DATA SHEET

TEA1100; TEA1100T
Battery monitor for NiCd and NiMH chargers

Philips Semiconductors

PHILIPS

Battery monitor for NiCd and NiMH chargers

TEA1100; TEA1100T

FEATURES

- Accurate regulation of charge current settings in co-operation with a switched mode power supply
- Accurate detection of fully charged batteries by currentless battery voltage sensing
- Switch over from fast to normal charging when batteries are fully charged
- Adjustable fast charging level (1 C to 5 C)
- Adjustable normal charging level (0.05 C to 0.25 C)
- Temperature guarding by means of an NTC resistor
- Tracking of maximum fast charging time with fast charging current level
- Protections against short-circuited and open batteries
- Large battery voltage range
- Both DC and PWM outputs with polarity switch

APPLICATIONS

- Charge systems for NiCd and NiMH batteries

GENERAL DESCRIPTION

The TEA1100 is manufactured in a BICMOS process intended to be used as a battery monitor circuit in charge systems for NiCd and NiMH batteries.

The circuit has to be situated on the secondary side in mains-isolated systems where it monitors the battery voltage and the charge current. The circuit drives, by means of an opto-coupler or a pulse transformer interface, an SMPS circuit, situated on the primary side of the system, thus controlling the charge current of the batteries. The circuit can drive the external power transistor in switched mode systems, which have a DC power source, via a driver stage.

ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TEA1100	16	DIL	plastic	SOT38G
TEA1100T	16	SO16L	plastic	SOT162A

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	positive supply voltage range		5.65	–	11.5	V
I_P	supply current	outputs off	–	–	4.1	mA
V_{VAC}	voltage range of battery-full detection		0.385	–	3.85	V
dV_{VAC}/V_{VAC}	–dV detection level w.r.t. top value	note 1	–	1	–	%
I_{VAC}	input current battery monitor		–	–	1	nA
V_{VAC}	voltage protection battery low battery high		– –	0.3 4.25	– –	V V
I_{ref} I_n	charging level fast normal	$I_{charge} = R1/R_s \times I$; see Fig. 3 $I = I_{ref}$ $I = 1/p \times 0.1 \times I_n$ (p = prescale factor)	20 10	– –	100 50	µA µA
f_{osc}	oscillator frequency		10	–	100	kHz

Note to the quick reference data

1. The –dV detection level can be adjusted by use of an external voltage regulator diode to increase the sensitivity.
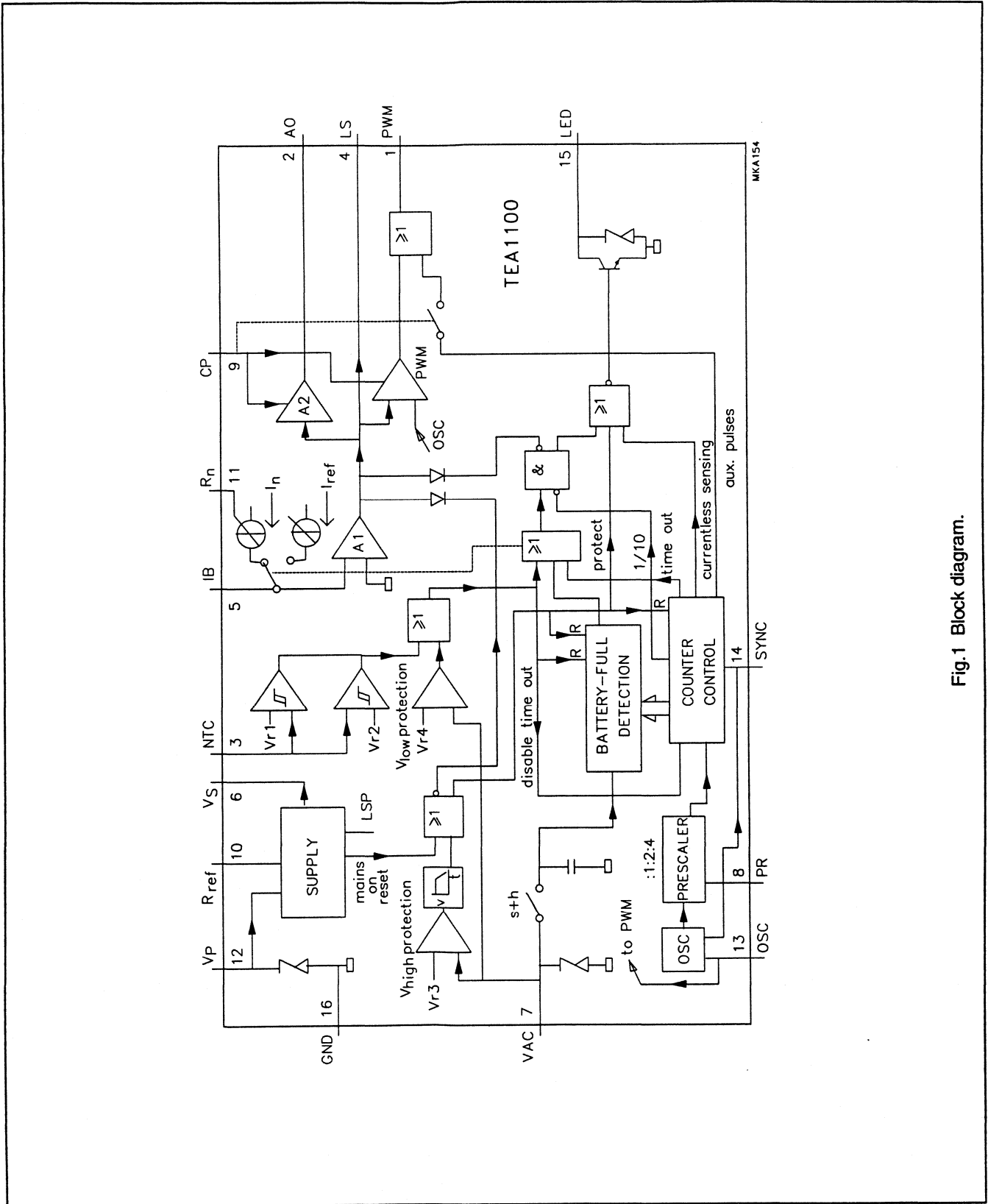
Fig.1 Block diagram.

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PINNING

SYMBOL	PIN	DESCRIPTION
PWM	1	pulse width modulator
AO	2	analog output
NTC	3	temperature sensor input
LS	4	loop stability
IB	5	charge current
V_S	6	stabilized supply voltage
VAC	7	battery voltage
PR	8	prescaler
CP	9	change polarity
R_{ref}	10	reference resistor
R_n	11	normal charge reference resistor
V_P	12	positive supply voltage
OSC	13	oscillator input
SYNC	14	synchronization input
LED	15	LED output
GND	16	ground

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PWM  [ 1        16 ]  GND
 AO  [ 2        15 ]  LED
NTC  [ 3        14 ]  SYNC
 LS  [ 4  TEA1100   13 ]  OSC
 IB  [ 5  TEA1100T  12 ]  Vp
 Vs  [ 6        11 ]  Rn
VAC  [ 7        10 ]  Rref
 PR  [ 8         9 ]  CP
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MKA155

Fig.2 Pin configuration.
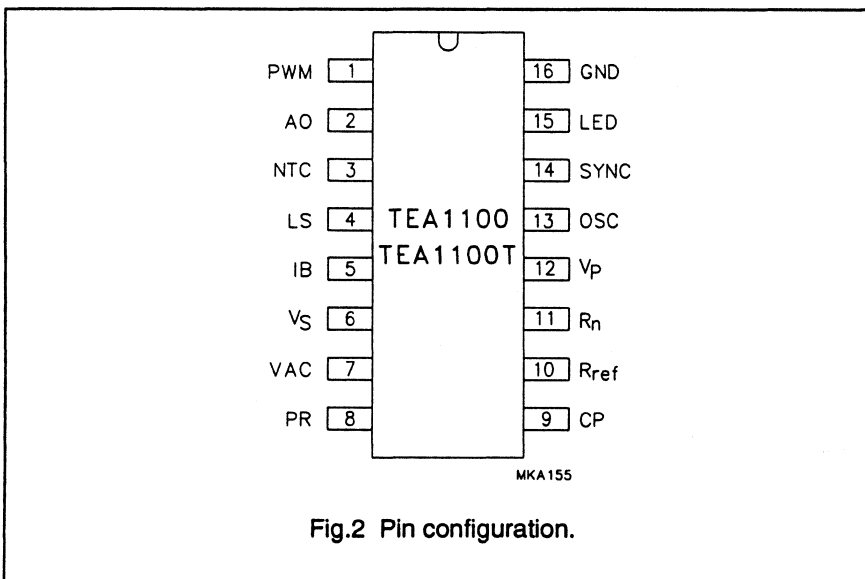
FUNCTIONAL DESCRIPTION

The operation of the circuit will be explained with the aid of Fig.1 (block diagram) and Fig.3 (application diagram). The circuit is divided into several blocks which are described separately.

Supply block

The circuit needs a supply voltage on pin V_P with a value between 5.65 and 11.5 V. Above 6.4 V typ., the circuit starts up assuming that mains is connected to the system and the charge session begins. This supply can be generated by a separate winding on the transformer, as shown in Fig.3 (application diagram), in either the flyback or the forward stroke. Another possibility is rectification from the mains secondary winding (at the connection D1 and L2). Considerations for choosing the way of supplying the IC are:

- supply voltage range of 5.65 to 11.5 V under all circumstances (also during the 90% pause at normal charging, the standby current then is 1 mA typ.)

- maximum battery voltage (flyback stroke)

- minimum power delivered by the primary SMPS (normal charging)

The supply block delivers the following outputs:

- By using an external resistor R_{ref} at pin 10 (R_{ref}) a reference current is obtained which defines all external related currents (charge reference currents, oscillator).

- Externally available 4.25 V stabilized voltage source (V_S). This source is used internally for a large part of the circuit and can be used to set the NTC biasing and to supply other external circuitry. V_S is cut off in the 90% pause during normal charging.

- Low Supply voltage Protection signal (LSP). When the supply voltage is lower than 5.25 V typ., there is supply voltage enough left to switch off the power regulation and hereafter the IC current is limited to the start level of 35 μA typ.

- Mains on reset pulse resets all digital circuitry after a start or restart due to an interrupted supply (V_P).

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Charge current regulation

The charge current has to be sensed by means of a low-ohmic resistor in series with diode D1. The waveform on resistor R_s (see Fig.4 for a flyback converter) has the form of a negative-going ramp and after filtering a negative DC voltage is obtained. Across resistor R1 a positive voltage is created by means of the current sources set by the pins R_{ref} and R_n. The error amplifier A1 references the result to ground and via the regulation loop of the SMPS, the secondary current will be regulated to a value which is defined by:

$I_{ch} \times R_s = R1 \times I_{ref}$ (fast charge) or,

$I_{ch} \times R_s = R1 \times I_n$ (normal charge)

The I_{ref} current is the fast charging reference current, the I_n current is used for regulation after a full battery is detected. The I_{ref} current is the reference current set by R_{ref} while I_n is dependent on the resistor at pin R_n. With no resistor on pin R_n, the I_n current has a default value which is half the I_{ref} current.
By choosing the correct resistor values R_s, R1, R_{ref} and R_n, a wide range of charge currents can be set as well as a wide range of the ratio fast charge current as a function of normal charge current. For determination of the normal charge current the 1:10 duty cycle and the programmable prescale factor (p) should be taken into account (see Logic block); $I_n = 1/p \times 0.1 \times I_n$. The output of amplifier A1 is available at the loop stability pin (LS), so the time constant of the SMPS loop can be set at the secondary side of the system.

NTC block

The voltage at the NTC pin is compared with two reference voltages. When the NTC voltage is between V_{r1} and V_{r2}, the charge current regulation is unaffected. When the NTC voltage is outside this window, the power of the SMPS is reduced to the normal charge level.
The NTC input can be used for temperature protection as shown in Fig.3 (application diagram) by using a suitable NTC resistor. To avoid switching on and off with temperature, a hysteresis is built in for both levels.

Output drivers

The SMPS regulation signal is available at different pins:

- Analog voltage output (push or pull) at AO (pin 2) to drive an opto-coupler in mains separated applications when an external resistor is connected between AO and the opto-coupler. The maximum current through the opto-coupler diode is 2 mA. The voltage gain of amplifier A2 is: $A = (V_{LS} - 1.4) \times 4$ and is typ. 12 dB. The voltage at AO can also be used to drive a PWM input of an SMPS circuit directly. During 'inhibit SMPS' the AO output is fixed to zero charge current for currentless sensing.

- The LS voltage is compared internally with the oscillator voltage to deliver a pulse width modulated output at PWM (pin 1) to drive an output device in a DC/DC converter application via a driver stage. The PWM output is latched to prevent multi-pulsing. Moreover with the latch a kind of current mode control is possible. The maximum duty cycle is internally fixed to 78% (typ.). The 'PWM' output can be used for synchronization and duty cycle control of a primary SMPS via a pulse transformer (the SMPS inhibit and auxiliary pulses are also available at pin PWM).

- The AO and PWM outputs can be changed in polarity by programming the change polarity pin CP. The PWM output in the on-state pushes current (CP = 0) or pulls current (CP = 1). The appearance of the auxiliary pulses at pin PWM can also be programmed with CP.

The 'LED' output pin offers the following output signals:

- 10/90% signal for driving a LED when the duty cycle is too small during the 10% time. This occurs when there is a large difference between fast and normal charge currents. The LED frequency is $f_{LED} = 2^{-12} \times 1/p \times f_{osc}$

- An SMPS inhibit period (duration 10 OSC pulses) for currentless VAC sensing.

- VAC high voltage protection signals.

Battery monitor

At higher battery voltages it is advised to divide the battery voltage with a factor 5 before offering this to pin VAC (Voltage ACcumulator). It is also possible to take a tap on the chain of batteries.
The VAC voltage range has to be between 0.385 V and 3.85 V.
The VAC voltage is sampled at a low cycle frequency ($f_{cycle} = 2^{-16} \times f_{osc}$) and the analog value of VAC is digitized and stored in a register. One cycle later, the digitized value is converted back to the analog value and compared with the actual value of VAC. If the actual value is higher, then the new VAC voltage is stored in the register, otherwise no conversion is done. So the VAC top value is stored and it is possible to detect an increasing VAC indicating 'not yet full batteries' or decreasing VAC indicating that the batteries are probably fully charged.

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The circuit waits until the battery voltage has dropped 1% below the top value before indicating 'full batteries'. However, by applying a voltage regulator diode in the battery voltage sense-line (see Fig.7) an increased sensitivity of the –dV detection level can be obtained, e.g. 0.5% or even a lower value.
In Fig.5 the battery voltage as function of the charging time is shown. The negative slope depends on the charge current and is approximately 3 mV/cell/K.

The switching of the SMPS can cause interference on the battery voltage and therefore it has been necessary to stop the SMPS during the inhibit time (see Fig.8). This can be done automatically via the regulation pins AO and PWM or by using the SYNC output of the logic block. The SMPS is stopped for 10 periods at the end of which sampling is done. The VAC voltage will now be sensed currentless. To avoid false decisions concerning a falling VAC voltage, VAC is digitally filtered and analog stored in a sample-and-hold circuit. This approach ensures, even at very high –dV sensitivity (<1%) accurate detection of the battery full condition. Immediately hereafter decisions and VAC digitizing takes place. The benefit of a sample-and-hold circuit is that at high frequencies the noise on the VAC voltage is filtered and the VAC manipulations like decisions and digitizing are done on the same VAC voltage available in the sample-and-hold circuit.

When a –dV is detected, the reference current I_{ref} is switched off, the normal current I_n is switched on during 10% of regulation and the outputs are high-ohmic during 90%. This 1:10 ratio in active regulation, together with the ratio in reference currents (I_n as a function of I_{ref}),

ensures that the resulting charge current is low enough to be allowed to flow through the batteries for a long time to overcome the self-discharge of the batteries without causing memory effects. In case the prescale factor p is programmed, the I_n current has to be lowered with the p factor, so $I_n = 1/p \times 0.1 \times I_n$.

Protections

- The circuit goes into standby (not active, low current consumption) when the supply voltage is less than 5.25 V (LSP).

- When the divided battery voltage exceeds the V_{r3} level (nominal 4.25 V) this is recognized as open or removed batteries and the output control signals terminate to stop the SMPS operation. This over-voltage sensing is digitally filtered. In above cases the 'battery full detector' and the 'counter/control' will be reset.

- When the divided battery voltage is less than V_{r4} (0.3 V), the circuit assumes short-circuited batteries, the charge current is reduced to the normal charge level. As soon as the voltage exceeds V_{r4}, the fast charging starts.

- The temperature protections are already mentioned in section NTC. In the case of short-circuited batteries or active temperature protections the 'battery full detector' is reset and the 'counter/control' is stopped.

Oscillator and control logic

The whole timing of the circuit is controlled by the oscillator.
The period time is defined by:
$T_{OSC} = 0.93 \times R_{ref} \times C_{OSC}$.

The counter block defines a maximum fast charge time called 'Time Out' (TO). As the charge current and the oscillator frequency (and so the TO) are both set by R_{ref}, changing one effects the other. Initially the oscillator capacitor can be chosen such that the fast charge time is half the TO time. This means that in case of a one hour (1C) charger, the TO signal occurs at 2 hours, in case of a quarter of an hour (4C) charger, the TO signal is active after half an hour. After that the circuit switches over to normal charging.

To adapt the SMPS switching frequency in the synchronized mode to the required oscillator frequency of the timing logic, the timer logic is preceded by a programmable divider. By means of the PR pin the divider ratio can be set to 1, 2 or 4 (p factor). Doing so the oscillator frequency can be increased with the factor p without changing TO.

Fast charging current:
$I_{ch} = R1/R_s \times V_{ref}/R_{ref}$
Time out:
$TO = 2^{26} \times 0.93 \times R_{ref} \times C_{OSC} \times p$
Normal charging current:
$I_{ch} = R1/R_s \times 1/p \times 0.1 \times V_{ref}/R_n$

The control block determines the following timing sequences:

- VAC sampling; this takes 1 clock pulse every interval cycle.
  The power converter is switched off during VAC sampling. As there are several types of converters, there also are several control signals available at :
  - pin 'SYNC' for synchronization in analog voltage controlled primary SMPS circuits
  - pin 'PWM' for digital controlled primary SMPS and DC/DC converters
  - pin 'LED' in special applications

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- Disabling –dV during 2^{-5} x TO (3% of TO) for proper start with flat or inverse polarized batteries. Disabling is active at each fast charge cycle.
- Maximum fast charging time (TO): the maximum timer is stopped during VAC low voltage protection and outside temperature range.
- The normal charge duty cycle is $1/p$ x 0.1
- Auxiliary pulses to support the supply voltage of the primary SMPS circuit via pin PWM: the pulses can be programmed on and off at an appearance rate of $f_{osc}/8$ with a duty cycle of 14%; programming is achieved by activating CP.

The timing logic and the –dV recognition circuitry are reset after each supply voltage failure and after a battery over-voltage recognition. The –dV circuit is also reset during normal charging.

The SYNC output delivers negative-going synchronization pulses which are suppressed during the sampling of the battery voltage. With these sync pulses the SMPS can be synchronized. The polarity of the sync pulses is chosen so that in case of an open SYNC pin in the synchronization mode, the power is regulated to a minimum. During the VAC sampling the absense of sync pulses causes the SMPS to stop thus minimizing interference (see Fig.8, synchronization waveforms).

During the 90% pause, only the oscillator and the control logic are operative to save current. In the pause V_P is never allowed to become less than V_{LSP}. This would cause a 'mains-on-reset' and so fast charging.

Programming

With pins 'CP' (change polarity) and 'PR' (prescaler) several functions can be programmed.

By defining the current (V_{ref}/R_{CP}) at pin CP, the following functions can be activated :

1	change polarity	CP = 0, normal polarity CP = 1, changed polarity
2	no auxilliary pulses at PWM	aux = 0
3	auxilliary pulses at f/8	aux = 8

CP PIN	FUNCTIONS	
	CP	aux
open pin	0	0
10 µA	0	8
22 µA	1	0
57 µA	1	8

By defining the voltage at pin PR, the following functions can be activated :

PR PIN	FUNCTIONS
V_s	prescaler divide by 1
open pin	prescaler divide by 2
ground	prescaler divide by 4

Formulas

DESCRIPTION	SYMBOL	FORMULA	FUNCTION
timing	T_{osc}	0.93 x R_{ref} x C_{osc}	repetition
	TO	2^{-26} x p x T_{osc}	duration
	$T_{disable}$	2^{-5} x TO	duration
	$T_{LED} = T_{trickle}$	2^{12} x p x T_{osc}	repetition
	$T_{LED} = T_{trickel}$	3/4 x 2^9 x T_{osc}	duration
	T_{inhibt}	2^{16} x T_{osc}	repetition
	T_{inhibt}	10 x T_{osc}	duration
charge currents	I_{fast}	R1/R_s x V_{ref}/R_{ref}	
	I_{normal}	R1/R_s x 1/p x $0.1 V_{ref}/R_n$	

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LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134)

All voltages with respect to ground; positive currents flow into the IC; all pins not mentioned in the voltage list are not
allowed to be voltage driven. The voltage ratings are valid provided other ratings are not violated; current ratings are
valid provided the power rating is not violated.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
Voltages					
V_P	positive supply voltage (pin 12)		−0.5	13.2	V
V_{LED}	LED voltage (pin 15)		−0.5	13.2	V
$V_{1,8,4,3}$	voltage at PWM (pin 1), PR (pin 8), LS (pin 4), NTC (pin 3)		−0.5	V_P	V
V_{IB}	voltage at IB (pin 5)		−0.5	−1	V
Currents					
I_{VS}	current at V_S (pin 6)		−3	+0.01	mA
I_{LED}	current at LED (pin 15)		−	25	mA
I_{AO}	current at AO (pin 2)		−5	+5	mA
I_{PWM}	current at PWM (pin 1)		−15	+15	mA
I_{SYNC}	current at SYNC (pin 14)		−2	+2	mA
$I_{11,10,9}$	current at R_n (pin 11), R_{ref} (pin 10), CP (pin 9)		−1	+0.01	mA
$I_{4,5,7}$	current at LS (pin 4), IB (pin 5), VAC (pin 7)		−1	+1	mA
I_P	current at V_P (pin 6)		−	15	mA
Dissipation					
P_{tot}	total power dissipation	T_{amb} = 85 °C SOT38G SOT162A	− −	0.6 0.3	W W
Temperatures					
T_{amb}	operating ambient temperature		−20	+85	°C
T_j	junction temperature		−	+150	°C
T_{stg}	storage temperature		−55	+150	°C

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CHARACTERISTICS

T_{amb} = 25 °C; V_P = 10 V; R_{ref} = 33 kΩ; R_n = 68 kΩ; C_{OSC} = 1 nF; CP is open; PR connected to V_S; unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (V_P, V_S, R_{ref})						
V_P	supply voltage range		5.65	–	11.5	V
V_{PC}	clamp voltage	I_{PC} = 10 mA	11.5	–	12.8	V
V_{PS}	start voltage		6.1	6.4	6.7	V
V_{PLSP}	low supply protection level		4.85	5.25	5.65	V
V_{PLSPH}	hystereris of V_{PLSP}		0.3	0.95	–	V
I_P	supply current	outputs off	–	–	4.1	mA
I_{PP}	supply pause current	V_P = 6 V	–	–	1.71	mA
I_{PSB}	standby current	V_P = 4 V	–	35	45	μA
V_S	source voltage (stabilized)	I_S = 1 mA	4.03	4.25	4.46	V
V_{ref}	reference voltage	I_{ref} = 20 μA	1.18	1.25	1.31	V
TC_{Vref}	temperature coefficient of V_{ref}	T_{amb} = 0 to 45 °C	–	±100	±200	ppm/K
dV_{ref}/dV_P	power supply rejection ratio (PSRR) of V_{ref}	f = 100 Hz; dV_P = 2 V (peak-to-peak value); V_P = 8 V	–46	–	–	dB
ΔV_{ref}	voltage difference	dI_S = 1 mA	–	–	5	mV
I_{Rref}	current range of R_{ref}		10	–	100	μA
Charge current regulation (IB, R_n, R_{ref})						
V_n	voltage at pin R_n	I_n = 10 μA; I_{ref} = 20 μA	1.17	1.25	1.32	V
I_n	current range at R_n		5	–	50	μA
I_{IB}/I_{ref}	input current ratio normal charging fast charging	R_n not connected V_{IB} = 0 V_{IB} = 0	0.475 0.95	0.5 1	0.525 1.05	
I_{IB}/I_n	input current ratio normal charging	R_n connected	0.90	0.97	1.04	
V_{thIB}	threshold voltage at IB	T_{amb} = 25 °C T_{amb} = 0 to 45 °C	–5 –7	– –	+5 +7	mV mV
NTC input						
V_{NTCSPH}	switching protection voltage on high temperatures		0.75	0.81	0.87	V
V_{NTCHH}	hysteresis of V_{NTCSPH}		60	90	120	mV
V_{NTCSPL}	switching protection voltage on low temperatures		2.78	3.00	3.20	V
V_{NTCHL}	hysteresis of V_{NTCSPL}		65	100	135	mV
I_{NTC}	input current	V_{NTC} = 2 V	–5	–	+5	μA

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output drivers (AO, LS, PWM, LED)						
$I_{AOsource}$	source current	$V_{AO} = 3$ V; CP = 0	–	–	–2	mA
I_{AOsink}	sink current	$V_{AO} = 0.5$ V; CP = 1	2	–	–	mA
g_m	transconductance A1	$V_{IB} = 50$ mV	–	300	–	μS
G_{V1}	voltage gain A1 x A2	$V_{AO} = 2$ V (peak-to-peak value)	–	72	–	dB
G_{V2}	voltage gain A2	$V_{AO} = 2$ V (peak-to-peak value)	–	12	–	dB
$I_{LSsource}$	maximum source current	$V_{LS} = 2.25$ V	–25	–21	–16	μA
I_{LSsink}	maximum sink current	$V_{LS} = 2.25$ V	16	21	25	μA
I_{PWMH}	HIGH level output current	$V_{PWM} = 3$ V	–18	–14	–10	mA
I_{PWML}	LOW level output current	$V_{PWM} = 0.5$ V	7	12	17	mA
$I_{PWMleak}$	leakage current	$V_{PWM} = 4.25$ V	–	0.2	10	μA
δ_{PWM}	maximum duty cycle		70	78	86	%
δ_{PWMaux}	auxiliary pulse duty cycle		12.6	14	15.4	%
V_{LEDsat}	saturation voltage	$I_{LED} = 15$ mA	–	–	600	mV
$I_{LEDleak}$	leakage current	$V_{LED} = 10$ V	–	–	5	μA
Battery monitor (VAC)						
I_{VAC}	input current	$V_{VAC} = 4.25$ V	–	1	–	nA
V_{VAC}	voltage range of –dV detection		0.385	–	3.85	V
dV_{VAC}/V_{VAC}	–dV detection level w.r.t. top level	$V_{VAC} = 2$ V	0.85	1	1.15	%
ΔV_{VAC}	resolution –dV		0.42	0.6	0.78	mV
T_{-dV}	temperature range of –dV detection		0	–	50	°C
Protections (VAC)						
V_{VACLBP}	low battery voltage protection		–	0.3	0.33	V
V_{VACHBP}	high battery voltage protection	with respect to V_P	–	0	150	mV
Oscillator, logic (OSC, SYNCH)						
V_{OSCH}	oscillator switching level HIGH		–	2.5	–	V
V_{OSCL}	oscillator switching level LOW		–	1.5	–	V
K	period time $T_{OSC} = K \times R_{ref} \times C_{OSC}$		0.84	0.93	1.02	
f_{OSC}	oscillator frequency range		10	–	100	kHz
V_{SYNCH}	SYNC output level HIGH	$I_{SYNCH} = -0.4$ mA	3.4	–	–	V
V_{SYNCL}	SYNC output level LOW	$I_{SYNCL} = 0.4$ mA	–	–	0.85	V

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Programming (CP)						
I_{CP}	programming currents					
	CP = 0; aux = 0	R_{CP} = 330 kΩ	–	–	4.2	μA
	CP = 0; aux = 8	R_{CP} = 120 kΩ	9.4	10.4	11.4	μA
	CP = 1; aux = 0	R_{CP} = 56 kΩ	20.0	22.3	24.5	μA
	CP = 1; aux = 8	R_{CP} = 22 kΩ	51.1	56.8	62.5	μA

QUALITY SPECIFICATION

General quality specification for integrated circuits: UZW-B0/FQ-0601.

Remark: for the synchronization pin (14), the ESD positive zap voltage is restricted to a maximum of 1000 V.

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TEST AND APPLICATION INFORMATION
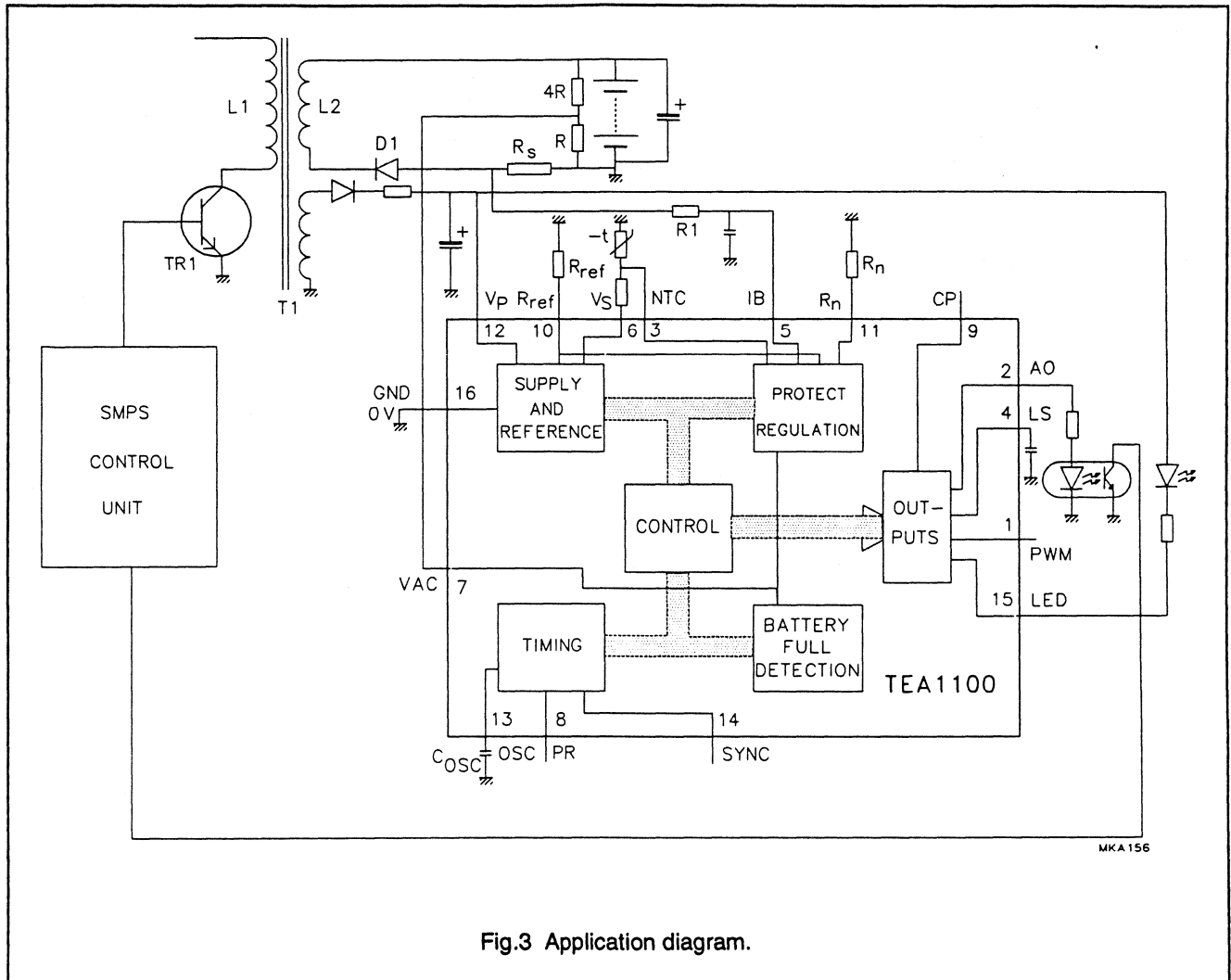
Fig.3 Application diagram.

Notes to Fig.3

1. Signaling the status of the charging session can be done by a LED-diode-resistor combination parallel to L2 (transformer T1). During the fast charging period the LED will burn continuously. During normal charging the LED will switch with the 10/90% rhythm. With mains-off the LED is off, thus not discharging the batteries. If at normal charging the duty cycle is too low during the 10% because of a very large difference between the fast charge and the normal charge levels, the LED can be driven by the LED pin.

2. With R_s = 50 mΩ and a required fast charging current level of 6 A (5C for 1.2 Ah batteries), the average current sense level is 300 mV. Power dissipation in R_s = 1.8 W.
With a 3 kΩ resistor for R1, the required I_{ref} current is 300 mV/3 kΩ = 100 µA. For a normal charge level of 0.25C (300 mA) the voltage drop over R_s is 15 mV. Taken into account the duty cycle of 10%, the voltage drop over R1 = 150 mV. So the I_{Rn} current has to be: 150 mV/3 kΩ = 50 µA (p = 1).

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Method to increase –dV sensitivity

The basic, direct battery sensing via a resistive divider, which adapts the battery voltage within the V_{AC} range, is shown in Fig.6. Detection occurs at –dV = 1% of $V_{B(max)}$.

The position of the Zener diode is shown in Fig.7. The TEA1100 now senses the voltage V_R, which is the battery voltage minus the Zener-diode voltage ($V_R = V_B - V_Z$).

Detection occurs at $-dV_R$ = 1% of V_{Rmax}. This detection corresponds with a –dV in the battery in accordance with:

$$dV_{bat} = (V_Z/V_{B(max)}) - 1 \text{ (in \%)}.$$

If the Zener voltage is half the maximum battery voltage, the dV_B detection will be at –0.5%.

Design example for six-cells' battery and 5% –dV cut-off

Conditions:

- maximum battery voltage (1.7 V/cell) = 10.2 V
- sense network current ≈ 300 μA
- maximum monitor sense voltage V_{AC} = 3.6 V (<3.85 V)

For –dV ≈ 0.5%, a Zener voltage of about half the battery voltage is required; choose V_Z = 5 V. Now V_R at top level is ≈5.2 V and the required divider factor (V_{AC}/V_R) is 0.69. R1 and R2 become 5.6 kΩ and 12 kΩ respectively (see Figs 6 and 7).

During charge the battery voltage rises with a minimum rate of ≈8 mV per minute for 6 cells under 1 C charge. The temperature coefficient of the Zener diode and its ambient temperature change should not cause a premature full detection.

With the following equation the allowance of the Zener-diode temperature change can be derived:

K/minute < {0.5%($V_B - V_Z$) + (8 mV/minute)}/S_Z

At the early state of charging, V_B ≈ 8.4 V for 6 cells; 0.5% is a safe value for 1% detection in the TEA1100 and V_Z = 5 V.

Assuming a S_Z of +0.5 mV/K (typ. 0.2 mV/K for e.g. Zener diode PLVA450A), this results in maximum 50 K/minute.
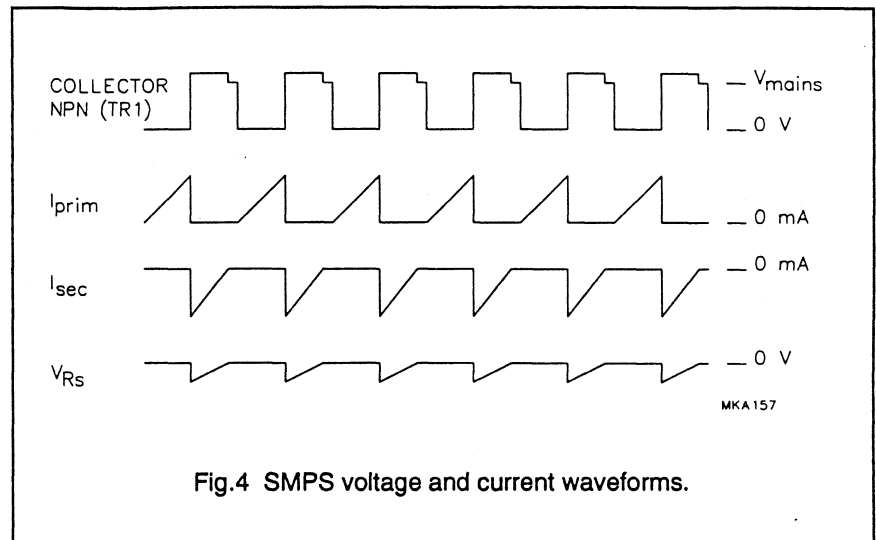

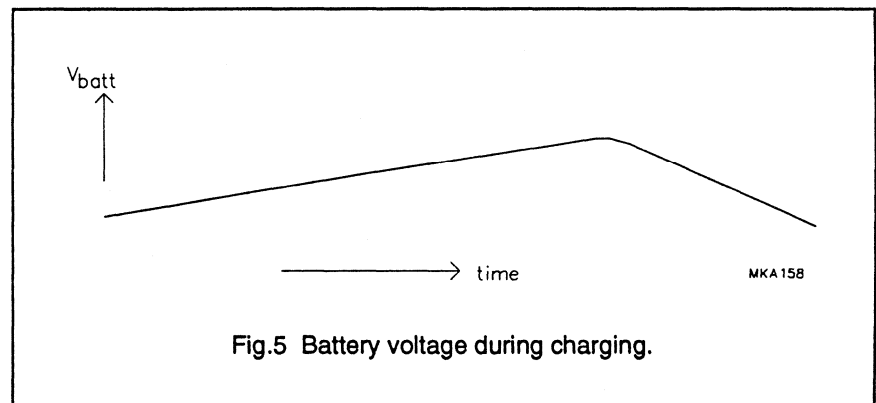Fig.4 SMPS voltage and current waveforms.
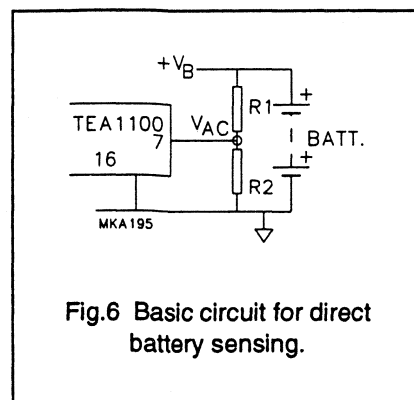

Fig.5 Battery voltage during charging.
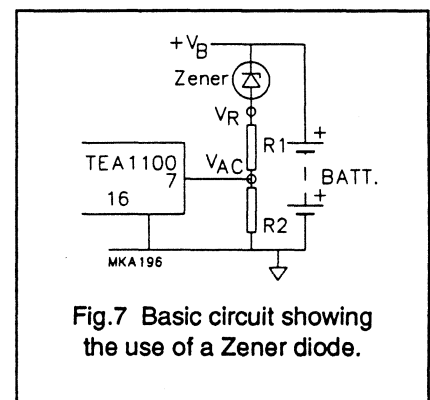

Fig.6 Basic circuit for direct battery sensing.

Fig.7 Basic circuit showing the use of a Zener diode.

Battery monitor for NiCd and NiMH
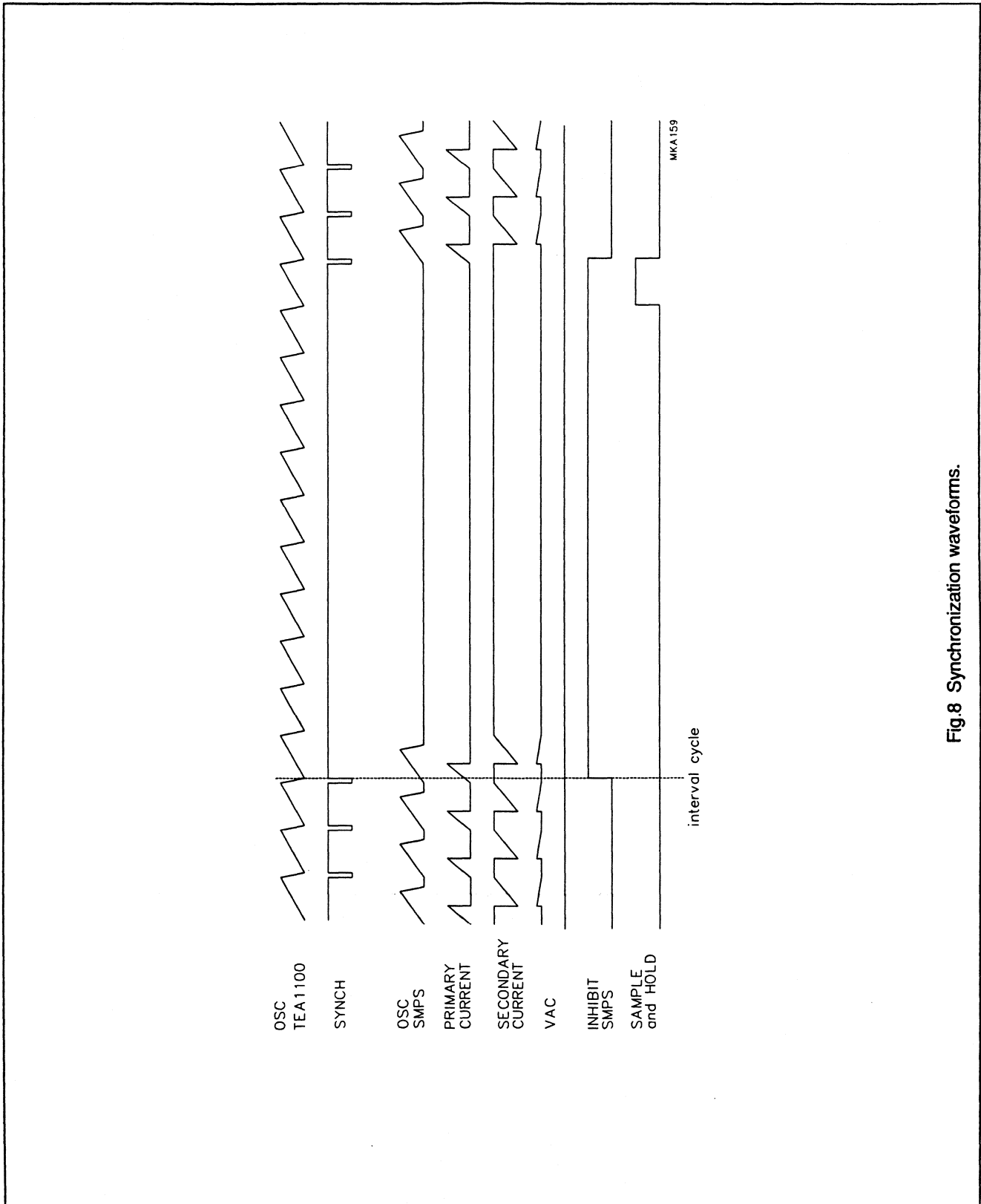chargers

TEA1100; TEA1100T

OSC
TEA1100

SYNCH

OSC
SMPS

PRIMARY
CURRENT

SECONDARY
CURRENT

VAC

INHIBIT
SMPS

SAMPLE
and HOLD

interval cycle

MKA159

Fig.8 Synchronization waveforms.

Battery monitor for NiCd and NiMH
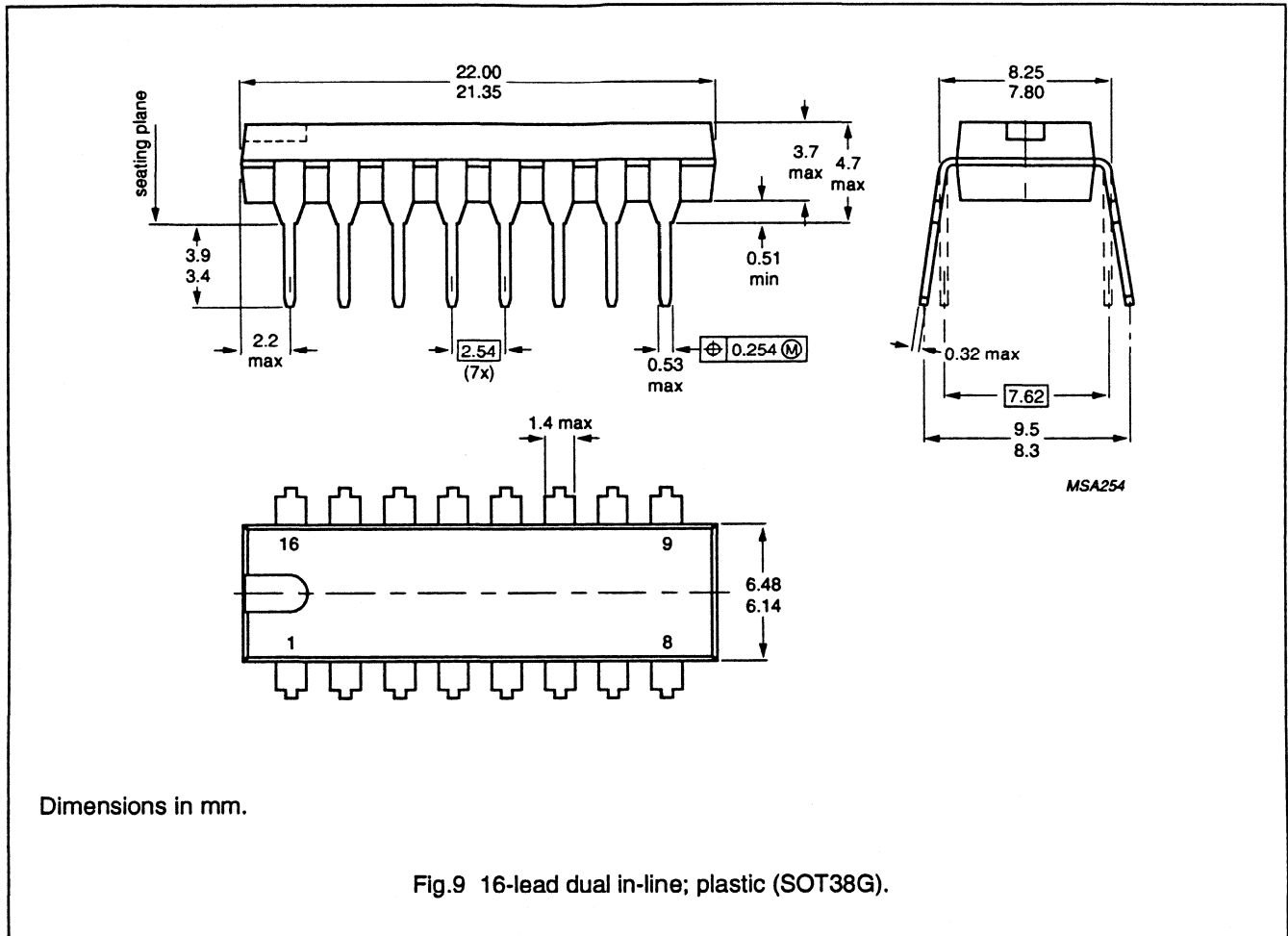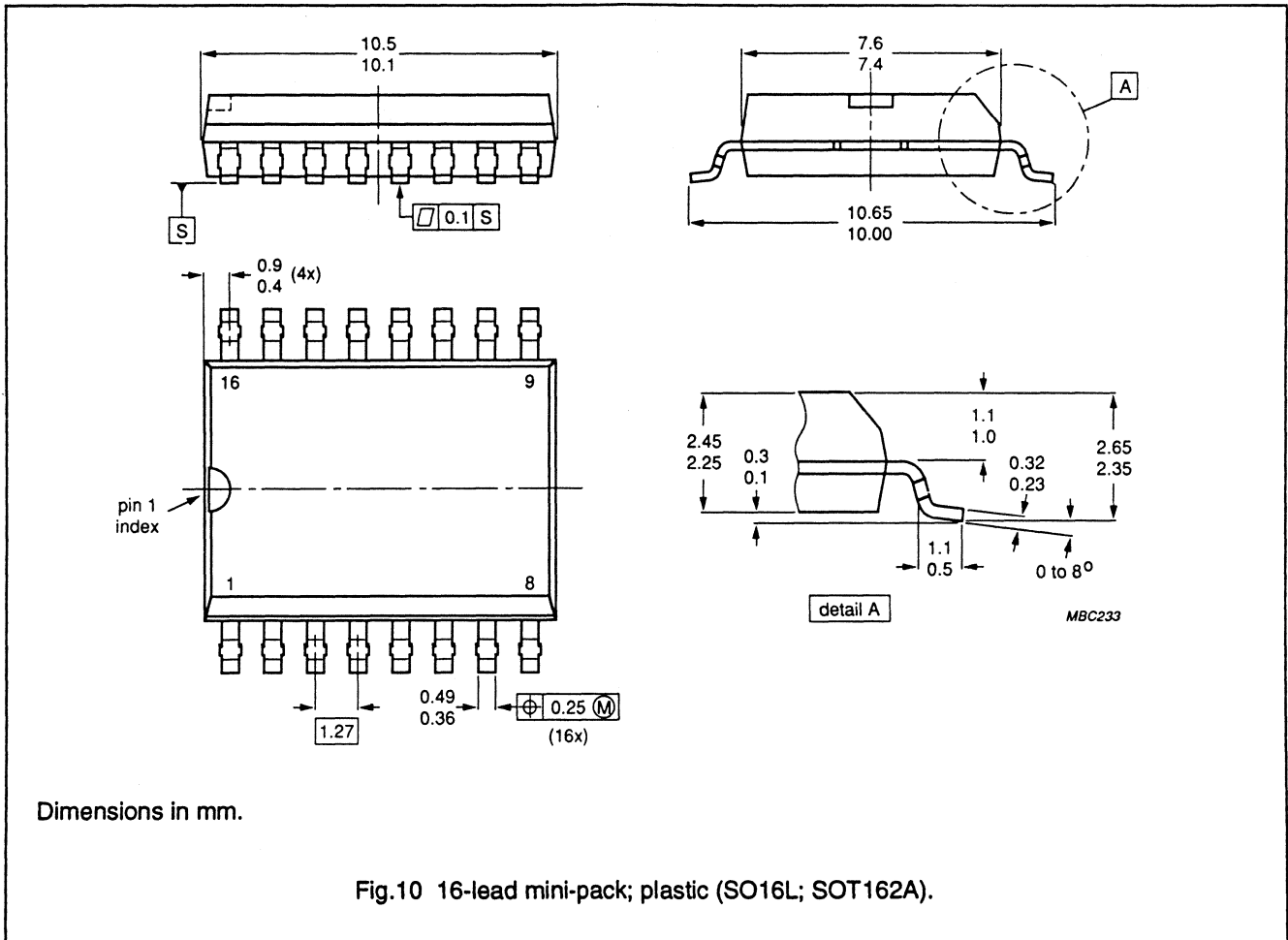chargers

TEA1100; TEA1100T

PACKAGE OUTLINES

Dimensions in mm.

Fig.9 16-lead dual in-line; plastic (SOT38G).

Battery monitor for NiCd and NiMH
chargers

TEA1100; TEA1100T

Dimensions in mm.

Fig.10 16-lead mini-pack; plastic (SO16L; SOT162A).

Battery monitor for NiCd and NiMH chargers

TEA1100; TEA1100T

SOLDERING

Plastic dual in-line packages

BY DIP OR WAVE

The maximum permissible temperature of the solder is 260 °C; this temperature must not be in contact with the joint for more than 5 s. The total contact time of successive solder waves must not exceed 5 s.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified storage maximum. If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply the soldering iron below the seating plane (or not more than 2 mm above it). If its temperature is below 300 °C, it must not be in contact for more than 10 s; if between 300 and 400 °C, for not more than 5 s.

SOLDERING

Plastic mini-packs

BY WAVE

During placement and before soldering, the component must be fixed with a droplet of adhesive. After curing the adhesive, the component can be soldered. The adhesive can be applied by screen printing, pin transfer or syringe dispensing.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder bath is 10 s, if allowed to cool to less than 150 °C within 6 s. Typical dwell time is 4 s at 250 °C.

A modified wave soldering technique is recommended using two solder waves (dual-wave), in which a turbulent wave with high upward pressure is followed by a smooth laminar wave. Using a mildly-activated flux eliminates the need for removal of corrosive residues in most applications.

BY SOLDER PASTE REFLOW

Reflow soldering requires the solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the substrate by screen printing, stencilling or pressure-syringe dispensing before device placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt, infrared, and vapour-phase reflow. Dwell times vary between 50 and 300 s according to method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 min at 45 °C.

REPAIRING SOLDERED JOINTS (BY HAND-HELD SOLDERING IRON OR PULSE-HEATED SOLDER TOOL)

Fix the component by first soldering two, diagonally opposite, end pins. Apply the heating tool to the flat part of the pin only. Contact time must be limited to 10 s at up to 300 °C. When using proper tools, all other pins can be soldered in one operation within 2 to 5 s at between 270 and 320 °C. (Pulse-heated soldering is not recommended for SO packages.

For pulse-heated solder tool (resistance) soldering of VSO packages, solder is applied to the substrate by dipping or by an extra thick tin/lead plating before package placement.

Battery monitor for NiCd and NiMH
chargers   TEA1100; TEA1100T

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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