2uA 600mA Ultra-LowDropout Regulator

Features

- 2μA Ground Current at no Load
- ±2% Output Accuracy
- 600mA Output Current
- 10nA Disable Current (by option)
- Wide Operating Input Voltage Range: 1.2V to 5.5V
- Dropout Voltage: 0.32V at 600mA / V_{OUT} 3.3V
- Adjustable Output Voltage
- Stable with Ceramic or Tantalum Capacitor
- Current Limit Protection
- Over-Temperature Protection
- SOT-23-5 Packages Available

Applications

- Portable, Battery Powered Equipment
- Low Power Microcontrollers
- Laptop, Palmtops and PDAs
- Wireless Communication Equipment
- Audio/Video Equipment
- Car Navigation Systems

General Description

The FC172CADJS5 are a group of low-dropout (LDO) voltage regulators offering the benefits of wide input voltage range from 1.2V to 5.5V, low dropout voltage, low power consumption, and miniaturized packaging. Quiescent current of only 2μA makes these devices ideal for powering the battery-powered, always-on systems that require very little idle-state power dissipation to a longer service life. There is an option of shutdown mode by selecting the parts with the EN pin and pulling it low. The shutdown current in this mode goes down to only 10nA (typical).

The FC172CADJS5 of linear regulators are stable with the ceramic output capacitor over its wide input range from 1.2V to 5.5V and the entire range of output load current (0mA to 600mA).

Ordering Information

FC172CADJS5

- S5:SOT23- 5 Package
- Output voltage: ADJ
  (SNS)VFB=0.8V

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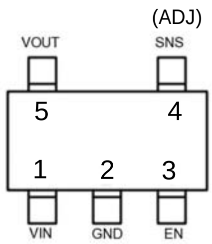

Pin No	Pin Name	Pin Function
2	GND	Ground
5	VOUT	Output of the Regulator
1	VIN	Input of Supply Voltage.
3	EN	Enable Control Input.
4	SNS	Sense of Output Voltage.

TYPICAL APPLICATION

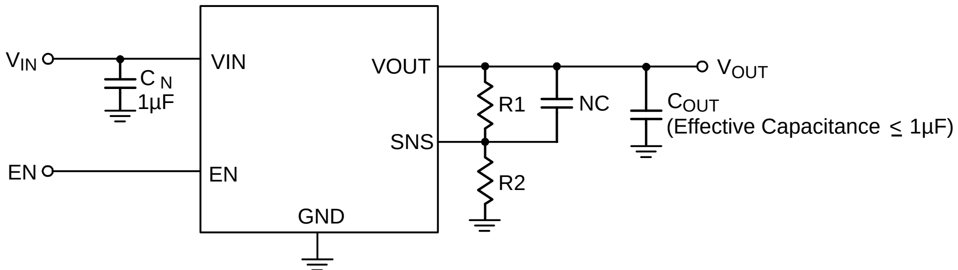

Figure 3. Adjustable Output Voltage Application Circuit

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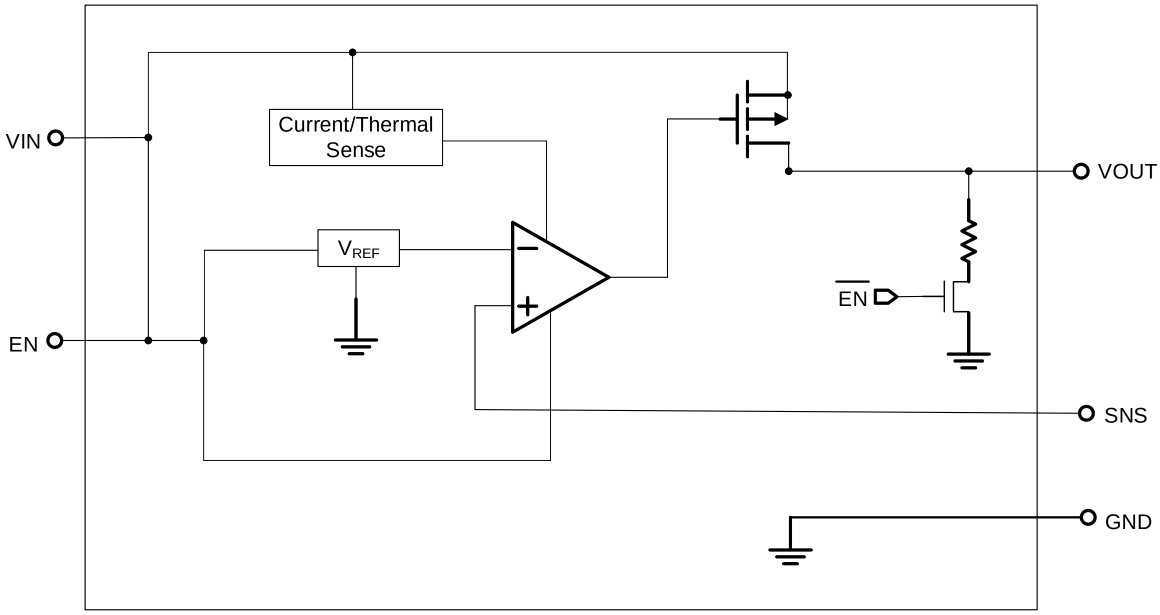
BLOCK DIAGRAM



Absolute Maximum Rating (T$_A$=25°C unless otherwise noted)

VIN to GND -- -0.3V to 6.5V

VOUT, EN, SNS to GND -- -0.3V to 6V

VOUT to VIN -- -6V to 0.3V

Package Thermal Resistance (Note 2)

SOT-23-5, θ_{JA} -- 200 °C /W

Lead Temperature (Soldering, 10 sec.) -- 260 °C

Junction Temperature -- 150 °C

Storage Temperature Range -- -60 °C to 150 °C

ESD Susceptibility

HBM -- 2KV

MM -- 200V

CDM -- 2KV

Recommended Operating Conditions

Input Voltage VIN -- 1.2V to 5.5V

Junction Temperature Range -- -40 °C to 125 °C

Ambient Temperature Range -- -40 °C to 85 °C

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Electrical Characteristics

(V_{IN} =5V, V_{EN} = 5V T_A=25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{N}		1.2	--	5.5	V
DC Output Voltage Accuracy	V_{SNS}	I_{LOAD} =0.1mA		0.8		V
SNS Input Current	I_{SNS}	SNS = V_{OUT}		0.7		μA
Dropout Voltage (I_{LOAD} =600mA) (Note 3)	V_{DROP_3V}	V_{OUT} ≥ 3V		0.32		V
	$V_{DROP\_2.8V}$	V_{OUT} = 2.8V		0.36		
	$V_{DROP\_2.5V}$	V_{OUT} = 2.5V		0.36		
	$V_{DROP\_1.8V}$	V_{OUT} = 1.8V		0.57		
	$V_{DROP\_1.5V}$	V_{OUT} = 1.5V		0.71		
	$V_{DROP\_1.2V}$	V_{OUT} = 1.2V		0.8		
Ground Current	I_Q	I_{LOAD} = 0mA		2		μA
Shutdown Ground Current	I_{SD}	V_{EN} = 0V, V_{OUT} = 0V		0.01	0.5	μA
V_{OUT} Shutdown Leakage Current	I_{LEAK}			0.01	0.5	
Enable Threshold Voltage	V_{H}	EN Rising			2	V
	V_{IL}	EN Falling	0.6			
EN Input Current	I_{EN}	V_{EN} = 5V		10	100	nA
Line Regulation	ΔLINE	I_{LOAD} =30mA, 1.5V ≤ V_{IN} ≤ 5.5V or (V_{OUT} + 0.2V) ≤ V_{IN} ≤ 5.5V		0.2		%
Load Regulation	ΔLOAD	10mA ≤ I_{LOAD} ≤ 0.3A		0.2		%
Output Current Limit	I_{LIM}	V_{OUT} =0	600	1100		mA
Power Supply Rejection Ratio (I_{LOAD} =5mA)	PSRR	V_{OUT} =1.2V, V_{IN} = 2V; f = 100Hz	--	80	--	dB
		V_{OUT} =1.2V, V_{IN} = 2V; f = 1kHz	--	75	--	
Output Voltage Noise (BW = 10Hz to 100kHz, C_{OUT} =1μF,)	Noise	V_{IN} = 3.5V, I_{LOAD} =0.1A; V_{OUT} =0.9V	--	40	--	μV_{RMS}
		V_{IN} = 3.5V, I_{LOAD} =0.1A; V_{OUT} =2.8V	--	50	--	
Thermal Shutdown Temperature	T_{SD}	I_{LOAD} =10mA	--	155	--	°C
Thermal Shutdown Hysteresis	ΔT_{SD}		--	15	--	°C
Discharge Resistance		EN = 0V , V_{OUT} = 0.1V	--	100	--	Ω

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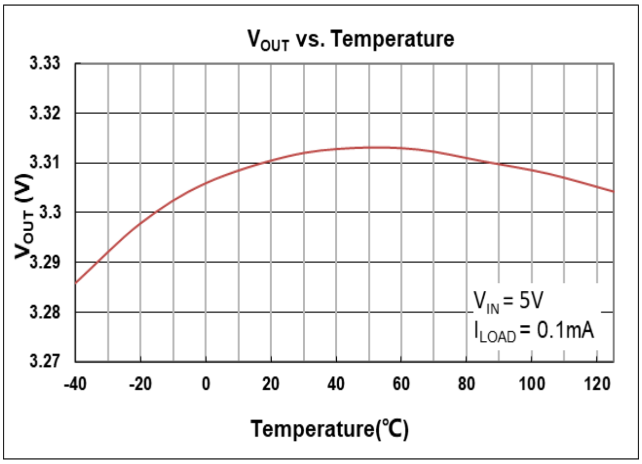
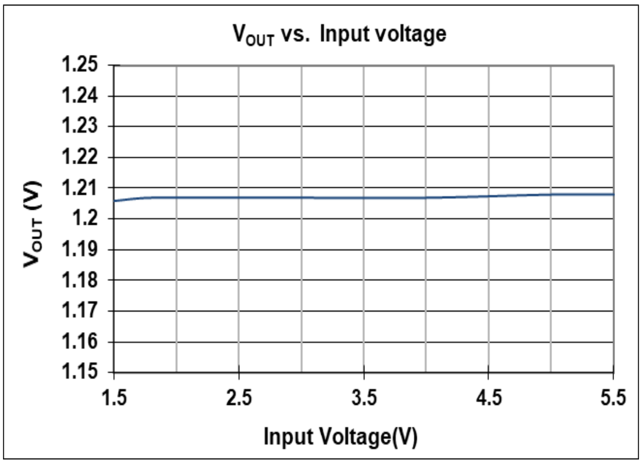
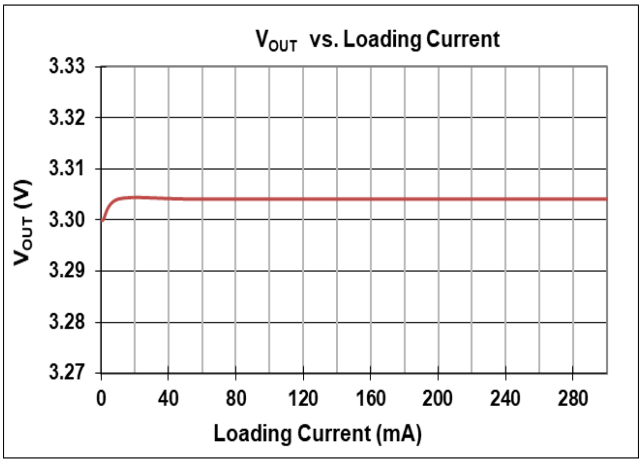
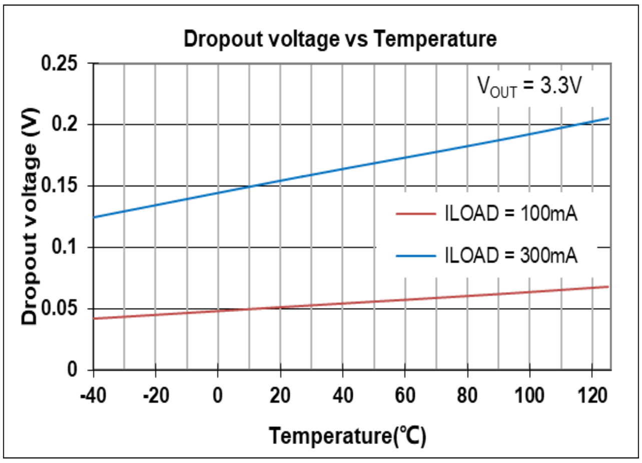
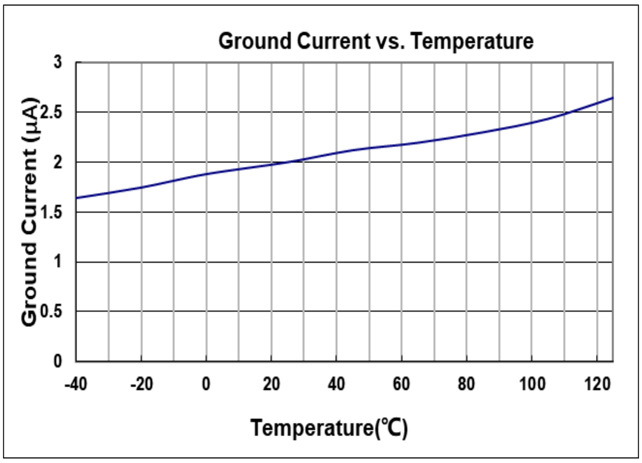
Typical Characteristics

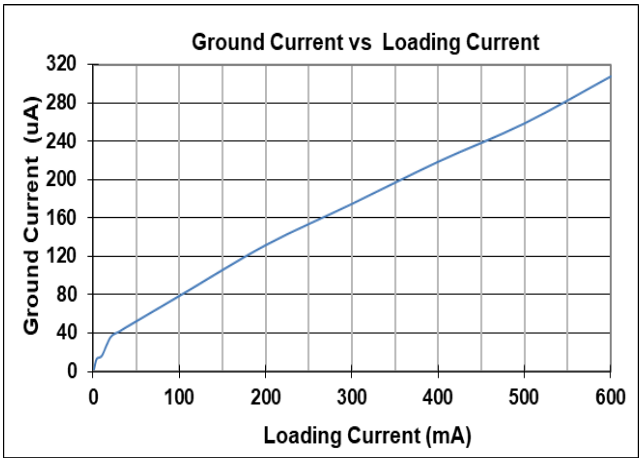












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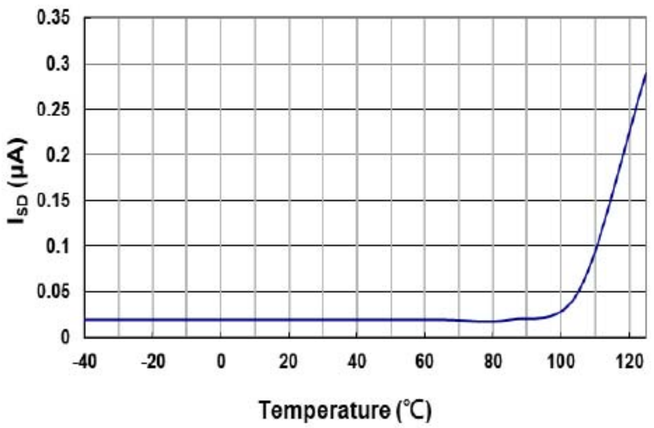

Fig. 11 Shutdown Ground Current vs. Temperature

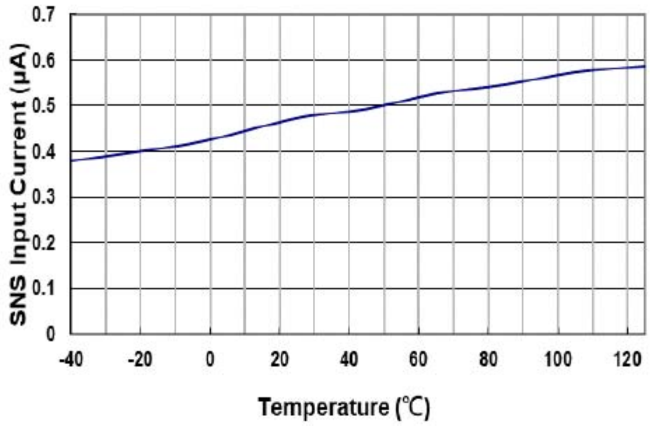

Fig. 12 SNS Input Current vs. Temperature

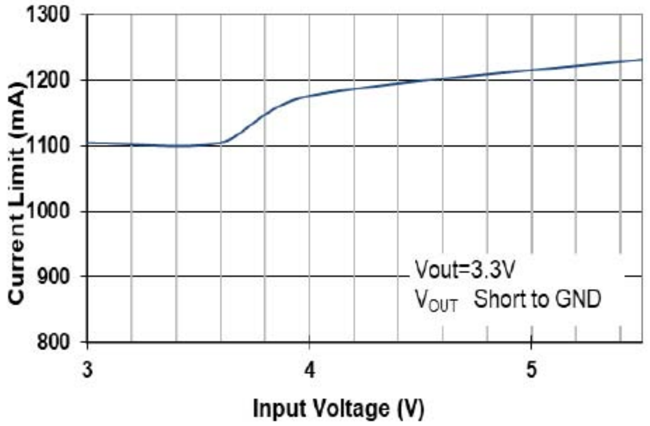

Fig. 13 Current Limit vs. Input Voltage

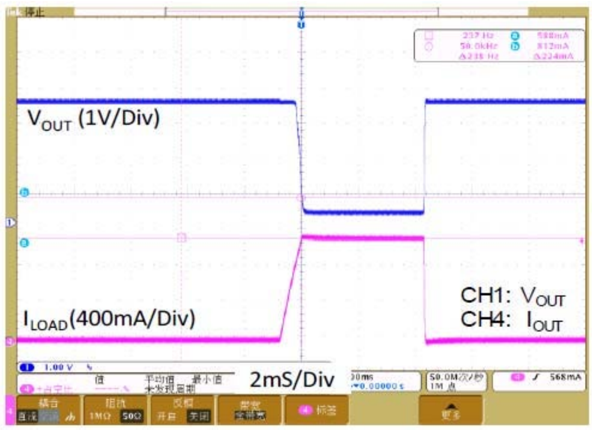

Fig. 14 Current Limit Response

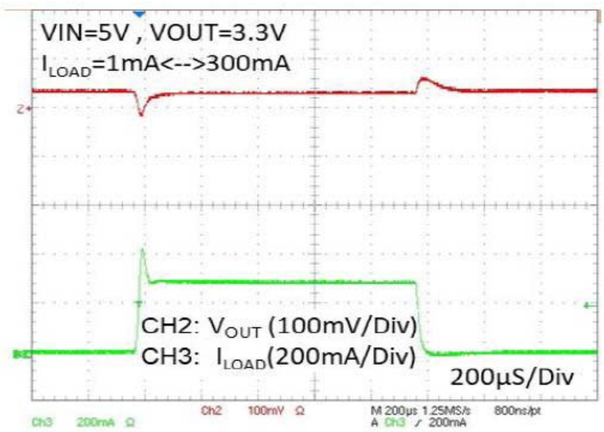

Fig. 15 Load Transient Response

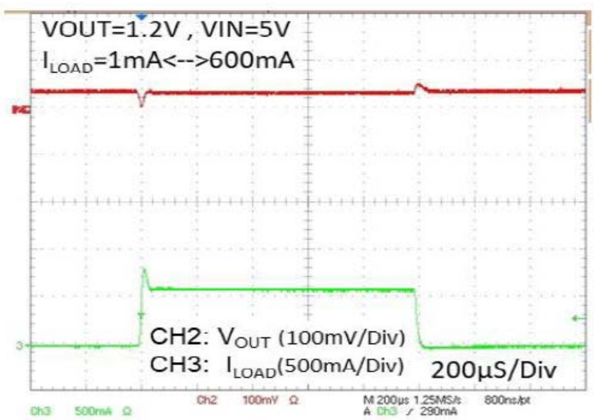

Fig. 16 Load Transient Response

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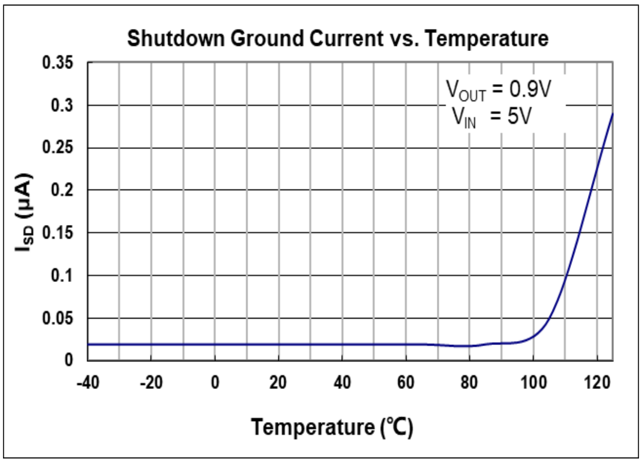
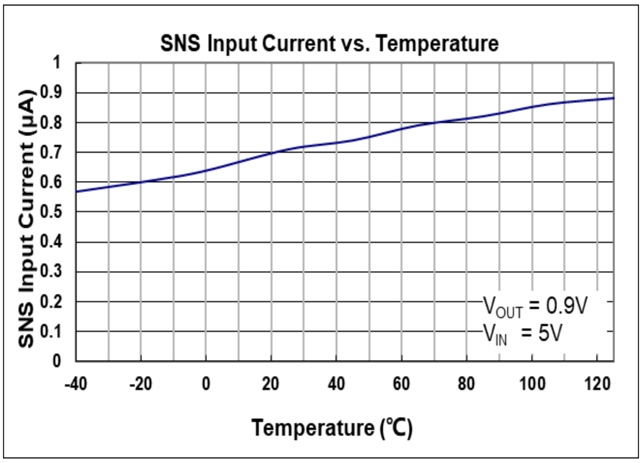
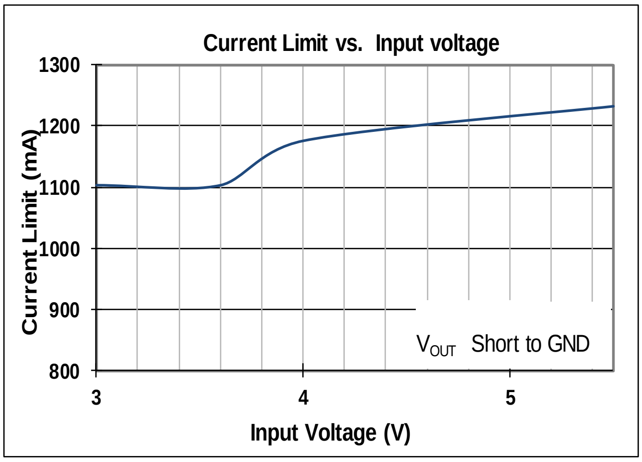
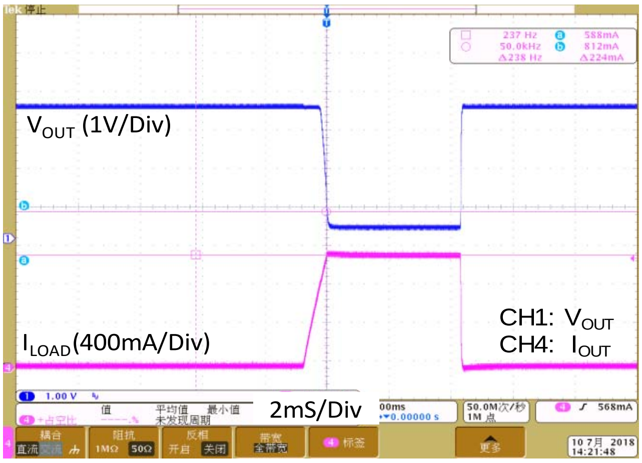


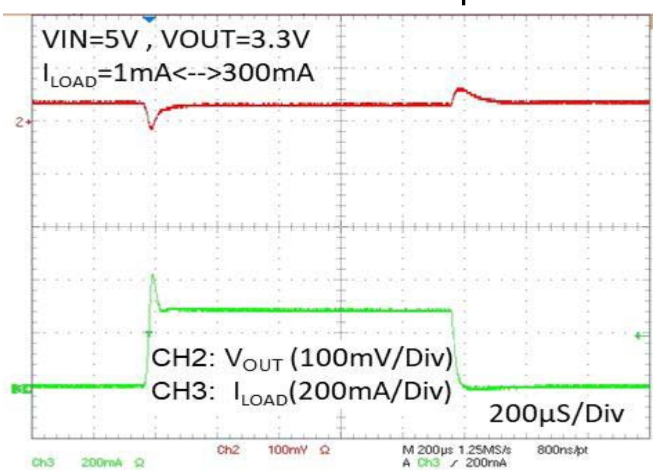




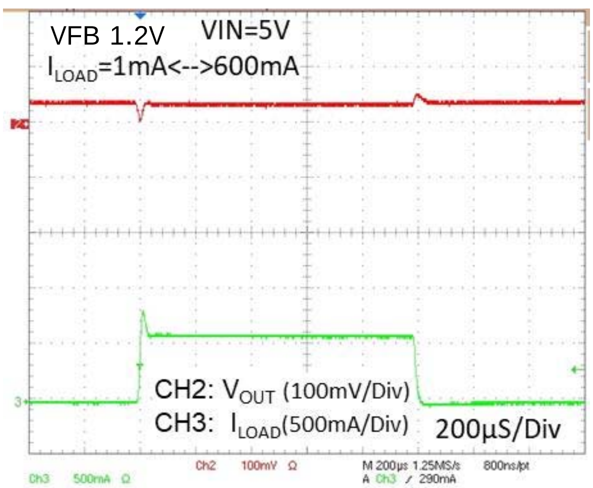
Current Limit Response



Load Transient Response I



Load Transient Response II



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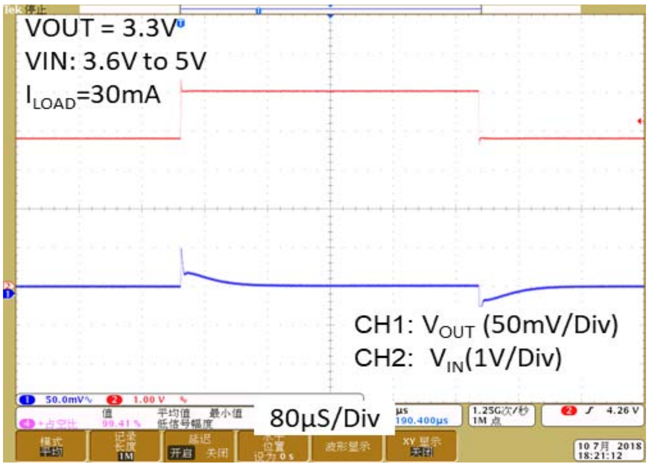
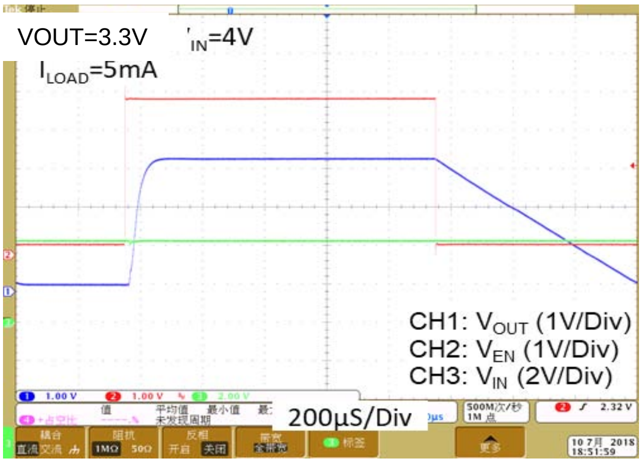
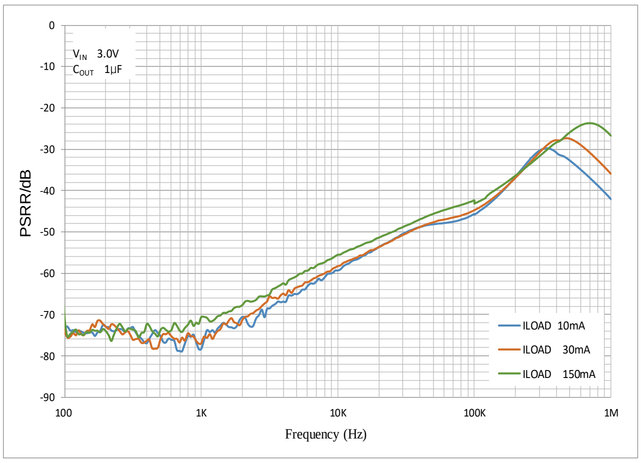
Line Transient Response



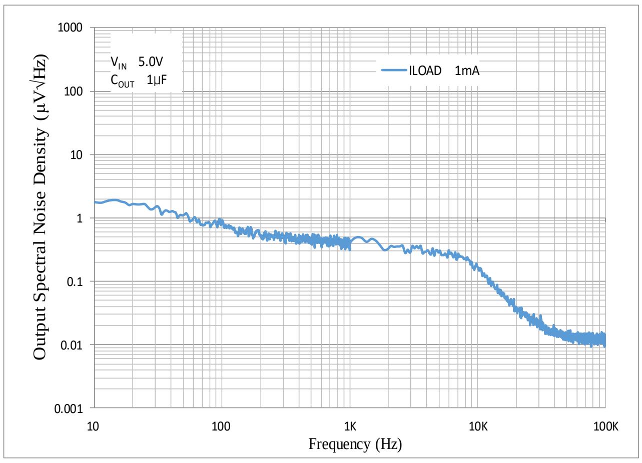
V_OUT Turn On/Off by EN



PSRR vs. Frequency



Noise Density Spectrum



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Application Guideline

Input and Output Capacitor Requirements

The external input and output capacitors of FC172C ADJS5 must be properly selected for stability and performance. Use a 1μF 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 between 1μF and 22μF 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.

Current Limit

The FC172CADJS5 contain the current limiter of output power transistor, which monitors and controls the transistor, limiting the output current to 1100mA (typical).

The output can be shorted to ground indefinitely without damaging the part.

Dropout Voltage

The FC172CADJS5 use a PMOS pass transistor to achieve low dropout. When (V_{IN} – V_{OUT}) is less than the dropout voltage (V_{DROP}), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the $RDS_{(ON)}$ of the PMOS pass element. V_{DROP} scales approximately with the output current because the PMOS device behaves as a resistor in dropout condition.

As any linear regulator, PSRR and transient response are degraded as (V_{IN} – V_{OUT}) approaches dropout condition.

Adjustable Output Voltage Application

FC172CADJS5 by SNS pin also can work as an adjustable output voltage LDO. Figure 1 gives the connections for the adjustable output voltage application. The resistor divider from V_{OUT} to SNS sets the output voltage when in regulation.

The voltage on the SNS pin sets the output voltage and is determined by the values of R1 and R2. To keep a good temperature coefficient of output voltage, the values of R1 and R2 should be selected carefully to ignore the temperature effect of input current at the SNS pin. A current greater than 50μA in the resistor divider is recommended to meet the above requirement. The adjustable output voltage can be calculated using the formula given in equation 1:

$$V_{OUT} = \frac{R1+R2}{R2} \times SNS \qquad (1)$$

where V_{SNS} is determined by the output voltage selections in the ordering information of

The minimum recommended 50μA in the resistor divider makes the application no longer a 2μA low quiescent LDO.

OTP (Over Temperature Protection)

The over temperature protection function of FC172CADJS5 series will turn off the P-MOSFET when the junction temperature exceeds 155°C (typ.). Once the junction temperature cools down by approximately 15°C, the regulator will automatically resume operation.

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Thermal Application

For continuous operation, do not exceed the 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 as below:

T_A=25°C, TECH PUBLIC PCB,
The max PD (Max) = (125°C − 25°C) / (200°C/W) = 0.5W for SOT-23-5 package.

Power dissipation (PD) is equal to the product of the output current and the voltage drop across the output pass element, as shown in the equation below:

PD = (VIN – VOUT) × IOUT

Layout Consideration

By placing input and output capacitors on the same side of the PCB as the LDO, and placing them as close as is practical to the package can achieve the best performance. The ground connections for input and output capacitors must be back to the FC172CADJS5 ground pin using as wide and as short of a copper trace as is practical. Connections using long trace lengths, narrow trace widths, and/or connections through via must be avoided. These add parasitic inductances and resistance that results in worse performance especially during transient conditions.

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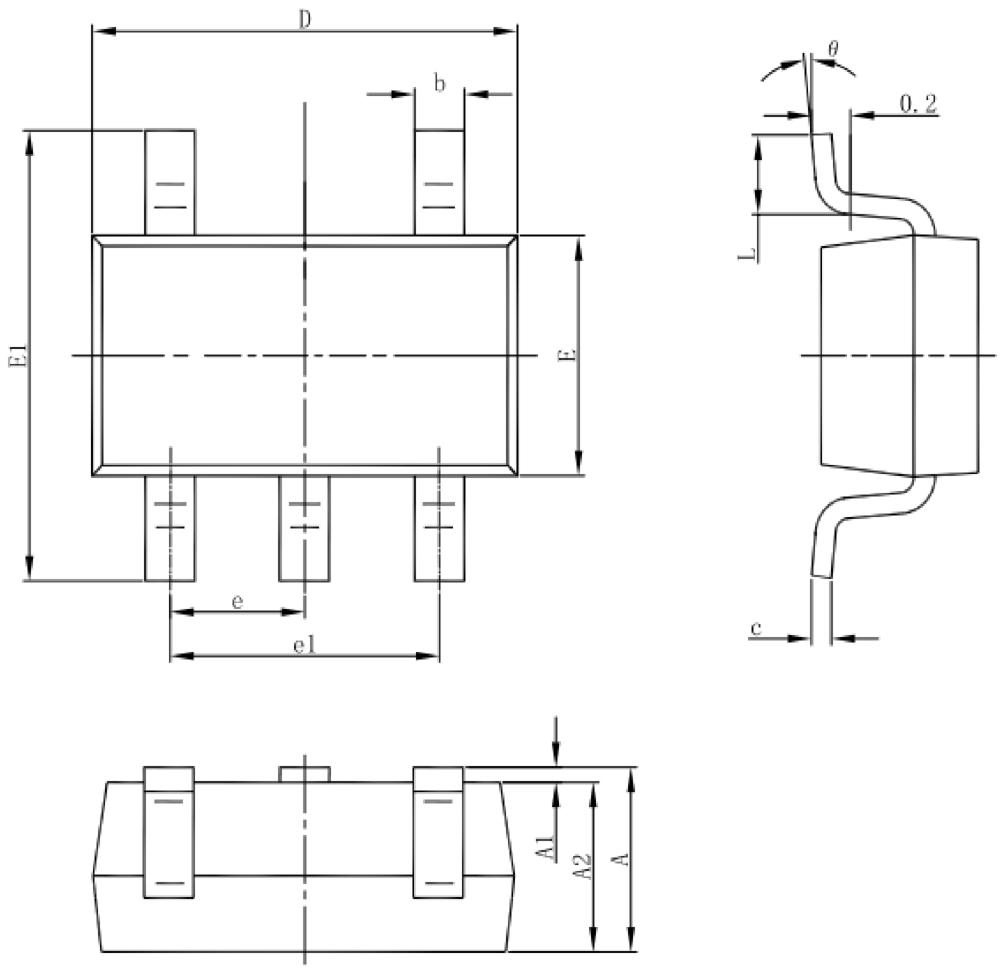
Package informantion

SOT23-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°