CONSONANCE

1A LDO Linear Regulator for Solar-Powered Systems

CN2628

General Description:

   The CN2628 is a low-noise, linear regulator that delivers up to 1A of output current. The regulator maintain ±1% output accuracy over a wide input voltage range of 5.5V to 7V. The 520μA no-load supply current is independent of drop-out voltage.

The on-chip adaptive cell can adjust output current automatically based on the output capability of input power supply, so CN2628 is ideally suited for the solar-powered systems, or the applications that need to charge a cell phone with an input power supply whose output capability is limited.

The CN2628 adopts constant current mode for users to set the maximum output current flexibly. When the output is shorted, the output current will be limited to 10% of the constant current. Also CN2628 adopts temperature regulation instead of over-temperature protection, which will regulates the output current to limit the die temperature during high power operation or high ambient temperature.

The other features include on-chip soft-start, output over-current protection and chip enable, etc.

The CN2628 is available in a thermally enhanced 8-pin SOP package.

Applications:

- Chargers Powered by Solar Panel
- Cell Phone Charger
- Wireless LAN
- Charger Cable with Indications
- IoT Applications
- Applications Powered by Solar Panel

Features:

- 5.5V to 7V Input Voltage Range
- Suitable for Solar- Powered Applications
- Factory-Preset Output Voltage of 5V
- Output Voltage Accuracy: ±1%
- Maximum Output Current: 1A
- 53dB PSRR at 10kHz
- Operating Supply Current at 6V: 520uA
- Shutdown Supply Current: 3.3uA@VIN=6V
- On-Chip Soft-Start
- Stable with 1μF(Min) Output Capacitance
- Constant Current Mode
- Short Circuit Current: 10% of Constant Current
- Overcurrent Protection
- Output-to-Input Reversed Current Protection
- On-Chip Temperature Regulation Instead of Over-Temperature Protection
- WORK and IDLE state indications
- Available in eSOP8 Package
- Pb-free, rohs-Compliant and Halogen Free

Pin Assignment
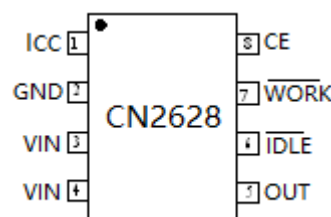
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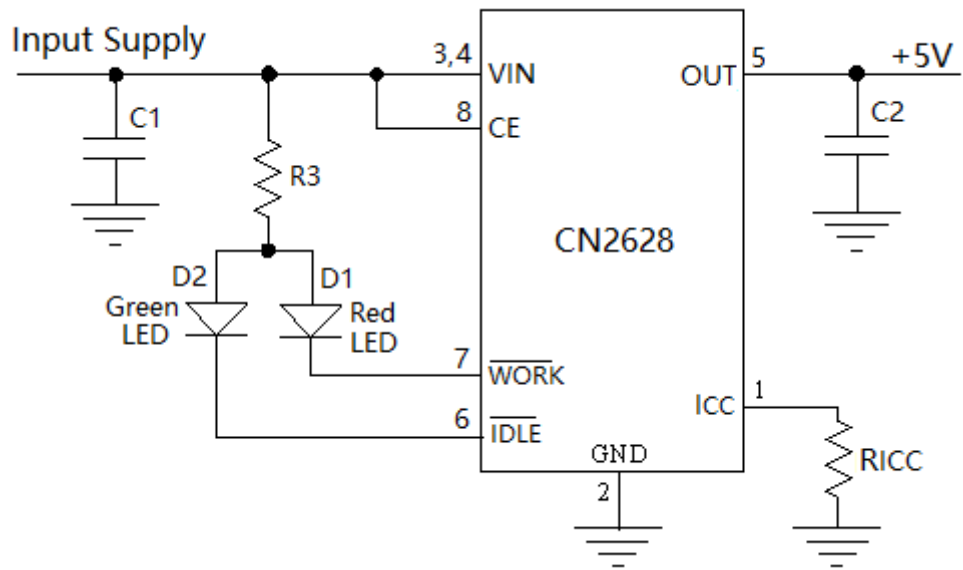
Typical Application Circuit

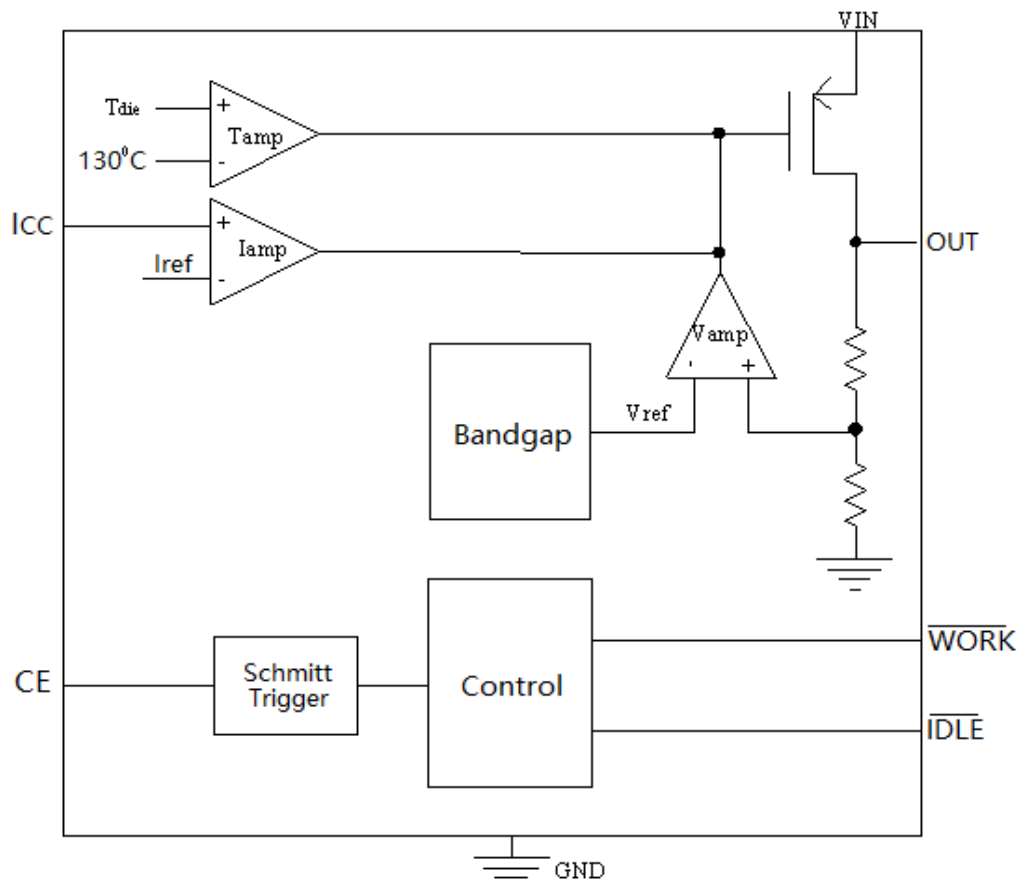Figure 1   Typical Application Circuit

Block Diagram

Figure 2   Block Diagram

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Ordering Information：

Part No.	Package	Output Voltage	Shipping
CN2628	eSOP8	5.0V	Tape and Reel, 4000/Reel

Pin Description

Pin No.	Name	Function Description
1	ICC	**Output Constant Current Setting and Output Current Monitoring Pin.** The maximum output current is set by connecting a resistor R_{ICC} from this pin to GND, and is determined by: $$I_{CC} = 1188V / R_{ICC}$$ In normal operating mode, the voltage on ICC pin can be used to measure the output current as follows: $$I_{OUT} = (V_{ICC} / R_{ICC}) \times 986$$
2	GND	**Ground Terminal (Ground).** The negative terminal of the input voltage and the output voltage.
3,4	VIN	**Positive Terminal of Input Supply Voltage.** VIN is the power supply to the internal circuit. Bypass with a capacitor from VIN to GND.
5	OUT	**Positive Terminal of Output Regulation Voltage.** Sources up to 1A and Bypass with a low ESR capacitor to GND.
6	$\overline{IDLE}$	**Idle State Indication Output.** Open drain active low output. If output current falls below 10% of the constant current set by R_{ICC} at ICC pin, this pin is pulled to GND by an internal N-channel MOSFET. Otherwise, this pin is in high impedance state.
7	$\overline{WORK}$	**Work State Indication Output.** Open drain active low output. If output current rises above 21% of the constant current set by R_{ICC} at ICC pin, this pin is pulled to GND by an internal N-channel MOSFET. Otherwise, this pin is in high impedance state.
8	CE	**Chip Enable Pin.** A high input will put the device in the normal operating mode. Pulling the CE pin to low level will put the CN2628 into disable mode. The CE pin can be driven by TTL or CMOS logic level.
9	EP	Exposed Pad. Connect the exposed pad to a ground plane with low thermal resistance to ambient to provide best heat sinking.

Absolute Maximum Ratings

All Terminal Voltage……………－0.3V to 6.5V   Maximum Junction Temperature…...150℃

OUT Short-Circuit Duration………...Continuous   Operating Temperature…...－40℃ to 85℃

ICC to GND………..……. －0.3V to VIN+0.3V   Thermal Resistance (eSOP8)…...…….TBD

Lead Temperature(Soldering, 10s)……....260℃   Storage Temperature…......－65℃ to 150℃

Stresses beyond those listed under 'Absolute Maximum Ratings' may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

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Electrical Characteristics

(VIN=3.7V, T_A=－40℃ to 85℃, Typical Values are measured at T_A=25℃,unless otherwise noted)

Parameters	Symbol	Test Conditions		Min	Typ	Max	Unit
Input Supply Voltage	VIN			5.5		7	V
Supply Current	I_{VIN}	VIN＝6.0V, CE is high		420	520	620	uA
	I_{SHDN}	VIN＝6.0V, CE is low		1.9	3.3	5	uA
	I_{SLP}	V_{IN}＝5V,VIN－V_{OUT}≤－20mV		1	1.7	2.5	uA
OUT Reverse Current	I_{REV}	V_{OUT}＝5.0V,VIN－V_{OUT}≤－20mV				2	uA
Undervoltage Lockout	Vuvlo	VIN falling			2.4	2.55	V
Undervoltage Lockout Hysteresis	Huvlo				0.12		V
Soft Start Time	tss			100	160	220	uS
Output Voltage	V_{REG}			4.95	5.0	5.05	V
Output Accuracy				-1		+1	%
Constant Current	I_{CC}	R_{ICC}=1.188K, Constant Current		0.9	1.0	1.1	A
Overcurrent Protection	I_{LIM}	Over Current Protection		1.05	1.25	1.45	A
Short Circuit Threshold	V_{SC}	Output Voltage		0.5	0.75	1.0	V
Short Circuit Current	I_{SC}	R_{ICC}＝1.188K, V_{OUT}≤V_{SC}		75	100	125	mA
(VIN－V_{OUT}) Comparator Trip Point		VIN falls, V_{OUT}＝5.0V		－12	－10	－6	mV
		VIN rises, V_{OUT}＝5.0V		28	40	58	mV
Power Suply Rejection Ratio	PSRR	C_{OUT}＝10uF, Iout＝800mA	f＝10KHz		53		dB
			f＝100KHz		40		
			f＝1MHz		42		
Load Regulation		I_{OUT} from 1mA to 1A, VIN = V_{OUT} + 500mV			0.0036		%／mA
Line Regulation		VIN from V_{OUT} + 0.5V to 6V I_{OUT}＝500mA			0.001		%／V
ICC Pin							
ICC Pin Voltage	V_{ICC}	Constant Current Mode		1.18	1.205	1.23	V
WORK Pin							
WORK Sink Current	I_{WORK}	V_{WORK}=0.3V，Work State			10		mA
WORK Leakage Current		V_{WORK}=6V，Idle State				1	μA
IDLE Pin							
IDLE Sink Current	I_{IDLE}	V_{IDLE}=0.3V，Idle State			10		mA
IDLE Leakage Current		V_{IDLE}=6V，Work State				1	μA
CE PIN							
Logic Input Low	V_{CEL}	CE voltage falling, Chip disabled				0.7	V
Logic Input High	V_{CEH}	CE voltage rising, Chip enabled		2.2			V
CE input Current	I_{CEL}	CE=GND, VIN=6V		－1			uA
	I_{CEH}	CE=VIN=6V				1	

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Detailed Description

The CN2628 is a low noise linear regulator which can deliver up to 1A of output current. The device regulates the output voltage over a wide input range from 5.5V to 6V, and requires only 0.3V of dropout voltage at 1A output current that can help improve the power efficiency of the systems.

The on-chip adaptive cell can adjust output current automatically based on the output capability of input power supply, so CN2628 is ideally suited for the solar-powered systems, or the applications that need to charge a cell phone with an input power supply whose output capability is limited.

The CN2628 has fixed output voltages of 5V. The on-chip precision bandgap, error amplifier and resistor divider provide a maximum accuracy of 1%. The CN2628 is stable with low ESR output capacitor that is down to 1uF. The protection features include temperature regulation, short circuit current foldback, constant current mode, high-speed overcurrent protection and Output-to-Input reversed current protection, etc.

The CN2628 adopts temperature regulation instead of over-temperature protection, which will regulates the output current to limit the die temperature during high power operation or high ambient temperature.

The CN2628 has 2 open drain state indication outputs, $\overline{\text{WORK}}$ and $\overline{\text{IDLE}}$, which can drive external LED or interface with MCU. If output current rises above 21% of the constant current set by R_{ICC} at ICC pin, this pin is pulled to GND by an internal N-channel MOSFET. Otherwise, this pin is in high impedance state. If output current falls below 10% of the constant current set by R_{ICC} at ICC pin, this pin is pulled to GND by an internal N-channel MOSFET. Otherwise, this pin is in high impedance state.

The CN2628 is basically a voltage source, but with constant current mode, which sets the maximum output current in the range of 30mA to 1.05A with an external resistor at ICC pin, so the CN2628 can also be used as the current source by properly setting the constant current level. The operating profile of CN2628 is shown in Figure 3.
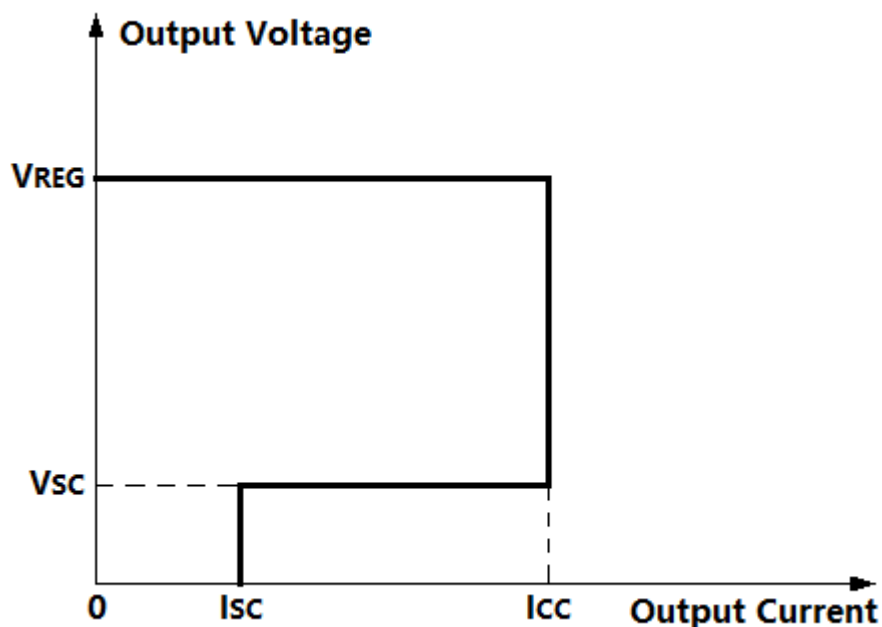

Figure 3 Operating Profile

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Application Information

Undervoltage Lockout (UVLO)

An internal undervoltage lockout circuit monitors the input voltage and keeps the CN2628 in shutdown mode until VIN rises above the undervoltage lockout voltage. The UVLO circuit has a built-in hysteresis of 0.12V.

Chip Enable/Disable

The CN2628 can be disabled by pulling the CE pin to less than 0.7V. For normal operation, pull the CE pin above 2.2V. Applying a voltage between 0.7V to 2.2V to this pin may cause larger operating current, and the CN2628 may be in uncertain state. When the chip is disabled, the internal linear regulator and the power MOSFET are turned off, the device only consumes 3.3uA current at 6V.

Constant Current Mode and Setting Constant Current

The CN2628 is basically a voltage source, but with constant current mode, which sets the maximum output current in the range of 30mA to 1.05A with an external resistor at ICC pin, so the CN2628 can also be used as the current source by properly setting the constant current level.

The formula for setting the constant current is:

$$I_{CC} = 1188V / R_{ICC}$$

Where:

I_{CC} is the constant current in ampere

R_{ICC} is the total resistance from the ICC pin to ground in ohm

For example, if 1A maximum output current is required, calculate:

$$R_{ICC} = 1188V/1A = 1.188k\ \Omega$$

For best stability over temperature and time, 1% metal film resistors are recommended. In normal operating mode, the output current can be monitored by measuring the ICC pin voltage, and the output current is calculated as the following equation:

$$I_{CC} = (V_{ICC} / R_{ICC}) \times 986$$

Open-Drain State Indication Outputs

The CN2628 has 2 open drain state indication outputs, $\overline{WORK}$ and $\overline{IDLE}$, which can drive external LED or interface with MCU. If output current rises above 21% of the constant current set by R_{ICC} at ICC pin, this pin is pulled to GND by an internal N-channel MOSFET. Otherwise, this pin is in high impedance state. If output current falls below 10% of the constant current set by R_{ICC} at ICC pin, this pin is pulled to GND by an internal N-channel MOSFET. Otherwise, this pin is in high impedance state.

The following table lists the 2 pins' state, it is assumed that red LED is connected at $\overline{WORK}$ pin, and green LED is at $\overline{IDLE}$ pin.

$\overline{WORK}$ Pin State	$\overline{IDLE}$ Pin State	State Description
Low (Red LED on)	High Impedance (LED off)	Output current above ICC*21%
High Impedance (Red LED off)	Low (Green LED on)	Output current below ICC*10%
High Impedance (Red LED off)	High Impedance (Green LED off)	3 possible states: ● Input voltage is lower than under voltage threshold, or ● Input voltage is lower than output voltage, or ● Shorted Output

If not used, connect $\overline{WORK}$ and $\overline{IDLE}$ to GND.

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Overcurrent Protection
In addition to constant current mode, the CN2628 also adopts a high-speed overcurrent protection scheme. The overcurrent protection level is internally set at 1.25A typical

Short Circuit Protection
When the output voltage is less than the short circuit threshold, the short circuit protection is asserted, and the output current is limited to 10% of the constant current that is set by the resistor at ICC pin.

OUT-to-VIN Reversed Current Protection
The CN2628 is also protected against reverse current when the output voltage is higher than the input. In the event that extra output capacitance is used at the output, a power-down transient at the input would normally cause a large reverse current through a conventional regulator. The CN2628 includes (VIN – VOUT) comparator that trips when VIN drops 10mV below OUT, the device is shut down to prevent any reverse current from OUT to VIN. So if an external voltage applied to OUT does not reverse charge a battery or power source applied to VIN (the leakage current from OUT to VIN is 2uA maximum).

Temperature Regulation
The CN2628 adopts temperature regulation instead of over-temperature protection, which will regulates the output current to limit the junction temperature during high power operation or high ambient temperature.
If the power dissipation of the CN2628 results in the junction temperature approaching 130℃, an internal amplifier will begin decreasing the output current to limit the junction temperature to approximately 130℃.

Dropout Voltage
A regulator's minimum dropout voltage determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. The CN2628 uses a p-channel MOSFET pass transistor to achieve low dropout voltage.
When (VIN – VOUT) is less than the dropout voltage, the PMOS pass device is in the linear region of operation, as with any linear regulator, PSRR and transient response degrade as (VIN – VOUT) approaches dropout voltage.

No Load Stability
The CN2628 will remain stable and in regulation with no external load.

PSRR and Transient Response
The CN2628 is designed to deliver high PSRR as well as low dropout in battery-powered systems. The CN2628 power-supply rejection is 53dB at 10kHz, 42dB at 1MHz.
The improved supply-noise rejection and transient response can be achieved by increasing the values of the input and output bypass capacitors, and through passive filtering techniques.

Output Bypass Capacitor
The CN2628 requires a ceramic output capacitance of 1 μF or larger for stability over the full temperature range and with load currents up to 1A. Use X5R- and X7R-type ceramic capacitors because these capacitors have minimal variation in value and equivalent series resistance (ESR) over temperature. When choosing a capacitor for a specific application be sure to look at the dc bias characteristics for the capacitor. Higher output voltages cause a significant derating of the capacitor.
To improve load transient response, stability and power-supply rejection, large ceramic output capacitor values can be used such as 10μF and 20uF,etc.

VIN Bypass Capacitor
Many types of capacitors can be used for input bypassing(C1 in Figure 1), Generally, a 1uF ceramic capacitor, placed in close proximity to VIN and GND pins, works well. In some applications depending on the power supply characteristics and cable length, it may be necessary to increase the capacitor's value.
For better transient response and power-supply rejection, large ceramic capacitor can be used.

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CN2628 Powered by 6V Solar Panel

The CN2628 specially designed to charge cell phone with 6V solar panel. For the 6V solar panel, the open-circuit voltage may be above 7.5V. In this case, the input voltage can be applied to CN2628's pin 4 (VIN) through a schottky diode as shown in Figure 4, in which diode D3 is for this purpose.
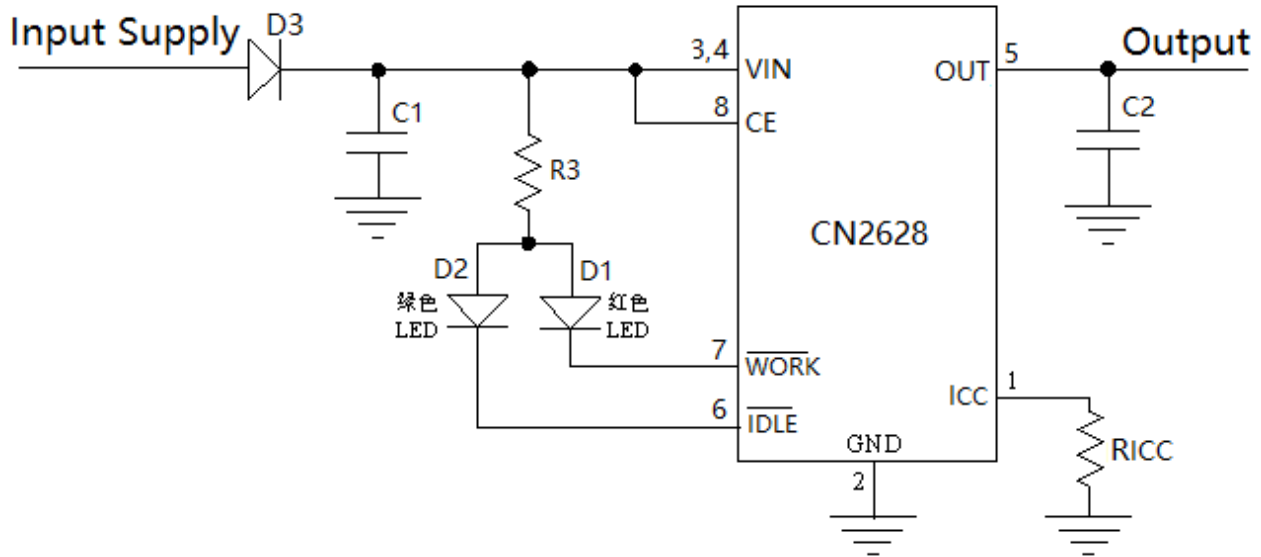


Figure 4   CN2628 Powered by 6V Solar Panel

Board Layout Considerations

1. R_{ICC} at ICC pin should be as close to CN2628 as possible, also the parasitic capacitance at ICC pin should be kept as small as possible.

2. The capacitors at VIN pin and OUT pin should be as close to CN2628 as possible.
   Every capacitor must be placed on the same side of the PCB as the CN2628. Do not place any of the capacitors on the opposite side of the PCB from where the device is installed.
   The use of vias and long traces is strongly discouraged because of the negative impact on system performance. Vias and long traces can also cause instability.

3. It is very important to use a good thermal PC board layout to maximize output current. The thermal path for the heat generated by the IC is from the die to the copper lead frame through the package lead(especially the ground lead) to the PC board copper, the PC board copper is the heat sink. The footprint copper pads should be as wide as possible and expand out to larger copper areas to spread and dissipate the heat to the surrounding ambient. Feedthrough vias to inner or backside copper layers are also useful in improving the overall thermal performance of the regulator. Other heat sources on the board, not related to the regulator must also be considered when designing a PC board layout because they will affect overall temperature rise and the maximum output current.
   The ability to deliver maximum output current under all conditions require that the exposed metal pad on the back side of the CN2628 package be soldered to the PC board ground. Failure to make the thermal contact between the exposed pad on the backside of the package and the copper board will result in larger thermal resistance.

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Package Information
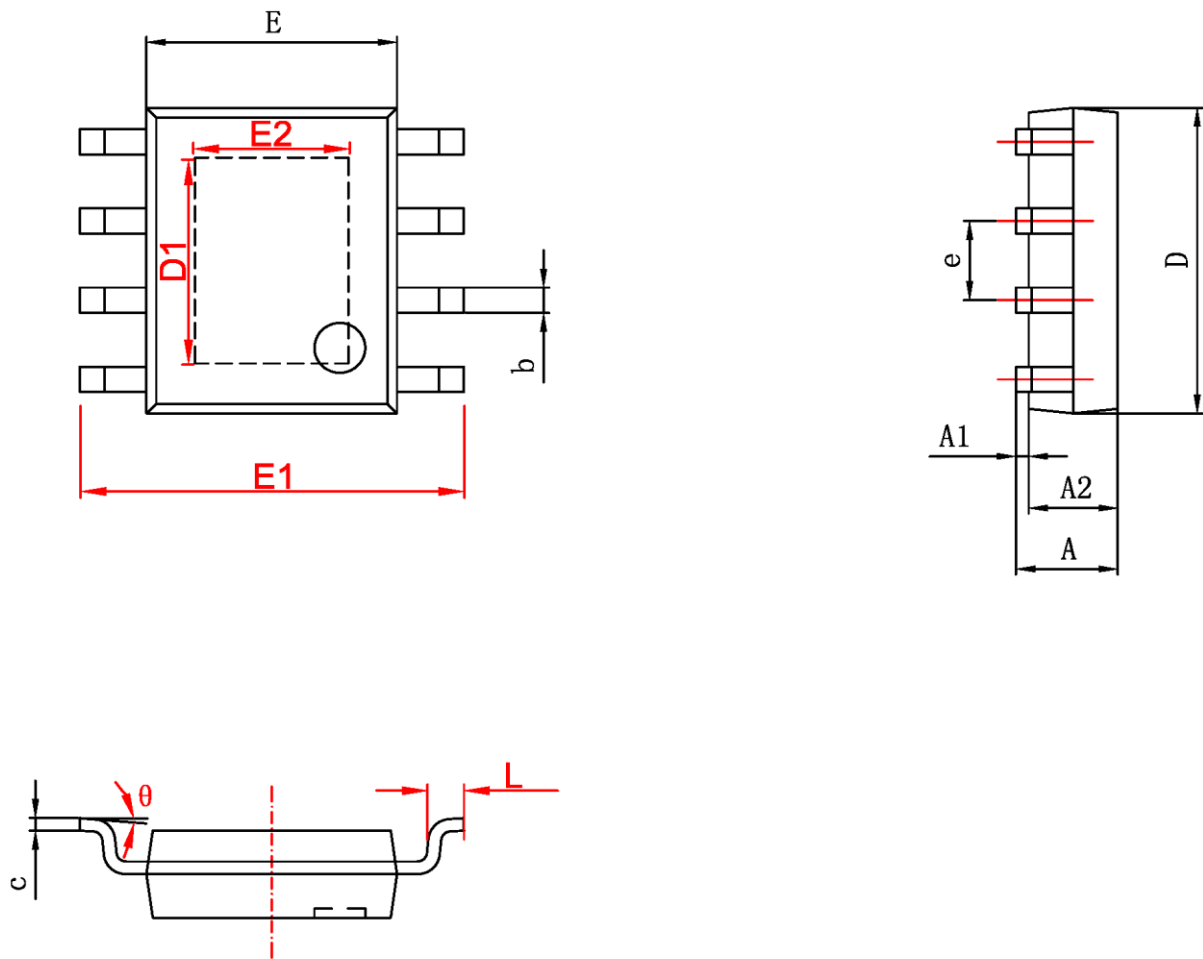
字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Consonance does not assume any responsibility for use of any circuitry described. Consonance reserves the right to change the circuitry and specifications without notice at any time.