

Precision Adjustable Power Distribution Switch

Features

- Integrated 60mΩ Power MOSFET
- Adjustable Current Limit 0.3A to 2.5A (typ.)
- Low Supply Current
- 30μA Typical at Switch On State
- 1μA Typical at Switch Off State
- Wide Input Voltage Range: 2.5V to 5.5V
- Fast Transient Response: 8μs
- 0.1ms Typical Rise Time
- Reverse Current Flow Blocking
- Deglitched Open-Drain Over-Current Flag Output (TMI6260C and TMI6260D)
- Thermal Shutdown Protection
- Hot Plug-In Application (Soft-Start)
- UL 2367 Certification - E528420
- SOT-23-5/SOT-23-6/DFN2x2-6L Package

Description

The TMI6260X is a cost-effective, low voltage, single P-MOSFET load switch, optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. This switch operates with inputs ranging from 2.5V to 5.5V, making it ideal for both 3V and 5V systems. The switch's low RDS(ON), 60mΩ, meets USB voltage drop requirements. A built-in P-channel MOSFET with true shutdown function to eliminate any reversed current flow across the switch when it is powered off. When the output voltage is higher than input voltage, the power switch is turned off by internal output reverse-voltage comparator.

The TMI6260X offers a programmable current limit threshold via an external resistor on ILIM pin to GND. nFLG is an open-drain output report over-current or over temperature event.

Application

- USB Bus/Self Powered Hubs
- Battery-Charger Circuits
- Personal Communication Devices
- Notebook Computers

Typical Application

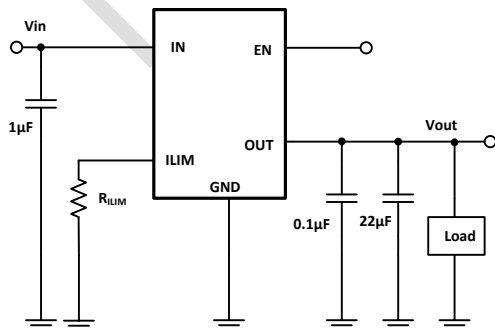


Figure 1. TMI6260A/B Application Circuit

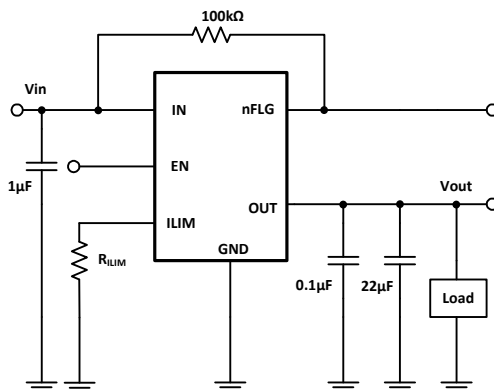


Figure 2. TMI6260C/D Application Circuit

Absolute Maximum Ratings (Note 1)

Parameter	Min	Max	Unit
Input Supply Voltage	-0.3	7	V
EN Voltage	-0.3	VIN+0.3	V
ILIM, VOUT Voltage	-0.3	VIN+0.3	V
Storage Temperature Range	-65	150	°C
Junction Temperature (Note2)	160		°C
Power Dissipation	1000		mW
Lead Temperature (Soldering, 10s)	260		°C

Package

IN [1] OUT [5] GND [2] EN [3] ILIM [4]	IN [1] OUT [6] GND [2] ILIM [5] EN [3] nFLG [4]	OUT [1] IN [6] ILIM [2] GND [5] nFLG [3] EN [4]
SOT23-5 (Top View) TMI6260A and TMI6260B	SOT23-6 (Top View) TMI6260C	DFN2x2-6L (Top View) TMI6260D

Order Information

Top Mark: TXXXXX (TXXX: Device Code, XXX: Inside code)

Part Number	Package	Top mark	Quantity/ Reel
TMI6260A	SOT23-5	T04BXXX	3000
TMI6260B	SOT23-5	T05BXXX	3000
TMI6260C	SOT23-6	T06BXXX	3000
TMI6260D	DFN2x2-6L	T6DXXX	3000

TMI6260A, TMI6260B, TMI6260C and TMI6260D devices are Pb-free and RoHS compliant.

Pin Functions

Pin			Name	Function
TMI6260A/B SOT23-5	TMI6260C SOT23-6	TMI6260D DFN2x2-6L		
1	1	6	IN	Input Supply: Output MOSFET Drain, which also supplies IC's internal circuitry. Connect to positive supply.
2	2	5	GND	IC ground connection
3	3	4	EN	Enable: Logic level enable input. Make sure EN pin never floating. Pull high to enable IC.
	4	3	nFLG	Over-Current: Open-Drain Fault Flag Output.
4	5	2	ILIM	External resistor used to set current-limit ILIM threshold
5	6	1	OUT	Switch Output: Output MOSFET Source of switch. Typically connect to switched side of load.

ESD Rating

Items	Description	Value	Unit
V _{ESD_HBM}	Human Body Model for all pins	±2000	V
V _{ESD_CDM}	Charged Device Model for all pins	±1000	V

JEDEC specification JS-001

Recommended Operating Conditions

Items	Description	Min	Max	Unit
Voltage Range	IN	2.5	5.5	V
T _J	Operating Junction Temperature	-40	125	°C

Thermal Resistance (Note3)

Items	Description	Package	Value	Unit
θ_{JA}	Junction-to-ambient thermal resistance	SOT23-5	220	°C/W
		SOT23-6	170	
		DFN2x2-6L	152	
θ_{JC}	Junction-to-case thermal resistance	SOT23-5	62	°C/W
		SOT23-6	56	
		DFN2x2-6L	25	

Electrical Characteristics

$V_{IN} = 5V$, $C_{IN} = 1\mu F$, $C_{OUT} = 1\mu F$, $T_A = 25^\circ C$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
IN section						
V_{IN}	Input voltage		2.5		5.5	V
I_{IN_ON}	Supply current, Enable	$V_{IN}=5.5V$, No load on OUT		30	60	μA
I_{IN_OFF}	Shutdown current, Disable	$V_{IN}=5.5V$, No load on OUT		0.1	1	μA
I_{REV}	Reverse leakage current	$V_{OUT}=5.5V$, $V_{IN}=0V$		2	5	μA
V_{UVLO_ON}	Under voltage lockout exit	V_{IN} rising from 0V-5V		2	2.3	V
V_{UVLO_HY}	UVLO Hysteresis			100		mV
EN section						
V_{EN_H}	High-level enable voltage	$V_{IN}=5.5V$	1.5			V
V_{EN_L}	Low-level disable voltage	$V_{IN}=2.5V$			1.0	V
I_{EN}	EN input current	$V_{EN}=5.5V$ or 0V	-0.5	5	10	μA
T_{ON}	Turn on time	$C_L=1\mu F$, $R_L=100\Omega$		0.2		ms
T_{OFF}	Turn off time	$C_L=1\mu F$, $R_L=100\Omega$		0.1		ms
OUT section						
I_{OC}	Over Current CC Regulation	TMI6260A $R_{ILIM}=20k\Omega$, $V_{OUT}=3.5V$	1.21	1.35	1.49	A
		TMI6260B $R_{ILIM}=20k\Omega$, $V_{OUT}=3.5V$	1.59	1.7	1.95	A
		TMI6260C $R_{ILIM}=19.1k\Omega$, $V_{OUT}=3.5V$	1.95	2.25	2.50	A
		TMI6260D $R_{ILIM}=20k\Omega$, $V_{OUT}=3.5V$	1.21	1.35	1.49	A
$V_{REVERSE}$	Reverse voltage protection	$V_{OUT} - V_{IN}$, TMI6260C, TMI6260D	85	100	115	mV
		$V_{OUT} - V_{IN}$, TMI6260A, TMI6260B	10	20	25	mV
T_{RISE}	Output rise time	$C_L=1\mu F$, $R_L=100\Omega$		0.1		ms
T_{FALL}	Output fall time	$C_L=1\mu F$, $R_L=100\Omega$		0.3		ms
T_{IOS}	Response time to short circuit			12		μs
nFLG (Fault Flag) section (TMI6260C and TMI6260D)						
V_{OL}	Output low voltage	$I_{FLG}=1mA$			180	mV
I_{FLG}	Continuous FLG sink				10	mA
I_{FLG_LEAK}		Off-state leakage			1	μA
T_{FLG}	Fault flag deglitch time			2.5		ms
Power switch						
R_{DS_ON}		$I_{OUT}=1A$		60		m Ω

ELECTRICAL CHARACTERISTICS (Continued)

$V_{IN} = 5V$, $C_{IN} = 1\mu F$, $C_{OUT} = 1\mu F$, $T_A = 25^\circ C$, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Thermal Shutdown						
T_{NORMAL}	Thermal shutdown Temperature (Note 4)		2.5		5.5	V
T_{NORMAL_HY}	Thermal shutdown hysteresis (Note 4)			30	60	μA

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \times \theta_{JA}$. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$.

Note 3: Measured on JESD51-7, 4-layer PCB.

Note 4: Thermal shutdown threshold and hysteresis are guaranteed by design.

The block diagram illustrates the PMOS gate control circuit. It features an input (IN) and an output (OUT) terminal. The circuit includes a PMOS Gate Control block, a Reverse voltage comparator, a Current Limit block, a UVLO (Under Voltage Lock Out) block, and an OTP (One Time Programmable) block. The Reverse voltage comparator is configured with its non-inverting input (+) connected to the output (OUT) and its inverting input (-) connected to the input (IN) through a voltage source V_{offset} . The output of the comparator is connected to the PMOS Gate Control block. The PMOS Gate Control block also receives inputs from the UVLO and OTP blocks. The output of the PMOS Gate Control block is connected to the nFLG (negative feedback loop gain) block, which is also connected to the output (OUT). The nFLG block is further connected to a current source (represented by a diode and a resistor) that is connected to the output (OUT) and the input (IN) through a current limit (ILIM) block. The current limit (ILIM) block is connected to the output (OUT) and the input (IN) through a current limit (ILIM) block.

TMI6260x V1.6 2024.01

Application Information

The TMI6260X is current-limited, power distribution switches using P-channel MOSFETs for applications where short circuits or heavy capacitive loads will be encountered and provide up to 2.1A of continuous load current. These devices allow the user to program the current-limit threshold between 300mA and 2.5A (typ.) via an external resistor. Additional device shutdown features include over temperature protection and reverse-voltage protection. The driver controls the gate voltage of the power switch. The driver incorporates circuitry that controls the rise and fall times of the output voltage to limit large current and voltage surges and provides built-in soft-start functionality. The TMI6260X enters constant current mode when the load exceeds the current-limit threshold.

Input and Output

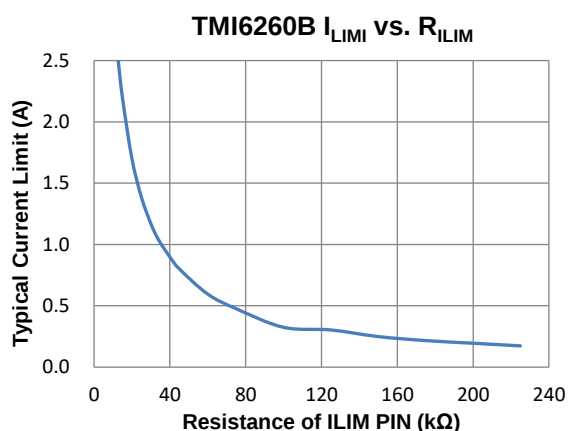
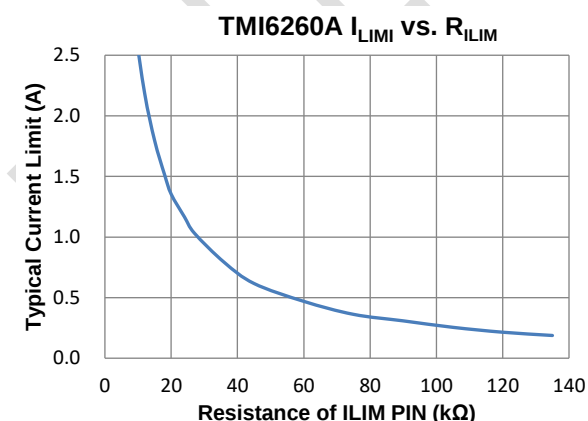
IN (input) is the power supply connection to the logic circuitry and the drain of the output MOSFET. OUT(output) is the source of the output MOSFET. In a typical application, current flows through the switch from IN to OUT toward the load. OUT pin must be connected to the load.

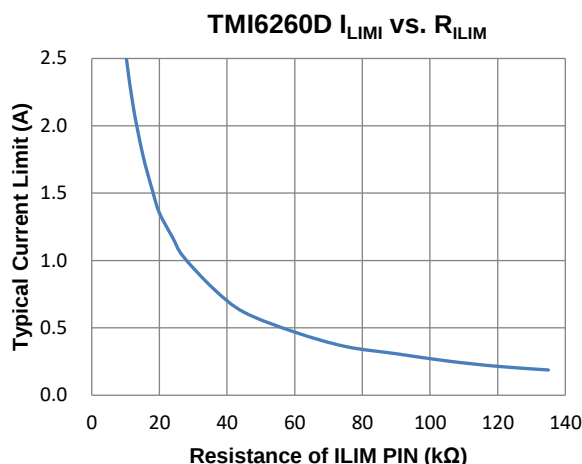
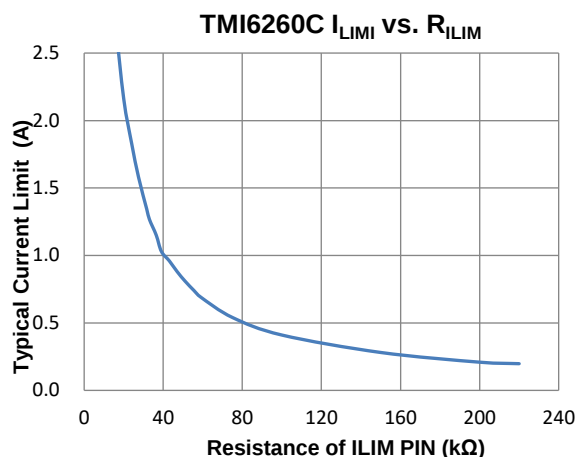
Soft Start for Hot Plug-In Applications

In order to eliminate the upstream voltage droop caused by the large inrush current during hot-plug events, the “soft-start” feature effectively isolates the power source from extremely large capacitive loads, satisfying the USB voltage droop requirements.

Setting Current Limit

The over-current threshold is user programmable via an external resistor. The TMI6260X use an internal regulation loop to provide a regulated voltage on the ILIM pin. The current-limit threshold is proportional to the current sourced out of ILIM. Many applications require that the minimum current limit is above a certain current level or that the maximum current limit is below a certain current level, so it is important to consider the tolerance of the over current threshold when selecting a value for R_{ILIM}. The following Figures can be used to select the resulting type over-current threshold for a given external resistor value (R_{ILIM}) for TMI6260A, TMI6260B, TMI6260C and TMI6260D respectively. The recommended tolerance of resistance on ILIM pin is 1% or higher accuracy.





The relationship of current limit and R_{ILIM} can be expressed:

TMI6260A and TMI6260D: $I_{LIM}(A) = \frac{25.5}{R_{ILIM}(k\Omega)^{0.986}}$

TMI6260B: $I_{LIM}(A) = \frac{27.9}{R_{ILIM}(k\Omega)^{0.94}}$

TMI6260C: $I_{LIM}(A) = \frac{46.513}{R_{ILIM}(k\Omega)^{1.024}}$

A few standard resistor values are listed in the table "Current Limit R_{ILIM} Values for TMI6260C."

Table: Current Limit R_{ILIM} Values for TMI6260C

VIN = 5V, VOUT= 3.5V TMI6260C current limit

R_{ILIM} (kΩ 1%)	Continuous Current(A)	Current Limit (A)		
		Min	Typ	Max
56.2	0.5	0.63	0.75	0.87
31.6	1	1.23	1.35	1.47
20.5	1.5	1.95	2.1	2.25
15.8	2.1	2.6	2.75	2.9
13.7	2.4	3	3.2	3.4

For example, the USB port requires 2.1A:

- 1) Confirm that the expected "Continuous Current" is 2.1A;
- 2) Find corresponding R_{ILIM} in the table: Select 15.8kΩ 1% for the expected 2.1A continuous current.

FLG Function (TMI6260C and TMI6260D)

The nFLG open-drain output is asserted (active low) when an over current condition is encountered after a 2.5ms deglitch timeout. The nFLG output remains asserted until the over-current condition is removed. Over temperature condition is also reported by nFLG open-drain output. In addition, nFLG is also asserted (active low) in output reverse-voltage condition when the output reverse-voltage condition is removed.

Thermal Shutdown

The TMI6260x has internal over temperature protection to shut down the device when its junction temperature exceeds 150°C with overload current condition, then after the device is disabled if the junction temperature drops 20°C hysteresis typically the device will resume and restart to work. The

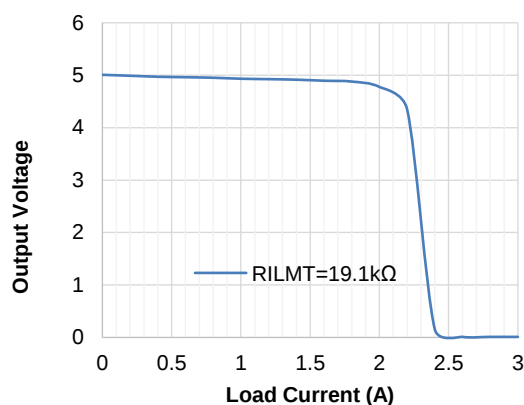
switch continues to cycle off and on until the over current fault is removed.

EN, the Enable Input

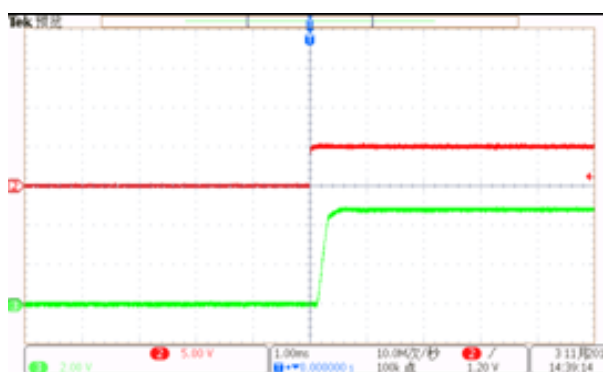
EN must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation, so please do not float EN input pin.

Typical Performance Characteristics (TMI6260C)

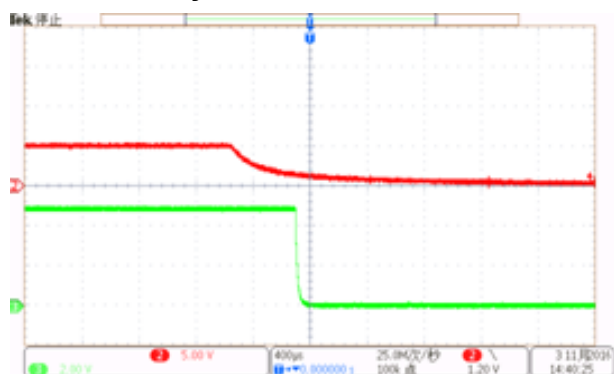
Over current Protection Characteristics



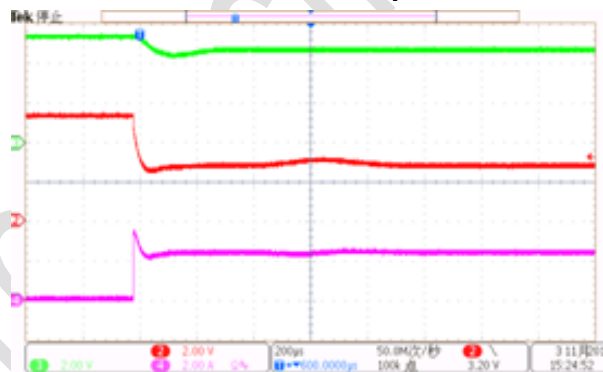
Turn on Delay Time and Rise Time



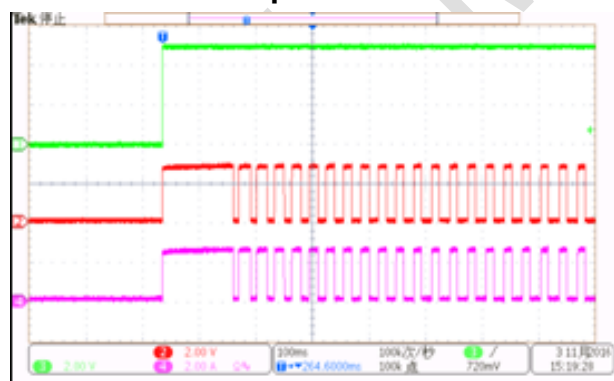
Turn off Delay Time and Fall Time



Resistance Load Inrush Response



Over current Response



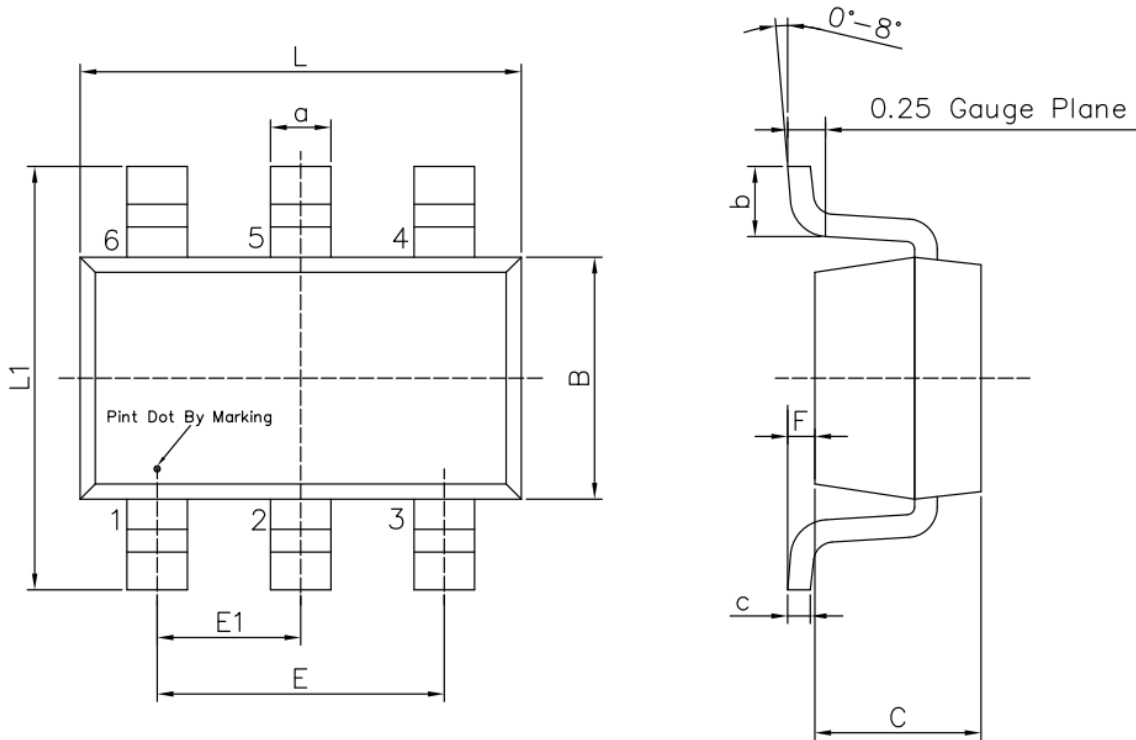
PCB Layout Guide

For best performance of the TMI6260X, the following guidelines must be strictly followed.

- 1) Input and output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
- 2) The GND should be connected to a strong ground plane for heat sink.
- 3) Keep the main current traces as possible as short and wide.

Package Information

SOT23-6



Unit: mm

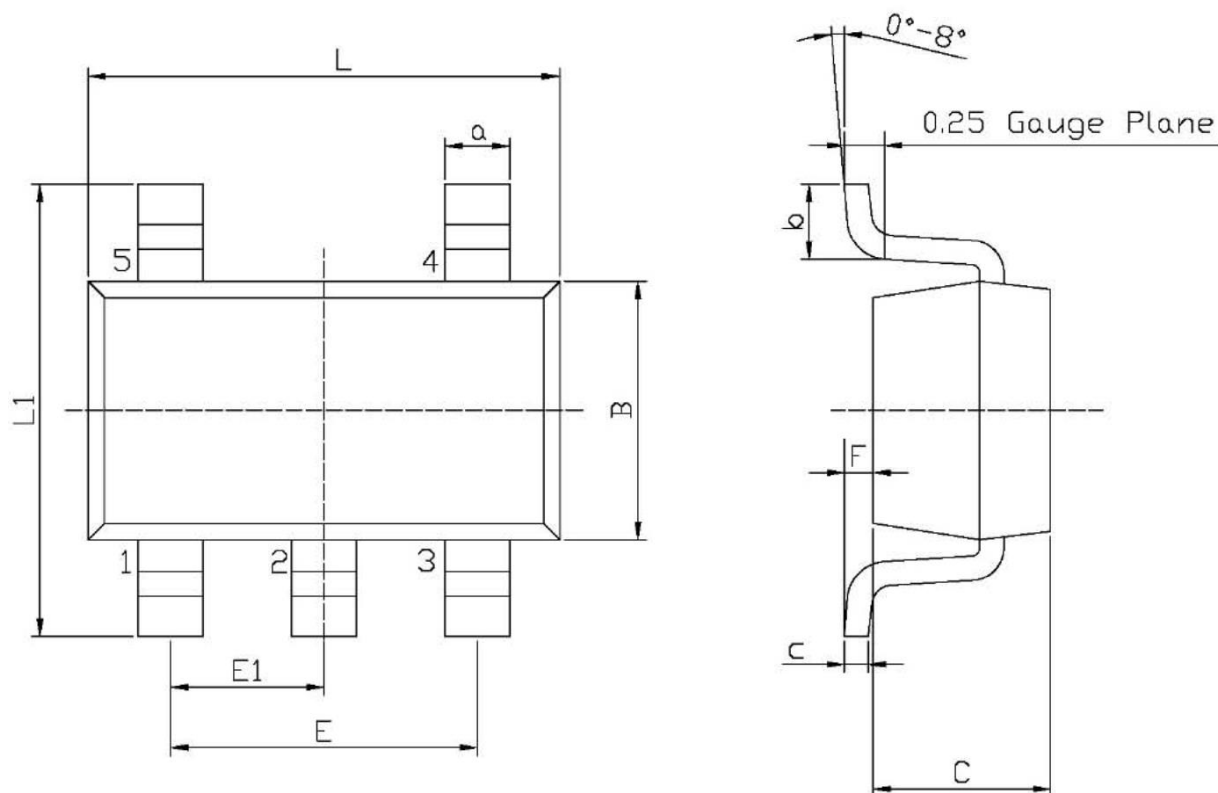
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

Note:

- 1) All dimensions are in millimeters.
- 2) Package length does not include mold flash, protrusion or gate burr.
- 3) Package width does not include inter lead flash or protrusion.
- 4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
- 5) Pin 1 is lower left pin when reading top mark from left to right.

PACKAGE INFORMATION

SOT23-5



Unit: mm

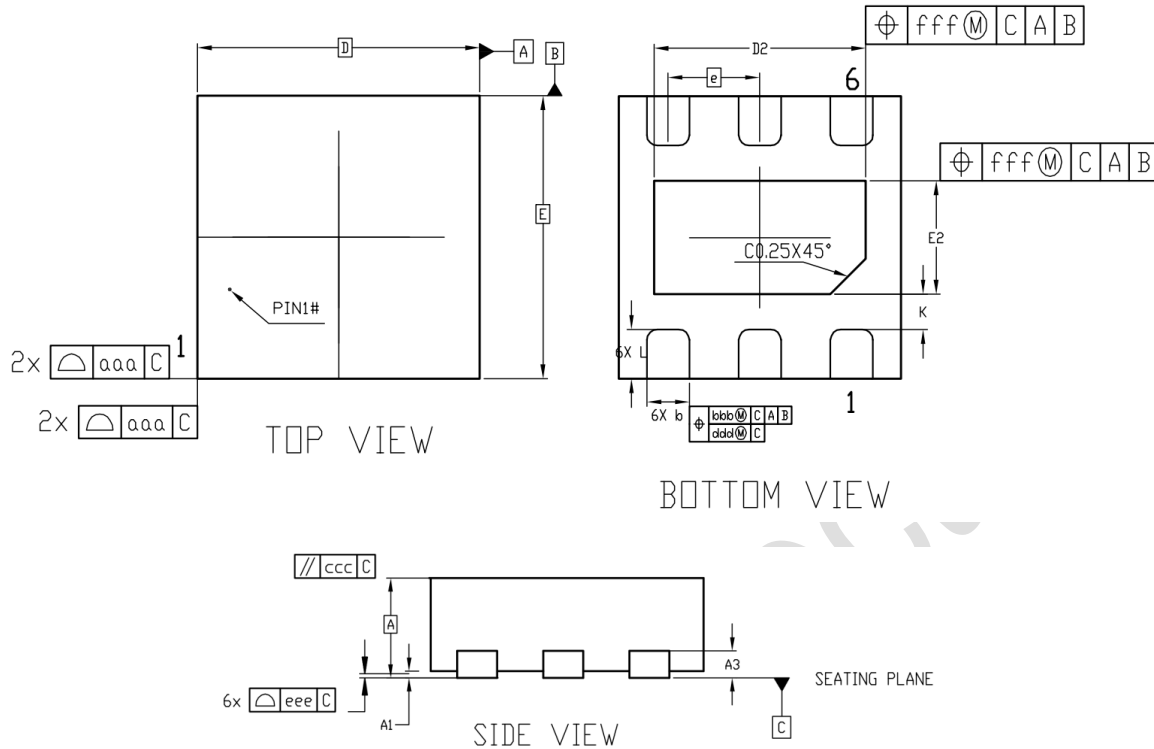
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

Note:

- 1) All dimensions are in millimeters.
- 2) Package length does not include mold flash, protrusion or gate burr.
- 3) Package width does not include inter lead flash or protrusion.
- 4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
- 5) Pin 1 is lower left pin when reading top mark from left to right.

PACKAGE INFORMATION

DFN2x2-6L



Unit: mm

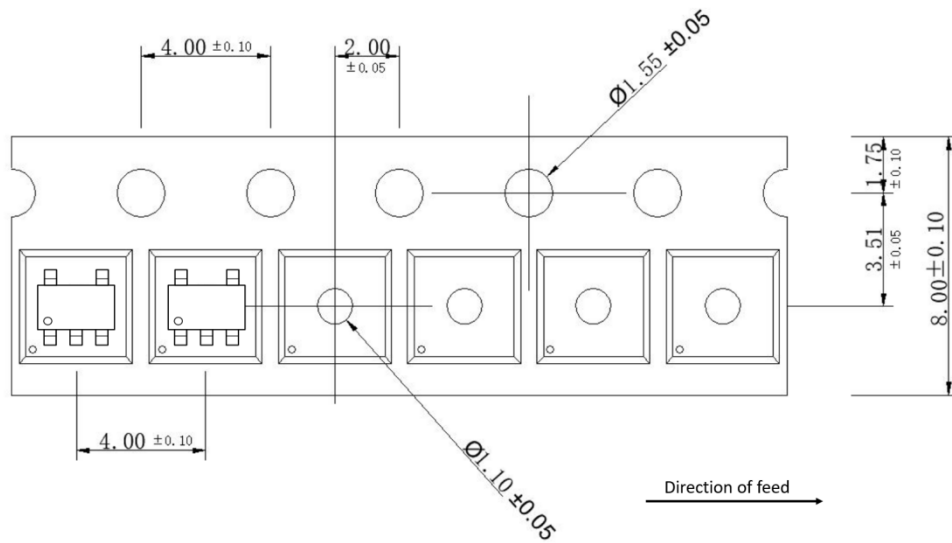
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	0.70	0.75	0.80	e	0.65 BSC		
	0.80	0.85	0.90	L	0.25	0.35	0.45
A1	0	0.02	0.05	K	0.25	-	-
A3	-	0.20 REF	-	aaa	0.15		
b	0.25	0.30	0.35	bbb	0.10		
D	1.95	2.00	2.05	ccc	0.10		
E	1.95	2.00	2.05	ddd	0.05		
D2	1.35	1.50	1.60	eee	0.08		
E2	0.70	0.80	0.90	fff	0.10		

Note:

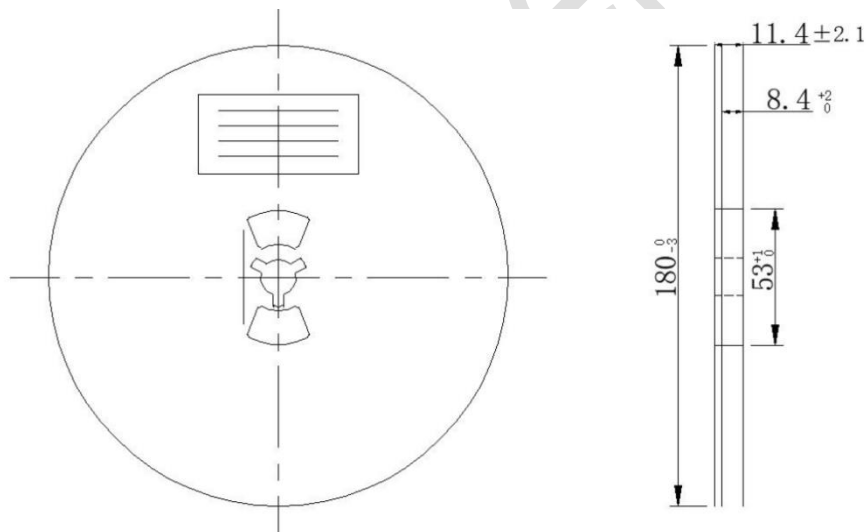
- 1) All dimensions are in millimeters. Angles are in degree.
- 2) Dimensioning and tolerancing confirm to ASME Y14.5M-1994.
- 3) Unilateral coplanarity zone applies to the exposed heat sink slug as well as the thermals.
- 4) Dimension b applies to metallized terminal and is measured between 0.150mm to 0.30mm from the thermal tip. Dimension b should not be measured in radius area.
- 5) All specs take JEDEC MO-229 for reference.

TAPE AND REEL INFORMATION

TAPE DIMENSIONS: SOT23-5/SOT23-6



REEL DIMENSIONS: SOT23-5/SOT23-6

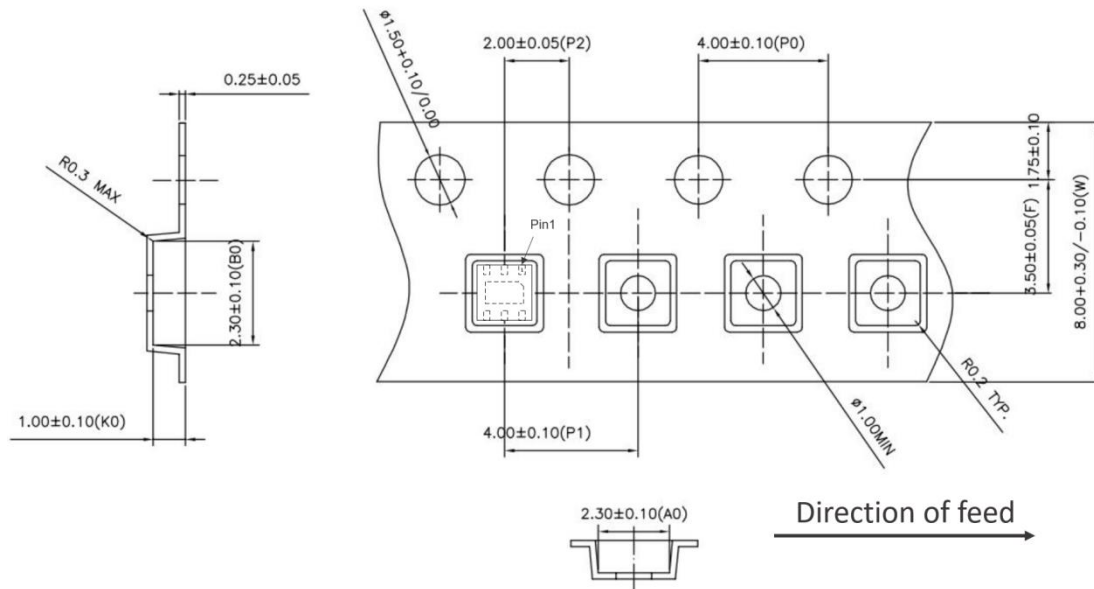


Note:

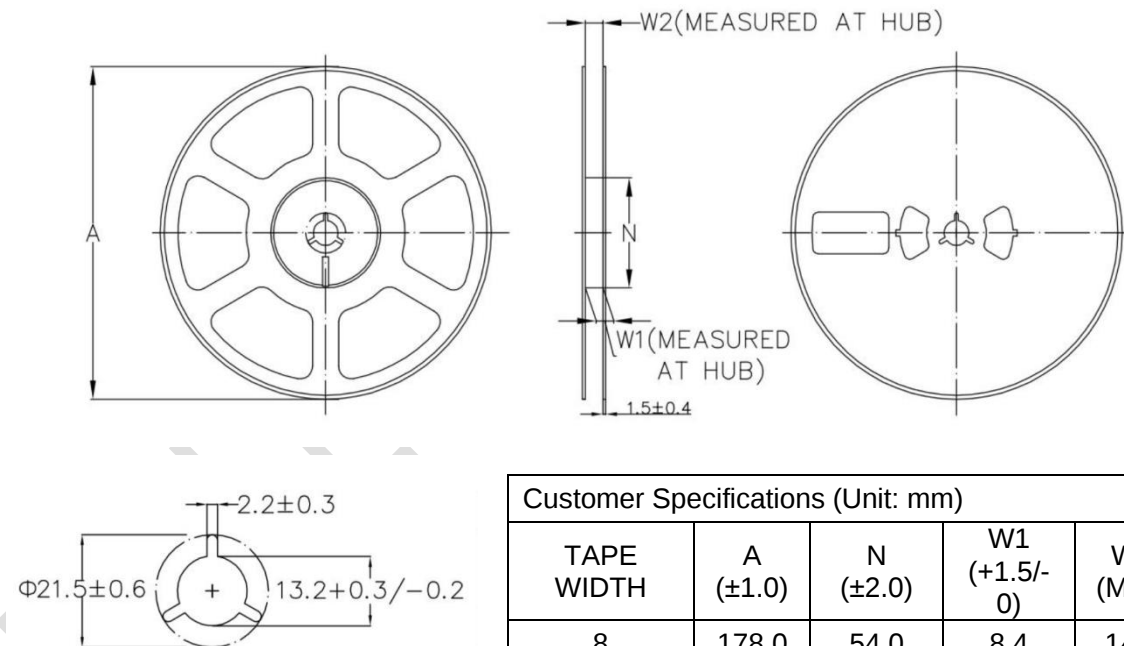
- 1) All Dimensions are in Millimeter
- 2) Quantity of Units per Reel is 3000
- 3) MSL level is level 3.

TAPE AND REEL INFORMATION

TAPE DIMENSIONS: DFN2x2-6L



REEL DIMENSIONS: DFN2x2-6L



Note:

- 1) All Dimensions are in Millimeter
- 2) Quantity of Units per Reel is 3000
- 3) MSL level is level 3.

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