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## REFERENCE SCHEMATIC 4477

# Reference Design of a 1-Wire® Bidirectional Voltage-Level Translator for 1.8V to 5V

By: Stewart Merkel, Senior Member Technical Staff

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*Abstract: Designers need open-drain logic to run at 1.8V at the 1-Wire master IO. Most 1-Wire slave devices cannot run at 1.8V. This application note presents an RD (reference design) of a circuit that translates from a 1.8V 1-Wire master to a 5V 1-Wire slave device. The RD is used for driving typical 1-Wire slave devices. The MAX3394E voltage-level translator is featured in the design.*

## Introduction

Devices such as FPGAs, microprocessors, the [DS2482-100](#), and [DS2480B](#) are examples of 1-Wire master devices. The 1-Wire/iButton® slave devices are manufactured by Maxim and comprise an extensive family of parts that typically operate from 2.8V to 5.25V. The 1-Wire masters and slave devices have traditionally been 5V open-drain logic in the past.

Today designers need open-drain logic to run at 1.8V at the 1-Wire master IO. While most 1-Wire slave devices can run safely at 5V, most of those same devices cannot run at 1.8V. A bidirectional voltage-level translator circuit is needed to overcome this limitation. This RD (reference design) features the Maxim® [MAX3394E](#), which is a bidirectional voltage-level translator for these applications.

## Voltage-Level Translator

The MAX3394E is a dual-level translator available in an 8-pin, 3mm x 3mm TDFN package. It is ideal for driving high-capacitive loads, thanks to its internal slew-rate enhancement circuitry. 1-Wire slave devices often have capacitive loading greater than 500pF. The MAX3394E's  $V_{CC}$  I/O pins are protected to  $\pm 15\text{kV}$  HBM (Human Body Model), which protects the 1-Wire master. The 1-Wire bus architectures often interface to the external world, making HBM essential. However, it is recommended that a [DS9503P](#) be added as ESD protection for the pullup resistor (R3), the optional strong pullup circuitry, and the 1-Wire slave device.

## Application Circuit

The circuit in **Figure 1** shows the MAX3394E used to perform bidirectional 1.8V to 5V voltage-level translation in an open-drain system.

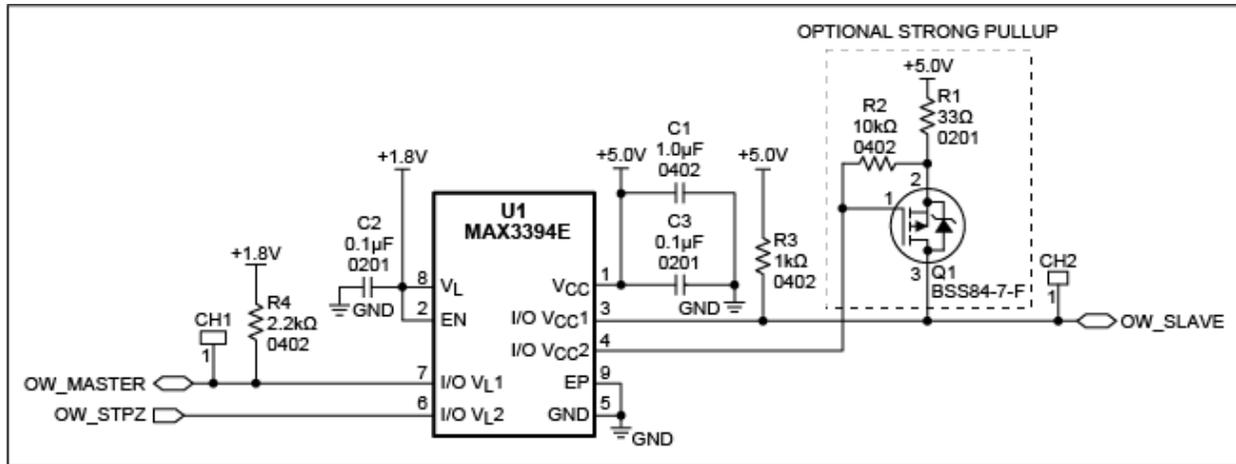


Figure 1. Schematic of 1-Wire bidirectional voltage level translation from 1.8V to 5V. Note that the pins I/O  $V_L$  and I/O  $V_{CC}$  have a typical 10k $\Omega$  internal pullup.

The BOM (bill of materials) for this reference design is given in **Table 1**.

Table 1. Bill of Materials					
Item	Quantity	Reference	Part	Manufacturer	Part Number
1	1	C1	1.0 $\mu$ F 0402	Panasonic	ECJ-0EB0J105M
2	2	C2, C3	0.1 $\mu$ F 0201	Panasonic	ECJ-ZEB0J104K
3	1	Q1	BSS84-7-F	Diodes, Inc/Zetex	BSS84-7-F
4	1	R1	33 $\Omega$ 0201	Panasonic	ERJ-1GEJ330C
5	1	R2	10k $\Omega$ 0402	Panasonic	ERJ-2RKF1002X
6	1	R3	1k $\Omega$ 0402	Panasonic	ERJ-2RKF1001X
7	1	R4	2.2k $\Omega$ 0402	Panasonic	ERJ-2RKF2201X
8	2	CH1, CH2	TEST POINT	N/A	N/A
9	1	U1	MAX3394E	Maxim	MAX3394EETA+

## Waveform Measurements/Test Results

The test results in **Figures 2** through **5** were generated from the board built for evaluating the circuit.

Setup:

- $V_L = 1.8V$
- $V_{CC} = 5.0V$
- CH1: 1-Wire master (OW\_MASTER)
- CH2: DS1920 (OW\_SLAVE)
- OW\_SLAVE wire length: 2.4m, max.
- Test results did not include the optional strong pullup circuitry in Figure 1.
- Room temperature measurements only

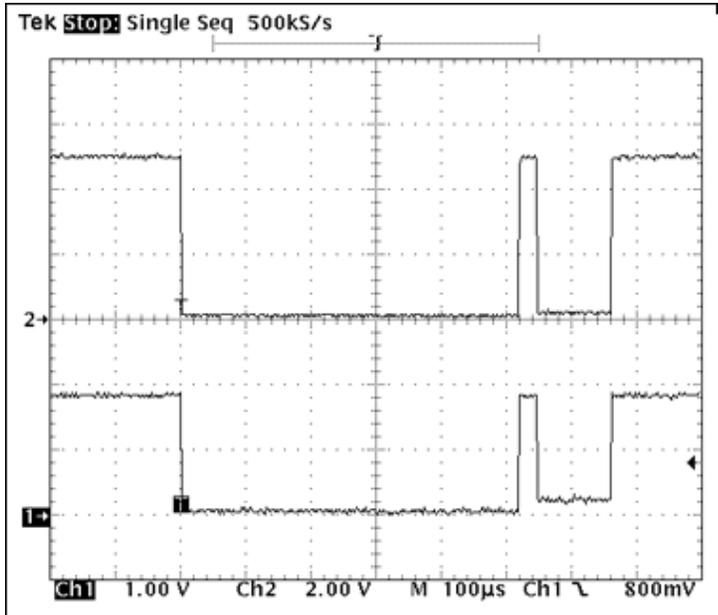


Figure 2. The scope plot of a 1-Wire Reset shows the performance of the MAX3394E with presence pulse amplitude of no more than 250mV, lower than a typical 1-Wire master  $V_{IL}$  maximum of 0.4V.

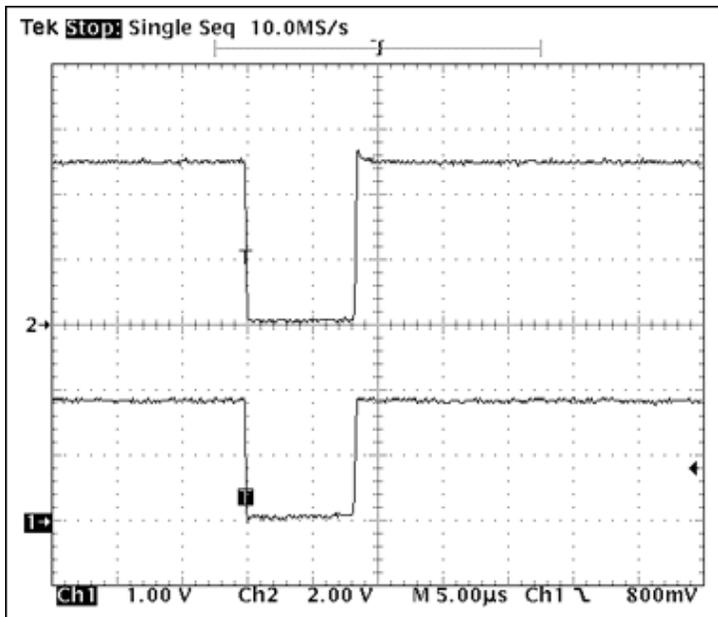


Figure 3. The scope plot of a 1-Wire Write, one timeslot with a clean  $t_{LOW1} < 15\mu s$ .

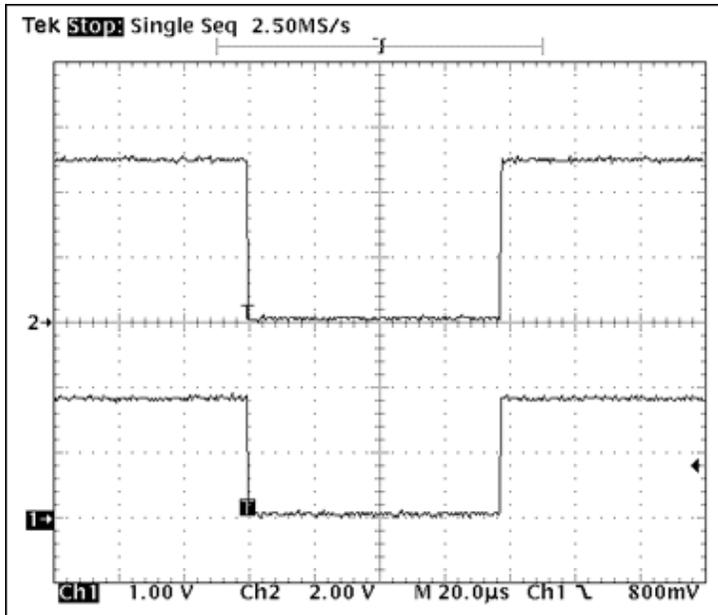


Figure 4. The scope plot of a 1-Wire Write, zero timeslot with  $60\mu\text{s} < t_{LOW0} < 120\mu\text{s}$ .

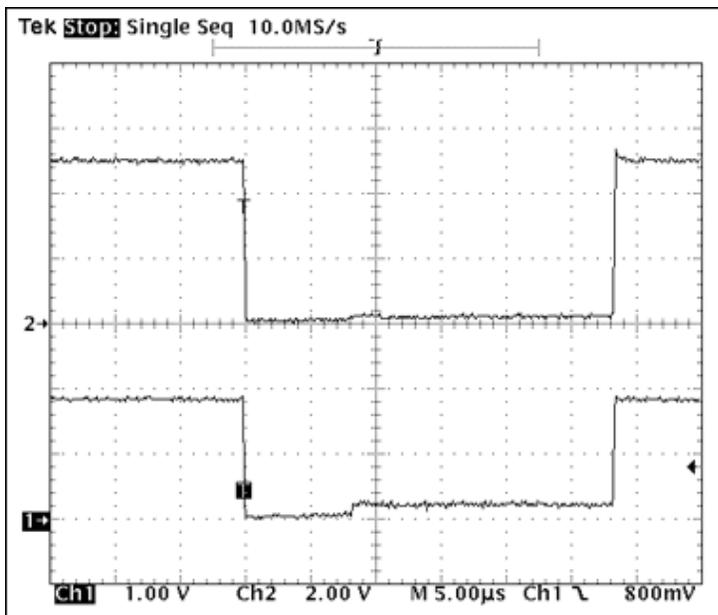


Figure 5. The scope plot of a 1-Wire Read, zero timeslot with an active 1-Wire slave open-drain return and lower than a typical 1-Wire master  $V_{IL}$  maximum of 0.4V.

## Conclusion

This RD for 1.8V to 5V 1-Wire bidirectional logic-level translation drives typical 1-Wire slave devices. The design was built and then tested. The circuit schematic, BOM, and typical waveforms have been presented.

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<a href="#">DS1822</a>	Econo 1-Wire Digital Thermometer	<a href="#">Free Samples</a>
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<a href="#">DS18B20-PAR</a>	1-Wire Parasite-Power Digital Thermometer	
<a href="#">DS18S20</a>	1-Wire Parasite-Power Digital Thermometer	<a href="#">Free Samples</a>
<a href="#">DS18S20-PAR</a>	Parasite-Power Digital Thermometer	
<a href="#">DS1920</a>	iButton Temperature Logger	
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<a href="#">MAX31826</a>	1-Wire Digital Temperature Sensor with 1Kb Lockable EEPROM	<a href="#">Free Samples</a>
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<a href="#">MAX3394E</a>	±15kV ESD-Protected, High-Drive Current, Dual-/Quad-/Octal-Level Translators with Speed-Up Circuitry	<a href="#">Free Samples</a>
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