Description

The CAT4101 is a constant−current sink driving a string of high−brightness LEDs up to 1 A with very low dropout of 0.5 V at full load. It requires no inductor, provides a low noise operation and minimizes the number of components. The LED current is set by an external resistor connected to the RSET pin. The LED pin is compatible with high voltage up to 25 V, allowing the driving of long strings of LEDs. The device ensures an accurate and regulated current in the LEDs independent of supply and LED forward voltage variation.

The PWM/EN input allows the device shutdown and the LED brightness adjustment by using an external pulse width modulation (PWM) signal.

The driver features a thermal shutdown protection that becomes active whenever the die temperature exceeds 150°C.

July, 2012 − Rev. 8

Publication Order Number:
CAT4101/D

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter		
VIN, RSET, EN/PWM Voltages		
	ï65 to +150	C
	ï40 to +150	C
		C

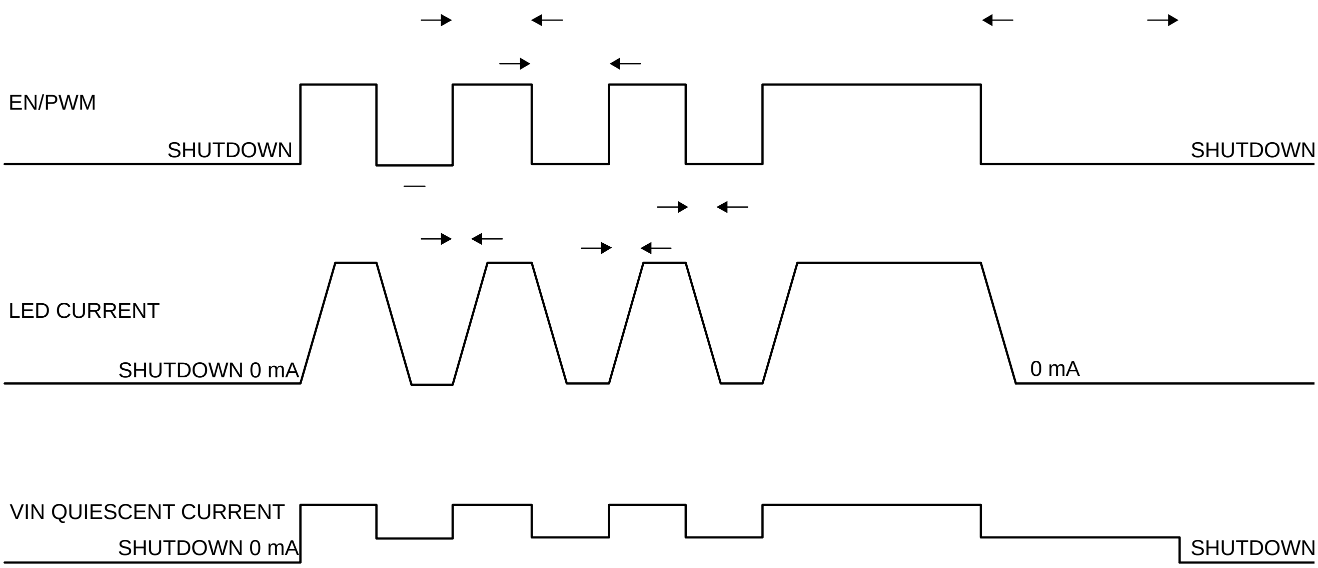
Table 2. RECOMMENDED OPERATING CONDITIONS

Parameter		
VIN Voltage		
	ï40 to +85	C

Table 3. ELECTRICAL OPERATING CHARACTERISTICS (Min and Max values in bold are over recommended operating conditions unless specified otherwise. Typical values are at V_{IN} = 5.0 V, T_{AMB}

Table 4. RECOMMENDED EN/PWM TIMING
(For 3.0 V ≤ VIN ≤ 5.5 V, over full ambient temperature range −40°C to +85°C.)

Symbol	Name	Conditions	Min	Typ	Max	Units
T_{PS}	Turn−On time, EN/PWM rising to I_{LED} from Shutdown	I_{LED} = 1 A I_{LED} = 350 mA		1.6 1.1		μs
T_{P1}	Turn−On time, EN/PWM rising to I_{LED}	I_{LED} = 1 A I_{LED} = 350 mA		920 620		ns
T_{P2}	Turn−Off time, EN/PWM falling to I_{LED}	I_{LED} = 1 A I_{LED} = 350 mA		440 310		ns
T_R	LED rise time	I_{LED} = 1 A I_{LED} = 350 mA		840 390		ns
T_F	LED fall time	I_{LED} = 1 A I_{LED} = 350 mA		470 350		ns
T_{LO}	EN/PWM low time		1			μs
T_{HI}	EN/PWM high time		5			μs
T_{PWRDWN}	EN/PWM low time to shutdown delay				8	ms



TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = 5 V, V_{CC} = 5 V, V_F = 3.5 V, I_{LED} = 1 A (1 LED), C_{IN} = 1 μF, T_{AMB} = 25°C unless otherwise specified.)

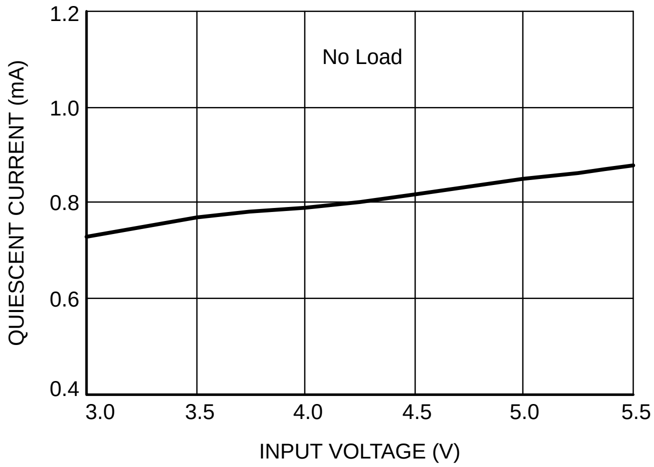


Figure 3. Quiescent Current vs. VIN Voltage (I_{LED} = 0 mA)

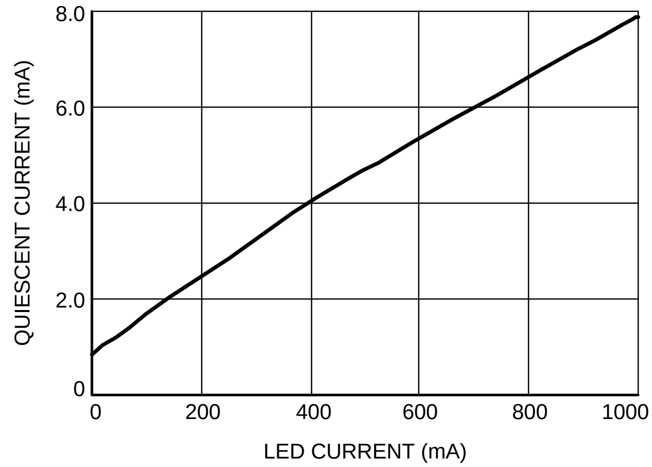


Figure 4. Quiescent Current vs. LED Current

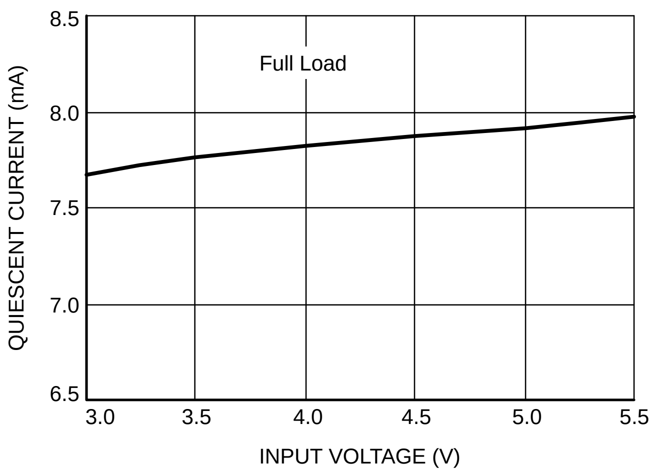


Figure 5. Quiescent Current vs. VIN Voltage (Full Load)

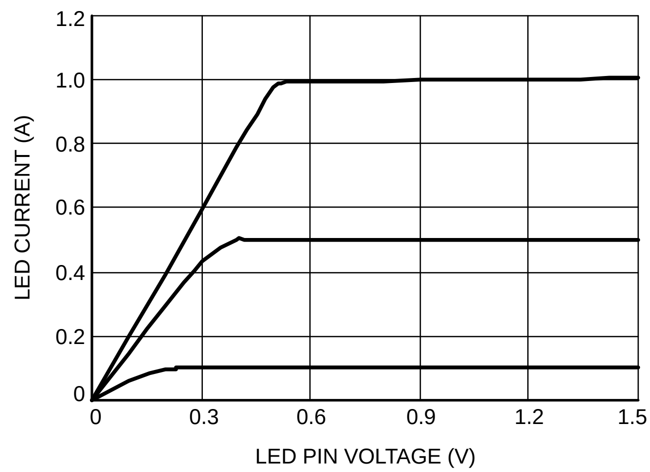


Figure 6. LED Current vs. LED Pin Voltage

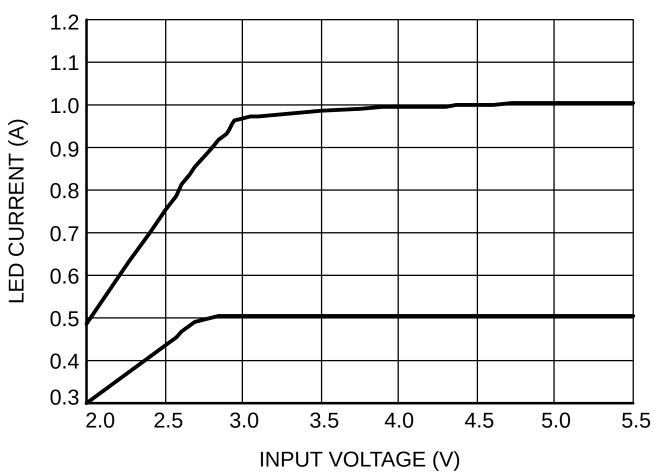


Figure 7. LED Current Change vs. VIN Voltage

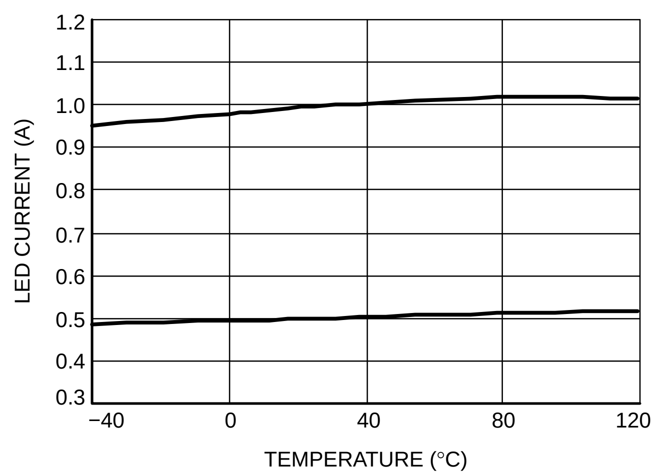


Figure 8. LED Current Change vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = 5 V, V_{CC} = 5 V, V_F = 3.5 V, I_{LED} = 1 A (1 LED), C_{IN} = 1 μF, T_{AMB} = 25°C unless otherwise specified.)

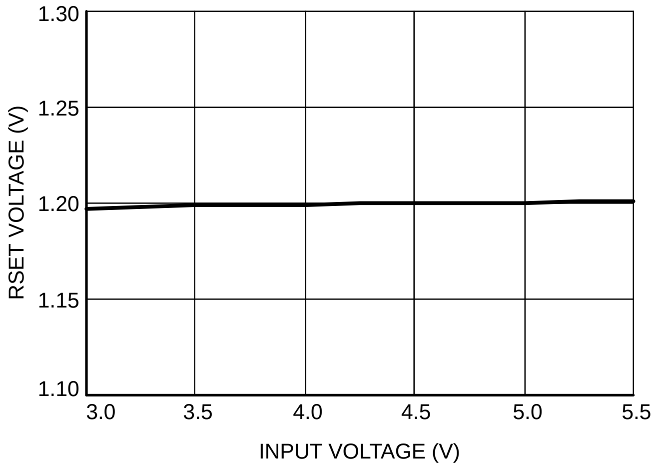


Figure 9. RSET Pin Voltage vs. VIN Voltage

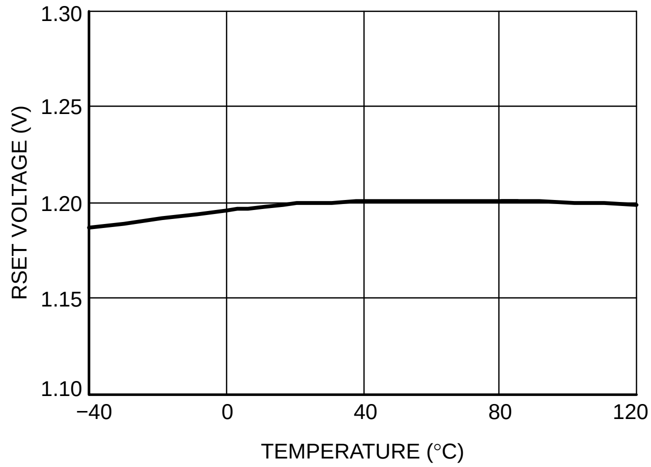


Figure 10. RSET Pin Voltage vs. Temperature

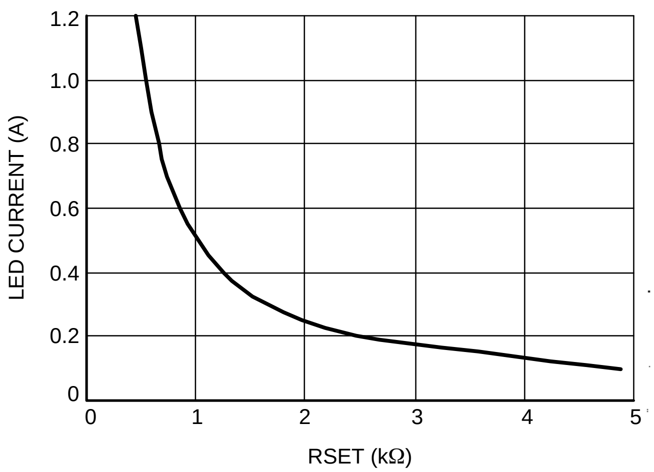


Figure 11. LED Current vs. RSET Resistor

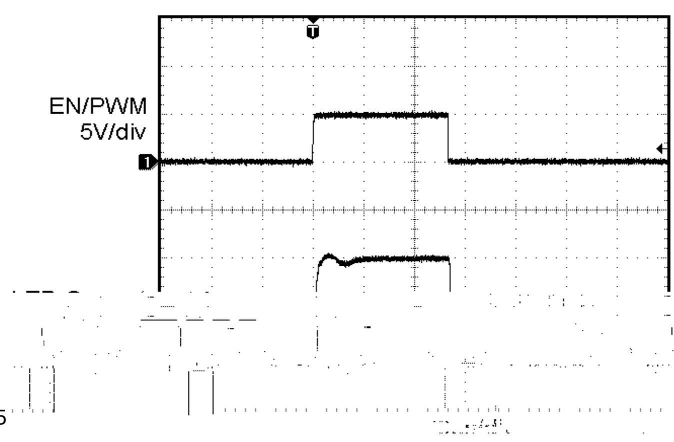


Figure 12. PWM 200 Hz, 1% Duty Cycle

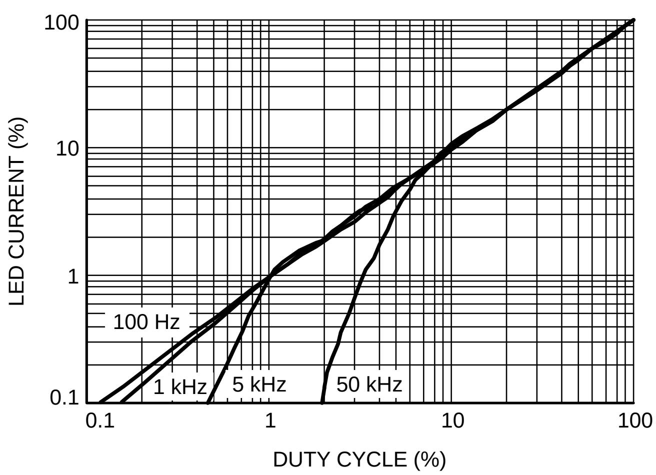


Figure 13. LED Current vs. PWM Duty Cycle

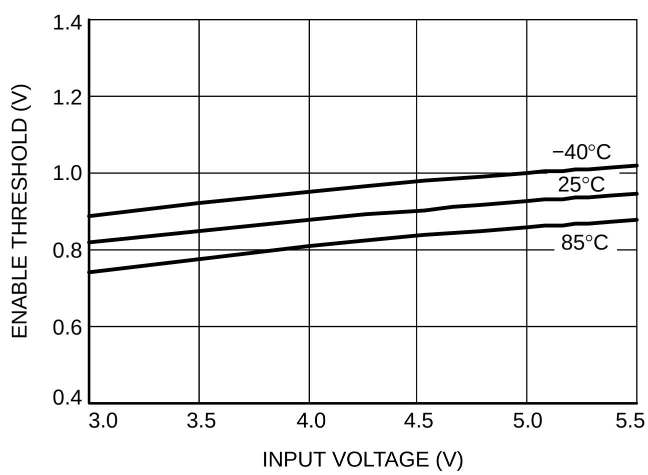


Figure 14. EN/PWM Threshold vs. VIN

Table 5. PIN DESCRIPTIONS

Name	Pin	Function
EN/PWM	1	Device enable (active high) and PWM control.
VIN	2	Device supply input, connect to battery or supply.

Block Diagram

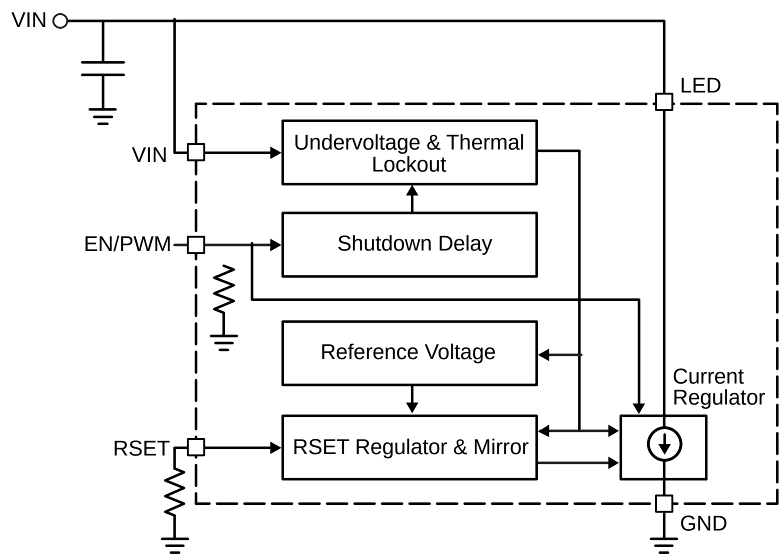


Figure 15. CAT4101 Functional Block Diagram

Application Information

Single 12 V Supply

The circuit shown in Figure 16 shows how to power three LEDs in series from a single 12 V supply using the CAT4101. The CAT4101 can not be driven directly from 12 V, three components are needed to create a lower voltage for the VIN pin (below 5.5 V). Resistor R2 and zener diode D provide a regulated voltage while the quiescent current runs through the N−Channel transistor M. Suitable parts for this circuit are the ON Semiconductor MM3Z6V2 zener diode and the 2N7002L N−channel transistor (SOT23 package).

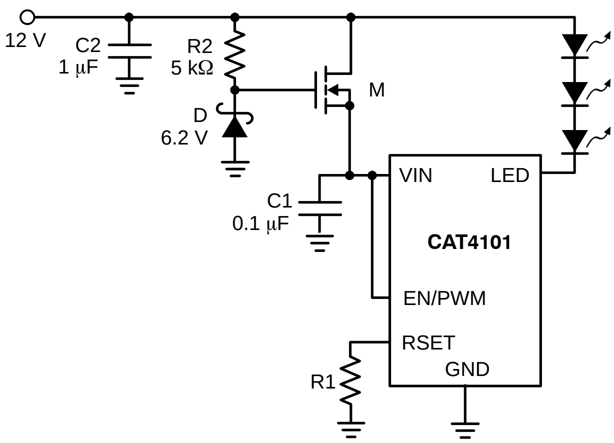


Figure 16. Single Supply Driving Three LEDs

Power Dissipation

The power dissipation (P_D) of the CAT4101 can be calculated as follows:

$$P_D = (V_{IN} \times I_{IN}) + (V_{LED} \times I_{LED})$$

where V_{LED} is the voltage at the LED pin. Combinations of high V_{LED} voltage or high ambient temperature can cause the CAT4101 to enter thermal shutdown. In applications where V_{LED} is high, a resistor can be inserted in series with the LED string to lower P_D.

Thermal dissipation of the junction heat consists primarily of two paths in series. The first path is the junction to the case (θ_{JC}) thermal resistance which is defined by the package style, and the second path is the case to ambient (θ_{CA}) thermal resistance, which is dependent on board layout. The overall junction to ambient (θ_{JA}) thermal resistance is equal to:

$$\theta_{JA} = \theta_{JC} + \theta_{CA}$$

For a given package style and board layout, the operating junction temperature T_J is a function of the power dissipation P_D, and the ambient temperature, resulting in the following equation:

$$T_J = T_{AMB} + P_D(\theta_{JC} + \theta_{CA}) = T_{AMB} + P_D\,\theta_{JA}$$

The CAT4101 TO−263 5−lead package provides a thermal resistance when the ground tab is soldered down to the PCB. When mounted on a double−sided printed circuit board with two square inches of copper allocated for “heat spreading”, the resulting θ_{JA} is about 30°C/W.

For example, at 60°C ambient temperature, the maximum power dissipation is calculated as follow:

$$P_{Dmax} = \frac{T_{Jmax} - T_{AMB}}{\theta_{JA}} = \frac{150 - 60}{30} = 3\text{ W}$$

Recommended Layout

The board layout should provide good thermal dissipation through the PCB. Multiple via can be used to connect the tab of the CAT4101 to a large ground plane underneath the package.

Input capacitor C1 should be placed as close to the driver IC as possible. The RSET resistor should have a Kelvin connection to the GND pin of the CAT4101.

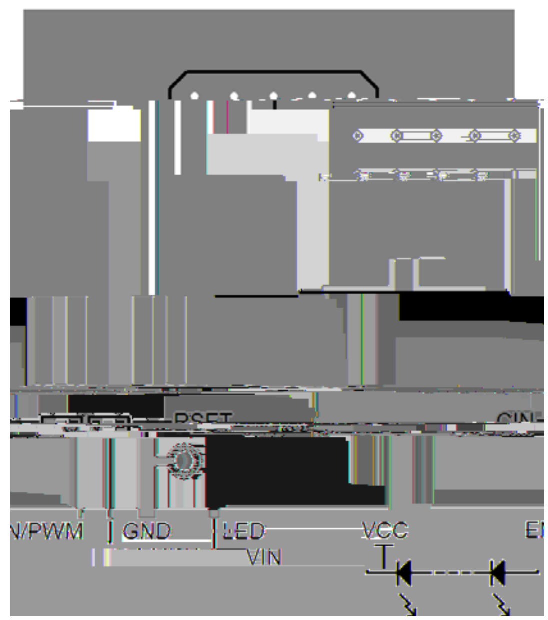
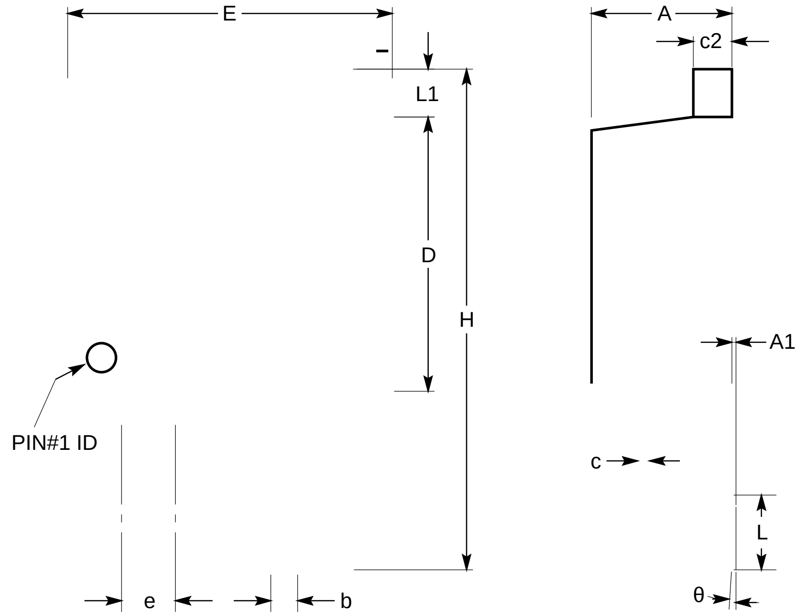


Figure 17. CAT4101 Recommended Layout



A	4.20		4.80
A1	0.00		0.25
b	0.60		0.88
c	0.33		0.50
c2	1.15		1.60
D	8.40		9.60
D1	6.86		
E	9.80		10.67
e	1.70 BSC		
H	14.61		15.87
L	1.78		2.79
L1			1.67
θ	0º		8º

(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC standard TO-263.

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