TS5215

300mA Low Noise LDO Voltage Regulator with Enable

SOT-25

Pin Definition:
1. Input
2. Ground
3. Enable
4. Bypass / Adjust
5. Output

SOT-89-5L

Pin Definition:
1. Bypass / Adjust
2. Ground
3. Enable
4. Input
5. Output

SOP-8

Pin Definition:
1. Enable
2. Input
3. Output
4. Bypass / Adj
5. Ground
6. Ground
7. Ground
8. Ground

General Description

TS5215 is an efficient linear voltage regulator with ultra low noise output, very low dropout voltage (typically 17mV at light loads and 300mV at 300mA), and very low power consumption (125uA at 100uA), providing high output current even when the application requires very low dropout voltage. The Chip Enable (EN) includes a CMOS or TTL compatible input allows the output to be turned off to prolong battery life. When shutdown, power consumption drops nearly to zero.

TS5215 is included a precision voltage reference, error correction circuit, a current limited output driver, over temperature shutdown, revered battery protection and a reference bypass pin to improve its already excellent low-noise performance.

Features

- Ultra Low Noise Output
- Output Current up to 350mA
- Low Dropout Voltage
- Low Power Consumption
- “Zero” Off-mode Current
- Logic Controlled Electronic Enable
- Internal Current Limit
- Thermal Shutdown Protection

Application

- Cellular Telephones
- Palmtops, Notebook Computers
- Battery Powered Equipment
- Consumer and Personal Electronics
- SMPS Post Regulator and DC to DC Modules
- High-efficiency Linear Power Supplies
- Portable Application

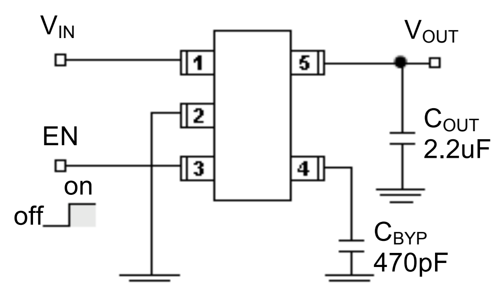
Ordering Information

Part No.	Package	Packing
TS5215CX5**xx** RF	SOT-25	3Kpcs / 7” Reel
TS5215CY5**xx** RM	SOT-89-5L	1Kpcs / 7” Reel
TS5215CS**xx** RL	SOP-8	2.5Kpcs / 13” Reel

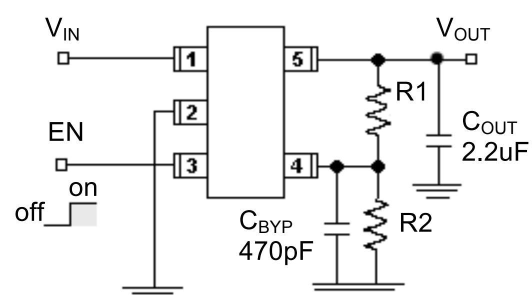
Note: Where **xx** denotes voltage option, available are
50=5.0V
33=3.3V
25=2.5V
Leave blank for adjustable version.
Contact factory for additional voltage options.

Typical Application Circuit

TS5215CX5xx



TS5215CX5



Adjustable Version: V_{OUT} = 1.24 (R1+R2)/R2
(Adjustable output range up to 8V)

EN (pin3) may be connected directly to V_{IN} (pin 1)
Low noise operation: C_{BYP} =470pF, C_{OUT} >2.2uF
Basic operation: C_{BYP} =not used, C_{OUT} >2uF

Absolute Maximum Rating (Note 1)

Parameter		Symbol	Limit	Unit
Input Supply Voltage		V_{IN}	-20~ +20	V
Enable Input Voltage		V_{CE}	-20~ +20	V
Power Dissipation (Note 2)		P_D	Internal limited	
Thermal Resistance	SOT-25	Θ_{JA}	220	$^oC/W$
	SOT-89-5L		110	
	SOP-8		160	
Operating Junction Temperature Range		T_J	-40 ~ +125	^oC
Storage Temperature Range		T_{STG}	-65 ~ +150	^oC
Lead Soldering Temperature (260^oC)			5	S

Recommend Operating Rating (Note 2)

Parameter	Symbol	Limit	Unit
Input Supply Voltage	V_{IN}	+2.5 ~ +16	V
Enable Input Voltage	V_{CE}	0 ~ V_{IN}	V

Electrical Specification (V_{IN} =Vo+1V, Io=100uA, C_{OUT}=1uF, Vce≥2V, T_J = 25^oC, unless otherwise specified.)

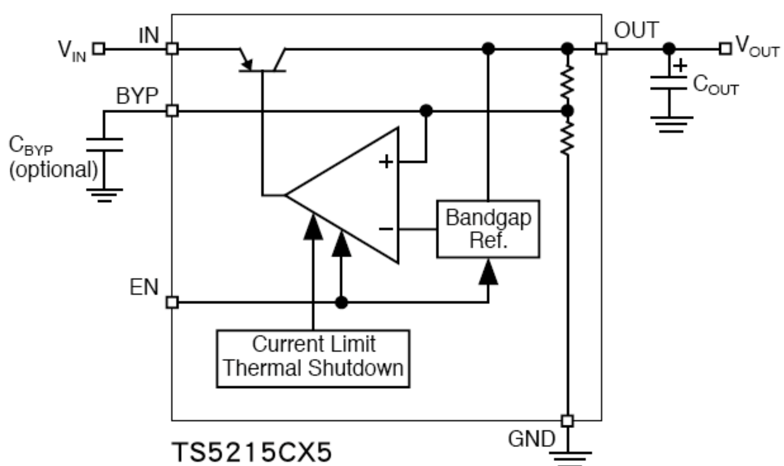
Parameter	Conditions	Min	Typ	Max	Unit
Output Voltage	V_{IN}=Vo + 1V	0.98|Vo|	V_{OUT}	1.02|Vo|	V
Output Voltage Temp. Coefficient	(Note 4)	--	40	--	ppm/^oC
Line Regulation	Vo+1V ≤ V_{IN} ≤ 16V	--	0.005	0.05	%
Load Regulation (Note 5)	0.1mA ≤ Io ≤ 300mA	--	0.02	0.2	%
Dropout Voltage (Note 6)	Io=100uA	--	40	48	mV
	Io=50mA	--	150	190	
	Io=150mA	--	220	265	
	Io=300mA	--	300	360	
Ground Pin Current (Note 7)	Io=100uA	--	80	125	uA
	Io=50mA	--	350	600	
	Io=150mA	--	1000	1500	
	Io=300mA	--	2500	5000	
Quiescent Current	V_{IN} <0.4V (Shutdown)	--	0.01	1	uA
	V_{IN} <0.18V (Shutdown)	--	--	5	
Output Current Limit	V_{OUT}=0V	--	400	600	mA
Power Supply Rejection Ratio	At f=100Hz, Io=100uA,	--	75	--	dB
Thermal Regulation (Note 8)		--	0.05	--	%/W
Output Noise	Io=50mA, C_{OUT}=2.2uF,	--	260	--	nV√Hz
Enable Function					
Enable Input Logic-Low Voltage	Regulation shutdown	--	--	0.4	V
Enable Input Logic-Low Voltage	Regulation enable	2.0	--	--	V
Enable input Current	V_{IL}≤ 0.4V	--	0.01	-1	uA
	V_{IH}≥ 2.0V	--	5	20	

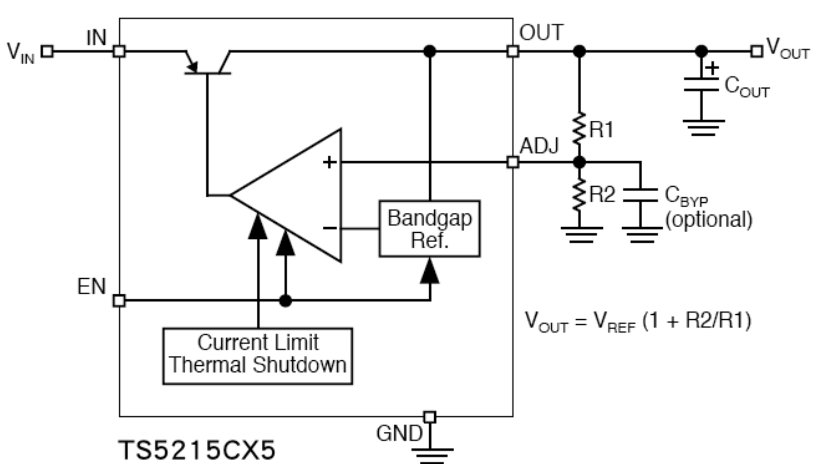
Electrical Specification (Continue)

Note:

1. Exceeding the absolute maximum rating may damage the device.
2. The maximum allowable power dissipation at any Ta is Pd(max) = [$T_{J(MAX)}$ - Ta] + Θ_{JA}. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
3. The device is not guaranteed to function outside its operating rating.
4, Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
5, Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 1mA to 300mA (5V version) and 1mA to 120mA (V_{OUT} <5V version). Changes in output voltage due to heating effects are covered by the thermal regulation specification.
6, Dropout voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.
7, Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground pin current.
8, Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 300mA load pulse at Vin=16V for t=10mS.

Block Diagrams





Application Information

Enable Input

TS5215 series feature an active-high (>2V) enable (EN) input that allows ON/OFF control of the regulator. Current drain reduces to "zero" when the device is shutdown, with only micro-amperes of leakage current. The EN is compatible with CMOS logic interfacing. EN may be directly tied to V_{IN} and pulled up to the maximum supply voltage.

Input Capacitor Requirement

An input capacitor of 0.1uF or greater is recommended when the device is more than 10" away from the bulk AC supply capacitance or when the supply is a battery.

Output Capacitor Requirement

The TS5215 series requires an output capacitor to maintain stability and improve transient response is necessary. 2.2uF minimum is recommended. Larger values improve the regulator's transient response. The output capacitor value may be increased without limit.

The output capacitor should have an ESR (effective series resistance) less than 5Ω and a resonant frequency above 1MHz. Ultra low ESR capacitors can cause a low amplitude oscillation on the output and/or under damped transient response. Most of tantalum or aluminum electrolytic capacitors are adequate; film types will work. Since many aluminum electrolytic have electrolytes that freeze at about –30^{o}C, solid tantalums are recommended for operation below –25^{o}C. At lower values of output current, less output capacitance is required for output stability. The capacitor can be reduced to 0.47uF for current below 10mA or 0.33uF for currents below 1mA.

Reference Bypass Capacitor

Bypass is connected to the internal voltage reference. A 470pF capacitor (C_{BYPASS}) connected from Bypass to Ground quiets this reference, providing a significant reduction in output noise. C_{BYPASS} reduces the regulator phase margin; when using C_{BYPASS}, output capacitors of 2.2uF or greater are generally required to maintain stability.

The star up speed of the TS5215 is inversely proportional to the size of the reference bypass capacitor. Applications requiring a slow ramp up of output voltage should consider larger values of C_{BYPASS}. Likewise, if rapid turn on is necessary, consider omitting C_{BYPASS}. If output noise is not a major concern, omitted C_{BYPASS} and leave Bypass open.

No Load Stability

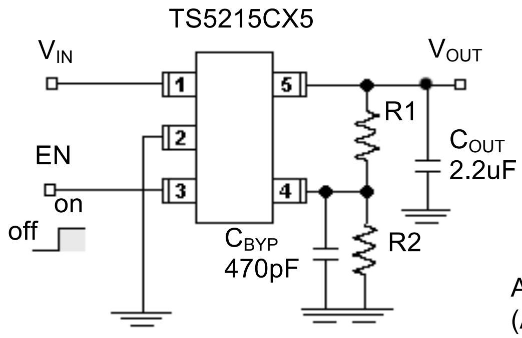
The TS5215 series will remain stable and in regulation with no load, unlike many other voltage regulators. This is especially important in CMOS RAM keep alive applications.

Adjustable Regulator Design

The adjustable regulator versions can be adjusted to a specific output voltage by using two external resistors to programming the output voltage anywhere between 1.25 and the 8V maximum operating rating of the family.

Two resistors are used. Resistors can be quite large up to 470kΩ, because of the very high input impedance and low bias current of the sense comparator, the resistor values are calculated by:

A capacitor from Adjust to Ground provides greatly improved noise performance.



Adjustable Version: V_{OUT} = 1.24 (1+R2/R1)
(Adjustable output range up to 8V)

Application Information (Continue)

Dual Supply Operation

When used in dual supply systems where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground.

Thermal Characteristics

TS5215 series is designed to provide 300mA (5V version) of continuous current in a very small package. Maximum power dissipation can be calculated based on the output current and the voltage drop across the part. To determine the maximum power dissipation of the package, use the junction-ambient thermal resistance of the device and the following basic equation:

$$P_{D(MAX)} = [\, T_{J(MAX)} - T_A \,] / \Theta_{JA}$$

$T_{J(MAX)}$ is the maximum junction temperature of the die(125°C), and Ta is the ambient operating temperature. Θ_{JA} is layout dependent, the actual power dissipation of the regulator circuit can be determined using the equation:

$$P_D = (V_{IN} - V_{OUT}) * I_{OUT} + V_{IN} * I_{GND}$$

Substituting Pd(max) for Pd and solving for the operating conditions that are critical to the application will give the maximum operating conditions for the regulator circuit. For example, when operating the TS5215CX33 at room temperature with a minimum footprint layout, the maximum input voltage for a set output current can be determined as follows:

$$P_{D(MAX)} = (125^{o}C - 25^{o}C) / 220^{o}C/W$$

$$P_{D(MAX)} = 455mW$$

The junction to ambient thermal resistance for the minimum footprint is 220°C/W, the maximum power dissipation must not be exceeded for proper operation. Using the output voltage of 3.3V and an output current of 120mA, the maximum input voltage can be determined. From the electrical characteristics table, the maximum ground current for 120mA output current is 2.5mA.

$$445mW = (V_{IN} - 3.3V) * 300mA + V_{IN} * 2.5mA$$

$$445mW = V_{IN} * 300mA - 3.3 * 300mA + V_{IN} * 2.5mA$$

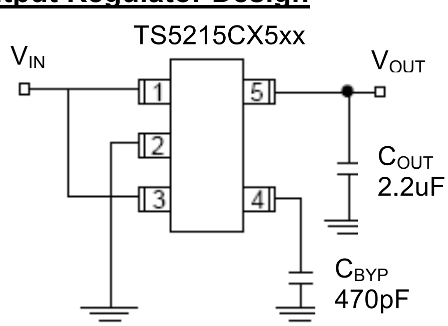
$$445mW = V_{IN} * 300mA - 990mW + V_{IN} * 2.5mA$$

$$1435mW = V_{IN} * 302.5mA$$

$$V_{IN}\ (max) = 4.74V$$

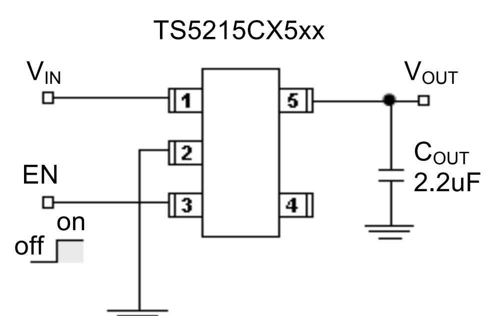
Therefore, a 3.3V application at 300mA of output current can accept a maximum input voltage of 4.74V in a SOT-25 package.

Fixed Output Regulator Design



Ultra Low Noise Fixed Voltage Application

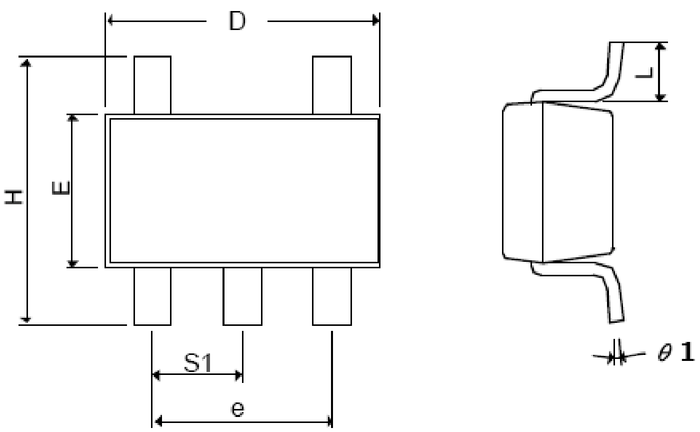
Includes a 470pF capacitor for low noise operation and shows EN connected to IN for an application where enable/shutdown is not required. C_{OUT}= 2.2uF minimum.



Low Noise Fixed Voltage Application

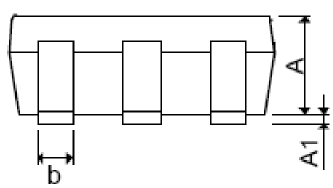
An example of a low noise configuration where bypass is not required. C_{OUT}= 2.2uF minimum

SOT-25 Mechanical Drawing

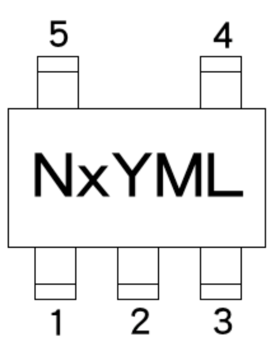


SOT-25 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A+A1	0.09	1.25	0.0354	0.0492
B	0.30	0.50	0.0118	0.0197
C	0.09	0.25	0.0035	0.0098
D	2.70	3.10	0.1063	0.1220
E	1.40	1.80	0.0551	0.0709
E	1.90 BSC		0.0748 BSC	
H	2.40	3.00	0.09449	0.1181
L	0.35 BSC		0.0138 BSC	
ϴ1	0º	10º	0º	10º
S1	0.95 BSC		0.0374 BSC	

Front View

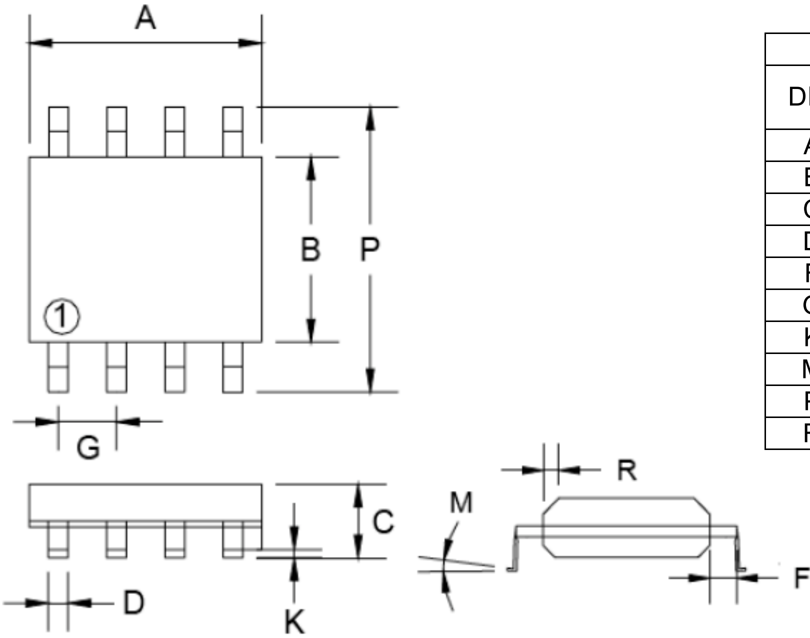


Marking Diagram



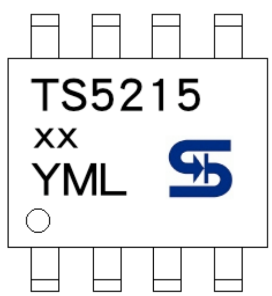
H = Device Code
X = Voltage Code
(**5** = 5.0V, **S** = 3.3V, **K** = 2.5V)
Y = Year Code
M = Month Code
(**A**=Jan, **B**=Feb, **C**=Mar, **D**=Apl, **E**=May, **F**=Jun, **G**=Jul, **H**=Aug, **I**=Sep, **J**=Oct, **K**=Nov, **L**=Dec)
L = Lot Code

SOP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0º	7º	0º	7º
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

Marking Diagram



XX = Voltage Code
(**50** = 5.0V, **33** = 3.3V, **25** = 2.5V)
Y = Year Code
M = Month Code
(**A**=Jan, **B**=Feb, **C**=Mar, **D**=Apl, **E**=May, **F**=Jun, **G**=Jul, **H**=Aug, **I**=Sep, **J**=Oct, **K**=Nov, **L**=Dec)
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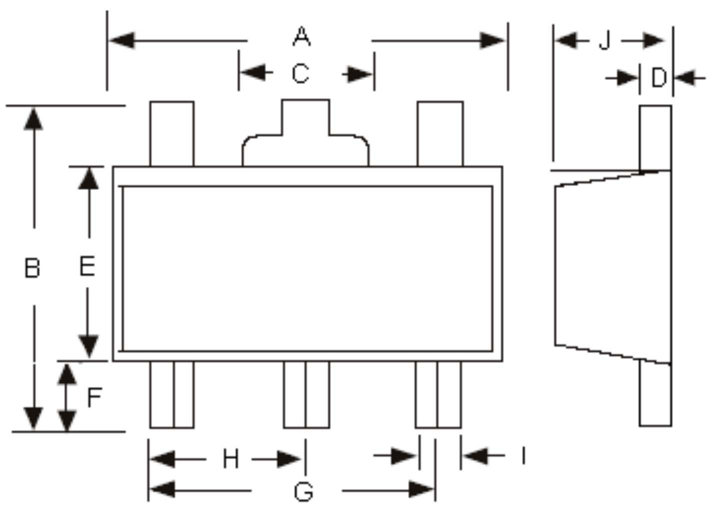
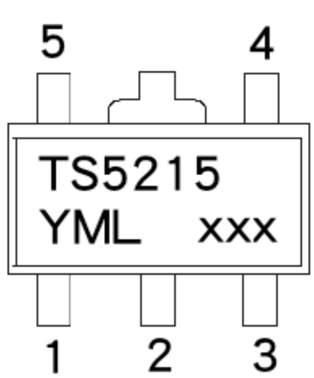
SOT-89-5L Mechanical Drawing



SOT-89-5L DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.40	4.60	0.17	0.18
B	4.05	4.25	0.16	0.17
C	1.50	1.70	0.06	0.07
D	0.35	0.41	0.01	0.02
E	2.40	2.60	0.09	0.10
F	0.80	--	0.03	--
G	3.00(typ)		0.12(typ)	
H	1.50(typ)		0.06(typ)	
I	0.40	0.52	0.01	0.02
J	1.40	1.60	0.05	0.06

Marking Diagram



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M = Month Code
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L = Lot Code
XX = Voltage Code
(**50** = 5.0V, **33** = 3.3V, **25** = 2.5V)
= Package Code for Adjustable type
(CY5 = SOT-89-5L)

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