参考文献

EVM User's Guide: LMG5126EVM

LMG5126 评估模块

说明

LMG5126EVM 评估模块展示了 LMG5126 宽输入电压同步 GaN 升压转换器的特性和性能。该 EVM 旨在简化配置，使用户能够在同一模块上评估许多不同的应用。标准配置旨在提供 24V 稳压输出，开关频率为 400kHz。输出电压可利用 ATRK、DTRK 引脚进行动态调节。

开始使用

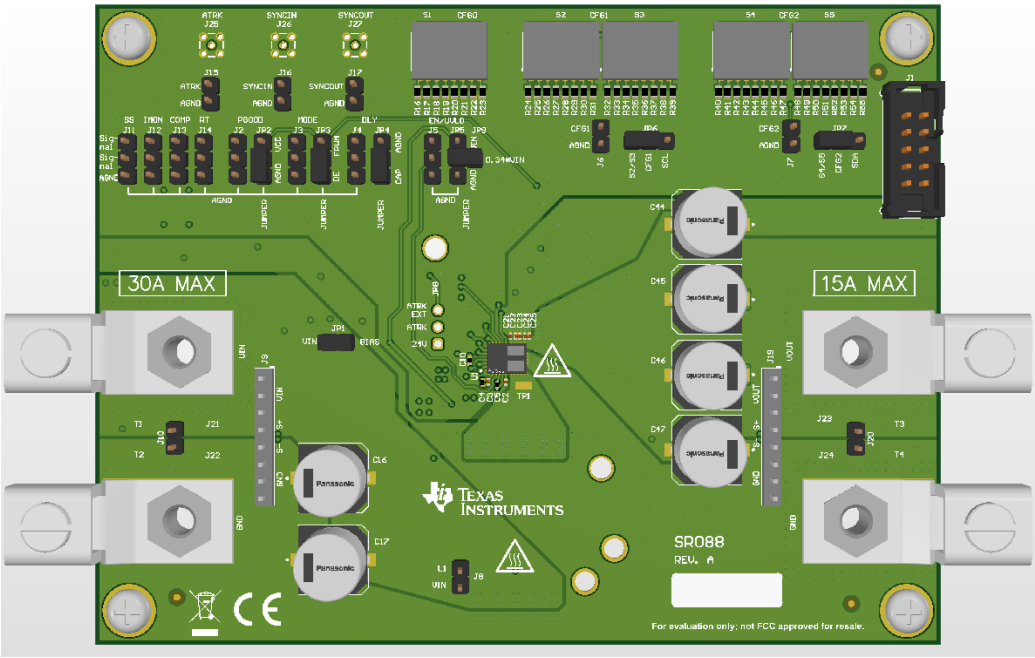
1. 将 EVM 连接到电源和负载

特性

- 可堆叠
- 输出电压跟踪
- 宽输入电压范围
- 电感器电流监控和平均电流限制
- 旁路模式、PGOOD 指示器和双随机展频 (DRSS)
- 软启动和峰值电流限制
- 可选同步 (SYNC)
- 可编程线路欠压锁定 (UVLO) 和迟滞

应用

- 汽车级 H 类音频功率放大器
- 汽车 LED 前照灯



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1 评估模块概述

1.1 简介

LMG5126EVM 评估模块为设计工程师提供了功能齐全的同步升压转换器，用于评估 LMG5126 同步 GaN 升压转换器。该 EVM 在 8V 至 18V 的输入电压范围内运行，并可处理高达 42V 的输入瞬态。该 EVM 提供 24V 输出电压，最大功率为 240W。使用散热器可以将最大功率增加到 400W。输出电压也可以通过 ATRK/DTRK 引脚调整至 60V。图 1-1 展示了 LMG5126EVM 评估模块的标准应用电路。

1.2 套件内容

- 一个 LMG5126EVM PCB 组件
- EVM 免责声明自述文件

1.3 规格

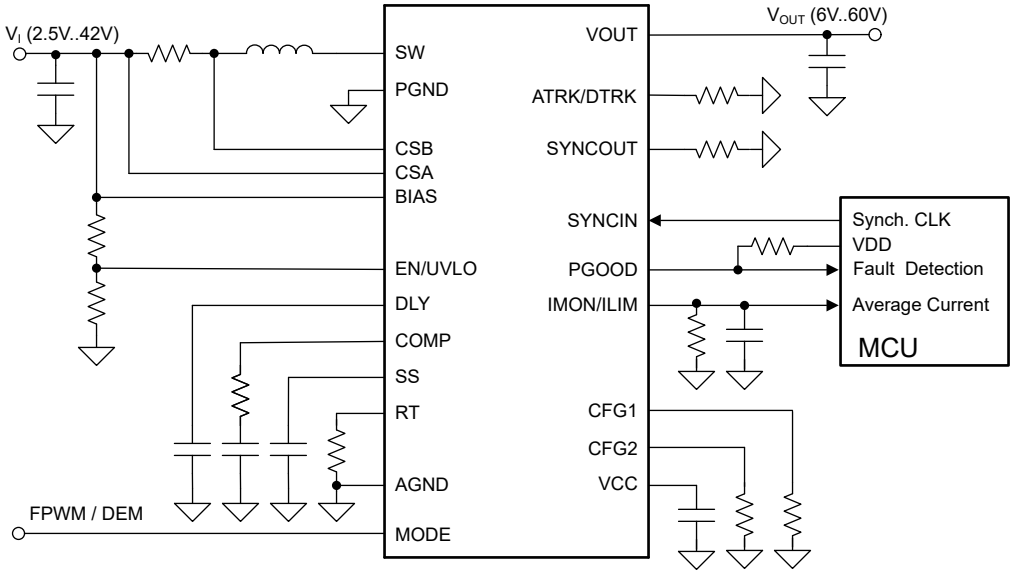

图 1-1. 典型应用电路

1.4 器件信息

LMG5126 是一款同步 GaN 升压转换器。当输入电压高于所需的输出电压时，器件会进入旁路模式。

- 宽输入电压范围：2.5V 至 42V
- 输出电压：6V 至 60V
- 峰值电流调节方案
- 输出电压动态跟踪
  - 模拟和数字 PWM 跟踪输入
- 最小静态电流
  - 50 µA 的低关断 IQ

2 硬件

2.1 EVM 特性、测试点和连接器说明

本节介绍 EVM 的工作条件以及评估模块的配置点。

2.1.1 EVM 特性

表 2-1 详细说明了 EVM 特性。

表 2-1. EVM 特性

参数	测试条件		最小值	典型值	最大值	单位
输入电压特性						
输入电压范围	运行		8	14	18	V
	UVLO 电压电平	导通		4.2		V
		关断		3.2		V
输入电流	空载运行 V_{in} = 12V，V_{out} = 24V			1.7		mA
输出特性						
输出电压	R_{ATRK} = 40.2kΩ			24		V
	R_{ATRK} = 75kΩ			45		V
输出功率	Vin = 16V，JP4 引脚 1-2 短接（停用平均电流限制功能）			240	400（带散热器）	W
系统特性						
开关频率				400		kHz
满负载效率	V_{IN} = 12V，V_{OUT} = 24V			95.6		%

2.1.2 EVM 连接器和测试点

节 2.1.2 描述了评估模块的连接点。表 2-2 至 表 2-4 描述了这些连接。表 2-2 列出了评估模块的电源连接。这些连接旨在处理相对较大的电流。

表 2-2. 电源连接

连接器	引脚	说明
T1	VIN+	评估模块的正输入电压电源
T2	VIN-	评估模块的负输入电压电源
T3	VOUT+	评估模块的正输出电压电源
T4	VOUT-	评估模块的负输出电压电源
J9	VIN	正输入电压引脚 1 - 引脚 3，负输入引脚 6 - 引脚 8（引脚 4 和 5 仅用于检测输入电压）
J19	VOUT	正输出电压引脚 1 - 引脚 3，负输出引脚 6 - 引脚 8（引脚 4 和 5 仅用于检测输出电压）

表 2-3 列出了根据需要配置 LMG5126 和 LMG51261 的 EVM 跳线和测试点。这些跳线可以设置不同的工作模式或向 LMG5126 和 LMG51261 的不同引脚提供信号。

表 2-3. 可编程跳线连接

连接器	引脚	说明	默认连接
JP1	BIAS 至 VIN	将 LMG5126 的 BIAS 引脚连接到 VIN	X
JP2	引脚 1 至引脚 2	将 PGOOD 引脚连接到 VCC 以启用电源正常状态指示器	X
	断开	如果不使用电源正常状态指示器，则该引脚可以保持悬空	
JP3	引脚 1 至引脚 2	将 MODE 引脚连接到 VCC 以启用 FPWM 模式	
	引脚 2 至引脚 3	将 MODE 引脚连接到 AGND 以启用 DEM	X

表 2-3. 可编程跳线连接（续）

连接器	引脚	说明	默认连接
JP4	引脚 1 至引脚 2	将 DLY 引脚连接到电阻器以禁用延迟功能和平均电流限制特性	
	引脚 2 至引脚 3	将 DLY 引脚连接到电容器以启用延迟功能	X
	引脚 2 至 JP8	将 DLY 引脚连接到 GND 以禁用延迟功能和平均电流限制特性	
JP5	引脚 1 至引脚 2	当 VIN 斜升时，UVLO/EN 连接至 VIN 一旦超过 UVLO 阈值，UVLO/EN 引脚也会斜升，并且会启用 LMG5126。	
	引脚 2 至引脚 3	将 EN2 连接到 AGND 来禁用 LMG5126	
	引脚 2 至 JP9	EN UVLO 引脚连接到由 R14、R15 和 C51 组成的电阻分压器网络，其中该电阻分压器网络设置 UVLO 阈值，以启用 LMG5126。	X
JP6	引脚 1 至引脚 2	使用 DIP 开关 S2 和 S3 进行 CFG1 设置	X
	引脚 2 至引脚 3	针对 I2C 版本将 CFG1 设置为 I2C 引脚	
JP7	引脚 1 至引脚 2	使用 DIP 开关 S4 和 S5 进行 CFG2 设置	X
	引脚 2 至引脚 3	针对 I2C 版本将 CFG2 设置为 I2C 引脚	
JP8	引脚 1 至引脚 2	将 ATRK 连接至 40.2k 电阻以将 Vout 设置为 24V	X
	引脚 2 至引脚 3	将 ATRK 连接到 J15 以从外部供电	
J25	MMCX 插孔	ATRK/DTRK 引脚的数字 PWM 信号输入	
J26	MMCX 插孔	外部同步	
J27	MMCX 插孔	外部 SYNCOUT	

表 2-4 指示了 EVM 的专用电压探测点。这些点用于在 EVM 上进行测量。

表 2-4. 探测点

检测点	名称	说明
TP1	SW	升压转换器开关节点的检测点
J1	I2C	具有模拟接地的 I2C 测量接头
J2	PGOOD	具有模拟接地的电源正常状态测量接头
J3	模式	具有模拟接地的 MODE 引脚测量接头
J4	DLY	具有模拟接地的 DLY 引脚测量接头
J5	UVLO	具有模拟接地的 UVLO 引脚测量接头
J6	CFG1	具有模拟接地的 CFG1 引脚测量接头
J7	CFG2	具有模拟接地的 CFG2 引脚接头
J8	CS	电流检测电阻器的端子
J10	Vin 检测	输入电压的检测引脚
J11	SS	具有模拟接地的 SS 引脚测量接头
J12	ILIM/IMON	具有模拟接地的 ILIM/IMON 引脚接头
J13	COMP	具有模拟接地的 COMP 引脚接头
J14	RT	具有模拟接地的 RT 引脚接头
J15	ATRK	具有模拟接地的 ATRK 引脚接头
J16	SYNCIN	具有模拟接地的 SYNCIN 引脚接头
J17	SYNCOUT	具有模拟接地的 SYNCOUT 引脚接头
J18	PGND	连接至 PGND
J20	Vout 检测	输出电压的检测引脚

3 EVM 配置

节 3 展示了用于进一步评估 LMG5126 的默认配置之外的修改。

3.1 输出电压跟踪

节 3.1 介绍了如何设置用于动态输出电压跟踪的评估模块。

LMG5126EVM 是典型配置，具有 24V 的固定输出电压。图 3-1 展示了从 ATRK、DTRK 引脚到模拟地的电阻器将输出电压设置为 24V。参考原理图，R_{ATRK} 是 R11。

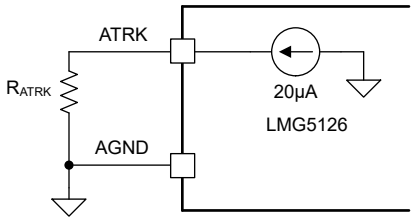

图 3-1. 固定输出电压配置

为了通过模拟信号动态地改变输出电压，可移除 R_{ATRK}，并直接驱动 ATRK、DTRK 引脚电压以改变输出电压。有关如何选择电压范围和设置 ATRK 引脚电压以产生所需的输出电压，请参阅 LMG5126 宽输入、2.5MHz 升压转换器数据表。图 3-2 展示了通过施加电压或提供模拟信号来动态更改输出电压的配置。

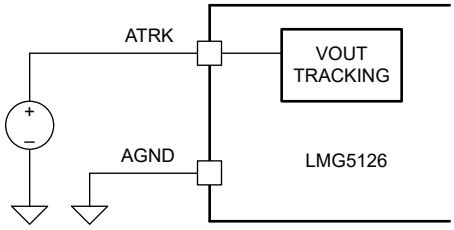

图 3-2. 通过模拟信号实现可变输出电压配置

向 ATRK、DTRK 引脚施加大约 0.8V 和 1.5V 的模拟电压将分别设置 24V 和 45V 的输出电压。

为了以数字方式动态地改变输出电压，可移除 R_{ATRK}，并直接向 ATRK/DTRK 引脚馈送 PWM 信号以改变输出电压。有关设置 DTRK 引脚电压的 PWM 占空比以产生所需输出电压的信息，请参阅 LMG5126 宽输入、2.5MHz 升压转换器数据表。图 3-3 展示了通过施加数字信号来动态更改输出电压的配置。

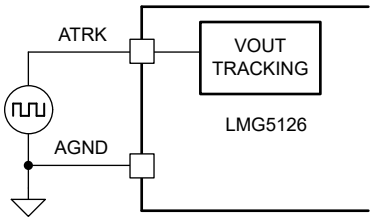

图 3-3. 通过数字信号实现可变输出电压配置

在占空比为 32% 和 60% 的 ATRK/DTRK 引脚上施加 PWM 信号会将输出电压分别设置为 24V 和 45V。

3.2 器件配置

LMG5126 可以使用三个引脚 SYNCOUT、CFG1 和 CFG2 进行配置。在 LMG5126EVM 中，当连接器 JP6 和 JP7 上的跳线分别将 CFG1 连接到 DIP1、将 CFG2 连接到 DIP2 时，这些引脚可通过五个 DIP 开关进行配置，具体方式是每个引脚均提供 16 种电平选项，通过操作开关可从两种配置中选定所需电平。每个 DIP 开关都有八个切换开关，用于将固定值电阻器与配置引脚连接或断开连接。同一时间，每个配置引脚只能从 16 种电平中选择一种，用于配置 LMG5126，具体如下，且需参照 LMG5126 宽输入、2.5MHz 升压转换器数据表 中的信息。

SYNCOUT 引脚用于定义过压保护电平，而 ATRK 引脚与 DTRK 引脚的 20uA 电流可通过电阻器实现输出电压的编程。

表 3-1. SYNCOUT 引脚设置

电平	OVP 等级	20 µA ATRK 电流
1	25V	导通
2	25V	关闭
3	35V	导通
4	35V	关闭
5	50V	导通
6	50V	关闭
7	65V	导通
8	65V	关闭

CFG1 引脚设置定义了时钟抖动、峰值电流限制 (ICL_latch) 运行、电流检测电压电平以及栅极驱动器强度。

表 3-2. CFG1 引脚设置

电平	展频	检测电压	ICL_{latch}	栅极驱动强度
1	DRSS 开启	30mV	启用	弱
2	DRSS 开启	60mV	启用	弱
3	DRSS 开启	30mV	启用	强
4	DRSS 开启	60mV	启用	强
5	DRSS 开启	30mV	禁用	弱
6	DRSS 开启	60mV	禁用	弱
7	DRSS 开启	30mV	禁用	强
8	DRSS 开启	60mV	禁用	强
9	DRSS 关闭	30mV	启用	弱
10	DRSS 关闭	60mV	启用	弱
11	DRSS 关闭	30mV	启用	强
12	DRSS 关闭	60mV	启用	强
13	DRSS 关闭	30mV	禁用	弱
14	DRSS 关闭	60mV	禁用	弱
15	DRSS 关闭	30mV	禁用	强
16	DRSS 关闭	60mV	禁用	强

CFG2 引脚定义了器件是配置为单芯片设置还是多芯片设置，然后定义了 SYNCIN 和 SYNCOUT 引脚的运行模式。同时也可设置 PGOOD OVP。

表 3-3. CFG2 引脚设置

电平	单芯片或多芯片	SYNCOUT	SYNCIN	PGOOD OVP 启用
1	单通道	关断	关断	导通
2	单通道	关断	导通	导通
3	初级	90°	导通	导通
4	初级	120°	导通	导通

表 3-3. CFG2 引脚设置（续）

电平	单芯片或多芯片	SYNCOUT	SYNCIN	PGOOD OVP 启用
5	初级	180°	导通	导通
6	次级	关断	导通	导通
7	次级	90°	导通	导通
8	次级	120°	导通	导通
9	单通道	关断	关断	关断
10	单通道	关断	导通	关断
11	初级	90°	导通	关闭
12	初级	120°	导通	关闭
13	初级	180°	导通	关闭
14	次级	关断	导通	关断
15	次级	90°	导通	关闭
16	次级	120°	导通	关闭

S1 至 S5 是 8 位 DIP 开关。

- S1 用于 SYNCOUT
  - S1 位置 1 选择电平 1，⋯，S1 位置 8 选择电平 8
- S2 和 S3 用于 CFG1
  - S2 位置 1 选择电平 1，⋯，S2 位置 8 选择电平 8
  - S3 位置 1 选择电平 9，⋯，S3 位置 8 选择电平 16
- S4 和 S5 用于 CFG2
  - S4 位置 1 选择电平 1，⋯，S4 位置 8 选择电平 8
  - S5 位置 1 选择电平 9，⋯，S5 位置 8 选择电平 16

默认为 S1 选择位置 7，以将 SYNCOUT 的电平设置为 7：

- OVP 电平 65V
- 20uA ATRK 电流源导通

默认为 S3 选择位置 2，以将 CFG1 的电平设置为 10：

- DRSS 关闭
- 检测电压 = 60mV
- ICL_latch 启用
- 栅极驱动器强度：弱

默认为 S4 选择位置 1，以将 CFG2 的电平设置为 1：

- 单芯片运行
- SYNCOUT 关断
- SYNCIN 关断
- PGOOD OVP 使能导通

4 实现结果

4.1 测试装置和过程

4.1.1 测试设置

图 4-1 展示了评估 LMG5126EVM 所需的测试设置。

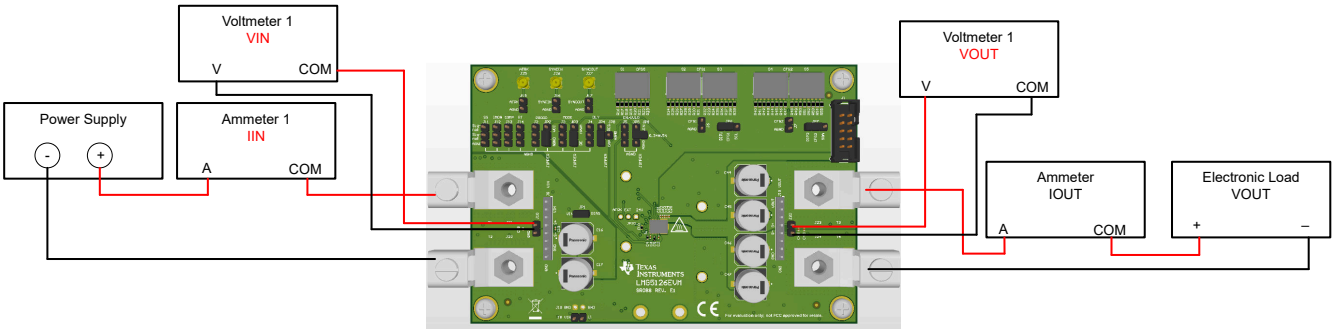

图 4-1. EVM 测试设置

4.1.2 测试过程和设备

需要以下测试设备来测试 LMG5126EVM：

- 电源：输入电压源 (V_{IN}) 为可变电源。电源需至少提供 20V 的电压并能够提供 30A 以上的电流。关闭电源。将电源的正输出连接到 T1，负输出连接到 T2。
- 电子负载：将负载连接到 T3 实现正连接，连接到 T4 实现负连接。电子负载在 60V 时应能够耗散 350W 的功率。

万用表：对于直流测量，连接如 图 6-1 所示。

-
  - 电压表 1 (V_{IN})：能够测量高达至少 20V 的输入电压范围
  - 电压表 2 (V_{OUT})：能够测量 60V 的输出电压
  - 电流表 1 (I_{IN})：能够进行 30A 直流测量。还可以使用分流电阻器来测量输入电流
  - 电流表 2 (I_{OUT})：能够进行至少 15A 直流测量
- 示波器：20MHz 带宽最小值和 10 个探头。
- 将电源电压设置为 12V，将电子负载设置为 0.1A。电子负载电压必须通过标称 24V 输出进行调节。
- 缓慢增大负载，同时监控 J23-VOUT 和 J24-GND 之间的输出电压。当负载增加到 7A 时，电压必须保持标称 24V 输出的稳压。
- 从 8V 至 18V 缓慢扫描输入电压。输出电压必须通过标称 24V 输出进行调节。
- 从 18V 至 8V 缓慢扫描输入电压。输出电压必须通过标称 24V 输出进行调节。

4.1.3 注意事项

警告

电路板表面和散热器会很烫。请勿触摸。接触可能导致灼伤。

5 应用曲线

5.1 效率

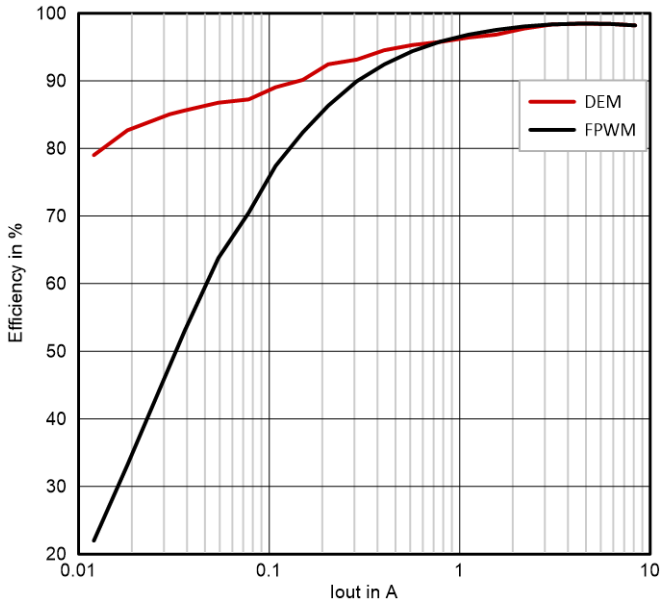

图 5-1. 效率与输出电流间的关系，Vin = 14.4V，Vout = 24V

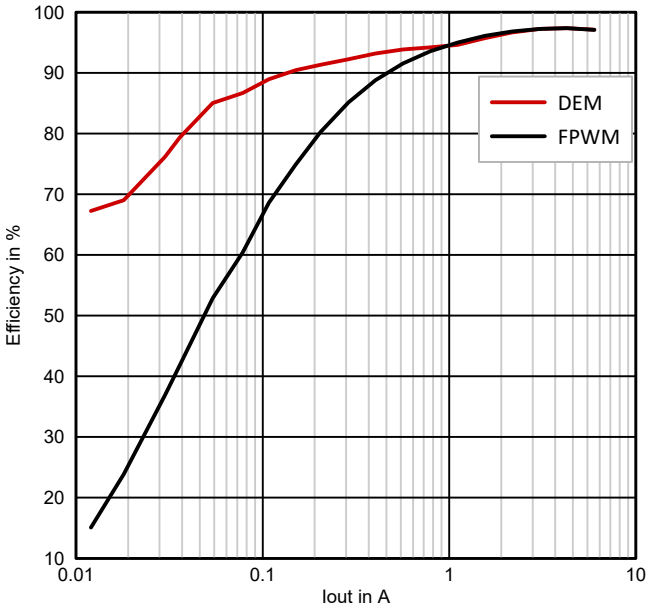

图 5-2. 效率与输出电流间的关系，Vin = 14.4V，Vout = 45V

5.2 稳态波形

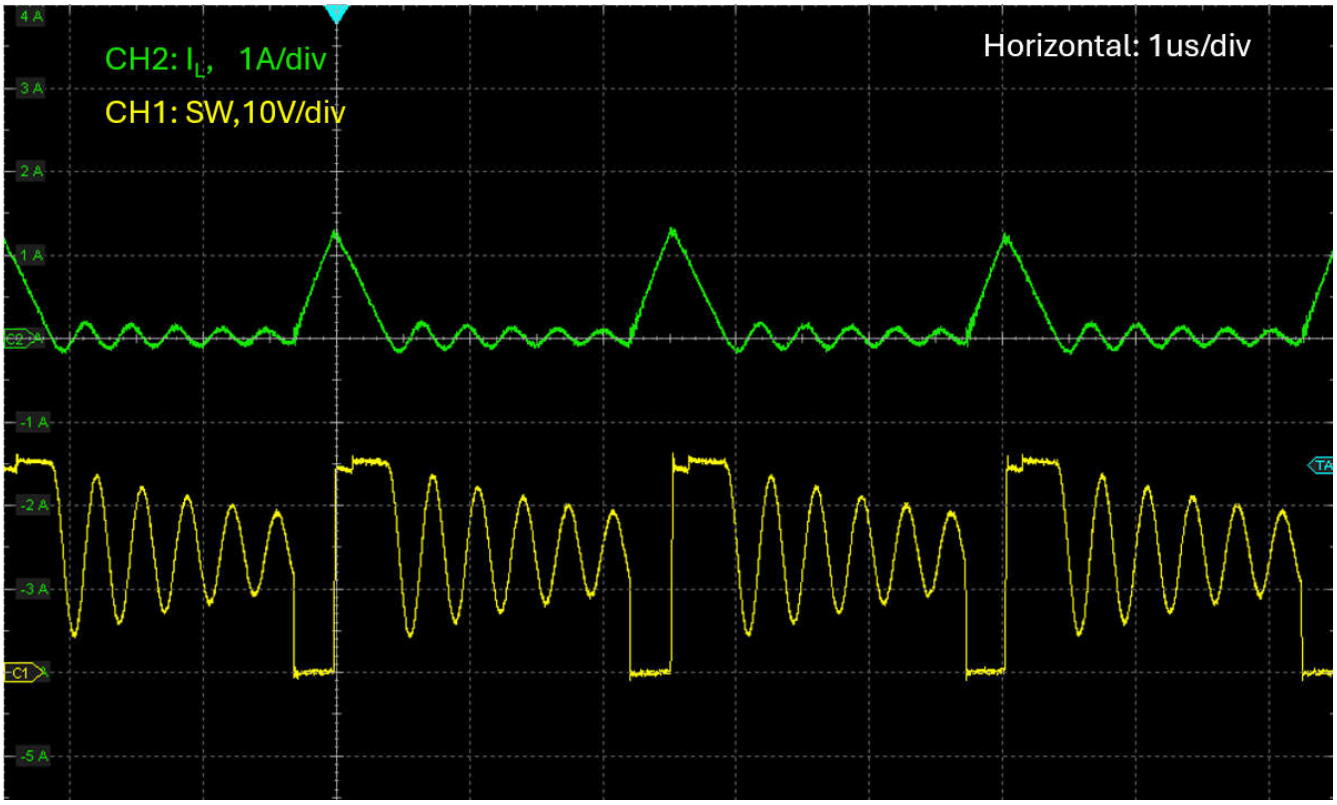

图 5-3. V_{in} = 14.4V，V_{out} = 24V，DEM，I_{load}= 0.1A

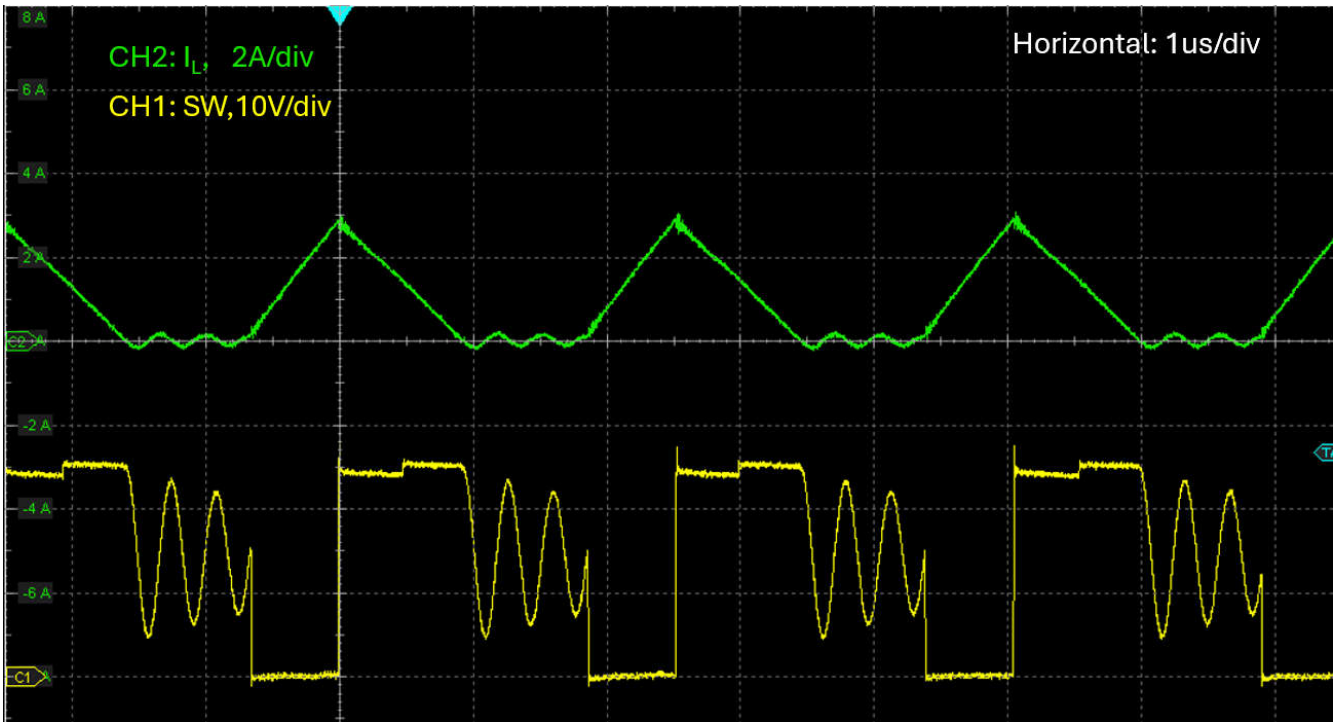

图 5-4. V_{in} = 14.4V，V_{out} = 24V，DEM，I_{load}= 0.5A

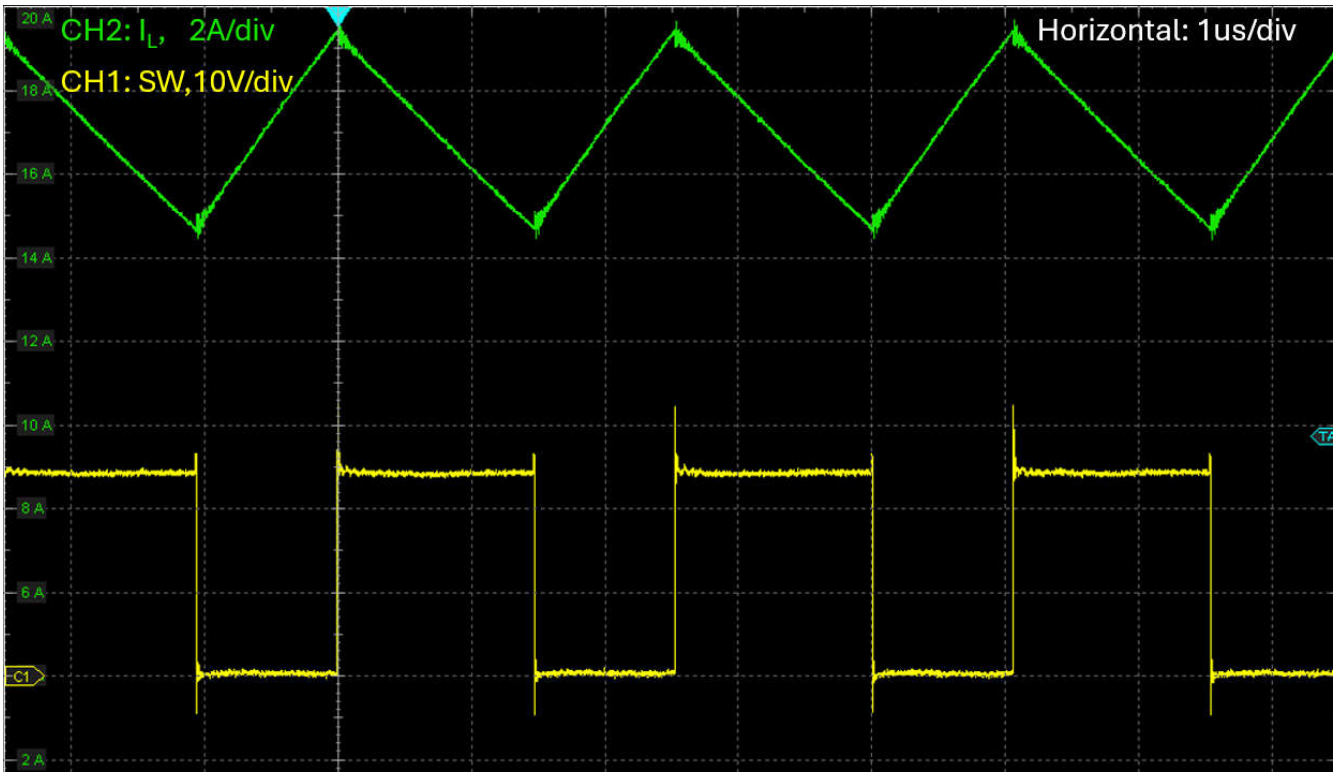

图 5-5. V_{in} = 14.4V，V_{out} = 24V，DEM，I_{load}= 10A

6 硬件设计文件

6.1 原理图

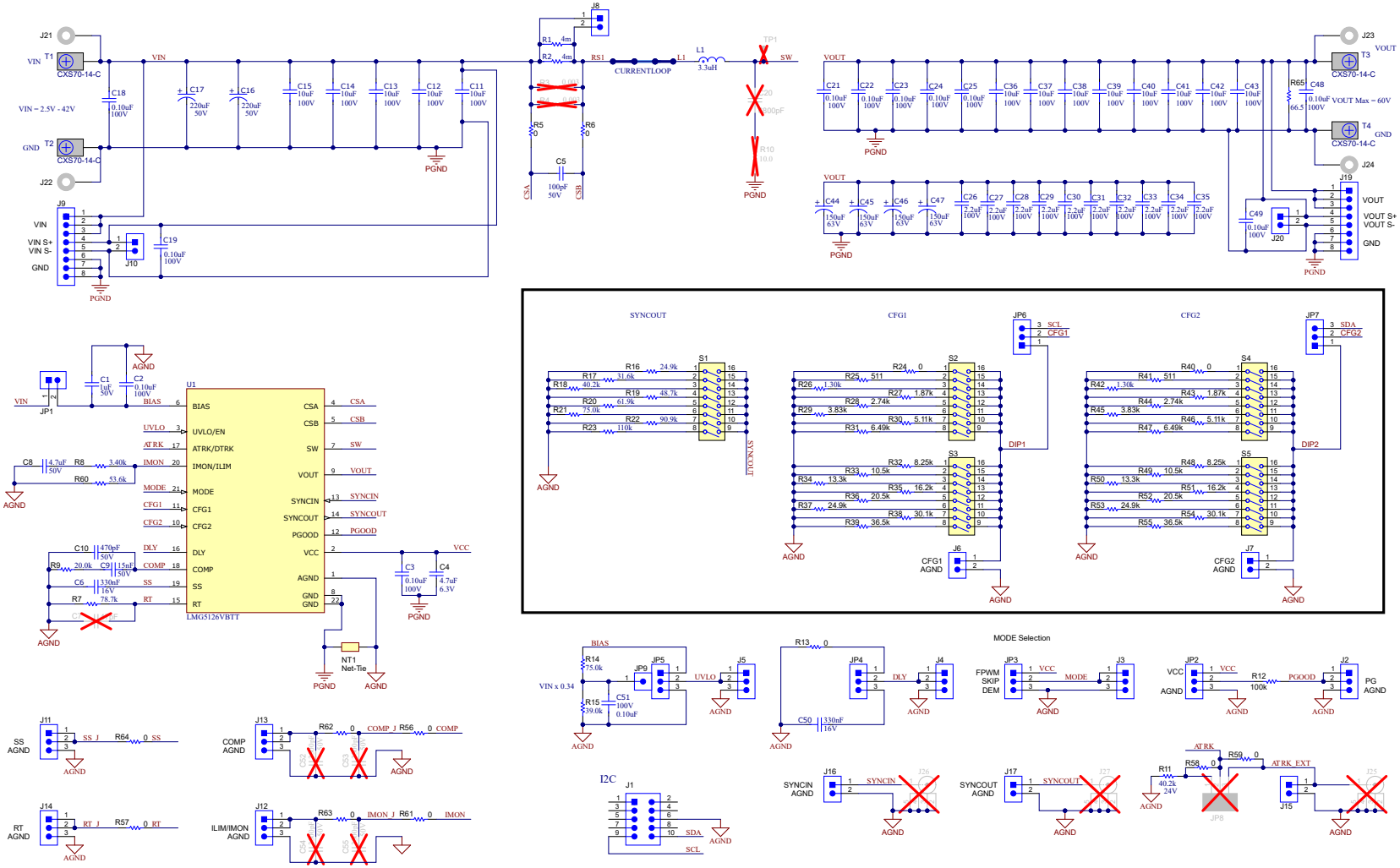

图 6-1. 原理图

6.2 PCB 板层

图 6-2 至 图 6-3 展示了 EVM PCB 布局。

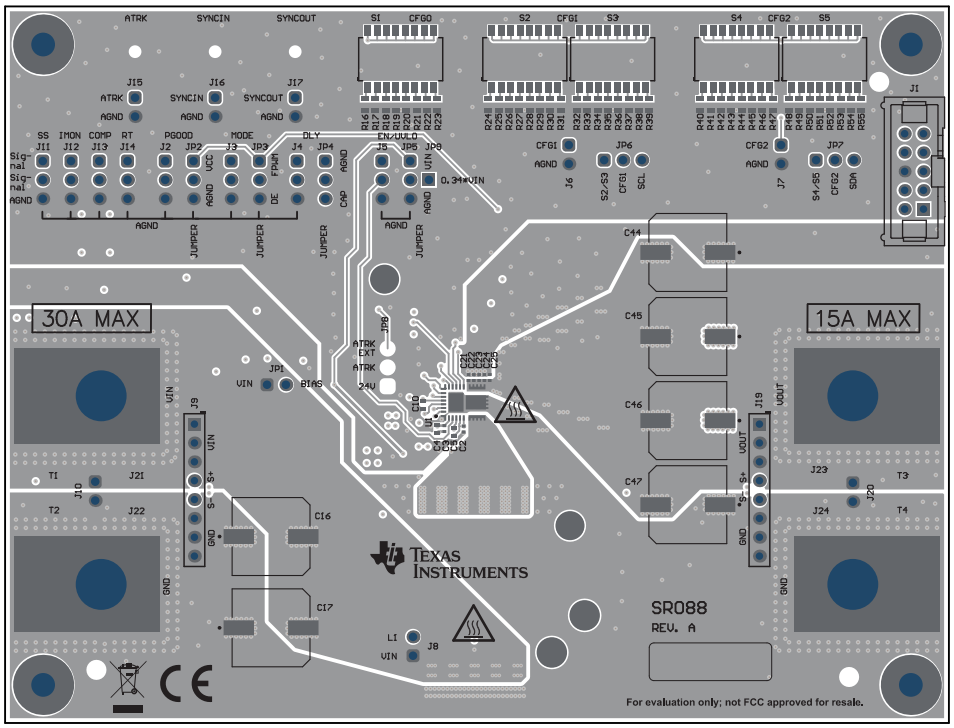

图 6-2. 顶部丝网印刷层

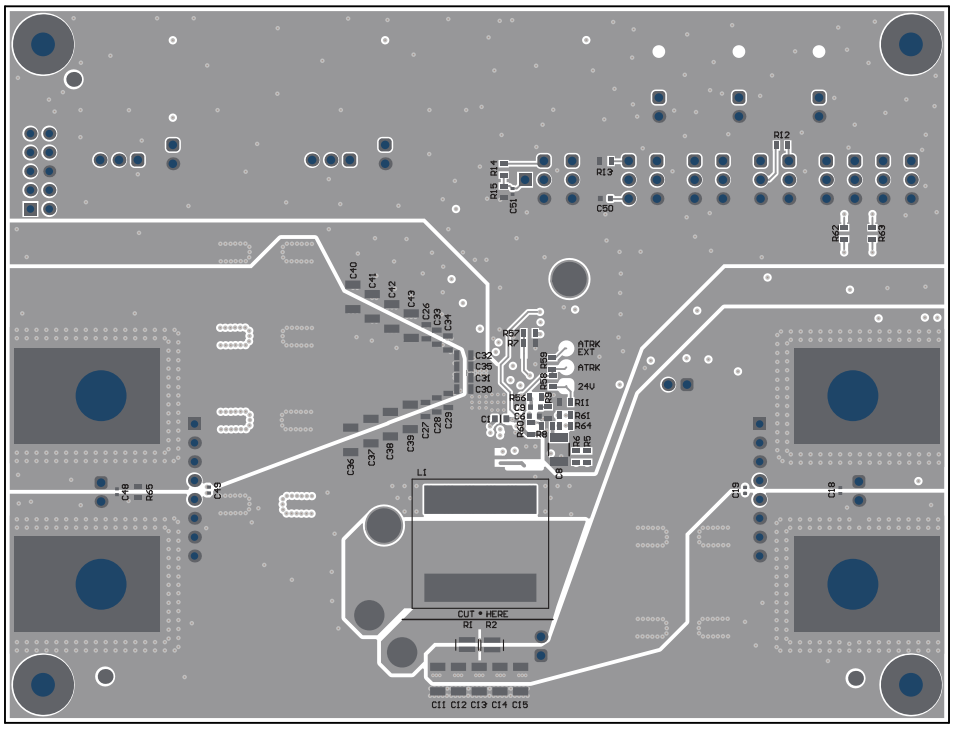

图 6-3. 底部丝网印刷层

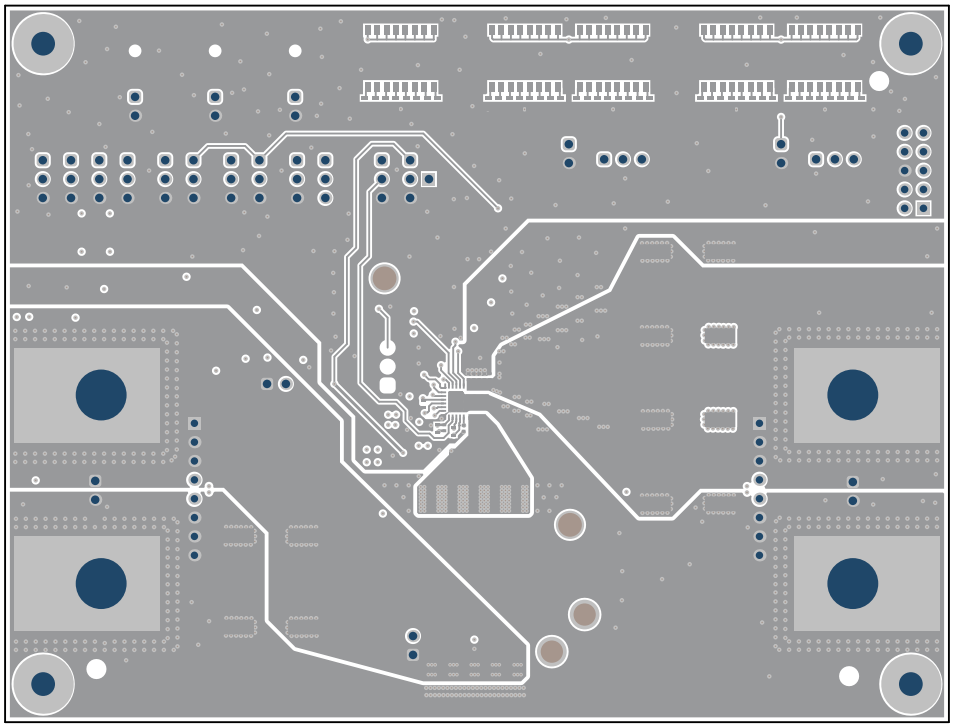

图 6-4. 顶层

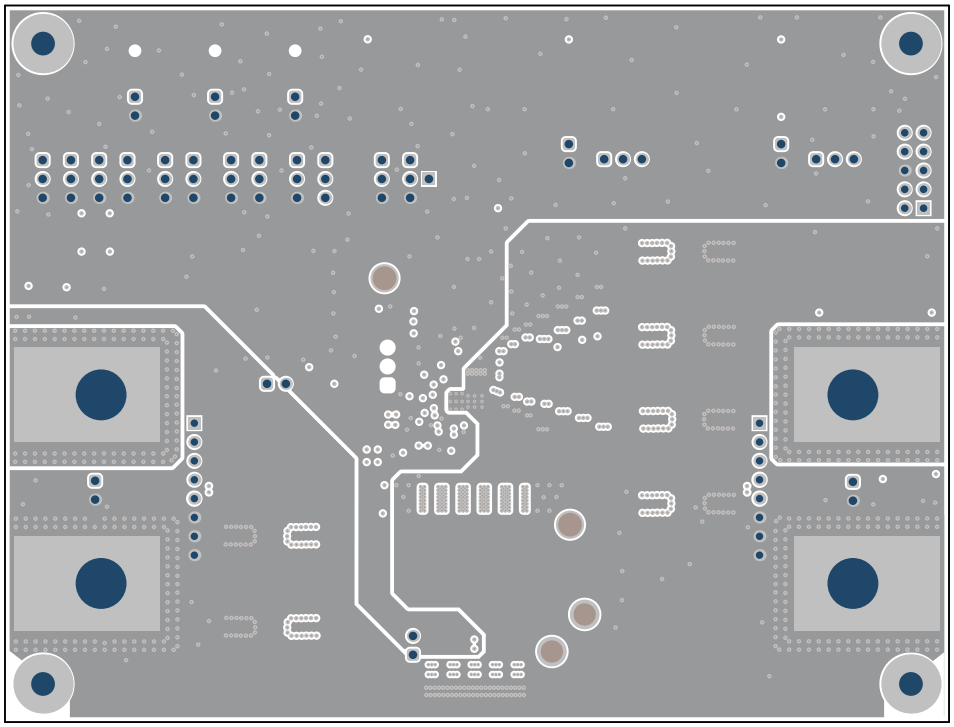

图 6-5. 信号层 1

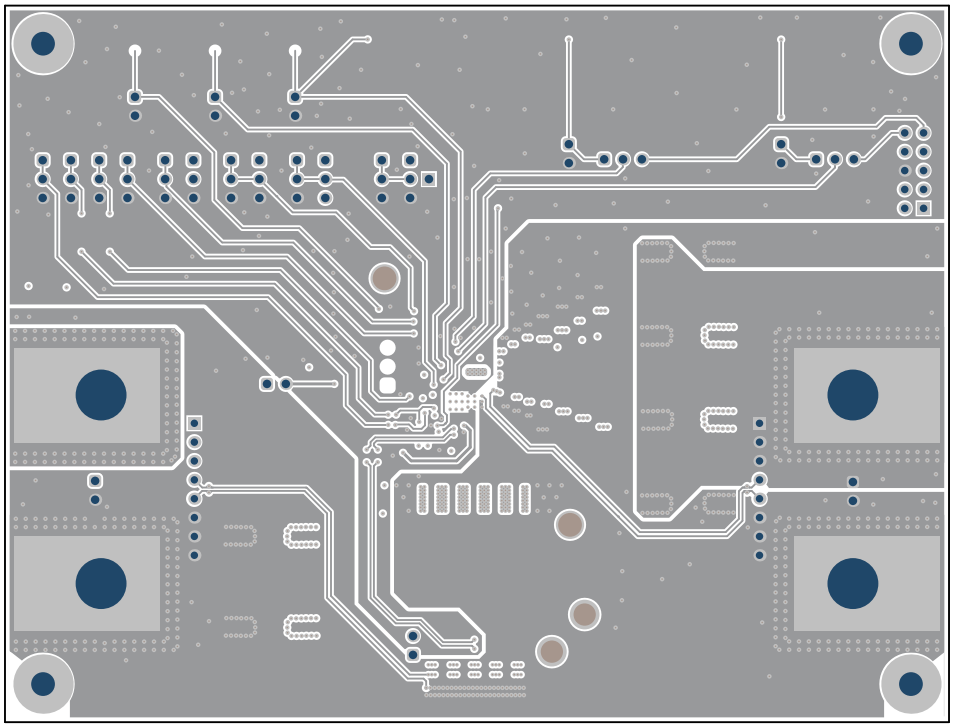

图 6-6. 信号层 2

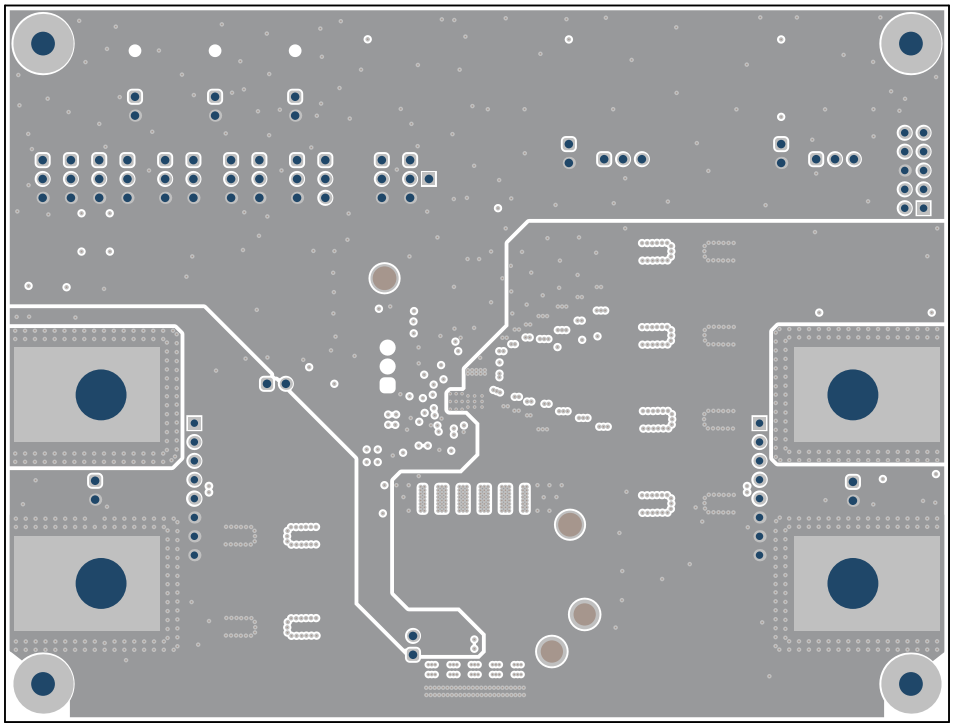

图 6-7. 信号层 3

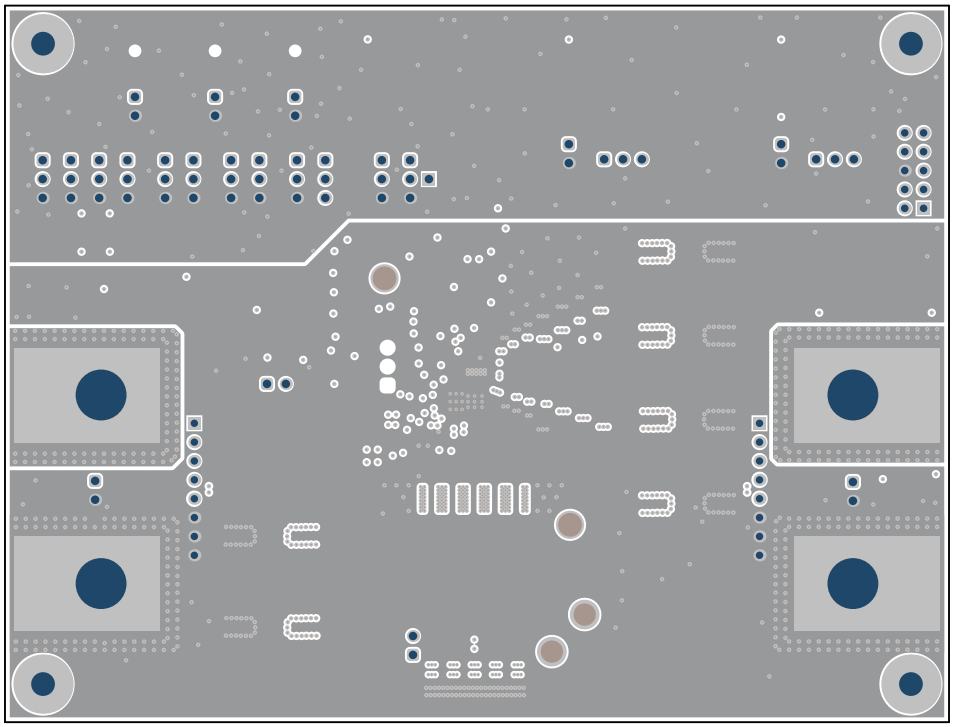

图 6-8. 信号层 4

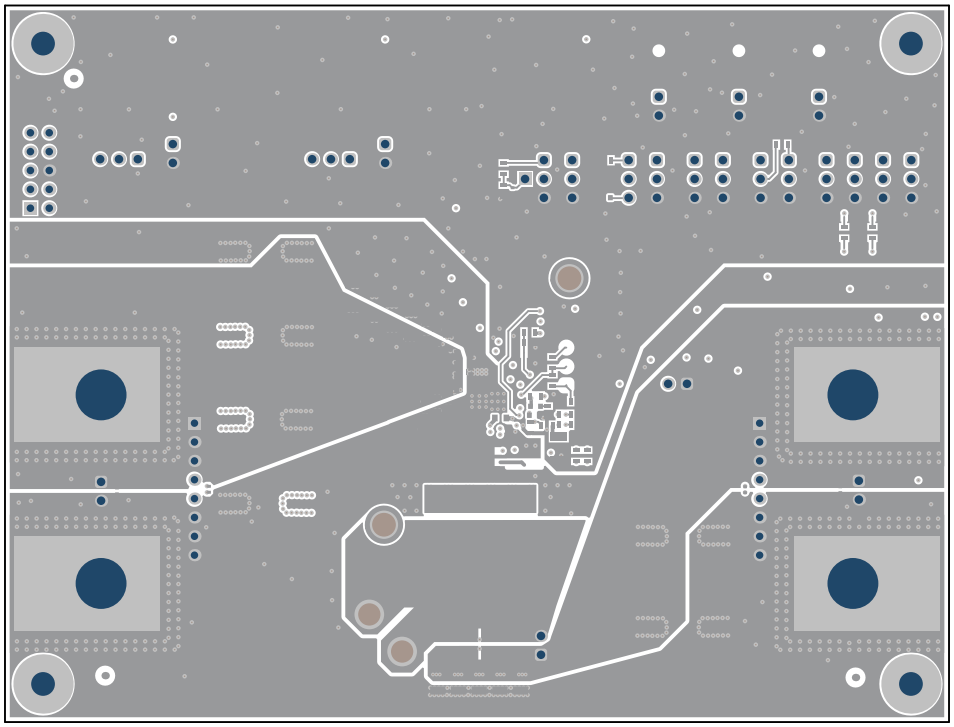

图 6-9. 底层

6.3 物料清单

节 6.3 详细介绍了 EVM 物料清单。

表 6-1. 物料清单

位号	数量	值	器件型号	制造商	说明
C1	1	1μF	GCM188D71H105KE36J	Murata	1μF ±10% 50 V 陶瓷电容器 X7T 0603（公制 1608）
C2、C3、C18、C19、C21、C22、C23、C24、C25、C48、C49、C51	12	100nF	GRM155R62A104ME14D	Murata	通用片状多层陶瓷电容器，0402，0.10uF，X5R，15%，20%，100V
C4	1	4.7 μ F	GRM155R60J475ME87D	MuRata	电容，陶瓷，4.7uF，6.3V，+/-20%，X5R，0402
C5	1	100pF	CGA2B2C0G1H101J050BA	TDK	电容，陶瓷，100pF，50V，+/-5%，C0G/NP0，AEC-Q200 1 级，0402
C6、C50	2	330nF	GRT188R71C334KE01D	Murata	多层陶瓷电容器，330nF，16V，X7R ±10%，0603，纸质 T/R
C8	1	4.7 μ F	CGA6P3X7R1H475K250AB	TDK	电容，陶瓷，4.7μF，50V，+/-10%，X7R，AEC-Q200 1 级，1210
C9	1	15nF	GCD188R71H153KA01D	Murata	适用于汽车的片状多层陶瓷电容器，0603，15000pF，X7R，15%，10%，50V，1 级
C10	1	470pF	GRM1555C1H471JA01D	MuRata	电容，陶瓷，470pF，50V，+/-5%，C0G/NP0，0402
C11、C12、C13、C14、C15、C36、C37、C38、C39、C40、C41、C42、C43	13		GRM32EC72A106KE05L	Murata	10μF ±10% 100V 陶瓷电容器 X7S 1210（公制 3225）
C16、C17	2	220μF	EEHZU1H221P	Panasonic	铝混合聚合物电容器 220uF 20% 50V 寿命 4000 小时 AEC-Q200 径向 SMT
C26、C27、C28、C29、C30、C31、C32、C33、C34、C35	10	2.2μF	GRM21BD72A225ME01K	Murata	通用片状多层陶瓷电容器 2.2uF ±20% 100V X7T SMD 0805

表 6-1. 物料清单（续）

位号	数量	值	器件型号	制造商	说明
C44、C45、C46、C47	4	150µF	EEHZU1J151P	Panasonic	铝混合聚合物电容器 150uF 20% 63V 寿命 4000 小时 AEC-Q200 径向 SMT
FID4、FID5、FID6	3		不适用	不适用	基准标记。没有需要购买或安装的元件。
H1、H2、H3、H4	4		NY PMS 440 0025 PH	B&F Fastener Supply	机械螺钉，圆头，#4-40 x 1/4，尼龙，飞利浦盘形头
J1	1		N2510-6002-RB	3M	接头（有罩），100mil，5x2，高温，镀金，TH
J21、J22、J23、J24	4		108-0740-001	Cinch Connectivity	标准香蕉插孔，非绝缘，15A
JP9	1		61300111121	Wurth Elektronik	接头，2.54mm，1x1，金，TH
L1	1	3.3uH	XGL1712-332MED	Coilcraft	屏蔽式功率电感器 3.3µH ±20% 41.7A 1.9mΩ
R1、R2	2	4m	KRL2012E-M-R004F-T5	Susumu	4mΩ，±1%，1W，片上电阻，宽，0805（公制 2012），0508，汽车 AEC-Q200，电流检测，金属箔
R5、R6、R62、R63	4	0	ERJ-3GEY0R00V	Panasonic	电阻，0，5%，0.1W，AEC-Q200 0 级，0603
R7	1	78.7k	CRCW060378K7FKEA	Vishay-Dale	电阻，78.7k，1%，0.1W，AEC-Q200 0 级，0603
R8	1	3.40k	CRCW06033K40FKEA	Vishay-Dale	电阻，3.40k，1%，0.1W，AEC-Q200 0 级，0603
R9	1	20.0k	CRCW060320K0FKEA	Vishay-Dale	电阻，20.0k，1%，0.1W，AEC-Q200 0 级，0603
R11、R18	2	40.2k	CRCW060340K2FKEA	Vishay-Dale	电阻，40.2k，1%，0.1W，AEC-Q200 0 级，0603
R12	1	100k	CRCW0603100KFKEA	Vishay-Dale	电阻，100k，1%，0.1W，AEC-Q200 0 级，0603
R13、R24、R40、R56、R57、R58、R59、R61、R64	9	0	RMCF0603ZT0R00	Stackpole Electronics Inc	电阻，0，1%，0.1W，AEC-Q200 0 级，0603

表 6-1. 物料清单（续）

位号	数量	值	器件型号	制造商	说明
R14、R21	2	75.0k	CRCW060375K0FKEA	Vishay-Dale	电阻，75.0k，1%，0.1W，AEC-Q200 0 级，0603
R15	1	39.0k	RC0603FR-0739KL	Yageo	电阻，39.0k，1%，0.1W，0603
R16、R37、R53	3	24.9k	CRCW060324K9FKEA	Vishay-Dale	电阻，24.9k，1%，0.1W，AEC-Q200 0 级，0603
R17	1	31.6k	CRCW060331K6FKEA	Vishay-Dale	电阻，31.6k，1%，0.1W，AEC-Q200 0 级，0603
R19	1	48.7k	CRCW060348K7FKEA	Vishay-Dale	电阻，48.7k，1%，0.1W，AEC-Q200 0 级，0603
R20	1	61.9k	CRCW060361K9FKEA	Vishay-Dale	电阻，61.9k，1%，0.1W，AEC-Q200 0 级，0603
R22	1	90.9k	CRCW060390K9FKEA	Vishay-Dale	电阻，90.9k，1%，0.1W，AEC-Q200 0 级，0603
R23	1	110k	CRCW0603110KFKEA	Vishay-Dale	电阻，110k，1%，0.1W，AEC-Q200 0 级，0603
R25、R41	2	511	CRCW0603511RFKEA	Vishay-Dale	电阻，511，1%，0.1W，AEC-Q200 0 级，0603
R26、R42	2	1.30k	CRCW06031K30FKEA	Vishay-Dale	电阻，1.30k，1%，0.1W，AEC-Q200 0 级，0603
R27、R43	2	1.87k	CRCW06031K87FKEA	Vishay-Dale	电阻，1.87k，1%，0.1W，AEC-Q200 0 级，0603
R28、R44	2	2.74k	CRCW06032K74FKEA	Vishay-Dale	电阻，2.74k，1%，0.1W，AEC-Q200 0 级，0603
R29、R45	2	3.83k	CRCW06033K83FKEA	Vishay-Dale	电阻，3.83k，1%，0.1W，AEC-Q200 0 级，0603
R30、R46	2	5.11k	CRCW06035K11FKEA	Vishay-Dale	电阻，5.11k，1%，0.1W，AEC-Q200 0 级，0603
R31、R47	2	6.49k	CRCW06036K49FKEA	Vishay-Dale	电阻，6.49k，1%，0.1W，AEC-Q200 0 级，0603

表 6-1. 物料清单（续）

位号	数量	值	器件型号	制造商	说明
R32、R48	2	8.25k	CRCW06038K25FKEA	Vishay-Dale	电阻，8.25k，1%，0.1W，AEC-Q200 0 级，0603
R33、R49	2	10.5k	CRCW060310K5FKEA	Vishay-Dale	电阻，10.5k，1%，0.1W，AEC-Q200 0 级，0603
R34、R50	2	13.3k	CRCW060313K3FKEA	Vishay-Dale	电阻，13.3k，1%，0.1W，AEC-Q200 0 级，0603
R35、R51	2	16.2k	CRCW060316K2FKEA	Vishay-Dale	电阻，16.2k，1%，0.1W，AEC-Q200 0 级，0603
R36、R52	2	20.5k	CRCW060320K5FKEA	Vishay-Dale	电阻，20.5k，1%，0.1W，AEC-Q200 0 级，0603
R38、R54	2	30.1k	CRCW060330K1FKEA	Vishay-Dale	电阻，30.1k，1%，0.1W，AEC-Q200 0 级，0603
R39、R55	2	36.5k	CRCW060336K5FKEA	Vishay-Dale	电阻，36.5k，1%，0.1W，AEC-Q200 0 级，0603
R60	1	53.6k	CRCW060353K6FKEA	Vishay-Dale	电阻，53.6k，1%，0.1W，AEC-Q200 0 级，0603
R65	1	66.5k	CRCW060366K5FKEA	Vishay-Dale	电阻，66.5k，1%，0.1W，AEC-Q200 0 级，0603

7 其他信息

7.1 商标

所有商标均为其各自所有者的财产。

8 修订历史记录

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision A (July 2025) to Revision B (December 2025)	Page
• 更新了开关频率，从：420kHz 更改为 400kHz	1
• 删除了断开跳线 JP10 和 JP2 的说明	5
• 更新了表名称，从：“CHG0 引脚设置”更改为：SYNCOUT 引脚设置	5
• 添加了引脚设置位置信息	5
• 添加了应用曲线部分	9
• 更新了“物料清单”	17

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

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/lsds/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

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/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.

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:*

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8. *Limitations on Damages and Liability:*

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