User's Guide

Using the LM2105EVM

ABSTRACT

This user's guide describes the characteristics, operation, and use of the LM2105 Evaluation Module (EVM). A complete schematic diagram, PCB layouts, and BOM are included in this document.

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1 Introduction

The LM2105 is designed to primarily evaluate the LM2105 performance. This driver is a 105-V boot voltage, high-side, low-side driver with 0.5-A peak source and 0.8-A sink current for driving two N-channel MOSFETs. The same board can be used to evaluate other pin-to-pin compatible parts in the supported package. The LM2105 has low propagation delay and low propagation delay matching between the high- and low-side rising and falling edges of the driver outputs for reliable timing of the gate-drive signals.

2 Description

The EVM is developed in such a way that the LM2105 driver performance can be evaluated and compared to data sheet parameters, or externally connected to power devices with provisions for source and sink gate-resistance flexibility. The LM2105 evaluation board uses surface-mount test points allowing connection to INL, INH, GVDD, and BST inputs. A variety of other test points are available for probing the LM2105. The input bias is configured such that the BST-SH high-side bias can be sourced from GVDD, or an external additional bias can be added to provide BST-SH directly. The high- and low-side driver output returns are separated on SH and GND respectively to allow evaluation of the LM2105 SH negative voltage capabilities.

2.1 Features

The EVM supports the following features:

- EVM for the low-voltage features of the LM2105 gate driver
- 5-V to 18-V VCC power supply range
- TTL and CMOS compatible inputs
- PCB layout optimized for bias supply bypassing cap, gate-drive resistance selection
- Capacitive load, external gate drive resistor and diode for gate drive network evaluation
- Allows quick verification of most of the data sheet parameters
- Test points allow probing all the key pins of the LM2105

2.2 I/O Description

Table 2-1 details the connection descriptions.

Table 2-1. Connection Descriptions

Pins	Description
VCC	VCC positive input test point. Powers IC GVDD pin, use 5-V to 18-V range.
GVDD	GVDD positive input of LM2105 IC
GND	Multiple test points. VCC negative input, INL_IN, and INH_IN negative inputs, and ground at LM2105 IC
INH_IN	High-side input to EVM
INH	High-side input pin, INH
INL_IN	Low-side input to EVM
INL	Low-side input pin, INL
BST	BST pin voltage
GH LD	High-side output at capacitive load
GH	High-side output pin
SH	High-side driver return pin. Usually connected to high-side MOSFET source.
GL LD	Low-side output at capacitive load
GL	Low-side output pin

3 Electrical Specifications

For the full range of recommended operating specifications and design guidelines for driving loads, see the LM2105 data sheet.

CAUTION

The LM2105 is designed for low-voltage evaluation only, and is not certified for evaluation with voltages beyond the absolute maximums listed in the electrical specifications. Do **not** evaluate high-voltage parameters with this board.

4 Test Summary

4.1 Definitions

This procedure details how to configure the LM2105 evaluation board. Within this test procedure, the following naming conventions are applied. See the LM2105 Bench Setup Diagram and Configuration, Figure 4-1, for details.

DMM: Digital multimeter

EVM: Evaluation module

4.2 Equipment

4.2.1 Power Supply

DC power supply with voltage and current above 20 V and 1 A, for example: Agilent E3634A

4.2.2 Function Generator

Two-channel function generator over 10 MHz, for example: Tektronics AFG3252

4.2.3 DMM

DMM with voltage and current above 25 V and 1 A, for example: Fluke 187

4.2.4 Oscilloscope

Four channel oscilloscope with 500 MHz or greater bandwidth, for example: DPO 7054

4.3 Equipment Setup

4.3.1 DC Power Supply Settings

- DC power supply #1
  - Voltage setting: 12 V
  - Current limit: 0.05 A

4.3.2 Digital Multimeter Settings

- DMM #1
  - DC current measurement, auto-range. Expected current is within 1 mA to 15 mA.

4.3.3 Two-Channel Function Generator Settings

Table 4-1 displays the two-channel function generator settings.

Table 4-1. Two-Channel Function Generator Settings

	Mode	Frequency	Width	Delay	High	Low	Output Impedance
Channel A	Pulse	100 kHz	2.5 µs	0 us	5 V	0 V	High Z
Channel B			2.5 µs	5 µs			

4.3.4 Oscilloscope Settings

Table 4-2 details the oscilloscope settings.

Table 4-2. Oscilloscope Settings

	Bandwidth	Coupling	Termination	Scale Settings	Inverting
Channel A	500 MHz or above	DC	1 MΩ or automatic	10× or automatic	OFF
Channel B					

4.3.5 Bench Setup Diagram

The bench setup diagram includes the function generator and oscilloscope connections.

Use the following connection procedure, refer to Figure 4-1.

- First, make sure the output of the function generator and power supplies are disabled before connection.
- Apply function generator channel-A on INL_IN-GND.
- Apply function generator channel-B on INH_IN-GND.
- Power supply #1: apply positive lead to current input of DMM #1 and current output of DMM #1 to test point VCC; apply negative lead to test point GND.
- Apply oscilloscope channel-1 probes on GL LO-SH, minimizing the loop area as much as possible. Note the scope ground is connected to SH test point.
- Apply oscilloscope channel-2 probes on GH LO-GND, minimizing the loop area as much as possible.

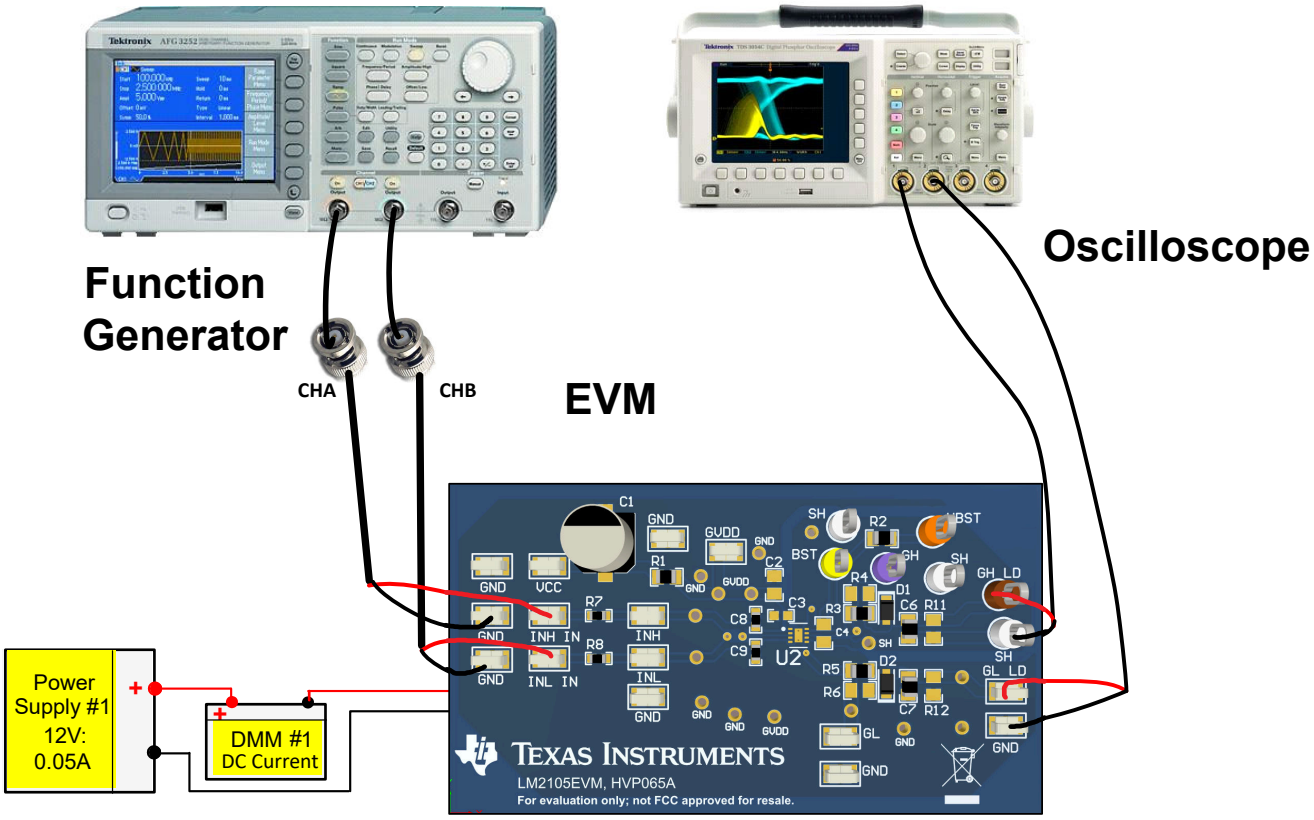

Figure 4-1. Bench Setup Diagram and Configuration

5 Power-Up and Power-Down Procedure

5.1 Power Up

1. Before beginning the power up test procedure, verify the connections with Figure 4-1.
2. Enable supply #1, if the current on DMM1 is more than 0.25 mA and less than 0.71 mA, everything is set correctly.
3. Enable function generator outputs channel-A and channel-B.
4. The following conditions should be present:
   a. Stable pulse output on channel-1 and channel-2 in the oscilloscope, refer to Figure 5-1.
   b. Frequency measurement should be 100 kHz, ±5 kHz or equal to the programmed function generator frequency.
   c. DMM #1 should display around 3.2 mA ± 1.5 mA with the default load capacitance of 1.0 nF. For more information about operating current, see the LM2105 data sheet.

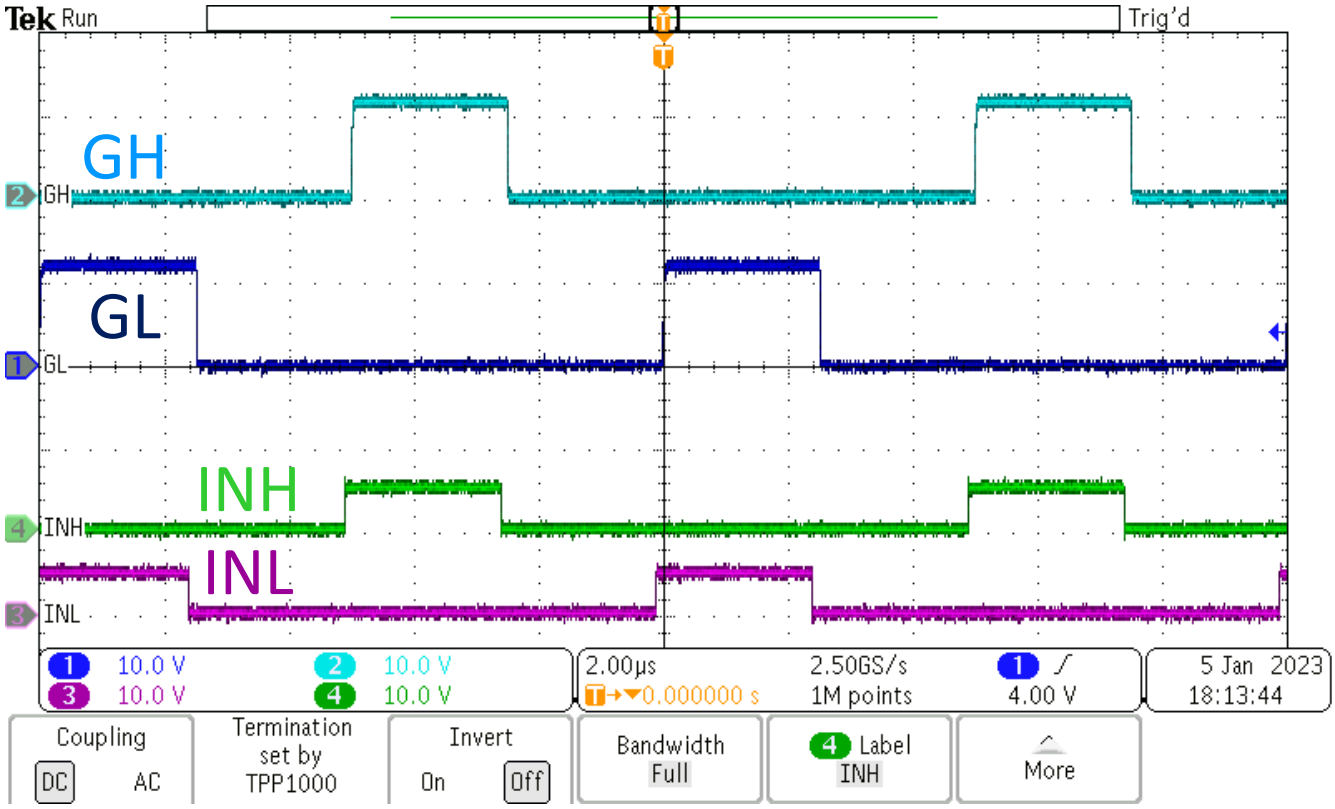

Figure 5-1. Example Input and Output Waveforms (green and magenta are PWM inputs, blue and dark blue are driver outputs)

5.2 Power Down

Use the following steps to power down the EVM:

1. Disable function generator
2. Disable power supply #1
3. Disconnect cables and probes

6 Operation With External Bootstrap Diode

The LM2105 has an internal bootstrap diode included, the series resistor (R10) is not populated. This allows the user to evaluate pin compatible drivers that do not have the internal bootstrap diode which is included with the LM2105 high-side and low-side driver.

As a general guideline, when using the external bootstrap diode a resistance value of 2.2 Ω to 10 Ω is recommended. Install the R10 1206-size resistor for evaluation of pin compatible drivers without the internal bootstrap diode.

7 Typical Performance Waveforms (C_L = 1000 pF)

7.1 Propagation Delays

The waveforms below illustrate the HI input and HO output on the top traces, and the LI input and LO output on the bottom traces in each plot.

To evaluate propagation delays and rising and falling details, it is recommended to have scope probe connections with short ground leads.

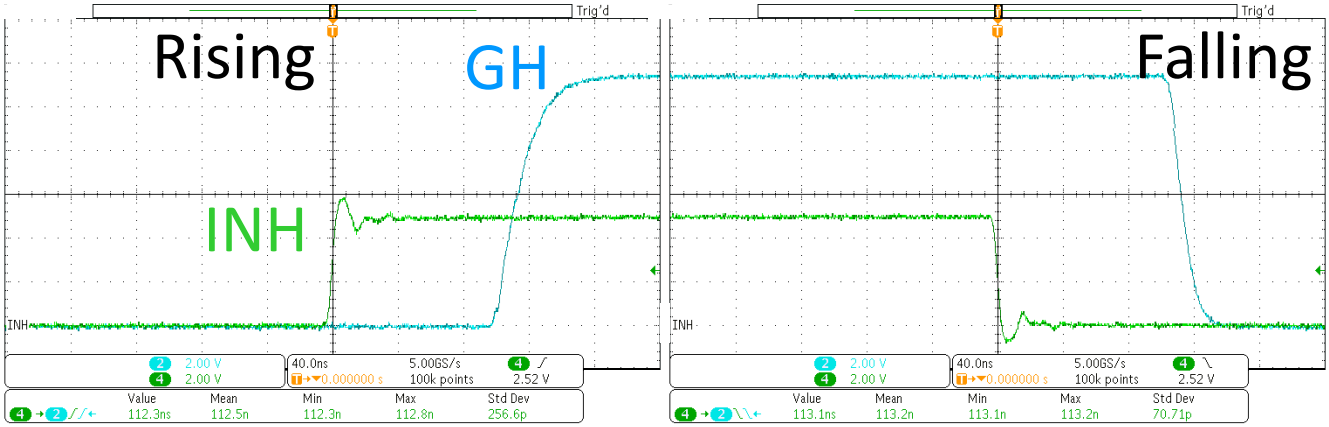

Figure 7-1. INH and GH Propagation Delay Waveforms (green is INH, blue is GH)

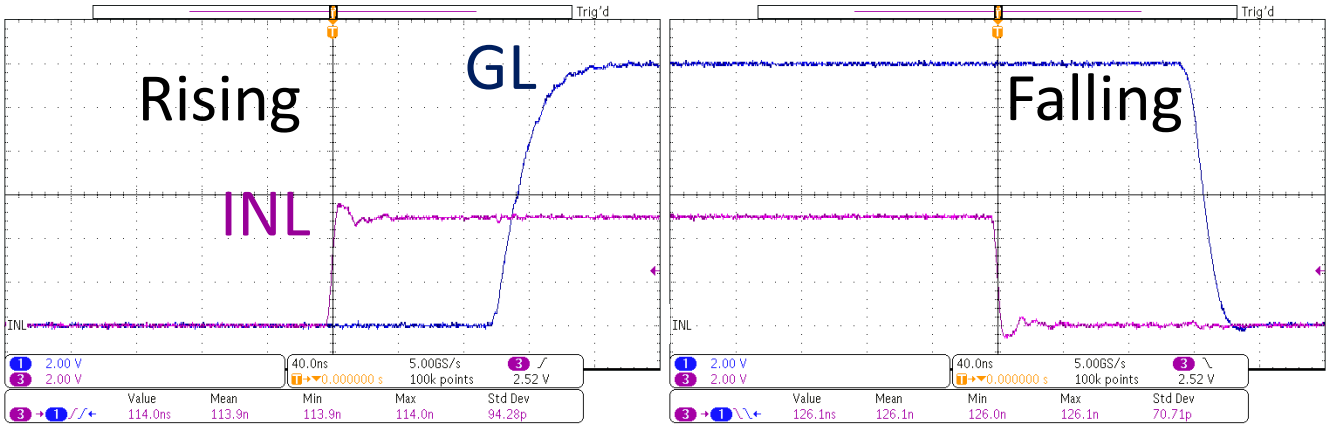

Figure 7-2. INL and GL Propagation Delay Waveforms (green is GL, dark blue is GL)

8 Schematic

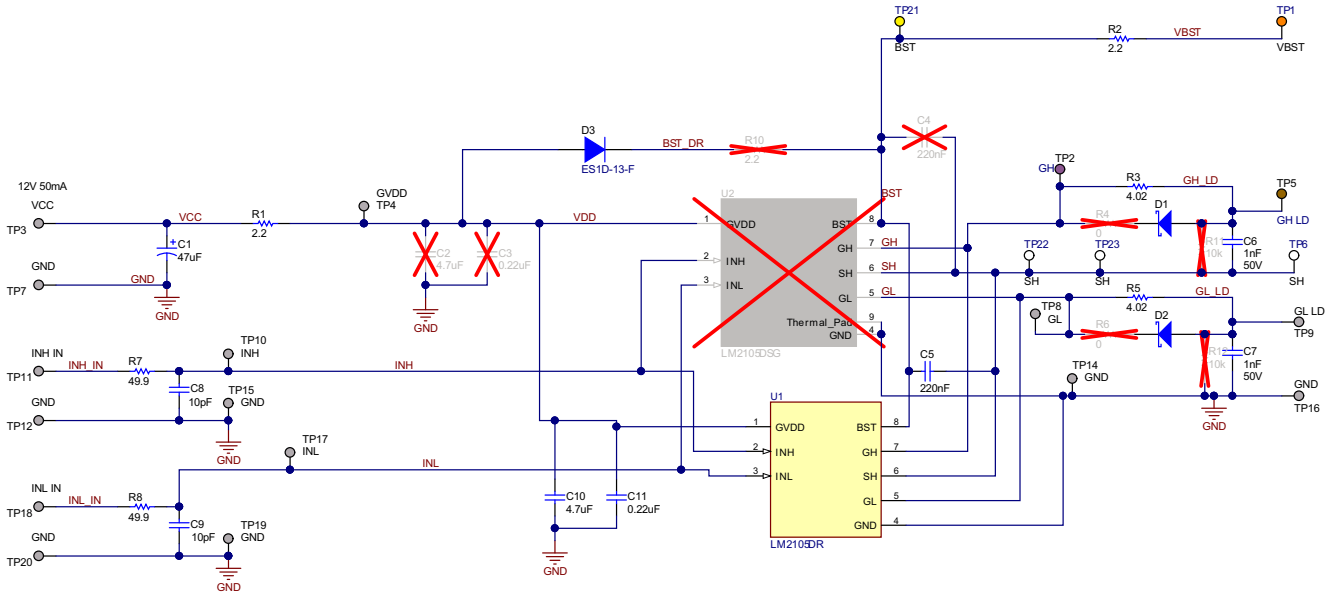

Figure 8-1. LM2105 Schematic

U2 is not installed since it is an alternate driver IC used on a different board assembly variation.

9 Layout Diagrams

The PCB layout information for LM2105 is shown in Figure 9-1 through Figure 9-4.

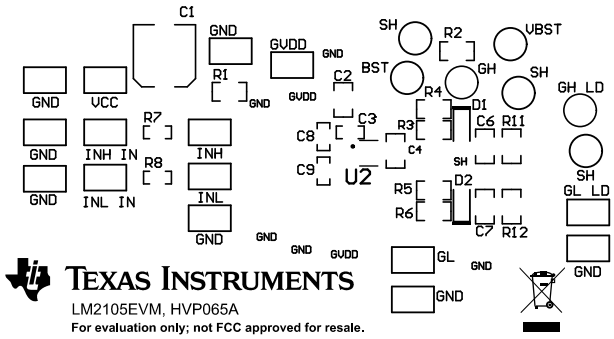

Figure 9-1. Top Overlay

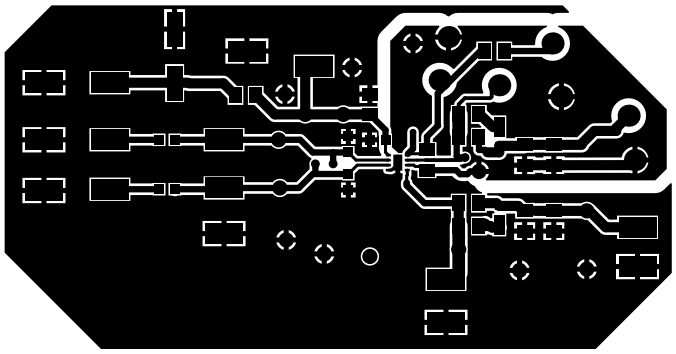

Figure 9-2. Top Layer

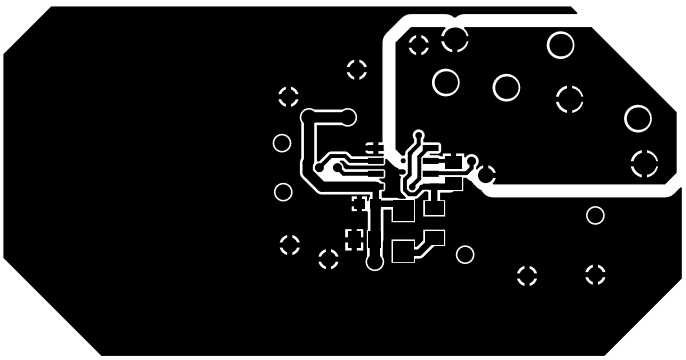

Figure 9-3. Bottom Layer

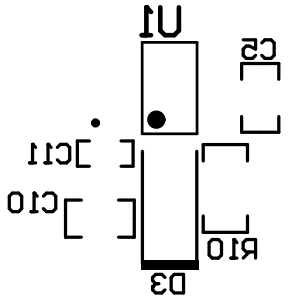

Figure 9-4. Bottom Overlay

10 Bill of Materials

Table 10-1 lists the LM2105 bill of materials.

Table 10-1. LM2105 Bill of Materials

Des	Qty	Description	Part Number	Manufacturer
C1	1	CAP, AL, 47 uF, 50 V, +/- 20%, 0.68 ohm, SMD	UUD1H470MCL1GS	Nichicon
C5	1	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805	C0805C224K5RACTU	Kemet
C6, C7	2	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, 0805	C0805C102J5RACTU	Kemet
C8, C9	2	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0603	C0603C100J5GACTU	Kemet
C10	1	CAP, CERM, 4.7 uF, 25 V, +/- 10%, X7R, 0805	C2012X7R1E475K125AB	TDK
C11	1	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0603	C1608X7R1H224K080AB	TDK
D1, D2	2	Diode, Schottky, 30 V, 1 A, AEC-Q101, MicroSMP	MSS1P3L-M3/89A	Vishay-Semiconductor
D3	1	Diode, Ultrafast, 200 V, 1 A, SMA	ES1D-13-F	Diodes Inc.
R1, R2	2	RES, 2.2, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	CRCW08052R20JNEA	Vishay-Dale
R3, R5	2	RES, 4.02, 1%, 0.125 W, 0805	RC0805FR-074R02L	Yageo America
R7, R8	2	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060349R9FKEA	Vishay-Dale
TP1	1	Test Point, Multipurpose, Orange, TH	5013	Keystone Electronics
TP2	1	Test Point, Multipurpose, Purple, TH	5129	Keystone Electronics
TP3, TP4, TP7,TP8, TP9, TP10,TP11, TP12,TP14, TP15,TP16, TP17,TP18, TP19, TP20	15	Test Point, Miniature, SMT	5019	Keystone
TP5	1	Test Point, Multipurpose, Brown, TH	5125	Keystone Electronics
TP6, TP22, TP23	3	Test Point, Multipurpose, White, TH	5012	Keystone Electronics
TP21	1	Test Point, Multipurpose, Yellow, TH	5014	Keystone Electronics
U1	1	105-V, 2x2mm Half-Bridge Gate Driver with Integrated Bootstrap Diode	LM2105DR	Texas Instruments
C2	0	CAP, CERM, 4.7 uF, 25 V, +/- 10%, X7R, 0805	C2012X7R1E475K125AB	TDK
C3	0	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0603	C1608X7R1H224K080AB	TDK
C4	0	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805	C0805C224K5RACTU	Kemet
R4, R6, R11, R12	0	RES, 0, 5%, 0.125 W, 0805	MCR10EZPJ000	Rohm
R10	0	RES, 2.2, 5%, 0.5 W, 1206	CRM1206-JW-2R2ELF	Bourns
U2	0	105-V, 2x2mm Half-Bridge Gate Driver with Integrated Bootstrap Diode	LM2105DSG	Texas Instruments

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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.

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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.

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- *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.*

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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

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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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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.

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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.

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