

## SM74611 Smart Bypass Diode

Check for Samples: [SM74611](#)

### FEATURES

- Maximum reverse voltage ( $V_R$ ) of 30 V
- Maximum forward current ( $I_F$ ) of 15A
- Low average forward voltage (26mV at 8A)
- Less power dissipation than Schottky diode
- Lower leakage current than Schottky diode
- Footprint and pin compatible with conventional D2PAK Schottky diode

- Operating range ( $T_j$ ) of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$

### APPLICATIONS

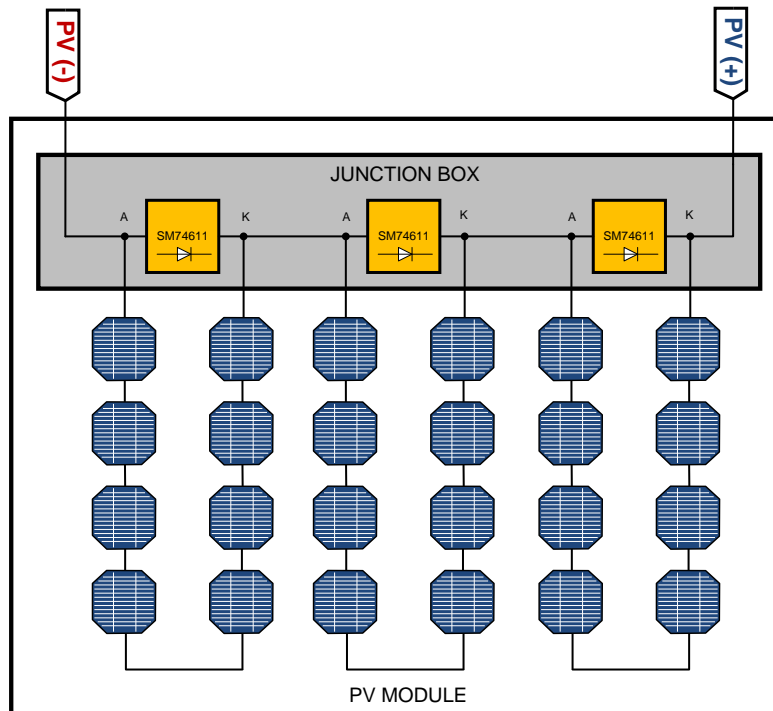
- Bypass Diodes for Photovoltaic Panels
- Bypass Diodes for Microinverter and Power Optimizer

### DESCRIPTION

The SM74611 is a smart bypass diode used in photovoltaic applications. It serves the purpose of providing an alternate path for string current when parts of the panel are shaded during normal operation. Without bypass diodes, the shaded cells will exhibit a hot spot which is caused by excessive power dissipation in the reverse biased cells. Currently, conventional P-N junction diodes or Schottky diodes are used to mitigate this issue. Unfortunately the forward voltage drop for these diodes is still considered high ( $\sim 0.6\text{V}$  for normal diodes and  $0.4\text{V}$  for Schottky). With 10A of currents flowing through these diodes, the power dissipation can reach as high as 6W. This in turn will raise the temperature inside the junction box where these diodes normally reside and reduce module reliability.

The advantage of the SM74611 is that it has a lower forward voltage drop than P-N junction and Schottky diodes. It has a typical average forward voltage drop of 26mV at 8A of current. This translates into typical power dissipation of 208mW, which is significantly lower than the 3.2W of conventional Schottky diodes. The SM74611 is also footprint and pin compatible with conventional D2PAK Schottky diodes, making it a drop-in replacement in many applications.

### TYPICAL APPLICATION CIRCUITS



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## CONNECTION DIAGRAM

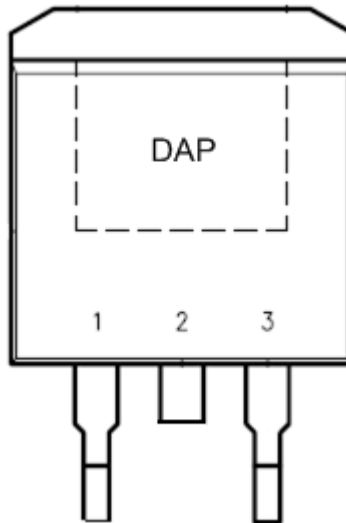


Figure 1. D2PAK

## PIN DESCRIPTIONS

Pin		DESCRIPTION
NO.	NAME	
1,3 <sup>(1)</sup>	ANODE	Connect both of these pins to the negative side of the PV cells
2,DAP <sup>(2)</sup>	CATHODE	Pin 2 and the DAP are shorted internally. Connect the DAP to the positive side of the PV cells

- (1) Pin 1 and Pin 3 should be connected together for proper operation  
 (2) Package drawing at the end of datasheet is shown without Pin 2 being trimmed



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

DC Reverse Voltage	30V
Forward Current	15A
Ambient Storage Temperature	-65°C to 125°C

- (1) Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are conditions under which operation of the device is guaranteed. Operating Ratings do not imply guaranteed performance limits. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics tables.

## RECOMMENDED OPERATING CONDITIONS<sup>(1)</sup>

DC Reverse Voltage	28V
Junction Temperature Range (T <sub>J</sub> )	-40°C to 125°C
Forward Current	0-15A

- (1) System must be thermally managed so as not to exceed maximum junction temperature

**ESD RATINGS**

All Pins, Human Body Model (HBM)	>1kV
All Pins, Charge Model (CDM)	>250V

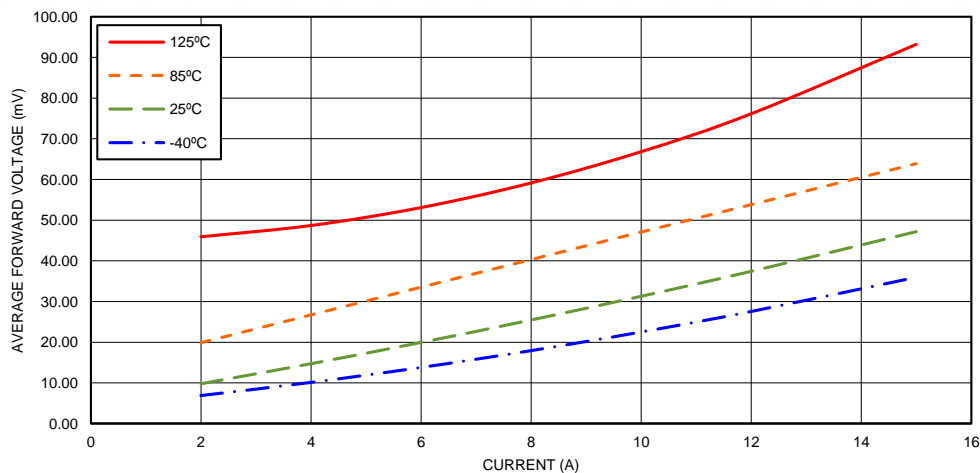
**ELECTRICAL CHARACTERISTICS<sup>(1)</sup>**

SYMBOL	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
$I_{F(AVG)}$	Forward Current				8	15	A
$V_{F(AVG)}$	Forward Voltage	$I_F = 8A$	$T_J = 25^\circ C$		26		mV
$P_D$	Power Dissipation	$I_F = 8A$	$T_J = 25^\circ C$		208		mW
			$T_J = 125^\circ C$		450	<b>575</b>	
		$I_F = 15A$	$T_J = 25^\circ C$		695		
			$T_J = 125^\circ C$		1389		
D	Duty Cycle	$I_F = 8A$	$T_J = 25^\circ C$		99.5		%
			$T_J = 125^\circ C$		96.0		
$R_{JC}$	Thermal Resistance, FET Junction to Case (D2PAK)				0.5		$^\circ C/W$
$I_R$	Reverse Leakage Current	$V_{REVERSE} = 28V$	$T_J = 25^\circ C$		0.3		$\mu A$
			$T_J = 125^\circ C$		3.3		

(1) Limits appearing in **boldface** type apply over the entire junction temperature range for operation. Limits appearing in normal type apply for  $T_A = T_J = 25^\circ C$ .

**TYPICAL CHARACTERISTICS**

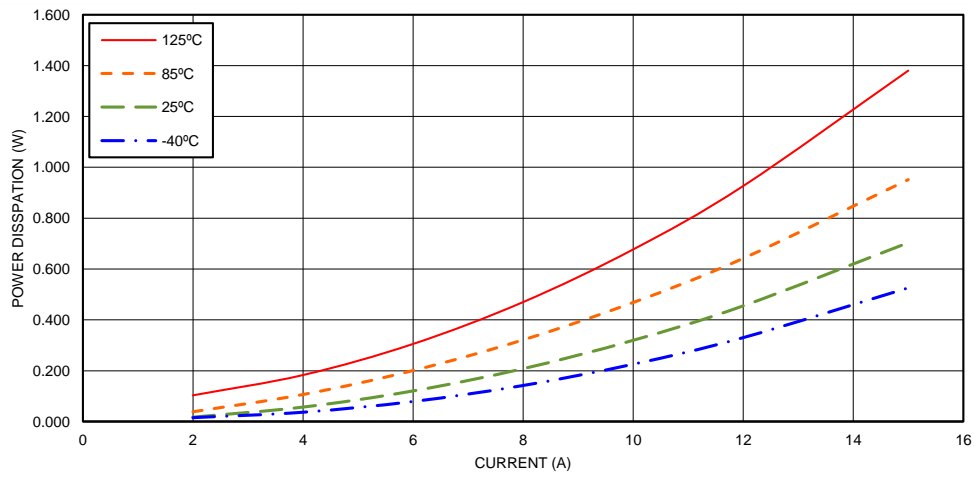
**Average Forward Voltage (Anode to Cathode)  
Vs.  
Current**



**Figure 2. Average Forward Voltage (Anode to Cathode) Over Temperature**

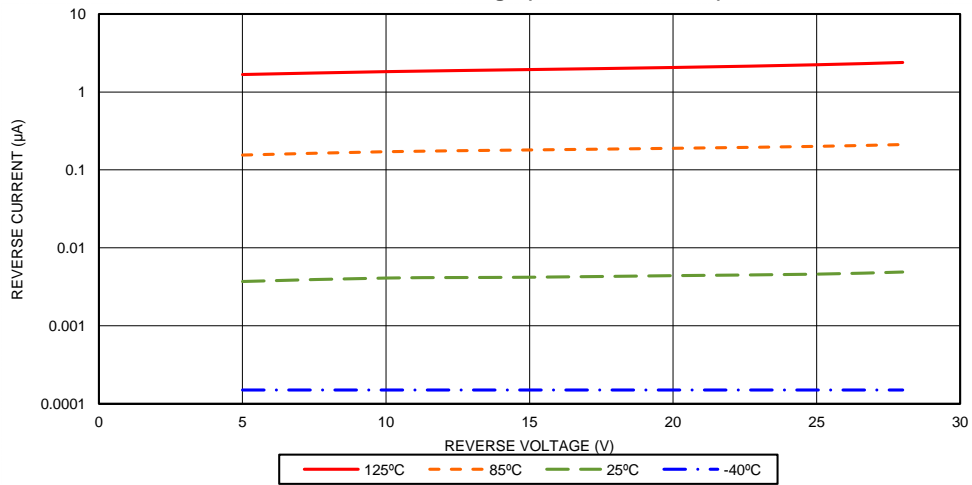
**TYPICAL CHARACTERISTICS (continued)**

**Power Dissipation  
Vs.  
Current**



**Figure 3. Power Dissipation Over Temperature**

**Reverse Current  
vs  
Reverse Voltage (Cathode to Anode)**



**Figure 4. Reverse Current Over Temperature**

## APPLICATION INFORMATION

The SM74611 is designed for use as a bypass diode in photovoltaic modules. The SM74611 utilizes a charge pump to drive an N-channel FET to provide a resistive path for the bypass current to flow. Please refer to [Figure 5](#) and [Figure 6](#) for operational description below

### From $t_0$ to $t_1$ :

When cells in the solar panels are shaded, the FET Q1 is off and the bypass current will flow through the body diode of the FET as shown on [Figure 5](#). This current will produce a voltage drop ( $V_F$ ) across ANODE and CATHODE terminal of the bypass diode. During this time, the charge pump circuitry is active and charging capacitor C1 to a higher voltage.

### At $t_1$ :

Once the voltage on the capacitor reaches its predetermined voltage level, the charge pump is disabled and the capacitor voltage is used to drive the FET through the FET driver stage.

### From $t_1$ to $t_2$ :

When the FET is active, it provides a low resistive path for the bypass current to flow thus minimizing the power dissipation across ANODE and CATHODE. Since the FET is active, the voltage across the ANODE and CATHODE is too low to operate the charge pump. During this time, the stored charge on C1 is used to supply the controller as well as drive the FET.

### At $t_2$ :

When the voltage on the capacitor C1 reaches its predetermined lower level, the FET driver shuts off the FET. The bypass current will then begin to flow through the body diode of the FET, causing the FET body diode voltage drop of approximately 0.6V to appear across ANODE and CATHODE. The charge pump circuitry is re-activated and begins charging the capacitor C1. This cycle repeats until the shade on the panel is removed and the string current begins to flow through the PV cells instead of the body diode of the FET.

The key factor to minimizing the power dissipation on the device is to keep the FET on at a high duty cycle. The average forward voltage drop will then be reduced to a much lower voltage than for a Schottky or regular P-N junction diode.

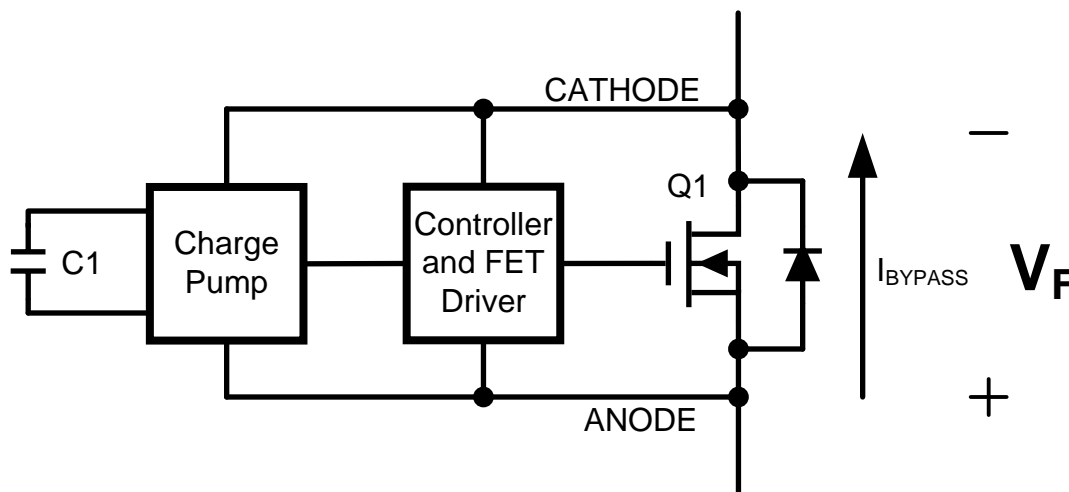


Figure 5. SM74611 Block Diagram

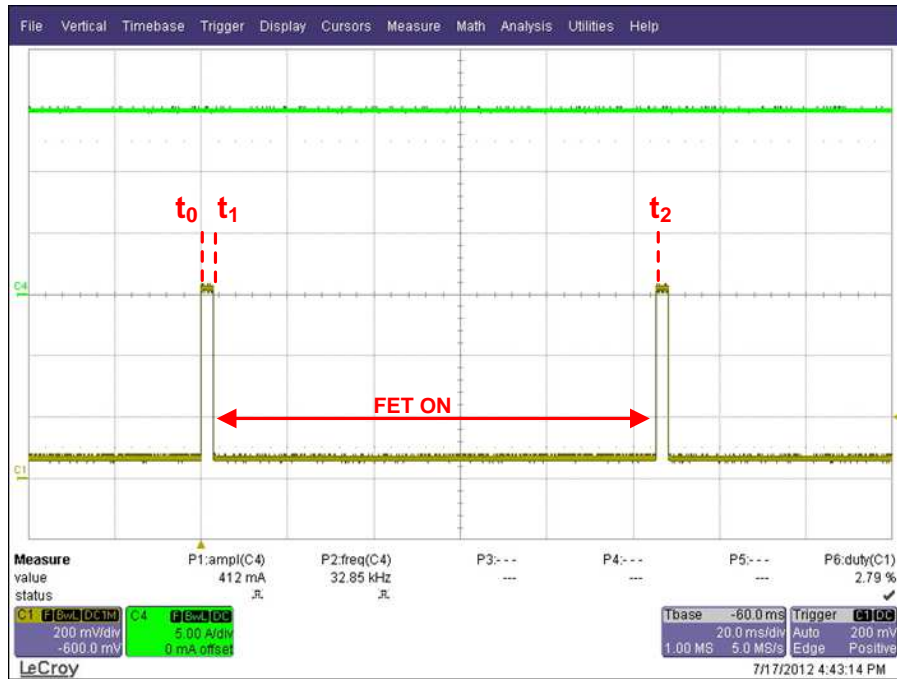


Figure 6. ANODE to CATHODE voltage (Ch1) with  $I_{BYPASS} = 15A$  (Ch4) for SM74611 in Junction Box at 85°C ambient

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
SM74611KTTR	ACTIVE	DDPAK/ TO-263	KTT	3	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 125		<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

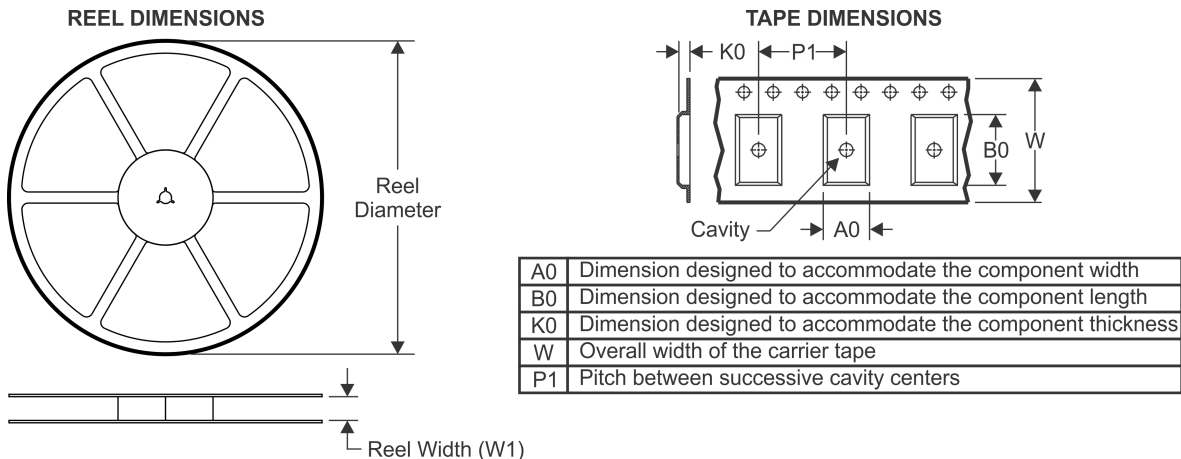
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Only one of markings shown within the brackets will appear on the physical device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SM74611KTTR	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.6	15.8	4.9	16.0	24.0	Q2



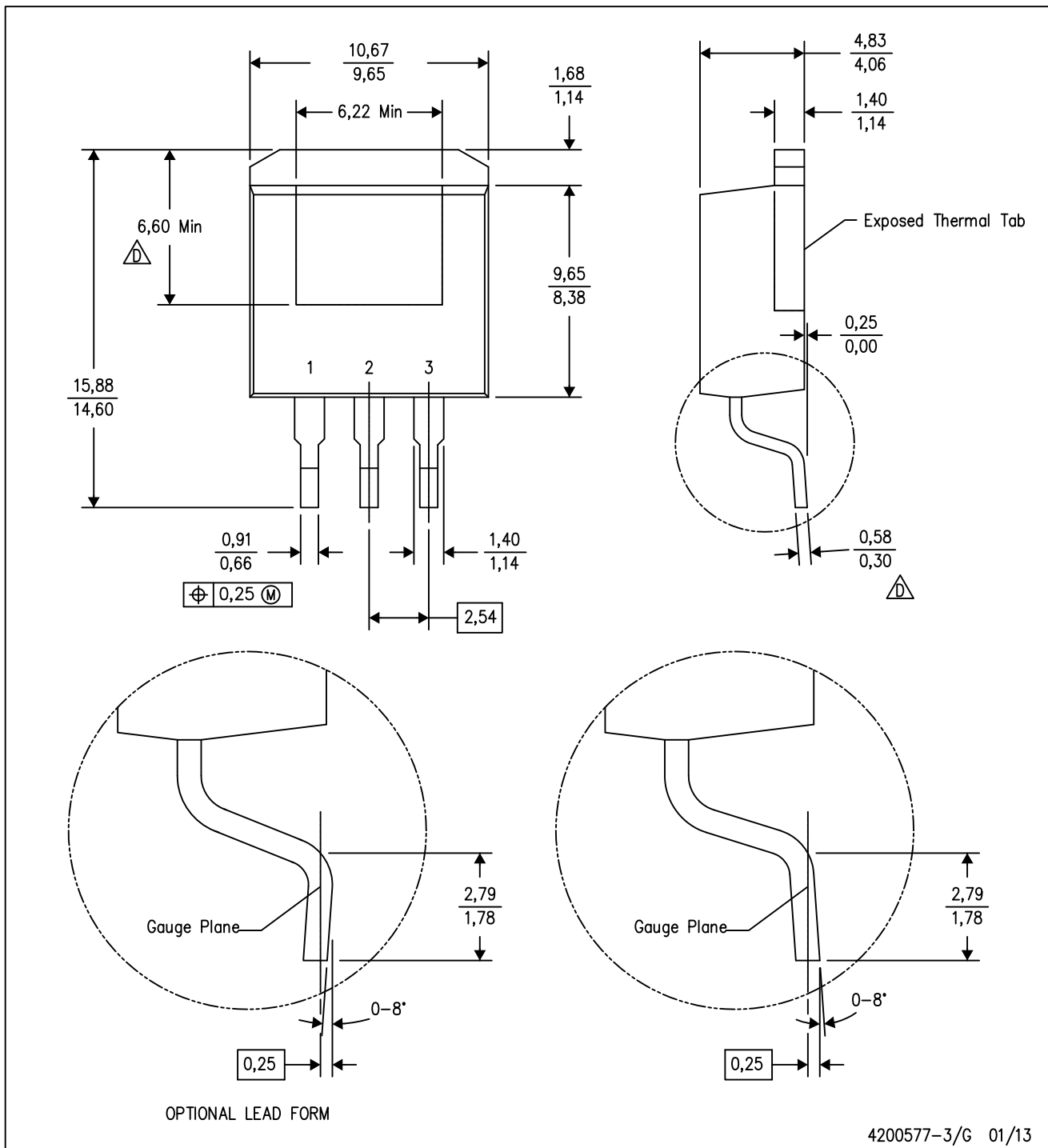
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SM74611KTTR	DDPAK/TO-263	KTT	3	500	340.0	340.0	38.0

KTT (R-PSFM-G3)

PLASTIC FLANGE-MOUNT PACKAGE



4200577-3/G 01/13

- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
  - $\triangle$  Falls within JEDEC TO-263 variation AA, except minimum lead thickness and minimum exposed pad length.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)