

POWER MANAGEMENT
Description

The SC553 is a low dropout linear regulator that operates from a +2.25V to +6.5V input range and delivers up to 150mA. A PMOS pass transistor allows the low 75µA supply current to remain independent of load, making these devices ideal for battery operated portable equipment such as cellular phones, cordless phones and personal digital assistants.

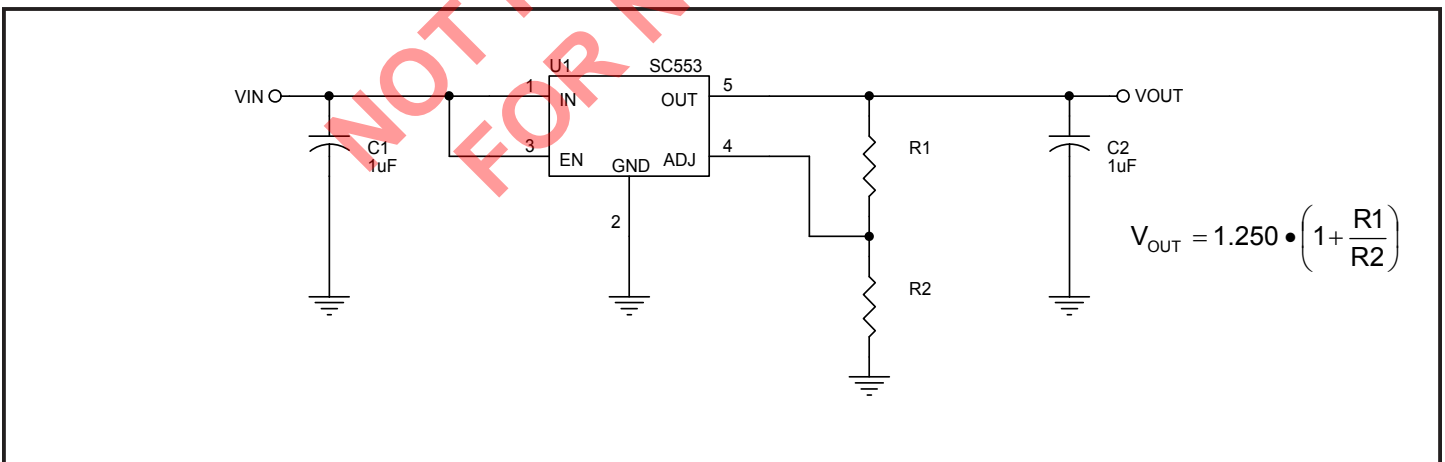
The SC553 has an adjust pin (ADJ) enabling the user to set the output voltage anywhere from 1.25V to 6V. For a low noise version, see SC1453 and for an error flag see SC1457. Other features include low powered shutdown, short circuit protection, thermal shutdown protection and reverse battery protection. The SC553 comes in the tiny 5 lead SOT-23 package.

Features

- ◆ “5205” compatible pinout
- ◆ 2% output accuracy guaranteed over line, load and temperature
- ◆ Guaranteed 150 mA output current
- ◆ Very small external components - designed to work with ceramic capacitors
- ◆ Output adjustable from 1.25V to 6V
- ◆ Very low supply current
- ◆ Thermal overload protection
- ◆ Reverse battery protection
- ◆ Low power shutdown
- ◆ Full industrial temperature range
- ◆ Surface mount packaging (5 pin SOT-23)

Applications

- ◆ Battery Powered Systems
- ◆ Cellular Telephones
- ◆ Cordless Telephones
- ◆ Personal Digital Assistants
- ◆ Portable Instrumentation
- ◆ Modems
- ◆ PCMCIA cards

Typical Application Circuit


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Absolute Maximum Ratings

Exceeding the specifications below may result in permanent damage to the device, or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not implied.

Parameter	Symbol	Maximum	Units
Input Supply Voltage	V_{IN}	-0.6 to +7	V
Enable Voltage	V_{EN}	-0.6 to V_{IN}	V
Output Pin Voltage	V_{OUT}	-0.6 to +7	V
Adjust Pin Voltage	V_{ADJ}	-0.6 to +7	V
Thermal Resistance Junction to Ambient	θ_{JA}	256	°C/W
Thermal Resistance Junction to Case	θ_{JC}	81	°C/W
Operating Ambient Temperature Range	T_A	-40 to +85	°C
Operating Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering) 10 Sec.	T_{LEAD}	300	°C

Electrical Characteristics

Unless specified: $V_{IN} = 2.25V$, $V_{EN} = V_{IN}$, $I_{OUT} = 100\mu A$, $C_{IN} = C_{OUT} = 1\mu F$, $T_A = 25^\circ C$. Values in **bold** apply over full operating ambient temperature range.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
IN						
Supply Voltage Range	V_{IN}		2.25		6.50	V
Supply Current	I_Q	$I_{OUT} = 0mA$ to $150mA$, $2.25V \leq V_{IN} \leq 6.5V$		75	130	μA
					160	
Off-State Supply Current	$I_{Q(OFF)}$	$V_{IN} = 6.5V$, $V_{EN} = 0V$		0.1	1.0	μA
					1.5	
ADJ						
Adjust Pin Voltage ⁽¹⁾	V_{ADJ}	$I_{OUT} = 1mA$	-1.5%	1.250	+1.5%	V
		$0mA \leq I_{OUT} \leq 150mA$, $2.25V \leq V_{IN} \leq 6.5V$	-2.0%		+2.0%	
Adjust Pin Input Current ⁽²⁾	I_{ADJ}	$V_{ADJ} = 1.3V$		0.015	2.500	nA
					5.000	
OUT						
Line Regulation ⁽¹⁾	$REG_{(LINE)}$	$V_{IN} = 2.25V$ to $5.5V$, $I_{OUT} = 1mA$, $V_{ADJ} = V_{OUT}$		1.5	10	mV
					12	
Load Regulation ⁽¹⁾	$REG_{(LOAD)}$	$I_{OUT} = 0.1mA$ to $150mA$, $V_{IN} = 2.25V$, $V_{ADJ} = V_{OUT}$		-1	-10	mV
					-20	

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Electrical Characteristics (Cont.)

Unless specified: $V_{IN} = 2.25V$, $V_{EN} = V_{IN}$, $I_{OUT} = 100\mu A$, $C_{IN} = C_{OUT} = 1\mu F$, $T_A = 25^\circ C$. Values in **bold** apply over full operating ambient temperature range.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUT (Cont.)						
Current Limit	I_{LM}		400			mA
Dropout Voltage ⁽¹⁾⁽³⁾	V_D	$I_{OUT} = 1mA$		1		mV
		$I_{OUT} = 50mA$		50	65	mV
					75	
		$I_{OUT} = 100mA$		100	125	mV
					155	
$I_{OUT} = 150mA$		150	190	mV		
			230			
EN						
Enable Input Threshold	V_{IH}	$2.25V \leq V_{IN} \leq 6.5V$	1.6			V
	V_{IL}	$2.25V \leq V_{IN} \leq 6.5V$			0.4	
Enable Input Bias Current ⁽²⁾	I_{EN}	$0V \leq V_{EN} \leq V_{IN}$	-0.5	0	+0.5	μA
Over Temperature Protection						
High Trip Level	T_{HI}			150		$^\circ C$
Hysteresis	T_{HYST}			15		$^\circ C$

Notes:

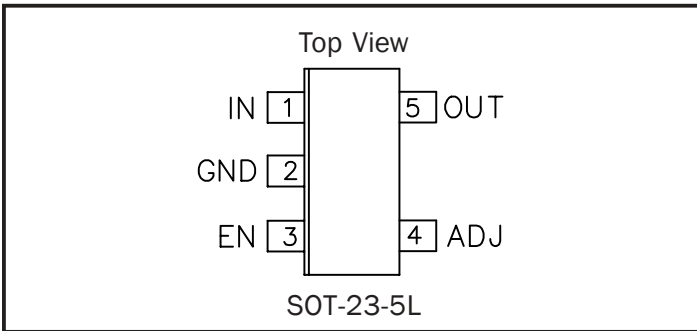
(1) Low duty cycle pulse testing with Kelvin connections required.

(2) Guaranteed by design.

(3) $V_{OUT} = 3.3V$. Defined as the input to output differential at which the output voltage drops 100mV below the value measured at a differential of 1V. Not measurable on outputs set below 2.25V due to minimum V_{IN} constraints. See Typical Characteristics for typical dropout voltage at other output voltage settings.

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Pin Configuration



Ordering Information

Part Number ⁽¹⁾	Package
SC553ISKTR	SOT-23-5
SC553ISKTRT ⁽²⁾	

Notes:

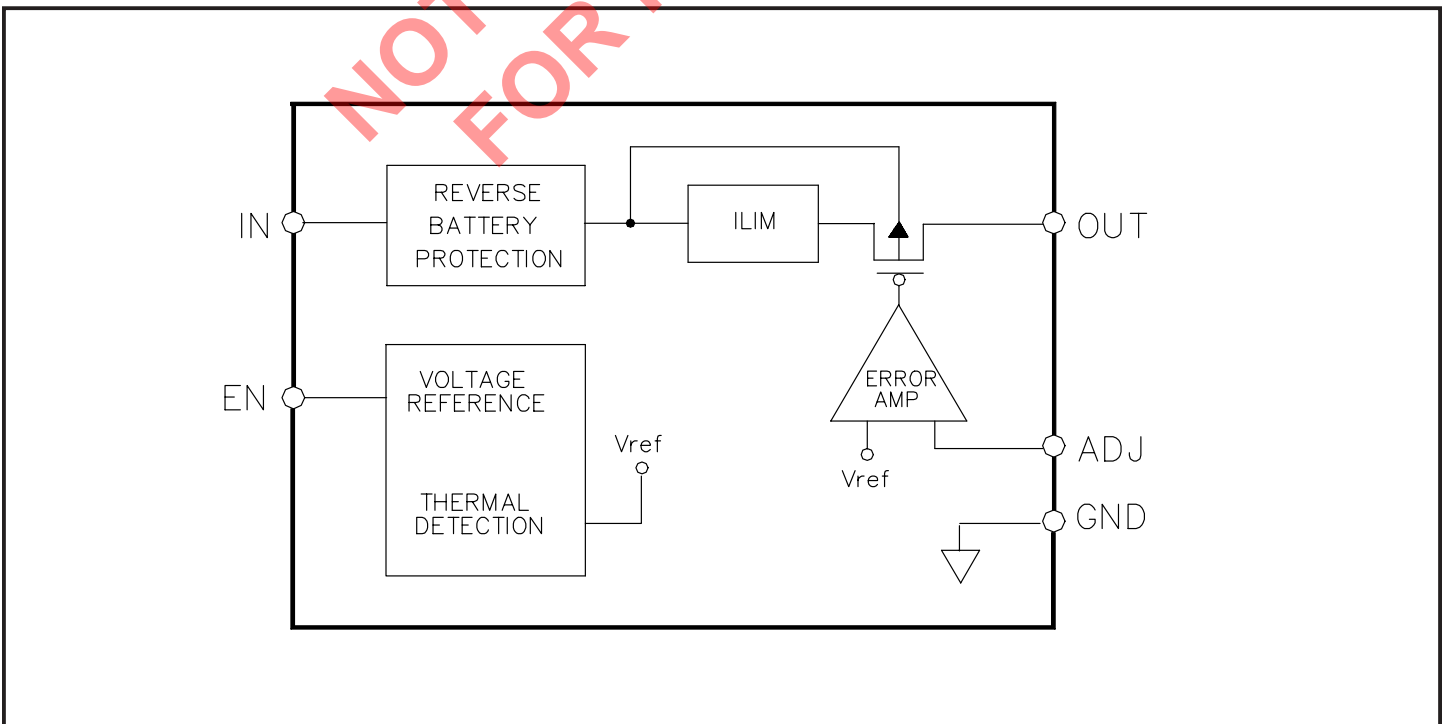
(1) Only available in tape and reel packaging. A reel contains 3000 devices.

(2) Lead free product. This product is fully WEEE and RoHS compliant.

Pin Descriptions

Pin #	Pin Name	Pin Function
1	IN	Input pin.
2	GND	Ground pin. Can be used for heatsinking if needed.
3	EN	Active high enable pin. Connect to IN if not being used.
4	ADJ	Adjust pin. Connecting this pin to an external resistor divider (see Typical Application Circuit on page 1) sets V_{OUT} to: $V_{OUT} = 1.250 \cdot \left(1 + \frac{R1}{R2}\right)$
5	OUT	Regulator output, sourcing up to 150mA.

Block Diagram



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Marking Information



Applications Information

Theory Of Operation

The SC553 is intended for applications where very low dropout voltage, low supply current and low output noise are critical. It provides a very simple, low cost solution that uses very little pcb real estate. Only two external capacitors are required for operation.

The SC553 contains a bandgap reference trimmed for optimal temperature coefficient which is fed into the inverting input of an error amplifier. The output voltage of the regulator is divided down externally using a resistor divider and compared to the bandgap voltage via the adjust pin (ADJ). The error amplifier drives the gate of a low $R_{DS(ON)}$ P-channel MOSFET pass device to maintain V_{OUT} such that $V_{ADJ} = V_{REF}$.

An active high enable pin (EN) allows the regulator to be shut down. Pulling this pin low causes the device to enter a very low power shutdown mode, where it will draw typically 0.1µA from the input supply.

The regulator has its own current limit circuitry to ensure that the output current will not damage the device during output short, overload or start-up. The current limit is guaranteed to be greater than 400mA to allow fast charging of the output capacitor and high initial currents for DSP initialization.

The SC553 includes thermal shutdown circuitry to turn off the device if T_j exceeds 150°C (typical), with the device remaining off until T_j drops by 15°C (typical). Reverse battery protection circuitry ensures that the device cannot be damaged if the input supply is accidentally reversed, limiting the reverse current to less than 1.5mA.

Component Selection - General

Output capacitor - Semtech recommends a minimum capacitance of 1µF at the output with an equivalent series resistance (ESR) of < 1Ω over temperature. While the SC553 has been designed to be used with ceramic capacitors, it does not have to be used with ceramic capacitors, allowing the designer a choice. Increasing the bulk capacitance will further reduce output noise and improve the overall transient response.

Input capacitor - Semtech recommends the use of a 1µF ceramic capacitor at the input. This allows for the device being some distance from any bulk capacitance on the rail. Additionally, input droop due to load transients is reduced, improving overall load transient response.

External voltage selection resistors - the use of 1% resistors, and designing for a current flow $\geq 10\mu A$ is recommended to ensure a well regulated output (thus $R2 \leq 125k\Omega$). The output voltage (referring to Figure 1 below) will be:

$$V_{OUT} = 1.250 \cdot \left(1 + \frac{R1}{R2} \right)$$

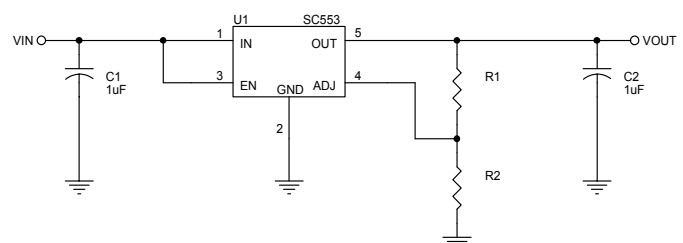


Figure 1

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Applications Information (Cont.)

Thermal Considerations

The worst-case power dissipation for this part is given by:

$$P_{D(MAX)} = (V_{IN(MAX)} - V_{OUT(MIN)}) \cdot I_{OUT(MAX)} + V_{IN(MAX)} \cdot I_{Q(MAX)} \quad (1)$$

For all practical purposes, equation (1) can be reduced to the following expression:

(2)

Looking at a typical application, 3.3V to 2.8V at 150mA:

$$\begin{aligned} V_{IN(MAX)} &= 3.3 + 5\% = 3.465V \\ V_{OUT(MIN)} &= 2.8V - 2\% = 2.744V \\ I_{OUT} &= 150mA \\ T_A &= 85^\circ C \end{aligned}$$

Inserting these values into equation (2) gives us:

Using this figure, we can calculate the maximum thermal impedance allowable to maintain $T_J \leq 125^\circ C$:

$$\theta_{JA(MAX)} = \frac{(T_{J(MAX)} - T_{A(MAX)})}{P_{D(MAX)}} = \frac{(125 - 85)}{0.108} = 370^\circ C/W$$

With the standard SOT-23-5 Land Pattern shown at the end of this datasheet, and minimum trace widths, the thermal impedance junction to ambient for SC553 is $256^\circ C/W$. Thus no additional heatsinking is required for this example.

The junction temperature can be reduced further (or higher power dissipation can be allowed) by the use of larger trace widths and connecting PCB copper to the GND pin (pin 2), which connects directly to the device substrate. Adding approximately one square inch of PCB copper to pin 2 will reduce θ_{JA} to approximately $130^\circ C/W$ and $T_{J(MAX)}$ for the example above to approximately $100^\circ C$. The use of multi layer boards with internal ground/power planes will lower the junction temperature and improve overall output voltage accuracy.

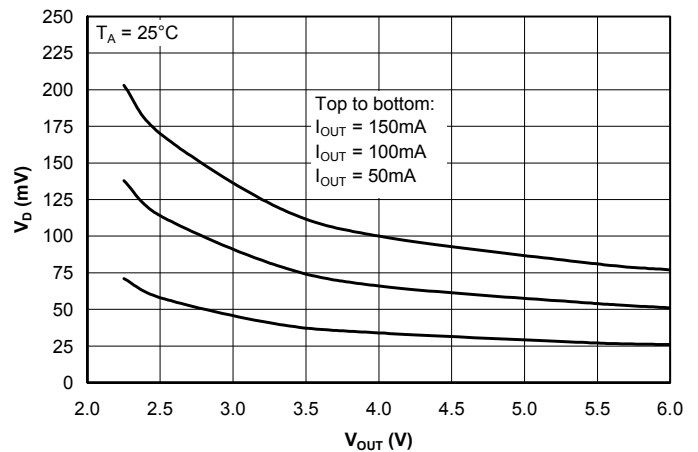
Layout Considerations

While layout for linear devices is generally not as critical as for a switching application, careful attention to detail will ensure reliable operation.

- 1) Attaching the part to a larger copper footprint will enable better heat transfer from the device, especially on PCBs where there are internal ground and power planes.
- 2) Place the input and output capacitors close to the device for optimal transient response and device behaviour.
- 3) While the external resistor divider does not need to be close to the device, care should be taken to avoid routing the connections next to any lines carrying large amounts of noise. The simplest solution is to place these resistors close to the device and routing the top of R1 to the load if not adjacent to the part.
- 4) Connect all ground connections directly to the ground plane. If there is no ground plane, connect to a common local ground point before connecting to board ground.

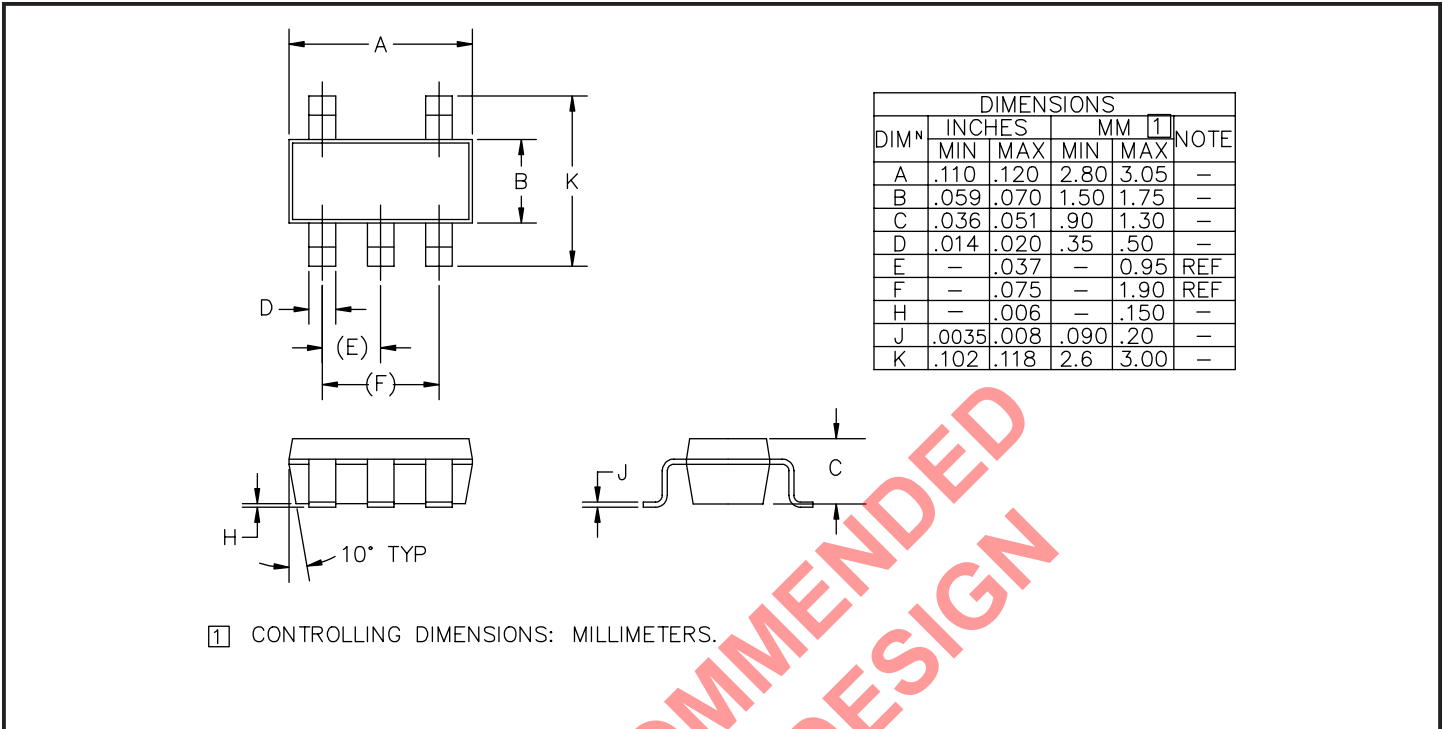
Typical Characteristics

Dropout Voltage vs. Output Voltage vs. Output Current

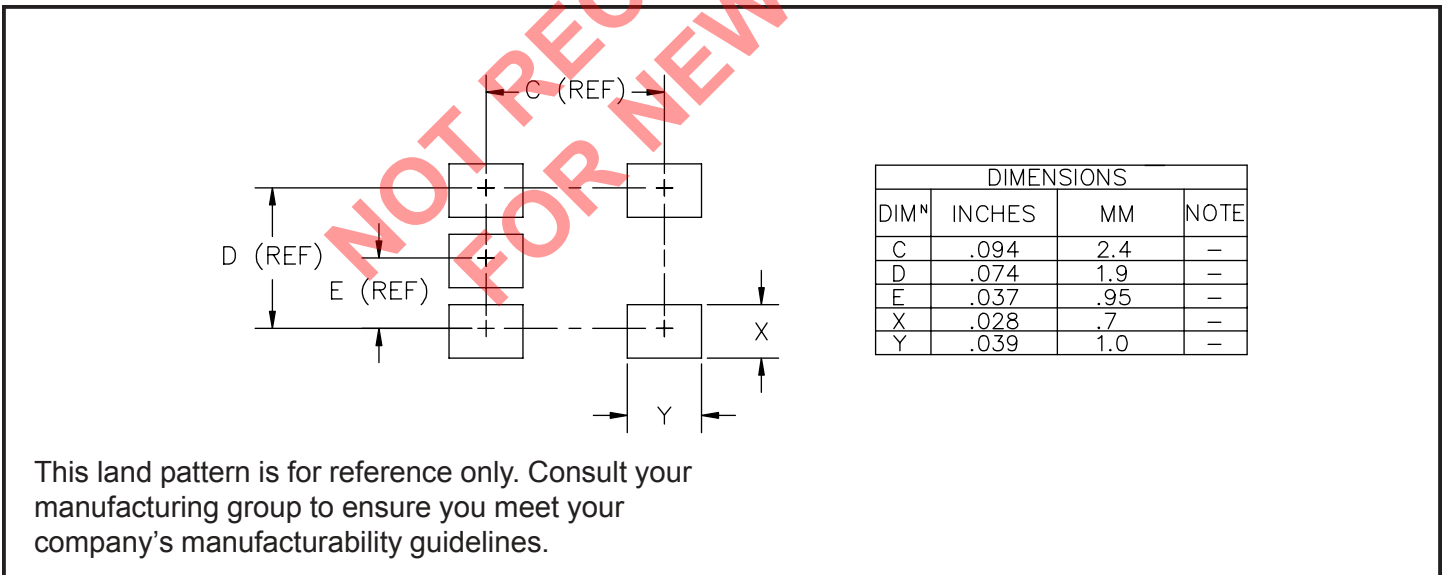


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Outline Drawing - SOT-23-5



Land Pattern - SOT-23-5



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