Test Report: PMP23329

Bidirectional 10s-16s Battery Pack Reference Design With Arm® Cortex® M0+ Processor

Description

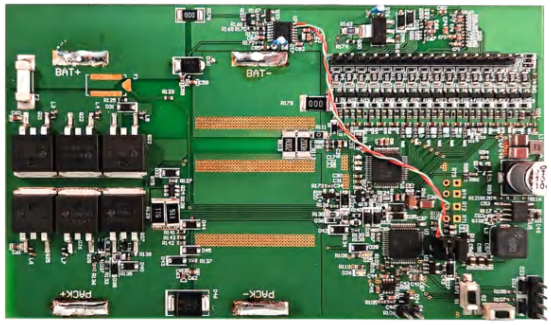
This reference design measures high cell voltage accuracy for 10s to 16s $LiFePO_4$ battery packs. The reference design consists of a high accuracy battery monitor-protector, a gas-gauge, a secondary protection device, and an M0 to help program and communicate with the other devices. The design monitors each cell voltage, pack voltage, and pack current to protect the $LiFePO_4$ battery pack against cell overvoltage, cell undervoltage, and charge and discharge overcurrent. The gauge accurately predicts the capacity and life of the battery pack. The design adopts high-side N-channel metal-oxide semiconductor field-effect transistor (MOSFET) architecture and has strong driving on and off capability.

Features

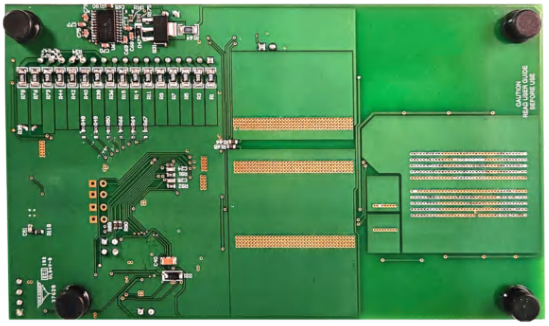
- 3.2V nominal cell voltage-16 in series
- 5A charging current
- 3A discharge current
- Protections tested: OCP(charging) OCP(discharging); cell UVP; cell OVP

Applications

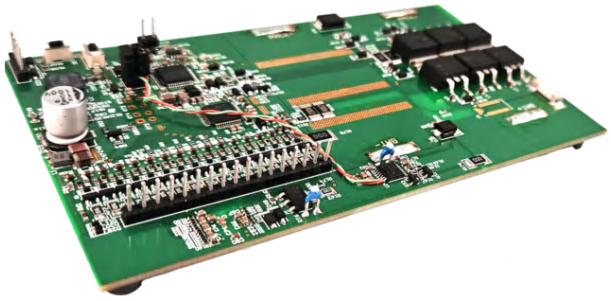
- Other industrial battery pack (>=10S)



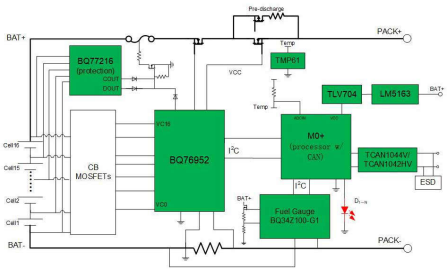
Top Photo of the Board



Bottom Photo of the Board



Angle Photo of the Board



Block Diagram of PMP23329

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Battery Specifications and Protection Parameters

PARAMETER	SPECIFICATIONS
Battery type	$LiFePO_4$
Battery configuration	16 cells connected in series
Battery part number	IFR26650
Typical cell Capacity	3800mAh (0.5C)
Nominal Cell voltage	3200mV
Cell overvoltage protection threshold	4200mV
Cell undervoltage protection threshold	2700mV
Over-current protection during charge	6A
Over-current protection during discharge	3.5A

1.2 Required Equipment

- Isolated DC power source, 0V to 70V, 6A minimum
- 60V, 5A electronic load
- Digital multimeters
- PC for M0, monitor, gauge programming and telemetry

1.3 Considerations

All measurements taken at 25ºC ambient.

Where applicable, measurements were taken with the battery pack attached. DC supply was also used to mimic pack voltage whenever possible.

2 Testing and Results

2.1 State of Charge(SOC)

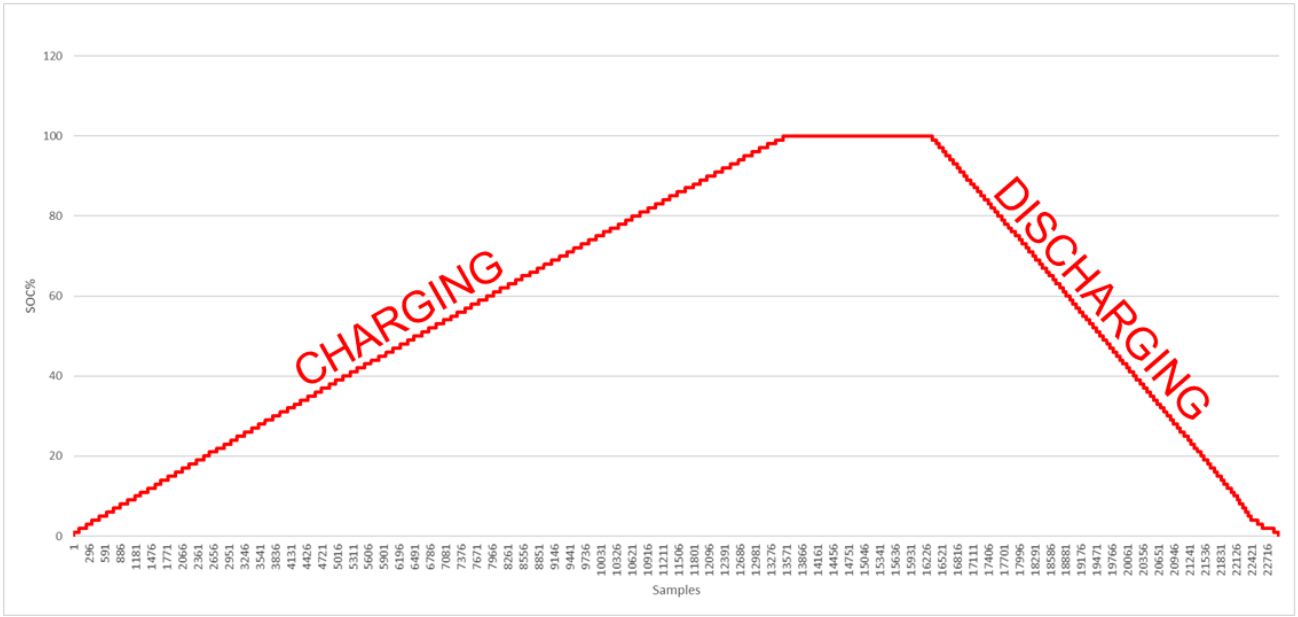


Figure 2-1. State of Charge Data Showing Charge and Discharge Data

2.2 Battery Stack Voltage and Charge and Discharge current

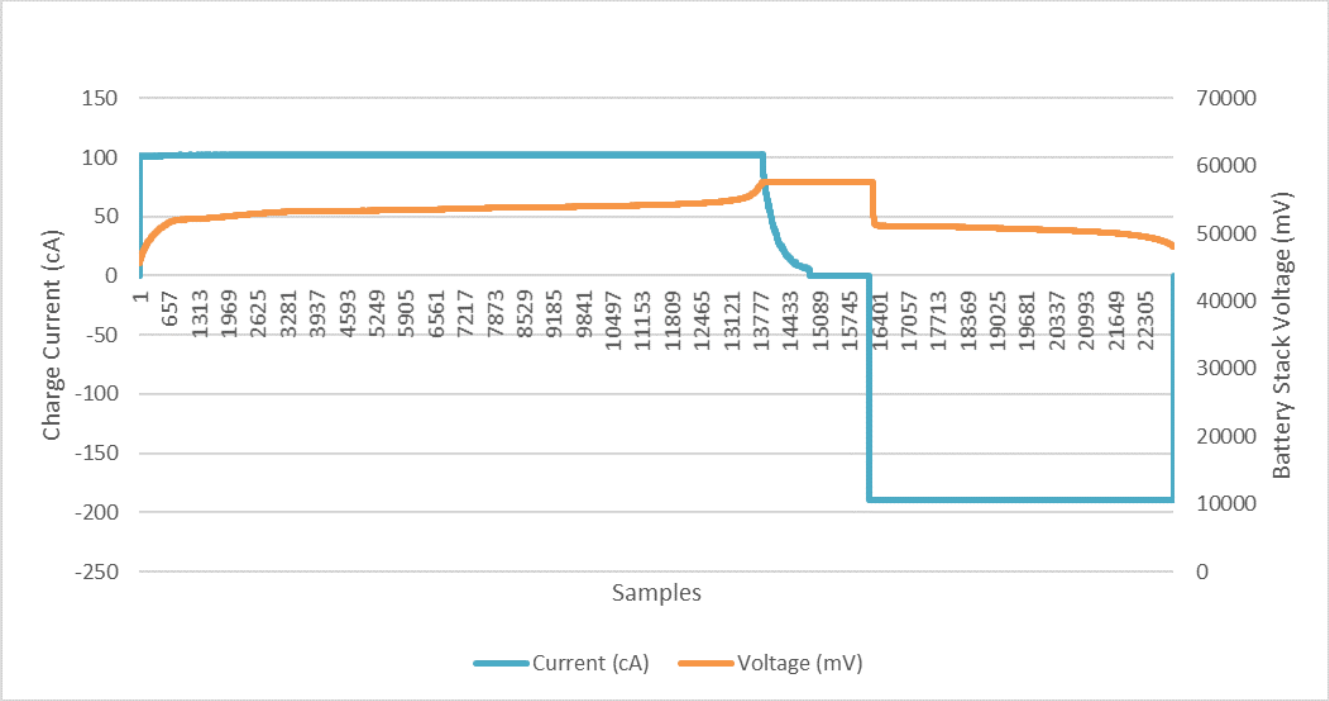


Figure 2-2. Battery Stack Voltage and Charge and Discharge Current

2.3 SoC With Battery Voltage and Charge and Discharge Current

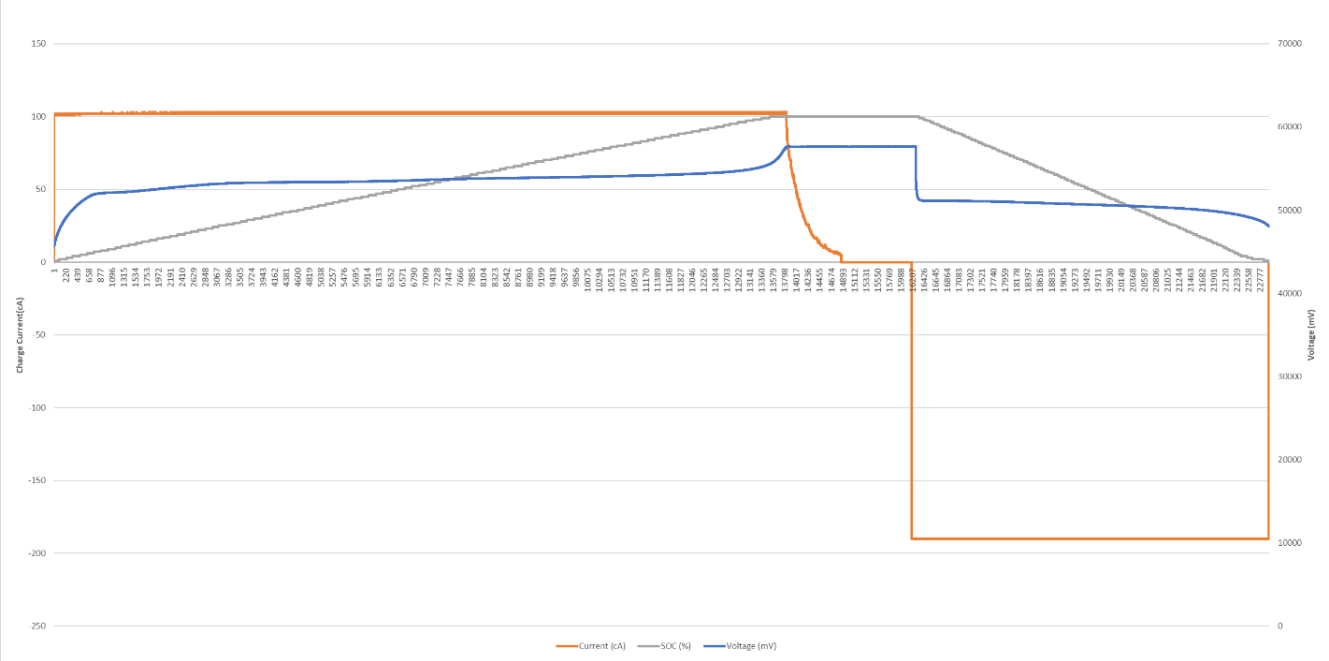


Figure 2-3. State of Charge With Battery Voltage and Charge and Discharge Current

3 Waveforms

3.1 Overcurrent Protection During Charge

C1(yellow): Vpack (20V-div)

C2(pink): CHG (20V-div)

C3(pink): DSG (50V-div)

C4(green): Charge current (2A-div)

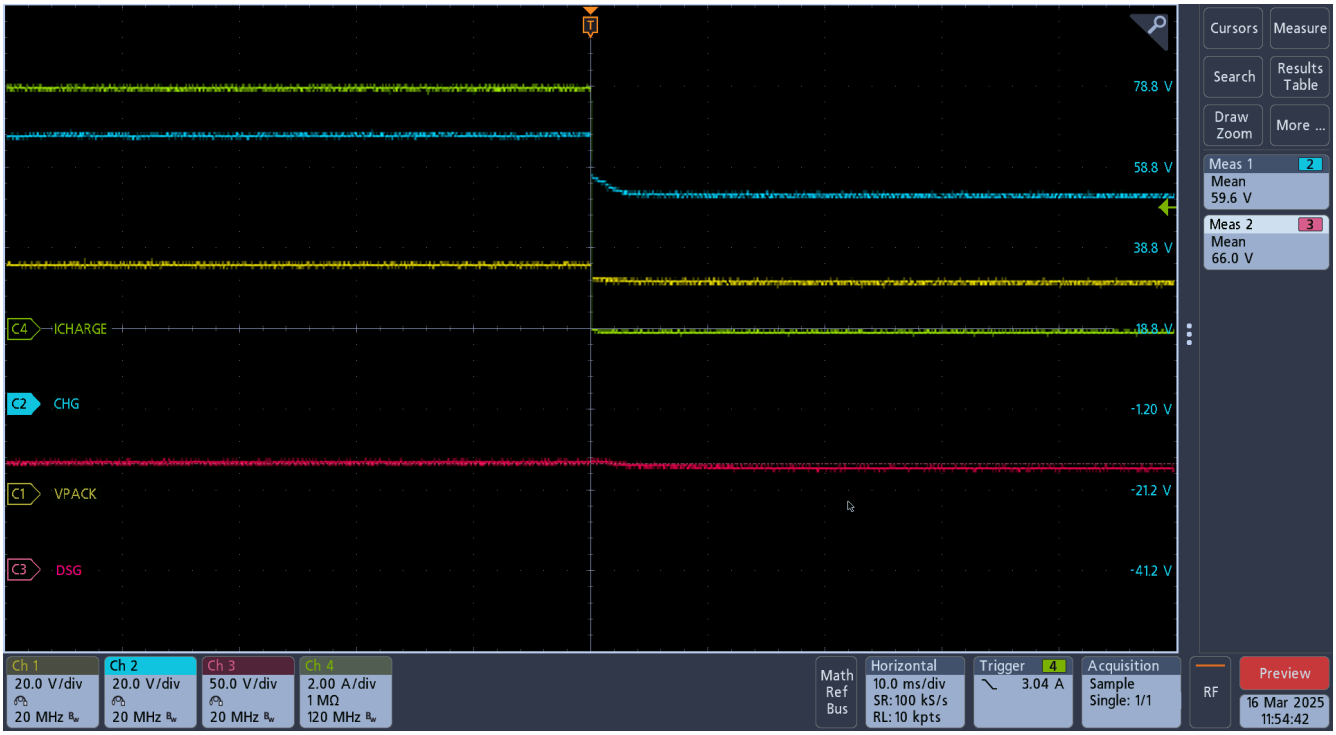


Figure 3-1. Overcurrent Protection at 6A During Charge

3.2 Overcurrent Protection During Discharge

Undervoltage protection is shown in Figure 3-2.

C1 (yellow): Vpack (20V-div)

C2 (pink): CHG (20V-div)

C3 (pink): DSG (50V-div)

C4 (green): Charge current (2A-div)

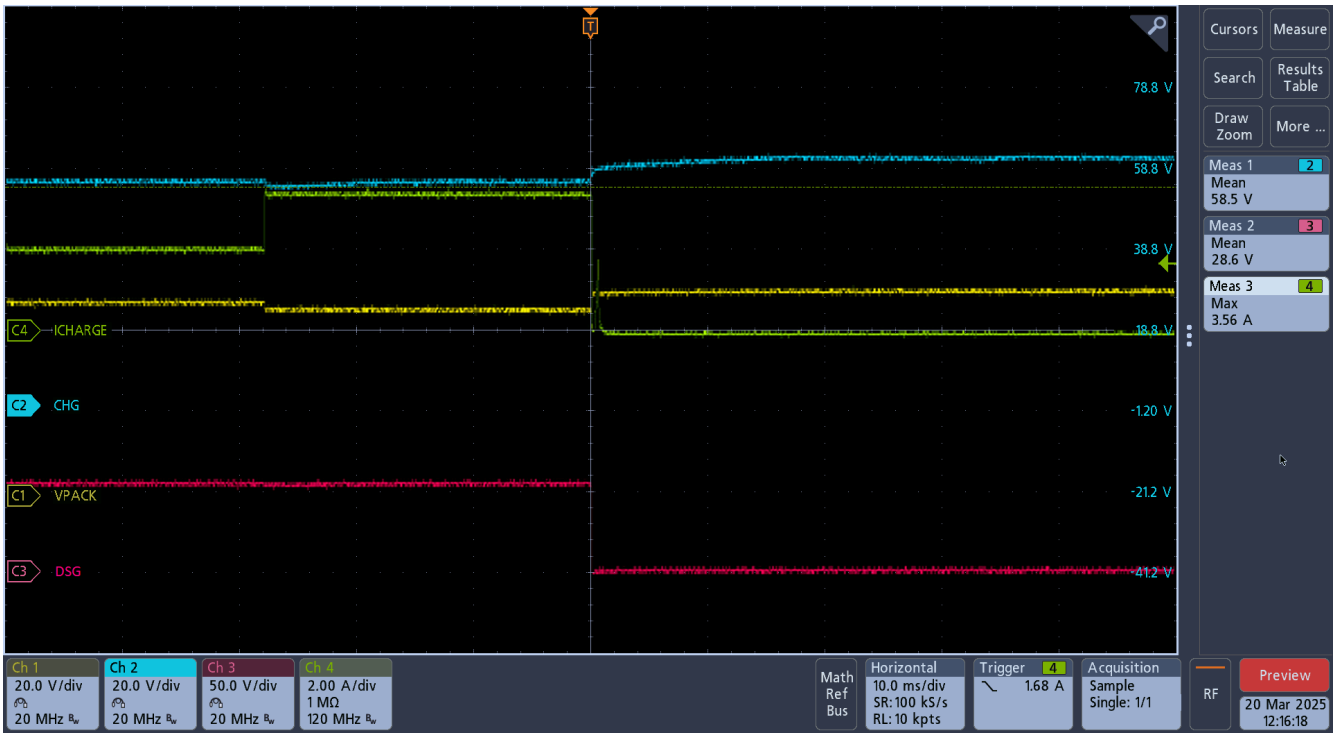


Figure 3-2. Overcurrent Protection at 3.5A During Discharge

3.3 Cell Undervoltage Protection

C1: VCell0 (1V-div)

C2: CHG (20V-div)

C3: DSG (50V-div)

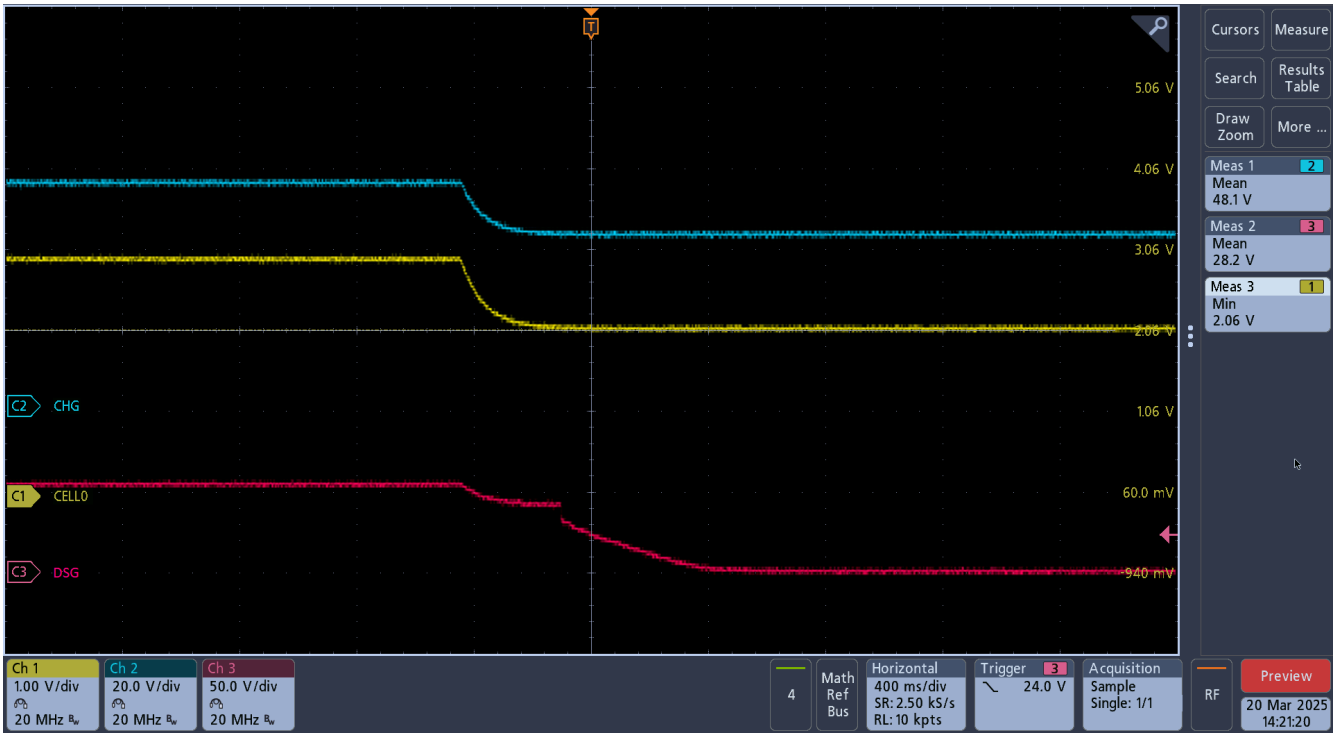


Figure 3-3. Cell Undervoltage Protection at 2.7V

3.4 Cell Overvoltage Protection

C1: VCell0 (1V-div)

C2: CHG (20V-div)

C3: DSG (50V-div)

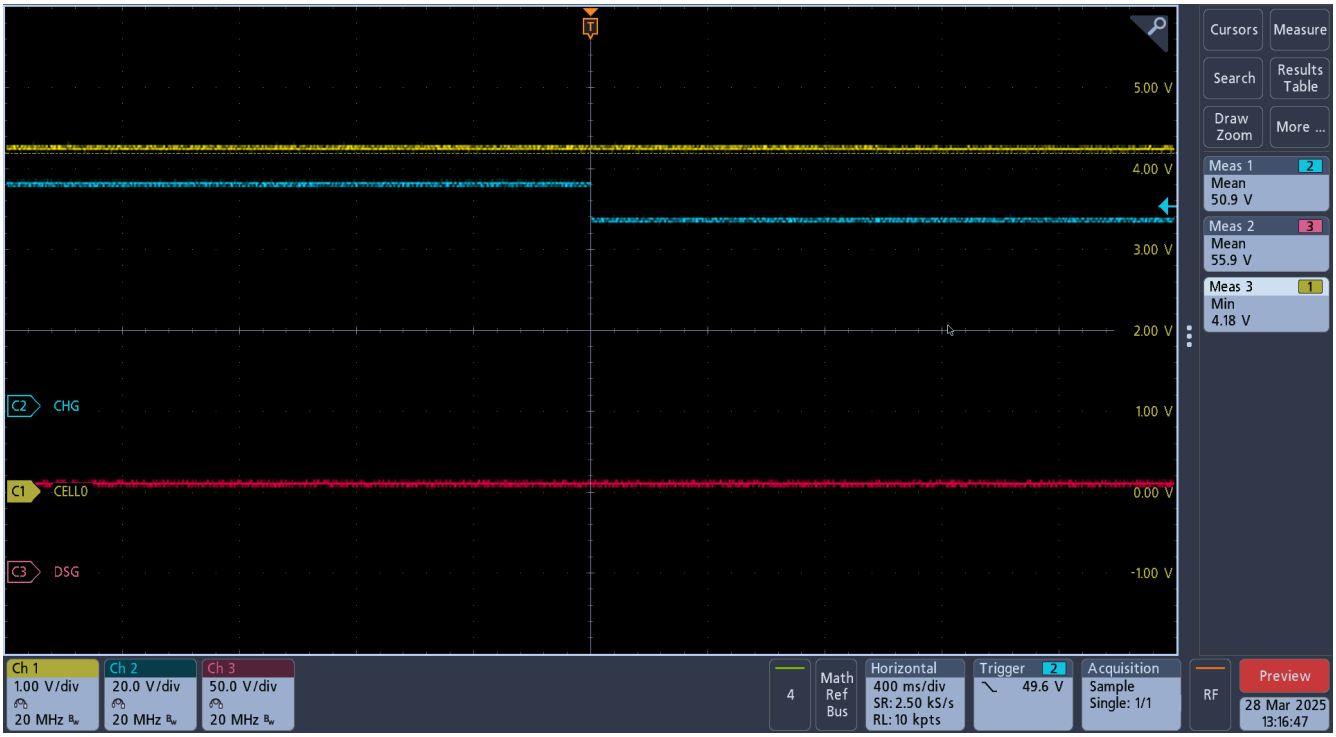


Figure 3-4. Cell Overvoltage Protection at 4.2V

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265