POWER MANAGEMENT

Description

The SC801 is a fully integrated, single cell, constant-current/constant-voltage Lithium-Ion\Li-Polymer battery charger management system. The SC801 has built in intelligence and extreme functionality. When the battery voltage is below 2.8V the charger operates in a pre-charge mode with a charging current of up to 125mA based on the ITERM pin resistor. This pre-charge mode is set to limit power dissipation due to an undercharged battery. When the battery voltage exceeds 2.8V, the charger enters a fast charge mode. In this mode, the SC801 delivers up to 1.5A to the battery based on the IPRGM pin resistor.

The part also features current termination, ending the charge cycle when the battery is charged and the charge current drops below the current programmed by the ITERM pin resistor. In addition, the charge current can be monitored by the voltage on the IPRGM pin allowing a microcontroller or ADC to access the current information to determine when to externally terminate the charge cycle. Once the charge cycle is complete and terminates, the device enters the charge monitor mode where the output voltage of the battery is monitored. If this voltage drops below the recharge threshold the device will enter the fast charge mode again, to bring the battery to its fully charged state. Both the shutdown and monitor modes drain no more than 1uA from the battery guaranteed.

The output voltage to the battery is controlled to within 1% of the programmed voltage for either 4.1V or 4.2V. The SC801 can also function as a general purpose current source or as a current source for charging nickel-cadmium (NiCd) and nickel-metal-hydride (NiMH) batteries using external termination.

Features

- ◆ Fully integrated charger with FET pass transistor, reverse-blocking diode, sense resistor and thermal protection
- ◆ 4.1V, 4.2V & Adjustable Output Voltage
- ◆ Programmable precharge, fastcharge & termination current
- ◆ Battery voltage controlled to 1% accuracy
- ◆ Soft-start for step load and adaptor plug-in
- ◆ Up to 1.5A continuous charge current
- ◆ Charge current monitor output from microcontroller or ADC Interface
- ◆ Input voltages range from 4.2V to 14V
- ◆ 0.1µA Battery leakage in shutdown and monitor modes
- ◆ Operates without a battery in regulated LDO mode
- ◆ Small 4mm x 4mm 16 lead MLP package
- ◆ Low thermal impedance of 50°C/watt
- ◆ Few external components
- ◆ Over current protection in all charging modes
- ◆ Over voltage protection
- ◆ All outputs able to drive LED's and interface to host processor
- ◆ Remote Kelvin sensing at the battery terminal
- ◆ Small input & output filter capacitors
- ◆ Status output communicates charging and end of charge cycle
- ◆ Now Available in Lead-Free Packaging
- ◆ Charges Li-Ion, Li-Polymer, NiCd and NiMH Batteries

Applications

- ◆ Cellular phones
- ◆ PDA's and Handheld computers
- ◆ Handheld meters
- ◆ Charging stations
- ◆ Digital cameras

Typical Application Circuit

$$Pre\text{-}Charge\,Current = \left(\frac{2.8}{R_2}\right) \bullet 88 \quad Fast\text{-}Charge\,Current = \left(\frac{1.5}{R_1}\right) \bullet 1000 \quad Termination\,Current = \left(\frac{1.5}{R_2}\right) \bullet 88$$
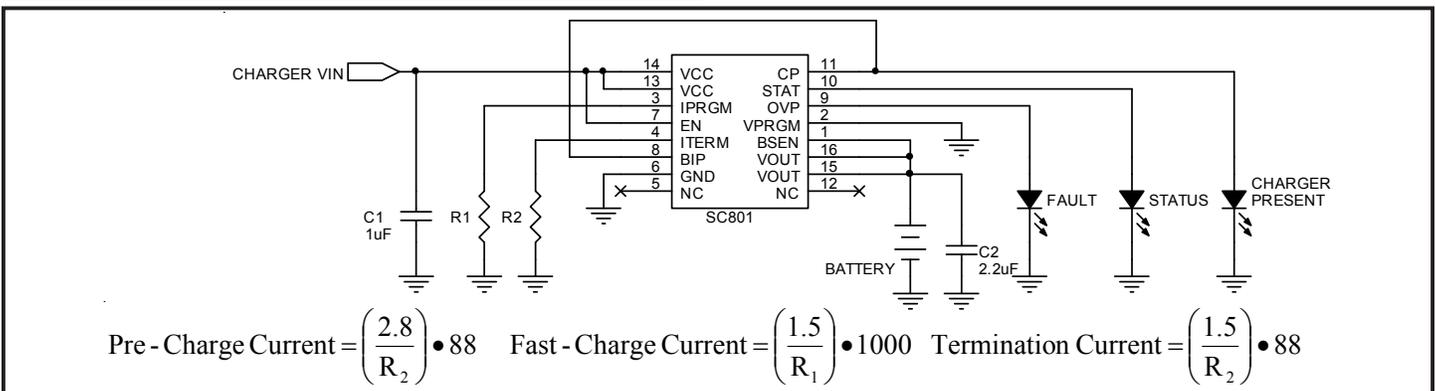
POWER MANAGEMENT

Absolute Maximum Ratings

Exceeding the specifications below may result in permanent damage to the device, or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not implied.

Parameter	Symbol	Maximum	Units
VCC, EN to GND		-0.3 to 14.0	V
VOUT, VPRGM, IPRGM, CP, OVP, STAT, ITERM, BIP to GND		-0.3 to +6.0	V
Power Dissipation, MLP (Derate 20mW/ °C above 85 °C)	P_D	2.5	W
VOUT short to GND		Continuous	
Thermal Resistance, Junction to Ambient	θ_{JA}	48	°C/W *
Operating Junction Temperature	T_J	150	°C
IR Reflow Temperature (Soldering) 10 seconds	TR option	T_{IRRT}	240	°C
	TRT option (leadfree leadframe)	T_{IRRT}	260	°C
Storage Temperature	T_{STG}	-65 to 150	°C
ESD Rating (Human Body Model)	ESD	2	kV

* Tied to PCB with 1 Square Inch, 2 Ounce Copper

Electrical Characteristics

Unless otherwise noted: VCC = 4.75V - 5.25V

Parameter	Symbol	Conditions	25°C			T_A (-40°C to +85°C)		Units
			Min	Typ	Max	Min	Max	
Input Voltage	VCC					4.2	14	V
Operating Voltage	V_{OP}					4.2	6.5	V
Operating Current	I_{CC}	Charging Mode OVP, STATUS, CP = 0µA					2	mA
		LDO Mode OVP, STATUS, CP = 0µA					25	
Battery Leakage Current	I_{VOUT}	VCC = 0V		0.1			1	µA
Regulated Voltage	V_{BAT}	V_{PRGM} = Logic High V_{PRGM} = Logic Low		4.20 4.10		4.16 4.06	4.24 4.14	V
Adjust Mode Feedback Voltage		V_{PRGM} = External Divider V_{CC} = 4.2V - 6.5V		3.0		2.97	3.03	V
Battery Pre-Charge Current	P_{CI}	I_{TERM} Resistor R = 3.01k $V_{BATTERY}$ > 2.5V		82		72	92	mA
Battery Termination Current	I_{TERM}			45		38	52	
Battery Fast-Charge Current	F_{CI}	I_{PRGM} = 3.01k I_{PRGM} = 1.87k $V_{BATTERY}$ = 3.8V Dropout Voltage = 550mV		500 800		450 750	550 850	mA

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Electrical Characteristics Cont.

Unless otherwise noted: VCC = 4.75V - 5.25V

Parameter	Symbol	Conditions	25°C			T_A (-40°C to +85°C)		Units
			Min	Typ	Max	Min	Max	
Battery Fast-Charge Current Limit		2.8V < $V_{BATTERY}$ < V_{BAT} Dropout voltage = 1V					1.5**	A
I_{PROG} Regulated Voltage				1.5		1.4	1.6	V
V_{IN} UVLO Rising Threshold				4.2			4.3	V
Adjust Mode Threshold Voltage				90				mV
V_{BAT} Precharge Threshold				2.8		2.7	2.9	V
V_{BAT} Recharge Threshold		V_{BAT} - $V_{BATTERY}$		200		170	220	mV
V_{IN} OVP Rising Threshold				6.8		6.525	7.1	V
V_{IN} OVP Falling Threshold				6.5		6.2	6.8	V
V_{IN} OVP Hysteresis				300		200	400	mV
Over Temperature Shutdown		Hysteresis = 10°C		165				°C
Status Output Source Current		Pre-Charge or Fast-Charge VSTAT = 2.8V		10				mA
		End of Charge, VSTAT= 0.25V		1				mA
		No Adaptor or LDO mode, High Impedance		1				µA
OVP Output Source Current		VCC > OVP		10				mA
CP Output Source Current		VCC > UVLO		10				mA
BSENSE Input Leakage Current				0.1			1	µA
STAT, OVP, CP Outputs	V_{OH}	Load = 10mA				2.4		V
		Load = 1mA				2.6		
	V_{OL}	Load = -500µA					0.25	V
EN, BIP, VPRGM Inputs	V_{IH}					1.8		V
	V_{IL}						0.4	V

** Thermally Limited

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POWER MANAGEMENT

Pin Configuration

MLP16: 4X4 16 LEAD
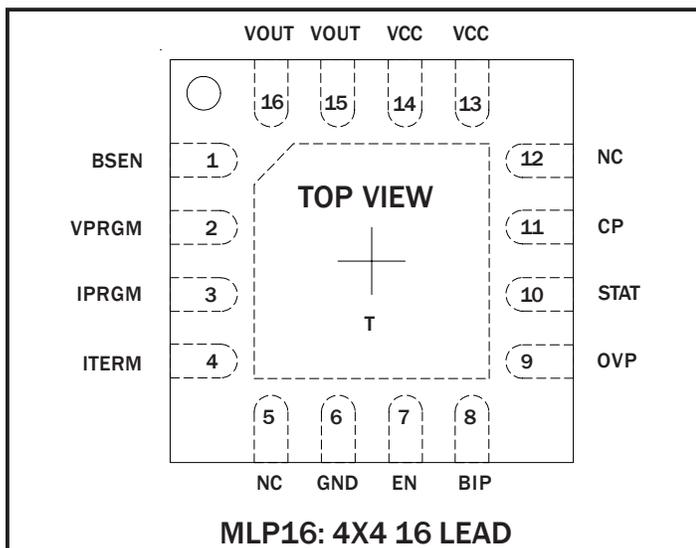
Ordering Information

| DEVICE[1]	PACKAGE
SC801IMLTR	MLP16
SC801IMLTRT[2]	MLP16
SC801EVB[3]	Evaluation Board

Notes:
(1) Only available in tape and reel packaging. A reel contains 3,000 devices.
(2) TRT extension designates the lead-free leadframe package option.
(3) Specify the desired IC part number when ordering.

Pin Descriptions

Pin #	Pin Name	Pin Function
1	BSEN	Battery voltage sense pin. Connect to battery terminal to Kelvin sense battery voltage. Do not leave this pin floating.
2	VPRGM	Selectable voltage program pin. Logic low = 4.1V. Logic high = 4.2V. Resistor = adjustable.
3	IPRGM	Charger current program pin in fast charge mode. Requires a resistor to ground to program fast-charge current.
4	ITERM	Selection for current termination and pre-charge current. Requires a resistor to ground to program pre-charge and termination current.
5	NC	No Connect
6	GND	Ground
7	EN	Device enable/disable pin. Logic high enables device. Logic low disables device.
8	BIP	Input derived from external circuitry or microcontroller that signals Battery In Place. Logic high indicates Battery In Place and in charging mode. Logic low puts device into LDO mode. Do not leave this pin floating.
9	OVP	Overvoltage fault flag if charger input voltage is higher than 6.5V This pin can Source 10mA.
10	STAT	Charger Status Pin: Pre-charge (High), Fastcharge (High) and end of charge (Low). When in LDO mode this pin is high impedance. This pin can source 10mA.
11	CP	Charger present indicator, logic high when there is power to the VCC pins regardless of the Enable pin state. This pin can source 10mA.
12	NC	No Connect
13	VCC	Supply pin, connect to adaptor power.
14	VCC	Supply pin, connect to adaptor power.
15	VOUT	Charger output, connect to battery.
16	VOUT	Charger output, connect to battery.
T	Thermal Pad	Thermal-conduction pad on bottom of the package. Solder directly to the ground plane with multiple thermal vias to all other ground planes.

POWER MANAGEMENT

Block Diagram
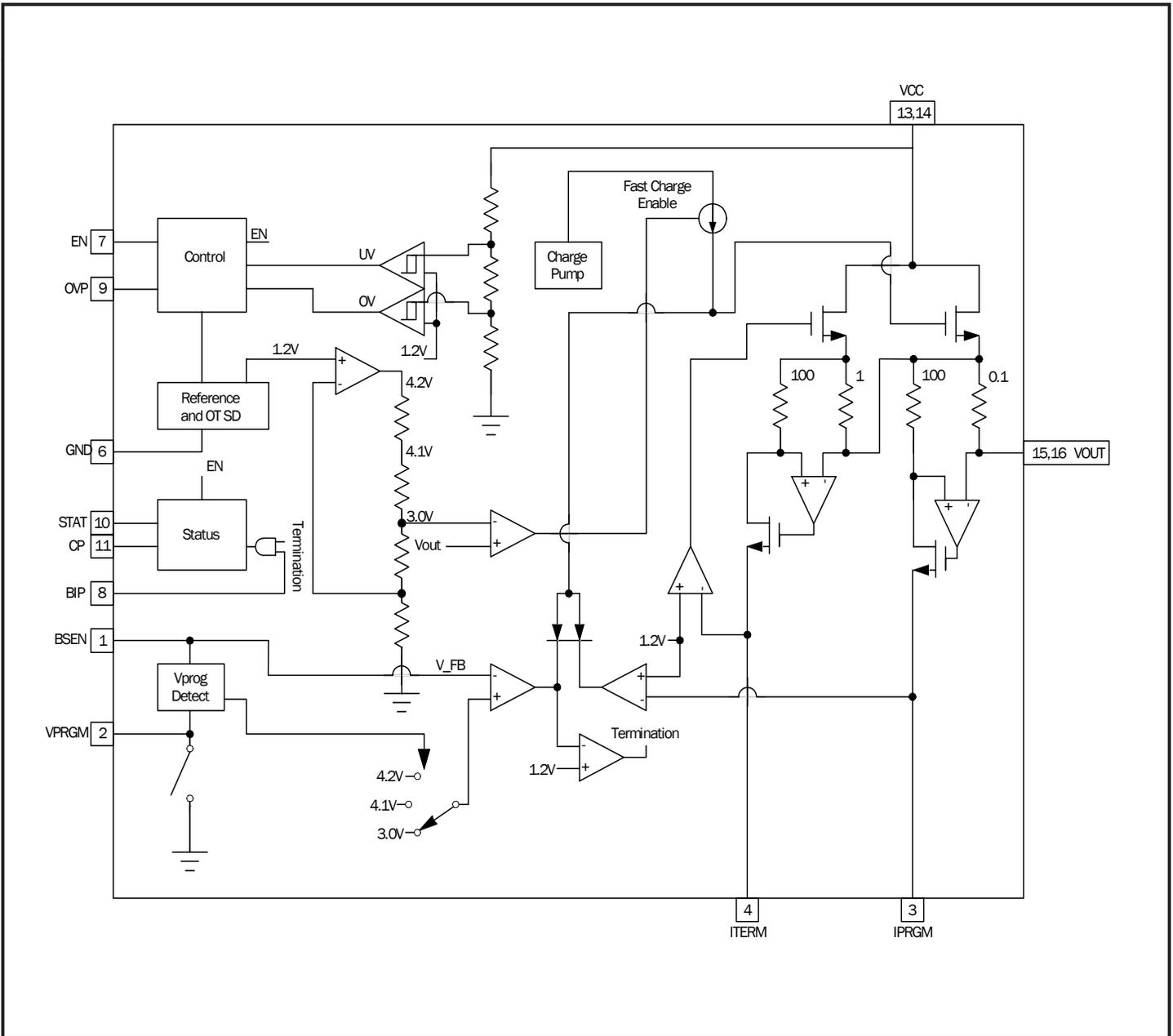
POWER MANAGEMENT

Applications Information

Pre-Charge Mode

Pre-charge mode is automatically enabled whenever the battery voltage is below 2.8V. It is primarily used to limit the power dissipation of the battery and the SC801 device whenever the battery is undercharged. As the battery begins to charge in this mode, the voltage of the battery will rise and when the 2.8V limit is reached, the SC801 will switch to the fast charge mode. The pre-charge current value is selected by the termination resistor on the ITERM pin. The maximum range of the pre-charge current is from 10mA to 125mA. Whenever the charger is in pre-charge or fast-charge the status LED will light indicating that the battery is being charged. The equation to select the pre-charge current is given by:

$$PCI = \left(\frac{2.8}{R_{TERM}}\right) \bullet 88$$

Fast-Charge Mode

The fast-charge mode exists while the battery voltage is above 2.8V and the battery is not fully charged. The fast-charge current can be set to a maximum of 1.5A and is selected by the program resistor on the IPRGM pin. In fact, the voltage on this pin will represent the current through the battery enabling a microprocessor or analog-to-digital converter (ADC), to monitor battery current by sensing the voltage on the IPRGM pin. The equation to set the fast-charge current is given by:

$$FCI = \left(\frac{1.5}{R_{PRGM}}\right) \bullet 1000$$

Note that for a given program resistor the current through the battery can be determined by replacing 1.5 with the actual voltage on the IPRGM pin in the above equation.

Termination Current

Once the battery reaches the program voltage of 4.1V, 4.2V or externally set voltage, the device will transition from a constant current source to a constant voltage source, as the current through the battery begins to decrease while the voltage remains constant. During this time when the current falls below the programmed termination current set by the termination resistor on the ITERM pin, the SC801 will turn off and the end of charge will be indicated by the status LED turning off. The equation to set the termination current is given by:

$$ITERM = \left(\frac{1.5}{R_{TERM}}\right) \bullet 88$$

Monitor Mode

In the monitor mode the voltage of the battery will be monitored against the programmed voltage. This will occur after a battery has been fully charged and the device has shut off. If the voltage of the battery falls below the recharge threshold (specified at 200mV) the charger will activate and charge the battery to its programmed voltage. This means that it will enter the full charging sequence from fast-charge to terminating the charging cycle when the programmed termination current is reached. The maximum current drain of the battery during monitor mode will be no more than 1uA over temperature.

LDO Mode

One of the nice features of the SC801 is its ability to work with or without a battery. If the battery is not in place the device can enter the LDO mode. In this mode the SC801 will act like a low dropout regulator. The output voltage is set to 4.1V, 4.2V or externally set by a resistor divider. See the section titled "Configuring the Output Voltage to the Battery" for setting an output voltage other than 4.1V or 4.2V. The input pin BIP (Battery In Place) is used to switch the SC801 from charger mode to LDO mode. If this pin is logic high the device will be in charger mode, if it is logic low it will be in the LDO mode. During LDO mode the device will regulate the output voltage with a current limit set by the resistor tied to the IPRGM pin. The BIP pin can be tied to the CP pin to place the device in charge mode whenever the adaptor is in place. The maximum voltage on the BIP input pin is 6V, so do not tie it to the VCC input since this voltage can exceed 6V in some conditions. The BIP pin should never be left floating, but instead, should be tied through pull-up/pull-down resistors when connected to a high impedance control pin, otherwise it can be connected directly to the CP pin or GND. The equation for setting the current limit in the LDO mode will be:

$$ILDO = \left(\frac{1.5}{R_{PRGM}}\right) \bullet 1000$$

LED Flags

There are three LED drivers on the SC801: OVP (Over Voltage), STAT (Status) and CP (Charger Present). Each output can drive an LED directly without a current limit resistor. In addition, each output can be monitored by a microprocessor for change in their status. The table above defines each LED output.

POWER MANAGEMENT
Applications Information (Cont.)

LED FLAG	ON	OFF	HIGH IMPEDANCE
CP	POWER TO VCC PINS	NO POWER TO VCC PINS	X
OVP	VCC OVER-VOLTAGE	VCC VOLTAGE NORMAL	X
STAT	BATTERY CHARGING	BATTERY FULLY CHARGED	LDO MODE

$$VOUT = \left(1 + \frac{R4}{R3}\right) \bullet 3.0$$

FIGURE 1

The CP output can be used for a UVLO indicator. Regardless of the state of EN, the CP output reflects the voltage of the VCC (adapter) input. When VCC is above UVLO, CP is high, 2.8V. When VCC is below UVLO, CP is low, 0V. The CP pin can also put the device into the charge mode whenever the adaptor has power, by connecting it to the BIP pin.

The OVP LED will light whenever the SC801 is enabled and there is an overvoltage on the VCC pins. When this occurs the SC801 will turn off and stay off as long as the overvoltage condition remains. As soon as the overvoltage is removed the SC801 will resume operation. The OVP LED will not light if the part is disabled, even though an overvoltage is present on the VCC pins.

Configuring the Output Voltage to the Battery
The battery voltage is set by the VPRGM pin. If this pin is logic high the output voltage is set to 4.2V. If this pin is logic low the output voltage will be set to 4.1V. The VPRGM pin can be tied to the CP pin for 4.2V operation and ground for 4.1V operation. For a value other than 4.1V or 4.2V a resistor divider is required. This divider is set between the VOUT pin and the VPRGM pin with the divider tap connected to the BSEN pin. The schematic for such a connection and the equation to set the output voltage is given in Figure 1. The output voltage for Figure 1 will be set to 4.77V with the resistors shown. The capacitor C1 may be needed for stability and or reduced ripple voltage. It is advisable to leave room on the PCB for adding this capacitor, since it can be left out if it is not needed. The evaluation board does have a place for the resistor divider and capacitor to allow an adjustable voltage to be set on this board via R1, R2 and C2 (see schematic on page 10). With JP7 removed, jumper JP2 should be added to complete the changes required for adjustable mode operation on the evaluation board. For further evaluation board information, see the section tilted Evaluation Board.
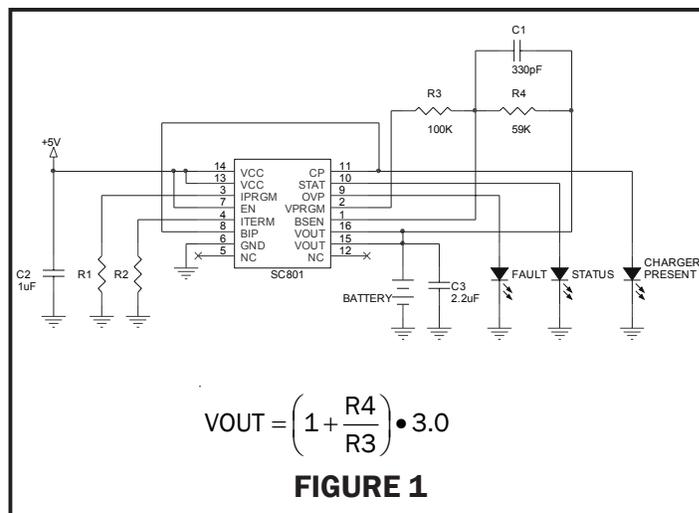
Remote Kelvin Sensing at the Battery
Another nice feature of the SC801 is its ability to sense the battery voltage directly at the battery with its Kelvin BSEN pin. This allows the designer great flexibility in PCB layout and achieves a much greater accuracy in sensing the battery voltage where it counts, at the battery terminals! Therefore, when laying out the PCB the designer should route the BSEN pin directly to the terminal at which the battery gets connected. In addition, in the LDO mode, the BSEN pin will still need to sense the output voltage. In LDO mode, the BSEN pin becomes the regulation feedback for the control-loop. In this case it is sensing the output voltage of itself, since the battery is not in place. Therefore BSEN should never be left floating.

Capacitor Selection
Input and output capacitors can be low cost ceramic type. The output capacitance range is 1uF to 4.7uF. The input capacitor should be between 0.1uF to 1uF.

Overcurrent and Temperature Protection
Overcurrent protection is inherent to the SC801. The SC801 operates as a current source and the output current is limited by the mode it is in at the time. If in the fast-charge mode the current is limited by the IPRGM resistor, the fast-charge current. When the output voltage is less than 2.8V, the current is limited by the ITERM resistor, the pre-charge current. Both of these functions protect the device in an event of a short circuit condition on the output. In the LDO mode the current is limited to the fast-charge current, provided there is voltage on the output. Under a short circuit condition in the LDO mode the current will enter a "hiccup" mode. The temperature shutdown can protect the device in conditions of excess current as well, by shutting down the device when its die temperature exceeds 165°C.

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Applications Information (Cont.)

Using the SC801 With a Charge Controller IC
The SC801 can also be used with numerous charge controller ICs on the market. In many instances the charge controller will control the charging and termination of the SC801. The best method of interfacing the SC801 with such a device is to place the SC801 in LDO mode, and monitor the current to the battery by an ADC that samples the voltage on the IPRGM pin. Slow and fast charge can be controlled by placing two resistors in series from IPRGM to GND and adding a transistor switch across one of the resistors. This way the current can be monitored for proper termination by the charge controller. In LDO mode the STAT LED will not light. When charging the battery in LDO mode the charge profile will be the same as in charge mode except there will be no precharge or termination current function. Meanwhile, the maximum current the battery will see is set by the battery equivalent circuit or the fast-charge current limit. The battery will still charge in this mode, albeit a slightly different approach than placing the charger in the charge mode.

Evaluation Board
The evaluation board is shown on Page 10. The evaluation board was designed to test the complete operation of the SC801 and the SC801M. Note the minimum parts requirement is shown within the dotted rectangle on the schematic. The adaptor voltage of 5V is applied to TP1 and TP2 which supplies power to the SC801. The output charger voltage or LDO output voltage is taken off of TP4 and TP5. Jumper JP5 will set the device in LDO mode when inserted or charge mode when left open. Jumper JP6 will enable the device when inserted or disable the device when left open. Note as long as power is applied to VCC the CP LED will light, regardless of the EN pin level. Jumper JP4 is used to measure the bias current of the SC801 and should always be in place except when measuring bias current. JP1 and JP3 set the charge limit voltage to 4.2V or 4.1V respectively. Only one of these jumpers JP1 or JP3 should be in place at any given time. If you expect VCC to exceed 6V (testing breakdown of the SC801) and you want to set the output voltage to 4.2V you should remove any jumper on JP1 and manually tie pin 2 of JP1 to the CP pin, because the absolute maximum voltage on the VPRGM input pin is 6V. Jumper JP7 when inserted will short the BSEN line to Vout for charging Lithium-Ion batteries. Jumper JP2 should be inserted when an adjustable voltage is required, with the addition of R1, R2 & C2. For more information about selection of an adjustable voltage see the section titled, Configuring the Output Voltage to the Battery. Note, only one of these jumpers JP2 or JP7 should be inserted at any given time. Jumper JP8 should be left open and is used only for testing SC801M operation. Connector J1 is used for connecting the evaluation board to a demonstration platform to exemplify the SC801 operation. Other components on the eval board consist of Semtech's SD12 and SD05 ESD clamp diodes which should be part of any system requiring ESD protection. LED's for status information and TP3 which will allow the current through the battery to be monitored. The input capacitor C1 is chosen to be 10uF to decouple any inductance from a laboratory supply when evaluation is taking place.

Complete Charge Cycle
The complete charge cycle of the SC801 is shown on page 15. The pre-charge current will be under control until the precharge threshold of 2.8V is reached. At this time the device enters the fast-charge mode and the output voltage continues to increase as the constant current is applied to the battery. Eventually constant voltage is reached and the current begins to decrease until the termination current threshold is reached at which time the SC801 will turn off. Many Lithium-Ion batteries have a built in under-voltage detect circuit. This makes the battery pack open circuited when the battery voltage falls below 3V typically. With these batteries the SC801 will unlikely enter pre-charge operation because the battery voltage will always be above 2.8V.

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Applications Information (Cont.)

Layout Guidelines

Try to keep the traces from the adaptor input to the VCC pins as wide as possible, to eliminate any voltage drop across the device input traces. You want to make sure the input-to-output voltage differential of the device does not approach the dropout voltage. A curve of the dropout voltage vs. output current is shown on page 15. Any voltage dropped over the input traces from the adaptor will reduce the dropout voltage margin.

Make the high current output trace from the VOUT pins as wide as possible. The BSEN line should be used properly to compensate for any voltage drops from the output trace to the battery. Make a Kelvin connection with the BSEN trace to where VOUT connects the battery terminals. This is done by taking the BSEN trace and tying it to the VOUT trace as close to the battery terminals as possible. This way, any voltage drop across the trace resistance to the battery will be compensated for because BSEN will regulate the device output voltage (VOUT) at the point it connects to the VOUT trace. If you tie the BSEN line to the VOUT pin at the device you will eliminate the benefit of its purpose and the trace resistance drop will not be compensated. Therefore, it is best to have the BSEN trace follow in parallel the VOUT trace and tie them together at the contact point of the battery terminal for the best result.

The bottom of the SC801 package has a heat slug and this slug should be tied to a ground plane of the PCB through one large via or a series of smaller vias. If there is no ground plane, an area should be dedicated on the bottom of the PCB to act as a heat sink. The evaluation board has 1 square inch of copper and allows an output current of greater that 1A. The more copper tied to this slug the greater the output current available before thermal limitations dominate. The two pins that are labeled NC are not connected to the die. Therefore, tying these pins to the ground plane offers no aide in heat removal and has no electrical benefit.

POWER MANAGEMENT

## Evaluation Board Schematic
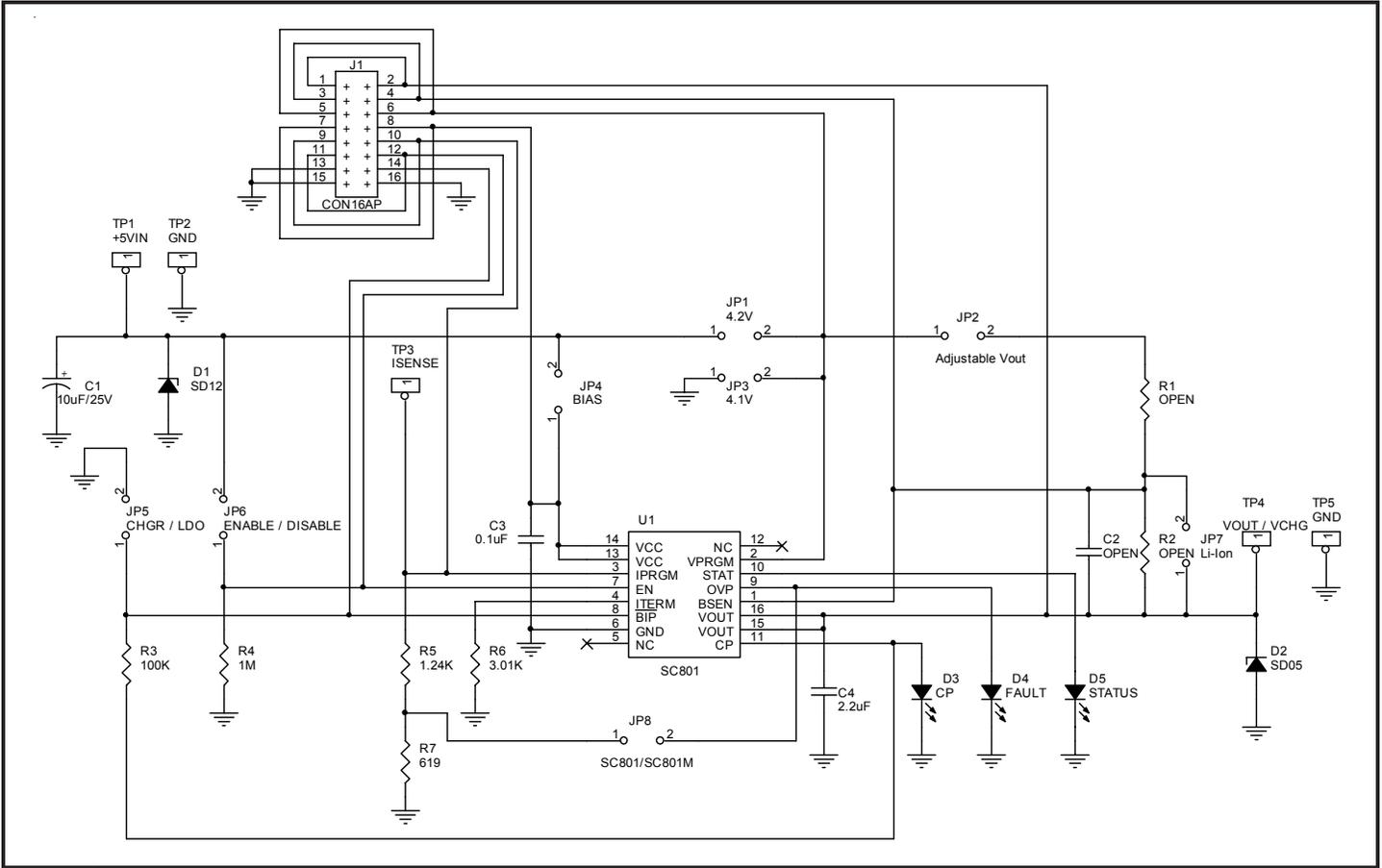
## Evaluation Board Gerber Plots

Top Gerber
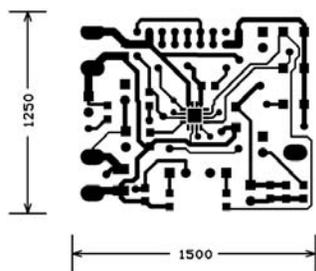
Bottom Gerber
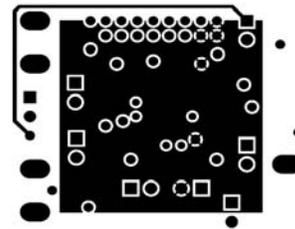
Inner Gerber

Silk Screen Gerber

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LDO Mode

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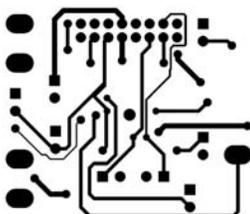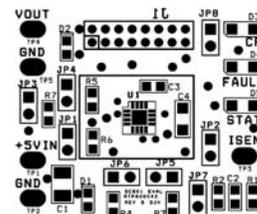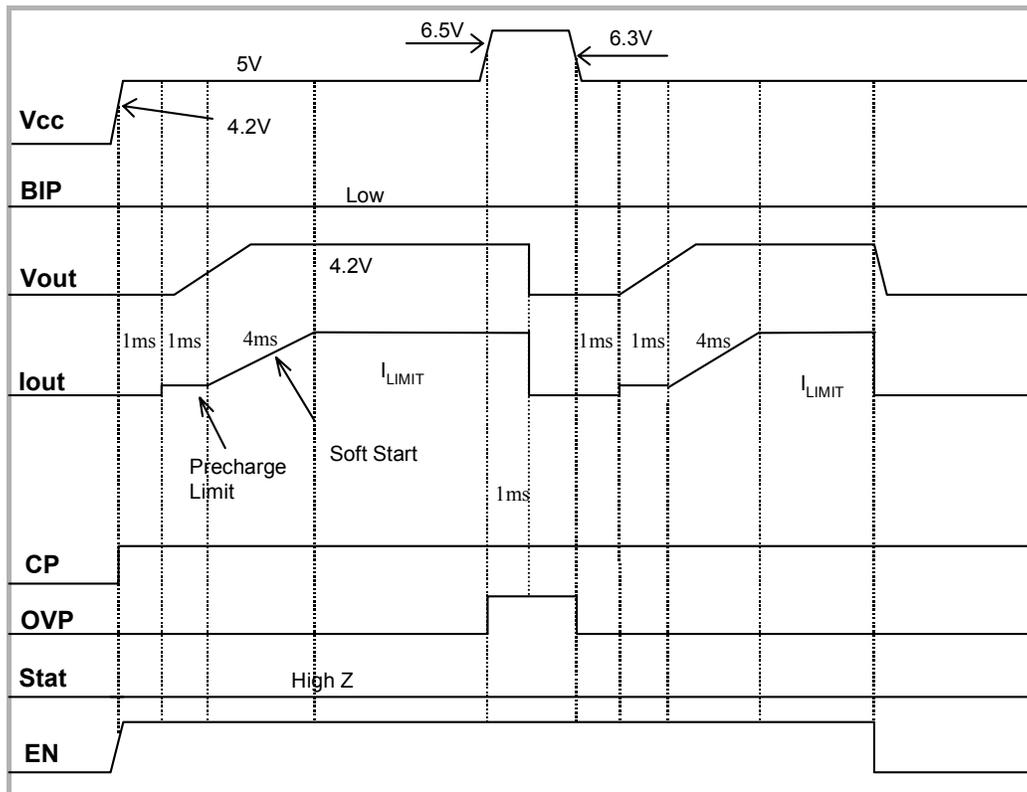
POWER MANAGEMENT

Charge Mode Timing Diagram

Charge Mode

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Vin > UVLO

Shutdown Mode
Vout/Iout off
CP,STAT,OVP Low

CP Output = High

Over Voltage, Under Voltage, or Over Temperature will force the SC801 into Shutdown Mode from any state.

En = High
And
T_j < Over Temp SD

Yes

LDO Mode
STAT = High Z,

BIP High

Yes

Charge Mode
STAT=High,

Start Pre-Charge

VOUT > 2.8V

Yes

BSEN = CV

Iout = 246/Rterm

Soft Start
Fast Charge Mode

Iout > 1500/Rprog

VOUT > 2.8V

Yes

Yes

Iout = 1500/Rprog

LDO Current Limit

BSEN = CV

Iout = 1500/Rprog

Yes

Start CV Mode

BSEN = CV ?

IOUT < ITERM

Yes

Yes

Monitor Mode
STAT = Low
Vout off

BSEN < CV-200mV

Yes

Typical Characteristics

LDO Mode Bias Current vs Input Voltage
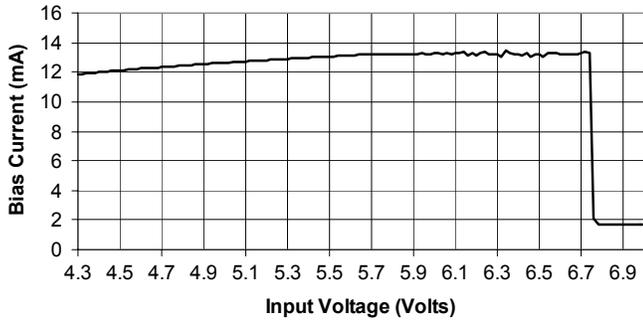
Charge Mode Bias Current vs Input Voltage
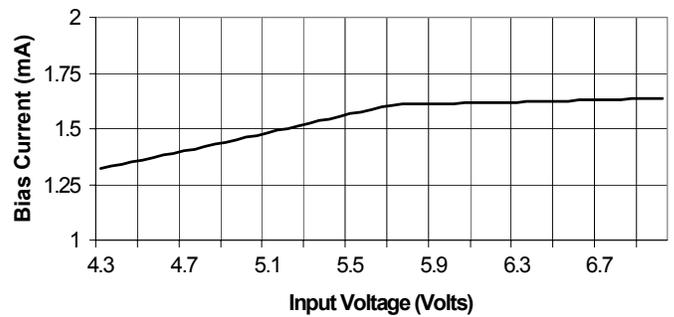
Fast Charge Current vs IPRGM Resistance
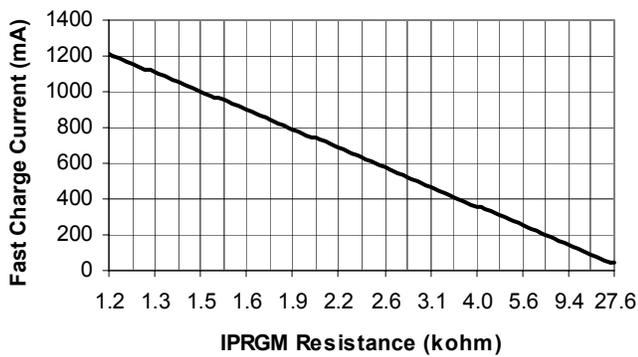
Vout Leakage Current vs Temperature
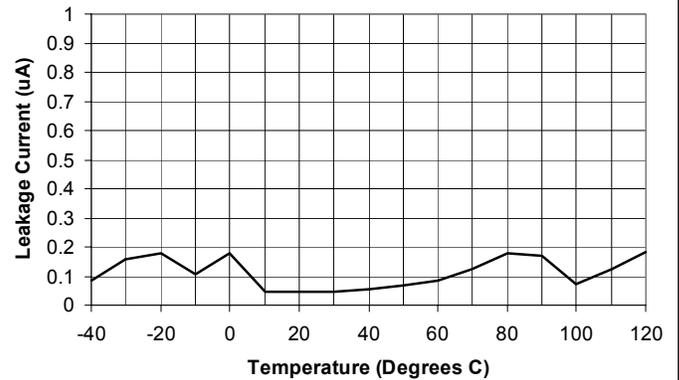
Output Voltage vsTemperature

ILOAD = 250mA
ILOAD = 500mA

Output Voltage vs Temperature

ILOAD = 250mA
ILOAD = 500mA

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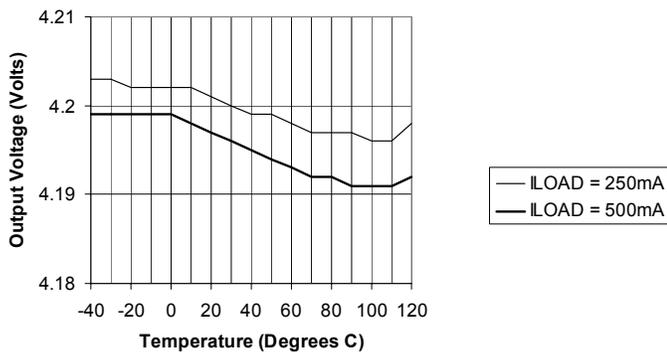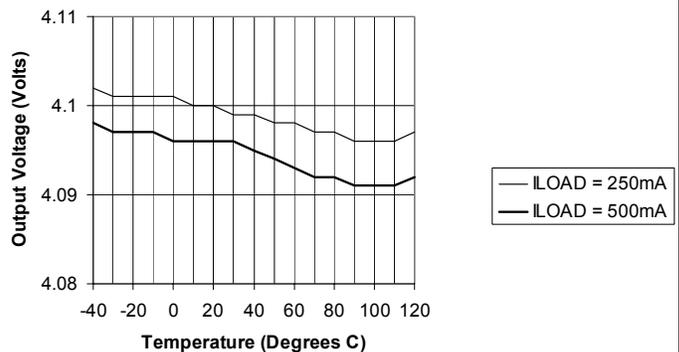
Typical Characteristics

Dropout Voltage vs Output Current
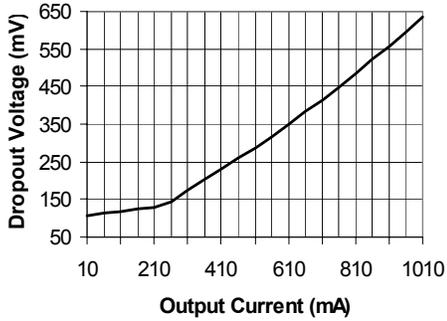
IPRGM Voltage vs Output Current

RPRGM = 1.87K
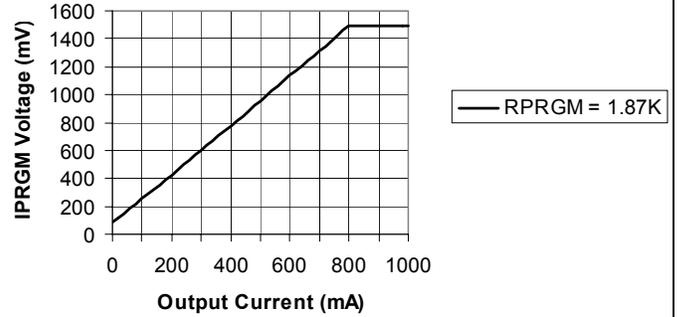
Battery Charge Profile

Vout
Iout

SEMTECH
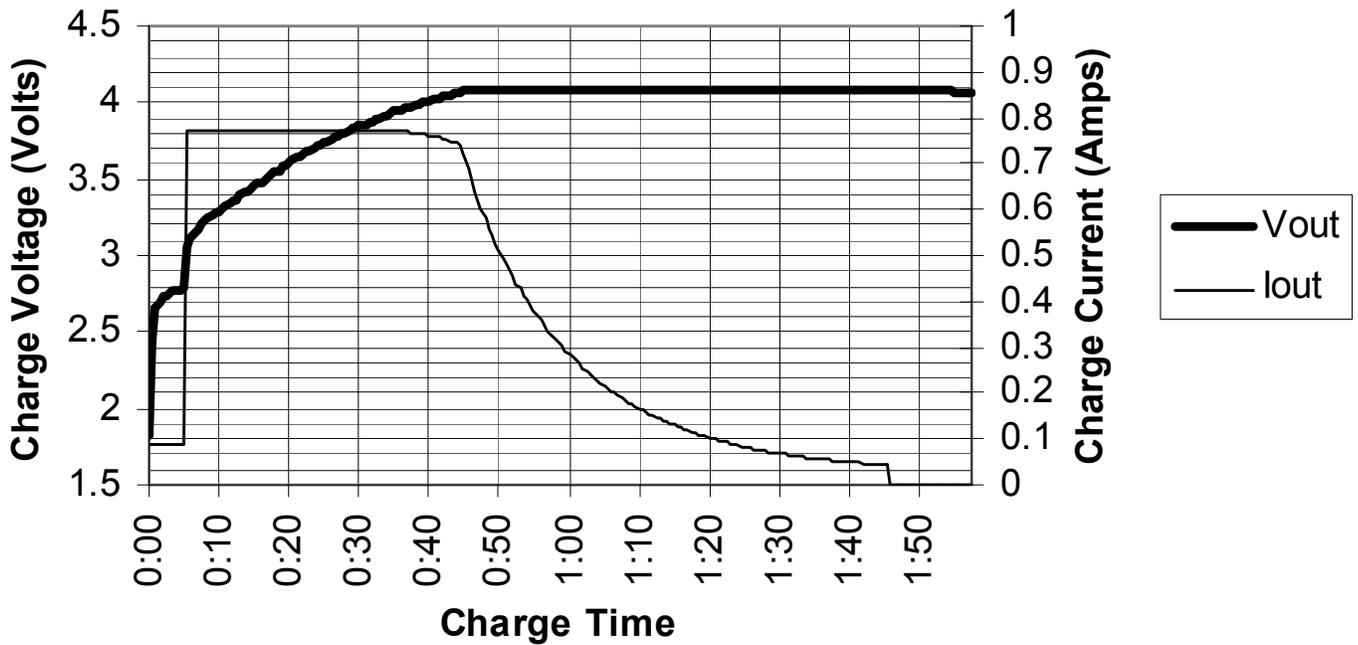
POWER MANAGEMENT

Outline Drawing - MLP (16 pin)

DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	.031	-	.040	0.80	-	1.00
A1	.000	-	.002	0.00	-	0.05
A2	-	(.008)	-	-	(0.20)	-
b	.010	.012	.014	0.25	0.30	0.35
D	.153	.157	.161	3.90	4.00	4.10
D1	.074	.085	.089	1.90	2.15	2.25
E	.153	.157	.161	3.90	4.00	4.10
E1	.074	.085	.089	1.90	2.15	2.25
e	.026 BSC			0.65 BSC		
L	.018	.022	.026	0.45	0.55	0.65
N	16			16		
aaa	.003			0.08		
bbb	.004			0.10		
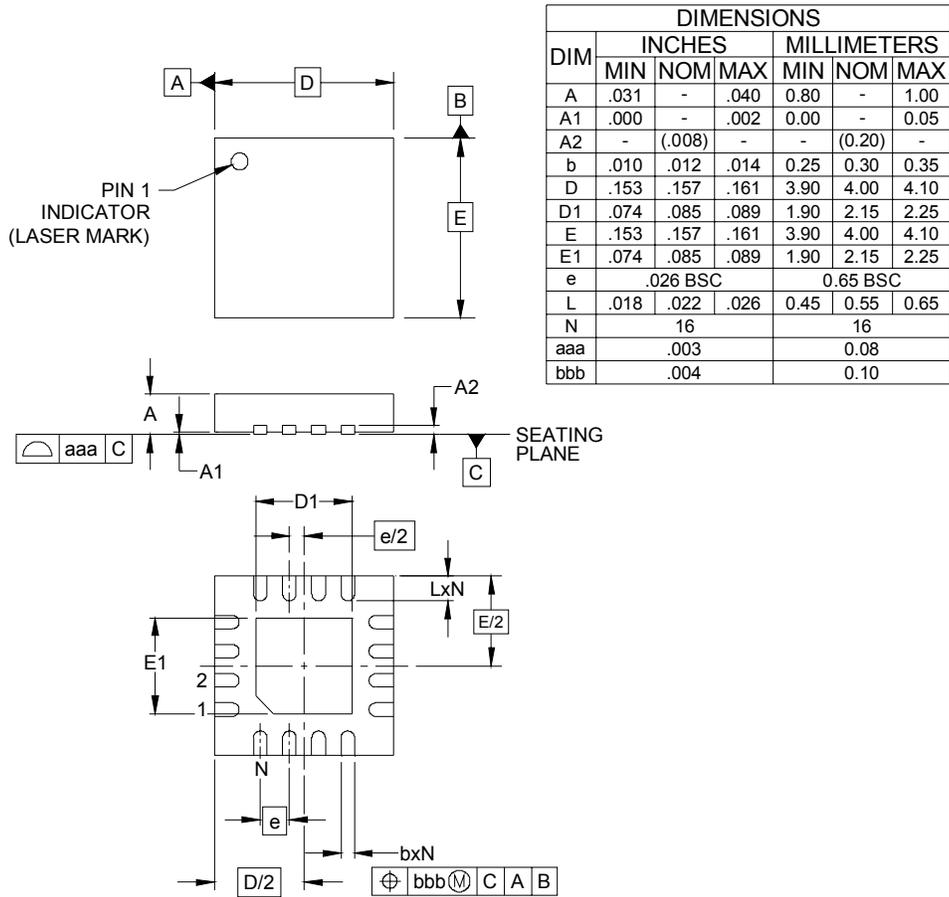
NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).

2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

Marking Information

Top Mark

yy = two-digit year of manufacture
ww = two-digit week of manufacture

SEMTECH
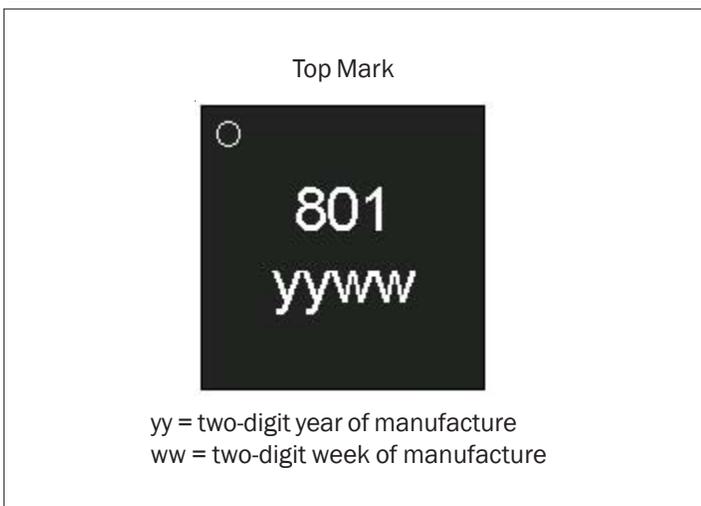
Land Pattern MLP-16 pin
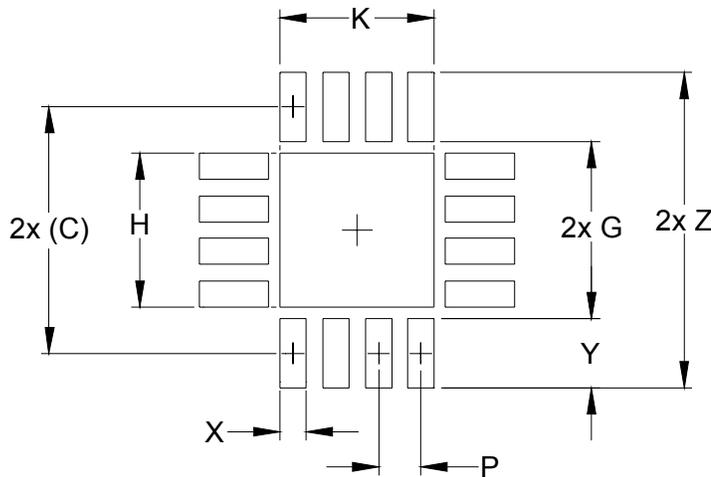
DIMENSIONS		
DIM	INCHES	MILLIMETERS
C	(.148)	(3.75)
G	.106	2.70
H	.091	2.30
K	.091	2.30
P	.026	0.65
X	.016	0.40
Y	.041	1.05
Z	.189	4.80

NOTES:

1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY.
CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR
COMPANY'S MANUFACTURING GUIDELINES ARE MET.

Contact Information

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