MICROPOWER, REGULATED 5V CHARGE PUMP

SC1517-5

October 3, 2000 TEL:805-498-2111 FAX:805-498-3804 WEB:http://www.semtech.com

DESCRIPTION

The SC1517-5 is pin compatible with LTC1517-5. This versatile charge pump produces a regulated 5V output from an input voltage ranging from 2.7V to 5V. The Extremely low operating current (typically 10µA with no load) prolongs battery usage time. The small device footprint and the low external parts count (one 0.1µF flying capacitor and two small bypass capacitors at V_{IN} and V_{OUT}) make the part ideally suited for compact circuit design.

The SC1517-5 charge pump can be used for applications that require up to 20mA ($3V \leq V_{IN} \leq 5V$) of output current, while providing a regulated 5V output voltage. During short circuit a current limit circuitry provides protection, while the thermal shutdown capability cycles V_{OUT} to prevent device failure. The SC1517-5 is available in a 5 lead SOT-23 package.

FEATURES

- Ultra low power: I_{CC} = 10µA typ
- Soft start / Short circuit Current limit
- Thermal protected
- 5V±4% Regulated output
- V_{IN} Range: 2.7V to 5V
- Output current:
  10mA ($V_{IN} \geq$ 2.7V)
  20mA ($V_{IN} \geq$ 3V)
- No inductors
- Ultra small application circuit
- 800kHz switching frequency
- Surface mount packaging (5 pin SOT-23)
- All specifications rated over full temperature range (-40°C to 85°C)

APPLICATIONS

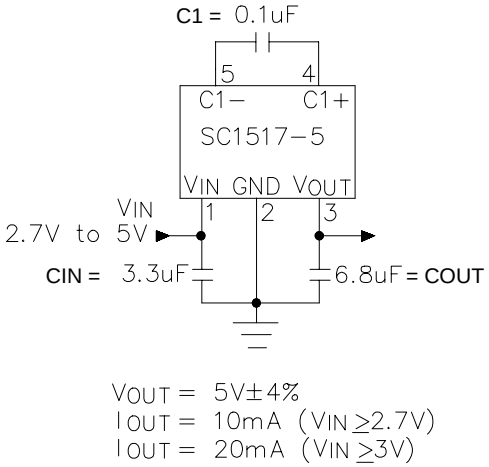
- Cellular telephones
- Battery-operated equipment
- Local power supplies
- Handheld instruments
- PCMCIA supplies

ORDERING INFORMATION

Device[1]	Package	Temp. Range (T_A)
SC1517ISK-5.TR	SOT-23-5	-40° to 85°C

Notes:
(1) Only available in tape and reel packaging. A reel contains 3000 devices

TYPICAL APPLICATION SCHEMATIC



VOUT = 5V±4%
IOUT = 10mA (VIN ≥2.7V)
IOUT = 20mA (VIN ≥3V)

Note :
Ceramic capacitors used for improved performance, Low ESR Tantalum with ESR < 0.5 Ohms could also be used.

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ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Maximum	Units
Input Supply Voltage	V_{in}	-0.3 to 6	V
Output Supply Voltage	V_{out}	-0.3 to 6	V
Power Dissipation	P_d	391	mW
Thermal Resistance	θ_{JA}	256	°C/W
Operating Ambient Temperature Range	T_A	-40 to +85	°C
Operating Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10 Sec	T_{LEAD}	+300	°C
ESD Rating (Human Body Model)	ESD	2	kV

ELECTRICAL CHARACTERISTICS

Unless specified: T_A = -40°C to 85°C, V_{IN} = 2.7V to 5V, C1 = 0.1µF, C_{IN} = 3.3µF, C_{OUT} = 6.8µF.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Operating Input Voltage	V_{IN}		2.7		5	V
Output Voltage	V_{OUT}	$2.7V \le V_{IN} \le 5V$, $I_{OUT} \le 10mA$	4.8	5.0	5.2	V
		$3V \le V_{IN} \le 5V$, $I_{OUT} \le 20mA$	4.8	5.0	5.2	V
Input Supply Current	I_{CC}	$2.7V \le V_{IN} \le 5V$, I_{OUT} = 0		10	15	µA
V_{OUT} Ripple (pk-pk)[1][2]	V_R	V_{IN} = 3V, I_{OUT} = 20mA, C_{OUT} = 6.8µF		75		mV_{P-P}
Oscillator Frequency[1][2]	f_{OSC}			800		kHz
V_{OUT} Turn-On Time[1][2]	t_{ON}	V_{IN} = 3V, I_{OUT} = 0mA		1		ms
Soft start / Short circuit Current limit[1][2][3]	I_{limit}	Short circuit applied at Vout to GND	35	65		mA

NOTES:
(1) All electrical characteristics are for the application circuit on page 1.
(2) Guaranteed by design.
(3) Indefinite duration.

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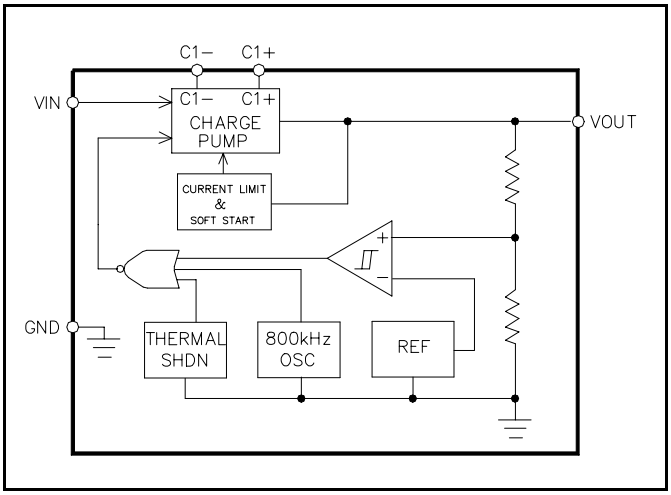
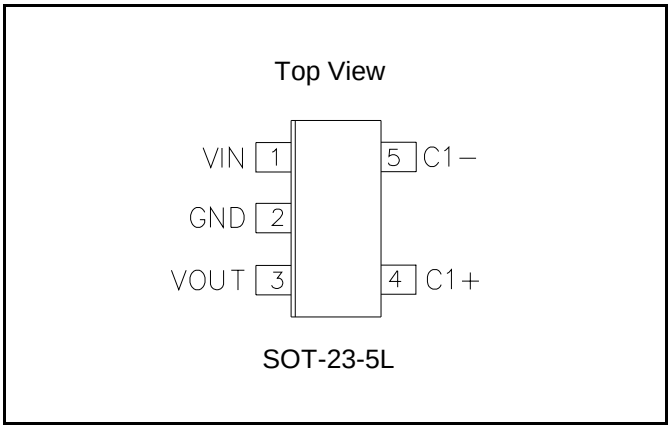
BLOCK DIAGRAM



PIN CONFIGURATION



PIN DESCRIPTION

Pin #	Pin Name	Description
1	VIN	Charge pump input voltage. May be between 2.7V and 5V. V_{IN} should be bypassed with a ≥3.3µF low ESR capacitor as close as possible to the pin for best performance.
2	GND	Ground pin.
3	VOUT	Regulated output voltage. V_{OUT} should be bypassed with a ≥3.3µF low ESR capacitor as close as possible to the pin for best performance.
4	C1+	Charge pump flying capacitor positive terminal.
5	C1-	Charge pump flying capacitor negative terminal.

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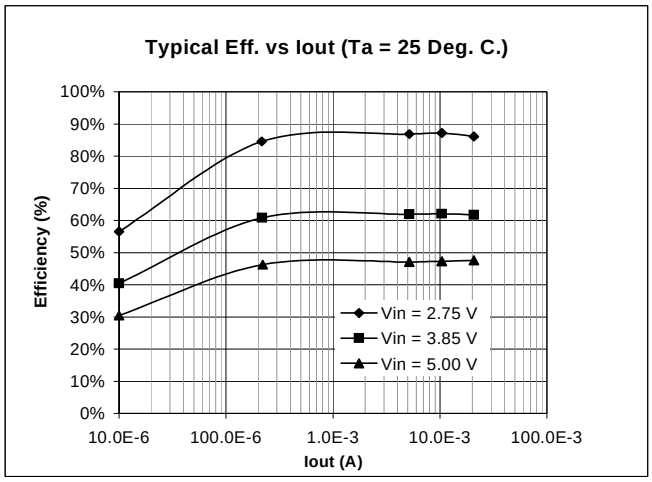

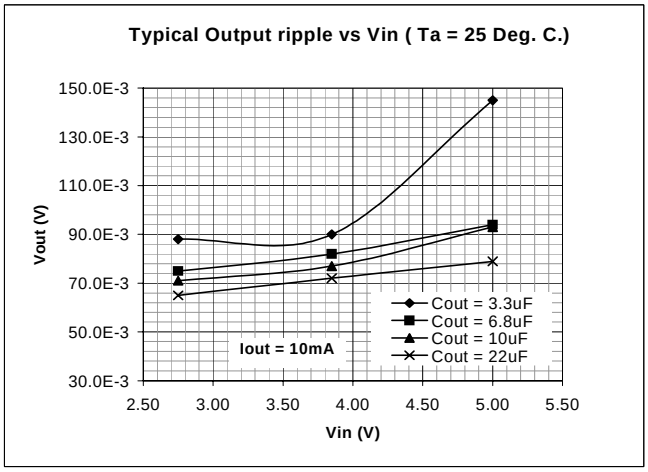

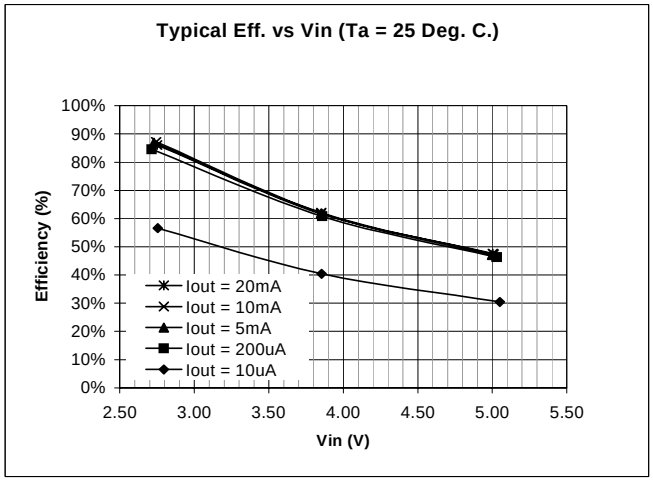

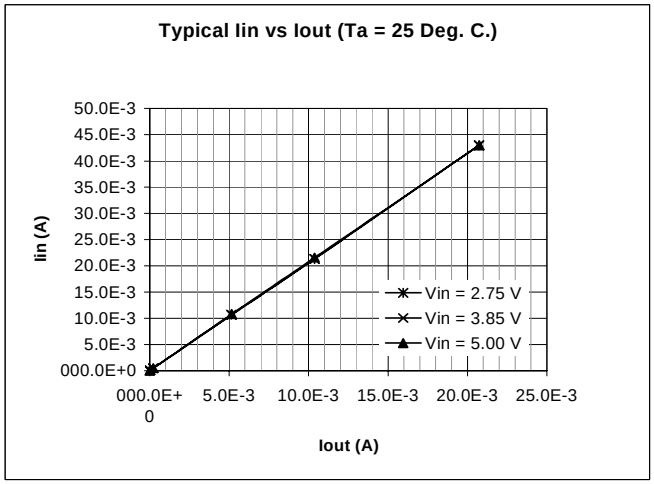

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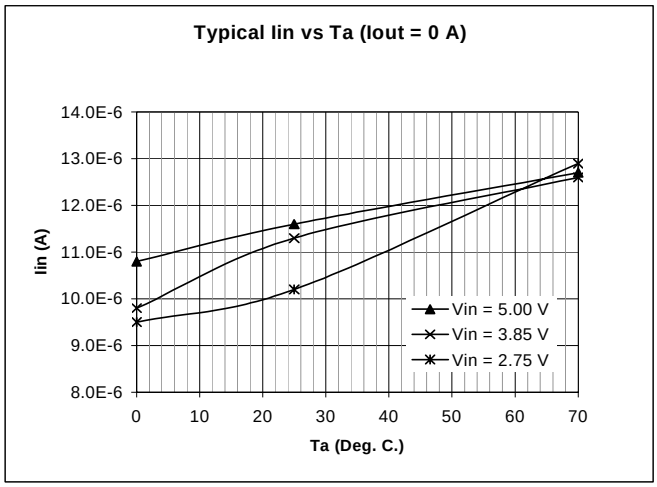

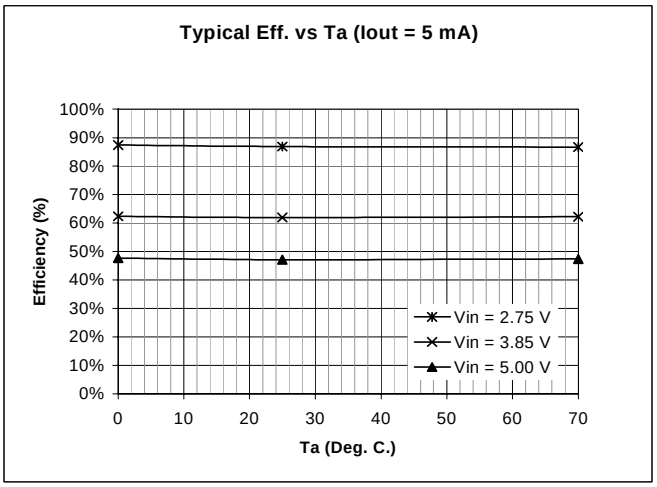

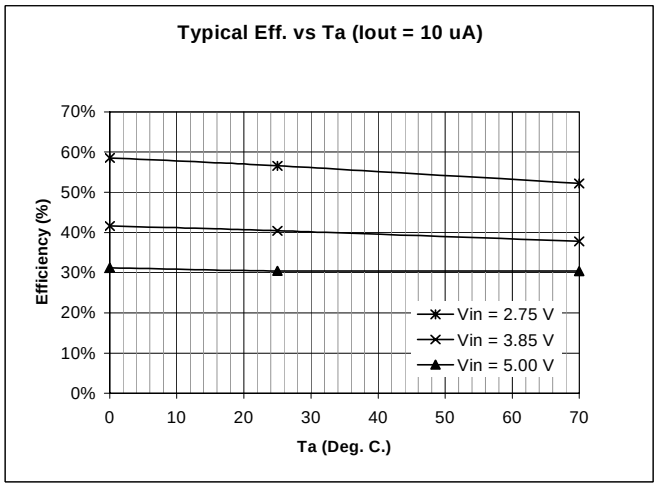

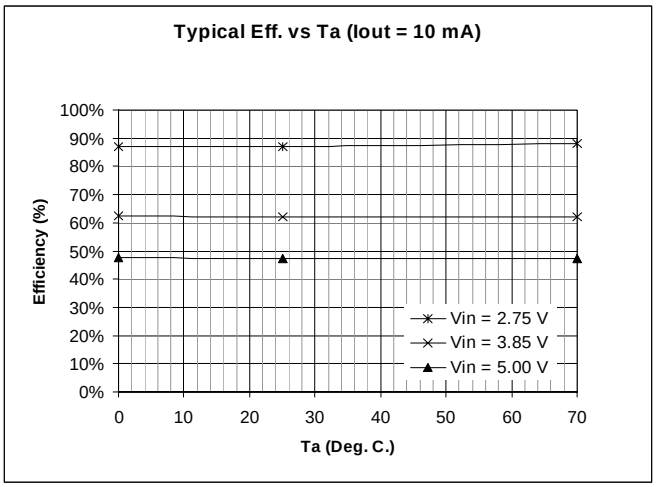

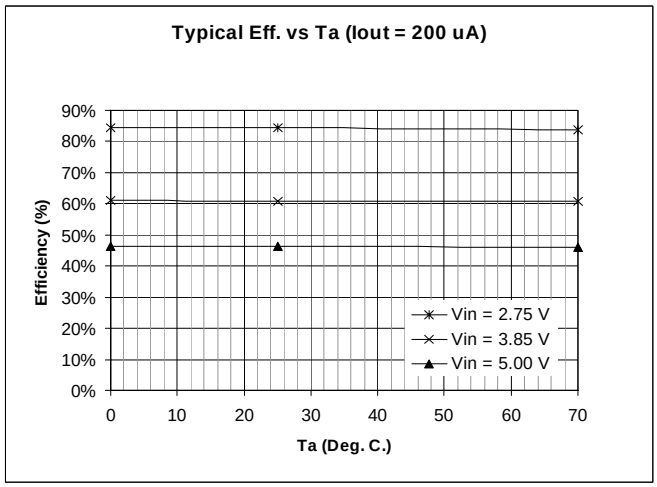

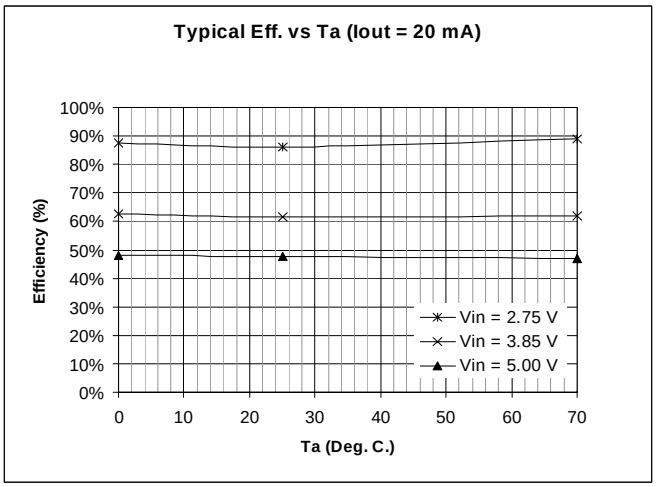

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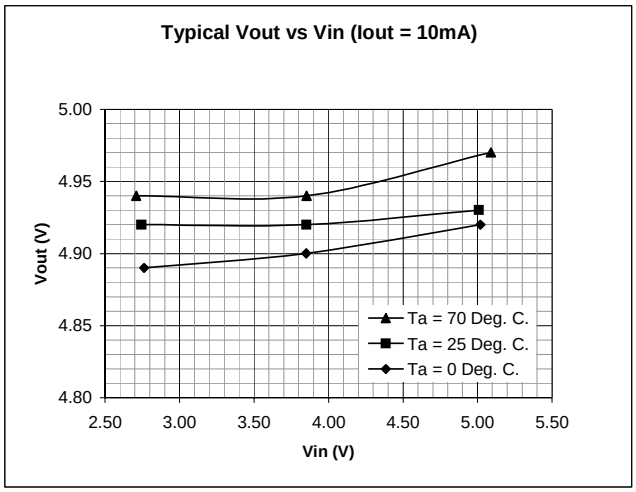

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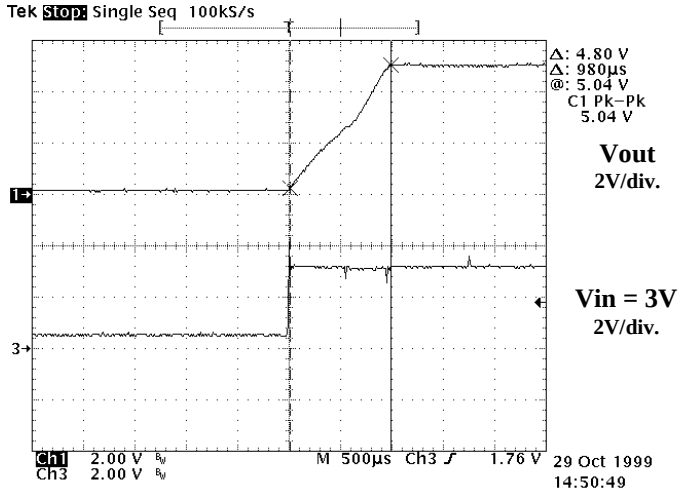
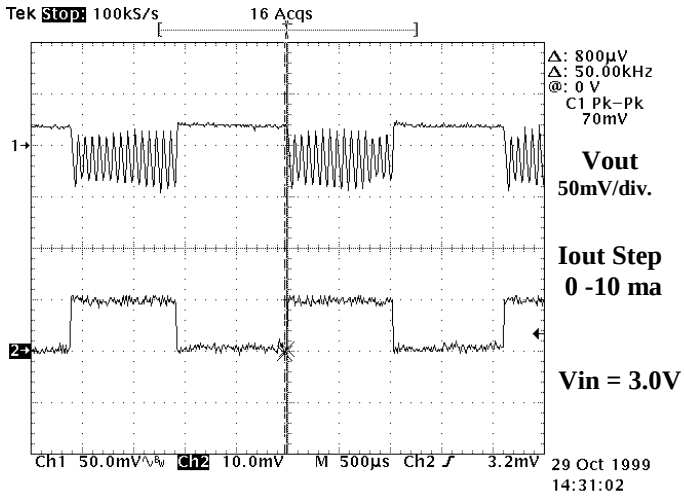


Turn on Regulation time(Ta = 25 Deg. C.)



Load Transient Response(Ta = 25 Deg. C.)

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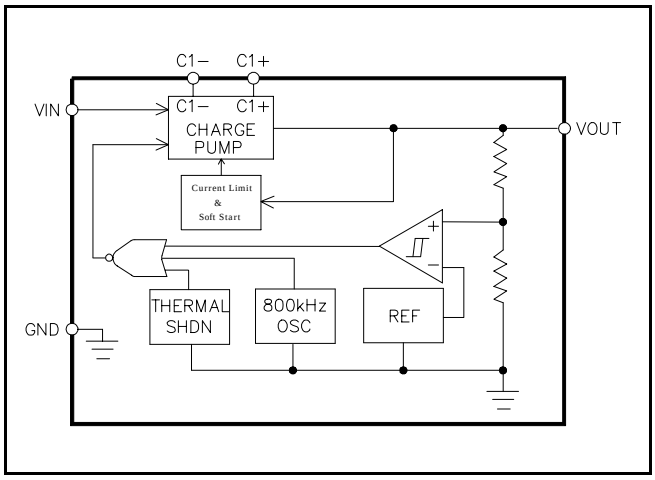
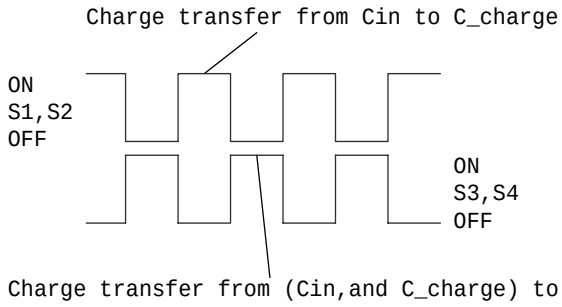
APPLICATION NOTES

THEORY OF OPERATION

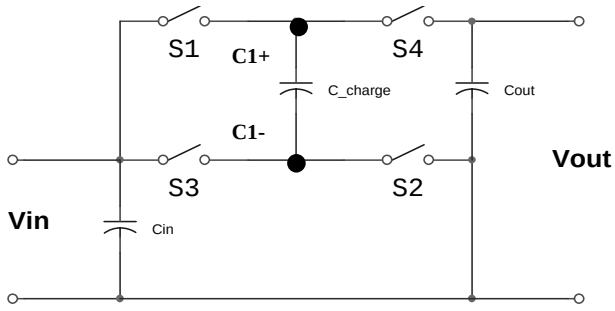
The SC1517-5 utilizes a switched capacitor charge pump, to generate an output voltage regulated to 5V+/-4%.



An internal oscillator generates two out of phase clock signals which turn on and off internal MOSFET switches. During phase1 of clock, the flying charge



pump capacitor is charged to Vin through switches S1, and S2. During phase2 the flying charge pump capacitor is connected in series with the input voltage via S3, and S4, producing an output voltage.
An integrated comparator senses the output voltage



and disable the charge pump once an upper threshold is reached. As the output voltage drops below the lower threshold, the comparator enables the charge pump and hence regulation is achieved.

SHORT CIRCUIT / SOFT START

An internal current limit and soft start circuit provides protection against output short circuit and limits large current spikes generated during the initial start up to charge output capacitor.

As the over current condition is applied at the output, a comparator senses the output voltage and compares it to a signal approximating V_{IN} - 500mV.
If $V_{OUT} < V_{IN}$ - 500mV, the comparator enables a 65mA typical limited current source and the charge pump is disabled. Once the over current is removed and $V_{OUT} > V_{IN}$ - 500mV, the current source is disconnected from output and the charge pump circuitry is enabled again.

THERMAL SHUTDOWN

The thermal shutdown circuit provides added protection to the SC1517-5. During a V_{OUT} short circuit condition or if the load is excessive (I_{OUT} > = 20mA), the thermal shut down circuit is active and if the junction temperature exceeds approximately 160°C, the charge pump is disabled. The charge pump is enabled only if the junction temperature drops to approximately 145°C. The SC1517-5 will cycle in and out of thermal shut down until the short circuit or the excessive load condition on V_{OUT} is removed, thereby improving device reliability.

V_{OUT} RIPPLE & CAPACITOR SELECTION

The peak to peak output ripple voltage is dependent on the following factors:

1- Oscillator Frequency
2- Hysteresis window of the comparator
3- ESR of C_{Charge} , and C_{out}
4- Capacitance value of C_{out} , and C_{Charge}

Item 1, and 2 are fixed and depend on the charge pump device used. Item 3, and 4 can be optimized for best performance and reduction of the output ripple.

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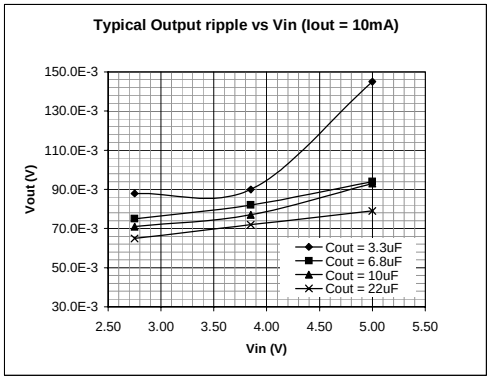
The following formula could be used for an approximation for V_{out_ripple}.

$$V_{out_ripple} = \frac{I_{out}}{2 \times F_{osc} \times C_{out}} + I_{out} \times ESR_ C_{out}$$

Figure below shows the effect of output capacitance value on the ripple voltage. Capacitors used were multilayer ceramic with low ESR < 0.1 Ohms .



Following table shows typical capacitor characteristics :

Component	ESR (Ohms)	ESL (nH)
0.1 uF Ceramic 0603 package	0.100	1.60
1.0 uF Ceramic 1206 package	0.120	0.47
10 uF Ceramic 1206 package	0.075	0.5
47 uF, 16V Tantalum D case	0.100	0.60
330 uF, 6.3V “OSCON”	0.025	2.5
330 uF, 16V Al Electrolytic	0.143	2.37
820 uF, 4.0V “OSCON”	0.012	2.5
1000 uF, 10V Al Electrolytic	0.053	5

Capacitor Manufacturers

Manufacturer	Phone
AVX Corp.	(803)-448-9411
VISHAY	(207)-324-4140
Nichicon Corp.	(708)-843-7500
muRata	(800)-831-9172
TOKIN	(408)-432-8020
Taiyo Yuden	(800)-348-2496
Sanyo	(619)-661-6835

LAYOUT CONSIDERATION

Standard power board layout should followed to ensure proper operation. Any stray inductance should be minimized, this can be achieved by using large power planes or traces, and reducing the distances between input, output and the load. All components should be placed as close as possible to the SC1517-5.

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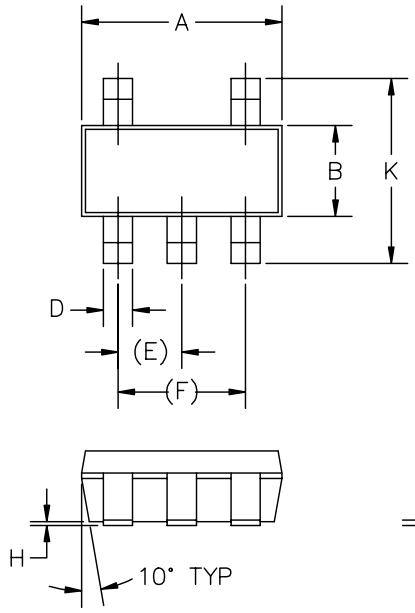
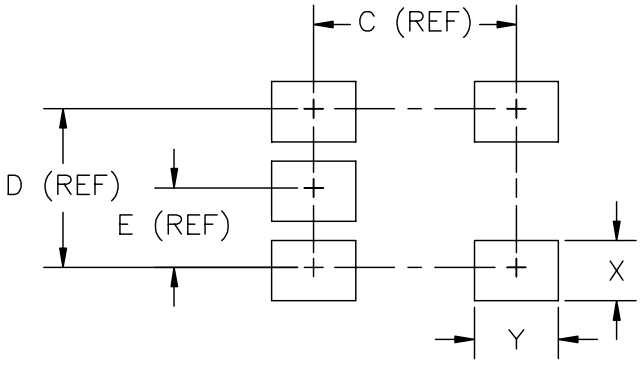
DEVICE OUTLINE SOT23-5L



DIMENSIONS					
DIMN	INCHES		MM [1]		NOTE
	MIN	MAX	MIN	MAX	
A	.110	.120	2.80	3.05	–
B	.059	.070	1.50	1.75	–
C	.036	.051	.90	1.30	–
D	.014	.020	.35	.50	–
E	–	.037	–	0.95	REF
F	–	.075	–	1.90	REF
H	–	.006	–	.150	–
J	.0035	.008	.090	.20	–
K	.102	.118	2.6	3.00	–

[1] CONTROLLING DIMENSIONS: MILLIMETERS.

LAND PATTERN SOT23-5L



DIMENSIONS			
DIMN	INCHES	MM	NOTE
C	.094	2.4	–
D	.074	1.9	–
E	.037	.95	–
X	.028	.7	–
Y	.039	1.0	–

ECN00-1360

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