EVM User's Guide: TPS92201AEVM

TPS92201A Evaluation Module

Description

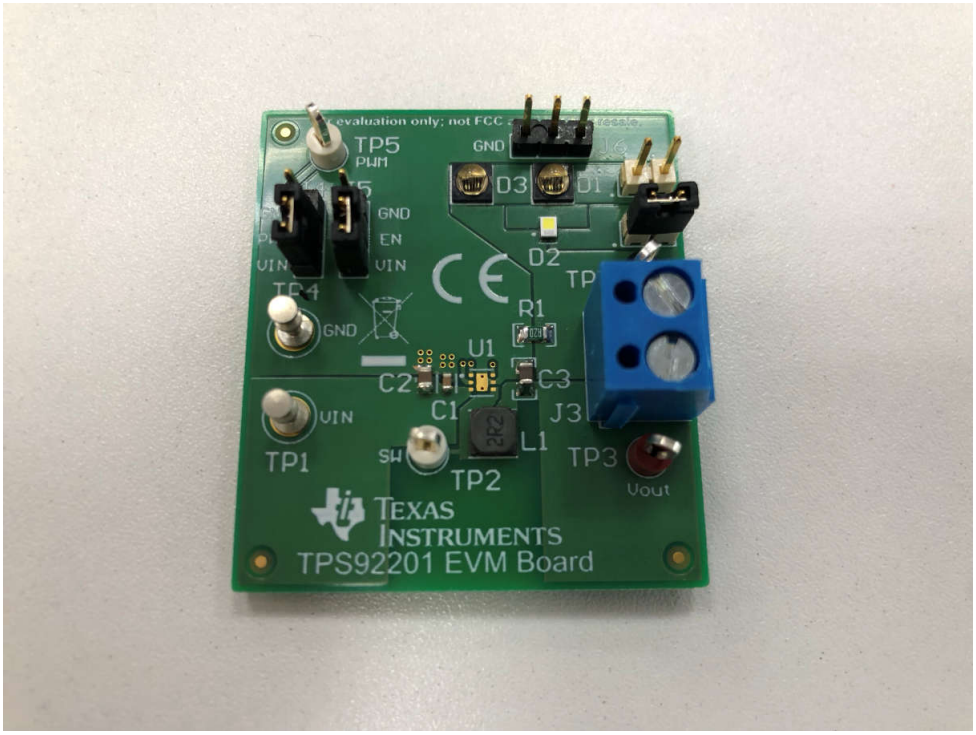
The TPS92201AEVM provides an LED driver based on the TPS92201A buck regulator. The TPS92201AEVM is designed to operate with an input voltage in the range of 2.2 V to 5.5 V. The EVM is set up for a default output current of 0.5 A at 3.3 V / 100% duty cycle PWM input. The load can be selected as 1 IR light, 2 IR lights ,1 white LED or external self-defined LED load through the jumper. The TPS92201 helps provide high efficiency, wide dimming range, good line regulation, and low output ripple LED driver.

Features

- 2.5-V to 5.5-V input voltage range
- 1-/1.5-A constant output current
- Up to 95% efficiency
- 35-µA operating quiescent current
- 1-µA shutdown current
- 200-mΩ (HS) / 160-mΩ (LS) MOSFETs
- Up to 100% switching duty cycle
- 1.5-MHz switching frequency
- Force PWM mode for low output ripple
- Power save mode for high efficiency in light load (for TPS92201A)
- 0.1-V to VIN output voltage range
- 100 mV feedback regulation voltage
- 1% to 100% analog dimming
- 20-kHz to 200-kHz PWM input frequency
- Internal soft startup
- Full protection with over current, LED open/short, FB resistor open/short
- Thermal shutdown protection
- Available in ultra-small SOT563 package

Applications

- Video doorbell
- Smart home camera
- IP camera
- Smart door lock
- Notebook camera
- Flashlight
- Rider accessories



1 Evaluation Module Overview

1.1 Introduction

The TPS92201A evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92201A synchronous buck switching regulator designed for high-current LED driver applications. The TPS92201A is a 1.5-A synchronous buck LED driver with input voltage range of approximately 2.2-5.5V, deep analog mode dimming (0.1% to 100%) implemented by PWM input, and external EN input. The EVM also has full protection, including LED open protection and short protection, sense resistor open protection and short protection, and thermal protection.

This user's guide describes the characteristics and use of the high-current buck light-emitting diode (LED) driver evaluation module.

1.2 Kit Contents

The evaluation module contains the TPS92201AEVM.

1.3 Specification

This converter design describes an application of the TPS92201A as an LED driver using the following specifications. For applications with a different input voltage range or different output voltage and current, see the TPS92201 data sheet.

Table 1-1 lists the electrical performance specifications.

Table 1-1. TPS92201AEVM Electrical Performance Specifications

Parameter	Test Conditions	MIN	TYP	MAX	Units
Input voltage range, V_{IN}		2.2		5.5	V
Input shutdown current, I_{SD}	V_{IN} = 3.6V, V_{EN} = 0				uA
Output current	R_{sense} = 200 mohms, V_{IN} = 3.6V, 100% duty PWM input	490	500	510	mA
Output current range				1.5A	A
Output current ripple	V_{IN} = 5 V, 2 IR LEDs, 1-A output current		20		mApp
Analog dimming range	3.3-V PWM amplitude, approx. 20-200 kHz	0.1		100	%
Efficiency	V_{IN} = 5 V, 1 IR LED, 1-A output current, Analog dimming		96		%
Efficiency	V_{IN} = 5 V, 2 IR LEDs, 1-A output current, Analog dimming		96		%
Switching frequency			1		MHz

1.4 Device Information

The TPS92201 is a high-efficiency 1.5-A synchronous buck-type LED driver with 2.5-V to 5.5-V input range. By integrating the high-side and low-side MOSFET, high efficiency and compact solution-size can be achieved. The ultra-low 1-µA shutdown current helps saving power in battery-powered applications.

Adaptive off-time with peak current control scheme is adapted in the TPS92201. To get the smallest output ripple, the device operates at typically 1.5-MHz pulse width modulation (PWM) mode in full current range.

Adaptive off-time with peak current control scheme is adapted in the TPS92201A. At medium to heavy load, the device operates in pulse width modulation (PWM) mode with 1.5-MHz switching frequency. At light load, the device automatically enters pulse frequency modulation (PFM) to maintain high efficiency over the entire load current range for TPS92201A.

The integrated switches have the capability to deliver up to 1.5-A constant current. Analog dimming is achieved by adjusting the duty cycle of the PWM input with 1% to 100% range. 20 kHz to 200 dkHz input PWM frequency can be supported to avoid audible noise.

Full protection methods are implemented in the TPS92201, including LED open, LED short, FB resistor open, FB resistor short and thermal shutdown. The device is available in WSON package with better thermal performance and SOT563 package with ultra-low size.

2 Hardware

2.1 Test Setup

This section describes the connectors and test points on the EVM and how to properly connect, setup, and use the TPS92201A EVM.

2.1.1 Connector Description

Table 2-1. EVM Connectors and Test Points

Reference Designator	Function
TP1	V_{IN} (see Table 1-1 for V_{IN} range).
TP2	SW test point.
TP3	VOUT test point, also the anode of the LED load.
TP4	General purpose GND test point.
TP5	PWM input.
TP6	FB test point.
J1	Jumper choice for 2 IR LEDs load.
J2	Jumper choice for 1 white LED load.
J3	Connector for external LED load.
J4	Connect a jumper between VIN (pin1) and PWM (pin2) to enable the positive converter, or connect a jumper between PWM (pin2) and GND (pin3) to disable. Or disconnect and use TP5 as the external input
J5	Connect a jumper between VIN (pin1) and EN (pin2) to enable the positive converter or between EN (pin2) and GND (pin3) to disable.
J6	General purpose GND test point.

2.1.2 Input/Output Connection

A power supply capable of supplying 2 A must be connected to TP1 and TP4. The LED load has 3 options to choose from:

1. For 2 IR LEDs, the jumper J1 needs to be connected.
2. For 1 white LED, the jumper J2 needs to be connected.
3. The jumper J3 is for external LEDs load.

Wires must be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission. TP5 are the input terminals for the PWM dimming signal. The PWM frequency range is 20 kHz to 200 kHz.

Once the connection is ready, apply the input voltage first, then apply the PWM signal.

2.1.3 No Dimming Application

In a case where no dimming function is needed, PWM signal can be directly connected to VIN by J4, thus no external PWM signal is needed.

2.2 Best Practices

2.2.1 Warnings and Cautions

Observe the following precautions when using the TPS54201EVM-818.

WARNING

When choosing an LED component (not included with this EVM), the end-user must consult the LED data sheet supplied by the LED manufacturer to identify the EN62471 Risk Group Rating and review any potential eye hazards associated with the LED chosen. Always consider and implement the use of effective light filtering and darkening protective eye wear and be fully aware of surrounding laboratory-type set-ups when viewing intense light sources that can be required to minimize or eliminate such risks to avoid accidents related to temporary blindness.

3 Hardware Design Files

3.1 Schematic

Figure 3-1 displays the EVM schematic.

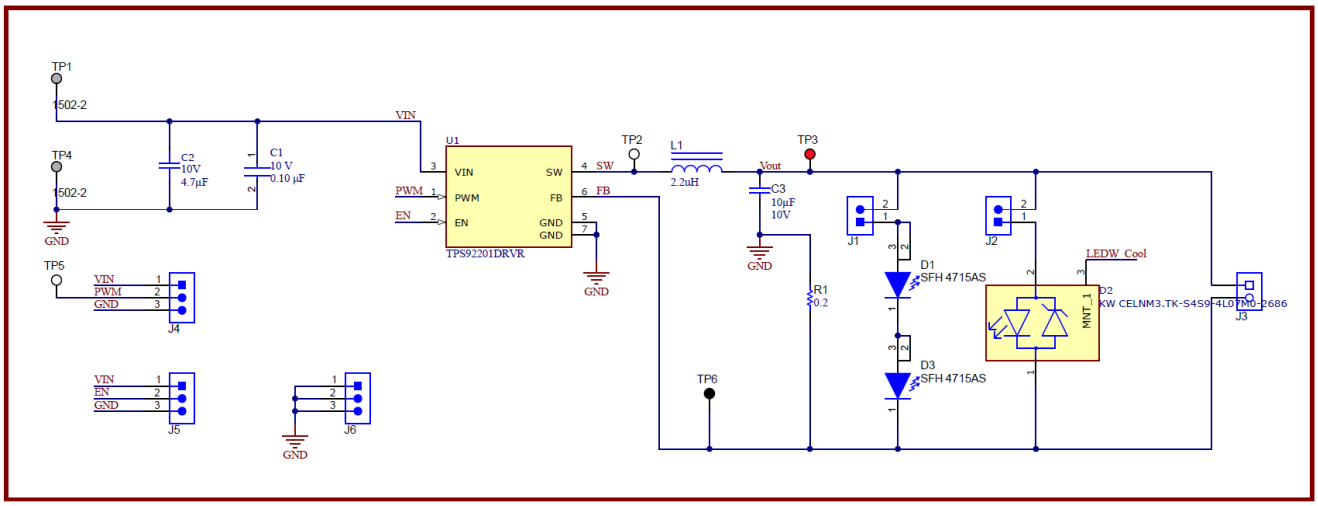


Figure 3-1. TPS92201AEVM Schematic

3.2 PCB Layouts

Figure 3-2 and Figure 3-3 show the design of the TPS92201AEVM printed-circuit board.

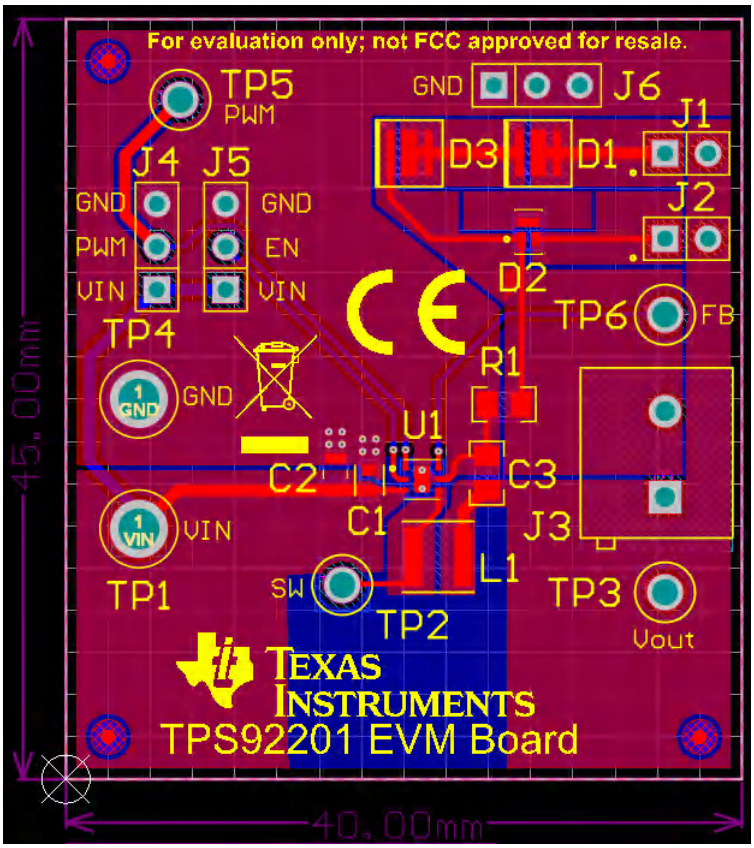
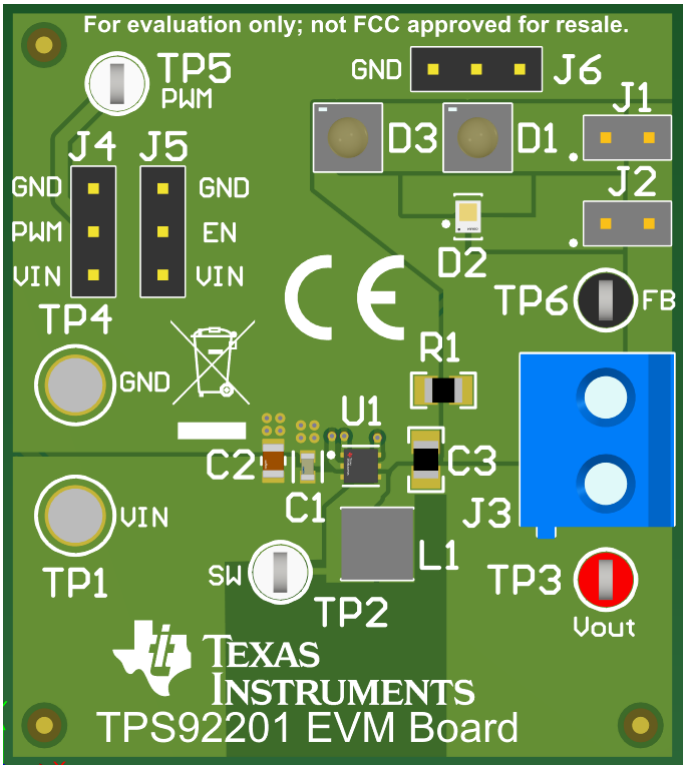


Figure 3-2. Top Layer and Top Overlay (Top View 2D)



Top Layer and Top Overlay (Top View)

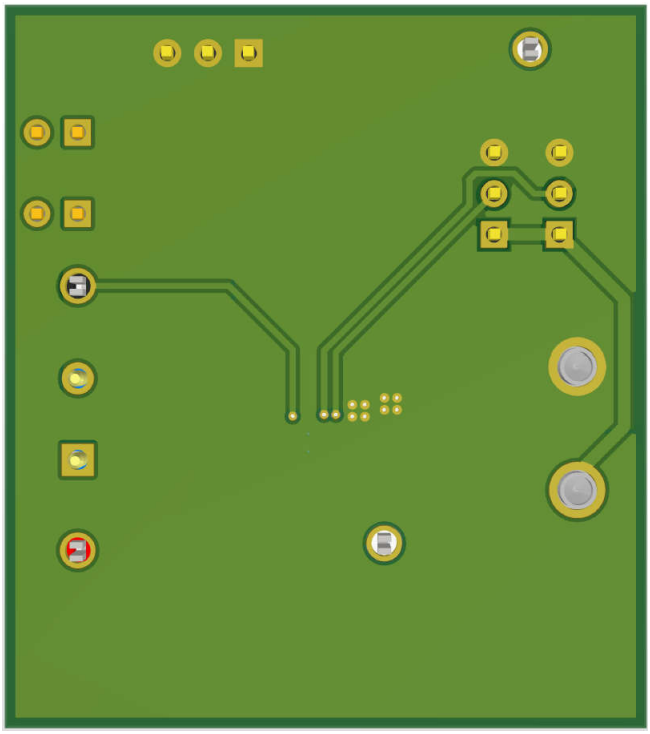


Figure 3-3. Bottom Layer and Bottom Overlay (Bottom View)

3.3 Bill of Materials

Table 3-1 displays the TPS92201AEVM bill of materials according to the schematic in Figure 3-1.

Table 3-1. TPS92201AEVM Components List

Designator	Qty	Value	Description	Package	Part Number	Manufacturer
C1	1	0.1uF	CAP CER 0.1UF 10 V X7R 0603	0603	C0603C104K8RAC7867	KEMET
C2	1	4.7uF	Chip Multilayer Ceramic Capacitors for General Purpose, 0805, 4.7uF, X7R, 15%, 10%, 10 V	0805	GRM21BR71A475KE51L	Murata
C3	1	10uF	CAP, CERM, 10 µF, 10 V,+/- 5%, X7R, AEC-Q200 Grade 1, 0805	0805	C0805C106J8RACAUTO	Kemet
D1, D3	2	Infrared	LED, Infrared, SMD	3.95x3.95mm	MGN1108MS-TR	OSRAM
D2	1		LED Lighting OSLON® Compact PL White 3.16V 1 A 120° 2-SMD, No Lead Exposed Pad	SMT_1MM9_1MM5	KW CELNM3.TK-S4S9-4L07M0-2686	OSRAM
J1, J2	2		Header, 100mil, 2x1, Gold, TH	Header, 100mil, 2x1, TH	HTSW-102-07-G-S	Samtec
J3	1		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J4, J5, J6	3		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
L1	1	2.2uH	Inductor, 2.2 uH, 2.8 A, 0.045 ohm, SMD	4x4mm	SDER041H-2R2MS	Cyntec
R1	1	0.2	RES, 0.2, 1%, 0.333 W, 0805	0805	RL1220S-R20-F	Susumu Co Ltd
TP1, TP4	2		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
TP2, TP5	2		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone
TP3	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP6	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		2.2V TO 5.5V INPUT VOLTAGE, 1/1.5 A OUTPUT CURRENT, High Efficiency Synchronous Buck LED Driver	WSON6	TPS92201DRVR	Texas Instruments

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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:

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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.

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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.

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

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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.

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

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

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