TPS3762-Q1 具有内置自检和锁存器的汽车级 65V 窗口 (OV & UV) 监控器

1 特性

- 符合 ASIL-D 功能安全标准
  - 可帮助进行 ISO 26262 系统设计的文档
  - 系统可满足 ASIL D 级要求
  - 硬件可满足 ASIL-D 要求
- 符合面向汽车应用的 AEC-Q100 标准
  - 器件温度等级 1：-40°C 至 +125°C
- 器件灵活性可满足设计要求
  - 宽电压阈值范围：2.7V 至 60V
  - 800mV 选项 - 与外部电阻分压器配合使用来设置阈值
  - 内置迟滞（2%、5% 和 10% 选项）
  - 固定和可编程复位延时时间
  - 固定和可编程检测延迟
- 监测高压电源轨
  - 宽输入电压范围：2.7V 至 65V
  - 在检测引脚上提供 -65V 反极性保护
- 在 12V/24V/48V 系统中实现快速 UV/OV 保护
  - 输出复位锁存特性
  - 超快检测延时时间选项 (5μs)
  - 内置自检

2 应用

- 传感器融合和摄像头
- 数字驾驶舱处理单元
- 车载充电器
- ADAS 域控制器

3 说明

TPS3762-Q1 是一款具有 4μA I_{DD}、0.9% 精度、快速检测时间 (5μs) 和内置自检功能的 65V 输入电压监控器。该器件可直接连接到 12V/24V 汽车电池系统，用于持续监测过压 (OV) 和欠压 (UV) 条件；由于使用内部电阻分压器，TPS3762-Q1 的总体解决方案尺寸非常小。支持宽迟滞电压选项，可忽略较大的电压瞬变并防止出现错误的复位信号。

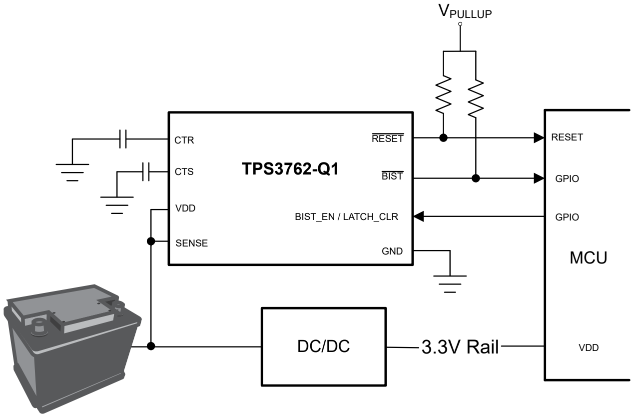
通过单独的 VDD 和 SENSE 引脚，可实现高可靠性系统所需的冗余，并且 SENSE 引脚可以监控比 VDD 更高和更低的电压。SENSE 引脚的高阻抗输入支持使用可选的外部电阻器。通过 CTS 和 CTR 引脚，可以对 RESET 信号的上升沿和下降沿进行延迟调整。CTS 忽略受监控电压轨上的电压干扰，从而充当去抖动器。

TPS3762-Q1 采用 2.9mm × 1.6mm SOT23 8 引脚封装。

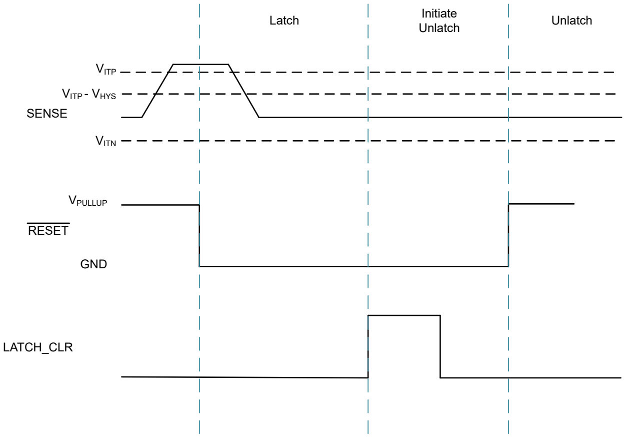
器件信息

器件型号	封装 [1]	本体尺寸（标称值）[2]
TPS3762-Q1	SOT-23 (8) (DDF)	2.9mm x 1.6mm

(1) 如需了解封装详细信息，请参阅数据表末尾的机械制图附录。
(2) 封装尺寸（长 × 宽）为标称值，并包括引脚（如适用）。



典型应用电路



锁存器功能波形

Table of Contents

4 Device Nomenclature

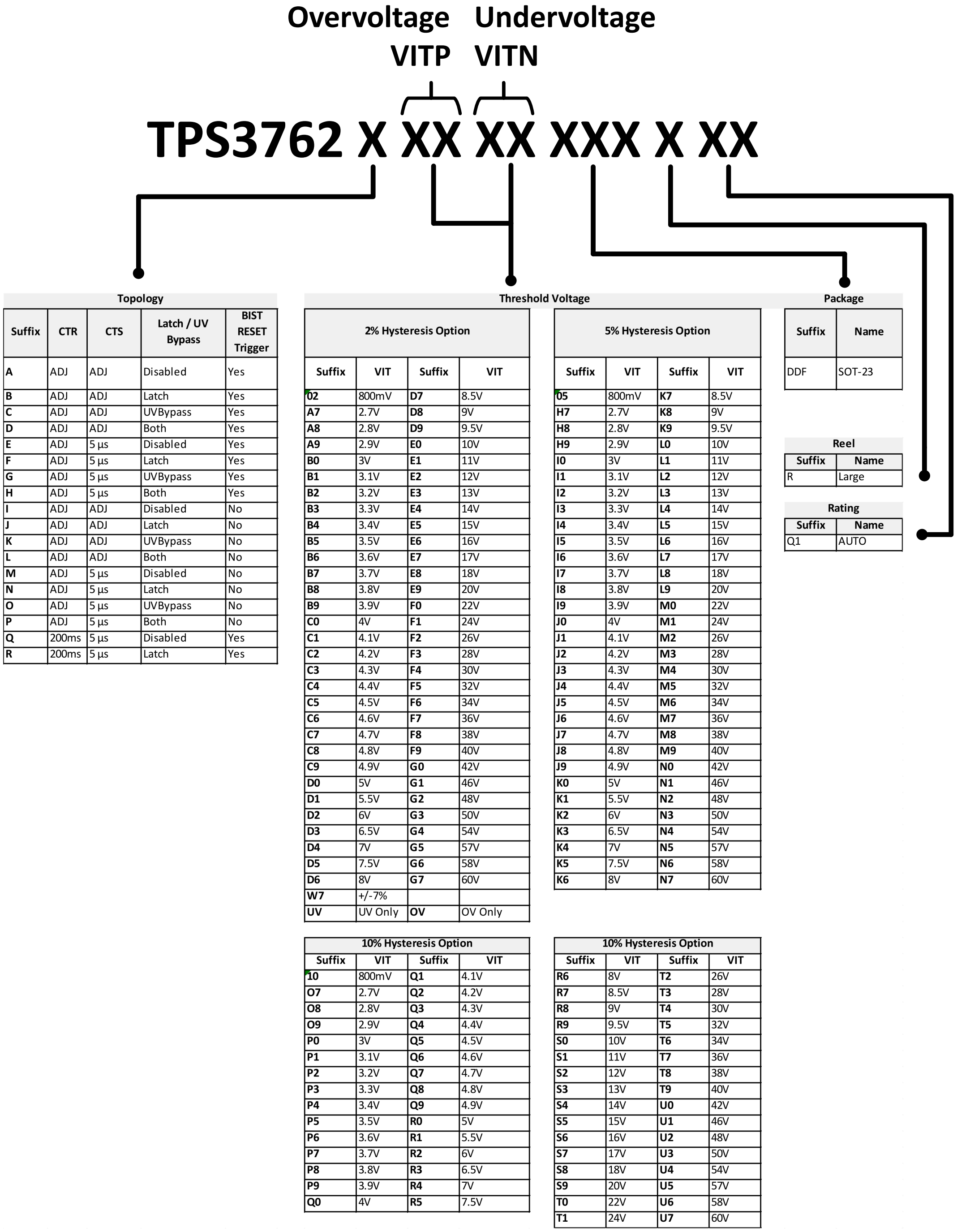
Device Decoder in 节 5 describe how to decode certain device function of the device based on its part number. Not all part numbers follow this nomenclature. Use 表 4-1 as the part number decoding table for all devices.

表 **4-1. Device Configuration Table**

ORDERABLE PART NAME	Overvoltage (V_{ITP})	Overvoltage Hysteresis	Undervoltage (V_{ITN})	Undervoltage Hysteresis	CTR / CTS	Latch / UVbypass	BIST RESET Trigger
TPS3762D02OVDDFRQ1	800mV	2%	N/A	N/A	ADJ / ADJ	Both	Yes

5 Device Comparison

Device Decoder shows some of the device naming nomenclature of the TPS3762-Q1. Not all device namings follow this nomenclature table. For a detailed breakdown of every device part number by threshold voltage options, BIST configurations, Latch configurations, CTR options, CTS options, and UV bypass, see 节 4 for more details. Contact TI sales representatives or on TI's E2E forum for detail and availability of other options.



Topology

Suffix	CTR	CTS	Latch / UV Bypass	BIST RESET Trigger
A	ADJ	ADJ	Disabled	Yes
B	ADJ	ADJ	Latch	Yes
C	ADJ	ADJ	UVBypass	Yes
D	ADJ	ADJ	Both	Yes
E	ADJ	5 µs	Disabled	Yes
F	ADJ	5 µs	Latch	Yes
G	ADJ	5 µs	UVBypass	Yes
H	ADJ	5 µs	Both	Yes
I	ADJ	ADJ	Disabled	No
J	ADJ	ADJ	Latch	No
K	ADJ	ADJ	UVBypass	No
L	ADJ	ADJ	Both	No
M	ADJ	5 µs	Disabled	No
N	ADJ	5 µs	Latch	No
O	ADJ	5 µs	UVBypass	No
P	ADJ	5 µs	Both	No
Q	200ms	5 µs	Disabled	Yes
R	200ms	5 µs	Latch	Yes

Threshold Voltage

2% Hysteresis Option

Suffix	VIT	Suffix	VIT
02	800mV	D7	8.5V
A7	2.7V	D8	9V
A8	2.8V	D9	9.5V
A9	2.9V	E0	10V
B0	3V	E1	11V
B1	3.1V	E2	12V
B2	3.2V	E3	13V
B3	3.3V	E4	14V
B4	3.4V	E5	15V
B5	3.5V	E6	16V
B6	3.6V	E7	17V
B7	3.7V	E8	18V
B8	3.8V	E9	20V
B9	3.9V	F0	22V
C0	4V	F1	24V
C1	4.1V	F2	26V
C2	4.2V	F3	28V
C3	4.3V	F4	30V
C4	4.4V	F5	32V
C5	4.5V	F6	34V
C6	4.6V	F7	36V
C7	4.7V	F8	38V
C8	4.8V	F9	40V
C9	4.9V	G0	42V
D0	5V	G1	46V
D1	5.5V	G2	48V
D2	6V	G3	50V
D3	6.5V	G4	54V
D4	7V	G5	57V
D5	7.5V	G6	58V
D6	8V	G7	60V
W7	+/-7%		
UV	UV Only	OV	OV Only

5% Hysteresis Option

Suffix	VIT	Suffix	VIT
05	800mV	K7	8.5V
H7	2.7V	K8	9V
H8	2.8V	K9	9.5V
H9	2.9V	L0	10V
I0	3V	L1	11V
I1	3.1V	L2	12V
I2	3.2V	L3	13V
I3	3.3V	L4	14V
I4	3.4V	L5	15V
I5	3.5V	L6	16V
I6	3.6V	L7	17V
I7	3.7V	L8	18V
I8	3.8V	L9	20V
I9	3.9V	M0	22V
J0	4V	M1	24V
J1	4.1V	M2	26V
J2	4.2V	M3	28V
J3	4.3V	M4	30V
J4	4.4V	M5	32V
J5	4.5V	M6	34V
J6	4.6V	M7	36V
J7	4.7V	M8	38V
J8	4.8V	M9	40V
J9	4.9V	N0	42V
K0	5V	N1	46V
K1	5.5V	N2	48V
K2	6V	N3	50V
K3	6.5V	N4	54V
K4	7V	N5	57V
K5	7.5V	N6	58V
K6	8V	N7	60V

Package

Suffix	Name
DDF	SOT-23

Reel

Suffix	Name
R	Large

Rating

Suffix	Name
Q1	AUTO

10% Hysteresis Option

Suffix	VIT	Suffix	VIT
10	800mV	Q1	4.1V
O7	2.7V	Q2	4.2V
O8	2.8V	Q3	4.3V
O9	2.9V	Q4	4.4V
P0	3V	Q5	4.5V
P1	3.1V	Q6	4.6V
P2	3.2V	Q7	4.7V
P3	3.3V	Q8	4.8V
P4	3.4V	Q9	4.9V
P5	3.5V	R0	5V
P6	3.6V	R1	5.5V
P7	3.7V	R2	6V
P8	3.8V	R3	6.5V
P9	3.9V	R4	7V
Q0	4V	R5	7.5V

10% Hysteresis Option

Suffix	VIT	Suffix	VIT
R6	8V	T2	26V
R7	8.5V	T3	28V
R8	9V	T4	30V
R9	9.5V	T5	32V
S0	10V	T6	34V
S1	11V	T7	36V
S2	12V	T8	38V
S3	13V	T9	40V
S4	14V	U0	42V
S5	15V	U1	46V
S6	16V	U2	48V
S7	17V	U3	50V
S8	18V	U4	54V
S9	20V	U5	57V
T0	22V	U6	58V
T1	24V	U7	60V

1. Suffix 02, 05, and 10 with VIT of 800mV corresponds to the adjustable variant, do not have internal voltage divider
2. Not all TPS3762-Q1 devices can be decoded by this table. Refer to 节 4 for a decoding table by part number.

6 Pin Configuration and Functions

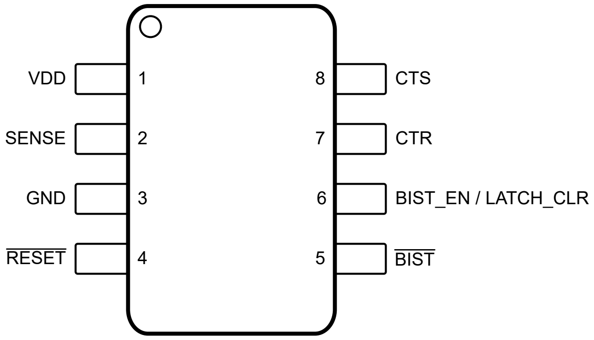


图 6-1. DDF Package,
8-Pin SOT-23,
TPS3762-Q1 (Top View)

表 6-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
VDD	1	I	**Input Supply Voltage:** Supply voltage pin. For noisy systems, bypass with a 0.1µF capacitor to GND.
SENSE	2	I	**Sense Voltage:** Connect this pin to the supply rail that must be monitored. See Section 8.3.2 for more details. Sensing Topology: **Overvoltage (OV) or Undervoltage (UV) or Window (OV + UV)**
GND	3	-	**Ground.** Ground pin. All GND pins must be electrically connected to the board ground.
$\overline{\text{RESET}}$	4	O	**Output Reset Signal:** $\overline{\text{RESET}}$ asserts when SENSE crosses the voltage threshold after the sense time delay, set by CTS, and remains asserted for the reset time delay period, set by CTR, after SENSE transitions out of a fault condition. For latch variants $\overline{\text{RESET}}$ remains asserted until the latch is cleared. The active low open-drain reset output requires an external pullup resistor. See Section 8.3.3.2 for more details. Output topology: **Open-Drain Active-Low**
$\overline{\text{BIST}}$	5	O	**Built-In Self-Test:** $\overline{\text{BIST}}$ asserts when a logic high input occurs on the BIST_EN / LATCH_CLR or BIST_EN pin, this initiates the internal BIST testing. $\overline{\text{BIST}}$ recovers after t_{BIST} to signify BIST completed successfully. $\overline{\text{BIST}}$ remains asserted for a time period longer than $t_{\overline{BIST}}$ if there is a failure during BIST. $\overline{\text{BIST}}$ active-low open-drain output requires an external pullup resistor. See Section 8.3.6 for more details.
BIST_EN / LATCH_CLR	6	I	**Built-in Self-test Enable and Latch Clear:** A logic high input must occur on the BIST_EN / LATCH_CLR to initate BIST and clear a latched $\overline{\text{OV}}$/$\overline{\text{UV}}$ fault. See Section 8.3.6 for more details.
CTR	7	O	**RESET Time Delay:** User-programmable reset time delay for $\overline{\text{RESET}}$. Connect an external capacitor for adjustable time delay or leave the pin floating for the shortest delay. See Section8.3.4 for more details.
CTS	8	O	**SENSE Time Delay:** User-programmable sense time delay for SENSE. Connect an external capacitor for adjustable time delay or leave the pin floating for the shortest delay. See Section 8.3.5 for more details.

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Voltage	V_{DD}, $V_{SENSE(Adjustable)}$, $V_{\overline{RESET}}$	–0.3	70	V
Voltage	$V_{SENSE(Fixed)}$	–65	70	V
Voltage	V_{CTS}, V_{CTR}	–0.3	6	V
Voltage	V_{BIST}, V_{BIST_EN}, $V_{BIST\_EN/LATCH\_CLR}$	–0.3	6	V
Current	I_{RESET}, I_{BIST}		10	mA
Temperature (2)	Operating junction temperature, T_J	–40	150	°C
Temperature (2)	Operating Ambient temperature, T_A	–40	150	°C
Temperature (2)	Storage, T_{stg}	–65	150	°C

(1) Stresses beyond those 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.

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

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 (1)	±2000	V
		Charged device model (CDM), per AEC Q100-011	±750	

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

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Voltage	V_{DD}	2.7		65	V
Voltage	V_{SENSE}, $V_{\overline{RESET}}$	0		65	V
Voltage	V_{CTS}, V_{CTR}	0		5.5	V
Voltage	$V_{\overline{BIST}}$, V_{BIST_EN}, $V_{BIST\_EN/LATCH\_CLR}$	0		5.5	V
Current	$I_{\overline{RESET}}$, $I_{\overline{BIST}}$	0		5	mA
T_J (1)	Junction temperature (free air temperature)	–40		125	°C

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

7.4 Thermal Information

THERMAL METRIC [1]		TPS3762-Q1	UNIT
		DDF	
		8-PIN	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	154.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	77.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	73.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter	4.8	°C/W
ψ_{JB}	Junction-to-board characterization parameter	72.9	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

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

7.5 Electrical Characteristics

At $V_{DD(MIN)} \leqslant V_{DD} \leqslant V_{DD\ (MAX)}$, CTR = CTS = open, output $\overline{\text{RESET}}$ pull-up resistor R_{PU} = 10kΩ, voltage V_{PU} = 5.5V, output $\overline{\text{BIST}}$ pull-up resistor R_{PU_BIST} = 10kΩ, voltage V_{PU_BIST}= 5.5V, and load C_{LOAD} = 10pF. The operating free-air temperature range T_A = –40°C to 125°C, unless otherwise noted. Typical values are at T_A = 25°C and V_{DD} = 12V and V_{IT} = 6.5V (V_{IT} refers to V_{ITN} or V_{ITP}).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
V_{DD}	Supply Voltage		2.7		65	V
UVLO (1)	Undervoltage Lockout	V_{DD} rising above $V_{DD\ (MIN)}$			2.6	V
UVLO(HYS) (1)	Undervoltage Lockout Hysteresis	V_{DD} falling below $V_{DD\ (MIN)}$		500		mV
$V_{POR(\overline{RESET})}$	Power on Reset Voltage (2) $\overline{\text{RESET}}$, Active Low (Open-Drain)	$V_{OL(MAX)}$ = 300mV $I_{OUT\ (Sink)}$ = 15µA			1.4	V
$V_{POR(\overline{BIST})}$	Power on Reset Voltage (2) $\overline{\text{BIST}}$, Active Low (Open-Drain)	$V_{OL(MAX)}$ = 300mV $I_{OUT\ (Sink)}$ = 15µA			1.4	V
I_{DD}	Supply current into V_{DD} pin	V_{IT} = 800mV $V_{DD\ (MIN)} \leqslant V_{DD} \leqslant V_{DD\ (MAX)}$		4	8.1	µA
SENSE (Input)						
I_{SENSE}	Input current	V_{IT} = 800mV			200	nA
V_{ITN}	Input Threshold Negative (Undervoltage)	V_{IT} = 800mV (3)	-0.9		0.9	%
V_{ITP}	Input Threshold Positive (Overvoltage)	V_{IT} = 800mV (3)	-0.9		0.9	%
V_{HYS}	Hysteresis Accuracy (4)	V_{IT} = 0.8V V_{HYS} Range = 2%	1.5	2	2.5	%
$\overline{\text{RESET}}$ (Output)						
$I_{lkg(OD)}$	Open-Drain leakage	$V_{\overline{RESET}}$ = 5.5V $V_{ITN} < V_{SENSE} < V_{ITP}$			300	nA
$I_{lkg(OD)}$	Open-Drain leakage	$V_{\overline{RESET}}$ = 65V $V_{ITN} < V_{SENSE} < V_{ITP}$			300	nA
V_{OL} (5)	Low level output voltage	2.7V ⩽ VDD ⩽ 65V $I_{\overline{RESET}}$ = 2.7mA			350	mV

7.5 Electrical Characteristics（续）

At $V_{DD(MIN)} \leqslant V_{DD} \leqslant V_{DD\ (MAX)}$, CTR = CTS = open, output $\overline{RESET}$ pull-up resistor R_{PU} = 10kΩ, voltage V_{PU} = 5.5V, output $\overline{BIST}$ pull-up resistor $R_{PU\_\overline{BIST}}$ = 10kΩ, voltage $V_{PU\_\overline{BIST}}$= 5.5V, and load C_{LOAD} = 10pF. The operating free-air temperature range T_A = – 40°C to 125°C, unless otherwise noted. Typical values are at T_A = 25°C and V_{DD} = 12V and V_{IT} = 6.5V (V_{IT} refers to V_{ITN} or V_{ITP}).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Capacitor Timing (CTS, CTR)						
R_{CTR}	Internal resistance (CTR)		2.96	3.7	4.44	MΩ
R_{CTS}	Internal resistance (CTS)		2.96	3.7	4.44	MΩ
Built-in Self-test						
$I_{lkg(\overline{BIST})}$	Open-Drain leakage	$V_{\overline{BIST}}$ = 5.5V $V_{ITN} < V_{SENSE} < V_{ITP}$			300	nA
$I_{lkg(\overline{BIST})}$	Open-Drain leakage	$V_{\overline{BIST}}$ = 3.3V $V_{ITN} < V_{SENSE} < V_{ITP}$			300	nA
$V_{\overline{BIST}\_OL}$	Low level output voltage	2.7V ⩽ VDD ⩽ 65V $I_{\overline{BIST}}$ = 5mA			300	mV
V_{BIST_EN}	BIST_EN pin logic low input				500	mV
V_{BIST_EN}	BIST_EN pin logic high input		1300			mV
$V_{BIST\_EN/}$ LATCH_CLR	LATCH_CLR pin logic low input				500	mV
$V_{BIST\_EN/}$ LATCH_CLR	LATCH_CLR pin logic high input		1300			mV

(1) When V_{DD} voltage falls below UVLO, $\overline{RESET}$ is asserted. V_{DD} slew rate ⩽ 100mV / µs
(2) V_{POR} is the minimum V_{DD} voltage for a controlled output state. Below V_{POR}, the output cannot be determined. V_{DD} slew rate ⩽ 100mV/µs
(3) For adjustable voltage guidelines and resistor selection refer to **Adjustable Voltage Thresholds** in **Application and Implementation section**
(4) Hysteresis is with respect to V_{ITP} and V_{ITN} voltage threshold. V_{ITP} has negative hysteresis and V_{ITN} has positive hysteresis.
(5) For V_{OH} and V_{OL} relation to output variants refer to **Timing Figures after the Timing Requirement Table**

7.6 Switching Requirements

At $V_{DD(MIN)} \leqslant V_{DD} \leqslant V_{DD\ (MAX)}$, CTR = CTS = open and enabled, output $\overline{\text{RESET}}$ pull-up resistor R_{PU} = 10kΩ, voltage V_{PU} = 5.5V, output $\overline{\text{BIST}}$ pull-up resistor $R_{PU\_\overline{BIST}}$ = 10kΩ, voltage $V_{PU\_\overline{BIST}}$= 5.5V, and load C_{LOAD} = 10pF. The operating free-air temperature range T_A = – 40°C to 125°C, unless otherwise noted. Typical values are at T_A = 25°C and V_{DD} = 12V and V_{IT} = 6.5V (V_{IT} refers to V_{ITN} or V_{ITP}).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Common Switching Requirements						
$t_{CTR(No\ Cap)}$	$\overline{\text{RESET}}$ release time delay (CTR)(1)	VIT = 800mV C_{CTR} = Open 20% Overdrive from Hysteresis		350	600	µs
$t_{CTS(No\ Cap)}$	Sense detect time delay (CTS)(2)	VIT = 800mV C_{CTS} = Open 20% Overdrive from V_{IT}		85	100	µs
t_{SD}	Startup Delay (3)	C_{CTR} = Open		1		ms
BIST Switching Requirements						
$t_{BIST\_en\_pd}$	Rising edge of BIST_EN to BIST asserting			2.3		µs
$t_{BIST\_en\_pd}$	Rising edge of BIST_EN to RESET asserting			2.3		µs
$t_{\overline{BIST}\_recover}$	Rising edge of $\overline{\text{BIST}}$ to SENSE input valid	C_{CTR} = Open, BIST = Enabled		350	600	µs
$t_{\overline{BIST}}$	BIST run time				3.5	ms
$t_{SD+\overline{BIST}}$	Startup time with BIST run time				4.5	ms
LATCH Switching Requirements						
$t_{BIST\_EN/LATCH\_CLR\_Recover}$	Rising edge of $\overline{\text{BIST}}$ to SENSE input valid	C_{CTR} = Open, BIST = Disabled		10		µs

(1) **CTR Reset detect time delay:**
Overvoltage active-low output is measure from $V_{ITP\ -\ HYS}$ to V_{OH}
Undervoltage active-low output is measure from $V_{ITN\ +\ HYS}$ to V_{OH}

(2) **CTS Sense detect time delay:**
Overvoltage active-low output is measure from V_{ITP} to V_{OL}
Undervoltage active-low output is measure from V_{ITN} to V_{OL}

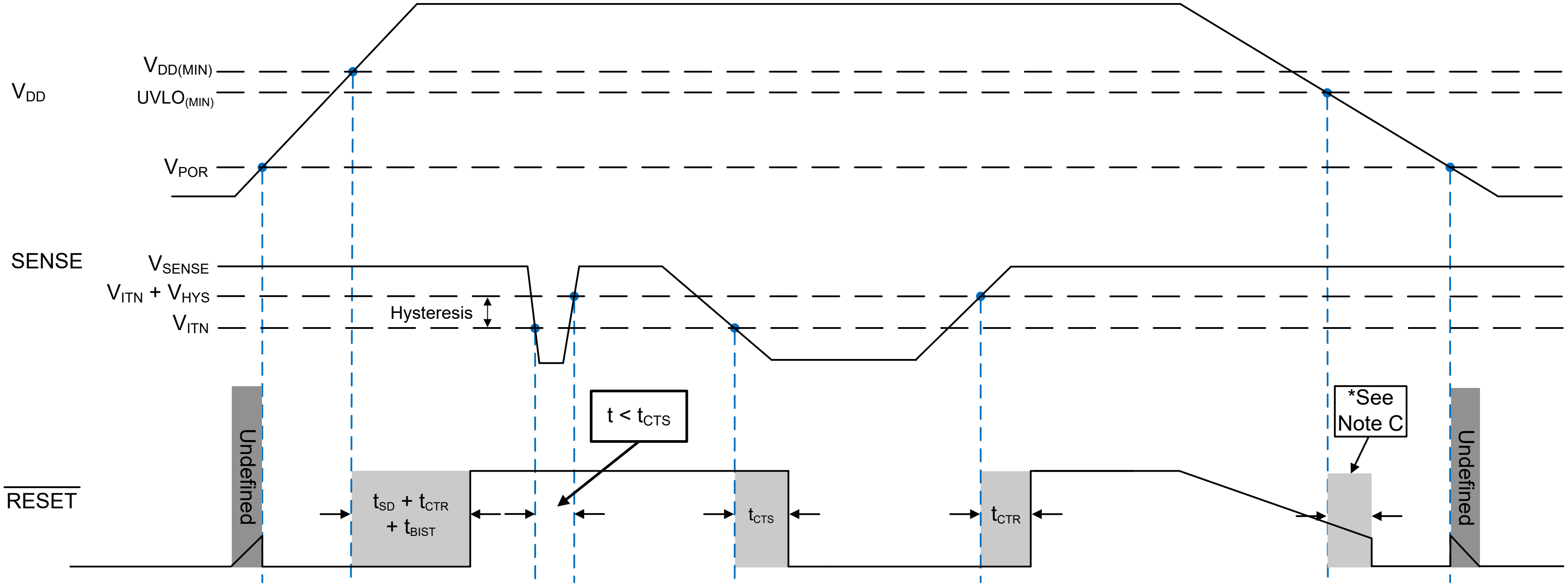
(3) During the power-on sequence, V_{DD} must be at or above $V_{DD\ (MIN)}$ for at least $t_{SD+\overline{BIST}} + t_{CTR}$ before the output is in the correct state based on V_{SENSE}.
t_{SD} time includes the propagation delay (C_{CTR} = Open). Capacitor on CTR will add time to t_{SD}.

7.7 Timing Requirements

At $V_{DD(MIN)} \leqslant V_{DD} \leqslant V_{DD\ (MAX)}$, CTR = CTS = open and enabled, output $\overline{RESET}$ pull-up resistor R_{PU} = 10kΩ, voltage V_{PU} = 5.5V, output $\overline{BIST}$ pull-up resistor $R_{PU\_\overline{BIST}}$ = 10kΩ, voltage $V_{PU\_\overline{BIST}}$= 5.5V, and load C_{LOAD} = 10pF. The operating free-air temperature range T_A = –40°C to 125°C, unless otherwise noted. Typical values are at T_A = 25°C and V_{DD} = 12V and V_{IT} = 6.5V (V_{IT} refers to V_{ITN} or V_{ITP}).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Common timing parameters						
BIST timing parameters						
$t_{BIST\_en\ Glitch}$	BIST_EN Glitch immunity			1.1		µs
t_{BIST_en}	Minimum BIST_EN input width to initate BIST			1.2	8	µs
LATCH timing parameters						
$t_{BIST\_EN/LATCH\_CLR\ Glitch}$	Latch Glitch immunity			1.5		µs
$t_{BIST\_EN/LATCH\_CLR}$	Latch input width to clear latch			1.6		µs

8 Timing Diagrams

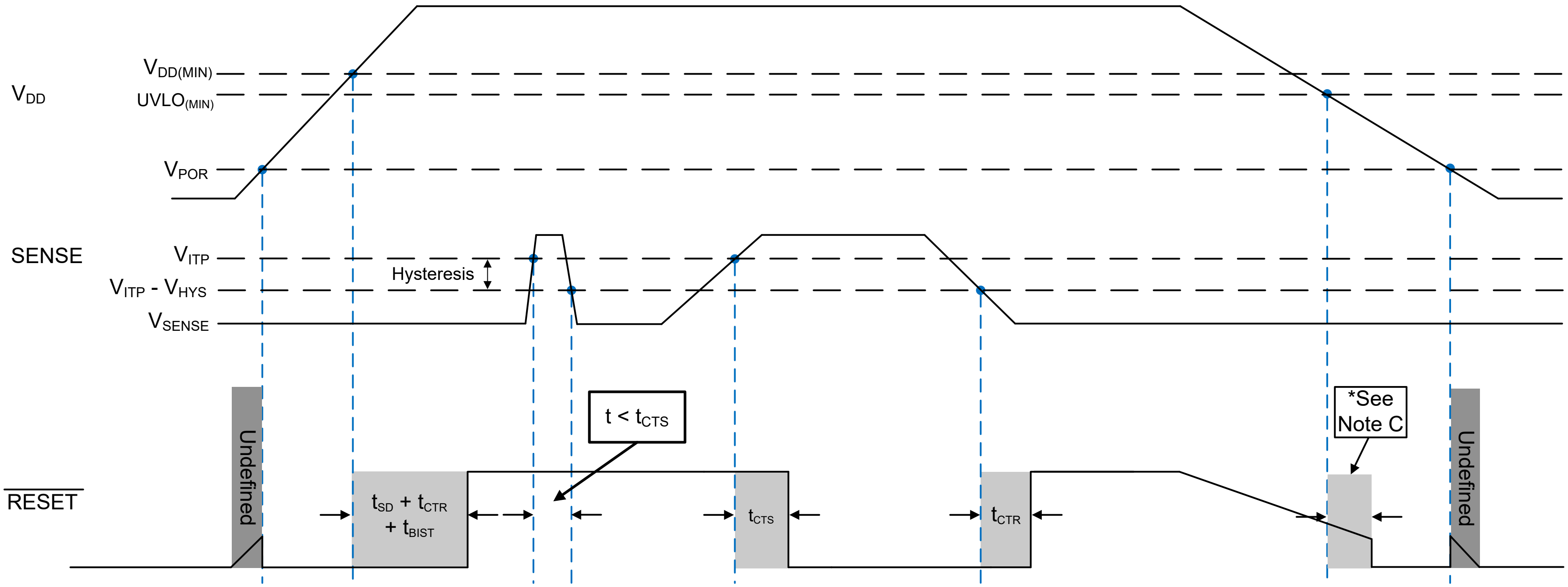


A. The timing diagram assumes the open-drain output $\overline{\text{RESET}}$ pin is connected via an external pull-up resistor to V_{DD}.

B. Be advised that 图 8-1 shows the V_{DD} falling slew rate is slow or the V_{DD} decay time is much larger than the propagation detect delay (t_{CTR}) time.

C. $\overline{\text{RESET}}$ is asserted when V_{DD} goes below the $UVLO_{(MIN)}$ threshold after the time delay, t_{CTR}, is reached.

图 8-1. SENSE Undervoltage (UV) Timing Diagram



A. The timing diagram assumes the open-drain output $\overline{\text{RESET}}$ pin is connected via an external pull-up resistor to V_{DD}.

B. Be advised that 图 8-2 shows the V_{DD} falling slew rate is slow or the V_{DD} decay time is much larger than the propagation detect delay (t_{CTR}) time.

C. $\overline{\text{RESET}}$ is asserted when V_{DD} goes below the $UVLO_{(MIN)}$ threshold after the time delay, t_{CTR}, is reached.

图 8-2. SENSE Overvoltage (OV) Timing Diagram

9 Typical Characteristics

Typical characteristics show the typical performance of the TPS3762-Q1 device. Test conditions are taken at T_A = 25°C, unless otherwise noted.

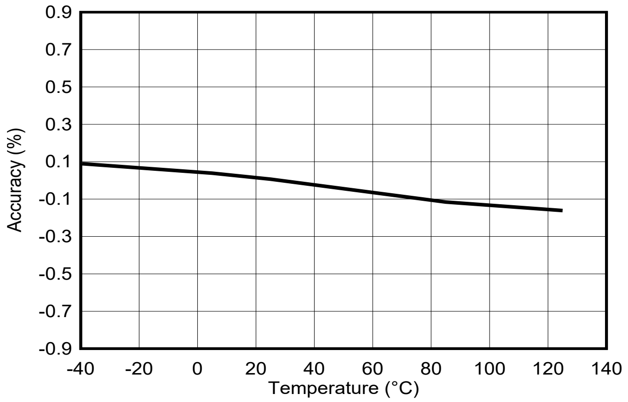


图 9-1. Undervoltage Accuracy vs Temperature (V_{IT} = 0.8V)

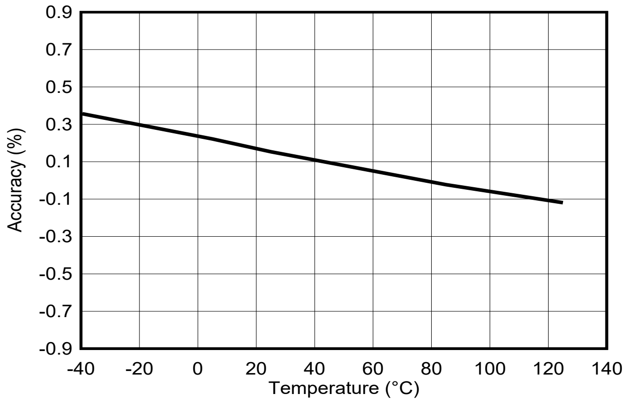


图 9-2. Overvoltage Accuracy vs Temperature (V_{IT} = 0.8V)

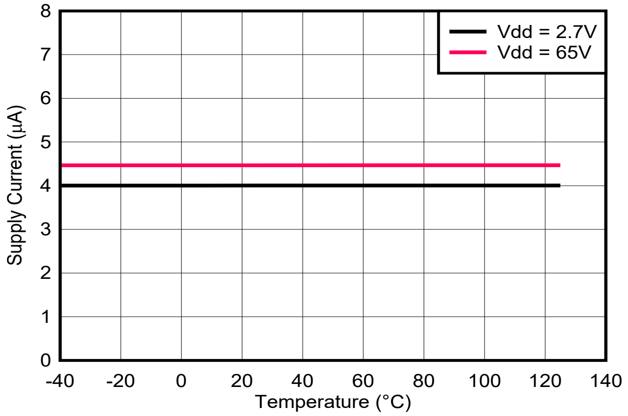


图 9-3. I_{DD} vs Temperature ($\overline{RESET}$ = High, V_{IT} = 0.8V)

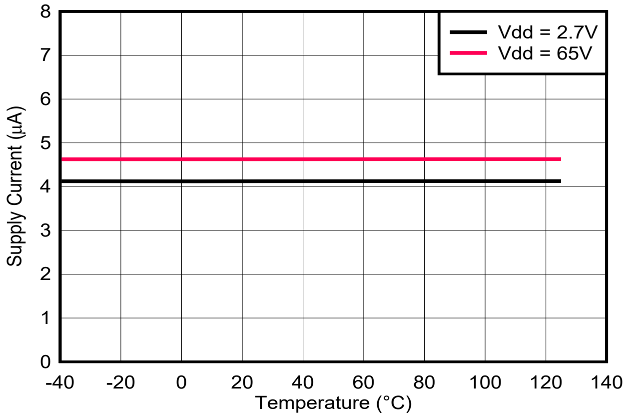


图 9-4. I_{DD} vs V_{DD} ($\overline{RESET}$ = Low, V_{IT} = 0.8V)

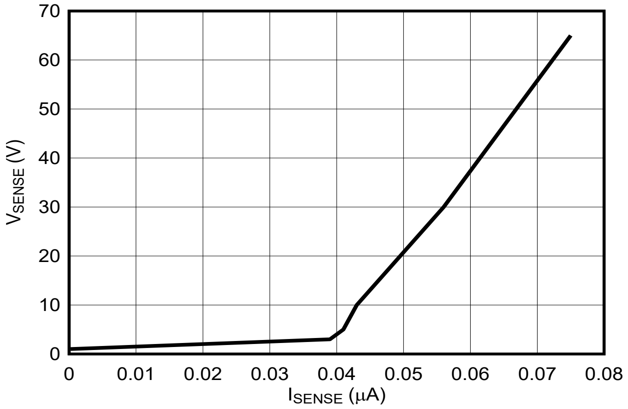


图 9-5. V_{SENSE} vs I_{SENSE} (V_{DD} = 2.7V)

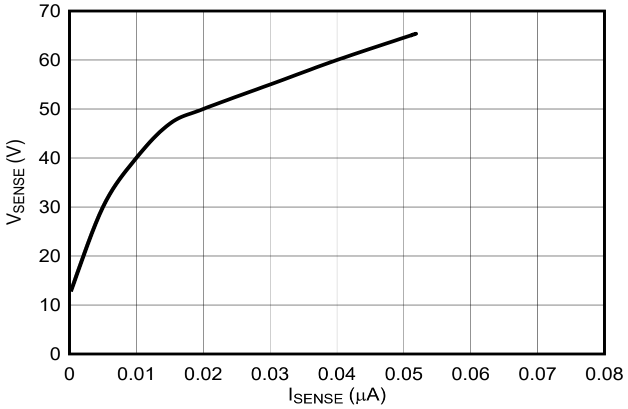


图 9-6. V_{SENSE} vs I_{SENSE} (V_{DD} = 65V)

9 Typical Characteristics (continued)

Typical characteristics show the typical performance of the TPS3762-Q1 device. Test conditions are taken at T_A = 25°C, unless otherwise noted.

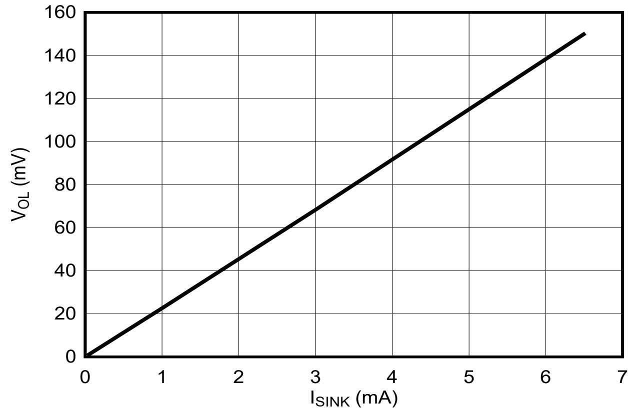


图 9-7. Open-Drain Active Low V_{OL} vs $I_{\overline{RESET}}$ (V_{DD} = 2.7V)

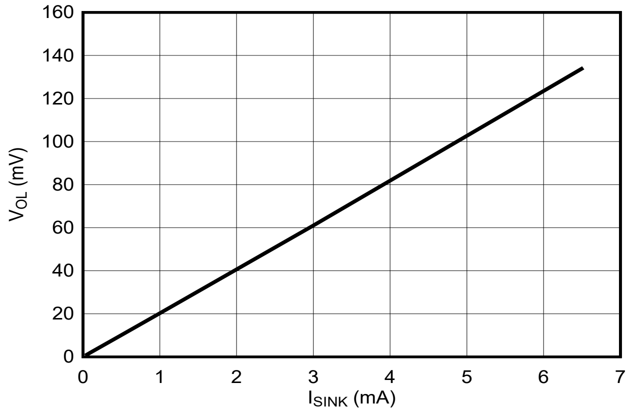


图 9-8. Open-Drain Active Low V_{OL} vs $I_{\overline{RESET}}$ (V_{DD} = 65V)

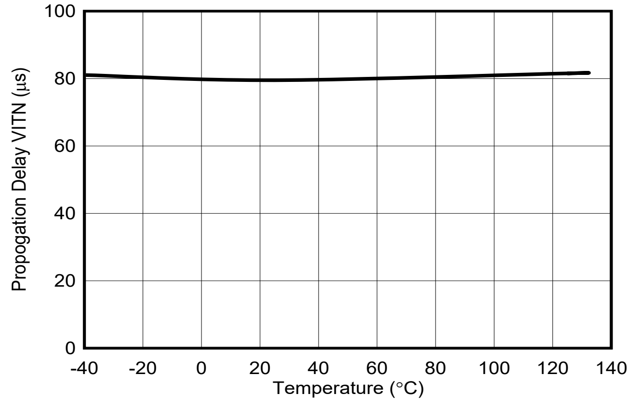


图 9-9. Propogation Delay (Undervoltage) vs Temperature (V_{IT} = 0.8V, CTS = Enabled = 50pF)

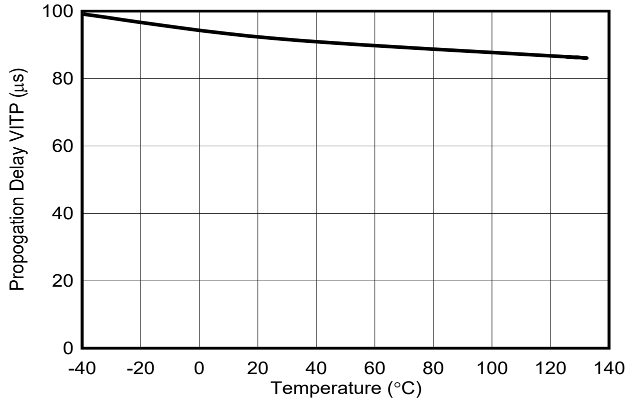


图 9-10. Propogation Delay (Overvoltage) vs Temperature (V_{IT} = 0.8V, CTS = Enabled = 50pF)

10 Detailed Description

10.1 Overview

The TPS3762-Q1 is a family of high voltage and low quiescent current voltage supervisors with overvoltage and undervoltage threshold voltage options, delay timings, Built-In Self-Test, and latch. The TPS3762-Q1 over and undervoltage thresholds are device specific and are offered in either adjustable thresholds or fixed threholds. The adjustable threshold option uses an external resistor ladder to make a voltage divider on SENSE pin which uses the internal 800mV threshold to trigger overvoltage and undervoltage faults. The benefit of using an adjustable option with external resistors is the faster reaction speed compared to a fixed internal threshold variant. The TPS3762-Q1 fixed threshold option utilizes an integrated voltage divider to eliminate the need for external resistors and provides a lower system leakage current.

VDD, SENSE and $\overline{\text{RESET}}$ pins can support 65V continuous operation. SENSE has -65V reverse polarity protection. VDD, SENSE, and $\overline{\text{RESET}}$ voltage levels can be independent of each other. TPS3762-Q1 includes a reset output latching feature that holds the output active to help system achieve safe state. Fixed and programmable sense and reset delay are available to avoid false resets and false reset releases.

10.2 Functional Block Diagram

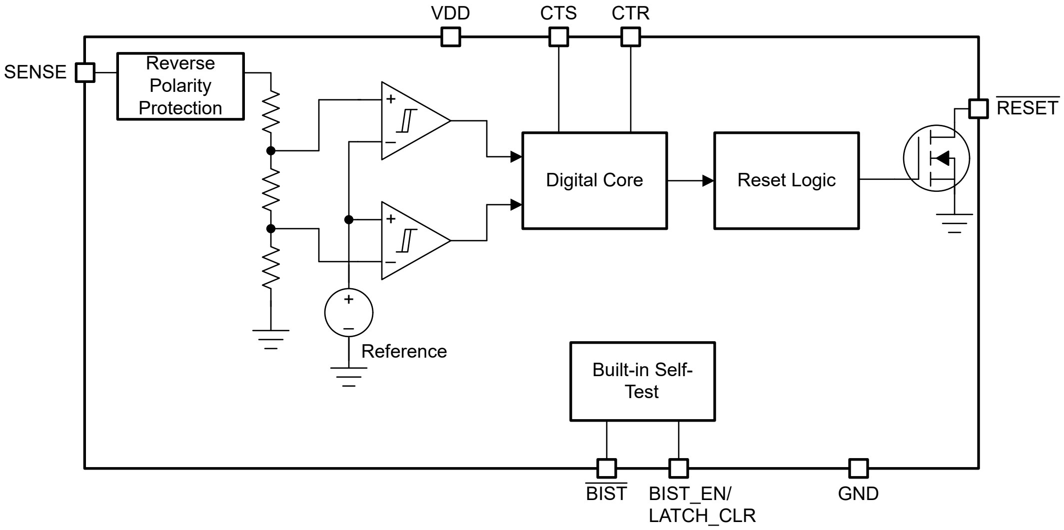


图 10-1. Fixed Threshold Functional Block Diagram

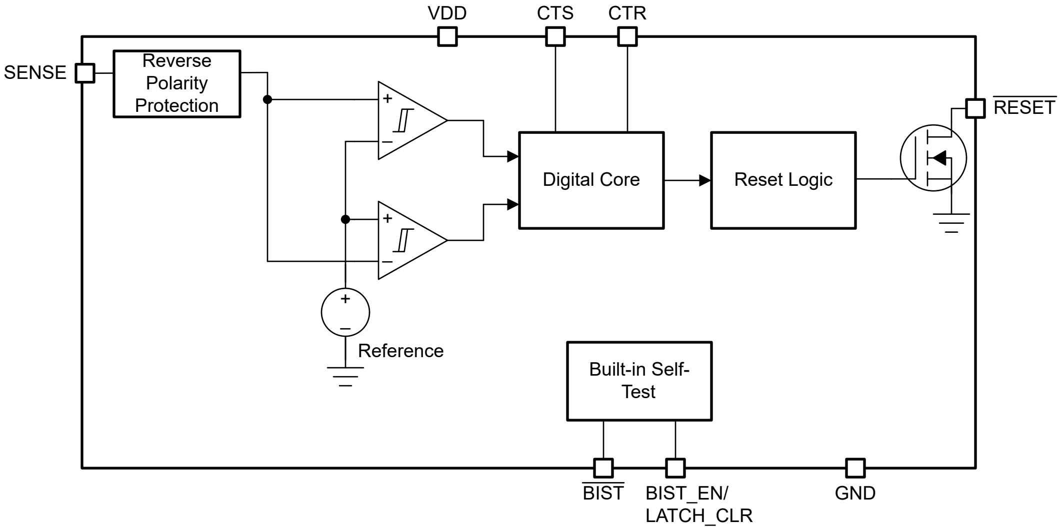


图 10-2. Adjustable Threshold Functional Block Diagram

10.3 Feature Description

10.3.1 Input Voltage (VDD)

VDD operating voltage ranges from 2.7V to 65V. An input supply capacitor is not required for this device; however, if the input supply is noisy good analog practice is to place a 0.1µF capacitor between the VDD and GND.

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

VDD voltage is independent of V_{SENSE} and V_{RESET}, meaning that VDD can be higher or lower than the other pins.

10.3.1.1 Undervoltage Lockout ($V_{POR} < V_{DD} <$ UVLO)

When the voltage on V_{DD} is less than the UVLO voltage, but greater than the power-on reset voltage (V_{POR}), the $\overline{\text{RESET}}$ and $\overline{\text{BIST}}$ pins will be asserted, regardless of the voltage at SENSE pin.

10.3.1.2 Power-On Reset ($V_{DD} < V_{POR}$)

When the voltage on VDD is lower than the power on reset voltage (V_{POR}), the output signal is undefined and is not to be relied upon for proper device function.

Note: 图 10-3 and 图 10-4 assume an external pull-up resistor is connecting the $\overline{\text{RESET}}$ pin to VDD.

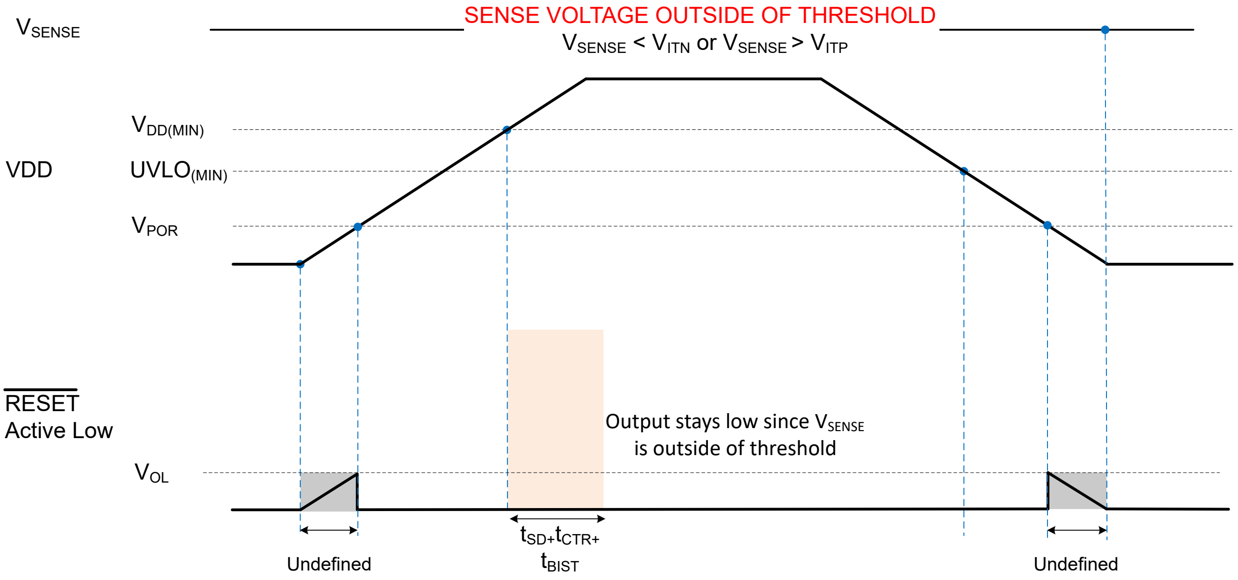


图 10-3. Power Cycle (SENSE Outside of Nominal Voltage)

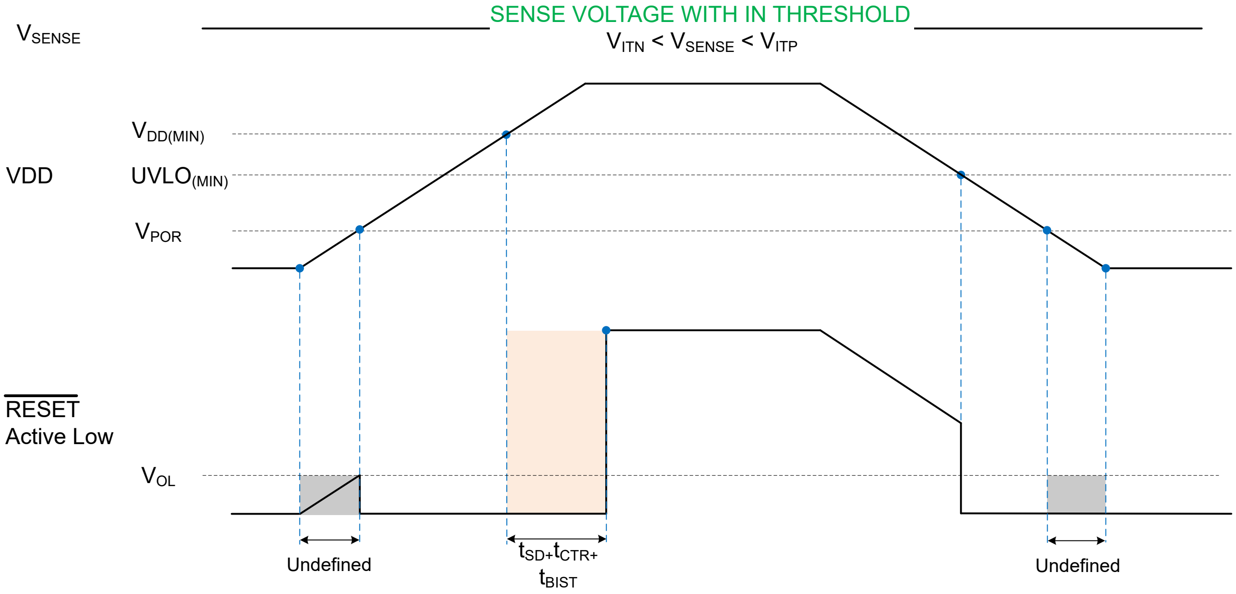


图 10-4. Power Cycle (SENSE Within Nominal Voltage)

10.3.2 SENSE

The SENSE pin connects to the supply rail that is to be monitored. The sense pin on each device is configured to monitor either overvoltage (OV), undervoltage (UV), or window (OV&UV) conditions. TPS3762-Q1 device offers built-in hysteresis that provides noise immunity and maintains stable operation.

Although not required in most cases, for noisy applications where t_{CTS} is not sufficient glitch rejection, good analog design practice is to place a 10nF to 100nF bypass capacitor at the SENSE input to reduce sensitivity to transient voltages on the monitored signal. SENSE can be connected directly to VDD pin.

10.3.2.1 Reverse Polarity Protection

The TPS3762-Q1 has reverse polarity protection on the sense pin up to -65V. This allows the TPS3762-Q1 to support accidental or test simulated reverse connections without damaging the device. This protection permits the TPS3762-Q1 to connect directly off of the supply prior to any reverse polarity protection diodes for accurate voltage measurement.

10.3.2.2 SENSE Hysteresis

TPS3762-Q1 device offers built-in hysteresis around the UV and OV thresholds to avoid erroneous $\overline{\text{RESET}}$ deassertions. The hysteresis is opposite to the threshold voltage; for overvoltage options the hysteresis is subtracted from the positive threshold (V_{ITP}), for undervoltage options hysteresis is added to the negative threshold (V_{ITN}).

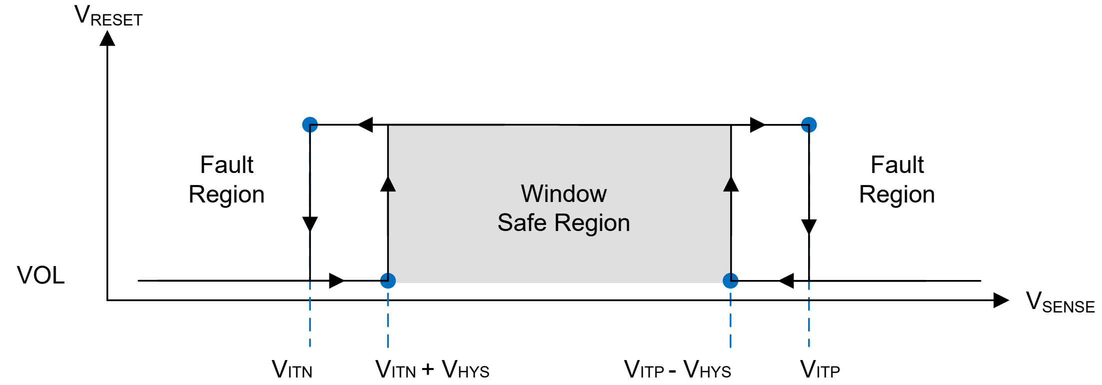


图 10-5. Hysteresis (Undervoltage & Overvoltage Active-Low)

表 10-1. Common Adjustable Hysteresis Lookup Table

TARGET			DEVICE HYSTERESIS OPTION
ADJUSTABLE THRESHOLD	TOPOLOGY	RELEASE VOLTAGE (V)	
800mV	Overvoltage	784mV	-2%
800mV	Overvoltage	760mV	-5%
800mV	Overvoltage	720mV	-10%
800mV	Undervoltage	816mV	2%
800mV	Undervoltage	840mV	5%
800mV	Undervoltage	880mV	10%

表 10-1 shows a sample of hysteresis for the 800mV adjustable variant of TPS3762-Q1.

Knowing the amount of hysteresis voltage, the release voltage for the undervoltage (UV) channel is (V_{ITN} + V_{HYS}) and for the overvoltage (OV) channel is (V_{ITP} - V_{HYS}).

Undervoltage (UV)

V_{ITN} = 800mV

Voltage Hysteresis (V_{HYS}) = 2% = 16mV

Hysteresis Accuracy = +1.5% to +2.5% = 16.24mV to 16.4mV

Release Voltage = V_{ITN} + V_{HYS} = 816.24mV to 816.4mV

Overvoltage (OV)

V_{ITP} = 800mV

Voltage Hysteresis (V_{HYS}) = 2% = 16mV

Hysteresis Accuracy = +1.5% to +2.5% = 16.24mV to 16.4mV

Release Voltage = V_{ITP} - V_{HYS} = 783.6mV to 783.76mV

10.3.3 Output Logic Configurations

TPS3762-Q1 is a single channel device that has a single input SENSE pin and a single $\overline{\text{RESET}}$ pin. The single $\overline{\text{RESET}}$ is available only with open drain topology.

10.3.3.1 Open-Drain

Open-drain output requires an external pull-up resistor to hold the voltage 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 select the right pull-up resistor consider system V_{OH} and the Open-Drain Leakage Current (I_{lkg}) provided in the electrical characteristics, high resistors values will have a higher voltage drop affecting the output voltage high. The open-drain output can be connected as a wired-AND logic with other open-drain signals such as another TPS3762-Q1 open-drain output pin.

10.3.3.2 Active-Low ($\overline{\text{RESET}}$)

$\overline{\text{RESET}}$ (active low) denoted with a bar above the pin label. $\overline{\text{RESET}}$ remains high voltage (V_{OH}, deasserted) as long as sense voltage is in normal operation within the threshold boundaries and VDD voltage is above UVLO. To assert a reset sense pins needs to meet the condition below:

- For undervoltage the SENSE voltage need to cross the lower boundary (V_{ITN}).
- For overvoltage the SENSE voltage needs to cross the upper boundary (V_{ITP}).

10.3.3.3 Latching

The TPS3762-Q1 comes with the optional output reset latching feature, check the 节 5 to verify variant specific latch functionality. When using a variant with latch enabled ($V_{BIST\_EN/LATCH\_CLR}$ <0.5V), whenever a fault, OV or UV, occurs $\overline{\text{RESET}}$ asserts and goes low and remains low until cleared by a logic high input ($V_{BIST\_EN/LATCH\_CLR}$ > 1.3V) on the BIST_EN / LATCH_CLR pin. If the SENSE pin is in a safe region and latch is disabled, the $\overline{\text{RESET}}$ deasserts after a delay. This delay is dependent on BIST and CTR timing. See 节 10.3.6 for more details. While $V_{BIST\_EN/LATCH\_CLR}$ > 1.3V, the device is in latch disabled mode and the $\overline{\text{RESET}}$ does not latch for OV and UV on SENSE pin. While the device is in latch disabled mode the $\overline{\text{RESET}}$ asserts for OV and UV faults. When $V_{BIST\_EN/LATCH\_CLR}$ < 0.5V, latch mode is enabled.

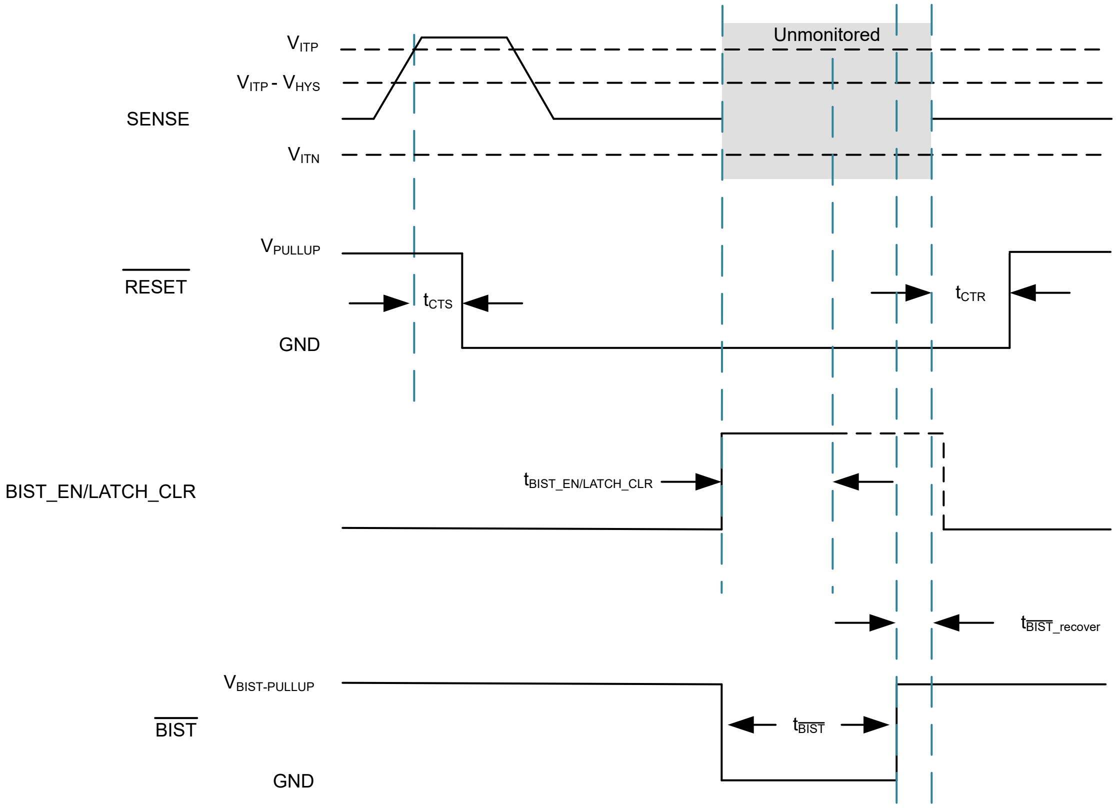


图 10-6. $\overline{\text{RESET}}$ Latch & Unlatch

10.3.3.4 UVBypass

The TPS3762-Q1 comes with the optional undervoltage bypass (UVbypass) feature, check 节 5 to verify variant specific UVbypass functionality. When using a variant with UVbypass enabled, the first undervoltage event after $V_{DD} > V_{POR}$ is ignored. In cases where an undervoltage event has not occurred UVbypass can be cleared by running BIST.

UVbypass is targeted at specific applications in which the TPS3762-Q1 is powered Off-battery and is monitoring the Off-battery DC-DC output, as shown in 图 10-7. If the Off-battery DCDC output is outside of threshold the TPS3762-Q1 resets this device. See 图 10-8 and 图 10-9 for more details.

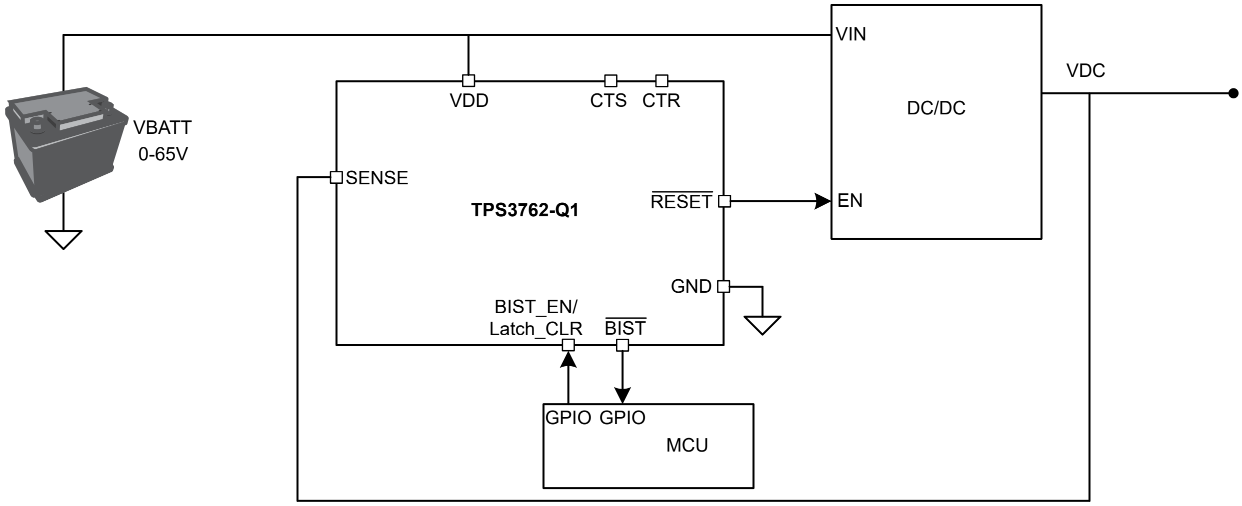


图 10-7. UVbypass Schematic

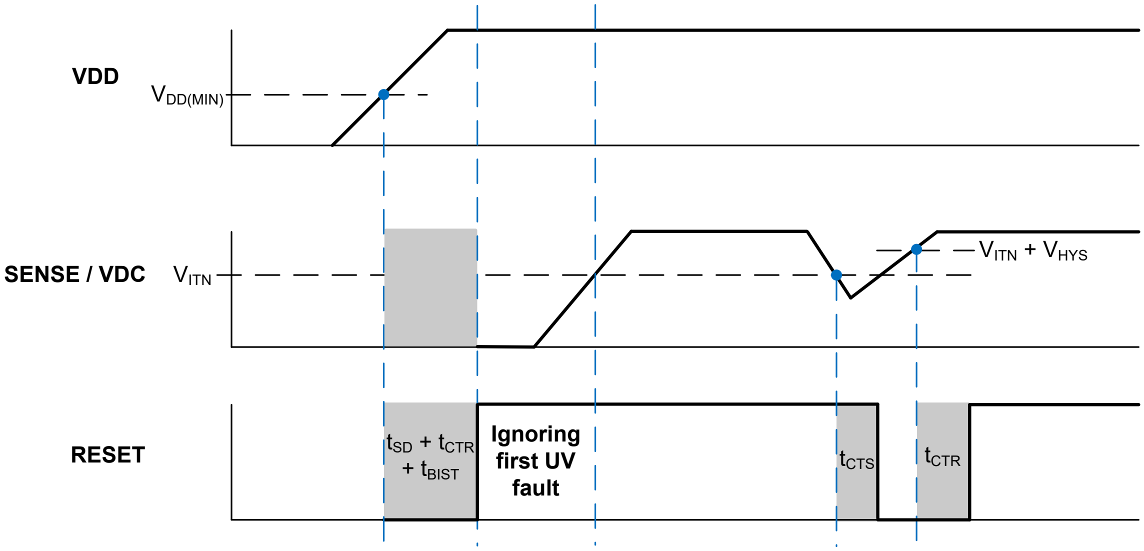


图 10-8. UVbypass Enabled

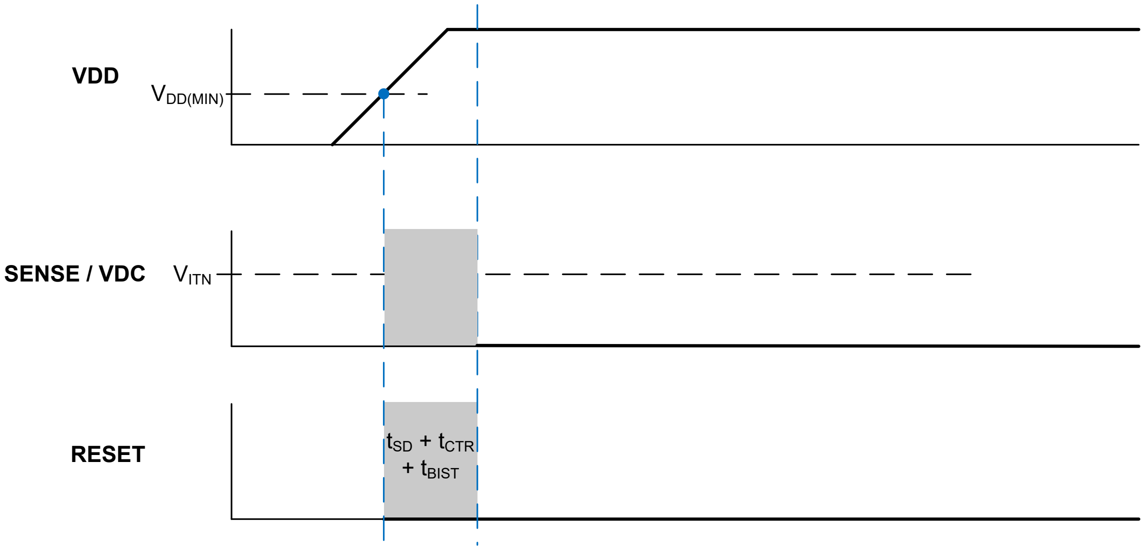


图 10-9. UVbypass Disabled

10.3.4 User-Programmable Reset Time Delay

TPS3762-Q1 has adjustable reset release time delay with external capacitors.

- A capacitor on CTR programs the reset time delay of the output.
- No capacitor on this pin gives the fastest reset delay time indicated by t_{CTR} in 节 7.6.
- Variants such as TPS3762Q use a fixed internal time delay. check the 节 5 to verify variant specific timing.

10.3.4.1 Reset Time Delay Configuration

RESET time delay (t_{CTR}) occurs when the $\overline{\text{RESET}}$ is transitioning from a fault state (V_{OL}) to a non-fault state (V_{OH}). The time delay (t_{CTR}) can be programmed by connecting a capacitor between CTR pin and GND. For situations with a fault on SENSE after $\overline{\text{RESET}}$ recovers, the TPS3762-Q1 makes sure that the CTR capacitor is fully discharged before starting the recovery sequence. This makes sure that the programmed CTR time is maintained for consecutive faults.

The relationship between external capacitor $C_{CTR\_EXT\ (typ)}$ and the time delay $t_{CTR\ (typ)}$ is given by 方程式 1.

$$t_{CTR\ (typ)} = R_{CTR\ (typ)} \times C_{CTR\_EXT\ (typ)} + t_{CTR\ (no\ cap)} \times 10^{-6} \tag{1}$$

$R_{CTR\ (typ)}$ = is in mega ohms (MΩ)

$C_{CTR\_EXT\ (typ)}$ = is given in microfarads (μF)

$t_{CTR\ (typ)}$ = is the reset time delay/delays

The reset delay varies according to three variables: the external capacitor (C_{CTR_EXT}), CTR pin internal resistance (R_{CTR}) provided in 节 7.5, and the constant ($t_{CTR\ (no\ cap)}$) provided in 节 7.6. The minimum and maximum variance due to the constant is show in 方程式 2 and 方程式 3:

$$t_{CTR\ (min)} = R_{CTR\ (min)} \times C_{CTR\_EXT\ (min)} + t_{CTR\ (no\ cap\ (min))} \times 10^{-6} \tag{2}$$

$$t_{CTR\ (max)} = R_{CTR\ (max)} \times C_{CTR\_EXT\ (max)} + t_{CTR\ (no\ cap\ (max))} \times 10^{-6} \tag{3}$$

There is no limit to the capacitor on CTR pin. Having a too large of a capacitor value can cause very slow charge up (rise times) due to capacitor leakage and system noise can cause the internal circuit to hold $\overline{\text{RESET}}$ active.

* Leakages on the capacitor can effect accuracy of reset time delay.

10.3.5 User-Programmable Sense Delay

TPS3762-Q1 has adjustable sense release time delay with external capacitors.

- A capacitor on CTS programs the sense time delay of the input.
- No capacitor on this pin gives the fastest sense delay time indicated by t_{CTS} in 节 7.7.
- The TPS3762-Q1 comes with an optional fixed internal time delay that ignores the capacitor value at the CTS pin, check the 节 5 to verify variant specific functionality.

10.3.5.1 Sense Time Delay Configuration

SENSE time delay (t_{CTS}) occurs when the $\overline{\text{RESET}}$ is transitioning from a non-fault state (V_{OH}) to a fault state (V_{OL}). The time delay (t_{CTS}) can be programmed by connecting a capacitor between CTS pin and GND.

The relationship between external capacitor $C_{CTS\_EXT\ (typ)}$ and the time delay $t_{CTS\ (typ)}$ is given by 方程式 4.

$$t_{CTS\ (typ)} = R_{CTS\ (typ)} \text{ x } C_{CTS\_EXT\ (typ)} + t_{CTS\ (no\ cap)} \text{ x } 10^{-6} \tag{4}$$

$R_{CTS\ (typ)}$ = is in mega ohms (MΩ)

$C_{CTS\_EXT\ (typ)}$ = is given in microfarads (μF)

$t_{CTS\ (typ)}$ = is the sense time delay/delays

The sense delay varies according to three variables: the external capacitor (C_{CTS_EXT}), CTS pin internal resistance (R_{CTS}) provided in 节 7.5, and the constant ($t_{CTS\ (no\ cap)}$) provided in 节 7.6. The minimum and maximum variance due to the constant is show in 方程式 5 and 方程式 6:

$$t_{CTS\ (min)} = R_{CTS\ (min)} \text{ x } C_{CTS\_EXT\ (min)} + t_{CTS\ (no\ cap\ (min))} \text{ x } 10^{-6} \tag{5}$$

$$t_{CTR\ (max)} = R_{CTS\ (max)} \text{ x } C_{CTS\_EXT\ (max)} + t_{CTSx\ (no\ cap\ (max))} \text{ x } 10^{-6} \tag{6}$$

The recommended maximum sense delay capacitor for the TPS3762-Q1 is 10μF as this makes sure there is enough time for the capacitor to fully discharge when a voltage fault occurs. Also, having a too large of a capacitor value can cause very slow charge up (rise times) and system noise can cause the internal circuit to trip unpredictably. This leads to a variation in time delay where the delay accuracy can be worse in the presence of system noise.

* Leakages on the capacitor can effect accuracy of sense time delay.

10.3.6 Built-In Self-Test

The TPS3762-Q1 has a Built-In Self-Test (BIST) feature that runs diagnostics internally in the device. During power-up BIST is initiated automatically after crossing $V_{DD(min)}$. During BIST the $\overline{BIST}$ pin and $\overline{RESET}$ output asserts low and deasserts if the $\overline{BIST}$ test completes successfully indicating no internal faults in the device. The length of the BIST and $\overline{BIST}$ assertion is specified by t_{BIST}. If BIST is not successful, the $\overline{BIST}$ pin will say asserted low signifying an internal fault. The $\overline{RESET}$ output will stay assert on $\overline{BIST}$ failure. During BIST, the device is not monitoring the SENSE pin for faults and the $\overline{RESET}$ is not dependent on the SENSE pin voltage. The $\overline{BIST}$ sequence of internal tests verifies the internal signal chain of the device by checking for faults on the internal comparators on the SENSE pin, bandgap voltage, and the $\overline{RESET}$ output. See 图 10-10 for more details.

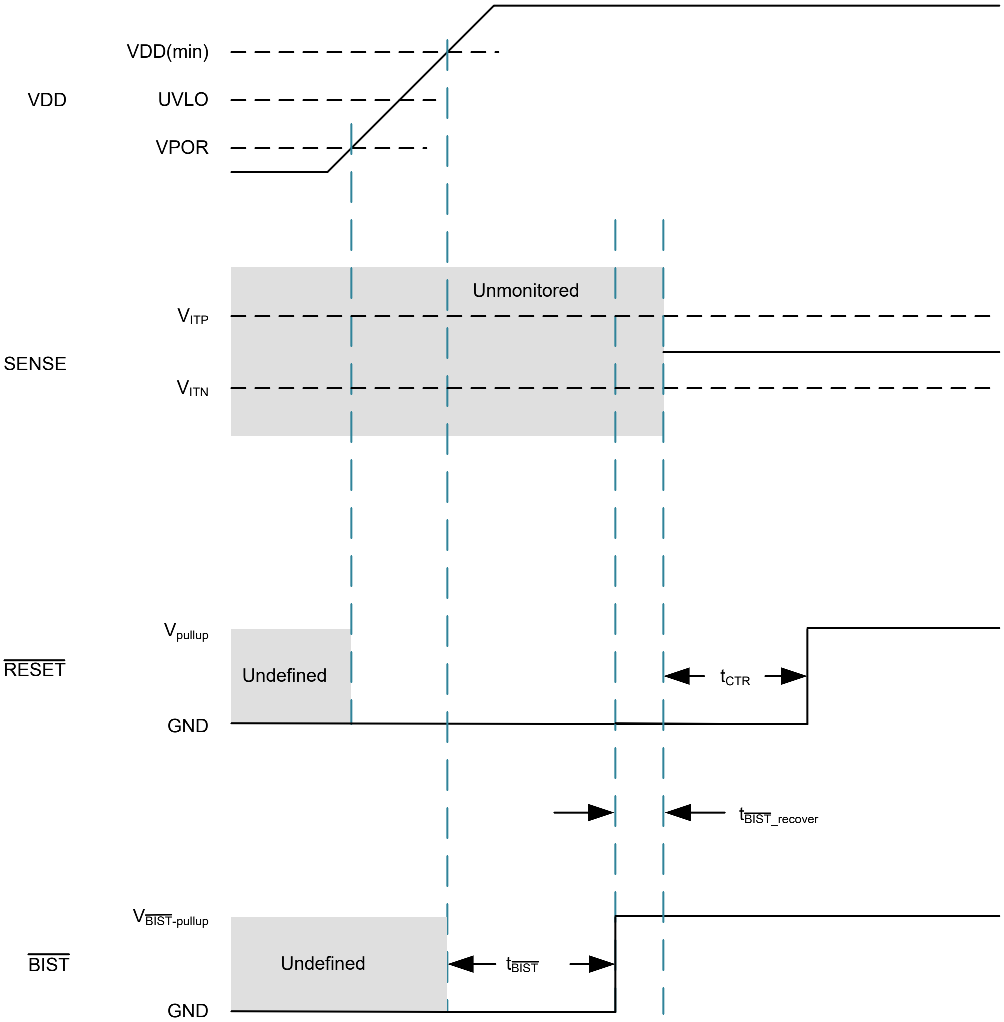


图 10-10. TPS3762-Q1 Start-Up Sequence

After a successful power-up sequence, BIST can be initiated any time with a logic high input (V_{BIST_EN} or $V_{BIST\_EN/LATCH\_CLR}$ > 1.3V) on the BIST_EN / LATCH_CLR pin. BIST initiates and the $\overline{BIST}$ pin asserts only if the SENSE pin is not in a overvoltage or undervoltage fault mode. During this BIST test time period, $t_{\overline{BIST}}$, $\overline{BIST}$ pin asserts low to signify that $\overline{BIST}$ has started and $\overline{RESET}$ assertion is dependent on the device variant. Upon a successful BIST the $\overline{BIST}$ pin and $\overline{RESET}$ pin are deasserted. If BIST is not successful due to an internal device not working properly, the $\overline{RESET}$ pin and $\overline{BIST}$ pin remain asserted low signifying a fault internal to the device. See 图 10-11 and 图 10-12 for more details.

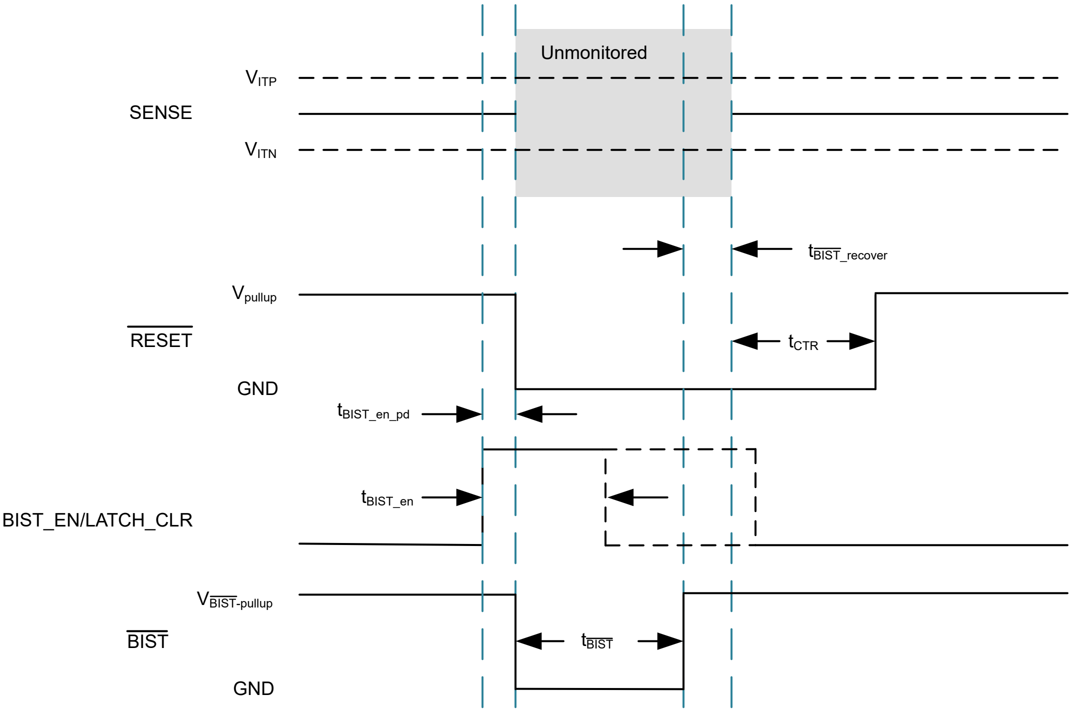


图 10-11. $\overline{\text{BIST}}$ With $\overline{\text{RESET}}$ Assertion

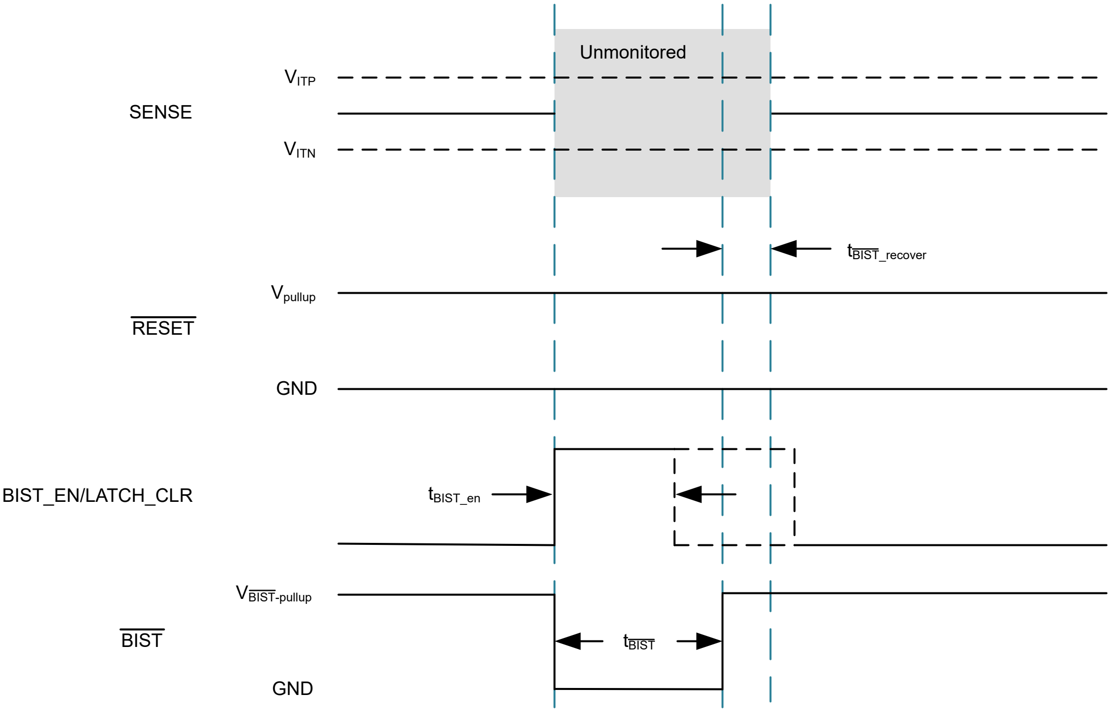


图 10-12. $\overline{\text{BIST}}$ With No $\overline{\text{RESET}}$ Assertion

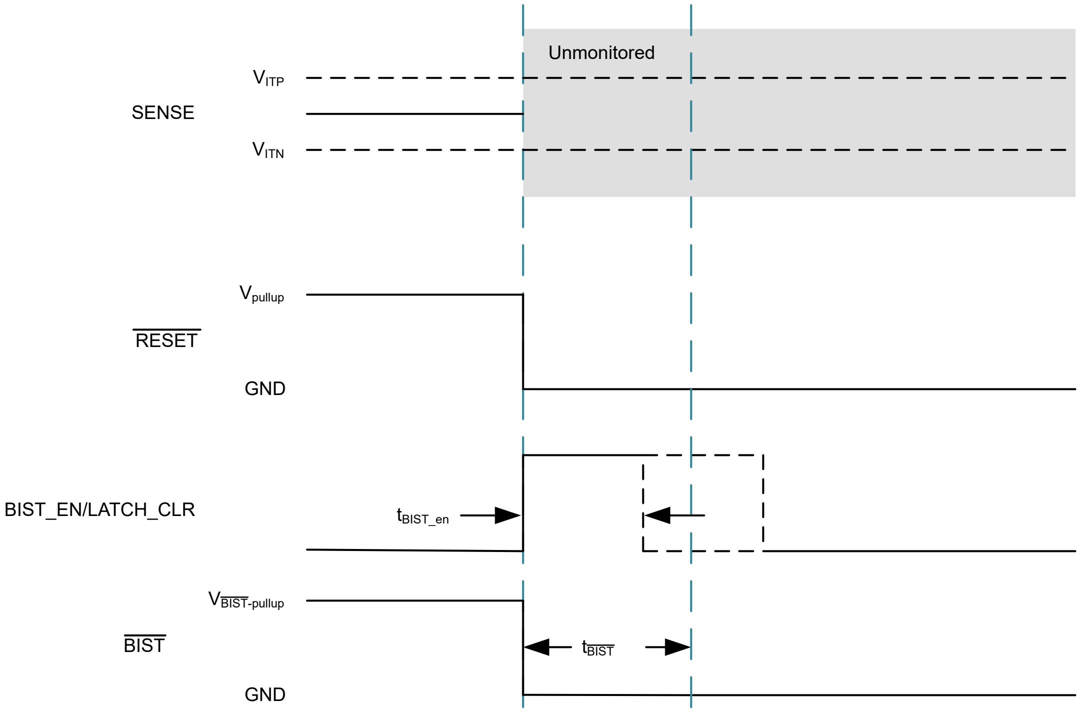


图 10-13. $\overline{\text{BIST}}$ Fail With $\overline{\text{RESET}}$ Assertion

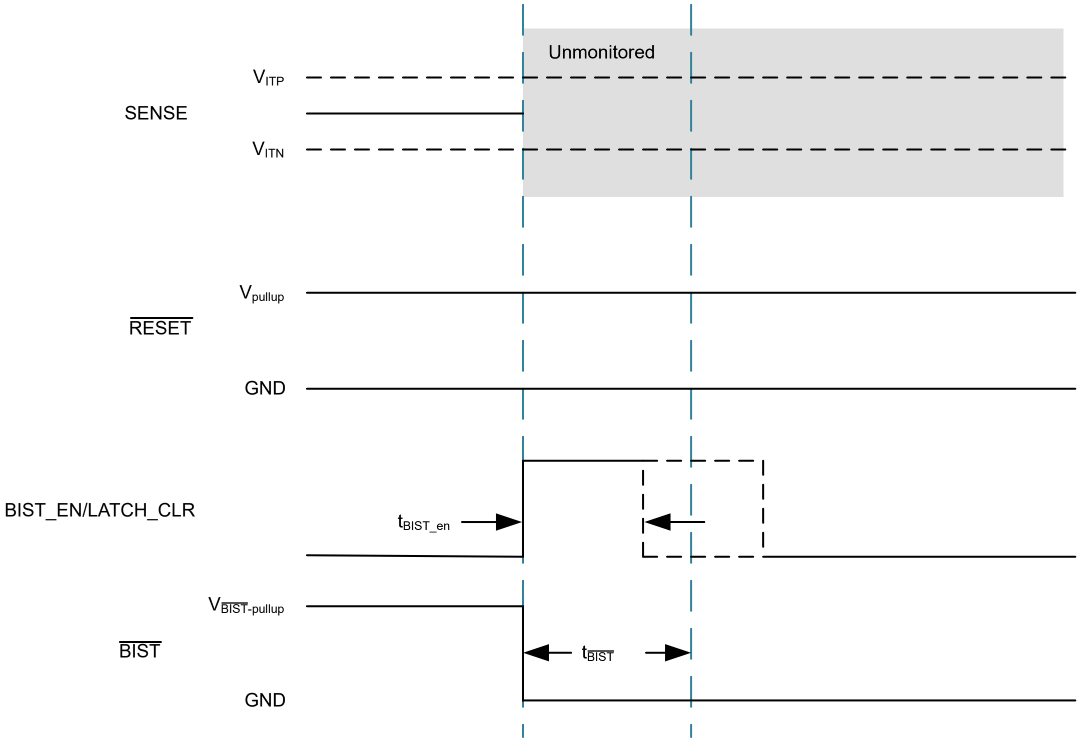


图 10-14. $\overline{\text{BIST}}$ Fail With No $\overline{\text{RESET}}$ Assertion

10.4 Device Functional Modes

表 10-2. Undervoltage Detect Functional Mode Truth Table

DESCRIPTION	SENSE		CTR (1) / $\overline{MR}$ PIN	V_{DD} PIN	OUTPUT (2) (RESET PIN)
	PREVIOUS CONDITION	CURRENT CONDITION			
Normal Operation	SENSE > V_{ITN}	SENSE > V_{ITN}	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	High
Undervoltage Detection	SENSE > V_{ITN}	SENSE < V_{ITN}	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	Low
Undervoltage Detection	SENSE < V_{ITN}	SENSE > V_{ITN}	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	Low
Normal Operation	SENSE < V_{ITN}	SENSE > V_{ITN} + HYS	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	High
UVLO Engaged	SENSE > V_{ITN}	SENSE > V_{ITN}	Open or capacitor connected	$V_{POR} < V_{DD} < V_{DD(MIN)}$	Low
Below V_{POR}, Undefined Output	SENSE > V_{ITN}	SENSE > V_{ITN}	Open or capacitor connected	$V_{DD} < V_{POR}$	Undefined

(1) Reset time delay is ignored in the truth table.
(2) Open-drain active low output requires an external pull-up resistor to a pull-up voltage.

表 10-3. Overvoltage Detect Functional Mode Truth Table

DESCRIPTION	SENSE		CTR (1) / $\overline{MR}$ PIN	V_{DD} PIN	OUTPUT (2) ($\overline{RESET}$ PIN)
	PREVIOUS CONDITION	CURRENT CONDITION			
Normal Operation	SENSE < V_{ITN}	SENSE < V_{ITN}	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	High
Overvoltage Detection	SENSE < V_{ITN}	SENSE > V_{ITN}	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	Low
Overvoltage Detection	SENSE > V_{ITN}	SENSE < V_{ITN}	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	Low
Normal Operation	SENSE > V_{ITN}	SENSE < V_{ITN} - HYS	Open or capacitor connected	$V_{DD} > V_{DD(MIN)}$	High
UVLO Engaged	SENSE < V_{ITN}	SENSE < V_{ITN}	Open or capacitor connected	$V_{POR} < V_{DD}$ < UVLO	Low
Below V_{POR}, Undefined Output	SENSE < V_{ITN}	SENSE < V_{ITN}	Open or capacitor connected	$V_{DD} < V_{POR}$	Undefined

(1) Reset time delay is ignored in the truth table.
(2) Open-drain active low output requires an external pull-up resistor to a pull-up voltage.

11 Application and Implementation

备注

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, as well as validating and testing their design implementation to confirm system functionality.

11.1 Application Information

The following sections describe in detail proper device implementation, depending on the final application requirements.

11.2 Adjustable Voltage Thresholds

图 11-1 illustrates an example of how to adjust the voltage threshold with external resistor dividers. The resistors can be calculated depending on the desired voltage threshold and device part number. TI recommends using the adjustable (0.8V voltage threshold device) when setting adjustable voltage thresholds. This variant bypasses the internal resistor ladder.

For example, consider a 12V rail, V_{MON}, being monitored for overvoltage (OV) using of the TPS3762D02OVDDFRQ1 variant, as shown in 图 11-1. The monitored OV threshold, denoted as V_{MON+}, is the desired voltage where the device asserts the reset. For this example V_{MON+} = 35V. To assert an overvoltage reset the voltage at the sense pin, V_{SENSE}, needs to be equal to the input threshold positive, V_{ITP}. For this example variant $V_{SENSE} = V_{ITP}$ = 0.8V. Using R_1 and R_2 the correlation between V_{MON+} and V_{SENSE} can be seen in 方程式 8. Assuming R_2 = 10kΩ, and R_1 can be calculated as R_1 = 427.5kΩ.

$$V_{SENSE} = V_{MON+} \times (R_2 \div (R_1 + R_2)) \tag{7}$$

The TPS3762D02OVDDFRQ1 comes with variant specific 2%, 5%, or 10% voltage threshold hysteresis. For the reset signal to become deasserted, V_{MON} must go below V_{ITP} - V_{HYS}. For this example variant a 2% voltage threshold hysteresis was selected. Therefore, V_{MON} equals 34.3V when the reset signal becomes deasserted.

There are inaccuracies that must be taken into consideration while adjusting voltage thresholds. Aside from the tolerance of the resistor divider, there is the internal resistance of the SENSE pin that can affect the accuracy of the resistor divider. Although expected to be very high impedance, users are recommended to calculate the values for the design specifications. The internal SENSE resistance (R_{SENSE}) can be calculated by the SENSE voltage (V_{SENSE}) divided by the SENSE current (I_{SENSE}) as shown in 方程式 9. V_{SENSE} can be calculated using 方程式 7 depending on the resistor divider and monitored voltage. I_{SENSE} can be calculated using 方程式 8.

$$I_{SENSE} = [(V_{MON} - V_{SENSE}) \div R_1] - (V_{SENSE} \div R_2) \tag{8}$$

$$R_{SENSE} = V_{SENSE} \div I_{SENSE} \tag{9}$$

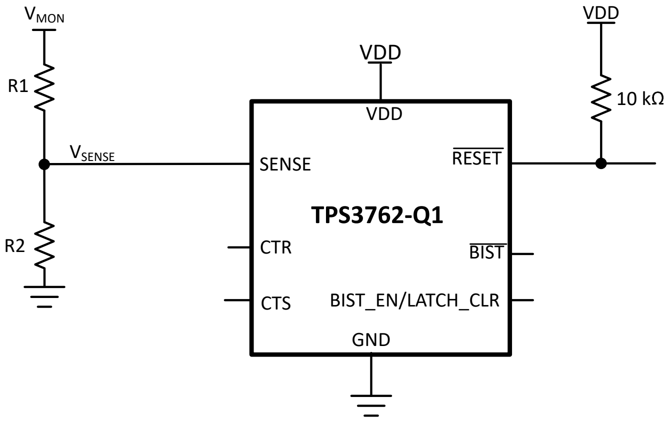


图 11-1. Adjustable Voltage Threshold with External Resistor Dividers

11.3 Typical Application

11.3.1 Design 1: Off-Battery Monitoring

This application is intended for the initial power stage in applications with the 12V batteries. The TPS3762-Q1 utilizes high-voltage SENSE and V_{DD} inputs to monitor an automotive battery.

图 11-6 illustrates an example of how the TPS3762-Q1 is monitoring the battery voltage while being powered by it, as well.

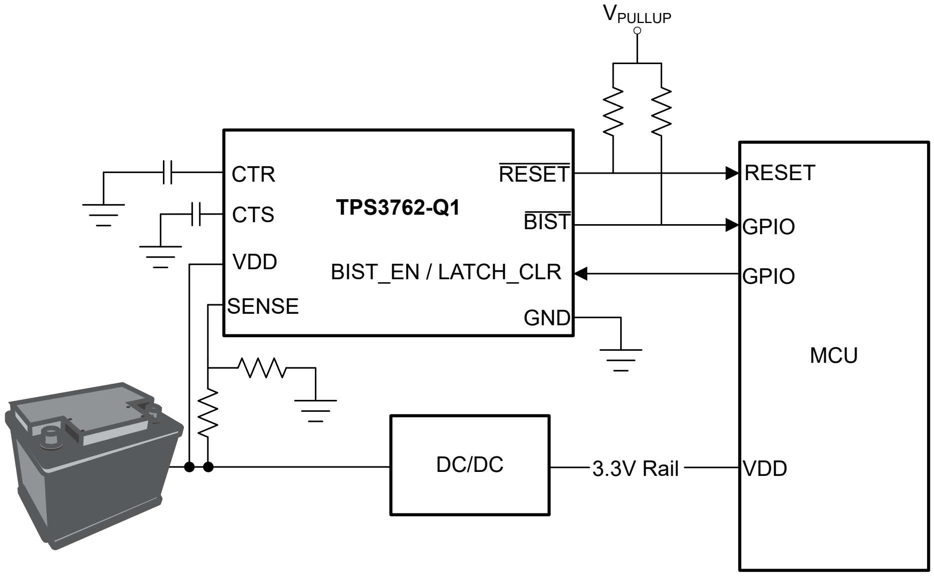


图 11-2. Off-Battery Monitoring

11.3.1.1 Design Requirements

表 11-1. Design Parameters

PARAMETER	DESIGN REQUIREMENT
Voltage Threshold	Typical OV voltage threshold 30V.
Maximum Input Power	Operate with power supply input up to 65V
Output Logic	Open-Drain
SENSE Delay	>100ms
$\overline{\text{RESET}}$ Delay	>300ms
Output Features	Output latching and built-in self-test

11.3.1.2 Detailed Design Procedure

The TPS3762-Q1 utilizes high-voltage SENSE and V_{DD} inputs to monitor an automotive battery. In this design example TPS3762D02OVDDFRQ1 is used.

11.3.1.2.1 Setting Voltage Threshold

The positive-going threshold voltage, V_{ITP}, is set by the device variant. In this example, the nominal supply voltage from the battery is 12V. Setting a overvoltage threshold of 30V makes sure that the device resets before supply voltage violates the allowed boundary. The adjustable voltage variant is chosen and R_1 and R_2 are adjusted to meet the threshold. Assuming R_2 equal to 10kΩ and R_1 is calculated as 365kΩ. For additional information on selecting resistor values see 节 11.2. TPS3762-Q1 also supports fixed voltage threshold variants. Threshold voltage decoding can be found in Device Decoder.

11.3.1.2.2 Meeting the Sense and Reset Delay

The TPS3762-Q1 features both reset assertion (sense) delay, t_{CTS}, and reset deassertion (reset) delay, t_{CTR}. The TPS3762-Q1 features two options for selecting sense and reset delays: fixed delays and capacitor-programmable delays. For the device variant used in this design, TPS3762D02OVDDFRQ1, the capacitor programmable delay is chosen. 节 10.3.5 and 节 10.3.4 show how to set the timings for the capacitor-programmable delays. The application requires greater than 100 ms sense delay, thus a 0.033 μF capacitor is used. The application requires greater than 300 ms reset delay, thus a 0.1 μF capacitor is used.

11.3.1.2.3 Setting Supply Voltage

Setting the supply voltage is done by connecting the V_{DD} input directly to the battery rail without the need for external circuitry. The device being able to handle 65V on V_{DD} means the monitored voltage rail can handle any voltage transience up to 65V. Good analog design practice recommends using a 0.1 μF capacitor on the V_{DD} pin.

11.3.1.2.4 Initiating Built-In Self-Test and Clearing Latch

Built-In Self-Test (BIST) is asserted on device power-up, as outlined in 图 10-10. BIST can also be initiated any time by a rising edge that crosses the voltage logic high input (V_{BIST_EN} or $V_{BIST\_EN/LATCH\_CLR}$ > 1.3V) on the BIST_EN / LATCH_CLR pin, as outlined in 图 10-11. Output reset latching is set by the device variant. For the device variant used in this design, TPS3762D02OVDDFRQ1, the output has latch. Device specific output reset latching feature can be found in Device Decoder. To clear the latch a logic high input on the BIST_EN / LATCH_CLR pin is required. When clearing latch, BIST is initiated and the $\overline{\text{RESET}}$ returns logic level high once $t_{BIST} + t_{BIST\_recover} + t_{CTR}$ has expired, outlined in 图 10-6. While $V_{BIST\_EN/LATCH\_CLR}$ > 1.3V, the device is in latch disabled mode and the $\overline{\text{RESET}}$ does not latch for OV and UV on SENSE pin. While the device is in latch disabled mode the $\overline{\text{RESET}}$ still asserts for OV and UV faults.

11.3.1.3 Application Curves

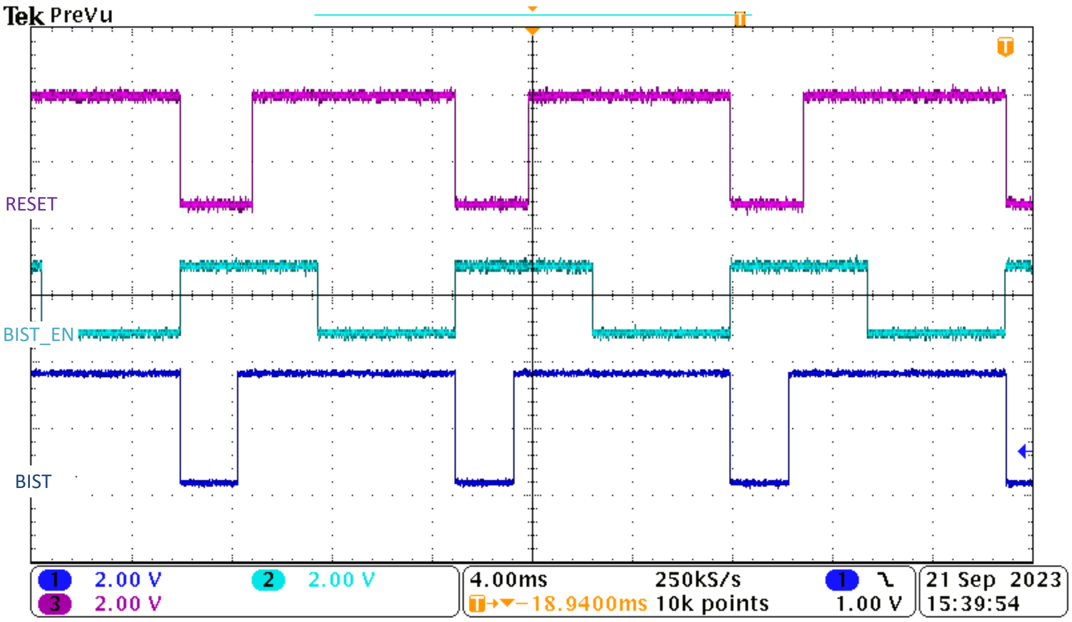


图 11-3. BIST with $\overline{\text{RESET}}$ Assertion Waveform

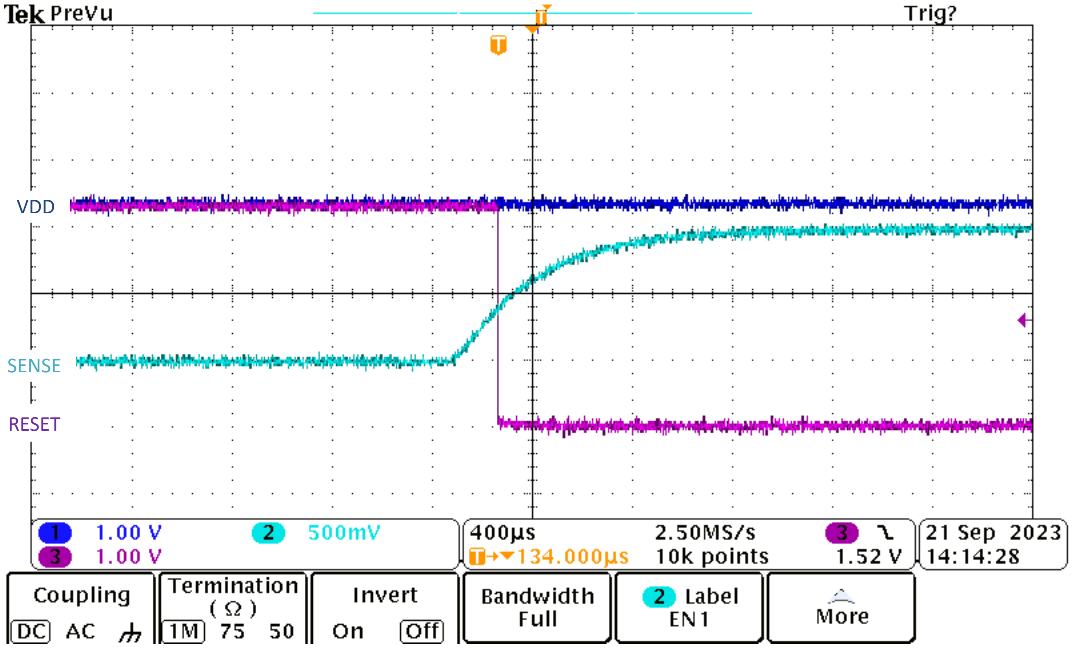


图 11-4. Overvoltage $\overline{\text{RESET}}$ Latching Waveform

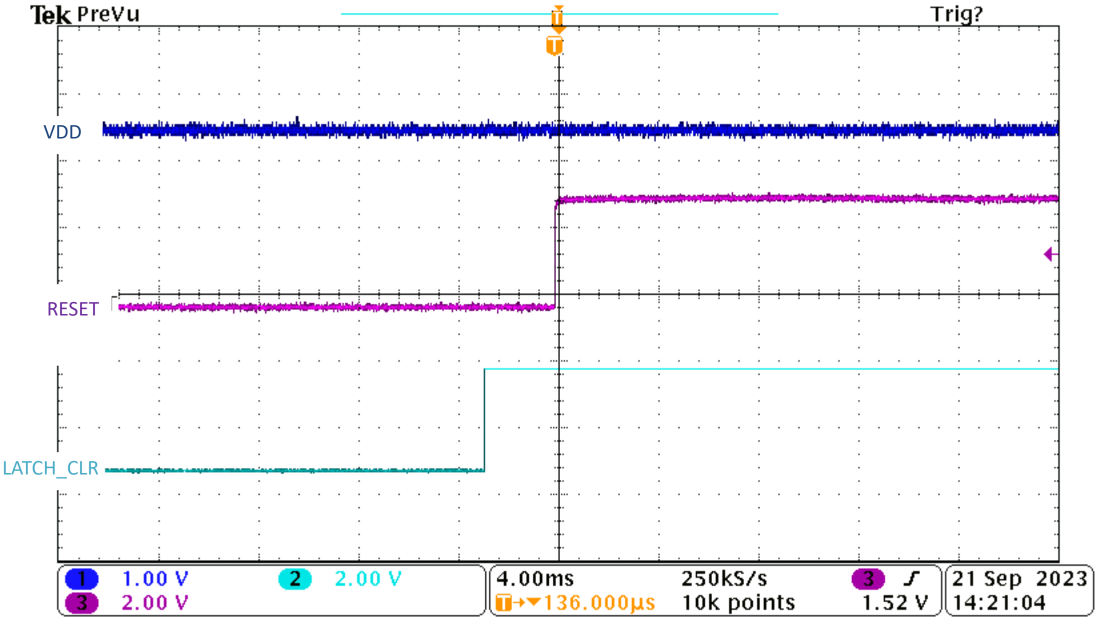


图 11-5. Overvoltage $\overline{\text{RESET}}$ Unlatching Waveform

11.4 Power Supply Recommendations

TPS3762-Q1 is designed to operate from an input supply with a V_{DD} voltage between 2.7V (minimum operation) to 65V (maximum operation). Good analog design practice recommends placing a minimum 0.1µF ceramic capacitor as near as possible to the V_{DD} pin.

11.4.1 Power Dissipation and Device Operation

The permissible power dissipation for any package is a measure of the capability of the device to pass heat from the power source, the junctions of the IC, to the ultimate heat sink, the ambient environment. Thus, the power dissipation is dependent on the ambient temperature and the thermal resistance across the various interfaces between the die junction and ambient air.

The maximum continuous allowable power dissipation for the device in a given package can be calculated using 方程式 10:

$$P_{D\text{-}MAX} = ((T_{J\text{-}MAX} - T_A) / R_{\theta JA}) \qquad (10)$$

The actual power being dissipated in the device can be represented by 方程式 11:

$$P_D = V_{DD} \times I_{DD} + p_{RESET} \qquad (11)$$

p_{RESET} is calculated by 方程式 12 or 方程式 13

$$p_{RESET\ (PUSHPULL)} = V_{DD} - V_{RESET} \times I_{RESET} \qquad (12)$$

$$p_{RESET\ (OPEN\text{-}DRAIN)} = V_{RESET} \times I_{RESET} \qquad (13)$$

方程式 10 and 方程式 11 establish the relationship between the maximum power dissipation allowed due to thermal consideration, the voltage drop across the device, and the continuous current capability of the device. These two equations must be used to determine the optimum operating conditions for the device in the application.

In applications where lower power dissipation (P_D) and/or excellent package thermal resistance ($R_{\theta JA}$) is present, the maximum ambient temperature ($T_{A\text{-}MAX}$) can be increased.

In applications where high power dissipation and/or poor package thermal resistance is present, the maximum ambient temperature ($T_{A\text{-}MAX}$) may have to be de-rated. $T_{A\text{-}MAX}$ is dependent on the maximum operating junction temperature ($T_{J\text{-}MAX\text{-}OP}$ = 125°C), the maximum allowable power dissipation in the device package in the application ($P_{D\text{-}MAX}$), and the junction-to ambient thermal resistance of the part/package in the application ($R_{\theta JA}$), as given by 方程式 14:

$$T_{A\text{-}MAX} = (T_{J\text{-}MAX\text{-}OP} - (R_{\theta JA} \times P_{D\text{-}MAX})) \qquad (14)$$

11.5 Layout

11.5.1 Layout Guidelines

- Make sure that the connection to the VDD pin is low impedance. Good analog design practice is to place a greater than 0.1µF ceramic capacitor as near as possible to the VDD pin.
- To further improve the noise immunity on the SENSE pins, placing a 10nF to 100nF capacitor between the SENSE pin and GND can reduce the sensitivity to transient voltages on the monitored signal.
- If a capacitor is used on CTS or CTR, place these components as close as possible to the respective pins. If the capacitor adjustable pins are left unconnected, make sure to minimize the amount of parasitic capacitance on the pins to less than 5pF.
- Place the pull-up resistors on $\overline{\text{RESET}}$ as close to the pin as possible.

- When laying out metal traces, separate high voltage traces from low voltage traces as much as possible. If high and low voltage traces need to run close by, spacing between traces must be greater than 20mils (0.5mm).
- Do not have high voltage metal pads or traces closer than 20 mils (0.5mm) to the low voltage metal pads or traces.

11.5.2 Layout Example

The layout example in 图 11-6 shows how the TPS3762-Q1 is laid out on a printed circuit board (PCB) with user-defined delays.

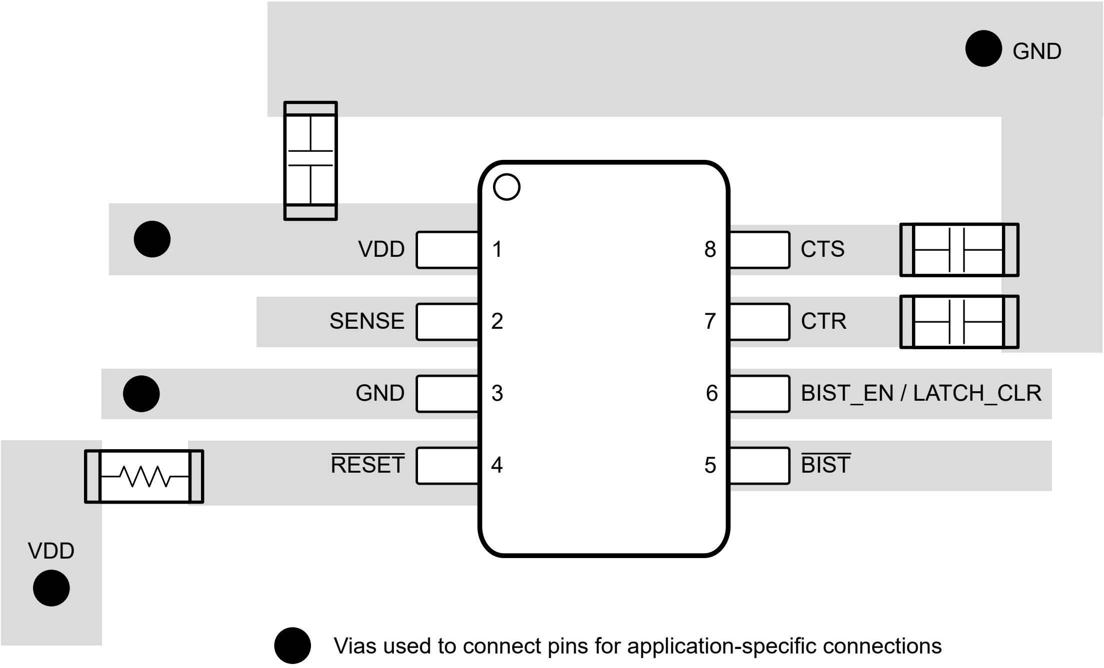


图 11-6. TPS3762-Q1 Recommended Layout

12 Device and Documentation Support

12.1 接收文档更新通知

要接收文档更新通知，请导航至 ti.com 上的器件产品文件夹。点击*通知* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

12.2 支持资源

TI E2E™ 中文支持论坛是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的使用条款。

12.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.
所有商标均为其各自所有者的财产。

12.4 静电放电警告

静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

12.5 术语表

TI 术语表	本术语表列出并解释了术语、首字母缩略词和定义。

13 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (October 2023) to Revision A (May 2024)	Page
• 生产数据发布	1

14 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.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS3762D02OVDDFRQ1	ACTIVE	SOT-23-THIN	DDF	8	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	62D02	Samples

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

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

[6] Lead finish/Ball material - Orderable Devices 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.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF TPS3762-Q1 :

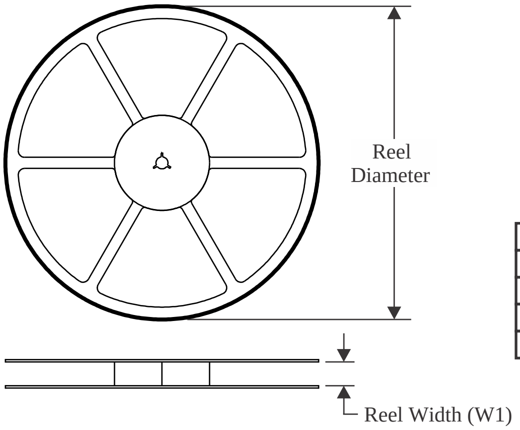
- Catalog : TPS3762

NOTE: Qualified Version Definitions:

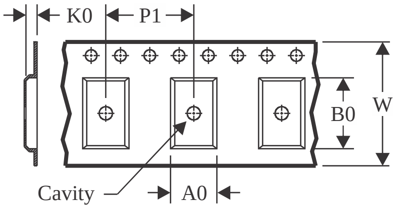
  - Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

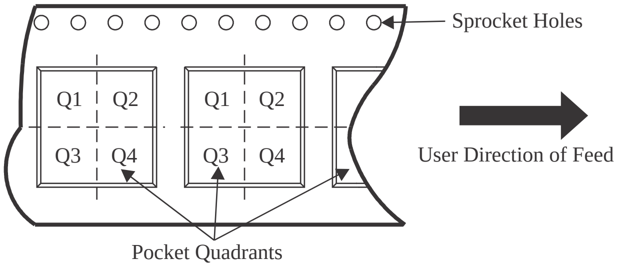


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	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

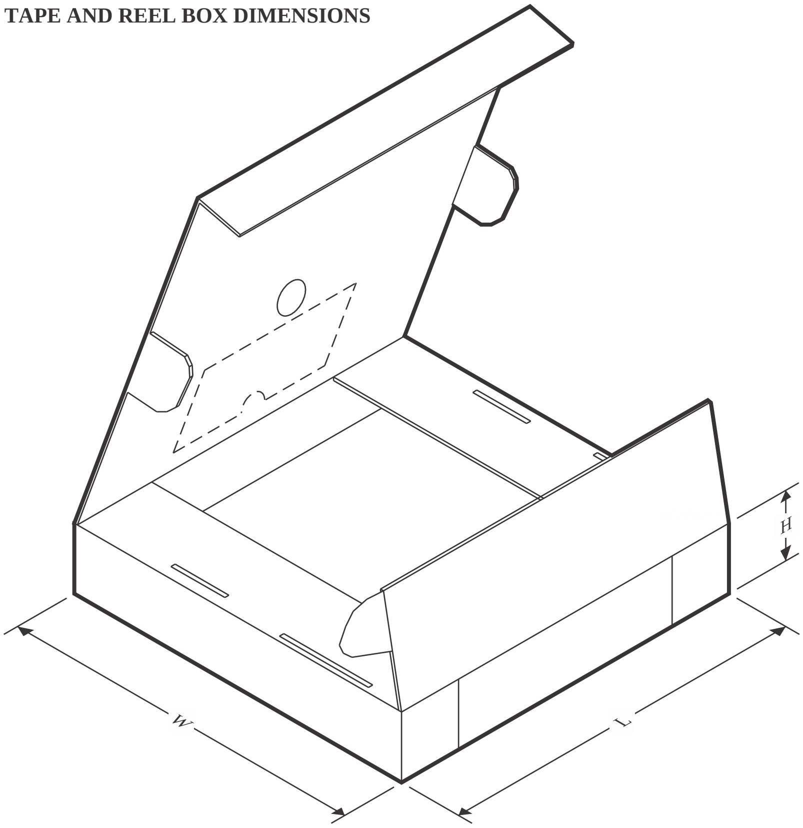
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

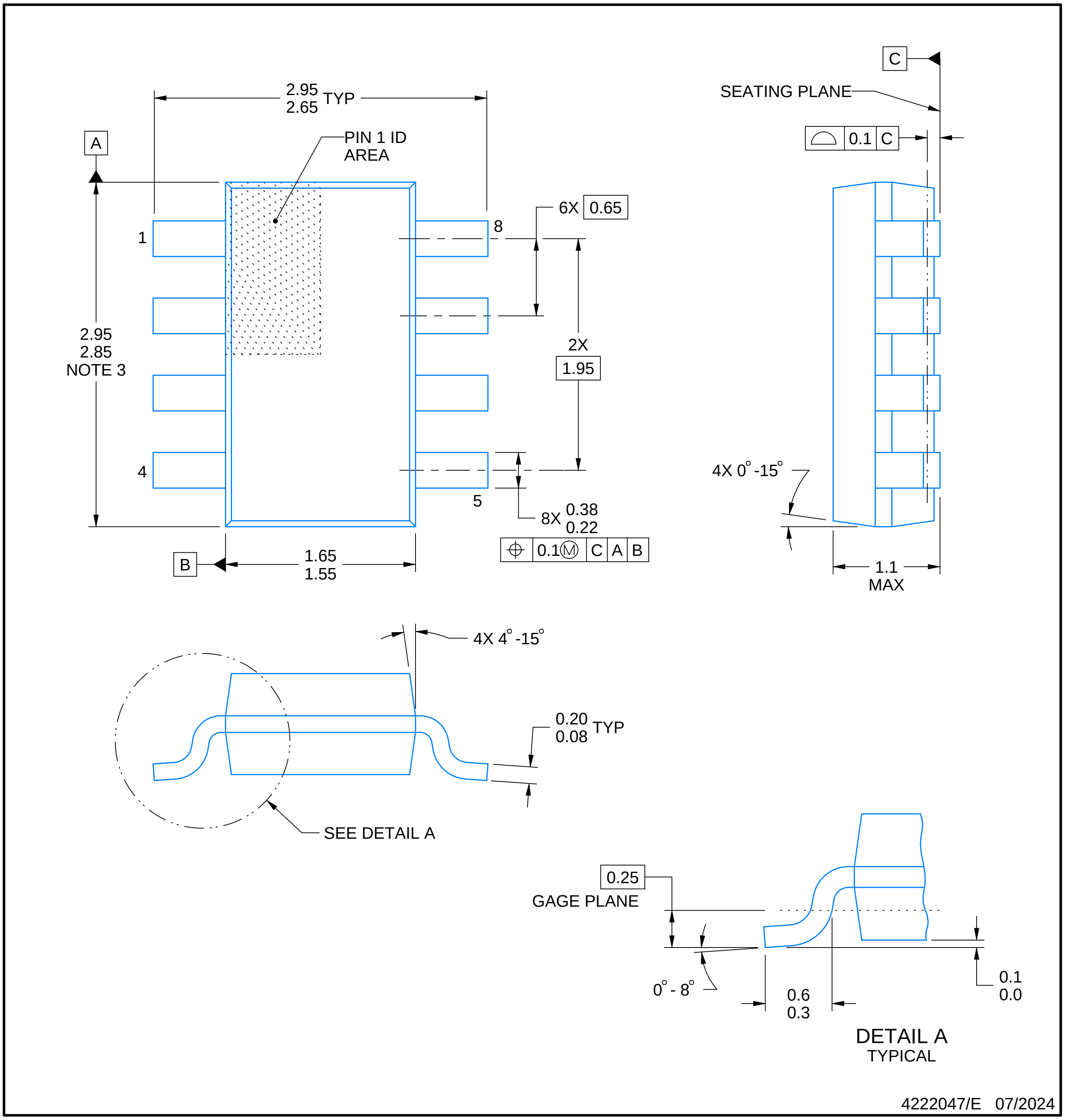
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS3762D02OVDDFRQ1	SOT-23-THIN	DDF	8	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS3762D02OVDDFRQ1	SOT-23-THIN	DDF	8	3000	210.0	185.0	35.0



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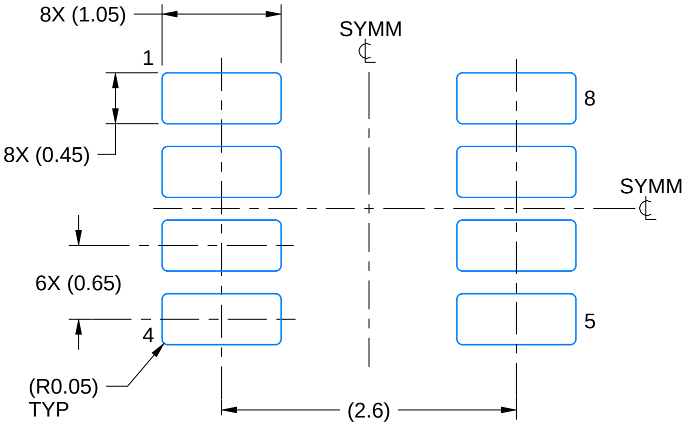
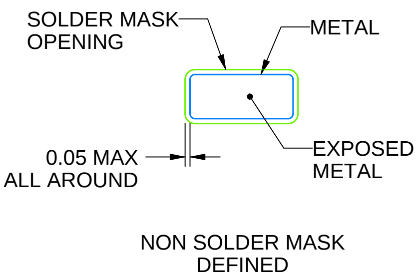
NOTES:

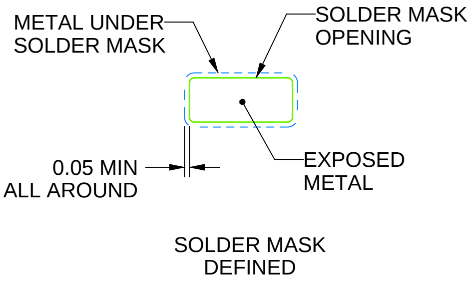
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



NON SOLDER MASK
DEFINED



SOLDER MASK
DEFINED

SOLDER MASK DETAILS

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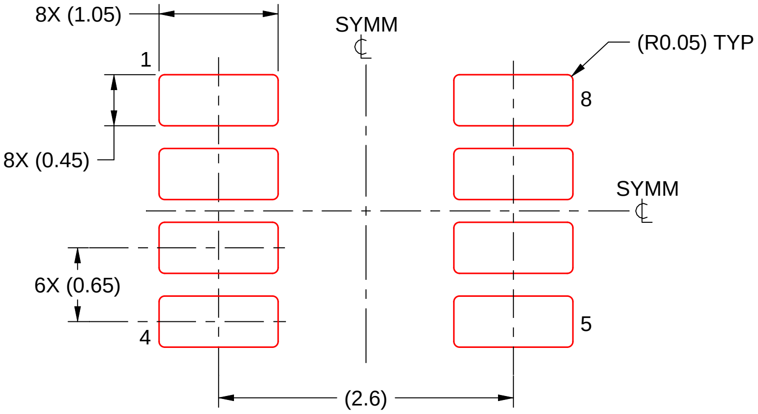
NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4222047/E 07/2024

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

重要声明和免责声明

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