Charge Controller

C C S 9 4 1 0

D a t a s h e e t

Applications for the *CCS-System*:

Alarm Systems, Cellular Phones, Computer, Electric Vehicles, HiFi, Hobby, Instruments, Lamps, Medical Electronics, Pager, Portables, Radio, Solar Systems, Telephone, Tools, Toys, UPS, Video..

Special Features

☺ **Singlechip for a threefold (3 in 1) battery charger**
☺ **Serial, automatic charge of 3 battery packs**
☺ **Minimized hardware**
☺ **Option: PC-Interface**

Features:

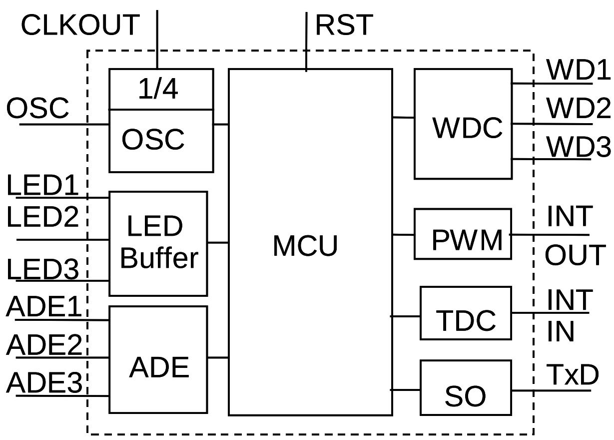
☺ Microcomputer controlled quickcharge up to 100% exactly in 20-30 minutes
☺ CCS charge termination
☺ No overcharge, no memory effect
☺ Extended battery life, >5000 cycles
☺ Independent of battery type: NiCd, NiMH, etc.
☺ Number of cells unlimited
☺ Automatic recharge, MC controlled
☺ Independent of precharging state, no discharge needed
☺ Reliable function also with protection diodes in the battery pack
☺ Simple handling, fail-safe by watchdog control
☺ Independent of external influences (e.g. temperature)
☺ Improved start up characteristic on empty cells
☺ Battery fault detection (LED signal)

Characteristics:

Input voltage:	3.0V to 5.5V
Low power:	< 2 mA
Package:	PDIP 18, SOIC 18, SSOP 20

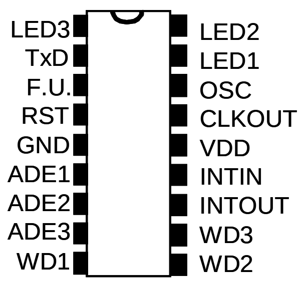
Operating temperature:	
Commercial:	0 to +70 °C
Industrial:	-40 to +85 °C
Storage temperature:	-65 to +150 °C

Block Diagram:



Pin Configuration:

1	LED 3	10	WD 2
2	TxD	11	WD 3
3	F.U.	12	INTOUT, Integrator
4	RST	13	INTIN, Integrator
5	GND	14	V_{DD}
6	ADE 1	15	CLKOUT
7	ADE 2	16	OSC
8	ADE 3	17	LED 1
9	WD 1	18	LED 2



F.U. = Factory Use

Absolute Maximum Ratings:	**min.**	**max.**	**units**
V_{DD}	0	5.5	V
Operating current I_{DD}	-	50	mA
I/O pins	-0.6	V_{DD}+0.6	V
INPUT-port pin-No. 4,6,7,8,13,16	-	+/- 500	µA
OUTPUT-port pin-No. 1,2,9,10,11,12,13,17,18	-	+/- 20	mA
Total power dissipation	-	800	mW

Supply: at 25°C	**min.**	**typ.**	**max.**	**units**
V_{DD}	3.0	5.0	5.5	V
Standby current (OUT1/2 n.c.)	-	1.8	3.3	mA
Characteristics: at 25°C	**min.**	**typ.**	**max.**	**units**
Input low-value	V_{SS}	-	0.2V_{DD}	V
Input high-value	0.2V_{DD}+1	-	V_{DD}	V
Input leakage current	-1	0.5	+1	µA
Output low-value (I_{OL}=8.7mA, V_{DD}=4.5V)	-	-	0.6	V
Output high-value (I_{OH}=-5.4mA, V_{DD}=4.5V)	V_{DD}-0.7	-	-	V
RESET low-timing (pulse width)	100	-	-	ns
RC-oscillator (3k6@330pF or 10k@120pF)	530	625	737	kHz

Functional Description

The CCS controller with appropriate circuitry controls the charging of a rechargeable battery up to 100% of the available capacity. The inner impedance between electrode and electrolyte is used for the determination of the 100% full charge state (patented worldwide). In addition the CCS controller features a battery fault detection and an intelligent recharging procedure for maintaining charge in standby operation without derating the performance of the battery by memory effect. Automatic on/off switching of the charging current is controlled by a fail-safe Watch Dog Circuit (WDC).

Power Source:
For the calculation of the inner impedance (according to the new process) it is essential, that the power is supplied with the sinusoidal 100/120Hz pulsation of the rectified line current.
Although the battery is charged correctly in many cases, the use of a DC current may not prevent in every condition from uncertain calculations which may lead to premature shut off, overloading, excessive heating and damage of the battery and surrounding material. Therefore the use of a smoothing capacitor as well as the operation from a DC supply (battery) is strictly forbidden.

Battery Voltage:
In principle the controller is independent of cell voltage and number of cells. In every case the battery voltage is reduced by a voltage divider to normalized 1.26V at battery nominal voltage.

Charge Current:
To ensure best results it is necessary that the parameters remain inside their computational limits. Therefore the mean charging current should be stabilized around $1C_A$ (0,5-2).

Process Timing:
The moment, the power supply is switched on (t0), the controller is in standby operation. When a battery connection is detected (t1) in one of the 3 battery shafts, the CCS9410 starts the measurement of the inner impedance and switches on a pulsating charging current. When the measurement of the inner impedance of the battery points to a 100% full charge, the controller switches off the charging current (t4’).

Battery Fault Detection:

a) Over voltage (open circuit): If the battery voltage exceeds the upper „limit S2“, the charging process stops immediately and the controller signals „Battery disconnected“.
S2: e.g. for NiCd V_{nom}. = 1,2V 166% of V_{nom} = 1,99V / cell

b) Under voltage (shorted cell): If, at moment t4’, which is 30 sec after charge termination t3, the battery voltage is below a defined lower „limit S1“, the charging cycle will be restarted for a maximum of two times. If the voltage is still out of that range, the controller signals "Battery defective" (LED flashing). If the battery is not disconnected, recharge will follow in every case.
S1: e.g. for NiCd V_{nom}. = 1,2V 119% of V_{nom} = 1,42V / cell

For the second battery and all the next batteries, the above mentioned procedure will be repeated.

Recharge:
The recharge for the first battery starts at moment t7. The shut off is detected by measurement of the inner impedance of the battery as mentioned before

Charge Order:

Order for battery connection: optional!
At any time and in any battery shaft it is possible to connect a battery or to replace a fully charged or defective battery with another battery.

Order for battery charging: battery A1, battery A2, battery A3
If more than 1 batteries are put into the charging station at the same time, the battery, that is put in first, will be charged first. All other batteries will be charged serially (A1, A2, A3, A1, etc.).
Recharge, if necessary, will always follow the order A1, A2, A3.
In any case every battery will be charged only one time (charge and recharge). If a battery shaft is empty or a battery is already charged+recharged, the CCS9410 turns over to the next battery shaft. If all batteries are fully charged, the charging station stays in standby position. The moment when a battery is replaced, a new charging process starts and all batteries will be recharged.

Status:

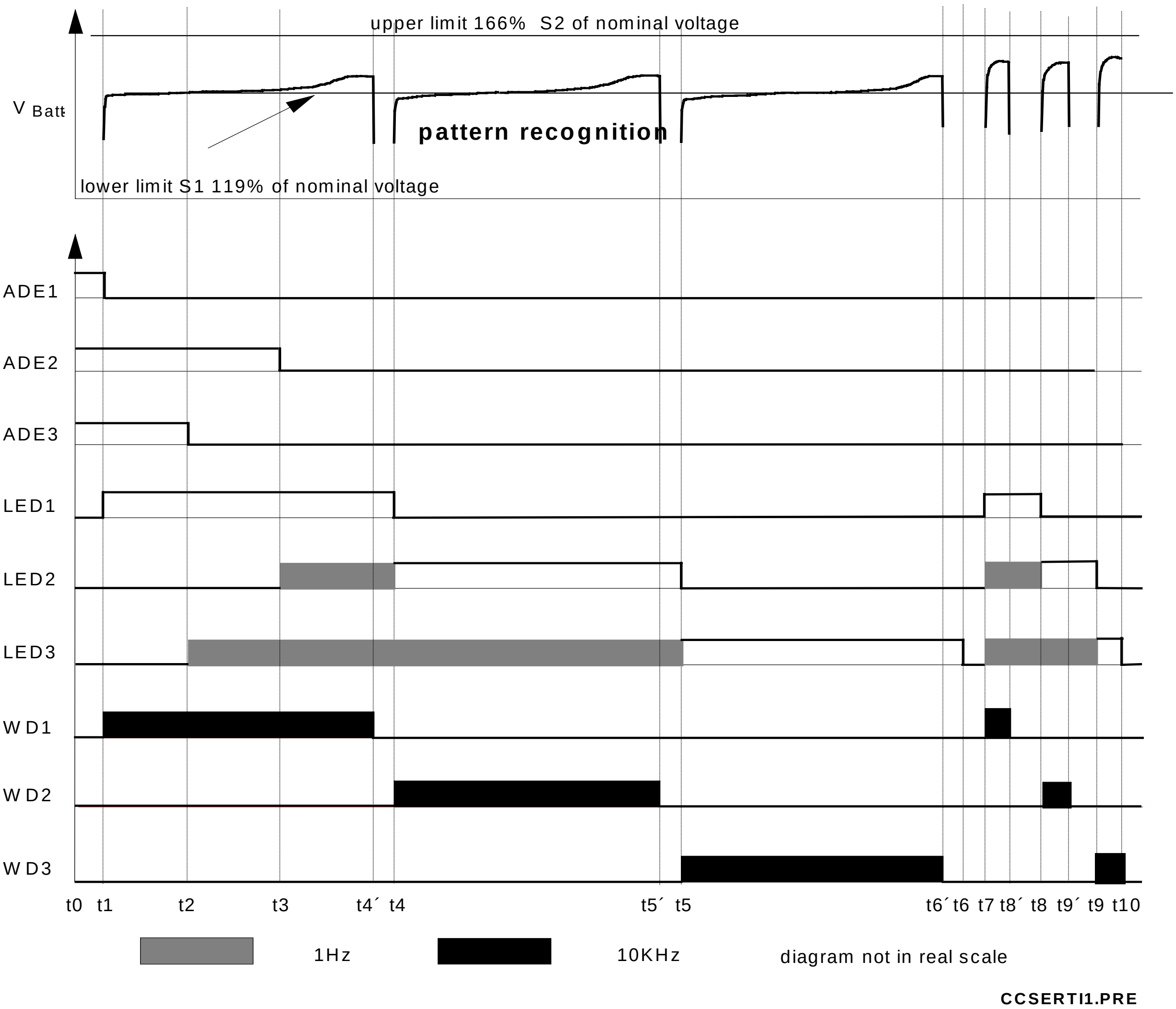
LED on	Battery charging
LED flashing slowly	Battery waiting for charge
LED flashing fast	Battery defective
LED off	Battery fully charged, or no connection

Pin Description

Pin 5	GND	Ground
Pin 14	V_{DD}	Positive input voltage
Pin 4	RST	GND = RESET / V_{DD} (Pull-up) = program start rising edge to $V_{DD,}$ RESET-TIME = 18 msec
Pin 16	OSC	R/C oscillator input
Pin 15	CLKOUT	Oscillator output (1/4 f_{OSC})
Pin 12	INTOUT	Integrator output: pulse, period T = 52 msec ± 18% Duty cycle (H/T) < 23%...battery connected Duty cycle (H/T) approx. 14% to 23%... measurement, battery full Duty cycle (H/T) < 14%...battery fault, limit S1 Duty cycle (H/T) over 23%...battery fault, limit S2, no battery
Pin 13	INTIN	Integrator input
Pin 2	TxD	Datatransfer output, BTI-Adapter to PC
Pin 9 Pin 10 Pin 11	WD 1-3	Control output for charging current (off = 0V, on = 5V approx. 10 kHz) Output LOW: no battery or battery waiting for charge Pulse signal: battery charging
Pin 6 Pin 7 Pin 8	ADE 1-3	Control input for battery detection Input HIGH: no battery connected Input LOW: battery connected
Pin 1 Pin 17 Pin 18	LED 1-3	Status indicator (level 0V-5V) Battery connected: output HIGH Charging cycle: output stays HIGH Battery full: output LOW Battery waiting: 1 Hz pulses Battery fault: 2 Hz pulses until next recharge

Pin 16: For a new design use R6=3k6 and C6=330pF, oscillator is more stable!
Do not connect F.U. Pins!!

Charge Diagram:

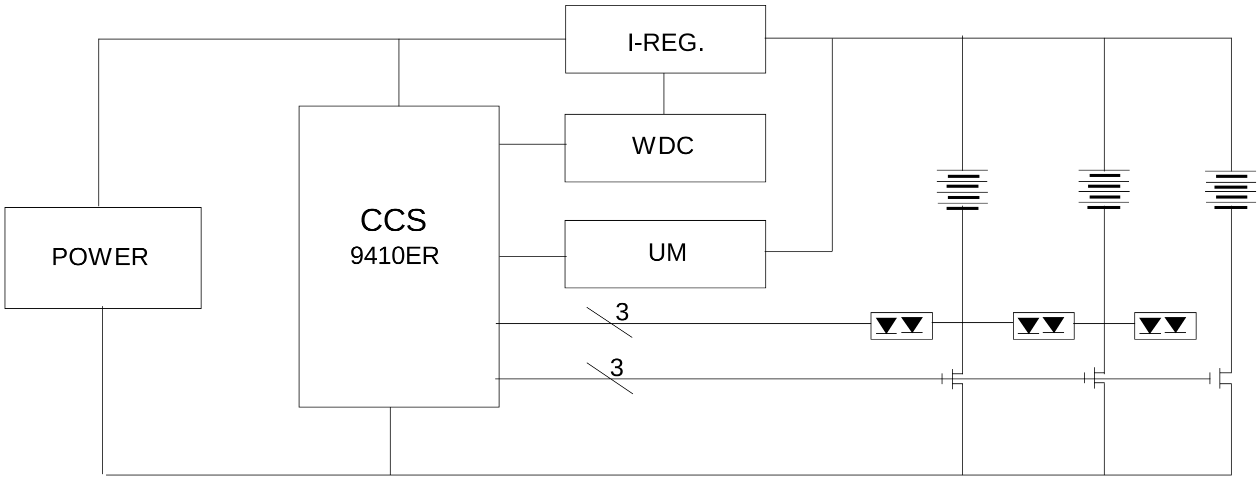


Process-Timing

t0-t1	Standby	Until battery is connected.
t1		First battery A1 connected
t2		Second battery A3 connected
t3		Third battery A2 connected
t1-t4'	Charging	A1 until 100% fullcharge of the battery Time depends on precharging state and charging current From 1 min. to approx. 60 min. at 1C (120 min. at 0,5C; 30 min. at 2C)
t4-t5'	Charging	A2 until 100% fullcharge of the battery See above
t5-t6'	Charging	A3 until 100% fullcharge of the battery See above
t6-t7	Standby	Until next recharge Approx. 1 hour (MC-controlled)
t7-t8'	Charging	Recharge A1 (similar to t1-t4')
t8-t9'	Charging	Recharge A2 (similar to t4-t5')
t9-t10	Charging	Recharge A3 (similar to t5-t6')
tx'-tx	Delay	Approx. 5 min (no reaction when battery connected/disconnected)

Block Diagram:

for typical application



Application:

The circuit must be supplied with a full bridge rectifier - **no smoothing capacitor!**

Supply Voltage Vin:
As supply voltage V_{in} use a rectified 50/60 Hz AC voltage pulsating with a 100/120 Hz frequency.

R9 Number of cells:

$$R9 = R10 \times [(V_{Battery} / 1.2) - 1]$$

$$V_{Battery} = 1.2 \times [1 + (R9 / R10)]$$

Exception: $V_{Battery} = 1.2$ (R9 = 1K)

R9 @ R10 = 33K

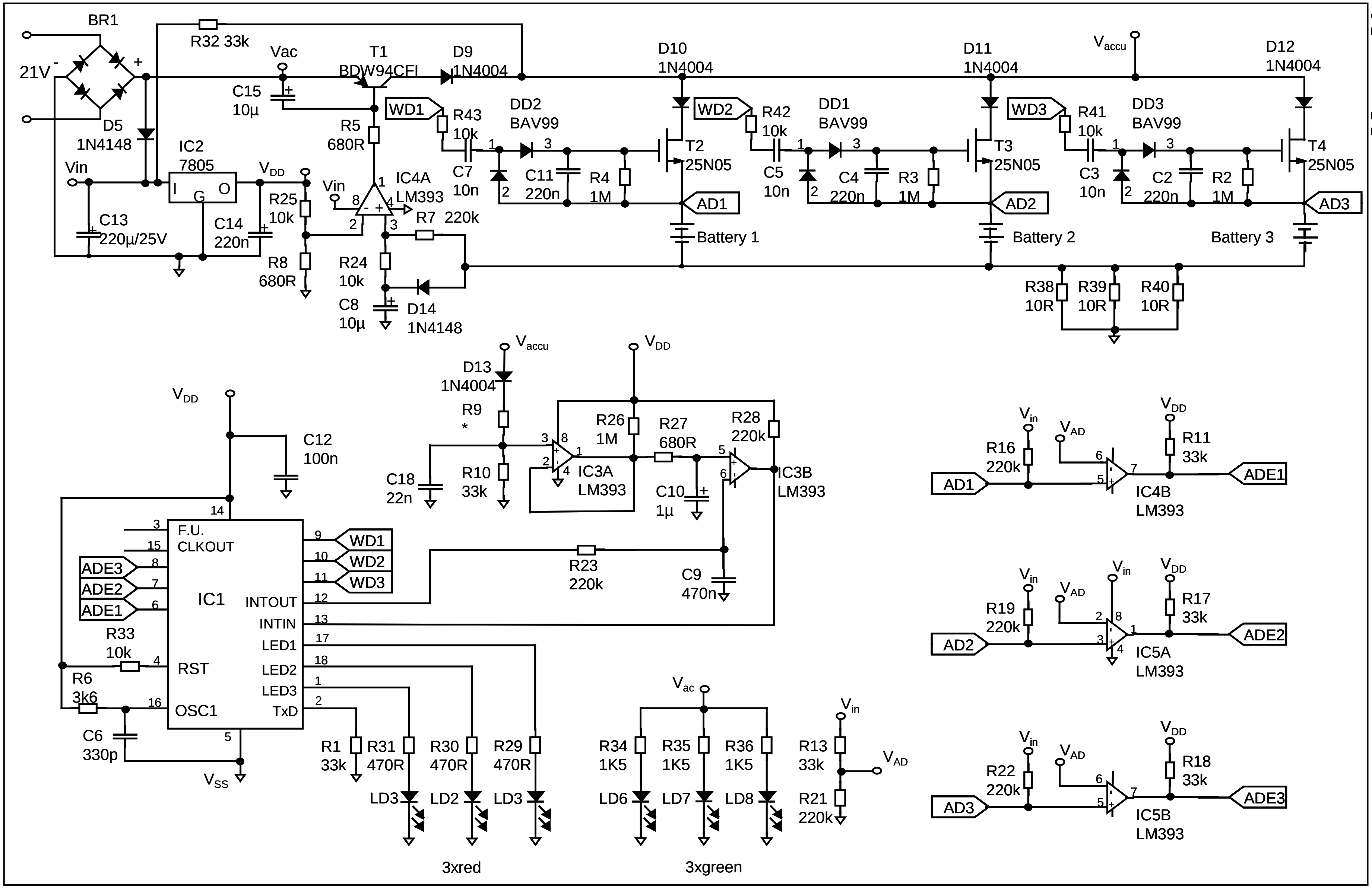
Battery nominal-voltage	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	V=
Number of cells	1	2	3	4	5	6	7	8	9	10	
Resistor R9	1	34	67	100	133	166	199	232	265	298	KOhm
V_{in} typ.	9	9	9	10	12	14	16	18	20	22	V_{eff}

Charge Current:
The charge current must be stabilized around 1 C_A.
$I_{charge} = U_{ref}$ / (Resistor R38 parallel to R39 parallel to R40) with $U_{Ref} = 0{,}3V_{eff}$
Limits: min. ½ C_A (20-30 minutes charge) to max. 2 C_A. (2 hours charge)

Operating Instructions:

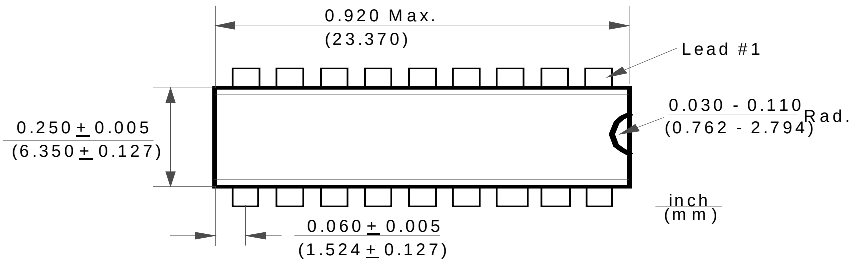
1) Power supply on: green LED on (standby).
2) Battery charging: red LED on. (not protected against false polarity!)
3) Battery fully charged: red LED off.
4) Battery fault: red LED flashing fast
5) Battery waiting: red LED flashing slowly.
6) Battery change during charge possible

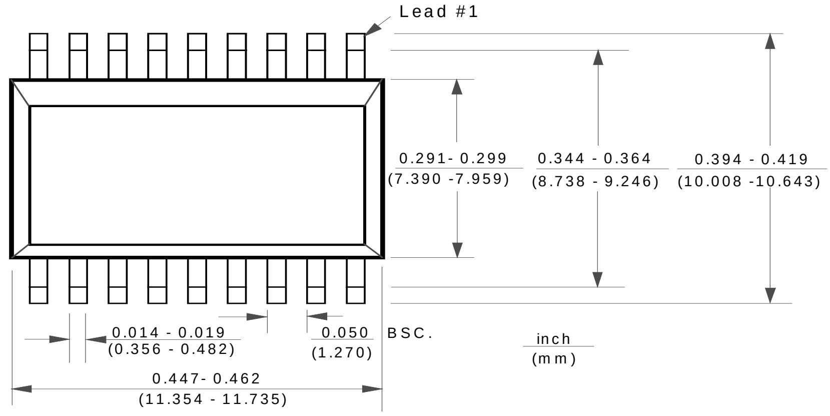
Typical Application: (for 300mA charge current)



Package:

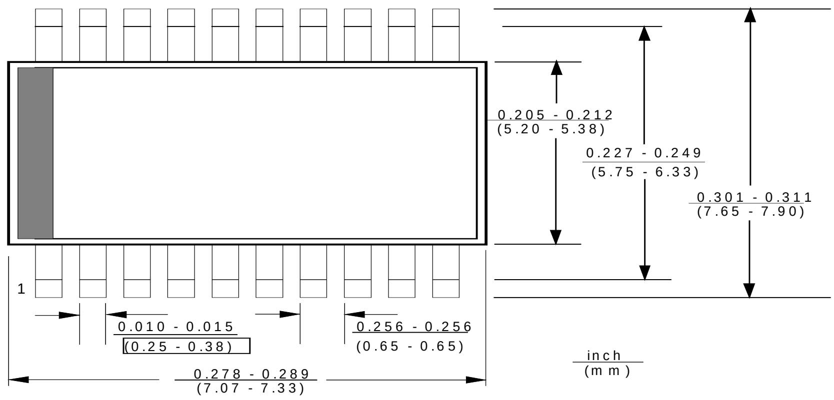
18 - Lead Plastic Dual In-line **DIP 18**





18 - Lead Plastic Surface Mount
SOIC -Wide **SMD**

20 - Lead Plastic Surface Mount **SSOP**



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