U2402B-B

Fast Charge Controller for NiCd/NiMH Batteries

Description

The fast charge battery controller circuit, U2402B-B, uses bipolar technology. It enables an efficient and economic charge system. It incorporates intelligent multiple gradient battery voltage monitoring and mains phase control for power management. With automatic top-off charging, the integrated circuit enables the charge device to stop regular charging, before the critical stage of overcharging can occur. It has two LED driver indications for charge and temperature status.

Features

- Multiple gradient monitoring
- Temperature window (T_{min}/T_{max})
- Exact battery voltage measurement without charge
- Phase control for charge current regulation
- Top off and trickle charge function
- Two LED outputs for charge status indication
- Disabling of d^2V/dt^2 switch-off criteria during battery formation
- Battery voltage check

Applications

- Portable power tools
- Laptop/notebook personal computer
- Cellular/cordless phones
- Emergency lighting systems
- Hobby equipment
- Camcorder

Package: DIP18, SO20

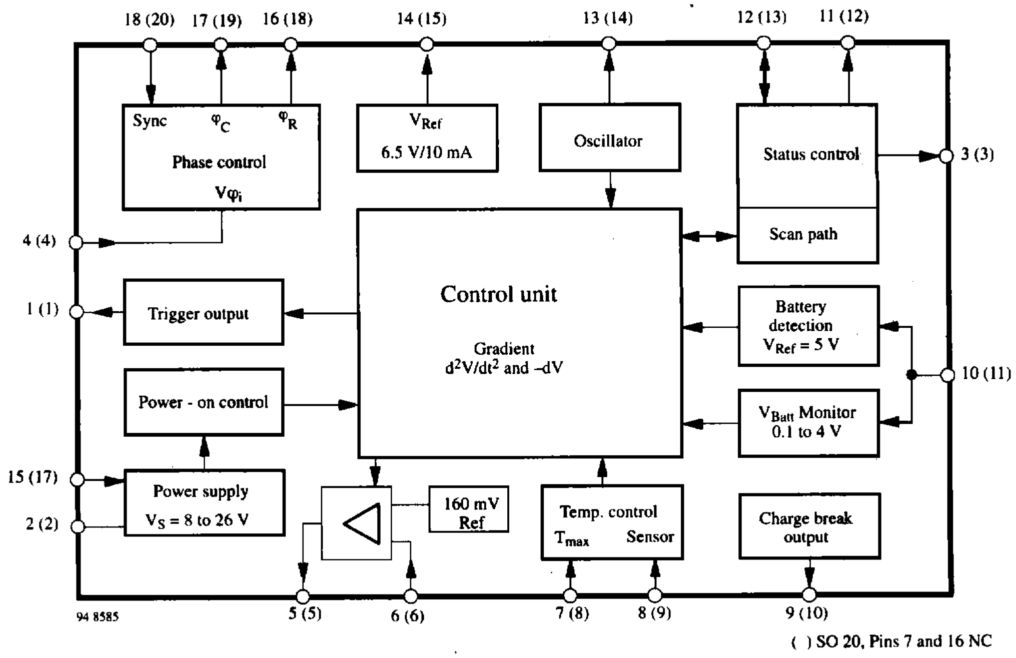
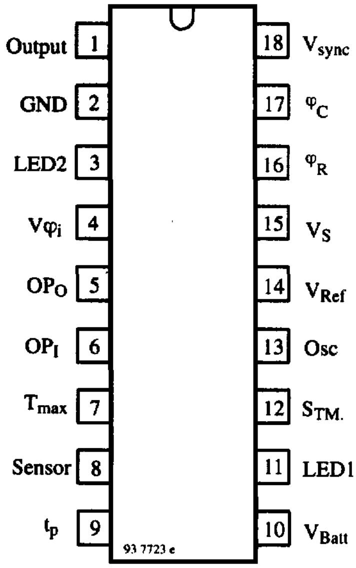


Figure 1. Block diagram

Pinning

Package: DIP18



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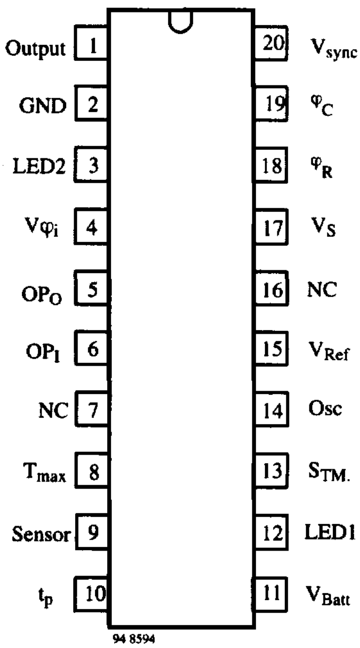

Pin Description

Pin	Symbol	Function
1	Output	Trigger output
2	GND	Ground
3	LED2	Display output "Green"
4	$V\varphi_i$	Phase angle control input voltage
5	OP_O	Operational amplifier output
6	OP_I	Operational amplifier input
7	T_{max}	Maximum temperature
8	Sensor	Temperature sensor
9	t_p	Charge break output
10	V_{Batt}	Battery voltage
11	LED1	LED display output "Red"
12	$S_{TM.}$	Test mode switch (status control)
13	Osc	Oscillator
14	V_{Ref}	Reference output voltage
15	V_S	Supply voltage
16	φ_R	Ramp current adjustment – resistance
17	φ_C	Ramp voltage – capacitance
18	$V_{sync.}$	Mains synchronization input

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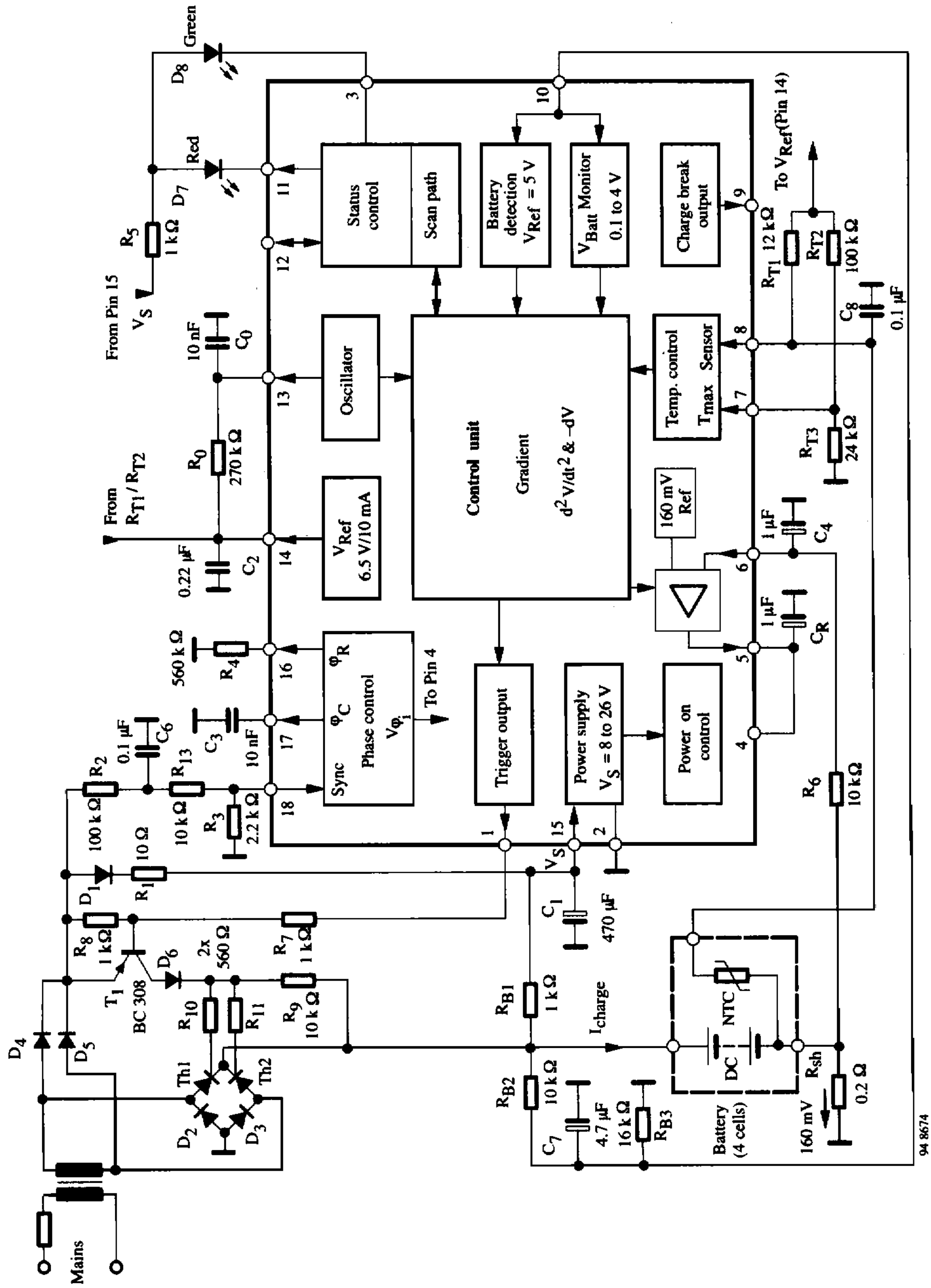


Figure 2. Block diagram with external circuit (DIP pinning)

Flow Chart Explanation, f_{osc} = 800 Hz (Figures 2 and 3)

Battery pack insertion disables the voltage lock at battery detection input Pin 10. All functions in the integrated circuit are reset. For further description, DIP-pinning is taken into consideration.

Battery Insertion and –ΔV Monitoring

The charging procedure is carried out if battery insertion is recognized. If the polarity of the inserted battery is not according to the specification, the fast charge rate will stop immediately. After the polarity test, if positive, the defined fast charge rate, I_O, begins for the first 5 minutes according to –ΔV monitoring. After 5 minutes of charging, the first identification control is executed.

If the inserted battery has a signal across its terminal of less than 0.1 V, then the charging procedure is interrupted. This means that the battery is defective i.e., it is not a rechargeable battery – "shorted batteries ignored".

Voltage and temperature measurements across the battery are carried out during charge break interval, i.e., currentless or idle measurements.

If the inserted battery is *fully charged*, the –ΔV control will signal a charge stop after six measurements (approximately 110 seconds). All the above mentioned functions are recognized during the first 5 minutes according to –ΔV method. During this time, $+d^2V/dt^2$ remains inactive. In this way, the battery is protected from unnecessary damage.

d^2V/dt^2-Gradient

If there is no charge stop within the first 5 minutes after battery insertion, then d^2V/dt^2 monitoring will be active. In this actual charge stage, all stop-charge criteria are active.

When close to the battery's capacity limit, the battery voltage curve will typically rise. As long as the $+d^2V/dt^2$ stop-charging criteria are met, the device will stop the fast charge activities.

Top-Off Charge Stage

By charge disconnection through the $+d^2V/dt^2$ mode, the device switches automatically to a defined protective top-off charge with a pulse rate of 1/4 I_O (pulse time, t_p = 5.12 s, period, T = 20.48 s).

The top-off charge time is specified for a maximum time of 10 minutes @ 800 Hz. A voltage drop during top-off charge leads to the –ΔV switch-off.

Trickle Charge Stage

When top-off charge is terminated, the device switches automatically to trickle charge with 1/16 I_O (t_p = 320 ms, period = 5.12 s). The trickle continues until the battery pack is removed.

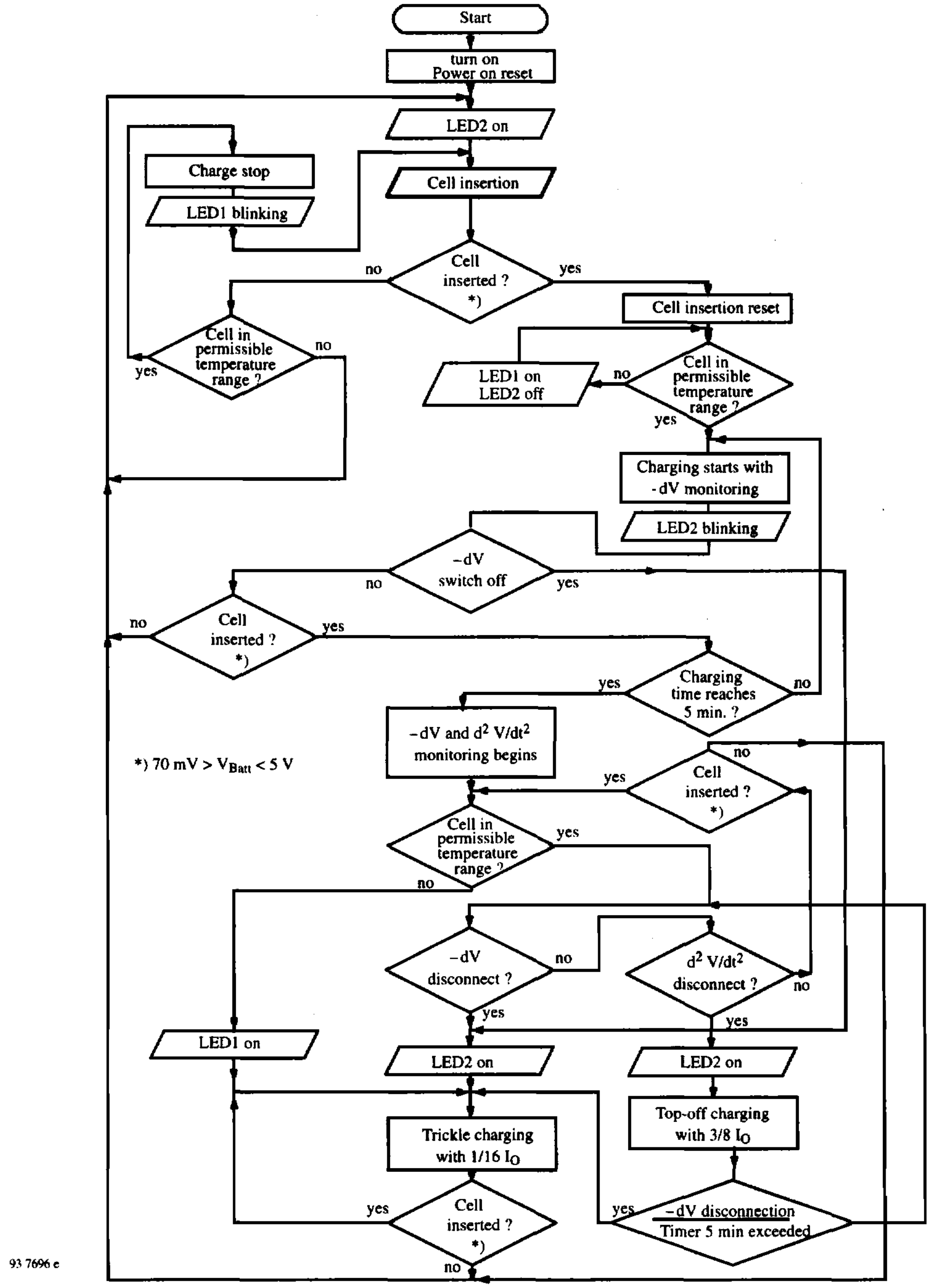


Figure 3. Flow chart

Current Regulation Via Phase Control (Figure 4)

Phase Control

An internal phase control monitors the angle of current flow through the external thyristors as shown in figure 2. The phase control block represents a ramp generator synchronized by a mains zero cross over and comparator.

The comparator isolates the trigger output, Pin 1, until the end of the half wave (figure 4) when the ramp voltage, V_{ramp}, reaches the control voltage level, $V\varphi_i$, within a mains half wave.

Charge Current Regulation (Figure 2)

According to figure 2, the operational amplifier (OpAmp) regulates the charge current, I_{ch} (= 160 mV / R_{sh}), average value. The OpAmp detects the voltage drop across the shunt resistor (R_{sh}) at input Pin 6 as an actual value. The actual value is then compared with an internal reference value (rated value of 160 mV).

The regulator's output signal, V_5, is at the same time the control signal of the phase control, $V\varphi_i$ (Pin 4). In the adjusted state, the OpAmp regulates the current flow angle through the phase control until the average value at the shunt resistor reaches the rated value of 160 mV.

The corresponding evaluation of capacitor C_R at the operational amplifier (regulator) output determines the dynamic performance of current regulation.

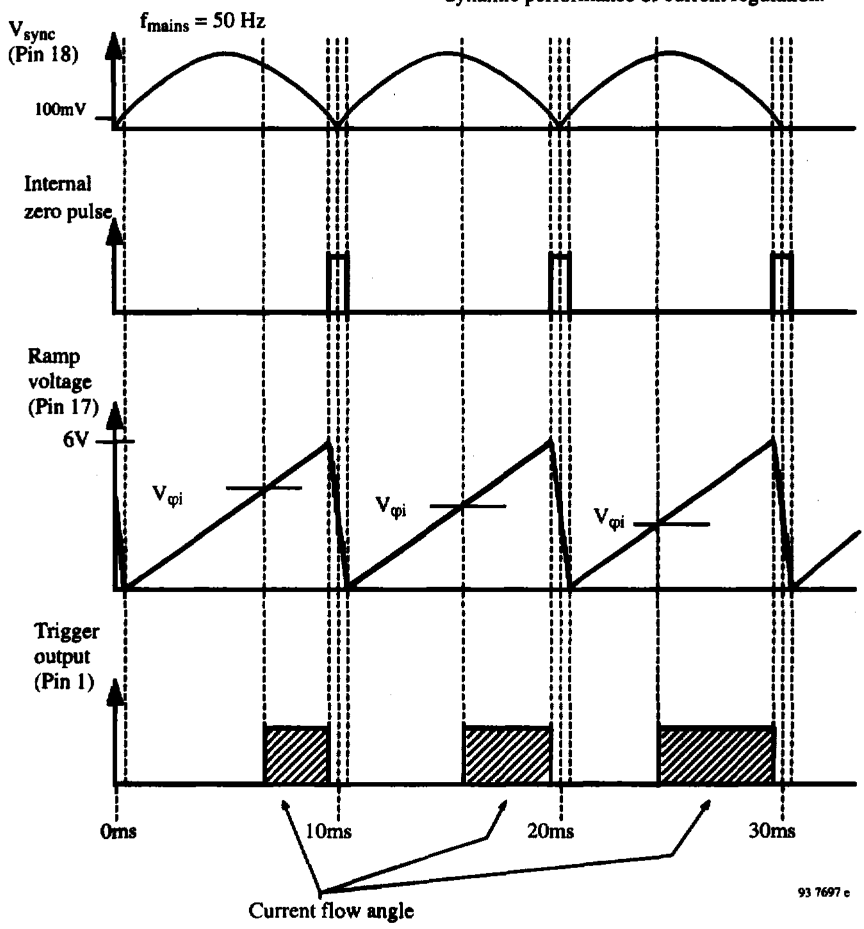


Figure 4. Phase control function diagram

Absolute Maximum Ratings

Reference point Pin 2 (GND), unless otherwise specified

Parameters		Symbol	Value	Unit
Supply voltage	Pin 15	V_S	26	V
Voltage limitation	I_S = 10 mA	V_S	31	V
Current limitation t < 100 µs	Pin 15	I_S	25 100	mA
Voltages at different pins	Pins 1, 3 and 11 Pins 4 to 10, 12 to 14 and 16 to 18	V	26 7	V
Currents at different pins	Pin 1 Pins 3 to 14 and 16 to 18	I	25 10	mA
Power dissipation	T_{amb} = 60°C	P_{tot}	650	mW
Ambient temperature range		T_{amb}	– 10 to 85	°C
Junction temperature		T_j	125	°C
Storage temperature range		T_{stg}	– 40 to 125	°C

Thermal Resistance

Parameters	Symbol	Maximum	Unit
Junction ambient	R_{thJA}	100	K/W

Electrical Characteristics

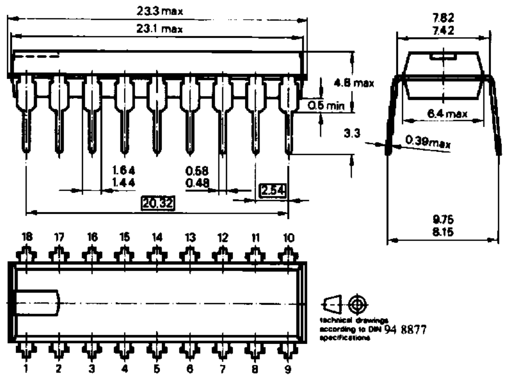
V_S = 12 V, T_{amb} = 25°C, reference point Pin 2 (GND), unless otherwise specified.

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Power supply	Pin 15					
Voltage range		V_S	8		26	V
Power-on threshold	ON OFF	V_S	3.0 4.7		3.8 5.7	V V
Current consumption	without load	I_S	3.9		9.1	mA
Reference	Pin 14					
Reference voltage	I_{Ref} = 5 mA I_{Ref} = 10 mA	V_{Ref}	6.19 6.14	6.5 6.5	6.71 6.77	V V
Reference current		$-I_{Ref}$			10	mA
Temperature coefficient		TC		– 0.7		mV/K
Operational amplifier OP						
Output voltage range	I_5 = 0 Pin 5	V_5	0.15		5.8	V
Output current range	V_5 = 3.25 V Pin 5	$\pm I_5$	80			µA
Output pause current	Pin 5	$\pm I_{pause}$	100			µA
Non-inverting input voltage	Pin 6	V_6	0		5	V
Non-inverting input current	Pin 6	$\pm I_6$			0.5	µA

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Comparator or Temperature control						
Input current	Pin 7, 8	$I_{7,8}$	– 0.5		0.5	µA
Input voltage range	Pin 7, 8	$V_{7,8}$	0		5	V
Threshold voltage	Pin 8	V_8	3.85		4.15	V
Charge break output Pin 9						
Output voltage	High, I_9 = 4 mA Low, I_9 = 0 mA	V_9	8.4		 100	V mV
Output current	V_9 = 1 V	I_9	10			mA
Battery detection Pin 10						
Analog-digital converter	Conversion range Full scale level	V_{Batt}	0 3.85		4.0	V
Input current	0.1 V ≤ V_{Batt} ≤ 4.5 V	– I_{Batt}			0.5	µA
Input voltage for reset		V_{Batt}	4.8	5.0	5.3	V
Input current for reset	V_{Batt} ≧ 5 V	I_{Batt}	8		35	µA
Battery detection	Maximum voltage	Δ V_{Batt}	80		120	mV
Hysteresis	Maximum voltage	V_{hys}		15		mV
Mode select Pin 12						
Threshold voltage	Test mode	V_{12}			4.7	V
Input current	Normal mode Open	I_{12}	20 0			µA
Sync. oscillator Pin 13						
Frequency	R = 150 kΩ C = 10 nF	f_{osc}		800		Hz
Threshold voltage	High level Low level	$V_{T(H)}$ $V_{T(L)}$		4.3 ± 3% 2.2 ± 3%		V
Input current		I_{13}	– 0.5		0.5	µA
Phase control						
Ramp voltage	R_φ = 270 kΩ Pin 16	V_{16}	2.9		3.9	V
Ramp current		I_{16}	0		100	µA
Ramp voltage range		V_{17}	0		5	V
Ramp discharge current		I_{17}	3.3		8	mA
Synchronization Pin 18						
Minimum current	V_{sync} ≤ 80 mV	– I_{sync}	10		2	µA
Maximum current	V_{sync} = 0 V	– I_{sync}	15		30	µA
Zero voltage detection		V_{sync}	83	100	135	mV
Hysteresis		V_{hys}		15		mV
Charge stop criteria (function) Pin 10						
Positive gradient-turn-off threshold	f_{osc} = 800 Hz	d^2V/dt^2		4.8		mV/ min²
– ΔV-turn-off threshold		– ΔV		18		mV

Dimensions in mm

Package: DIP18



Package: SO20