PRODUCTION DATA SHEET

DESCRIPTION

The LX12973 operates as a Current Mode PWM Buck regulator that switches to PFM mode with light loads. The entire regulator function is implemented with few external components.

The LX12973 responds quickly to dynamic load changes using a high bandwidth error amplifier and internal compensation. Tight output voltage regulation is maintained with the compensated 800mV, +/-2% reference (line and temp regulation). With two external resistors the output voltage is easily programmed, from 800mV to 90% of Vin.

The regulator is capable of providing an output load current of 1.5A, has no minimum load current requirement for stable operation. Current limit is cycle-by-cycle to protect the switch. Power conversion efficiency is maximized with low low regulator IQ and PFM mode of operation

The LX12973 operational range covers 4.0V to 6.0V, features include power on delay; soft start to limit inrush currents; and thermal shutdown during fault conditions.

The 6 pin MO-229 package provides a small form factor with excellent power dissipation capability.

IMPORTANT: For the most current data, consult *MICROSEMI*'s website: **http://www.microsemi.com**

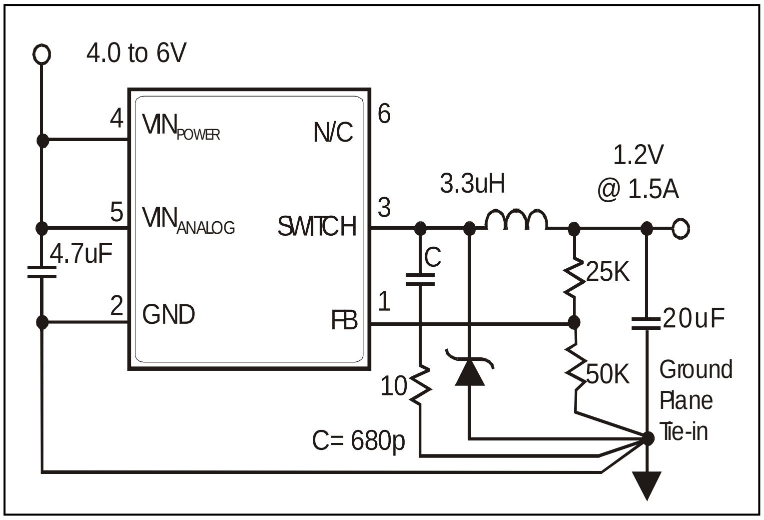
KEY FEATURES

- Internal Reference 800mv ±2% Accuracy (Line and Temp.)
- 4.5V to 5.5V Input Range
- Internal Soft Start
- Adj. Output From 0.8V to VIN
- Output Current (I >1.5A)
- Quiescent Current < 550µA, typ at 23°C
- 1.1MHz PWM Frequency
- Micro Lead-frame, Thin MO-229, 6-Pin Package

APPLICATIONS/BENEFITS

- Portable Microprocessor Core Voltage Supplies
- 5V to 3V
- RoHS compliant product

PRODUCT HIGHLIGHT



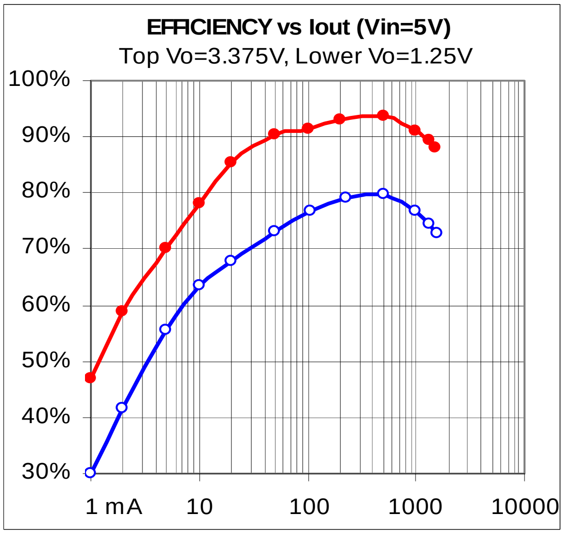
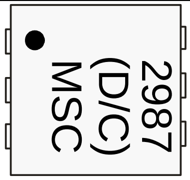


Figure 1 – LX12973 Circuit Topology and Typical Efficiency Performance

PACKAGE ORDER INFO

T_J (°C)	Input Voltage	Output Voltage Range	LD Plastic MO229 6 Pin (3mm²) RoHS Compliant / Pb-free
0 to 125	4.5V – 5.5V	Adjustable	LX12973CLD



Note: Available in Tape & Reel. Append the letters "TR" to the part number. (i.e. LX12973CLD-TR)

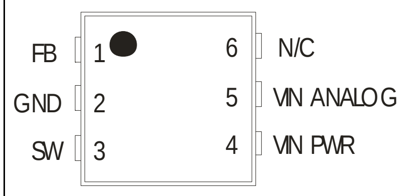
Microsemi
Integrated Products Division
11861 Western Avenue, Garden Grove, CA. 92841, 714-898-8121, Fax: 714-893-2570

ABSOLUTE MAXIMUM RATINGS

Input Voltage (IN) .... -0.3V to 7.0V
SW to GND .... -0.3V to (V_{IN} + 0.3V)
V_{FB} to GND .... -0.3V to +2V
SW Peak Current (Internally Limited) 1800mA
Operating Temperature Range .... -40°C to +125°C
Storage Temperature Range, T_A .... -65°C to 150°C
Maximum Junction Temperature .... 150°C
Package Peak Temp. for Solder Reflow (40 seconds max. exposure) .... 260°C (+0, -5)

Note: Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of specified terminal.

PACKAGE PIN OUT



LD PACKAGE (Top View)

Note: Heatsink pad on bottom should be connected to ground or left floating.

THERMAL DATA: "LD" PACKAGE

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA} (ASSUMES NO AMBIENT AIRFLOW)	**25-40°C/W** (PCB layout dependent)

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$. The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.

FUNCTIONAL PIN DESCRIPTION

NAME	DESCRIPTION
VIN ANALOG	Unregulated supply voltage input, ranging from +4V to 6.0V for internal analog control circuitry.
VIN PWR	Unregulated supply voltage input (+4V to 6.0V), high current path, connects to PMOS Source of PWM switch.
FB	Feedback input for setting programming output voltage.
GND	Circuit ground providing bias for IC operation and high frequency gate drive bias, can be connected to heatsink terminal.
SW	Inductor and commutation diode connection point. Connects to internal PMOSFET source.

ELECTRICAL CHARACTERISTICS

Specifications apply over junction temperature of: 0°C ≤ T ≤ 125°C for V_{IN} = 5V (except where otherwise noted). Typical values are at T_A=23°C.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Range	V_{IN}	Functional operation guaranteed by design	4.5		5.5	V
Feed Back Threshold	V_{FBT}	4.0V ≤ V_{IN} ≤ 6.0V	784	800	816	mV
FB Input Current	I_{FB}	V_{FB} = 0.81V		40	75	nA
Error Amplifier	BW	Closed Loop		100		Khz
Quiescent Operating Current	I_Q (Pin 5)	V_{FB} > 0.825V, Rload Switch Pin < 1K ohms		500	850	µA
Soft Start, Vout Slew Rate	Vo	Initial Power On or after Short Circuit		21	50	V/mS
P-Channel Switch ON Resistance	$R_{DS(ON)}$	I_{SW} = 1.0A		0.25	0.5	Ω
Maximum Duty Cycle	D	I_{SW} = 1.0A (assured by design, not ATE tested)	80	100		%
SW Leakage Current	I_{LEAK}	V_{FB} = 0.825V		0.01	5	µA
P-Channel Current Limit	I_{LIM}	Peak Current at Switch Pin (not dc current)	1.6	1.9		A
PWM Frequency	F_{OP-PWM}	PWM Mode	700	1020	1400	KHz
PFM Mode Region	Io	PFM Mode		250		mA
Feed Back PSRR		1hz < Frequency Vin < 10Khz		-40		dB
Closed Loop Load Regulation	Load Reg	V_O = 1.2V, 50mA ≤ I_O ≤ 1.2A, ckt figure 1		0.85		%V_O
Thermal Shutdown	T_{SD}	(assured by design, not ATE tested)	135	150		°C

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SIMPLIFIED BLOCK DIAGRAM

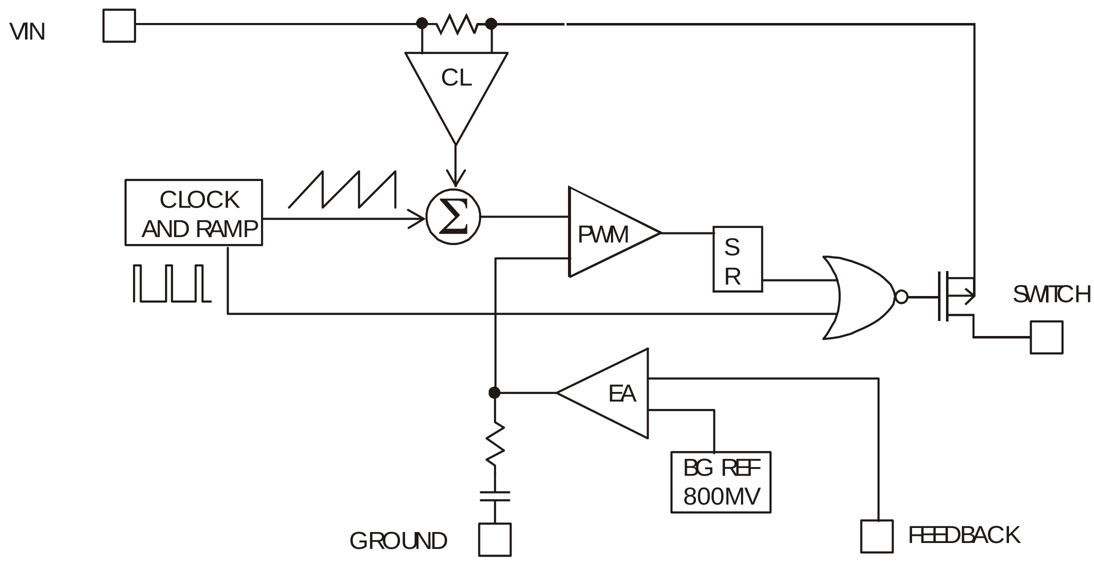


Figure 2 – LX12973 Block Diagram

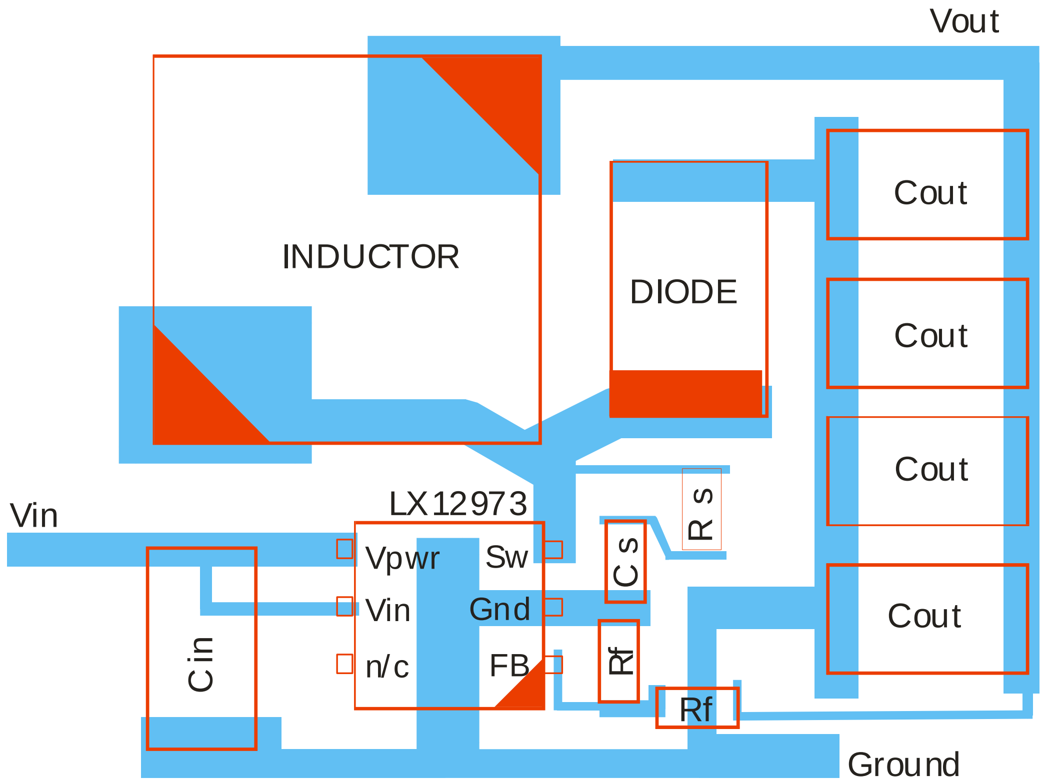


Figure 3 – PCB Layout Considerations

APPLICATION NOTE

FUNCTIONAL DESCRIPTION

The LX12973 is a Current Mode PWM regulator with internal compensation.

The internal PMOS high side switch is protected with current limit on a pulse by pulse basis and with thermal shutdown. Thermal shutdown is activated with a junction temperature of 160°C (typical) and has 20°C of hysteresis.

The regulator has an internal Power On Reset delay of 50-100us to ensure all circuitry is operating before enabling the Switch output.

Soft Start is activated upon initial power-on, or following recovery from either thermal shutdown or short circuit. The Soft start control block generates a voltage ramp that clamps the error amplifier non-inverting reference voltage. As this clamp voltage rises, the duty cycle is gradually increased, thus limiting the peak inrush currents.

PWM / PFM mode of operation is determined by the load current condition. The PFM mode increases system efficiency by reducing the switching frequency thus switching losses. During light loading, Iout < 200ma typically, PFM mode becomes active, the switching frequency begins to decrease, the frequency change occurs over a continuous range, decreasing further as Iout decreases.

OUTPUT VOLTAGE PROGRAMMING

Resistors R1 and R2 program the output voltage. The value of R2 (lower resistor of divider) should be less than 10KΩ. The value of R1 can be determined using the following equation, note V_{REF} is also referred to as V_{FBT}.

$$R1 = R2\left[\left(\frac{V_{OUT}}{V_{REF}}\right) - 1\right]$$

DIODE SELECTION

A Schottky diode is required for switching speed and low forward voltage. Efficiency is determined mostly by the diode's forward voltage. The diode conducts 1-D%, for Vout=1.2V this becomes 76% in a 5V system.

INDUCTOR SELECTION

Selecting the appropriate inductor type and value ensures optimal performance of the converter circuit for the intended application. A primary consideration requires the selection of an inductor that will not saturate at the peak current level. EMI, output voltage ripple, and overall circuit efficiency affect inductor choice. The inductor that works best depends upon the application's requirements and some experimentation with actual devices in-circuit is typically necessary to make the most effective choice.

INDUCTOR SELECTION, CONT.

The LX12973 allows for a broad selection of inductor values and choosing a value between 2.2µH and 22µH supports a majority of applications. The benefit of a larger inductor value can increase efficiency at the lower output currents and reduces output voltage ripple, thus output capacitance related to ripple filtering. Smaller inductors typically provide smaller package size (critical in many portable applications) at the expense of increasing output ripple current. Regardless of inductor value, selecting a device manufactured with a ferrite-core produces lower losses at higher switching frequencies and thus better overall performance. Larger inductors may lead to diminished Step-Load response.

CAPACITOR SELECTION

To minimize ripple voltage, output capacitors with a low series resistance (ESR) are recommended. Multi-layer ceramic capacitors with X5R or X7R dielectric make an effective choice because they feature small size, very low ESR, a temperature stable dielectric, and can be connected in parallel to increase capacitance. Typical output capacitance values of 10 to 30µF has proven effective. Other low ESR capacitors such as solid tantalum, specialty polymer, or organic semiconductor, make effective choices provided that the capacitor is properly rated for the output voltage and ripple current. Finally, choose an input capacitor of sufficient size to effectively decouple the input voltage source impedance (e.g., $C_{IN} \geq 4.7\mu F$).

LAYOUT CONSIDERATIONS

The high peak currents and switching frequencies present in DC/DC converter applications require careful attention to device layout for optimal performance. Basic design rules include: (1) maintaining wide traces for power components (e.g., width > 50mils); (2) place C_{IN}, C_{OUT}, the Schottky diode, and the inductor close to the LX12973; (3) minimizing trace capacitance by reducing the etch area connecting the SW pin to the inductor; and (4) minimizing the etch length to the FB pin to reduce noise coupling into this high impedance sense input. Other considerations include placing a 0.1uF capacitor between the LX12973 VOUT pin and GND pin to reduce high frequency noise and decoupling the VIN pin using a 0.1uF capacitor. The LX12973 Switch has fast switching speeds which may generate noise spikes when a high capacitance Schottky diode is selected for the catch diode. A simple snubber circuit, as shown in Figure 1, R=10 ohms and C=680pF has proven effective to reduce the spike voltage generated at the Switch Pin / Diode connection.

CHARACTERISTIC CURVES

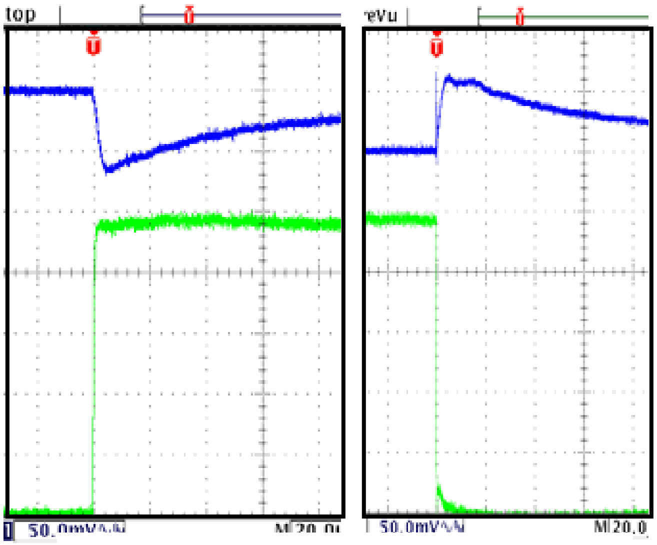


Figure 4– Step Load Response 250ma-1.2A 3.3uH, 40uF
Blue: Vout 50mV/div AC; Green: Istep 200ma/div

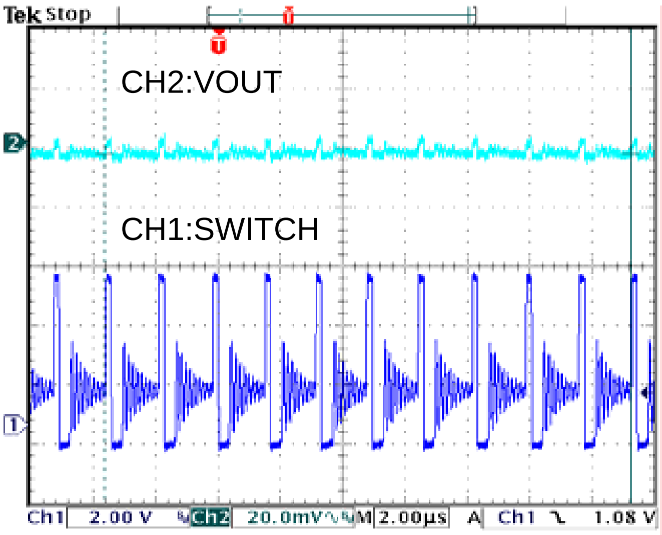


Figure 5 – Switching Waveforms: PFM Mode

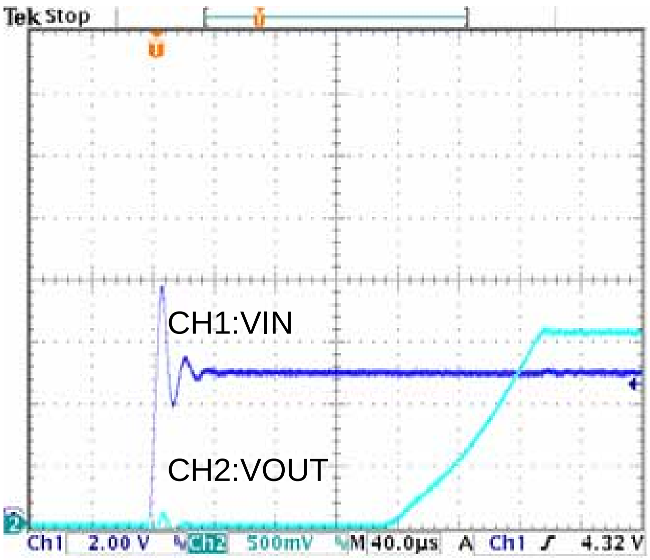


Figure 6 – Power On and Soft Start
For Iout 10ma to 1amp

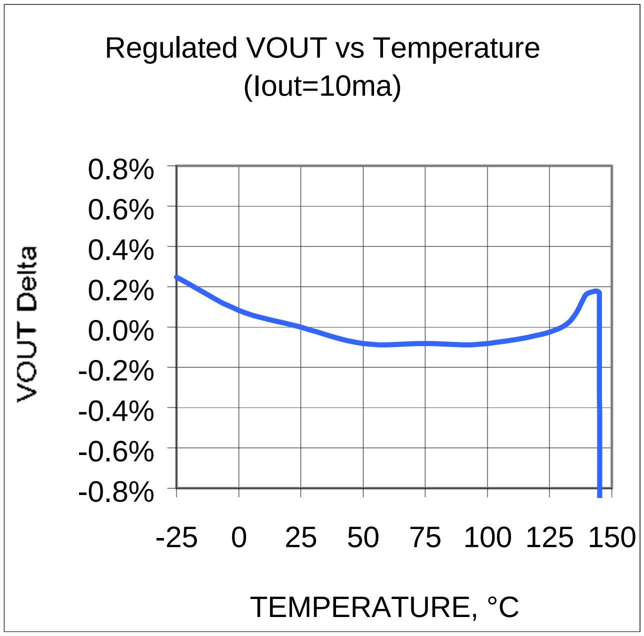
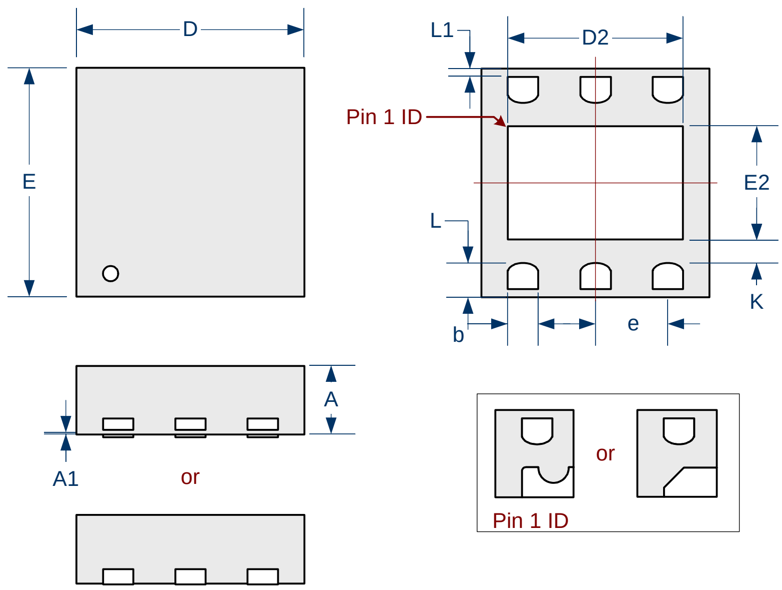


Figure 7– Vout Temperature Stability

PACKAGE DIMENSIONS

LD **6 Pin Plastic 3 x 3 x .9 mm**



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.80	1.00	0.031	0.039
A1	0.00	0.05	0.000	0.002
K	0.20 MIN		0.008 MIN	
e	0.95 BSC		0.037 BSC	
L	0.30	0.50	0.012	0.02
b	0.30	0.45	0.012	0.018
D2	1.90	2.40	0.75	0.094
E2	1.15	1.65	0.045	0.065
D	3.00 BSC		0.118 BSC	
E	3.00 BSC		0.118 BSC	
L1	0.00	0.15	0.000	0.006

Note:

1. Dimensions do not include mold flash or protrusions; these shall not exceed 0.155mm(.006") on any side. Lead dimension shall not include solder coverage.

NOTES