Application Note

TPS22995H-Q1 Humidity Performance

TEXAS INSTRUMENTS

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ABSTRACT

Many automotive applications exist in humid environments where conformal coating is necessary to prevent potential shorts between pins of ICs on the electrical control unit. These conformal coatings are expensive, increase manufacturing time, and make trouble shooting afterward very difficult. With more humidity resistant devices this conformal coating material does not have to be as extensive which can reduce prices and manufacturing time. The worst case resistive short due to humidity is expected to be 100 kΩ and the device needs to be tested adjacent pins-to-pins and each pin-to-ground showing the device still functions.

Table of Contents

List of Figures

List of Tables

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1 Test setup

While it would be quick to set up a humidity chamber and test our device in the humidity chamber, the results might not be easily reproducible. We determined that developing a board with configurable 100 kΩ (expected worst-case condition) shorts between each adjacent pin to pin, and pin to GND can be reproducible and show that TPS22995H-Q1 can still function within expectations.

1.1 Schematic

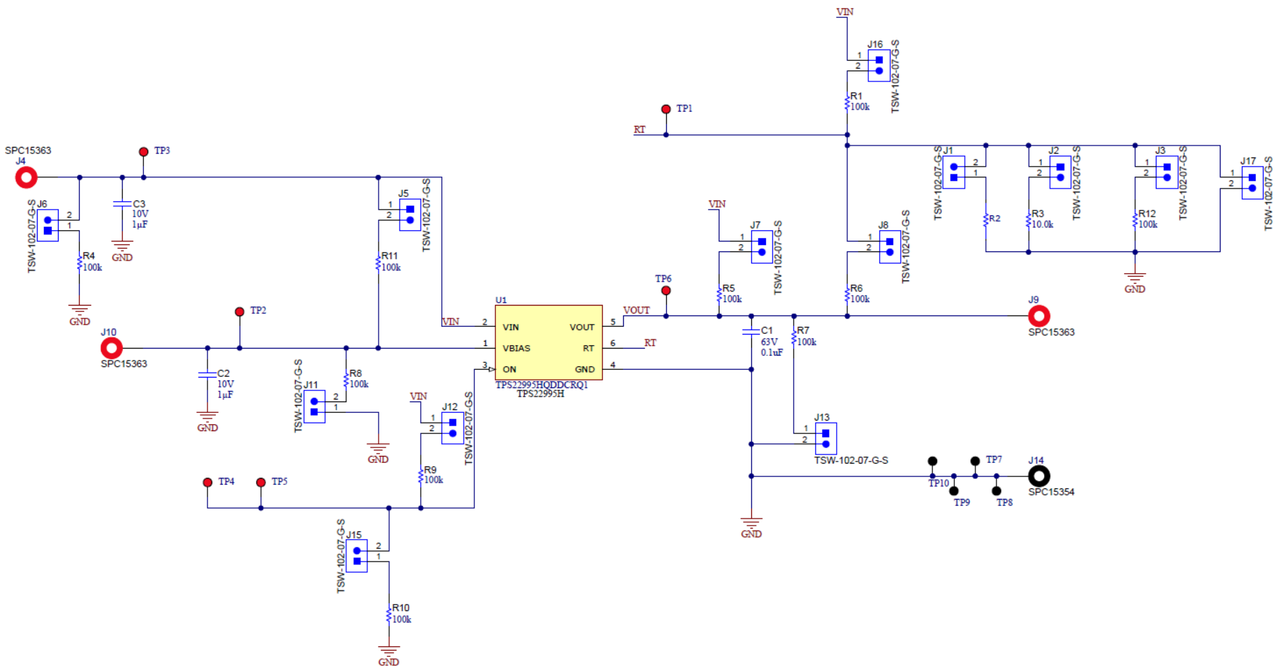

Figure 1-1. TPS22995H-Q1 Humidity Board Schematic

1.2 Layout

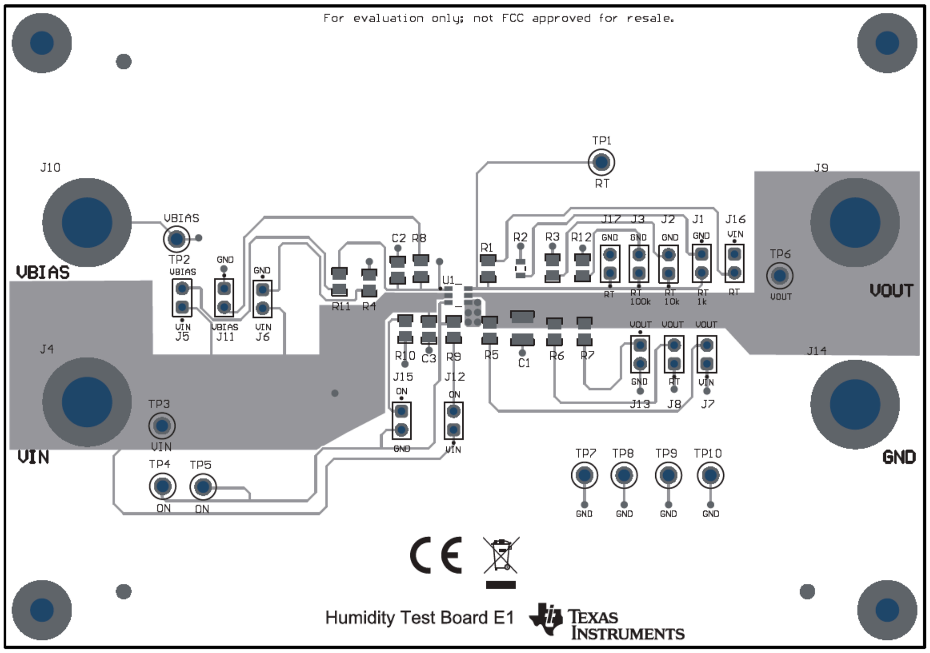

Figure 1-2. Top Layout

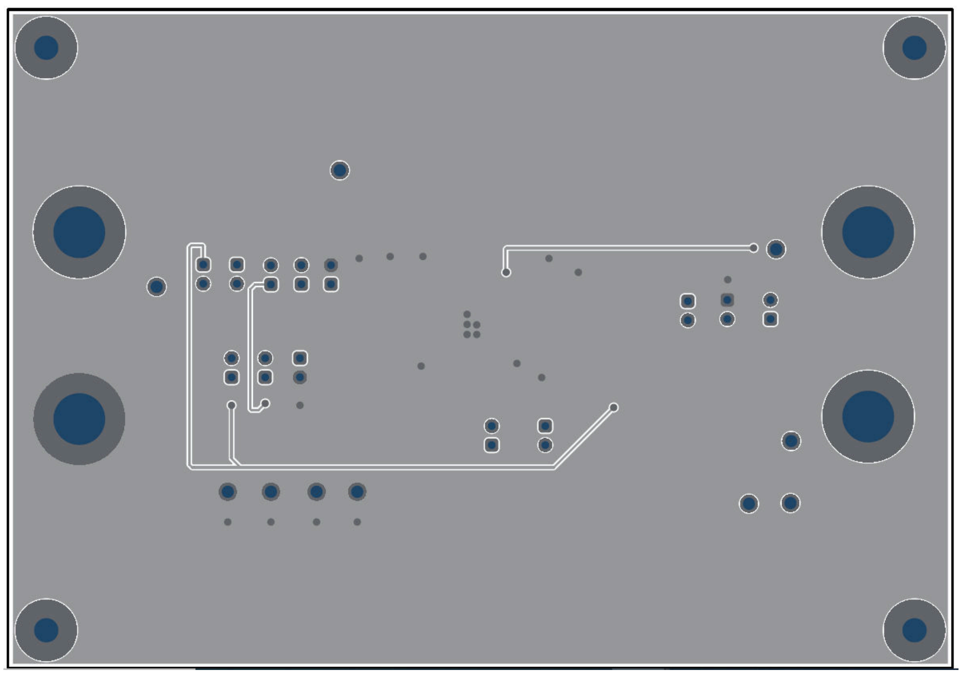

Figure 1-3. Bottom Layout

1.3 Test Conditions

Test 1 conditions: 100 kΩ Short From RT to GND

- V_{IN} = 5 V
- V_{BIAS} = 5 V
- C_{IN} = 1 µF
- RT = 1 kΩ
- R_{LOAD} = 100 Ω
- C_{OUT} = 0.1 µF

Test 2 Conditions: 100 kΩ Short From RT to GND

- V_{IN} = 1.8 V
- V_{BIAS} = 1.8 V
- C_{IN} = 1 µF
- RT = 1 kΩ
- R_{LOAD} = 100 Ω
- C_{OUT} = 0.1 µF

Test 3 Conditions: 100kΩ Short From RT to V_{IN}

- V_{IN} = 5 V
- V_{BIAS} = 5 V
- C_{IN} = 1 µF
- RT = 1kΩ
- R_{LOAD} = 100Ω
- C_{OUT} = 0.1µF

Test 4 Conditions: 100 kΩ Short From RT to V_{IN}

- V_{IN} = 1.8 V
- V_{BIAS} = 1.8 V
- C_{IN} = 1 µF
- RT = 1 kΩ
- R_{LOAD} = 100 Ω
- C_{OUT} = 0.1 µF

Test 5 Conditions: 100 kΩ Short From RT to V_{OUT}

- V_{IN} = 5 V
- V_{BIAS} = 5 V
- C_{IN} = 1 µF
- RT = 1 kΩ
- R_{LOAD} = 100 Ω
- C_{OUT} = 0.1 µF

Test 6 Conditions: 100 kΩ Short From RT to V_{OUT}

- V_{IN} = 1.8 V
- V_{BIAS} = 1.8 V
- C_{IN} = 1 µF
- RT = 1 kΩ
- R_{LOAD} = 100 Ω
- C_{OUT} = 0.1 µF

2 Results

2.1 Functional Test Results

Table 2-1 shows the results of all functional tests. You can find the oscilloscope measurements in Appendix A.

Table 2-1. Functional Test Results

Pins	VBIAS	VIN	ON	GND	VOUT	RT
VBIAS	N/A	✓	N/A	✓	N/A	N/A
VIN	✓	N/A	✓	✓	✓	✓
ON	N/A	✓	N/A	✓	N/A	N/A
GND	✓	✓	✓	N/A	✓	✓
VOUT	N/A	✓	N/A	✓	N/A	✓
RT	N/A	✓	N/A	✓	✓	N/A

2.2 Base Measurements

Figure 2-1 and Figure 2-2 were created without any 100kΩ shorts between any pins to compare with the results of the 100kΩ short tests.

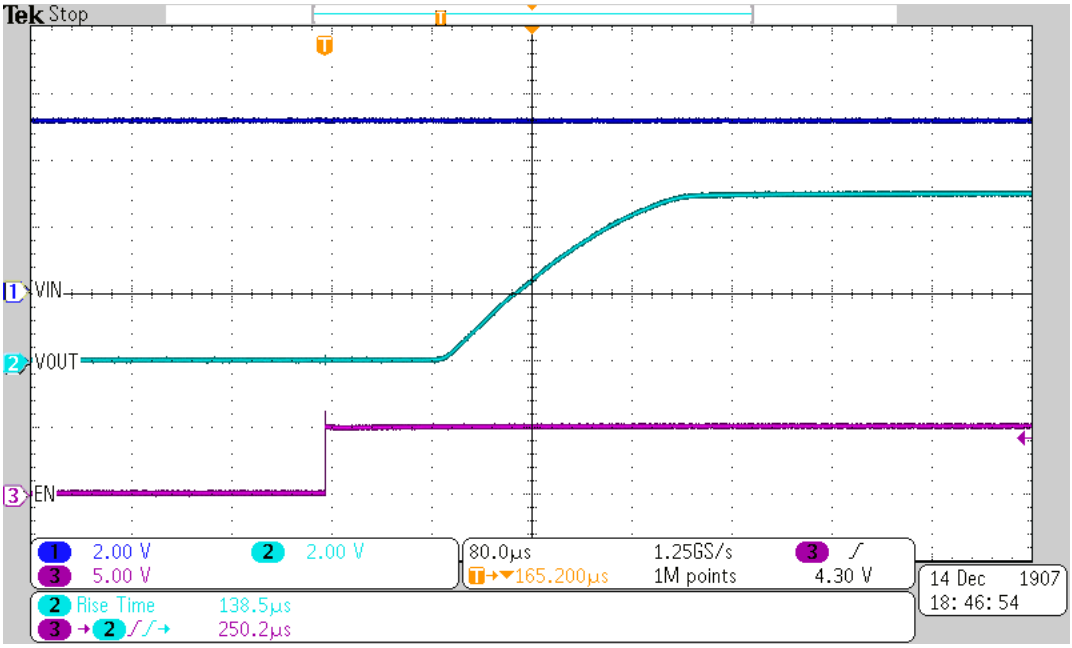

Figure 2-1. Base 5 V t_{RISE} and t_{ON} Measurement

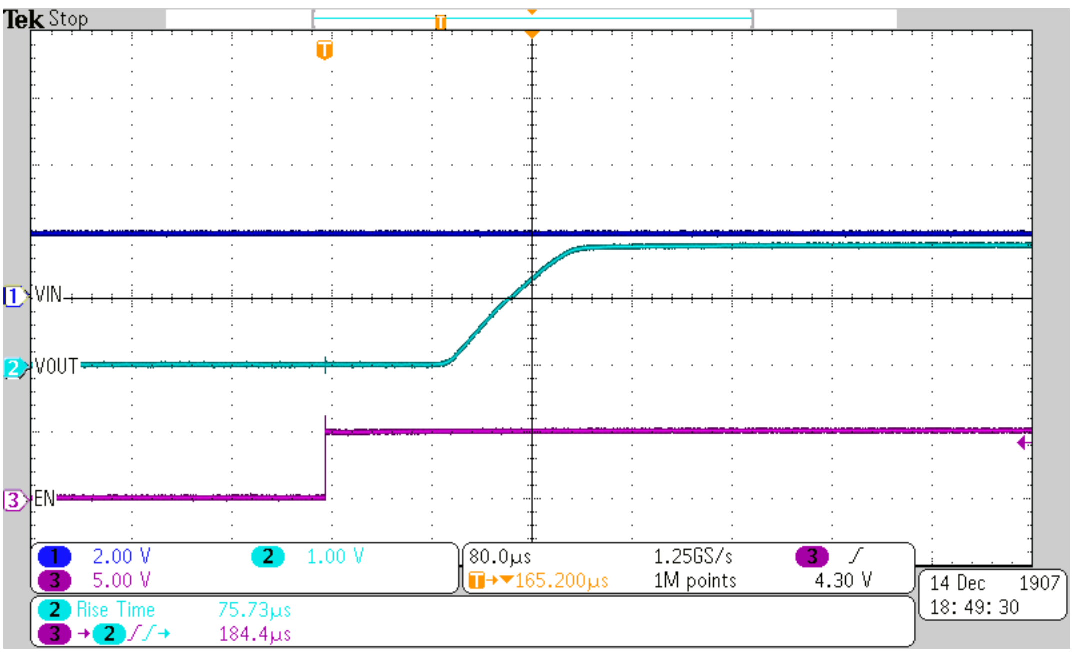

Figure 2-2. Base 1.8 V t_{RISE} and t_{ON} Measurement

2.3 Test 1: 100 kΩ Short From RT to GND 5 V

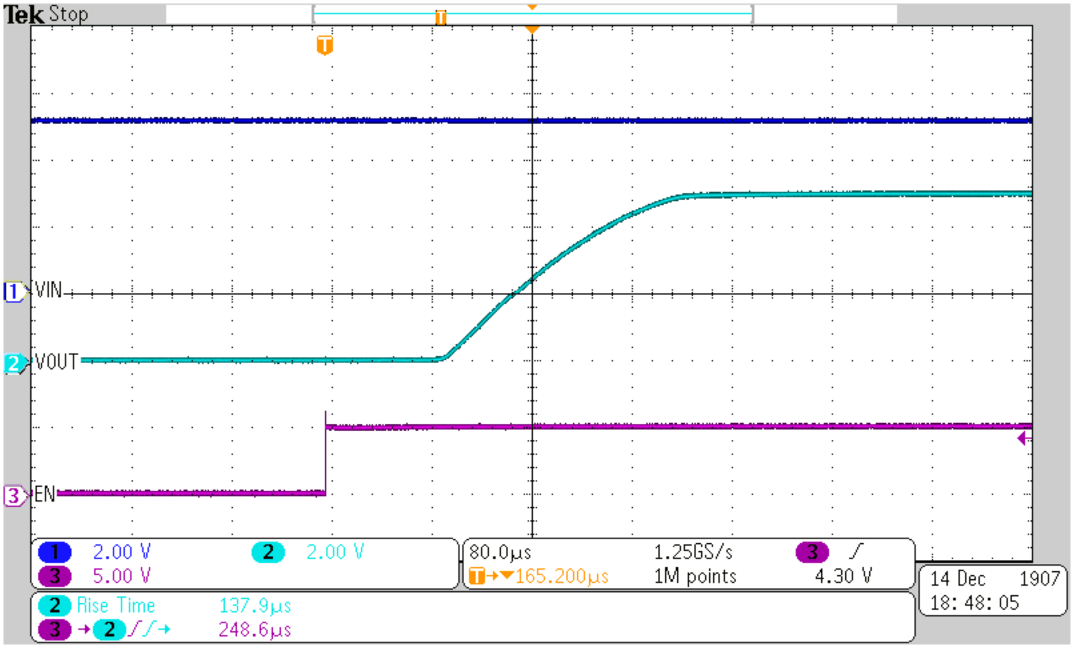

Figure 2-3. 100 kΩ Short From RT to GND 5 V t_{RISE} and t_{ON} Oscilloscope Shot

2.4 Test 2: 100 kΩ Short From RT to GND 1.8 V

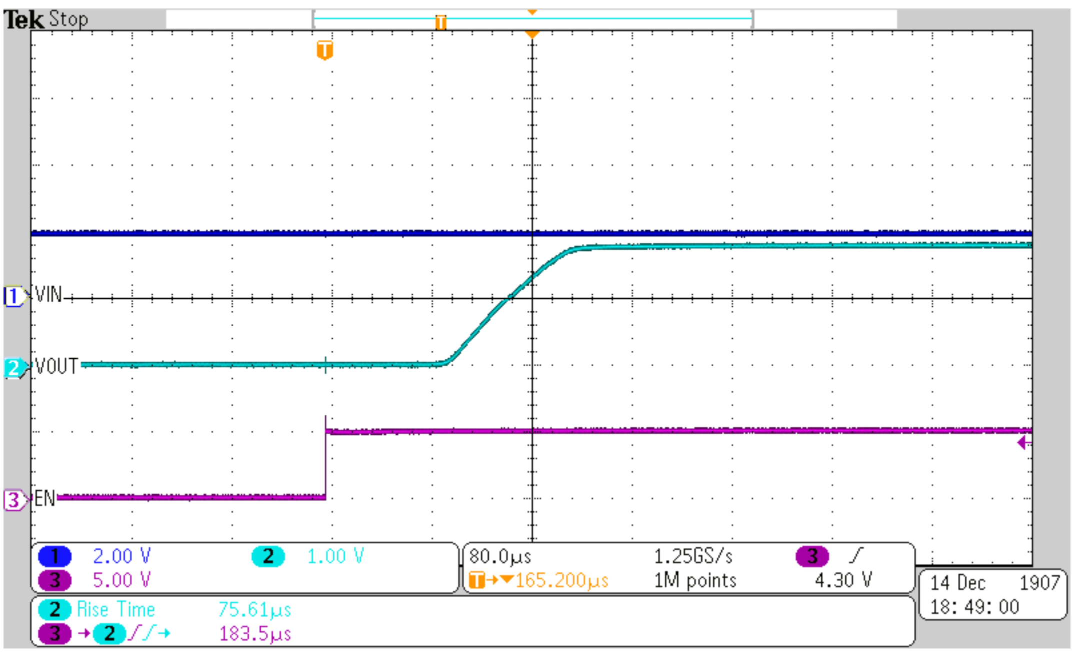

Figure 2-4. 100 kΩ Short From RT to GND 1.8 V t_{RISE} and t_{ON} Oscilloscope Shot

2.5 Test 3: 100kΩ short from RT to V_{IN} 5V

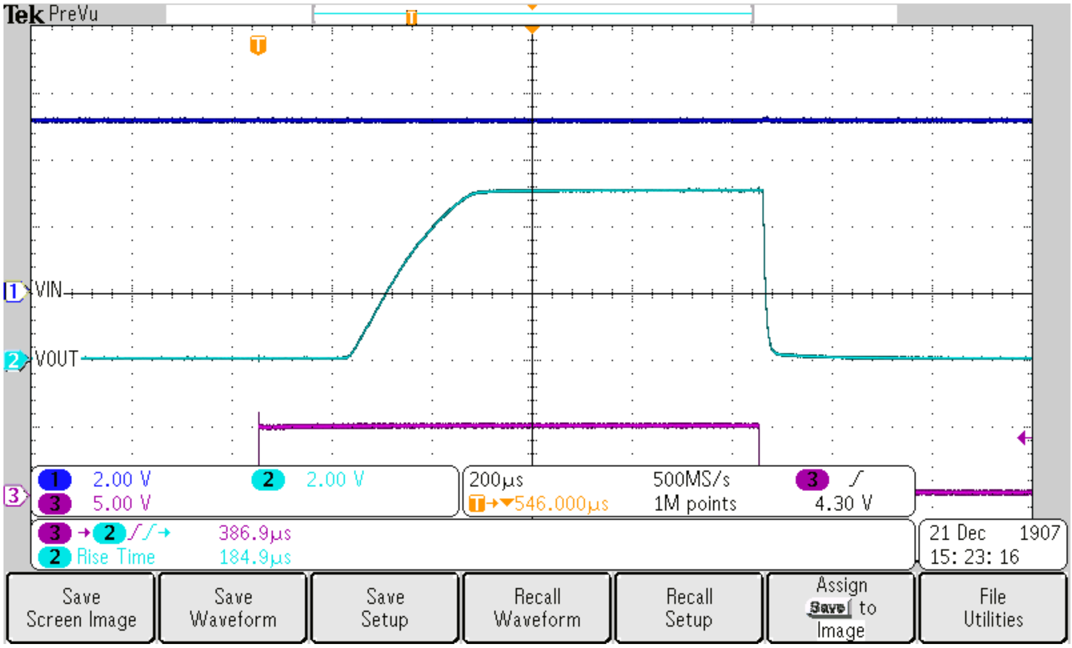

Figure 2-5. 100 kΩ Short From RT to V_{IN} 5V t_{RISE} and t_{ON} Oscilloscope Shot

2.6 Test 4: 100 kΩ Short From RT to V_{IN} 1.8 V

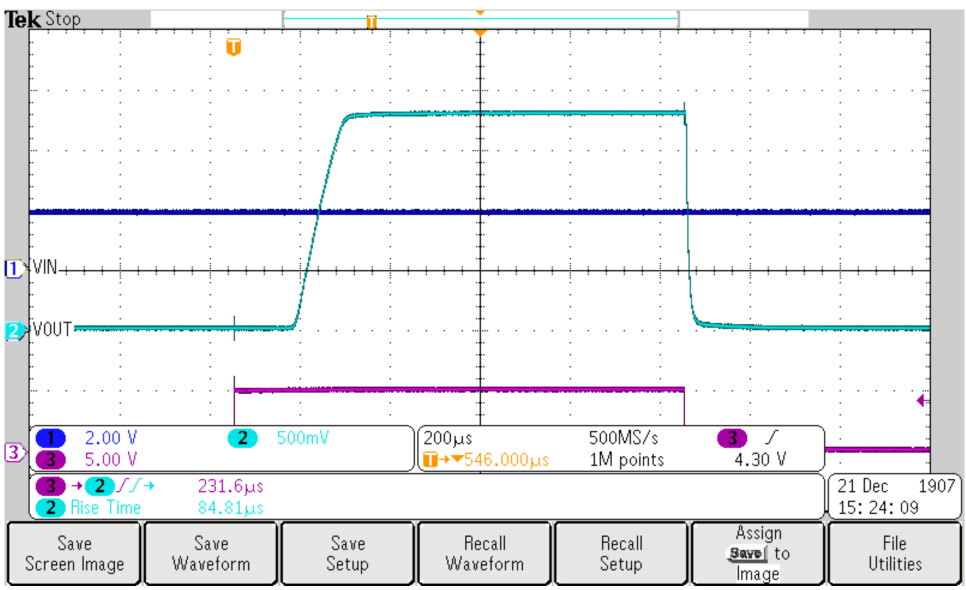

Figure 2-6. 100 kΩ Short From RT to V_{IN} 1.8 V t_{RISE} and t_{ON} Oscilloscope Shot

2.7 Test 5: 100 kΩ Short From RT to V_{OUT} 5 V

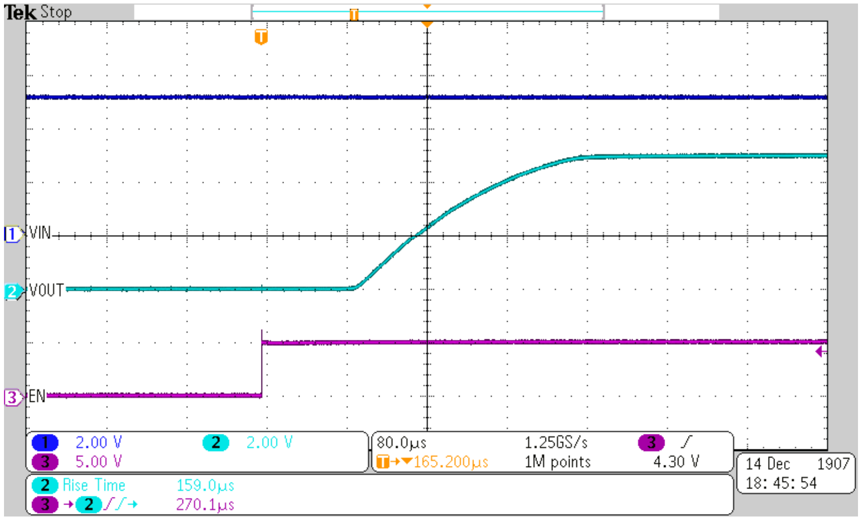

Figure 2-7. 100 kΩ Short From RT to V_{OUT} 5 V t_{RISE} and t_{ON} Oscilloscope Shot

2.8 Test 6: 100 kΩ Short From RT to V_{OUT} 1.8 V

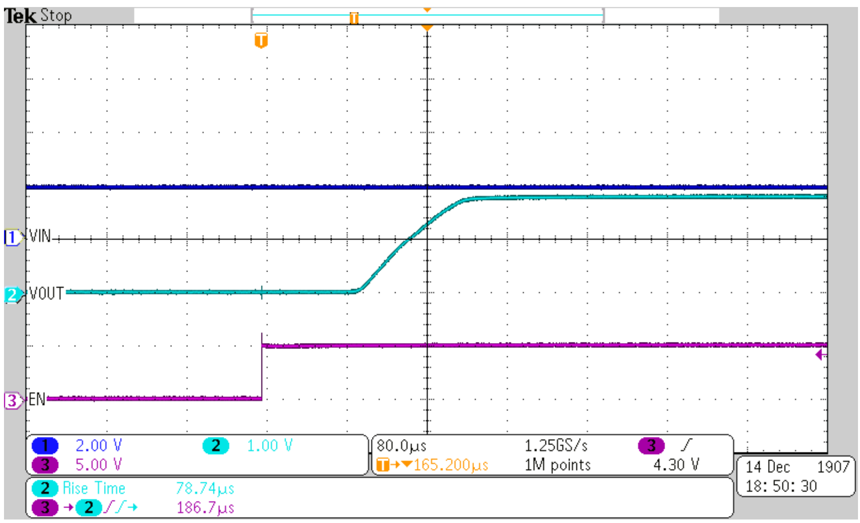

Figure 2-8. 100 kΩ Short From RT to V_{OUT} 1.8 V t_{RISE} and t_{ON} Oscilloscope Shot

3 Summary

The test results for 100-kΩ humidity shorts between RT to GND, RT TO V_{IN}, and RT to V_{OUT} show that no significant impacts occur such as device shutdown or significant timing impacts.

- Test 1 t_{RISE} and t_{ON} timing is 0.43% and 0.64% off from base measurements respectively
- Test 2 t_{RISE} and t_{ON} timing is 0.16% and 0.49% off from base measurements respectively
- Test 3 t_{RISE} and t_{ON} timing is 33.5% and 54.6% off from base measurements respectively
- Test 4 t_{RISE} and t_{ON} timing is 12% and 25.6% off from base measurements respectively
- Test 5 t_{RISE} and t_{ON} timing is 14.8% and 7.95% off from base measurements respectively
- Test 6 t_{RISE} and t_{ON} timing is 3.97% and 1.25% off from base measurements respectively

These results fall within expectations. The timing results for test 3 (short between RT and V_{IN})are due to the RT pin voltage starting high when the device is first turned on; however, you will notice that the slew rate is still controlled and is within the range of the RT configuration. A short between the RT pin and VIN pin is extremely unlikely.

4 References

- Texas Instruments, *TPS22995H-Q1 Automotive 5.5-V, 3-A, 16-mΩ Load Switch with Adjustable Rise Time* data sheet.
- Texas Instruments, *TPS22995H-Q1 Evaluation Module for Load Switch* evaluation module.

6 Appendix A

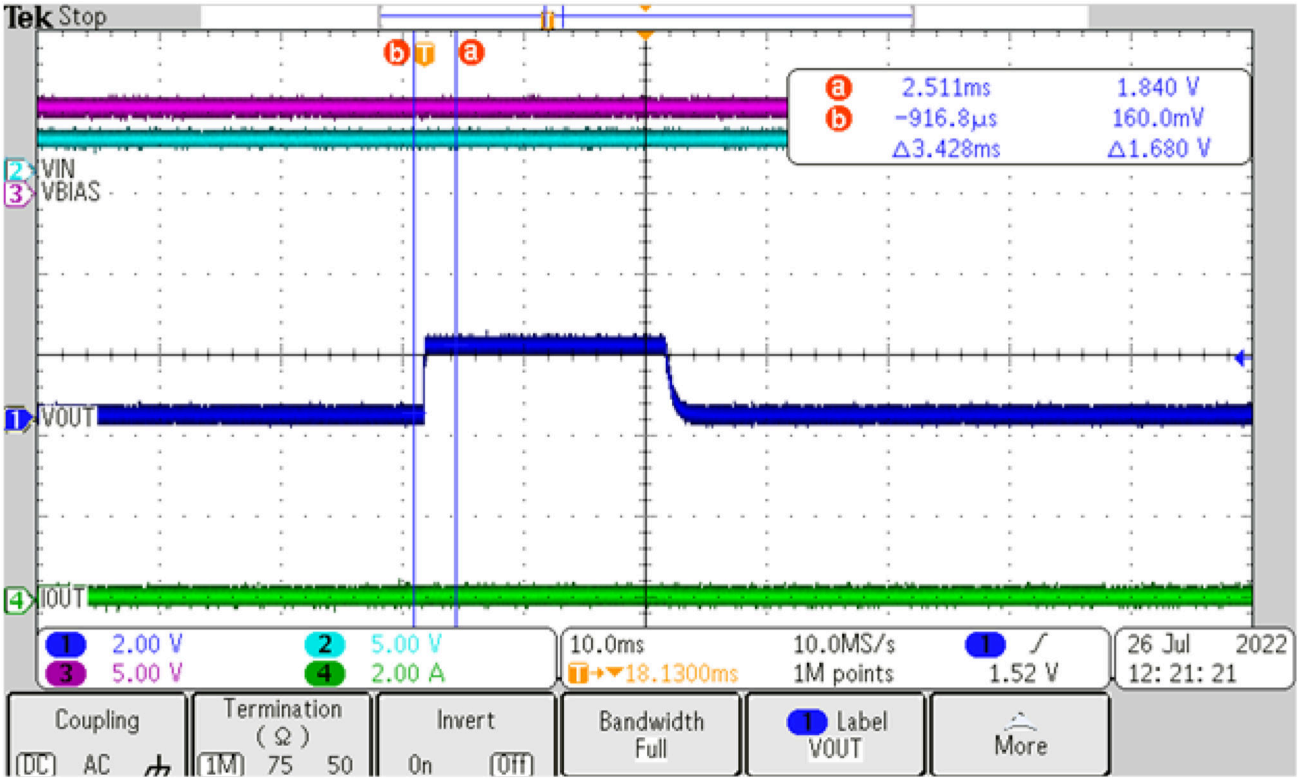

Figure 6-1. V_{IN} 100 kΩ Short to V_{BIAS}

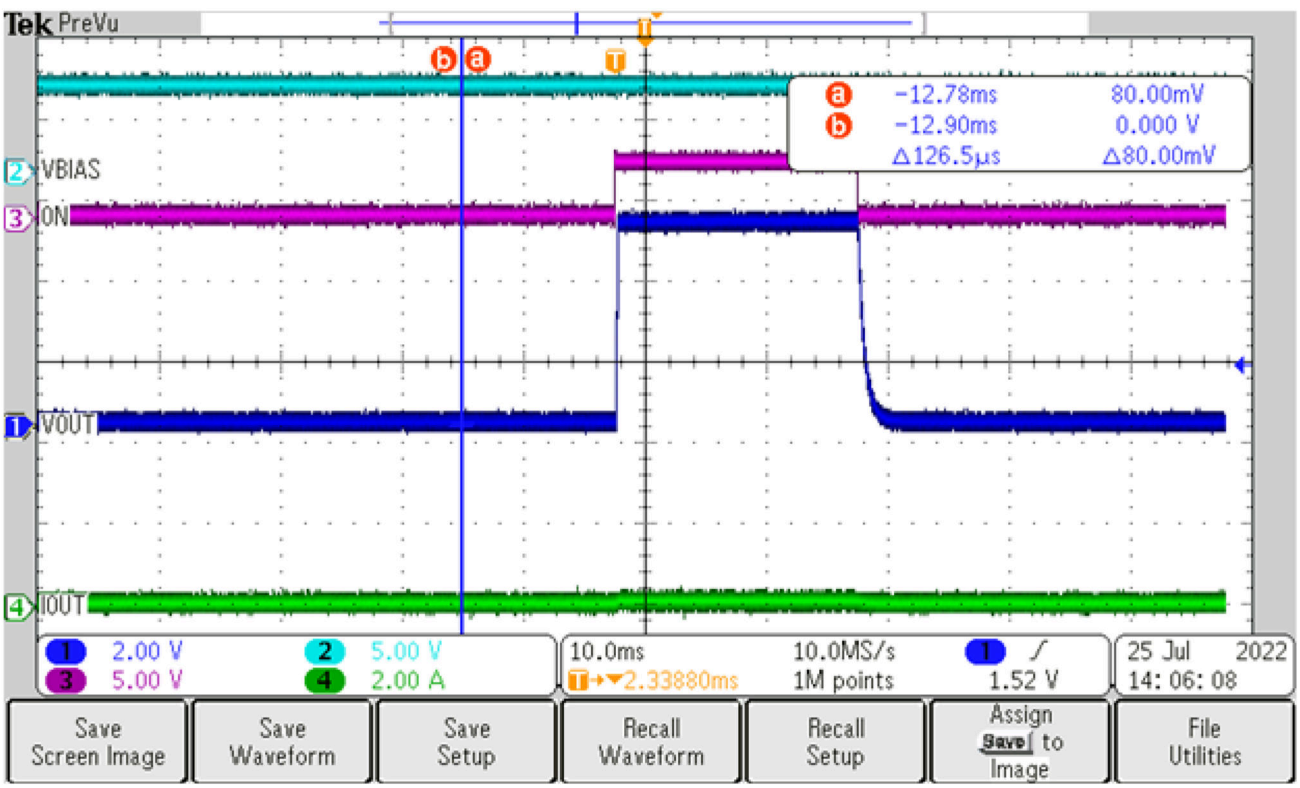

Figure 6-2. V_{BIAS} 100 kΩ to GND

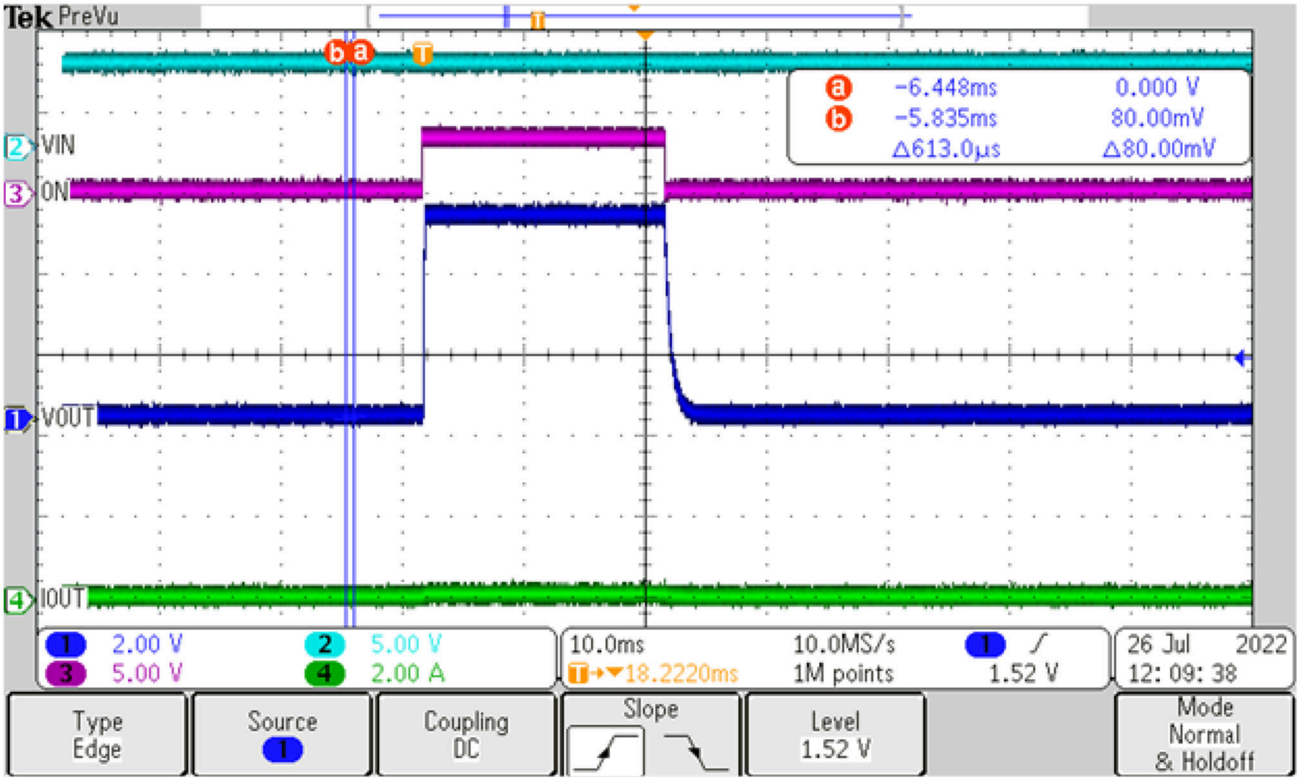

Figure 6-3. V_{IN} 100 kΩ Short to ON

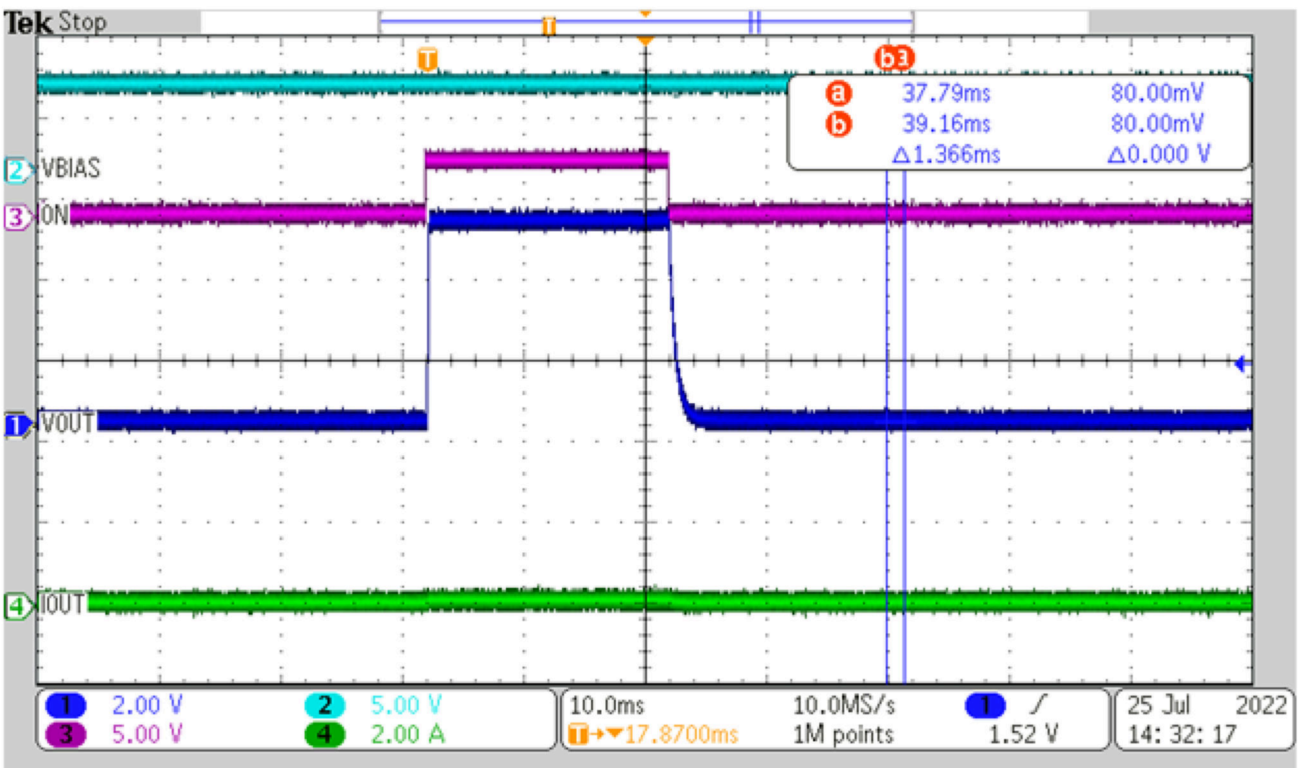

Figure 6-4. V_{IN} 100 kΩ Short to V_{OUT}

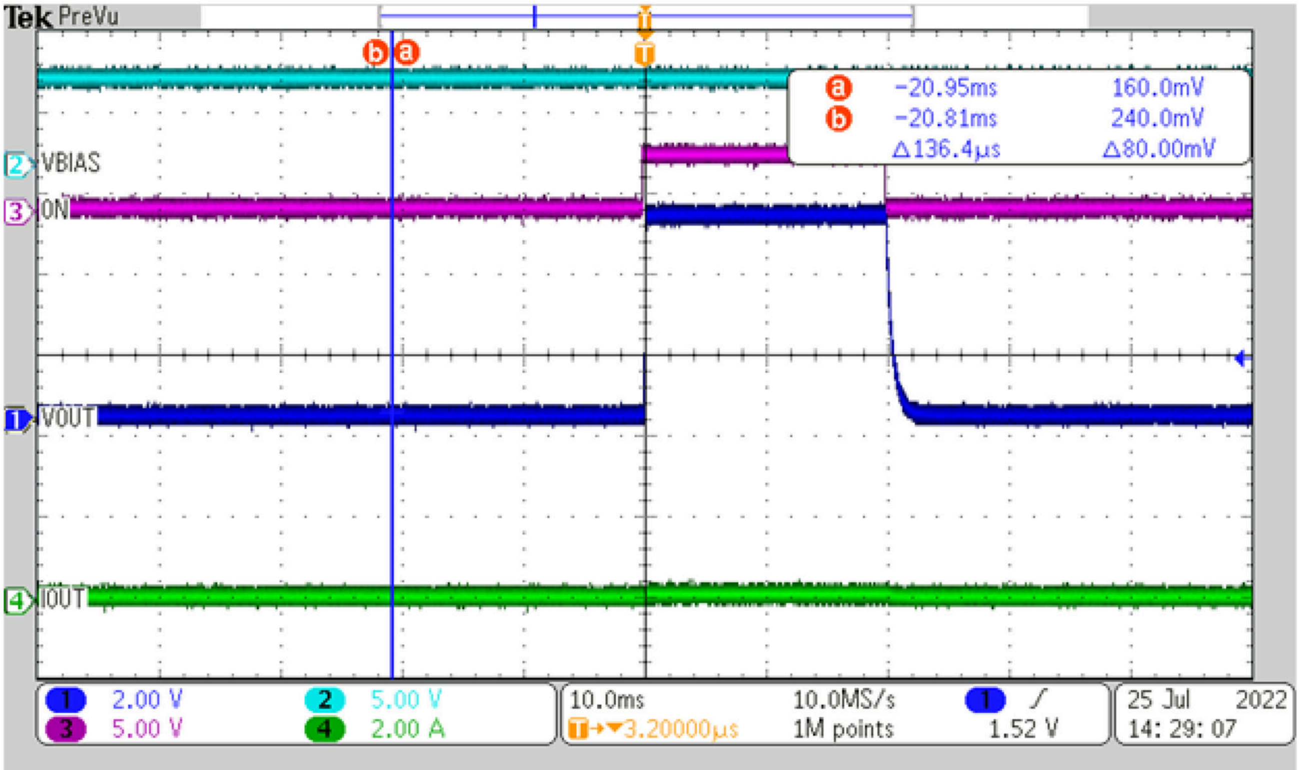

Figure 6-5. V_{OUT} 100 kΩ Short to GND