The PJ3963 is designed to optimize charging of Li-Ion and NiMH batteries. A flexible pulse-width modulation regulator allows the PJ3963 to control voltage and current during charging. The regulator frequency is set by an external capacitor for design flexibility. The switch-mode design keeps power dissipation to a minimum.

The PJ3963 measures battery temperature using an external thermistor for charge qualification. Charging begins when power is applied or on battery insertion.

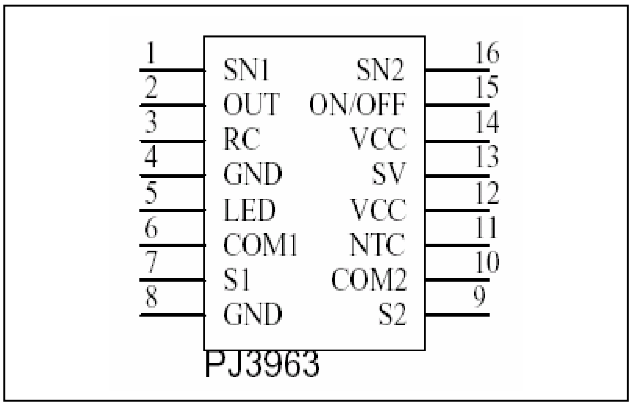
For safety, the PJ3963 inhibits charging until the battery voltage and temperature are within configured limits. If the battery voltage is less than the low-voltage threshold, the PJ3963 provides low-current conditioning of the battery.

A constant current-charging phase replenishes up to 70% of the charge capacity, and a voltage-regulated phase returns the battery to full. The charge cycle terminates when the charging current falls below a user-selectable current limit. For safety, charging is suspended if the temperature is out-side the preconfigured limits.

The PJ3963 provides status indications of charger states and faults for accurate determination of the battery and charge system conditions.

FEATURES

- 3V to 40V input voltage range
- Programmable charge current
- Output voltage adjustable (1% accurate reference).
  - For Li-ion battery: 4.2V, 8.4V, 12.6V, 16.8V
  - For NiMH battery: 1.4V, 2.8V, 4.2V
- Output switch current to 1A
- LED charge status output
- Vmax, Vmin, and Temp. detection and protection



APPLICATIONS

- Wireless Devices
  : Wireless Mouse, Wireless Telephone, Remote Control Aircraft
- Desktop Chargers: Cellular, PDA, DSC Charger
- USB Chargers
- Electric Tools, Toys

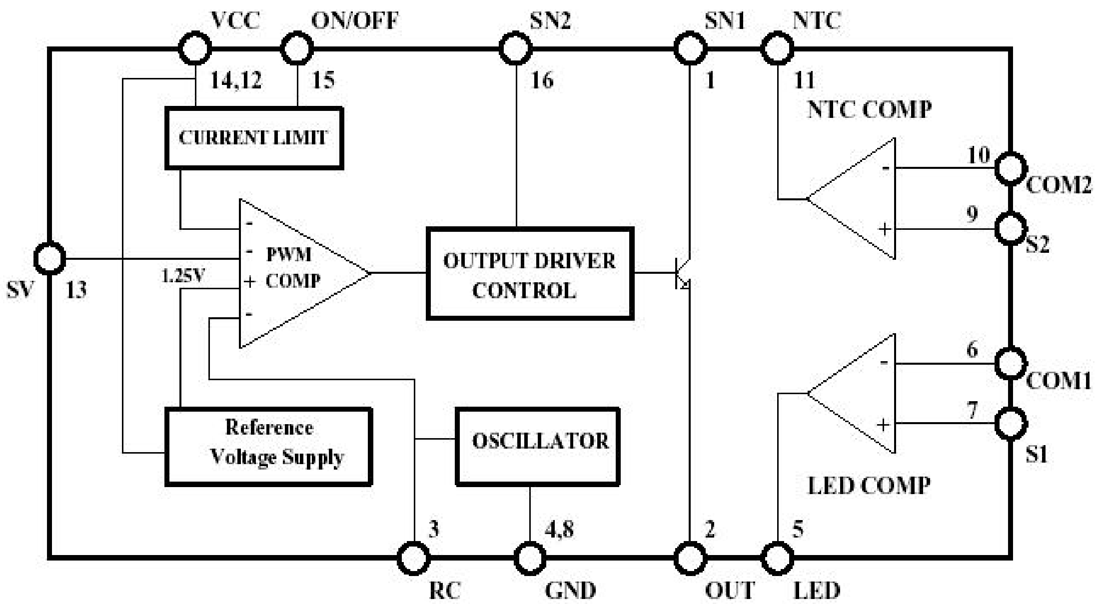
ORDERING INFORMATION

Device	Operating Temperature	Package
PJ3963CD	-20℃～+85℃	DIP-16
PJ3963CS		SOP-16

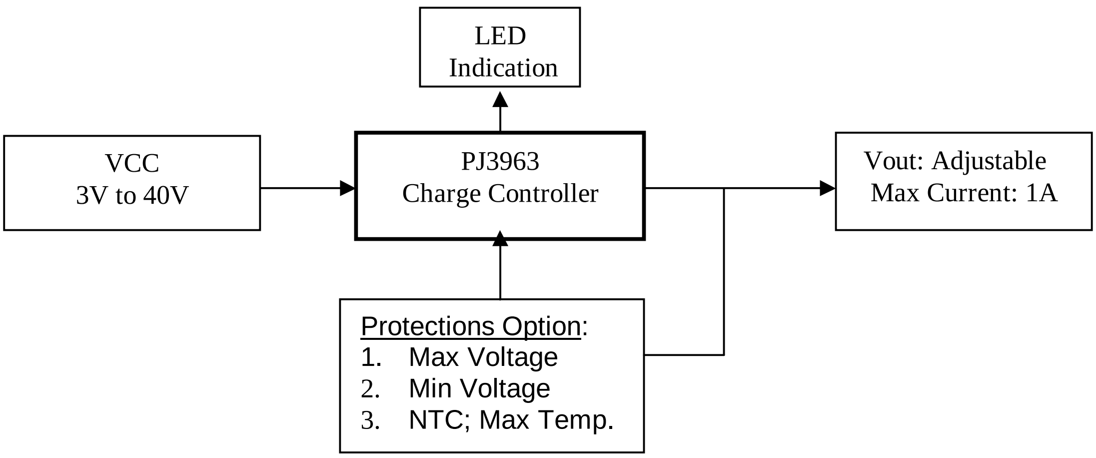
PIN DEFINE

PIN	Name	Description	PIN	Name	Description
1	**SN1**	SENSE Net 1	16	**SN2**	SENSE Net 2
2	**OUT**	OUTPUT	15	**ON/OFF**	Switching On/Off
3	**RC**	Oscillator Capacitor	14	**VCC**	Power Supply
4	**GND**	Power ground	13	**SV**	Sense Voltage
5	**LED**	LED charger indicator	12	**VCC**	Power Supply
6	**COM1**	Common 1	11	**NTC**	NTC input
7	**S1**	Send output 1	10	**COM2**	Common 2
8	**GND**	Power ground	9	**S2**	Send output 2

BLOCK DIAGRAM



FUNCTION DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	40	Vdc
Comparator Input Voltage Range	V_{FB}	-0.3 ~ VCC	Vdc
PWM Out Collector Voltage	$V_{C(SW)}$	40	Vdc
PWM Out Collector to Emitter Voltage	$V_{CE(SW)}$	40	Vdc
PWM Out Switch Current	Isw	1	A
Operating Junction Temperature	T_J	+125	℃
Operating Ambient Temperature Range	T_A	-20 to +85	℃

Storage Temperature Range	Tstg	-65 to +150	℃

ELECTRICAL CHARACTERISTICS

(V_{CC} = 5.0V. Ta= Tlow to Thigh. unless otherwise specified)

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
OSCILLATOR						
Oscillator Frequency	fosc	V_{PIN5}=0V, C_T=1.0nF , T_A=25℃	24	33	42	KHz
Charging Current	I_{chg}	V_{CC}=5 to 40V, T_A=25℃	24	35	42	μ A
Discharge Current	I_{dischg}	V_{CC}=5 to 40V, T_A=25℃	140	220	260	μ A
Discharge To Charge Current Ratio	I_{dischg}/I_{chg}	Pin7 to V_{CC} , T_A=25℃	5.2	6.5	7.5	--
Current Limit Sense Voltage	$V_{IPK(sense)}$	$I_{chg} = I_{dischg}$, T_A=25℃	250	300	350	mV
OUTPUT SWITCH						
Saturation Voltage , Darlington Connection	$V_{CE(sat)}$	Isw=0.5A, Pins1 connected	--	1.0	1.3	V
DC Current Gain	h_{FE}	Isw=1.0A, V_{CE} = 5.0V, T_A=25℃	50	75	--	--
Collector Off- State Current	$I_{C(off)}$	V_{CE} =40V	--	40	100	μ A
COMPARATOR						
Threshold Voltage	V_{TH}	T_A=25℃	1.23	1.25	1.27	V
Threshold Voltage Line Regulation	Regline	V_{CC} = 3 to 40V	--	1.4	5.0	mV
Input Bias Current	I_{IB}	V_{IN}=0V	--	-20	-400	nA
ON/OFF DRIVER CONTROL						
ON Driver Voltage	V_{ON}	V_{CC} = 3 to 40V	4	--	5	V
OFF Driver Voltage	V_{OFF}	V_{CC} = 3 to 40V	--	--	1	V
ON Driver Current	Ion	V_{CC} = 3 to 40V			100	mA
TOTAL DEVICE						
Supply Current	I_{CC}	V_{CC}=5 to 40V, C_T=1.0nF, Pin7=Vcc ,V_{PIN} 5>Vth Pin 2 =GND, remaining pins open	--	--	4.0	mA

Notes : 1.Maximum package power dissipation limits must be observed.
2.Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

Table : Design Formula

Calculation	Step-Up	Step-Down	Voltage-Inverting
$\frac{ton}{toff}$	$\frac{Vout+VF-Vin(min)}{V_{CC}(min)-Vsat}$	$\frac{VOUT+VF}{VCC-Vsat-VOUT}$	$\frac{\lvert Vout \rvert + V_F}{V_{CC}+Vsat}$
(ton+toff) max	$\frac{1}{f\ min}$	$\frac{1}{f\ min}$	$\frac{1}{f\ min}$
C_T	4.0×10^{-5} ton	4.0×10^{-5} ton	4.0×10^{-5} ton
I_{pk}(switch)	$2Iout(max)\left(\frac{ton}{toff}+1\right)$	2Iout(max)	$2Iout(max)\left(\frac{ton}{toff}+1\right)$
Rsc (**R5**)	0.3/I_{PK}(switch)	0.3/I_{PK}(switch)	0.3/I_{PK}(switch)
L (min)	$\left(\frac{Vin(min)-Vsat}{Ipk(switch)}\right) ton(max)$	$\left(\frac{Vin(min)-Vsat-Vout}{Ipk(switch)}\right) ton(max)$	$\left(\frac{Vin(min)-Vsat}{Ipk(switch)}\right) ton(max)$

Co	$\left(9\dfrac{Ioutton}{Vripple(pp)}\right)$	$\left(\dfrac{Ipk(switch)(ton+toff)}{8Vripple(pp)}\right)$	$\left(9\dfrac{Ioutton}{Vripple(pp)}\right)$

TERMS AND DEFINITIONS

- Vsat = Saturation Voltage of the output switch.
- V_F = Forward Voltage drop of the rectifier.

The following power supply characteristics must be chosen:

- V_{in}= Normal input voltage
- Vout: Desied Output voltage, $|Vout|=1.25\ (1+\dfrac{R2}{R1})$
- Iout : Desired output current.
- fmin : Minimum desired output switching frequency at the selected values for V_{in} and.Io.
- Vripple(p-p): Desired peak-to-peak output ripple voltage. in practice, the calculated capaitor value will need to be increased due to its equivalent series resistance and board layout. The ripple voltage should be kept to a low value since it will directly affect the line and load regulation.

CHARGE ALGORITHM

The PJ3963 uses a two-phase fast charge algorithm. In phase 1, the PJ3963 regulates constant current (Imax) until Vbattery rises to Vmax

- Li-ion battery: 1 cell = 4.2~4.3V, 2 cell = 8.4~8.5V
- NiMH battery: 1 cell = 1.35~1.5V, 2 cell = 2.8~3.0V

PJ3963 then transitions to phase 2 and regulates constant voltage (Vbattery =Vmax) until the charging current falls below the programmed Imin threshold (around Imax/10). Fast charge then terminates, and the PJ3963 enters the Charge Complete state.

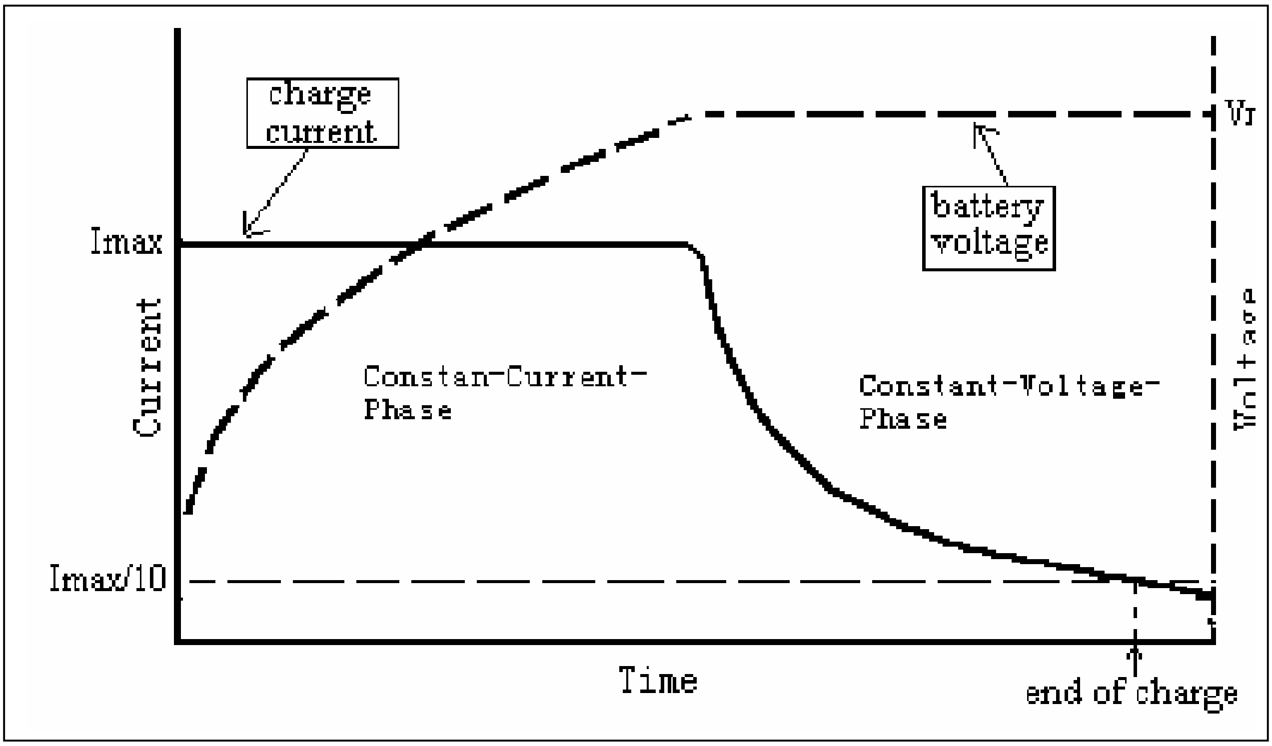
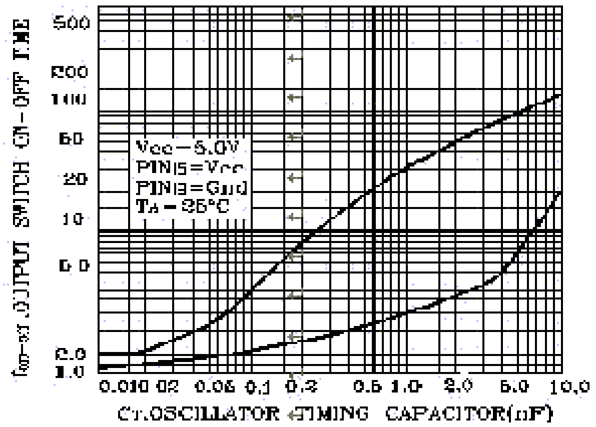
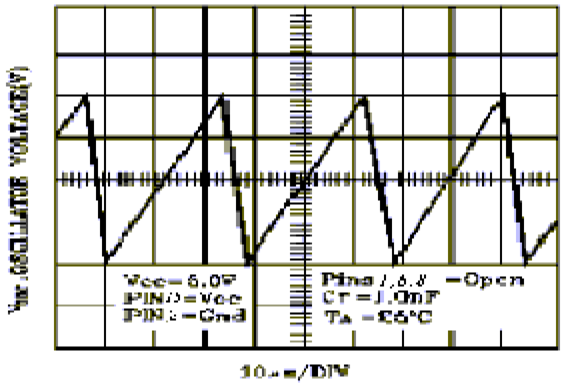


FIGURE 1.OUTPUT SWITCH ON-OFF TIME versus OSCILLATOR TIMING CAPACITOR	FIGURE 2.TIMING CAPACITOR WAVEFORM
	

IGURE 3.EMITTER FOLLOWER CONFIGURATION OUTPUT SATURATION VOLTAGE versus EMITTER CURRENT

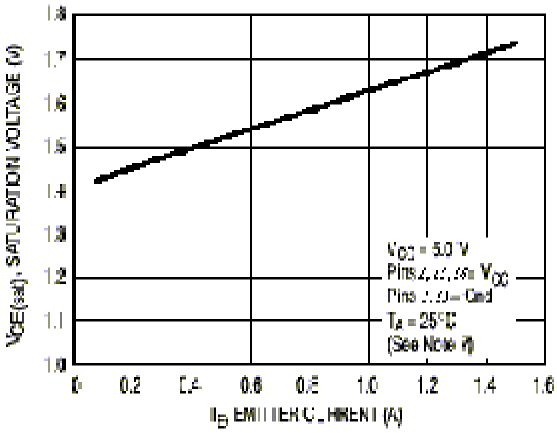


FIGURE 4.COMMON EMITTER CONFIGURATION OUTPUT SWITCH SATURATION VOLTAGE versus COLLECTOR CURRENT

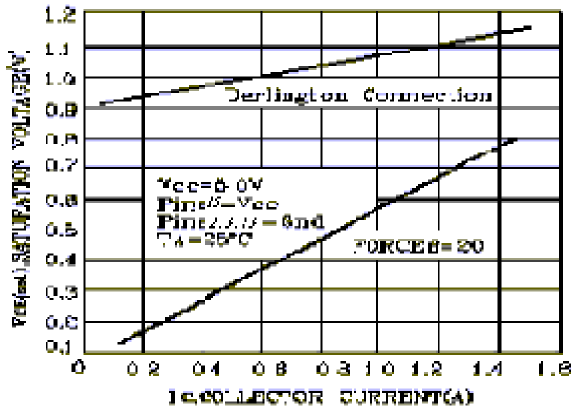


FIGURE 5.CURRENT LIMIT SENSE VOLTAGE versus TEMPERATURE

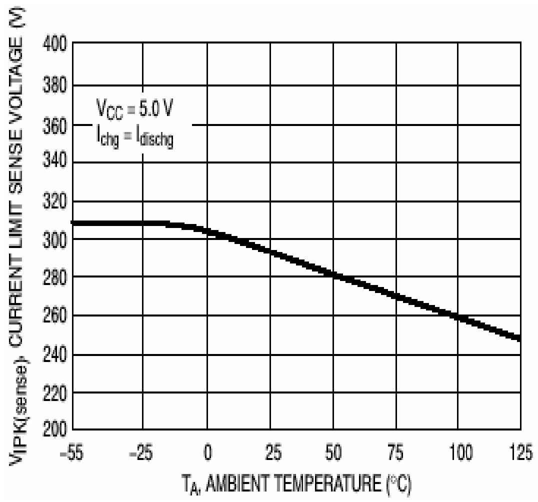
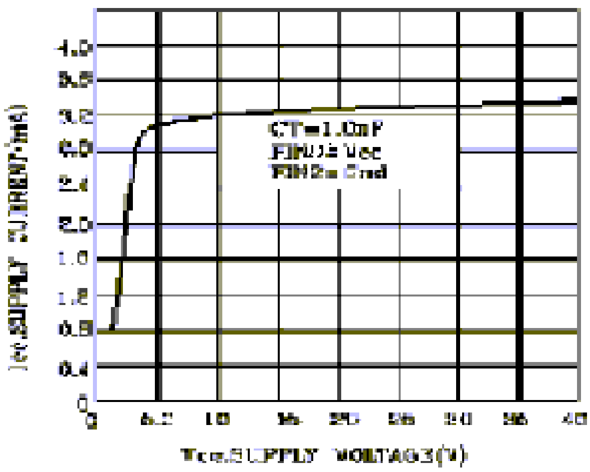


FIGURE 6.STANDBY SUPPLY CURRENT versus SUPPLY VOLTAGE



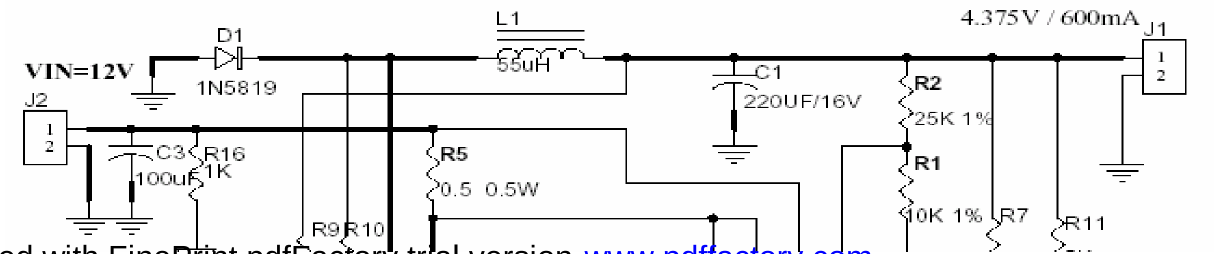
APPLICATION EXAMPLES

1. To design a Charger suitable for charging 3.6V/1000mAH Li-ion Battery

- Power Supply: 12V / 290mA
- Fast Charging Current: Imax=600mA
- Maxium Charging Voltage: Vmax=4.375V

- Charging Efficiency: 75%
- Charging time: 2 Hour
- Operation Temp.: Under 45℃

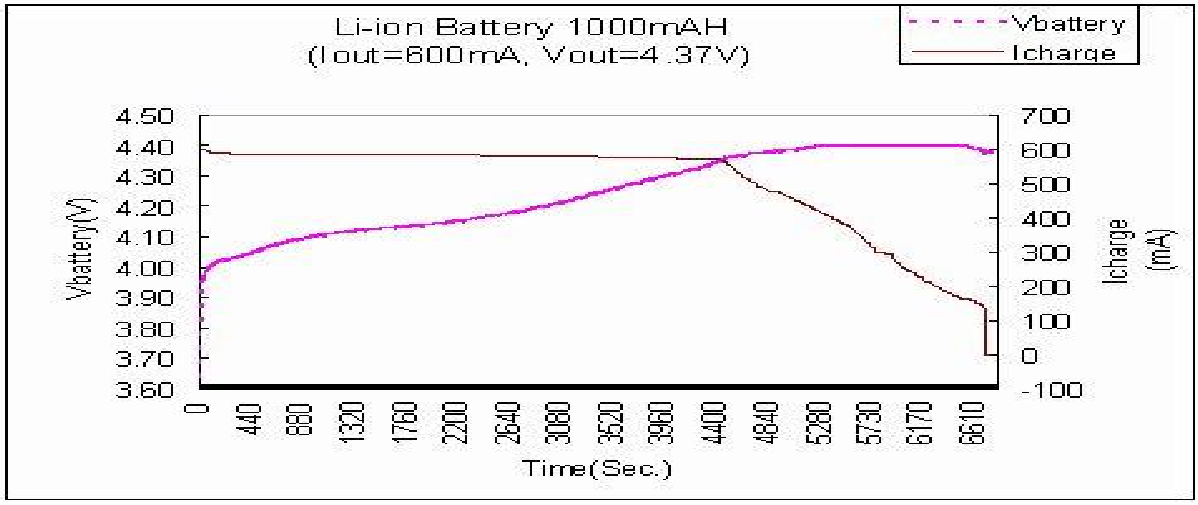
PJ3963 FOR LI - BATTERY CHARGER



(The test condition is Vin=12V. If user changes the Vin, some parameters have to be adjusted.)

1. **Vout=1.25V(1+R2/R1)** (Vout=4.375V, R1=10KΩ, R2=25KΩ)
2. **Iout,max= 0.3V /R5** (Iout=0.6A , R5=0.5Ω)
3. NTC, Temperature Protection: R3 is NTC Resistor. NTC in 25℃ is 10KΩ, K=3977(R25/85), Tolerance:2%
   R4=R3 (NTC Value in 45℃) =4.85KΩ (substitute by 4.7KΩ)
   *NTC：45℃(4.83K)、50℃(4.07K)、55℃(3.45K)、60℃(2.94K)

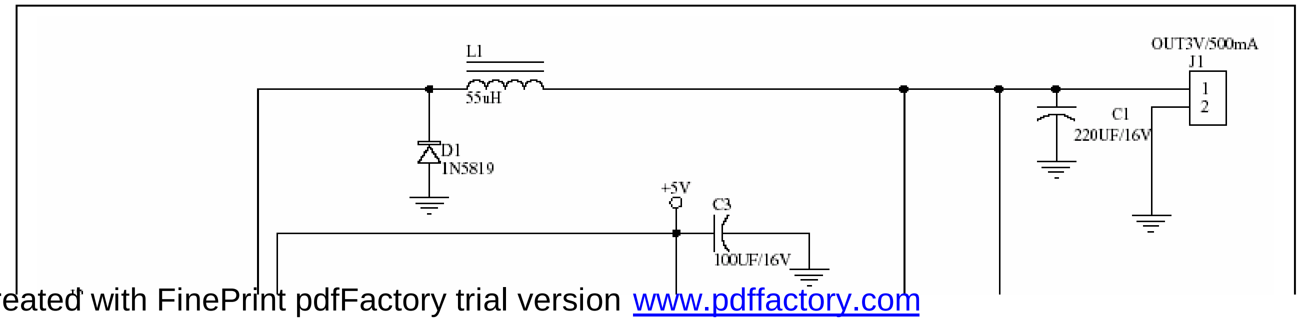
Charging Curve:



2. To design a USB Charge Circuit suitable for charging 2 series NiMH Battery, 2.4V/1500mAH.

- Power Supply from USB Port: 5V/500mA
- Vout: R1=10K, R2=14K
- Imax: R5=0.22Ω/0.5W
- V_L=1.8V Protection: R11=2K, R4=2.5K
- V_H=3.1V Protection: R7=5K, R3=2.5K

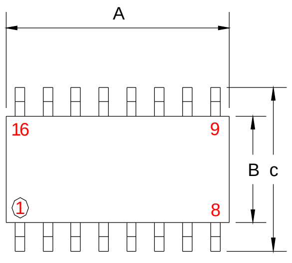
- Output Voltage & Current: Vmax=3.0V, Imax=650mA
- Charging Efficiency: 75%
- Charging time: 4~6 hour
- Trickle Current: 30~50mA
- Low Voltage Protection: 1.8V
- High Voltage Protection: 3.1V



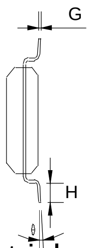
DIMENSION

SOP-16

1.Top View



2.Side View



3.DIMENSION

SOP-16 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.8	10.20	0.386	0.402
B	3.80	4.00	0.150	0.157
C	5.80	6.20	0.228	0.244
D	1.35	1.50	0.053	0.059
E	0.35	0.49	0.014	0.019
F	1.27BSC		0.05BSC	