Elektronische Bauelemente

S5U2188

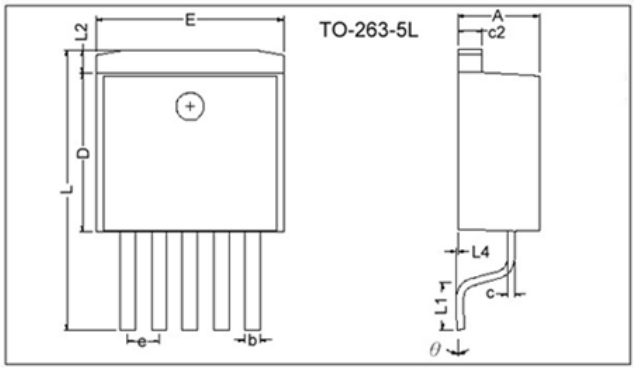
1.5A CMOS

Low Dropout Voltage Regulator

RoHS Compliant Product

Description

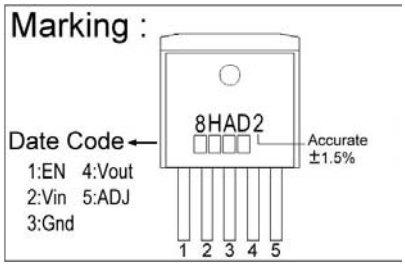
The S5U2188 of positive,linear regulators feature low quiescent current (45μA typ.) with low dropout voltage, making them ideal for battery applications. Output voltage are set at the factory and trimmed to 1.5% accuracy.These rugged devices have both Thermal Shutdown and Current Fold-back to prevent device failure under the "Worst" of operating conditions.The S5U2188 is stable with an output capacitance of 4.7μF or greater.



REF.	Millimeter		REF.	Millimeter	
	Min.	Max.		Min.	Max.
A	4.40	4.80	c2	1.25	1.45
b	0.66	0.91	L2	1.27 REF.	
L4	0.00	0.30		8.6	9.0
c	0.36	0.5	e	1.70 REF.	
L1	2.29	2.79	L	14.6	15.8
E	9.80	10.4	θ	0˚	8˚

Features

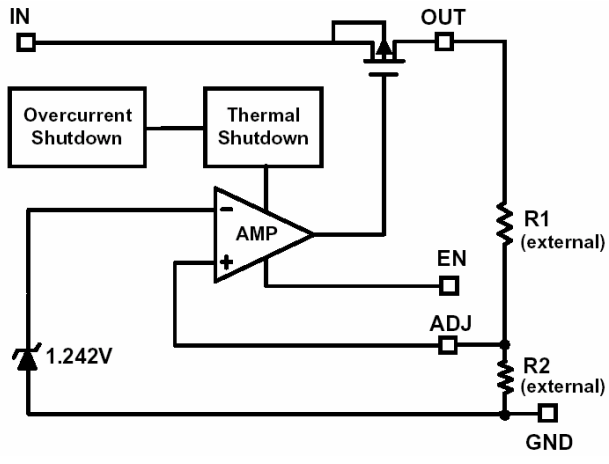
* Low Temperature Coefficient
* Over-Temperature Shutdown
* Adjustable Version
* Very Low Dropout Voltage
* High Accurate ±1.5%
* Short Circuit Current Fold-back
* Guaranteed 1.5A output
* Current Limiting
* Power-Saving Shutdown Mode



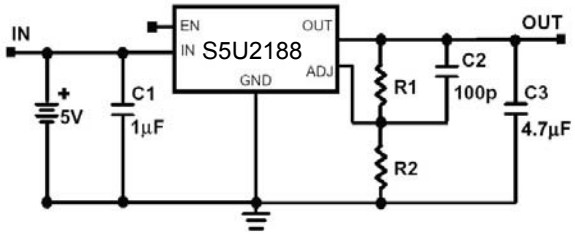
Applications

* PC Peripherals
* Wireless Devices
* Portable Electronics
* Battery Powered Widgets
* Instrumentation

Functional Block Diagram



Typical Application Circuit



Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
Input Voltage	V_{IN}	8	V
Output Current	I_{OUT}	$P_D/(V_{IN}-V_O)$	mA
Output Voltage	V_{OUT}	Gnd-0.3~V_{IN}+0.3	V
Operating Ambient Temperature	Topr	-40~+85	°C
Junction Temperature	Tj	-40~+125	°C
Max. Junction Temperature	Tj Max.	150	°C
Power Dissipation (△ T=100°C)	P_D	3.0	W
EDS Classification		B	

Electrical Characteristics $V_{IN}=V_{OUT}(T)+2V$, $V_{EN}=V_{IN}$, $T_A=25℃$ unless otherwise noted

Parameter	Symbol	Condition		Min	Typ	Max	Unit
Output Voltage	$V_{OUT}(E)$ (Note1)	$V_{EN}=V_{EH}$min, I_O=1mA		-1.5%	$V_{OUT}(T)$ (Note2)	1.5%	V
Output Current	I_O	V_{OUT}>1.2V		1.5	-	-	A
Current Limit	I_{LIM}	V_{OUT}>1.2V		1.5	2.0	-	A
Load Regulation	REG_{LOAD}	I_O=1mA to 1.5A		-1	0.2	1	%
Dropout Voltage	$V_{DROPOUT}$	I_O=1.5A $V_O=V_{OUT}(E)$-2%	1.5V<$V_{OUT}(T)$≦2.0V	-	-	1300	mV
			2.0V<$V_{OUT}(T)$≦2.8V	-	-	800	
			2.8V<$V_{OUT}(T)$	-	-	600	
Ground Pin Current	I_{GND}	I_O=1mA~1.5A		-	45	-	μA
Line Regulation	REG_{LINE}	I_O=1mA $V_{IN}=V_{OUT}(T)$+1 to $V_{OUT}(T)$+2	$V_{OUT}(T)$<2.0V	-0.15	-	0.15	%
			2.0V≦$V_{OUT}(T)$<4.0V	-0.1	0.02	0.1	
			4.0V≦$V_{OUT}(T)$	-0.4	-	0.4	
Input Voltage	V_{IN}			Note3	-	7	V
Over Temperature Shutdown	OTS			-	150	-	℃
Over Temperature Hysterisis	OTH			-	30	-	℃
Output Voltage Temperature Coefficient	TC			-	30	-	ppm/℃
Short Circuit Current	I_{SC}	V_{OUT}<0.4V		-	750	-	mA
ADJ Input Bias Current	I_{ADJ}	V_{IN}=5V, V_{ADJ}=1.242V		-	1	-	μA
Minimum Load Current	I_{Min}			1	-	-	mA
ADJ Reference Voltage	V_{REF}			1.223	1.242	1.261	V
Power Supply Rejection	PSRR	Io=100mA Co=4.7μF ceramic	f=1kHz	-	50	-	dB
			f=10kHz	-	20	-	
Output Voltage Noise	eN	f=10Hz~100kHz Io=10mA,	Co=4.7μF	-	30	-	μVrms
EN Input Threshold	V_{EH}	V_{IN}=2.7V to 7V		2.0	-	V_{IN}	V
	V_{EL}	V_{IN}=2.7V to 7V		0	-	0.4	V
EN Input Bias Current	I_{EH}	V_{IN}=7V		-	-	0.1	μA
	I_{EL}	V_{EN}= 0V, V_{IN}=7V		-	-	0.5	μA
Shutdown Supply Current	I_{SD}	V_{IN}=5V, V_{OUT}=0V, V_{EN}=0V		-	0.5	2	μA

Note 1: V_{OUT} (E) =Effective Output Voltage (i.e. the output voltage when "V_{OUT} (T) + 2.0V" is provided at the VIN pin while maintaining a certain I_{OUT} value).

2: V_{OUT} (T) =Specified Output Voltage

3: $V_{IN\ (MIN)}=V_{OUT}+V_{DROPOUT}$

Ordering Information(contd.)

Part Number	Marking	Output Voltage	Part Number	Marking	Output Voltage
S5U 2188-AD	8HAD2 XXXX	Adjustable			

Detailed Description

The S5U2188 of COMS regulator contains a PMOS pass transistor, voltage reference, error amplifier, over-current protection, and thermal shutdown.

The P-channel pass transistor receives data from the error amplifier, over-current shutdown, and thermal protection circuits. During normal operation, the error amplifier compares the output voltage to a precision reference. Over-current and Thermal shutdown circuits become active when the junction temperature exceeds 140℃, or the current exceeds 2.2A. During thermal shutdown, the output voltage remains low. Normal operation is restored when the junction temperature drops below 120℃.

The S5U2188 behaves like a current source when the load reaches 2.2A. However, if the load impedance drops below 0.3Ω, the current drops back to 600mA to prevent excessive power dissipation. Normal operation is restored when the load resistance exceeds 0.75Ω.

External Capacitors

The S5U2188 is stable with an output capacitance to ground of 4.7μF or greater. Ceramic capacitors have the lowest ESR, and will offer the best AC performance. Conversely, Aluminum Electrolytic capacitors exhibit the highest ESR, resulting in the poorest AC response. Unfortunately, large value ceramic capacitors are comparatively expensive. One option is to parallel a 0.1μF ceramic capacitor with a 10μF Aluminum Electrolytic. The benefit is low ESR, high capacitance, and low overall cost.

A second capacitor is recommended between the input and ground to stabilize Vin. The input capacitor should be at least 0.1μF to have a beneficial effect.

All capacitors should be placed in close proximity to the pins. A “Quiet” ground termination is desirable. This can be achieved with a “Star” connection.

Enable

When pulled low, the PMOS pass transistor shuts off, and all internal circuits are powered down. In this state, the quiescent current is less than 1μA. This pin behaves much like an electronic switch.

100kΩ resistor is necessary between V_{EN} source and EN pin when V_{EN} is higher than V_{IN}.

(Note: there is no internal pull-up for EN PIN)

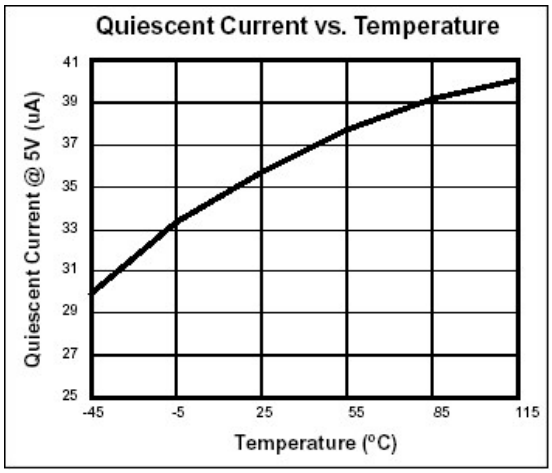
Adjustable Version

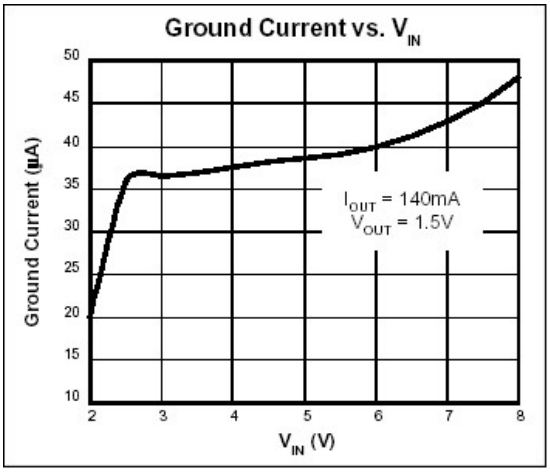
The adjustable version uses external feedback resistors to generate an output voltage anywhere from 1.5V to 5.0V. Vadj is trimmed to 1.242V and Vout is given by the equation:

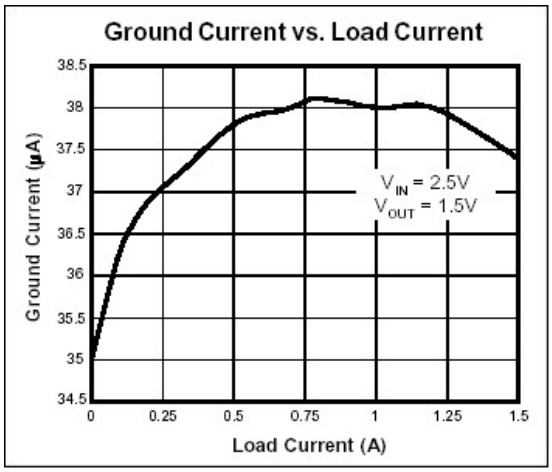
$$V_{OUT}=Vadj * (1+R1/R2)$$

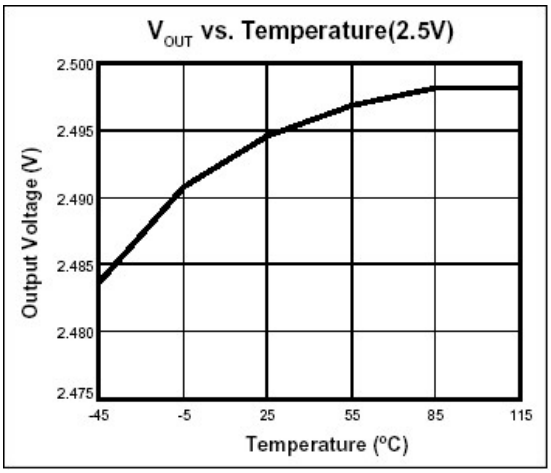
Feedback resistors R1 and R2 should be high enough to keep quiescent current low, but increasing R1+R2 will reduce stability. In general, R1 and R2 in the 10’s of kΩ will produce adequate stability, given reasonable layout precautions. To improve stability characteristics, keep parasitic on the ADJ pin to minimum, and lower R1 and R2 values.

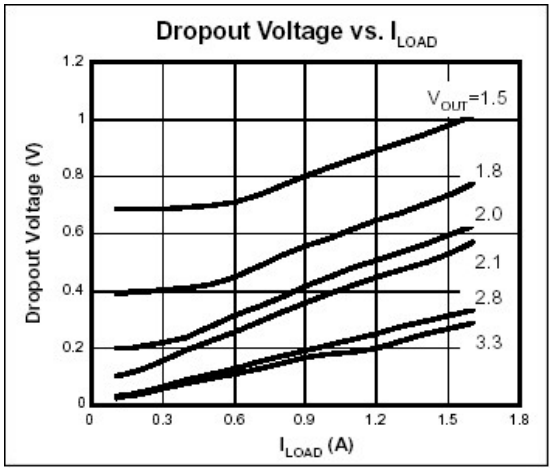
Characteristics Curve

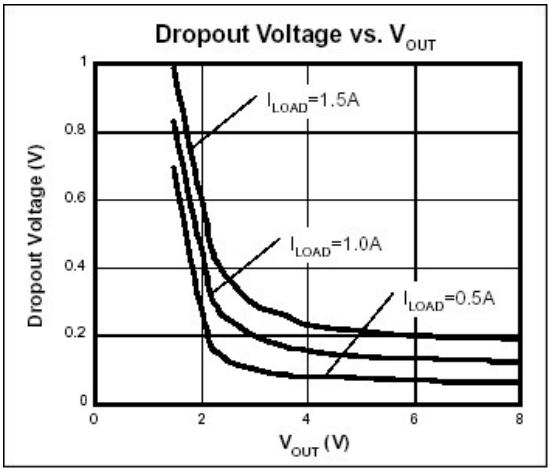


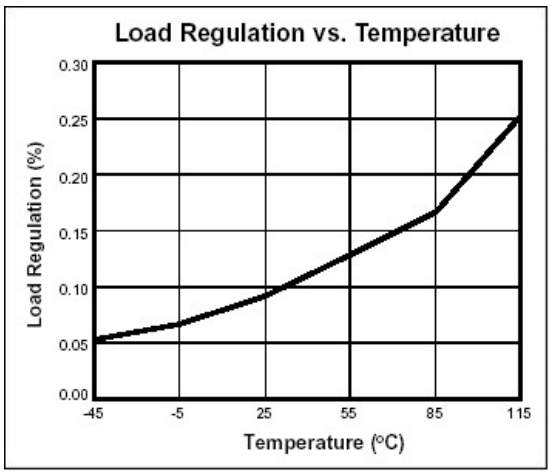


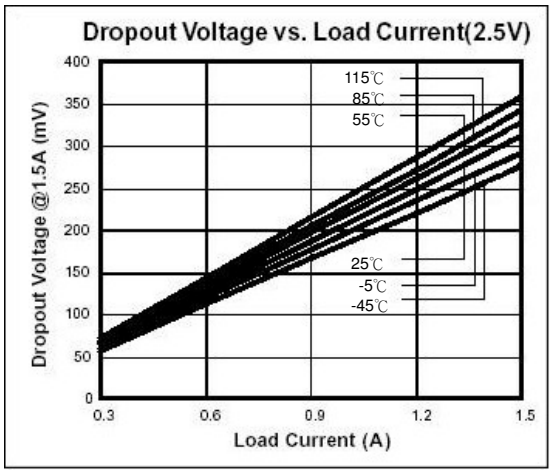


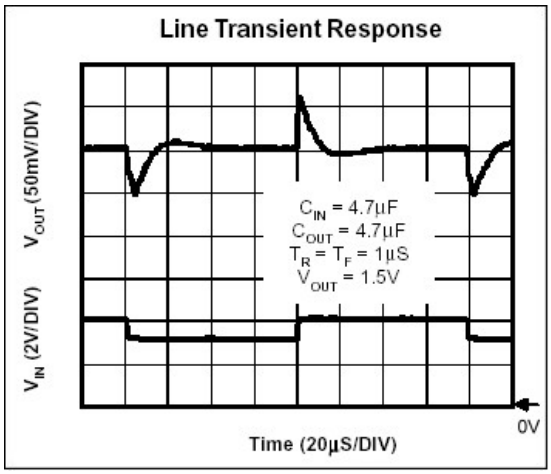


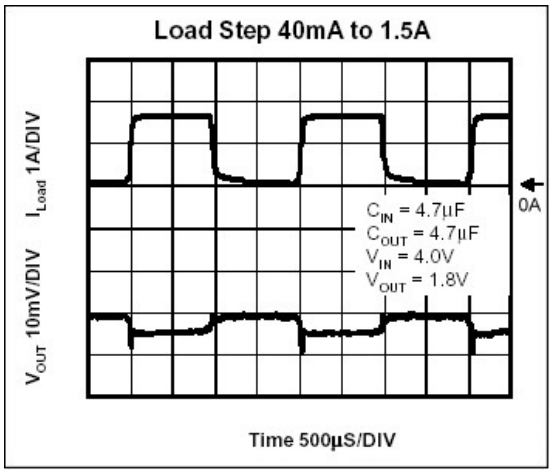


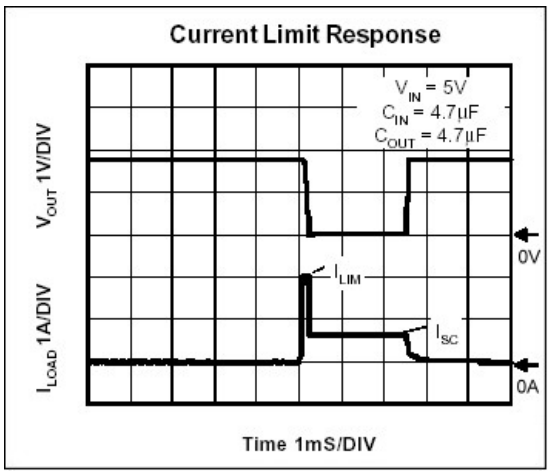


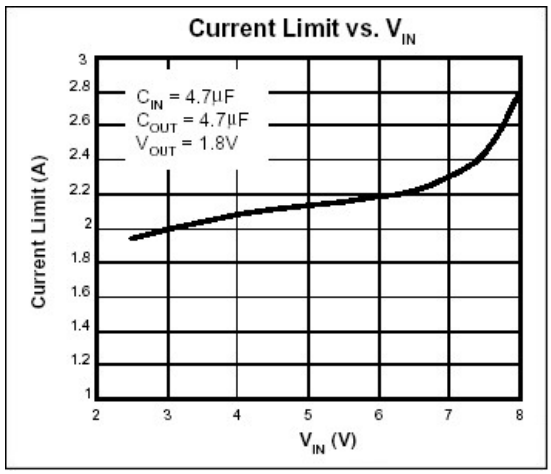

Load Regulation vs. Temperature
Load Regulation (%)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-45
-5
25
55
85
115
Temperature (°C)

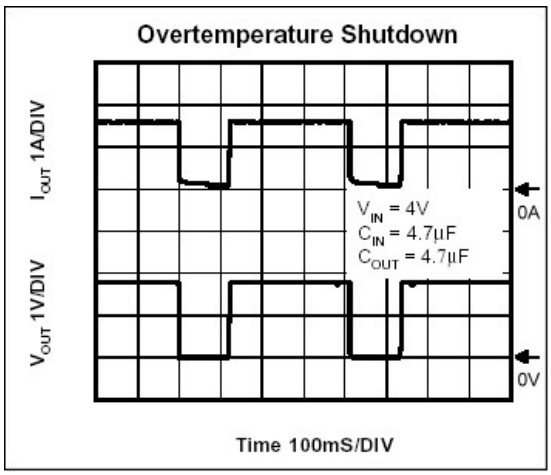

Dropout Voltage vs. Load Current(2.5V)
Dropout Voltage @1.5A (mV)
400
350
300
250
200
150
100
50
0
115℃
85℃
55℃
25℃
-5℃
-45℃
0.3
0.6
0.9
1.2
1.5
Load Current (A)

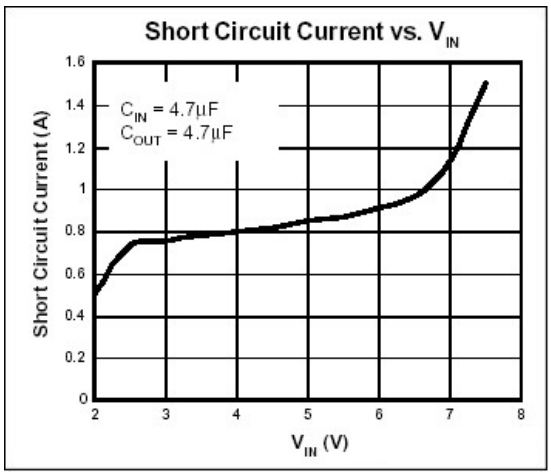

Line Transient Response
V_{OUT} (50mV/DIV)
V_{IN} (2V/DIV)
C_{IN} = 4.7µF
C_{OUT} = 4.7µF
T_R = T_F = 1µS
V_{OUT} = 1.5V
0V
Time (20µS/DIV)

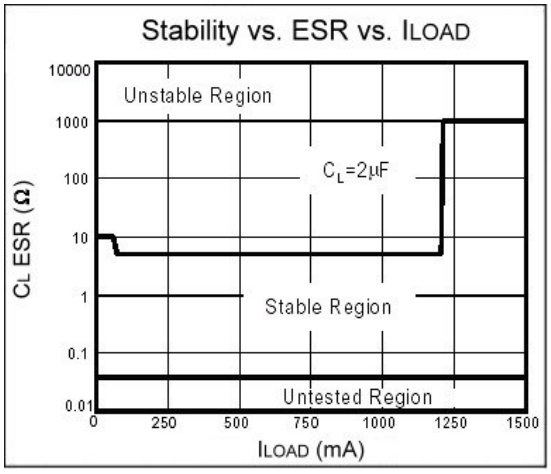

Load Step 40mA to 1.5A
I_{Load} 1A/DIV
V_{OUT} 10mV/DIV
C_{IN} = 4.7µF
C_{OUT} = 4.7µF
V_{IN} = 4.0V
V_{OUT} = 1.8V
0A
Time 500µS/DIV

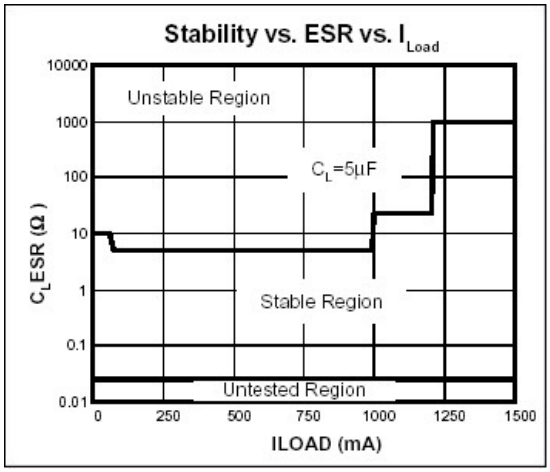

Current Limit Response
V_{OUT} 1V/DIV
I_{LOAD} 1A/DIV
V_{IN} = 5V
C_{IN} = 4.7µF
C_{OUT} = 4.7µF
I_{LIM}
I_{SC}
0V
0A
Time 1mS/DIV

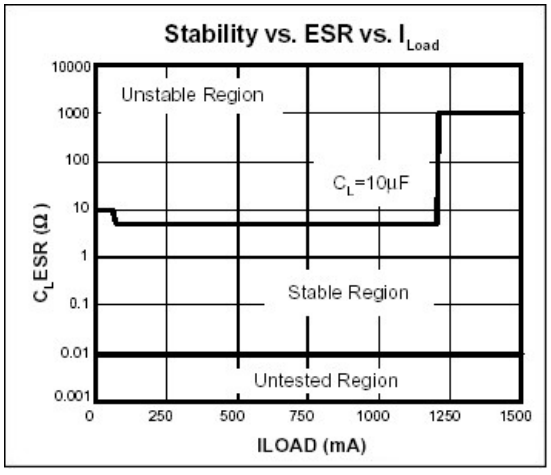

Current Limit vs. V_{IN}
Current Limit (A)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
C_{IN} = 4.7µF
C_{OUT} = 4.7µF
V_{OUT} = 1.8V
2
3
4
5
6
7
8
V_{IN} (V)

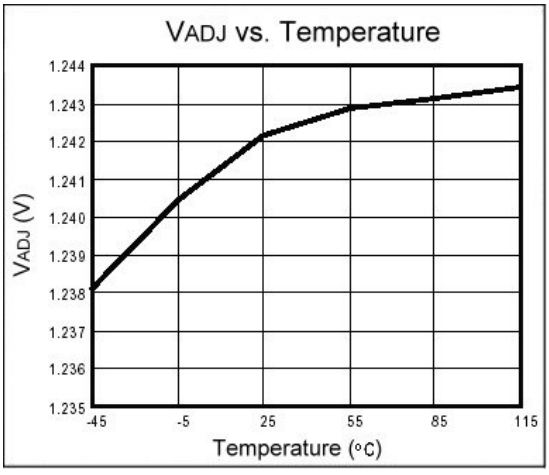

Overtemperature Shutdown
I_{OUT} 1A/DIV
V_{OUT} 1V/DIV
V_{IN} = 4V
C_{IN} = 4.7µF
C_{OUT} = 4.7µF
0A
0V
Time 100mS/DIV


Short Circuit Current vs. V_{IN}
C_{IN} = 4.7µF
C_{OUT} = 4.7µF
Short Circuit Current (A)
V_{IN} (V)


Stability vs. ESR vs. ILOAD
Unstable Region
C_L=2µF
Stable Region
Untested Region
C_L ESR (Ω)
ILOAD (mA)


Stability vs. ESR vs. I_{Load}
Unstable Region
C_L=5µF
Stable Region
Untested Region
C_L ESR (Ω)
ILOAD (mA)


Stability vs. ESR vs. I_{Load}
Unstable Region
C_L=10µF
Stable Region
Untested Region
C_L ESR (Ω)
ILOAD (mA)


VADJ vs. Temperature
VADJ (V)
Temperature (°C)

External Resistor Divider Table

R1(kΩ)	1	2	5	10	20	50
VOUT	R2(kΩ)=(1.242*R1(kΩ))/(VOUT-1.242)					
1.30	21.41	42.83	107.07	214.14	428.28	1070.7
1.35	11.50	23.00	57.50	115.00	230.00	575.00
1.40	7.86	15.72	39.30	78.61	157.22	393.04
1.45	5.97	11.94	29.86	59.71	119.42	298.56
1.50	4.81	9.63	24.07	48.14	96.28	240.70
1.55	4.03	8.06	20.16	40.32	80.65	201.62
1.60	3.47	6.94	17.35	34.69	68.39	173.46
1.65	3.04	6.09	15.22	30.44	60.88	152.21
1.70	2.71	5.42	13.56	27.12	54.24	135.59
1.75	2.44	4.89	12.22	24.45	48.90	122.24
1.80	2.23	4.45	11.13	22.26	44.52	111.29
1.85	2.04	4.09	10.21	20.43	40.86	102.14
1.90	1.89	3.78	9.44	18.88	37.75	94.38
1.95	1.75	3.51	8.77	17.54	35.08	87.71
2.00	1.64	3.28	8.19	16.39	32.77	81.93
2.05	1.54	3.07	7.69	15.37	30.74	76.86
2.10	1.45	2.90	7.24	14.48	28.95	72.38
2.15	1.37	2.74	6.84	13.68	27.36	68.39
2.20	1.30	2.59	6.48	12.96	25.93	64.82
2.25	1.23	2.46	6.16	12.32	24.65	61.61
2.30	1.17	2.35	5.87	11.74	23.48	58.70
2.35	1.12	2.24	5.60	11.21	22.42	56.05
2.40	1.07	2.15	5.36	10.73	21.45	53.63
2.45	1.03	2.06	5.14	10.28	20.56	51.41
2.50	0.99	1.97	4.94	9.87	19.75	49.36
2.55	0.95	1.90	4.75	9.50	18.99	47.48
2.60	0.91	1.83	4.57	9.15	18.29	45.73
2.65	0.88	1.76	4.41	8.82	17.64	44.11
2.70	0.85	1.70	4.26	8.52	17.04	42.59
2.75	0.82	1.65	4.12	8.24	16.47	41.18
2.80	0.80	1.59	3.99	7.97	15.94	39.86
2.85	0.77	1.54	3.86	7.72	15.45	38.62
2.90	0.75	1.50	3.75	7.49	14.98	37.45
2.95	0.73	1.45	3.64	7.27	14.54	36.36
3.00	0.71	1.41	3.53	7.06	14.13	35.32
3.05	0.69	1.37	3.43	6.87	13.74	34.35
3.10	0.67	1.34	3.34	6.68	13.37	33.42
3.15	0.65	1.30	3.25	6.51	13.02	32.55

R1(kΩ)	1	2	5	10	20	50
VOUT	R2(kΩ)=(1.242*R1(kΩ))/(VOUT-1.242)					
3.20	0.63	1.27	3.17	6.34	12.69	31.72
3.25	0.62	1.24	3.09	6.19	12.37	30.93
3.30	0.60	1.21	3.02	6.03	12.07	30.17
3.35	0.59	1.18	2.95	5.89	11.78	29.46
3.40	0.58	1.15	2.88	5.76	11.51	28.78
3.45	0.56	1.13	2.81	5.63	11.25	28.13
3.50	0.55	1.10	2.75	5.50	11.00	27.50
3.55	0.54	1.08	2.69	5.38	10.76	26.91
3.60	0.53	1.05	2.63	5.27	10.53	26.34
3.65	0.52	1.03	2.58	5.16	10.32	25.79
3.70	0.51	1.01	2.53	5.05	10.11	25.26
3.75	0.50	0.99	2.48	4.95	9.90	24.76
3.80	0.49	0.97	2.43	4.86	9.71	24.28
3.85	0.48	0.95	2.38	4.76	9.52	23.81
3.90	0.47	0.93	2.34	4.67	9.35	23.36
3.95	0.46	0.92	2.29	4.59	9.17	22.93
4.00	0.45	0.90	2.25	4.50	9.01	22.52
4.05	0.44	0.88	2.21	4.42	8.85	22.12
4.10	0.43	0.87	2.17	4.35	8.69	21.73
4.15	0.43	0.85	2.14	4.27	8.54	21.35
4.20	0.42	0.84	2.10	4.20	8.40	20.99
4.25	0.41	0.83	2.06	4.13	8.26	20.64
4.30	0.41	0.81	2.03	4.06	8.12	20.31
4.35	0.40	0.80	2.00	4.00	7.99	19.98
4.40	0.39	0.79	1.97	3.93	7.87	19.66
4.45	0.39	0.77	1.94	3.87	7.74	19.36
4.50	0.38	0.76	1.91	3.81	7.62	19.06
4.55	0.38	0.75	1.88	3.75	7.51	18.77
4.60	0.37	0.74	1.85	3.70	7.40	18.49
4.65	0.36	0.73	1.82	3.64	7.29	18.22
4.70	0.36	0.72	1.80	3.59	7.18	17.96
4.75	0.35	0.71	1.77	3.54	7.08	17.70
4.80	0.35	0.70	1.75	3.49	6.98	17.45
4.85	0.34	0.69	1.72	3.44	6.88	17.21
4.90	0.34	0.68	1.70	3.40	6.79	16.98
4.95	0.33	0.67	1.67	3.35	6.70	16.75
5.00	0.33	0.66	1.65	3.30	6.61	16.52

Note: Small load (greater than 2mA) is necessary as R1 or R2 is larger than 50kΩ. Otherwise, output voltage probably can not be pulled down to 0V on disable mode.