14h	IEN_UVLF		Section 8.1.2.5
register. 1Bh IEN_CONTROL Control and Communication Fault Interrupt Enable register. 1Ch IEN_TEST Internal Test and Configuration Load Fault Interrupt Section 8.1.2.8 register. 1Dh IEN_VENDOR Vendor Specific Internal Interrupt Enable register. Section 8.1.2.10 Section 8.1.2.10 Section 8.1.2.10 Section 8.1.2.11 IFh WRANGE_MULT Channel Voltage Monitoring Enable. Section 8.1.2.11 Section 8.1.2.12 Channel Voltage Monitoring Range/Scaling. Section 8.1.2.13 Section 8.1.2.13 Section 8.1.2.13 Section 8.1.2.13 Section 8.1.2.14 Section 8.1.2.15 Section 8.1.2.15 Section 8.1.2.15 Section 8.1.2.15 Section 8.1.2.15 Section 8.1.2.16 Section 8.1.2.17 Section 8.1.2.18 Section 8.1.2.17 Section 8.1.2.18 Section 8.1.2.18 Section 8.1.2.18 Section 8.1.2.18 Section 8.1.2.19 Section 8.1.2.19 Section 8.1.2.19 Section 8.1.2.19 Section 8.1.2.20 Section 8.1.2.20 Section 8.1.2.21 Section 8.1.2.23 Section 8.1.2.23 Section 8.1.2.24 Section 8.1.2.24 Sectio	15h	IEN_OVHF		Section 8.1.2.6
register. 1Ch IEN_TEST Internal Test and Configuration Load Fault Interrupt Enable register 1Dh IEN_VENDOR Vendor Specific Internal Interrupt Enable register. Section 8.1.2.10 1Eh MON_CH_EN Channel Voltage Monitoring Enable. Section 8.1.2.11 1Fh VRANGE_MULT Channel Voltage Monitoring Range/Scaling. Section 8.1.2.12 30h UV_HF[2] Channel 2 High Frequency channel Under-Voltage Section 8.1.2.13 31h OV_HF[2] Channel 2 High Frequency channel Over-Voltage Section 8.1.2.13 32h UV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.15 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.15 34h FLT_HF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.16 35h FC_LF[2] Channel 2 Low Frequency Channel Over-Voltage Section 8.1.2.17 35h FC_LF[2] Channel 2 Low Frequency Endough Section 8.1.2.17 36h FC_LF[3] Channel 2 Low Frequency Path G(s) Cutoff Frequency Gale point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.19 41h OV_HF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.20 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.22 44h FLT_HF[3] Channel 3 Low Frequency Channel Over-Voltage Section 8.1.2.22 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.23 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.24 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.25 50h UV_HF[4] Channel 4 High Frequency Channel Under-Voltage Section 8.1.2.25 50h UV_HF[4] Channel 4 High Frequency Channel Under-Voltage Section 8.1.2.25	16h	IEN_OVLF		Section 8.1.2.7
Enable register	1Bh	IEN_CONTROL	•	Section 8.1.2.8
1Eh MON_CH_EN Channel Voltage Monitoring Enable. Section 8.1.2.11 1Fh VRANGE_MULT Channel Voltage Monitoring Range/Scaling. Section 8.1.2.12 30h UV_HF[2] Channel 2 High Frequency channel Under-Voltage threshold. Section 8.1.2.13 31h OV_HF[2] Channel 2 Low Frequency channel Over-Voltage threshold. Section 8.1.2.14 32h UV_LF[2] Channel 2 Low Frequency channel Under-Voltage threshold. Section 8.1.2.15 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage threshold. Section 8.1.2.16 34h FLT_HF[2] Channel 2 UV and OV debouncing for High Frequency thresholds comparator output. Section 8.1.2.16 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. Section 8.1.2.18 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.20 41h OV_LF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.21 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.22	1Ch	IEN_TEST		Section 8.1.2.9
1Fh VRANGE_MULT Channel Voltage Monitoring Range/Scaling. Section 8.1.2.12 30h UV_HF[2] Channel 2 High Frequency channel Under-Voltage threshold. Section 8.1.2.13 31h OV_HF[2] Channel 2 High Frequency channel Over-Voltage threshold. Section 8.1.2.14 32h UV_LF[2] Channel 2 Low Frequency channel Under-Voltage threshold. Section 8.1.2.15 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage threshold. Section 8.1.2.16 34h FLT_HF[2] Channel 2 UV and OV debouncing for High Frequency thresholds comparator output. Section 8.1.2.17 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. Section 8.1.2.18 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage threshold. Section 8.1.2.20 41h OV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.21 threshold. Section 8.1.2.22 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. Section 8.1.2.23 threshold. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.24 thresholds comparator output. Section 8.1.2.24 45h FC_LF[3] Channel 3 Low Frequency Path G(s) C	1Dh	IEN_VENDOR	Vendor Specific Internal Interrupt Enable register.	Section 8.1.2.10
30h UV_HF[2] Channel 2 High Frequency channel Under-Voltage Section 8.1.2.13 31h OV_HF[2] Channel 2 High Frequency channel Over-Voltage Section 8.1.2.14 32h UV_LF[2] Channel 2 Low Frequency channel Under-Voltage Section 8.1.2.15 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.15 33h FLT_HF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.16 34h FLT_HF[2] Channel 2 UV and OV debouncing for High Frequency Section 8.1.2.17 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.19 41h OV_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.20 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 44h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.23 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.24 45h UV_HF[4] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.25 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	1Eh	MON_CH_EN	Channel Voltage Monitoring Enable.	Section 8.1.2.11
threshold. 31h OV_HF[2] Channel 2 High Frequency channel Over-Voltage threshold. 32h UV_LF[2] Channel 2 Low Frequency channel Under-Voltage Section 8.1.2.15 threshold. 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.16 threshold. 34h FLT_HF[2] Channel 2 LOW Frequency channel Over-Voltage Section 8.1.2.17 thresholds comparator output. 35h FC_LF[2] Channel 2 LOW Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.19 threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.20 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.21 threshold. 45h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 45h FC_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.23 threshold. 45h FC_LF[3] Channel 3 Low Frequency path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.	1Fh	VRANGE_MULT	Channel Voltage Monitoring Range/Scaling.	Section 8.1.2.12
threshold. 32h UV_LF[2] Channel 2 Low Frequency channel Under-Voltage Section 8.1.2.15 threshold. 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.16 threshold. 34h FLT_HF[2] Channel 2 UV and OV debouncing for High Frequency Section 8.1.2.17 thresholds comparator output. 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.18 (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.19 threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.20 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.23 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.24 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.24 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.25 of the programmable LPF such that the total frequency Fresponse G(s) meets these cutoff frequencies.	30h	UV_HF[2]		Section 8.1.2.13
threshold. 33h OV_LF[2] Channel 2 Low Frequency channel Over-Voltage Section 8.1.2.16 threshold. 34h FLT_HF[2] Channel 2 UV and OV debouncing for High Frequency Section 8.1.2.17 thresholds comparator output. 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequency escution 8.1.2.19 threshold. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage Section 8.1.2.20 threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.20 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.23 threshold. 50h UV_HF[4] Channel 3 Low Frequency Path G(s) Cutoff Frequency Section 8.1.2.24 of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.	31h	OV_HF[2]		Section 8.1.2.14
threshold. 34h FLT_HF[2] Channel 2 UV and OV debouncing for High Frequency thresholds comparator output. 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.19 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 45h FC_LF[3] Channel 3 UV and OV debouncing for High Frequency Section 8.1.2.23 (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.	32h	UV_LF[2]	, , , , , , , , , , , , , , , , , , ,	Section 8.1.2.15
thresholds comparator output. 35h FC_LF[2] Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.20 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 45h FC_LF[3] Channel 3 UV and OV debouncing for High Frequency Section 8.1.2.23 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	33h	OV_LF[2]		Section 8.1.2.16
(-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 40h UV_HF[3] Channel 3 High Frequency channel Under-Voltage threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.20 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.21 threshold. 44h FLT_HF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 45h FC_LF[3] Channel 3 UV and OV debouncing for High Frequency Section 8.1.2.23 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	34h	FLT_HF[2]		Section 8.1.2.17
threshold. 41h OV_HF[3] Channel 3 High Frequency channel Over-Voltage Section 8.1.2.20 threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 UV and OV debouncing for High Frequency Section 8.1.2.23 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	35h	FC_LF[2]	(-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency	Section 8.1.2.18
threshold. 42h UV_LF[3] Channel 3 Low Frequency channel Under-Voltage Section 8.1.2.21 threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 UV and OV debouncing for High Frequency Section 8.1.2.23 thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	40h	UV_HF[3]		Section 8.1.2.19
threshold. 43h OV_LF[3] Channel 3 Low Frequency channel Over-Voltage Section 8.1.2.22 threshold. 44h FLT_HF[3] Channel 3 UV and OV debouncing for High Frequency thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	41h	OV_HF[3]		Section 8.1.2.20
threshold. 44h FLT_HF[3] Channel 3 UV and OV debouncing for High Frequency thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	42h	UV_LF[3]	, ,	Section 8.1.2.21
thresholds comparator output. 45h FC_LF[3] Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	43h	OV_LF[3]		Section 8.1.2.22
(-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies. 50h UV_HF[4] Channel 4 High Frequency channel Under-Voltage Section 8.1.2.25	44h	FLT_HF[3]		Section 8.1.2.23
= ··	45h	FC_LF[3]	(-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency	Section 8.1.2.24
	50h	UV_HF[4]		Section 8.1.2.25



Table 8-26. BANK1 Registers (continued)

Offset	Acronym	Register Name	Section
51h	OV_HF[4]	Channel 4 High Frequency channel Over-Voltage threshold.	Section 8.1.2.26
52h	UV_LF[4]	Channel 4 Low Frequency channel Under-Voltage threshold.	Section 8.1.2.27
53h	OV_LF[4]	Channel 4 Low Frequency channel Over-Voltage threshold.	Section 8.1.2.28
54h	FLT_HF[4]	Channel 4 UV and OV debouncing for High Frequency thresholds comparator output.	Section 8.1.2.29
55h	FC_LF[4]	Channel 4 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.	Section 8.1.2.30
9Eh	ESM	ESM threshold time for asserting a fault.	Section 8.1.2.31
9Fh	TI_CONTROL	Manual BIST/WD EN/Manual Reset via I2C/ESM deglitch/ Reset delay	Section 8.1.2.32
A1h	AMSK_ON	Auto-mask UVLF, UVHF, and OVHF interrupts on power up transitions.	Section 8.1.2.33
A2h	AMSK_OFF	Auto-mask UVLF, UVHF, and OVHF interrupts on power down transitions.	Section 8.1.2.34
A5h	SEQ_TOUT_MSB	Timeout for UV faults during powerup and power down.	Section 8.1.2.35
A6h	SEQ_TOUT_LSB	Timeout for UV faults during powerup and power down.	Section 8.1.2.36
A8h	SEQ_UP_THLD	Threshold at which AMSK is released (VMON considered on) for power up.	Section 8.1.2.37
A9h	SEQ_DN_THLD	Threshold at which AMSK is released (VMON considered off) for power down.	Section 8.1.2.38
AAh	WDT_CFG	Max violation count for WD and Delay multiplier for Start Up Window.	Section 8.1.2.39
ABh	WDT_CLOSE	Close Window Time.	Section 8.1.2.40
ACh	WDT_OPEN	Open Window Time.	Section 8.1.2.41
ADh	WDT_QA_CFG	Feedback/Poly/Seed for Watchdog.	Section 8.1.2.42
AEh	WDT_ANSWER	Answer for the Watchdog.	Section 8.1.2.43
F0h	BANK_SEL	Bank Select.	Section 8.1.2.44

Complex bit access types are encoded to fit into small table cells. Table 8-27 shows the codes that are used for access types in this section.

Table 8-27. BANK1 Access Type Codes

14.5.0 0 = 11 = 1 11 11 1 1 1 1 1 1 1 1 1 1 1							
Access Type	Code	Description					
Read Type							
R	R	Read					
Write Type							
W	W	Write					
Reset or Default Value							
-n		Value after reset or the default value					



8.1.2.1 VMON_CTL Register (Offset = 10h) [Reset = 20h]

VMON_CTL is shown in Table 8-28.

Return to the Summary Table.

VMON device control register.

Table 8-28. VMON_CTL Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-5	RESERVED	R/W	0h	Reserved
4	FORCE_WDO_LOW	R/W	0h	Force assertion of WDO
3	RESET_PROT	R/W	0h	Reset_Prot = read 0, write 1 to clear Protection registers
2-1	RESERVED	R/W	0h	Reserved
0	FORCE_NIRQ_LOW	R/W	0h	Force assertion of NIRQ



8.1.2.2 VMON_MISC Register (Offset = 11h) [Reset = X0h]

VMON_MISC is shown in Table 8-29.

Return to the Summary Table.

Miscellaneous VMON configurations.

Table 8-29. VMON_MISC Register Field Descriptions

idado o 201 timo (_imo o 1.09.0.001 1.10.00 2.000p.u.o.10					
Bit	Field	Туре	Reset	Description	
7	RESERVED	R/W	0h	Reserved	
6-4	WDO_DLY[2:0]	R/W	0h	WDO_Delay (not applicable for latched WDO)	
3-2	RESERVED	R/W	0h	Reserved	
1	REQ_PEC	R/W	Xh	Require PEC. 0 = PEC not required 1 = PEC required	
0	EN_PEC	R/W	Xh	Enable PEC. 0 = PEC not enabled 1 = PEC enabled	



8.1.2.3 TEST_CFG Register (Offset = 12h) [Reset = X0h]

TEST_CFG is shown in Table 8-30.

Return to the Summary Table.

Built-In Self Test (BIST) execution configuration.

Table 8-30. TEST_CFG Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-3	RESERVED	R/W	0h	Reserved
2	AT_SHDN	R/W	Xh	Run BIST at SHDN
1	AT_POR[1]	R/W	Xh	Run BIST at POR, 2nd bit for redundancy
0	AT_POR[0]	R/W	Xh	Run BIST at POR



8.1.2.4 IEN_UVHF Register (Offset = 13h) [Reset = X0h]

IEN_UVHF is shown in Table 8-31.

Return to the Summary Table.

High Frequency channel Under-Voltage Interrupt Enable register

Table 8-31. IEN_UVHF Register Field Descriptions

	Table & C. F. Int. 1. Cogletter From Decemporarie						
Bit	Field	Туре	Reset	Description			
7-4	RESERVED	R/W	0h	Reserved			
3	MON[4]	R/W	Xh	UVHF interrupt enable for MON4, 0 = Disable, 1 = Enable			
2	MON[3]	R/W	Xh	UVHF interrupt enable for MON3, 0 = Disable, 1 = Enable			
1	MON[2]	R/W	Xh	UVHF interrupt enable for MON2, 0 = Disable, 1 = Enable			
0	RESERVED	R/W	0h	Reserved			



8.1.2.5 IEN_UVLF Register (Offset = 14h) [Reset = X0h]

IEN_UVLF is shown in Table 8-32.

Return to the Summary Table.

Low Frequency channel Under-Voltage Interrupt Enable register.

Table 8-32. IEN_UVLF Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	Xh	UVLF interrupt enable for MON4, 0 = Disable, 1 = Enable
2	MON[3]	R/W	Xh	UVLF interrupt enable for MON3, 0 = Disable, 1 = Enable
1	MON[2]	R/W	Xh	UVLF interrupt enable for MON2, 0 = Disable, 1 = Enable
0	RESERVED	R/W	0h	Reserved



8.1.2.6 IEN_OVHF Register (Offset = 15h) [Reset = X0h]

IEN_OVHF is shown in Table 8-33.

Return to the Summary Table.

High Frequency channel Over-Voltage Interrupt Enable register.

Table 8-33. IEN OVHF Register Field Descriptions

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Bit	Field	Туре	Reset	Description	
7-4	RESERVED	R/W	0h	Reserved	
3	MON[4]	R/W	Xh	OVHF interrupt enable for MON4, 0 = Disable, 1 = Enable	
2	MON[3]	R/W	Xh	OVHF interrupt enable for MON3, 0 = Disable, 1 = Enable	
1	MON[2]	R/W	Xh	OVHF interrupt enable for MON2, 0 = Disable, 1 = Enable	
0	RESERVED	R/W	0h	Reserved	



8.1.2.7 IEN_OVLF Register (Offset = 16h) [Reset = X0h]

IEN_OVLF is shown in Table 8-34.

Return to the Summary Table.

Low Frequency channel Over-Voltage Interrupt Enable register.

Table 8-34. IEN_OVLF Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	Xh	OVLF interrupt enable for MON4, 0 = Disable, 1 = Enable
2	MON[3]	R/W	Xh	OVLF interrupt enable for MON3, 0 = Disable, 1 = Enable
1	MON[2]	R/W	Xh	OVLF interrupt enable for MON2, 0 = Disable, 1 = Enable
0	RESERVED	R/W	0h	Reserved



8.1.2.8 IEN_CONTROL Register (Offset = 1Bh) [Reset = X0h]

IEN_CONTROL is shown in Table 8-35.

Return to the Summary Table.

Control and Communication Fault Interrupt Enable register.

Table 8-35. IEN_CONTROL Register Field Descriptions

Table 0-33. IEIN_CONTROL Register Field Descriptions					
Bit	Field	Туре	Reset	Description	
7-5	RESERVED	R/W	0h	Reserved	
4	RT_CRC_Int	R/W	Oh	Register Run time CRC (Cyclic Redundancy Checking) error Interrupt is a static CRC performed on the register map content. If enabled there does not need to be any data read or write for this CRC check to occur. The purpose of this CRC is to identify if a static bit flip or random error in the register map content has occurred. This safety mechanism is carried out using a CRC-8 polynomial, in the case of a read or write operation the register map content will change and the polynomial is re-calculated with the new value after the changes. Interrupt is reported in INT_CONTROL_F_CRC register of Bank 0. 0 = Disable Interrupt Mapping, 1 = Enable Interrupt Mapping	
3	RESERVED	R/W	0h	Reserved	
2	TSD_INT	R/W	Xh	Thermal shutdown Interrupt. 0 = Disable, 1 = Enable	
1	RESERVED	R/W	0h	Reserved	
0	PEC_INT	R/W	Xh	PEC Error Interrupt. 0 = Disable, 1 = Enable	



8.1.2.9 IEN_TEST Register (Offset = 1Ch) [Reset = X0h]

IEN_TEST is shown in Table 8-36.

Return to the Summary Table.

Internal Test and Configuration Load Fault Interrupt Enable register

Table 8-36. IEN_TEST Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	ECC_SEC	R/W	Xh	SEC Error Interrupt. 0 = Disable, 1 = Enable
2	RESERVED	R/W	0h	Reserved
1	BIST_Complete_INT	R/W	Xh	BIST complete Interrupt. 0 = Disable, 1 = Enable
0	BIST_Fail_INT	R/W	Xh	BIST Fail Interrupt. 0 = Disable, Enable = 1



8.1.2.10 IEN_VENDOR Register (Offset = 1Dh) [Reset = X0h]

IEN_VENDOR is shown in Table 8-37.

Return to the Summary Table.

Vendor Specific Internal Interrupt Enable register.

Table 8-37. IEN_VENDOR Register Field Descriptions

Table 0-07. IEIN_VENDOR Register Fleid Descriptions						
Bit	Field	Туре	Reset	Description		
7	Startup Self-Test_CRC	R/W	0h	Startup Self-Test_CRC Interrupt. 0 = Disable Interrupt Mapping, 1 = Enable Interrupt Mapping		
6	RESERVED	R/W	0h	Reserved		
5	NRST_MISMATCH	R/W	0h	NRST mismatch Interrupt. 0 = Disable Interrupt Mapping, 1 = Enable Interrupt Mapping		
4	ESM_TO_WDO	R/W	0h	Maps ESM fault to WDO. 0 = Not mapped 1 = Mapped		
3	ESM_TO_NIRQ	R/W	Xh	Maps ESM fault to NIRQ. 0 = Not mapped 1 = Mapped		
2	WDT_TO_NIRQ	R/W	Xh	Maps Watchdog fault to NIRQ. 0 = Not mapped 1 = Mapped		
1	ESM_TO_NRST	R/W	Xh	Maps ESM fault to NRST. 0 = Not mapped 1 = Mapped		
0	WDT_TO_NRST	R/W	Xh	Maps Watchdog fault to NRST. 0 = Not mapped 1 = Mapped		



8.1.2.11 MON_CH_EN Register (Offset = 1Eh) [Reset = X0h]

MON_CH_EN is shown in Table 8-38.

Return to the Summary Table.

Channel Voltage Monitoring Enable.

Table 8-38. MON_CH_EN Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	Xh	Enables MON4 monitoring. 0 = Disabled, 1 = Enabled
2	MON[3]	R/W	Xh	Enables MON3 monitoring. 0 = Disabled, 1 = Enabled
1	MON[2]	R/W	Xh	Enables MON2 monitoring. 0 = Disabled, 1 = Enabled
0	RESERVED	R/W	0h	Reserved



8.1.2.12 VRANGE_MULT Register (Offset = 1Fh) [Reset = X0h]

VRANGE_MULT is shown in Table 8-39.

Return to the Summary Table.

Channel Voltage Monitoring Range/Scaling.

Table 8-39. VRANGE_MULT Register Field Descriptions

				regiotor i ioia 2000 i pirono	
Bit	Field	Туре	Reset	Description	
7-4	RESERVED	R/W	0h	Reserved	
3	MON[4]	R/W	Xh	Scalar for MON4. 0 = 1x, 1 = 4x	
2	MON[3]	R/W	Xh	Scalar for MON3. 0 = 1x, 1 = 4x	
1	MON[2]	R/W	Xh	Scalar for MON2. 0 = 1x, 1 = 4x	
0	RESERVED	R/W	0h	Reserved	



8.1.2.13 UV_HF[2] Register (Offset = 30h) [Reset = X0h]

UV_HF[2] is shown in Table 8-40.

Return to the Summary Table.

Channel 2 High Frequency channel Under-Voltage threshold.

Table 8-40. UV_HF[2] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Undervoltage threshold for High Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.

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8.1.2.14 OV_HF[2] Register (Offset = 31h) [Reset = X0h]

OV_HF[2] is shown in Table 8-41.

Return to the Summary Table.

Channel 2 High Frequency channel Over-Voltage threshold.

Table 8-41. OV_HF[2] Register Field Descriptions

	14515 5 111 6 1 _ 11 10 global 1 1514 2 5 5 5 11 pt 151							
Bit	Field	Туре	Reset	Description				
7-0	THRESHOLD[7:0]	R/W	Xh	Overvoltage threshold for High Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.				



8.1.2.15 UV_LF[2] Register (Offset = 32h) [Reset = X0h]

UV_LF[2] is shown in Table 8-42.

Return to the Summary Table.

Channel 2 Low Frequency channel Under-Voltage threshold.

Table 8-42. UV_LF[2] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Undervoltage threshold for Low Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.



8.1.2.16 OV_LF[2] Register (Offset = 33h) [Reset = X0h]

OV_LF[2] is shown in Table 8-43.

Return to the Summary Table.

Channel 2 Low Frequency channel Over-Voltage threshold.

Table 8-43. OV_LF[2] Register Field Descriptions

	idate o iti o i _ i i cogistor i iti d z scoriptione							
Bit	Field	Туре	Reset	Description				
7-0	THRESHOLD[7:0]	R/W	Xh	Overvoltage threshold for Low Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.				



8.1.2.17 FLT_HF[2] Register (Offset = 34h) [Reset = X0h]

FLT_HF[2] is shown in Table 8-44.

Return to the Summary Table.

Channel 2 UV and OV debouncing for High Frequency thresholds comparator output.

Table 8-44. FLT_HF[2] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	OV_DEB[3:0]	R/W	Oh	Overvoltage comparator output debounce time (dont assert until output is stable for debounce time) for High Frequency monitoring path. 0000b = 0.1µs 1000b = 25.6µs 0001b = 0.2µs 1001b = 51.2µs 0010b = 0.4µs 1010b = 102.4µs 0011b = 0.8µs 1011b = 102.4µs 0100b = 1.6µs 1100b = 102.4µs 0101b = 3.2µs 1101b = 102.4µs 0110b = 6.4µs 1110b = 102.4µs 0111b = 12.8µs 1111b = 102.4µs
3-0	UV_DEB[3:0]	R/W	Xh	Undervoltage comparator output debounce time (dont assert until output is stable for debounce time) for High Frequency monitoring path. 0000b = 0.1µs 1000b = 25.6µs 0001b = 0.2µs 1001b = 51.2µs 0010b = 0.4µs 1010b = 102.4µs 0011b = 0.8µs 1011b = 102.4µs 0100b = 1.6µs 1100b = 102.4µs 0101b = 3.2µs 1101b = 102.4µs 0110b = 6.4µs 1110b = 102.4µs 01111b = 12.8µs 11111b = 102.4µs



8.1.2.18 FC_LF[2] Register (Offset = 35h) [Reset = X0h]

FC_LF[2] is shown in Table 8-45.

Return to the Summary Table.

Channel 2 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.

Table 8-45. FC_LF[2] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-5	RESERVED	R/W	0h	Reserved
4	OVHF_TO_NRST	R/W	0h	Maps MON2 OVHF fault to NRST 0 = Not mapped, 1 = Mapped
3	UVHF_TO_NRST	R/W	Xh	Maps MON2 UVHF fault to NRST 0 = Not mapped, 1 = Mapped
2-0	Cut_off_Freq[2:0]	R/W	Xh	MON2 Cut of frequency for LF faults filter 000 = Invalid 001 = Invalid 010 = 250Hz 011 = 500Hz 100 = 1kHz 101 = 2kHz 110 = 4kHz 111 = Invalid



8.1.2.19 UV_HF[3] Register (Offset = 40h) [Reset = X0h]

UV_HF[3] is shown in Table 8-46.

Return to the Summary Table.

Channel 3 High Frequency channel Under-Voltage threshold.

Table 8-46. UV_HF[3] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Undervoltage threshold for High Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8Vto 5.9V with 1 LSB = 20mV.

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8.1.2.20 OV_HF[3] Register (Offset = 41h) [Reset = X0h]

OV_HF[3] is shown in Table 8-47.

Return to the Summary Table.

Channel 3 High Frequency channel Over-Voltage threshold.

Table 8-47. OV_HF[3] Register Field Descriptions

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Bit	Field	Туре	Reset	Description				
7-0	THRESHOLD[7:0]	R/W	Xh	Overvoltage threshold for High Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.				



8.1.2.21 UV_LF[3] Register (Offset = 42h) [Reset = X0h]

UV_LF[3] is shown in Table 8-48.

Return to the Summary Table.

Channel 3 Low Frequency channel Under-Voltage threshold.

Table 8-48. UV_LF[3] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Undervoltage threshold for Low Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.



8.1.2.22 OV_LF[3] Register (Offset = 43h) [Reset = X0h]

OV_LF[3] is shown in Table 8-49.

Return to the Summary Table.

Channel 3 Low Frequency channel Over-Voltage threshold.

Table 8-49. OV_LF[3] Register Field Descriptions

rusic o 40. 01_Er [0] register i leia bescriptions							
Bit	Field	Туре	Reset	Description			
7-0	THRESHOLD[7:0]	R/W	Xh	Overvoltage threshold for Low Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.			



8.1.2.23 FLT_HF[3] Register (Offset = 44h) [Reset = X0h]

FLT_HF[3] is shown in Table 8-50.

Return to the Summary Table.

Channel 3 UV and OV debouncing for High Frequency thresholds comparator output.

Table 8-50. FLT_HF[3] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	OV_DEB[3:0]	R/W	Oh	Overvoltage comparator output debounce time (dont assert until output is stable for debounce time) for High Frequency monitoring path. $0000b = 0.1 \mu s \ 1000b = 25.6 \mu s \\ 0001b = 0.2 \mu s \ 1001b = 51.2 \mu s \\ 0010b = 0.4 \mu s \ 1010b = 102.4 \mu s \\ 0011b = 0.8 \mu s \ 1011b = 102.4 \mu s \\ 0100b = 1.6 \mu s \ 1100b = 102.4 \mu s \\ 0101b = 3.2 \mu s \ 1101b = 102.4 \mu s \\ 0110b = 6.4 \mu s \ 1110b = 102.4 \mu s \\ 0111b = 12.8 \mu s \ 1111b = 102.4 \mu s$
3-0	UV_DEB[3:0]	R/W	Xh	Undervoltage comparator output debounce time (dont assert until output is stable for debounce time) for High Frequency monitoring path. 0000b = 0.1µs 1000b = 25.6µs 0001b = 0.2µs 1001b = 51.2µs 0010b = 0.4µs 1010b = 102.4µs 0011b = 0.8µs 1011b = 102.4µs 0100b = 1.6µs 1100b = 102.4µs 0101b = 3.2µs 1101b = 102.4µs 0110b = 6.4µs 1110b = 102.4µs 0111b = 12.8µs 1111b = 102.4µs



8.1.2.24 FC_LF[3] Register (Offset = 45h) [Reset = X0h]

FC_LF[3] is shown in Table 8-51.

Return to the Summary Table.

Channel 3 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.

Table 8-51. FC_LF[3] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-5	RESERVED	R/W	0h	Reserved
4	OVHF_TO_NRST	R/W	0h	Maps MON3 OVHF fault to NRST 0 = Not mapped, 1 = Mapped
3	UVHF_TO_NRST	R/W	Xh	Maps MON3 UVHF fault to NRST 0 = Not mapped, 1 = Mapped
2-0	Cut_off_Freq[2:0]	R/W	Xh	MON3 Cut of frequency for LF faults filter 000 = Invalid 001 = Invalid 010 = 250Hz 011 = 500Hz 100 = 1kHz 101 = 2kHz 110 = 4kHz 111 = Invalid



8.1.2.25 UV_HF[4] Register (Offset = 50h) [Reset = X0h]

UV_HF[4] is shown in Table 8-52.

Return to the Summary Table.

Channel 4 High Frequency channel Under-Voltage threshold.

Table 8-52. UV_HF[4] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Undervoltage threshold for High Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.

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8.1.2.26 OV_HF[4] Register (Offset = 51h) [Reset = X0h]

OV_HF[4] is shown in Table 8-53.

Return to the Summary Table.

Channel 4 High Frequency channel Over-Voltage threshold.

Table 8-53. OV_HF[4] Register Field Descriptions

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Bit	Field	Туре	Reset	Description				
7-0	THRESHOLD[7:0]	R/W	Xh	Overvoltage threshold for High Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.				



8.1.2.27 UV_LF[4] Register (Offset = 52h) [Reset = X0h]

UV_LF[4] is shown in Table 8-54.

Return to the Summary Table.

Channel 4 Low Frequency channel Under-Voltage threshold.

Table 8-54. UV_LF[4] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Undervoltage threshold for Low Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.

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8.1.2.28 OV_LF[4] Register (Offset = 53h) [Reset = X0h]

OV_LF[4] is shown in Table 8-55.

Return to the Summary Table.

Channel 4 Low Frequency channel Over-Voltage threshold.

Table 8-55. OV_LF[4] Register Field Descriptions

	iui	gister i leia bescriptions		
Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Overvoltage threshold for Low Frequency component of monitored channel. The 8-bit value interpretation depends on the scaling setting in register VRANGE_MULT. With scaling = 1x, the 8-bit value represents the range 0.2V to 1.475V with 1 LSB = 5mV. With scaling = 4x, the 8-bit value represents the range 0.8V to 5.9V with 1 LSB = 20mV.



8.1.2.29 FLT_HF[4] Register (Offset = 54h) [Reset = X0h]

FLT_HF[4] is shown in Table 8-56.

Return to the Summary Table.

Channel 4 UV and OV debouncing for High Frequency thresholds comparator output.

Table 8-56. FLT_HF[4] Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	OV_DEB[3:0]	R/W	Oh	Overvoltage comparator output debounce time (dont assert until output is stable for debounce time) for High Frequency monitoring path. 0000b = 0.1µs 1000b = 25.6µs 0001b = 0.2µs 1001b = 51.2µs 0010b = 0.4µs 1010b = 102.4µs 0011b = 0.8µs 1011b = 102.4µs 0100b = 1.6µs 1100b = 102.4µs 0101b = 3.2µs 1101b = 102.4µs 0111b = 6.4µs 1110b = 102.4µs 0111b = 12.8µs 1111b = 102.4µs
3-0	UV_DEB[3:0]	R/W	Xh	Undervoltage comparator output debounce time (dont assert until output is stable for debounce time) for High Frequency monitoring path. 0000b = 0.1µs 1000b = 25.6µs 0001b = 0.2µs 1001b = 51.2µs 0010b = 0.4µs 1010b = 102.4µs 0011b = 0.8µs 1011b = 102.4µs 0100b = 1.6µs 1100b = 102.4µs 0101b = 3.2µs 1101b = 102.4µs 0110b = 6.4µs 1110b = 102.4µs



8.1.2.30 FC_LF[4] Register (Offset = 55h) [Reset = X0h]

FC_LF[4] is shown in Table 8-57.

Return to the Summary Table.

Channel 4 Low Frequency Path G(s) Cutoff Frequency (-3dB point). The register changes the filter properties of the programmable LPF such that the total frequency response G(s) meets these cutoff frequencies.

Table 8-57. FC_LF[4] Register Field Descriptions

		togioto: i ioid 2000iiptiono		
Bit	Field	Туре	Reset	Description
7-5	RESERVED	R/W	0h	Reserved
4	OVHF_TO_NRST	R/W	Oh	Maps MON4 OVHF fault to NRST 0 = Not mapped, 1 = Mapped
3	UVHF_TO_NRST	R/W	Xh	Maps MON4 UVHF fault to NRST 0 = Not mapped, 1 = Mapped
2-0	Cut_off_Freq[2:0]	R/W	Xh	MON4 Cut of frequency for LF faults filter 000 = Invalid 001 = Invalid 010 = 250Hz 011 = 500Hz 100 = 1kHz 101 = 2kHz 110 = 4kHz 111 = Invalid



8.1.2.31 ESM Register (Offset = 9Eh) [Reset = X0h]

ESM is shown in Table 8-58.

Return to the Summary Table.

ESM threshold time for asserting a fault.

Table 8-58. ESM Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	THRESHOLD[7:0]	R/W	Xh	Threshold value representing the ESM delay time (1ms to 864ms)



8.1.2.32 TI_CONTROL Register (Offset = 9Fh) [Reset = X0h]

TI_CONTROL is shown in Table 8-59.

Return to the Summary Table.

Manual BIST/WD EN/Manual Reset via I2C/ESM deglitch/Reset delay

Table 8-59. TI CONTROL Register Field Descriptions

D.1				2 Register Freid Beeeriptions
Bit	Field	Туре	Reset	Description
7	ENTER_BIST	R/W	0h	Manual BIST. 1 = Enter BIST
6	WDT_EN	R/W	0h	Watchdog EN to be used along with hardware WD_EN pin. 1 = Watchdog Enabled, 0 = Watchdog Disabled
5	I2C_MR	R/W	0h	Manual Reset. 1 = Assert NRST low
4-3	ESM_DEB[1:0]	R/W	Xh	ESM debounce filter 00 = 10μs 01 = 25μs 10 = 50μs 11 = 100μs
2-0	RST_DLY[2:0]	R/W	Xh	Reset delay 000 = 200 µs 001 = 1 ms 010 = 10 ms 011 = 16 ms 100 = 20 ms 101 = 70 ms 110 = 100 ms 111 = 200 ms



8.1.2.33 AMSK_ON Register (Offset = A1h) [Reset = X0h]

AMSK_ON is shown in Table 8-60.

Return to the Summary Table.

Auto-mask UVLF, UVHF, and OVHF interrupts on power up transitions.

Table 8-60. AMSK_ON Register Field Descriptions

				<u>, </u>
Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	Xh	Automask at power on for MON4. 0 = Disabled 1 = Enabled
2	MON[3]	R/W	Xh	Automask at power on for MON3. 0 = Disabled 1 = Enabled
1	MON[2]	R/W	Xh	Automask at power on for MON2. 0 = Disabled 1 = Enabled
0	RESERVED	R/W	0h	Reserved



8.1.2.34 AMSK_OFF Register (Offset = A2h) [Reset = X0h]

AMSK_OFF is shown in Table 8-61.

Return to the Summary Table.

Auto-mask UVLF, UVHF, and OVHF interrupts on power down transitions.

Table 8-61. AMSK_OFF Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	Xh	Automask at power off for MON4. 0 = Disabled 1 = Enabled
2	MON[3]	R/W	Xh	Automask at power off for MON3. 0 = Disabled 1 = Enabled
1	MON[2]	R/W	Xh	Automask at power off for MON2. 0 = Disabled 1 = Enabled
0	RESERVED	R/W	0h	Reserved

Product Folder Links: TPS389C03-Q1

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8.1.2.35 SEQ_TOUT_MSB Register (Offset = A5h) [Reset = X0h]

SEQ_TOUT_MSB is shown in Table 8-62.

Return to the Summary Table.

Timeout for UV faults during powerup and power down.

Table 8-62. SEQ_TOUT_MSB Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	MILLISEC[15:8]	R/W	Xh	Sequence time out MSB



8.1.2.36 SEQ_TOUT_LSB Register (Offset = A6h) [Reset = X0h]

SEQ_TOUT_LSB is shown in Table 8-63.

Return to the Summary Table.

Timeout for UV faults during powerup and power down.

Table 8-63. SEQ TOUT LSB Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	MILLISEC[7:0]	R/W	Xh	Sequence time out LSB



8.1.2.37 SEQ_UP_THLD Register (Offset = A8h) [Reset = X0h]

SEQ_UP_THLD is shown in Table 8-64.

Return to the Summary Table.

Threshold at which AMSK is released (VMON considered on) for power up.

Table 8-64. SEQ_UP_THLD Register Field Descriptions

	:				
Bit	Field	Туре	Reset	Description	
7-4	RESERVED	R/W	0h	Reserved	
3	MON[4]	R/W	Xh	AMSK releases at UVLF or OFF threshold for MON4. 0 = off threshold, 1 = UVLF threshold	
2	MON[3]	R/W	Xh	AMSK releases at UVLF or OFF threshold for MON3. 0 = off threshold, 1 = UVLF threshold	
1	MON[2]	R/W	Xh	AMSK releases at UVLF or OFF threshold for MON2. 0 = off threshold, 1 = UVLF threshold	
0	RESERVED	R/W	0h	Reserved	



8.1.2.38 SEQ_DN_THLD Register (Offset = A9h) [Reset = X0h]

SEQ_DN_THLD is shown in Table 8-65.

Return to the Summary Table.

Threshold at which AMSK is released (VMON considered off) for power down.

Table 8-65. SEQ_DN_THLD Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-4	RESERVED	R/W	0h	Reserved
3	MON[4]	R/W	Xh	AMSK releases at UVLF or OFF threshold for MON4. 0 = off threshold, 1 = UVLF threshold
2	MON[3]	R/W	Xh	AMSK releases at UVLF or OFF threshold for MON3. 0 = off threshold, 1 = UVLF threshold
1	MON[2]	R/W	Xh	AMSK releases at UVLF or OFF threshold for MON2. 0 = off threshold, 1 = UVLF threshold
0	RESERVED	R/W	0h	Reserved



8.1.2.39 WDT_CFG Register (Offset = AAh) [Reset = X0h]

WDT_CFG is shown in Table 8-66.

Return to the Summary Table.

Max violation count for WD and Delay multiplier for Start Up Window.

Table 8-66. WDT_CFG Register Field Descriptions

Bit	Field	Туре	Reset	Description
7	RESERVED	R/W	0h	Reserved
6-4	MAX_VIOLATION_COUN T	R/W	Oh	Max violation count for Watchdog 000 = 0 001 = 1 010 = 2 011 = 3 100 = 4 101 = 5 110 = 6 111 = 7
3	RESERVED	R/W	0h	Reserved
2-0	WDT_Startup_DLY_MULT IPLIER[2:0]	R/W	Xh	Watchdog Startup delay multiplier 000 = 0 001 = 1 010 = 2 011 = 3 100 = 4 101 = 5 110 = 6 111 = 7



8.1.2.40 WDT_CLOSE Register (Offset = ABh) [Reset = X0h]

WDT_CLOSE is shown in Table 8-67.

Return to the Summary Table.

Close Window Time.

Table 8-67. WDT CLOSE Register Field Descriptions

			_	•
Bit	Field	Туре	Reset	Description
7-0	CLOSE[7:0]	R/W	Xh	Close window time (1ms to 864ms)



8.1.2.41 WDT_OPEN Register (Offset = ACh) [Reset = X0h]

WDT_OPEN is shown in Table 8-68.

Return to the Summary Table.

Open Window Time.

Table 8-68. WDT_OPEN Register Field Descriptions

			_	•
Bit	Field	Туре	Reset	Description
7-0	OPEN[7:0]	R/W	Xh	Open window time (1ms to 864ms)



8.1.2.42 WDT_QA_CFG Register (Offset = ADh) [Reset = 00h]

WDT_QA_CFG is shown in Table 8-69.

Return to the Summary Table.

FeedbackPolt/Seed for Watchdog.

Table 8-69. WDT QA CFG Register Field Descriptions

_					
	Bit	Field	Туре	Reset	Description
	7-6	FDBK[1:0]	R/W	0h	Feedback used for computing answer
	5-4	POLY[1:0]	R/W	0h	Poly used for computing answer
	3-0	SEED[3:0]	R/W	0h	Seed used for computing answer



8.1.2.43 WDT_ANSWER Register (Offset = AEh) [Reset = 00h]

WDT_ANSWER is shown in Table 8-70.

Return to the Summary Table.

Answer for the Watchdog.

Table 8-70. WDT_ANSWER Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-0	ANSWER[7:0]	R/W	0h	Answer



8.1.2.44 BANK_SEL Register (Offset = F0h) [Reset = 00h]

BANK_SEL is shown in Table 8-71.

Return to the Summary Table.

Bank Select.

Table 8-71. BANK_SEL Register Field Descriptions

Bit	Field	Туре	Reset	Description
7-1	RESERVED	R/W	0h	Reserved
0	BANK_Select	R/W	1 -	Represents bank selection. 0 = Bank 0 1 = Bank 1



9 Application and Implementation

Note

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

Modern SOC and FPGA devices typically have multiple power rails to provide power to the different blocks within the IC. Accurate voltage level and timing requirements are common and must be met to provide proper operation of these devices. By utilizing TPS389C03-Q1 along with a multichannel voltage sequencer, the power up and power down sequencing requirements as well as the core voltage requirements of the target SOC or FPGA device can be met. This design focuses on meeting the timing requirements for an SOC by using the TPS389C03-Q1.



9.2 Typical Application

9.2.1 Automotive Multichannel Sequencer and Monitor

A typical application for the TPS389C03-Q1 is shown in Figure 9-1. TPS389C03-Q1 is used to provide the proper voltage monitoring for the target SOC device. A mulitchannel voltage monitor TPS389C03-Q1 is used to monitor the voltage rails as these rails power up and power down to make sure that the correct sequence occurs in both occasions. A safety microcontroller is also used to provide ACT, NIRQ, and I²C commands to the TPS389C03-Q1 and sequencer. The ACT signal from the safety microcontroller determines when the TPS389C03-Q1 enters into ACTIVE or SHDN states while the NIRQ pin of the TPS389C03-Q1 acts as an interrupt pin that is set when a fault has occurred. The host microcontroller can clear the fault by writing 1 to the affected register. The power rails for the safety microcontroller are not shown in Figure 9-1 for simplicity.

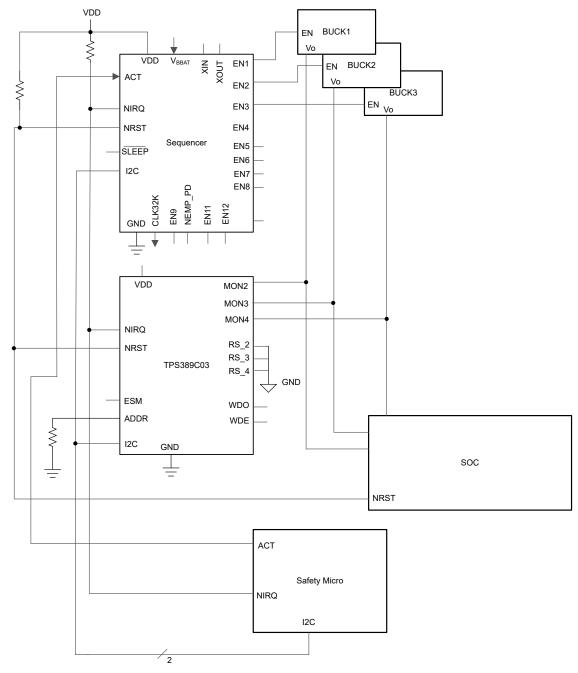


Figure 9-1. TPS389C03-Q1 Voltage Monitor Design Block Diagram



9.2.2 Design Requirements

- Three different voltage rails supplied by DC/DC converters need to be properly monitored in this design.
- All detected failures in sequencing are reported via an external hardware interrupt signal.
- All detected failures are logged in internal registers and be accessible to an external processor via I²C.

9.2.3 Detailed Design Procedure

- TPS389C03-Q1 device option comes preprogrammed with default values for over voltage, under voltage.
- NIRQ pin requires a pull up resistor in the range of $1k\Omega$ to $100k\Omega$.
- NRST pin requires a pull up resistor in the range of $1k\Omega$ to $100k\Omega$.
- WDO pin requires a pull up resistor in the range of $1k\Omega$ to $100k\Omega$.
- SDA and SCL lines require pull up resistors in the range of 10kΩ.
- The safety microcontroller is used to clear fault interrupts reported through the NIRQ interrupt pin and the INT_SCR1 and INT_SCR2 registers. The interrupt flags can only be cleared by the host micrcontroller with a write-1-to-clear operation; interrupt flags are not automatically cleared if the fault condition is no longer present.

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9.2.4 Application Curves

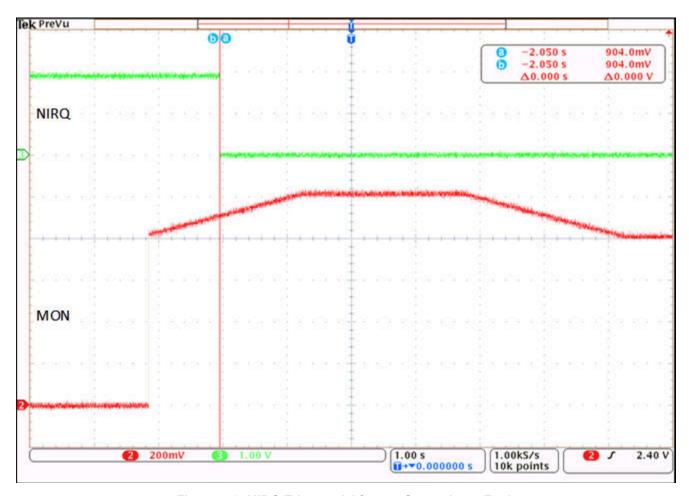


Figure 9-2. NIRQ Triggered After an Overvoltage Fault

Product Folder Links: TPS389C03-Q1

120

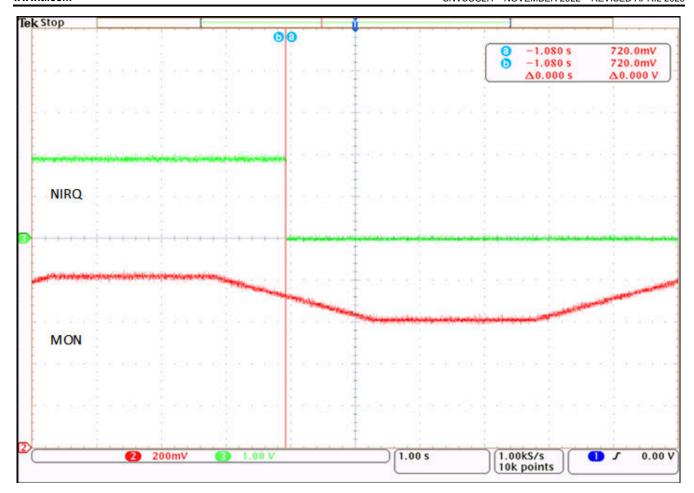


Figure 9-3. NIRQ Triggered After an Undervoltage Fault



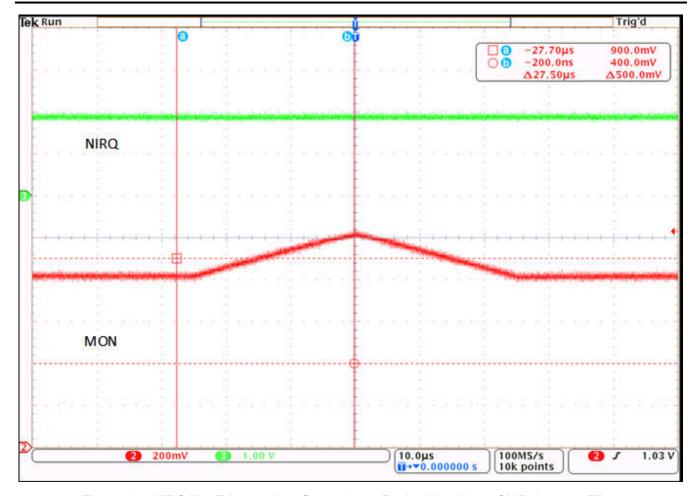


Figure 9-4. NIRQ Not Triggered on Overvoltage Fault with 51.2 us OV Debounce Filter

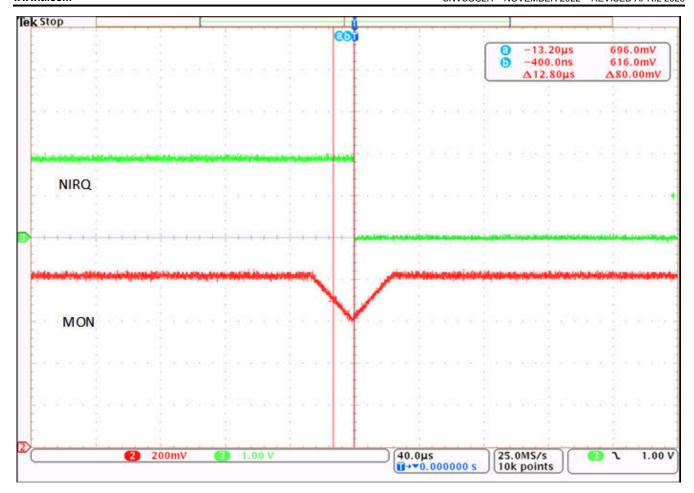


Figure 9-5. NIRQ Triggered on Undervoltage Fault with 12.8 us UV Debounce Filter



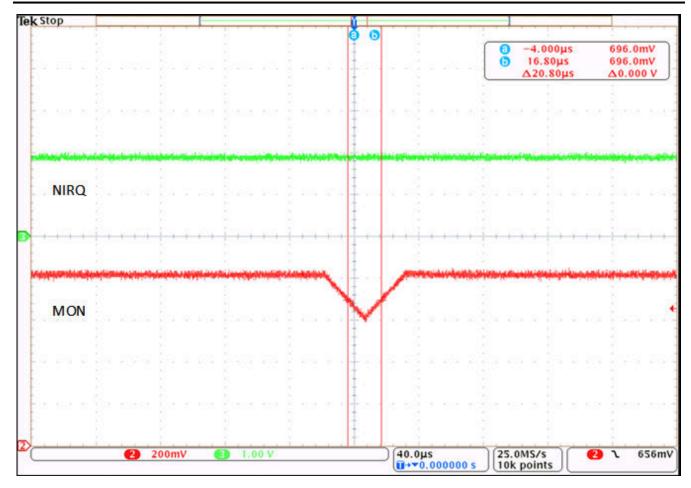


Figure 9-6. NIRQ Not Triggered on Undervoltage Fault with 25 us UV Debounce Filter

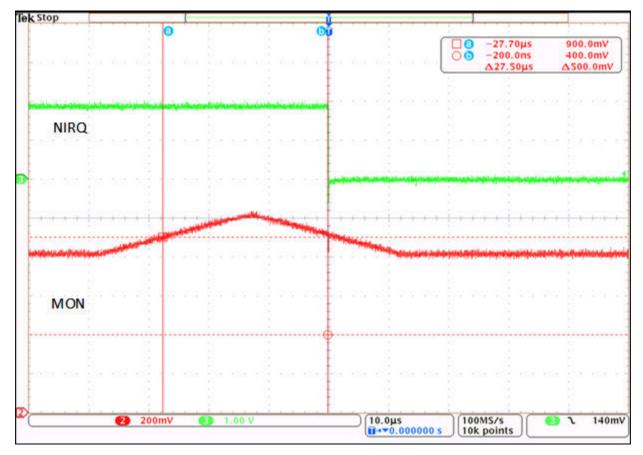


Figure 9-7. NIRQ Triggered on Overvoltage Fault with 25 us OV Debounce Filter



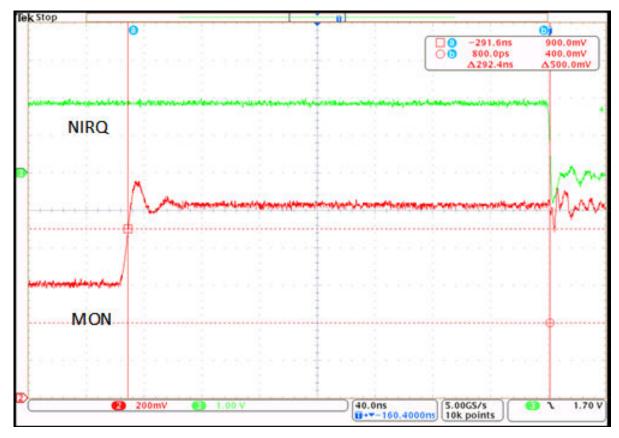


Figure 9-8. NIRQ Propogation Delay Resulting from Overvoltage Fault

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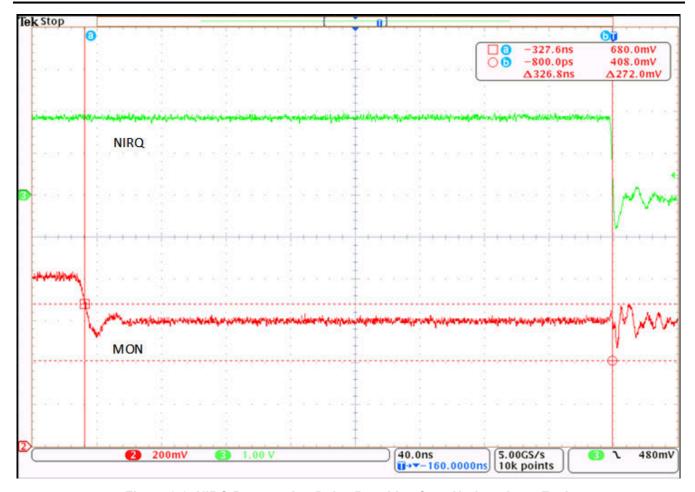


Figure 9-9. NIRQ Propogation Delay Resulting from Undervoltage Fault



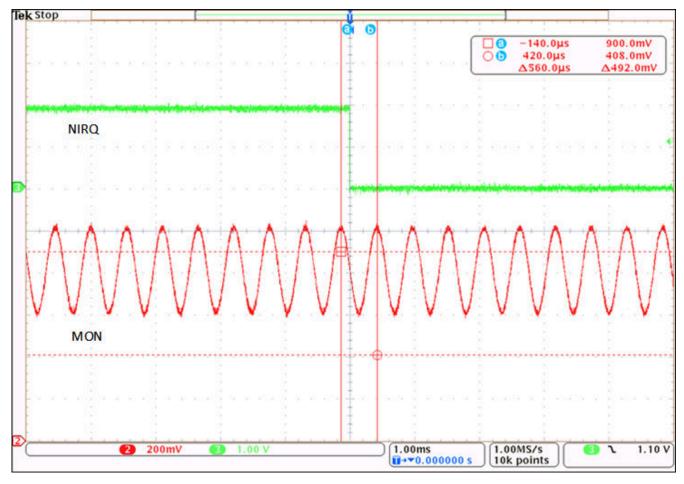


Figure 9-10. 1kHz Low Pass Filter Setting. NIRQ Triggered at 1.8kHz Signal with a 0.8V DC Component and 200mVp-p AC Signal. OV and UV Thresholds Set to 0.9V and 0.7V. Reduced the Frequency From 2kHz Until the NIRQ Pin Went Low.

Product Folder Links: TPS389C03-Q1

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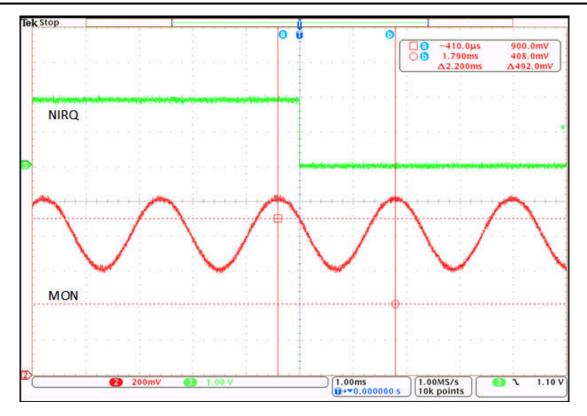


Figure 9-11. 250Hz Low Pass Filter setting. NIRQ Triggered at 455Hz Signal With a 0.8V DC Component and 200mVp-p AC Signal. OV and UV Thresholds Set to 0.9V and 0.7V. Reduced the Frequency From 500Hz Until the NIRQ Pin Went Low.



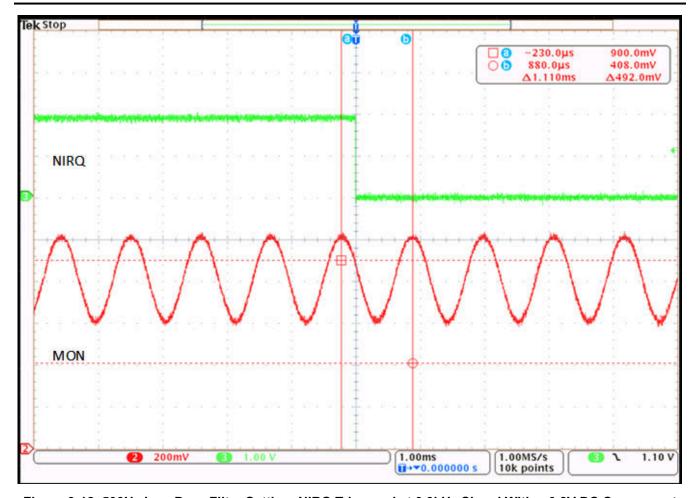


Figure 9-12. 500Hz Low Pass Filter Setting. NIRQ Triggered at 0.9kHz Signal With a 0.8V DC Component and 200mVp-p AC Signal. OV and UV Thresholds Set to 0.9V and 0.7V. Reduced the Frequency From 1kHz Until the NIRQ Pin Went Low.

9.3 Power Supply Recommendations

9.3.1 Power Supply Guidelines

This device is designed to operate from an input supply with a voltage range between 2.6V to 5.5V. This device has a 6V absolute maximum rating on the VDD pin. Good analog practice is to place a 0.1µF to 1µF capacitor between the VDD pin and the GND pin depending on the input voltage supply noise. If the voltage supply providing power to VDD is susceptible to any large voltage transient that exceed maximum specifications, additional precautions must be taken. See SNVA849 for more information.

9.4 Layout

9.4.1 Layout Guidelines

- Place the external components as close to the device as possible. This configuration prevents parasitic errors from occurring.
- Avoid using long traces for the VDD supply node. The VDD capacitor, along with parasitic inductance from the supply to the capacitor, can form an LC circuit and create ringing with peak voltages above the maximum VDD voltage.
- Avoid using long traces of voltage to the MON pin. Long traces increase parasitic inductance and cause inaccurate monitoring and diagnostics.

- www.ti.com
- If differential voltage sensing is required for MON2 and/or MON3 and/or MON4 route RS 2,3,4 pin to the point of measurement. If RS 2,3,4 are not routed to the point of measurement, then route RS 2,3,4 to the GND pin of the device.
- · Do not run sensitive analog traces in parallel with digital traces. Avoid crossing digital and analog traces if possible, and only make perpendicular crossings when absolutely necessary.
- For logic pins such as WD_EN and ESM, make sure the correct pull-up/down voltage is applied as per device logic levels for the associated functionality.
- For open-drain outputs like WDO, NIRQ, and NRST, select a pull-up resistor value such that the absolute maximum ratings of the device are not violated.

9.4.2 Layout Example

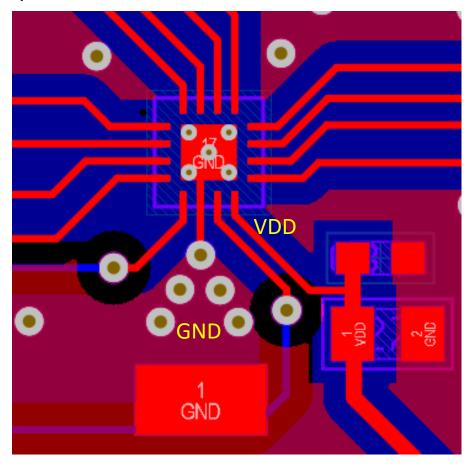


Figure 9-13. Recommended Layout



10 Device and Documentation Support

10.1 Device Nomenclature

Table 10-1 shows how to decode the function of the device based on the part number.

Table 10-1. Device Thresholds

ORDERING CODE	Description
TPS389C0300CRTERQ1	3 Monitors, Q&A Watchdog, ESM
TPS389C03A26RTERQ1	3 Monitors, Q&A Watchdog, ESM

Table 10-2. TPS389C0300CRTERQ1 OTP Configuration

ADDR	DATA	Configuration Description			
0x00	0x28	DEVICE_MODEL[7:3] and VENDOR_ID[2:0]			
0x01	0x43	SILICON_REV[7:6] and OTP_REV[5:0]			
0x02	0xF1	Channels disabled. MON2, 3, 4 enabled.			
0x11	0x0C	WDO_DLY not applicable for latched WDO configuration			
0x12	0x03	BIST at POR			
0x13	0x06	Enable UVHF Mon2,3			
0x14	0x06	Enable UVLF Mon2,3			
0x15	0x06	Enable OVHF Mon2,3			
0x16	0x06	Enable OVLF Mon2,3			
0x1B	0x04	Thermal Shut Down Interrupt Enable			
0x1C	0x01	Bist Fail Interrupt			
0x1D	0x25	NRST MISMATCH, WDT \to NIRQ, WDT \to NRST, ESM \to WDO not Mapped, ESM \to NIRQ not Mapped, ESM \to NRST not Mapped			
0x1E	0x06	Enable Mon2,3			
0x1F	0x06	Mon2,3 x4 Scaling			
0x30	0xBC	4.56V UVHF Threshold Mon2			
0x31	0xE8	5.44V OVHF Threshold Mon2			
0x32	0xBC	4.56V UVLF Threshold Mon2			
0x33	0xE8	5.44V OVLF Threshold Mon2			
0x34	0xAA	102.4µs De-Bounce			
0x35	0x1C	O VHF \rightarrow NRST, UVHF \rightarrow NRST, 1kHz LF Cutoff			
0x40	0x6F	3.02V UVHF Threshold Mon3			
0x41	0x8C	3.6V OVHF Threshold Mon3			
0x42	0x6F	3.02V UVLF Threshold Mon3			
0x43	0x8C	3.6V OVLF Threshold Mon3			
0x44	0xAA	102.4µs De-bounce			
0x45	0x1C	O VHF → NRST, UVHF → NRST, 1kHz LF Cutoff			
0X9E	0x01	ESM Threshold = 2ms			
0X9F	0x59	Reset Delay 1ms, WD EN			
0xA1	0x06	AMSK ON MON2,3			
0xA2	0x06	AMSK OFF MON2,3			
0xA5,6	0x00	SEQ Timeout = 1ms			
0xA8	0x06	SEQ UP Mon2,3 UVLF			

Table 10-2. TPS389C0300CRTERQ1 OTP Configuration (continued)

		• • • • • • • • • • • • • • • • • • • •			
ADDR	DATA	Configuration Description			
0xA9	0x06	SEQ DOWN Mon2,3 UVLF			
0xAA	0x27	WD Violation Count = 2, WD Delay = 7			
0xAB	0x1D	WD Close = 30ms			
0xAC	0x1D	WD Open = 30ms			
0xFA	0x00	3.3V I2C interface			

Table 10-3. TPS389C03A26RTERQ1 OTP Configuration

ADDR	DATA	Configuration Description			
0x00	0x00	DEVICE_MODEL[7:3] and VENDOR_ID[2:0]			
0x01	0x42	SILICON_REV[7:6] and OTP_REV[5:0]			
0x02	0xF1	Channels disabled. MON2, 3, 4 enabled.			
0x11	0x0F	Timestamp & sequence overwrite, PEC enabled.			
0x12	0x03	BIST at POR			
0x13	0x0E	Enable UVHF interrupt MON 2, 3, 4.			
0x14	0x00	UVLF interrupt disabled.			
0x15	0x0E	Enable OVHF interrupt MON 2, 3, 4.			
0x16	0x00	OVLF interrupt disabled.			
0x1B	0x14	Thermal Shut Down Interrupt Enable			
0x1C	0x03	BIST complete and fail interrupt enabled.			
0x1D	0xAB	NRST MISMATCH, ESM \rightarrow NIRQ, ESM, WDT \rightarrow NRST, ESM \rightarrow WDO not mapped.			
0x1E	0x0E	Enable MON 2, 3, 4.			
0x1F	0x06	MON 2, 3 x4 Scaling			
0x30	0x6E	3.0V UVHF Threshold MON 2			
0x31	0x8C	3.6V OVHF Threshold MON 2			
0x32	0x76	3.16V UVLF Threshold MON 2			
0x33	0x84	3.44V OVLF Threshold MON 2			
0x34	0xAA	102.4µs De-Bounce			
0x35	0x1C	OVHF, UVHF → NRST, 1kHz LF Cutoff			
0x40	0x2D	1.7V UVHF Threshold MON 3			
0x41	0x37	1.9V OVHF Threshold MON 3			
0x42	0x2E	1.72V UVLF Threshold MON 3			
0x43	0x36	1.88V OVLF Threshold MON 3			
0x44	0xAA	102.4µs De-bounce			
0x45	0x1C	OVHF, UVHF → NRST, 1kHz LF Cutoff			
0x50	0xB4	1.1V UVHF Threshold MON 4			
0x51	0xDE	1.31V OVHF Threshold MON 4			
0x52	0xBD	1.145V UVLF Threshold MON 4			
0x53	0xD2	1.25V OVLF Threshold MON 4			
0x54	0xAA	102.4μs De-bounce			
0x55	0x1C	OVHF, UVHF → NRST, 1kHz LF Cutoff			
0X9E	0xFF	ESM Threshold = 864ms			



Table 10-3. TPS389C03A26RTERQ1 OTP Configuration (continued)

ADDR	DATA	Configuration Description
0X9F	0x5C	Reset Delay 20ms, WD EN
0xA1	0x0E	AMSK ON MON 2, 3, 4
0xA2	0x0E	AMSK OFF MON 2, 3, 4
0xA5,6	0x31	SEQ Timeout = 50ms
0xA8	0x00	SEQ UP Mon 2, 3, 4 OFF Threshold
0xA9	0x00	SEQ DOWN Mon 2, 3, 4 OFF Threshold
0xAA	0x71	WD Violation Count = 7, WD Delay = 1
0xAB	0x40	WD Close = 100ms
0xAC	0x40	WD Open = 100ms
0xFA	0x00	3.3V I2C interface

Product Folder Links: TPS389C03-Q1

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10.2 Documentation Support

10.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

10.4 Support Resources

TI E2E[™] support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

10.5 Trademarks

TI E2E[™] is a trademark of Texas Instruments.

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10.6 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

10.7 Glossary

TI Glossary

This glossary lists and explains terms, acronyms, and definitions.

11 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision G (January 2025) to Revision H (April 2025)	Page
Added ordering information for TPS389C03A26RTERQ1	3
Added OTP information for TPS389C0300CRTERQ1	132
Changes from Revision F (June 2024) to Revision G (January 2025)	Page
Modified state diagram to reflect timing for OTP load and BIST	44
PROT1 and PROT2 registers bit 4 changed to reserved	46
Changes from Revision E (February 2024) to Revision F (June 2024)	Page
Updated WDO delays typ	9
	9
Removed T _{HD:DAT} max limits to confirm to I ² C standards	• • • • • • • • • • • • • • • • • • • •
 Removed T_{HD;DAT} max limits to confirm to I²C standards Modify Register Protection Feature Description remove WRKS prot groups since these groups. 	
	groups are not



Changes from Revision D (October 2023	to Revision E (February 2024)	Page
Specify device behavior when fault repo	rting output is un-mapped	0
 Addition of device summary tables Table 	4-1, Table 4-2, and Table 4-3	3
· Specify device behavior when fault repo	rting output is un-mapped	18
· Specificy device behavior when fault rep	orting output is un-mapped	19
·	ration of PEC	
 Clarify watchdog window delay accuracy 	[/]	26
	rting output is un-mapped	
Clarification of WDO signal timing		39
Changes from Revision C (May 2023) to	Revision D (October 2023)	Page
` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` ` `		

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



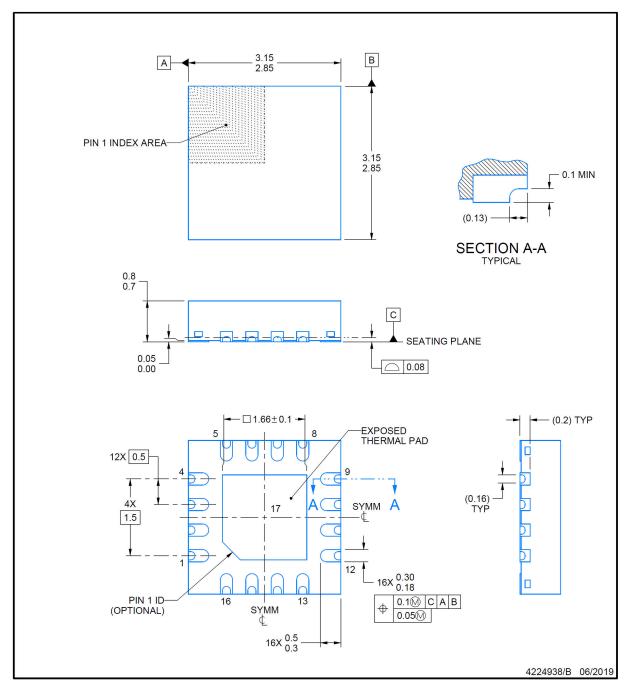
RTE0016K



PACKAGE OUTLINE

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
 This drawing is subject to change without notice.
- 3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

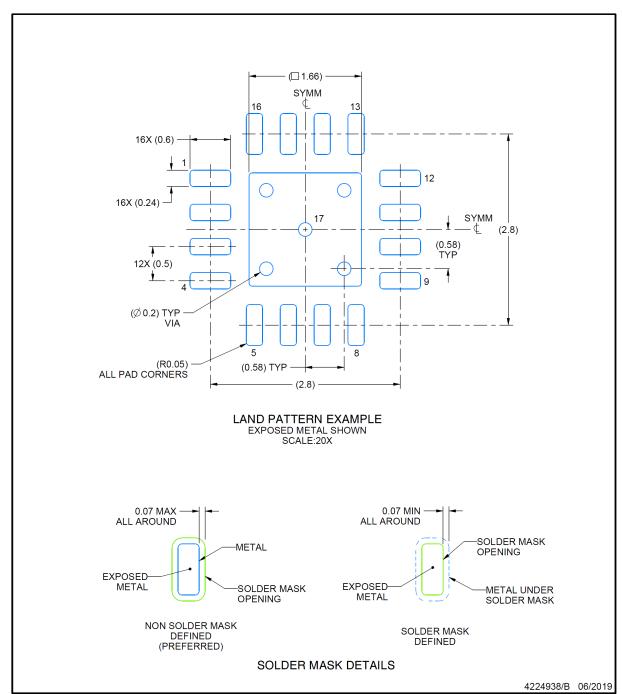


EXAMPLE BOARD LAYOUT

RTE0016K

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- 5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



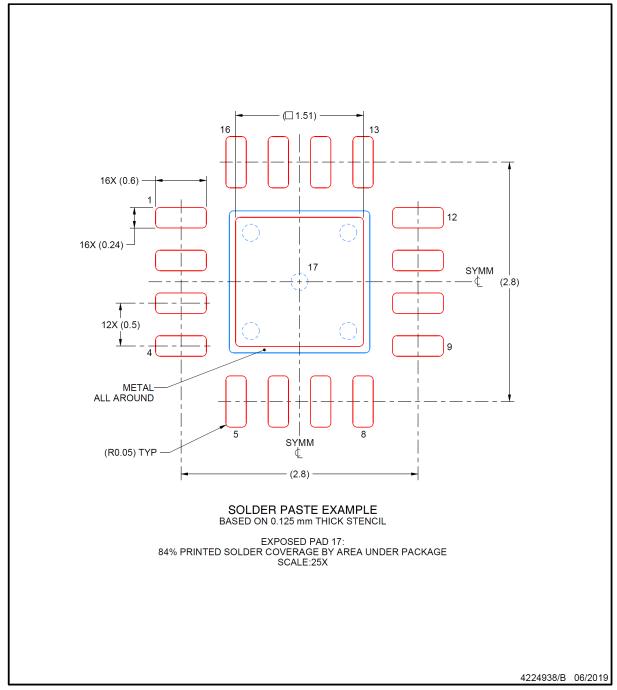


EXAMPLE STENCIL DESIGN

RTE0016K

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

www.ti.com 7-Nov-2025

PACKAGING INFORMATION

Orderable part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
	()	()			(-)	(4)	(5)		(-)
TPS389C0300CRTERQ1	Active	Production	WQFN (RTE) 16	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	C030Q
TPS389C0300CRTERQ1.A	Active	Production	WQFN (RTE) 16	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	C030Q
TPS389C03A26RTERQ1	Active	Production	WQFN (RTE) 16	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	T6ADJ
TPS389C03A26RTERQ1.A	Active	Production	WQFN (RTE) 16	3000 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	T6ADJ

⁽¹⁾ Status: For more details on status, see our product life cycle.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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⁽²⁾ Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

⁽⁴⁾ Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

PACKAGE MATERIALS INFORMATION

www.ti.com 13-May-2025

TAPE AND REEL INFORMATION





A0	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS389C0300CRTERQ1	WQFN	RTE	16	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TPS389C03A26RTERQ1	WQFN	RTE	16	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2

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*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS389C0300CRTERQ1	WQFN	RTE	16	3000	367.0	367.0	35.0
TPS389C03A26RTERQ1	WQFN	RTE	16	3000	367.0	367.0	35.0

3 x 3, 0.5 mm pitch

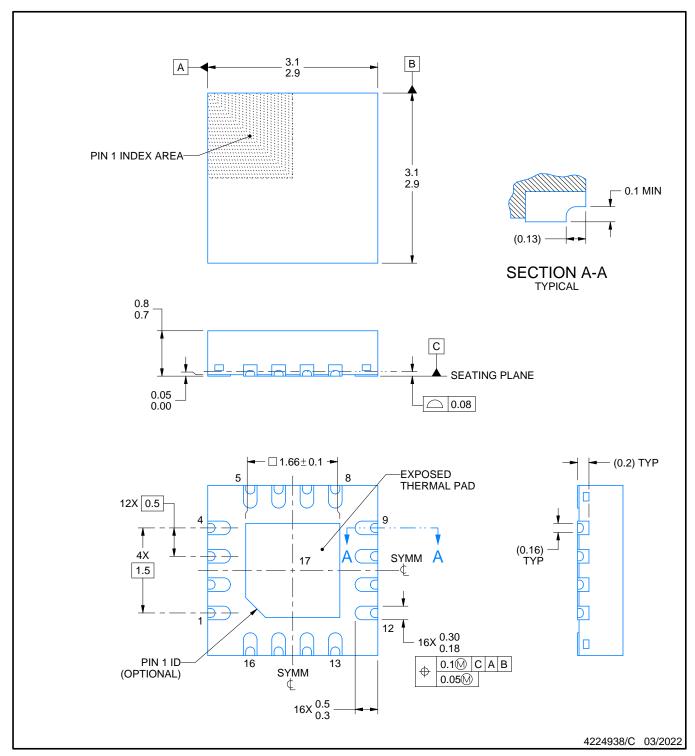
PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary. Refer to the product data sheet for package details.





PLASTIC QUAD FLATPACK - NO LEAD

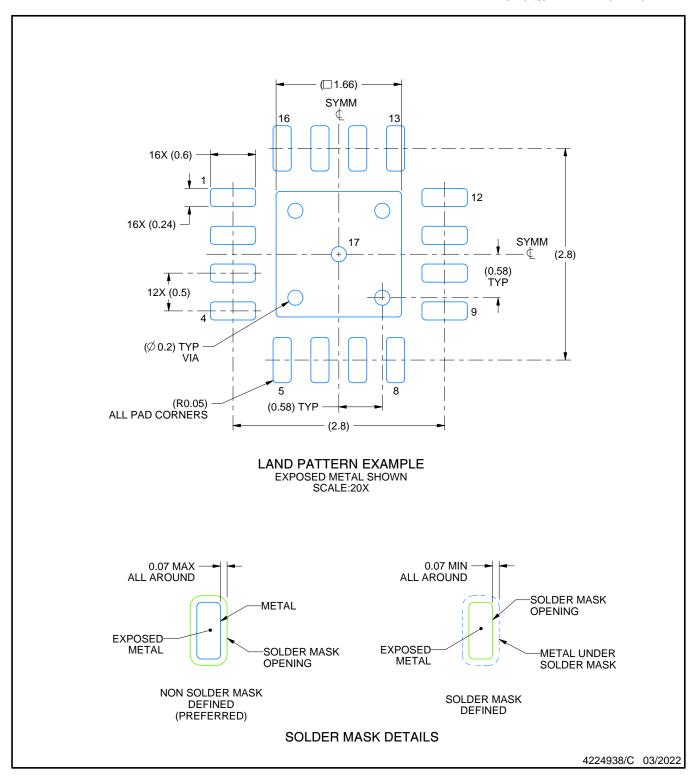


NOTES:

- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
 2. This drawing is subject to change without notice.
- 3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



PLASTIC QUAD FLATPACK - NO LEAD

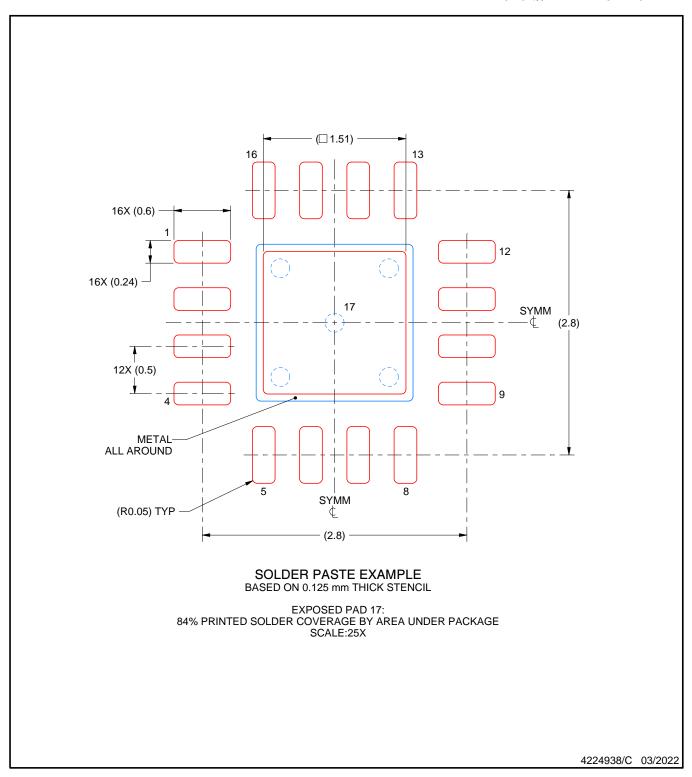


NOTES: (continued)

- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
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PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



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