CR78L

LDO

Data Sheet

30V 100mA Low Dropout Voltage Regulator

Version: V1.3

1. General Description

The CR78LXX three terminal positive regulators are available with 5V fixed output voltage, making it useful in a wide range of applications. Used as a Zener-diode and resistor combination replacement, the CR78LXX usually provides an effective output impedance improvement of two orders of magnitude and lower quiescent current. These regulators can provide local, on-card regulation, eliminating distribution problems associated with single-point regulation. The available voltages allow the CR78LXX to be used in logic systems, instrumentation, HiFi, and other solid-state electronic equipment.

The CR78LXX is available in the plastic SOT89-3 package, SOT23-3 package,. With adequate heat sinking, the regulator can deliver 100-mA output current. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistors is provided to limit internal power dissipation. If internal power dissipation is too high for the heat sinking provided, the thermal shutdown circuit prevents the IC from overheating.

2. Ordering Information

Part Number	Package	Output Voltage
CR78L33_893	SOT89-3	3.3V
CR78L33_233A	SOT23-3	3.3V
CR78L05_893	SOT89-3	5V
CR78L05_233A	SOT23-3	5V

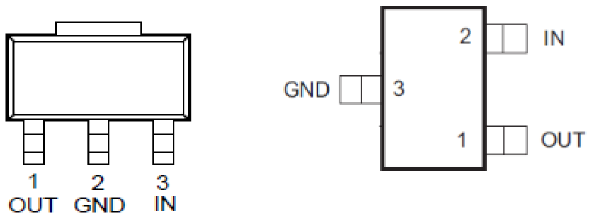
3. Features

- VIN Range up to 30V
- Output Voltage Tolerances of ±5% Over the Temperature Range
- Output Current of 100 mA
- Output Transistor Safe Area Protection
- Internal Thermal Overload Protection
- Internal Short-Circuit Current Limit

4. Applications

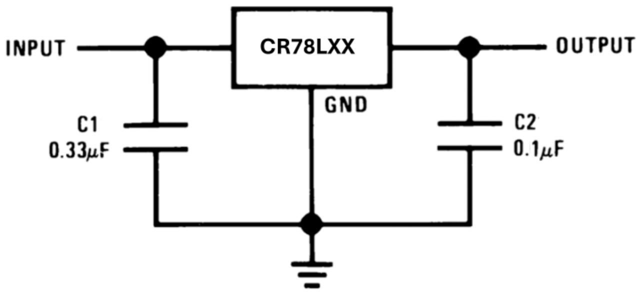
- Battery Chargers
- Portable Instrumentation
- LED Lighting
- Low Wattage Power Supplies

5. Pin Configuration



SOT89-3 SOT23-3

6. Typical Application Circuit

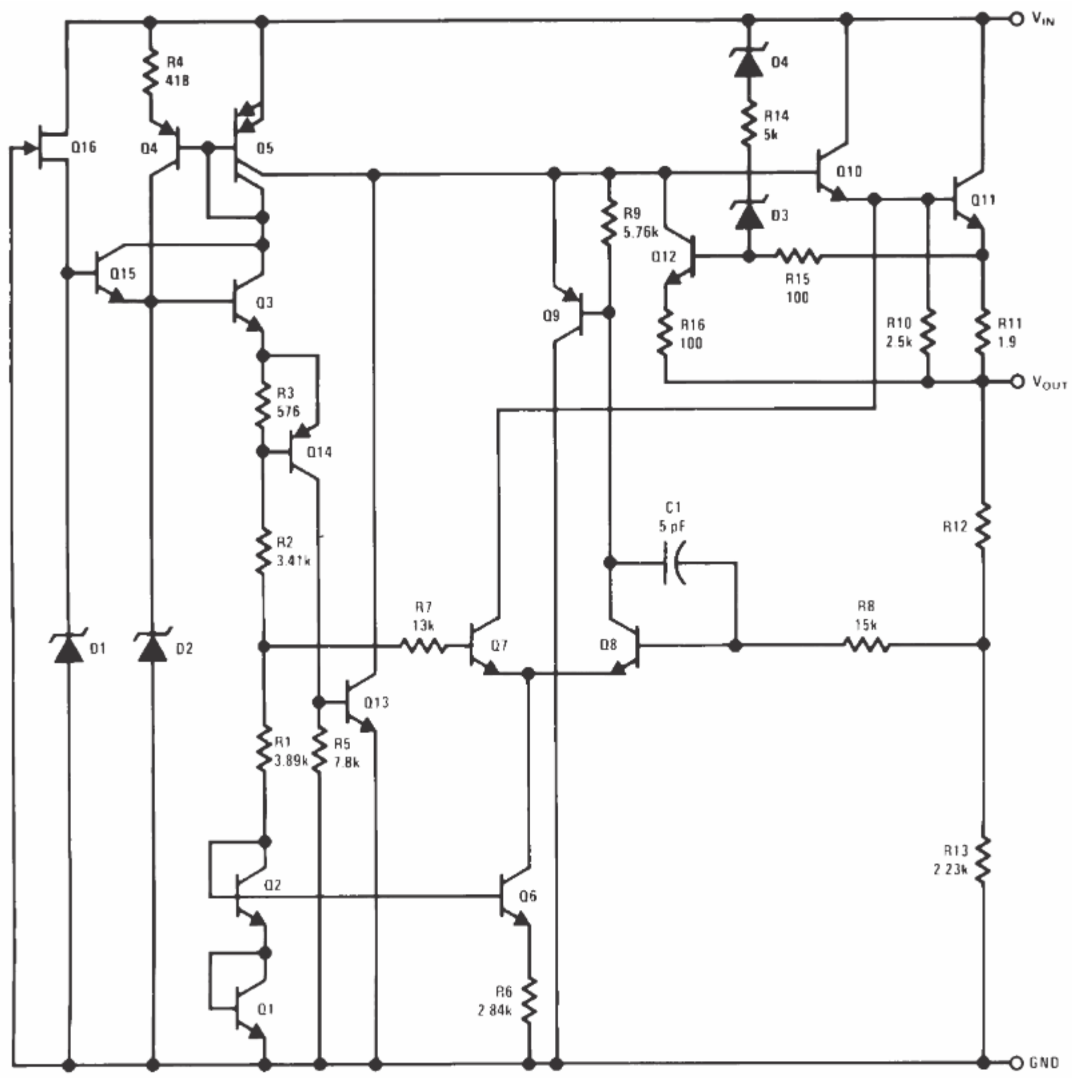


7. List of Contents

8. Pin Assignment

Pin Name	Pin No. SOT89	Pin No. SOT23	Pin Function
VOUT	1	1	Output Voltage Pin
GND	2	3	Ground
VIN	3	2	Input Voltage pin.

9. Function Block Diagram



10. Absolute Maximum Ratings (Note1)

- V_{IN} -- -0.3V to +35V
- Power Dissipation, PD@T_A=25°C, SOT23-3---0.4W
- Thermal Resistance, θ_{JA}, SOT23-3---250°C/W
- Power Dissipation, PD@T_A=25°C, SOT89-3---1.8W
- Thermal Resistance, θ_{JA}, SOT89-3--55°C/W
- Junction Temperature-- 150°C
- Lead Temperature (Soldering, 10 sec.)--- 300°C
- Storage Temperature --- –65°C to 150°C

11. Recommended Operating Conditions

- Input Voltage, VIN -- +7V to +30V
- Junction Temperature -- -40°C to 125°C
- Ambient Temperature-- -40°C to 85°C

12. Electrical Characteristics

V_{IN}=10V, I_{OUT}=40mA, C_{IN}=0.33uF, C_{OUT}=0.1uF, T_J=25°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage (CR78L33)	V_{OUT}	T_J = 25°C	3.168	3.3	3.432	V
		V_{IN} = 7 to 20V, I_{OUT} = 1mA to 40mA T_J = 0°C to 125°C	3.135		3.465	
		I_{OUT} = 1mA to 70mA T_J = 0°C to 125°C	3.135		3.465	
Output Voltage (CR78L05)	V_{OUT}	T_J = 25°C	4.8	5	5.2	V
		V_{IN} = 7 to 20V, I_{OUT} = 1mA to 40mA T_J = 0°C to 125°C	4.75		5.25	
		I_{OUT} = 1mA to 70mA T_J = 0°C to 125°C	4.75		5.25	
Line Regulation	$\triangle V_{LINE}$	V_{IN} = 7 to 20V,V_{OUT}=3.3V		0.36	0.90	%
		V_{IN} = 8 to 20V, V_{OUT}=3.3V		0.30	0.75	
Load Regulation	$\triangle V_{LOAD}$	I_{OUT} = 1mA to 100mA, V_{OUT}=3.3V		0.60	1.51	%
		I_{OUT} = 1mA to 40mA, V_{OUT}=3.3V		0.30	0.75	
Quiescent Current	I_Q	T_J = 25°C		0.3		mA
		T_J = 125°C			1	
Quiescent Current Change	$\triangle I_Q$	V_{IN} = 8 to 20V, T_J = 0°C to 125°C			0.2	mA
		I_{OUT} = 1mA to 40mA T_J = 0°C to 125°C			0.1	
Ripple Rejection	PSRR	f = 120Hz, V_{IN} = 8V to 20V, T_J = 25°C	75	84		dB
Output Noise Voltage	V_N	f = 10Hz to 100KHz		32		uV
Dropout Voltage	V_{DROP}			0.8		V
V_{OUT} Temp. Coefficient	$\triangle V_{OUT}/\triangle T$	I_{OUT} = 5mA		0.2	0.5	mV/°C
Peak Output Current	I_{PK}			170		mA

13. Typical Characteristics

V_{IN}=10V, I_{OUT}=40mA, C_{IN}=0.33uF, C_{OUT}=0.1uF, T_J=25°C, unless otherwise specified

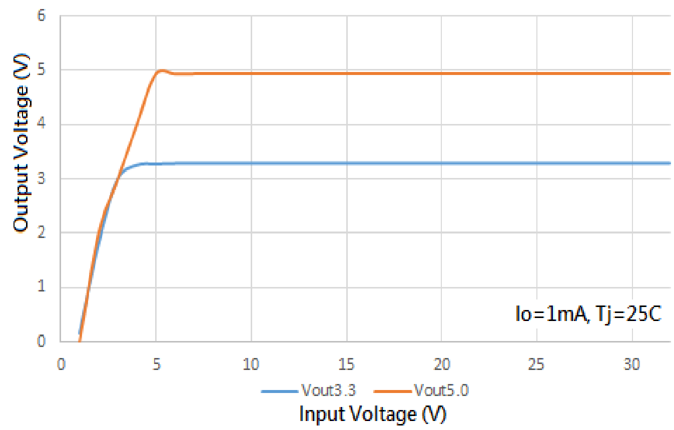


Fig 1. Output Voltage vs Input Voltage

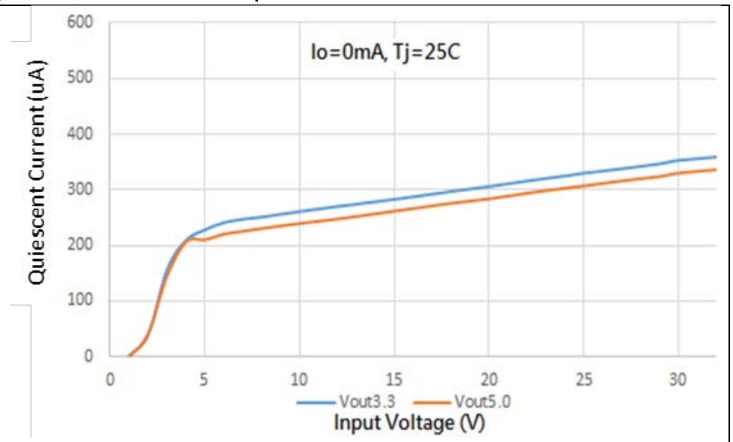


Fig 2. Quiescent Current vs Input Voltage

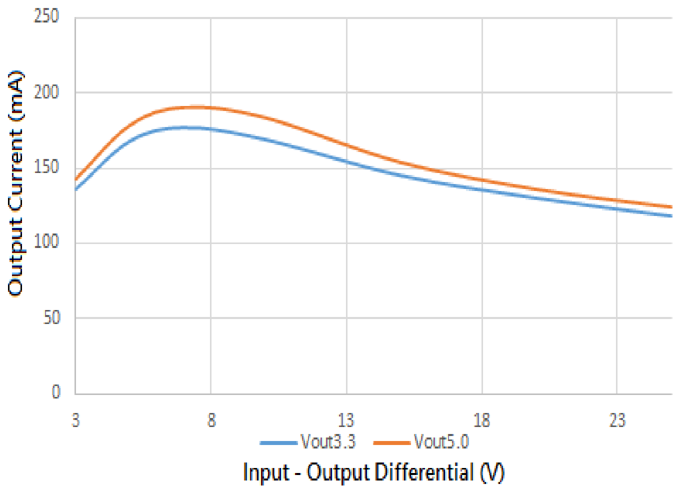


Fig 3. Peak Output Current vs Input-Output Differential

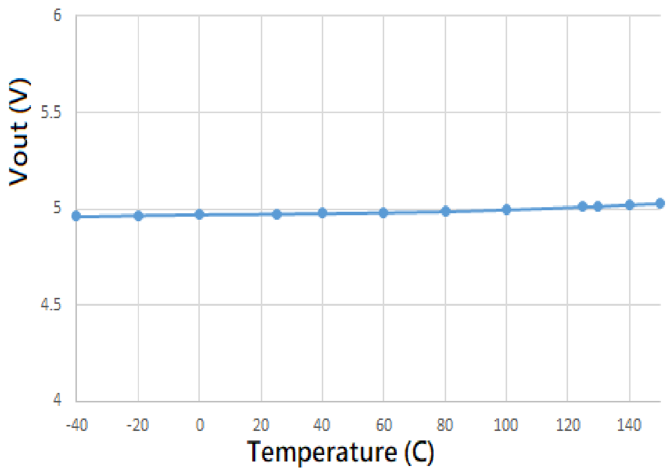
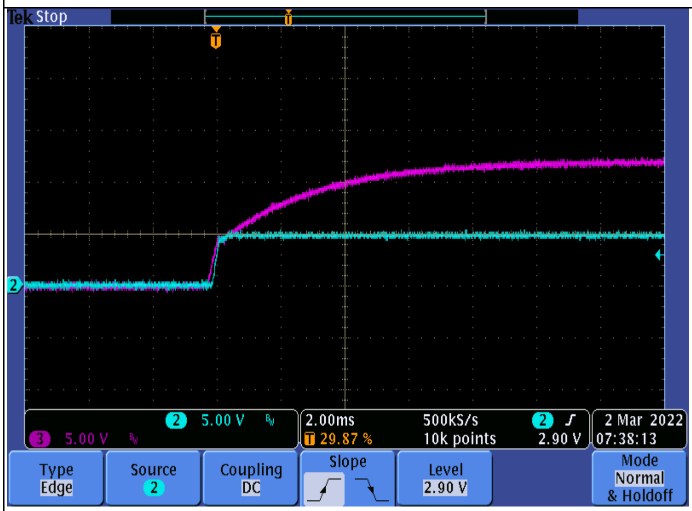
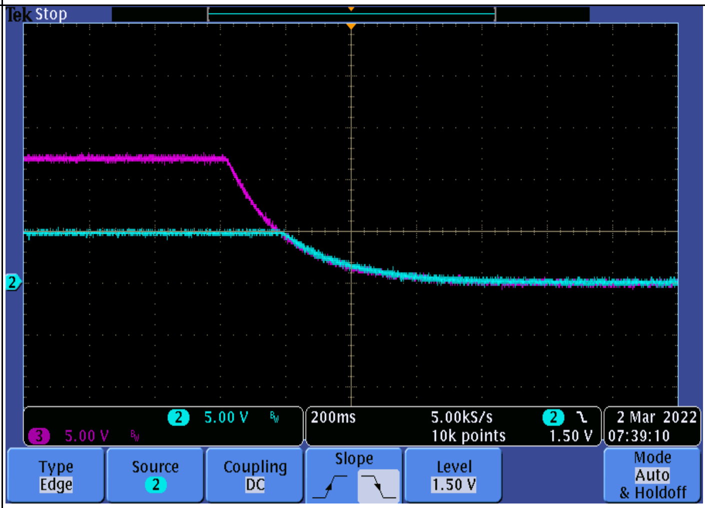


Fig 4. V_{OUT} vs Temp



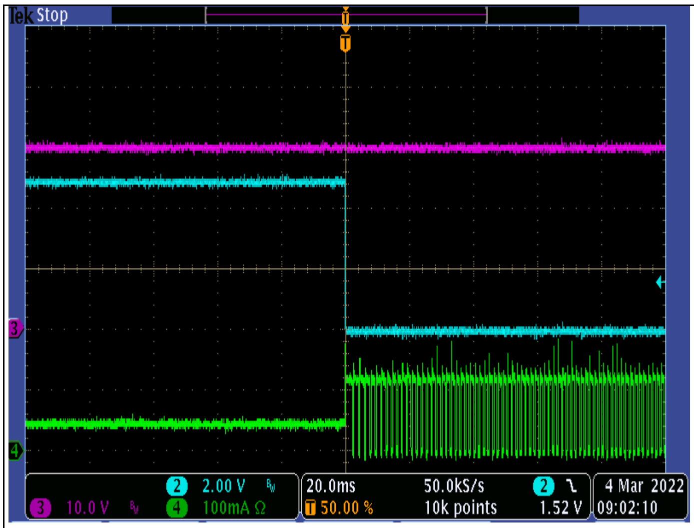
CH2: V_{OUT}, CH3: V_{IN}

Fig 5. V_{IN} Start up



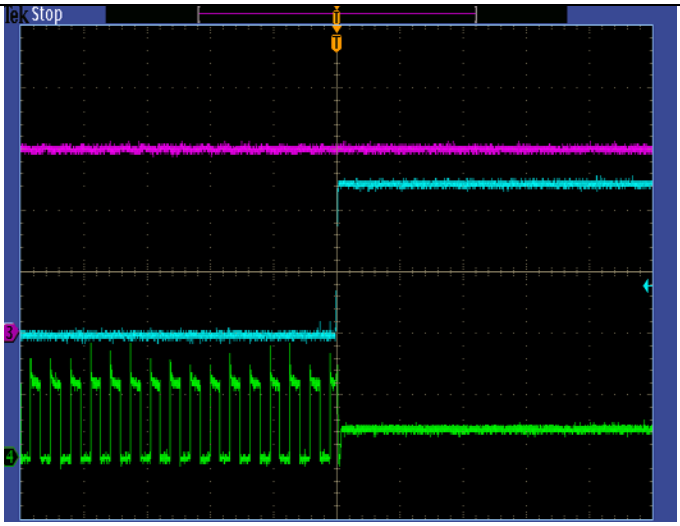
CH2: V_{OUT}, CH3: V_{IN}

Fig 6. V_{IN} Power off



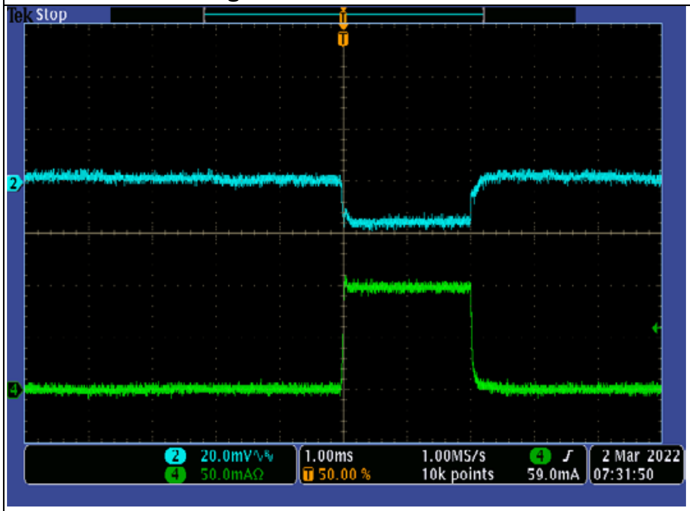
CH2: V_{OUT}, CH3: V_{IN}, CH4: I_{OUT}

Fig 7. V_{OUT} Short to GND



CH2: V_{OUT}, CH3: V_{IN}, CH4: I_{OUT}

Fig 8. V_{OUT} Short and Release



CH2: V_{OUT}, CH4: I_{OUT}

Fig 9. Load Transient

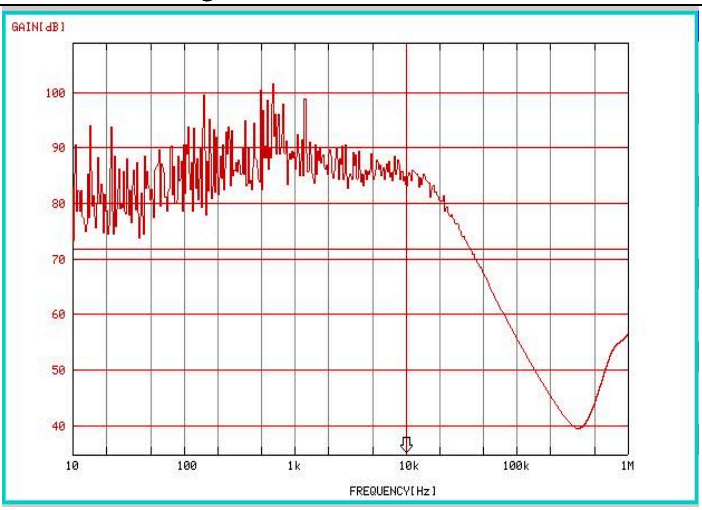


Fig 10. PSRR vs Frequency (V_{IN} = 9V, V_{OUT} = 5V)

14. IC Operation Information

14.1. Basic Operation

The CR78LXX is a high input voltage linear regulator specifically designed to minimize external components. The input voltage range is from 7V to 30V. The minimum required output capacitance for stable operation is 0.1μF effective capacitance after consideration of the temperature and voltage coefficient of the capacitor.

14.2. Current-limit Protection

The CR78LXX provides current limit function to prevent the device from damages during overload or shorted-circuit condition. This current is detected by an internal sensing transistor.

15. IC Application Information

Like any low dropout linear regulator, the CR78LXX external input and output capacitors must be properly selected for stability and performance. Use a 0.33μF (X5R or X7R) or larger input capacitor and place it close to the IC's VIN and GND pins. Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) and effective capacitance larger than 0.1μF (X5R or X7R) requirement may be used. Place the output capacitor close to the IC's VOUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

15.1. Current Limit

The CR78LXX contains an independent current limiter, which monitors and controls the pass transistor's gate voltage, limiting the output current to 0.17A (typ.). The output can be shorted to ground indefinitely without damaging the part.

15.2. Dropout Voltage

The dropout voltage refers to the voltage difference between the VIN and VOUT pins while operating at specific output current. The dropout voltage V_{DROP} can also be expressed as the voltage drop on the power device at specific output current (I_{RATED}) while the power device is fully operating at ohmic region and the power device can be characterized as an resistance $R_{DS(ON)}$. Thus the dropout voltage can be defined as ($V_{DROP} = V_{VIN} - V_{VOUT} = R_{DS(ON)} \times I_{RATED}$). For normal operation, the suggested LDO operating range is ($V_{VIN} > V_{VOUT} + 1.5V$) for good transient response and PSRR ability. Conversely, operating at the ohmic region will degrade this performance severely.

15.3. Minimum Operating Input Voltage (VIN)

The CR78LXX does not include any dedicated UVLO circuitry. The CR78LXX at least 7V. The output voltage is not regulated until VIN has reached at least the greater of 7 V or (VOUT + 1.5V)

15.4. Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by the following formula:

$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$ and

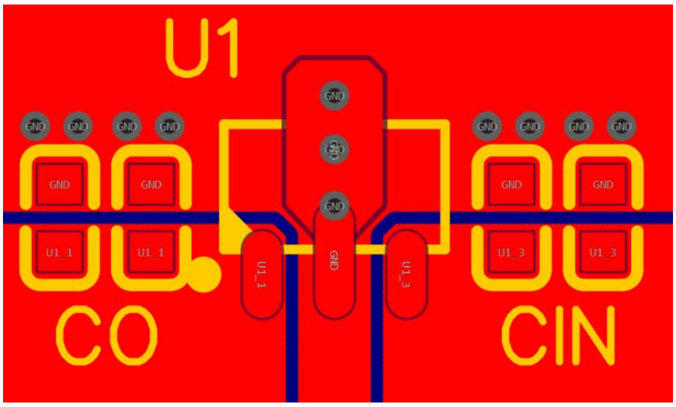
$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$ where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction to ambient thermal resistance. For recommended operating condition specifications the maximum junction temperature is 125°C and T_A is the ambient temperature. The junction to ambient thermal resistance, θ_{JA}, is layout dependent. For SOT893 package, the thermal resistance, θ_{JA}, is 55°C/W on a two-layer Chip1 evaluation board. For SOT233 package, the thermal resistance, θ_{JA}, is 250°C/W on a two-layer Chip1 evaluation board. The maximum power dissipation at T_A = 25°C can be calculated by the following formula:

$P_{D(MAX)}$ = (125°C − 25°C) / (55°C/W) = 1.8W for SOT893 package

$P_{D(MAX)}$ = (125°C − 25°C) / (250°C/W) = 0.4W for SOT233 package. The maximum power dissipation depends on the operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance, θ_{JA}.

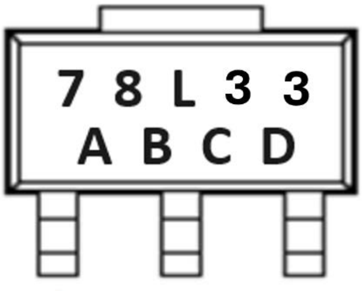
15.5. Layout Considerations

The dynamic performance of the CR78LXX is dependent on the layout of the PCB. PCB layout practices that are adequate for typical LDOs may degrade the PSRR, noise, or transient performance of the CR78LXX. Best performance is achieved by placing CIN and COUT on the same side of the PCB as the CR78LXX, and as close to the package as possible is practical. The ground connections for C_{IN} and C_{OUT} must be back to the CR78LXX ground pin using a copper trace as wide and short as possible. Connections using long trace lengths, narrow trace widths, and/or connections through vias must be avoided. These added parasitic inductances and resistance may result in inferior performance especially during transient conditions.



16. Ordering & Marking Information

Device Name: CR78L33 for SOT89-3



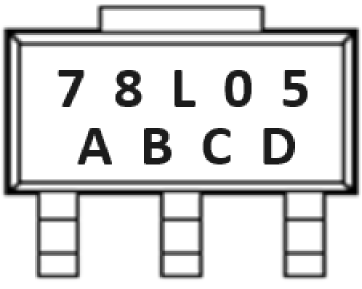
CR78L33 Device Name

ABCD: Date Code

Device Name: CR78L33 for SOT23-3

Device Name: GA
XX: Date Code

Device Name: CR78L05 for SOT89-3



CR78L05 Device Name

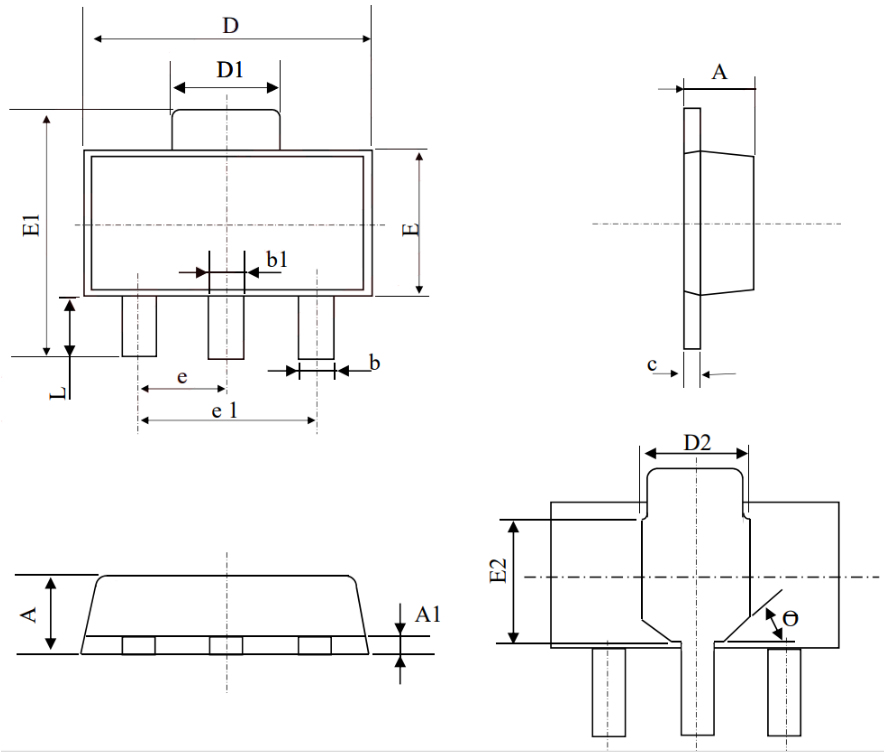
ABCD: Date Code

Device Name: CR78L05 for SOT23-3

Device Name: GA
XX: Date Code

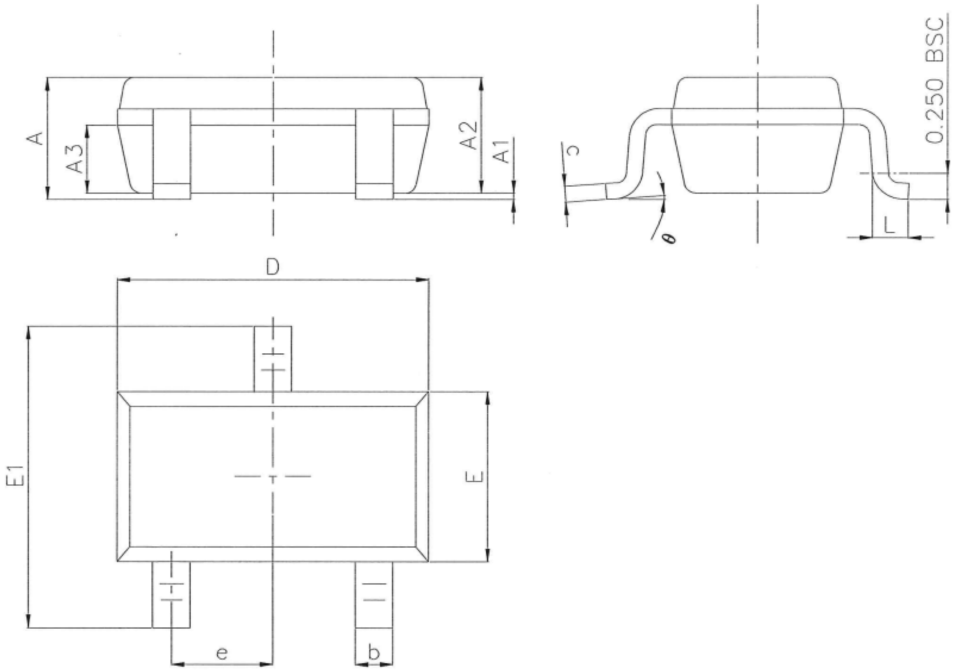
17. Package Information

17.1. SOT89-3



Symbol	Dimension in mm			Dimension in inch		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.400	1.500	1.600	0.055	0.059	0.063
A1	0.300	0.400	0.500	0.012	0.016	0.020
L	0.800	1.000	1.200	0.031	0.039	0.047
b	0.350	0.400	0.450	0.014	0.016	0.018
b1	0.400	0.480	0.550	0.016	0.019	0.022
c	0.300	0.400	0.500	0.012	0.016	0.020
D	4.400	4.500	4.600	0.173	0.177	0.181
D1	1.600	1.700	1.800	0.063	0.067	0.071
D2	1.72			0.068		
E	2.40	2.50	2.60	0.094	0.098	0.102
E1	3.94	4.10	4.25	0.155	0.161	0.167
E2	1.9			0.075		
e	1.5			0.059		
e1	3.0			0.118		
θ	45°			45°		

17.2. SOT23-3



Symbol	Dimension in mm			Dimension in inch		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.050	1.150	1.250	0.041	0.045	0.049
A1	0.000	0.060	0.100	0.000	0.002	0.004
A2	1.000	1.100	1.200	0.039	0.043	0.047
A3	0.550	0.650	0.750	0.022	0.026	0.030
D	2.820	2.920	3.020	0.111	0.115	0.119
E	1.510	1.610	1.700	0.059	0.063	0.067
E1	2.650	2.800	2.950	0.104	0.110	0.116
b	0.300	0.400	0.500	0.012	0.016	0.020
e	0.95BSC			0.037BSC		
θ	0°	4°	8°	0°	4°	8°
L	0.300	0.420	0.570	0.012	0.017	0.022
c	0.100	0.152	0.200	0.004	0.006	0.008

18. Revision History

Rev	Descriptions	Date
V1.1	Initial version preliminary released	2024/08/26
V1.2	1. Add Revision History table 2. Modify the errors in the minimum, maximum, and nominal dimensions. 3. Correct the order errors of dimensions **E1** and **E**.	2024/11/08
V1.3	Update document Layout Configuration	2024/11/27

19. Disclaimers

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