

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

APPLICATIONS

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

GENERAL 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 $R_{DS(ON)}$, 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. In addition, nFLG also has typical 2.5ms deglitch timeout period and reports output reverse-voltage condition.

TYPICAL APPLICATION

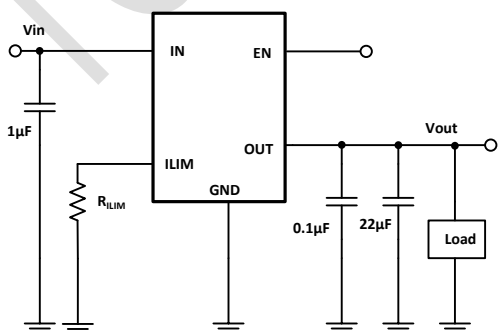


Figure 1. TMI6260A/B Application Circuit

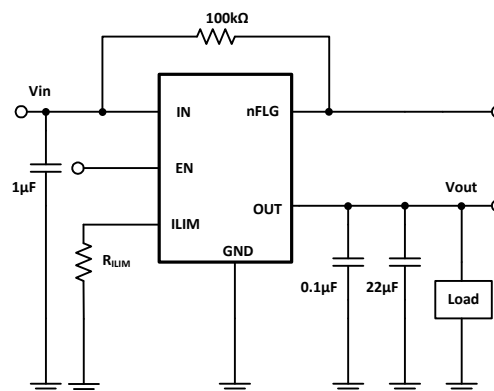
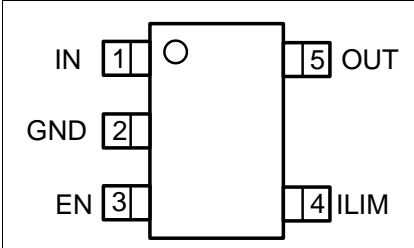
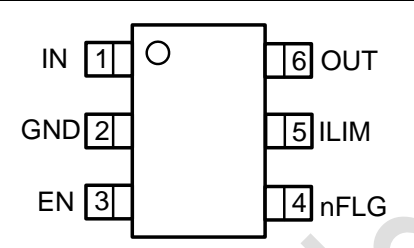
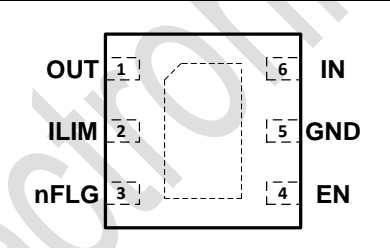


Figure 2. TMI6260C/D Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

Parameter	Value	Unit
Input Supply Voltage	-0.3~7	V
EN Voltages	-0.3~V _{IN} +0.3	V
ILIM, VOUT Voltage	-0.3~V _{IN} +0.3	V
Junction Temperature <small>(Note2)</small>	160	°C
Storage Temperature Range	-65~150	°C
Lead Temperature (Soldering,10s)	260	°C

PIN CONFIGURATION

		
SOT23-5 (Top View)	SOT23-6 (Top View)	DFN2x2-6L (Top View)
TMI6260A and TMI6260B	TMI6260C	TMI6260D

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 No.			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 RATINGS

Items	Description	Value	Unit
V _{ESD}	Human Body Model for all pins	±2000	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 Range	-40	125	°C

THERMAL RESISTANCE (Note 3)

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

ELECTRICAL CHARACTERISTICS

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

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	$CL=1\mu F$, $RL=100\Omega$		0.2		ms
T_{OFF}	Turn off time	$CL=1\mu F$, $RL=100\Omega$		0.1		ms
OUT section						
I_{OC}	Over Current CC Regulation	TMI6260A $R_{ILIM}=20k\Omega$ $V_{IN}=5V$, $V_{OUT}=3.5V$	1.21	1.35	1.49	A
		TMI6260B $R_{ILIM}=20k\Omega$ $V_{IN}=5V$, $V_{OUT}=3.5V$	1.59	1.7	1.95	A
		TMI6260C $R_{ILIM}=19.1k\Omega$ $V_{IN}=5V$, $V_{OUT}=3.5V$	1.95	2.25	2.50	A
		TMI6260D $R_{ILIM}=20k\Omega$ $V_{IN}=5V$, $V_{OUT}=3.5V$	1.21	1.35	1.49	A
$V_{REVERSE}$	Reverse voltage protection	$V_{OUT} - V_{IN}$	5	20	50	mV
T_{RISE}	Output rise time	$CL=1\mu F$, $RL=100\Omega$		0.1		ms
T_{FALL}	Output fall time	$CL=1\mu F$, $RL=100\Omega$		0.3		ms
T_{IOS}	Response time to short circuit			12		μs

ELECTRICAL CHARACTERISTICS (Continued)

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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
Thermal Shutdown						
T_{NORMAL}	Thermal shutdown Temperature (Note 4)			150		$^\circ C$
T_{NORMAL_HY}	Thermal shutdown hysteresis (Note 4)			20		$^\circ C$

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 PD according to the following formula: $T_J = T_A + (PD) \times \theta_{JA}$.

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

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

FUNCTIONAL BLOCK DIAGRAM

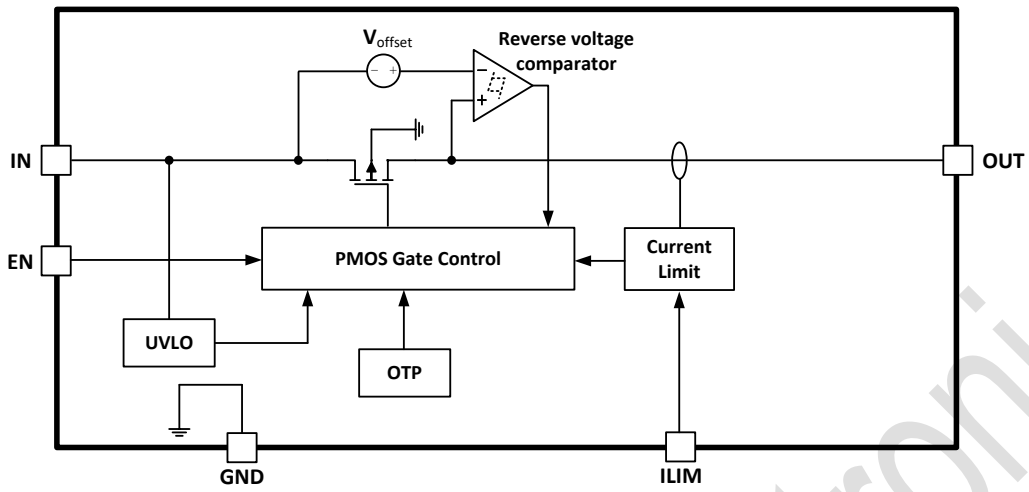


Figure 5. TMI6260A and TMI6260B Block Diagram

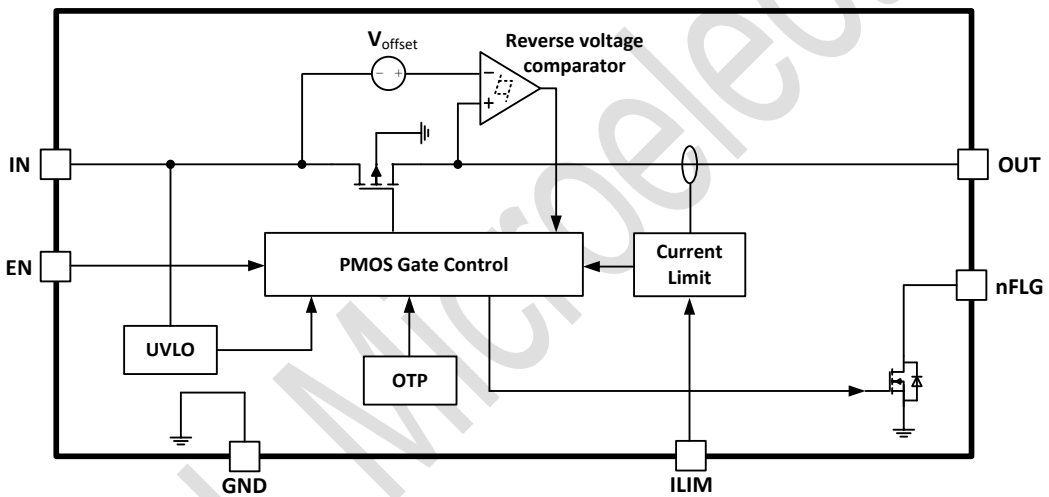
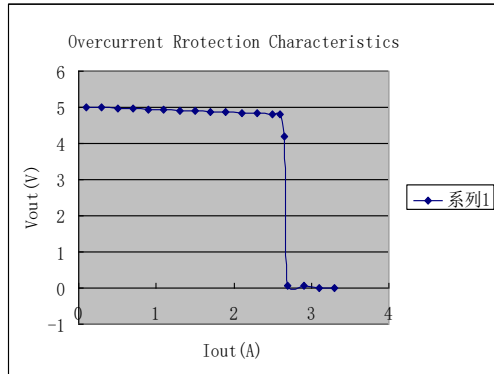


Figure 6. TMI6260C and TMI6260D Block Diagram

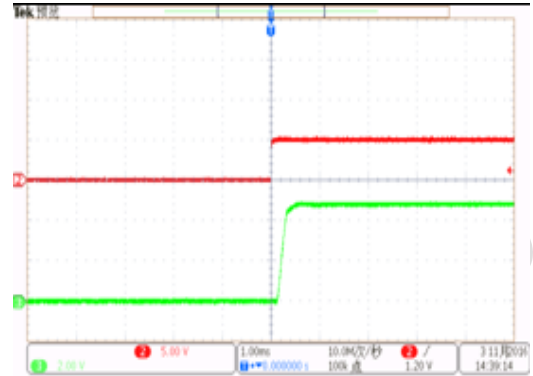
TYPICAL PERFORMANCE CHARACTERISTICS

TMI6260C characteristic

Over current Protection Characteristics

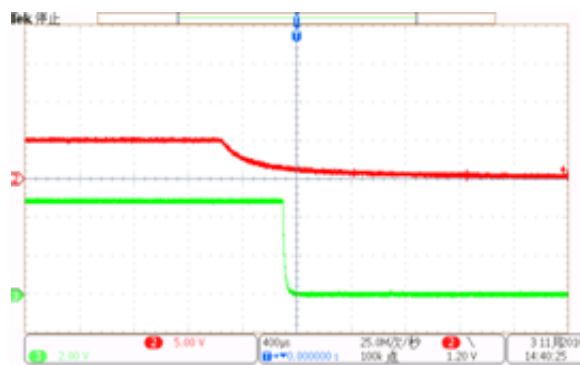


Turn on Delay Time and Rise Time



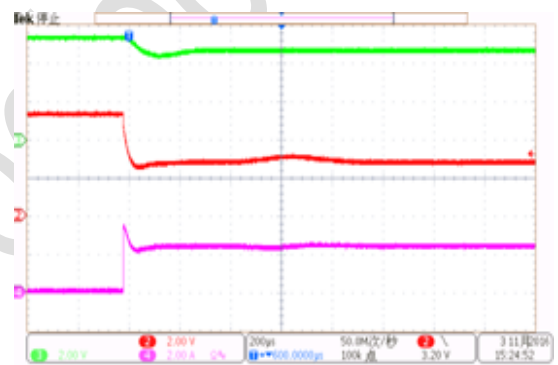
CH2:EN CH3:VOUT 1ms/div

Turn off Delay Time and Fall Time



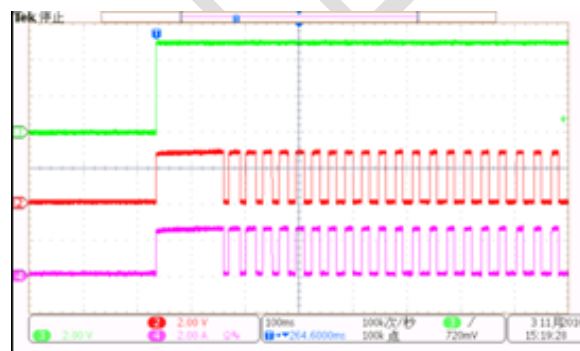
CH2:EN CH3:VOUT 400μs/div

Resistance Load Inrush Response



CH2:VOUT CH3:VIN CH4:IOUT 200μs/div

Over current Response



CH2:VOUT CH3:EN CH4:IOUT 200μs/div

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

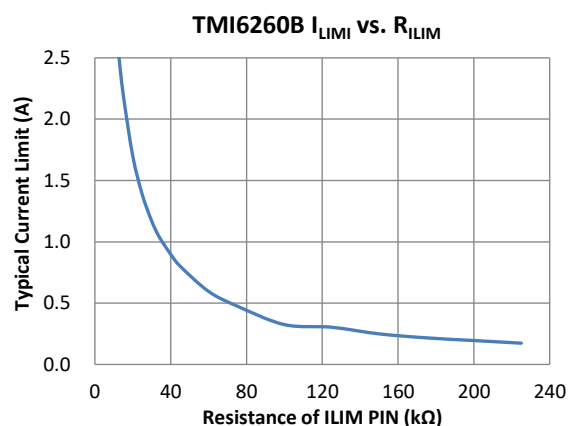
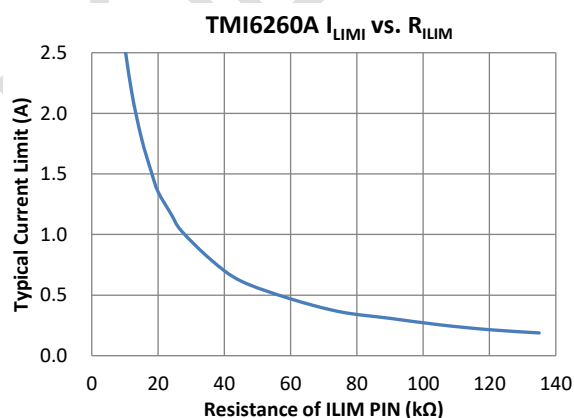
IN (input) is the power supply connection to the logic circuitry and the drain of the output MOSFET. OUT(output) is the source of the output MOSFET. In a typical application, current flows through the switch from IN to OUT toward the load. OUT pin must be connected together to the load.

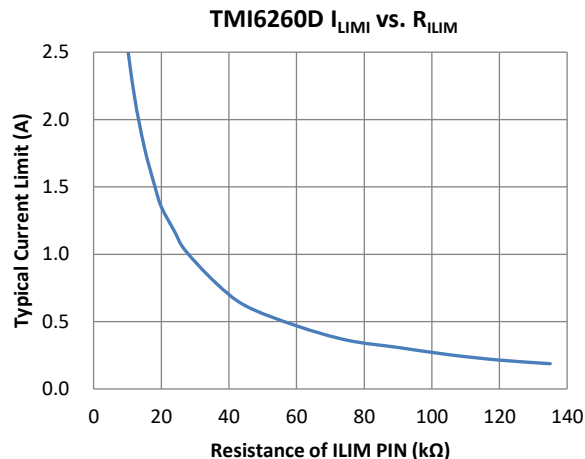
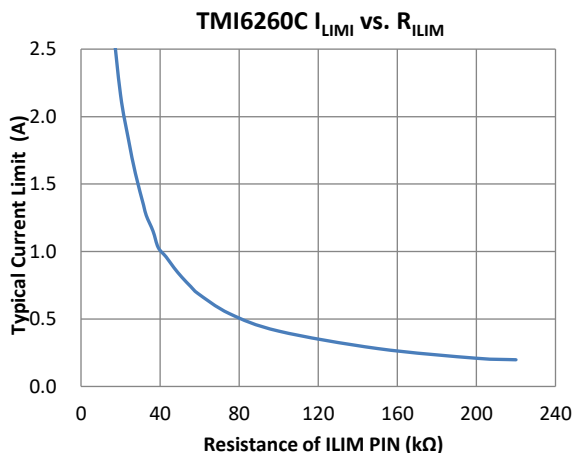
Soft Start for Hot Plug-In Applications

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_{LIM} can be expressed:

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

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

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

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

Table: Current Limit R_{LIM} Values for TMI6260C

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

R _{LIM} (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_{LIM} 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 over load 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.

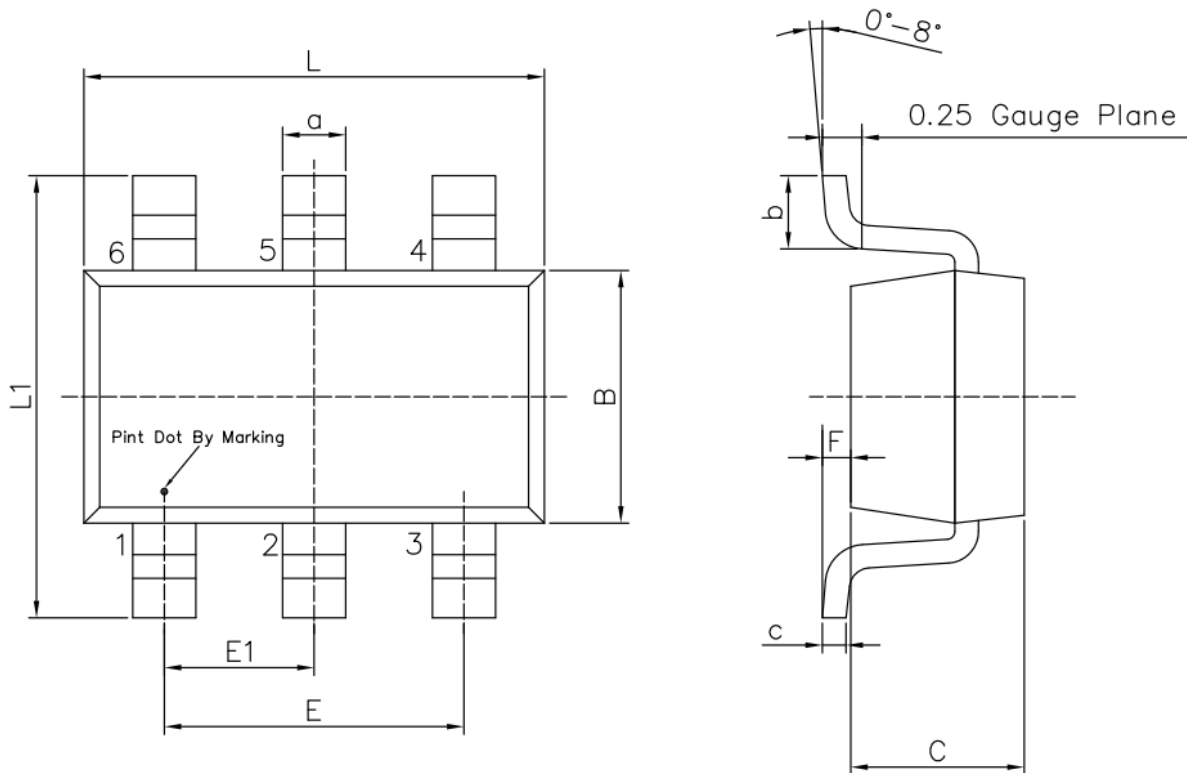
Layout Consideration

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

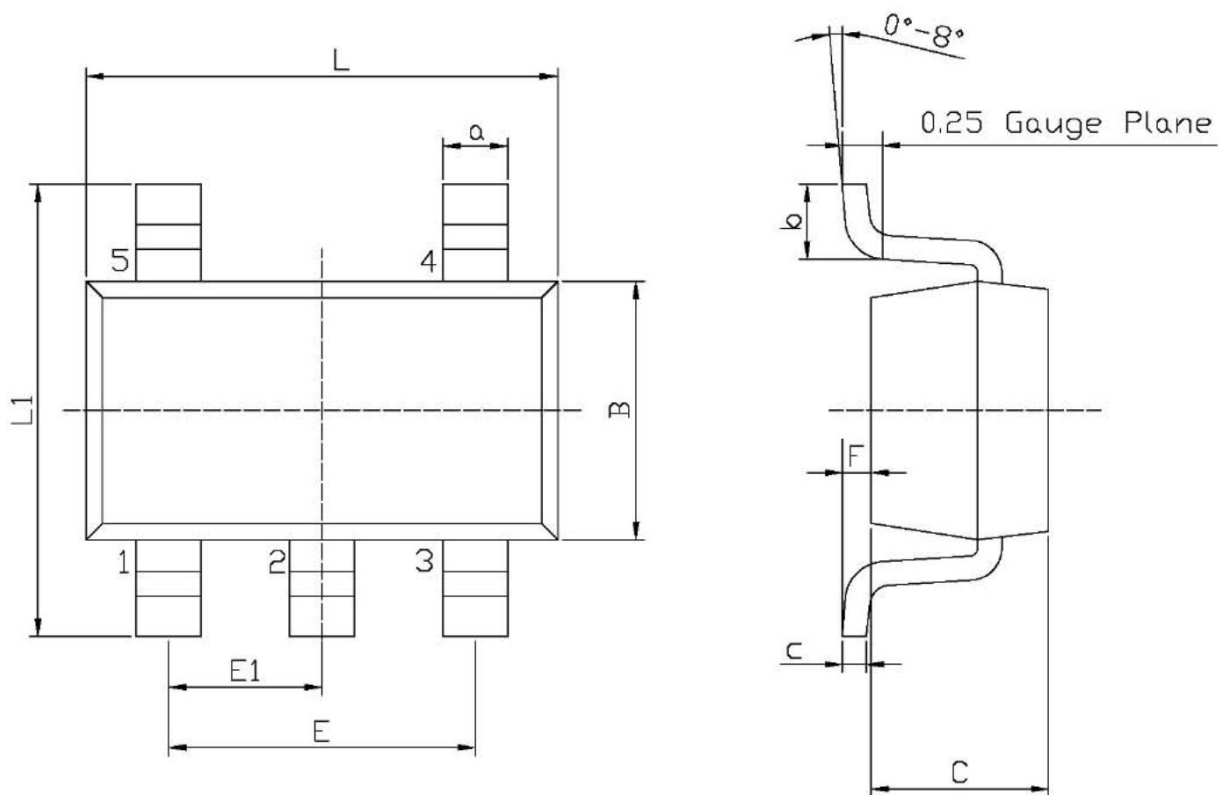
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

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

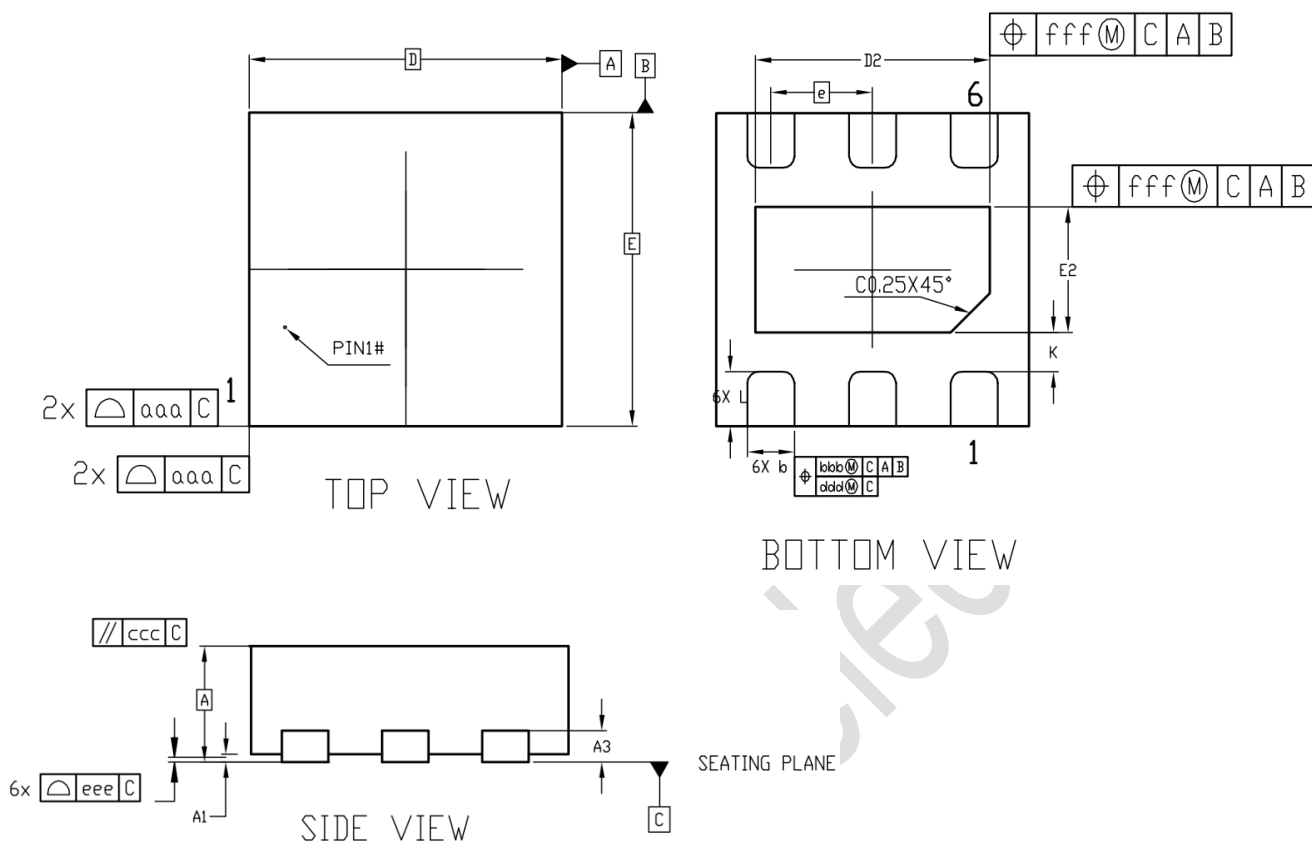
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

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

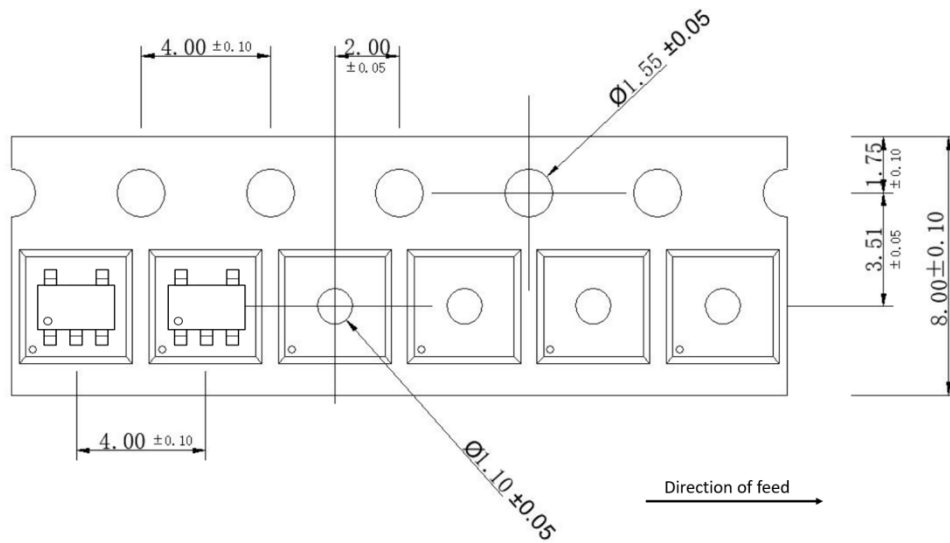
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	0.70	0.75	0.80	e	0.65 BSC		
	0.80	0.85	0.90	L	0.30	0.35	0.40
A1	0	0.02	0.05	K	0.25	-	-
A3	-	0.20 REF	-	aaa	0.15		
b	0.25	0.30	0.35	bbb	0.10		
D	2.00 BSC			ccc	0.10		
E	2.00 BSC			ddd	0.05		
D2	1.40	1.50	1.60	eee	0.08		
E2	0.70	0.80	0.90	fff	0.10		

Note:

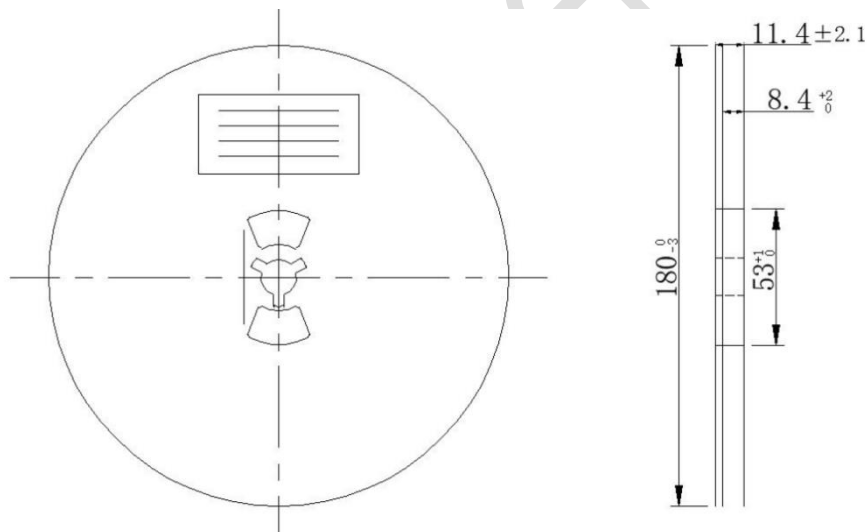
- 1) All dimensions are in millimeters. Angles are in degree.
- 2) Dimensioning and tolerancing confirm to ASME Y14.5M-1994.
- 3) Unilateral coplanarity zone applies to the exposed heat sink slug as well as the thermals.
- 4) Dimension b applies to metallized terminal and is measured between 0.150mm 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

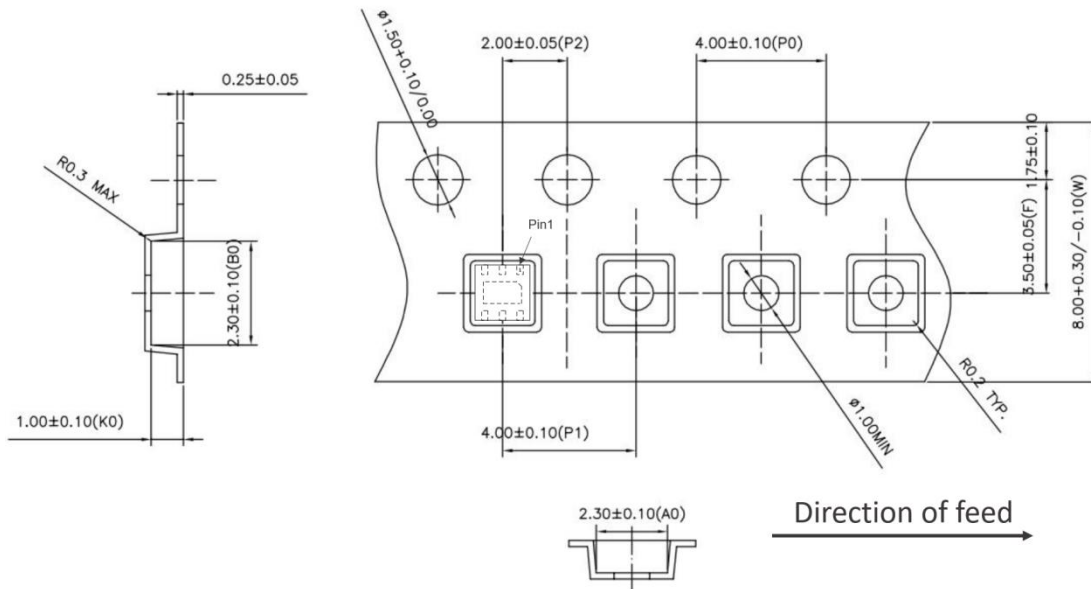


Note:

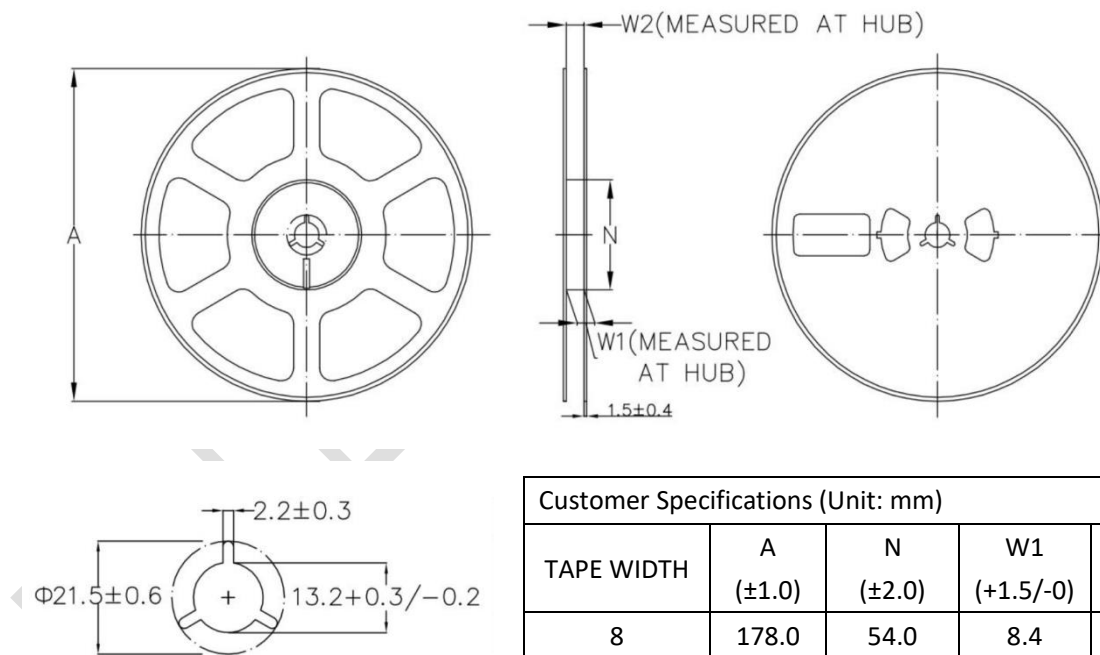
- 1) All Dimensions are in Millimeter
- 2) Quantity of Units per Reel is 3000
- 3) MSL level is level 3.

TAPE AND REEL INFORMATION

TAPE DIMENSIONS: DFN2x2-6L



REEL DIMENSIONS: DFN2x2-6L



Customer Specifications (Unit: mm)				
TAPE WIDTH	A (±1.0)	N (±2.0)	W1 (+1.5/-0)	W2 (Max)
8	178.0	54.0	8.4	14.4

- 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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