bq76PL455A-Q1 EVM Test Report – TI Design TIDA-00717

Introduction

This document provides a report of the tests that were carried out to validate the bq76PL455A-Q1 EVM board.

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Stacked Operation

Hardware Requirements

The boards are stacked as shown in Figure 1 below and communication and fault transmission is verified.

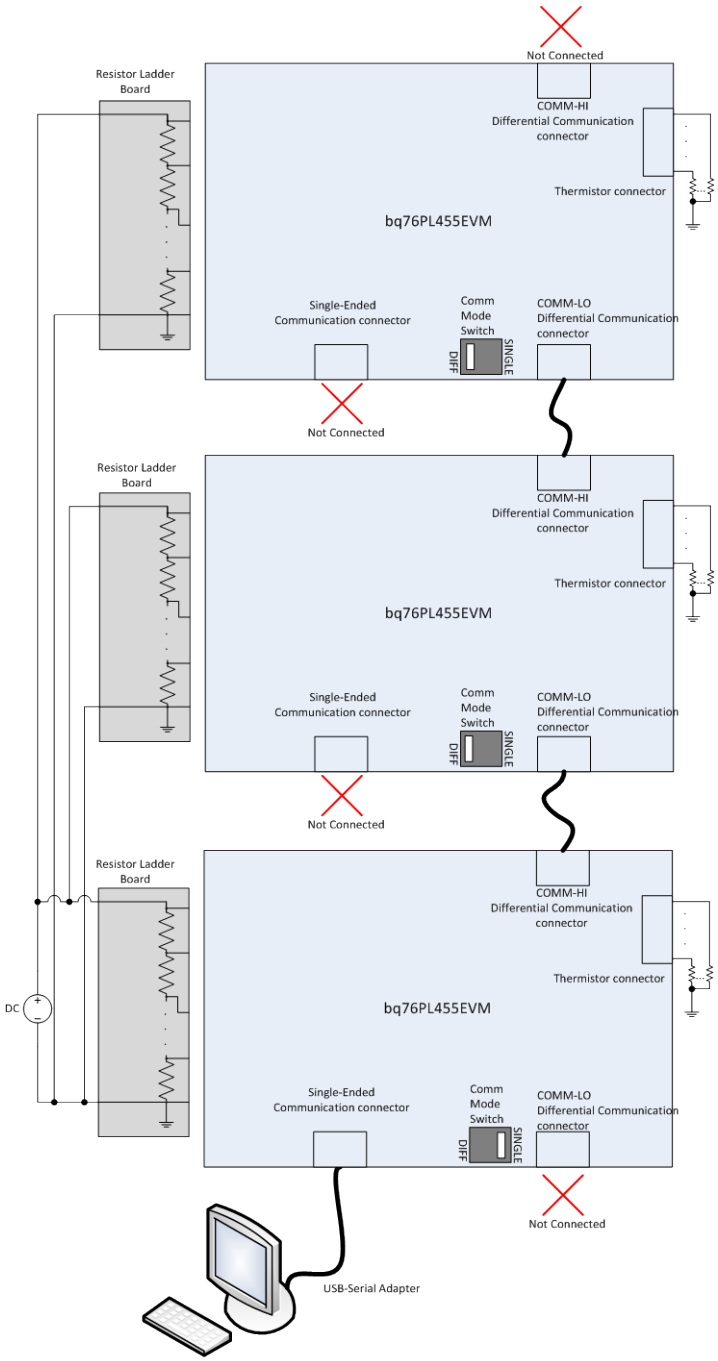

Figure 1. Test Setup

Bulk Current Injection (BCI)

Purpose and Description of Test

Bulk Current Injection (BCI) is a method of assessing the immunity of the DUT (and associated PCB and external components) to electromagnetic fields that are coupled onto the communications line wiring harnesses.

Testing was done using a method based on the Substitution Method as described in ISO 11452-4. The current injection probe was calibrated and the equivalent current injected into the DUT was calculated using this calibration data (see Section 1.1.4 of this document for the calibration data).

The test was conducted on a bq76PL455EVM.

1.1.1 Definitions

BCI	Bulk Current Injection
PL455A	bq76PL455A-Q1
DUT	Device Under Test
EVM	Evaluation Module

Test Descriptions and Results

1.1.2 Block Diagrams

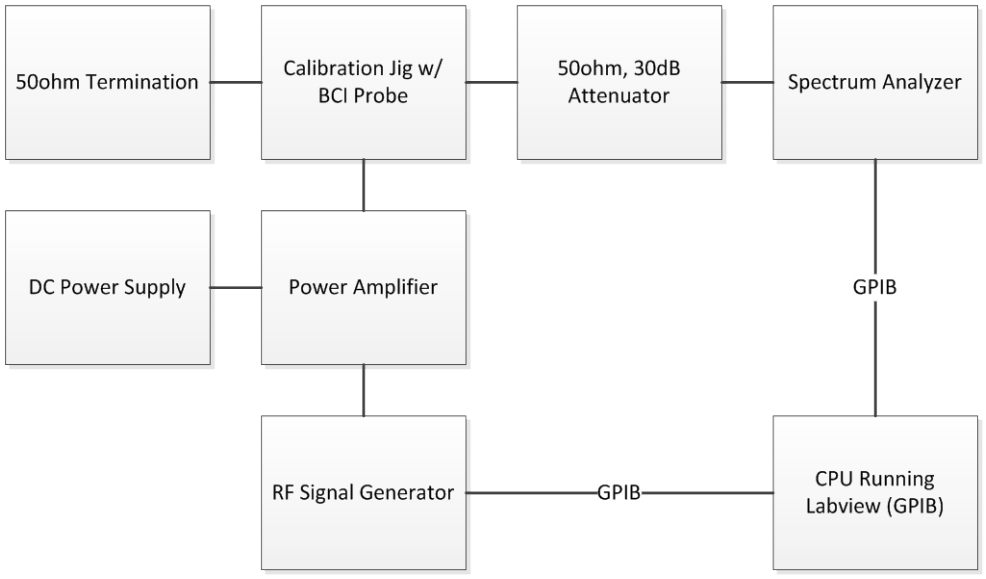

Figure 2. Calibration Block Diagram

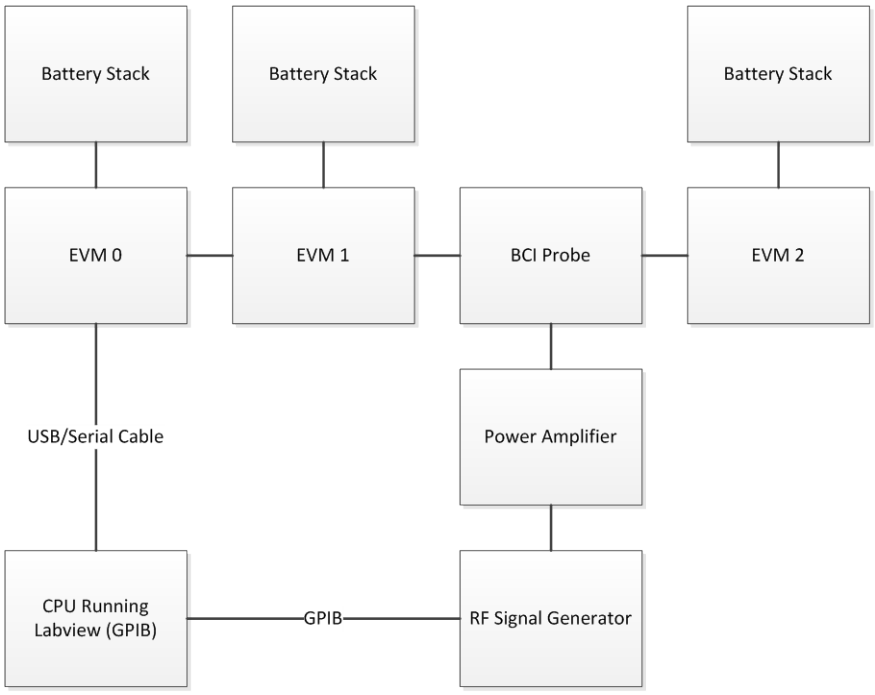

Figure 3. Block Diagram – Communications Lines Testing

1.1.3 Limits

BCI testing on the bq76PL455A-Q1 will use the limits shown in Figure 4 below. The power amplifier used has an input limit of 0 dBm, which results in the Amplifier Limit also shown.

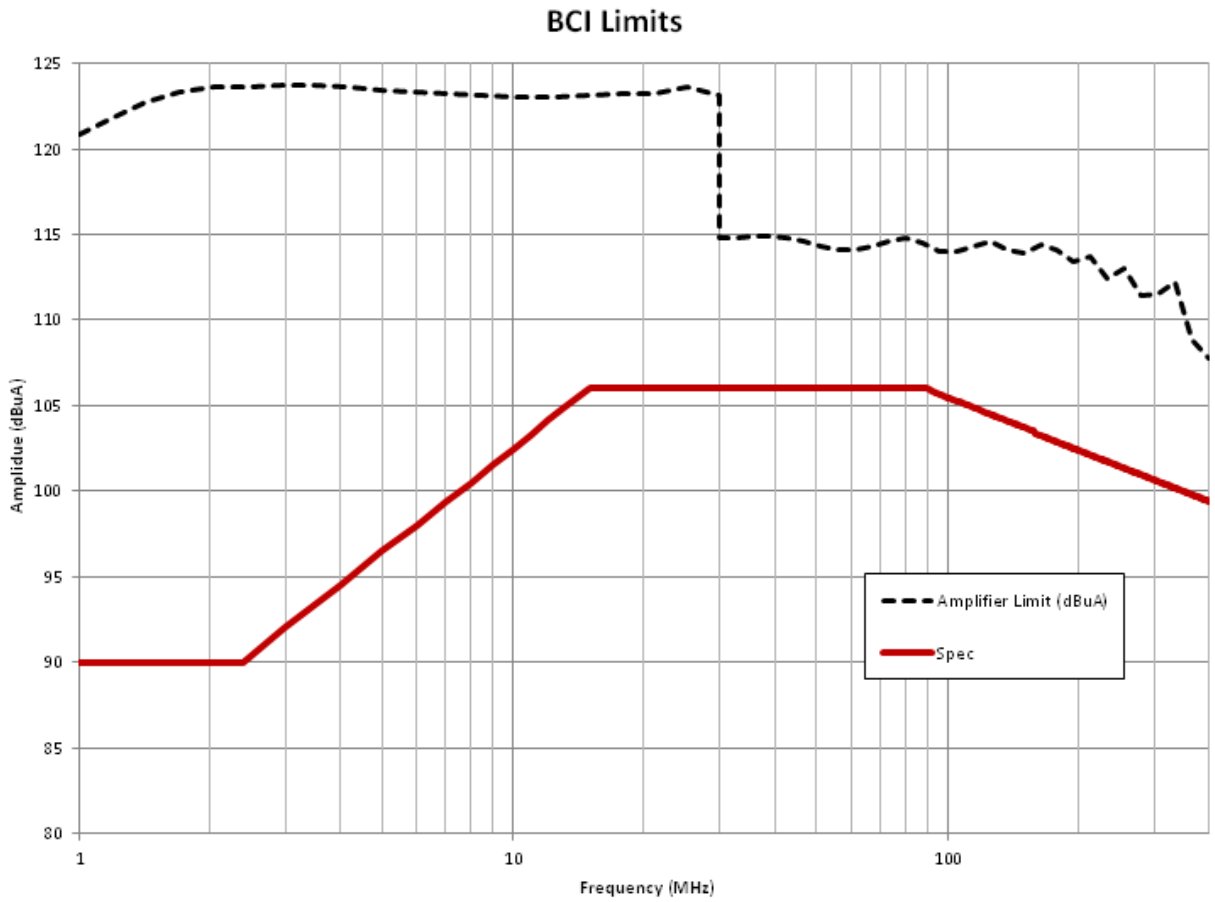

Figure 4. BCI Limits

BCI Test

1.1.4 Calibration

1.1.4.1 100 mA Constant Current Calibration

For this calibration, the signal-generator output power required to drive 100 mA (100dBµA) into the calibration fixture will be recorded for each frequency of interest. The actual current value achieved will also be recorded, and should be within ±1 dB of the target value. These power/frequency combinations will then be used during the Communications/Fault testing.

1.1.4.2 Limit Calibration

For this calibration, the signal-generator output power required to obtain the BCI current limit depicted in Figure 4 will be recorded. The actual current achieved will also be recorded and should be within ±1 dB of the target value.

1.1.5 Communications

1.1.5.1 Description of Test

This test will check the immunity of the differential communications and fault lines. The flow diagram for this test is in Figure 5 as follows:

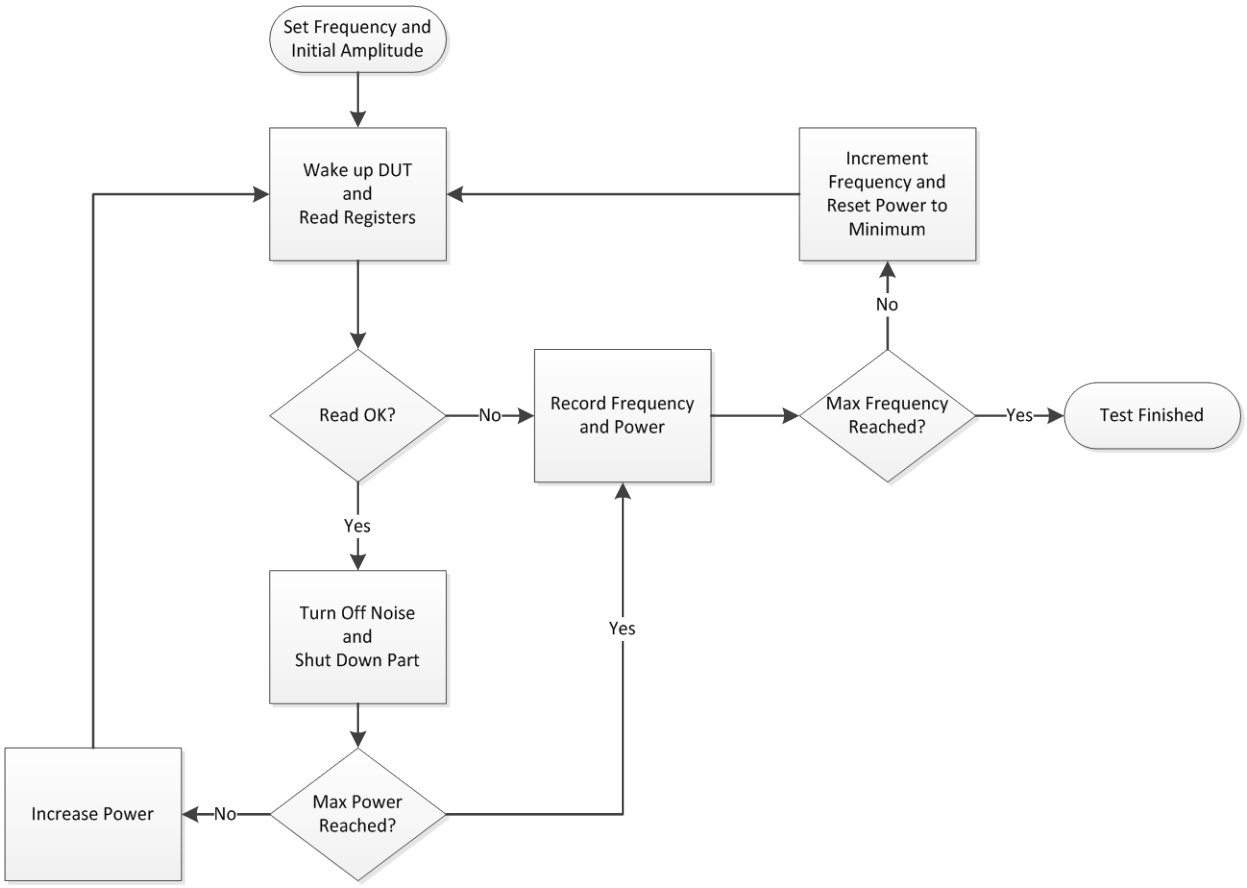

Figure 5. BCI Test Flow Diagram

The ‘Read OK’ decision block in Figure 5 checks for successful communication through the stack of EVMs. Once a communications failure occurs, the noise power and frequency are recorded and the test proceeds.

1.1.5.2 Results

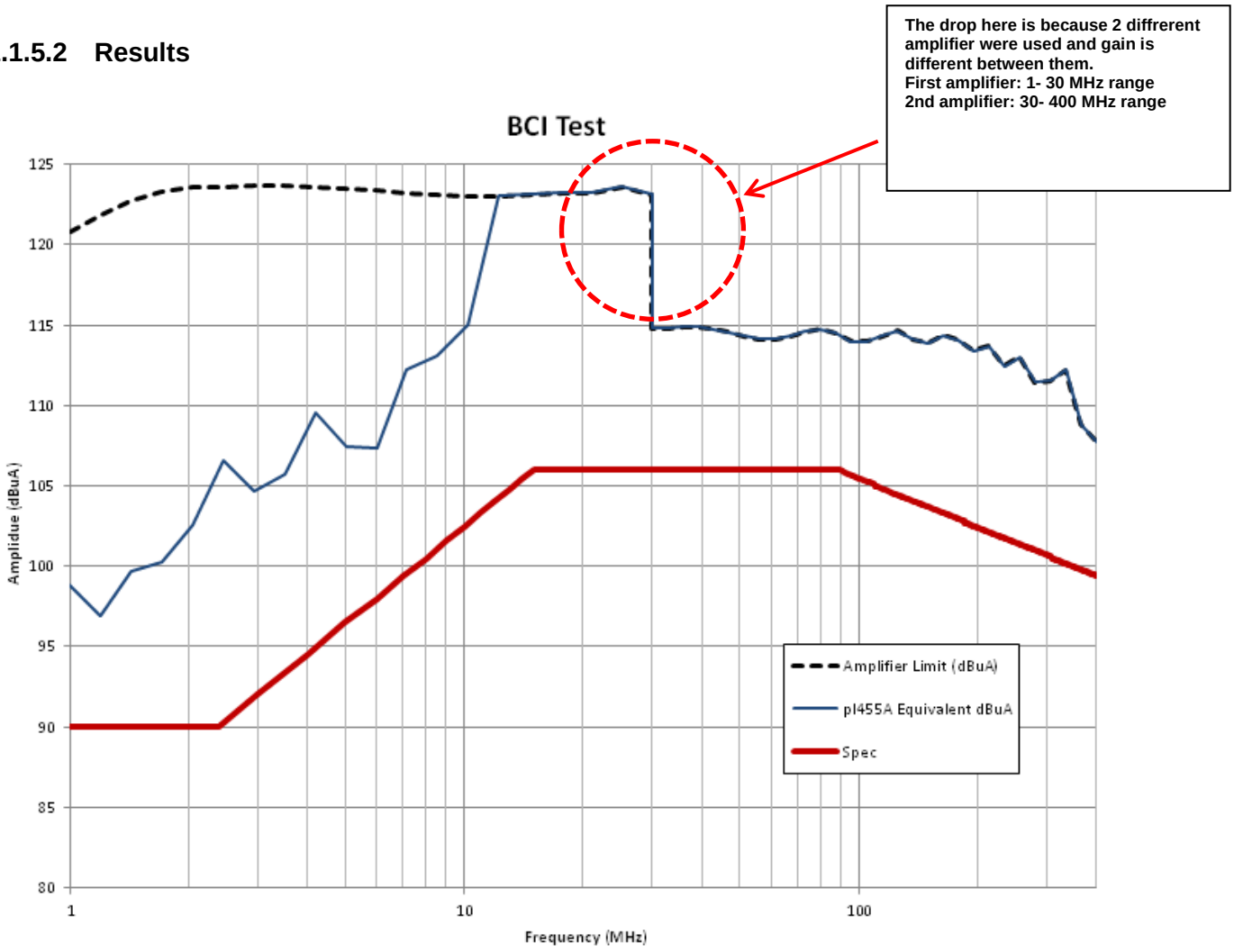

Figure 6. Results from Communications Testing on the bq76PL455A-Q1

Summary

All communications tests passed the specification. Please note that two different sets of amplifiers (with different gain) were used to achieve the full frequency range. That is why the drop is noticed (circled in red) at 30 MHz.

Electro-Magnetic Compatibility Tests

An independent test facility was contracted to do the testing. A separate report is available on request.

Hot-Plug

The hot-plug test is designed for validating the bq76PL455A-Q1 evaluation board capability of handling different use cases of battery assembly and service.

These use cases are:

1. Single board power cable insertion
2. Two board communication cable insertion

Standard

The single board hot-plug test follows ISO 7637-2:2011(E) standard, except the VTEST source is a Chroma 100V/50A programmable power supply, which has a very large output capacitor (>50 mF) similar to a Li-ion cell.

Other hot plug tests use longer cable (6-feet, 18AWG) than what ISO 7637-2:2011(E) defines.

Target Under Test (DUT)

- bq76PL455A-Q1 PWR517 rev B modified with the following:
  - bq76PL455A-Q1 IC

Test Equipment

- Oscilloscope
  - High Voltage Differential Probe (1400 V, 100 MHz)
  - Current Probe (100 MHz)
- Bench Top Power Supply (Chroma 100V/50A)
- Bench Top Power Supply (2 x 75V/2A)
- High Voltage Bench Top Power Supply (0-600V)
- OMRON Mechanical Relay
- Programmable Power Supply (To drive OMRON relay)

- EIG Battery Pack (2 x 48-Cell stackable, 40 Ah, 403.2 Vmax)
- PC + USB-UART(5 V) Cable + GUI

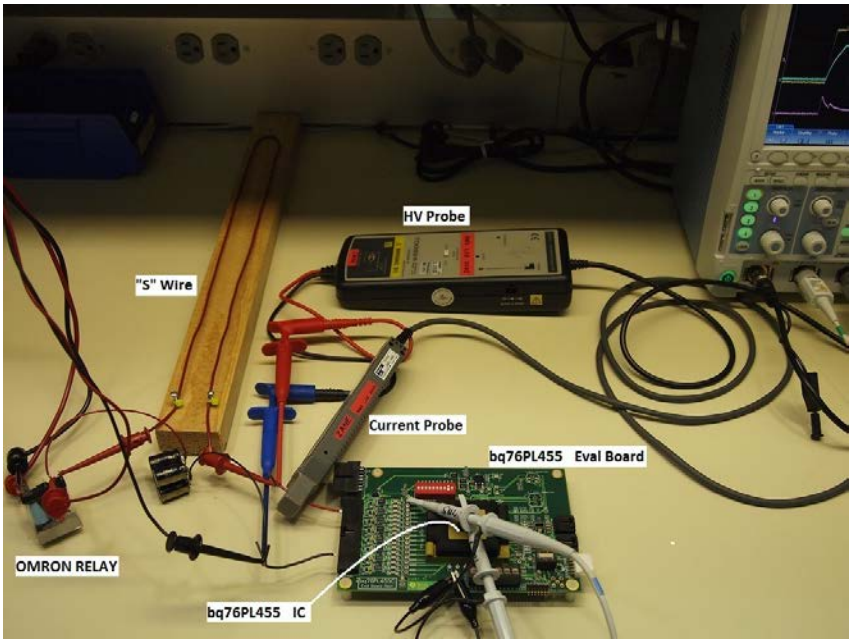

Figure 7. Single Board Hot-Plug Test Setup

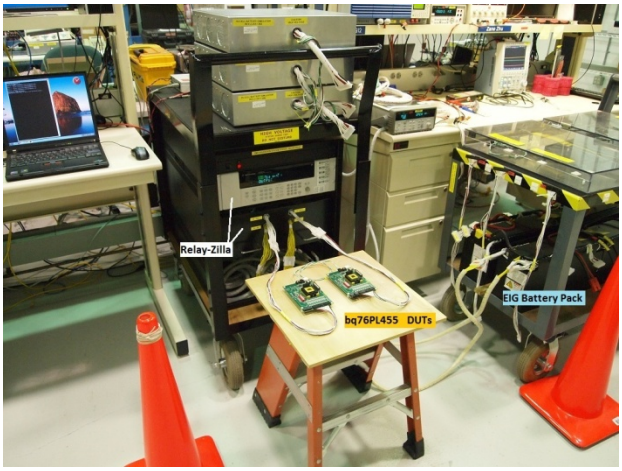

Figure 8. Stacked Boards Hot-Plug Test Setup

Single Board Power Cable Insertion

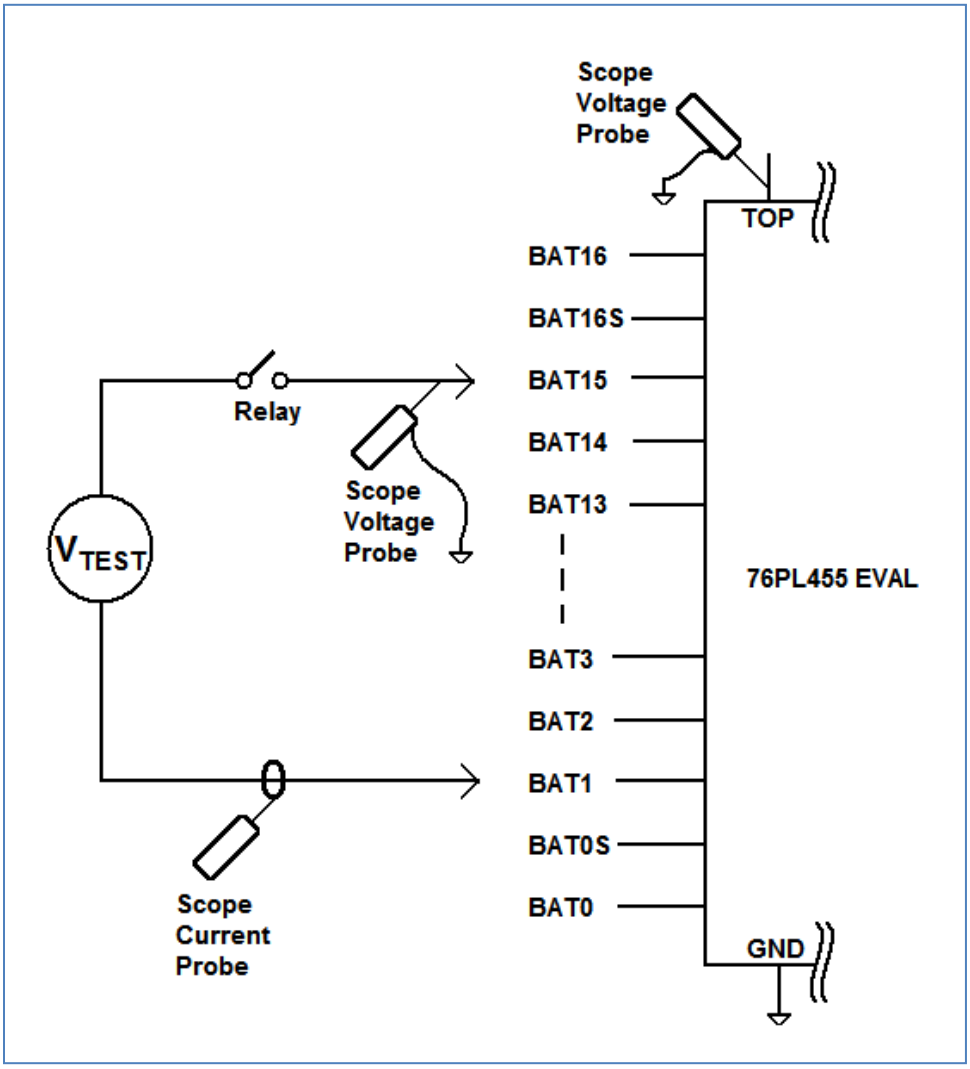

Figure 9. Single Board Power Cable Insertion Hot-Plug Test Setup

Figure 10. Scope Capture (VTEST = 80 V Across BAT16 → BAT0)

The VTOP and VSENSE16 are rising smoothly, the voltages are under VTEST and no voltage spike and ringing are observed. The HP current is under 100 mA and the peak lasts about 50 µs.

1.1.6 Pass/Fail Criteria

A test voltage is applied on two pins by mechanical relays. The amplitude and width of the inrush current pulse should be within the range of 1.5 A by 2 µs. After all hot-plug tests in this section are complete, the bq76PL455A-Q1 AFE accuracy, window comparator accuracy, and communication should be verified and should work as specified.

	BAT0	BAT0S	BAT1	BAT2	BAT3	BAT4	BAT5	BAT6	BAT7	BAT8	BAT9	BAT10	BAT11	BAT12	BAT13	BAT14	BAT15	BAT16S	BAT16
BAT0			5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	80.0
BAT0S			5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	80.0
BAT1				5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	75.0
BAT2					5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	70.0
BAT3						5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	65.0
BAT4							5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	60.0
BAT5								5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	55.0
BAT6									5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	50.0
BAT7										5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	45.0
BAT8											5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	40.0
BAT9												5.0	10.0	15.0	20.0	25.0	30.0	35.0	35.0
BAT10													5.0	10.0	15.0	20.0	25.0	30.0	30.0
BAT11														5.0	10.0	15.0	20.0	25.0	25.0
BAT12															5.0	10.0	15.0	20.0	20.0
BAT13																5.0	10.0	15.0	15.0
BAT14																	5.0	10.0	10.0
BAT15																		5.0	5.0
BAT16S																			
BAT16																			

Figure 11. Test Voltage (VTEST) Matrix and Test Result (Green Means PASS; Grey Means N/A)

The bq76PL455A-Q1 AFE/WinCOMP/Comm verification result: PASS

Two Boards Communication Cable Insertion

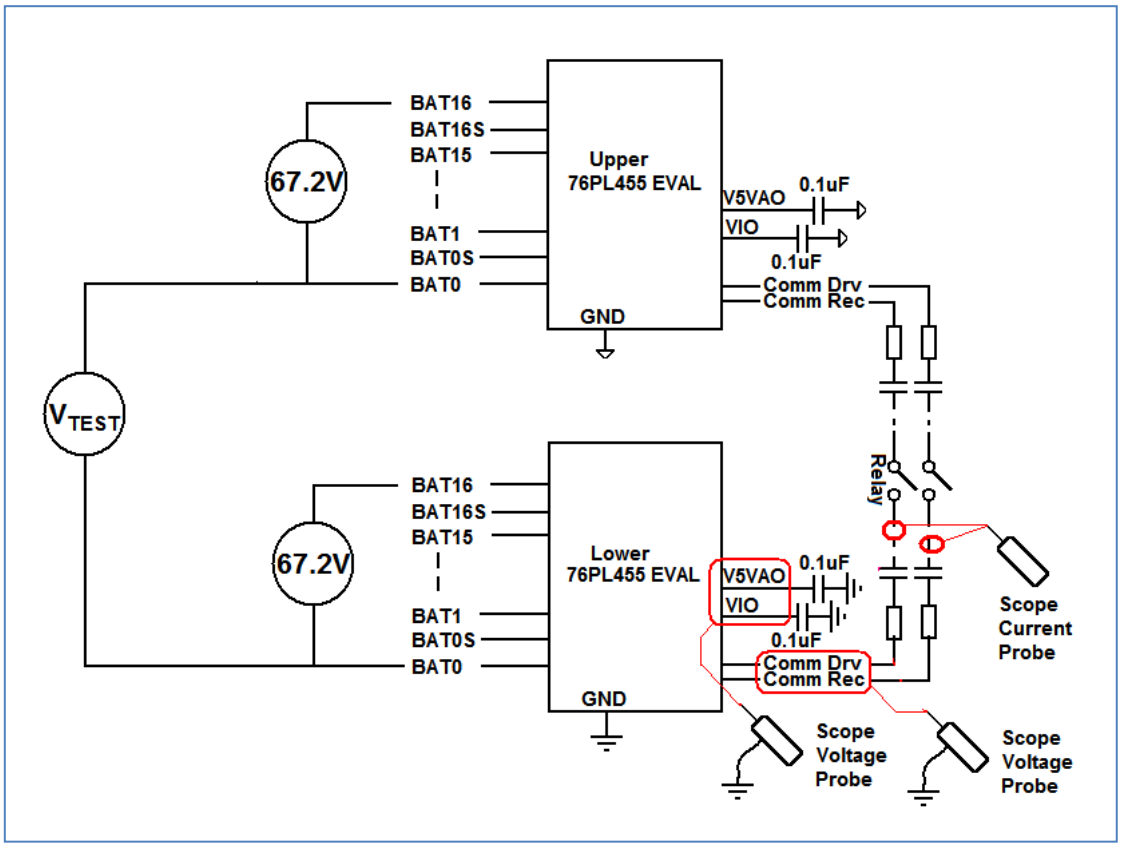

Figure 12. Communication Cable Insertion Hot-Plug Test Setup

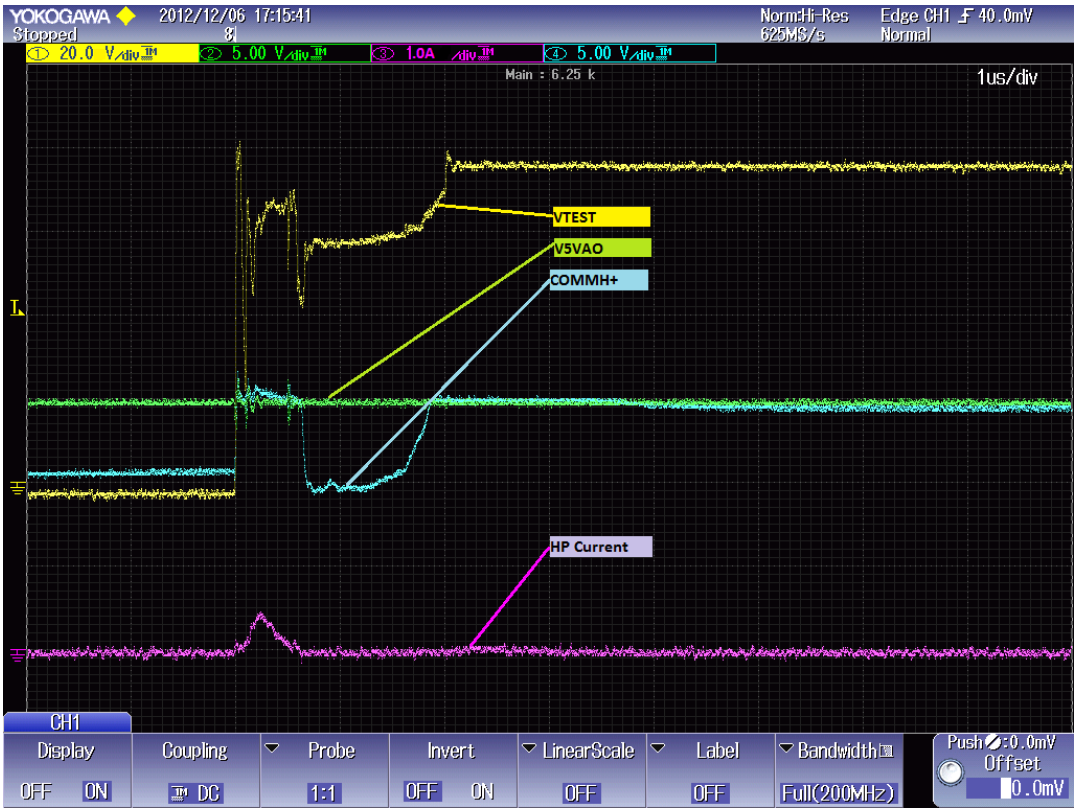

Figure 13. Scope Capture (VTEST = 80 V)

The V5VAO keeps straight and the COMMH+ is clamped. The HP current is about 0.5 A and lasts 0.5 µs.

1.1.7 PASS/FAIL Criteria

A proper stack test voltage is applied on the setup and a mechanical relay, which is in series with communication line, is closed, the following conditions have to be met.

- The amplitude and width of inrush current pulse should be within the range of 1.5 A by 2 µs
- The V5VAO voltage should be stable at 5.00 V ± 0.1 V

After all hot-plug tests in this section are complete, the bq76PL455A-Q1 AFE accuracy, window comparator accuracy, and communication should be verified and should work as specified.

Table 1. Stack Test Voltage (VTEST) Matrix and Test Result

80.0 V	140.0 V	210 V	280 V	360.0 V
PASS	PASS	PASS	PASS	PASS

The bq76PL455A-Q1 AFE/WinCOMP/Comm verification result: PASS

Single Board Power Cable Insertion - Pattern

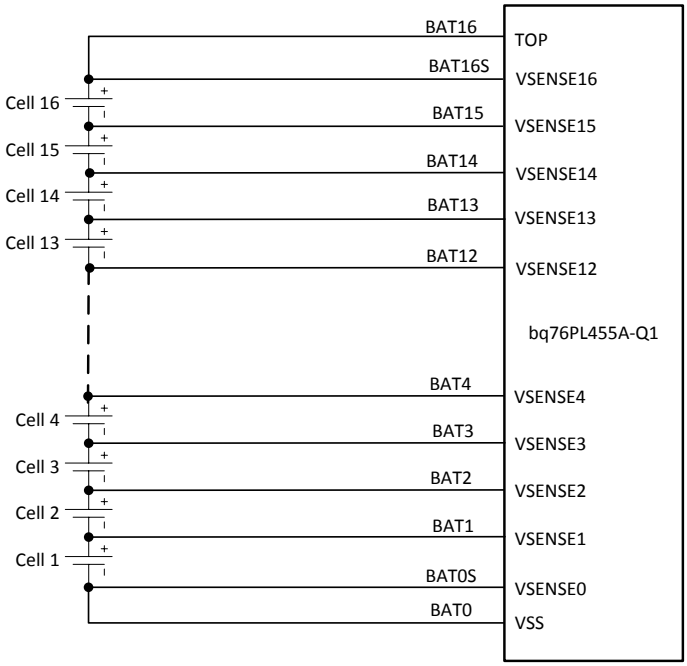

Figure 14. Single Board Battery Cable Insertion Pattern Hot-Plug Test Setup

A bq76PL455A-Q1 battery harness contains 19 wires (16 cell connections, 1 additional at top of stack, and 2 additional at bottom of stack) which were used to connect to the bq76PL455EVM.

1.1.8 Pass/Fail Criteria

After each hot plug in, the bq76PL455A-Q1 AFE accuracy, window comparator accuracy, and communication were verified to work as specified.

Fixed Pattern Hot Plug Test Result:

bq76PL455A-Q1 AFE/WinCOMP/Comm PASS

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