

MAX13046E/MAX13047E

General Description

The MAX13046E/MAX13047E $\pm 15\text{kV}$ ESD-protected bidirectional level translators provide level shifting for data transfer in a multivoltage system. The MAX13046E is a single-channel translator, and the MAX13047E is a dual-channel translator. Externally applied voltages, V_{CC} and V_L , set the logic level on either side of the device. The MAX13046E/MAX13047E utilize a transmission-gate-based design to allow data translation in either direction ($V_L \leftrightarrow V_{CC}$) on any single data line. The MAX13046E/MAX13047E accept V_L from +1.1V to the minimum of either +3.6V or ($V_{CC} + 0.3\text{V}$), and V_{CC} from +1.65V to +5.5V, making these devices ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems.

The MAX13046E/MAX13047E feature a shutdown mode that reduces supply current to less than $1\mu\text{A}$ thermal short-circuit protection, and $\pm 15\text{kV}$ ESD protection on the V_{CC} side for enhanced protection in applications that route signals externally. The MAX13046E/MAX13047E operate at a guaranteed data rate of 8Mbps when push-pull driving is used.

The MAX13046E is available in a 6-pin μDFN package, and the MAX13047E is available in a 10-pin UTQFN. Both devices are specified over the extended -40°C to $+85^\circ\text{C}$ operating temperature range.

Applications

- I²C and 1-Wire[®] Level Translation
- CMOS Logic-Level Translation
- Cell Phones
- Portable Devices

Ordering Information/Selector Guide

| PART | PIN-PACKAGE | NUMBER OF CHANNELS | TOP MARK |
|---------------|------------------------------------|--------------------|----------|
| MAX13046EELT+ | 6 μDFN (1mm x 1.5mm) | 1 | OC |
| MAX13047EEVB+ | 10 UTQFN (1.4mm x 1.8mm) | 2 | AAC |

Note: All devices are specified over the extended -40°C to $+85^\circ\text{C}$ operating temperature range.

+Denotes a lead-free/RoHS-compliant package.

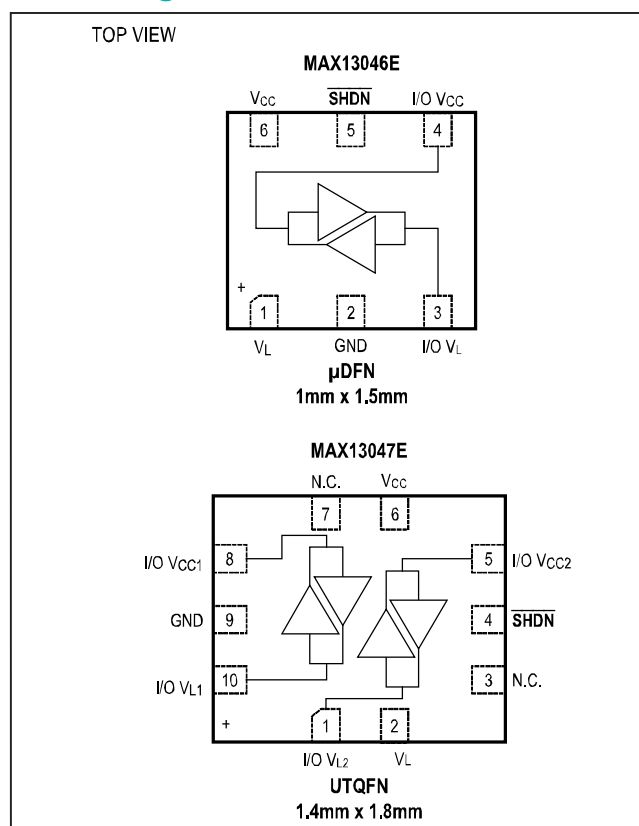
1-Wire is a registered trademark of Maxim Integrated Products, Inc.

Single- and Dual-Bidirectional Low-Level Translator

Features

- Bidirectional Level Translation
- Operation Down to +1.1V on V_L
- Ultra-Low Supply Current in Shutdown Mode $1\mu\text{A}$ (max)
- Guaranteed Push-Pull Driving Data Rate
 - 8Mbps ($+1.2\text{V} \leq V_L \leq +3.6\text{V}$, $V_{CC} \leq +5.5\text{V}$)
 - 16Mbps ($+1.8\text{V} \leq V_L \leq V_{CC} \leq +3.3\text{V}$)
- Extended ESD Protection on the I/O V_{CC} Lines
 - $\pm 15\text{kV}$ Human Body Model
 - $\pm 15\text{kV}$ IEC61000-4-2 Air-Gap Discharge Method
 - $\pm 8\text{kV}$ IEC61000-4-2 Contact Discharge
- Low Supply Current
- Short-Circuit Protection
- Space-Saving μDFN and UTQFN Packages

Pin Configurations



Typical Application Circuits appear at end of data sheet.

Absolute Maximum Ratings

(All voltages referenced to GND.)

| | |
|---|-----------------------------------|
| V _{CC} | -0.3V to +6V |
| V _L | -0.3V to +4V |
| I/O V _{CC} | -0.3V to (V _{CC} + 0.3V) |
| I/O V _L | -0.3V to (V _L + 0.3V) |
| SHDN..... | -0.3V to +6V |
| Short-Circuit Duration I/O V _L , I/O V _{CC} to GND..... | Continuous |
| Power Dissipation (T _A = +70°C) | |
| 6-Pin μDFN (derate 2.1mW/°C above +70°C)..... | 168mW |
| 10-Pin UTQFN (derate 6.9mW/°C above +70°C)..... | 559mW |

| | |
|--|-----------------|
| Junction-to-Ambient Thermal Resistance (θ _{JA}) (Note 1) | |
| 6-Pin μDFN..... | 477°C/W |
| 10-Pin UTQFN..... | 20.1°C/W |
| Junction-to-Ambient Thermal Resistance (θ _{JC}) (Note 1) | |
| 6-Pin μDFN..... | 20.1°C/W |
| 10-Pin UTQFN..... | 143.1°C/W |
| Operating Temperature Range..... | -40°C to +85°C |
| Junction Temperature..... | +150°C |
| Storage Temperature Range..... | -65°C to +150°C |
| Lead Temperature (soldering, 10s)..... | +300°C |

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.

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.

Electrical Characteristics

(V_{CC} = +1.65V to +5.5V, V_L = +1.1V to minimum of either +3.6V or (V_{CC} + 0.3V)), I/O V_L and I/O V_{CC} are unconnected, T_A = -40°C to +85°C, unless otherwise noted. Typical values are V_{CC} = +3.3V, V_L = +1.8V at T_A = +25°C.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|---------------------|------------------------------------|----------------------|------------------------|------|-------|
| POWER SUPPLY | | | | | | |
| V _L Supply Range | V _L | V _{CC} > 3.3V | 1.1 | | 3.6V | V |
| | | V _{CC} ≤ 3.3V | 1.1 | V _{CC} + 0.3V | | |
| V _{CC} Supply Range | V _{CC} | | 1.65 | | 5.5 | V |
| Supply Current from V _{CC} | I _{QVCC} | | | | 10 | μA |
| Supply Current from V _L | I _{QVL} | | | | 15 | μA |
| V _{CC} Shutdown-Mode Supply Current | I _{SD-VCC} | T _A = +25°C, SHDN = GND | | 0.03 | 1 | μA |
| V _L Shutdown-Mode Supply Current | I _{SD-VL} | T _A = +25°C, SHDN = GND | | 0.03 | 1 | μA |
| I/O V _L and I/O V _{CC} Shutdown-Mode Leakage Current | I _{SD-LKG} | T _A = +25°C, SHDN = GND | | 0.02 | 0.5 | μA |
| SHDN Input Leakage | | T _A = +25°C | | 0.02 | 0.1 | μA |
| ESD PROTECTION | | | | | | |
| I/O V _{CC} (Note 4) | | Human Body Model | | ±15V | | kV |
| | | IEC 61000-4-2 Air-Gap Discharge | | ±15V | | |
| | | IEC 61000-4-2 Contact Discharge | | ±8V | | |
| All Other Pins | | Human Body Model | | ±2 | | kV |
| LOGIC-LEVEL THRESHOLDS | | | | | | |
| I/O V _L Input-Voltage High | V _{IHL} | | V _L - 0.2 | | | V |
| I/O V _L Input-Voltage Low | V _{ILL} | | | | 0.15 | V |

Electrical Characteristics (continued)

($V_{CC} = +1.65V$ to $+5.5V$, $V_L = +1.1V$ to minimum of either $+3.6V$ or $(V_{CC} + 0.3V)$), I/O V_L and I/O V_{CC} are unconnected, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are $V_{CC} = +3.3V$, $V_L = +1.8V$ at $T_A = +25^\circ C$.) (Notes 2, 3)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------------------------|--|----------------------------|------|------|-----------|
| I/O V_{CC} Input-Voltage High | V_{IHC} | | $V_{CC} - 0.4$ | | | V |
| I/O V_{CC} Input-Voltage Low | V_{ILC} | | | | 0.15 | V |
| I/O V_L Output-Voltage High | V_{OHL} | I/O V_L source current = $20\mu A$, $V_{I/O V_{CC}} > V_{CC} - 0.4V$ | $0.67 \times V_L$ | | | V |
| I/O V_L Output-Voltage Low | V_{OLL} | I/O V_L sink current = $1mA$, $V_{I/O V_{CC}} < 0.15V$ | | | 0.4 | V |
| I/O V_{CC} Output-Voltage High | V_{OHC} | I/O V_{CC} source current = $20\mu A$, $V_{I/O V_L} > V_L - 0.2V$ | $0.67 \times V_{CC}$ | | | V |
| I/O V_{CC} Output-Voltage Low | V_{OLC} | I/O V_{CC} sink current = $1mA$, $V_{I/O V_L} < 0.15V$ | | | 0.4 | V |
| \overline{SHDN} Input-Voltage High | $V_{IH-\overline{SHDN}}$ | $V_L > 1.2$ $1.1 \leq V_L < 1.2$ | $V_L - 0.2$ $V_L - 0.1$ | | | V |
| \overline{SHDN} Input-Voltage Low | $V_{IL-\overline{SHDN}}$ | | | | 0.15 | V |
| I/O V_L -to-I/O V_{CC} Resistance | | | | 80 | 250 | Ω |
| V_{CC} Shutdown Threshold Low | $V_{TH_L_V_{CC}}$ | V_{CC} falling, $V_L = +3.3V$ | 0.5 | 0.8 | 1.1 | V |
| V_{CC} Shutdown Threshold High | $V_{TH_H_V_{CC}}$ | V_{CC} rising, $V_L = +3.3V$ | 0.3 | 0.6 | 0.9 | V |
| V_L Shutdown Threshold | $V_{TH_V_L}$ | | 0.35 | 0.75 | 1.06 | V |
| Pullup Resistance | | $V_{CC} = V_L = +3.3V$ | 6 | 10 | 15.5 | $k\Omega$ |
| RISE/FALL-TIME ACCELERATOR STAGE | | | | | | |
| Accelerator Pulse Duration | | | | 20 | | ns |
| I/O V_L Output-Accelerator Source Impedance | | $V_L = 1.7V$ | | 13 | | Ω |
| I/O V_{CC} Output-Accelerator Source Impedance | | $V_{CC} = 2.2V$ | | 17 | | Ω |
| I/O V_L Output-Accelerator Source Impedance | | $V_L = 3.2V$ | | 6 | | Ω |
| I/O V_{CC} Output-Accelerator Source Impedance | | $V_{CC} = 3.6V$ | | 10 | | Ω |

Timing Characteristics For $+1.2V \leq V_L \leq$ Minimum Of Either $+3.6V$ OR $(V_{CC} + 0.3V)$

($V_{CC} \leq \pm 5.5V$, $+1.2V \leq V_L \leq$ minimum of either $+3.6V$ or $(V_{CC} + 0.3V)$), $R_S = 50\Omega$, $R_L = 1M\Omega$, $C_L = 15pF$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are $V_{CC} = +3.3V$, $V_L = +1.8V$ at $T_A = +25^\circ C$.) (Notes 2, 3, 5)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|-------------------------|-----------------|--------------------------------|--------------------|-----|-----|------|-------|
| I/O V_{CC} Rise Time | t_{RVCC} | Push-pull driving, Figure 1a | | | 7 | 25 | ns |
| | | Open-drain driving, Figure 1c | | | 170 | 400 | |
| I/O V_{CC} Fall Time | t_{FVCC} | Push-pull driving, Figure 1a | | | 6 | 37 | ns |
| | | Open-drain driving, Figure 1c | | | 20 | 50 | |
| I/O V_L Rise Time | t_{RVL} | Push-pull driving, Figure 1b | | | 8 | 30 | ns |
| | | Open-drain driving, Figure 1d | | | 180 | 400 | |
| I/O V_L Fall Time | t_{FVL} | Push-pull driving, Figure 1 | | | 3 | 56 | ns |
| | | Open-drain driving, Figure 1d | | | 30 | 60 | |
| Propagation Delay | $t_{PD-VL-VCC}$ | Driving I/O V_L | Push-pull driving | | 5 | 30 | ns |
| | | | Open-drain driving | | 210 | 1000 | |
| | $t_{PD-VCC-VL}$ | Driving I/O V_{CC} | Push-pull driving | | 4 | 30 | |
| | | | Open-drain driving | | 190 | 1000 | |
| Channel-to-Channel Skew | t_{SKEW} | Each translator equally loaded | Push-pull driving | | | 20 | ns |
| | | | Open-drain driving | | | 50 | |
| Maximum Data Rate | | Push-pull driving | | 8 | | | Mbps |
| | | Open-drain driving | | 500 | | | kbps |

Timing Characteristics For $+1.1V \leq V_L \leq +1.2V$

($V_{CC} \leq \pm 5.5V$, $+1.1V \leq V_L \leq +1.2V$, $R_S = 50\Omega$, $R_L = 1M\Omega$, $C_L = 15pF$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are $V_{CC} = +3.3V$, $V_L = +1.8V$ at $T_A = +25^\circ C$.) (Notes 2, 3, 5)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|-------------------------|-----------------|--------------------------------|--------------------|-----|-----|------|-------|
| I/O V_{CC} Rise Time | t_{RVCC} | Push-pull driving, Figure 1a | | | 7 | 200 | ns |
| | | Open-drain driving, Figure 1c | | | 170 | 400 | |
| I/O V_{CC} Fall Time | t_{FVCC} | Push-pull driving, Figure 1a | | | 6 | 37 | ns |
| | | Open-drain driving, Figure 1c | | | 20 | 50 | |
| I/O V_L Rise Time | t_{RVL} | Push-pull driving, Figure 1b | | | 8 | 30 | ns |
| | | Open-drain driving, Figure 1d | | | 180 | 400 | |
| I/O V_L Fall Time | t_{FVL} | Push-pull driving, Figure 1 | | | 3 | 30 | ns |
| | | Open-drain driving, Figure 1d | | | 30 | 60 | |
| Propagation Delay | $t_{PD-VL-VCC}$ | Driving I/O V_L | Push-pull driving | | 5 | 200 | ns |
| | | | Open-drain driving | | 210 | 1000 | |
| | $t_{PD-VCC-VL}$ | Driving I/O V_{CC} | Push-pull driving | | 4 | 200 | |
| | | | Open-drain driving | | 190 | 1000 | |
| Channel-to-Channel Skew | t_{SKEW} | Each translator equally loaded | Push-pull driving | | | 20 | ns |
| | | | Open-drain driving | | | 50 | |
| Maximum Data Rate | | Push-pull driving | | 1.2 | | | Mbps |
| | | Open-drain driving | | 500 | | | kbps |

Timing Characteristics For $+1.8V \leq V_L \leq V_{CC} \leq +3.3V$

($+1.8V \leq V_L \leq V_{CC} \leq +3.3V$, $R_S = 50\Omega$, $R_L = 1M\Omega$, $C_L = 15pF$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are $V_{CC} = +3.3V$, $V_L = +1.8V$ at $T_A = +25^\circ C$.) (Notes 2, 3, 5)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------|-----------------|---|-----|-----|-----|-------|
| I/O V_{CC} Rise Time | t_{RVCC} | Push-pull driving, Figure 1a | | | 15 | ns |
| I/O V_{CC} Fall Time | t_{FVCC} | Push-pull driving, Figure 1a | | | 15 | ns |
| I/O V_L Rise Time | t_{RVL} | Push-pull driving, Figure 1b | | | 15 | ns |
| I/O V_L Fall Time | t_{FVL} | Push-pull driving, Figure 1b | | | 15 | ns |
| Propagation Delay | $t_{PD-VL-VCC}$ | Push-pull driving, driving I/O V_L | | | 15 | ns |
| | $t_{PD-VCC-VL}$ | Push-pull driving, driving I/O V_{CC} | | | 15 | |
| Channel-to-Channel Skew | t_{SKEW} | Push-pull driving, each translator equally loaded | | | 10 | ns |
| Maximum Data Rate | | Push-pull driving | 16 | | | Mbps |

Note 2: All units are 100% production tested at $T_A = +25^\circ C$. Limits over the operating temperature range are guaranteed by design and not production tested.

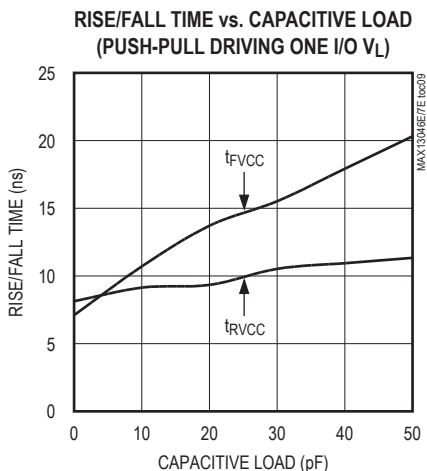
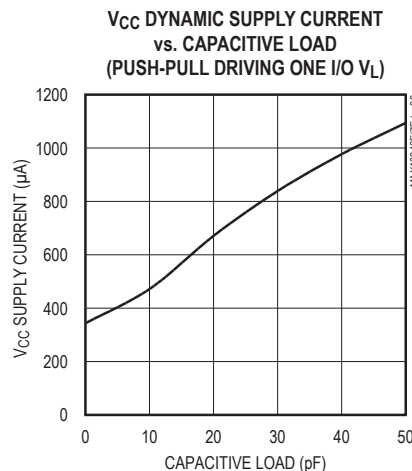
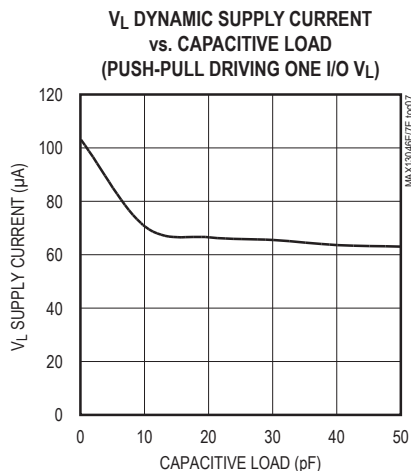
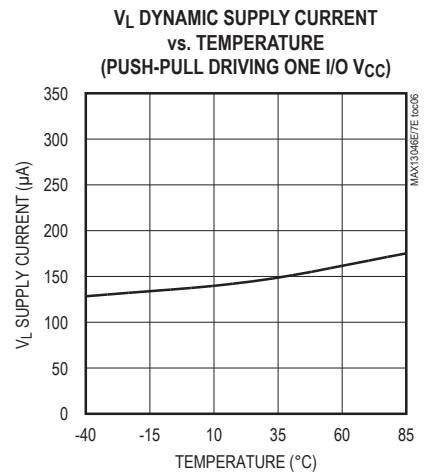
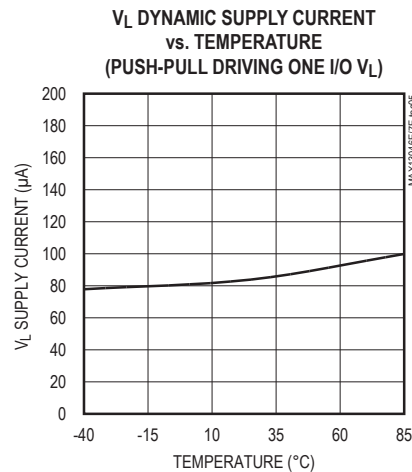
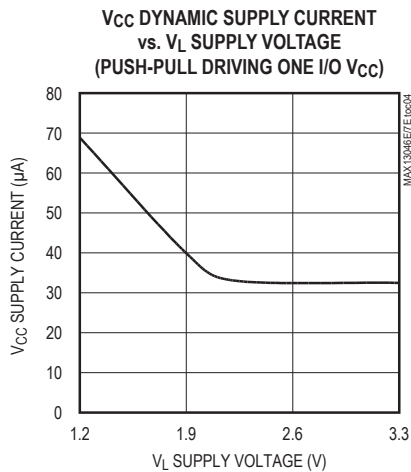
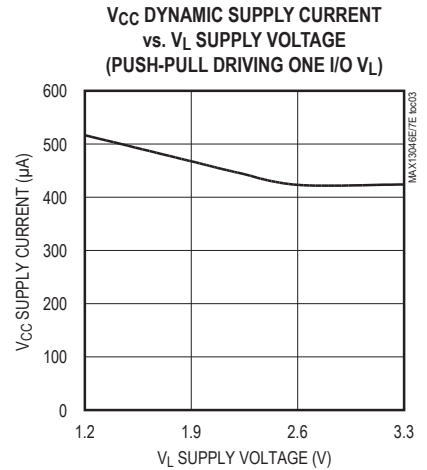
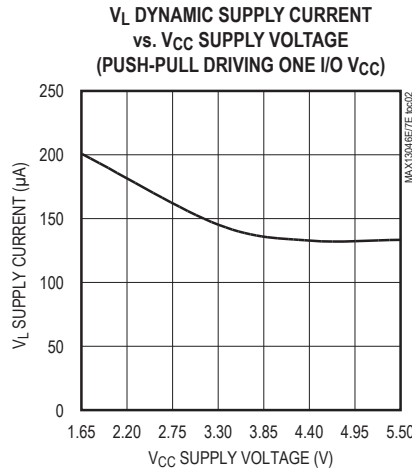
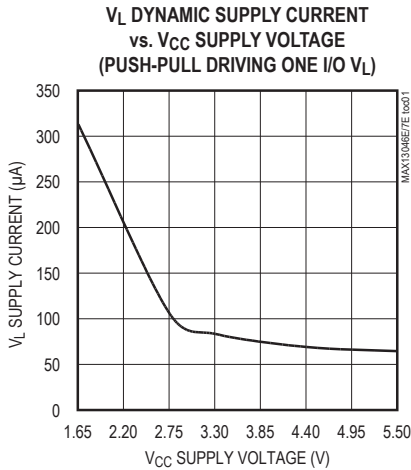
Note 3: For normal operation, ensure $V_L < (V_{CC} + 0.3V)$. During power-up, $V_L > (V_{CC} + 0.3V)$ does not damage the device.

Note 4: ESD protection is guaranteed by design. To ensure maximum ESD protection, place a $1\mu F$ ceramic capacitor between V_{CC} and GND. See *Typical Application Circuits*.

Note 5: Timing is measured using 10% of input to 90% of output.

Typical Operating Characteristics

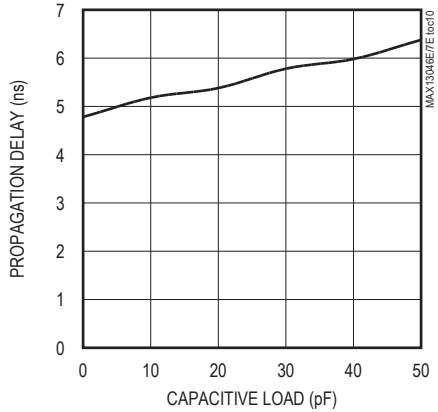
($V_{CC} = +3.3V$, $V_L = +1.8V$, $R_L = 1M\Omega$, $C_L = 15pF$, push-pull driving data rate = 8Mbps, $T_A = +25^\circ C$, unless otherwise noted.)



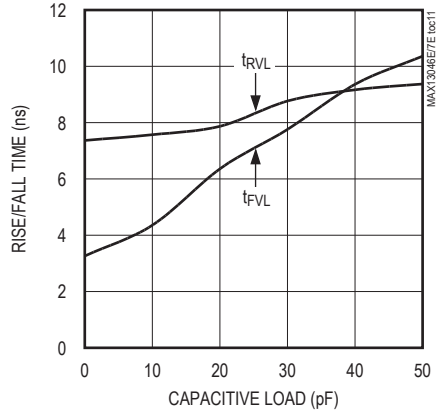
Typical Operating Characteristics (continued)

($V_{CC} = +3.3V$, $V_L = +1.8V$, $R_L = 1M\Omega$, $C_L = 15pF$, push-pull driving data rate = 8Mbps, $T_A = +25^\circ C$, unless otherwise noted.)

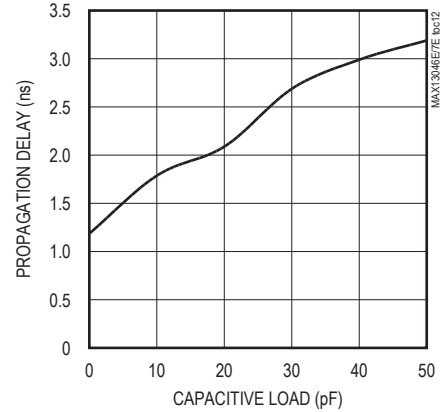
PROPAGATION DELAY vs. CAPACITIVE LOAD (PUSH-PULL DRIVING ONE I/O V_L)



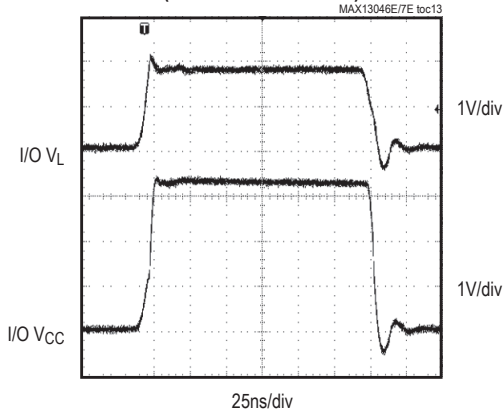
RISE/FALL TIME vs. CAPACITIVE LOAD (PUSH-PULL DRIVING ONE I/O V_{CC})



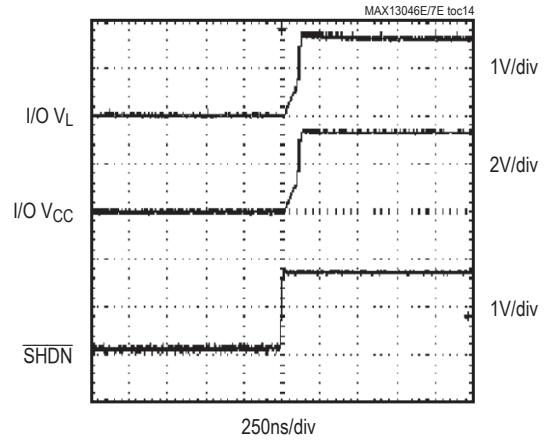
PROPAGATION DELAY vs. CAPACITIVE LOAD (PUSH-PULL DRIVING ONE I/O V_{CC})



RAIL-TO-RAIL DRIVING (DRIVING ONE I/O V_L)



EXISTING SHUTDOWN MODE



MAX13046E Pin Description

| MAX13046E | | FUNCTION |
|-----------|--------------------------|--|
| μ DFN | NAME | |
| 1 | V_L | V_L Input Supply Voltage. Bypass V_L with a 0.1 μ F ceramic capacitor located as close as possible to the input. |
| 2 | GND | Ground |
| 3 | I/O V_L | Input/Output. Referenced to V_L . |
| 4 | I/O V_{CC} | Input/Output. Referenced to V_{CC} . |
| 5 | $\overline{\text{SHDN}}$ | Shutdown Input. Drive $\overline{\text{SHDN}}$ high to enable the device. Drive $\overline{\text{SHDN}}$ low to put the device in shutdown mode. |
| 6 | V_{CC} | V_{CC} Input Supply Voltage. Bypass V_{CC} with a 1 μ F ceramic capacitor located as close as possible to the input for full ESD protection. If full ESD protection is not required, bypass V_{CC} with a 0.1 μ F ceramic capacitor. |

MAX13047E Pin Description

| MAX13047E | | FUNCTION |
|-----------|--------------------------|--|
| UTQFN | NAME | |
| 1 | I/O V_{L2} | Input/Output 2. Referenced to V_L . |
| 2 | V_L | V_L Input Supply Voltage. Bypass V_L with a 0.1 μ F ceramic capacitor located as close as possible to the input. |
| 3, 7 | N.C. | Not Connected. Internally not connected. |
| 4 | $\overline{\text{SHDN}}$ | Enable Input. Drive $\overline{\text{SHDN}}$ high to enable the device. Drive $\overline{\text{SHDN}}$ low to put the device in shutdown mode. |
| 5 | I/O V_{CC2} | Input/Output 2. Referenced to V_{CC} . |
| 6 | V_{CC} | V_{CC} Input Supply Voltage. Bypass V_{CC} with a 1 μ F ceramic capacitor located as close as possible to the input for full ESD protection. If full ESD protection is not required, bypass V_{CC} with a 0.1 μ F ceramic capacitor. |
| 8 | I/O V_{CC1} | Input/Output 1. Referenced to V_{CC} . |
| 9 | GND | Ground |
| 10 | I/O V_{L1} | Input/Output 1. Referenced to V_L . |

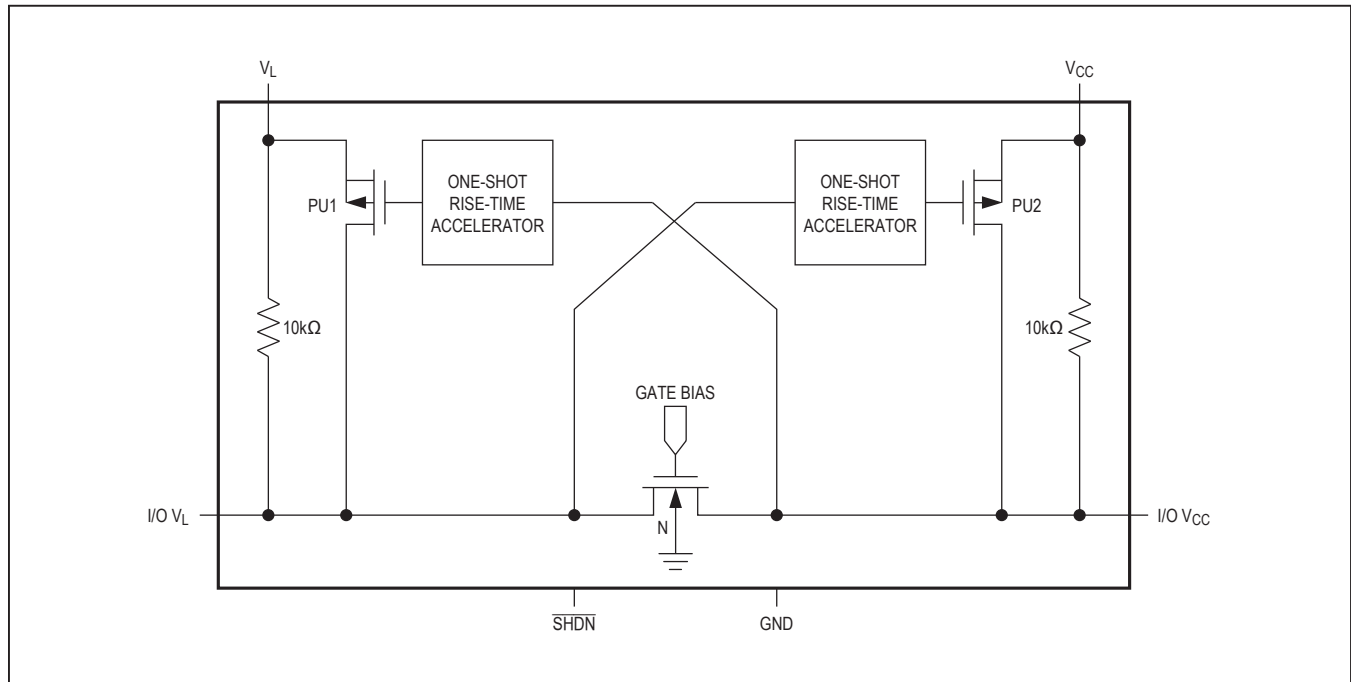
Detailed Description

The MAX13046E/MAX13047E ± 15 kV ESD-protected bidirectional level translators provide level shifting for data transfer in a multivoltage system. The MAX13046E is a single-channel translator and the MAX13047E is a dual-channel translator. Externally applied voltages, V_{CC} and V_L , set the logic level on either side of the device. The MAX13046E/MAX13047E utilize a transmission-gate-based design to allow data translation in either direction ($V_L \leftrightarrow V_{CC}$) on any single data line. The MAX13046E/MAX13047E accept V_L from +1.1V to the minimum of either +3.6V or ($V_{CC} + 0.3$ V) and V_{CC} from +1.65V

to +5.5V, making these devices ideal for data transfer between low-voltage ASICs/PLDs and higher voltage systems.

The MAX13046E/MAX13047E feature a shutdown mode that reduces supply current to less than 1 μ A thermal short-circuit protection, and ± 15 kV ESD protection on the V_{CC} side for enhanced protection in applications that route signals externally. The MAX13046E/MAX13047E operate at a guaranteed data rate of 8Mbps when push-pull driving is used. See the *Functional Diagram*.

Functional Diagram



Level Translation

For proper operation, ensure that $+1.65V \leq V_{CC} \leq +5.5V$ and $+1.1V \leq V_L \leq$ the minimum of either $+3.6V$ or $(V_{CC} + 0.3V)$. During power-up sequencing, $V_L \geq (V_{CC} + 0.3V)$ does not damage the device. The speed of the rise time accelerator circuitry limits the maximum data rate for the MAX13046E/MAX13047E to 16Mbps.

Rise-Time Accelerators

The MAX13046E/MAX13047E have an internal rise-time accelerator, allowing operation up to 16Mbps. The rise-time accelerators are present on both sides of the device and act to speed up the rise time of the input and output of the device, regardless of the direction of the data. The triggering mechanism for these accelerators is both level and edge sensitive. To guarantee operation of the rise time accelerators the maximum parasitic capacitance should be less than 200pF on the I/O lines.

Shutdown Mode

Drive \overline{SHDN} low to place the MAX13046E/MAX13047E in shutdown mode and drive \overline{SHDN} high for normal operation. Activating the shutdown mode disconnects the internal 10kΩ pullup resistors on the I/O V_{CC} and I/O V_L lines. This forces the I/O lines to a high-impedance state, and

decreases the supply current to less than 1μA. The high-impedance I/O lines in shutdown mode allow for use in a multidrop network. The MAX13046E/MAX13047E have a diode from each I/O to the corresponding supply rail and GND. Therefore, when in shutdown mode, do not allow the voltage at I/O V_L to exceed $(V_L + 0.3V)$, or the voltage at I/O V_{CC} to exceed $(V_{CC} + 0.3V)$.

Operation with One Supply Disconnected

Certain applications require sections of circuitry to be disconnected to save power. When V_L is connected and V_{CC} is disconnected or connected to ground, the device enters shutdown mode. In this mode, I/O V_L can still be driven without damage to the device; however, data does not translate from I/O V_L to I/O V_{CC} . If V_{CC} falls more than $V_{TH_L_V_{CC}}$ below V_L , the device disconnects the pullup resistors at I/O V_L and I/O V_{CC} . To achieve the lowest possible supply current from V_L when V_{CC} is disconnected, it is recommended that the voltage at the V_{CC} supply input be approximately equal to GND.

When V_{CC} is connected and V_L is less than $V_{TH_V_L}$, the device enters shutdown mode. In this mode, I/O V_{CC} can still be driven without damage to the device; however, data does not translate from I/O V_{CC} to I/O V_L .

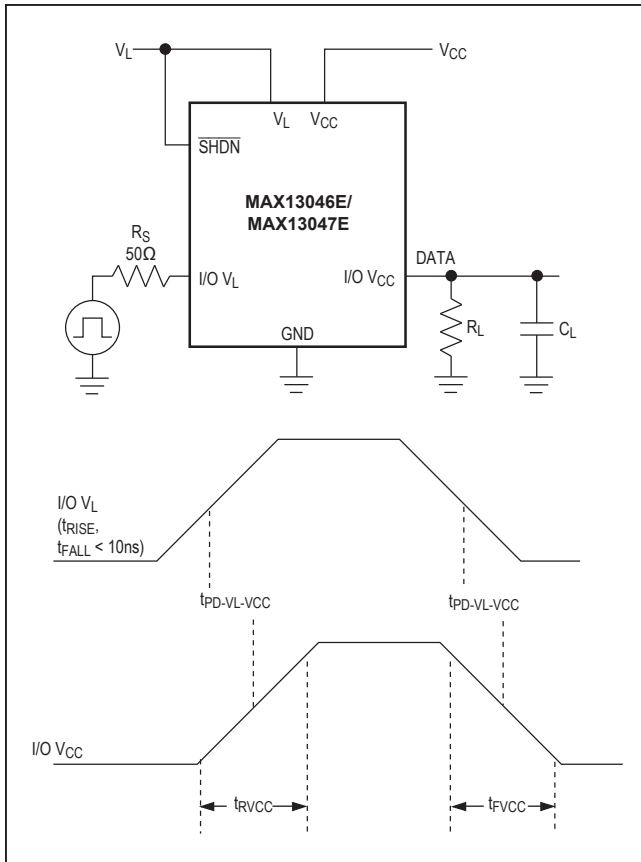


Figure 1a. Rail-to-Rail Driving I/O V_L

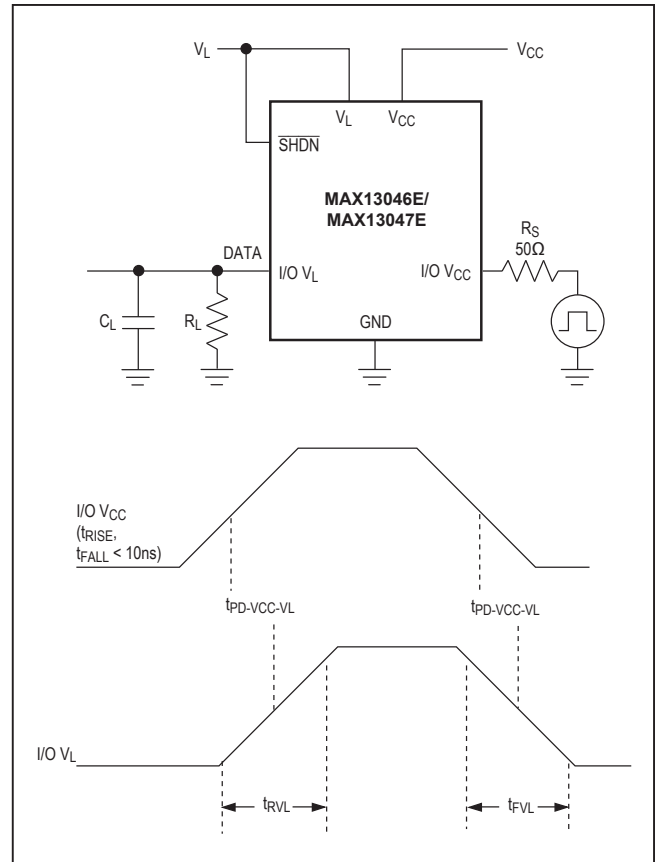


Figure 1b. Rail-to-Rail Driving I/O V_{CC}

When V_{CC} is disconnected or connected to ground, I/O V_{CC} must not be driven more than $V_{CC} + 0.3V$. When V_L is disconnected or connected to ground, I/O V_L must not be driven more than $V_L + 0.3V$.

Short-Circuit Protection

Thermal-overload detection protects the MAX13046E/MAX13047E from short-circuit fault conditions. In the event of a short-circuit fault, when the junction temperature (T_J) exceeds $+150^\circ C$, the device enters shutdown mode. When the device has cooled to below $+140^\circ C$, normal operation resumes.

$\pm 15kV$ ESD Protection

ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The ESD structures withstand electrostatic discharge in all states: normal

operation, shutdown mode, and powered down. The I/O V_{CC} lines of the MAX13046E/MAX13047E are characterized for protection to the following limit:

- $\pm 15kV$ using the Human Body Model

ESD Test Conditions

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

Human Body Model

Figure 2a shows the Human Body Model, and Figure 2b shows the current waveform it generates when discharged into a low-impedance state. This model consists of a $100pF$ capacitor charged to the ESD voltage of interest that is then discharged into the test device through a $1.5k\Omega$ resistor.

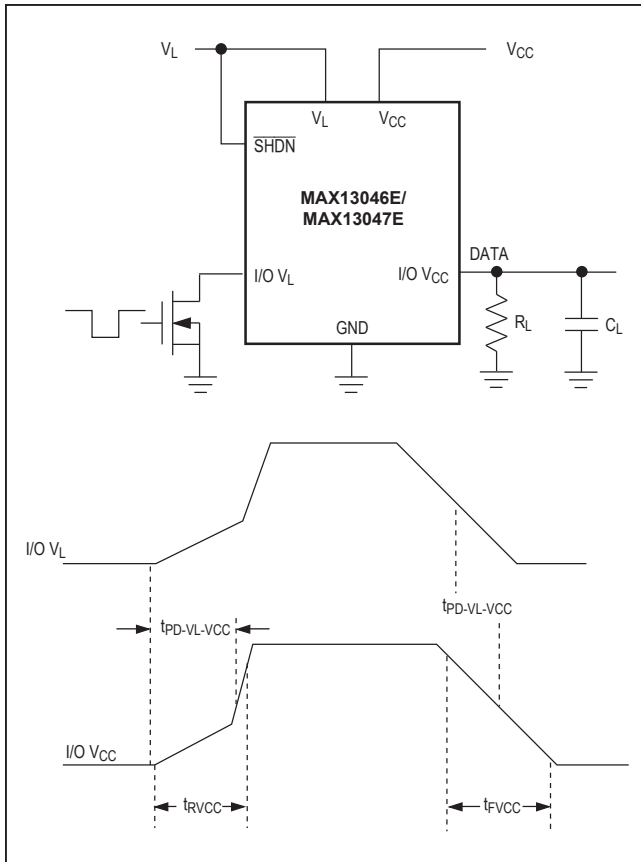


Figure 1c. Open-Drain Driving I/O V_L

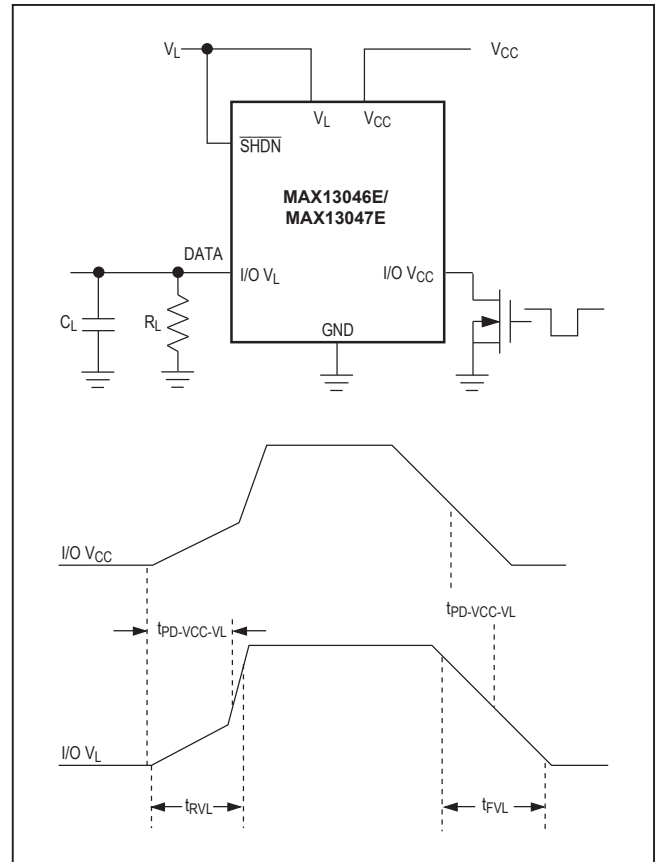


Figure 1d. Open-Drain Driving I/O V_{CC}

IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment; it does not specifically refer to integrated circuits. The MAX13046E/MAX13047E help to design equipment that meets Level 4 of IEC 61000-4-2 without the need for additional ESD-protection components. The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 can be lower than that measured using the Human Body Model. Figure 3a shows the IEC 61000-4-2 model, and Figure 3b shows the current waveform for the ±8kV, IEC 61000-4-2, Level 4, ESD contact-discharge test. The Air-Gap test involves approaching the device with a charged probe. The contact-discharge method connects the probe to the device before the probe is energized.

Applications Information

Power-Supply Decoupling

To reduce ripple and the chance of transmitting incorrect data, bypass V_L and V_{CC} to ground with a 0.1µF ceramic capacitor. To ensure full ±15kV ESD protection, bypass V_{CC} to ground with a 1µF ceramic capacitor. Place all capacitors as close as possible to the power-supply inputs.

I²C Level Translation

The MAX13046E/MAX13047E level shifts the data present on the I/O lines between +1.1V and +5.5V, making them ideal for level translation between a low-voltage ASIC and an I²C device. A typical application involves interfacing a low-voltage microprocessor to a +3V or +5V D/A converter, such as the MAX517.

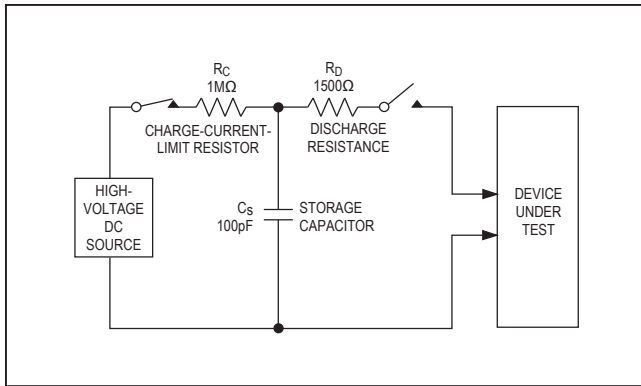


Figure 2a. Human Body ESD Test Model

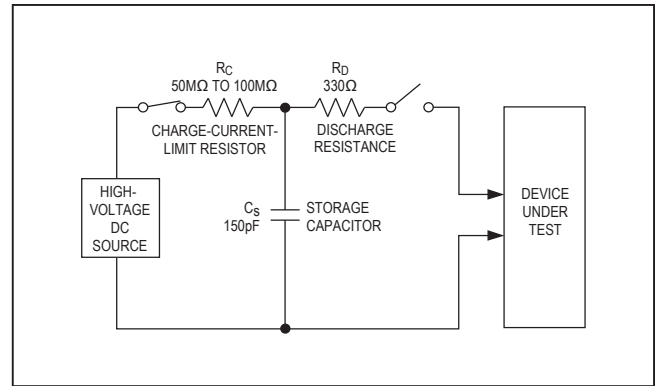


Figure 3a. IEC 61000-4-2 ESD Test Model

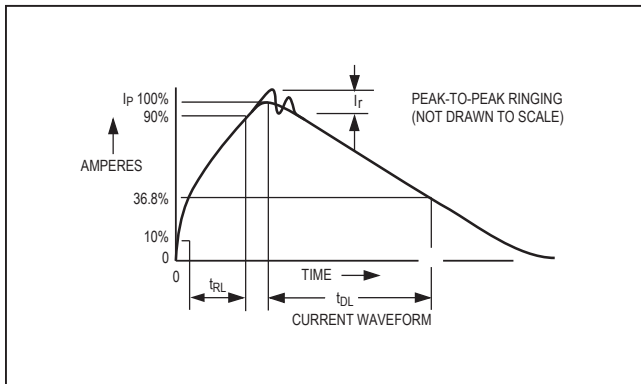


Figure 2b. Human Body Current Waveform

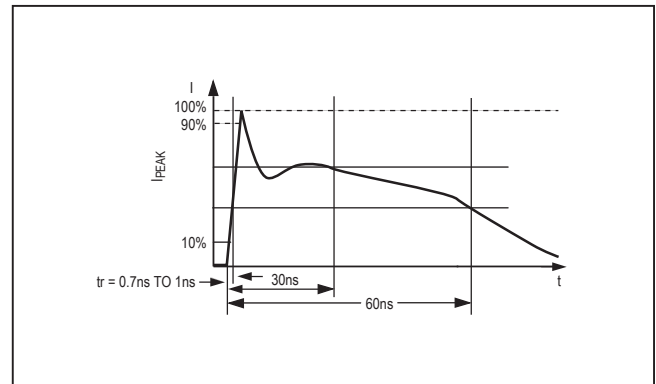


Figure 3b. IEC 61000-4-2 ESD Generator Current Waveform

1-Wire Interface Translation

The MAX13046E/MAX13047E are ideal for level translation between a low-voltage ASIC and 1-Wire device. A typical application involves interfacing a low-voltage microprocessor to an external memory, such as the DS2502. The maximum data rate depends on the 1-Wire device. For the DS2502, the maximum data rate is 16.3kbps. A 5kΩ pullup resistor is recommended when interfacing with the DS2502.

Push-Pull vs. Open-Drain Driving

The MAX13046E/MAX13047E can be driven in a pushpull or open-drain configurations. For open-drain configuration, internal 10kΩ resistors pull up I/O V_L and I/O V_{CC} to their respective power supplies. See the *Timing Characteristics* table for maximum data rates when using open-drain drivers.

PCB Layout

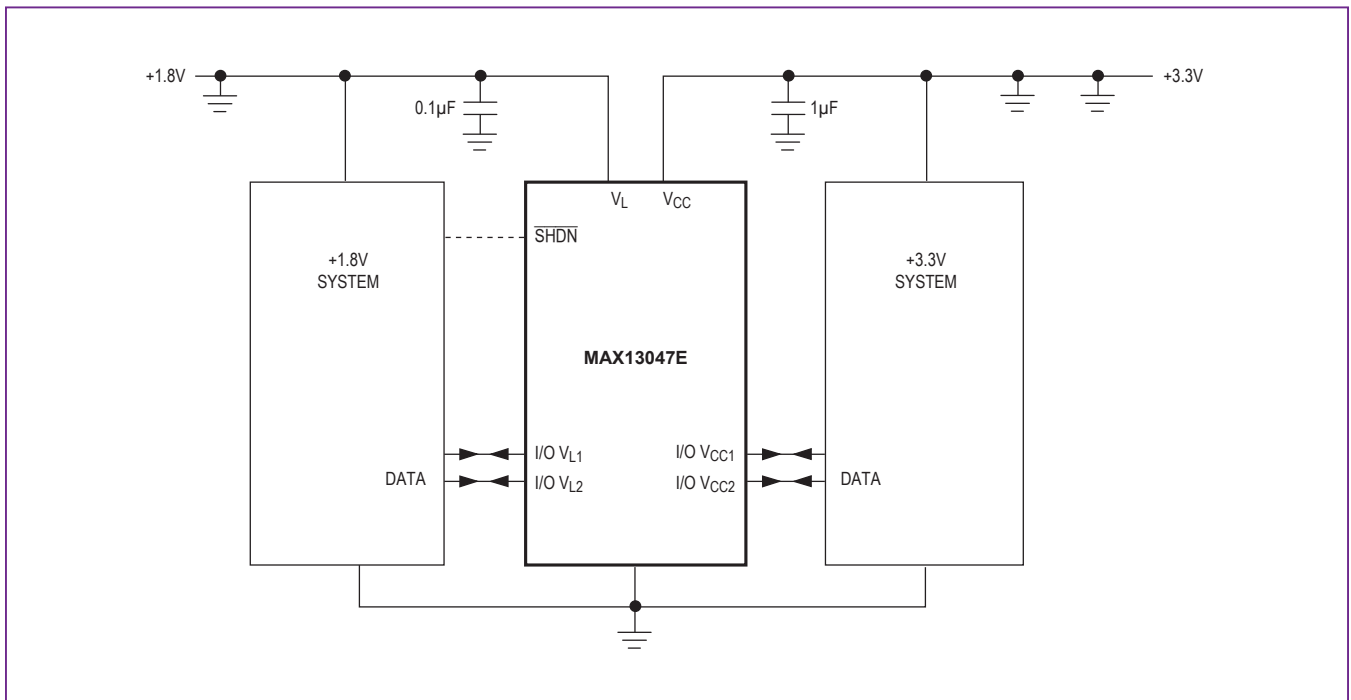
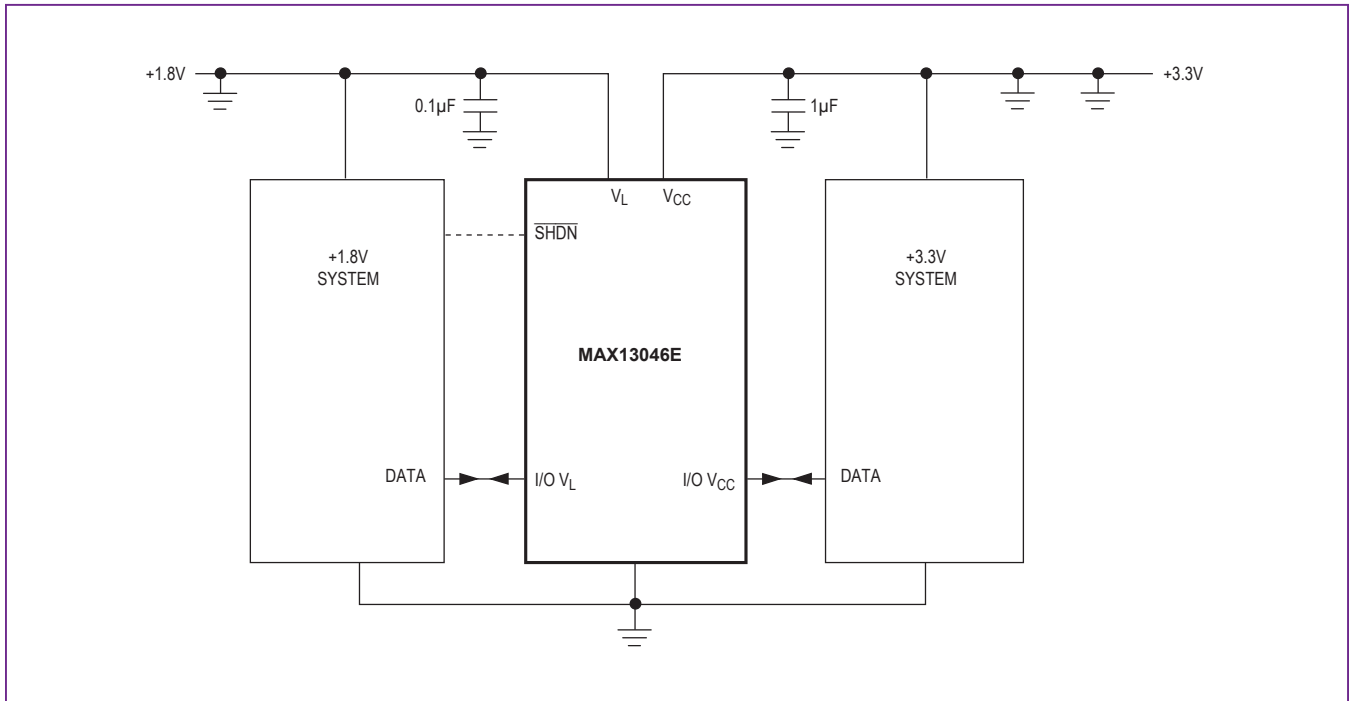
The MAX13046E/MAX13047E require good PCB layout for proper operation and optimal rise/fall time performance. Ensure proper high-frequency PCB layout even when operating at low data rates.

Driving High-Capacitive Load

Capacitive loading on the I/O lines impacts the rise time (and fall time) of the MAX13046E/MAX13047E when driving the signal lines. The actual rise time is a function of the load capacitance, parasitic capacitance, the supply voltage, and the drive impedance of the MAX13046E/MAX13047E.

Operating the MAX13046E/MAX13047E at a low data rate does **NOT** increase capacitive load driving capability.

Typical Application Circuits



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 | DOCUMENT NO |
|--------------|--------------|-------------------------|
| 6 μ DFN | L611-1 | 21-0147 |
| 10 UTQFN | V101A1CN-1 | 21-0028 |

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|--|---------------|
| 0 | 5/08 | Initial release | — |
| 1 | 8/08 | Removing future product asterisks from MAX13047, changing <i>Electrical Characteristics</i> Table, packaging changes, changing ESD information | 1–4, 6, 10 |
| 2 | 10/19 | Updated <i>MAX13047E Pin Description</i> table | 8 |
| 3 | 7/21 | Updated <i>Pin Configurations</i> . | 1 |

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at <https://www.maximintegrated.com/en/storefront/storefront.html>.

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