

EVM User's Guide: VCA710RGR

VCA710RGR 评估模块



说明

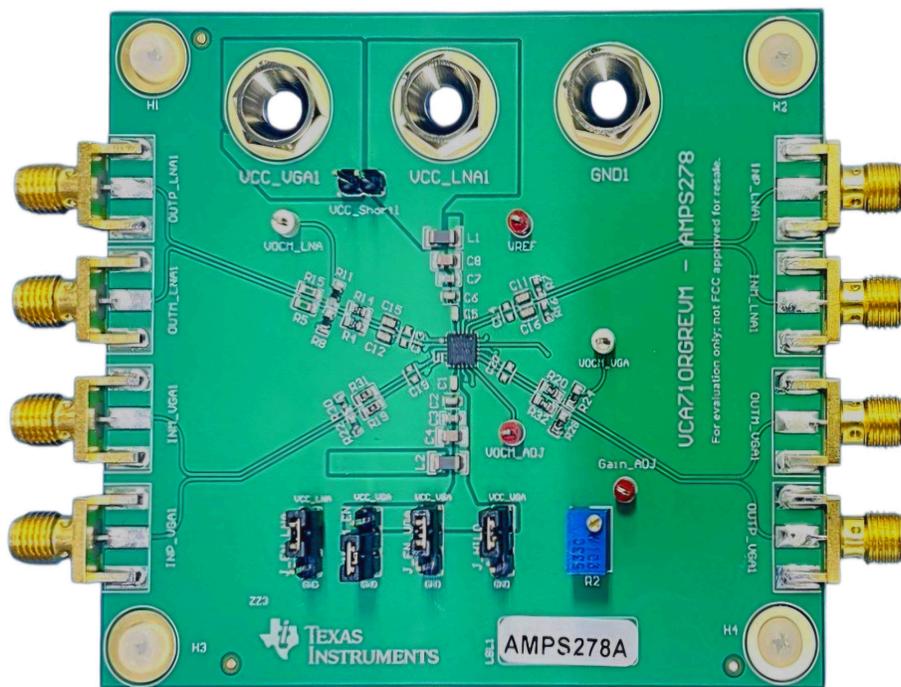
VCA710RGREVM 是专为 VCA710RGR 而设计的评估模块 (EVM)，作为一款模拟前端器件，其包含两个主要组件：具有 20dB 固定内部增益的低噪声放大器 (LNA) 和可变增益放大器 (VGA)。此 EVM 旨在快速轻松地演示放大器的功能和多用性。此 EVM 配备了板载连接器，便于连接电源、信号源和测试仪器。此 EVM 经过配置，可在输入和输出点与标准实验室设备进行直接连接。此外，其还具有用于电源的香蕉连接器和跳线，使用户能够轻松启用、禁用或配置不同的工作模式。LNA 和 VGA 的输入和输出布线都采用受控 100 Ω 差分阻抗进行差分布线，从而确保器件具有出色的性能。

特性

- 单电源工作电压范围为 3.3V 至 5.25V
- 易于使用的 SMA 连接器，适用于所有输入和输出信号
- 易于使用的香蕉连接器，适用于器件电源
- 用于在不同模式下配置器件的跳线
- 布局配置为更大限度地减少寄生和噪声

应用

- 光电前端
- 声纳系统
- 超声波系统
- 音频前端
- AGC 接收器



VCA710RGREVM 电路板 (顶视图)

1 评估模块概述

1.1 简介

VCA710RGR 是一款单通道、低噪声、低功耗可变增益放大器 (VGA)，专为宽带模拟前端中的高性能信号调节而设计。它具有一个增益为 10V/V (20dB)、带宽为 220MHz 的低噪声放大器 (LNA) 以及一个提供 110MHz 带宽的 VGA。这种组合可提供高动态范围和灵活的增益控制。VGA 的增益可以通过两种方法调节：第一种是精细模拟增益调节。这通过 GAIN_ADJ 引脚实现，可实现连续的增益调节。第二种是粗略的数字增益控制。这通过 HILO 引脚实现，该引脚提供两个增益设置档位。通过这两种增益控制方式，当 HILO = 0 时，VCA710 的增益范围为 -35dB 至 +20dB，当 HILO = 1 时，增益范围为 -15dB 至 +40dB。

VCA710RGREVM 设计用于评估 VCA710RGR 的性能。此评估模块包括用于所有输入和输出引脚的 SMA 连接器、用于电源的香蕉连接器、用于将器件配置为不同模式的跳线，以及用于设置共模和基准电压的测试点连接器。本用户指南提供了器件及连接器的说明、电路板原理图与 PCB 布局，以及物料清单。

1.2 套件内容

包装中包含：

- VCA710RGREVM
- EVM 免责声明自述文件

1.3 规格

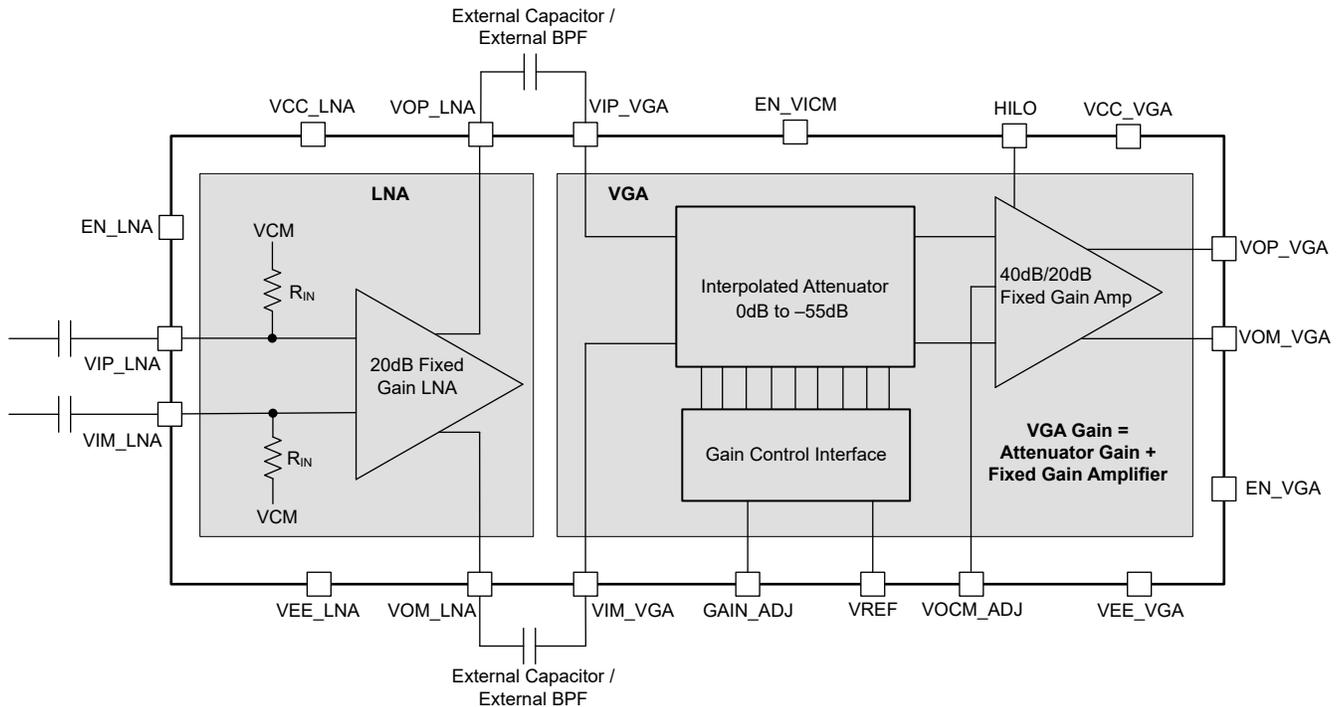


图 1-1. VCA710RGR 功能框图

1.4 器件信息

VCA710RGR 是一款采用 20 引脚 VQFN 封装的模拟前端器件。它由两个主要组件组成：一个具有 20dB 固定内部增益的低噪声放大器 (LNA) 和一个可变增益放大器 (VGA)。LNA 同时接受差分 and 单端输入信号并提供差分输出。请注意，LNA 仅在交流耦合信号下工作。VGA 能够接受单端或差分的交流和直流信号。由于这两个模块采用单独的输入和输出连接，它们可以独立运行，并且还提供单独的断电功能。对于需要直流耦合的用户，建议禁用 LNA 并将输入直接连接到 VGA。

VCA710RGR 的一个主要特性是精细增益调节引脚，这使得用户能够使用 0V 至 1V 的可编程模拟电压来控制增益。除了精细增益调节之外，VGA 块还通过 HILO 模式引脚提供粗略增益设置。借助模拟增益控制模块和 HILO

引脚，VCA710RGR 可提供 -35dB 至 $+20\text{dB}$ 以及 -15dB 至 $+40\text{dB}$ 的增益范围，因此可高度配置用于各种应用。此外，该器件还包括一个内部基准电压，适用于增益精度不重要的应用。对于要求高增益精度的情况，可以施加外部精密 VREF。

VCA710RGR 的 LNA 和 VGA 均在 3.3V 至 5.25V 的电源电压下运行，额定环境温度范围为 -55°C 至 $+125^\circ\text{C}$ 。

2 硬件

2.1 其他图像

2.1.1 引脚配置

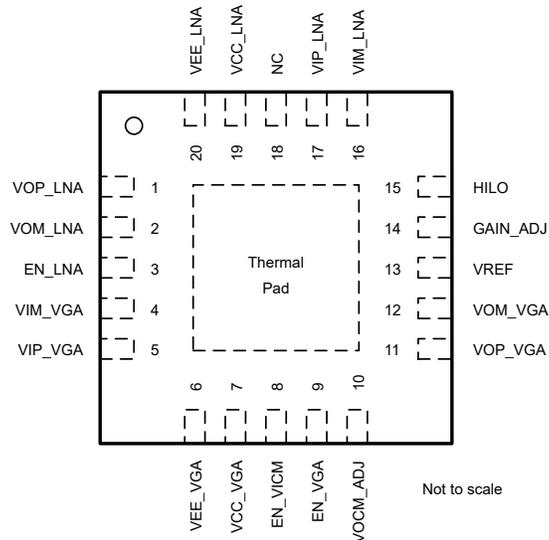


图 2-1. RGR 封装，20 引脚 VQFN (顶视图)

2.2 电源要求

该 EVM 配备了三个香蕉连接器：VGA 模块电源使用 VCC_VGA1，LNA 模块电源使用 VCC_LNA1，接地连接使用 GND1。为确保正常运行，请使用 3.3V 至 5.25V 的电源电压为器件供电。请注意，该器件本身不能使用分离电源，因此 EVM 也无法使用分离电源供电。

2.3 输入和输出 SMA 连接器

INM_LNA1 和 INP_LNA1：这两个 SMA 连接器分别连接到器件 LNA 模块的反向输入 (VIM_LNA、引脚 16) 和非反相输入 (VIP_LNA、引脚 17)。来自这些连接器的信号交流耦合到器件的相应输入引脚。默认情况下，连接器配置为差分输入连接并与 $100\ \Omega$ 电阻器差分端接，以匹配仪器的源阻抗。

INM_VGA1 和 INP_VGA1：这两个 SMA 连接器分别连接到器件 VGA 模块的反向输入 (VIM_VGA、引脚 4) 和非反相输入 (VIP_VGA、引脚 5)。这些连接器的信号通过电阻器 R19 和 R31 直流耦合到器件的相应输入。默认情况下，这些连接器还配置为差分输入连接并与 $100\ \Omega$ 电阻器差分端接。

OUTM_LNA1 和 OUTP_LNA1：来自 LNA 模块的反相输出 (VOM_LNA、引脚 2) 和非反相输出 (VOP_LNA、引脚 1) 的信号分别交流耦合到 OUTM_LNA1 和 OUTP_LNA1 连接器。将具有 $100\ \Omega$ 差分输入阻抗 (或 $50\ \Omega$ 单端输入阻抗) 的测试仪器连接到这两个连接器时，默认电阻网络会向 LNA 输出端提供 $300\ \Omega$ 的差分负载。此外，EVM 上这些连接器的阻抗为差分 $100\ \Omega$ ，从而确保 EVM 输出连接器和仪器输入端口之间的阻抗匹配。但请注意，电阻网络会使输出信号衰减 15.58dB 。

OUTM_VGA1 和 OUTP_VGA1：来自 VGA 模块的反相输出 (VOM_VGA、引脚 12) 和非反相输出 (VOP_VGA、引脚 11) 的信号分别连接到 OUTM_VGA1 和 OUTP_VGA1 连接器。将具有 $100\ \Omega$ 差分输入阻抗 (或 $50\ \Omega$ 单端输入阻抗) 的测试仪器连接到这两个连接器时，默认电阻网络会向 VGA 输出端提供 $500\ \Omega$ 的差分负载。EVM 上这些连接器的阻抗同样为差分 $100\ \Omega$ ，从而确保 EVM 输出连接器和仪器输入端口之间的阻抗匹配。但请注意，电阻网络会使输出信号衰减 18.95dB 。

2.4 跳线信息

J_EN_LNA：此跳线连接至器件的 LNA 使能引脚 (EN_LNA)。要使用此跳线关断 LNA，请短接引脚 1 和 2。要启用器件，请短接 J_EN_LNA 的引脚 2 和 3。

J_EN_VGA：此跳线连接至器件的 VGA 使能引脚 (EN_VGA)。要使用此跳线关断 VGA，请短接引脚 1 和 2。要启用器件，请短接 J_EN_VGA 的引脚 2 和 3。

J_HILO：该跳线可通过 HILO 模式引脚提供粗增益设置的选项。短接引脚 1 和 2 以将器件配置为低增益模式 (- 35dB 至 20dB)，并短接引脚 2 和 3 以将器件配置为高增益模式 (- 15dB 至 40dB)

J_VICM EN：此跳线用于配置 VGA 的输入共模。短接引脚 1 和 2 可在外部设置输入共模，并在输入进行直流耦合时使用。短接引脚 2 和 3，以将输入共模设置为 $1/2 V_s$ 。这用于交流耦合输入

2.5 测试点连接器

VOCM_ADJ：此连接器连接到器件的 VOCM_ADJ 引脚，并用于设置 VGA 的输出共模。如果该引脚悬空，则由 R35 和 R40 形成的电阻分压器会将 VOCM_ADJ 引脚偏置到 VGA 的 $1/2 V_s$ 电压

Gain_ADJ：此连接器用于设置 VGA 的增益调节电压。默认情况下，电阻器 R3 已安装，增益调节电压由电位器 R2 的位置决定。如果需要使用外部电压设置增益，请移除 R3，并在此 Gain_ADJ 测试点连接器上施加所需的电压。

VREF：此连接器用于在外部为器件设置 0.5V 基准电压，这对于需要高增益精度的应用尤其重要。VREF 引脚上的电压也可以使用板载外部基准 REF35 进行配置。要启用该功能，请短接 R43 和 R41。如果保持未连接状态，VGA 的内部基准将提供器件正常运行所需的电压。

3 硬件设计文件

3.1 原理图

下图为 VCA710RGREVM 原理图。

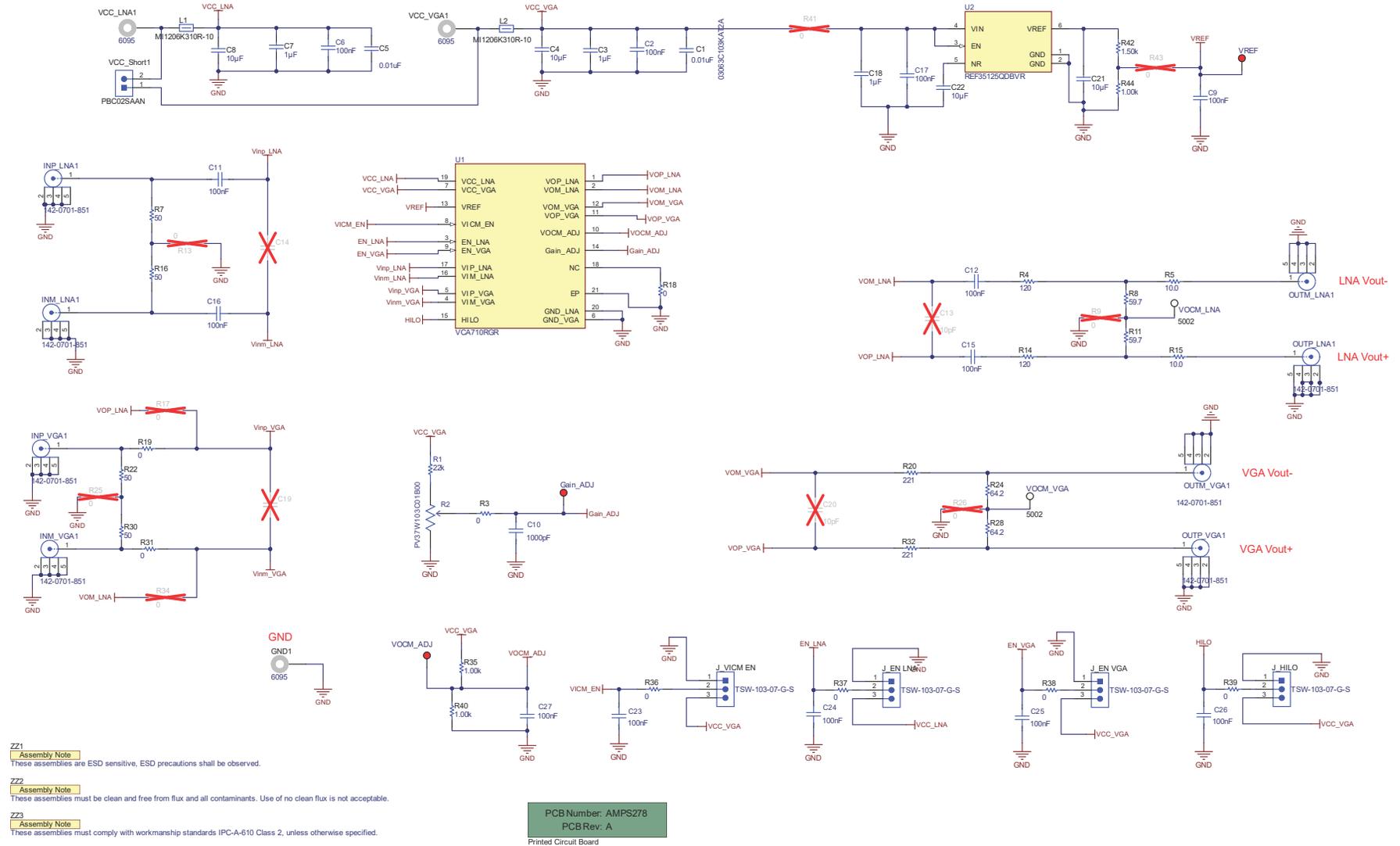


图 3-1. VCA710RGREVM 原理图

3.2 PCB 布局

下图显示了 VCA710RGREVM 的 PCB 布局。

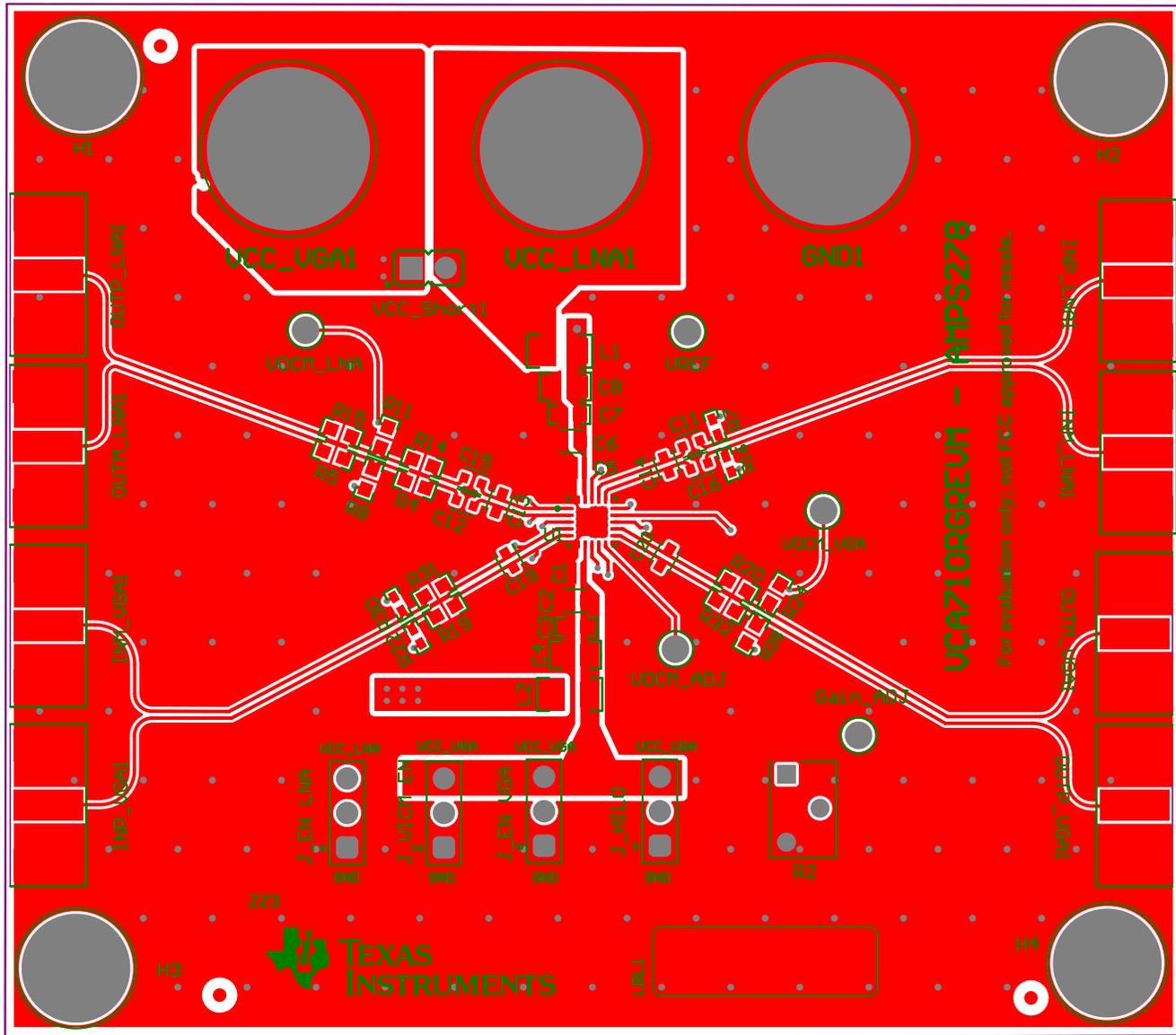


图 3-2. VCA710RGREVM 顶层

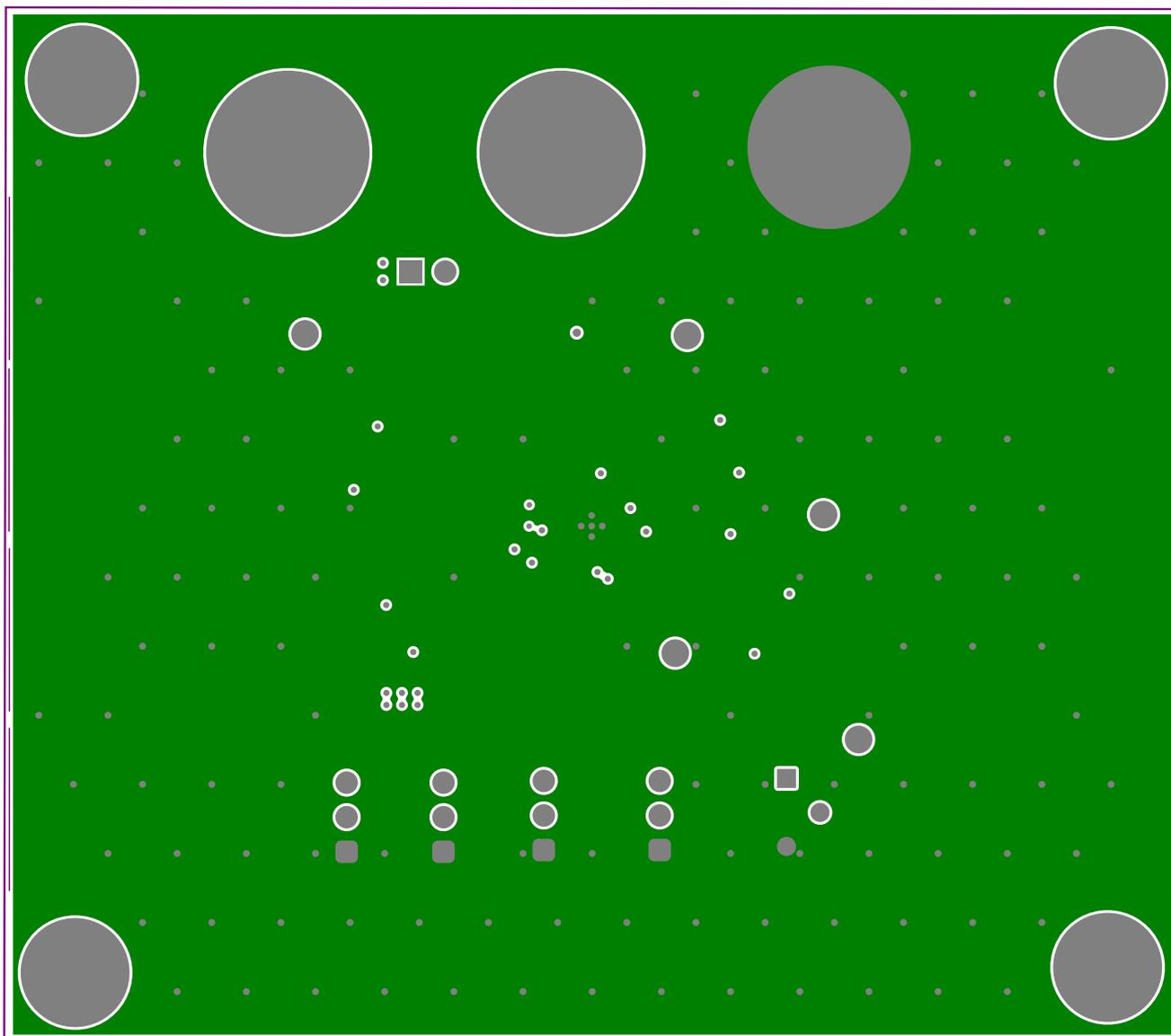


图 3-3. VCA710RGREVM 第二层 (接地平面)

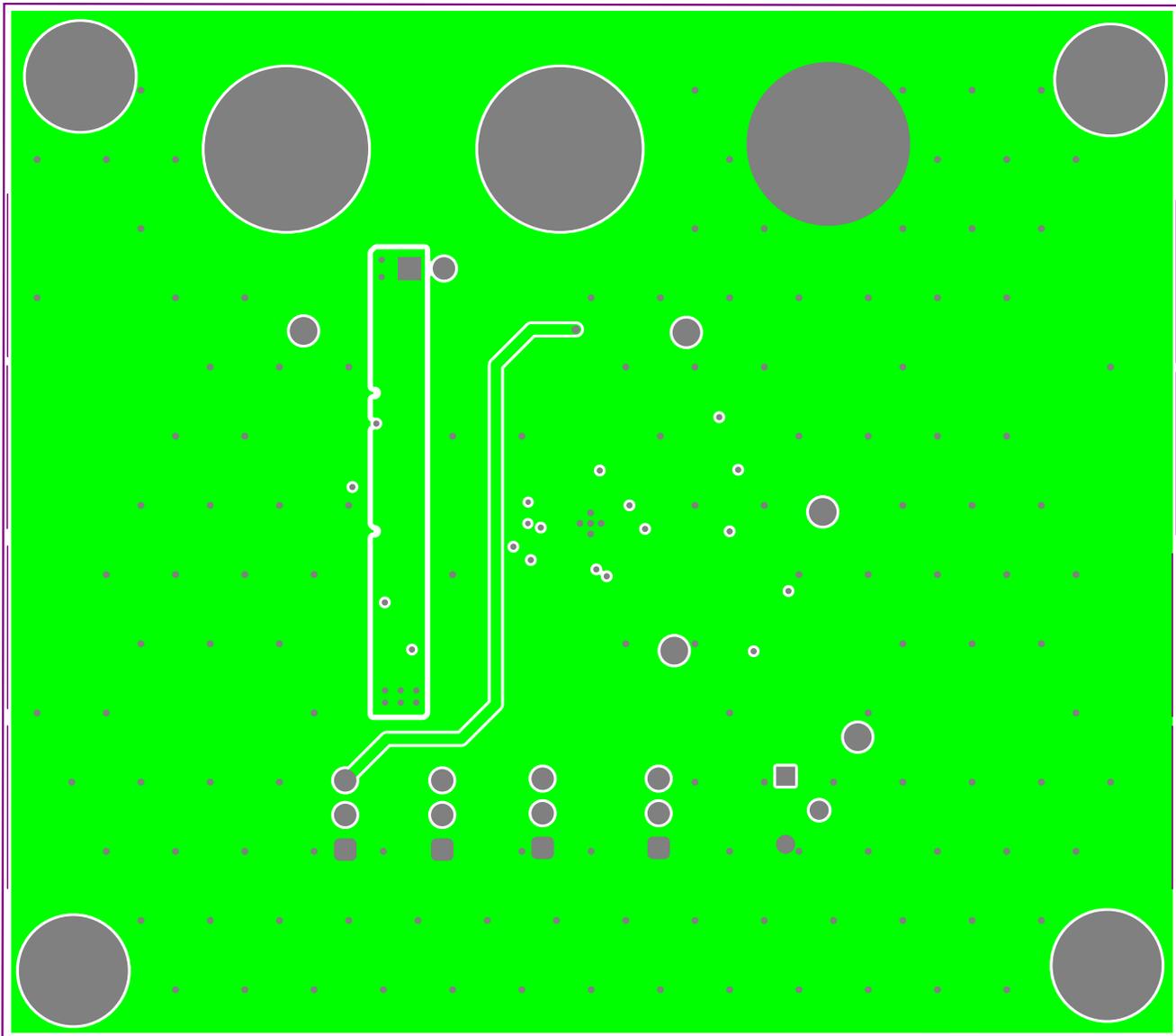


图 3-4. VCA710RGREVM 第三层 (电源平面)

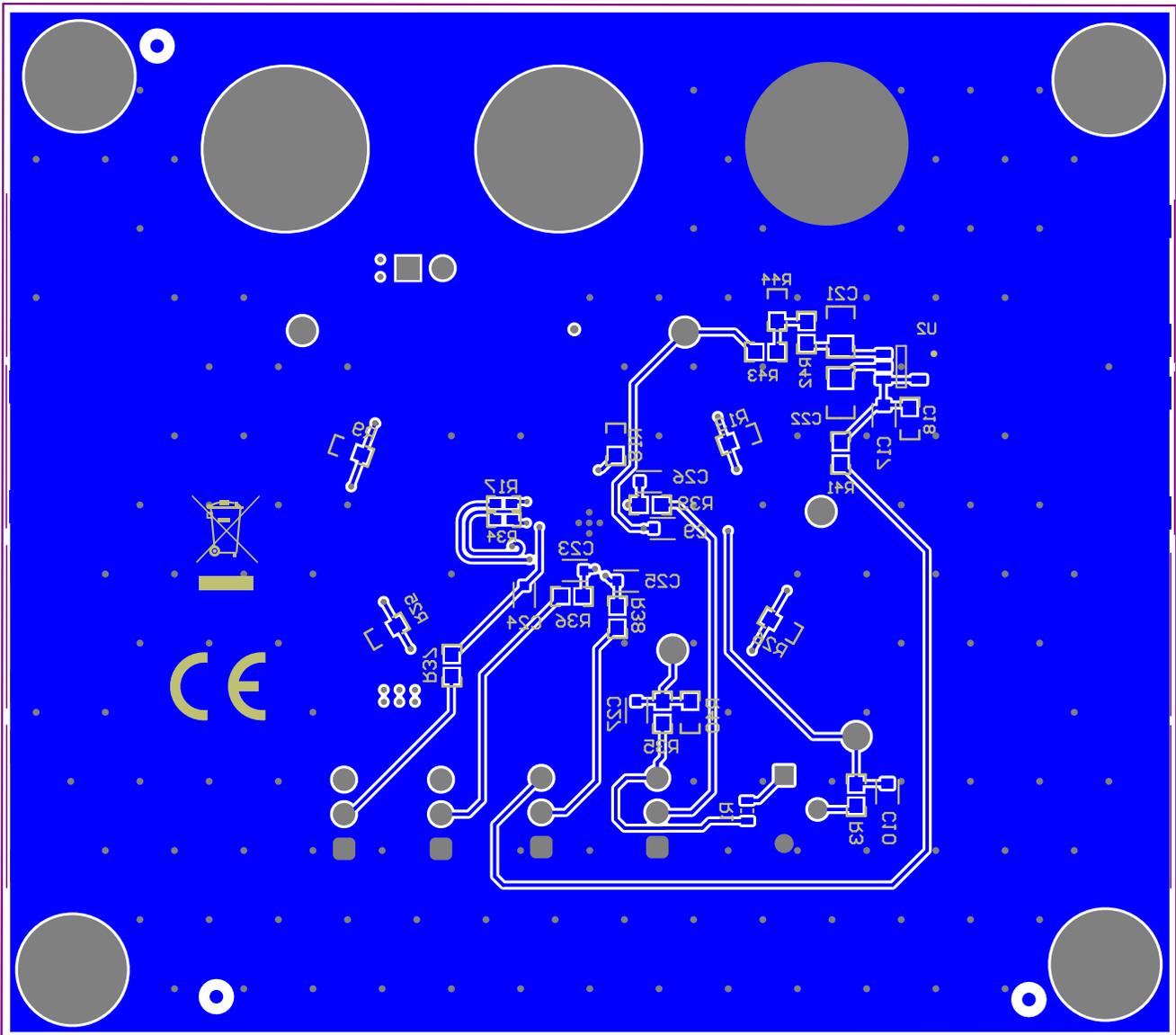


图 3-5. VCA710RGREVM 底层

3.3 物料清单 (BOM)

表 3-1. VCA710RGREVM BOM

条目	位号	说明	制造商	器件型号	数量
1	!PCB1	印刷电路板	不限	AMPS278	1
2	!PCB2	印刷电路板	不限	AMPS278	1
3	C1	电容, 陶瓷, 10000PF, 25V, X7R, 0306	KYOCERA AVX	03063C103KAT2A	1
4	C2	0.1 μ F \pm 5% 50V 陶瓷电容器 X7R 0603 (公制 1608)	Yageo	CC0603JRX7R9BB104	1
5	C3	电容, 陶瓷, 1 μ F, 16V, +/-10%, X7R, AEC-Q200 1 级, 0603	MuRata	GCM188R71C105KA64J	1
6	C4	电容, 陶瓷, 10 μ F, 10V, +/-10%, X7R, 0805	MuRata	GCM21BR71A106KE22L	1
7	C5	电容, 陶瓷, 10000PF, 25V, X7R, 0306	KYOCERA AVX	03063C103KAT2A	1
8	C6	0.1 μ F \pm 5% 50V 陶瓷电容器 X7R 0603 (公制 1608)	Yageo	CC0603JRX7R9BB104	1
9	C7	电容, 陶瓷, 1 μ F, 16V, +/-10%, X7R, AEC-Q200 1 级, 0603	MuRata	GCM188R71C105KA64J	1
10	C8	电容, 陶瓷, 10 μ F, 10V, +/-10%, X7R, 0805	MuRata	GCM21BR71A106KE22L	1
11	C9	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
12	C10	陶瓷电容 0.001 μ F 16V C0G 1% SMD 0603 125°C 纸质 T/R	KEMET	C0603C102F4GAC7867	1
13	C11	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
14	C12	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
15	C15	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
16	C16	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
17	C17	0.1 μ F \pm 5% 50V 陶瓷电容器 X7R 0603 (公制 1608)	Yageo	CC0603JRX7R9BB104	1
18	C18	电容, 陶瓷, 1 μ F, 16V, +/-10%, X7R, AEC-Q200 1 级, 0603	MuRata	GCM188R71C105KA64J	1
19	C21	电容, 陶瓷, 10 μ F, 10V, +/-10%, X7R, 0805	MuRata	GCM21BR71A106KE22L	1
20	C22	电容, 陶瓷, 10 μ F, 10V, +/-10%, X7R, 0805	MuRata	GCM21BR71A106KE22L	1
21	C23	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
22	C24	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
23	C25	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
24	C26	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
25	C27	0.1 μ F \pm 10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	1
26	FID1	基准标记。没有需要购买或安装的元件。	不适用	不适用	1
27	FID2	基准标记。没有需要购买或安装的元件。	不适用	不适用	1
28	FID3	基准标记。没有需要购买或安装的元件。	不适用	不适用	1
29	FID4	基准标记。没有需要购买或安装的元件。	不适用	不适用	1

表 3-1. VCA710RGREVM BOM (续)

条目	位号	说明	制造商	器件型号	数量
30	FID5	基准标记。没有需要购买或安装的元件。	不适用	不适用	1
31	FID6	基准标记。没有需要购买或安装的元件。	不适用	不适用	1
32	Gain_ADJ	测试点, 微型, 红色, TH	Keystone	5000	1
33	GND1	标准的蕉形插头, 非绝缘	Keystone	6095	1
34	H1	机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头	B&F Fastener Supply	NY PMS 440 0025 PH	1
35	H2	机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头	B&F Fastener Supply	NY PMS 440 0025 PH	1
36	H3	机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头	B&F Fastener Supply	NY PMS 440 0025 PH	1
37	H4	机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头	B&F Fastener Supply	NY PMS 440 0025 PH	1
38	H5	六角螺柱, 0.5"L #4-40, 尼龙	Keystone	1902C	1
39	H6	六角螺柱, 0.5"L #4-40, 尼龙	Keystone	1902C	1
40	H7	六角螺柱, 0.5"L #4-40, 尼龙	Keystone	1902C	1
41	H8	六角螺柱, 0.5"L #4-40, 尼龙	Keystone	1902C	1
42	INM_LNA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
43	INM_VGA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
44	INP_LNA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
45	INP_VGA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
46	J_EN LNA	接头, 100mil, 3x1, 金, TH	Samtec	TSW-103-07-G-S	1
47	J_EN VGA	接头, 100mil, 3x1, 金, TH	Samtec	TSW-103-07-G-S	1
48	J_HILO	接头, 100mil, 3x1, 金, TH	Samtec	TSW-103-07-G-S	1
49	J_VICM EN	接头, 100mil, 3x1, 金, TH	Samtec	TSW-103-07-G-S	1
50	L1	铁氧体磁珠, 31 Ω (100MHz 时), 1.5A, 1206	Laird-Signal Integrity Products	MI1206K310R-10	1
51	L2	铁氧体磁珠, 31 Ω (100MHz 时), 1.5A, 1206	Laird-Signal Integrity Products	MI1206K310R-10	1
52	LBL1	热转印打印标签, 0.650" (宽) x 0.200" (高) - 10,000/卷	Brady	THT-14-423-10	1
53	OUTM_LNA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
54	OUTM_VGA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
55	OUTP_LNA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
56	OUTP_VGA1	连接器, 末端发射 SMA, 50 欧姆, SMT	Cinch Connectivity	142-0701-851	1
57	R1	1k Ω, ±1%, 0.1W, 22/10W, 片上电阻, 0603 (1608 公制), 厚膜	Vishay	CRCW060322K0FKEAC	1
58	R2	10 千欧 0.25W, 1/4W PC 引脚通孔微调电位器金属陶瓷 12 转顶部调节	Bourns	PV37W103C01B00	1
59	R3	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1

表 3-1. VCA710RGREVM BOM (续)

条目	位号	说明	制造商	器件型号	数量
60	R4	电阻, 120, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD07120RL	1
61	R5	电阻, 10.0, 0.1%, 0.1W, 0603	Vishay-Dale	TNPW060310R0BEEA	1
62	R7	电阻, 50, 0.1%, 0.05W, 0402	Vishay-Dale	FC0402E50R0BST1	1
63	R8	电阻, 59.7, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD0759R7L	1
64	R11	电阻, 59.7, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD0759R7L	1
65	R14	电阻, 120, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD07120RL	1
66	R15	电阻, 10.0, 0.1%, 0.1W, 0603	Vishay-Dale	TNPW060310R0BEEA	1
67	R16	电阻, 50, 0.1%, 0.05W, 0402	Vishay-Dale	FC0402E50R0BST1	1
68	R18	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
69	R19	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
70	R20	电阻, 221, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD07221RL	1
71	R22	电阻, 50, 0.1%, 0.05W, 0402	Vishay-Dale	FC0402E50R0BST1	1
72	R24	电阻, 64.2, 0.1%, 0.1W, 0603	KOA Speer Electronics, Inc.	RN73R1JTTD64R2B25	1
73	R28	电阻, 64.2, 0.1%, 0.1W, 0603	KOA Speer Electronics, Inc.	RN73R1JTTD64R2B25	1
74	R30	电阻, 50, 0.1%, 0.05W, 0402	Vishay-Dale	FC0402E50R0BST1	1
75	R31	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
76	R32	电阻, 221, 0.1%, 0.1W, 0603	Yageo America	RT0603BRD07221RL	1
77	R35	电阻 SMD 1K Ω 0.1% 1/10W 0603	Panasonic	ERA-3AEB102V	1
78	R36	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
79	R37	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
80	R38	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
81	R39	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	1
82	R40	电阻 SMD 1K Ω 0.1% 1/10W 0603	Panasonic	ERA-3AEB102V	1
83	R42	RES 1.5K Ω 0.05% 1/8W 0603	Panasonic Electronic Components	ERA-3VRW1501V	1
84	R44	电阻 SMD 1K Ω 0.02% 1/10W 0603	Susumu	RG1608P-102-P-T1	1
85	U1	VCA710RGR	德州仪器 (TI)	VCA710RGR	1
86	U2	超低功耗、高精度电压基准	德州仪器 (TI)	REF35125QDBVR	1
87	VCC_LNA1	标准的蕉形插头, 非绝缘	Keystone	6095	1
88	VCC_Short1	接头, 100mil, 2x1, 金, TH	Sullins Connector Solutions	PBC02SAAN	1
89	VCC_VGA1	标准的蕉形插头, 非绝缘	Keystone	6095	1
90	VOCM_ADJ	测试点, 微型, 红色, TH	Keystone	5000	1
91	VOCM_LNA	测试点, 微型, 白色, TH	Keystone	5002	1

表 3-1. VCA710RGREVM BOM (续)

条目	位号	说明	制造商	器件型号	数量
92	VOCM_VGA	测试点, 微型, 白色, TH	Keystone	5002	1
93	VREF	测试点, 微型, 红色, TH	Keystone	5000	1
94	C13	10pF ±5% 25V 陶瓷电容器 C0G, NP0 0603 (公制 1608)	AVX	06033A100JAT2A	0
95	C14	0.1µF ±10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	0
96	C19	0.1µF ±10% 16V 陶瓷电容器 X7R 0603 (公制 1608)	Murata Electronics North America	GCJ188R71C104KA01D	0
97	C20	10pF ±5% 25V 陶瓷电容器 C0G, NP0 0603 (公制 1608)	AVX	06033A100JAT2A	0
98	R9	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	0
99	R13	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	0
100	R17	电阻, 0, 5%, 0.063W, 0402	Vishay-Dale	CRCW04020000Z0ED	0
101	R25	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	0
102	R26	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	0
103	R34	电阻, 0, 5%, 0.063W, 0402	Vishay-Dale	CRCW04020000Z0ED	0
104	R41	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	0
105	R43	电阻, 0, 5%, 0.1W, AEC-Q200 0 级, 0603	Panasonic	ERJ-3GEY0R00V	0

4 其他信息

4.1 商标

所有商标均为其各自所有者的财产。

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 DEGRADATION 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/llds/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.

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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。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page

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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:*
 - 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.
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8. *Limitations on Damages and Liability:*

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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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