User's Guide
SLLU218–June 2015

ISO5851 Evaluation Module

The manual describes the ISO5851 Evaluation Module (EVM). The ISO5851 EVM allows designers to evaluate device AC and DC performance with a pre-populated 1-nF load or with a user-installed IGBT in either of the standard TO-247 or TO-220 packages.

Warning: Note that although these devices provide galvanic isolation of up to 5700-V, the EVM cannot be used for isolation voltage testing. Voltage exceeding the EVM's ratings (V_{CC1} > 5.5-V, V_{CC2} – V_{EE2} > 30-V, or IGBT Collector-Emitter Voltage V_{CE} > 50-V) can damage the EVM resulting in personal injury.

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1 Overview

The ISO5851 is a 5.7-kV_{RMS}, reinforced isolated, IGBT gate driver with 2.5-A source and 5-A sink currents. The primary side operates from a single 3-V to 5.5-V supply. The output side allows for a supply range from minimum 15-V to maximum 30-V. Two complementary CMOS inputs control the output state of the gate driver. The short propagation time assures accurate control of the output stage.

An internal desaturation detection recognizes when the IGBT is in an overload condition. Upon a desaturation detect, the gate driver output is driven low to V_{EE2} potential, turning the IGBT immediately off.

When desaturation is active, a fault signal is sent across the isolation barrier pulling the $\overline{FLT}$ output at the primary side low and blocking the isolator input. The $\overline{FLT}$ output condition is latched and can be reset through a low-active pulse at the $\overline{RST}$ input.

When the IGBT is turned off during normal operation with bipolar output supply, the output is hard clamp to V_{EE2}. If the output supply is unipolar, an active Miller clamp can be used, allowing Miller current to sink across a low impedance path preventing IGBT to dynamically turned on during high voltage transient conditions.

The readiness for the gate driver to be operated is under the control of two undervoltage-lockout circuits monitoring the primary and secondary supplies. If either side have insufficient supply, the RDY output goes low, otherwise the output is high.

2 EVM Setup and Precautions

2.1 Power Supply Connections

Figure 1 illustrates the EVM power supply schematic.

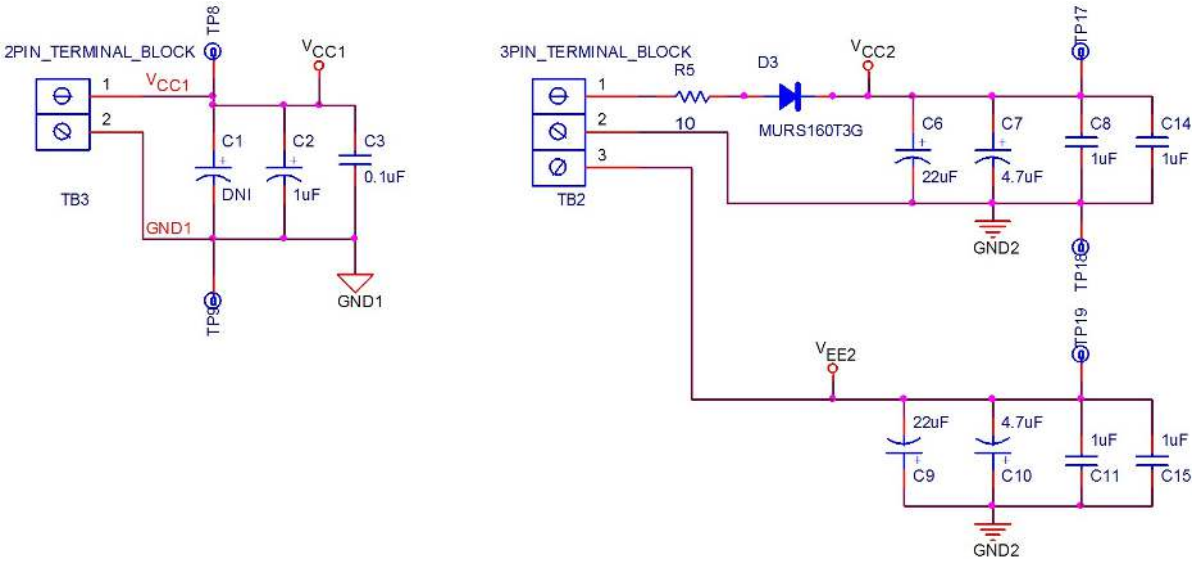

Figure 1. ISO5851 EVM Power Supply Schematic

The primary side of the EVM (V_{CC1}) operates from a single 3-V to 5.5-V power supply and connected via TB3. Test point (TP8) is available for monitoring the primary power supply.

The EVM provides connections for evaluating the output side (V_{CC2}, V_{EE2}) with either a bipolar or unipolar power supply, from a minimum 15-V to maximum 30-V. For unipolar operation, connect V_{EE2} to GND2 through a wire-bridge between pin 2 and pin 3 of TB2, as shown in Figure 2. V_{CC2} and V_{EE2} can be monitored via TP17 and TP19, respectively.

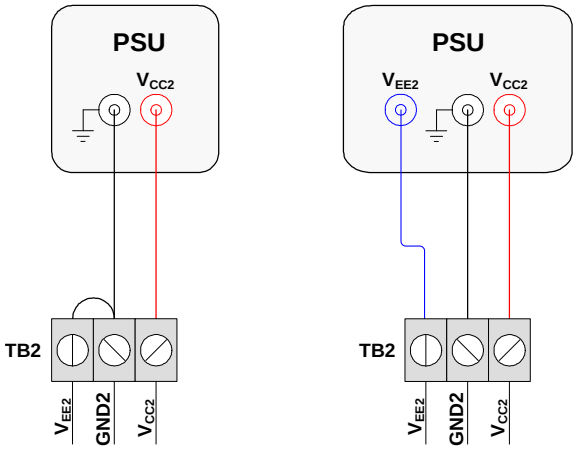

Figure 2. Output Power Supply for Unipolar (Left) or Bipolar (Right) Operation

2.2 Signal Connections

Figure 3 illustrates the ISO5851 EVM signal path schematic.

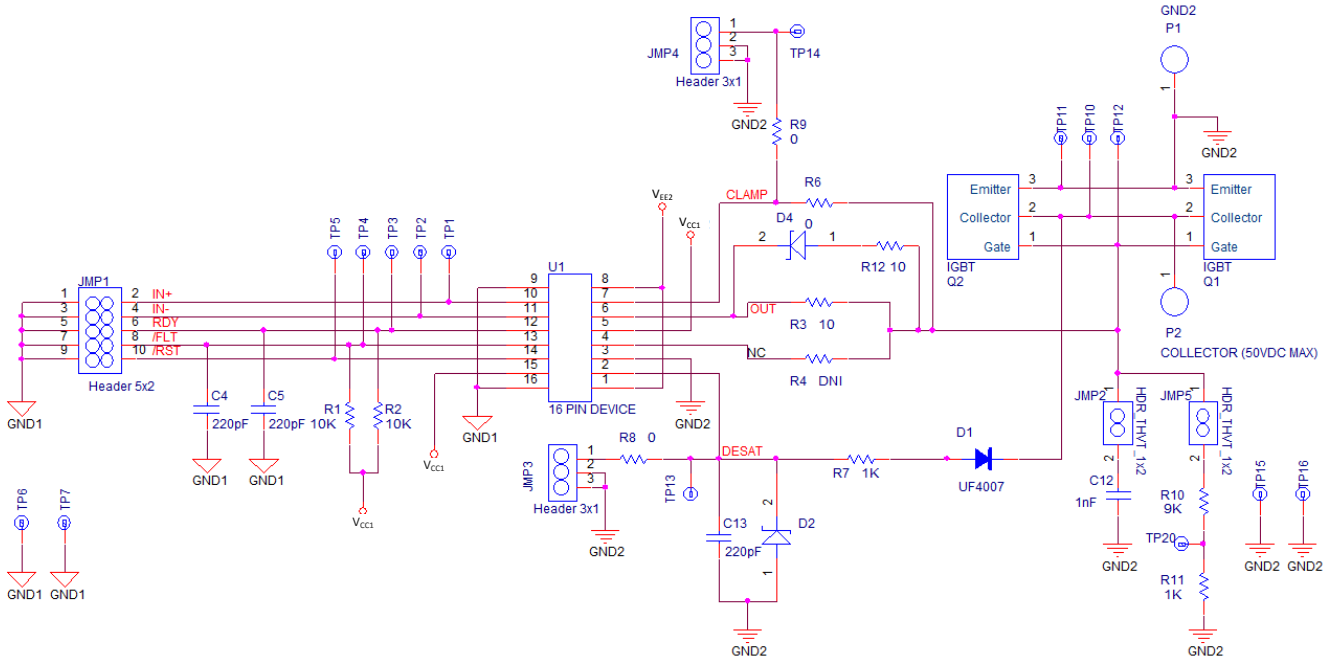

Figure 3. ISO5851 EVM Signal Path Schematic

2.2.1 I/O Connections

Figure 3 shows the signal path schematic of the EVM. JMP1 allows for stimulus or monitoring of the device I/O pins IN+, IN-, RDY, $\overline{\text{FLT}}$, and $\overline{\text{RST}}$. Test points 1, 2, 3, 4, and 5 provide additional access to the I/O pins. The EVM comes populated with 10-kΩ pullup resistors (R1, R2) on the RDY and $\overline{\text{FLT}}$ pins, as well as 220-pF capacitors (C4, C5) to GND1 for noise filtering.

2.2.2 Output and Loading

The EVM comes populated with a 1-nF load (C12) on the output side. The output can be monitored directly via TP12. A 10:1 resistor-divider network is provided for monitoring the output with a low-voltage probe via TP20. The divider circuit can be disconnected from the output by removing the shunt on JMP5. 10-Ω gate resistors (R3, R12) control the rise and fall times of the output. These resistors can be modified by the user to alter the turn-on and turn-off characteristics of the output.

The EVM also allows for evaluation of the device with an IGBT load in either of the standard TO-247 or TO-220 footprints. During evaluation with an IGBT load, the pre-installed capacitive load (C12) can be disconnected from the output by removing the shunt on JMP2.

The EVM provides an additional connection (P2) for applying an external power supply to the IGBT Collector. The EVM is not intended for high voltage testing and the voltage applied to P2 should be limited to 50-V DC.

When evaluating the device with an IGBT load using P2, the components D1, D2, R7, and C13 should be populated with their default values, specified in Figure 3. Additionally, ensure that the DESAT pin is **not** connected to GND2 when driving an IGBT load using P2, either by removing R8, or verifying that all jumpers are removed from JMP3.

2.2.3 DESAT

The EVM comes populated with a 220-pF DESAT capacitance. Pin1 on JMP3 can be used to apply a signal directly to the DESAT pin.

For evaluation with the default 1-nF load, when actual IGBT is not connected as load, the desaturation function should be disabled by connecting the DESAT pin to GND2 by shunting pin 1 to pin 2 on JMP3.

2.2.4 CLAMP

By default, the CLAMP pin is connected to the output via a 0-Ω resistor (R6). The CLAMP feature can be disabled by removing R6. CLAMP can be monitored via TP14, and a signal can be applied directly to the CLAMP pin via JMP4.

3 Example Measurements

Figure 4 illustrates measurements performed under the default EVM configuration. For these measurements, V_{IN-} is connected to GND1.

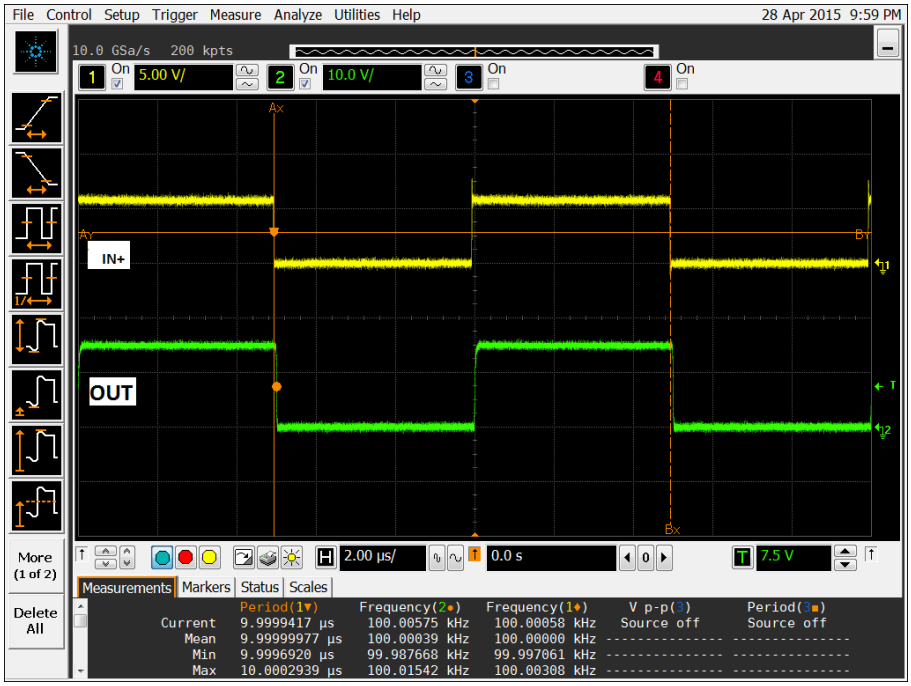

Figure 4. ISO5851 EVM Input and Output With Unipolar Output Supply

Figure 4 shows the input and output of the ISO5851 EVM for a 100-kHz clock with R_G = 10 Ω (R3) and R12 = 10 Ω and a unipolar output supply (V_{CC2} = 15-V, V_{EE2} = GND2). The output is measured at TP12.

Figure 5 shows the input and output of the ISO5851 EVM for a 100-kHz clock with R_G = 10 Ω (R3) and R12 = 10 Ω and a bipolar output supply (V_{CC2} = 15-V, V_{EE2} = –8-V).

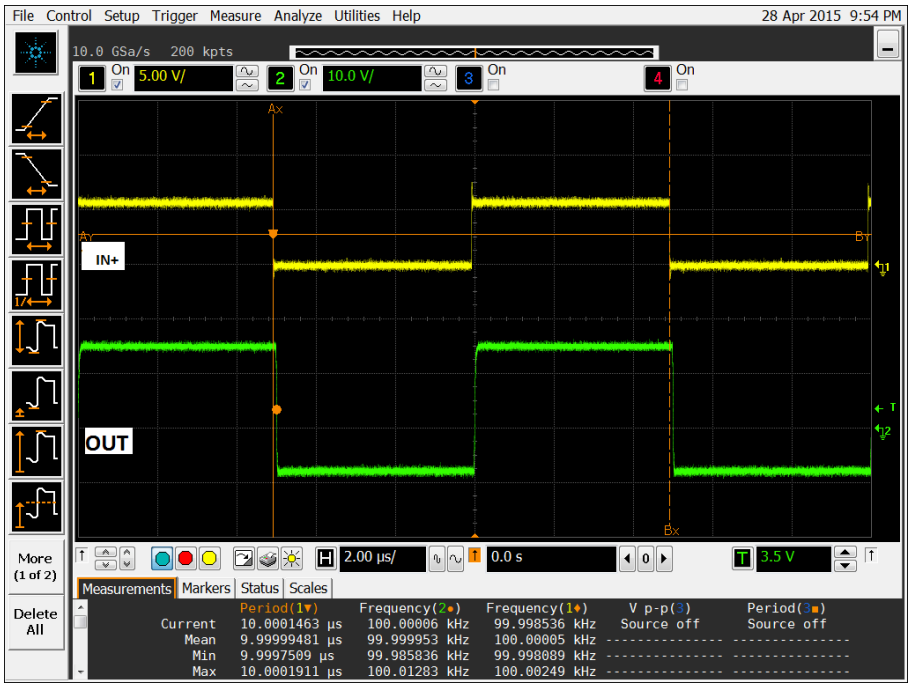

Figure 5. ISO5851 EVM Input and Output With Bipolar Output Supply (V_{CC2} = 15-V, V_{EE2} = –8-V)

Figure 6 with Unipolar Output Supply and Figure 7 with Bipolar Output Supply, shows the functionality of the DESAT, $\overline{FLT}$, and $\overline{RST}$ pins. IN+ is set to 5-V_{DC}, and an 10-µs pulse is applied to $\overline{RST}$. On the rising edge of $\overline{RST}$, the fault is cleared and the DESAT capacitor begins to charge. As the DESAT pin reaches the DESAT threshold voltage, a fault is triggered on $\overline{FLT}$, and the output goes into active turn-off. $\overline{RST}$ must be toggled low, then high to reset the device, and the cycle begins again.

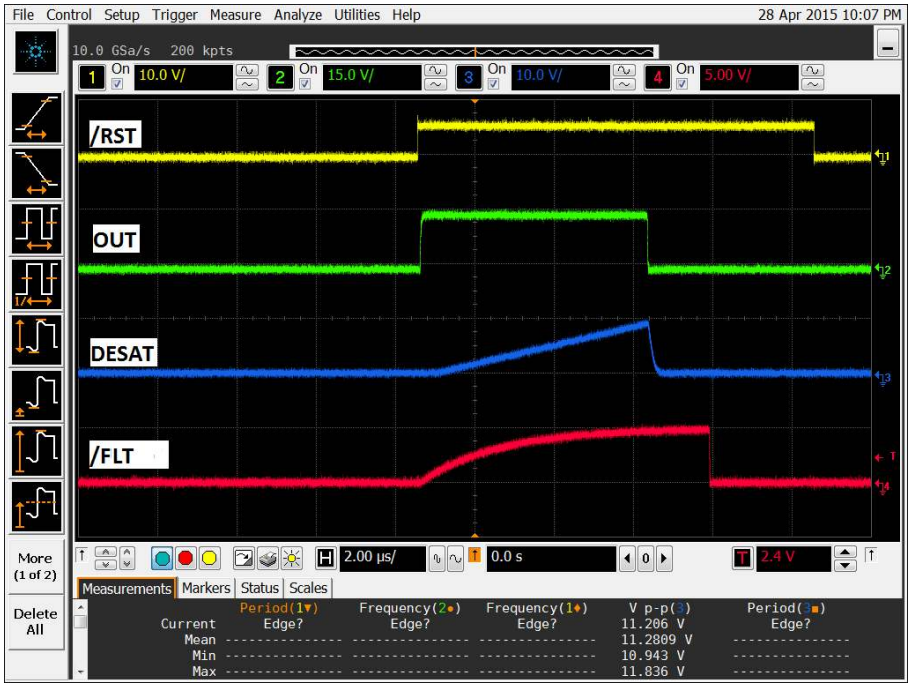

Figure 6. ISO5851 EVM DESAT and Reset with Unipolar Output Supply

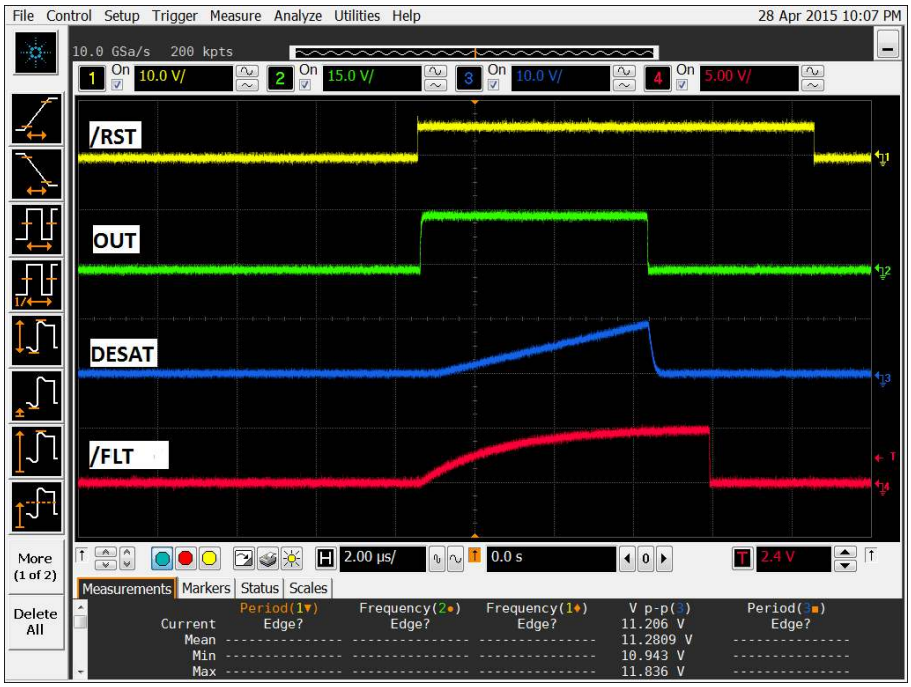

Figure 7. ISO5851 EVM DESAT and Reset with Bipolar Output Supply

4 Printed-Circuit Board

The ISO5851 is an isolated gate driver with several important features. The printed-circuit board (PCB)/EVM, as shown in Figure 8 ISO5851 EVM, has been designed to support the ISO5851 device and to allow the user to evaluate its basic operation and features. The left side of the PCB contains the interface to the input, control, and status functions of the integrated circuit (IC). The right side of the PCB has been designed to interface to an IGBT. No electrical connections exist between the right and left sides of the PCB.

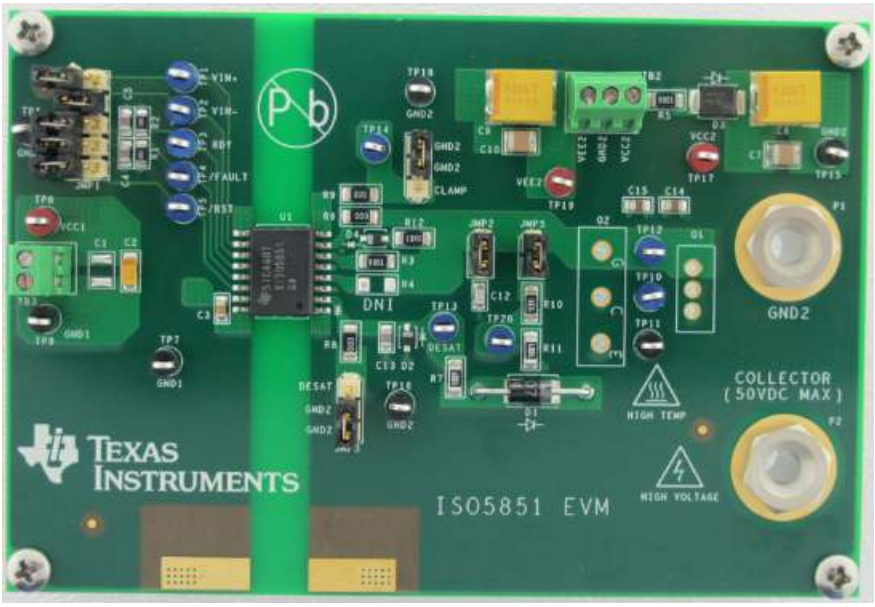

Figure 8. ISO5851 EVM

Refer to the ISO5851EVM schematic shown in Figure 3 and the bill of materials given in Table 2, to become familiar with the PCB components and layout.

The following table pertains to the labels on the EVM board (Figure 8):

Given	Read As
VCC1	V_{CC1}
VCC2	V_{CC2}
VEE2	V_{EE2}
VCE	V_{CE}
VIN+	IN+
VIN–	IN–
/FAULT	$\overline{FLT}$

4.1 ISO5851 Operation

4.1.1 Left-Side Operation: DC Power, Control, and Status

4.1.1.1 DC Input Power

The left side of the ISO5851 (and therefore the PCB) can be operated using either a +3-V (±10%) to +5.5-V (±10%) dc power supply. As the current requirement is extremely low, the user can choose to operate the ISO5851 EVM by battery. The dc power supply must be connected to the TB3 terminal having V_{CC1} (+5.5-V DC) and GND1 (+5.5-V DC return).

4.1.1.2 Control and Status

The interface to the device is via the JMP1 header. It contains the IN+ and IN– inputs, the device $\overline{RST}$, RDY, and $\overline{FLT}$ indicator output. The JMP1 header allows easy connections to test equipment using standard clip leads. Each of the five signals also has a test point for additional connections. These are test points TP1–TP5.

4.1.2 Right-Side Operation

4.1.2.1 DC Output Power

Power is provided to V_{CC2} on the right side of the device at TB2 terminal as shown in Figure 2. The dc supply must be able to provide a bias voltage over the range of +15-V DC to +30-V DC. As the current requirement is extremely low, the user can choose to operate the ISO5851 EVM by battery. If a negative gate drive is required, a dc supply (or battery) must be connected across V_{EE2} at the TB3 terminal as shown in Figure 2. The voltage range must be between 0-V and 15-V DC.

4.1.2.2 DESAT – JMP3

One of the features of the ISO5851 is the IGBT desaturation protection. JMP3 provides access to the DESAT pin. It is a 3-pin male header, and installing a shorting jumper between pin 1 and pin 2 on JMP3 disables the DESAT function.

4.1.2.3 Load

As shipped, the ISO5851EVM does not have an IGBT installed. The user can evaluate device operation using a capacitive load of 1nF provided on EVM or capacitive load can be removed and IGBT can be connected onto the board. Most IGBTs are available in the standard TO-247 or TO-220 package. The PCB has provisions to solder an IGBT directly onto the board.

4.1.2.3.1 No IGBT Installed – JMP2

When using the capacitive load, the user must install a jumper short onto JMP2. It connects a 1-nF capacitor (C12) to the OUT pin. The capacitive consists of the 10-Ω gate resistor (R3) and the 1-nF capacitor (C12).

4.1.2.3.2 IGBT Installed – REMOVE JMP2

If the user chooses to install an IGBT, JMP2 must be left open with no shorting jumper installed. The PCB has been designed with plated-through holes (or vias) as Q1 and Q2 shown on the schematic for IGBT connections.

4.1.2.4 Turn-on and Turn-off Adjust

The PCB contains10-Ω gate resistor (R3), D4 diode, and 10-Ω R12 resistor. It allows the user to evaluate device operation with different turn-on and turn-off characteristics. It is shown in Figure 9.

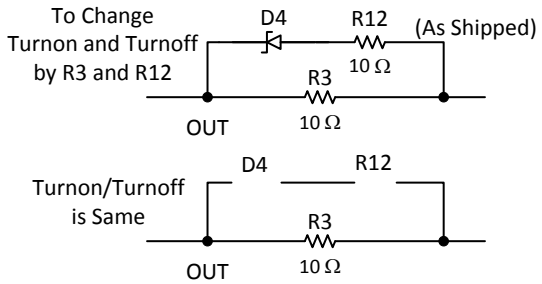

Figure 9. To have different Turn-on and Turn-off

4.1.3 Test Points

Test points have been provided for ready access to signal monitoring and are listed in Table 1.

Table 1. Test Points

Test Points	I/O	Function	
TP1	Input	IN+	(Side 1)
TP2	Input	IN–	(Side 1)
TP3	Output	RDY	(Side 1)
TP4	Output	$\overline{\text{FLT}}$	(Side 1)
TP5	Input	$\overline{\text{RST}}$	(Side 1)
TP6	Ground	GND1	(Side 1)
TP7	Ground	GND1	(Side 1)
TP8	Supply	V_{CC1}	(Side 1)
TP9	Ground	GND1	(Side 1)
TP10	Input	COLLECTOR VOLTAGE	(Side 2)
TP11	Input	EMITTER VOLTAGE	(Side 2)
TP12	Output	GATE VOLTAGE	(Side 2)
TP13	Input	DESAT	(Side 2)
TP14	Input	CLAMP	(Side 2)
TP15	Ground	GND2	(Side 2)
TP16	Ground	GND2	(Side 2)
TP17	Supply	V_{CC2}	(Side 2)
TP18	Ground	GND2	(Side 2)
TP19	Supply	V_{EE2}	(Side 2)
TP20	Output	OUT	(Side 2)
P1	Ground	GND2	(Side 2)
P2	Input	COLLECTOR VOLTAGE	(Side 2)

4.2 ISO5851 EVM Bill of Materials

The ISO5851 EVM bill of materials is shown in Table 2.

Table 2. Bill of Materials

Item	QTY	Reference	Part	Manufacturer	Manufacturer Part Number
1	1	C1	DNI	DNI	DNI
2	1	C2	1 µF	AVX Corporation	TPSA105K020R3000
3	1	C3	0.1 µF	Kemet Electronic Components	C0805C104J5RACTU
4	2	C4,C5	220 pF	Vankel	C0805COG101-221JNE
5	2	C6,C9	22 µF	AVX Corporation	TAJV226K050RNJ
6	2	C7,C10	4.7 µF	Kemet Electronic Components	C1210X475K5RACTU
7	4	C8,C11,C14,C15	1 µF	Murata Electronics North America	GRM21BR71H105KA12L
8	1	C12	1 nF	Murata Electronics North America	GRM2195C2A102JA01D
9	1	C13	220 pF	Venkel	C0805COG101-221JNE
10	1	D1	UF4007	Fairchild Semiconductor	UF4007
11	1	D2	BAT165	Infineon Technologies	BAT 165 E6327
12	1	D3	MURS160T3G	ON Semiconductor	MURS160T3G
13	1	D4	BAT165	Infineon Technologies	BAT 165 E6327
16	1	JMP1	Header 5x2	Samtec Inc	HTSW-105-07-G-D
17	2	JMP2,JMP5	HDR_THVT_1x2	Samtec Inc	HTSW-102-07-G-S
18	2	JMP3,JMP4	Header 3x1	Samtec Inc	HTSW-103-07-G-S
19	1	P1	GND2	Emerson Network Power	108-0740-001
20	1	P2	COLLECTOR (50-V DC MAX)	Emerson Network Power	108-0740-001
21	2	Q1, Q2	IGBT	DNI	DNI
22	2	R1,R2	10 kΩ	Vishay Dale	CRCW080510K0FKEA-
23	2	R3, R12	10	Vishay Dale	CRCW120610R0FKEA
23b	1	R4	DNI	DNI	DNI
24	1	R5	10	Vishay/Dale	CRCW120610R0FKEA
25	3	R6,R8,R9	0	Vishay Dale	CRCW12060000Z0EA-
26	1	R7	1 kΩ	Panasonic - ECG	ERJ-8ENF1001V
27	1	R10	9 kΩ	Yageo	RC1206FR-079K09L
28	1	R11	1 kΩ	Panasonic - ECG	ERJ-8ENF1001V
29	1	TB2	3PIN_TERMINAL_BLOCK	TE Connectivity	282834-3
30	1	TB3	2PIN_TERMINAL_BLOCK	TE Connectivity	282834-2
32	1	U1	16 PIN DEVICE	Texas Instruments	ISO5851DW
33	20	TP1 through TP20	Color: Red for Power, Black for Ground and Blue for Signal		
34	4	Standoff/spacers	1 inch		
Note: C6, C7, C8, C9, C10, C11, C12, C13, C14, and C15 **are rated for > 50-V**					
Jumpers (default):					
	a. Pins 1 and 2 of JMP2 are connected with a jumper.				
	b. Pins 1 and 2 of JMP5 are connected with a jumper.				
	c. No jumper on any pins of JMP3 & JMP4.				
	d. Pin 3 and 4 of JMP1 are connected with a jumper and rest pins of JMP1 are kept open				

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

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

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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

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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.

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