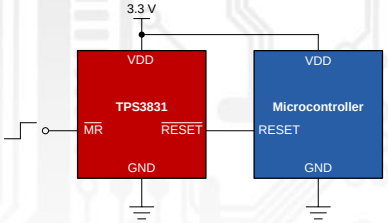
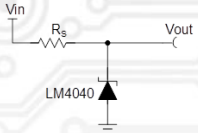
Voltage References & Supervisors (VRS) New Product Broadcast

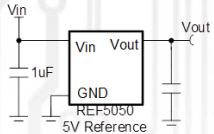
TI.com/VREF

TI.com/SVS

November 2019







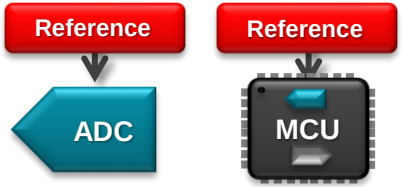
Agenda

- Overview
- Supervisors
  - Use-cases and portfolio
  - Functional Safety
  - New devices
    - Upgraded TLV803/9 with lower IQ and smaller package options - TLV803E/9E
    - Upgraded LP3470 with lower IQ – LP3470A
    - Nanopower, high-input voltage supervisor - TPS3840
    - High accuracy, small size, overvoltage supervisor - TPS3870
    - OV/UV supervisor – TPS3703
- Voltage References (Shunt and Series)
  - Use-cases and portfolio
  - New devices
    - New 43X family of parts (small size available) - TL431LI, TL432LI, ATL431LI, ATL432LI
- Technical Resources on ti.com (app notes,videos, technical articles)

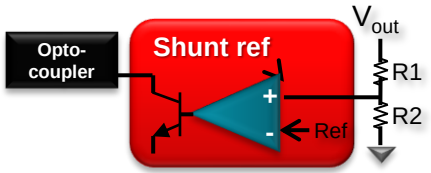
Voltage references & supervisors - Overview

Use cases

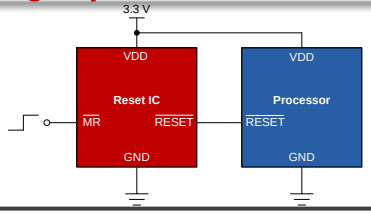
Signal conditioning



Voltage regulation



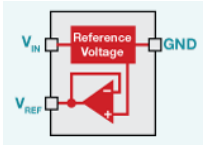
Voltage / processor monitoring



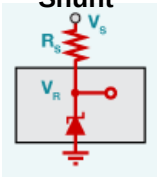
Products

Voltage References

Series

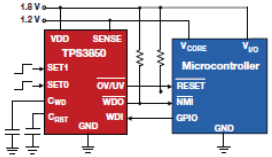


Shunt

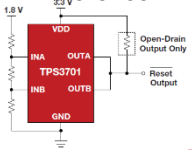


Supervisors and Reset ICs

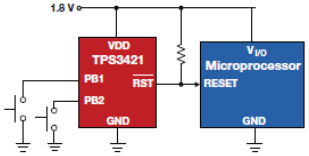
Supervisor + Watchdog Timer



Window Supervisor + Internal Reference



Push-Button Reset IC



System benefits

High accuracy

Low noise

Wide Vin

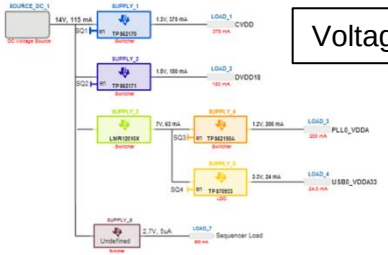
Low I_Q

Small solution size

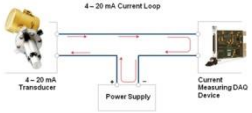
Supervisors

Voltage supervisor, monitor, detector, reset IC….

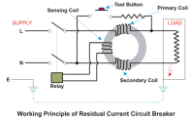
Supervisor, Monitor, Detector, Reset IC….

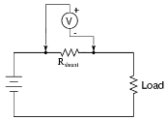


Voltage monitoring



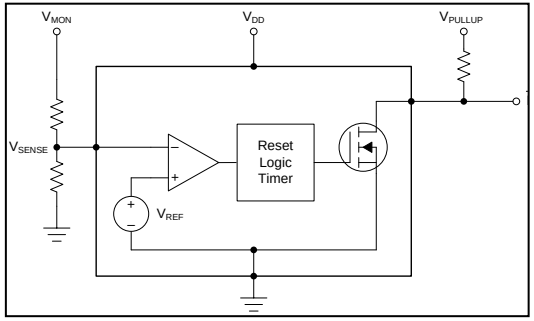
Current monitoring

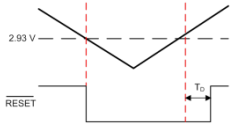




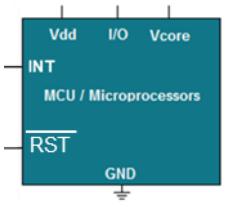
Time monitoring

Vref + Comparator
+ Timer + Driver



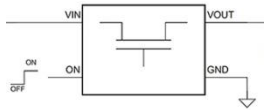


CPU Safety



In rush control

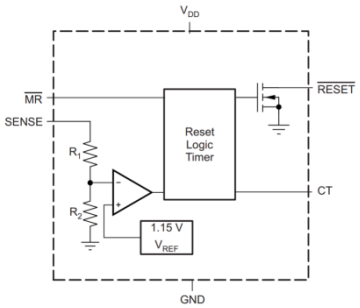
Power Mux



Power Indicator

Point of load monitoring

Voltage supervisor

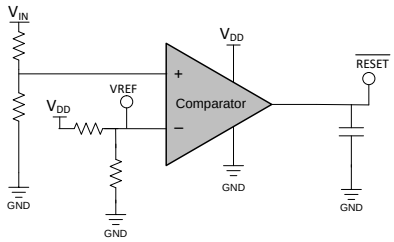


✓ **Power consumption**:
- Nano-Amp options available

✓ **Reliability**
- Consolidated errors, easier to error budget
- Features such as RESET delay and manual reset
- Highest accuracy across temperature
- Low VPOR

✓ **Flexibility**
- Includes integrated resistor dividers to set voltage thresholds
- Features: WD, Reset delay, latching, PFI

Discrete voltage detector

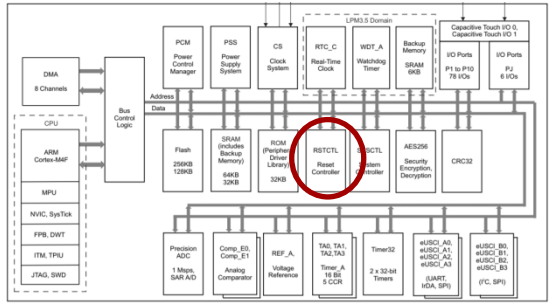


X **Power consumption:**
- High power consumption due to external divider

X **Reliability**
- Requires external resistor dividers which adds risk to large errors and more point of failures

✓ **Flexibility**
- Flexibility in choosing reference and comparator separately to optimize cost and specifications
- Voltage threshold cannot go below 1.2V

Integrated within MCU



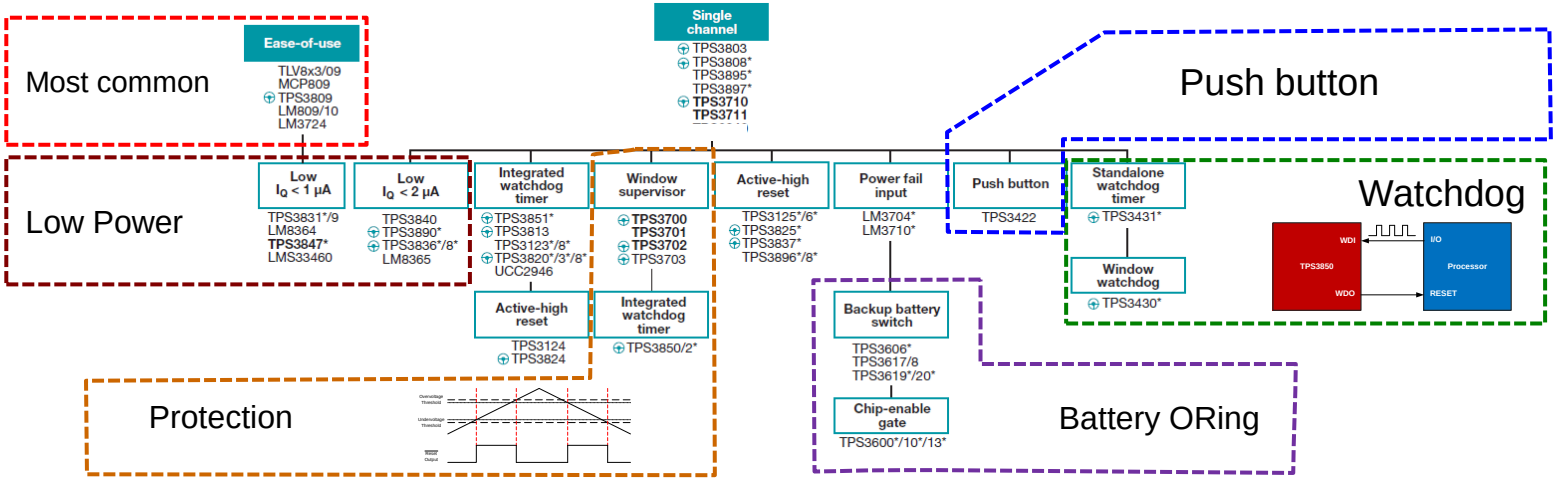
X **Power consumption**:
- Power up inrush current cannot be delayed
- Higher power consumption (~10uA to 100uA)

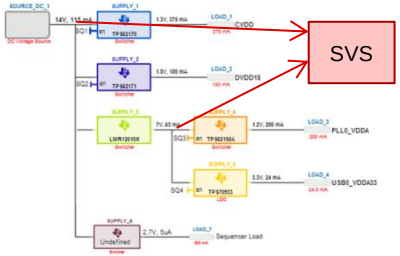
- Reliability
- Detection feature can unintentionally be disabled by software
- POR may not work for fast VCC rise rate

X **Flexibility**
- Non-programmable voltage thresholds & delay times

TI's broad supervisor portfolio

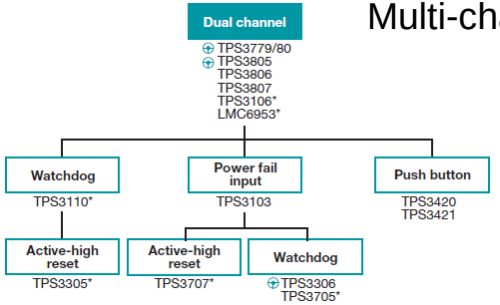
On ti.com/svs → SLYT361

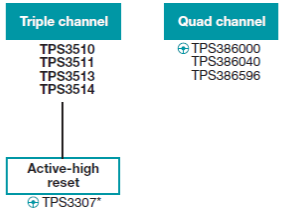


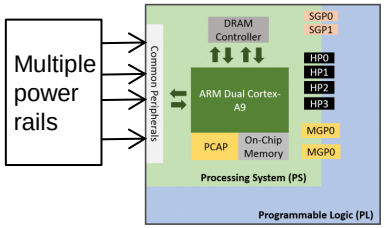


SVS

Multi-channel







Relevance of Voltage Supervisor to Safety

How voltage references and supervisors help achieve ASIL functional safety goals

Ethan T
May 10, 2019

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TPS3890-Q1
supervisor
LM4132-Q1
TPS3703-Q1
voltage reference
advanced driver assistance systems
reset ICs
TPS3850-Q1

Options

Many safety related automotive systems are required to meet Automotive Safety Integrity Level (ASIL) as defined by International Organization for Standardization (ISO) 26262.

It is a common misconception that integrated circuits (ICs) not developed following the ISO 26262 standards cannot be used to achieve functional safety goals. Many automotive OEMs have been able to use the features and reliability of non-ASIL compliant semiconductor devices to develop systems that target ASIL requirements. In this post, it will be demonstrated how both voltage references and supervisors can help you achieve ASIL compliance for your automotive systems.

Voltage references and supervisors

Devices such as voltage references and supervisors (reset ICs) are common semiconductor devices that can help automotive system integrators develop functionally safe systems. When used in automotive applications, these devices provide diagnostic coverage or redundant monitoring capability.

Figure 1 is taken from ISO26262-10:2018, 9.2.3.4 and is an example of how safety elements out of context (SEooC) can implement voltage supervisors and watchdogs as safety mechanisms.

9.2.3.4 Step 1b — Assumptions on system level design

Some examples of system level design assumptions, external to the SEooC:

a) The system will implement a safety mechanism on the power supply to the MCU to detect over voltage and under voltage failure modes.

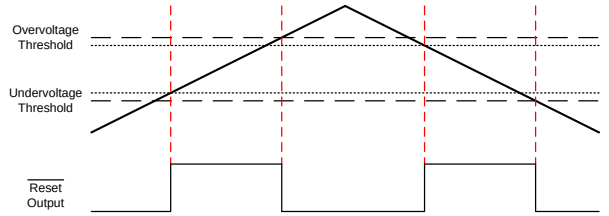
b) The system will implement a windowed watchdog safety mechanism external to the MCU to detect either clocking or program sequence failures of the MCU.

Figure 1: System-level design assumptions for SEooC based on ISO 26262

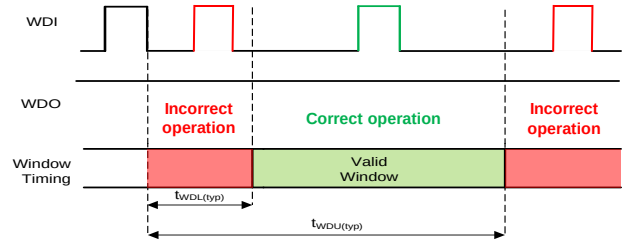
Features and mechanisms of voltage reference and supervisors

A voltage supervisor can help achieve system-level functional safety targets by providing power supply fault detection. A voltage supervisor implements a safety mechanism to the microcontroller (MCU) when an overvoltage or undervoltage failure mode is detected on the power supply. Some voltage supervisors can also provide digital diagnostics with watchdog timers that can detect clocking failures of an MCU. Clocking failures include late pulses or early pulses sent from the MCU. The window watchdog timer can monitor these pulses and alert the system that a fault has occurred. Another method of under and overvoltage monitoring is to use an analog-to-digital converter (ADC) with a precision voltage reference to monitor multiple voltage rails. Figure 2 shows how a window watchdog timer operates. In some cases, systems with very high diagnostic coverage goals may require redundant safety mechanisms in order to achieve system-level functional safety goals. This means that in addition to an ADC and voltage reference to monitor potential

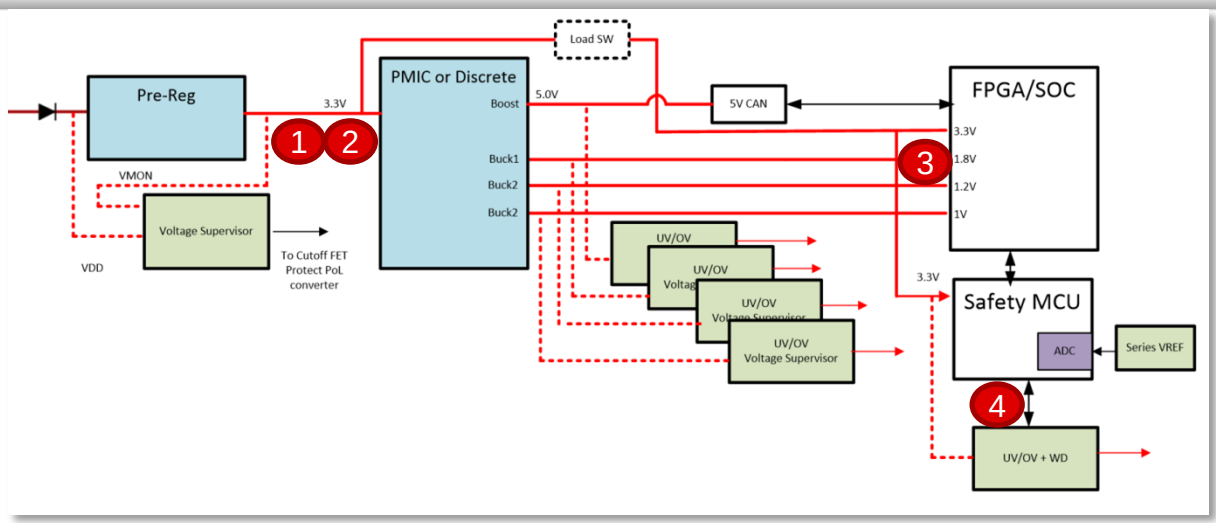
Under and over voltage



Watchdog timer (WDT)



Possible System Failures & Mitigation



Potential failure

Key Standards and Ratings

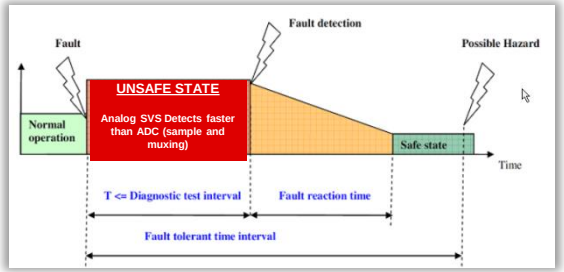
- IEC 61508
  - Safety Integrity Level
  - SIL1 to SIL4
- ISO 13849
  - Performance levels
  - PLa to PLe
- IEC 61800-5-2 / UL 60950-1
  - SELV
- ISO 13849
  - CAT1 to CAT4

	Failure Mode	Possible Prevention
1	Power supply failure	Overvoltage and Undervoltage detection for unstable power supply, and initiate power-down or switch to backup power Detect voltage drift due to: Over temperature and over current failures
2	Short/Open circuit fault	Detect short circuit as low voltage
3	MCU Brownout	Reset MCU for brownout. Monitor power supply with bandgap independent Reset IC
4	MCU Failure	Watchdog independent of MCU, Reset MCU if WD fails power up sequence issue

SVS Safety Related Functions

FTTI - Fault Tolerant Time Interval

ISO 26262-10:2018, 4.4.1



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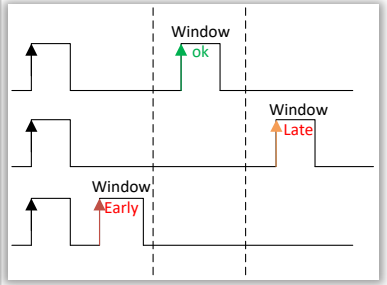
FTTI: "*time-span in which a fault or faults can be present in a system before a hazardous event occurs*"

Watchdog Independent time base

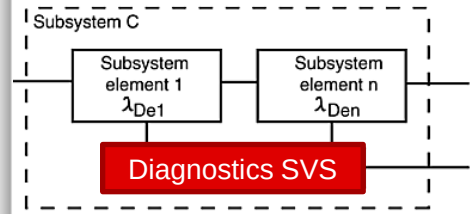
IEC 61508-2 (Table A.10) and ISO 26262-5 (Table D.8)



Coverage:
Standard WD–'up to Low' (60%)
Window WD– up to 'Medium' (90%)
Window WD– up to 'High' (99%)

OV/UV - Over & under voltage monitoring

ISO 26262-11:2018, 5.2.4.2



Low coverage (60%)
Detect OV or UV only

High coverage (99%)
Detect UV+OV on secondary voltages

Redundancy with independent Bandgap

Safety Relevant Documents

- ❑ Device Failure Mode Distribution
- ❑ FIT rate based on IEC TR 62380
- ❑ Detailed PIN FMEA

New Supervisors

TLV803E / TLV809E - Low I_Q Reset IC

Samples available

Features

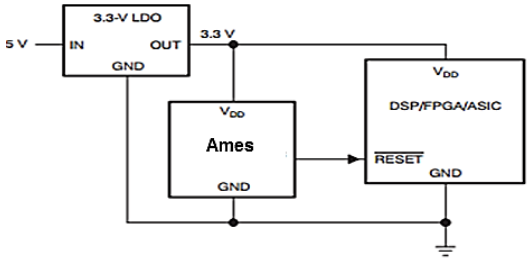
- VDD **1.7V to 5.5V** (operational)
- Precision Supply Voltage Monitor: **1% (typ); 2% (max)**
- Fixed reset delay Time **0ms, 200ms**
- Low Quiescent Current: **0.25uA (typ); 2 µA (Max)**
- Output Topology: **Push-Pull Output Active Low (809E)**
  Open-Drain, Active-Low (803E)
- Temperature Range: **–40°C to +125°C**
- Packages: SOT23-3 (DBV), SC70

Applications

- DSPs, Microcontrollers, and Microprocessors
- FPGAs and ASICs
- Notebook and Desktop Computers
- Smartphones and Tablets
- Portable and Battery-Powered Products
- TV
- IP cameras

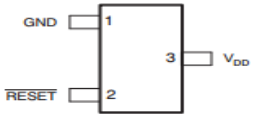
Benefits

- Fixed time delay, no external capacitor needed for delay function.
- Low power consumption for portable systems.
- Open drain for OR wire connections and voltage translation.
- Push Pull no resistor required for smaller footprint
- Industrial temp range
- Leaded package option and small form factor package option for space-constrained systems



Voltage options

Monitor rail (nom. Voltage)	3.3V	3V	5V	3.3V	5V
Tolerance	11%	12%	12%	7%	7%
Voltage VTH (trippoint)	2.93V	2.64V	4.38V	3.08V	4.63V



- **SOT-23 DBZ**
- **SC70**

LP3470A

Ultra-low leakage, wide-VIN, programmable reset time supervisor, -40C to 125C

Features

- Wide V_{IN} operational range: 0.9V – 10V (12V Abs max)
- Temperature range **-40 ºC to 125 ºC T_J range**
- Low IQ: **350nA (typ)**, **1 µA (max 125 ºC)**
- Threshold Accuracy: **1% (typ), 1.5% (max @125 ºC)**
- Threshold Voltages:
  - **2.63, 2.75, 2.93, 3.08, 3.65, 4, 4.38, 4.63**
- Capacitor programmable reset time delay
  - Fast reset time with no capacitor at CT pin
  - **30% delay time accuracy**
- Output topology: Open Drain Active Low
- Package: SOT23-5 (DBV)

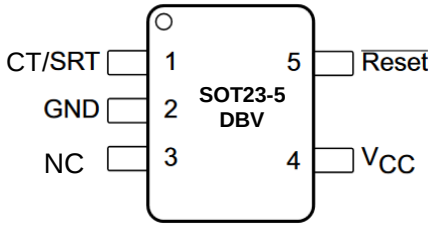
Benefits

- Wide Vin enable operation form high voltage rail or multi cell battery supply
- High voltage threshold accuracy and time delay accuracy to improve system reliability
- Low power consumption to extend battery life and minimize power consumption in self-power systems
- Time delay programmability for sequencing or meeting system power up requirements
- Extended temperature range for industrial applications

Applications

- µP and µC Voltage Monitoring
- Portable and Battery Powered Equipment
- Circuit Breakers
- E-meters
- Low Battery Detection – multi cell applications
- Portable Industrial Control Systems

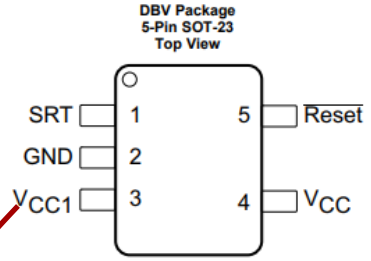
- **LP3470A**
  Open Drain Active Low



LP3470 vs LP3470A

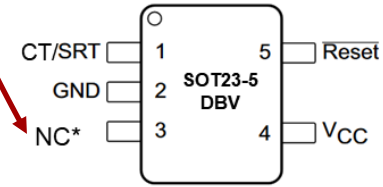
Parameter	Temperature	LP3470A	LP3470
VCC AbsMax (V)		12	6.5
VCC (Max) (V)		10	6
VCC (Min) (V)		0.9	0.5
Temp Min (°C)		-40	-40
Temp Max (°C)		125	85
IQ (µA)	Typical	0.35	16
	Max at 85c	0.5	30
	Max at 125c	1	N/A
Ileakage (µA) (RESET) (max)		0.09	6
VPOR (V)		0.9	0.5
VPOR Test Condition		VOL=0.2V IOL=5.6uA	VOL=0.1V IOL=30uA
VOL (V)		0.2	0.1
VOL Test Conditions		VCC=1.5 to 5V IOL=2mA	VCC=1V IOL=100uA
Threshold Voltages (V)		2.63, 2.75, ~~2.83~~, 2.93, 3.08, 3.65, 4, 4.38, 4.63, ~~4.8~~	2.63, 2.75, 2.83, 2.93, 3.08, 3.65, 4, 4.38, 4.63, 4.8
Threshold Accuracy at 25c (%)	at 25c	1	1
	at 85c	<1.5	1.5
	at 125c	1.5	N/A
Hysterisis Typ (mV)		100	35
Hysterisis Acc (% of typ)		25%	70%
Reset Time Delay Typ (No Cap) (µs)		40	40
Reset Time Delay Typ (ms) (w/Cap)		619*C_µf	2000*C_µf
Delay Accuracy	at 125c	35%	75%
Output Topology		Open-Drain, Active-Low	Open-Drain,Active-Low

LP3470



VCC1 must be connected to VCC (pin 4)

LP3470A



*NC pin can be connected to VCC/GND or left floating

TPS3840

VIN=10V, IDD=0.35uA, Manual Reset, Programmable Reset Time, -40C to 125C

Features

- Wide V_{IN} operational range: 1.5 V – 10V (12V max)
- Temperature range -40ºC to 125ºC T_J range
- 1% typical accuracy, 2.5% over temperature
- Fixed threshold Voltage (100mV step): 1.6V to 4.9V
- Capacitor programmable reset time delay
  - Fast reset time with no capacitor at C_D pin
  - 30% delay time accuracy
- Low I_Q : 350nA typical, 1uA max over temp (125C)
- Manual Reset: active low logic, can be left open when not in use
- Output topology: Open Drain and Push Pull
- Package: SOT23-5 (DBV)

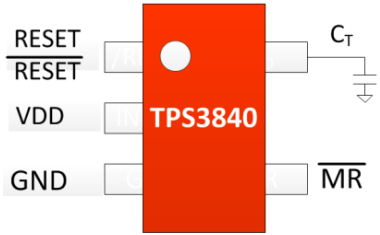
Benefits

- Wide Vin enable operation form high voltage rail or multi cell battery supply
- High voltage threshold accuracy and time delay accuracy to improve system reliability
- Low power consumption to extend battery life and minimize power consumption in self-power systems
- Time delay programmability for sequencing or meeting system power up requirements
- Extended temperature range for industrial applications

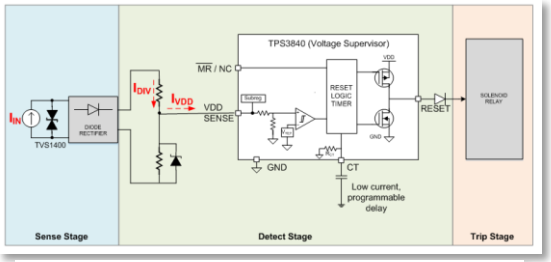
Applications

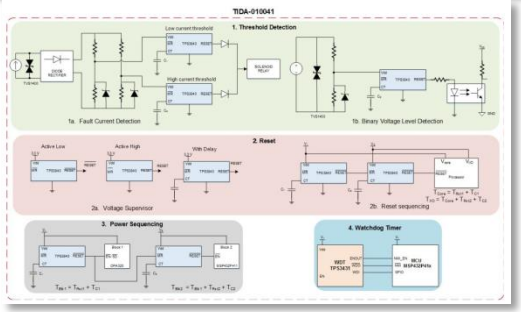
- Field Transmitters & PLCs
- Circuit Breakers & E-meters
- Low Battery Detection – multi cell applications
- µP and µC Voltage Monitoring
- Portable Industrial Control Systems

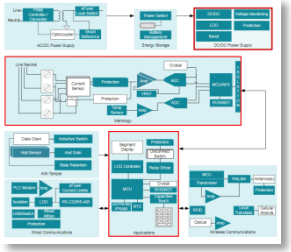
- **TPS3840DL**
  Open Drain Active Low
- **TPS3840PH**
  Push-Pull Active High
- **TPS3840PL**
  Push Pull Active Low



TPS3840 technical docs and reference designs







- Blog: Improve circuit breaker leakage current response with a voltage supervisor
  - Use TPS3840 in a leakage current detector circuit, taking advantage of the device's 200 µs startup time, IQ of 350 nA, and 300 mV V_{POR}!
- TI Design: TIDA-010041 - Nano power, wide VIN (12 V max) supervisor reference design used as comparator or power sequencer
- Blog: Voltage supervisor requirements for e-meter applications

TPS3870-Q1

Overvoltage detector

Features

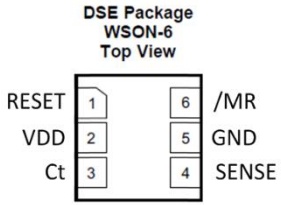
- Operating Voltage: **1.7 to 5.5V**
- OV/UV accuracy: 0.25% Typical , 0.7% across temp -40°C to +125°C
  - Nominal monitoring rails: 50mV steps from 0.5V to 1.3V and 1.5V, 1.8V, 2.5V, 2.9V, 2.8V, 3.3V, 5V.
  - Tolerance from nominal voltage 3%, 4%, 5% ,6%, 7%,
- Build in 0.5% hysteresis and Build in Glitch immunity
- Fixed and programmable reset time delay
  - Fixed rest time delay: 50us,1ms, 5ms, 10ms, 20ms,100ms, 200ms
  - Programmable and tunable with external capacitor
- RESET latching feature clear with external pulse
- MR active low reset: sequencing assist, AND logic, force reset.
- Low Supply Current: 4.5µA (Typical)
- Open Drain Active low output topology

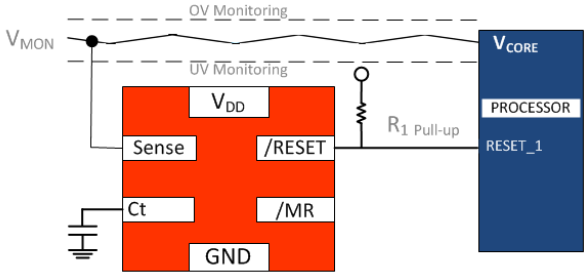
Benefits

- Combination of High Accuracy & Precision Hysteresis provide maximum useable bus voltage.
- Fixed thresholds with internal resistor devisor permits high precision monitoring without external resistor tolerance error.
- Programmable and fixed time delay to meet power up timing requirements and also provides sequencing.
- Build in hysteresis minimizes nuisance trips due to supply voltage ripple
- Open drain topology allows AND-wiring the RESET output with various devices; Open drain also provides level shifting

Applications

- Automotive ADAS Systems: CMOS imager monitoring, MCU monitoring
- Automotive Cluster and infotainment processor monitoring
- Industrial Motor Drivers control unit
- Automated Machinery
- Avionics system
- FPGA and ASIC Applications





TPS3703-Q1

Precise monitoring OV/UV monitoring to assist on safety solution

Features

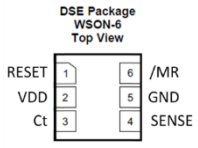
- Operating Voltage: 1.7 to 5.5V
- OV/UV accuracy: 0.25% (Typ.) , 0.9% across temp -40°C to +125°C
  - Nominal monitoring rails: 50mV steps from 0.5V to 1.3V and 1.5V, 1.8V, 2.5V, 2.9V, 2.8V, 3.3V, 5V.
  - OV and UV trip point from nominal rails 3%, 4%, 5% ,6%, 7%,
- Built-in 0.5% hysteresis and built-in Glitch immunity
- Fixed and programmable reset time delay
  - Fixed rest time delay: 50us,1ms, 5ms, 10ms, 20ms,100ms, 200ms
- Integrated RESET latching feature clear with external pulse
- MR active low reset: sequencing assist, AND logic, force reset.
- Low Supply Current: 6µA (Typical)
- Open Drain Active low output topology

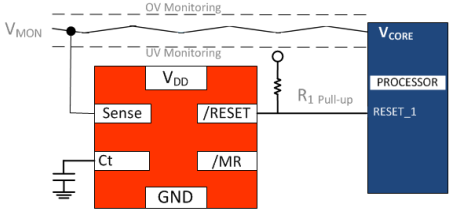
Applications

- Automotive ADAS Systems: CMOS imager monitoring, MCU monitoring
- Automotive Cluster and infotainment processor monitoring
- Industrial Motor Drivers control unit
- Automated Machinery
- Avionics system
- FPGA and ASIC Applications

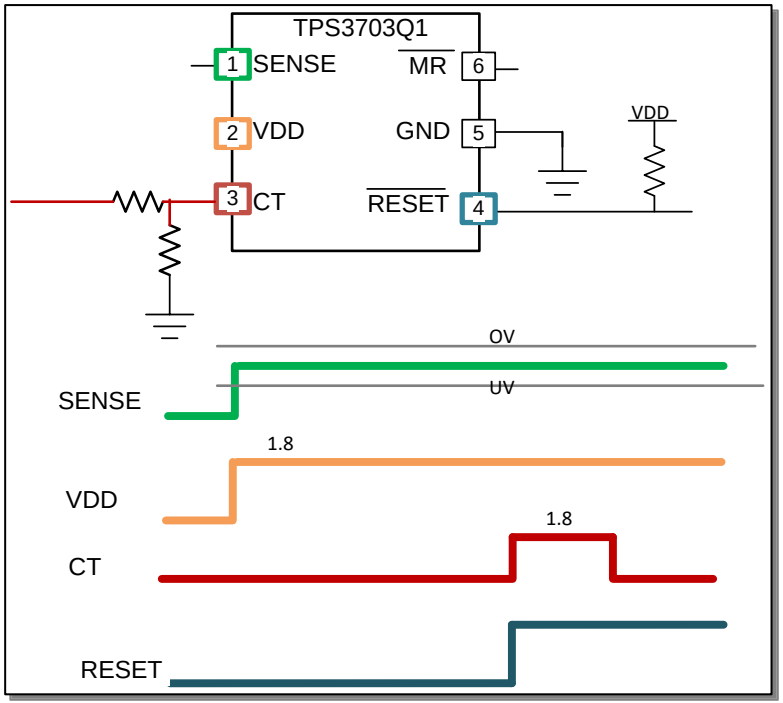
Benefits

- Combination of High Accuracy & Precision Hysteresis provide maximum useable bus voltage.
- Fixed thresholds with internal resistor devisor permits high precision monitoring without external resistor tolerance error.
- Programmable and fixed time delay to meet power up timing requirements and also provides sequencing.
- Built-in hysteresis minimizes nuisance trips due to supply voltage ripple
- Open drain topology allows AND-wiring the RESET output with various devices; Open drain also provides level shifting





TPS3703-Q1 RESET Latch details



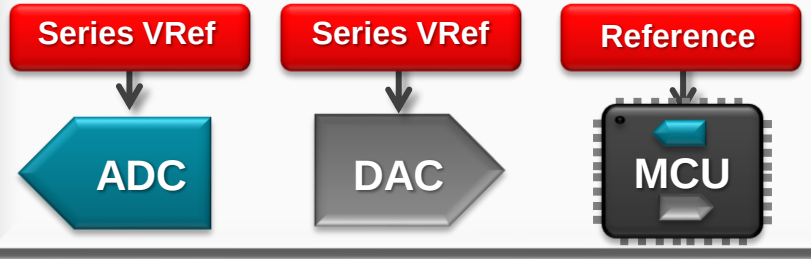
Latch setup CT function:

- In this configuration RESET output pin will remain low until CT voltage is driven above 1.4V
- To release RESET output CT voltage has to be driven above 1.4V but not exceeding V_{CTmax} = 5.5V

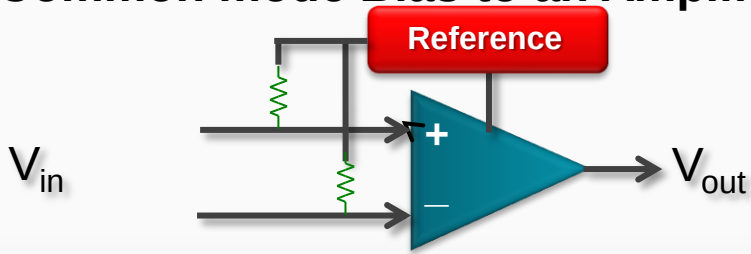
Voltage references

Voltage Reference example use cases

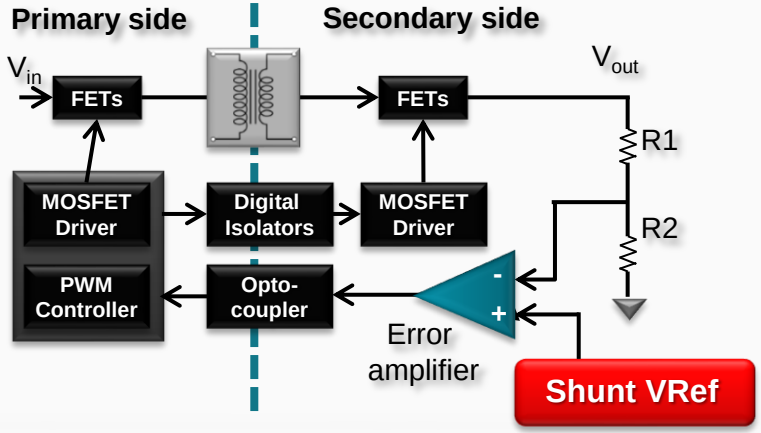
Power supply to a data converter



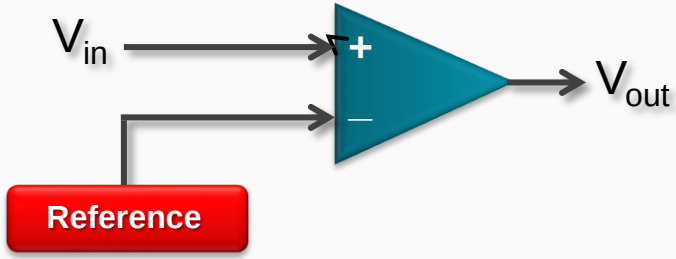
Common mode Bias to an Amplifier



Secondary side monitoring

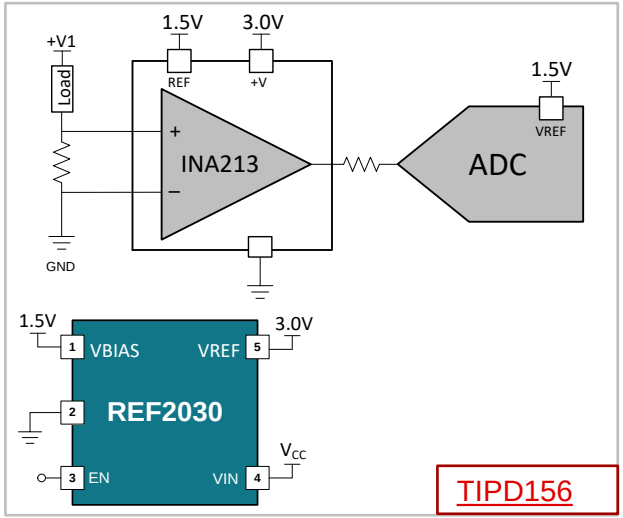


Accurate reference to a comparator



Function: Current Sensing

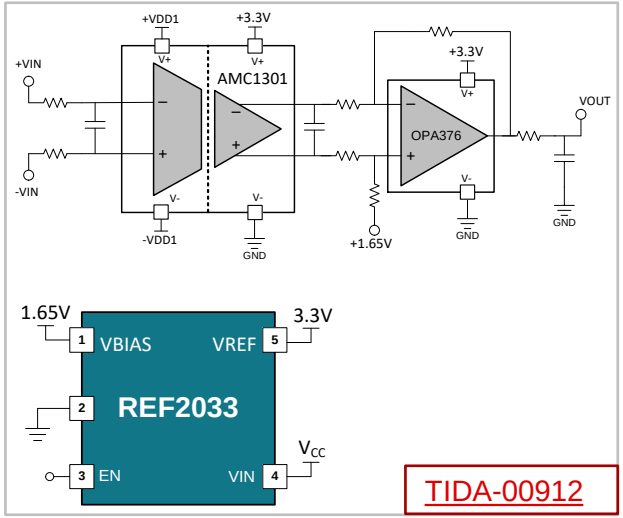
Low-side sense with ADC interface



TIPD156

Dual-output voltage reference provides both supply voltage and reference voltage. Single output series Vref can also be used.

Isolated sense with level-shifting

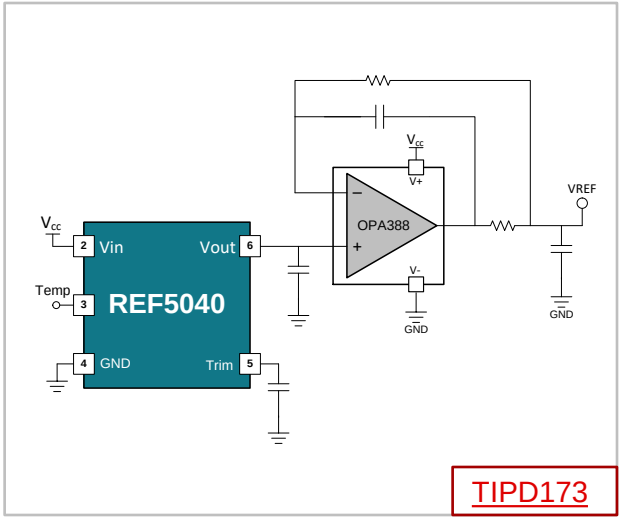


TIDA-00912

Voltage references can provide a supply voltage or a common-mode voltage for level shifting.

Function: Signal Chain Conditioning

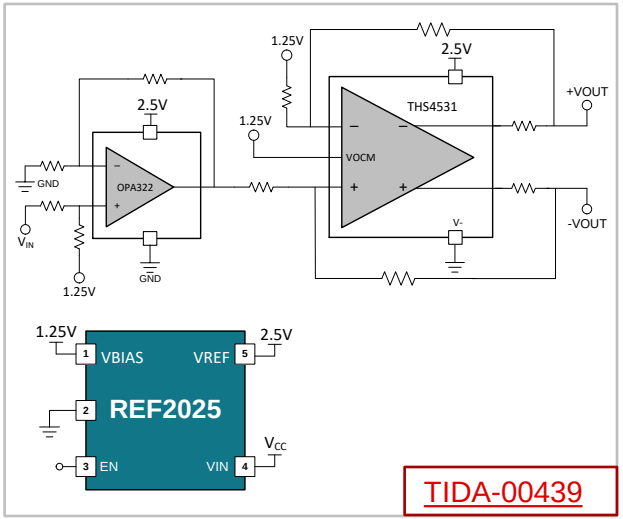
Reference buffer



TIPD173

Reference voltage is buffered to drive a required load or ADC. Use when a low-impedance voltage reference is needed.

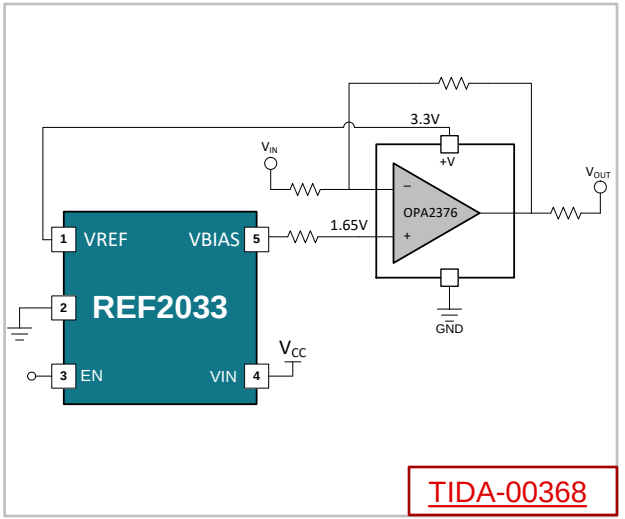
Single-ended to differential signals



TIDA-00439

Voltage reference used to bias amplifiers and provide reference for single-ended to differential signal conversion.

Level shifting

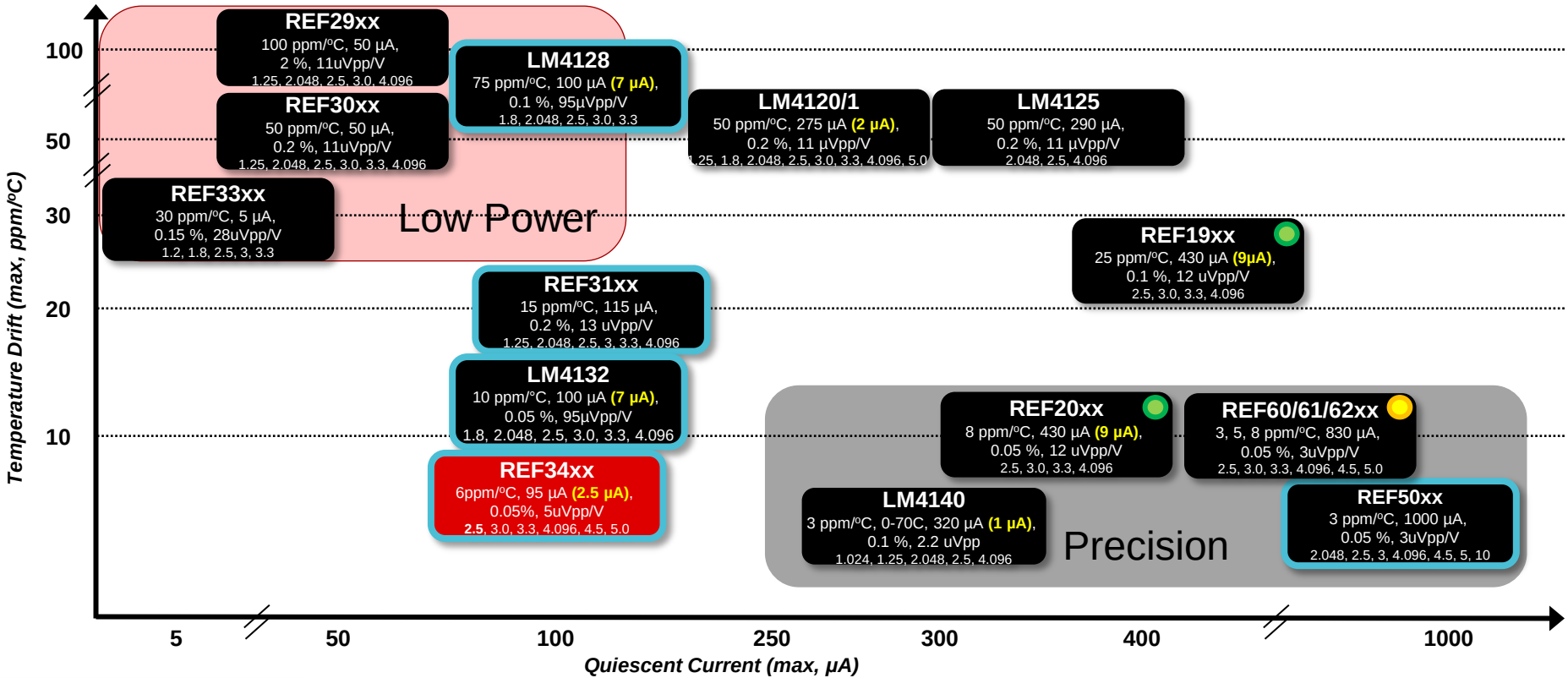


TIDA-00368

Voltage reference used to bias the amplifier and provide reference for level-shifting a signal.

Series voltage references

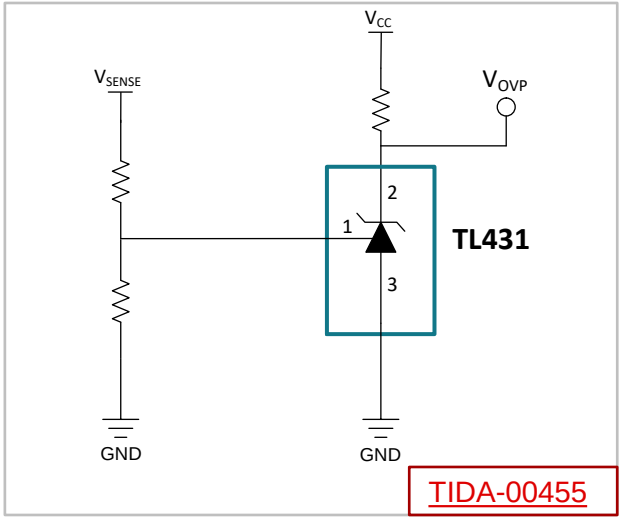
Need more? See
TI.com/VREF



Q-100 Automotive Qualified Dual outputs Integrated ADC Drive Buffer (shutdown IQ) NEW EXISTING

Shunt Vref example applications

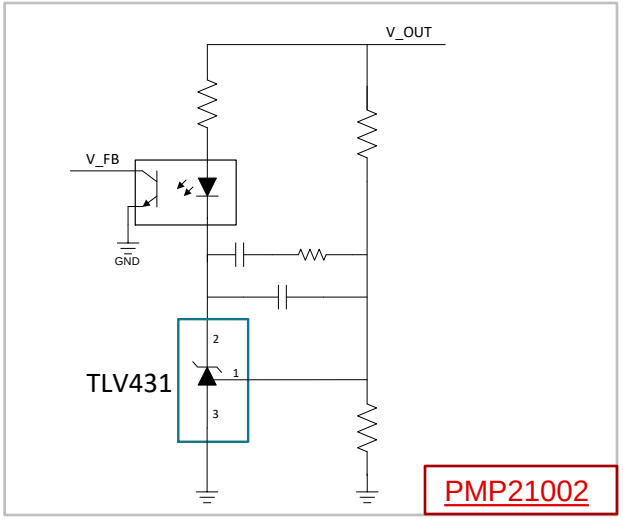
Adjustable shunt vref



TIDA-00455

Shunt references regulates with an internal reference and error amplifier. Use for low-cost applications.

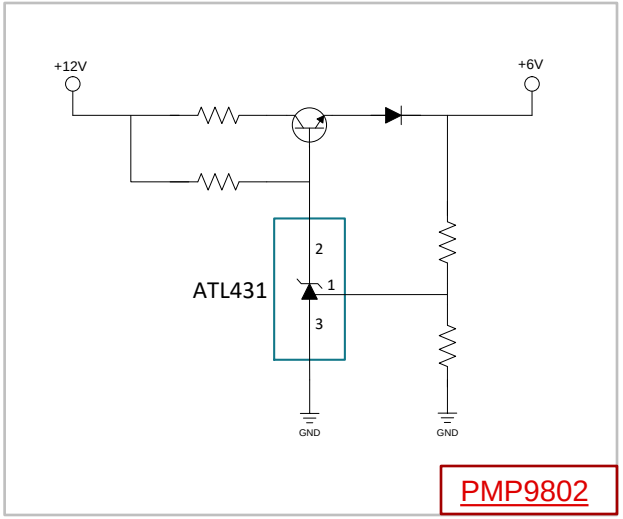
Optocoupler feedback regulator



PMP21002

The adjustable shunt reference is used to monitor an isolated output voltage and provide an accurate reference for proper regulation.

Precision voltage regulator

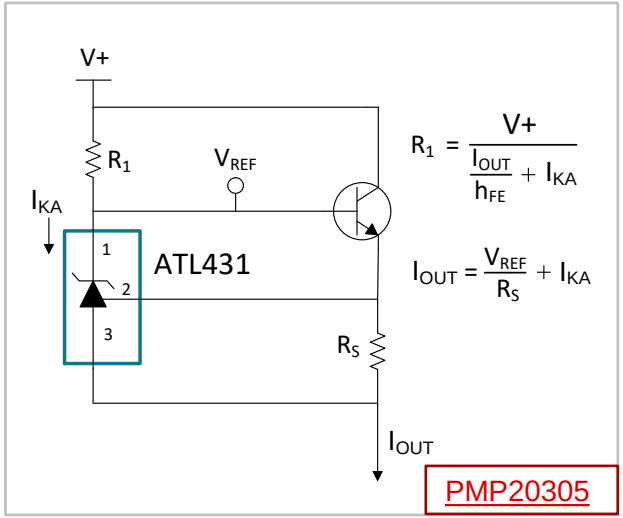


PMP9802

The adjustable shunt reference is used in the control loop of a step-down regulator. The reference is fed back to transistor for regulation.

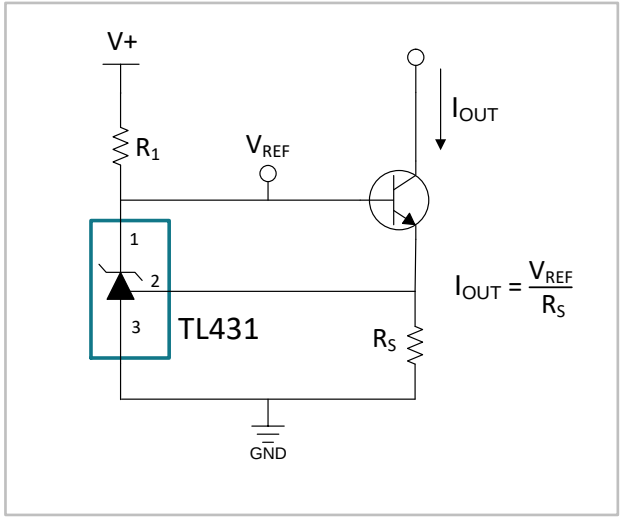
Shunt Vref for Current Sourcing and Sinking

Shunt Vref constant-current source



Low-cost precision constant-current source. The shunt reference regulates and feeds back to the transistor for accurate current sourcing.

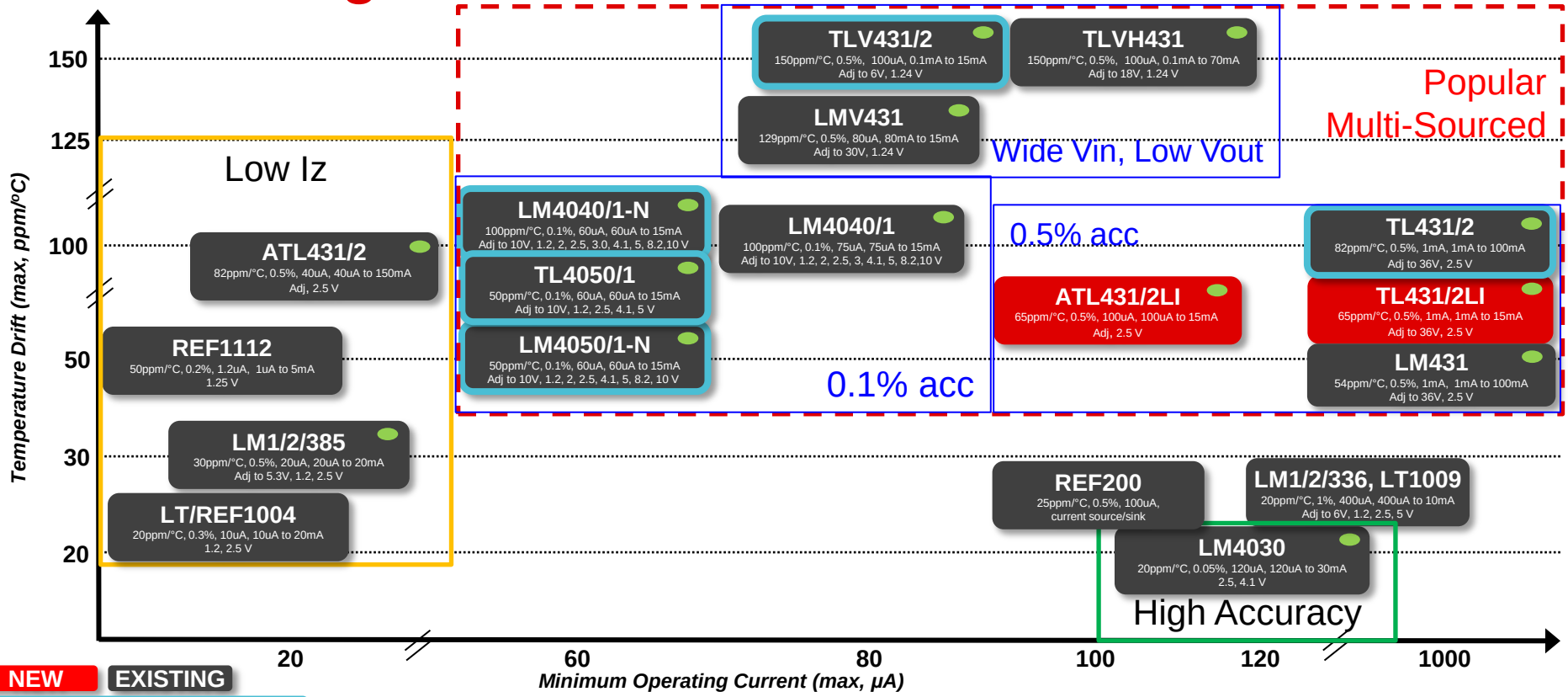
Shunt Vref Constant-current sink



Low-cost precision constant-current sink. The shunt reference regulates and feeds back to the transistor for accurate current sinking.

Shunt voltage references

Need more? See TI.com/VREF



NEW EXISTING

Q-100 Automotive Qualified

Multiple accuracy grades

New Voltage References

TL431/2LI

Precision Programmable Shunt Regulator

Features

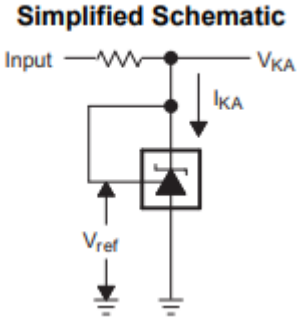
- Wide supply voltage range: V_{KA}=2.495V to 36V
- Vref tolerance @ 25C: A Grade: 1%, B Grade: 0.5%
- Ika min: 1mA
- Iref max: 0.4uA
- Max variation over temperature:
  - 11mV (0°C to 70°C) (C Grade)
  - 17mV (-40°C to 85°C) (I Grade)
  - 27mV (-40°C to 125°C) (Q Grade)
- Package: DBZ (Body size 2.9x1.3 SOT23-3)

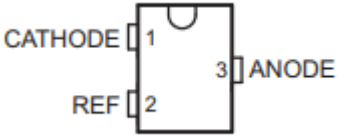
Applications

- Power Supply
- LED Lighting
- Factory Automation
- Building Automation

Benefits

- High voltage operation enables flexibility
- Accurate reference voltage
- Low operating power
- Low input leakage
- Small footprint





ATL431/2LI

Precision Programmable Shunt Regulator

Features

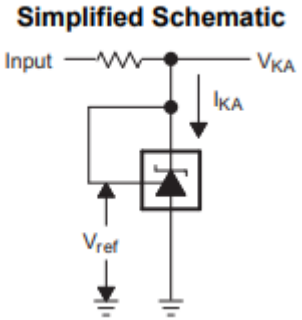
- Wide supply voltage range: V_{KA}=2.5V to 36V
- Vref tolerance @ 25C: A Grade: 1%, B Grade: 0.5%
- Ika min: 100uA
- Iref: 0.4uA
- Package: DBZ (Body size 2.9x1.3 SOT23-3)

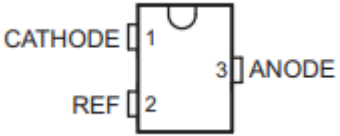
Benefits

- High voltage operation enables flexibility
- Accurate reference voltage
- Low operating power
- Low input leakage
- Small footprint

Applications

- Low standby power power supply
- LED Lighting
- Factory Automation/Building Automation





AC/DC or DC/DC with optocoupler:

System accuracy comparison

	TL431AI 1% grade with 0.5% resistors	TL431BI 0.5% grade with 0.5% resistors	*NEW* TL431LIAI 1% grade with 0.5% resistors
Vref (V)	2.495	2.495	2.495
Vref deviation over temp range (dev)(mV)	34	34	17
R1 (kΩ)	10	10	10
R2 (kΩ)	10	10	10
Iref (µA)	4	4	0.4
II(dev) (µA)	2.5	2.5	0.3
Error due to Iref and II(dev) (V)	0.06565	0.06565	0.007
Total output voltage (V)	5.198	5.173	5.106
Total Error	3.35%	2.85%	2.25%

Total output voltage = $(V_{ref}+V_{I(dev)})*(1+R1/R2)+(I_{ref}+I_{I(dev)})*R1$

V_{ref}, R1, R2 have errors referred in percentages in the table

TL431LIAI (1%) grade is *more accurate* than TL431AI (1%) grade by over 1% and TL431BI (0.5%) by 0.5%. The TL431LI is more accurate as you increase the resistors R1 and R2 to save power.

ATL431LI class 6 power supply power budgets

System requirements with no load condition:

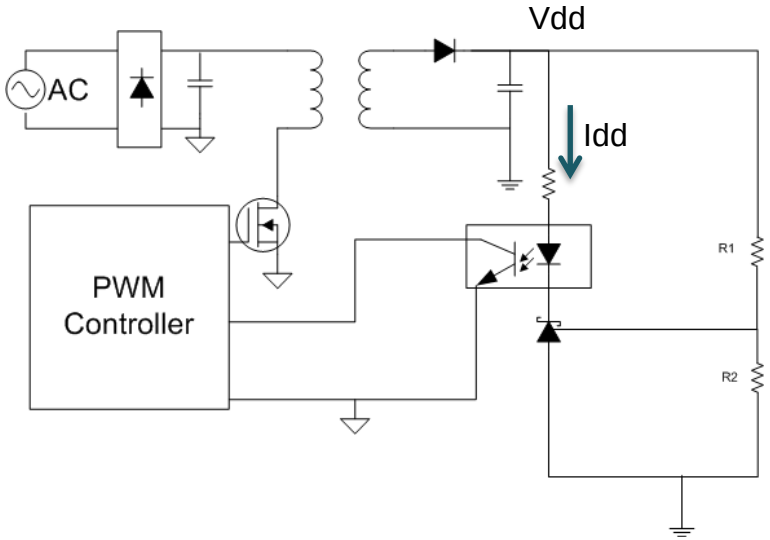
European COC	75mW	Adaptor power <49W

Power consumed by TL431 branch = Vdd * Idd

TL431LI Example: Vdd = 20V, Idd = 2mA given a practical design scenario using the TL431LI and a regular optocoupler.

ATL431LI Example: Vdd = 20V, Idd = 200uA given a practical design scenario using the ATL431LI and an advanced optocoupler.

230V AC input	TL431LI	*Components	ATL431LI	*Components
Power (mW)	40	40	4	40
Total (mW)	**80**		**44**	



ATL431LI saves standby power budget by at least 36mW given practical opto-coupler biasing conditions.

***Components consist of: MOSFETs, controllers, etc**

ATL431LI-DQN

High Bandwidth Low-IQ Programmable Shunt Regulator

Features

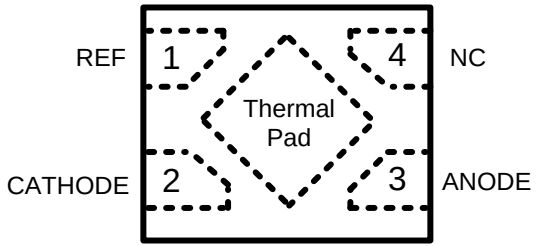
- Wide supply voltage range: V_{KA}=2.5V to 36V
- Vref tolerance @ 25C: A Grade: 1%, B Grade: 0.5%
- Ika min: **80uA**
- Vref over temp: **27mV**
- Iref: **0.4uA**
- II(dev): **0.3uA**
- Pkgs: DQN (Body size 1.0x1.0 mm^2 X2SON)

Applications

- Low standby power power supply
- LED Lighting
- Factory Automation
- Building Automation

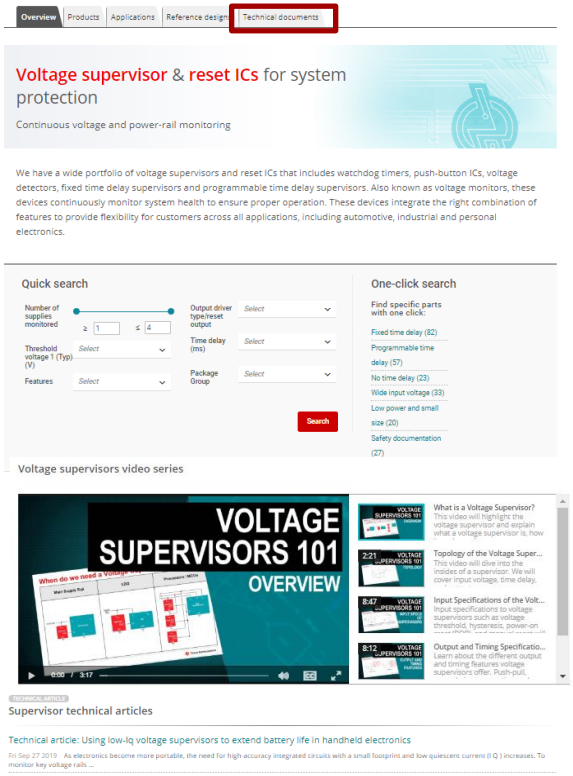
Benefits

- High voltage operation enables flexibility
- Accurate reference voltage
- Low operating power
- Low input leakage
- Small X2SON footprint



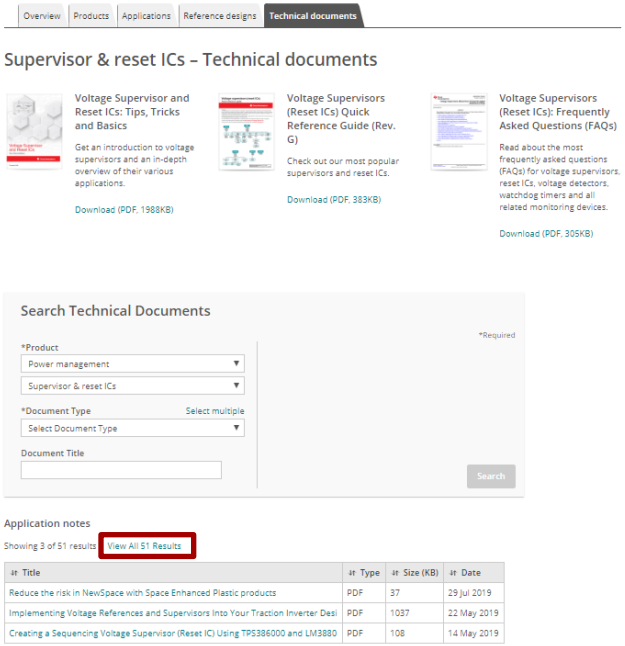
Technical Resources

Voltage Supervisors



Voltage References

Technical Documents



Selection guides

Showing 3 of 9 results View All 9 Results

Title	Type	Size (KB)	Date
Voltage Supervisors (Reset ICs) Quick Reference Guide (Rev. G)	PDF	383	11 Jul 2019
Power Management Guide 2018 (Rev. R)	PDF	6269	25 Jun 2018
Automotive Supervisor and Reset IC Selection Guide	PDF	4114	22 Feb 2016

White papers

Showing 2 of 2 results

Title	Type	Size (KB)	Date
Replacing single-phase ACIMs with three-phase BLDC motors saves energy	PDF	1718	14 Apr 2016
Spartan 6 LX150T Modular Solution	PDF	85	14 Oct 2009

Thank you