**SEMTECH**

POWER MANAGEMENT

Description

The SC1462 is a versatile charge pump designed for use in battery operated power supply applications over the wide input range of 1.65 to 5.5 volts. A simple, low quiescent current charge pump doubler can be implemented without costly inductors or capacitors. Internal MOSFETs and control circuitry eliminate the need for costly board space and design time. The small 6 lead SOT-23 package helps minimize board space.

The SC1462 charge pump can be used for applications that require up to 80mA of output current with V_{IN} = 2.5V to 5.5V. Typical dropout voltage (2*Vin)-Vout is shown below for several values of Vin.


Typical Dropout Voltage vs Iout @Ta = 25 Deg. C.
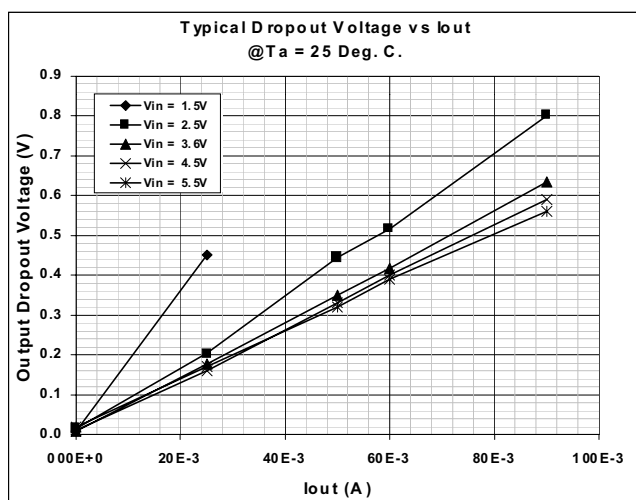
Features

◆ Input supply voltage range of 1.65V to 5.5V

◆ Small size - 6 pin SOT-23 package

◆ Typical efficiency of :
  91% @ Vin = 2.5V, Iout = 45mA
  94% @ Vin = 3.6V, Iout = 55mA

◆ Short circuit and over-temperature protection

◆ 140μA typical input current @ no load

◆ Shutdown current <1μA

◆ Designed to work with ceramic or Tantalum capacitors

◆ Fixed frequency of 160kHz

◆ All specifications rated over full temperature range (-40°C to 85°C)

Applications

◆ Cellular phones

◆ Handheld devices

Typical Application Schematic
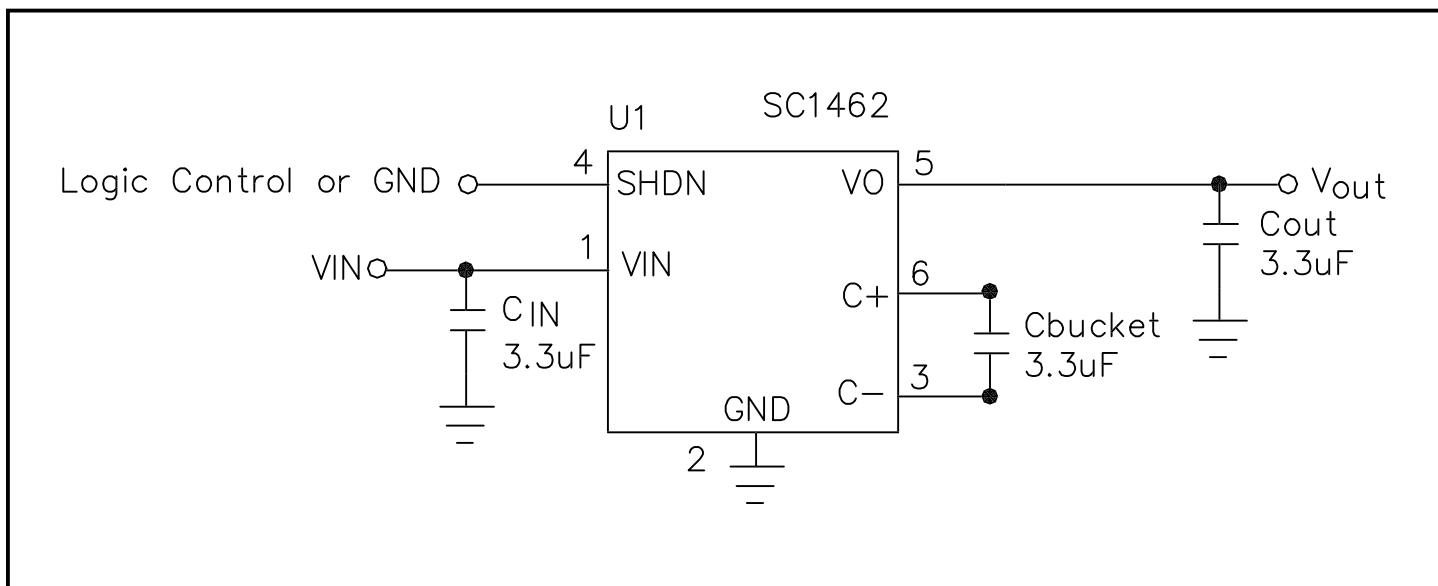
POWER MANAGEMENT

Absolute Maximum Rating

Parameter	Symbol	Maximum	Units
Supply Voltage	VIN	-0.3 to +6.0	V
Output Voltage	VO	-0.3 to +12	V
V_{OUT} Short Circuit Duration	SC	Indefinite	
Thermal Resistance Junction to Ambient	θ_{JA}	230	°C/W
Operating Ambient Temperature Range	T_A	-40 to +85	°C
Junction Temperature Range	T_J	-40 to +125	°C
Storage Temperature Range	T_{STG}	-65 to +150	°C
Lead Temperature (Soldering) 10 seconds	T_L	300	°C

Electrical Characteristics

Unless specified:

T_A = -40°C to 85°C, SHDN = GND, 1.65V $\leq V_{IN} \leq$ 5.5V, Frequency =160kHz, C_{IN} = C_{OUT} = C_{BUCKET} = 3.3µF (ESR = 0.3Ω).

Parameter	Symbol	Conditions	MIN	TYP	MAX	Units
Input Supply Voltage	V_{IN}		1.65		5.5	V
Input Supply Current	I_{IN}	I_O = 0, V_{IN} = 2.5V		140	260	µA
		I_O = 0, V_{IN} = 3.6V		200	400	µA
		SHDN = V_{IN}		0.1	1	µA
Output Resistance[5]	R_{OUT}	V_{IN} = 2.5V		9.5	13.5	Ω
Output Resistance[5]	R_{OUT}	V_{IN} = 3.6V		7.5	10.5	Ω
Total Switch Resistance[6]	R_{SW}	V_{IN} = 2.5V		3	4.5	Ω
Total Switch Resistance [6]	R_{SW}	V_{IN} = 3.6V		2	3	Ω
Output Current	I_O	V_{IN} = 2.5V			80	mA
		V_{IN} = 3.6V			80	mA
Oscillator Frequency	OSC		100	160	200	KHz
Short Circuit Current	I_{SC}	V_{OUT} = 0V		200		mA
Output ripple (pk-pk) [1] [3]	V_R	I_O = 45mA, V_{IN} = 2.5V		75		mV
Power Efficiency[1]	η	I_O = 45mA, V_{IN} = 2.5V	86			%
Maximum Output Voltage[3]	V_{out}	I_O = 0mA			2*V_{in}	V

NOTES:

(1) All electrical characteristics are for the application circuit on page 1.

(2) Soft start functionality is performed along with short circuit protection. If V_{OUT} is less than V_{IN} - 200mV, then all switches are turned off and V_{OUT} is charged with a 200mA current source from V_{IN}. When V_{OUT} reaches V_{IN} - 200mV all switches are enabled.

(3) Guaranteed by design.

(4) This device is ESD sensitive. Use of standard ESD handling precautions is required.

(5) The internal switch resistance, the capacitor ESR and the oscillator's switching frequency all contribute to R_{OUT}. See the CAPACITOR SELECTION section for information on applying the R_{OUT} specification.

(6) The parameter R_{SW} is equal to the total resistance of all 4 internal switches. See the CAPACITOR SELECTION section for information on applying the R_{SW} specification. The parameter was calculated from actual output resistance and the equation on page 6 for R_{OUT}.

POWER MANAGEMENT
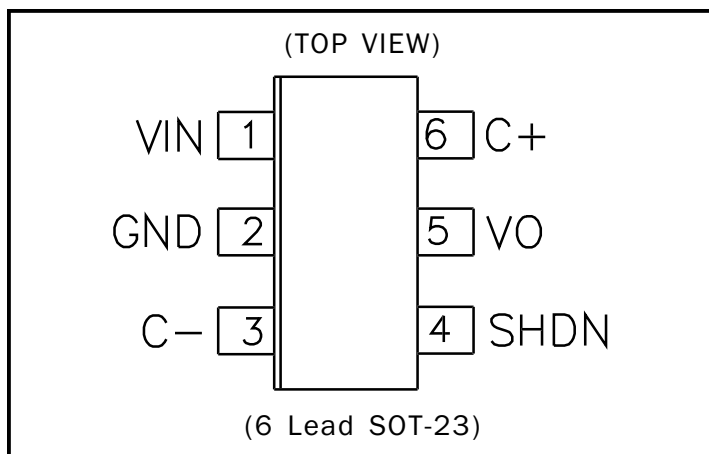
Electrical Characteristics (Cont.)

Unless specified:

T_A = -40°C to 85°C, SHDN = GND, 1.65V $\leq V_{IN} \leq$ 5.5V, Frequency =160kHz, $C_{IN} = C_{OUT} = C_{BUCKET}$ = 3.3µF (ESR = 0.3Ω).

Parameter	Symbol	Conditions	MIN	TYP	MAX	Units
Time to Regulation at Turn on[2]	t_{ON}	I_O = 0 to 60mA, V_{IN} = 3.6V		500		us
Input High Threshold	VIH	SHDN pin, 2.5V $\leq$ VIN $\leq$ 5.5V	1.6			V
Input Low Threshold	VIL	SHDN pin, 2.5V $\leq$ VIN $\leq$ 5.5V			0.4	V
Over Temperature Protection [3]	O.T.			140		°C
Over Temperature Hysteresis [3]	O.T.H.			20		°C

NOTES:

(1) All electrical characteristics are for the application circuit on page 1.

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Pin Configuration

(TOP VIEW)

VIN	1	6 C+
GND	2	5 VO
C−	3	4 SHDN

(6 Lead SOT-23)

Ordering Information

| Part Number[1]	Package
SC1462ISKTR	SOT-23-6

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

Pin Descriptions

Pin # SOT-23-6	Pin Name	Pin Function
1	VIN	Supply voltage input.
2	GND	Ground.
3	C-	This pin should be connected to the negative terminal of the external charging capacitor.
4	SHDN	Shutdown pin. When this pin is connected to VIN, the device enters sleep mode.
5	VO	Voltage output.
6	C+	This pin should be connected to the positive terminal of the external charging capacitor.

Block Diagram
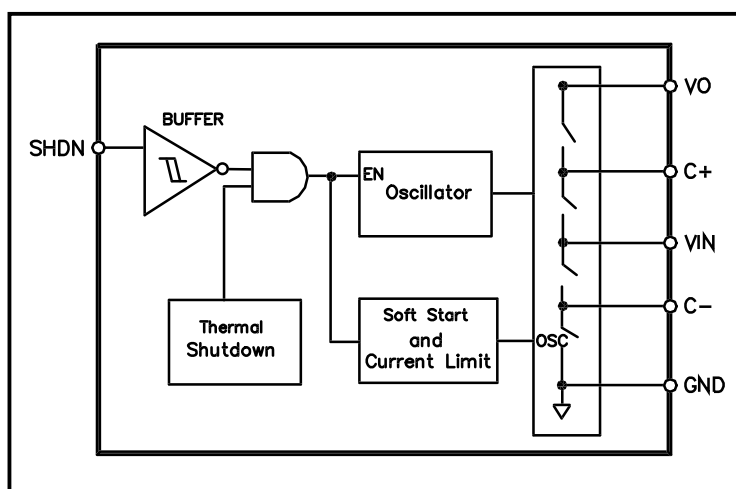
Marking Information

Top Mark
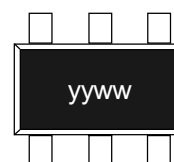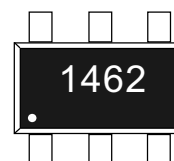
1462

yyww

Bottom Mark

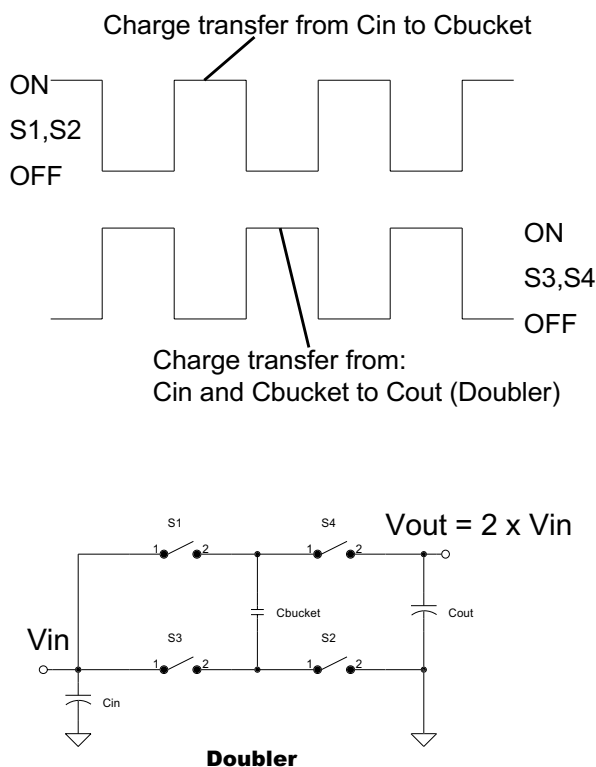yyww = Datecode (Example : 9908)

POWER MANAGEMENT

Applications Information

THEORY OF OPERATION

The SC1462 utilizes a switched capacitor charge pump, to generate an output voltage approximately 2xVin.

An internal oscillator generates two out of phase fixed frequency 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.

Charge transfer from Cin to Cbucket

ON
S1,S2
OFF

ON
S3,S4
OFF

Charge transfer from:
Cin and Cbucket to Cout (Doubler)

Vout = 2 x Vin

Doubler

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.

If V_{OUT} is less than V_{IN} - 200mV, then all switches are turned off and V_{OUT} is charged with a 200mA current source from V_{IN}. When V_{OUT} reaches V_{IN} - 200mV , the current source is disconnected from output and the charge pump circuitry is enabled again.

OUTPUT CURRENT

The dropout voltage for a charge pump doubler is defined as (2*Vin)-Vout. The maximum output current is usually specified as that which will not cause the dropout voltage to exceed the requirements of the application. The calculation of the dropout voltage is given in the capacitor selection section on page 6. Typical dropout voltages versus Iout are graphed on page 8.

THERMAL SHUTDOWN

The thermal shutdown circuit provides added protection to the SC1462. During a V_{OUT} short circuit condition or if the load is excessive , the over temperature circuitry will shut down the charge pump if the junction temperature exceeds approximately 140°C. The charge pump is enabled only if the junction temperature drops to approximately 120°C. The SC1462 will cycle in and out of thermal shut down until the short circuit or the excessive load condition on Vout is removed, there by improving device reliability. The junction temperature can be calculated from the following formula if the ambient temperature (Ta) and the charge pump power dissipation (Pdiss) are known.

$$T_J = T_a + P_{diss} * \theta JA \quad ; \quad \theta JA = 230 \ °C/W$$

CAPACITOR SELECTION

Capacitor selection is based on both the maximum acceptable ripple voltage and the maximum tolerable drop at the output.

Ripple

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

1- Oscillator Frequency
2- ESR of C_{OUT}
3- Capacitance value of C_{out}

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

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

$$V_{out\_ripple} = \frac{I_{out}}{2 \times F_{osc} \times C_{out}} + 2 \times I_{out} \times ESR\_C_{out}$$

Vout Drop

The voltage drop at the output is specified with the following equation:

$$Vout\_drop = Iout * Rout$$

Rout is dependent on the following factors:

1- Oscillator Frequency
2- ESR of C_{OUT} & C_{bucket}
3- Capacitance value of C_{OUT} & C_{bucket}
4- Internal switch resistance (Rsw = Total of all 4 switch resistances).

A good approximation for calculating the output resistance is shown below.

$$R_{out} \cong \frac{1}{F_{osc} \times C_{bucket}} + 2 \times R_{SW} + 4 \times ESR\_C_{bucket} + ESR\_C_{out}$$

This equation can be used to calculate Cbucket for a specific Vout when Vin and Iout are known. The maximum value for the Rsw from the Electrical Characteristics section on page 2 should be used in order to find a worst case number.
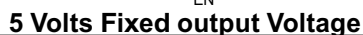
LAYOUT CONSIDERATION

Standard power board layout should be 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 SC1462.
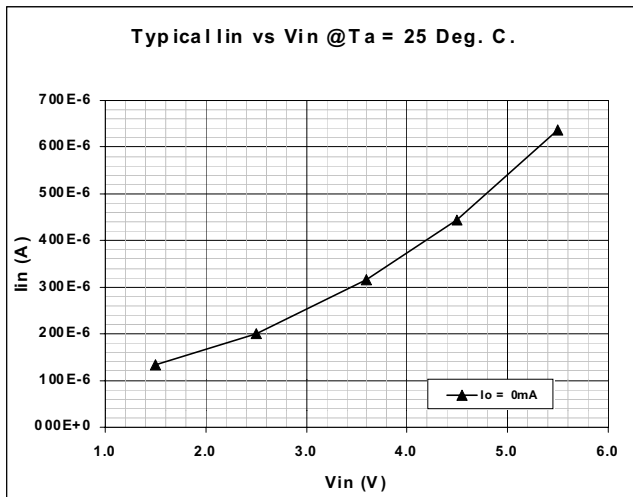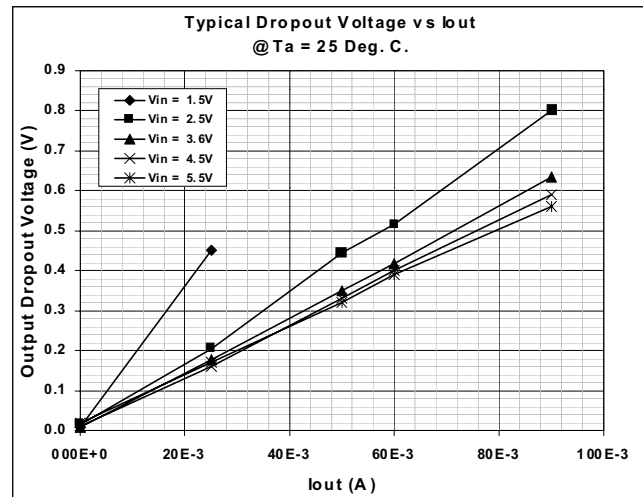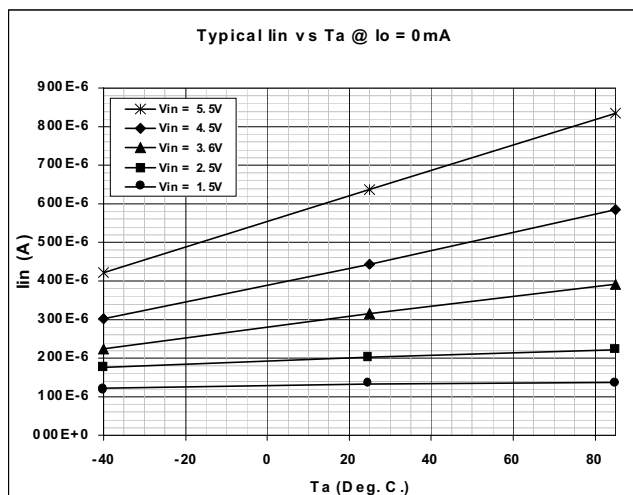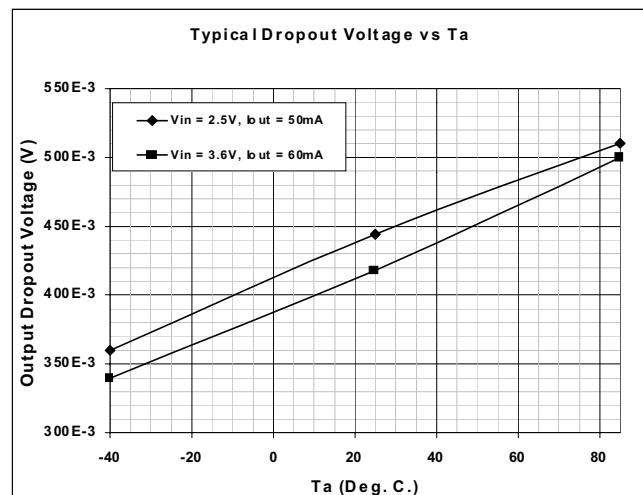
Following tables show typical capacitor characteristics, and capacitor manufactures.

Component	ESR(Ω)	ESL(nH)
0.1uF Ceramic 0603 Package	0.050	1.60
1.0uF Ceramic 1206 Package	0.040	0.47
10uF Ceramic 1206 Package	0.075	0.50
47uF,16V Tantalum D case	0.100	0.60
330uF,6.3V "OSCON"	0.025	2.50
330uF,16V Al. Electrolytic	0.143	2.37
820uF,4V "OSCON"	0.012	2.50
1000uF,10V Al. Electrolytic	0.053	5.00

Capacitor Manufacturers	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

SEMTECH

5 Volts Fixed output Voltage

3.3 Volts Fixed output Voltage

(3.3V Input supply) Battery Operated Synchronous Buck Converter

Typical Iin vs Vin Io = 0mA

Typical Dropout vs Iout

Typical Iin vs Ta Io = 0mA

Typical Dropout vs Ta
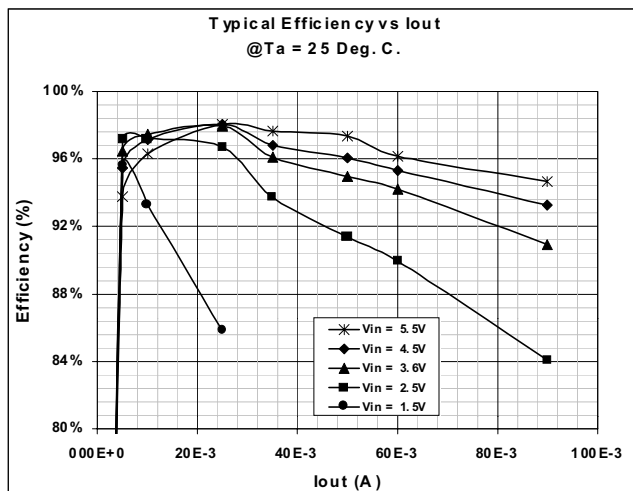
Typical Efficiency vs Iout
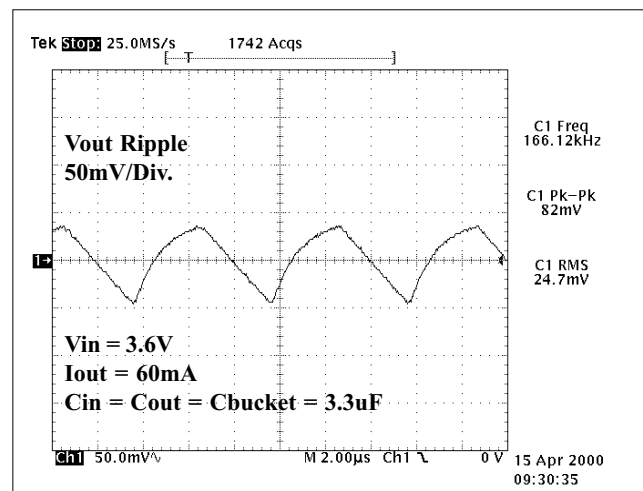
Typical Output Ripple

POWER MANAGEMENT

Outline Drawing - SOT-23-6L
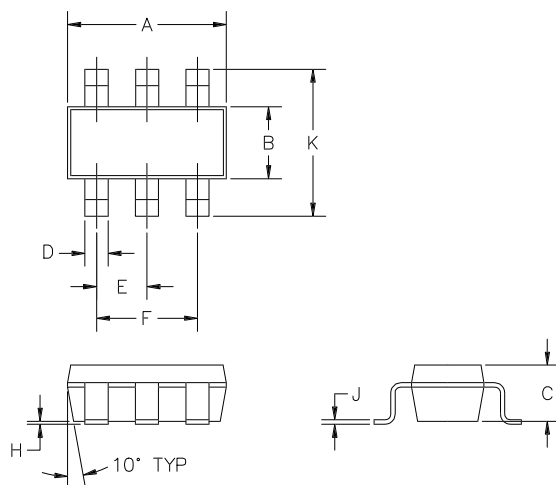
DIMENSIONS					①
DIMᴺ	INCHES		MM		NOTE
	MIN	MAX	MIN	MAX	
A	.110	.120	2.80	3.05	–
B	.059	.070	1.50	1.75	–
C	.036	.051	.90	1.30	–
D	.014	.020	.35	.50	–
E	.033	.040	.85	1.05	–
F	.067	.083	1.7	2.1	–
H	.0004	.006	.010	.150	–
J	.0035	.008	.090	.20	–
K	.102	.118	2.6	3.00	–

② PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH AND METAL BURR.

① CONTROLLING DIMENSIONS: MILLIMETERS.

Land Pattern - SOT-23-6L
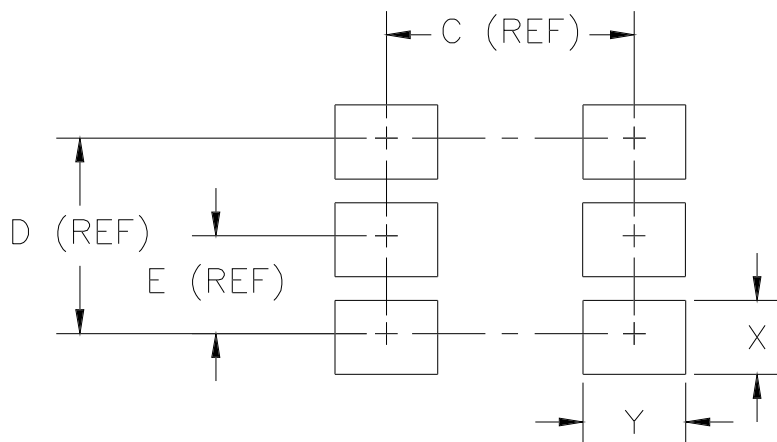
DIMENSIONS			
DIMᴺ	INCHES	MM	NOTE
C	.094	2.4	–
D	.074	1.9	–
E	.037	.95	–
X	.028	.7	–
Y	.039	1.0	–

Contact Information

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