*Application Brief*

# *Battery Detection Using Single Cell Charger*

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## Introduction

For many systems, determining when a battery is present or not is helpful. If the battery is present, higher system loads can be supported, or a notification to the end user can be provided if the battery is removed. Furthermore, when a battery is removed from the BAT pin and there is an adapter present, the charger begins charging the capacitance on the battery node. Once the regulation voltage is reached the charge stops until the BAT pin voltage falls below the recharge threshold, then the charge starts again. This can lead to audible noise, added EMI, or SYS voltage fluctuations. To mitigate these issues, the integrated features of the BQ2562x and BQ2563x single cell chargers can be leveraged to detect the presence of a battery and enable or disable charge accordingly.

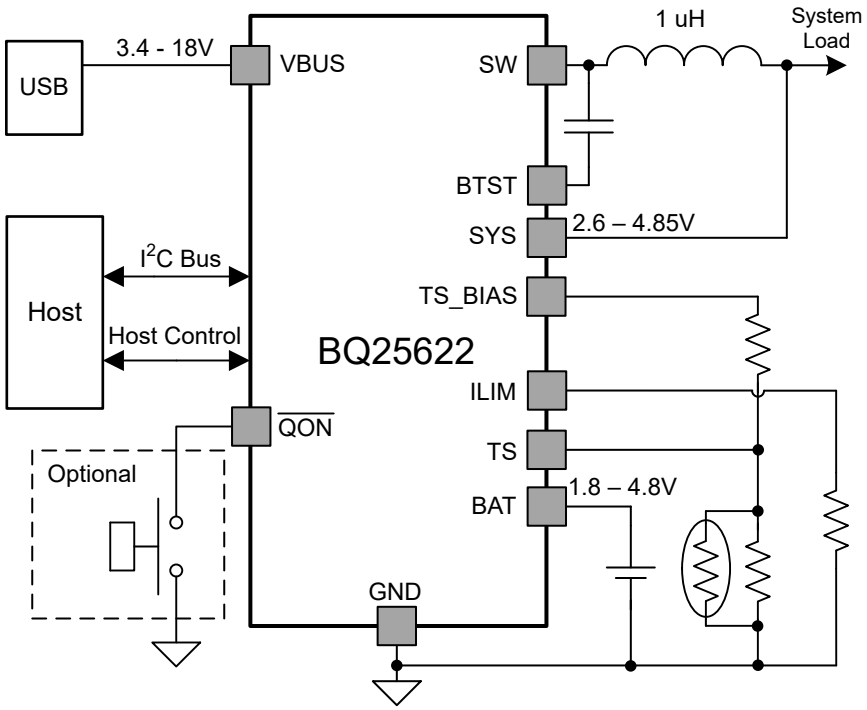


**Figure 1. BQ25622 Application Diagram**

### Battery Detection Method

The BQ2562x and BQ2563x charger families have the capability to apply an approximately 30mA discharge current on the BAT pin. This feature can be used to implement a battery detection algorithm. If there is no battery present, the 30mA discharge current removes any small capacitive charge on the BAT pin and causes the voltage to drop. When the battery is present, there is voltage on the BAT pin. In either case the battery voltage can be detected using the integrated ADC. If there is a protector IC used, the charger must be enabled for a short time to recover the Undervoltage Protection (UVP) of the protector IC. If VBAT is below $V_{REG}$-$V_{RECHG}$ while charge is enabled, the battery is present and the protector device is active. These methods allow for a quick way to check if the battery is inserted in the system; the methods do not require any additional components.

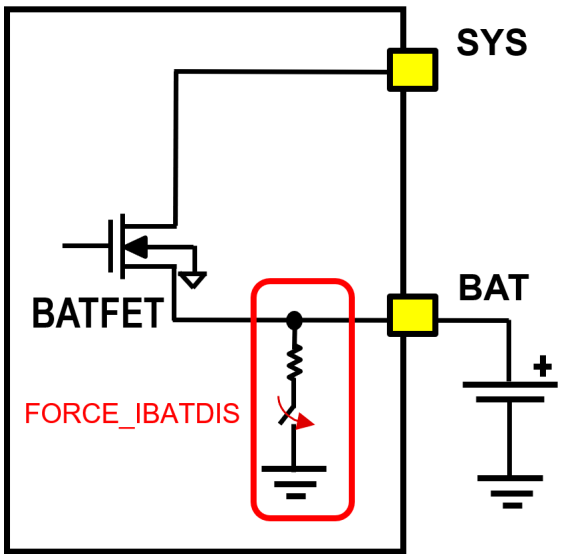


**Figure 2. BAT Pin Discharge Method**

### Battery Detection Sequence

To detect when the battery is removed or the UVP protection is active, the following steps can be executed on the host MCU firmware. The registers and bits provided in the sequences below correspond to the BQ2562x family of chargers. For other charger families, visit the data sheet register definitions.

To remove battery detection:

1. Make sure charging is disabled by either pulling the $\overline{CE}$ pin high or writing EN_CHG=0 (0x16[5]=0).
2. Enable IBAT discharge current by writing FORCE_IBATDIS=1 (0x16[6]=1).
3. Wait approximately 5ms.
4. Disable IBAT discharge current by writing FORCE_IBATDIS=0 (0x16[6]=0).
5. Set ADC to one-shot Mode and enable by writing ADC_RATE=1 (0x26[6]=1) & ADC_EN=1 (0x26[7]=1).
6. Readback VBAT ADC Value from 0x30.
7. If VBAT ADC Value is greater than the battery undervoltage threshold, valid battery attached and charge can be enabled EN_CHG=1 (0x16[5]=1).
8. If VBAT ADC value is less than the protector IC undervoltage threshold, continue to the next sequence to attempt recovery from UVP protection.

Make sure that there is long enough wait time in the firmware after enabling the ADC and before reading the value back between steps five and six. The conversion speed of the ADC can be adjusted, or only the VBAT ADC can be enabled to reduce ADC wait time.

Check and the recover protector IC:

1. Configure $V_{SYSMIN}$ = 3.84V (write 0x0E=0x0C00), $V_{REG}$ = 3.7V (write 0x04=0x0B90), Disable termination (write 0x14[2]=1), and disable PFM (write 0x18[4]=1)
2. Enable Charge by either pulling $\overline{CE}$ Pin low or writing EN_CHG=1 (0x16[5]=1)
3. Wait long enough time to close the discharge FET of the protector device.
4. Set ADC to One-Shot Mode and Enable by writing ADC_RATE=1 (0x26[6]=1) & ADC_EN=1 (0x26[7]=1)
5. Readback VBAT ADC Value from 0x30
6. If ($V_{REG}$-$V_{RECHG}$ - 100mV) is less than VBAT ADC Value, there is no valid battery attached. Disable charging by either pulling the $\overline{CE}$ pin high or writing EN_CHG=0 (0x16[5]=0).
7. If VBAT ADC Value < ($V_{REG}$-$V_{RECHG}$ + 100mV), valid battery attached and charge can continue.

The wait time in step three is dependent on the protection IC used for the battery. Tests are required to determine the exact wait period required to recover from UVP. The wait period is a function of how deeply discharged the battery is and the protector device recovery criteria. Once a determination has been made if the battery is present or not, all previous register configurations can be reset back to the application requirements.

### Example Waveforms

Testing was performed using a standard lithium-ion battery, BQ25620EVM, and BQ29700EVM.

When the battery is not present the initial FORCE_IBATDIS brings the battery voltage to 0V, then charge is enabled. After charge is enabled, VBAT fluctuates around $V_{REG}$-$V_{RECHG}$ and $V_{REG}$ which can be verified using the integrated VBAT ADC of the BQ25620 to confirm the battery is not attached.

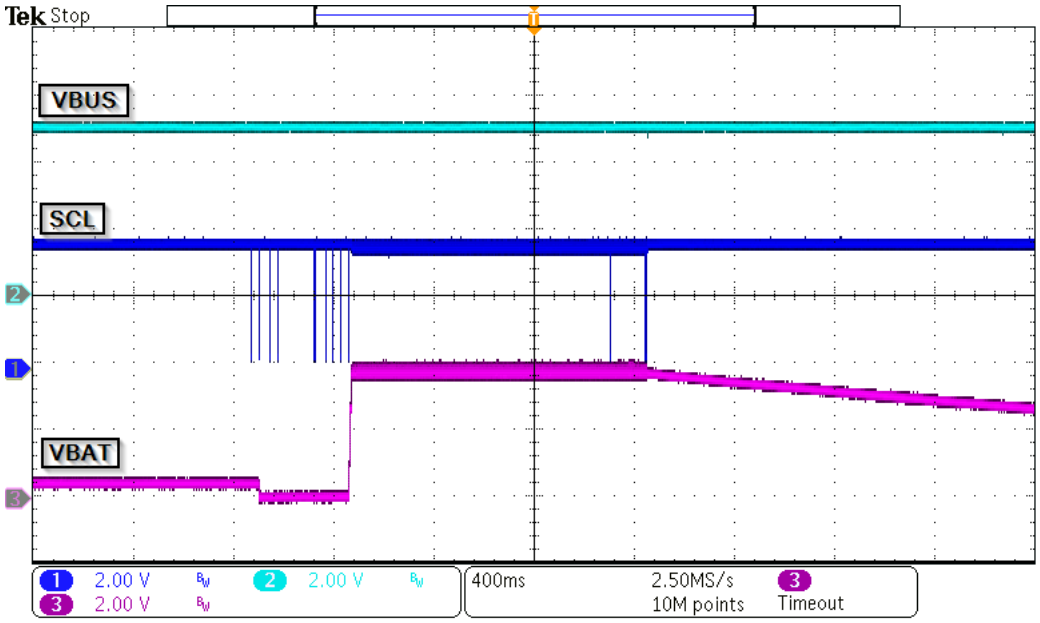


**Figure 3. Battery Not Present**

Only the first sequence is executed when the battery is detected since FORCE_IBATDIS does not pull VBAT below the UVP threshold.

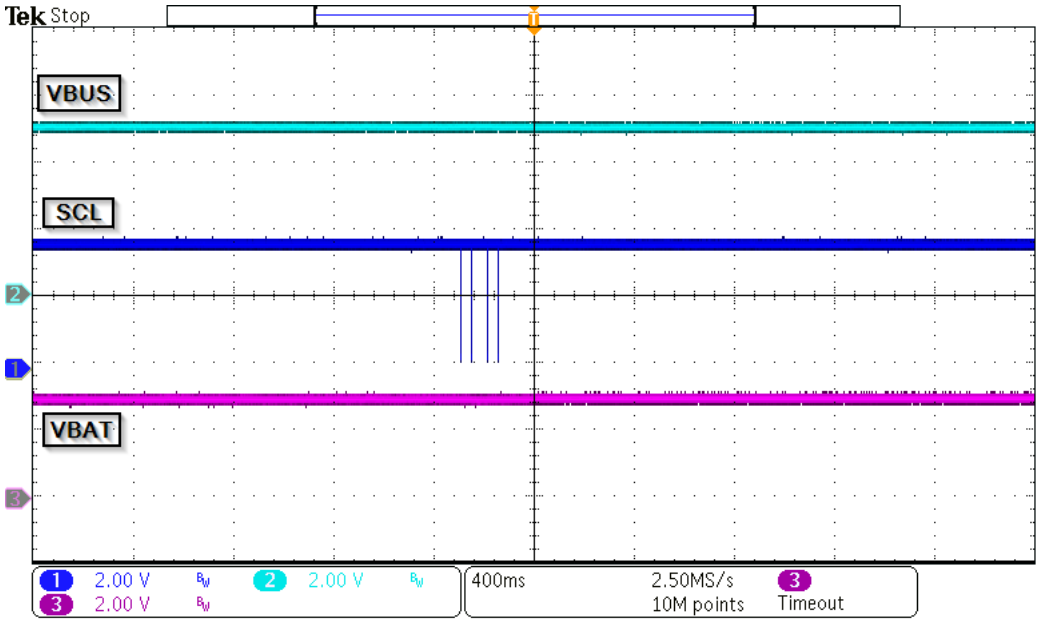


**Figure 4. Battery Present**

The protector UVP is recovered after approximately 800ms and the charge continues. The battery must be charged through the body diode of the discharge FET of the protector until $V_{UVP}$+$V_{HYS}$ is passed to allow the full recovery of the protector IC.

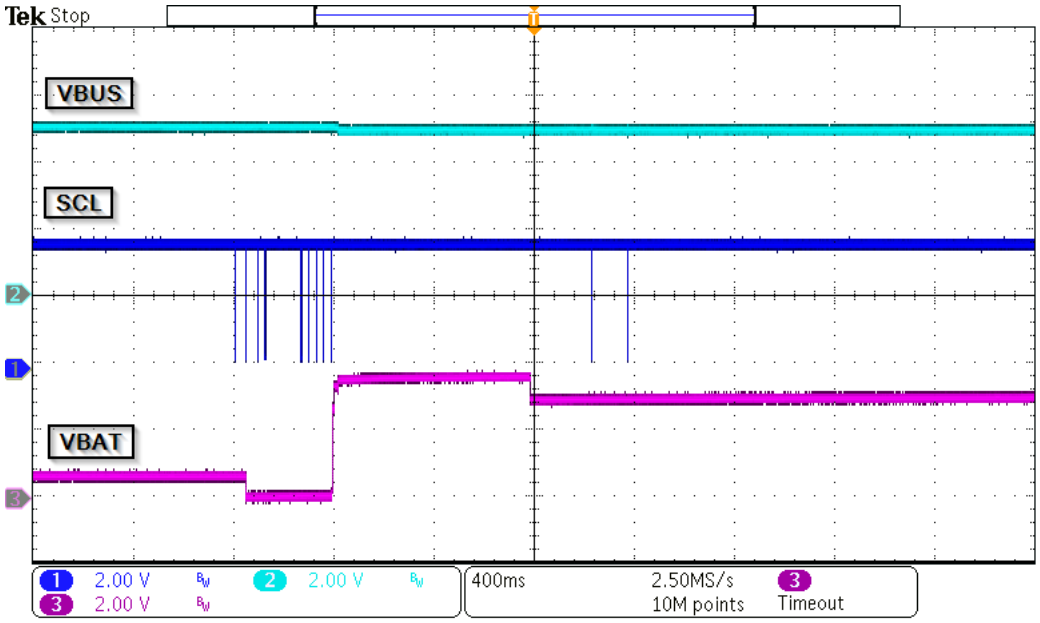


**Figure 5. Battery Present - UVP Recovery**

If the battery is deeply discharged, the voltage does not fully recover above $V_{UVP}$+$V_{HYS}$ within a short time. Depending on the protector IC that is used and how discharged the battery is determines how long the charge is enabled.

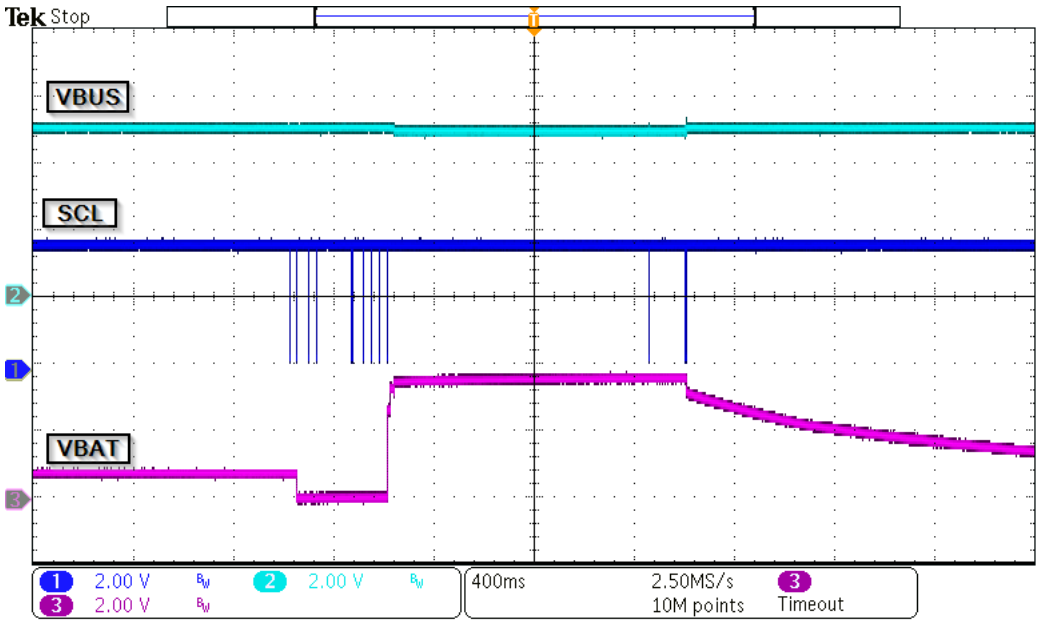


**Figure 6. Failed UVP Recovery**

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