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Texas Instruments New Product Update

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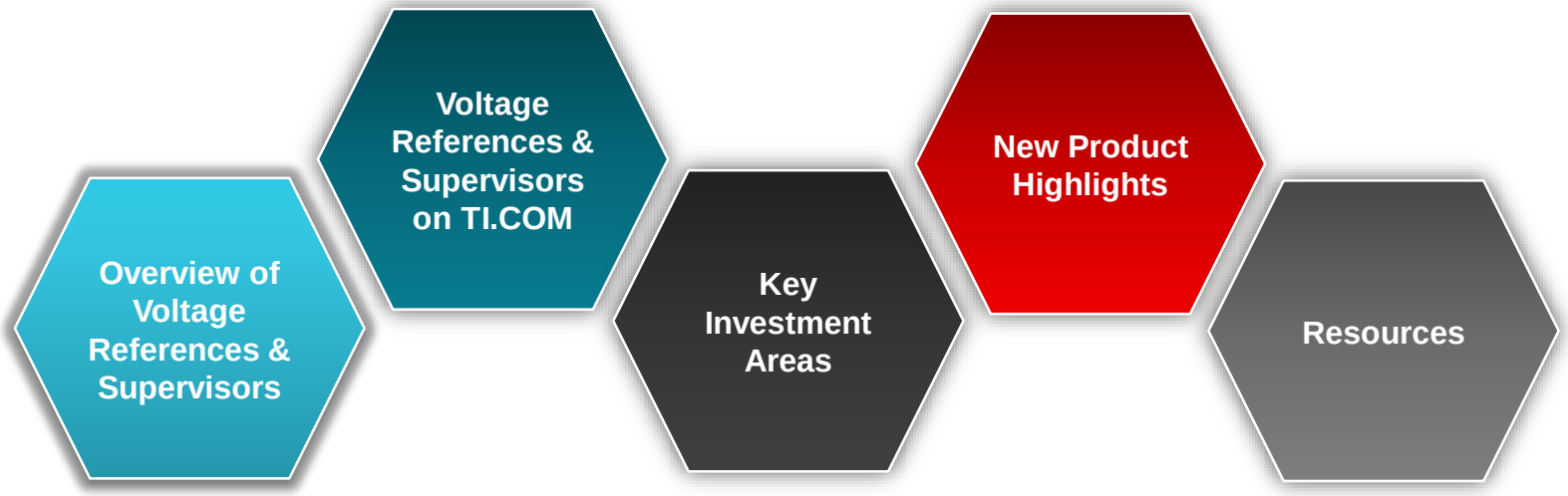
New Product Update:
Keep your system safe and accurate through Voltage References & Supervisors

Shridhar More

Marcoo Zamora

18th March 2021

Agenda

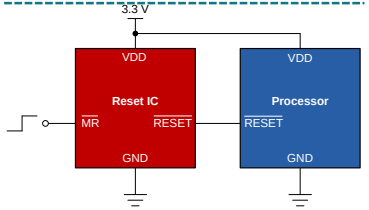

Overview of Voltage References & Supervisors
Voltage References & Supervisors on TI.COM
Key Investment Areas
New Product Highlights
Resources

Product Family Overview

Supervisors & Reset ICs

Product Families
- TPS37xx (window)
- TPS3840/TLV840 (low power)
- TLV841 (small size)
- TPS385x (watchdog timer)

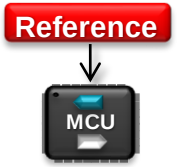
Sectors/EEs
- ADAS, Infotainment
- Personal Electronics
- FA&C, BA, Grid, MD



Series References

Product Families
- REF70xx/REF50xx (precision)
- REF33xx (low power)
- REF34xx/REF4132 (gen. purpose)

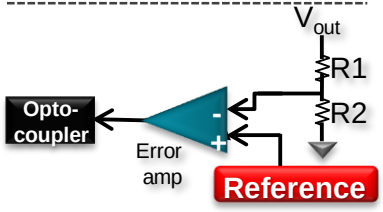
Sectors/Customers
- Factory automation - PLC
- Medical - BGM
- Automotive HEV/EV



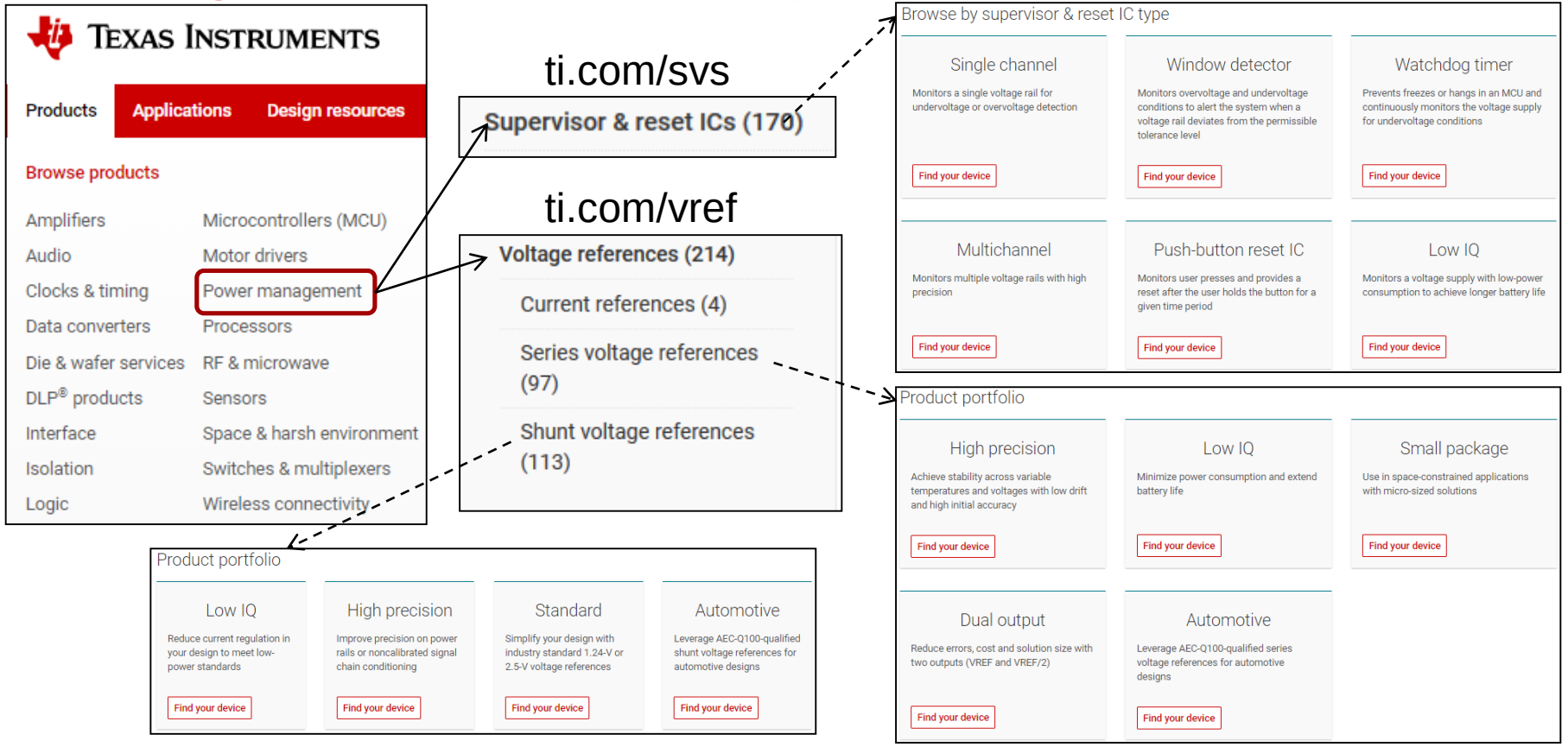
Shunt References

Product Families
- TL/TLV43x (commodity)
- ATL43x (low power)
- LM404x/405x (med accuracy)

Sectors/Customers
- Power Adaptors, Appliances
- Comm/Server power
- Automotive Body Electronics



Voltage References & Supervisors on TI.COM



Key Investment Areas

Automotive

Technology Highlights:
- Wide V_{IN} operation
- Highest accuracy across temperature
- Functional Safety compliant

Industrial

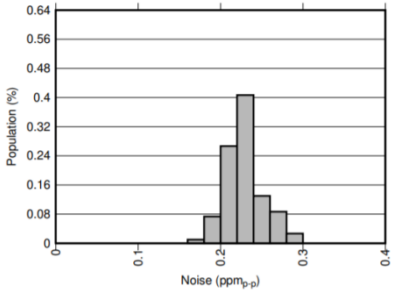
Technology Highlights:
- Lowest quiescent current
- Smallest form factor
- Lowest output noise

Wide V_{IN}	Increase safety with the highest working voltage and reliability
Low IQ	Extend battery and shelf life without compromising system performance
Precision	Enhance system performance by reducing component error contribution
Small Size	Achieve higher performance in smaller spaces, enhancing system functionality

REF70xx The Best VREF yet.

Industry lowest noise 0.1Hz - 10Hz

0.23ppm

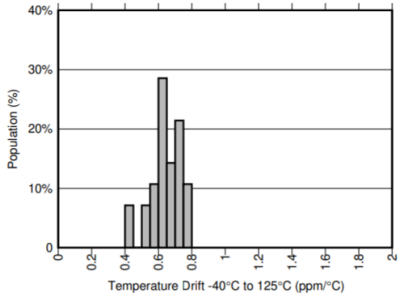


Enhanced signal integrity to improve system-level accuracy by increasing overall SNR

Best temperature drift over temperature

Full Range
-40C to 125C

2ppm/°C

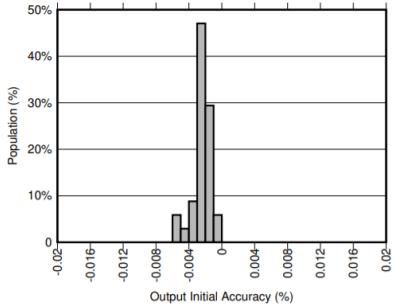


1ppm/°C (-40°C to 85°C)*

Minimizes error sources from thermal variation

Best initial accuracy

±0.025%

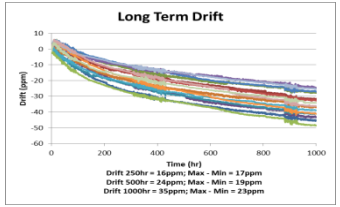


Out of the box accuracy

1000 hr Low Long Term Drift

Ceramic (5x5mm)

28ppm



Minimizes error sources from aging and thermal cycling to enable best product lifetime performance at highest possible precision

* - Evaluation ongoing

Supervisor & Reset IC – New device familie

Pin compatible – Lower cost

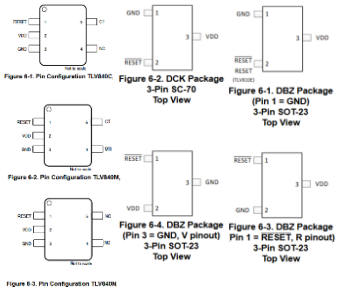
EE – Industrial, GI, PoS, STB etc

TLV8xxE – SC70-3, SOT23-3

Competition families – RT9818/9, MAX803/9, S-809, SGM803/9, DS1812, ADM803/9 etc

TLV840 – SOT23-5, SC82

Competition families – NCP30x, S-1003/9, S-1910, S-809, PST81/2, BD53, BU42, XC6118, R3116 etc



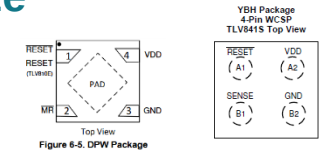
Small size

EE – Comms Infra, Personal Electronics, Handheld instruments

TLV841 – Industry smallest (0.73mm*0.73mm) WCSP supervisor

TLV8xxE – X2SON package (1mm * 1mm)

TPS3899 – Sense delay feature + Sense in small DSE package (1.5mm * 1.5mm)



Nano I_Q

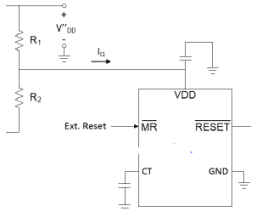
EE –Power tools, Battery powered appliances

TLV840, TLV841, TPS3899 – 120nA TYP

TLV8xxE – 250nA TYP

Longer battery life.

Monitor high voltage supplies through resistance divider



Specified low V_{POR} & V_{DDMIN}

EE – Industrial, GI, Medical, TnM

TLV840, TLV841, TPS3899 –

0.7V V_{POR}

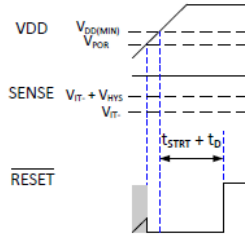
0.85V V_{DDMIN} Active low

1V V_{DDMIN} Active High

Specified across Industrial -40°C to 125°C temperature range.

V_{POR} - Controlled RESET assert even at low supply level. Helps system stability over wide voltage range.

V_{DDMIN} – Reliable supervision over wide voltage rail.



TLV840 and TPS3899 families –Q1 qualification ongoing

Resources

Overview | Products | Applications | Reference designs | **Technical documents** | Support & training

Voltage references – Technical documents

Voltage Reference Overview

Review the Shunt and Series selection guide parameters at a glance to choose the right VREF for your application.

Download (PDF, 1130KB)

Tips and tricks for designing with voltage references

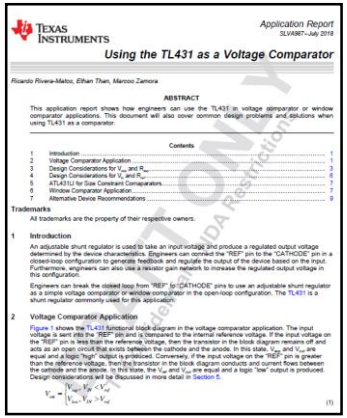
Tips and Tricks for Designing with Voltage References provides a comprehensive overview of voltage reference basics and application design.

Download (PDF, 5486KB)

Voltage reference selection basics white paper (Rev. A)

Voltage references are a key building block in data conversion systems, and understanding their specifications and how they contribute to error is necessary for selecting the right reference for the application.

Download (PDF, 1231KB)



Texas Instruments — Application Report SLVA887–July 2018

Using the TL431 as a Voltage Comparator

Ricardo Rivera-Matos, Ethan Than, Marcoo Zamora

ABSTRACT

This application report shows how engineers can use the TL431 in voltage comparator or window comparator applications. This document will also cover common design problems and solutions when using TL431 as a comparator.

Contents

1 Introduction 1
2 Voltage Comparator Application 1
3 Design Considerations for V_{ref} and R_{ref} 3
4 Design Considerations for V_{ka} and R_{ka} 4
5 ATL431LI for Size Constraint Comparators 7
6 Window Comparator Application 7
7 Alternative Device Recommendations 9

Trademarks

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1 Introduction

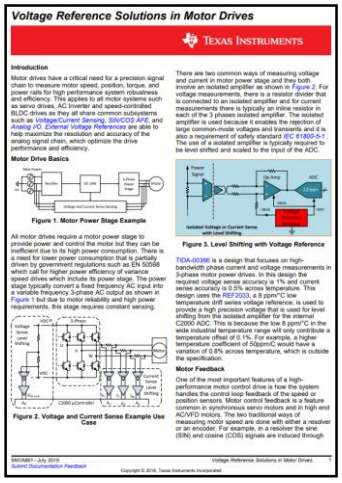
An adjustable shunt regulator is used to take an input voltage and produce a regulated output voltage determined by the device characteristics. Engineers can connect the "REF" pin to the "CATHODE" pin in a closed-loop configuration to generate feedback and regulate the output of the device based on the input. Furthermore, engineers can also use a resistor gain network to increase the regulated output voltage in this configuration.

Engineers can break the closed loop from "REF" to "CATHODE" pins to use an adjustable shunt regulator as a simple voltage comparator or window comparator in the open-loop configuration. The TL431 is a shunt regulator commonly used for this application.

2 Voltage Comparator Application

Figure 1 shows the TL431 functional block diagram in the voltage comparator application. The input voltage is sent into the "REF" pin and is compared to the internal reference voltage. If the input voltage on the "REF" pin is less than the reference voltage, then the transistor in the block diagram remains off and acts as an open circuit that exists between the cathode and the anode. In this state, V_{ka} and V_{ref} are equal and a logic "high" output is produced. Conversely, if the input voltage on the "REF" pin is greater than the reference voltage, then the transistor in the block diagram conducts and current flows between the cathode and the anode. In this state, the V_{ka} and V_{ref} are equal and a logic "low" output is produced. Design considerations will be discussed in more detail in Section 5.

$$V_{ref} = \begin{cases} V_{ka}, & V_{ka} < V_{ref} \\ V_{ref}, & V_{ka} > V_{ref} \end{cases} \quad (1)$$



Voltage Reference Solutions in Motor Drives

Texas Instruments

Introduction

Motor drives have a critical need for a precision signal chain to measure motor speed, position, torque, and power rails for high performance system robustness and efficiency. This applies to all motor systems such as servo drives, AC Inverter and speed-controlled BLDC drives as they all share common subsystems such as Voltage/Current Sensing, SINCOS AFE, and Analog I/O. External Voltage References are able to help maximize the resolution and accuracy of the analog signal chain, which optimize the drive performance and efficiency.

There are two common ways of measuring voltage and current in motor power stage and they both involve an isolated amplifier as shown in Figure 2. For voltage measurements, there is a resistor divider that is connected to an isolated amplifier and for current measurements there is typically an inline resistor in each of the 3 phases isolated amplifier. The isolated amplifier is used because it enables the rejection of large common-mode voltages and transients and it is also a requirement of safety standard IEC 61800-5-1. The use of a isolated amplifier is typically required to be level shifted and scaled to the input of the ADC.

Motor Drive Basics

Figure 1. Motor Power Stage Example

Figure 3. Level Shifting with Voltage Reference

All motor drives require a motor power stage to provide power and control the motor but they can be inefficient due to its high power consumption. There is a need for lower power consumption that is partially driven by government regulations such as EN 50598 which call for higher power efficiency of variance speed drives which include its power stage. The power stage typically convert a fixed frequency AC input into a variable frequency 3-phase AC output as shown in Figure 1 but due to motor reliability and high power requirements, this stage requires constant sensing.

TIDA-00366 is a design that focuses on high-bandwidth phase current and voltage measurements in 3-phase motor power drives. In this design the required voltage sense accuracy is 1% and current sense accuracy is 0.5% across temperature. This design uses the REF2033, a 8 ppm/°C low temperature drift series voltage reference, is used to provide a high precision voltage that is used for level shifting from the isolated amplifier for the internal C2000 ADC. This is because the low 8 ppm/°C in the wide industrial temperature range will only contribute a temperature offset of 0.1%. For example, a higher temperature coefficient of 50ppm/C would have a variation of 0.8% across temperature, which is outside the specification.

Figure 2. Voltage and Current Sense Example Use Case

Motor Feedback

One of the most important features of a high-performance motor control drive is how the system handles the control loop feedback of the speed or position sensors. Motor control feedback is a feature common in synchronous servo motors and in high end AC/VFD motors. The two traditional ways of measuring motor speed are done with either a resolver or an encoder. For example, in a resolver the sine (SIN) and cosine (COS) signals are induced through

SNVA887–July 2018 — Voltage Reference Solutions in Motor Drives

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Supervisor & reset ICs – Technical documents

Overview | Products | Applications | Reference designs | **Technical documents**

Voltage Supervisor and Reset ICs: Tips, Tricks and Basics

Get an introduction to voltage supervisors and an in-depth overview of their various applications.

Download (PDF, 2025KB)

Voltage Supervisors (Reset ICs) Quick Reference Guide (Rev. H)

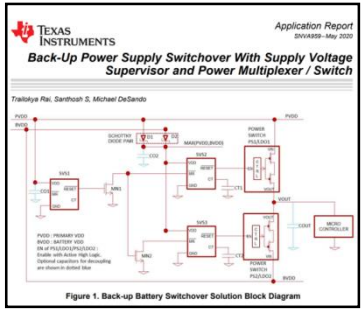
Check out our most popular supervisors and reset ICs.

Download (PDF, 422KB)

Voltage Supervisors (Reset ICs): Frequently Asked Questions (FAQs) (Rev. A)

Read about the most frequently asked questions (FAQs) for voltage supervisors, reset ICs, voltage detectors, watchdog timers and all related monitoring devices.

Download (PDF, 387KB)

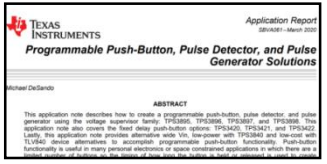


Texas Instruments — Application Report SNVA959–May 2020

Back-Up Power Supply Switchover With Supply Voltage Supervisor and Power Multiplexer / Switch

Trailokya Rai, Santhosh S, Michael DeSando

Figure 1. Back-up Battery Switchover Solution Block Diagram



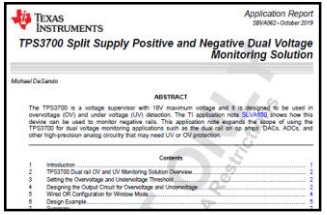
Texas Instruments — Application Report SBVA061–March 2020

Programmable Push-Button, Pulse Detector, and Pulse Generator Solutions

Michael DeSando

ABSTRACT

This application note describes how to create a programmable push-button, pulse detector, and pulse generator using the voltage supervisor family: TPS3895, TPS3896, TPS3897, and TPS3898. This application note also covers the fixed delay push-button options: TPS3420, TPS3421, and TPS3422. Lastly, this application note provides alternative wide Vin, low-power with TPS3840 and low-cost with TLV840 device alternatives to accomplish programmable push-button functionality. Push-button functionality is useful in many personal electronics or space constrained applications in which there are a



Texas Instruments — Application Report SBVA062–October 2019

TPS3700 Split Supply Positive and Negative Dual Voltage Monitoring Solution

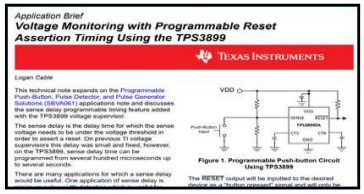
Michael DeSando

ABSTRACT

The TPS3700 is a voltage supervisor with 18V maximum voltage and it is designed to be used in overvoltage (OV) and under voltage (UV) detection. The TI application note SLVA950 shows how this device can be used to monitor negative rails. This application note expands the scope of using the TPS3700 for dual voltage monitoring applications such as the dual rail on an smart DACs, ADCs, and other high-precision analog circuitry that may need UV or OV protection.

Contents

1 Introduction 1
2 TPS3700 Dual rail OV and UV Monitoring Solution Overview 2
3 Setting the Overvoltage and Undervoltage Threshold 3
4 Designing the Output Circuit for Overvoltage and Undervoltage 4
5 Wired OR Configuration for Window Mode 5
6 Design Example 6



Application Brief

Voltage Monitoring with Programmable Reset Assertion Timing Using the TPS3899

Texas Instruments

Logan Cable

This technical note expands on the Programmable Push-Button, Pulse Detector, and Pulse Generator Solutions (SBVA061) applications note and discusses the sense delay programmable timing feature added with the TPS3899 voltage supervisor.

The sense delay is the delay time for which the sense voltage needs to be under the voltage threshold in order to assert a reset. On previous TI voltage supervisors this delay was small and fixed, however, on the TPS3899, sense delay time can be programmed from several hundred microseconds up to several seconds.

There are many applications for which a sense delay would be useful. One application of sense delay is

Figure 1. Programmable Push-button Circuit Using TPS3899

The RESET output will be inputted to the desired

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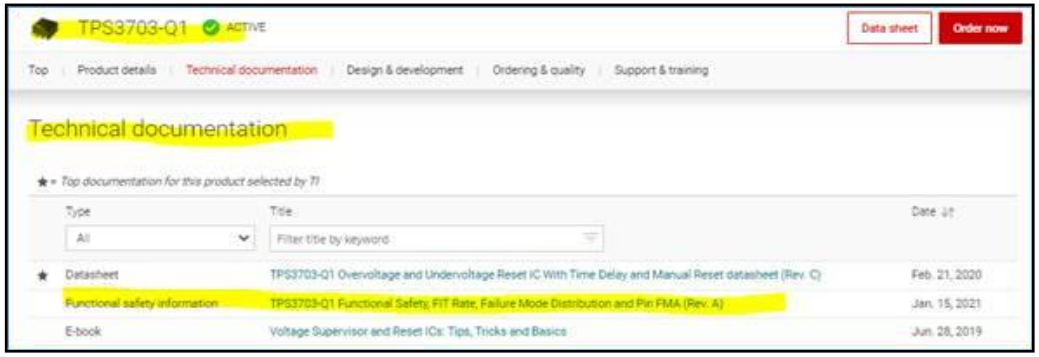
Functional Safety Documentation on TI.COM


TPS3703-Q1 ACTIVE

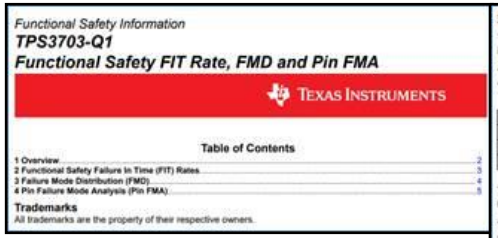
Data sheet | Order now

Top | Product details | Technical documentation | Design & development | Ordering & quality | Support & training

Technical documentation

★ = Top documentation for this product selected by TI

	Type	Title	Date
★	Datasheet	TPS3703-Q1 Overvoltage and Undervoltage Reset IC With Time Delay and Manual Reset datasheet (Rev. C)	Feb. 21, 2020
	Functional safety information	TPS3703-Q1 Functional Safety, FIT Rate, Failure Mode Distribution and Pin FMA (Rev. A)	Jan. 15, 2021
	E-book	Voltage Supervisor and Reset ICs: Tips, Tricks and Basics	Jun. 28, 2019


Functional Safety Information

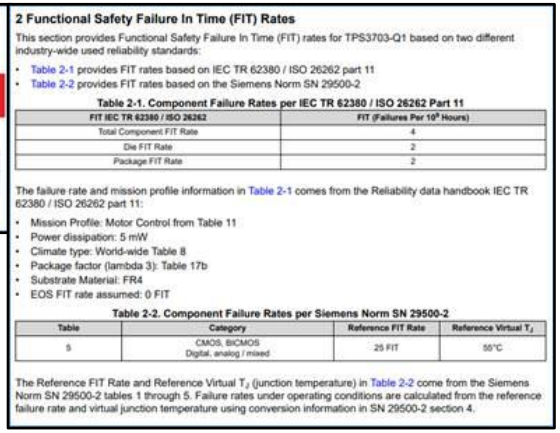
TPS3703-Q1

Functional Safety FIT Rate, FMD and Pin FMA

Texas Instruments

Table of Contents

Trademarks


2 Functional Safety Failure In Time (FIT) Rates

This section provides Functional Safety Failure In Time (FIT) rates for TPS3703-Q1 based on two different industry-wide used reliability standards:

- Table 2-1 provides FIT rates based on IEC TR 62380 / ISO 26262 part 11
- Table 2-2 provides FIT rates based on the Siemens Norm SN 29500-2

Table 2-1. Component Failure Rates per IEC TR 62380 / ISO 26262 Part 11

FIT IEC TR 62380 / ISO 26262	FIT (Failures Per 10^9 Hours)
Total Component FIT Rate	4
Die FIT Rate	2
Package FIT Rate	2

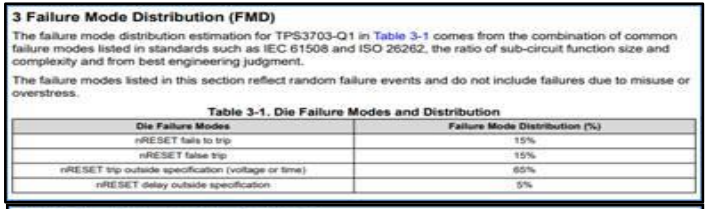
The failure rate and mission profile information in Table 2-1 comes from the Reliability data handbook IEC TR 62380 / ISO 26262 part 11:

- Mission Profile: Motor Control from Table 11
- Power dissipation: 5 mW
- Climate type: World-wide Table 8
- Package factor (lambda 3): Table 17b
- Substrate Material: FR4
- EOS FIT rate assumed: 0 FIT

Table 2-2. Component Failure Rates per Siemens Norm SN 29500-2

Table	Category	Reference FIT Rate	Reference Virtual T_J
5	CMOS, BICMOS Digital, analog / mixed	25 FIT	55°C

The Reference FIT Rate and Reference Virtual T_J (junction temperature) in Table 2-2 come from the Siemens Norm SN 29500-2 tables 1 through 5. Failure rates under operating conditions are calculated from the reference failure rate and virtual junction temperature using conversion information in SN 29500-2 section 4.

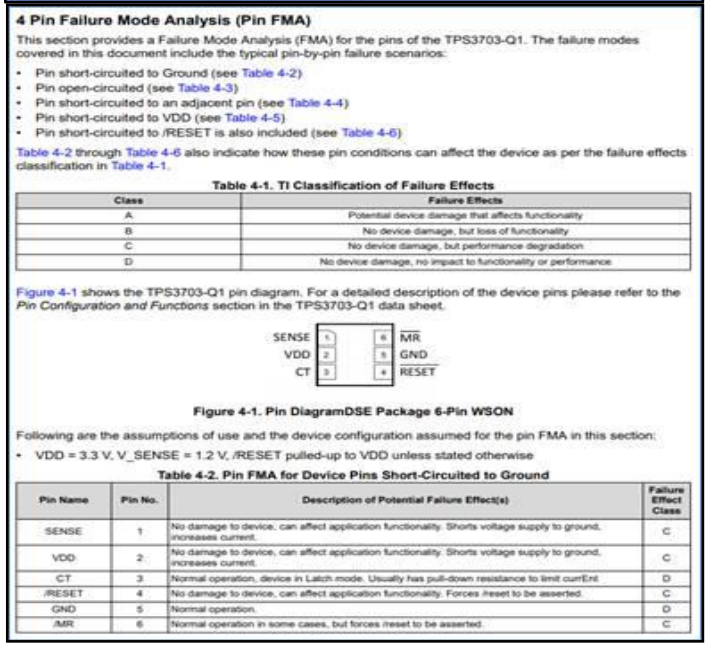

3 Failure Mode Distribution (FMD)

The failure mode distribution estimation for TPS3703-Q1 in Table 3-1 comes from the combination of common failure modes listed in standards such as IEC 61508 and ISO 26262, the ratio of sub-circuit function size and complexity and from best engineering judgment.

The failure modes listed in this section reflect random failure events and do not include failures due to misuse or overstress.

Table 3-1. Die Failure Modes and Distribution

Die Failure Modes	Failure Mode Distribution (%)
nRESET fails to trip	15%
nRESET false trip	15%
nRESET trip outside specification (voltage or time)	65%
nRESET delay outside specification	5%


4 Pin Failure Mode Analysis (Pin FMA)

This section provides a Failure Mode Analysis (FMA) for the pins of the TPS3703-Q1. The failure modes covered in this document include the typical pin-by-pin failure scenarios:

- Pin short-circuited to Ground (see Table 4-2)
- Pin open-circuited (see Table 4-3)
- Pin short-circuited to an adjacent pin (see Table 4-4)
- Pin short-circuited to VDD (see Table 4-5)
- Pin short-circuited to /RESET is also included (see Table 4-6)

Table 4-2 through Table 4-6 also indicate how these pin conditions can affect the device as per the failure effects classification in Table 4-1.

Table 4-1. TI Classification of Failure Effects

Class	Failure Effects
A	Potential device damage that affects functionality
B	No device damage, but loss of functionality
C	No device damage, but performance degradation
D	No device damage, no impact to functionality or performance

Figure 4-1 shows the TPS3703-Q1 pin diagram. For a detailed description of the device pins please refer to the *Pin Configuration and Functions* section in the TPS3703-Q1 data sheet.

Figure 4-1. Pin DiagramDSE Package 6-Pin WSON

Following are the assumptions of use and the device configuration assumed for the pin FMA in this section:

- VDD = 3.3 V, V_SENSE = 1.2 V, /RESET pulled-up to VDD unless stated otherwise

Table 4-2. Pin FMA for Device Pins Short-Circuited to Ground

Pin Name	Pin No.	Description of Potential Failure Effect(s)	Failure Effect Class
SENSE	1	No damage to device, can affect application functionality. Shorts voltage supply to ground, increases current.	C
VDD	2	No damage to device, can affect application functionality. Shorts voltage supply to ground, increases current.	C
CT	3	Normal operation, device in Latch mode. Usually has pull-down resistance to limit curr'Ent	D
/RESET	4	No damage to device, can affect application functionality. Forces /reset to be asserted.	C
GND	5	Normal operation.	D
/MR	6	Normal operation in some cases, but forces /reset to be asserted.	C

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