

# bq2510x 250mA 单节锂离子电池充电器, 1mA 终止电流、75nA 电池泄漏电流

## 1 特性

- 充电
  - 1% 充电电压准确度
  - 10% 充电电流准确度
  - 支持充电电流超低 (10mA 至 250mA) 的应用
  - 支持最低 1mA 充电终止电流
  - 超低电池输出泄漏电流: 75nA (最大值)
  - 可调节的终止和预充电阈值
  - 高电压化学支持: bq25100H/01H 为 4.35V, bq25100A 为 4.30V
- 保护
  - 30V 额定输入电压; 具有 6.5V 输入过压保护
  - 输入电压动态电源管理
  - 125°C 热调节; 150°C 热关断保护
  - OUT 短路保护和 ISET 短路检测
  - 通过电池负温度系数 (NTC) 在 JEITA 范围内运行 – 冷故障时的快速充电电流折半, 热故障时的电压为 4.06V (bq25100/01) 或 4.2V (bq25100H/01H)
  - 固定 10 小时安全定时器
- 系统
  - 针对电池组缺失情况的自动终止和定时器禁用模式 (TTDM)
  - 采用小型 1.60mm × 0.90mm 芯片尺寸球状引脚栅格阵列 (DSBGA) 封装

## 2 应用

- 健身配件
- 智能手表
- Bluetooth® 耳机
- 低功耗手持器件

## 3 说明

bq2510x 系列器件是面向空间受限类便携式应用的高度集成锂离子和锂聚合物线性充电器。具有输入过压保护的高输入电压范围支持低成本、未稳压的适配器。

bq2510x 具有一个可为电池充电的电源输出。如果在 10 小时的安全定时器期间内平均系统负载无法让电池充满电, 则可以使系统负载与电池并联。

电池充电经历以下三个阶段: 调节, 恒定电流和恒定电压。在所有充电阶段, 内部控制环路都会监控 IC 结温, 当其超过内部温度阈值时, 它会减少充电电流。

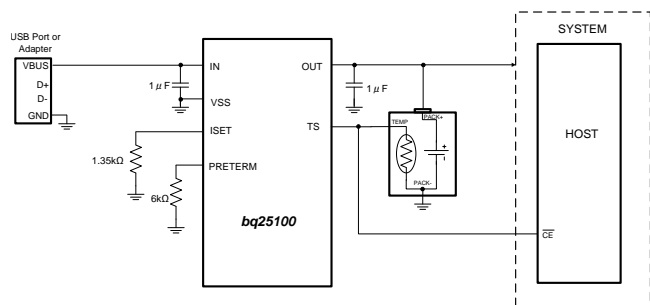
充电器功率级和充电电流感测功能均完全集成。该充电器具有高精度电流和电压调节环路以及充电终止功能。预充电电流和终止电流阈值可通过 bq2510x 上的一个外部电阻进行编程。快速充电电流值也可通过一个外部电阻进行编程。

### 器件信息(1)

| 器件型号                    | 封装        | 封装尺寸 (标称值)      |
|-------------------------|-----------|-----------------|
| bq25100                 | DSBGA (6) | 1.60mm × 0.90mm |
| bq25101                 | DSBGA (6) | 1.60mm × 0.90mm |
| bq25100A                | DSBGA (6) | 1.60mm × 0.90mm |
| bq25100H                | DSBGA (6) | 1.60mm × 0.90mm |
| bq25101H                | DSBGA (6) | 1.60mm × 0.90mm |
| bq25100L <sup>(2)</sup> | DSBGA (6) | 1.60mm × 0.90mm |

(1) 如需了解所有可用封装, 请见数据表末尾的可订购产品附录。

(2) 产品预览。欲了解器件的详细信息, 请联系当地的德州仪器 (TI) 代表。



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## 4 修订历史记录

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| <b>Changes from Revision B (October 2014) to Revision C</b>                   | <b>Page</b> |
|---|-------------|
| • 已更改 数据表标题.....  | <b>1</b>    |
| • 已删除 器件信息表中 bq25101H 的产品预览注释 .....   | <b>1</b>    |
| • Deleted product preview note from bq25101H in Device Comparison Table ..... | <b>3</b>    |

| <b>Changes from Revision A (September 2014) to Revision B</b>                             | <b>Page</b> |
|---|-------------|
| • 已删除 器件信息表中 bq25101 和 bq25100H 的产品预览注释.....  | <b>1</b>    |
| • Deleted product preview note from bq25101 and bq25100H in Device Comparison Table ..... | <b>3</b>    |

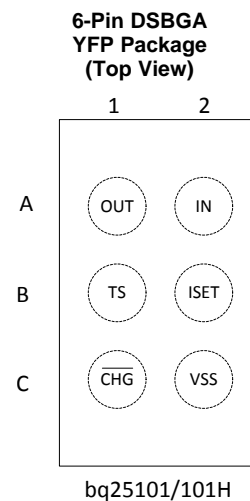
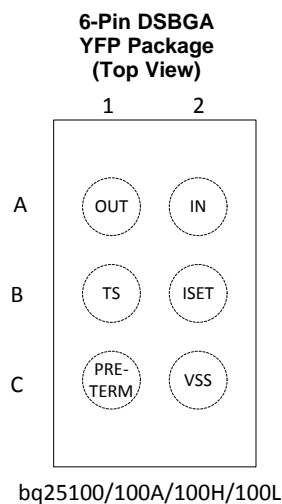
| <b>Changes from Original (August 2014) to Revision A</b> | <b>Page</b> |
|--|-------------|
| • 已发布为量产数据 .....   | <b>1</b>    |

## 5 Device Comparison Table

| PART NUMBER             | $V_{O(REG)}$ | $V_{OVP}$ | PreTerm $\overline{CHG}$ | TS         |
|-------------------------|--------------|-----------|--------------------------|------------|
| bq25100                 | 4.20 V       | 6.5 V     | PreTerm                  | TS (JEITA) |
| bq25101                 | 4.20 V       | 6.5 V     | $\overline{CHG}$         | TS (JEITA) |
| bq25100A                | 4.30 V       | 6.5 V     | PreTerm                  | TS         |
| bq25100H                | 4.35 V       | 6.5 V     | PreTerm                  | TS (JEITA) |
| bq25101H                | 4.35 V       | 6.5 V     | $\overline{CHG}$         | TS (JEITA) |
| bq25100L <sup>(1)</sup> | 4.06 V       | 6.5V      | PreTerm                  | TS         |

(1) Product preview. Contact the local TI representative for device details.

## 6 Pin Configuration and Functions



### Pin Functions

| PIN              |                   | I/O | DESCRIPTION   |
|------------------|-------------------|-----|---|
| NAME             | NUMBER            |     |   |
| $\overline{CHG}$ | C1 <sup>(1)</sup> |     | Low (FET on) indicates charging and open drain (FET off) indicates no charging or the first charge cycle complete.  |
| IN               | A2                | I   | Input power, connected to external DC supply (AC adapter or USB port). Expected range of bypass capacitors 1 $\mu$ F to 10 $\mu$ F, connect from IN to $V_{SS}$ .   |
| ISET             | B2                | I   | Programs the fast-charge current setting. External resistor from ISET to VSS defines fast charge current value. Recommended range is 13.5 k $\Omega$ (10 mA) to 0.54 k $\Omega$ (250 mA).   |
| OUT              | A1                | O   | Battery Connection. System Load may be connected. Expected range of bypass capacitors 1 $\mu$ F to 10 $\mu$ F.  |
| PRE-TERM         | C1 <sup>(1)</sup> | I   | Programs the current termination threshold ( 1% to 50% of Iout, 1mA minimum). The pre-charge current is twice the termination current level.<br>Expected range of programming resistor is 600 $\Omega$ to 30 k $\Omega$ (6k: Ichg/10 for term; Ichg/5 for precharge)  |
| TS               | B1                | I   | Temperature sense pin connected to 10k at 25°C NTC thermistor, in the battery pack. Floating TS pin or pulling high puts part in TTDM "Charger" mode and disables TS monitoring, Timers and Termination. Pulling pin low disables the IC. If NTC sensing is not needed, connect this pin to VSS through an external 10-k $\Omega$ resistor. A 250-k $\Omega$ resistor from TS to ground will prevent IC entering TTDM mode when battery with thermistor is removed. |
| VSS              | C2                | –   | Ground pin  |

(1) Spins have different pin definitions

## 7 Specifications

### 7.1 Absolute Maximum Ratings<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|                             |  | MIN  | MAX | UNIT |
|-----------------------------|--|------|-----|------|
| Input voltage               | IN (with respect to VSS)   | -0.3 | 30  | V    |
|                             | OUT (with respect to VSS)  | -0.3 | 7   | V    |
|                             | PRE-TERM, ISET, TS, $\overline{\text{CHG}}$<br>(with respect to VSS) | -0.3 | 7   | V    |
| Input current               | IN   |      | 300 | mA   |
| Output current (continuous) | OUT  |      | 300 | mA   |
| Output sink current         | $\overline{\text{CHG}}$  |      | 15  | mA   |
| T <sub>J</sub>              | Junction temperature   | -40  | 150 | °C   |

- (1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. All voltage values are with respect to the network ground terminal unless otherwise noted.

### 7.2 Handling Ratings

|                  |  |             |   | MIN | MAX                    | UNIT |
|------------------|--|-------------|---|-----|------------------------|------|
| ESD              | Electrostatic discharge<br>(IEC61000-4-2) <sup>(1)</sup> | IN, OUT, TS | 1 $\mu\text{F}$ between IN and GND,<br>1 $\mu\text{F}$ between TS and GND,<br>2 $\mu\text{F}$ between OUT and GND,<br>x5R Ceramic or equivalent |     | 8<br>contact<br>15 Air | kV   |
| T <sub>STG</sub> | Storage temperature                                      |             |   | -65 | 150                    | °C   |

- (1) The test was performed on IC pins that may potentially be exposed to the customer at the product level. The bq2510x IC requires a minimum of the listed capacitance, external to the IC, to pass the ESD test.

### 7.3 Recommended Operating Conditions<sup>(1)</sup>

|                       |   | MIN  | NOM  | UNIT       |
|-----------------------|---|------|------|------------|
| V <sub>IN</sub>       | IN voltage range  | 3.5  | 28   | V          |
|                       | IN operating voltage range, Restricted by V <sub>DPM</sub> and V <sub>OVP</sub> | 4.45 | 6.45 | V          |
| I <sub>IN</sub>       | Input current, IN pin   |      | 250  | mA         |
| I <sub>OUT</sub>      | Current, OUT pin  |      | 250  | mA         |
| T <sub>J</sub>        | Junction temperature  | 0    | 125  | °C         |
| R <sub>PRE-TERM</sub> | Programs precharge and termination current thresholds                           | 0.6  | 30   | k $\Omega$ |
| R <sub>ISET</sub>     | Fast-charge current programming resistor  | 0.54 | 13.5 | k $\Omega$ |
| R <sub>TS</sub>       | 10k NTC thermistor range without entering $\overline{\text{BAT\_EN}}$ or TTDM   | 1.66 | 258  | k $\Omega$ |

- (1) Operation with V<sub>IN</sub> less than 4.5V or in drop-out may result in reduced performance.

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | bq25100      | UNIT |
|-------------------------------|--|--------------|------|
|                               |  | YFP (6 PINS) |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 132.9        | °C/W |
| R <sub>θJctop</sub>           | Junction-to-case (top) thermal resistance    | 1.3          |      |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 21.8         |      |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 5.6          |      |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 21.8         |      |
| R <sub>θJcbot</sub>           | Junction-to-case (bottom) thermal resistance | n/a          |      |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](http://SPRA953).

## 7.5 Electrical Characteristics

 Over junction temperature range  $0^{\circ}\text{C} \leq T_J \leq 125^{\circ}\text{C}$  and recommended supply voltage (unless otherwise noted)

| PARAMETER                          |   | TEST CONDITIONS   | MIN   | TYP  | MAX   | UNIT          |
|------------------------------------|---|---|-------|------|-------|---------------|
| <b>INPUT</b>                       |   |   |       |      |       |               |
| UVLO                               | Undervoltage lock-out exit  | $V_{IN}: 0\text{ V} \rightarrow 4\text{ V}$   | 3.15  | 3.3  | 3.45  | V             |
| $V_{HYS\_UVLO}$                    | Hysteresis on $V_{UVLO\_RISE}$ falling                                | $V_{IN}: 4\text{ V} \rightarrow 0\text{ V};$<br>$V_{UVLO\_FALL} = V_{UVLO\_RISE} - V_{HYS\_UVLO}$   |       | 250  |       | mV            |
| $V_{IN\_DT}$                       | Input power good detection threshold is $V_{OUT} + V_{IN\_DT}$        | Input power good if $V_{IN} > V_{OUT} + V_{IN\_DT};$<br>$V_{OUT} = 3.6\text{ V}; V_{IN}: 3.5\text{ V} \rightarrow 4\text{ V}$   | 15    | 60   | 130   | mV            |
| $V_{HYS\_INDT}$                    | Hysteresis on $V_{IN\_DT}$ falling                                    | $V_{OUT} = 3.6\text{ V}; V_{IN}: 4\text{ V} \rightarrow 3.5\text{ V}$   |       | 31   |       | mV            |
| $t_{DGL(PG\_PWR)}$                 | Deglintch time on exiting sleep                                       | Time measured from $V_{IN}: 0\text{ V} \rightarrow 5\text{ V}$ 1- $\mu\text{s}$ rise-time to charge enables; $V_{OUT} = 3.6\text{ V}$   |       | 29   |       | ms            |
| $t_{DGL(PG\_NO\_PWR)}$             | Deglintch time on $V_{HYS\_INDT}$ power down. Same as entering sleep. | Time measured from $V_{IN}: 5\text{ V} \rightarrow 3.2\text{ V}$ 1- $\mu\text{s}$ fall-time to charge disables; $V_{OUT} = 3.6\text{ V}$  |       | 29   |       | ms            |
| $V_{OVP}$                          | Input over-voltage protection threshold                               | $V_{IN}: 5\text{ V} \rightarrow 12\text{ V}$  | 6.52  | 6.67 | 6.82  | V             |
| $t_{DGL(OVP\_SET)}$                | Input over-voltage blanking time                                      | $V_{IN}: 5\text{ V} \rightarrow 12\text{ V}$  |       | 113  |       | $\mu\text{s}$ |
| $V_{HYS\_OVP}$                     | Hysteresis on OVP   | $V_{IN}: 11\text{ V} \rightarrow 5\text{ V}$  |       | 110  |       | mV            |
| $t_{DGL(OVP\_REC)}$                | Deglintch time exiting OVP  | Time measured from $V_{IN}: 12\text{ V} \rightarrow 5\text{ V}$ 1- $\mu\text{s}$ fall-time to charge enables  |       | 450  |       | $\mu\text{s}$ |
| $V_{IN\_DPM}$                      | Low input voltage protection. Restricts Iout at $V_{IN\_DPM}$         | Limit input source current to 50 mA;<br>$V_{OUT} = 3.5\text{ V}; R_{ISET} = 1.35\text{ k}\Omega$  | 4.25  | 4.31 | 4.37  | V             |
| <b>ISET SHORT CIRCUIT TEST</b>     |   |   |       |      |       |               |
| $R_{ISET\_SHORT}$                  | Highest resistor value considered a fault (short).                    | $R_{ISET}: 540\ \Omega \rightarrow 250\ \Omega$ , Iout latches off;<br>Cycle power to reset   |       | 420  | 450   | $\Omega$      |
| $t_{DGL\_SHORT}$                   | Deglintch time transition from ISET short to Iout disable             | Clear fault by disconnecting IN or cycling (high / low) TS/BAT_EN   |       | 1    |       | ms            |
| $I_{OUT\_CL}$                      | Maximum OUT current limit regulation (Clamp)                          | $V_{IN} = 5\text{ V}; V_{OUT} = 3.6\text{ V}; R_{ISET}: 540\ \Omega \rightarrow 250\ \Omega;$<br>Iout latches off after $t_{DGL\_SHORT}$  | 550   | 600  | 650   | mA            |
| <b>BATTERY SHORT PROTECTION</b>    |   |   |       |      |       |               |
| $V_{OUT(SC)}$                      | OUT pin short-circuit detection threshold/ precharge threshold        | $V_{OUT}: 3\text{ V} \rightarrow 0.5\text{ V};$ No deglitch   | 0.75  | 0.8  | 0.85  | V             |
| $V_{OUT(SC\_HYS)}$                 | OUT pin Short hysteresis  | Recovery $\geq V_{OUT(SC)} + V_{OUT(SC\_HYS)}$ ; Rising; No deglitch  |       | 77   |       | mV            |
| $I_{OUT(SC)}$                      | Source current to OUT pin during short-circuit detection              |   | 9     | 11   | 13    | mA            |
| <b>QUIESCENT CURRENT</b>           |   |   |       |      |       |               |
| $I_{OUT(PDWN)}$                    | Battery current into OUT pin  | $V_{IN} = 0\text{ V}; 0^{\circ}\text{C}$ to $125^{\circ}\text{C}$   |       |      | 75    | nA            |
|                                    |   | $V_{IN} = 0\text{ V}; 0^{\circ}\text{C}$ to $85^{\circ}\text{C}$  |       |      | 50    |               |
| $I_{OUT(DONE)}$                    | OUT pin current, charging terminated                                  | $V_{IN} = 6\text{ V}; V_{OUT} > V_{OUT(REG)}$   |       |      | 6     | $\mu\text{A}$ |
| $I_{IN(STDBY)}$                    | Standby current into IN pin   | TS = GND; $V_{IN} \leq 6\text{ V}$  |       |      | 125   | $\mu\text{A}$ |
| $I_{CC}$                           | Active supply current, IN pin   | TS = open, $V_{IN} = 6\text{ V};$<br>TTDM – no load on OUT pin; $V_{OUT} > V_{OUT(REG)};$<br>IC enabled   |       | 0.75 | 1     | mA            |
| <b>BATTERY CHARGER FAST-CHARGE</b> |   |   |       |      |       |               |
| $V_{OUT(REG)}$                     | Output voltage  | $T_J = 0^{\circ}\text{C}$ to $125^{\circ}\text{C}; I_{OUT} = 0\text{ mA}$ to $250\text{ mA};$<br>$V_{IN} = 5.0\text{ V}; V_{TS-45^{\circ}\text{C}} \leq V_{TS} \leq V_{TS-0^{\circ}\text{C}}$ (bq25100/101)   | 4.16  | 4.2  | 4.23  | V             |
|                                    |   | $T_J = 0^{\circ}\text{C}$ to $125^{\circ}\text{C}; I_{OUT} = 0\text{ mA}$ to $250\text{ mA};$<br>$V_{IN} = 5.0\text{ V}; V_{TS-45^{\circ}\text{C}} \leq V_{TS} \leq V_{TS-0^{\circ}\text{C}}$ (bq25100A)      | 4.26  | 4.3  | 4.33  |               |
|                                    |   | $T_J = 0^{\circ}\text{C}$ to $125^{\circ}\text{C}; I_{OUT} = 0\text{ mA}$ to $250\text{ mA};$<br>$V_{IN} = 5.0\text{ V}; V_{TS-45^{\circ}\text{C}} \leq V_{TS} \leq V_{TS-0^{\circ}\text{C}}$ (bq25100H/101H) | 4.31  | 4.35 | 4.38  |               |
|                                    |   | $T_J = -5^{\circ}\text{C}$ to $55^{\circ}\text{C}; I_{OUT} = 10\text{ mA}$ to $75\text{ mA};$<br>$V_{IN} = 5.0\text{ V}; V_{TS-45^{\circ}\text{C}} \leq V_{TS} \leq V_{TS-0^{\circ}\text{C}}$ (bq25100A)      | 4.275 | 4.3  | 4.325 |               |
| $V_{O\_HT(REG)}$                   | Battery hot regulation voltage  | $V_{IN} = 5.0\text{ V}; I_{OUT} = 10\text{ mA}$ to $250\text{ mA};$<br>$V_{TS-60^{\circ}\text{C}} \leq V_{TS} \leq V_{TS-45^{\circ}\text{C}}$ (bq25100/101)   | 4.02  | 4.06 | 4.1   | V             |
|                                    |   | $V_{IN} = 5.0\text{ V}; I_{OUT} = 10\text{ mA}$ to $250\text{ mA};$<br>$V_{TS-60^{\circ}\text{C}} \leq V_{TS} \leq V_{TS-45^{\circ}\text{C}}$ (bq25100H/101H)   | 4.16  | 4.2  | 4.24  |               |
| $I_{OUT(RANGE)}$                   | Programmed output "fast charge" current range                         | $V_{OUT(REG)} > V_{OUT} > V_{LOWV}; V_{IN} = 5\text{ V};$<br>$R_{ISET} = 0.54\text{ k}\Omega$ to $13.5\text{ k}\Omega$  | 10    |      | 250   | mA            |

## Electrical Characteristics (continued)

 Over junction temperature range  $0^{\circ}\text{C} \leq T_J \leq 125^{\circ}\text{C}$  and recommended supply voltage (unless otherwise noted)

| PARAMETER                                |   | TEST CONDITIONS   | MIN                      | TYP                          | MAX                      | UNIT           |
|--|---|---|--------------------------|------------------------------|--------------------------|----------------|
| $V_{DO(IN-OUT)}$                         | Drop-Out, $V_{IN} - V_{OUT}$  | Adjust $V_{IN}$ down until $I_{OUT} = 0.2\text{ A}$ ; $V_{OUT} = 4.15\text{ V}$ ; $R_{ISET} = 680\ \Omega$ ; $T_J \leq 100^{\circ}\text{C}$   |                          | 220                          | 400                      | mV             |
| $I_{OUT}$                                | Output "fast charge" formula  | $V_{OUT(REG)} > V_{OUT} > V_{LOWV}$ ; $V_{IN} = 5\text{ V}$   |                          | $K_{ISET}/R_{ISET}$          |                          | A              |
| $K_{ISET}$                               | Fast charge current factor  | $R_{ISET} = K_{ISET}/I_{OUT}$ ; $20 < I_{OUT} < 250\text{ mA}$  | 129                      | 135                          | 145                      | A $\Omega$     |
|  |   | $R_{ISET} = K_{ISET}/I_{OUT}$ ; $5 < I_{OUT} < 20\text{ mA}$  | 125                      | 135                          | 145                      |                |
| <b>PRECHARGE – SET BY PRETERM PIN</b>    |   |   |                          |                              |                          |                |
| $V_{LOWV}$                               | Pre-charge to fast-charge transition threshold  |   | 2.4                      | 2.5                          | 2.6                      | V              |
| $t_{DGL1(LOWV)}$                         | Deglintch time on pre-charge to fast-charge transition  |   |                          | 57                           |                          | $\mu\text{s}$  |
| $t_{DGL2(LOWV)}$                         | Deglintch time on fast-charge to pre-charge transition  |   |                          | 32                           |                          | ms             |
| $I_{PRE-TERM}$                           | Refer to the Termination Section  |   |                          |                              |                          |                |
| $\%PRECHG$                               | Pre-charge current, default setting   | $V_{OUT} < V_{LOWV}$ ; $R_{ISET} = 2.7\text{ k}\Omega$ ; $R_{PRE-TERM} = \text{High Z}$ or for BQ25101/101H   | 18                       | 20                           | 22                       | $\%I_{OUT-CC}$ |
|  | Pre-charge current formula  | $R_{PRE-TERM} = K_{PRE-CHG}(\Omega/\%) \times \%PRE-CHG(\%)$  |                          | $R_{PRE-TERM}/K_{PRE-CHG\%}$ |                          |                |
| $K_{PRE-CHG}$                            | % Pre-charge Factor   | $V_{OUT} < V_{LOWV}$ ; $V_{IN} = 5\text{ V}$ ; $R_{PRE-TERM} = 6\text{ k}\Omega$ to $30\text{ k}\Omega$ ; $R_{ISET} = 1.8\text{ k}\Omega$ ; $R_{PRE-TERM} = K_{PRE-CHG} \times \%I_{PRE-CHG}$ , where $\%I_{PRE-CHG}$ is 20 to 100% | 280                      | 300                          | 320                      | $\Omega/\%$    |
|  |   | $V_{OUT} < V_{LOWV}$ ; $V_{IN} = 5\text{ V}$ ; $R_{PRE-TERM} = 3\text{ k}\Omega$ to $6\text{ k}\Omega$ ; $R_{ISET} = 1.8\text{ k}\Omega$ ; $R_{PRE-TERM} = K_{PRE-CHG} \times \%I_{PRE-CHG}$ , where $\%I_{PRE-CHG}$ is 10% to 20%  | 265                      | 300                          | 340                      | $\Omega/\%$    |
| <b>TERMINATION – SET BY PRE-TERM PIN</b> |   |   |                          |                              |                          |                |
| $\%TERM$                                 | Termination threshold current, default setting  | $V_{OUT} > V_{RCH}$ ; $R_{ISET} = 2.7\text{ k}\Omega$ ; $R_{PRE-TERM} = \text{High Z}$ or for BQ25101/101H  | 9                        | 10                           | 11                       | $\%I_{OUT-CC}$ |
|  | Termination current threshold formula   | $R_{PRE-TERM} = K_{TERM}(\Omega/\%) \times \%TERM(\%)$  |                          | $R_{PRE-TERM}/K_{TERM}$      |                          |                |
| $K_{TERM}$                               | % Term factor   | $V_{OUT} > V_{RCH}$ ; $V_{IN} = 5\text{ V}$ ; $R_{PRE-TERM} = 6\text{ k}\Omega$ to $30\text{ k}\Omega$ ; $R_{ISET} = 1.8\text{ k}\Omega$ ; $R_{PRE-TERM} = K_{TERM} \times \%I_{TERM}$ , where $\%I_{TERM}$ is 10 to 50%            | 575                      | 600                          | 640                      | $\Omega/\%$    |
|  |   | $V_{OUT} > V_{RCH}$ ; $V_{IN} = 5\text{ V}$ ; $R_{PRE-TERM} = 3\text{ k}\Omega$ to $6\text{ k}\Omega$ ; $R_{ISET} = 1.8\text{ k}\Omega$ ; $R_{PRE-TERM} = K_{TERM} \times \%I_{TERM}$ , where $\%I_{TERM}$ is 5 to 10%              | 555                      | 620                          | 685                      |                |
|  |   | $V_{OUT} > V_{RCH}$ ; $V_{IN} = 5\text{ V}$ ; $R_{PRE-TERM} = 750\ \Omega$ to $3\text{ k}\Omega$ ; $R_{ISET} = 1.8\text{ k}\Omega$ ; $R_{PRE-TERM} = K_{TERM} \times \%I_{TERM}$ , where $\%I_{TERM}$ is 1.25% to 5%                | 352                      | 680                          | 1001                     |                |
| $I_{PRE-TERM}$                           | Current for programming the term. and pre-chg with resistor, $I_{Term-Start}$ is the initial PRE-TERM current | $R_{PRE-TERM} = 6\text{ k}\Omega$ ; $V_{OUT} = 4.15\text{ V}$   | 23                       | 25                           | 27                       | $\mu\text{A}$  |
| $I_{TERM}$                               | Termination current range   | Minimum absolute termination current  | 1                        |                              |                          | mA             |
| $\%TERM$                                 | Termination current formula   |   |                          | $R_{TERM}/K_{TERM}$          |                          | %              |
| $t_{DGL(TERM)}$                          | Deglintch time, termination detected  |   |                          | 29                           |                          | ms             |
| <b>RECHARGE OR REFRESH</b>               |   |   |                          |                              |                          |                |
| $V_{RCH}$                                | Recharge detection threshold – normal temp  | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; $V_{OUT}: 4.25\text{ V} \rightarrow V_{RCH}$ (bq25100); $V_{OUT}: 4.35\text{ V} \rightarrow V_{RCH}$ (bq25100A); $V_{OUT}: 4.40\text{ V} \rightarrow V_{RCH}$ (bq25100H)          | $V_{O(REG)} - 0.125$     | $V_{O(REG)} - 0.095$         | $V_{O(REG)} - 0.075$     | V              |
|  | Recharge detection threshold – hot temp   | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.2\text{ V}$ ; $V_{OUT}: 4.15\text{ V} \rightarrow V_{RCH}$ (bq25100); $V_{OUT}: 4.25\text{ V} \rightarrow V_{RCH}$ (bq25100H)   | $V_{O\_HT(REG)} - 0.130$ | $V_{O\_HT(REG)} - 0.105$     | $V_{O\_HT(REG)} - 0.080$ | V              |
| $t_{DGL1(RCH)}$                          | Deglintch time, recharge threshold detected   | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; $V_{OUT}: 4.25\text{ V} \rightarrow 3.5\text{ V}$ in $1\ \mu\text{s}$ ; $t_{DGL(RCH)}$ is time to ISET ramp   |                          | 29                           |                          | ms             |

## Electrical Characteristics (continued)

 Over junction temperature range  $0^{\circ}\text{C} \leq T_J \leq 125^{\circ}\text{C}$  and recommended supply voltage (unless otherwise noted)

| PARAMETER   |   | TEST CONDITIONS   | MIN                     | TYP                     | MAX                     | UNIT          |
|---|---|---|-------------------------|-------------------------|-------------------------|---------------|
| $t_{DGL2(RCH)}$   | Deglitch time, recharge threshold detected in OUT-Detect Mode                     | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ;<br>$V_{OUT} = 3.5\text{ V}$ inserted;<br>$t_{DGL(RCH)}$ is time to ISET ramp          |                         | 29                      |                         | ms            |
| <b>BATTERY DETECT ROUTINE – (NOTE: In Hot mode <math>V_{O(REG)}</math> becomes <math>V_{O\_HT(REG)}</math>)</b> |   |   |                         |                         |                         |               |
| $V_{REG-BD}$  | VOUT reduced regulation during battery detect                                     | bq25100/101/bq25100H/101H;<br>$V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ , Battery absent  | $V_{O(REG)}^-$<br>0.450 | $V_{O(REG)}^-$<br>0.400 | $V_{O(REG)}^-$<br>0.350 | V             |
|   |   | bq25100A;<br>$V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; Battery absent   | $V_{O(REG)}^-$<br>0.550 | $V_{O(REG)}^-$<br>0.500 | $V_{O(REG)}^-$<br>0.450 |               |
| $I_{BD-SINK}$   | Sink current during $V_{REG-BD}$  | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; Battery absent  |                         | 2                       |                         | mA            |
| $t_{DGL(HI/LOW\ REG)}$  | Regulation time at $V_{REG}$ or $V_{REG-BD}$                                      | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; Battery absent  |                         | 25                      |                         | ms            |
| $V_{BD-HI}$   | High battery detection threshold  | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; Battery absent  | $V_{O(REG)}^-$<br>0.150 | $V_{O(REG)}^-$<br>0.100 | $V_{O(REG)}^-$<br>0.050 | V             |
| $V_{BD-LO}$   | Low battery detection threshold   | $V_{IN} = 5\text{ V}$ ; $V_{TS} = 0.5\text{ V}$ ; Battery absent  | $V_{REG-BD}$<br>+0.05   | $V_{REG-BD}$<br>+0.1    | $V_{REG-BD}$<br>+0.15   | V             |
| <b>BATTERY CHARGING TIMERS AND FAULT TIMERS</b>   |   |   |                         |                         |                         |               |
| $t_{PRECHG}$  | Pre-charge safety timer value   | Restarts when entering pre-charge;<br>Always enabled when in pre-charge.  | 1700                    | 1940                    | 2250                    | s             |
| $t_{MAXCH}$   | Charge safety timer value   | Clears fault or resets at UVLO, TS disable, OUT Short, exiting LOWV and Refresh   | 34000                   | 38800                   | 45000                   | s             |
| <b>BATTERY-PACK NTC MONITOR (see Note 1); TS pin: 10k NTC</b>   |   |   |                         |                         |                         |               |
| $I_{NTC-10k}$   | NTC bias current  | $V_{TS} = 0.3\text{ V}$   | 48.5                    | 50.5                    | 52.5                    | $\mu\text{A}$ |
| $I_{NTC-DIS-10k}$   | 10k NTC bias current when charging is disabled                                    | $V_{TS} = 0\text{ V}$   | 27                      | 30                      | 33                      | $\mu\text{A}$ |
| $I_{NTC-FLDBK-10k}$   | INTC is reduced prior to entering TTDM to keep cold thermistor from entering TTDM | $V_{TS}$ : Set to 1.525 V   | 4                       | 5                       | 6.5                     | $\mu\text{A}$ |
| $V_{TTDM(TS)}$  | Termination and timer disable mode Threshold – Enter                              | $V_{TS}$ : 0.5 V $\rightarrow$ 1.7 V; Timer held in reset   | 1550                    | 1600                    | 1650                    | mV            |
| $V_{HYS-TTDM(TS)}$  | Hysteresis exiting TTDM   | $V_{TS}$ : 1.7 V $\rightarrow$ 0.5 V; Timer enabled   |                         | 100                     |                         | mV            |
| $V_{CLAMP(TS)}$   | TS maximum voltage clamp  | $V_{TS} = \text{Open (float)}$  | 1900                    | 1950                    | 2000                    | mV            |
| $t_{DGL(TTDM)}$   | Deglitch exit TTDM between states   |   |                         | 57                      |                         | ms            |
|   | Deglitch enter TTDM between states  |   |                         | 8                       |                         | $\mu\text{s}$ |
| $V_{TS\_I-FLDBK}$   | TS voltage where INTC is reduce to keep thermistor from entering TTDM             | INTC adjustment (90 to 10%; 45 to 6.6 $\mu\text{A}$ ) takes place near this spec threshold;<br>$V_{TS}$ : 1.425 V $\rightarrow$ 1.525 V |                         | 1475                    |                         | mV            |
| $C_{TS}$  | Optional capacitance – ESD  |   |                         | 0.22                    |                         | $\mu\text{F}$ |
| $V_{TS-0^{\circ}\text{C}}$  | Low temperature CHG pending   | Low temp charging to pending;<br>$V_{TS}$ : 1 V $\rightarrow$ 1.5 V   | 1230                    | 1255                    | 1280                    | mV            |
| $V_{HYS-0^{\circ}\text{C}}$   | Hysteresis  | At $0^{\circ}\text{C}$ ;<br>Charge pending to low temp charging;<br>$V_{TS}$ : 1.5 V $\rightarrow$ 1 V                                  |                         | 100                     |                         | mV            |
| $V_{TS-10^{\circ}\text{C}}$   | Low temperature, half charge  | Normal charging to low temp charging;<br>$V_{TS}$ : 0.5 V $\rightarrow$ 1 V   | 775                     | 800                     | 830                     | mV            |
| $V_{HYS-10^{\circ}\text{C}}$  | Hysteresis  | At $10^{\circ}\text{C}$ ;<br>Low temp charging to normal CHG;<br>$V_{TS}$ : 1 V $\rightarrow$ 0.5 V                                     |                         | 55                      |                         | mV            |
| $V_{TS-45^{\circ}\text{C}}$   | High temperature  | At 4.1V (bq25100/101) or 4.2V (bq25100H/101H);<br>Normal charging to high temp CHG;<br>$V_{TS}$ : 0.5 V $\rightarrow$ 0.2 V             | 253                     | 268                     | 283                     | mV            |
| $V_{HYS-45^{\circ}\text{C}}$  | Hysteresis  | At $45^{\circ}\text{C}$ ;<br>High temp charging to normal CHG;<br>$V_{TS}$ : 0.2 V $\rightarrow$ 0.5 V                                  |                         | 20                      |                         | mV            |
| $V_{TS-60^{\circ}\text{C}}$   | High temperature disable  | bq25100/01/100H/101H/100L;<br>High temp charge to pending;<br>$V_{TS}$ : 0.2 V $\rightarrow$ 0.1 V                                      | 160                     | 170                     | 180                     | mV            |
| $V_{HYS-60^{\circ}\text{C}}$  | Hysteresis  | At $60^{\circ}\text{C}$ (bq25100/01/100H/101H/100L);<br>Charge pending to high temp CHG;<br>$V_{TS}$ : 0.1 V $\rightarrow$ 0.2 V        |                         | 20                      |                         | mV            |

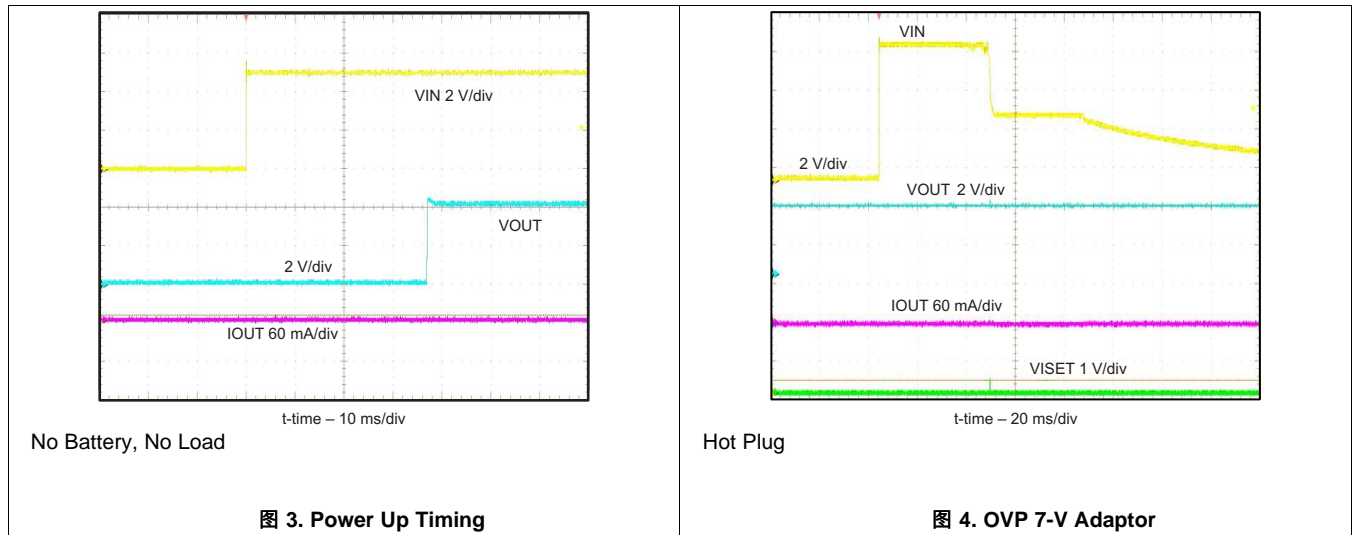
## Electrical Characteristics (continued)

Over junction temperature range  $0^{\circ}\text{C} \leq T_J \leq 125^{\circ}\text{C}$  and recommended supply voltage (unless otherwise noted)

| PARAMETER                    | TEST CONDITIONS  | MIN  | TYP | MAX | UNIT |                    |    |
|------------------------------|--|--|-----|-----|------|--------------------|----|
| $t_{\text{DGL(TS\_10C)}}$    | Deglitch for TS thresholds: 10C                        | Normal to cold operation; $V_{\text{TS}}: 0.6\text{ V} \rightarrow 1\text{ V}$ |     | 50  | ms   |                    |    |
|                              |  | Cold to normal operation; $V_{\text{TS}}: 1\text{ V} \rightarrow 0.6\text{ V}$ |     | 12  |      |                    |    |
| $t_{\text{DGL(TS)}}$         | Deglitch for TS thresholds: 0/45/60C                   | Battery charging   |     | 30  | ms   |                    |    |
| $V_{\text{TS-EN-10k}}$       | Charge enable threshold, (10k NTC)                     | $V_{\text{TS}}: 0\text{ V} \rightarrow 0.175\text{ V}$                         |     | 84  | 92   | 100                | mV |
| $V_{\text{TS-DIS\_HYS-10k}}$ | HYS below $V_{\text{TS-EN-10k}}$ to disable, (10k NTC) | $V_{\text{TS}}: 0.125\text{ V} \rightarrow 0\text{ V}$                         |     | 12  |      |                    | mV |
| <b>THERMAL REGULATION</b>    |  |  |     |     |      |                    |    |
| $T_{\text{J(REG)}}$          | Temperature regulation limit                           |  |     | 125 |      | $^{\circ}\text{C}$ |    |
| $T_{\text{J(OFF)}}$          | Thermal shutdown temperature                           |  |     | 155 |      | $^{\circ}\text{C}$ |    |
| $T_{\text{J(OFF-HYS)}}$      | Thermal shutdown hysteresis                            |  |     | 20  |      | $^{\circ}\text{C}$ |    |
| <b>LOGIC LEVELS ON /CHG</b>  |  |  |     |     |      |                    |    |
| $V_{\text{OL}}$              | Output low voltage                                     | $I_{\text{SINK}} = 5\text{ mA}$  |     |     | 0.4  | V                  |    |
| $I_{\text{LEAK}}$            | Leakage current into IC                                | $V_{\text{CHG}} = 5\text{ V}$  |     |     | 1    | $\mu\text{A}$      |    |

## 7.6 Typical Characteristics

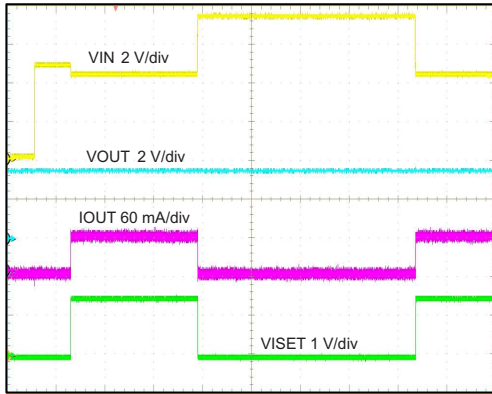
Setup: Typical Applications Schematic;  $V_{\text{IN}} = 5\text{ V}$ ,  $V_{\text{BAT}} = 3.6\text{ V}$  (unless otherwise noted)





Typical Characteristics (接下页)

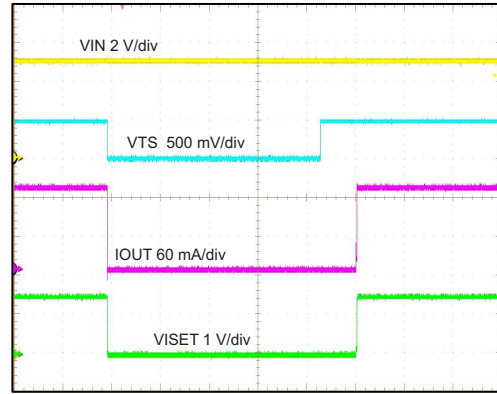
Setup: Typical Applications Schematic;  $V_{IN} = 5\text{ V}$ ,  $V_{BAT} = 3.6\text{ V}$  (unless otherwise noted)



$V_{IN} 0\text{ V} - 5\text{ V} - 7\text{ V} - 5\text{ V}$

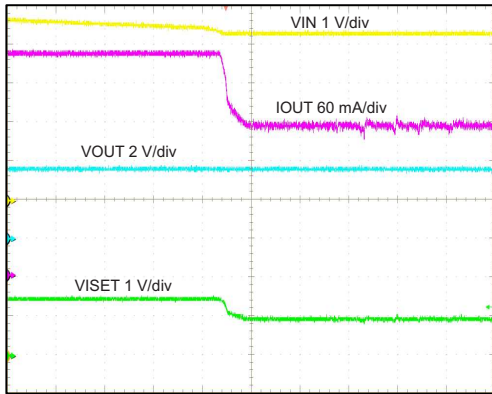
t-time – 50 ms/div

图 5. OVP from Normal Power-Up Operation



t-time – 50 ms/div

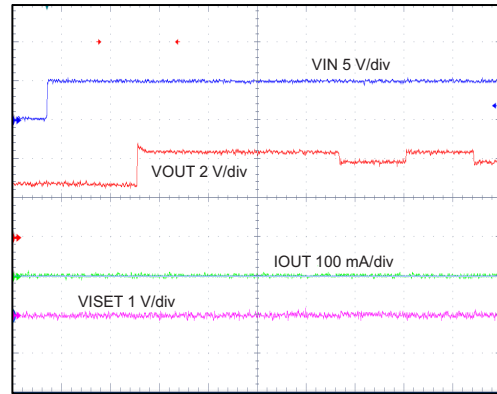
图 6. TS Enable and Disable



$V_{IN}$  Regulated

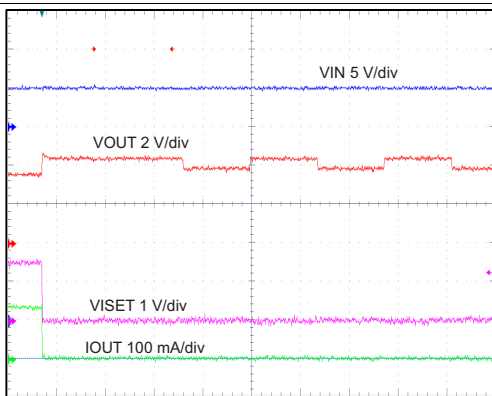
t-time – 5 ms/div

图 7. DPM-Adaptor Current Limits



t-time – 20 ms/div

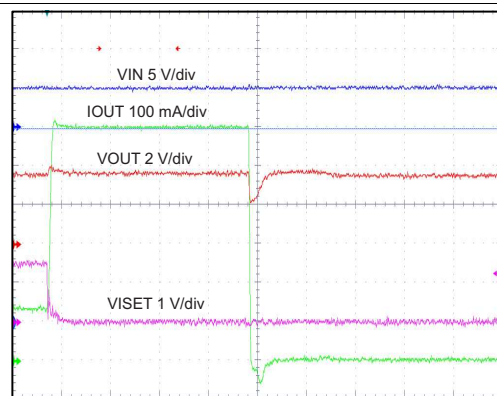
图 8. Hot Plug Source with No Battery - Battery Detection



No Load

t-time – 20 ms/div

图 9. Battery Removal

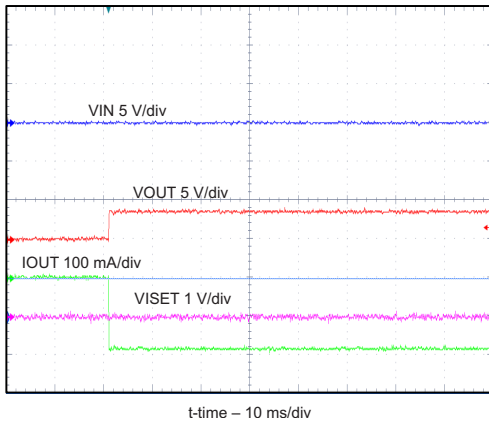


t-time – 200  $\mu$ s/div

图 10. ISET Shorted During Normal Operation

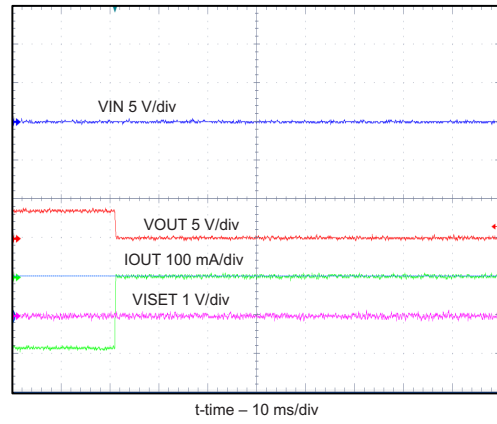
## Typical Characteristics ( 接下页 )

Setup: Typical Applications Schematic;  $V_{IN} = 5\text{ V}$ ,  $V_{BAT} = 3.6\text{ V}$  (unless otherwise noted)



20-Ω resistor at OUT, No input,  $V_{BAT} = 3.7\text{ V}$

图 11. Battery Plug In



20-Ω resistor at OUT, No input,  $V_{BAT} = 3.7\text{ V}$

图 12. Battery Removal

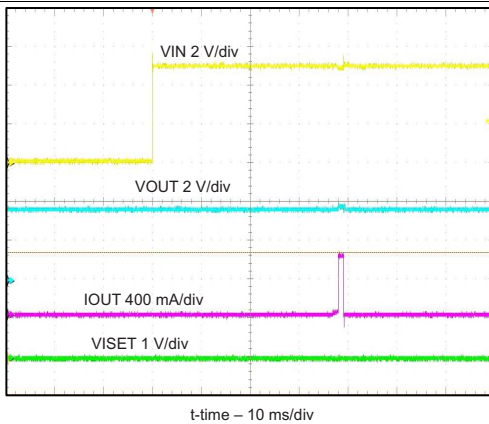
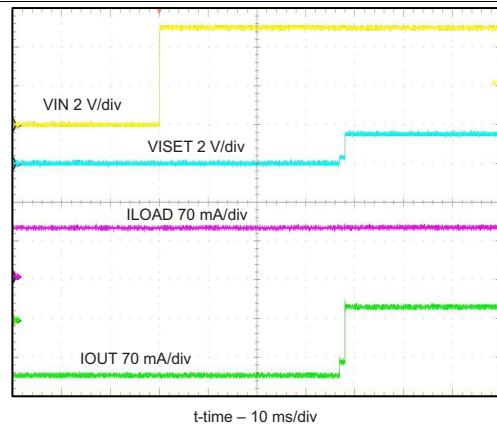


图 13. ISET Short Prior to Power Up



90-mA Load, 120-mA ICHG

图 14. Power Up

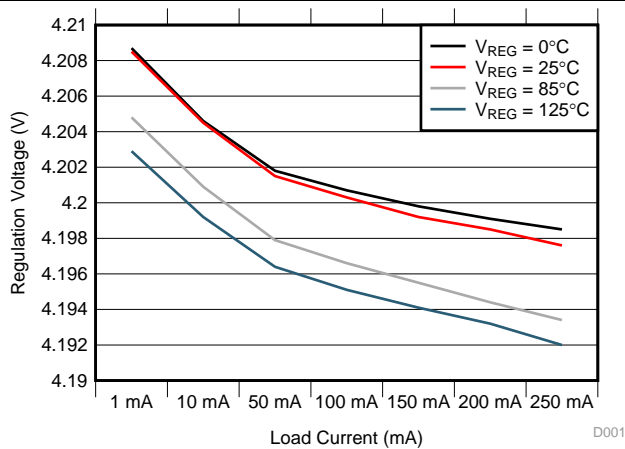


图 15. Load Regulation Over Temperature

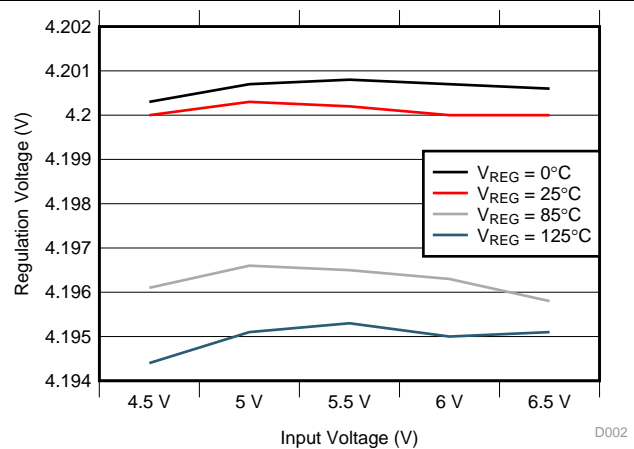


图 16. Line Regulation Over Temperature

Typical Characteristics (接下页)

Setup: Typical Applications Schematic;  $V_{IN} = 5\text{ V}$ ,  $V_{BAT} = 3.6\text{ V}$  (unless otherwise noted)

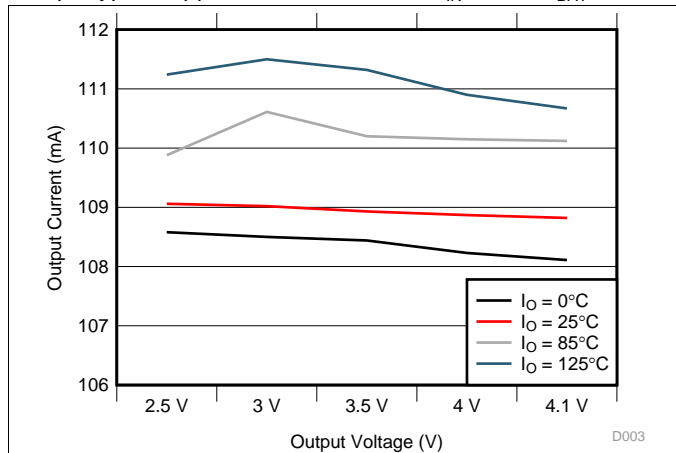


图 17. Current Regulation Over Temperature

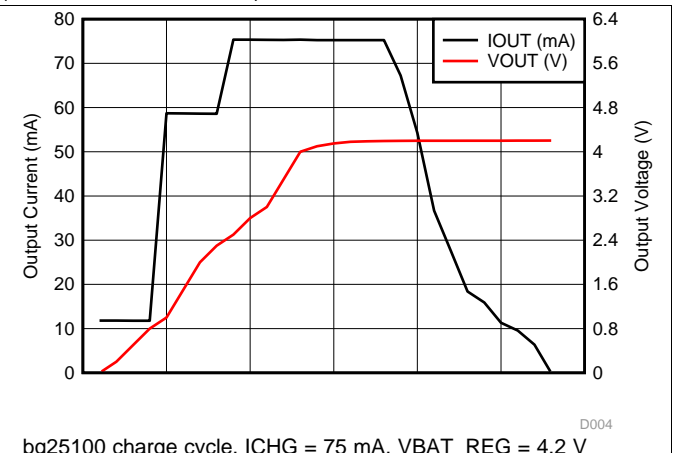


图 18. Battery Voltage vs Charge Current

## 8 Detailed Description


### 8.1 Overview

The bq2510x is a highly integrated family of single cell Li-Ion and Li-Pol chargers. The charger can be used to charge a battery, power a system or both. The charger has three phases of charging: pre-charge to recover a fully discharged battery, fast-charge constant current to supply the charge safely and voltage regulation to safely reach full capacity. The charger is very flexible, allowing programming of the fast-charge current and Pre-charge/Termination Current. This charger is designed to work with a USB connection (100-mA limit) or Adaptor (DC output). The charger also checks to see if a battery is present.

The charger also comes with a full set of safety features: JEITA Temperature Standard (bq25100/01/100H/101H), Over-Voltage Protection, DPM-IN, Safety Timers, and ISET short protection. All of these features and more are described in detail below.

The charger is designed for a single power path from the input to the output to charge a single cell Li-Ion or Li-Pol battery pack. Upon application of a 5-V DC power source the ISET and OUT short checks are performed to assure a proper charge cycle.

If the battery voltage is below the LOWV threshold, the battery is considered discharged and a preconditioning cycle begins. The amount of precharge current can be programmed using the PRE-TERM pin which programs a percent of fast charge current (10 to 100%) as the precharge current. This feature is useful when the system load is connected across the battery “stealing” the battery current. The precharge current can be set higher to account for the system loading while allowing the battery to be properly conditioned. The PRE-TERM pin is a dual function pin which sets the precharge current level and the termination threshold level. The termination “current threshold” is always half of the precharge programmed current level.

Once the battery voltage has charged to the VLOWV threshold, fast charge is initiated and the fast charge current is applied. The fast charge constant current is programmed using the ISET pin. The constant current provides the bulk of the charge. Power dissipation in the IC is greatest in fast charge with a lower battery voltage. If the IC reaches 125°C, the IC enters thermal regulation, slows the timer clock by half, and reduces the charge current as needed to keep the temperature from rising any further.  19 shows the charging profile with thermal regulation. Typically under normal operating conditions, the IC’s junction temperature is less than 125°C and thermal regulation is not entered.

Once the cell has charged to the regulation voltage the voltage loop takes control and holds the battery at the regulation voltage until the current tapers to the termination threshold. The termination can be disabled if desired.

Further details are described in the Operating Modes section.

Overview (接下页)

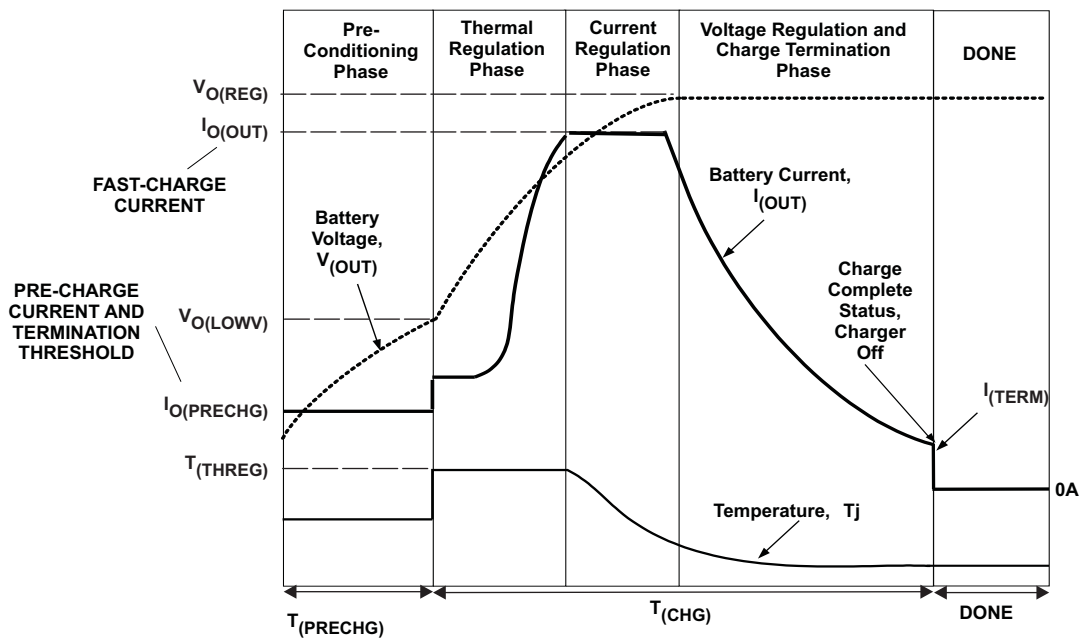
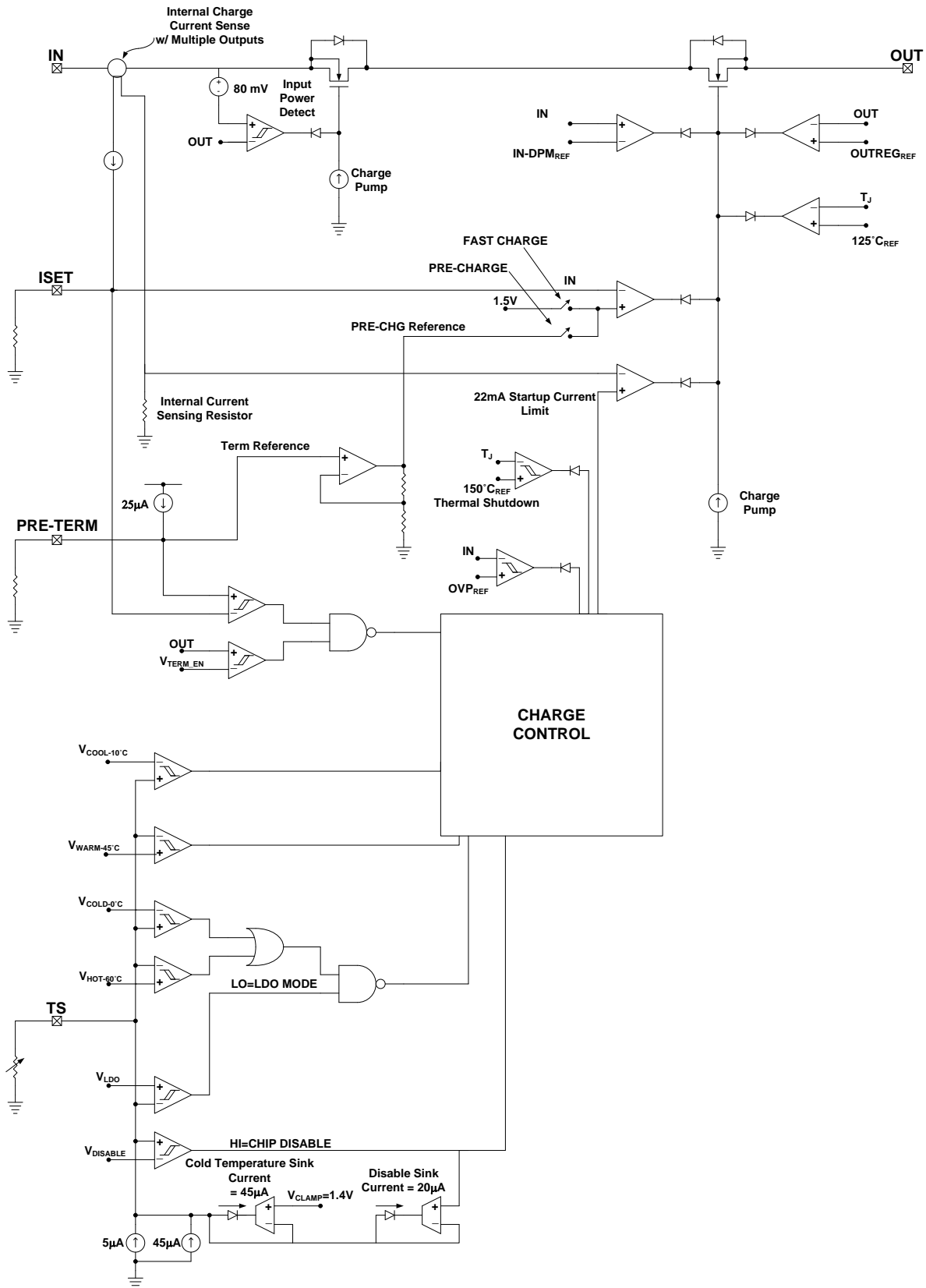


图 19. Charging Profile With Thermal Regulation

## 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Overvoltage-Protection (OVP) – Continuously Monitored

If the input source applies an overvoltage, the pass FET, if previously on, turns off after a deglitch,  $t_{BLK(OVP)}$ . The timer stops counting. Once the overvoltage returns to a normal voltage, the timer and charge continues.

### 8.3.2 $\overline{CHG}$ Pin Indication (bq25101, bq25101H)

The charge pin has an internal open drain FET which is on (pulls down to VSS) during the first charge only (independent of TTDM) and is turned off once the battery reaches voltage regulation and the charge current tapers to the termination threshold set by the PRE-TERM resistor. The bq25101/01H terminates at 10% of the programmed charge current. The charge pin is high impedance in sleep mode and OVP and returns to its previous state once the condition is removed. Cycling input power, removing and replacing the battery, pulling the TS pin low and releasing or entering pre-charge mode causes the  $\overline{CHG}$  pin to go reset (go low if power is good and a discharged battery is attached) and is considered the start of a first charge.

### 8.3.3 $\overline{CHG}$ Pin LED Pull-up Source (bq25101, bq25101H)

For host monitoring, a pull-up resistor is used between the  $\overline{CHG}$  pin and the VCC of the host and for a visual indication a resistor in series with an LED is connected between the  $\overline{CHG}$  pin and a power source. If the CHG source is capable of exceeding 7 V, a 6.2-V zener should be used to clamp the voltage. If the source is the OUT pin, note that as the battery changes voltage, and the brightness of the LEDs vary.

### 8.3.4 IN-DPM ( $V_{IN-DPM}$ or IN-DPM)

The IN-DPM feature is used to detect an input source voltage that is folding back (voltage dropping), reaching its current limit due to excessive load. When the input voltage drops to the  $V_{IN-DPM}$  threshold the internal pass FET starts to reduce the current until there is no further drop in voltage at the input. This would prevent a source with voltage less than  $V_{IN-DPM}$  to power the out pin. This is an added safety feature that helps protect the source from excessive loads. This feature is not applicable for bq25100A.

### 8.3.5 OUT

The Charger's OUT pin provides current to the battery and to the system, if present. This IC can be used to charge the battery plus power the system, charge just the battery or just power the system (TTDM) assuming the loads do not exceed the available current. The OUT pin is a current limited source and is inherently protected against shorts. If the system load ever exceeds the output programmed current threshold, the output will be discharged unless there is sufficient capacitance or a charged battery present to supplement the excessive load.

### 8.3.6 ISET

An external resistor is used to Program the Output Current (10 to 250 mA) and can be used as a current monitor.

$$R_{ISET} = K_{ISET} \div I_{OUT} \quad (1)$$

Where:

- $I_{OUT}$  is the desired fast charge current;
- $K_{ISET}$  is a gain factor found in the electrical specification

For greater accuracy at lower currents, part of the sense FET is disabled to give better resolution. Going from higher currents to low currents, there is hysteresis and the transition occurs around 50 mA.

The ISET resistor is short protected and will detect a resistance lower than  $\approx 420 \Omega$ . The detection requires at least 50 mA of output current. If a "short" is detected, then the IC will latch off and can be reset by cycling the power or cycling TS pin. The OUT current is internally clamped to a maximum current of 600 mA typical and is independent of the ISET short detection circuitry.

For charge current that is below 50 mA, an extra RC circuit is recommended on ISET to achieve more stable current signal. More detail is available in 9.1 Application Information.

Feature Description (接下页)

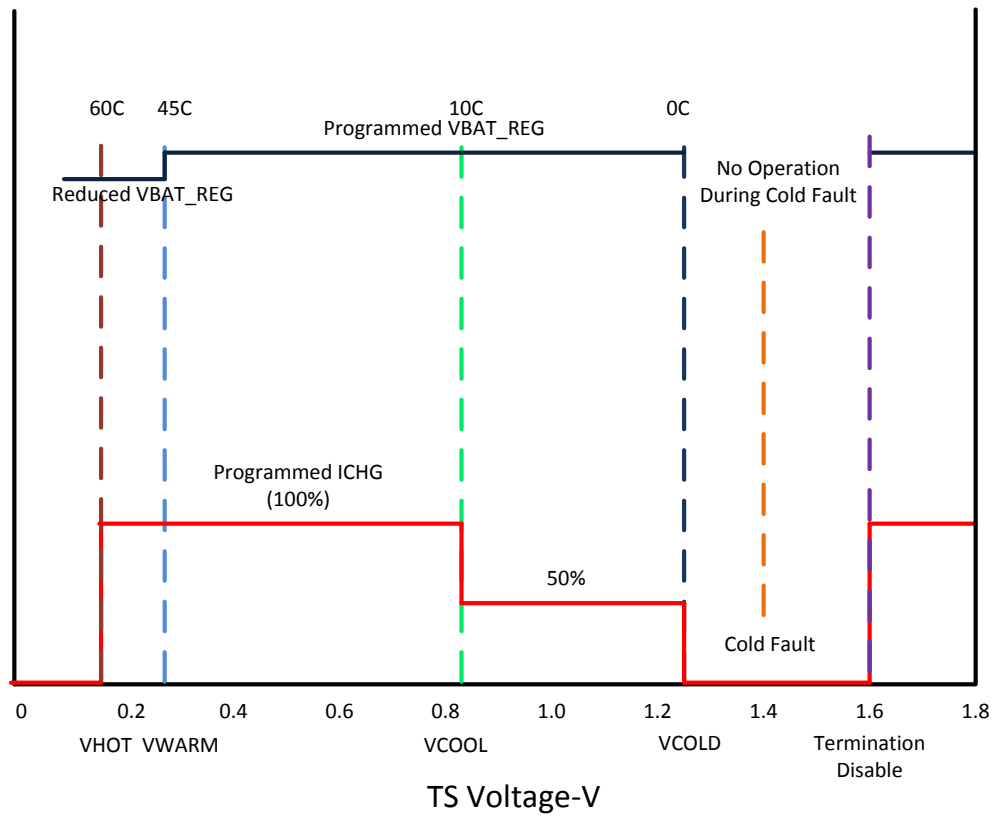


图 20. Operation Over TS Bias Voltage - bq25100, bq25100H, bq25101, bq25101H



Feature Description (接下页)

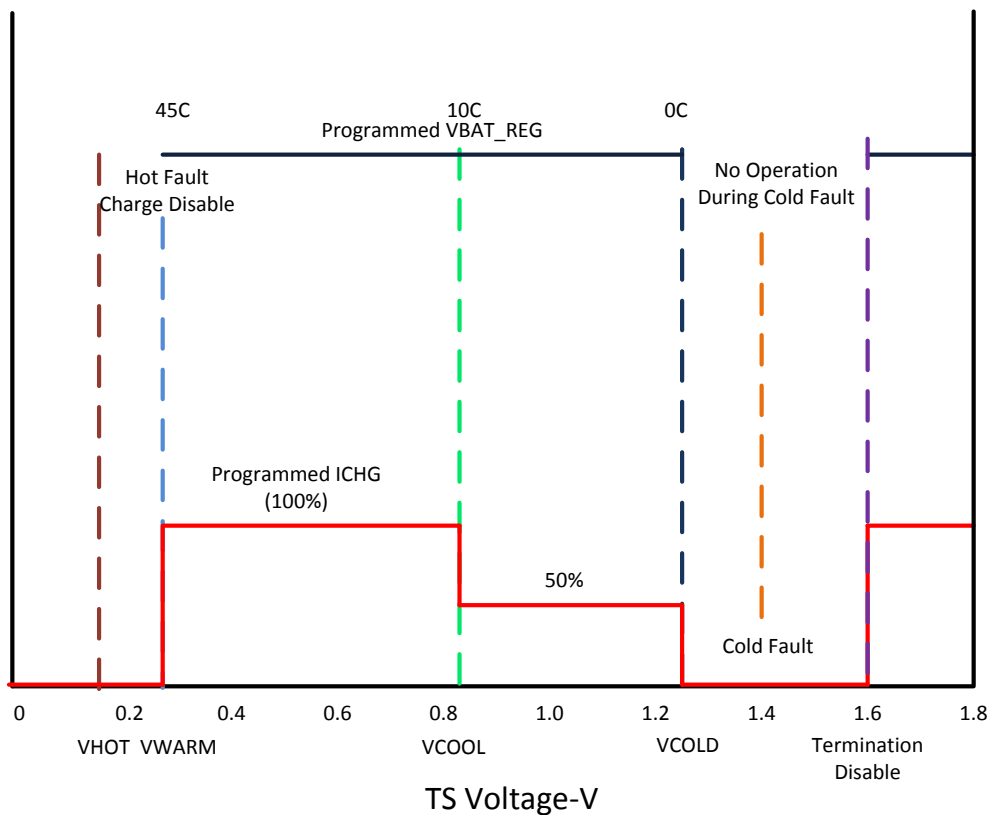


图 21. Operation Over TS Bias Voltage – bq25100A

8.3.7 PRE\_TERM – Pre-Charge and Termination Programmable Threshold

Pre-Term is used to program both the pre-charge current and the termination current threshold. The pre-charge current level is a factor of two higher than the termination current level. The termination can be set between 5 and 50% (recommended range) of the programmed output current level set by ISET. If left floating the termination and pre-charge are set internally at 10/20% respectively. The  $R_{PRE\_TERM}$  is ranged from 600  $\Omega$  to 30 k $\Omega$  and the minimum termination current can be programmed to 1 mA. The pre-charge-to-fast-charge,  $V_{lowv}$  threshold is set to 2.5 V.

$$R_{PRE\_TERM} = \%Term \times K_{TERM} = \%Pre\_CHG \times K_{PRE\_CHG} \tag{2}$$

Where:

- %Term is the percent of fast charge current where termination occurs;
- %Pre-CHG is the percent of fast charge current that is desired during precharge;
- $K_{TERM}$  and  $K_{PRE\_CHG}$  are gain factors found in the electrical specifications.

8.3.8 TS

The TS function for the bq2510x family is designed to follow the new JEITA temperature standard (bq25100/bq25100H/bq25101/bq25101H) for Li-Ion and Li-Pol batteries. There are now four thresholds, 60°C, 45°C, 10°C, and 0°C. Normal operation occurs between 10°C and 45°C. If between 0°C and 10°C the charge current level is cut in half and if between 45°C and 60°C the regulation voltage is reduced to 4.1 V max for bq25100 and 4.2 V max for bq25100H, see 图 20. The TS function for the bq25100A cut the charge current level in half between 0°C and 10°C and disables charging when the NTC temperature is above 45°C.

## Feature Description (接下页)

The TS feature is implemented using an internal 50 $\mu$ A current source to bias the thermistor (designed for use with a 10-k NTC  $\beta = 3370$  (SEMITEC 103AT-2 or Mitsubishi TH05-3H103F) connected from the TS pin to  $V_{SS}$ . If this feature is not needed, a fixed 10-k can be placed between TS and  $V_{SS}$  to allow normal operation. This may be done if the host is monitoring the thermistor and then the host would determine when to pull the TS pin low to disable charge.

The TS pin has two additional features, when the TS pin is pulled low or floated/driven high. A low disables charge and a high puts the charger in TTDM.

Above 60°C (45°C for bq25100A) or below 0°C the charge is disabled. Once the thermistor reaches  $\pm 10^\circ\text{C}$  the TS current folds back to keep a cold thermistor (between  $-10^\circ\text{C}$  and  $-50^\circ\text{C}$ ) from placing the IC in the TTDM mode. If the TS pin is pulled low into disable mode, the current is reduce to  $\approx 30 \mu\text{A}$ . Since the  $I_{TS}$  current is fixed along with the temperature thresholds, it is not possible to use thermistor values other than the 10-k NTC (at 25°C).

### 8.3.9 Timers

The pre-charge timer is set to 30 minutes. The pre-charge current, can be programmed to off-set any system load, making sure that the 30 minutes is adequate.

The fast charge timer is fixed at 10 hours and can be increased real time by going into thermal regulation or IN-DPM. The timer clock slows by a factor of 2, resulting in a clock than counts half as fast when in these modes. If either the 30 minute or ten hour timer times out, the charging is terminated and for bq25101/1H the  $\overline{\text{CHG}}$  pin goes high impedance if not already in that state. The timer is reset by disabling the IC, cycling power or going into and out of TTDM.

### 8.3.10 Termination

Once the OUT pin goes above VRCH, (reaches voltage regulation) and the current tapers down to the termination threshold, a battery detect route is run to determine if the battery was removed or the battery is full. If the battery is present, the charge current will terminate. If the battery was removed along with the thermistor, then the TS pin is driven high and the charge enters TTDM. If the battery was removed and the TS pin is held in the active region, then the battery detect routine will continue until a battery is inserted. The termination current can be programmed down to 625  $\mu\text{A}$ , however, the accuracy will reduce accordingly when the termination current is below 1 mA.

## 8.4 Device Functional Modes

### 8.4.1 Power-Down or Undervoltage Lockout (UVLO)

The bq2510x family is in power down mode if the IN pin voltage is less than UVLO. The part is considered “dead” and all the pins are high impedance. Once the IN voltage rises above the UVLO threshold the IC will enter Sleep Mode or Active mode depending on the OUT pin (battery) voltage.

### 8.4.2 Power-up

The IC is alive after the IN voltage ramps above UVLO (see sleep mode), resets all logic and timers, and starts to perform many of the continuous monitoring routines. Typically the input voltage quickly rises through the UVLO and sleep states where the IC declares power good, starts the qualification charge at 22 mA, sets the charge current base on the ISET pin, and starts the safety timer.

### 8.4.3 Sleep Mode

If the IN pin voltage is between  $V_{\text{OUT}}+V_{\text{DT}}$  and UVLO, the charge current is disabled, the safety timer counting stops (not reset). As the input voltage rises and the charger exits sleep mode, the safety timer continues to count and the charge is enabled. See [图 22](#).

### 8.4.4 New Charge Cycle

A new charge cycle is started when a good power source is applied, performing a chip disable/enable (TS pin), exiting Termination and Timer Disable Mode (TTDM), detecting a battery insertion or the OUT voltage dropping below the VRCH threshold.

Device Functional Modes (接下页)

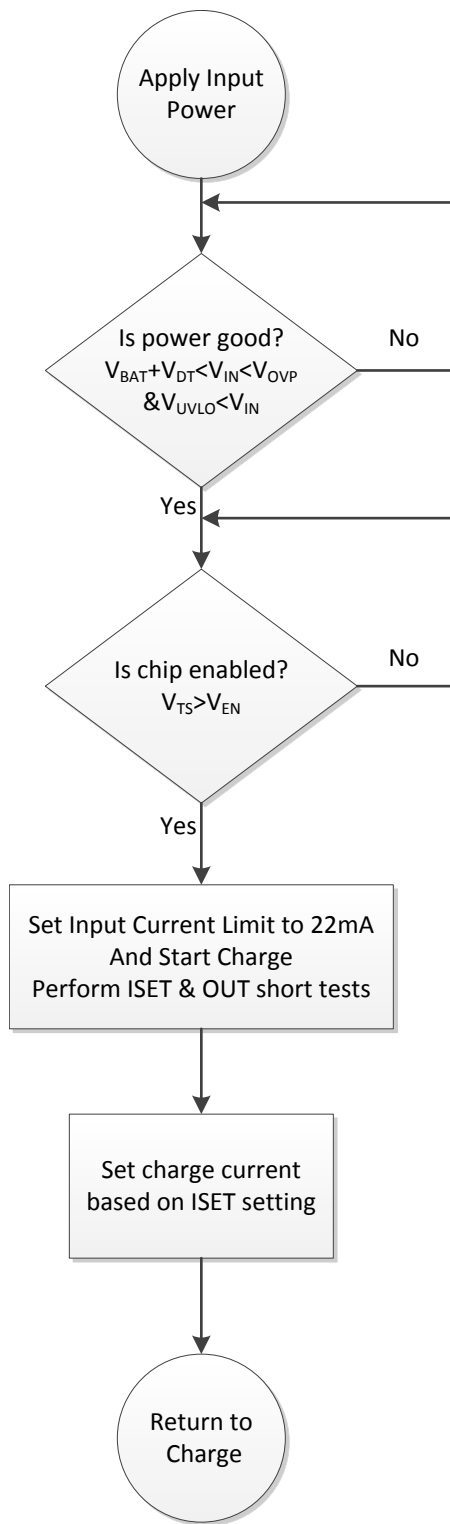


图 22. bq2510x Power-Up Flow Diagram

## Device Functional Modes (接下页)

### 8.4.5 Termination and Timer Disable Mode (TTDM) - TS Pin High

The battery charger is in TTDM when the TS pin goes high from removing the thermistor (removing battery pack/floating the TS pin) or by pulling the TS pin up to the TTDM threshold.

When entering TTDM, the 10 hour safety timer is held in reset and termination is disabled. A battery detect routine is run to see if the battery was removed or not. For bq25101/1H, if the battery was removed then the  $\overline{\text{CHG}}$  pin will go to its high impedance state if not already there. If a battery is detected the  $\overline{\text{CHG}}$  pin does not change states until the current tapers to the termination threshold, where the  $\overline{\text{CHG}}$  pin goes to its high impedance state if not already there (the regulated output will remain on).

The charging profile does not change (still has pre-charge, fast-charge constant current and constant voltage modes). This implies the battery is still charged safely and the current is allowed to taper to zero.

When coming out of TTDM, the battery detect routine is run and if a battery is detected, then a new charge cycle begins.

If TTDM is not desired upon removing the battery with the thermistor, one can add a 237-k $\Omega$  resistor between TS and  $V_{\text{SS}}$  to disable TTDM. This keeps the current source from driving the TS pin into TTDM. This creates  $\pm 0.1^{\circ}\text{C}$  error at hot and a  $\pm 3^{\circ}\text{C}$  error at cold.

### 8.4.6 Battery Detect Routine

The battery detect routine should check for a missing battery while keeping the OUT pin at a useable voltage.

The battery detect routine is run when entering and exiting TTDM to verify if battery is present, or run all the time if battery is missing and not in TTDM. On power-up, if battery voltage is greater than  $V_{\text{RCH}}$  threshold, a battery detect routine is run to determine if a battery is present.

The battery detect routine is disabled while the IC is in TTDM, or has a TS fault. See [图 23](#) for the Battery Detect Flow Diagram.

### 8.4.7 Refresh Threshold

After termination, if the OUT pin voltage drops to  $V_{\text{RCH}}$  (100mV below regulation) then a new charge is initiated.

### 8.4.8 Starting a Charge on a Full Battery

The termination threshold is raised by  $\pm 14\%$  for the first minute of a charge cycle so if a full battery is removed and reinserted or a new charge cycle is initiated, that the new charge terminates (less than 1 minute). Batteries that have relaxed many hours may take several minutes to taper to the termination threshold and terminate charge.

Device Functional Modes (接下页)

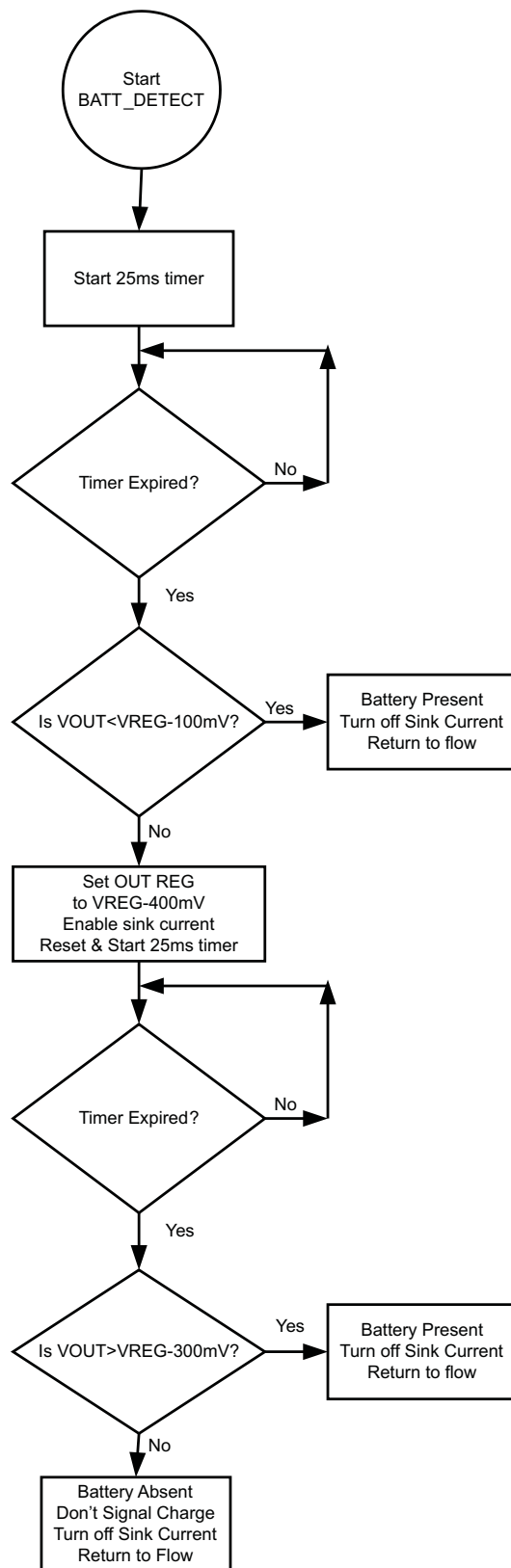


图 23. Battery Detect Routine

## 9 Application and Implementation

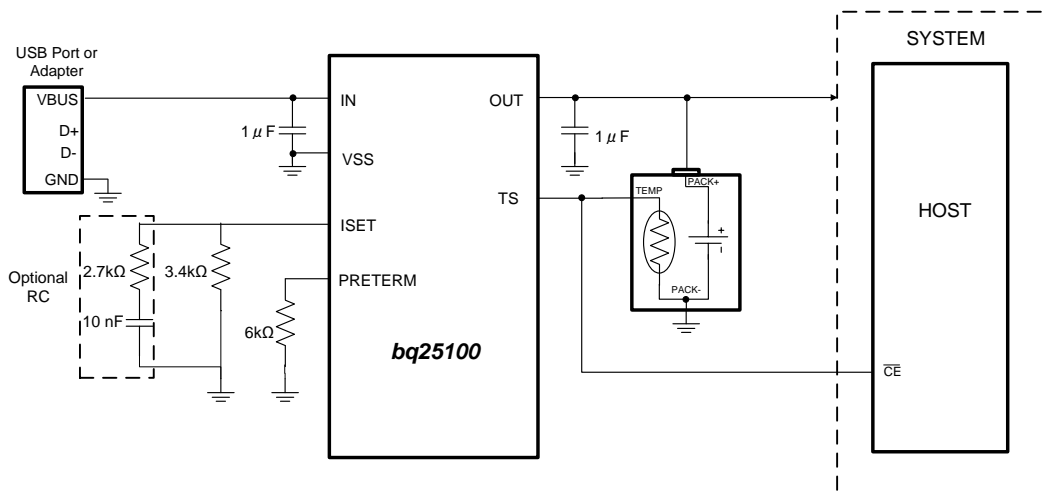
### 注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

The bq2510x series of devices are highly integrated Li-Ion and Li-Pol linear chargers targeted at space-limited portable applications. The fast charge current can be programmed from 10 mA to 250 mA through an external resistor on ISET pin. The pre\_charge and termination current can also be programmed through the resistor connected on PRETERM pin. The device has complete system-level protection such as input under-voltage lockout (UVLO), input over-voltage protection (OVP), sleep mode, thermal regulation, safety timers, and NTC monitoring input.

### 9.2 Typical Application - Charger Application Design Example



#### 9.2.1 Design Requirements

- Supply voltage = 5 V
- Fast charge current:  $I_{OUT-FC} = 40 \text{ mA}$ ;
- Termination Current Threshold:  $\%I_{OUT-FC} = 10\%$  of Fast Charge or  $\sim 4 \text{ mA}$
- Pre-Charge Current by default is twice the termination Current or  $\sim 8 \text{ mA}$
- TS – Battery Temperature Sense = 10-k NTC (103AT)
- /CE is an open drain control pin

#### 9.2.2 Detailed Design Procedures

- The regulation voltage is set to 4.2 V, the input voltage is 5 V and the charge current is programmed to 40 mA.
- For charge current that is below 50 mA, an extra RC circuit is recommended on ISET to achieve more stable current signal. For applications that need higher charge current, the RC circuit is not needed.
- For applications that use more than 200-mA current, there could be a very low level  $\sim 1\%$  of charge current ringing in the output. The ringing can be removed by increasing the input capacitance.

## Typical Application - Charger Application Design Example (接下页)

### 9.2.2.1 Calculations

#### 9.2.2.1.1 Program the Fast Charge Current, ISET:

$$R_{ISET} = [K_{(ISET)} / I_{(OUT)}]$$

from electrical characteristics table. . .  $K_{(SET)} = 135 \text{ A}\Omega$

$$R_{ISET} = [135 \text{ A}\Omega / 0.04 \text{ A}] = 3.4 \text{ k}\Omega$$

Selecting the closest standard value, use a 3.4-k $\Omega$  resistor between ISET and Vss.

#### 9.2.2.1.2 Program the Termination Current Threshold, ITERM:

$$R_{PRE-TERM} = K_{(TERM)} \times \%I_{OUT-FC}$$

$$R_{PRE-TERM} = 600 \text{ }\Omega/\% \times 10\% = 6 \text{ k}\Omega$$

Selecting the closest standard value, use a 6-k $\Omega$  resistor between PRETERM and Vss.

One can arrive at the same value by using 20% for a pre-charge value (factor of 2 difference).

$$R_{PRE-TERM} = K_{(PRE-CHG)} \times \%I_{OUT-FC}$$

$$R_{PRE-TERM} = 300 \text{ }\Omega/\% \times 20\% = 6 \text{ k}\Omega$$

#### 9.2.2.1.3 TS Function

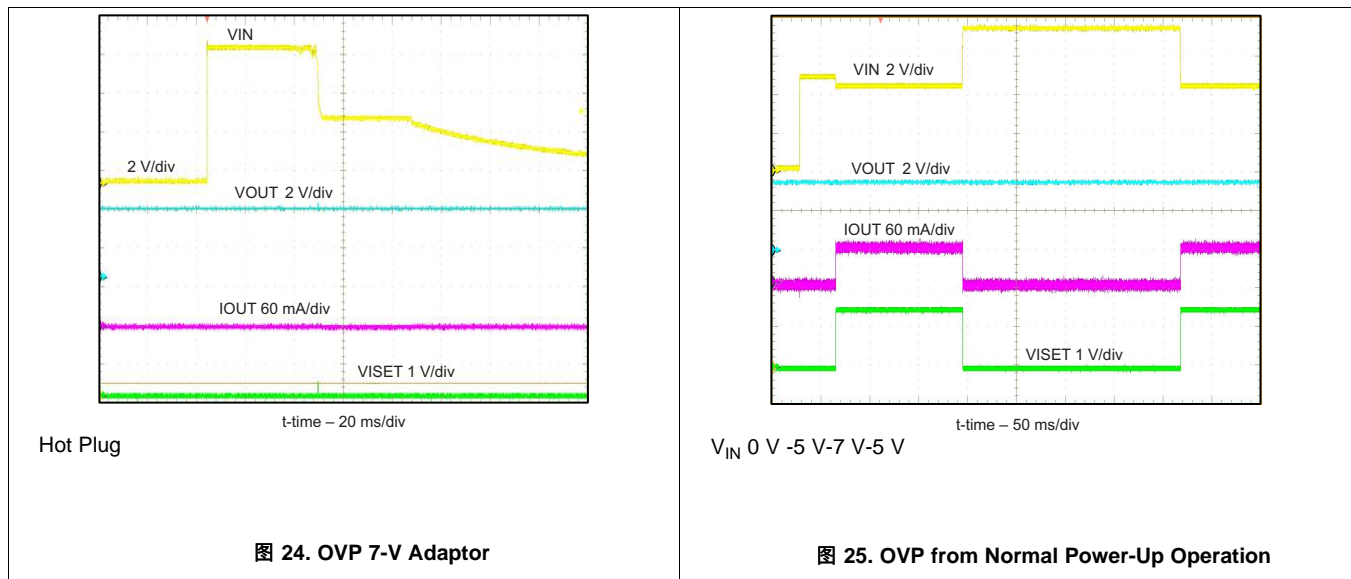
Use a 10-k NTC thermistor in the battery pack (103AT).

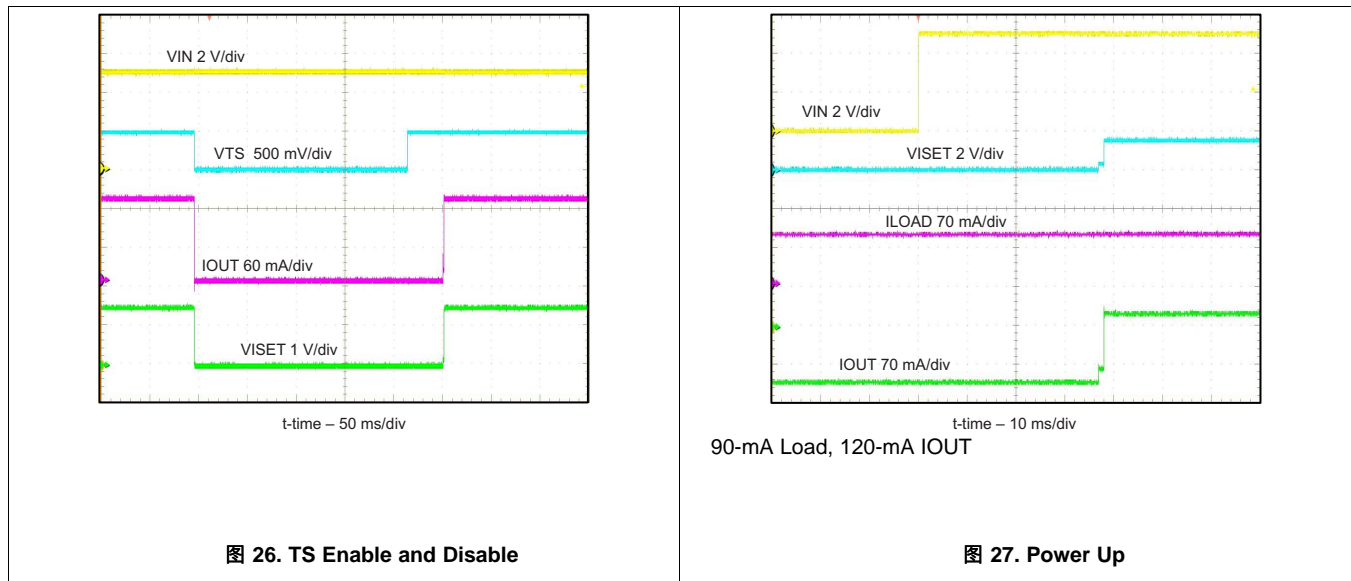
To Disable the temp sense function, use a fixed 10-k $\Omega$  resistor between the TS and VSS.

#### 9.2.2.1.4 Selecting IN and OUT Pin Capacitors

In most applications, all that is needed is a high-frequency decoupling capacitor (ceramic) on the power pin, input and output pins. Using the values shown on the application diagram is recommended. After evaluation of these voltage signals with real system operational conditions, one can determine if capacitance values can be adjusted toward the minimum recommended values (DC load application) or higher values for fast, high amplitude, pulsed load applications. Note if designed for high input voltage sources (bad adaptors or wrong adaptors), the capacitor needs to be rated appropriately. Ceramic capacitors are tested to 2x their rated values so a 16-V capacitor may be adequate for a 30-V transient (verify tested rating with capacitor manufacturer).

### 9.2.3 bq25100 Application Performance Plots



**Typical Application - Charger Application Design Example (接下页)**


## 10 Power Supply Recommendations

### 10.1 Leakage Current Effects on Battery Capacity

To determine how fast a leakage current on the battery will discharge the battery is an easy calculation. The time from full to discharge can be calculated by dividing the Amp-Hour Capacity of the battery by the leakage current. For a 0.1-AHr battery and a 75-nA leakage current ( $100\text{mAhr}/75\text{nA} = 250000$  Hours), it would take 1333k hours or 152 years to discharge. In reality the self discharge of the cell would be much faster so the 75-nA leakage would be considered negligible.

## 11 Layout

### 11.1 Layout Guidelines

To obtain optimal performance, the decoupling capacitor from IN to GND and the output filter capacitors from OUT to GND should be placed as close as possible to the bq2510x, with short trace runs to both IN, OUT and GND.

- All low-current GND connections should be kept separate from the high-current charge or discharge paths from the battery. Use a single-point ground technique incorporating both the small signal ground path and the power ground path.
- The high current charge paths into IN pin and from the OUT pin must be sized appropriately for the maximum charge current in order to avoid voltage drops in these traces



## 11.2 Layout Example

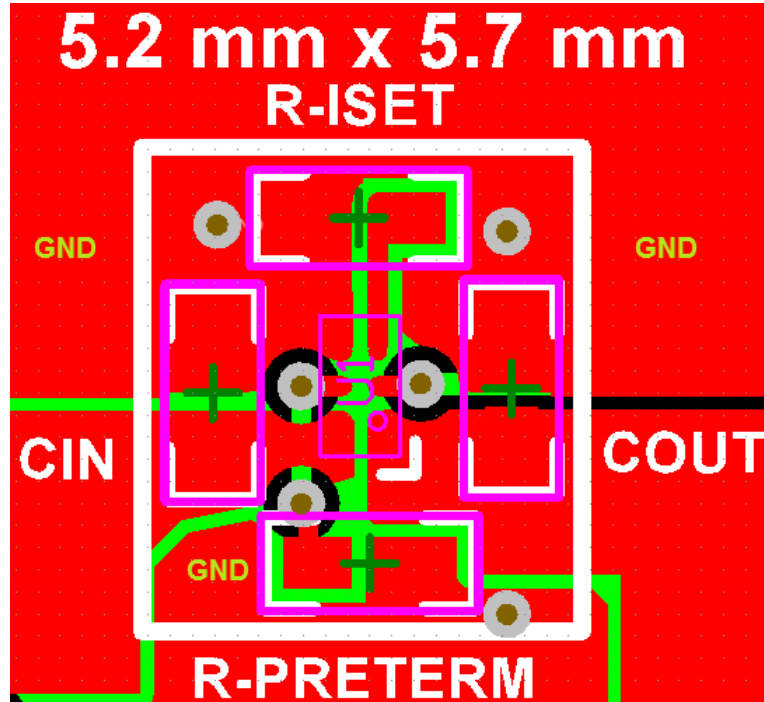


图 28. Board Layout

## 11.3 Thermal Package

The most common measure of package thermal performance is thermal impedance ( $\theta_{JA}$ ) measured (or modeled) from the chip junction to the air surrounding the package surface (ambient). The mathematical expression for  $\theta_{JA}$  is:

$$\theta_{JA} = (T_J - T) / P \quad (3)$$

Where:

$T_J$  = chip junction temperature

$T$  = ambient temperature

$P$  = device power dissipation

Factors that can influence the measurement and calculation of  $\theta_{JA}$  include:

1. Whether or not the device is board mounted
2. Trace size, composition, thickness, and geometry
3. Orientation of the device (horizontal or vertical)
4. Volume of the ambient air surrounding the device under test and airflow
5. Whether other surfaces are in close proximity to the device being tested

Due to the charge profile of Li-Ion and Li-Pol batteries the maximum power dissipation is typically seen at the beginning of the charge cycle when the battery voltage is at its lowest. Typically after fast charge begins the pack voltage increases to  $\approx 3.4$  V within the first 2 minutes. The thermal time constant of the assembly typically takes a few minutes to heat up so when doing maximum power dissipation calculations, 3.4 V is a good minimum voltage to use.

The device power dissipation,  $P$ , is a function of the charge rate and the voltage drop across the internal PowerFET. It can be calculated from the following equation when a battery pack is being charged :

$$P = [V_{(IN)} - V_{(OUT)}] \times I_{(OUT)} \quad (4)$$

## Thermal Package (接下页)

The thermal loop feature reduces the charge current to limit excessive IC junction temperature. It is recommended that the design not run in thermal regulation for typical operating conditions (nominal input voltage and nominal ambient temperatures) and use the feature for non typical situations such as hot environments or higher than normal input source voltage. With that said, the IC will still perform as described, if the thermal loop is always active.

## 12 器件和文档支持

### 12.1 器件支持

#### 12.1.1 第三方产品免责声明

TI 发布的与第三方产品或服务有关的信息，不能构成与此类产品或服务或保修的适用性有关的认可，不能构成此类产品或服务单独或与任何 TI 产品或服务一起的表示或认可。

### 12.2 相关链接

以下表格列出了快速访问链接。范围包括技术文档、支持与社区资源、工具和软件，并且可以快速访问样片或购买链接。

表 1. 相关链接

| 器件       | 产品文件夹                 | 样片与购买                 | 技术文档                  | 工具与软件                 | 支持与社区                 |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| bq25100  | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> |
| bq25101  | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> |
| bq25100A | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> |
| bq25100H | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> |
| bq25101H | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> |
| bq25100L | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> | <a href="#">请单击此处</a> |

### 12.3 商标

Bluetooth is a registered trademark of Bluetooth SIG, Inc..

### 12.4 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

### 12.5 术语表

[SLYZ022](#) — TI 术语表。

这份术语表列出并解释术语、首字母缩略词和定义。

## 13 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。这些信息是针对指定器件可提供的最新数据。这些数据会在无通知且不对本文档进行修订的情况下发生改变。欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| BQ25100AYFPR     | ACTIVE        | DSBGA        | YFP             | 6    | 3000        | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | -40 to 85    | 25100A                  | <a href="#">Samples</a> |
| BQ25100AYFPT     | ACTIVE        | DSBGA        | YFP             | 6    | 250         | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | -40 to 85    | 25100A                  | <a href="#">Samples</a> |
| BQ25100HYFPR     | ACTIVE        | DSBGA        | YFP             | 6    | 3000        | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25100H                  | <a href="#">Samples</a> |
| BQ25100HYFPT     | ACTIVE        | DSBGA        | YFP             | 6    | 250         | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25100H                  | <a href="#">Samples</a> |
| BQ25100YFPR      | ACTIVE        | DSBGA        | YFP             | 6    | 3000        | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25100                   | <a href="#">Samples</a> |
| BQ25100YFPT      | ACTIVE        | DSBGA        | YFP             | 6    | 250         | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25100                   | <a href="#">Samples</a> |
| BQ25101HYFPR     | ACTIVE        | DSBGA        | YFP             | 6    | 3000        | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25101H                  | <a href="#">Samples</a> |
| BQ25101HYFPT     | ACTIVE        | DSBGA        | YFP             | 6    | 250         | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25101H                  | <a href="#">Samples</a> |
| BQ25101YFPR      | ACTIVE        | DSBGA        | YFP             | 6    | 3000        | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25101                   | <a href="#">Samples</a> |
| BQ25101YFPT      | ACTIVE        | DSBGA        | YFP             | 6    | 250         | RoHS & Green    | SNAGCU                               | Level-1-260C-UNLIM   | 0 to 125     | 25101                   | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| BQ25100AYFPR | DSBGA        | YFP             | 6    | 3000 | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25100AYFPT | DSBGA        | YFP             | 6    | 250  | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25100HYFPR | DSBGA        | YFP             | 6    | 3000 | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25100HYFPT | DSBGA        | YFP             | 6    | 250  | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25100YFPR  | DSBGA        | YFP             | 6    | 3000 | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25100YFPT  | DSBGA        | YFP             | 6    | 250  | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25101HYFPR | DSBGA        | YFP             | 6    | 3000 | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25101HYFPT | DSBGA        | YFP             | 6    | 250  | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25101YFPR  | DSBGA        | YFP             | 6    | 3000 | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |
| BQ25101YFPT  | DSBGA        | YFP             | 6    | 250  | 180.0              | 8.4                | 0.98    | 1.68    | 0.59    | 4.0     | 8.0    | Q1            |

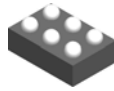
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| BQ25100AYFPR | DSBGA        | YFP             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| BQ25100AYFPT | DSBGA        | YFP             | 6    | 250  | 182.0       | 182.0      | 20.0        |
| BQ25100HYFPR | DSBGA        | YFP             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| BQ25100HYFPT | DSBGA        | YFP             | 6    | 250  | 182.0       | 182.0      | 20.0        |
| BQ25100YFPR  | DSBGA        | YFP             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| BQ25100YFPT  | DSBGA        | YFP             | 6    | 250  | 182.0       | 182.0      | 20.0        |
| BQ25101HYFPR | DSBGA        | YFP             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| BQ25101HYFPT | DSBGA        | YFP             | 6    | 250  | 182.0       | 182.0      | 20.0        |
| BQ25101YFPR  | DSBGA        | YFP             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| BQ25101YFPT  | DSBGA        | YFP             | 6    | 250  | 182.0       | 182.0      | 20.0        |

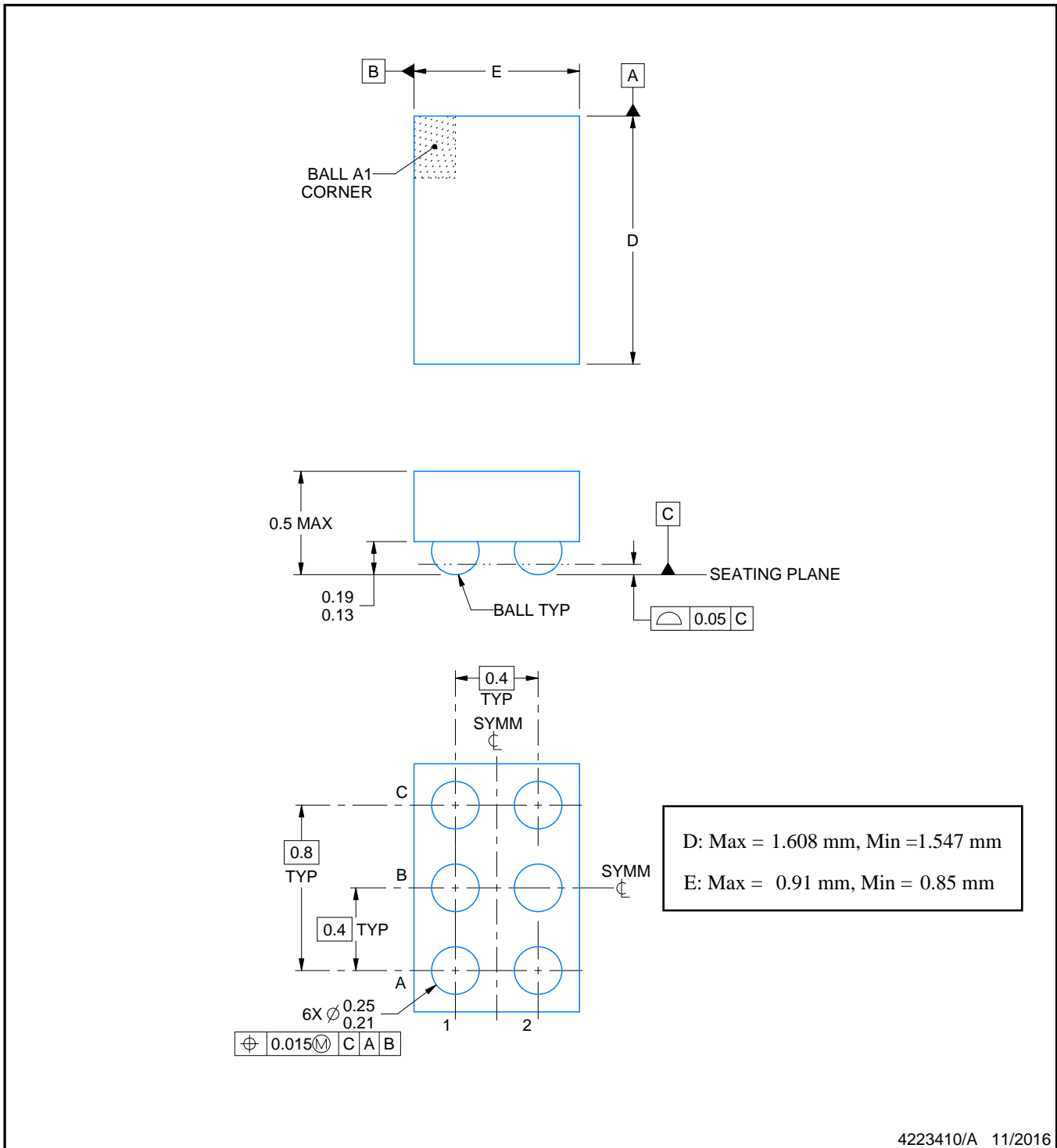
YFP0006



# PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



4223410/A 11/2016

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

YFP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE:50X



SOLDER MASK DETAILS  
NOT TO SCALE

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NOTES: (continued)

- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SNVA009 ([www.ti.com/lit/snva009](http://www.ti.com/lit/snva009)).

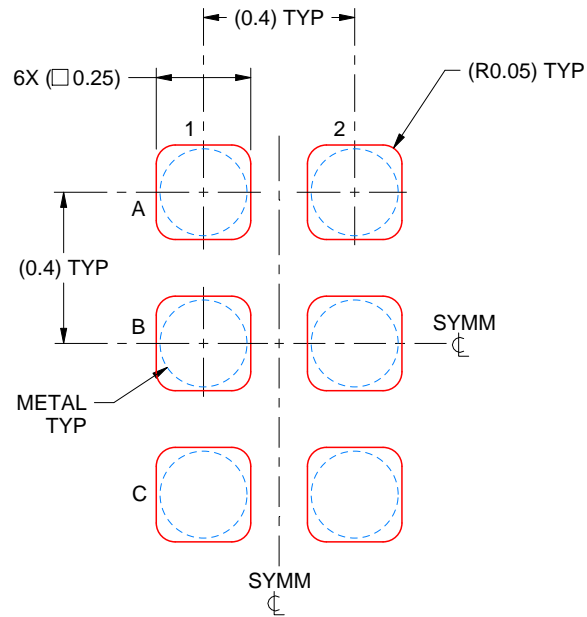


# EXAMPLE STENCIL DESIGN

YFP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL  
SCALE:50X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

## 重要声明和免责声明

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