TIDA-00657 Test Report

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Abstract

TI design TIDA-00657 is an SMBus 1- to 4-cell hybrid power boost mode battery charge controller with power and processor hot monitoring. The input voltage range is between 4.5 V and 24V, with a programmable output of 1–4 cells charge voltage and 128-mA to 8.128-A charge current. The first application circuit illustrates how bq24780S can be implemented. The second applications circuit shows how pairing the bq24780S with the ADS7924 allows for autonomous monitoring of the analog output pins of the battery charger and provides a threshold alarm to the overall system.

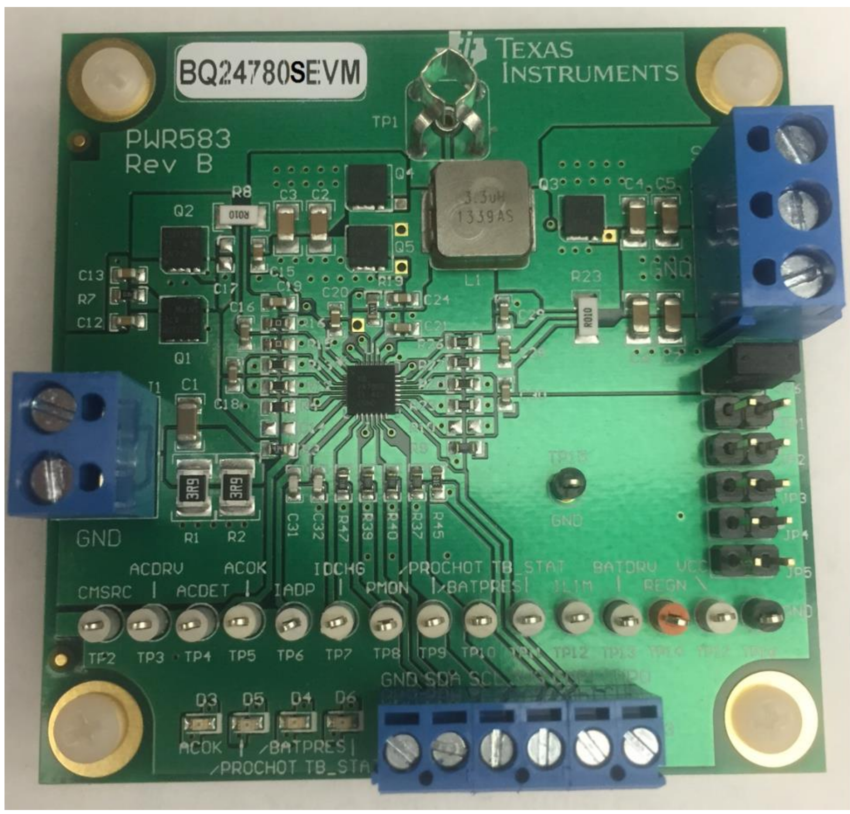

Figure 1. Board Photo

Document History

Version	Date	Author	Notes
1.0	07/2015	Wang Li	First release
2.0	9/14/17	Cynthia Sosa	Implementing ADS7924

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Bench Set up

- TIDA-00657 was tested on a bench setup using bq24780SEVM-583. The test equipment are as follows:
  - Oscilloscope: Tektronix TDS5054B
  - Passive Voltage Probes: Tektronix P6139A – 500 Mhz, 8 pF, 10 MΩ, 10x
  - Current Probe: Tektronix TCP202A Current Probe
  - Power Supply: Agilent E3634A 25V/7A, KEPCO BOP36-6M 36V/6A; 3.3V/1A bias supply
  - Electronic Load: HP 6060B 60V/6A
  - Multi-meter: HP 34401A

Application Circuits

- The application circuit shown in Figure 2 illustrates the implementation of a Li-Ion battery charger using bq24780S.

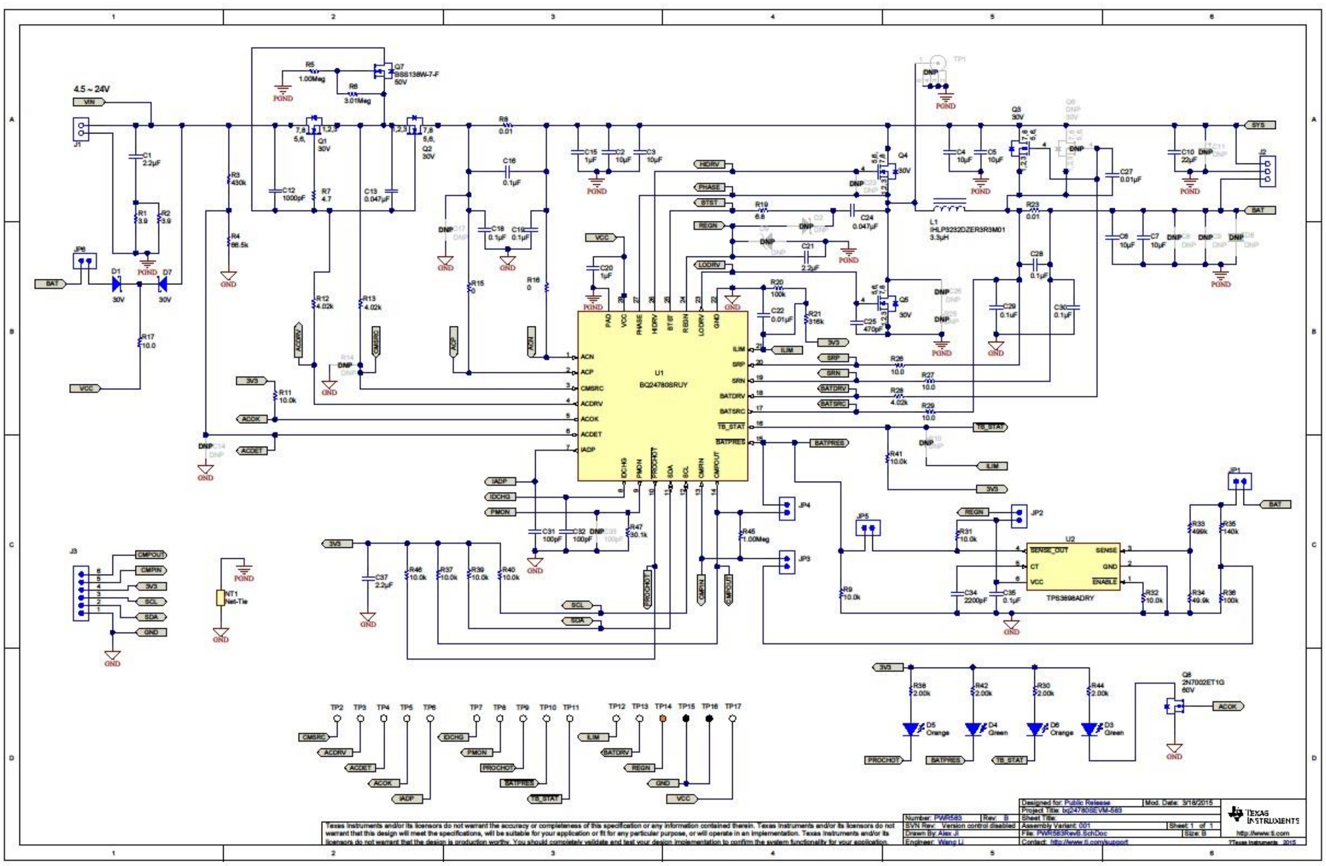


Figure 2. bq24780S Application Circuit

Efficiency

- Figure 3 shows the charging efficiency across the charge current range with the bq24780S at 25ºC.

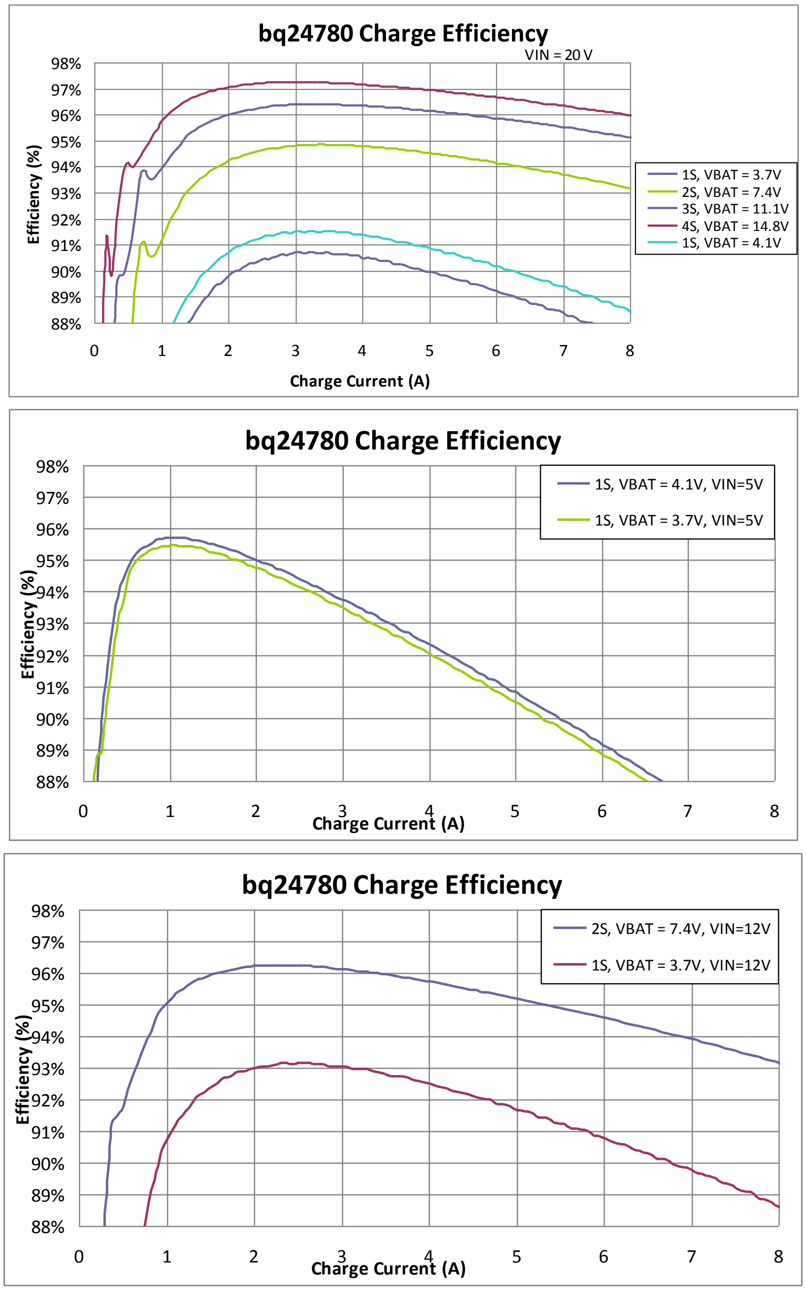


Figure 3. TIDA-00657 Charging Efficiency

Accuracy

- Figure 4 shows the bq24780S charge voltage accuracy across at 25ºC

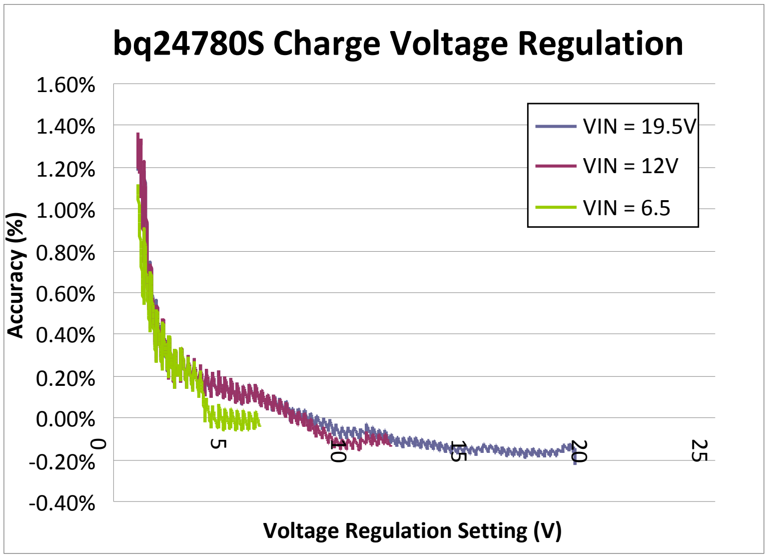


Figure 4. TIDA-00657 Charge Voltage Accuracy

- Figure 5 shows the bq24780S charge current accuracy at 25ºC.

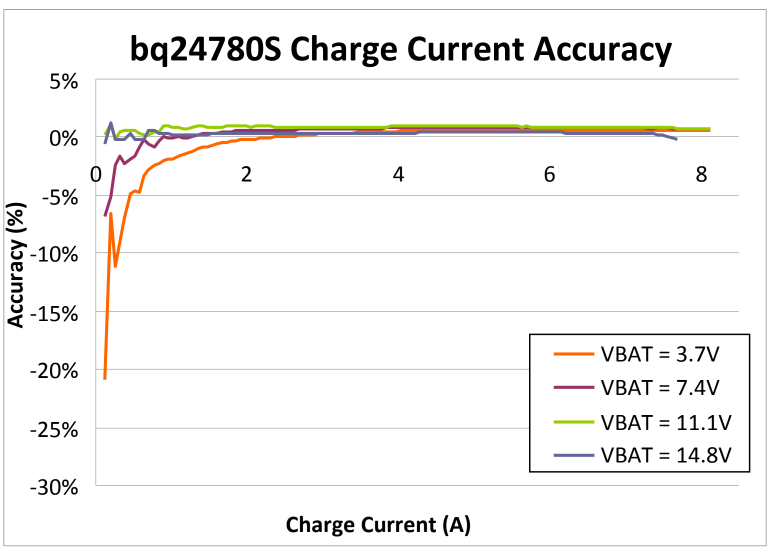


Figure 5. TIDA-00657 Charge Current Accuracy

- Figure 6 shows the bq24780S input current accuracy at 25ºC.

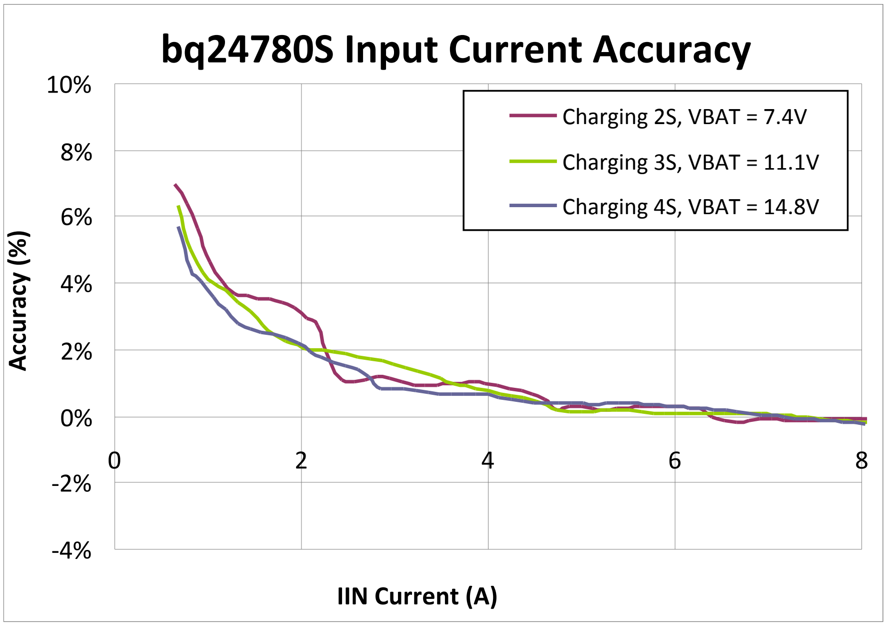


Figure 6. TIDA-00657 Input Current Accuracy

PMON Functions

- BATFET System Reset

PMON pin output current is proportional to the total power from the adapter and battery. The ratio is selectable through SMBus. Place a resistor from PMON pin to GND to generate PMON voltage. The resistor value is set so that the PMON voltage at peak system load doesn't exceed 3V. The PMON output voltage is clamped to 3.3 V. Place a 100-pF (or less) ceramic decoupling capacitor from PMON pin to GND. This pin can be floating if this output is not in use.

$$I_{PMON} = K_{PMON} \times \left(V_{IN} \times I_{IN} - V_{BAT} \times I_{BAT}\right) \qquad \textbf{(1)}$$

IBAT>0 during battery charging, IBAT<0 during battery discharging

$K_{PMON:}$ PMON Gain, REG0x3B[9]

Table 2. ChargeOption1 Register (REG0x3BH)

BIT	BIT NAME	DESCRIPTION
[13:12]	Input/Discharge Sense Resistor Ratio (RSNS_RATIO)	For PMON calculation. **00: RAC and RSR 1:1 (10mohm) <default @ POR>** 01: RAC and RSR 2:1 (20mohm/10mohm) 10: RAC and RSR 1:2 (10mohm/20mohm) 11: Reserved
[10]	EN_PMON	PMON output enable. **0: Disable PMON output to minimize Iq <default @ POR>** 1: Enable PMON output
[9]	PMON Gain (PMON_RATIO)	Ratio of PMON output current vs total input and battery power with 10mohm sense resistor. With the sense resistor is 10mohm (RAC and RSR) 0: 0.25uA/W **1: 1uA/W <default @ POR>** With the sense resistor is 20/10mohm or 10mohm/20mohm (RAC and RSR) 0: 0.125uA/W **1: 0.5uA/W <default @ POR>**

Figure 7 shows the bq24780S PMON accuracy at 25ºC.

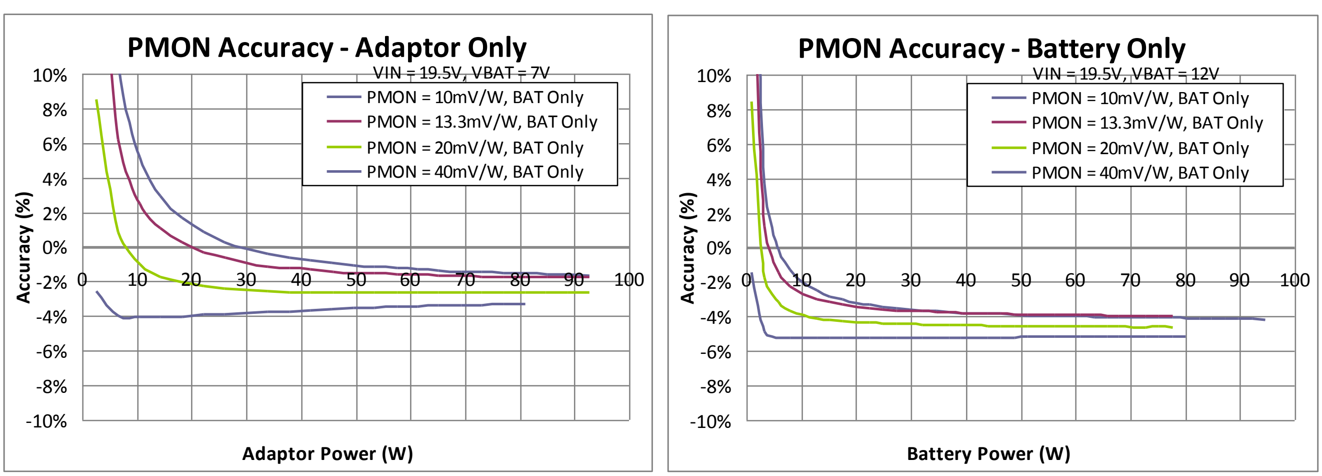


Figure 7. TIDA-00657 PMON accuracy

/PROCHOT Functions

The processor hot function in bq24780S monitors these events, and PROCHOT pulse is asserted.
The PROCHOT triggering events include:

- ICRIT: adapter peak current
- INOM: adapter average current (110% of input current limit)
- IDCHG: battery discharge current
- VSYS: system voltage on SRN for 2s - 4s battery
- ACOK: upon adapter removal (ACOK pin HIGH to LOW)
- BATPRES: upon battery removal (BATPRES pin LOW to HIGH)
- CMPOUT: Independent comparator output (CMPOUT pin HIGH to LOW)

The threshold of ICRIT, IDCHG or VSYS, and the deglitch time of ICRIT, INOM, IDCHG or CMPOUT are programmable through SMBus. Each triggering event can be individually enabled in REG0x3D[6:0].

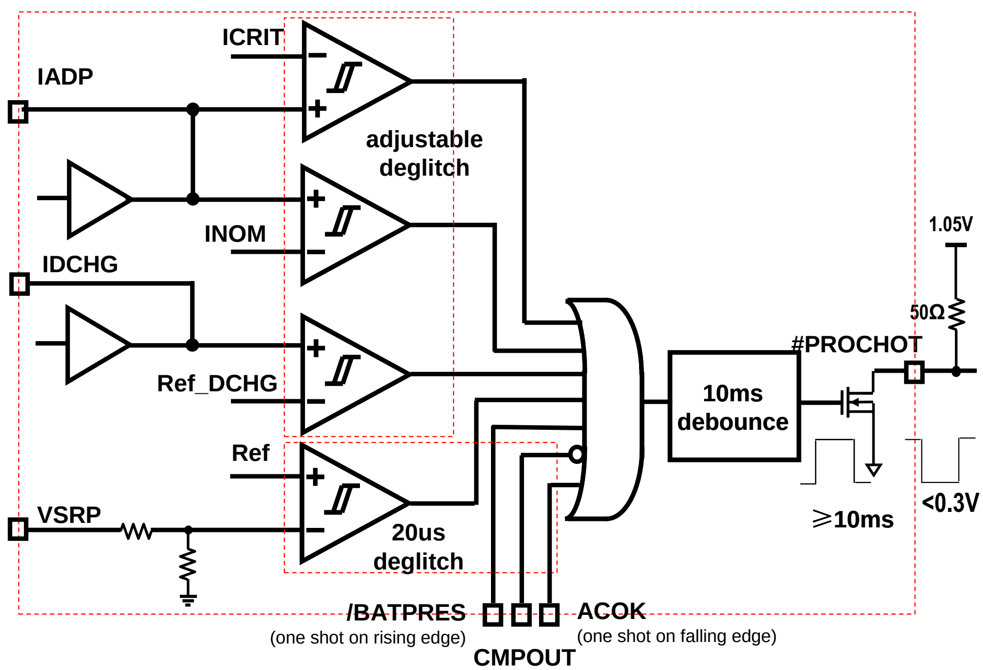
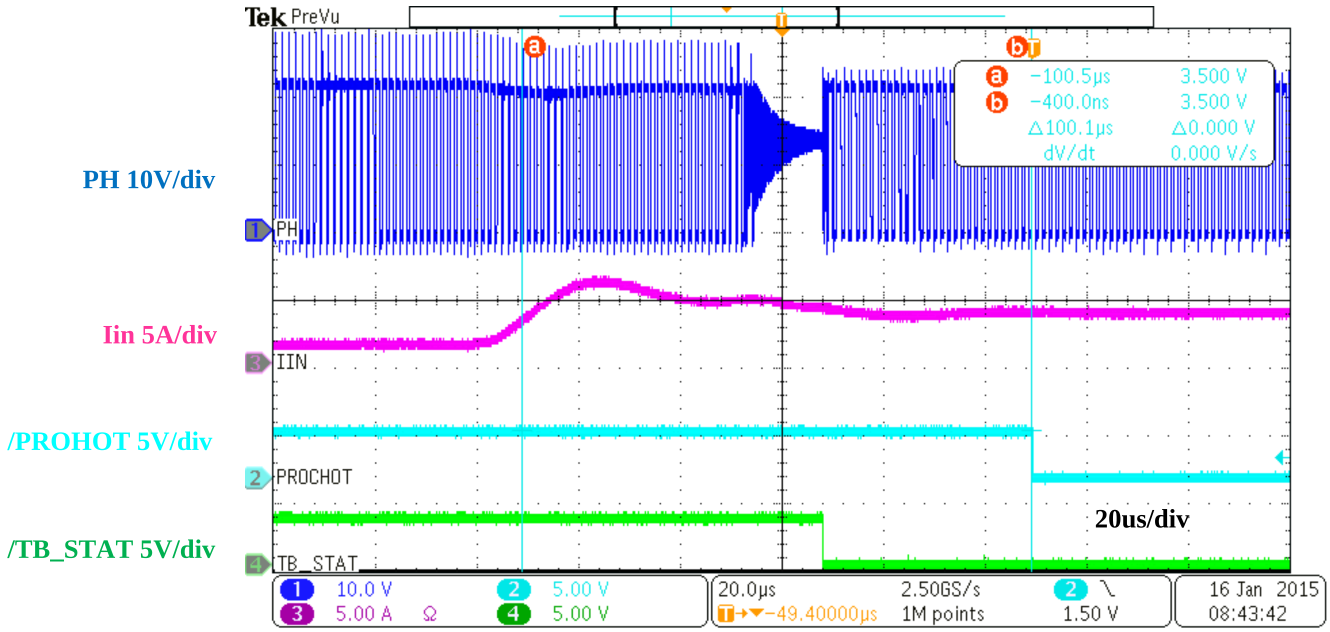


Figure 8 /PROCHOT block diagram

ProchotOption1 Register (REG0x3D[6:0])

BIT	BIT NAME	DESCRIPTION
[6:0]	/PROCHOT envelop selector (PROFILE)	When adapter is present, the /PROCHOT function is enabled by the below bits. When adapter is removed, ICRIT, INOM /BATPRES and ACOK functions are automatically disabled in the /PROCHOT profile. Independent comparator, IDCHG and VSYS function setting are preserved. When all the bits are 0, /PROCHOT function is disabled. Bit6: Independent comparator, **0: disable <default @ POR>**; 1: enable Bit5: ICRIT, 0: disable; **1: enable <default @ POR>** Bit4: INOM, **0: disable <default @ POR>**; 1: enable Bit3: IDCHG, **0: disable <default @ POR>**; 1: enable Bit2: VSYS, **0: disable <default @ POR>**; 1: enable Bit1: /BATPRES, **0: disable <default @ POR>** ; 1: enable (one-shot rising edge triggered) Bit0: ACOK, **0: disable <default @ POR>** ; 1: enable (one-shot falling edge triggered)



Vin=20V, VBAT = 13.3V, IIN = 2048mA, ICRIT threshold = 150%

Figure 8. TIDA-00657 /PROHOT System

Application Circuit II

- The second application circuit applies the previous implementation of the bq24780S and adds an ADS7924, as shown in Figure 9 below. The ADS7924 is a 12-bit, four-channel, low-power, successive approximation register (SAR) analog-to-digital converter (ADC) with a small footprint. The ADC has a digital comparator with programmable upper and lower limits for each of the four channels. Adding the ADC to the system allows the host to monitor the total power from the adapter and battery (PMON), as well as the discharge current (IDCHG) and the adapter current (IADP) of the battery. The ADC provides the host with an alarm on a dedicated interrupt output pin when any of the thresholds are crossed, allowing the host to take preventive measures.
- The remaining fourth ADC channel is available to monitor a different sensor or signal within the system.

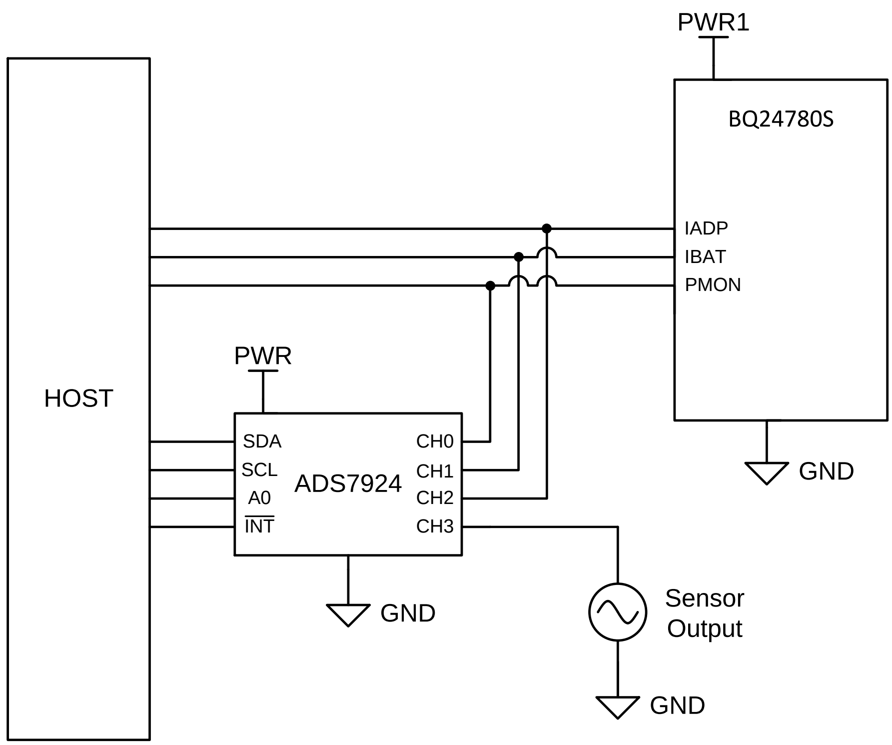


Figure 9. Block Diagram: Autonomous Monitoring Application using ADS7924

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