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MAX16193

0.3% Accuracy Dual-Channel Supervisory Circuit

General Description

The MAX16193 is an ultra-high accuracy, dual-channel window-detector supervisor circuit that monitors a system's supply rails for undervoltage and overvoltage faults. Input channel 1 (IN1) monitors low core voltage rails from a 0.6V to 0.9V threshold range with $\pm 0.3\%$ accuracy while input-channel 2 (IN2) monitors higher system rails from a 0.9V to 3.3V threshold range with $\pm 0.3\%$ accuracy. A variety of factory trimmed undervoltage/overvoltage thresholds from $\pm 2\%$ to $\pm 5\%$ are available to accommodate different supply voltages and tolerances.

The MAX16193 features two independent, active-low reset outputs. Both reset output are available in either an open-drain or push-pull version. Each reset output asserts low when the corresponding monitored rail falls outside of the undervoltage/overvoltage threshold window. The reset outputs deassert after a factory-set reset timeout period when the corresponding rail voltage returns to its nominal voltage level.

The MAX16193 is available in a small, 2mm x 3mm, 8-pin TDFN chip-on-lead, side-wettable package and operates over the automotive temperature range of -40°C to $+125^{\circ}\text{C}$.

Applications

- Advanced Driver-Assistance Systems (ADAS)
- Multivoltage ASICs
- Servers
- Storage Equipment

Benefits and Features

- $\pm 0.3\%$ IN1 Threshold Accuracy
- $\pm 0.3\%$ IN2 Threshold Accuracy
- 0.6V to 0.9V IN1 Threshold Range
- 0.9V to 3.3V IN2 Threshold Range
- $\pm 2\%$ to $\pm 5\%$ UV/OV Monitoring Range
- Open-Drain/Push-Pull Reset Output Options
- 8-Pin TDFN, 2mm x 3mm Side-Wettable Flanks
- -40°C to $+125^{\circ}\text{C}$ Temperature Range
- AEC-Q100 Qualified

[Ordering Information](#) appears at end of data sheet.

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Typical Application Circuit

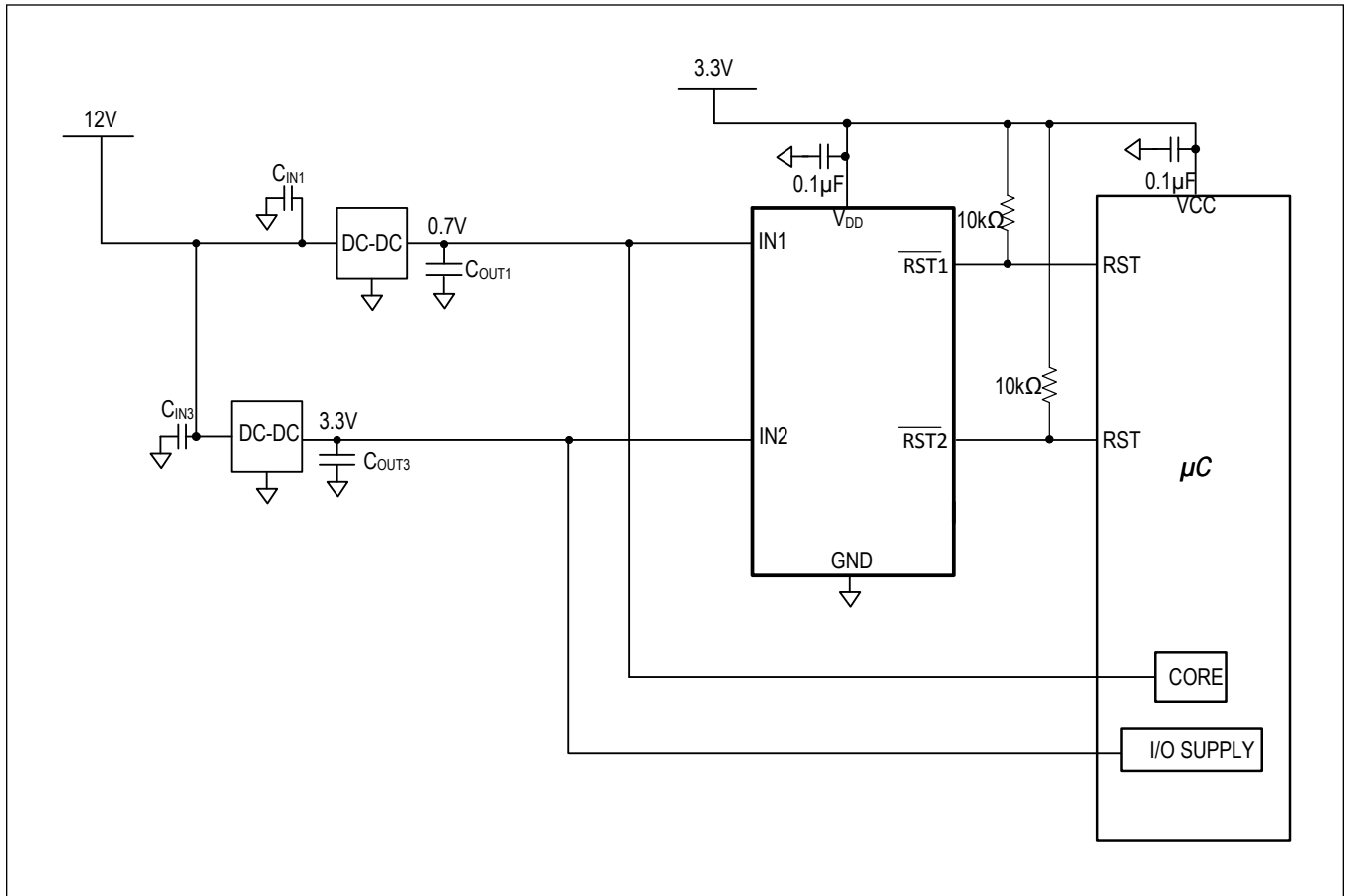


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MAX16193

0.3% Accuracy Dual-Channel Supervisory Circuit

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Absolute Maximum Ratings

| | | | |
|--|---------------------|--|-----------------|
| V _{DD} to GND..... | -0.3V to +6V | Operating Temperature Range | -40°C to +125°C |
| IN1, IN2 to GND | -0.3V to +6V | Junction Temperature | +150°C |
| RST1, RST2 (Open Drain Outputs) to GND..... | -0.3V to +6V | Soldering Temperature (Reflow)..... | +260°C |
| RST1, RST2 (Push-Pull Outputs) to GND.... | -0.3V to VDD + 0.3V | Storage Temperature Range | -65°C to +150°C |
| Input/Output Continuous Current | ±20mA | Lead Temperature (Soldering, 10s)..... | +300°C |
| Continuous Power Dissipation (Multilayer Board) (TDFN (T823Y+3C) T _A = +70°C, derate 16.7mW/°C above +70°C) | | | |
| T823Y+3C, 8-Pin TDFN (Multilayer derate 1333.3mW/°C above 70°C)..... | 1333.3mW | | |

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Information

8 TDFN (T823Y+3C)

| | |
|---|---------------------------|
| Package Code | T823Y+3C |
| Outline Number | 21-100417 |
| Land Pattern Number | 90-0091 |
| Thermal Resistance, Single Layer Board: | |
| Junction-to-Ambient (θ_{JA}) | |
| Junction-to-Case Thermal Resistance (θ_{JC}) | |
| Thermal Resistance, Four Layer Board: | |
| Junction-to-Ambient (θ_{JA}) | 60(C/W) |
| Junction-to-Case Thermal Resistance (θ_{JC}) | 11(C/W) |

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Electrical Characteristics

($V_{DD} = 1.7V$ to $5.5V$, $T_A = T_J = -40^\circ C$ to $+125^\circ C$, unless otherwise noted. Typical values are at $V_{DD} = 3.3V$, $V_{IN1} = 0.9V$, $V_{IN2} = 3.280V$, and $T_A = +25^\circ C$ under normal conditions, unless otherwise noted.)

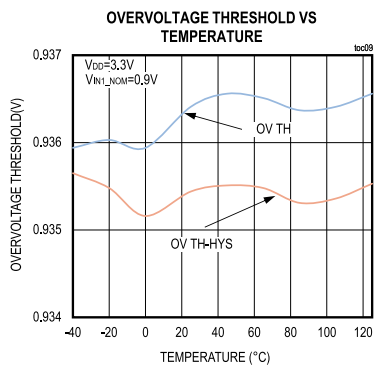
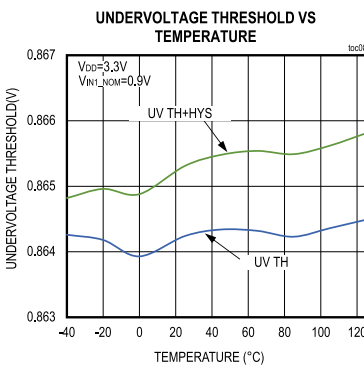
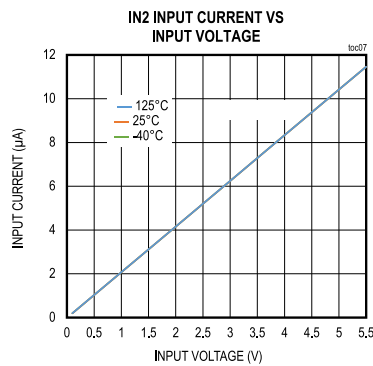
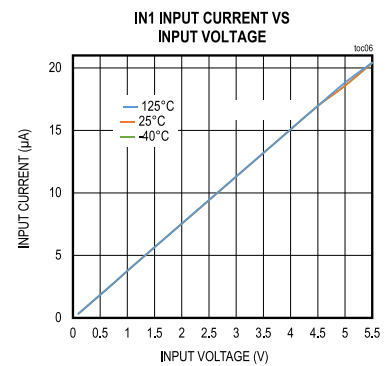
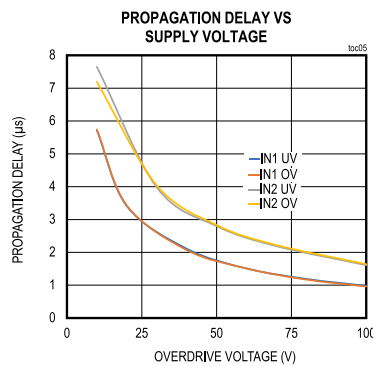
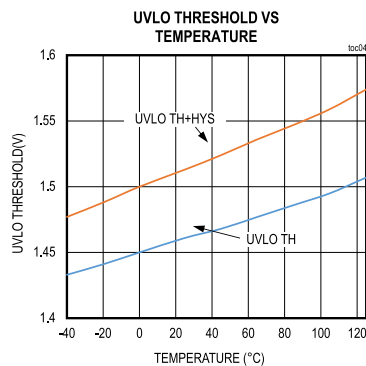
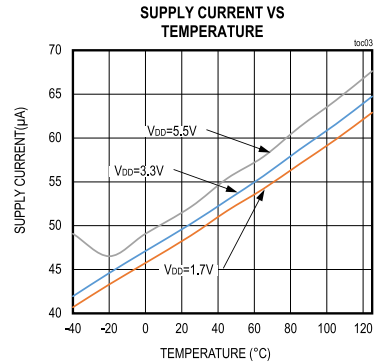
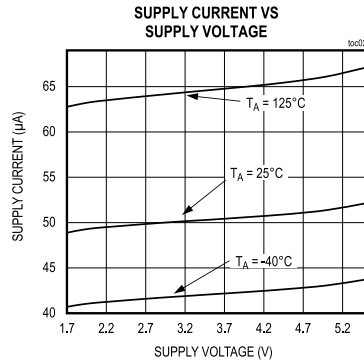
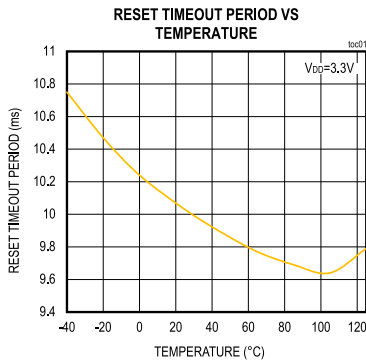
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|-----------------|--|---------|------|---------|--------------------|
| POWER SUPPLY | | | | | | |
| Operating Voltage Range | V_{DD} | Output guaranteed to be at known state | 1.7 | | 5.5 | V |
| Minimum Supply Voltage | V_{DD} | $\overline{RST1}$ and $\overline{RST2}$ are guaranteed to be at a known logic | 1.1 | | | V |
| Supply Current | I_{DD} | $\overline{RST1}$ and $\overline{RST2}$ not asserted | | 50 | 100 | μA |
| Undervoltage Lockout Threshold | V_{UVLO} | V_{DD} rising | 1.30 | 1.50 | 1.68 | V |
| Undervoltage Lockout Hysteresis | V_{UVLO_HYS} | V_{DD} falling | | 47 | | mV |
| INPUT VOLTAGE (IN1 AND IN2) | | | | | | |
| IN1 Input Voltage Range (Note 1) | V_{IN1_NOM} | | 0.6 | | 0.9 | V |
| IN2 Input Voltage Range (Note 1) | V_{IN2_NOM} | | 0.9 | | 3.3 | V |
| Undervoltage/Overvoltage Threshold Programming Range | TOL | Reset occurs when V_{IN} falls outside of $V_{IN_NOM} \times (1 \pm TOL)$ | ± 2 | | ± 5 | % of V_{IN_NOM} |
| INPUT THRESHOLD ACCURACY | | | | | | |
| IN1/IN2 Overvoltage Threshold Accuracy | V_{OVTH_A} | V_{IN1}/V_{IN2} rising, $V_{OVTH} = V_{IN_} \times (1 + TOL\%)$ | -0.3 | | +0.3 | % |
| IN1/IN2 Undervoltage Threshold Accuracy | V_{UVTH_A} | V_{IN1}/V_{IN2} falling, $V_{UVTH} = V_{IN_} \times (1 - TOL\%)$ | -0.3 | | +0.3 | % |
| Undervoltage/Overvoltage Hysteresis | V_{HYS} | | | 0.15 | | % V_{TH} |
| Input Current | I_{IN1} | $V_{IN1} = V_{IN1_NOM}$ | | 3 | 6 | μA |
| | I_{IN2} | $V_{IN2} = V_{IN2_NOM}$ | | 6 | 12 | μA |
| RESET OUTPUT ($\overline{RST1}$ AND $\overline{RST2}$) | | | | | | |
| Reset Timeout Period Accuracy | t_{RP} | From time V_{IN} enters overvoltage/undervoltage threshold-window to time $\overline{RST_}$ goes high | -20 | | +20 | % |
| IN1-to- $\overline{RST1}$ Propagation Delay | t_D | ($V_{UVTH} + 1\%$) to ($V_{UVTH} - 1\%$) or ($V_{OVTH} - 1\%$) to ($V_{OVTH} + 1\%$) | | 5 | | μs |
| IN2-to- $\overline{RST2}$ Propagation Delay | t_D | ($V_{UVTH} + 1\%$) to ($V_{UVTH} - 1\%$) or ($V_{OVTH} - 1\%$) to ($V_{OVTH} + 1\%$) | | 5 | | μs |
| OUTPUT VOLTAGE | | | | | | |
| Output Voltage Low | V_{OL} | $V_{DD} \geq 4.25V$, $I_{SINK} = 1mA$, | | | 0.1 | V |
| | | $V_{DD} = 2.5V$, $I_{SINK} = 250\mu A$ | | | 0.1 | |
| | | $V_{DD} = 1.2V$, $I_{SINK} = 25\mu A$ | | | 0.1 | |

Note 1: Input voltage for IN1 and IN2 is factory programmable to a midpoint between the undervoltage threshold and overvoltage threshold levels.

Note 2: Limits are 100% tested at $T_A = +25^\circ C$. Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization.

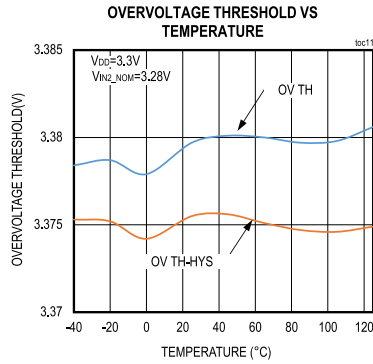
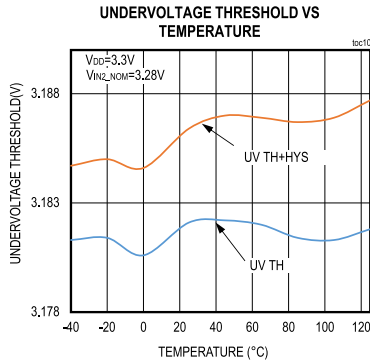
Typical Operating Characteristics

($V_{DD} = 1.70V$ to $5.5V$, $T_A = T_{MIN}$ to T_{MAX} unless otherwise noted.)



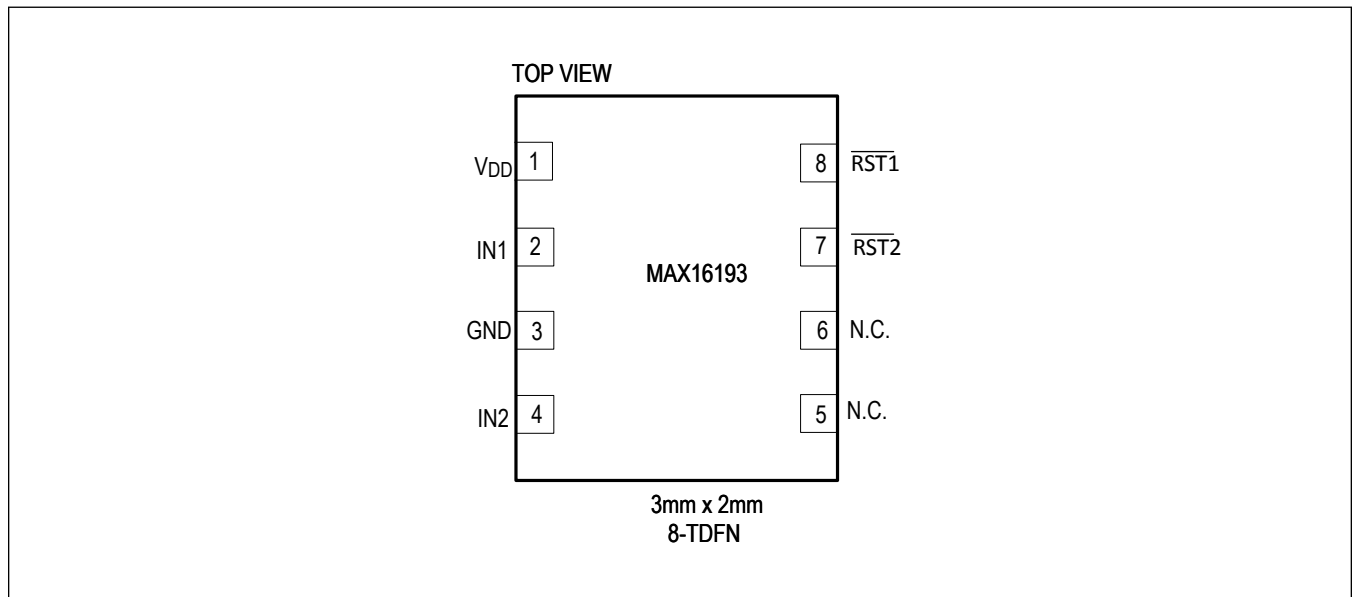
Typical Operating Characteristics (continued)

(V_{DD} = 1.70V to 5.5V, T_A = T_{MIN} to T_{MAX} unless otherwise noted.)



Pin Configuration

8-Pin TDFN

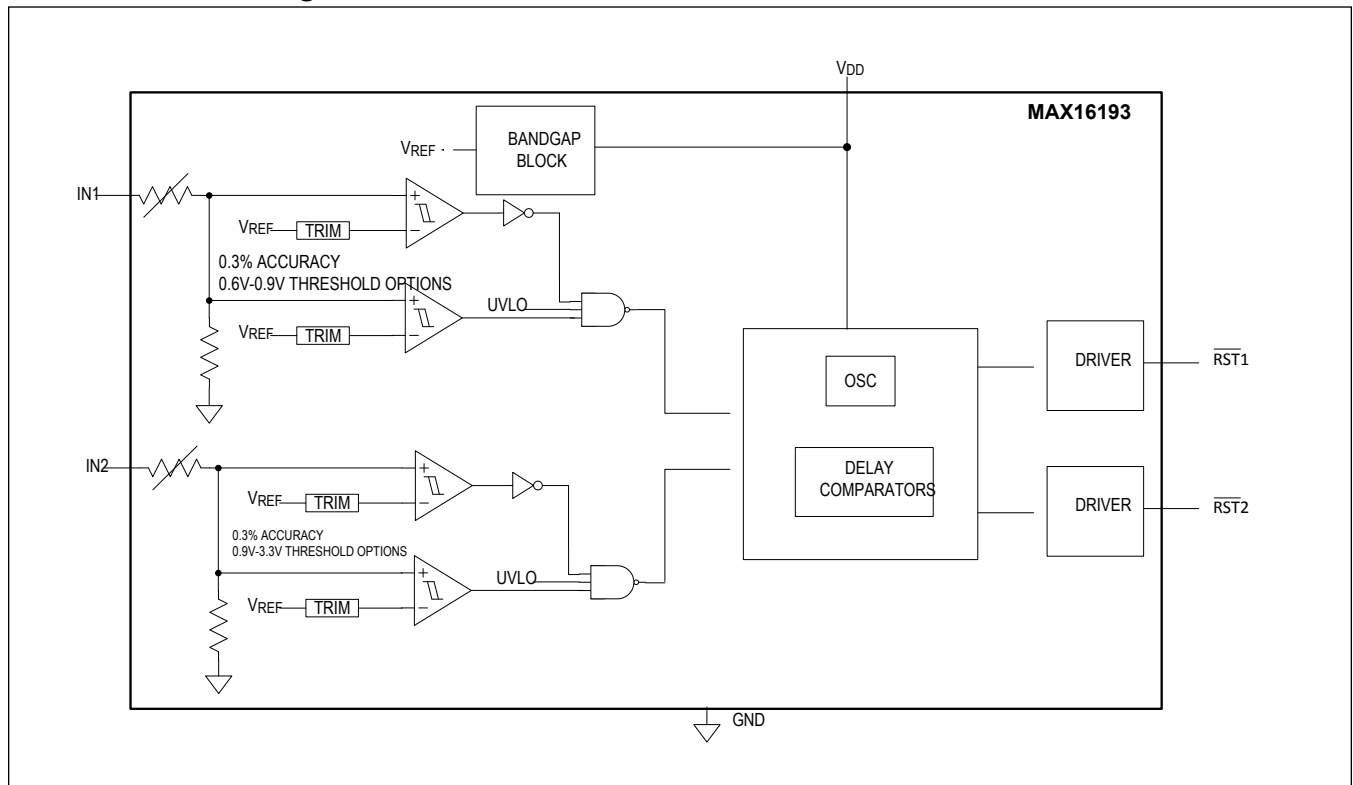


Pin Description

| PIN | NAME | FUNCTION |
|------|-----------------|--|
| 1 | V _{DD} | Supply Input. Bypass V _{DD} to ground with a 0.1μF capacitor. |
| 2 | IN1 | Monitoring Input 1. IN1 monitors supply rails for undervoltage/overvoltage faults with respect to a nominal input threshold. IN1 monitors supply range from 0.6V to 0.9V. When V _{IN1} falls outside the undervoltage/overvoltage thresholds window, RST1 asserts and stays asserted for the reset timeout period after V _{IN1} falls within undervoltage/overvoltage thresholds window. |
| 3 | GND | Ground |
| 4 | IN2 | Monitoring Input 2. IN2 monitors supply rails for undervoltage/overvoltage faults with respect to nominal input threshold. IN2 monitors supply range from 0.9V to 3.3V. When V _{IN2} falls outside the window between the undervoltage and overvoltage thresholds, RST2 asserts and stays asserted for the reset timeout period after V _{IN2} falls within this window. |
| 5, 6 | N.C. | No Connect |
| 7 | RST2 | Active-Low, Open-Drain or Push-Pull Reset Output 2. For the open-drain version, connect RST2 with a 10kΩ pullup resistor. |
| 8 | RST1 | Active-Low, Open-Drain or Push-Pull Reset Output 1. For the open-drain version, connect RST1 with a 10kΩ pullup resistor. |

Functional Diagrams

Functional Block Diagram



Detailed Description

The MAX16193 is a dual-channel, 0.3% accurate window-detector supervisor circuit that monitors two supply voltages in a system. The MAX16193 offers factory-trimmed nominal input voltage levels and a factory-trimmed window between the undervoltage and overvoltage thresholds, from $\pm 2\%$ to $\pm 5\%$. Contact Analog Devices for a threshold not listed in the [Ordering Information](#) table.

Reset Timeout Period

The active-low, open-drain reset outputs $\overline{\text{RST1}}$ and $\overline{\text{RST2}}$ assert low when the respective input voltage falls outside the factory-trimmed undervoltage and overvoltage threshold window. The corresponding reset output deasserts after the reset timeout period when the input voltage falls within the set window threshold. At power-up, resets stay asserted for the reset timeout period once V_{DD} is above the UVLO. The reset output is available in a factory-programmable open-drain or push-pull option. The reset output with open-drain configuration requires a pullup resistor. See [Figure 1](#) for more details.

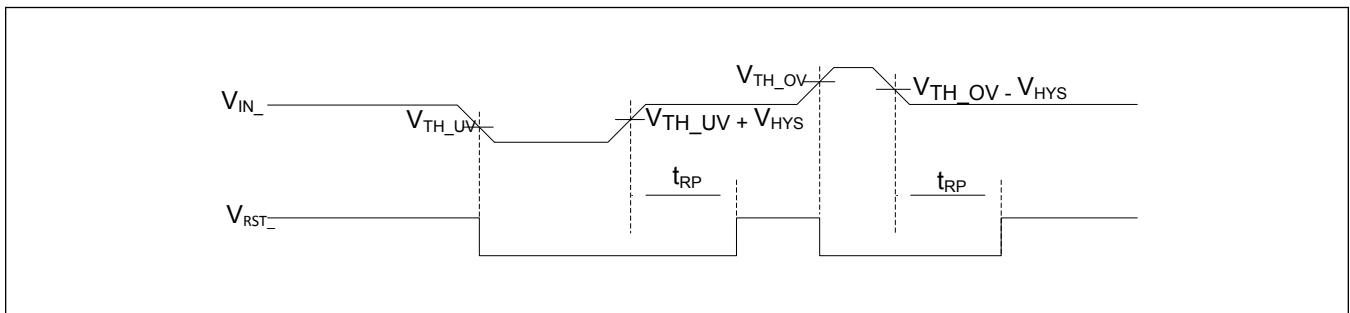


Figure 1. Reset Output Timing Diagram

Applications Information

Setting Input Thresholds and Hysteresis

The MAX16193 monitors a system supply voltage for undervoltage/overvoltage window threshold. Depending on the system supply tolerance requirement, the undervoltage/overvoltage thresholds can be factory-trimmed from $\pm 2\%$ to $\pm 5\%$ with respect to the selected nominal input threshold voltage. The following is a detailed calculation of how to determine the undervoltage/overvoltage threshold levels with $\pm 0.3\%$ threshold accuracy.

$$V_{IN_NOM} = 0.9V$$

$$TOL = \pm 3\%$$

$$V_{UVTH} = V_{IN_NOM} (1 - 3\%) = 0.9V \times (1 - 0.03) = 0.873V$$

$$V_{OVTH} = V_{IN_NOM} (1 + 3\%) = 0.9V \times (1 + 0.03) = 0.927V$$

Where V_{IN_NOM} is the selected nominal input threshold voltage, TOL is the input tolerance, V_{UVTH} is undervoltage threshold voltage, and V_{OVTH} is the overvoltage threshold voltage.

The MAX16193 monitors the supply voltage with $\pm 0.3\%$ accuracy over the operating temperature and supply range.

The accuracy range is shown as follows:

$$V_{UVTH_A} = V_{IN_NOM} (1 - 3\% \pm 0.3\%)$$

$$V_{OVTH_A} = V_{IN_NOM} (1 + 3\% \pm 0.3\%)$$

Where V_{UVTH_A} is the undervoltage threshold accuracy range and V_{OVTH_A} is the overvoltage threshold accuracy range. See [Figure 2](#) for details.

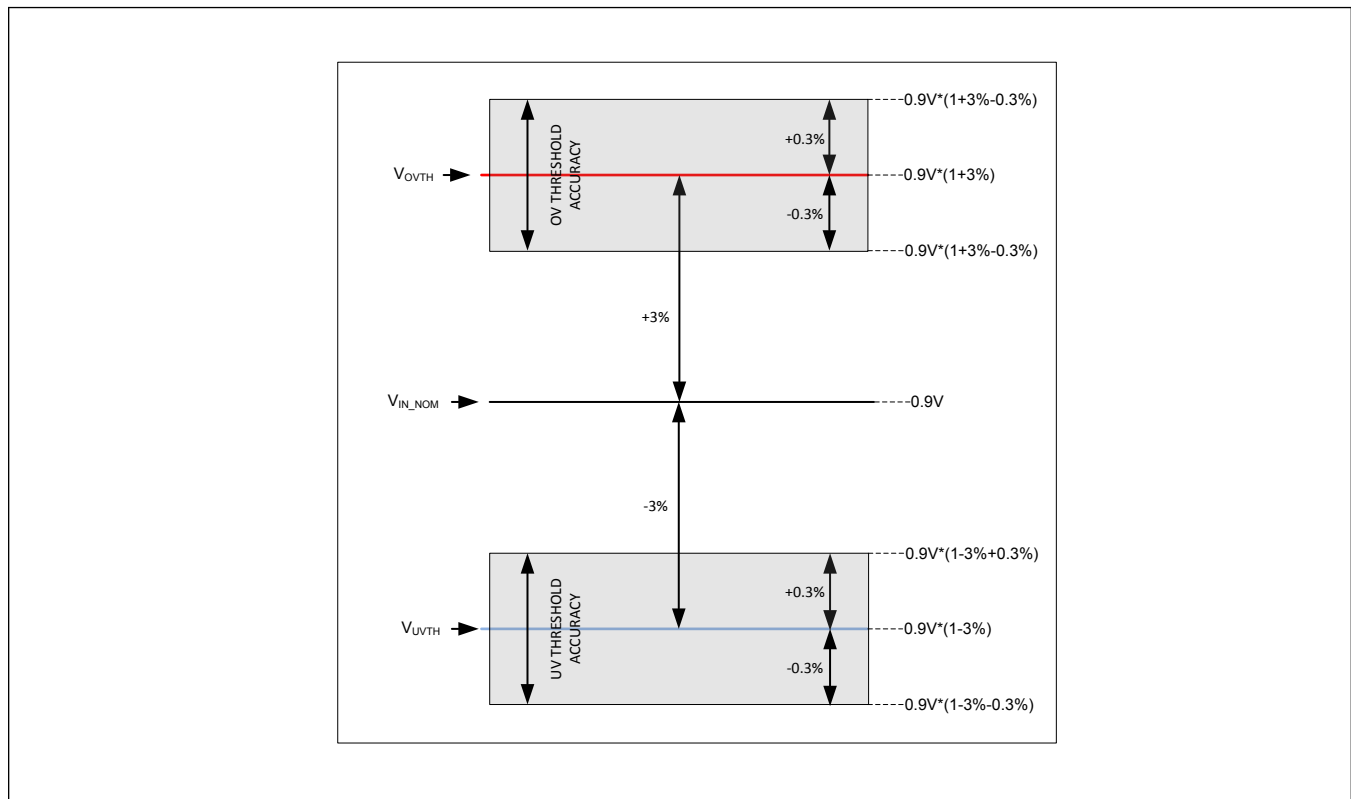


Figure 2. Undervoltage/Overvoltage Threshold Accuracy

Hysteresis adds noise immunity to the voltage monitors and prevents oscillation due to repeated triggering when the monitored voltage is near the threshold trip voltage.

Use the following equation to calculate the threshold hysteresis:

$$V_{IN_NOM} = 0.9V$$

$$\text{Hysteresis} = 0.15\%$$

$$V_{HYST} = 0.9V \times 0.15\% = 0.00135V$$

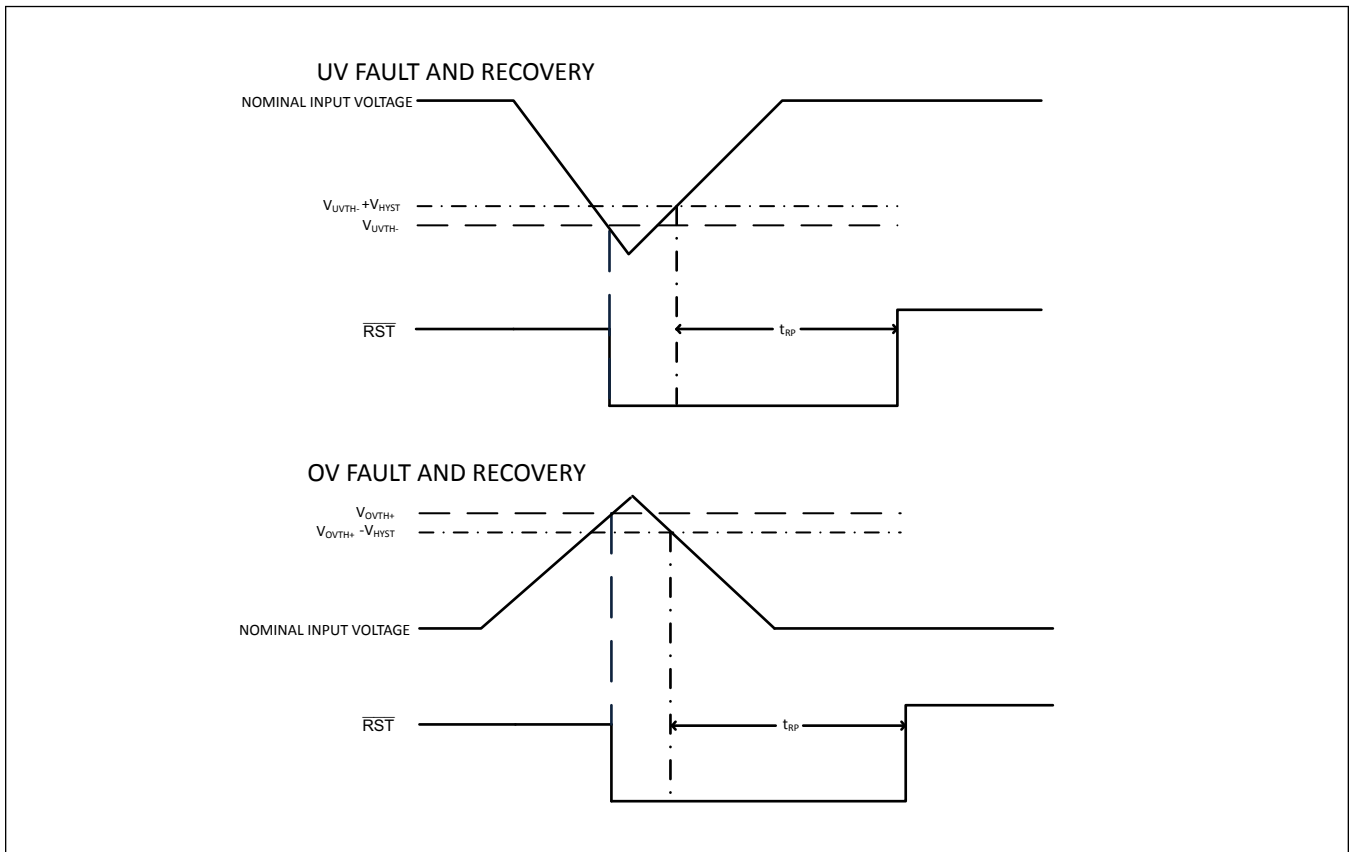


Figure 3. Undervoltage/Overvoltage Threshold Hysteresis

Power-Supply Bypassing/Noise Immunity

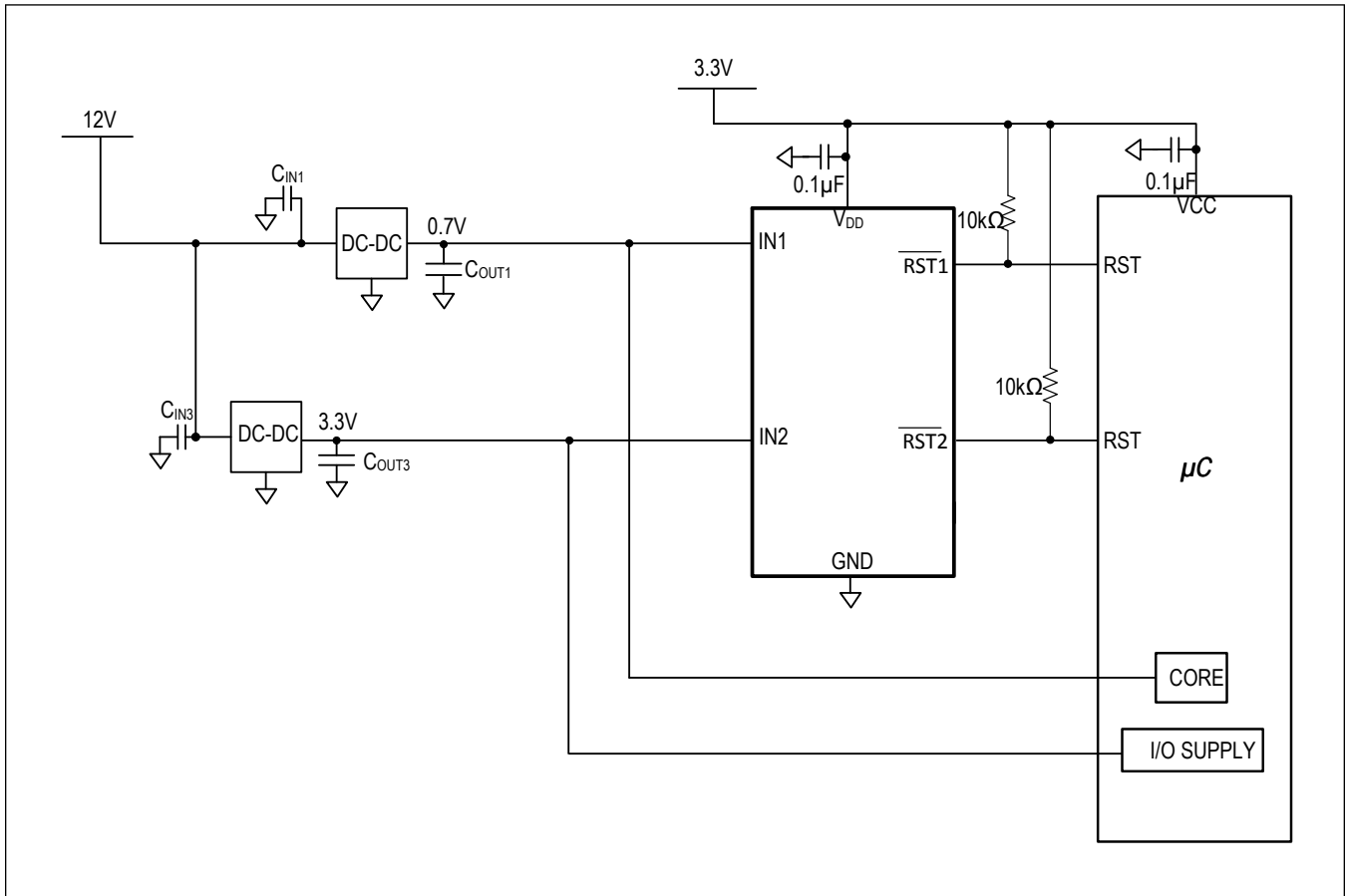
The MAX16193 operates from a 1.7V to 5.5V supply. Bypass V_{DD} to ground with a 0.1µF capacitor as close to the device as possible. An additional capacitor improves transient immunity.

Selector Guide Table

| PART NUMBER | IN1/IN2 THRESHOLD VOLTAGE | IN1/IN2 TOLERANCE | IN1/IN2 ACCURACY | IN1/IN2 HYSTERESIS | RESET TIMEOUT |
|--------------------|---------------------------|-------------------|------------------|--------------------|---------------|
| MAX16193ATA00/VY+T | 0.9V/3.280V | 4%/3% | 0.3%/0.3% | 0.15%/0.15% | 10ms |

Typical Application Circuits

Typical Application Circuit



Ordering Information

| PART NUMBER | TEMP RANGE | PIN-PACKAGE |
|--------------------|-----------------|-------------|
| MAX16193ATA00/VY+T | -40°C to +125°C | 8 TDFN |

+Denotes a lead(Pb)-free/RoHS-compliant package.

T = Tape and reel.

/V denotes an automotive qualified part.

Y = Side-wettable package.

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|--------------------------|---------------|
| 0 | 3/22 | Release for Market Intro | — |