

# EVM User's Guide: BQ2578X

## BQ25785EVM 评估模块



### 说明

BQ25785 评估模块 (EVM) 是一款使用 SMBus 控制的 NVDC 双相降压/升压充电控制器 BQ25785 的完整高功率高效电池充电器。输入电压范围为 3.5V 至 40V，具有 2 到 5 节电池的可编程输出以及 0A 至 16.3A 的充电电流范围。用户可使用此 BQ25785EVM 按照分步说明评估 BQ25785 的功能和性能。BQ25785EVM 还可用作参考设计，并具有完整的原理图、布局和物料清单 (BOM)。

### 开始使用

1. 在 [ti.com](https://www.ti.com) 上订购 BQ25785 EVM。
2. 下载最新的 [BQStudio GUI](#)。
3. 遵循此分步用户指南进行操作。

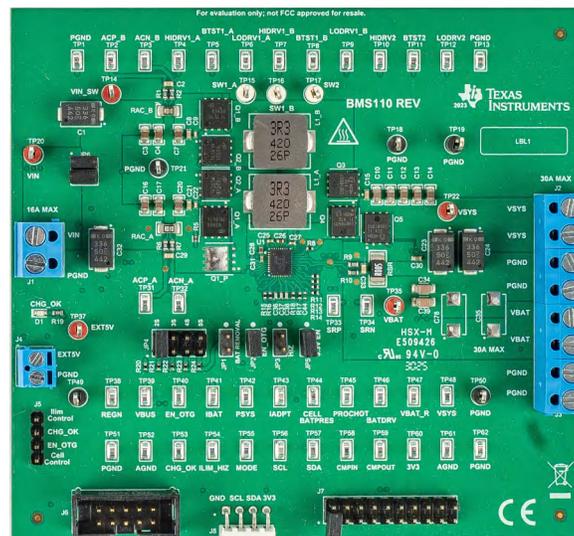
### 特性

- 支持 3.5V 至 40V 输入源
  - 工作输入范围为 3.5V 至 40V、0A 至 8.2A，支持 2 - 5 节电池配置

- 支持 USB 2.0、USB 3.0、USB 3.1 (USB Type-C®) 和 USB-C PD
- 支持具有 3V 至 5V 可调输出的 USB OTG
- 支持 USB\_PD 的快速角色交换 (FRS) 功能
- 窄 VDC (NVDC) 电源路径管理
  - 适配器满载时，电池可为系统补充电量
- 适用于薄型电感器的 600kHz 或 800kHz 开关频率
- 用于实现最佳系统性能和状态报告的 SMBus 端口
- 用于 CPU 节流的功率和电流监控器
- 安全
  - 热调节和热关断
  - 输入、系统和电池过压保护
  - 输入、MOSFET 和电感器过流保护
- 针对 Intel® 平台支持 Vmin 主动保护 (VAP) 模式
- 针对 LED 或主机处理器的充电状态输出
- 为关键信号提供了测试点，而且探针连接简单
- 跳线可用于轻松更改以进行重新配置

### 应用

- 标准笔记本电脑、Chromebook™
- 电器：电池充电器、制氧机



## 1 评估模块概述

### 1.1 简介

BQ25785 EVM 评估模块用于评估 SMBus 控制型降压/升压充电器 BQ25785。BQ25785 EVM 还可用作参考设计，并具有完整的原理图、布局和物料清单 (BOM)。本用户指南介绍了 BQ25785 EVM 评估板的特性、操作和使用。

### 1.2 套件内容

此评估套件包含一个全功率 BQ25785 EVM。此 EVM 不含 EV2400 接口器件；必须单独订购 EV2400 才能评估 BQ25785 EVM。

### 1.3 规格

表 1-1. 建议运行条件

符号	说明	最小值	典型值	最大值	单位
电源电压, $V_{IN}$	来自交流适配器输入的输入电压	3.5		40	V
电池电压, $V_{BAT}$	在 VBAT 端子上施加的电压	0		23	V
电源电流, $I_{AC}$	交流适配器输入提供的最大输入电流 (RAC = 10m $\Omega$ )	0		8.2	A
输出电流, $I_{out}$	系统电流或充电电流	0		16.3	A
工作结温范围, $T_J$		0		125	°C

### 1.4 器件信息

BQ25785 是一款同步 NVDC 降压/升压电池充电控制器，可通过各种输入源为 2 至 5 节电池充电。这些输入源包括 USB 适配器、扩展功率范围 (EPR) USB-C 电力输送 (PD) 源和标准功率范围 (SPR) USB-C 电力输送 (PD) 源以及传统适配器。BQ25785 一款元件数很少的高效器件，适用于空间受限的 2 至 5 节电池充电应用。

## 2 硬件

### 2.1 一般说明

NVDC 配置可将系统电压稳定在电池电压水平，但不会将其降至低于系统最小电压。即便在电池完全放电或被取出时，系统也仍会继续工作。当负载功率超过输入源额定值时，电池补电模式可防止输入源过载。

在上电期间，充电器基于输入源和电池状况，将转换器设置为降压、升压或降压/升压配置。在充电周期内，充电器自动在降压、升压、降压/升压配置间转换，无需主机控制。

BQ25785 可监控适配器电流、电池电流和系统功率。灵活编程的  $\overline{\text{PROCHOT}}$  输出直达 CPU，可根据需要降低其频率。

表 2-1 列出了 I/O 说明。

表 2-1. I/O 说明

插孔	说明
J1 - VIN	输入：正极端子
J1 - PGND	输入：负极端子 ( 接地端子 )
J2-VSYS	连接到系统输出
J2-PGND	接地
J3-VBAT	连接到电池包输出
J3-PGND	接地
J4-EXT5V	连接到外部 5V 电源
J4-PGND	接地
J5-ILIM_HIZ	外部转换器禁用
J5-CHRG_OK	CHRG_OK 输出
J5-EN_OTG	外部 OTG 启用引脚
J5-CELL_control	外部电池移除控制；逻辑高电平将 CELL 引脚拉低
J6 - 3V3	板载 3.3V 输出
J6 - SDA	SMBUS 或 I <sup>2</sup> C SDA
J6-SCL	SMBUS 或 I <sup>2</sup> C SCL
J6-GND	接地
J8 - SDA	SMBUS 或 I <sup>2</sup> C SDA
J8-SCL	SMBUS 或 I <sup>2</sup> C SCL
J8-GND	接地

表 2-2 显示了控制和关键参数设置。

表 2-2. 控制和关键参数设置

跳线	说明	出厂设置
JP1	跳线开启：电池移除 跳线关闭：由 JP4 进行电池设置	未安装
JP2	跳线开启：正向模式 跳线关闭：OTG 模式	已安装
JP3	用于输入电流设置： 跳线开启：进入高阻态模式。 跳线关闭：允许预偏置 EXTLIM	未安装
JP4	CELL 设置： 2S：JP4(1-2)，测量 CELL 引脚电压 2V 3S：JP4(3-4)，测量 CELL 引脚电压 2.75V 4S：JP4(5-6)，测量 CELL 引脚电压 3.76V 5S：JP4(7-8)，测量 CELL 引脚电压 5V	4S 设置：JP4(5-6)
JP5	跳线开启：板载 3.3V LDO 启用 跳线关闭：断开板载 3.3V LDO	已安装

## 2.2 定义

该过程详细说明了如何配置 BQ25785 评估板。对于测试过程，请遵循以下命名约定。有关详细信息，请参阅节 3.1。

VXXX :	外部电压源名称 ( VIN、VSY S、VBAT ) 。
LOADy :	外部负载名称 (LOADy)。
V(TPyyy) :	内部测试点 TPyyy 处的电压。例如，V(TP12) 表示 TP12 处的电压。
V(Jxx) :	插孔端子 Jxx 处的电压。
V(TP(XXX)) :	测试点“XXX”处的电压。例如，V(ACDET) 表示标记为“ACDET”的测试点处的电压。
V(XXX, YYY) :	XXX 和 YYY 两点之间的电压。
I(JXX(YYY)) :	从插孔 XX 的 YYY 端子流出的电流。
Jxx(BBB) :	插孔 xx 的端子或引脚 BBB。
JPxx 开启 :	内部跳线 JPxx 端子短接。
JPxx 关闭 :	内部跳线 JPxx 端子开路。
JPxx (-YY-) 开启 :	临近内部跳线 JPxx、标记为“YY”的端子短接。
测量 → A、B	检查指定的参数 A、B。如果测量值不在指定限制范围内，则表示受测器件发生故障。
观察 → A、B	观察是否出现 A、B。如果 A 或 B 未出现，则表示受测器件发生故障。

节 3.2 提供了跳线、测试点和各个元件的位置。

## 2.3 设备

EVM 测试需要用到下列设备：

1. **电源**：需要一个能够提供 40V 电压、20A 电流的电源。
2. **负载 1**：40V、20A 系统直流电子负载。
3. **负载 2**：一个 Kepco 负载：BOP25-40MG，直流 0V 至  $\pm 25V$ ，0A 至  $\pm 40A$  (或更高)，或等效设备。
4. **仪表**：六个 Fluke 75 万用表 (三个电压表和三个电流表) 或性能相当的仪表。
5. **计算机**：至少有一个 USB 端口和一条 USB 电缆的计算机。
6. **EV2400 通信套件**
7. **软件**：从 <https://www.ti.com.cn/tool/cn/BQSTUDIO> 下载 bqStudio 并正确安装该软件。

## 2.4 设备设置

图 2-1 显示了 BMS110 的测试设置。请参阅测试设置并遵循以下指南。

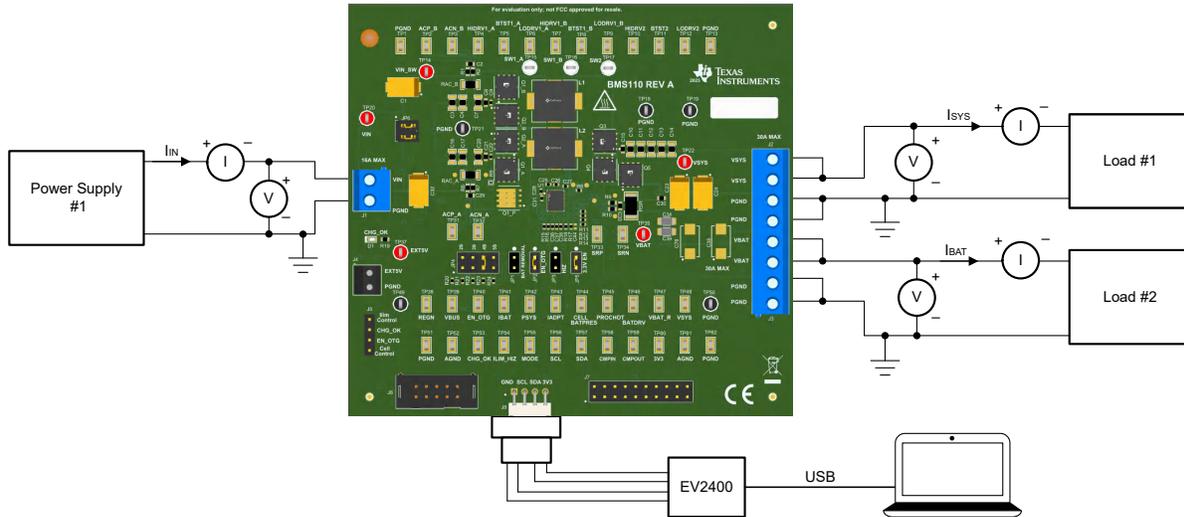


图 2-1. BMS110 的测试设置 (BQ25785EVM)

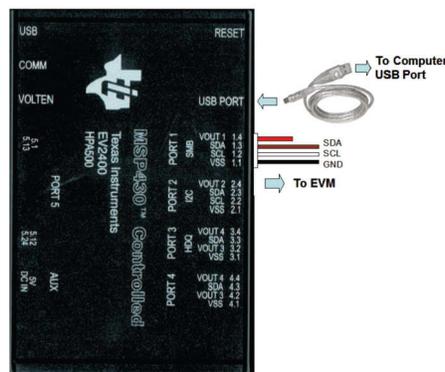
根据以下指南来设置设备：

1. 将电源 1 设置为 20V 直流、9A 电流限制，然后关闭电源。
2. 将电源 1 的输出与一个电流表串联在一起，然后连接到 J1 (VIN 和 PGND)。
3. 在 J1 (VIN) 和 J1 (PGND) 之间连接一个电压表。
4. 将负载 1 与一个电流表串联在一起，然后连接到 J2 (VSYS 和 PGND)。在 J2 (VSYS 和 PGND) 上连接一个电压表。在恒流模式下设置 2A。关闭负载 1。
5. 将负载 2 与一个电流表串联在一起，然后连接到 J3 (VBAT 和 PGND)。在 J3 (VBAT 和 PGND) 上连接一个电压表。在 KEPCO 负载输出端设置 15V。关闭负载 2。

### 备注

测试时如不使用真实电池，则要在 BAT 引脚上添加一个 100 $\mu$ F 电容器。

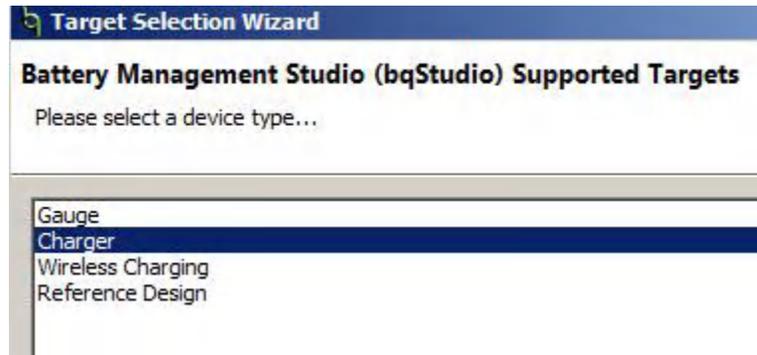
将 J8 连接到 EV2400。将 J8 连接到 EV2400 上的 SMBus 端口 1。图 2-2 显示了相关连接。



该图显示了使用 SMBus 时的 EVM 连接。

图 2-2. EV2400 连接

1. 按表 2-2 所述安装跳线。
2. 打开计算机和电源 1. 打开 bqStudio 软件。
  - a. 选择 *Charger* 并点击 *Next* 按钮。



- b. 对于 SMBus BQ25785，请在 *Select a Target* 页面中选择 *Charger\_1\_00\_BQ25785.bqz*。
- c. 选择目标器件后，点击 *Read Register* 按钮，此时会显示图 2-3 中的界面。窗口右上角出现 *Device ACK OK* 指示通信成功。

Register Name	Command	Current Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Charge Option 0	0x12	E70E	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	0
Charge Current	0x14	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charge Voltage	0x15	3138	0	0	1	1	0	0	0	1	0	0	1	1	1	0	0	0
OTGVoltage	0x3B	03E8	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0
OTGCurrent	0x3C	01E0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
VINDPM	0x3D	0280	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
VSYS_MIN	0x3E	0730	0	0	0	0	0	1	1	1	0	0	1	1	0	0	0	0
IIN_HOST	0x3F	0320	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
ChargeProfile	0x17	3020	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
GateDrive	0x18	6C6C	0	1	1	0	1	1	0	0	0	1	1	0	1	1	0	0
AutoCharge	0x1A	15C2	0	0	0	1	0	1	0	1	1	1	0	0	0	0	0	1
ChargerStatus0	0x1B	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ChargerStatus1	0x20	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ProchotStatus	0x21	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIN_DPM	0x22	0320	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
ADCOption	0x35	9000	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
ADC_VBUS	0x23	27CA	0	0	1	0	0	1	1	1	1	1	0	0	1	0	1	0
ADC_IBAT	0x24	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_IIN	0x25	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_VSYS	0x26	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_VBAT	0x27	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_PSYS	0x28	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_CMPIN_TR	0x29	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ChargeOption1	0x30	3201	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1
ChargeOption2	0x31	00B7	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1
ChargeOption3	0x32	1574	0	0	0	1	0	1	0	1	0	1	1	1	1	0	1	0
ChargeOption4	0x36	0048	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
ChargeOption5	0x19	0685	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	1
ProchotOption0	0x33	4A39	0	1	0	0	1	0	1	0	0	0	1	1	1	0	0	1
ProchotOption1	0x34	41A0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0
Vmin Active Protection	0x37	0024	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
VIRTUAL_CONTROL	0xFD	0013	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Manufacture ID	0xFE	0040	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Device ID	0xFF	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUTOTUNE_READ	0x60	C000	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUTOTUNE_FORCE	0x61	C8C8	1	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0
GM_ADJUST_FORCE	0x62	00C5	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1

图 2-3. BQ25785 评估软件的主窗口

## 2.5 过程

### 2.5.1 充电功能

要评估充电功能，请按照以下分步说明进行操作：

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#### 备注

要使用 bqStudio 软件写入寄存器，请将更新模式更改为 *Manual*、在寄存器映射的 *Current Value* 列中输入新值、按 *Write Register* 按钮、按 *Read Register* 回读，然后确认写入。或者，用户可以点击每个寄存器位或从右侧面板中选择一个值，然后按 *Write Register* 按钮。

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1. 确保已经执行节 2.4 中的步骤。
2. 将输入电源 1 设置为 20V 和 9A 电流限值，然后开启电源。
3. 将负载 2 设置为 15V，然后打开负载 2 (VBAT 负载)。
4. 将负载 1 设置为 2A，然后打开负载 1 (V<sub>SY</sub> 负载)。
5. 确认 BQ25785 的 *Tgt 地址* 为 12(9)
6. 禁用看门狗计时器。  
将 870E 写入充电选项 0 寄存器。  
测量 → V(J1(V<sub>IN</sub>)) = 20V ±0.5V  
测量 → V(TP53(CHRG\_OK)) = 3V 至 4.5V  
测量 → V(TP38(REGN)) = 5V ±1V  
测量 → V(TP54(ILIM\_HIZ)) = 3V
7. 在 AUTOTUNE\_FORCE 寄存器中设置电感器 L/DCR 时间常数。  
在 BQStudio 中将 A8A8 写入 0x61 寄存器。
8. 设置 GM\_ADJUST\_FORCE 寄存器中的电感器 DCR。  
在 BQStudio 中将 B2B3 写入 0x62 寄存器
9. 设置充电电压寄存器。  
将 “41A0” (16.8V) 写入充电电压寄存器。
10. 设置充电电流寄存器。  
将 “0800” (2048mA) 写入充电电流寄存器。
11. 测量 → V(J2(SYS)) = 15V ±0.5V  
测量 → V(J3(VBAT)) = 15V ±0.5V  
测量 → I(J3(VBAT)) = 2A ±0.5A。

## 2.5.2 OTG 功能

若要评估 OTG 功能，请按照以下分步说明进行操作：

1. 使用负载 2 作为电池电源，设置为 15V 或将 15V 电源连接到 J3。
2. 从 J1 上断开电源 1。（连接必须从电路板上物理移除）。
3. 将负载 1 连接到 J1。
4. 在 AUTOTUNE\_FORCE 寄存器中设置电感器 L/DCR 时间常数。  
将“**A8A8**”写入 0x61 寄存器。
5. 设置 GM\_ADJUST\_FORCE 寄存器中的电感器 DCR。  
将“**B2B3**”写入 0x62 寄存器。
6. 将 **03E8** (5000mV) 写入 OTG 电压寄存器。
7. 将 **01E0** (3000mA) 写入 OTG 电流寄存器。
8. 拆除 JP2 以启用 OTG 功能。
9. 选中 *Charge Option 3* 中的 **EN\_OTG** 位 (EN\_OTG=1)。请参阅 [图 2-4](#)。
10. 将负载 1 设置为 2A，然后打开负载。  
测量 →  $V(J1(V_{IN})) = 5V \pm 1V$   
测量 →  $I(J1(V_{IN})) = 2A \pm 0.5A$

The screenshot shows the Register Editor interface for the bq25785. The 'Registers' window is open, displaying a list of registers and their bit fields. The 'ChargeOption3' register (0x32) is highlighted, and its bit fields are shown on the right. The 'EN\_OTG' bit is checked, and the 'IL\_AVG' is set to 24A.

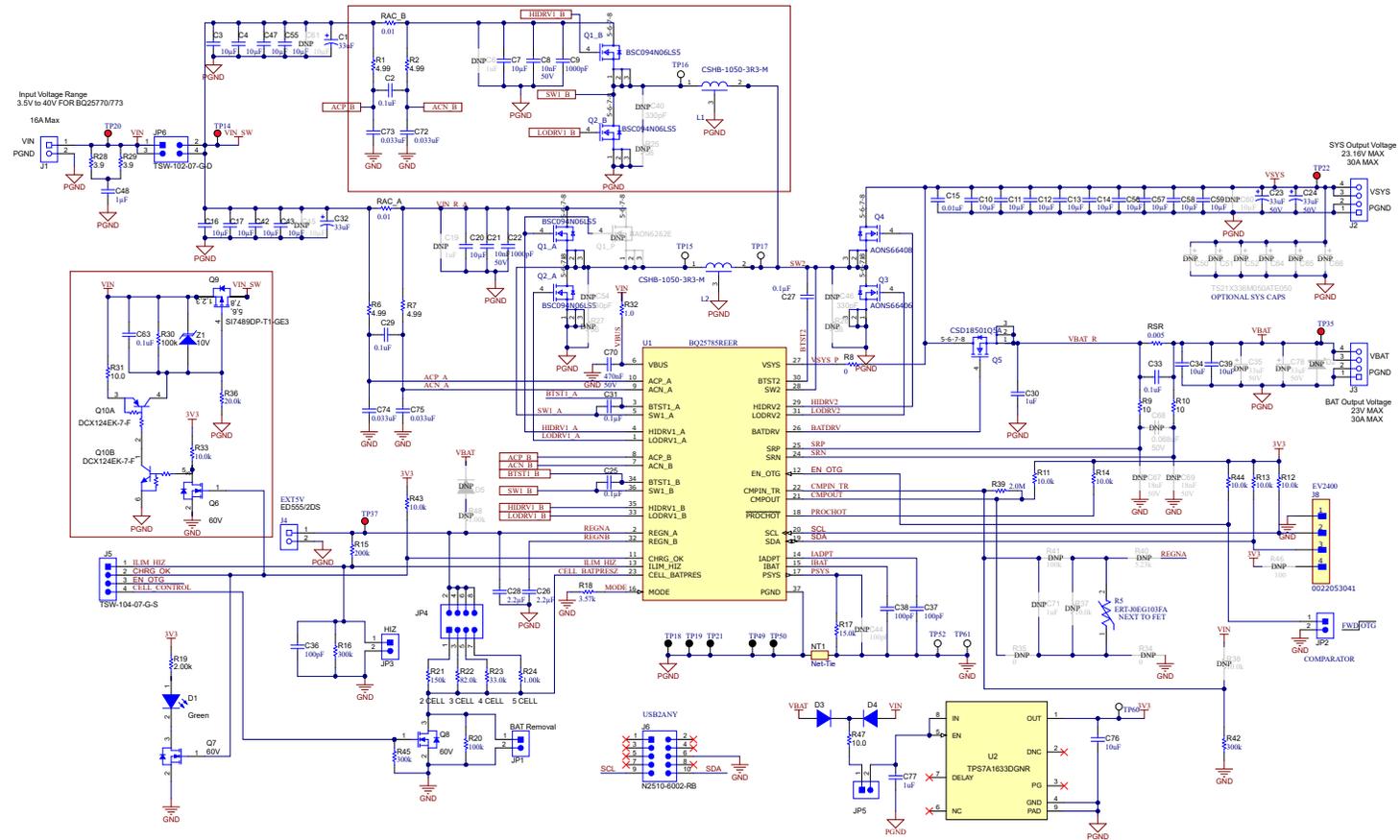
Register Name	Command	Current Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Charge Option 0	0x12	E70E	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	0
Charge Current	0x14	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charge Voltage	0x15	3138	0	0	1	1	0	0	0	1	0	0	1	1	1	0	0	0
OTGVoltage	0x3B	03E8	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0
OTGCurrent	0x3C	01E0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
VINDPM	0x3D	0280	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
VSYS_MIN	0x3E	0730	0	0	0	0	0	1	1	1	0	0	1	1	0	0	0	0
IIN_HOST	0x3F	0320	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
ChargeProfile	0x17	3020	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
GateDrive	0x18	6C6C	0	1	1	0	1	1	0	0	0	1	1	0	1	1	0	0
AutoCharge	0x1A	15C2	0	0	0	1	0	1	0	1	1	1	0	0	0	0	0	1
ChargerStatus0	0x1B	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ChargerStatus1	0x20	8000	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prochot Status	0x21	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IIN_DPM	0x22	0320	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
ADCOption	0x35	9000	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
ADC_VBUS	0x23	27CA	0	0	1	0	0	1	1	1	1	0	0	1	0	1	0	1
ADC_IBAT	0x24	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_IIN	0x25	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_VSYS	0x26	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_VBAT	0x27	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_PSYS	0x28	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_CMPIN_TR	0x29	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ChargeOption1	0x30	3201	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1
ChargeOption2	0x31	00B7	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1
ChargeOption3	0x32	1574	0	0	0	1	0	1	0	1	0	1	1	1	0	1	0	0
ChargeOption4	0x36	0048	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
ChargeOption5	0x19	0685	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	1
ProchotOption0	0x33	4A39	0	1	0	0	1	0	1	0	0	0	1	1	1	0	0	1
ProchotOption1	0x34	41A0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0
Vmin Active Protection	0x37	0024	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
VIRTUAL_CONTROL	0xFD	0013	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Manufacture ID	0xFE	0040	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Device ID	0xFF	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUTOTUNE_READ	0x60	C000	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUTOTUNE_FORCE	0x61	C8C8	1	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0
GM_ADJUST_FORCE	0x62	00C5	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1

图 2-4. 查看充电选项 3 寄存器中的 EN\_OTG 位

### 3 硬件设计文件

#### 3.1 原理图

图 3-1 所示为 EVM 原理图。



1.DNP 表示“不填充”。

图 3-1. BQ25785EVM 原理图

### 3.2 PCB 布局

图 3-2 至图 3-9 展示了电路板组装和布局图像。

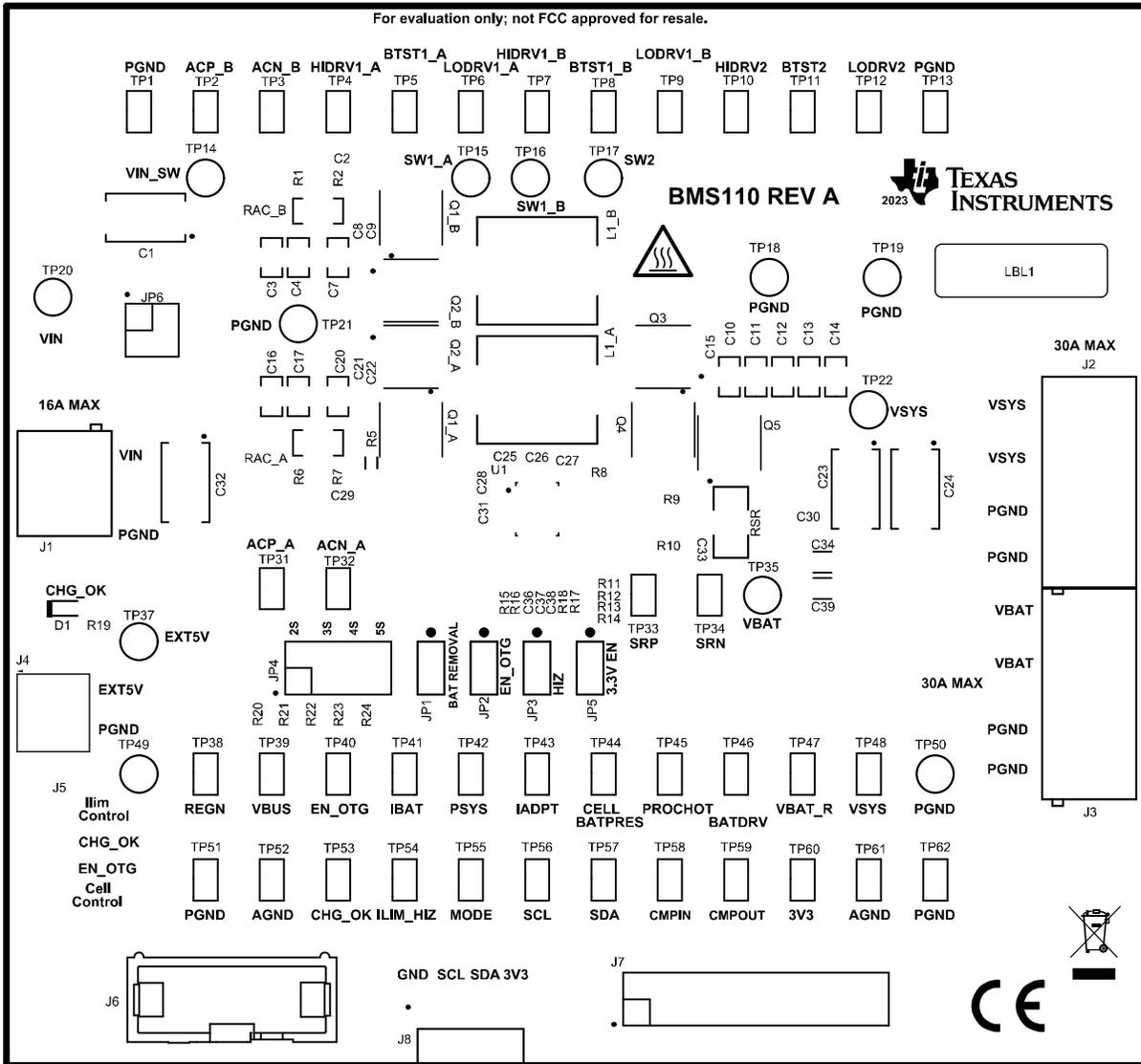


图 3-2. 顶层装配图

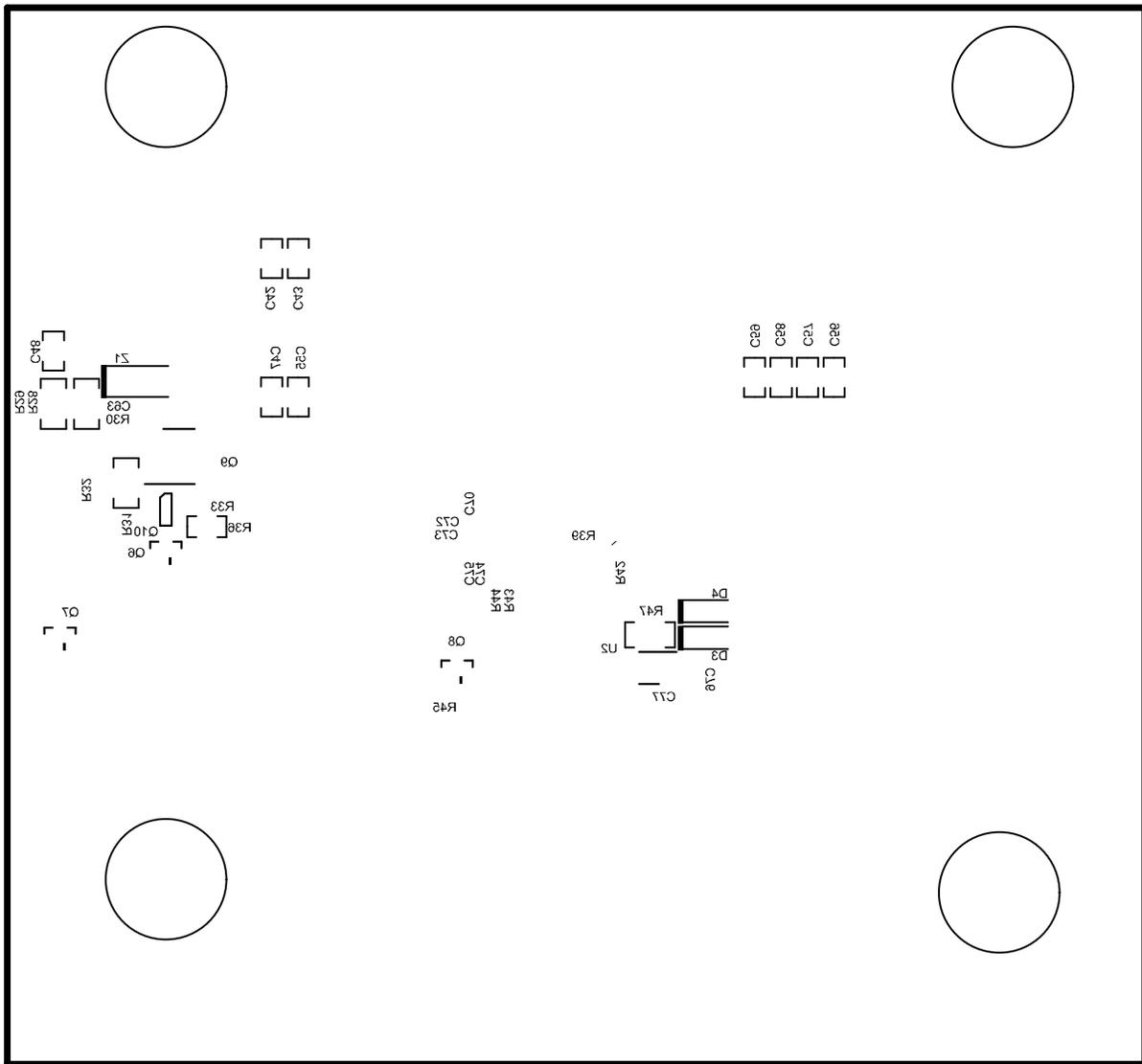


图 3-3. 底层装配图

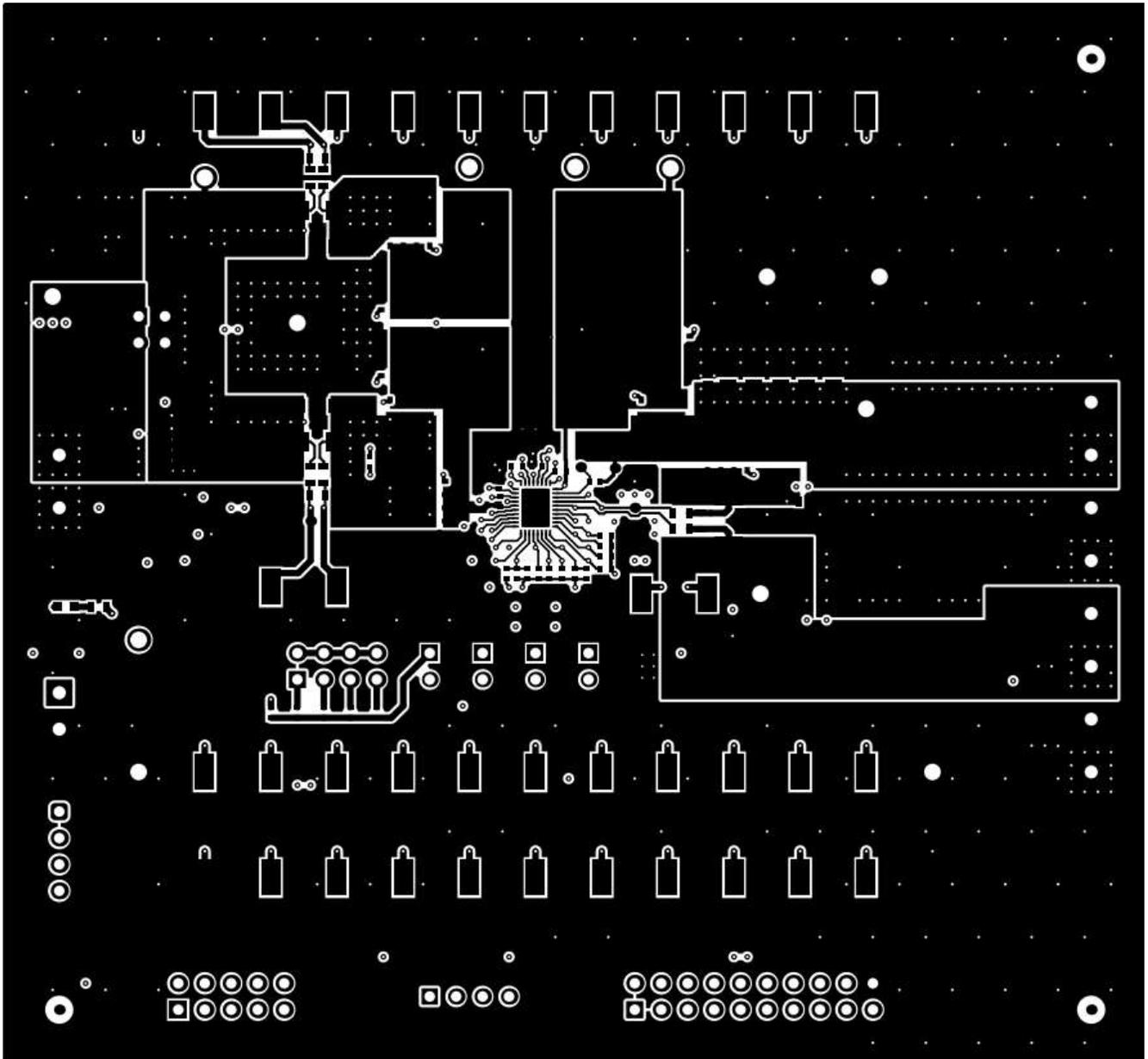


图 3-4. PCB 层 1

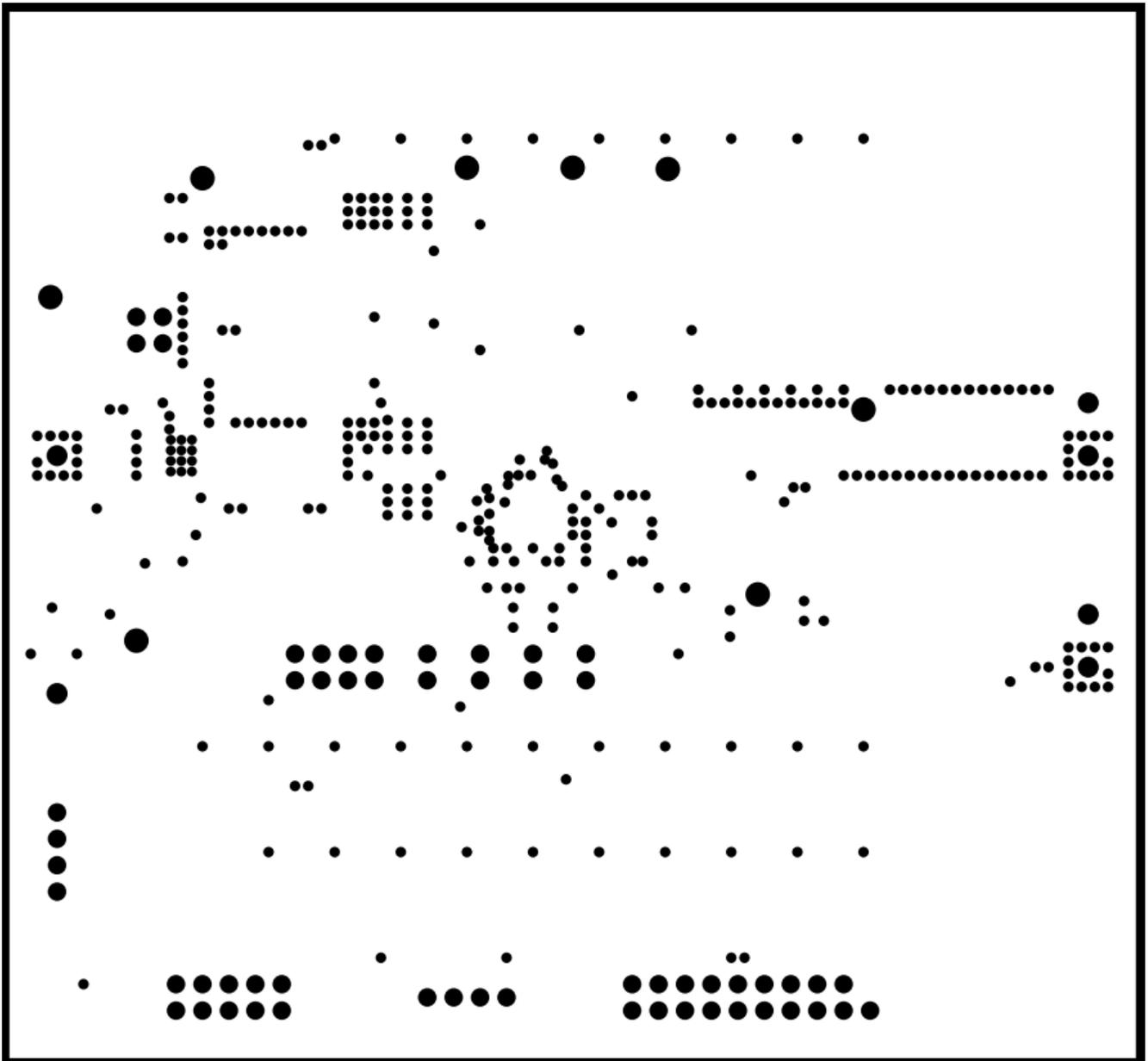


图 3-5. PCB 层 2 ( 负 )

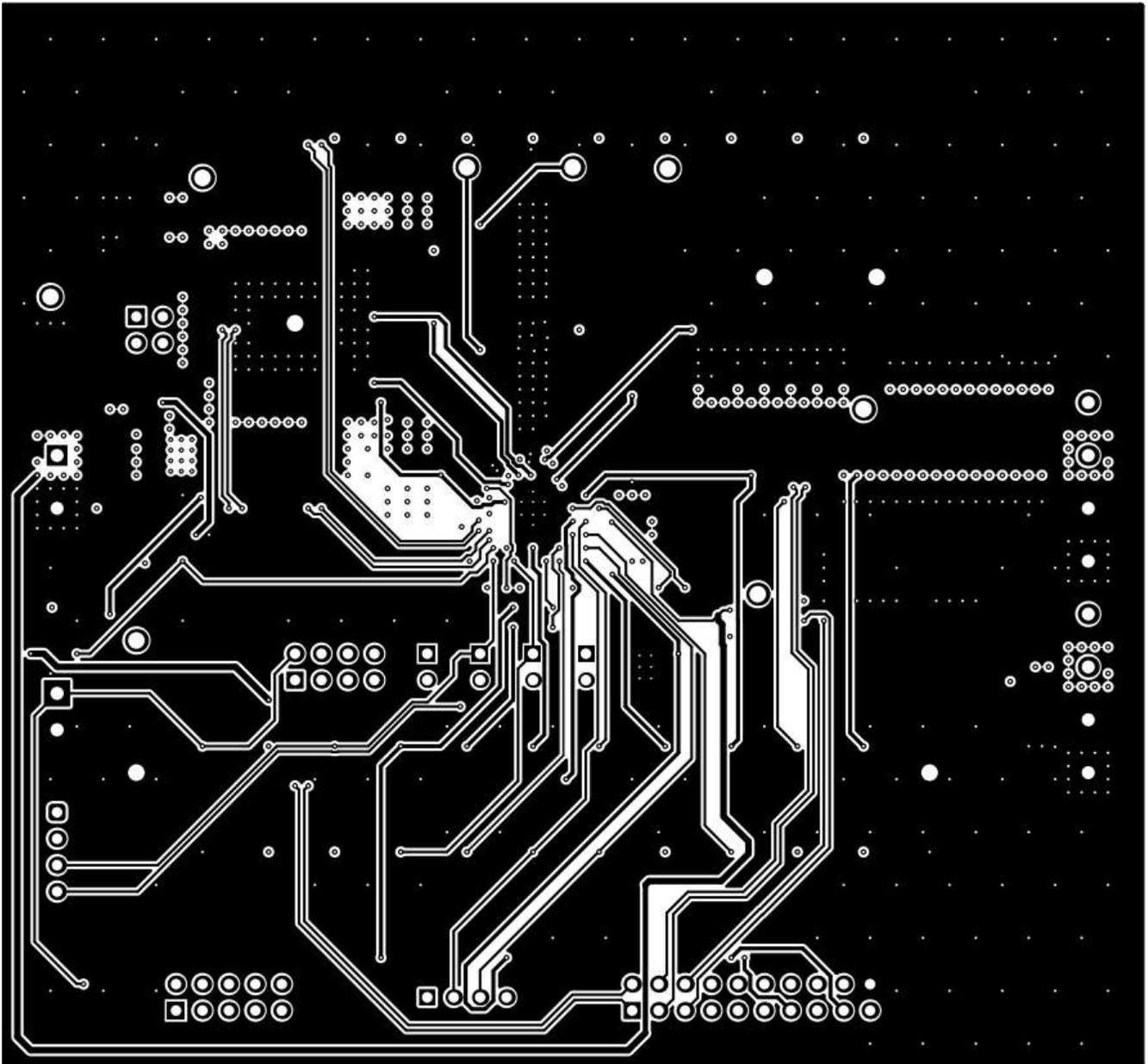


图 3-6. PCB 层 3

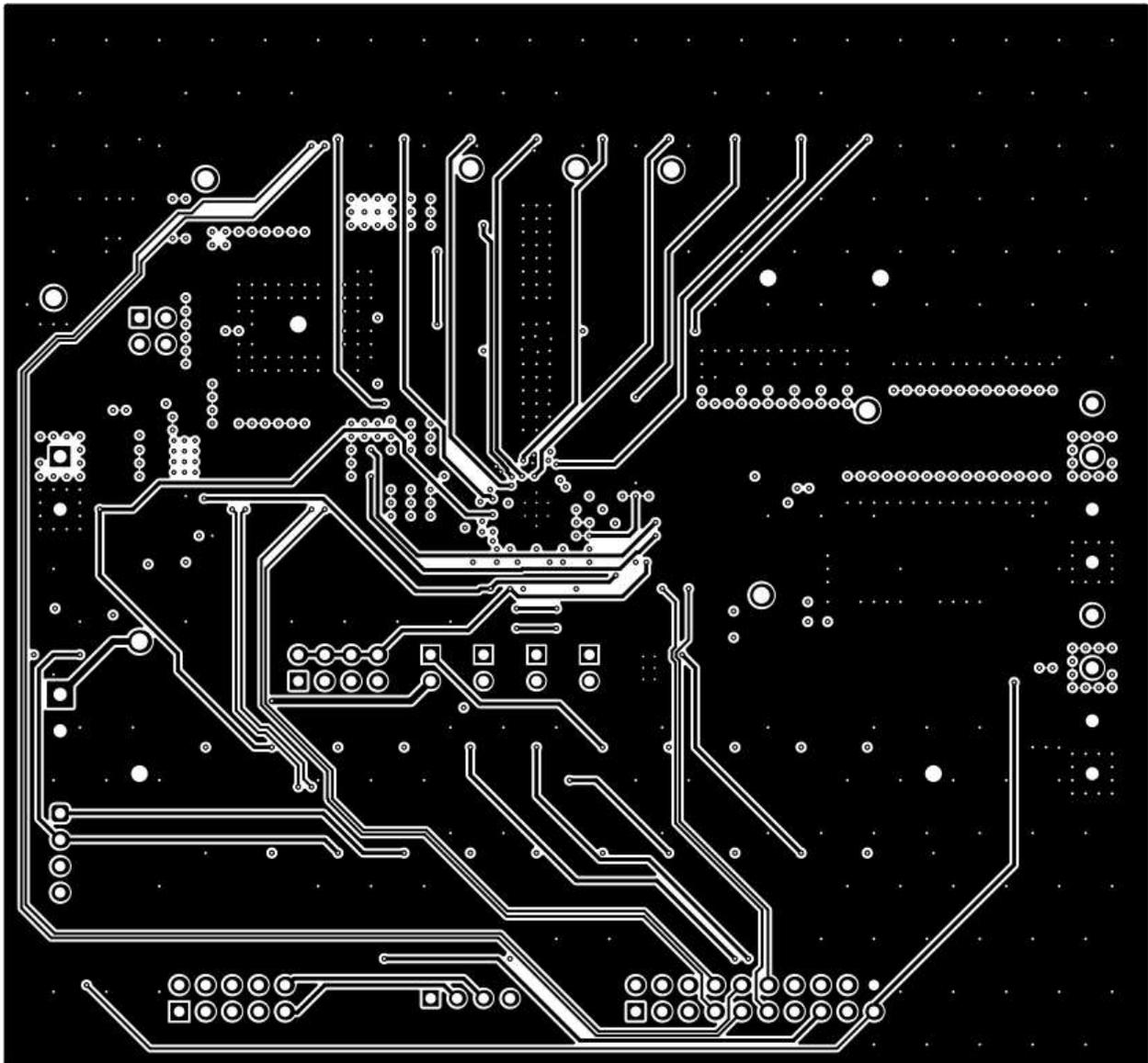


图 3-7. PCB 层 4

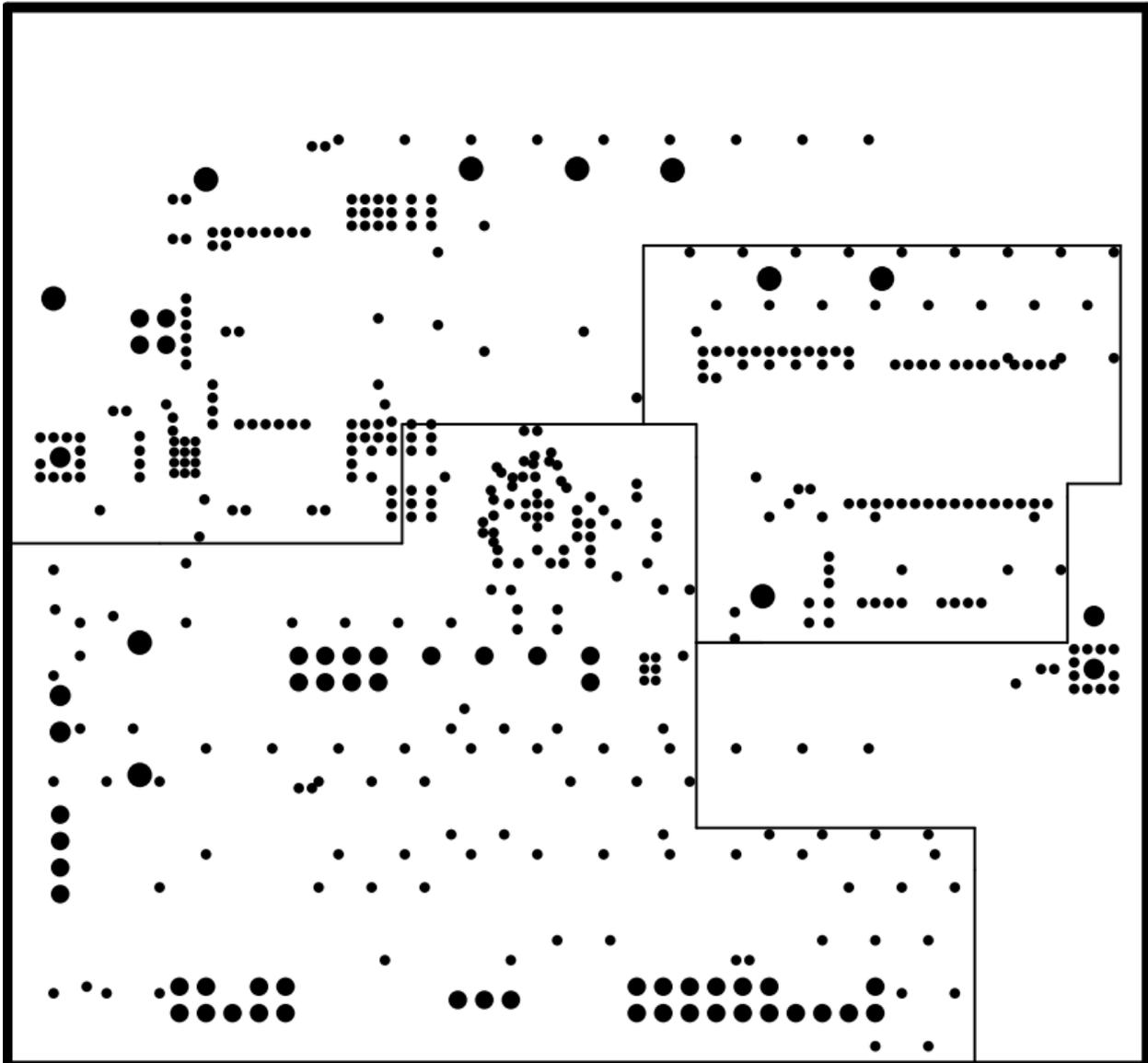


图 3-8. PCB 层 5 ( 负 )

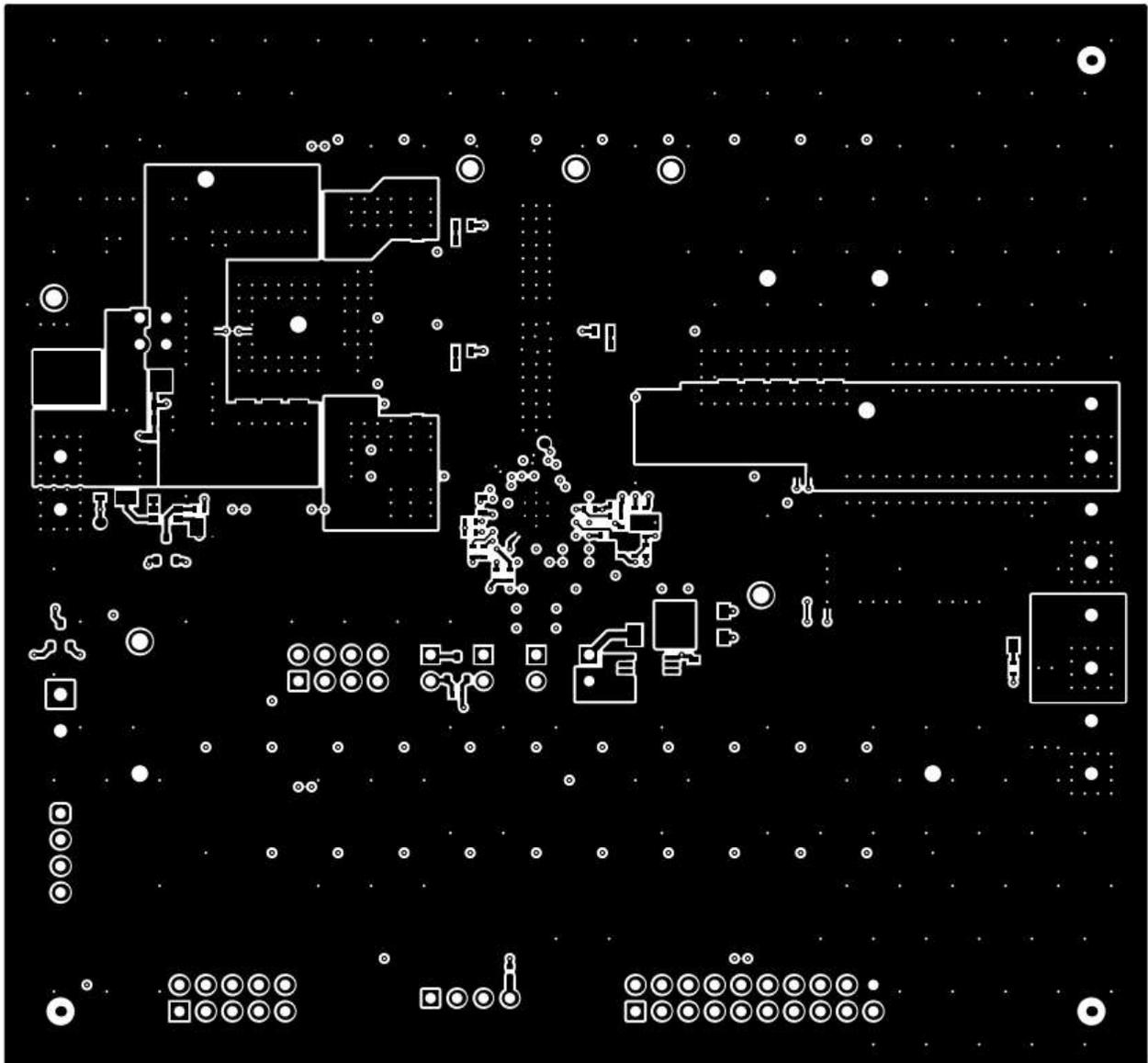


图 3-9. PCB 层 6

### 3.3 物料清单

表 3-1 列出了 BQ2578xEVM 物料清单。

表 3-1. BQ25785EVM 物料清单

位号	数量	值	说明	封装参考	器件型号	制造商
!PCB1	1		印刷电路板		BMS110	不限
C1、C23、C24、C32	4	33uF	电容, 钽聚合物, 33uF, 50V, +/-20%, 0.05 欧姆, 7343-43 SMD	7343-43	T521X336M050ATE050	Kemet
C2、C29、C33、C63	4	0.1uF	电容, 陶瓷, 0.1 μF, 50V, +/-10%, X7R, AEC-Q200 1 级, 0603	0603	CGA3E2X7R1H104K080AA	TDK
C3、C4、C7、C10、C11、C12、C13、C14、C16、C17、C20、C42、C43、C47、C55、C56、C57、C58、C59	19	10uF	电容, 陶瓷, 10μF, 50V, +/- 10%, JB, 0805	0805	GRM21BR61H106KE43L	muRata
C8、C15、C21	3	0.01uF	电容, 陶瓷, 0.01μF, 50V, +/-5%, X7R, 0603	0603	C0603C103J5RACTU	Kemet
C9、C22	2	1000pF	电容, 陶瓷, 1000pF, 50V, +/-5%, X7R, 0402	0402	04025C102JAT2A	AVX
C25、C27、C31	3	0.1uF	电容, 陶瓷, 1μF, 25V, +/-10%, X7R, AEC-Q200 0.1 级, 0402	0402	CGA2B3X7R1E104K050BB	TDK
C26、C28	2	2.2uF	电容, 陶瓷, 2.2μF, 25V, +/-20%, X5R, 0402	0402	GRM155R61E225ME15D	MuRata
C30、C77	2	1uF	电容, 陶瓷, 1μF, 50V, +/-10%, X5R, 0603	0603	C1608X5R1H105K080AB	TDK
C34、C39	2	10uF	电容, 陶瓷, 10μF, 35V, +/-10%, X7R, 1206_190	1206_190	GMK316AB7106KL-TR	Taiyo Yuden
C36、C37、C38	3	100pF	电容, 陶瓷, 100pF, 50V, +/-5%, C0G/NP0, 0402	0402	GRM1555C1H101JA01D	MuRata
C48	1	1uF	电容, 陶瓷, 1μF, 50V, +/-10%, X7R, AEC-Q200 1 级, 0805	0805	GCM21BR71H105KA03K	MuRata
C70	1	0.47uF	电容, 陶瓷, 0.47μF, 50V, +/-20%, X7R, AEC-Q200 1 级, 0603	0603	CGA3E3X7R1H474M080AE	TDK
C72、C73、C74、C75	4	0.033uF	电容, 陶瓷, 0.033 μF, 50V, +/-10%, X7R, AEC-Q200 1 级, 0402	0402	CGA2B3X7R1H333K050BB	TDK
C76	1	10uF	电容, 陶瓷, 10μF, 35V, +/-20%, X5R, 0603	0603	GRM188R6YA106MA73D	Murata
D1	1	绿色	LED, 绿色, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
D3、D4	2	100V	二极管, 开关, 100V, 0.3A, AEC-Q101, SOD-123	SOD-123	1N4148WQ-7-F	Diodes Inc.
H1、H2、H3、H4	4		Bumpon, 半球形, 0.44 X 0.20, 透明	透明 Bumpon	SJ-5303 (CLEAR)	3M
J1	1		端子块, 5.08mm, 2x1, 黄铜, TH	2x1 5.08mm 端子块	ED120/2DS	On-Shore Technology

表 3-1. BQ25785EVM 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
J2、J3	2		端子块, 5.08mm, 4x1, 黄铜, TH	4x1 5.08mm 端子块	ED120/4DS	On-Shore Technology
J4	1		端子块, 3.5mm 间距, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J5	1		接头, 100mil, 4x1, 金, TH	4x1 接头	TSW-104-07-G-S	Samtec
J6	1		接头 (有罩), 100mil, 5x2, 高温, 镀金, TH	5x2 有罩接头	N2510-6002-RB	3M
J7	1		接头, 100mil, 10x2, 金, TH	10x2 接头	TSW-110-07-G-D	Samtec
J8	1		连接器接头, 穿孔, 直角, 4 位, 0.100" (2.54mm)	HDR4	0022053041	Molex
JP1、JP2、JP3、JP5	4		接头, 100mil, 2x1, 金, TH	接头, 2x1, 100mil	5-146261-1	TE Connectivity
JP4	1		接头, 100mil, 4x2, 金, TH	4x2 接头	TSW-104-07-G-D	Samtec
JP6	1		接头, 100mil, 2x2, 金, TH	2x2 接头	TSW-102-07-G-D	Samtec
L1、L2	2	3.3uH	电感器	SMD3	CSHB-1050-3R3-M	CoilForce
LBL1	1		热转印打印标签, 0.650" (宽) x 0.200" (高) - 10,000/卷	PCB 标签, 0.650 x 0.200 英寸	THT-14-423-10	Brady
Q1_A、Q1_B、Q2_A、Q2_B	4		AOS、N 沟道 60V 表面贴装 8-DFN (5x6)	DFN8	BSC094N06LS5	Infineon Technologies
Q3	1		N 沟道 30V 27A (Ta)、60A (Tc) 6.2W (Ta)、31W (Tc) 表面贴装 8-DFN (5x6)	DFN8	AONS66406	Alpha & Omega Semiconductor
Q4	1		N 沟道 30V 27A (Ta)、60A (Tc) 6.2W (Ta)、31W (Tc) 表面贴装 8-DFN (5x6)	DFN8	AONS66408	Alpha & Omega Semiconductor
Q5	1		N 沟道 30V 27A (Ta)、60A (Tc) 6.2W (Ta)、31W (Tc) 表面贴装 8-DFN (5x6)	DFN8	CSD18501Q5A	Alpha & Omega Semiconductor
Q6、Q7、Q8	3	60V	MOSFET, N 沟道, 60V, 0.26A, SOT-23	SOT-23	2N7002ET1G	ON Semiconductor
Q9	1	-100V	MOSFET, P 沟道, -100V, -28A, PowerPAK SO-8	PowerPAK SO-8	SI7489DP-T1-GE3	Vishay-Semiconductor
Q10	1	50V	晶体管, NPN/PNP 对, 50V, 0.05A, SC-74R	SC-74R	DCX124EK-7-F	Diodes Inc.
R1、R2、R6、R7	4	4.99	电阻, 4.99, 1%, 0.1W, AEC-Q200 0 级, 0603	0603	CRCW06034R99FKEA	Vishay-Dale
R5	1		热敏电阻 NTC 10k $\Omega$ 3380K 0402	0402	ERT-J0EG103FA	Panasonic Electronic
R8	1	0	电阻, 0, 5%, 0.063W, 0402	0402	RC0402JR-070RL	Yageo America
R9、R10	2	10	电阻, 10, 5%, 0.1W, AEC-Q200 0 级, 0603	0603	CRCW060310R0JNEA	Vishay-Dale
R11、R12、R13、R14、R33、R43、R44	7	10.0k	电阻, 10.0k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R15	1	200k	电阻, 200k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW0402200KFKED	Vishay-Dale
R16、R42、R45	3	300k	电阻, 300k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW0402300KFKED	Vishay-Dale
R17	1	15.0k	电阻, 15.0k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW040215K0FKED	Vishay-Dale

**表 3-1. BQ25785EVM 物料清单 (续)**

位号	数量	值	说明	封装参考	器件型号	制造商
R18	1	3.57k	电阻, 3.57k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04023K57FKED	Vishay-Dale
R19	1	2.00k	电阻, 2.00k, 1%, 0.1W, AEC-Q200 0 级, 0603	0603	CRCW06032K00FKEA	Vishay-Dale
R20	1	100k	电阻, 100k, 1%, 0.0625W, 0402	0402	RC0402FR-07100KL	Yageo America
R21	1	150k	电阻, 150k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW0402150KFKED	Vishay-Dale
R22	1	82.0k	电阻, 82.0k, 1%, 0.063W, 0402	0402	RC0402FR-0782KL	Yageo America
R23	1	33.0k	电阻, 33.0k, 1%, 0.063W, 0402	0402	RC0402FR-0733KL	Yageo America
R24	1	1.00k	电阻, 1.00k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04021K00FKED	Vishay-Dale
R28、R29	2	3.9	电阻, 3.9, 5%, 0.25W, AEC-Q200 0 级, 1206	1206	CRCW12063R90JNEA	Vishay-Dale
R30	1	100k	电阻, 100k, 1%, 0.1W, 0603	0603	RC0603FR-07100KL	Yageo
R31、R47	2	10.0	电阻, 10.0, 1%, 0.25W, AEC-Q200 0 级, 1206	1206	ERJ-8ENF10R0V	Panasonic
R32	1	1.0	电阻, 1.0, 5%, 0.1W, AEC-Q200 0 级, 0603	0603	CRCW06031R00JNEA	Vishay-Dale
R36	1	20.0k	电阻, 20.0k, 1%, 0.125W, AEC-Q200 0 级, 0805	0805	CRCW080520K0FKEA	Vishay-Dale
R39	1	2.0Meg	电阻, 2.0M, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04022M00JNED	Vishay-Dale
RAC_A、RAC_B	2	0.01	电阻, 0.01, 1%, 1W, 1206	1206	WSLP1206R0100FEA	Vishay-Dale
RSR	1	0.005	电阻, 0.005, 1%, 1.5W, 2010	2010	CSNL2010FT5L00	Stackpole Electronics Inc
SH-JP2、SH-JP4、SH-JP5、SH-JP6、SH-JP7	5	1x2	分流器, 100mil, 镀金, 黑色	分流器	SNT-100-BK-G	Samtec
TP1、TP2、TP3、TP4、TP5、TP6、TP7、TP8、TP9、TP10、TP11、TP12、TP13、TP31、TP32、TP33、TP34、TP38、TP39、TP40、TP41、TP42、TP43、TP44、TP45、TP46、TP47、TP48、TP51、TP52、TP53、TP54、TP55、TP56、TP57、TP58、TP59、TP60、TP61、TP62	40		测试点, 微型, SMT	Testpoint_Keystone_Miniature	5015	Keystone Electronics
TP14、TP20、TP22、TP35、TP37	5		测试点, 多用途, 红色, TH	红色通用测试点	5010	Keystone Electronics
TP15、TP16、TP17	3		测试点, 通用, 白色, TH	白色通用测试点	5012	Keystone Electronics

表 3-1. BQ25785EVM 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
TP18、TP19、TP21、TP49、TP50	5		测试点，多用途，黑色，TH	黑色通用测试点	5011	Keystone Electronics
U1	1		具有系统功率监测器和处理器热量监测器的 SMBus、2 至 5 节、窄 VDC 双相降压/升压电池充电控制器	WQFN36	BQ25785REER	德州仪器 (TI)
U2	1		具有使能引脚和电源正常状态指示输出的 60V、5uA IQ 低压降 100mA 线性稳压器，DGN0008C (VSSOP-8)	DGN0008C	TPS7A1633DGNR	德州仪器 (TI)
Z1	1	10V	二极管，TVS，单向，10V，17Vc，400W，23.5A，SMA	SMA	SMAJ10A	Littelfuse

## 4 其他信息

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#### 3.1 United States

##### 3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

##### 3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

#### **CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### **FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

#### **FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

#### 3.2 Canada

##### 3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### **Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### **Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

#### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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4. *EVM Use Restrictions and Warnings:*
    - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
    - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
    - 4.3 *Safety-Related Warnings and Restrictions:*
      - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
      - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
    - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
  5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
  6. *Disclaimers:*
    - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
    - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
  7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.
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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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