

General Description

The MAX14826 transceiver is suitable for IO-Link® devices and 24V binary sensors. All specified IO-Link data rates are supported. In IO-Link applications, the transceiver acts as the physical layer interface to a microcontroller running the data-link layer protocol. Additional 24V digital inputs and outputs are provided. Two internal linear regulators generate common sensor and actuator power requirements: 5V and 3.3V.

On-board C/Q and DO drivers are independently-configurable for push-pull, high-side (PNP), or low-side (NPN) operation. The device detects the IO-Link C/Q wake-up condition and generates a wake-up signal on the active-low WU/THSD output.

The MAX14826 includes a selectable parallel or SPI interface for configuration and monitoring of the drivers. Extensive alarm conditions are detected and communicated through the interrupt outputs and the SPI interface. The device features reverse-polarity, short-circuit, and thermal protection. All power lines are monitored for undervoltage conditions.

The C/Q and DO drivers are specified for sinking/sourcing 200mA.

The MAX14826 is available in a 4mm x 4mm, 24-pin TQFN package, and is specified over the extended -40°C to +105°C temperature range.

Applications

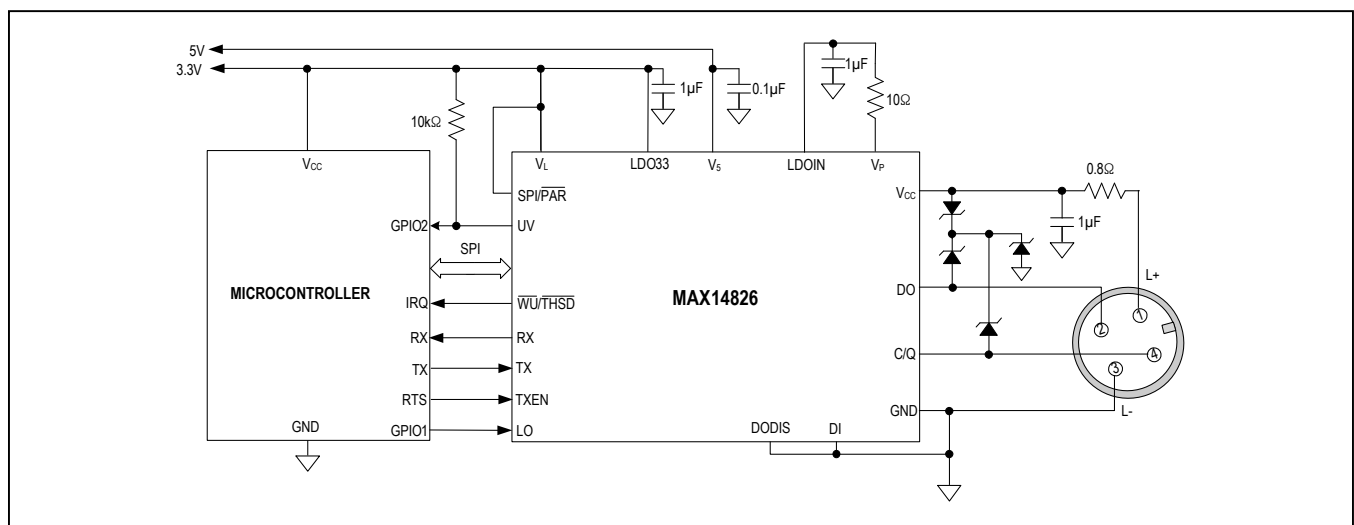
- IO-Link Sensors
- IO-Link Actuators
- Industrial Sensors and Actuators

Benefits and Features

- IO-Link Specification v.1.0 and v.1.1 Physical Layer Compliant
- High Configurability and Integration Reduce SKU's
 - Push-Pull, High-Side, or Low-Side Outputs
 - Supports COM1, COM2, and COM3 Data Rates
 - SPI or Pin-Driven Control and Monitoring
 - 2.5V to 5V Logic Interface Levels
 - C/Q and DO Drivers Can Be Connected in Parallel
 - Auxiliary 24V, 200mA Digital Output (DO)
 - Auxiliary 24V Digital Input (DI)
 - Integrated 5V and 3.3V Linear Regulators
 - Driver Currents Specified for 200mA, 100mA and 50mA
 - 1µF C/Q and DO Load Drive Capability
- Integrated Protection Enables Robust Solutions
 - Extensive Fault-Monitoring and Reporting
 - Reverse-Polarity and Short-Circuit Protection on All 24V Inputs/Outputs
 - Reverse-Polarity Protected 24V Supply Output
 - -40°C to +105°C Operating Temperature Range
- Backwards Pin-and Software-Compatible to MAX14821
- Space-Saving 4mm x 4mm TQFN Package

Ordering Information appears at end of data sheet.

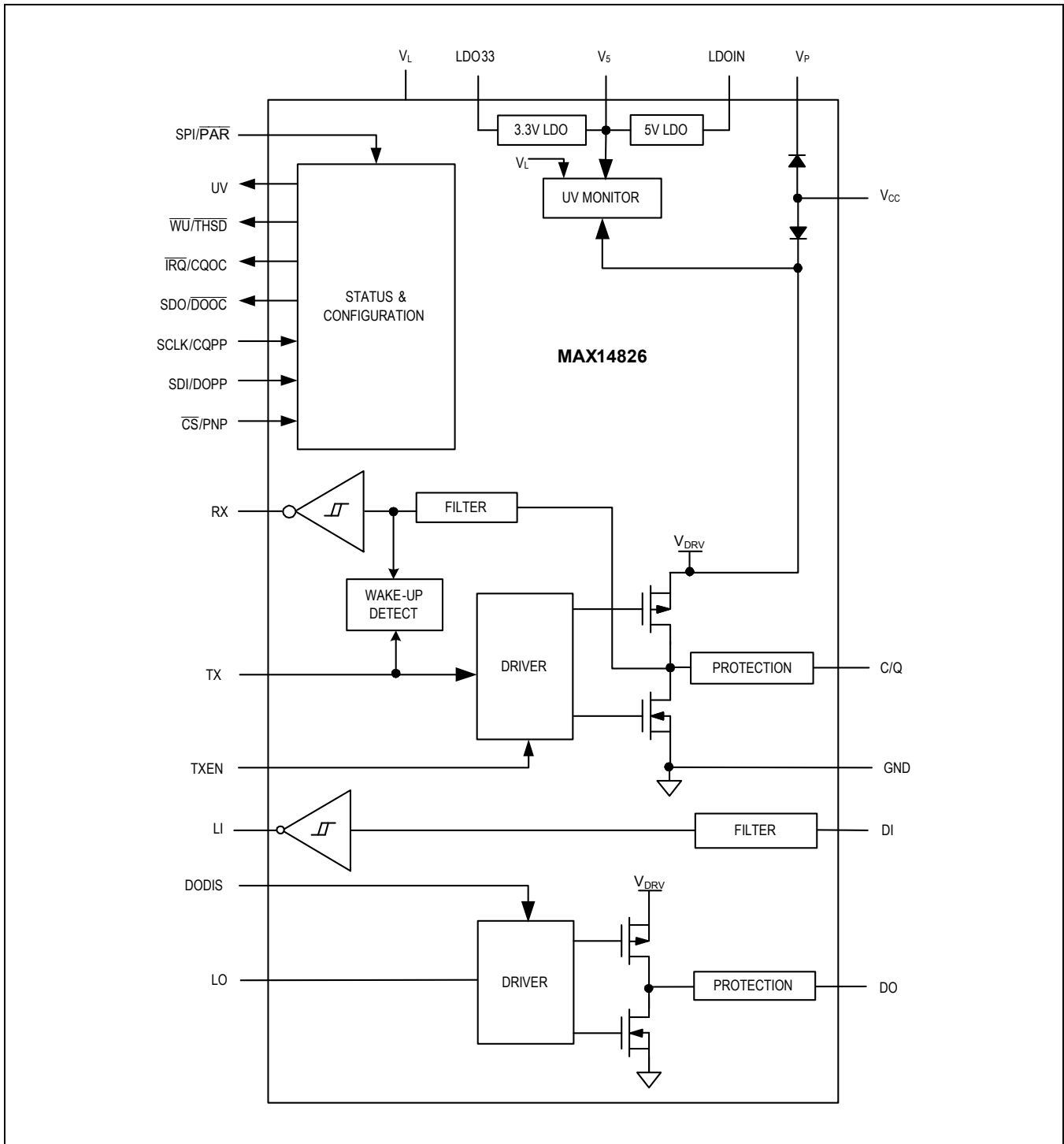
Typical Application Circuit



IO-Link is a registered trademark of Profibus User Organization (PNO).



Functional Diagram



Absolute Maximum Ratings

(All voltages referenced to GND, unless otherwise noted.)

| | |
|--|--|
| V _{CC} | -40V to +40V |
| V _P (I _{VP} < 50mA)..... | the higher of -0.3V and (V _{CC} - 1V) to +40V |
| LDOIN..... | -0.3V to +40V |
| V ₅ | -0.3V to the lesser of (V _{LDOIN} + 0.3V) and +6V |
| LDO33..... | -0.3V to the lesser of (V ₅ + 0.3V) and +6V |
| V _L | -0.3V to +6V |
| DI..... | -40V to +40V |
| C/Q, DO..... | MIN: the higher of -40V and (V _{CC} - 40V) MAX: the lesser of +40V and (V _{CC} + 40V) |

Logic Inputs

| | |
|--|----------------------------------|
| TX, TXEN, LO, $\overline{\text{CS}}$ /PNP, SDI/DOPP, SCLK/CQPP..... | -0.3V to (V _L + 0.3V) |
|--|----------------------------------|

Logic Outputs

| | |
|---|----------------------------------|
| RX, $\overline{\text{WU}}$ /THSD, LI, SDO/ $\overline{\text{DOOC}}$, $\overline{\text{IRQ}}$ / $\overline{\text{CQOC}}$ | -0.3V to (V _L + 0.3V) |
| UV..... | -0.3V to +6V |
| Continuous Current Into Any Logic Pin..... | ±50mA |
| Continuous Power Dissipation | |
| TQFN (derate 27.8mW/°C above +70°C)..... | 2222mW |
| Operating Temperature Range..... | -40°C to +105°C |
| Maximum Junction Temperature..... | +150°C |
| Storage Temperature Range..... | -65°C to +150°C |
| Lead Temperature (soldering, 10s)..... | +300°C |
| Soldering Temperature (reflow)..... | +260°C |

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 Thermal Characteristics (Note 1)

TQFN

| | | | |
|--|--------|---|-------|
| Junction-to-Ambient Thermal Resistance (θ _{JA})..... | 36°C/W | Junction-to-Case Thermal Resistance (θ _{JC})..... | 3°C/W |
|--|--------|---|-------|

Note 1: 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.

DC Electrical Characteristics

(V_{CC} = 18V to 36V, V_L = 2.3V to 5.5V, V_{GND} = 0V; all logic inputs at V_L or GND; T_A = -40°C to +105°C, unless otherwise noted.

Typical values are at V_{CC} = 24V, V_L = 3.3V, and T_A = +25°C, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|--------------------------|---|------|------|------|-------|
| V _{CC} Supply Voltage | V _{CC} | For driver operation | 9 | | 36 | V |
| V _{CC} Supply Current | I _{CC} | V _{CC} = 24V, C/Q as input, no load on V ₅ or LDO33, LDOIN not connected to V _P , V _{LDOIN} = 24V | | 1.2 | 2.5 | mA |
| V _{CC} Undervoltage Lockout Threshold | V _{CCUVLO} | V _{CC} falling | 6 | 7.4 | 8.4 | V |
| V _{CC} Undervoltage Lockout Threshold Hysteresis | V _{CCUVLO_HYST} | | | 200 | | mV |
| V ₅ Supply Current | I _{5_IN} | LDOIN shorted to V ₅ , external 5V applied to V ₅ , no switching, LDO33 disabled | | 3 | | mA |
| V ₅ Undervoltage Lockout Threshold | V _{5UVLO} | V ₅ falling | | 2.4 | | V |
| V _L Logic-Level Supply Voltage | V _L | | 2.3 | | 5.5 | V |
| V _L Logic-Level Supply Current | I _L | All logic inputs at V _L | | | 5 | μA |
| | | All logic inputs at GND | | | 100 | μA |
| V _L Undervoltage Threshold | V _{LUVLO} | V _L falling | 0.65 | 0.95 | 1.30 | V |

DC Electrical Characteristics (continued)

($V_{CC} = 18V$ to $36V$, $V_L = 2.3V$ to $5.5V$, $V_{GND} = 0V$; all logic inputs at V_L or GND ; $T_A = -40^\circ C$ to $+105^\circ C$, unless otherwise noted. Typical values are at $V_{CC} = 24V$, $V_L = 3.3V$, and $T_A = +25^\circ C$, unless otherwise noted.) (Note 2)

| PARAMETER | | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--------------------------------------|-----------------|---|--------------------|-----------------|-----------------|-------|---|
| 5V LDO (V₅) | | | | | | | |
| LDOIN Input Voltage Range | V_{LDOIN} | | 7 | | 36 | V | |
| LDOIN Supply Current | I_{LDOIN} | $V_{LDOIN} = 24V$, C/Q is configured as an input, no load on V_5 or LDO33 | | 2.5 | 5 | mA | |
| V_5 Output Voltage Range | V_5 | No load on V_5 , $7V \leq V_{LDOIN} \leq 36V$ | 4.75 | 5.00 | 5.25 | V | |
| Power Supply Rejection Ratio | V_{5PSRR} | $f_{LDOIN} = 100Hz$ | 60 | 88 | | dB | |
| V_5 Load Regulation | | $1mA < I_{LOAD} < 10mA$, $V_{LDOIN} = 7V$, $0.1\mu F$ bypass capacitor on V_5 | | 0.8 | | % | |
| | | $1mA < I_{LOAD} < 30mA$, $V_{LDOIN} = 7V$, $0.1\mu F$ bypass capacitor on V_5 , 10Ω – $1\mu F$ compensation network added to V_5 | | 0.8 | | | |
| 3.3V LDO (LDO33) | | | | | | | |
| LDO33 Output Voltage | V_{LDO33} | No load on LDO33 | 3.1 | 3.3 | 3.5 | V | |
| LDO33 Undervoltage Lockout Threshold | $V_{LDO33UVLO}$ | V_{LDO33} falling | | 2.4 | | V | |
| LDO33 Load Regulation | | $1mA < I_{LOAD} < 20mA$, $V_{LDOIN} = 7V$ | | 0.25 | | % | |
| 24V INTERFACE | | | | | | | |
| C/Q Driver Output Voltage High | $V_{OH_C/Q}$ | C/Q high-side enabled, $9V \leq V_{CC} \leq 36V$ | $I_{C/Q} = -200mA$ | $V_{CC} - 1.9$ | $V_{CC} - 1.4$ | V | |
| | | | $I_{C/Q} = -100mA$ | $V_{CC} - 1.4$ | $V_{CC} - 1$ | | |
| | | | $I_{C/Q} = -50mA$ | $V_{CC} - 1.1$ | $V_{CC} - 0.83$ | | |
| C/Q Driver Output Voltage Low | $V_{OL_C/Q}$ | C/Q low-side enabled, $9V \leq V_{CC} \leq 36V$ | $I_{C/Q} = +200mA$ | | 1.55 | 2 | V |
| | | | $I_{C/Q} = +100mA$ | | 1.2 | 1.7 | |
| | | | $I_{C/Q} = +50mA$ | | 0.98 | 1.3 | |
| C/Q Driver Source Current Limit | $I_{OH_C/Q}$ | C/Q high-side enabled, $V_{C/Q} < (V_{CC} - 5V)$, $9V \leq V_{CC} \leq 36V$ | +280 | +350 | +420 | mA | |
| C/Q Driver Sink Current Limit | $I_{OL_C/Q}$ | C/Q low-side enabled, $V_{C/Q} > 5V$, $9V \leq V_{CC} \leq 36V$ | -423 | -350 | -280 | mA | |
| DO Driver Output Voltage High | V_{OH_DO} | DO high-side enabled, $9V \leq V_{CC} \leq 36V$ | $I_{DO} = -200mA$ | $V_{CC} - 2.1$ | $V_{CC} - 1.5$ | V | |
| | | | $I_{DO} = -100mA$ | $V_{CC} - 1.45$ | 1.1 | | |
| | | | $I_{DO} = -50mA$ | $V_{CC} - 1.15$ | 0.87 | | |

DC Electrical Characteristics (continued)

($V_{CC} = 18V$ to $36V$, $V_L = 2.3V$ to $5.5V$, $V_{GND} = 0V$; all logic inputs at V_L or GND ; $T_A = -40^\circ C$ to $+105^\circ C$, unless otherwise noted. Typical values are at $V_{CC} = 24V$, $V_L = 3.3V$, and $T_A = +25^\circ C$, unless otherwise noted.) (Note 2)

| PARAMETER | | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|----------------|--|-------------------|------|------------------|------------|
| DO Driver Output Voltage Low | V_{OL_DO} | DO low-side enabled, $9V \leq V_{CC} \leq 36V$ | $I_{DO} = +200mA$ | 1.6 | 2.3 | V |
| | | | $I_{DO} = +100mA$ | 1.24 | 1.75 | |
| | | | $I_{DO} = +50mA$ | 1.04 | 1.4 | |
| DO Source Current Limit | I_{OH_DO} | DO high-side enabled, $V_{DO} < (V_{CC} - 5V)$ | -470 | -340 | -263 | mA |
| DO Sink Current Limit | I_{OL_DO} | DO low-side enabled, $V_{DO} > 5V$ | 270 | 360 | 480 | mA |
| C/Q, DI Input Voltage Range | V_{IN} | For valid RX, LI | -1.0 | | $V_{CC} + 1.0$ | V |
| C/Q Input Threshold High | $V_{IH_C/Q}$ | C/Q driver disabled | 10.5 | | 13 | V |
| C/Q Input Threshold Low | $V_{IL_C/Q}$ | C/Q driver disabled | 8.0 | | 11.5 | V |
| C/Q Input Hysteresis | $V_{HYS_C/Q}$ | C/Q driver disabled | 1.0 | 1.6 | | V |
| DI Input Threshold High | V_{IH_DI} | | 6.8 | | 8 | V |
| DI Input Threshold Low | V_{IL_DI} | | 5.2 | | 6.4 | V |
| DI Input Hysteresis | V_{HYS_DI} | | 1 | 1.6 | | V |
| C/Q Weak Pulldown Current | $I_{PDC/Q}$ | C/Q driver disabled, $V_{C/Q} = (V_{CC} - 1V)$ | | 48 | 100 | μA |
| DO Leakage Current | I_{PDDO} | DO driver disabled, $V_{CC} = 36V$, $V_{DO} = (V_{CC} - 1V)$ | -1 | | +1 | μA |
| DI Weak Pulldown Current | I_{PDDI} | $V_{CC} = 36V$, $V_{DI} = (V_{CC} - 1V)$ | | | 102 | μA |
| C/Q Input Capacitance | $C_{C/Q}$ | C/Q driver disabled | | 40 | | pF |
| DO Input Capacitance | C_{DO} | DO driver disabled | | 40 | | pF |
| DI Input Capacitance | C_{DI} | | | 20 | | pF |
| LOGIC INPUTS (TX, TXEN, LO, \overline{CS}/PNP, SDI/DOPP, SCLK/CQPP, SPI/\overline{PAR}, DODIS) | | | | | | |
| Logic-Input Voltage Low | V_{IL} | | $0.3 \times V_L$ | | | V |
| Logic-Input Voltage High | V_{IH} | | | | $0.7 \times V_L$ | V |
| Logic-Input Leakage Current High | I_{LEAK_H} | Logic input = V_L | -2 | | +2 | μA |
| Logic-Input Leakage Current Low | I_{LEAK_L} | TX, TXEN, LO, \overline{CS} /PNP, SDI/DOPP, SCLK/CQPP, Logic input = GND | -2 | | +2 | μA |
| SPI/ \overline{PAR} Pull-Up Resistance | R_{PUSPI} | | | 100 | | k Ω |
| Logic-Input Capacitance | C_{IN} | | | 5 | | pF |

DC Electrical Characteristics (continued)

($V_{CC} = 18V$ to $36V$, $V_L = 2.3V$ to $5.5V$, $V_{GND} = 0V$; all logic inputs at V_L or GND ; $T_A = -40^{\circ}C$ to $+105^{\circ}C$, unless otherwise noted. Typical values are at $V_{CC} = 24V$, $V_L = 3.3V$, and $T_A = +25^{\circ}C$, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|---|---|--------------|------|-----|-------------|
| LOGIC OUTPUTS (RX, WU/THSD, LI, UV, SDO/DOOC, IRQ/CQOC) | | | | | | |
| Logic-Output Voltage Low | V_{OL} | $I_{OUT} = -5mA$ | | | 0.4 | V |
| Logic-Output Voltage High | V_{OHRX} , V_{OHWU} , V_{OHLI} , V_{OHSDO} , V_{OHIRQ} | $I_{OUT} = 5mA$ (Note 3) | $V_L - 0.6$ | | | V |
| SDO/DOOC Leakage Current | I_{LK_SDO} | SDO/DOOC disabled, SDO/DOOC = GND or V_L | -2 | | +2 | μA |
| SDO/DOOC Output Voltage High | V_{SDO_DOOC} | SPI/PAR = GND; $I_{OUT} = 5mA$ | $V_L - 0.6V$ | | | V |
| THERMAL SHUTDOWN | | | | | | |
| Thermal Warning Threshold | | Die temperature rising, OTemp bit is set | | +127 | | $^{\circ}C$ |
| Thermal Warning Threshold Hysteresis | | Die temperature falling, OTemp bit is cleared | | +23 | | $^{\circ}C$ |
| Thermal-Shutdown Threshold | | Die temperature rising | | +165 | | $^{\circ}C$ |
| Thermal-Shutdown Hysteresis | | | | 20 | | $^{\circ}C$ |

AC Electrical Characteristics

($V_{CC} = 18V$ to $36V$, $V_L = 2.3V$ to $5.5V$, $V_{GND} = 0V$; all logic inputs at V_L or GND ; $T_A = -40^\circ C$ to $+105^\circ C$, unless otherwise noted. Typical values are at $V_{CC} = 24V$, $V_L = 3.3V$, and $T_A = +25^\circ C$, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-------------|---|------|-------|-------|---------|
| DRIVER (C/Q, DO) | | | | | | |
| Driver Low-to-High Propagation Delay | t_{PDLH} | Push-pull or high-side (PNP) configuration, Figure 1 | | 0.5 | 2 | μs |
| Driver High-to-Low Propagation Delay | t_{PDHL} | Push-pull or low-side (NPN) configuration, Figure 1 | | 0.5 | 2 | μs |
| Driver Skew | t_{SKEW} | $ t_{PDLH} - t_{PDHL} $ | | 0.1 | 2 | μs |
| Driver Rise Time | t_{RISE} | Push-pull or high-side (PNP) configuration, Figure 1 | | 0.4 | 1 | μs |
| Driver Fall Time | t_{FALL} | Push-pull or low-side (NPN) configuration, Figure 1 | | 0.4 | 1 | μs |
| Driver Enable Time High | t_{ENH} | Push-pull or high-side (PNP) configuration, Figure 3 | | 0.3 | 1 | μs |
| Driver Enable Time Low | t_{ENL} | Push-pull or low-side (NPN) configuration, Figure 2 | | 0.3 | 1 | μs |
| Driver Disable Time High | t_{DISH} | Push-pull or high-side (PNP) configuration, Figure 2 (Note 4) | | 1.6 | 3 | μs |
| Driver Disable Time Low | t_{DISL} | Push-pull or low-side (NPN) configuration, Figure 3 (Note 4) | | 0.1 | 3 | μs |
| RECEIVER (C/Q, DI) (Figure 4) | | | | | | |
| Receiver Low-to-High Propagation Delay | t_{PRLH} | RxFilter = 1 (Note 5), Figure 4 | | 0.2 | 2 | μs |
| | | RxFilter = 0, Figure 4 | | 0.4 | 2 | |
| Receiver High-to-Low Propagation Delay | t_{PRHL} | RxFilter = 1 (Note 5), Figure 4 | | 0.3 | 2 | μs |
| | | RxFilter = 0, Figure 4 | | 0.5 | 2 | |
| WAKE-UP DETECTION (Figure 5) | | | | | | |
| Wake-Up Input Minimum Pulse Width | t_{WUMIN} | | 30 | 40 | 50 | μs |
| Wake-Up Input Maximum Pulse Width | t_{WUMAX} | | 120 | 140 | 160 | μs |
| WU/THSD Output Low Time | t_{WUL} | Valid wake-up condition on C/Q | 120 | 200 | 260 | μs |
| Short-Circuit Detection | | | | | | |
| Short-Circuit Blanking Time | t_{SHBLK} | | 0.17 | 0.214 | 0.252 | ms |
| Short-Circuit Auto-Retry Time | t_{SHAR} | | 11 | 12.9 | 14.6 | ms |

AC Electrical Characteristics (continued)

($V_{CC} = 18V$ to $36V$, $V_L = 2.3V$ to $5.5V$, $V_{GND} = 0V$; all logic inputs at V_L or GND; $T_A = -40^\circ C$ to $+105^\circ C$, unless otherwise noted. Typical values are at $V_{CC} = 24V$, $V_L = 3.3V$, and $T_A = +25^\circ C$, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-------------|------------|-------|-----|-----|-------|
| SPI TIMING (\overline{CS}/PNP, SCLK/CQPP, SDI/DOPP, SDO/\overline{DOOC}) (Figure 6) | | | | | | |
| SCLK/CQPP Clock Period | t_{CH+CL} | | 83.3 | | | ns |
| SCLK/CQPP Pulse-Width High | t_{CH} | | 41.65 | | | ns |
| SCLK/CQPP Pulse-Width Low | t_{CL} | | 41.65 | | | ns |
| \overline{CS}/PNP Fall to SCLK/CQPP Rise Time | t_{CSS} | | 20 | | | ns |
| SCLK/CQPP Rise to \overline{CS}/PNP Rise Hold Time | t_{CSH} | | 20 | | | ns |
| SDI/DOPP Hold Time | t_{DH} | | 10 | | | ns |
| SDI/DOPP Setup Time | t_{DS} | | 10 | | | ns |
| Output Data Propagation Delay | t_{DO} | | | | 36 | ns |
| SDO/ \overline{DOOC} Rise and Fall Times | t_{FT} | | | | 20 | ns |
| Minimum \overline{CS}/PNP Pulse | t_{CSW} | | 76.8 | | | ns |

Note 2: All devices are 100% production tested at $T_A = +25^\circ C$. Limits over the operating temperature range are guaranteed by design.

Note 3: UV is an open-drain output. Connect UV to a voltage less than 5.5V through an external pullup resistor.

Note 4: Disable time measurements are load-dependent.

Note 5: RxFilter is on by default in parallel mode (SPI/PAR is low).

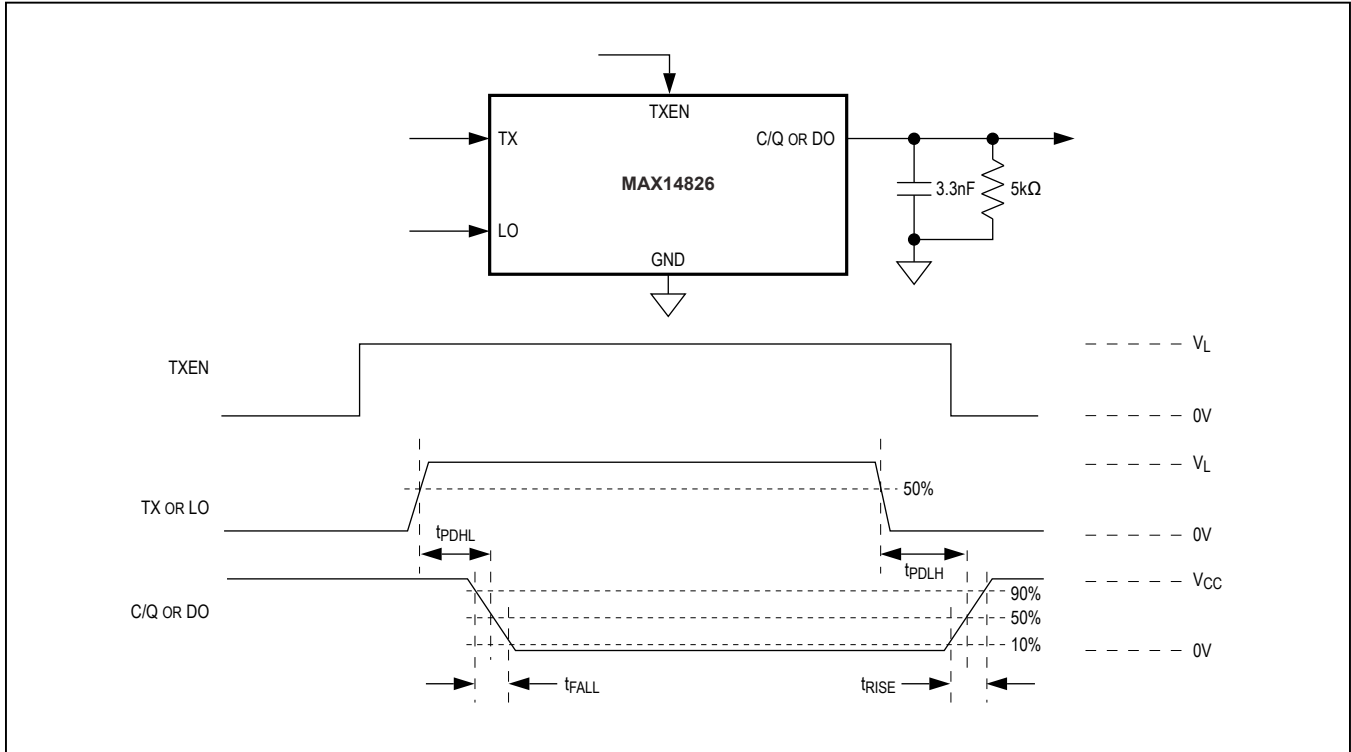


Figure 1. C/Q and LO Driver Propagation Delays and Rise/Fall Times

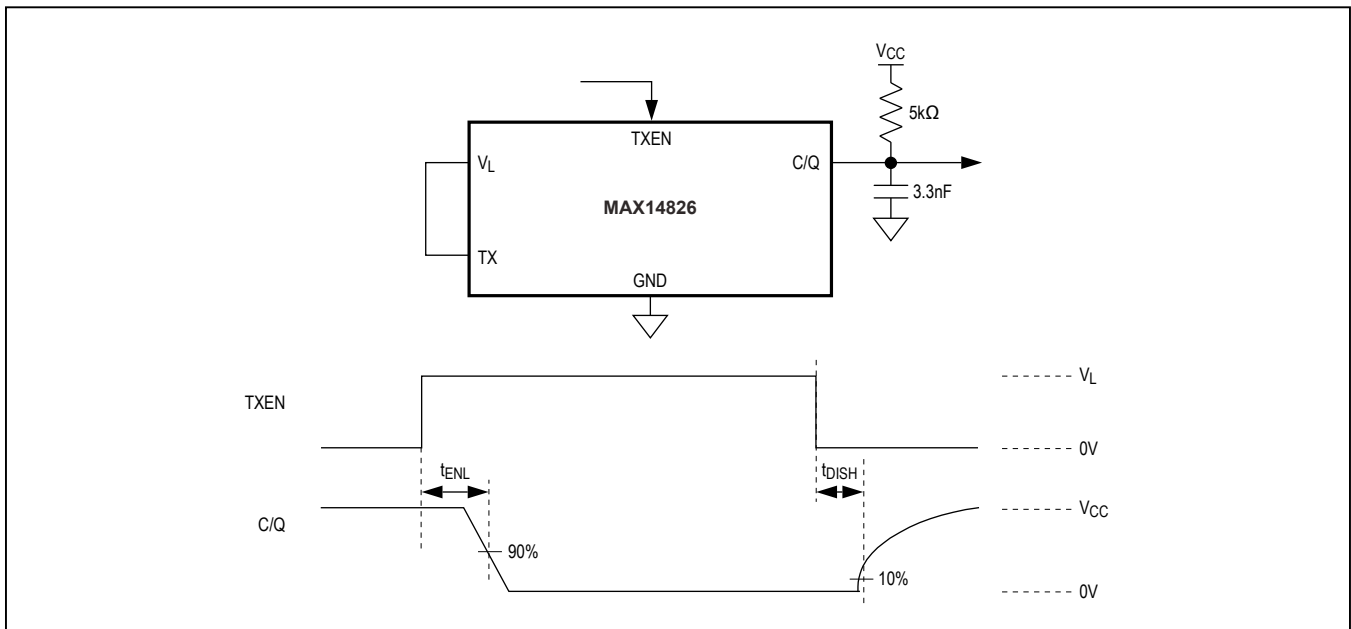


Figure 2. C/Q Driver Enable Low and Disable High Timing with External Pullup Resistor

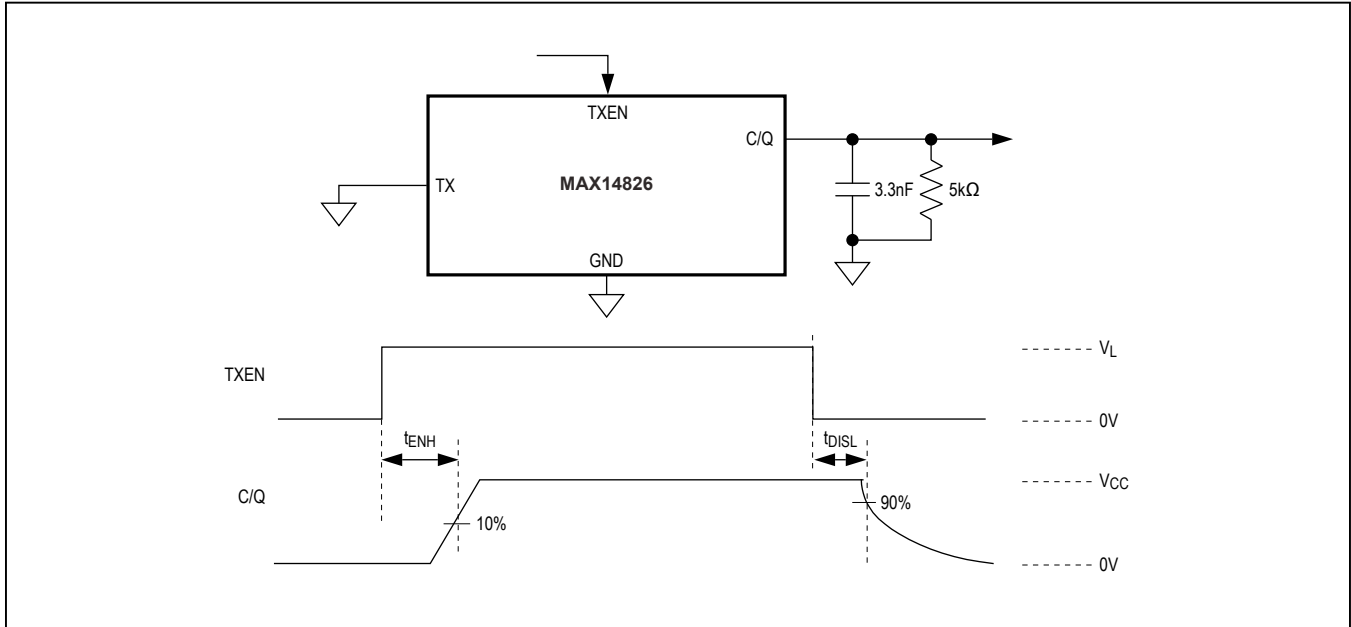


Figure 3. C/Q Driver Enable High and Disable Low Timing

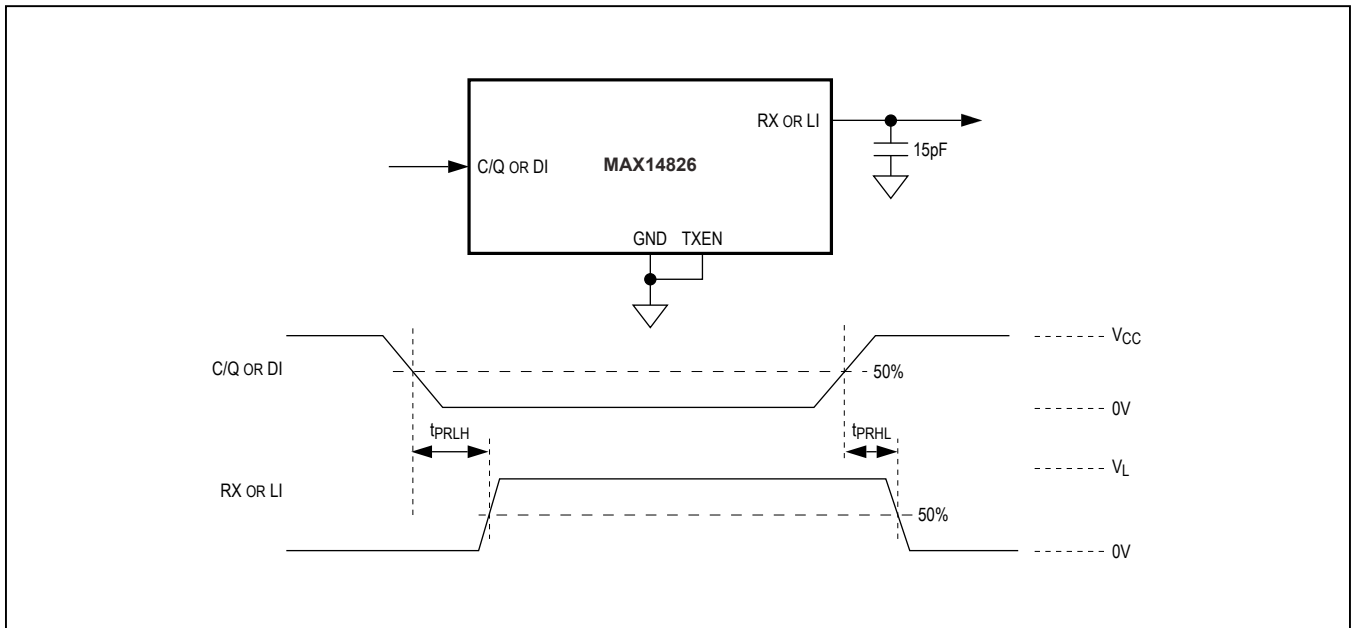


Figure 4. C/Q and DI Receiver Propagation Delays

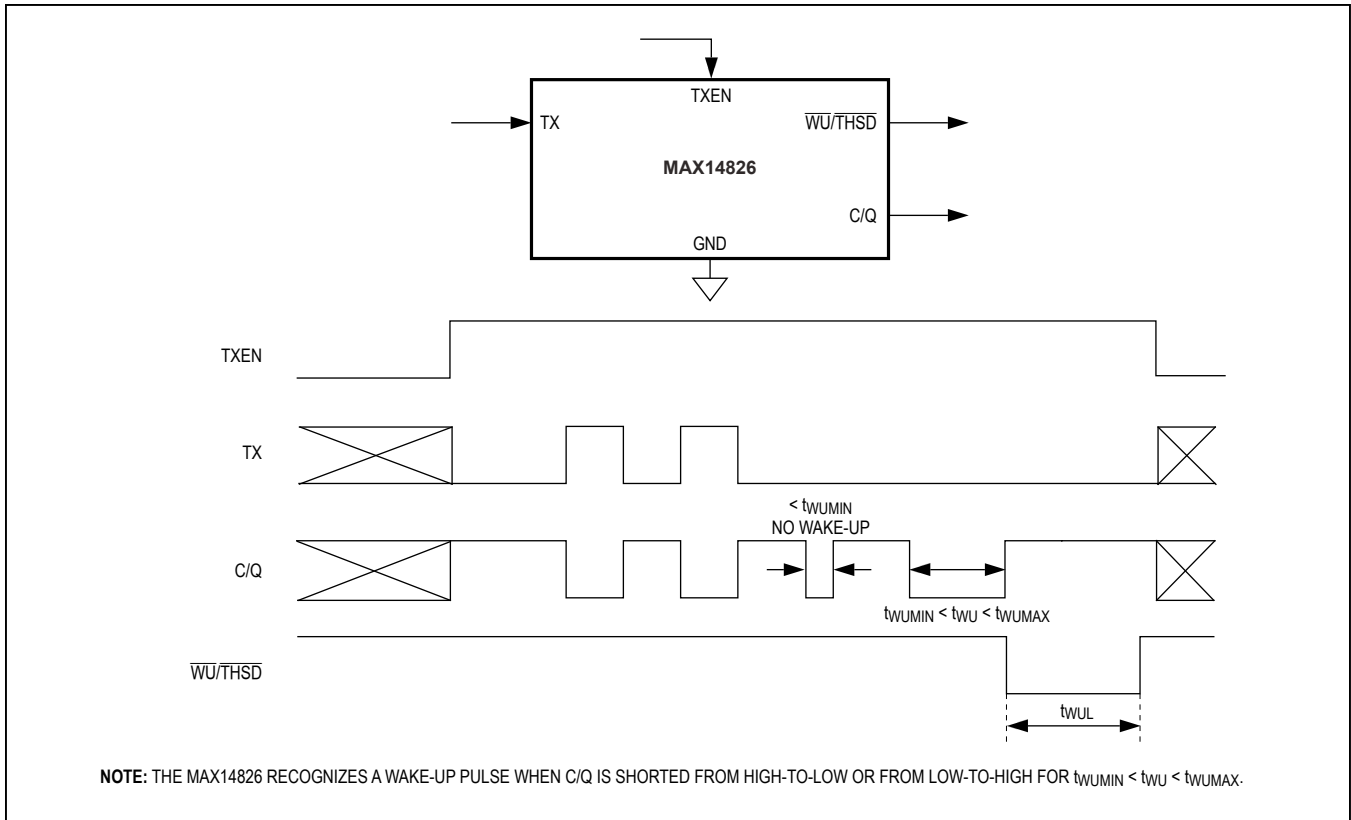


Figure 5. Wake-Up Detection Timing

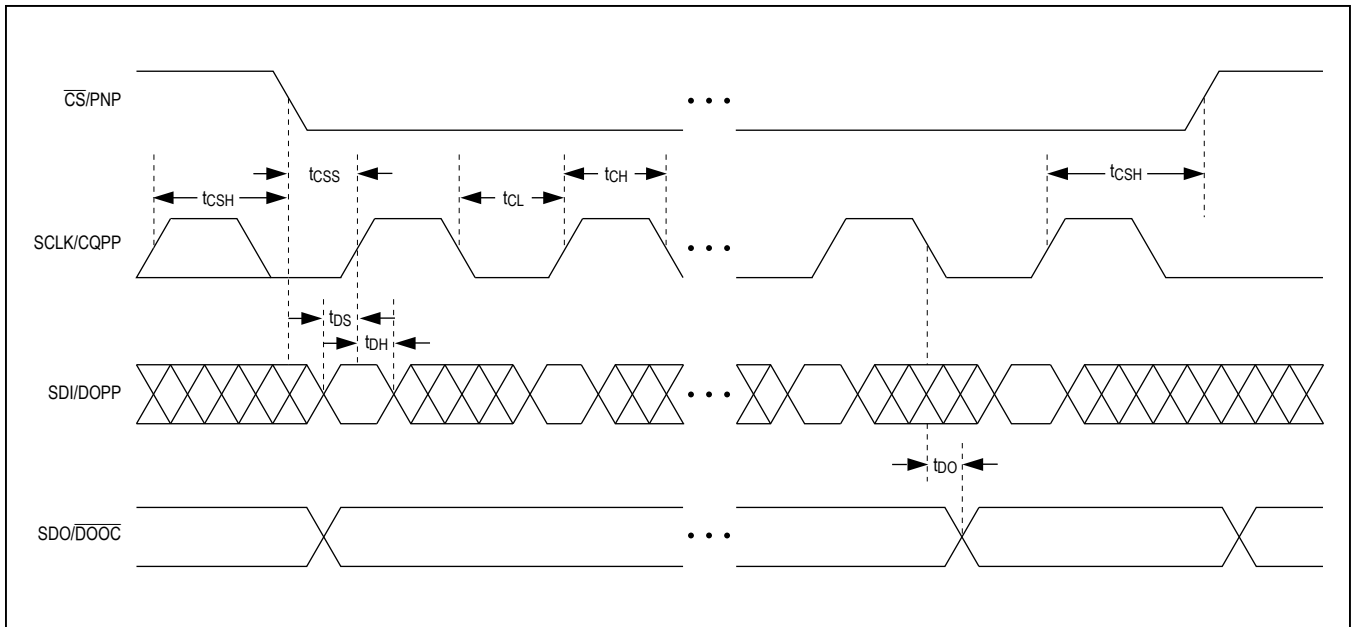
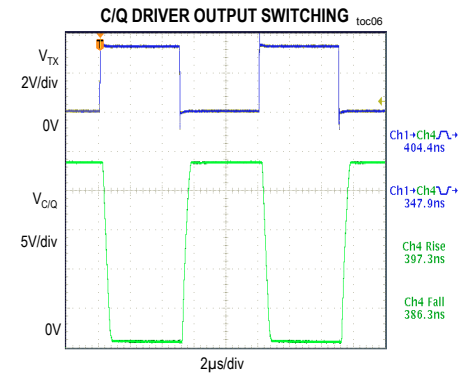
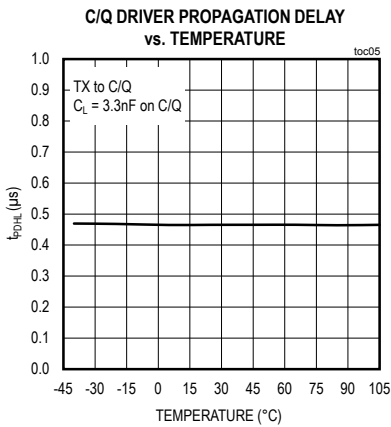
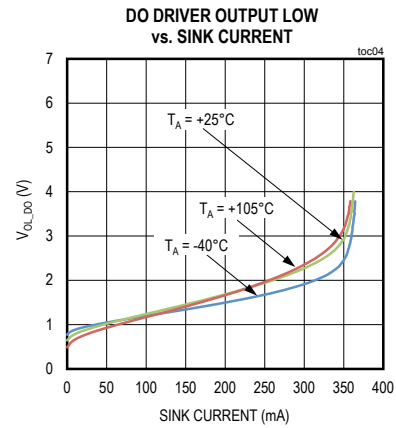
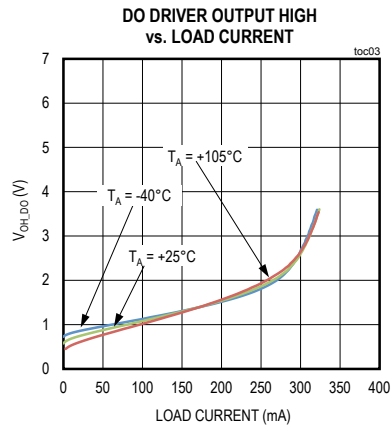
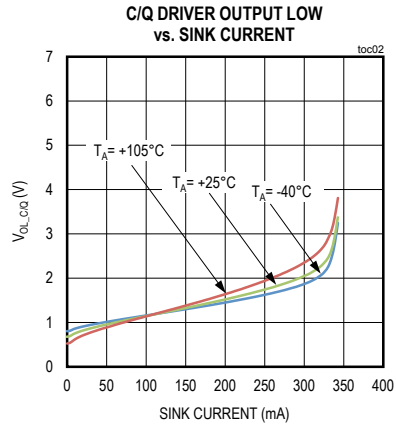
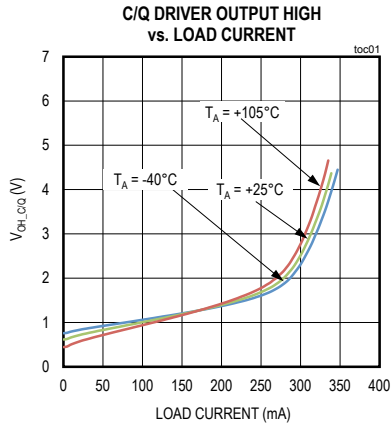


Figure 6. SPI Timing Diagram

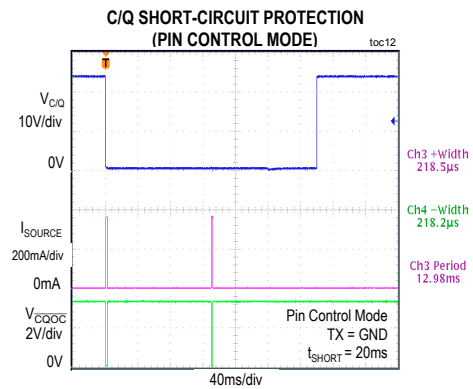
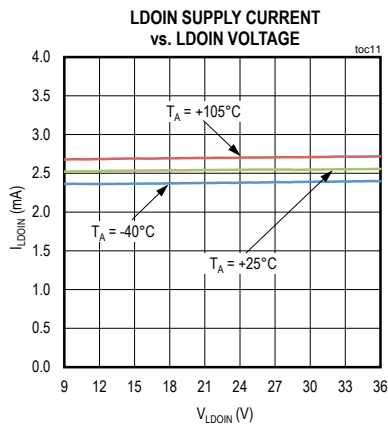
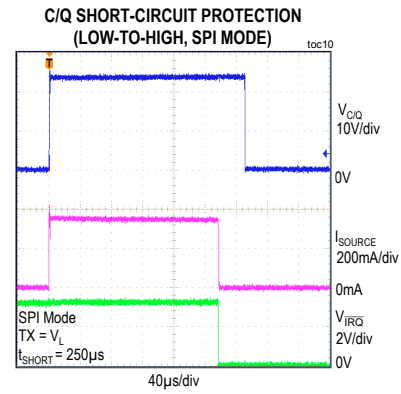
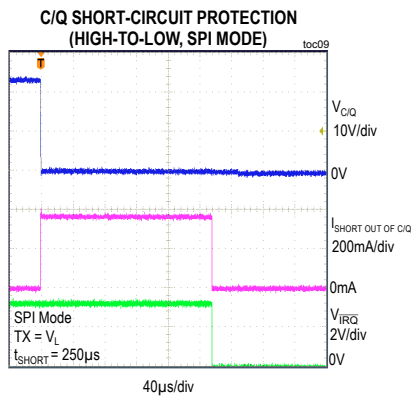
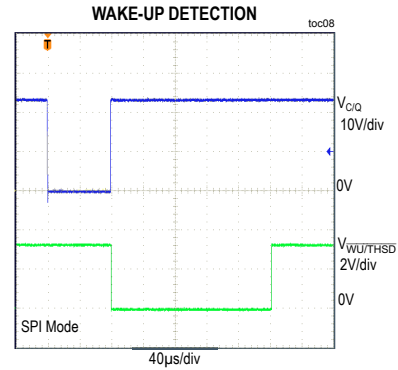
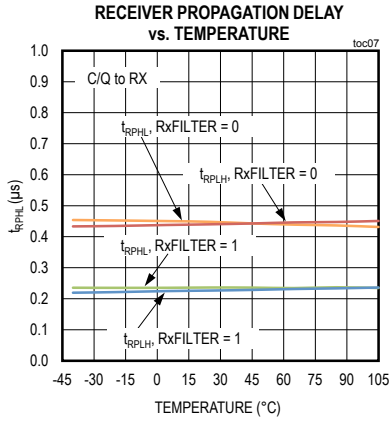
Typical Operating Characteristics

($V_{CC} = 24V$, $LDOIN = V_P$, $V_L = LDO33$, C/Q and DO in push-pull configuration, $T_A = +25^\circ C$, unless otherwise noted.)



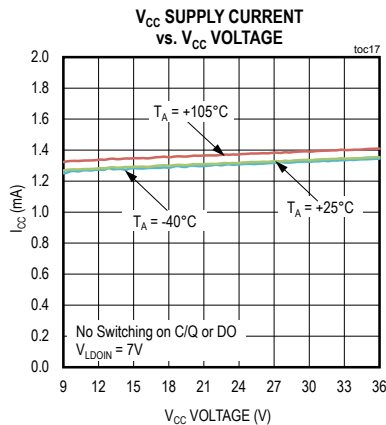
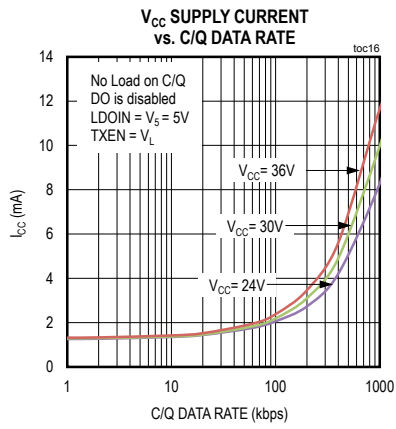
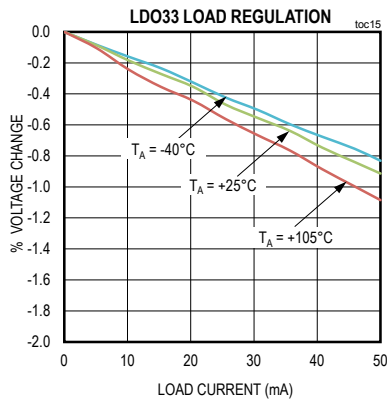
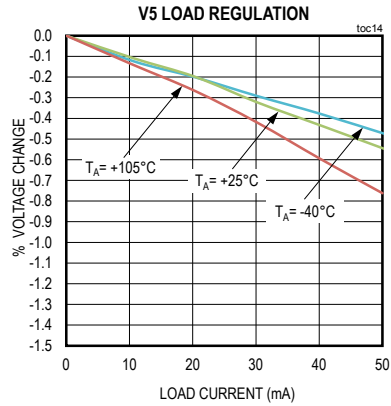
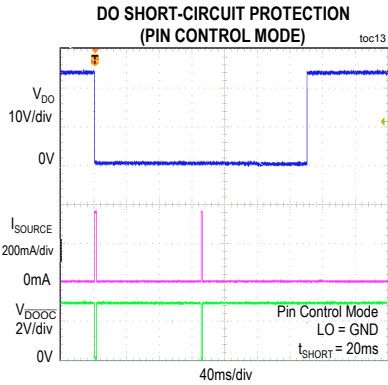
Typical Operating Characteristics (continued)

($V_{CC} = 24V$, LDOIN = V_P , $V_L = LDO33$, C/Q and DO in push-pull configuration, $T_A = +25^\circ C$, unless otherwise noted.)

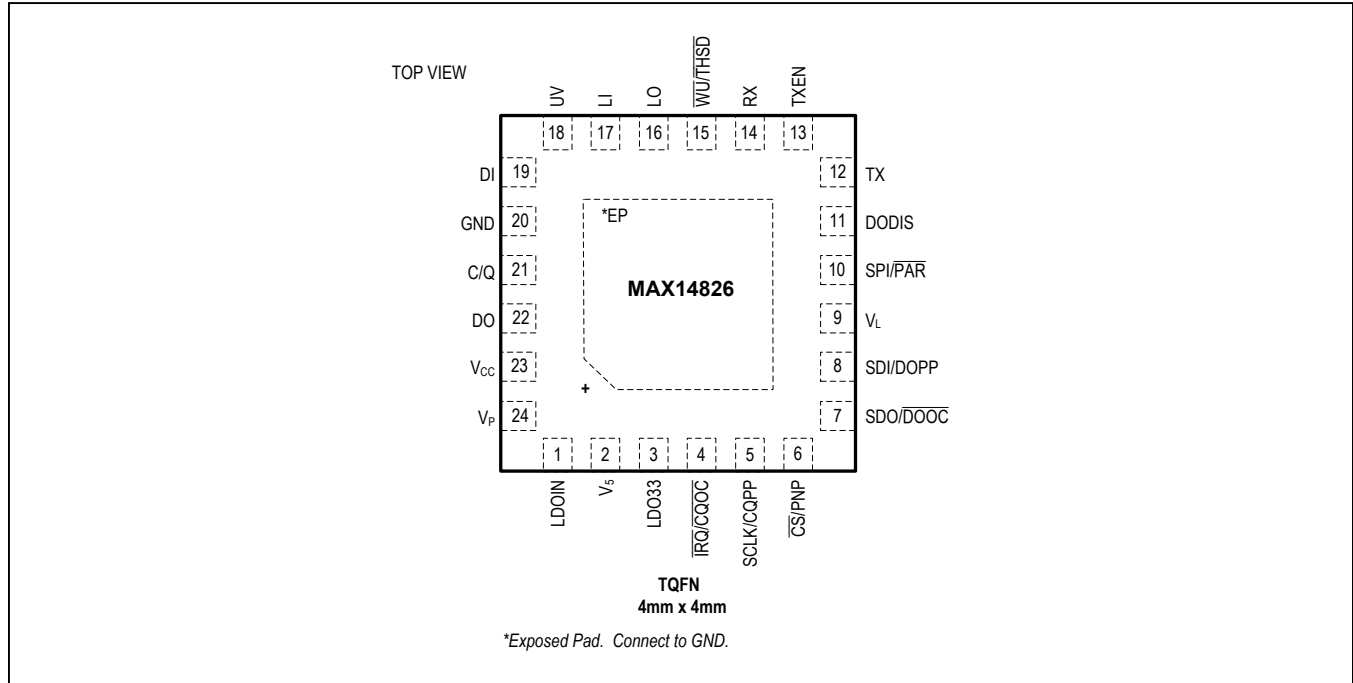


Typical Operating Characteristics (continued)

($V_{CC} = 24V$, $LDOIN = V_P$, $V_L = LDO33$, C/Q and DO in push-pull configuration, $T_A = +25^\circ C$, unless otherwise noted.)



Pin Configuration



Pin Description

| PIN | NAME | FUNCTION |
|-----|-------------------------------------|--|
| 1 | LDOIN | 5V Linear Regulator Input. Bypass LDOIN to GND with a 1µF ceramic capacitor. LDOIN can be powered from V _P or from an external source in the 7V to 36V range. If using V _P to power the LDO, connect LDOIN to V _P through a 10Ω resistor. |
| 2 | V ₅ | 5V Power-Supply Input and 5V Linear Regulator Output. Bypass V ₅ to GND with a 0.1µF ceramic capacitor for 10mA load capability. Add the recommended compensation network to increase the source capability to 30mA. See the 5V and 3.3V Linear Regulators section for more information. |
| 3 | LDO33 | 3.3V Linear Regulator Output. Bypass LDO33 to GND with a 1µF ceramic capacitor. |
| 4 | $\overline{\text{IRQ/CQOC}}$ | Interrupt Request Output C/Q Overcurrent Indicator. In SPI mode, $\overline{\text{IRQ/CQOC}}$ is a standard active-low interrupt request output activated by the bits in the Status register. In parallel mode, $\overline{\text{IRQ/CQOC}}$ pulses low when an overcurrent condition occurs on C/Q. $\overline{\text{IRQ/CQOC}}$ is a push-pull output referenced to V _L . |
| 5 | SCLK/CQPP | SPI Clock Input C/Q Mode Select Input. In SPI mode, SCLK/CQPP is the SPI clock input. In parallel mode, SCLK/CQPP sets the configuration of the C/Q driver. |
| 6 | $\overline{\text{CS/PNP}}$ | Active-Low SPI Chip-Select Input C/Q and DO Mode Select Input. In SPI mode, $\overline{\text{CS/PNP}}$ is the SPI chip-select input. In parallel mode, $\overline{\text{CS/PNP}}$ set the configuration for the C/Q and DO drivers. |
| 7 | $\text{SDO}/\overline{\text{DOOC}}$ | SPI Serial-Data Output/DO Overcurrent Indicator. In SPI mode, $\text{SDO}/\overline{\text{DOOC}}$ the SPI serial-data output. In parallel mode, $\text{SDO}/\overline{\text{DOOC}}$ pulses low when an overcurrent condition occurs on DO. |
| 8 | SDI/DOPP | SPI Serial-Data Input/ DO Mode Select Input. In SPI mode, SDI/DOPP is the SPI serial data input. In parallel mode, SDI/DOPP sets the configuration of the DO driver. |
| 9 | V _L | Logic-Level Supply Input. V _L defines the logic levels on all the logic inputs and outputs. Bypass V _L to GND with a 0.1µF ceramic capacitor. |

Pin Description (continued)

| PIN | NAME | FUNCTION |
|-----|------------------------------|---|
| 10 | SPI/ $\overline{\text{PAR}}$ | SPI-Mode/Parallel-Mode Select Input. Drive SPI/ $\overline{\text{PAR}}$ high to enable SPI functionality. Drive SPI/ $\overline{\text{PAR}}$ low to enable parallel-mode operation. |
| 11 | DODIS | DO Disable Input. Drive DODIS low to enable the DO output. Drive DODIS high to disable the DO output. DO is high-impedance when DODIS is high. |
| 12 | TX | Transmit Communication Input. The logic on the C/Q output is the inverse logic level of the signals on the TX input. |
| 13 | TXEN | Transmitter Enable. Drive TXEN high to enable the C/Q transmitter. TXEN is referenced to V_L . |
| 14 | RX | Receiver Output. RX is the inverse logic level of C/Q. RX is always high when the RxDis bit in the CQConfig register is set to 1. |
| 15 | $\overline{\text{WU/THSD}}$ | Wake-up Output/Active-Low Thermal-Shutdown Indicator. In SPI mode, $\overline{\text{WU/THSD}}$ is the wake-up output. In this mode, $\overline{\text{WU/THSD}}$ pulses low for 190 μs (typ) when a valid wake-up pulse is detected on the C/Q line. In parallel mode, $\overline{\text{WU/THSD}}$ is the thermal-shutdown indicator and asserts low during thermal shutdown. $\overline{\text{WU/THSD}}$ is a push-pull output referenced to V_L . |
| 16 | LO | Logic Input of the DO Output. LO is the logic input that drives DO. LO is referenced to V_L . |
| 17 | LI | Logic Output of the 24V DI Logic Input. LI is the inverse logic of DI. LI is referenced to V_L . |
| 18 | UV | Open-Drain Undervoltage Indicator Output. In case of an undervoltage, the UV open-drain transistor is off. |
| 19 | DI | 24V Logic-Level Digital Input |
| 20 | GND | Ground |
| 21 | C/Q | SIO/IO-Link Data Input/Output. Drive TXEN high to enable the C/Q driver. The logic on the C/Q output is the inverse logic level of the signals on the TX input. RX is the logic inverse of C/Q. The C/Q driver output level can be set by the TX input or programmed by the Q bit. The level on C/Q can be read by the RX output or the $\overline{\text{QLvl}}$ bit. |
| 22 | DO | 24V Logic-Level Digital Output. DO is the inverse logic level of the LO input and can be digitally-controlled through the DIOConfig register. |
| 23 | V_{CC} | Power-Supply Input. Bypass V_{CC} to GND with a 1 μF ceramic capacitor. |
| 24 | V_P | Protected 24V Supply Output. V_P is one diode drop below V_{CC} . V_P is reverse-polarity-protected and can be used as a 24V protected supply to the sensor or actuator electronics. |
| — | EP | Exposed Pad. Connect EP to GND. |

Detailed Description

The MAX14826 is a sensor/actuator transceiver designed for IO-Link® device applications supporting all the specified IO-Link data rates. In IO-Link applications, the devices act as the physical layer interface to a microcontroller running the data-link layer protocol. The device contains an additional 24V digital input and an additional 24V digital output. Two internal linear regulators generate common sensor and actuator power requirements: 5V and 3.3V.

The device detects IO-Link wake-up conditions on the C/Q line and generates a wake-up signal on the $\overline{WU/THSD}$ output. The C/Q and DO drivers are independently-configurable to any one of three driver output types: push-pull, high-side (PNP), or low-side (NPN).

This device is configured and monitored through a pin-selectable parallel or SPI™ interface. Extensive alarms are available through SPI.

24V Interface

The device features an IO-transceiver interface capable of operating with voltages up to 36V. This is the 24V interface and includes the C/Q input/output, the logic-level digital output (DO), and the logic-level digital input (DI).

Configurable Drivers

The device features selectable push-pull, high-side (PNP), or low-side (NPN) switching drivers at C/Q and DO.

Parallel Mode

In parallel mode, the C/Q and DO drivers are independently-configurable using the CQPP/SCLK, DOPP/SDI, and PNP/CS inputs. Set CQPP/SCLK high to select push-pull operation on the C/Q driver. Set DOPP/SDI high to select the push-pull operation on the DO driver.

The PNP/CS input selects NPN or PNP operation for drivers configured for open-drain operation. Set PNP/CS high for PNP operation. Set PNP/CS low for NPN operation. See Table 1.

Table 1. Parallel Mode Select Truth Table

| CQPP/SCLK | DOPP/SDI | PNP/CS | C/Q MODE | DO MODE |
|-----------|----------|--------|-----------|-----------|
| Low | Low | Low | NPN | NPN |
| Low | Low | High | PNP | PNP |
| High | Low | Low | Push-pull | NPN |
| High | Low | High | Push-pull | PNP |
| Low | High | Low | NPN | Push-pull |
| Low | High | High | PNP | Push-pull |
| High | High | x | Push-pull | Push-pull |

X = Don't care

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SPI is a trademark of Motorola, Inc.

SPI Mode

In SPI mode, write to the CQConfig and DIOConfig registers to configure the C/Q and DO drivers.

Set the C/Q_N/P and C/Q_PP bits in the CQConfig register to select the driver mode for the C/Q driver. When configured as a push-pull output, C/Q switches between VP and ground. Set the C/Q_PP bit to 1 to select push-pull operation at C/Q. Set the C/Q_PP bit to 0 to configure the C/Q output for open-drain operation. The C/Q_N/P bit selects NPN or PNP operation when C/Q is configured as an open-drain output.

Set the DoN/P and DoPP bits in the DIOConfig register to select the driver mode for the DO output. When configured as a push-pull output, DO switches between V_{CC} and ground. Set the DoPP bit to 1 for push-pull operation. The DoN/P bit selects NPN or PNP operation when DO is configured as an open-drain output. Set the DoPP bit to 0 to select high-side or low-side operation at DO.

C/Q Driver and Receiver

The C/Q driver can be enabled/disabled in either parallel-input mode or SPI mode.

The device's C/Q driver is specified for 200mA to drive large capacitive loads of up to 1μF and dynamic impedances like incandescent lamps. The maximum load current for C/Q is limited to 480mA.

The C/Q receiver is always on. In SPI mode, the RX output through the RxDis bit in the CQConfig register. Set the RxDis bit to 1 to set the RX output high. Set the RxDis bit to 0 for normal receive operation.

The C/Q receiver has an analog lowpass filter to reduce high-frequency noise present on the line.

C/Q Fault Detection

The device registers a C/QFault condition under either of two conditions:

- 1) When it detects a short-circuit for longer than 214μs (typ). A short condition exists when the C/Q driver's load current exceeds the 350mA (typ) current limit.
- 2) When it detects a voltage level error at the C/Q output. A voltage level error occurs when the C/Q driver is configured for open-drain operation (NPN or PNP), the driver is turned off, and the C/Q voltage is not pulled to exceed the C/Q receiver's threshold levels (< 8V or > 13V) by the external supply.

When a C/QFault error occurs, the C/QFault and C/QFaultInt bits are set, $\overline{IRQ/CQOC}$ asserts, and the driver is turned off after the start of the fault condition.

When a short-circuit event occurs on C/Q, the driver enters autoretry mode. In autoretry mode, the device periodically checks whether the short is still present and attempts to correct the driver output. Autoretry attempts last for 214µs (typ) and occur every 12.9ms (typ).

DO Fault Detection

The device registers a DoFault event when a short-circuit is present at the DO output for 214µs (typ). A short condition exists when the load current on the DO driver exceeds the 300mA (typ) DO current limit. When a short-circuit condition is detected, the DO driver enters autoretry mode. In autoretry mode the device periodically checks whether the error is still present. Autoretry attempts last for 214µs (typ) and occur every 12.9ms (typ). When a DoFault error is detected, SDO/DOOC asserts (parallel mode) or the DoFault and DoFaultInt bits are set, $\overline{IRQ/CQOC}$ asserts. The driver is turned off 214µs (typ) after the start of the DO faults.

Reverse-Polarity Protection

The device is protected against reverse-polarity connections on V_{CC}, C/Q, DO, DI, and GND. Any combination of these pins can be connected to DC voltages up to 40V (max). A short to 40V results in a current flow of less than 500µA.

Ensure that the maximum voltage between any of these pins does not exceed 40V.

5V and 3.3V Linear Regulators

The MAX14826 includes two internal regulators to generate 5V (V₅) and 3.3V (LDO33). V₅ is specified for a total of 10mA load current, including the load from LDO33, when bypassed with a 0.1µF capacitor to ground. Add

the compensation network shown in Figure 7 to draw up to 30mA of total external load current from V₅. LDO33 is specified up to 20mA. The input of V₅ (LDOIN) can be powered from V_P, the protected 24V supply output, or by another voltage in the 7V to 36V range.

If the external circuits powered by the linear regulators require an input bypass capacitance greater than 100nF for 5V, or 1µF for 3.3V, a compensation network must be added on the LDO output. In this situation, connect a capacitor equal to the value required by the external circuit to the LDO output and a 10Ω series resistor between the output and its load (see Figure 8). The capacitors (C5 and C33) in the figure represent the capacitance required by the external circuits. For simplicity, Figure 8 does not show the required protection diodes.

The 5V LDO can be disabled by connecting LDOIN to V₅. When the internal 5V LDO is not used, however, V₅ becomes the supply input for the internal analog and digital functions and must be supplied externally for normal operation. Apply an external voltage of 4.75V to 5.25V to V₅ when the LDO is disabled.

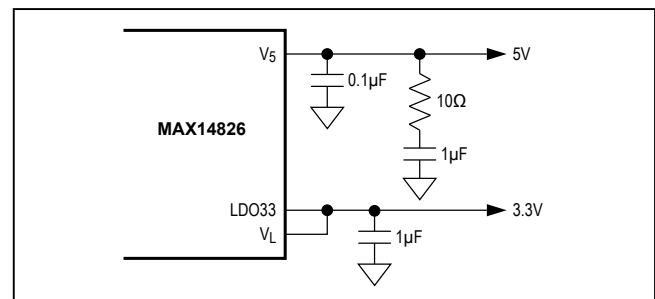


Figure 7. V₅ Compensation Network

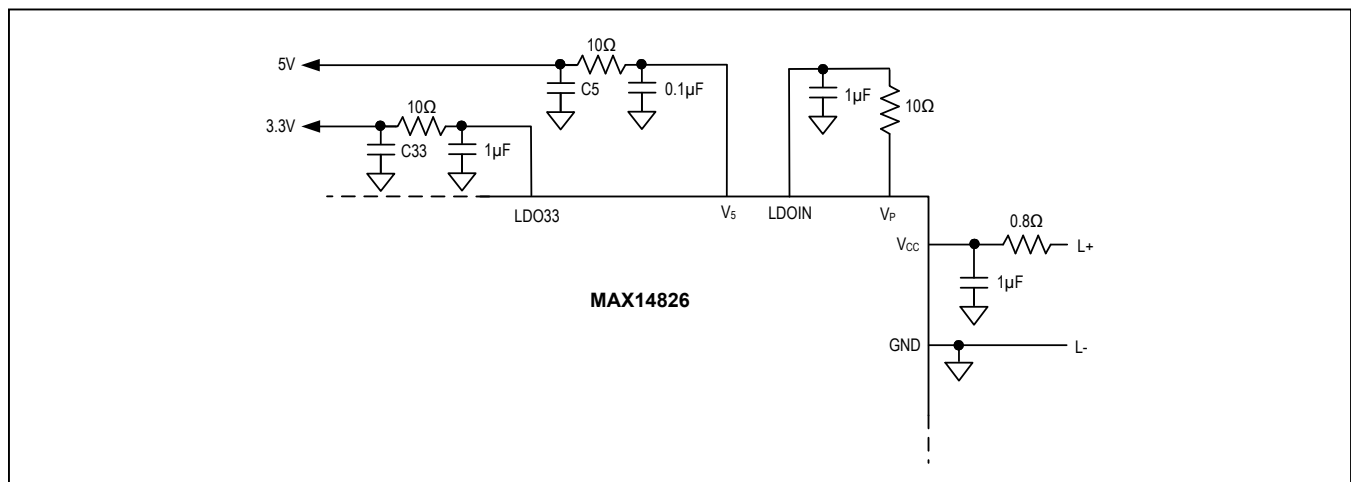


Figure 8. Larger Bypass Capacitance for Powering External Circuits

In SPI mode, use the LDO33Dis bit in the Mode register to disable the 3.3V LDO. See the Mode Register [R1, R0] = [1, 1] section for more information. LDO33 cannot be disabled in parallel mode.

V_5 and LDO33 are not protected against short-circuits.

Power-Up

The C/Q and DO driver outputs and the UV output are high impedance when V_{CC} , V_5 , V_L , and/or LDO33 voltages are below their respective undervoltage thresholds during power-up. UV goes low and the drivers are enabled when all these voltages exceed their respective undervoltage lockout thresholds.

The drivers are automatically disabled if V_{CC} , V_5 , or V_L falls below its threshold.

Undervoltage Detection

The device monitors V_{CC} , V_5 , V_L , and optionally LDO33 for undervoltage conditions. The C/Q and DO drivers, as well as UV, are high-impedance when any monitored voltage falls below its UVLO threshold.

V_{CC} , V_5 , and V_L undervoltage detection cannot be disabled. When V_{CC} falls below the V_{CCUVLO} threshold, UV asserts high, and $\overline{IRQ/CQOC}$ asserts low. In SPI mode, the UV24 and UV24Int bits are also set.

The SPI register contents are unchanged while V_5 is present, regardless of the state of V_{CC} and LDO33. The SPI interface is not accessible and $\overline{IRQ/CQOC}$ is not available when UV is asserted due to a V_5 or V_L undervoltage event.

In SPI mode, the internal 3.3V LDO regulator voltage (V_{LDO33}) falls below the LDO33 undervoltage lockout threshold, the UV33Int bit in the Status register is set and $\overline{IRQ/CQOC}$ asserts. UV asserts if the UV33En bit in the Mode register is set to 1.

The UV output deasserts once the undervoltage condition is removed; however, bits in the Status register and the $\overline{IRQ/CQOC}$ output are not cleared until the Status register has been read if using SPI functionality.

Wake-Up Detection (SPI Mode Only)

The device detects an IO-Link wake-up condition on the C/Q line in push-pull, high-side (PNP), or low-side (NPN) operation modes. A wake-up condition is detected when the C/Q output is shorted for $80\mu\text{s}$ (typ). WU/THSD pulses low for $190\mu\text{s}$ (typ) when the device detects a wake-up pulse on C/Q (Figure 5).

In SPI mode, set the WulntEn bit in the Mode register to set the Wulnt bit in the Status register and generate an interrupt on $\overline{IRQ/CQOC}$ when a wake-up pulse is detected. Wulnt is set and $\overline{IRQ/CQOC}$ asserts immediately after C/Q is released when WulntEn = 1.

The wake-up detection function is not available in parallel mode. For IO-Link applications, monitor the $\overline{CQOC}/\overline{IRQ}$ output with a microcontroller to detect the short-circuit on a C/Q driver during a wake-up event.

Short-Circuit Detect Outputs (Parallel Mode only)

The MAX14826 features independent overcurrent interrupt outputs for the C/Q and DO drivers. When an overcurrent condition occurs on C/Q, $\overline{IRQ/CQOC}$ pulses low. (Figure 9) Similarly, when an overcurrent condition occurs on DO, $\overline{SDO/DOOC}$ pulses low.

$\overline{IRQ/CQOC}$ and/or $\overline{SDO/DOOC}$ will also pulse low when driving capacitive and lamp loads. The drivers must deliver maximum current to these loads/lamps as they are being charged up or turned on.

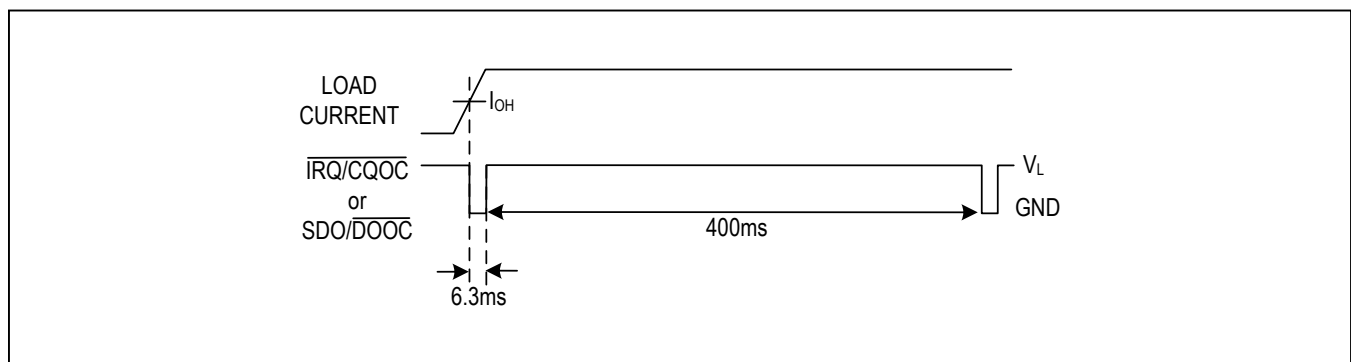


Figure 9. Short-Circuit Detect Output

Note that a short negative pulse on $\overline{\text{IRQ/CQOC}}$ and/or $\overline{\text{SDO/DOOC}}$ will occur at each driver switching event, even when no loads are driven.

Thermal Protection and Considerations

The internal LDOs and drivers can generate more power than the package for the devices can safely dissipate. Ensure that the driver LDO loading is less than the package can dissipate. Total power dissipation for the device is calculated using the following equation:

$$P_{\text{TOTAL}} = P_{\text{C/Q}} + P_{\text{DO}} + P_5 + P_{\text{LDO33}} + P_{\text{Q}} + P_{\text{CLCQ}} + P_{\text{CLDI}}$$

where $P_{\text{C/Q}}$ is the power generated in the C/Q driver, P_{DO} is the power dissipated by the DO driver, P_5 and P_{LDO33} are the power generated by the LDOs, P_{Q} is the quiescent power generated by the devices.

Ensure that the total power dissipation is less than the limits listed in the [Absolute Maximum Ratings](#) section.

Use the following to calculate the power dissipation (in mW) due to the C/Q driver:

$$P_{\text{C/Q}} = [I_{\text{C/Q}}(\text{max})] \times [0.5 + 7 \times I_{\text{C/Q}}(\text{max})]$$

Calculate the internal power dissipation of the DO driver using the following equation:

$$P_{\text{DO}} = [I_{\text{DO}}(\text{max})] \times [0.5 + 7 \times I_{\text{DO}}(\text{max})]$$

Calculate the power dissipation in the 5V LDO, V_5 , using the following equation:

$$P_5 = (V_{\text{LDOIN}} - V_5) \times I_5$$

where I_5 includes the I_{LDO33} current sourced from LDO33.

Calculate the power dissipated in the 3.3V LDO, LDO33, using the following equation:

$$P_{\text{LDO33}} = 1.7\text{V} \times I_{\text{LDO33}}$$

Calculate the quiescent power dissipation in the device using the following equation:

$$P_{\text{Q}} = I_{\text{CC}}(\text{max}) \times V_{\text{CC}}(\text{max})$$

Thermal Shutdown

All regulators and the C/Q and DO output drivers are automatically switched off when the internal die temperature exceeds the +165°C (typ) thermal shutdown threshold. The $\overline{\text{WU/THSD}}$ output asserts low during thermal shutdown and SPI communication is not available.

Regulators are automatically switched on and $\overline{\text{WU/THSD}}$ deasserts when the internal die temperature falls below the thermal shutdown threshold plus hysteresis. The internal registers return to their default state when the V_5 regulator is switched on.

Overtemperature Warning (SPI Mode only)

In SPI mode, bits in the Status and Mode registers are set when the temperature of the device exceeds +127°C (typ). The OTempInt bit in the Status register is set and $\overline{\text{IRQ/CQOC}}$ asserts when the OTemp bit in the mode register is set. Read the Status register to clear the OTempInt bit and $\overline{\text{IRQ/CQOC}}$.

The OTemp bit is cleared when the die temperature falls to +104°C.

The device continues to operate normally unless the die temperature reaches the +165°C thermal shutdown threshold, when the device enters thermal shutdown.

Register Functionality

The devices have four 8-bit-wide registers for configuration and monitoring (Table 2).

Table 2. Register Summary

| REGISTER | R1 | R0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|-----------|----|----|--------|------------|---------|--------------------|-------------|---------|---------|----------|
| Status | 0 | 0 | WuInt | DoFaultInt | DiLvl | \overline{Q} Lvl | C/QFaultInt | UV33Int | UV24Int | OTemplnt |
| CQConfig | 0 | 1 | RxFilt | — | C/Q_N/P | C/Q_PP | C/QDEn | Q | RxDis | — |
| DIOConfig | 1 | 0 | DoInv | DoAv | DoN/P | DoPP | DoEn | DoBit | LiDis | — |
| Mode | 1 | 1 | RST | WuIntEn | DoFault | C/QFault | UV24 | OTemp | UV33En | LDO33Dis |

R1/R0 = Register address.
 — = Register not used.

Status Register [R1, R0] = [0,0]

| Bit | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|-------|------------|-------|--------------------|-------------|---------|---------|----------|
| Bit Name | WuInt | DoFaultInt | DiLvl | \overline{Q} Lvl | C/QFaultInt | UV33Int | UV24Int | OTemplnt |
| Read/Write | R | R | R | R | R | R | R | R |
| POR State | 0 | 0 | X | X | 0 | 0 | 0 | 0 |
| Reset Upon Read | Yes | Yes | No | No | Yes | Yes | Yes | Yes |
| Parallel Pin Configuration (SPI is Low) | X | X | X | X | X | X | X | X |

X = Unknown. These bits are dependent on the DI logic and C/Q inputs.

The Status register reflects the logic levels of C/Q and DI and shows the source of interrupts that cause an $\overline{IRQ/CQOC}$ hardware interrupt. The $\overline{IRQ/CQOC}$ interrupt is asserted when an alarm condition (OTemp, UV33Int, UV24, C/QFault, DoFault, WuInt) is detected. All bits in the Status register are read-only. The interrupt bits return to the default state after the Status register is read. If a C/Q or DO fault condition persists, the associated interrupt bits are immediately set after the Status register is read.

| BIT | NAME | DESCRIPTION |
|-----|------------|---|
| D7 | WuInt | Wake-Up Interrupt Request. WuInt is set when an IO-Link wake-up request pulse is detected on C/Q and the WuIntEn bit in the Mode register is set. $\overline{IRQ/CQOC}$ asserts when WuInt is set to 1. Read the Status register to clear the WuInt bit and deassert $\overline{IRQ/CQOC}$. |
| D6 | DoFaultInt | DO Fault Interrupt. DoFaultInt interrupt bit and DoFault bit (in the Mode register) are set when a fault condition occurs on the DO driver output. The device registers a fault condition when a short-circuit or voltage fault is detected on DO (see the DO Fault Detection section for more information). $\overline{IRQ/CQOC}$ asserts when DoFaultInt is 1. Read the Status register to clear the DoFaultInt bit and deassert $\overline{IRQ/CQOC}$. |
| D5 | DiLvl | DI Logic Level. The DiLvl bit mirrors the current logic level at the DI input. It is the inverse of the LI output and is always active regardless of the state of the LiDis bit (Table 2). DiLvl does not affect $\overline{IRQ/CQOC}$. DiLvl is not changed when the Status register is read. |

| BIT | NAME | DESCRIPTION |
|-----|-------------------|---|
| D4 | $\overline{Q}Lvl$ | C/Q Logic Level. The $\overline{Q}Lvl$ bit is the inverse of the logic level at C/Q. $\overline{Q}Lvl$ is 1 when the C/Q input level is low (< 8V) and is 0 when the C/Q logic level is high (> 13V) (Table 3). $\overline{Q}Lvl$ remains active when the C/Q receiver output, RX is disabled (RxDis = 1). $\overline{Q}Lvl$ does not affect $\overline{IRQ}/\overline{CQOC}$. $\overline{Q}Lvl$ is not changed when the Status register is read. |
| D3 | C/QFaultInt | C/Q Fault Interrupt. The C/QFaultInt interrupt bit and C/QFault bit (in the Mode register) are set when a short-circuit or voltage fault occurs on the C/Q driver output (see the C/Q Fault Detection section for more information). $\overline{IRQ}/\overline{CQOC}$ asserts when C/QFault is 1. Read the Status register to clear the C/QFaultInt bit and deassert $\overline{IRQ}/\overline{CQOC}$. |
| D2 | UV33Int | Internal 3.3V LDO (LDO33) Undervoltage Warning. Both the UV33Int interrupt bit and the UV33En bit (in the Mode register) are set when V_{LDO33} falls below the 2.4V LDO33 undervoltage threshold. If UV33En is set in the Mode register, $\overline{IRQ}/\overline{CQOC}$ asserts low when the UV33Int bit is 1. Read the Status register to clear the UV33Int bit and deassert $\overline{IRQ}/\overline{CQOC}$. Set the UV33En bit to 1 in the Mode register to enable undervoltage monitoring for UV33Int. When enabled, UV asserts high when the UV33Int bit is 1. UV deasserts when V_{LDO33} rises above the LDO33 undervoltage threshold. |
| D1 | UV24Int | V_{CC} Undervoltage Interrupt. The UV24Int interrupt bit and the UV24 bit (in the Mode register) are set when the V _{CC} voltage falls below the 7.4V undervoltage threshold. $\overline{IRQ}/\overline{CQOC}$ asserts low when the UV24Int bit is 1. Read the Status register to clear the UV24Int bit and deassert $\overline{IRQ}/\overline{CQOC}$. V _{CC} undervoltage detection cannot be disabled. |
| D0 | OTempInt | Overtemperature Warning. The OTempInt interrupt bit and the OTemp bit (in the Mode register) are set when a high-temperature condition is detected by the devices. OTemp is set when the temperature of the die exceeds +127°C (typ). OTempInt is set and $\overline{IRQ}/\overline{CQOC}$ asserts when the OTemp bit is 1. The OTempInt bit is cleared and $\overline{IRQ}/\overline{CQOC}$ deasserts when the Status register is read. Once cleared, OTempInt is not reset if the die temperature remains above the thermal warning threshold and does not fall below +104°C. |

Table 3. DiLvl and LI Output

| V _{DI} (V) | DiLvl BIT | LI OUTPUT |
|---------------------|-----------|-----------|
| < 5.2 | 0 | High |
| > 8 | 1 | Low |

Table 4. $\overline{Q}Lvl$ and RX Output

| V _{C/Q} (V) | $\overline{Q}Lvl$ BIT | RX OUTPUT |
|----------------------|-----------------------|-----------|
| < 8 | 1 | High |
| >13 | 0 | Low |

CQConfig Register [R1, R0] = [0,1]

| Bit | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|--|----------|----|-------------------------------|-------------------------------|--------|-----|-------|----|
| Bit Name | RxFilter | — | C/Q_N/P | C/Q_PP | C/QDEn | Q | RxDis | — |
| Read/Write | R/W | — | R/W | R/W | R/W | R/W | R/W | — |
| POR State | 0 | — | 0 | 0 | 0 | 0 | 0 | — |
| Parallel Pin Configuration (SPI/PAR is low) | 0 | — | CQPP and PNP pins define mode | CQPP and PNP pins define mode | 0 | 0 | 0 | — |

— = Register not used.
 X = Unknown.

Use the CQConfig register to control the C/Q receiver and driver parameters. All bits in the CQConfig register are set to 0 at power-up.

| BIT | NAME | DESCRIPTION |
|-----|----------|---|
| D7 | RxFilter | C/Q and DI Receiver Filter Control. The C/Q and DI receivers have analog lowpass filters to reduce high-frequency noise on the receiver inputs. Set the RxFilter bit to 0 to set the filter corner frequency to 500kHz. Set the RxFilter bit to 1 to set the filter corner frequency to 1MHz (this setting is used for high-speed COM3 operation). Noise filters on C/Q and DI are controlled simultaneously by the RxFilter bit. |
| D6 | — | This bit is not used. |
| D5 | C/Q_N/P | C/Q Driver NPN/PNP Mode. The C/Q_N/P bit selects between low-side (NPN) and high-side (PNP) modes when the C/Q driver is configured as an open-drain output (C/Q_PP = 0). Set C/Q_N/P to 1 to configure the driver for low-side (NPN) operation. Set C/Q_N/P to 0 for high-side (PNP) operation. |
| D4 | C/Q_PP | C/Q Driver Push-Pull Operation. Set C/Q_PP to 1 to enable push-pull operation on the C/Q driver. The C/Q output is open-drain when C/Q_PP is 0. |
| D3 | C/QDEn | C/Q Driver Enable/Disable. Set the C/QDEn bit to 1 to enable the C/Q driver. Set C/QDEn to 0 for hardware (TXEN) control. See Table 4. |
| D2 | Q | C/Q Driver Output Logic. The Q bit can be used to program the C/Q output driver through software. The C/Q driver must be enabled and TX must be high to control the C/Q driver through the Q bit (Figure 9). C/Q has the same logic polarity as the Q bit. Set the Q bit to 0 to control the C/Q driver with TX. The C/Q driver output state depends on the C/Q_PP and C/Q_N/P bits as shown in Table 5. Note that Table 5 assumes that the C/Q driver is enabled (TXEN = V _L or C/QDEn = 1). |
| D1 | RxDis | C/Q Receiver Enable/Disable. Set the RxDis bit to 1 to disable the C/Q receiver. The RX output is high when RxDis is 1. |
| D0 | — | This bit is not used. |

Table 5. C/QDn and TXEN C/Q Driver Control

| C/QDn | TXEN | C/Q DRIVER |
|-------|------|------------|
| 0 | Low | Disabled |
| 1 | Low | Enabled |
| X | High | Enabled |

X = Don't care.

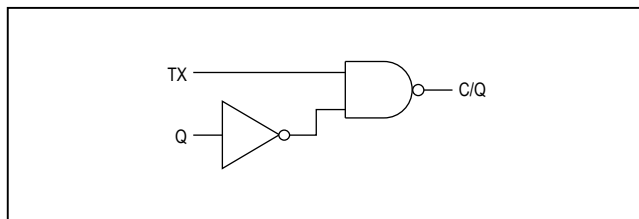


Figure 10. Equivalent C/Q Logic

Table 6. C/Q Driver Output State

| TX (SEE NOTE) | Q | C/Q_PP | C/Q_N/P | C/Q CONFIGURATION | C/Q STATE |
|------------------|---|--------|---------|-------------------|----------------------------|
| High | 1 | 0 | 0 | PNP, open-drain | On, C/Q is high |
| High | 0 | 0 | 0 | PNP, open-drain | Off, C/Q is high-impedance |
| High | 1 | 0 | 1 | NPN, open-drain | Off, C/Q is high-impedance |
| High | 0 | 0 | 1 | NPN, open-drain | On, C/Q is low |
| High | 1 | 1 | X | Push-pull | High |
| High | 0 | 1 | X | Push-pull | Low |

Note: TX = V_L .

X = Don't care.

DIOConfig Register [R1, R0] = [1,0]

| Bit | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|--|-------|------|-------------------------------|-------------------------------|------|-------|-------|----|
| Bit Name | DoInv | DoAv | DoN/P | DoPP | DoEn | DoBit | LiDis | — |
| Read/Write | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R |
| POR State | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parallel Pin Configuration (SPI/PAR is low) | 0 | 0 | DOPP and PNP pins define mode | DOPP and PNP pins define mode | 0 | 0 | 0 | X |

— = Register not used.

X = Unknown.

Use the DIOConfig register to control the DI and DO interfaces. All bits in the DIOConfig register are set to 0 at power-up.

| BIT | NAME | DESCRIPTION |
|-----|-------|--|
| D7 | DoInv | DO Output Polarity. Set the DoInv bit to 1 to invert the logic of the DO output. This bit also works in conjunction with the DoAv (Table 6). DO tracks the TX input with the opposite polarity when both the DoAv and DoInv bits are set. |
| D6 | DoAv | DO Antivalent Operation. Set the DoAv bit to 1 to enable antivalent output operation on DO. DO tracks the TX input (and the Q bit) when DoAv is 1 (Table 6). The LO input and the DoBit are ignored when the DoAv bit is 1. |
| D5 | DoN/P | DO Driver NPN/PNP Operation. The DoN/P bit selects between low-side (NPN) and high-side (PNP) modes when the DO driver is configured as an open-drain output (DoPP = 0). Set DoN/P to 1 to configure the driver for low-side (NPN) operation. Set DoN/P to 0 for high-side (PNP) operation. |
| D4 | DoPP | DO Driver Push-Pull Operation. Set the DoPP bit to 1 to configure the DO driver output for push-pull operation. DO is an open-drain output when DoPP is 0. |
| D3 | DoEn | DO Driver Enable/Disable. Set the DoEn bit to 1 to enable the DO driver. The DO driver is high-impedance with a weak pulldown when DoEn is 0. |
| D2 | DoBit | DO Driver Output Logic. The DoBit bit can be used to program the DO output driver through software. Drive LO high to activate DoBit programming (Figure 10). The DO output state is given in Table 7. Note that Table 7 assumes that the DoInv bit is 0. |
| D1 | LiDis | LI Output Enable/Disable. Set the LiDis bit to 1 to disable the LI output. The LI output is low when LiDis is 1. |
| D0 | — | This bit is not used. |

Table 7. DoAv and DoInv Operation

| DoAv | DoInv | TX (NOTE 1) | LO (NOTE 1) | DO (NOTE 2) | C/Q (NOTE 2) |
|------|-------|-------------|-------------|-------------|--------------|
| 0 | 0 | Low | Low | High | High |
| 0 | 0 | Low | High | Low | High |
| 0 | 0 | High | Low | High | Low |
| 0 | 0 | High | High | Low | Low |
| 0 | 1 | Low | Low | Low | High |
| 0 | 1 | Low | High | High | High |
| 0 | 1 | High | Low | Low | Low |
| 0 | 1 | High | High | High | Low |
| 1 | 0 | Low | Low | Low | High |
| 1 | 0 | Low | High | Low | High |
| 1 | 0 | High | Low | High | Low |
| 1 | 0 | High | High | High | Low |
| 1 | 1 | Low | Low | High | High |
| 1 | 1 | Low | High | High | High |
| 1 | 1 | High | Low | Low | Low |
| 1 | 1 | High | High | Low | Low |

Note 1: Low is when V_{TX} or $V_{LO} = 0V$; high is when V_{TX} or $V_{LO} = V_L$.

Note 2: Low is when C/Q or $DO < 8V$; high is when C/Q or $DO > 13V$.

Table 8. DO Output Programmed by DoBit

| LO | DoBit | DoPP | DoN/P | DO CONFIGURATION | DO STATE |
|------|-------|------|-------|------------------|---------------------------|
| High | 0 | 1 | X | Push-pull | Low |
| High | 1 | 1 | X | Push-pull | High |
| High | 0 | 0 | 0 | PNP | Off, DO is high-impedance |
| High | 1 | 0 | 0 | PNP | On, DO is high |
| High | 0 | 0 | 1 | NPN | On, DO is low |
| High | 1 | 0 | 1 | NPN | Off, DO is high-impedance |
| Low | X | X | X | See Table 6 | See Table 6 |

X = Don't care.

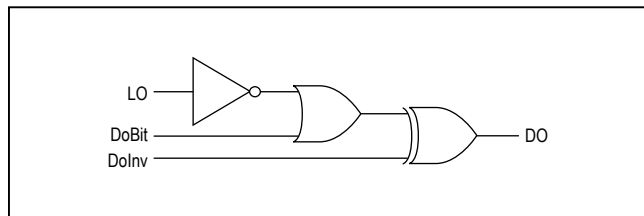


Figure 11. Equivalent DO Logic

Mode Register [R1, R0] = [1,1]

| Bit | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|--|-----|---------|--|---|-----------------------------|-------|--------|----------|
| Bit Name | RST | WulntEn | DoFault | C/QFault | UV24 | OTemp | UV33En | LDO33Dis |
| Read/Write | R/W | R/W | R | R | R | R | R | R/W |
| POR State | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parallel Pin Configuration (SPI/PAR is low) | 0 | 0 | $\overline{\text{DOOC}}$ asserts when DoFault is set | $\overline{\text{CQOC}}$ asserts when C/QFault is set | UV asserts when UV24 is set | 0 | 0 | 0 |

X = Unknown.

Use the Mode register to reset the MAX14826 and manage the 3.3V LDO. The Mode register has bits that represent the current status of fault conditions. When writing to the Mode register, the contents of the fault indication bits (bits 2 to 5) do not change.

| BIT | NAME | DESCRIPTION |
|-----|----------|--|
| D7 | RST | <p>Register Reset. Set RST to 1 to reset all registers to their default power-up state. Then set RST to 0 for normal operation.</p> <p>The Status register is cleared and $\overline{\text{IRQ/CQOC}}$ deasserts (if asserted) when RST = 1. Interrupts are not generated while RST = 1.</p> |
| D6 | WulntEn | <p>Wake-Up Interrupt Enable. Set WulntEn to 1 to enable wake-up interrupt generation. When WulntEn is set, the Wulnt bit in the Status register is set and $\overline{\text{IRQ/CQOC}}$ asserts when a valid wake-up condition is detected. The C/Q driver must be enabled for wake-up detection. The state of WulntEn does not affect the $\overline{\text{WU/THSD}}$ output. See the <i>Wake-Up Detection</i> section for more information.</p> |
| D5 | DoFault | <p>DO Fault Status. The DoFault bit is set when a short circuit or voltage fault occurs at the DO driver output (see the <i>DO Fault Detection</i> section for more information). The DoFault and DoFaultInt bits are both set when a fault occurs on DO. DoFault is cleared when the fault is removed.</p> |
| D4 | C/QFault | <p>C/Q Fault Status. The C/QFault bit is set when a short circuit or voltage fault occurs at the C/Q driver output (see the <i>C/Q Fault Detection</i> section for more information). The C/QFault and C/QFaultInt bits are both set when a fault occurs on C/Q. C/QFault is cleared when the fault is removed.</p> |
| D3 | UV24 | <p>V_{CC} Undervoltage Condition. Both the UV24 and the UV24Int bits are set when V_{CC} falls below V_{CCUVLO}. UV24 is cleared when V_{CC} rises above the V_{CC} threshold. V₅ must be present for SPI V_{CC} undervoltage monitoring.</p> |
| D2 | OTemp | <p>Temperature Warning. The OTemp bit is set when a high-temperature condition occurs on the devices. Both the OTempInt interrupt in the Status register and the OTemp bit are set when the junction temperature of the die rises to above +127°C (typ). The OTemp bit is cleared when the junction temperature falls below +104°C (typ).</p> |
| D1 | UV33En | <p>LDO33 UV Enable. Set the UV33En bit to 1 to assert the UV output when LDO33 voltage falls below the 2.4V (typ) undervoltage lockout threshold. The UV33En bit does not affect the UV33Int bit in the Status register; $\overline{\text{IRQ/CQOC}}$ asserts when V_{LDO33} falls below V_{LDO33UVLO} regardless of the state of UV33En.</p> |
| D0 | LDO33Dis | <p>LDO33 Enable/Disable. Set LDO33Dis to 1 to disable the 3.3V linear regulator (LDO33).</p> |

SPI Interface

The device communicates through an SPI-compatible 4-wire serial interface when SPI/PAR is high. The interface has three inputs—clock (SCLK/CQPP), chip select ($\overline{CS}/\overline{PNP}$), and data in (SDI/DOPP)—and one data out (SDO/ \overline{DOOC}). The maximum SPI clock rate for the device

is 12MHz. The SPI interface complies with clock polarity CPOL = 0 and clock phase CPHA = 0 (see [Figure 12](#) and [Figure 13](#)).

The SPI interface is not available when V₅ or V_L are not present.

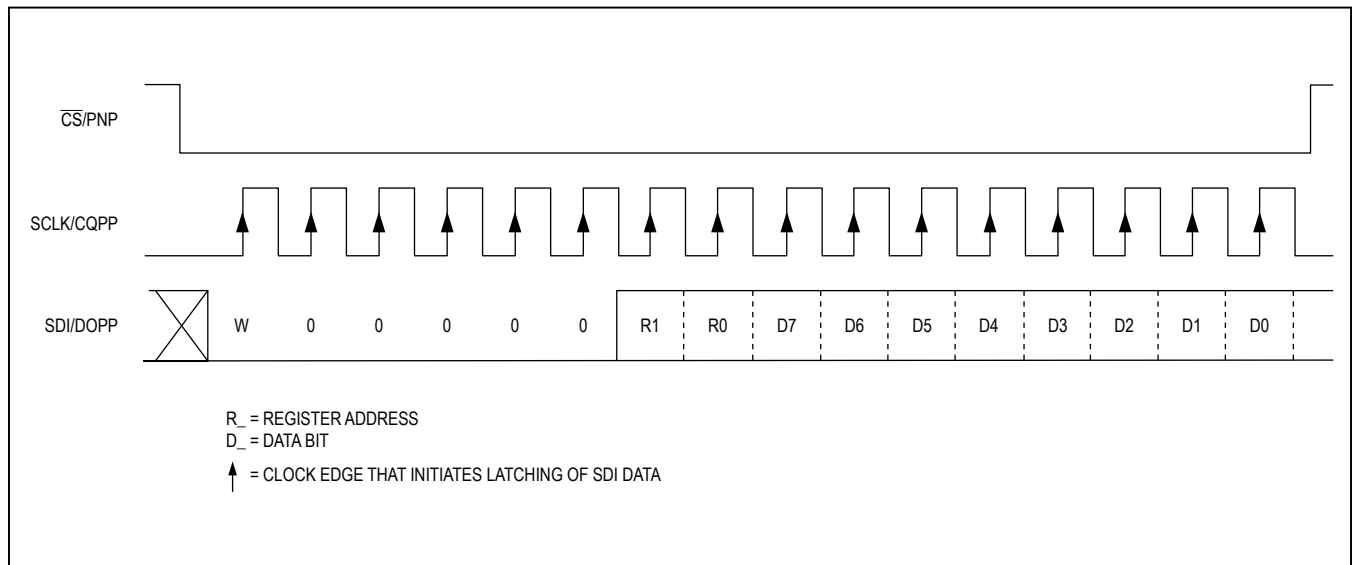


Figure 12. SPI Write Cycle

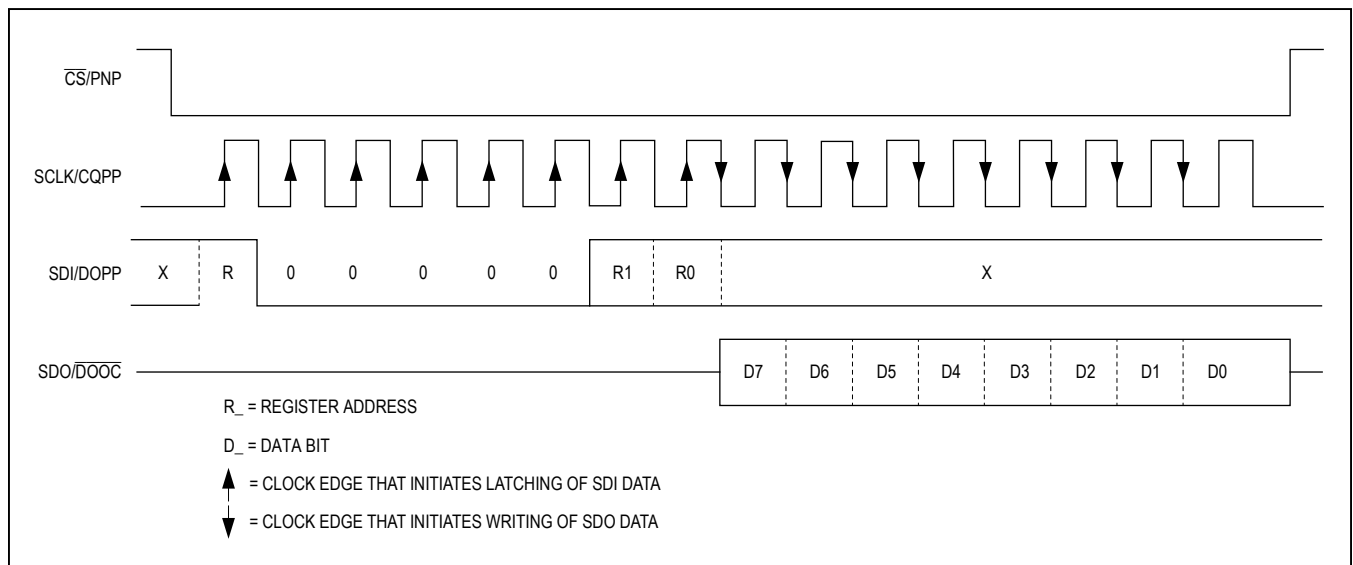


Figure 13. SPI Write Cycle

Applications Information

Transient Protection

Inductive load-switching, surges, and bursts create high transient voltages. C/Q, DO, and DI should be protected against high overvoltage and undervoltage transients. Positive voltage transients on C/Q, DO, and DI must be limited to +55V relative to GND and negative voltage transients must be limited to -55V (relative to V_{CC}) on DO and C/Q and to -55V (relative to GND) on DI. [Figure 14](#) shows suitable protection using TVS diodes to meet both the IEC 61000-4-2 ESD and IEC 61000-4-4 burst testing. Other protection schemes may also be suitable.

The V_{CC} and LDOIN must be protected against transients that occur during hot-plugging of the L+ sensor supply (V_{CC}). To protect the device, place a 10Ω resistor and 1μF capacitor before LDOIN and connect an RC between the sensor supply into and V_{CC}, as shown in [Figure 8](#). Ensure that the RC time constant of the filter on V_{CC} is at least 0.8μs.

Optional External Powering

The MAX14826 is powered by V_{CC} and V₅. V_L is a reference voltage input to set the logic levels of the microcontroller interface. The logic and SPI interface are operational when V₅ and V_L are present even if V_{CC} is not present.

The V_P output provides a reverse-polarity-protected voltage one diode drop below V_{CC} and can be used for supplying external circuitry, like power supplies. The current drawn from V_P cannot exceed 50mA. Be aware that capacitance on V_P can cause transient currents at power-up equal to C x dV_{CC}/dt.

V₅ is typically powered by the internal 5V regulator, but can alternatively be powered by an external 5V regulator. When powering V₅ externally, connect LDOIN to V₅. ([Figure 15](#)). This configuration disables operation of the internal 5V regulator and reduces power consumption.

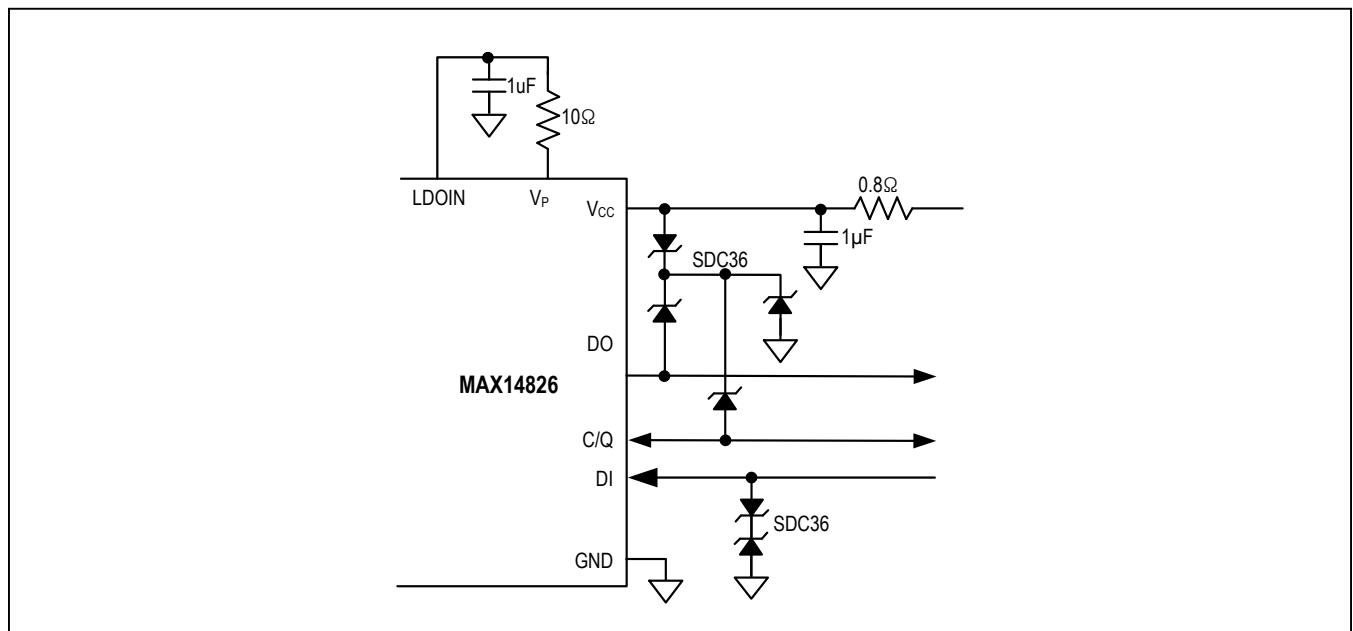


Figure 14. MAX14826 Operating Circuit with TVS Protection

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|--------------|-----------------|-------------|
| MAX14826GTG+ | -40°C to +105°C | 24 TQFN-EP* |

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

*EP = Exposed pad.

Chip Information

PROCESS: BICMOS

Package Information

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 TYPE | PACKAGE CODE | OUTLINE NO. | LAND PATTERN NO. |
|--------------|--------------|-------------------------|-------------------------|
| 24 TQFN-EP | T2444+4 | 21-0139 | 90-0022 |