

SAILOR



TECHNICAL MANUAL
FOR
14 HOURS NiCd BATTERY CHARGER
SP3911



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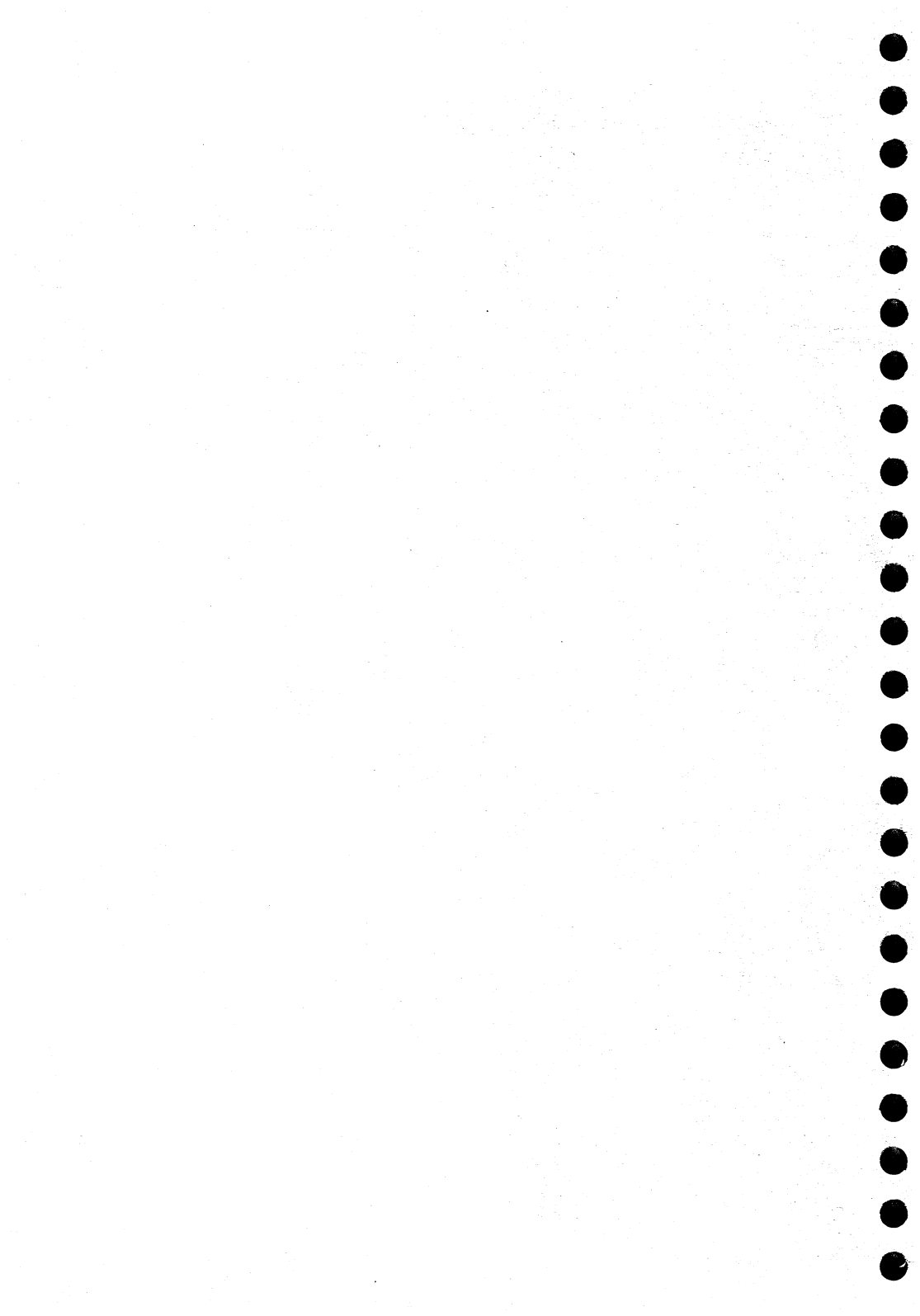
CONTENTS

1	GENERAL INFORMATION	1-1
1.1	INTRODUCTION	1-1
1.2	TECHNICAL DATA	1-3
1.3	CONTROLS AND OPERATION GUIDE	1-4
1.4	PRINCIPLE OF OPERATION AND BLOCK DIAGRAM	1-6
2	INSTALLATION	2-1
2.1	INSTALLATION GUIDE	2-1
2.2	MOUNTING POSSIBILITIES, DIMENSIONS AND DRILLING PLAN	2-2
2.3	POWER SOURCE	2-4
2.4	ENABLING OF THE REAR CHARGE POSITION	2-9
3	SERVICE	3-1
3.1	MAINTENANCE	3-1
3.2	PROPOSAL FOR NECESSARY TEST EQUIPMENT	3-1
3.3	TROUBLE SHOOTING	3-2
3.4	PERFORMANCE CHECK	3-4
3.5	REPLACEMENT OF COMPONENTS	3-6
3.6	PIN CONFIGURATIONS	3-7
4	MECHANICAL DESCRIPTION	4-1
4.1	MECHANICAL ASSEMBLING / DISASSEMBLING	4-1
5	CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM	5-1
5.1	CIRCUIT DESCRIPTION	5-1
6	PARTS LIST	6-1



CONTENTS

1	GENERAL INFORMATION	1-1
1.1	INTRODUCTION	1-1
1.2	TECHNICAL DATA	1-3
1.3	CONTROLS AND OPERATION GUIDE	1-4
1.4	PRINCIPLE OF OPERATION AND BLOCK DIAGRAM	1-6



1 GENERAL INFORMATION

1.1 INTRODUCTION

The **14 HOURS NiCd BATTERY CHARGER** is constructed for re-charging the 7.2 Volt Secondary Re-chargeable Battery, which is intended for the daily use of the hand portable VHF/UHF transceiver.

The **14 HOURS NiCd BATTERY CHARGER** has two completely independent charger positions, of which only the Front Charge Position is enabled from the factory. This means that the battery charger acts as a combined Battery holder and Battery charger.

The **Primary Emergency Battery** can be stored in the Rear Charge Position and the **Secondary Re-chargeable Battery** assembled with the hand portable VHF/UHF transceiver can be charged in the Front Charge Position.

If the Rear Charge Position is wanted for charging of an extra Secondary Re-chargeable Battery, it can easily be enabled by following the procedure described in section 2.4 in this manual.

The **14 HOURS NiCd BATTERY CHARGER** can be supplied from either an AC source (110/120V or 220/240V), or from a DC source (10.8V - 32V), due to appropriate strapping.

As indicated by the name of the battery charger, a complete charge cycle will take approx. 14 hours. After this periode, the charge current has to be interrupted or reduced to prevent the temperature inside the battery to increase. Such an increase in temperature would damage the battery and thereby reduce the useful life time remarkably.

To avoid the situation just described, the **14 HOURS NiCd BATTERY CHARGER** will change mode from regular charge to trickle charge, when the 14 hours has past. The trickle charge mode is simply characterized by a reduction of the charge current with a factor of 2.5. With this reduced current, the battery charger will only maintain the charge of the battery and the life time of the battery will not be affected.

The battery charger will automatically detect the type of battery, which is to say the ampere-hour rating of the battery. The Secondary Rechargeable Batteries are delivered in two types, which have a capacity of either 700mAh or 1200mAh.

The **14 HOURS NiCd BATTERY CHARGER** will charge the batteries with a current of 1/10 of the ampere-hour rating, which correspond to charge currents of 70mA or 120mA.

After the 14 hours time periode, the charge current is reduced to 1/25 of the ampere-hour rating, which correspond to charge current of 28mA or 48mA.

In spite of all the precautions taken in the design of the battery charger, a regular service and maintenance is recommended, to increase unit life-time and user safety.

The battery charger is developed and manufactured by **E/C/I** Denmark.

E/C/I is the European leading manufacturer of maritime radio communication equipment - a position which has been maintained by means of constant and extensive product development. We have a world-wide network of dealers with general agencies in fifty countries. All our dealers are well-trained, and will be able to make service on all **E/C/I** products.

1.2 TECHNICAL DATA

Power Source: 220/240 VAC 50/60 Hz
110/120 VAC 50/60 Hz
10.8 - 32.0 VDC

Power Consumption: **220/240 VAC**
Standby typ.: 8mA
Maximum: 50mA

110/120 VAC
Standby typ.: 16mA
Maximum: 100mA

10.8 - 32.0 VDC
Standby typ.: 50mA
Maximum: 300mA

Battery Type Detection: Automatic

Charge Voltage: Up to 9.6V (automatically regulated according to the actual charge current)

Charge Current: **700mAh Battery**
Regular Charge: 70mA
Trickle Charge: 28mA

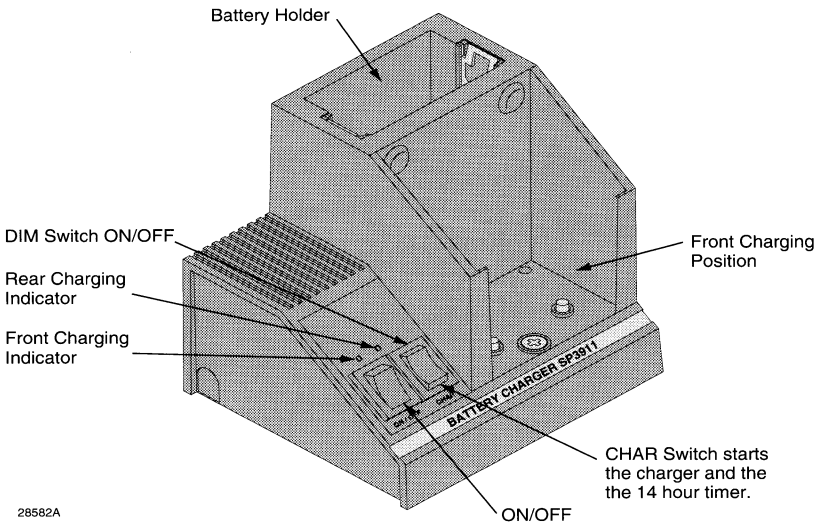
1200mAh Battery
Regular Charge: 120mA
Trickle Charge: 48mA

Temperature Range: -20°C to +55°C

Dimensions: Height: 100mm
Width: 115mm
Depth: 100mm

Weight: Approximate: 0.5kg.

1.3 CONTROLS AND OPERATION GUIDE



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The **14 HOURS NiCd BATTERY CHARGER** has two independent charge possibilities: Front Charge Position.
Rear Charge Position, if enabled.

FRONT CHARGE POSITION:

Press the power 'ON/OFF' button downwards, to turn on the charger.

Place the hand portable VHF/UHF transceiver inclusive the Secondary Re-chargeable Battery into the Front Charge Position and remember to switch off the transceiver before the charge cycle is started.

Press the 'CHAR' button downwards and check that the left charging indicator turn on with a red light, indicating that the battery is charged with the programmed current.

After approx. 14 hours the Battery Charger changes mode to trickle charge and the charging indicator will then flash with a green light. A complete charge cycle is now finished and the hand portable VHF/UHF transceiver is ready for use.

When the battery capacity has reached a few percent of full load, an audible alarm will sound in the loudspeaker of the transceiver and a battery sign will be shown in the display. At this moment the battery must be re-charged, which is done by using the procedure described above.

NOTE:

It is important that the battery always is fully discharged before a re-charge cycle is started. If the battery repeatedly is charged after a partly discharge, it will develop a memory effect. The memory effect is characterized by a reduced charging capability, which means that the battery is **not** working optimal.

REAR CHARGE POSITION, DISABLED:

Place the Primary Emergency Battery into the Rear Charge Position, which just acts as a battery holder.

REAR CHARGE POSITION, ENABLED:

Press the power 'ON/OFF' button downwards, to turn on the charger.

Place the Secondary Re-chargeable Battery into the Rear Charge Position.

Check that the right charging indicator turn on with a red light, indicating that the battery is charged with the programmed current.

After approx. 14 hours the Battery Charger changes mode to trickle charge and the charging indicator will then flash with a green light. A complete charge cycle is now finished and the battery is now ready for use in the hand portable VHF/UHF transceiver.

NOTE:

It is important that the battery always is fully discharged before a re-charge cycle is started. If the battery repeatedly is charged after a partly discharge, it will develop a memory effect. The memory effect is characterized by a reduced charging capability, which means that the battery is **not** working optimal.

When the hand portable VHF/UHF transceiver is **not** in use, it can be stored in the Front Charge Position. But remember **not** to press the 'CHAR' button, because this would start a fully charge cycle and then probably cause a memory effect to develop.

The Rear Charge Position is factory prepared for charging purpose, and if wanted for charging af an extra Secondary Re-chargeable Battery it can easily be enabled by following the procedure described in section 2.4 in this manual.

Press the 'DIM' button upwards to turn the charging indicator ON or OFF. The charging indicator will always be ON, when the power is switched on.

1.4 PRINCIPLE OF OPERATION AND BLOCK DIAGRAM

The block diagram for the **14 HOURS NiCd BATTERY CHARGER** can be divided into four separate blocks, which are:

- 1: Front Position Battery Charger
- 2: Rear Position Battery Charger
- 3: Oscillator and divider circuit
- 4: Power Supply Circuit

FRONT POSITION BATTERY CHARGER

The re-chargeable batteries include a resistor, which is used by the battery charger to detect the presence and the type of a battery. The resistor forms a voltage divider in conjunction with a pull-up resistor inside the battery charger. This voltage divider is used as input for the circuit called: **Battery in Front Position Detect**, which simply is a voltage comparator.

When a battery is placed in the front position, it will be detected by the voltage comparator, just described. This will enable the **Charge Switch**, and the charge current can now be switched on by pressing this switch.

If the **Charge Switch** is activated, it will turn on the **Differential Amplifier** and thereby turn on the charge current. When the charge current actually flows into the battery, it will also run through the **Sense Resistor** of 4.7 ohm, which is located at the minus-terminal of the battery. The current through this **Sense Resistor** will then cause a voltage to arise, which is used as feed-back for the **Differential Amplifier** and the **Voltage to Current Converter**.

The input reference signal to the **Differential Amplifier** determines the magnitude of the charge current. This reference signal is generated by the **Reference Voltage Control**, which combine the logic signals coming from the **Battery Type Detect** and the **14 Hours Counter**.

The voltage across the **Sense Resistor**, which is used for feed-back, is also feed to the voltage comparator called: **Charge Current Detect**, where the feed-back signal is compared with a reference signal. The output from the **Charge Current Detect** will be logic high, if the actual charge current is equal to the programmed current. This will turn on the red Light Emitting Diode (LED) and start the **14 Hours Counter**, which is clocked by the clock signal **CLK2**.

After 13 hours and 39 minutes, the output from the counter will go logic high, which will decrease the reference voltage generated by the **Reference Voltage Control**. This will reduce the Charge Current with a factor of 2.5, which means that the battery is trickle Charged. The logic high output from the **14 Hours Counter** will also activate the **LED Control Logic**, which will turn off the red LED and turn on the green LED. The green LED will be flashed by the clock signal **CLK1**.

The LED's can be switch ON or OFF by means of the **Dimmer Circuit**, which is controlled by the 'DIM' button.

REAR POSITION BATTERY CHARGER

The Rear Position Battery Charger is almost identical to the corresponding circuit for the front position. The only difference is the **Charge Switch**, which is **not** include in the Rear Position Battery Charger. This means that the charge cycle will start automatically and immediately, when a battery is placed in the rear position.

OSCILLATOR AND DIVIDER CIRCUIT

The oscillator and divider circuit generates two clock signals, which control the timing of the **14 Hours Counter** and the flashing of the green LED's.

The oscillator frequency is 32.768 kHz, which is controlled by a crystal. This frequency is divided by 2^{15} (=32768) and 2^{19} (=524288), which correspond to the following clock cycles: **CLK1** = 1 sec. and **CLK2** = 16 secs.

POWER SUPPLY CIRCUIT

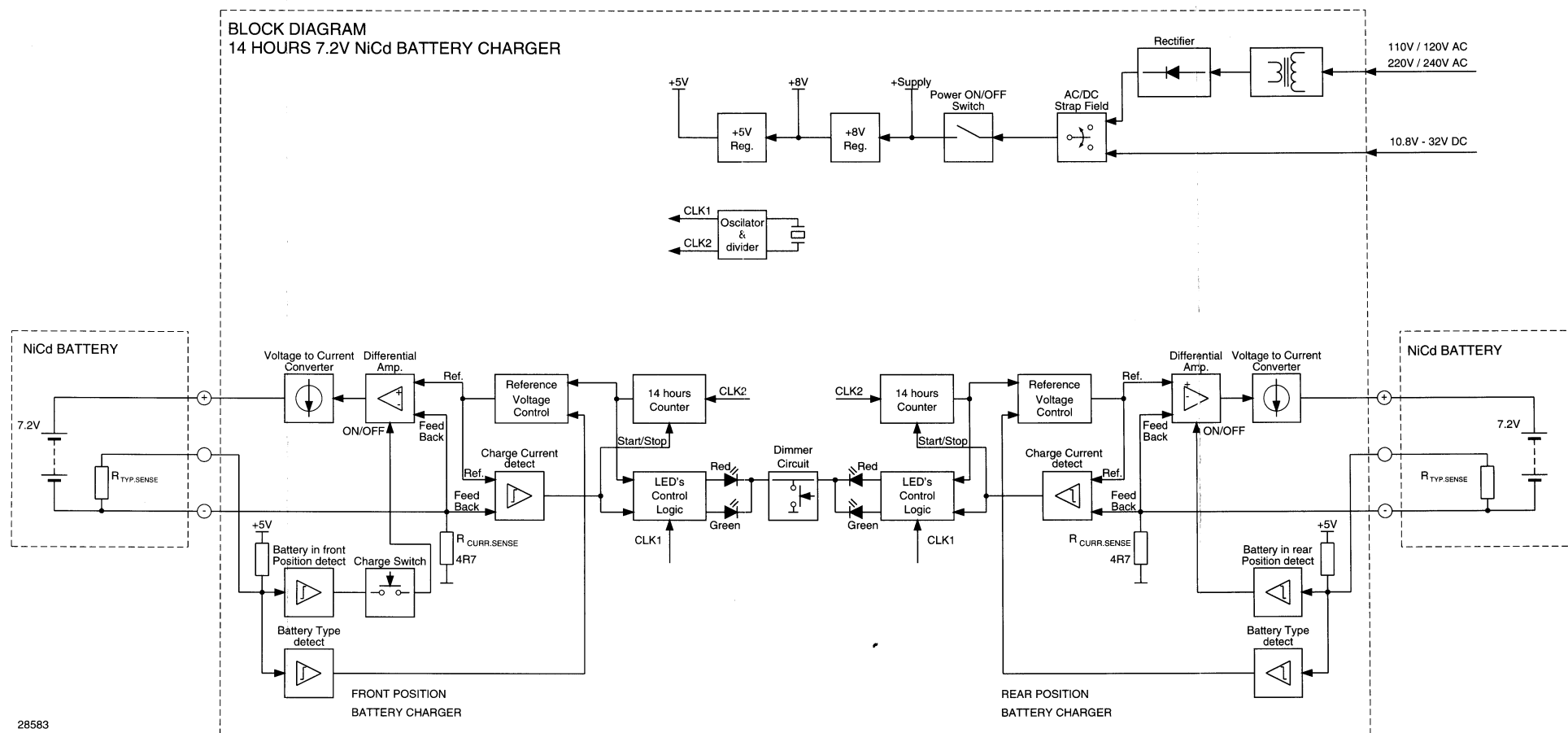
The Battery Charger can be sourced from both AC and DC power supplies.

The main AC voltage is downconverted and rectified to give a DC voltage of approx. 12V - measured with the maximum load current of 300mA. The downconverted and rectified voltage is feed to the **AC/DC Strap Field**, where the selection between AC and DC supply is performed.

The selected supply voltage is then feed to the **Power on/off Switch**, where the power can be switched ON or OFF from the front panel.

The input supply voltage, coming from the **Power on/off Switch**, is named: **+Supply** and it is used directly to source the two Current Generators. The **+Supply** voltage is also used as input to the two linear regulators, which are generating the two internal supply voltages: **+8V** and **+5V**.

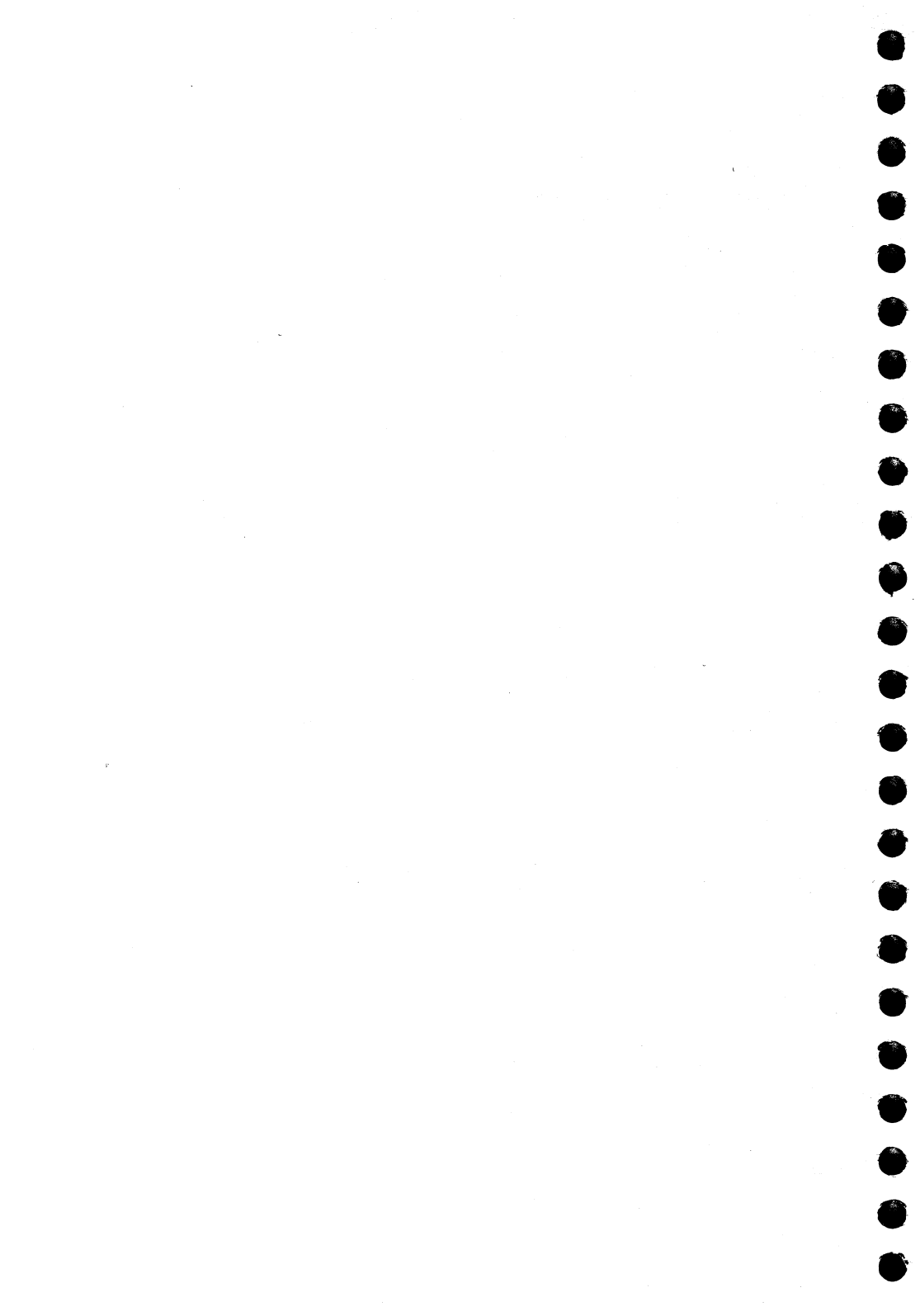
BLOCK DIAGRAM



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CONTENTS

2	INSTALLATION	2-1
2.1	INSTALLATION GUIDE	2-1
2.2	MOUNTING POSSIBILITIES, DIMENSIONS AND DRILLING PLAN	2-2
2.3	POWER SOURCE	2-4
2.4	ENABLING OF THE REAR CHARGE POSITION	2-9



2 INSTALLATION

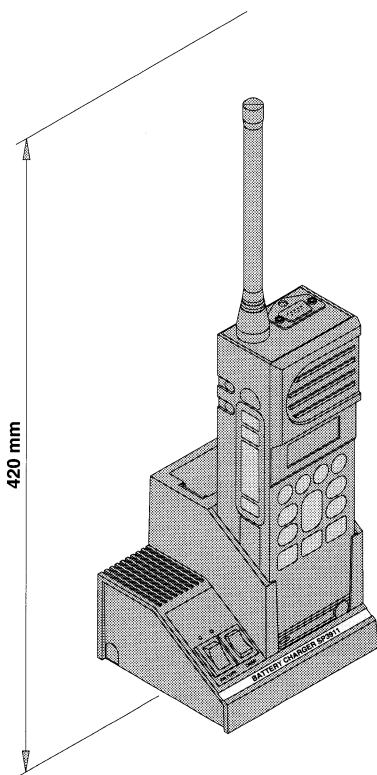
2.1 INSTALLATION GUIDE

- 1: Select a good place for mounting the **14 Hours NiCd Battery Charger** with sufficient free space above to ensure that the hand portable VHF/UHF transceiver can be placed in the Front Charge Position of the charger without problems. Look up section 2.2, MOUNTING POSSIBILITIES, DIMENSIONS AND DRILLING PLAN, for the physical dimensions of the charger inclusive the hand portable VHF/UHF transceiver.
- 2: Remove the plastics top as indicated in chapter 4, MECHANICAL DISASSEMBLING.
- 3: Mount the aluminium chassis onto a wall/bulkhead or on a table top, as shown in section 2.2, MOUNTING POSSIBILITIES, DIMENSIONS AND DRILLING PLAN.
- 4: Connect the power source to the unit as described in section 2.3, POWER SOURCE. (110/120 VAC, 220/240 VAC or 10.8-32 VDC)
- 5: Fasten the power supply cable by means of the strain relieve. If the diameter of the power supply cable is more than 4 mm, then please use the two M3x12mm screws, supplied in an antistatic plastics bag located inside the equipment package.
- 6: Program the strap field for AC or DC power supply.
- 7: If the Rear Charge Position is wanted for charging purpose, then look up section 2.4, ENABLING OF THE REAR CHARGER POSITION, for proper instructions.
- 8: Assemble the charger by pressing the plastics top gently downwards until the female connector inside the plastics top is connected to the male connector at the PCB. Be aware of the two LED's!!

2.2 MOUNTING POSSIBILITIES, DIMENSIONS AND DRILLING PLAN

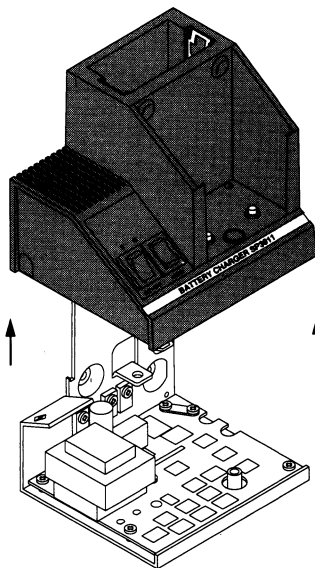
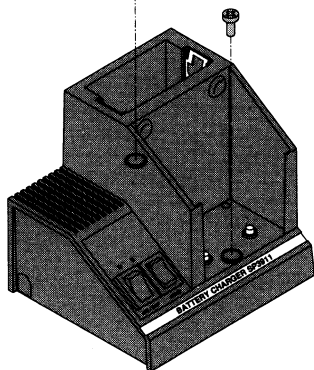
The **14 Hours NiCd Battery Charger** is very flexibel and easy to install. It can be mounted onto a wall/Bulkhead or on a table top. The Battery Charger is fixed by means of three screws in the Bulkhead case and two screws in the table top case. The screws are all included in an antistatic plastics bag located inside the equipment package.

The mounting possibilities are described below by means of mechanical figures with the corresponding dimensions.

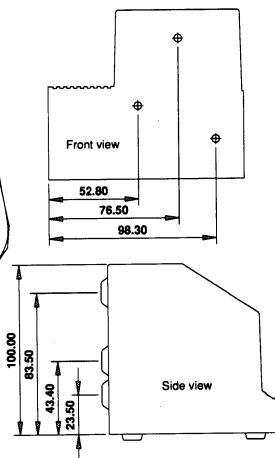
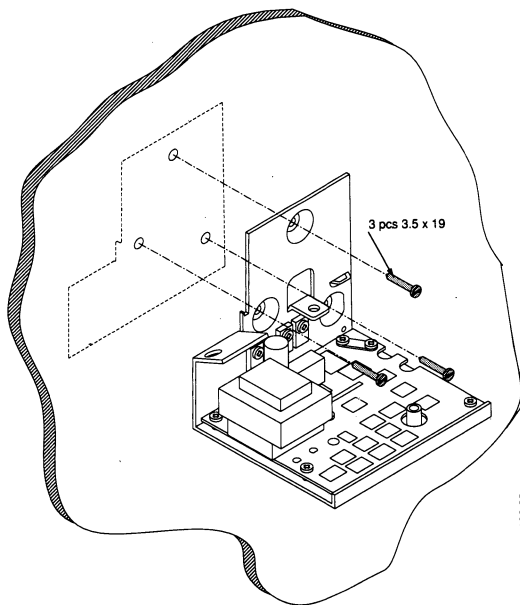


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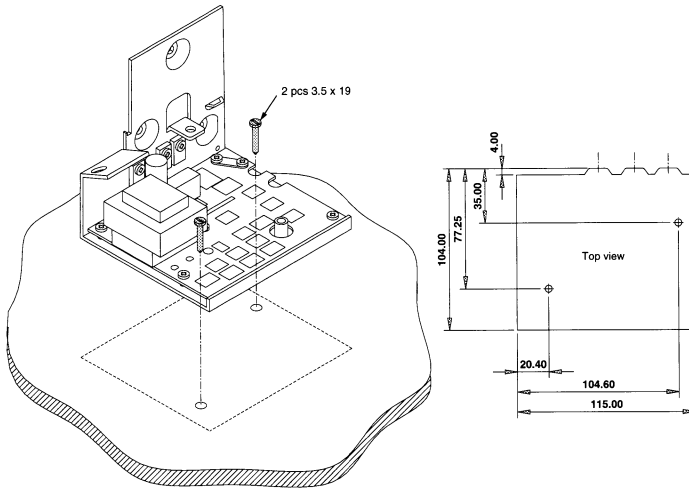
2 pcs M4 x 12



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BULKHEAD MOUNTING

28603

TABLE TOP MOUNTING

28602

2.3 POWER SOURCE

The **14 hours NiCd Battery Charger** can be supplied from both DC and AC power sources. The usable voltages are listed below:

AC	220/240V	FACTORY SET
AC	110/120V	
DC	10.8 - 32V	

How to strap for these three different power sources are described below and the corresponding schematic diagrams and component locations are shown on the following pages.

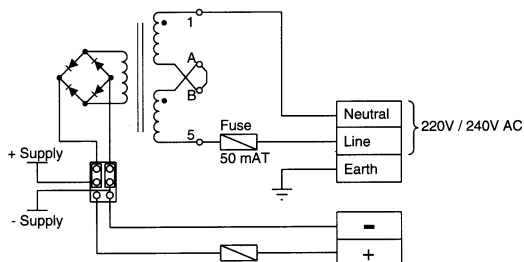
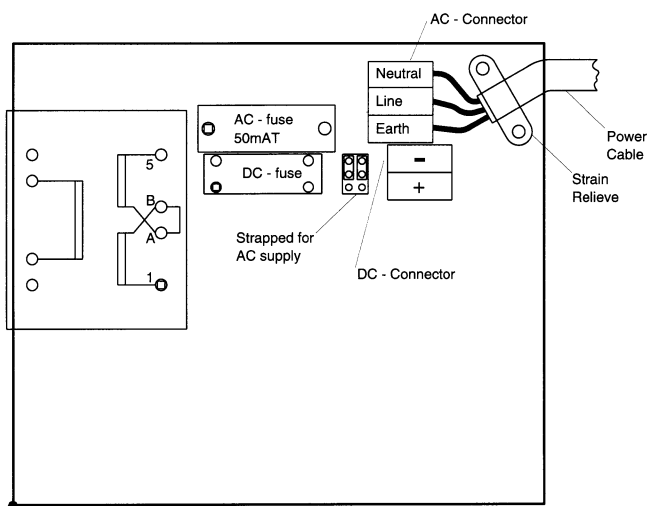
220/240 VAC SOURCE

NOTE! The **14 Hours Battery Charger** is factory strapped for 220/240 VAC source, so normally it is only necessary to connect the power cable to the AC power connector inside the battery charger.

- 1: Remove the Printed Circuit Board (PCB) from the aluminium chassis.

- 2: Connect pin A to pin B on the transformer.
- 3: Disconnect pin 1 from pin A and pin 5 from pin B on the transformer.
- 4: Assemble the PCB and the aluminium chassis.
- 5: Change the AC fuse F1 to 50mAT.
- 6: Program the strap field for AC power supply. Refer the schematic diagram and component location below.
- 7: Connect the power cable to the AC-connector as indicated on the component location below **and** fasten the power cable by means of the strain relieve.

NOTE! The unit may be safeguarded by connecting an earth wire to the earth terminal.

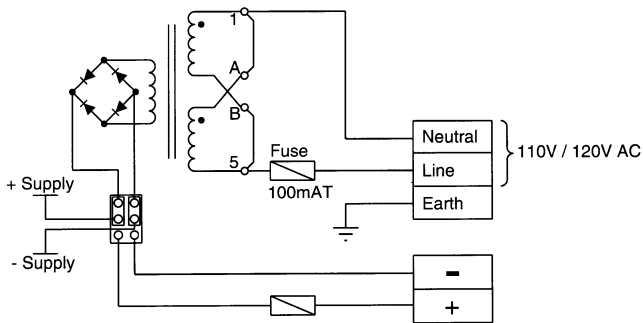
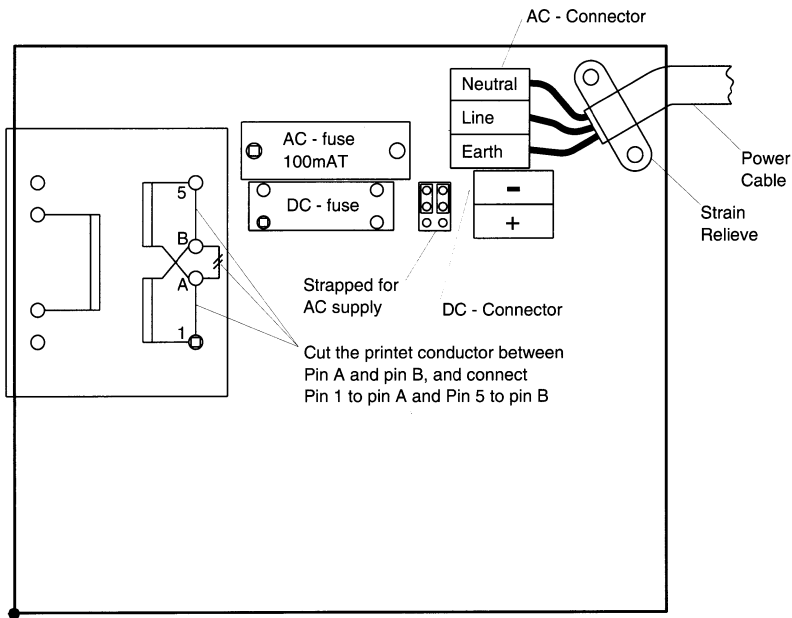


110/120 VAC SOURCE

NOTE! The mains transformer in the first 100 units was not prepared for 110/120V operation. To check whether the transformer in the actual case is able to operate on these voltages, please look at the date code of the transformer, which must be week 50 and year 92 **or** later.

- 1: Remove the Printed Circuit Board (PCB) from the aluminium chassis.
- 2: Disconnect the electrical connection between pin A and pin B on the transformer, by cutting the printed circuit wire on the rear side of the PCB.
- 3: Connect pin 1 to pin A and pin 5 to pin B on the transformer by means of two pieces of wire.
- 4: Assemble the PCB and the aluminium chassis.
- 5: Change the AC fuse F1 to 100mAT.
The 100mAT fuse is supplied together with the Battery Charger and is located inside it, in an antistatic plastics bag.
- 6: Program the strap field for AC power supply. Refer the schematic diagram and component location on next page.
- 7: Connect the power cable to the AC-connector as indicated on the component location on next page **and** fasten the power cable by means of the strain relieve.

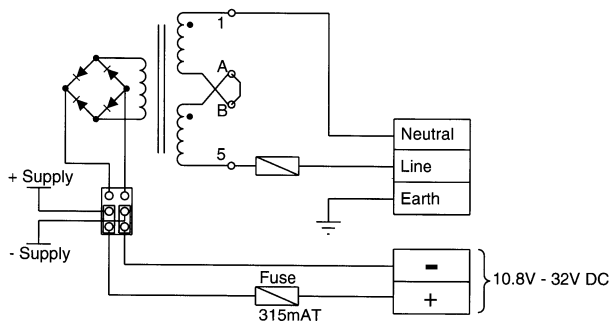
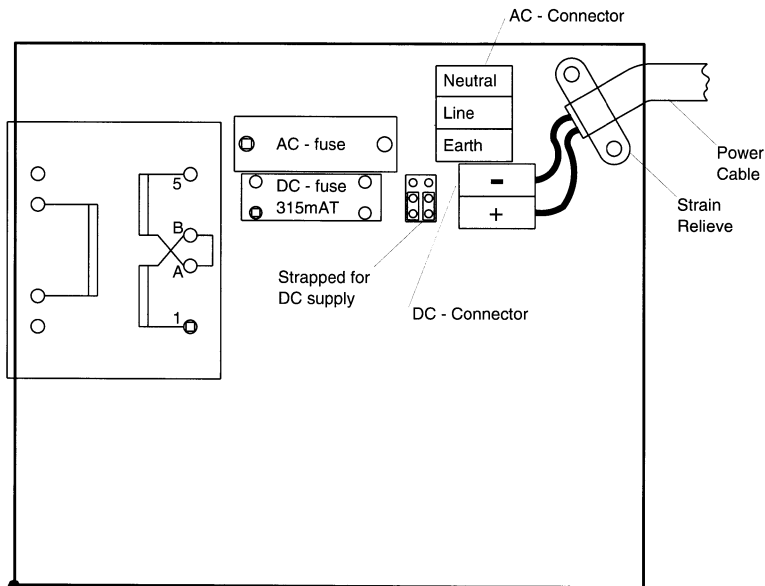
NOTE! The unit may be safeguarded by connecting an earth wire to the earth terminal.



28586

10.8 - 32 VDC SOURCE

- 1: Program the strap field for DC power supply. Refer the schematic diagram and component location on this page.
- 2: Connect the power cable to the DC-connector as indicated on the component location on this page **and** fasten the power cable by means of the strain relieve.

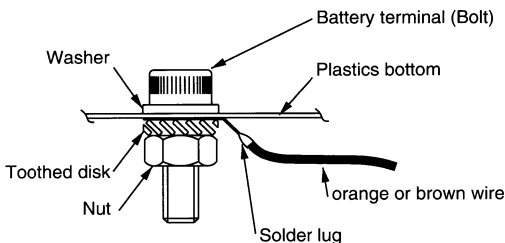


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2.4 ENABLING OF THE REAR CHARGE POSITION

The **14 Hours Battery Charger** is constructed with two charge positions, which are the **Front Charge Position** and the **Rear Charge Position**. Only the front position is enabled from the factory, but the rear position can easily be enabled by following the description below.

- 1: Remove the plastics top as indicated in chapter 4, MECHANICAL DISASSEMBLING.
- 2: Replace the two black plastics plugs in the Rear Charge Position with two battery terminals.
The two plastics plugs are located at the bottom of the Rear Charge Position inside the plastics top.
The two battery terminals and the corresponding washers and nuts are all included in an antistatic plastics bag, which is located inside the plastics top. (Terminal Kit No: 728513)
Refer the figure below for proper installation.
- 3: Remove the plastics protection from the **orange** and **brown** wire.
- 4: Connect the **orange** wire to the **plus-terminal** and the **brown** wire to the **minus-terminal**. The plus- and minus- terminals are indicated by the signs: “+” and “-”, casted into the plastics top.
- 5: The **Rear Charge Position** is now enabled and the Battery Charger can now be assembled by pressing the plastics top gently downwards until the female connector inside the plastics top is connected to the male connector at the Printed Circuit Board.



Cross section of the plastics top, showing how to mount one of the two battery terminals in the **Rear Charge Position**.



CONTENTS

3	SERVICE	3-1
3.1	MAINTENANCE	3-1
3.2	PROPOSAL FOR NECESSARY TEST EQUIPMENT	3-1
3.3	TROUBLE SHOOTING	3-2
3.4	PERFORMANCE CHECK	3-4
3.5	REPLACEMENT OF COMPONENTS	3-6
3.6	PIN CONFIGURATIONS	3-7

3 SERVICE

3.1 MAINTENANCE

PREVENTIVE MAINTENANCE

If the **14 Hours NiCd Battery Charger** has been installed in a proper way, the only maintenance needed is to keep the charge terminals dry and clean.

However, we will recommend you to make a performance check at intervals, not exceeding 24 months, **or** at least every time the NiCd battery is replaced with a new one.

A complete performance check is very easy to perform and the check procedure needed is enclosed in chapter 3.4 in this manual.

3.2 PROPOSAL FOR NECESSARY TEST EQUIPMENT

For service and performance check, we will recommend you the equipment listed below or equipment with equal parameters.

OSCILLOSCOPE:

Bandwidth	DC-35 MHz
Sensitivity	2mV/div
Input Impedance	1 Mohm//20 pF
E.g. Philips type	PM 3216

PASSIVE PROBE:

Attenuatin	20 dB
Input Impedance	10 Mohm//15 pF
Compensation Range	10-30 pF
E.g. Philips type	PM8936/091

MULTIMETER:

Input Impedance	10 Mohm
Accuracy DC (full scale deflection)	1.5%
E.g. Philips type	PM2505

3.3 TROUBLE SHOOTING

GENERAL

Trouble shooting should only be performed by persons with sufficient technical knowledge, who have the necessary test equipments at their disposal, and who have carefully studied the principle of operation of the **14 Hours NiCd Battery Charger**.

The first thing to check is whether the fault can be located to the battery, the power source or inside the Battery Charger it self.

In order to help you during trouble shooting, the section 5. CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS contains schematic diagrams, principle of operations, and drawings showing the location of the individual components. In addition, please read the hint given below, which will help you to make measurements while the Battery Charger is operating.

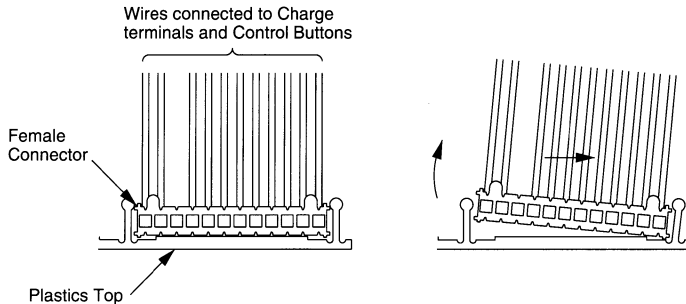
When measuring inside the unit, short circuits must be avoided, because this may damage transistors, diodes and integrated circuit outputs.

CAUTION! *HIGH VOLTAGE INSIDE THE BATTERY CHARGER - If the Battery Charger is supplied from an AC-source, there will still be power at the high voltage part, even though the power is turned off by means of the power 'ON/OFF' button. However, this fact should not give any problems in servicing, because the transformer and the AC fuse are electrical isolated and all high voltage printed wires are hidden away on the lower side of the PCB.*

HINT

To help you during trouble shooting and performance check, it is possible to disassemble the Battery Charger and still keep it operating. To obtain this feature please disassemble the Battery Charger by removing the plastics top from the aluminium chassis. Then take apart the female connector and the plastics top, which is done as indicated in the figure below. Now place the plastics top to the right or in front of the Battery Charger and connect the female connector to the male connector at the PCB. The cable from the PCB to the plastics top is produced with wires, which are longer than needed for normal operation. This feature makes it possible to measure inside the Battery Charger, while it is operated from

the buttons at the plastics top and while the battery is charged in its normal position.



28590

Instruction of how to take apart the female connector and the plastics top. The plastics top is seen from the bottom side.

BATTERY CHECK

If you have tried to charge a battery several times without any success, we will recommend you to check the battery before you use a lot of energy to trouble shoot inside the Battery Charger.

To check the battery, please look for two possible failures, which are described below:

1: Problem:

The Reed-switch inside the battery is not activated by the magnet, located inside the plastics top in the bottom of the Front Charge Position.

Test procedure:

To check this type of failure, you have to disassemble the Battery Charger as described by the hint, just given on the previous page. Then place the battery in the Front Charge Position and make sure that the Battery Charger is turned off, by means of the power "ON/OFF" - button. Now measure the voltage between pin 4 (yellow wire = minus terminal) and pin 6 (blue wire = plus terminal) of the female connector. If the measured voltage is **not** equal to the battery voltage, you should inspect the Reed-switch/ Magnet-system.

2: Problem:

One or more battery cells are short circuited inside the battery.

Test procedure:

Measure the unloaded battery voltage, which must be approx. 7.2V. A battery consist of six series connected cells, having a voltage of 1.2V. If one of the cells is short circuited, you will only measure an unloaded battery voltage of approx. 6.0V.

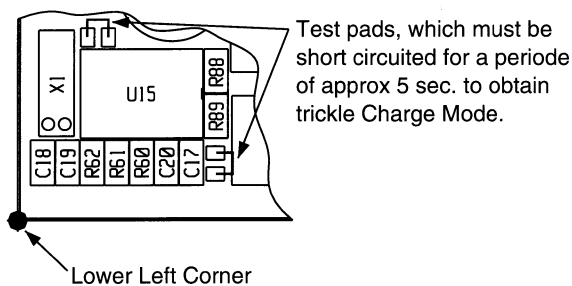
3.4 PERFORMANCE CHECK

PERFORMANCE CHECK OF THE FRONT POSITION BATTERY CHARGER

The performance of the Front Position Battery Charger is checked by starting a charge cycle and then determine the charge current by measuring the voltage drop across the current sense resistor. The Trickle Charge Mode is obtained by short circuiting two sets of test pads in the clock oscillator & divider circuit.

- 1: Disassemble the Battery Charger as described by the hint given in section 3.3.
- 2: Place a 700mAh battery in the Front Charge Position and press the 'CHAR' button downwards.
- 3: Check that the Light Emitting Diode (LED) to the left is turned on with a red coloured light.
- 4: Measure the voltage across the sense resistor R18 (4.7 ohm) and check that the voltage is 329mV +/- 10%, which corresponds to a current of 70mA +/- 10%.
- 5: Short circuit the two sets of test pads shown below for a periode of approx. 5 Secs.
- 6: Check that the LED to the left flashes with a green coloured light, indicating the tricle charge mode.
- 7: Measure the voltage across the sense resistor R18 (4.7 ohm) and check that the voltage is 131.6mV +/- 10%, which corresponds to a current of 28mA +/- 10%.

- 8: Press the 'DIM' button upwards and check that the LED is turned off.
- 9: Press the 'DIM' button upwards and check that the LED is turned on again.
- 10: If a 1200mAh battery is available, then place it in the Front Charge Position and press the 'CHAR' button downwards.
- 11: Repeat points 3 to 9 incl. and check that the measured voltages are 564mV +/- 10% and 225.6mV +/- 10%, which corresponds to currents with nominal values of 120mA and 48mA.



28591

PERFORMANCE CHECK OF THE REAR POSITION BATTERY CHARGER

The performance of the Rear Position Battery Charger is checked according to the procedure given below, which is almost equal to the procedure for the Front Position Battery Charger.

- 1: Disassemble the Battery Charger as described by the hint given in section 3.3.
- 2: Place a 700mAh battery in the Rear Charge Position.
- 3: Check that the Light Emitting Diode (LED) to the right is turned on with a red coloured light.

- 4: Measure the voltage across the sense resistor R46 (4.7 ohm) and check that the voltage is 329mV +/- 10%, which corresponds to a current of 70mA +/- 10%.
- 5: Short circuit the two sets of test pads shown above, for a periode of approx. 5 Secs.
- 6: Check that the LED to the right flashes with a green coloured light, indicating the tricle charge mode.
- 7: Measure the voltage across the sense resistor R46 (4.7 ohm) and check that the voltage is 131.6mV +/- 10%, which corresponds to a current of 28mA +/- 10%.
- 8: Press the 'DIM' button upwards and check that the LED is turned off.
- 9: Press the 'DIM' button upwards and check that the LED is turned on again.
- 10: If a 1200mAh battery is available, then place it in the Rear Charge Position.
- 11: Repeat points 3 to 9 incl. and check that the measured voltages are 564mV +/- 10% and 225.6mV +/- 10%, which corresponds to currents with nominal values of 120mA and 48mA.

3.5 REPLACEMENT OF COMPONENTS

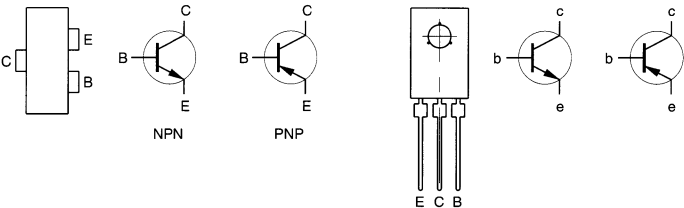
When replacing integreted circuits, transistors, diodes, resistors, capacitors and similar components you must use a small "pencil" soldering iron with a maximum temperature of 300°C (572°F). The soildering must be performed rapidly to avoid superheating and the use of a desoldering wire is recommended, as otherwise there is a risk that both the components and the printed circuit board will be spoiled.

3.6 PIN CONFIGURATIONS

TRANSISTOR:

BC848B, BC858B, BFR92A (SOT-23 CASE)

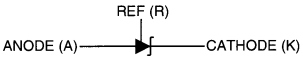
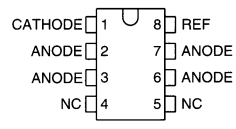
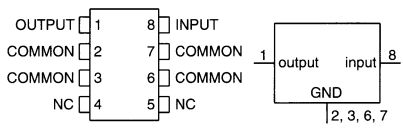
BD139, BD140 (TO-126 CASE)



VOLTAGE REGULATOR and VOLTAGE REFERENCE:

78L05 (SO-8 PACKAGE)

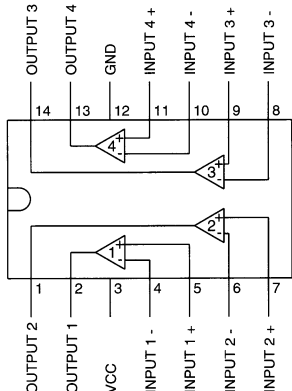
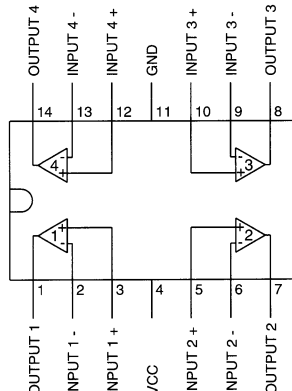
TL431C



INTEGRATED CIRCUIT, ANALOG:

LM324 (SO-8 PACKAGE)

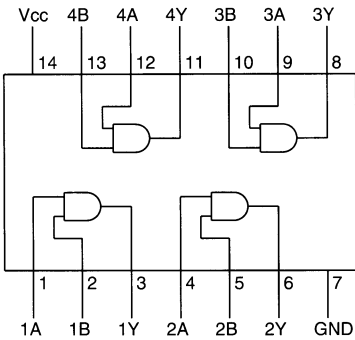
LM339 (SO-8 PACKAGE)



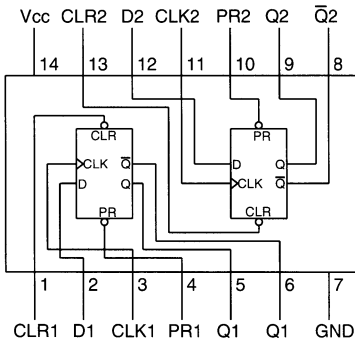
28596

INTEGRATED CIRCUIT, DIGITAL:

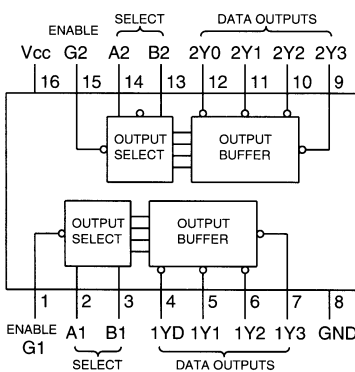
74HC08 (SO-14 PACKAGE)



74HC74 (SO-14 PACKAGE)



74HC139 (SO-16 PACKAGE)

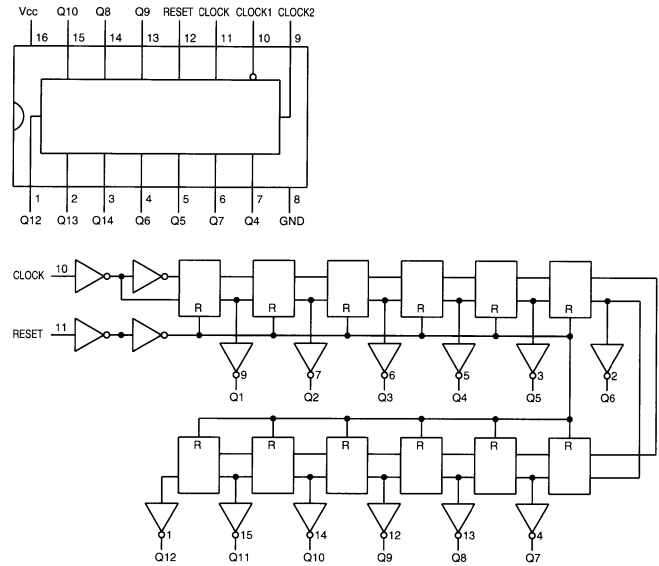


Inputs			Outputs			
Enable	Select					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

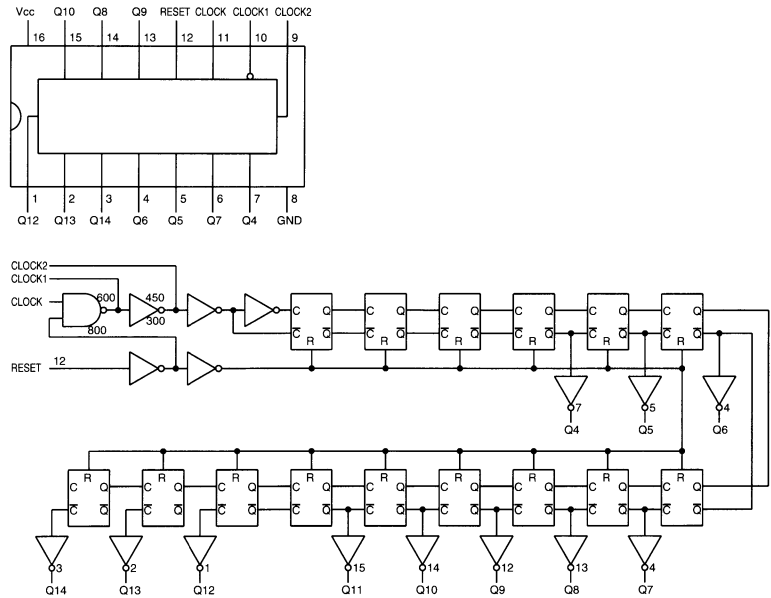
H=high level, L=low level, X=don't care

28597

74HC4040 (SO-16 PACKAGE)



74HC4060 (SO-16 PACKAGE)



28598

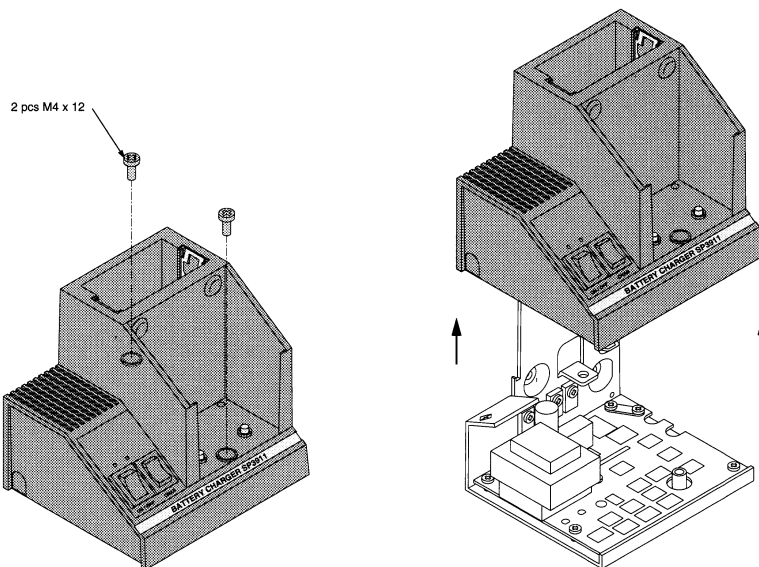


CONTENTS

4	MECHANICAL DESCRIPTION	4-1
4.1	MECHANICAL ASSEMBLING / DISASSEMBLING	4-1

4 MECHANICAL DESCRIPTION

4.1 MECHANICAL ASSEMBLING / DISASSEMBLING



28600



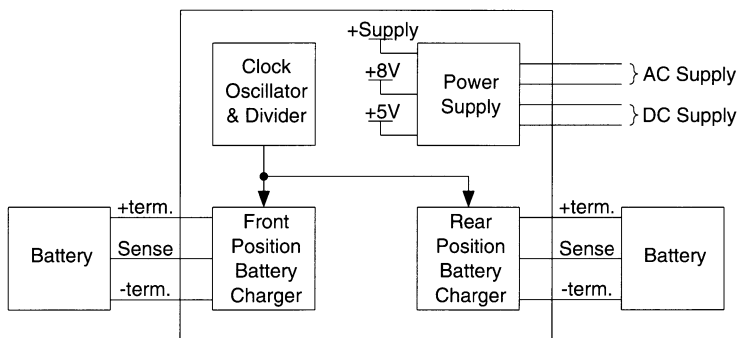
CONTENTS

5	CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM	5-1
5.1	CIRCUIT DESCRIPTION	5-1

5 CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM

5.1 CIRCUIT DESCRIPTION

The **14 Hours NiCd Battery Charger** can be divided into four separate blocks as indicated in the simplified block diagram below.



28592

The four blocks contains a number of subcircuits, which are described in details in this chapter. These subcircuits are listed below:

CLOCK OSCILLATOR & DIVIDER

Gate oscillator

Divider circuit

POWER SUPPLY

AC/DC converter

AC/DC strap field

8V regulator

5V regulator

FRONT POSITION BATTERY CHARGER

Battery in front position detect

Battery type detect

Power on reset

Current generator

Reference voltage control

Charge current detect

14 hours counter

LED control logic

Dimmer circuit

Charge switch

REAR POSITION BATTERY CHARGER

Battery in rear position detect
Battery type detect
Power on reset
Current generator
Reference voltage control
Charge current detect
14 hours counter
LED control logic
Dimmer circuit

As it can be seen from the list above, is the **Rear Position Battery Charger** almost a complete copy of the **Front Position Battery Charger**. The only difference between the two circuits is the **Charge Switch**, which is only included in the front position. All the duplicated subcircuits are of course only described once and the **Front Position Battery Charger** is used as the basis for this description.

BATTERY IN FRONT POSITION DETECT

The circuit used to detect the presence of a battery in the front position is build-up around the voltage comparator U9.1. The output voltage is used to enable or disable the function of the **Charge Switch** and thereby control the on/off function of the **Current Generator**.

The input voltage to the minus terminal of the comparator is generated by a voltage divider, which is formed by the pull-up resistor R31 and the sense resistor inside the battery. The plus terminal of the comparator is used for the reference voltage, which is programmed to approx. 4.7V by voltage division of +5V.

The voltage comparator has an input hysteresis of approx. 100mV, which is determine by the feed back resistor R24.

When a battery is placed in the front position, the input voltage to the minus terminal will be decreased from +5V to a voltage in the range from 1.6V to 4.1V, depending on the type of battery.

The voltage at the minus terminal will now be lower than the voltage at the plus terminal and the output will change from logic low to high.

If the **14 Hours NiCd Battery Charger** is vibrated, it may lose the connection to the battery in some short moments, because of the

springy charge terminals. This will instantly cause the output signal from the comparator to change a number of times from logic high to low and vice versa. To avoid that this fluctuation will clear the output of the **Charge Switch Circuit** and thereby turn off the charge current, the output of the comparator U9.1 is followed by a hold circuit. This hold circuit is build-up around the diode D10, the resistor R66 and the capacitor C21.

BATTERY TYPE DETECT

The batteries for the hand portable VHF/UHF transceiver is delivered in two types, which are characterized by their capacity - also called ampere-hour rating. The batteries have a capacity of 700mAh and 1200mAh.

The circuit to detect the battery type is build-up around the comparator U9.2 and is in principle identical to the circuit used for position detect. The input voltage is also the same, which means that the sense resistor inside the battery is used for detection of the battery type.

The sense resistor $R_{TYP,SENSE}$ is composed of a 1% resistor R_p and a NTC resistor R_{NTC} , which are connected in parallel with each other. The value of these resistors dependt on the battery type, which is indicated by the list below.

BATTERY TYPE	NTC (25°C)	R_p	$R_{typ.sense}$
700mAh	10k	12k7	5k59
1200mAh	100k	127k0	55k95

The voltage division between R31 (12k) and the sense resistor $R_{TYP,SENSE}$ will give an input voltage to the comparator, which is compared to the reference voltage of 2.56V at the plus terminal.

If a 700mAh battery is placed in the front position, it will give an input voltage to the minus terminal of 1.6V, which means that the output will go high. In the case of a 1200mAh battery, the input voltage to the minus terminal will be 4.1V, which will force the output to go low.

The output voltage is used as input to the **Reference Voltage Control**, which generates the reference voltage used to control the charge current.

POWER ON RESET

If a battery is placed in the front position and the power is turned on afterwards, the charge cycle may start by it self. This situation alone is of course unwanted, but it may furthermore result in an uncontrolled start of the **14 Hours Counter**. To avoid this situation, the circuit for position detect is followed by a **Power On Reset Circuit**, which is build-up around the AND-gate U4.1.

In the moment where the power is switched on, the second input port to the AND-gate is held at a low level for a periode of approx. 20msec. This time periode is determine by the RC-circuit, which is formed by the resistor R20 and the capacitor C8. The low input signal will, because of the AND-function, keep the output at a low level, irrespectively of the input signal from the **Battery in Front Position Detect**. The low output signal will then clear the **Charge Switch Circuit** and thereby reset the **14 Hours Counter**.

CHARGE SWITCH

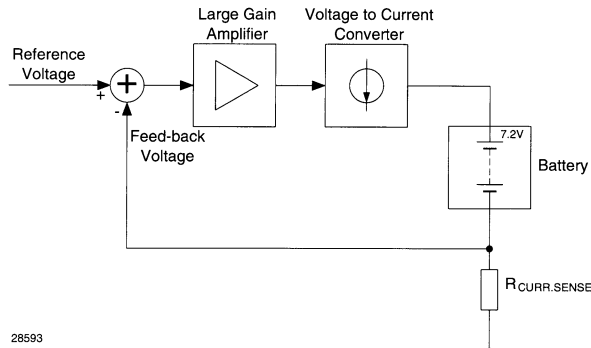
The **Charge Switch Circuit**, which is used to start the charge cycle at the front position, is build-up around the D-type FLIP-FLOP U16.2. The charge cycle is started by pressing the 'CHAR' button downwards and then release it. This will produce a positive going pulse, which is led to the clock input of the D-type FLIP-FLOP. The high input signal at the D-port is then clocked to the output and this will turn on the **Current Generator**.

Initially, when **no** battery is placed in the front position, the input signal to the CLEAR-pin is held at a low level. This will keep the output of the D-type FLIP-FLOP low, irrespectively of the clock input. If a battery is placed in the front position, the CLEAR signal will go high. This will enable the **Charge Switch** and the charge cycle can now be started.

The resistor R70 is used to pull-down the clock input port and the capacitor C27 works as a noise filter.

CURRENT GENERATOR

The **Current Generator** is constructed with a feed-back loop, which is shown by the block diagram below. The feed-back loop ensures that the charge current always is very close to the programmed value, independent of changes in semiconductors and supply voltage.



The charge current through the battery, will also runs through the Current Sense Resistor $R_{CURR.SENSE}$, which is located at the minus terminal of the battery. This will give rise to a voltage drop across $R_{CURR.SENSE}$, which is used as the feed-back signal. This feed-back signal is subtracted from the reference signal, which gives an error signal as result. The error signal is fed to the **Large Gain Amplifier**, where the signal is amplified approx. 500 times. The amplified output signal is then used to control the **Voltage to Current Converter**, which is generating the Charge Current.

The **Current Generator** is build-up around the operational amplifier U8.1 and the two transistors Q3 and Q4. The OP-AMP U8.1 is connected as a differential amplifier and it is therefore representing both the **Summing Device** and the **Large Gain Amplifier** in the block diagram. The two transistors Q3 and Q4 works as the **Voltage to Current Converter** and the resistor R18 (4.7 ohm) is used as the **Current Sense Resistor** $R_{CURR.SENSE}$.

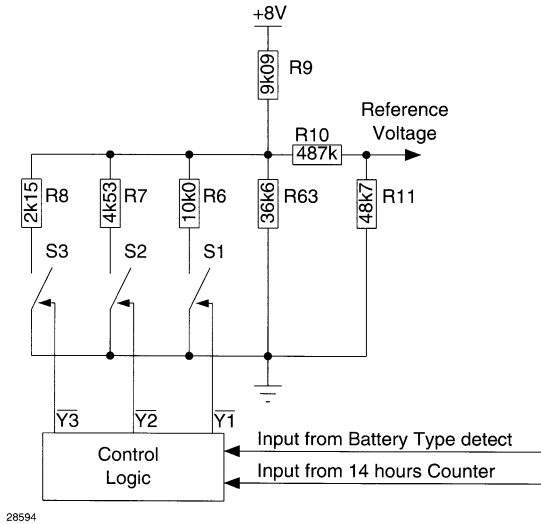
The diode D12 is a Schottky type with a low voltage drop and it ensures that the battery is **not** discharged through Q4 when the Battery Charger is turned off.

The transistor Q2 works as an electrical controlled switch for turning on/off the **Current Generator**. Initially, when **no** battery is placed in the front position, the transistor Q2 will be active. The transistor will then force a current to run through the resistors R12, R14 and R18. This will give an input voltage of approx. 2.3V to the inverting terminal at U8.1, while the reference voltage at the noninverting terminal only will be

564mV. The output from the OP-AMP will then be forced to a very low voltage, which will turn off the Charge Current.

REFERENCE VOLTAGE CONTROL

The magnitude of the charge current is determine by the reference voltage, which can be programmed to four different values. The reference voltage is generated by voltage division of the 8V supply voltage, where the value of the bottom resistor is changed by connecting different resistors in parallel with the resistor R63. The principle function of the circuit for **Reference Voltage Control** is described by the block diagram below.



The block called **Control Logic** is implemented by a **2-Line to 4-Line Decoder**, which is an IC of the type 74HC139. The switches S1, S2 and S3 are implemented by the three voltage comparators U7.1 - U7.3, which have an open collector output.

To see the connection between the magnitude of the charge current, the status of the switches and the two input signals to the **Control Logic**, please use the tabel below.

Input Comming From		Switches			Reference Voltage	Charge Current
Battery Type Detect	14 Hours Counter	S1	S2	S3		
0 (1200mAh)	0 (before 14h)	OFF	OFF	OFF	564mV	120mA
0 (1200mAh)	1 (after 14h)	OFF	ON	OFF	226mV	48mA
1 (700mAh)	0 (before 14h)	ON	OFF	OFF	329mV	70mA
1 (1200mAh)	1 (after 14h)	OFF	OFF	ON	132mV	28mA

As seen in the tabel, the reference voltage is in the range from 132mV to 564mV. These values are all in the same order of magnitude as the voltage drop across one of the output transistors in the voltage comparator LM339. This voltage drop is not very predictable and to avoid it from influence the reference voltage, it is camouflaged by the voltage divider consisting of the resistors R10 and R11. This voltage divider attenuate the signal, which is present at the node between the resistors R9 and R63. This signal is divided by a factor of 11, which means that it is 11 times higher than the reference voltage. The signal range is then from 1.5V to 6.2V and it is therefore fairly insensitive to changes in the output voltage drop from one comparator to another.

CHARGE CURRENT DETECT

The circuit for **Charge Current Detect** is used to check that the programmed charge current actually flows into the battery. The circuit is build-up around the voltage comparator U7.4 and the reference voltage at the minus terminal is generated by voltage division of the reference voltage used for the **Current Generator**. The input signal to the plus terminal is equal to the voltage drop across the **Current Sense Resistor** $R_{\text{CURR.SENSE}}$ and is therefore proportional to the Charge Current.

If the voltage drop across $R_{\text{CURR.SENSE}}$ is greater than the reference voltage at the minus terminal, the output will go high. This will indicate that a Charge Current with a certain minimum magnitude is flowing through the battery. The high output signal will start the **14 Hours Counter** and turn on the **red** charging indicator.

14 HOURS COUNTER

The **14 Hours Counter** is implemented by means of U6, which is a **12-Stage Binary Ripple Counter**. The input clock signal is called CLK2

5 CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM

SP3911

and it has a periode lenght of 16 seconds. This clock signal is divided by U6 to give the two output signals at pin 15 and pin 1. These signals will both go high after a time periode of 13 hours, 39 minutes and 12 seconds. This event will be detected by the AND-gate U4.2, which will change the non inverted output of the D-type FLIP-FLOP U3.1 from low to high by means of the clock input. The D-type FLIP-FLOP will then hold the information about the expired 14 hours time periode until it is cleared, which only will happen when the battery is removed from its charging position.

LED CONTROL LOGIC

The control of the LED's is performed by the two AND-gates U10.1 and U10.2.

The **red** LED will light, when the battery is charged with a normal charge current of 1/10 of the Ampere-hours rating.

The **green** LED is partly controlled by the clock signal CLK1 and it will flash, when the 14 hours time periode has past.

DIMMER CIRCUIT

The Dimmer function is implemented by the transistor Q9, which is located at the cathodes of the four LED's. When the transistor is turned on, the cathode of all LED's will be grounded and the activated LED's will light. Conversely, if the transistor is turned off, no current will runs through the LED's and all LED's will be turned off.

The transistor Q9 is controlled from the D-type FLIP-FLOP U16.1 by means of the inverted output, which also is feed back to the D-input. Initially the inverted output is high, because of the power on reset signal. But if the 'DIM'-button is pressed upwards and then released, the logic high signal at the D-input will be clocked to the non inverted output and the inverted output will then go low. This will turn off the transistor and thereby turn off all four LED's.

The D-input will now be low, because of the feed back from the inverted output. If the procedure, just described, is repeated, the inverted output will change once again and this time it will go high. The high signal at the inverted output will turn on the transistor and thereby turn on the activated LED's.

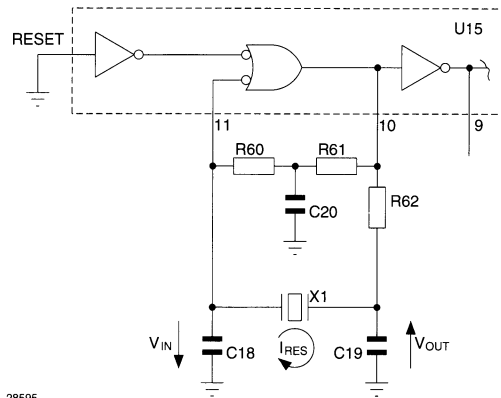
5 CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM

SP3911

The resistor R72 and the capacitor C24 is used to feed back the inverted output to the D-input. This RC-connection gives a delay function, which is used to remove chatter coming from the 'DIM'-switch.

GATE OSCILLATOR

The frequency of the **Gate Oscillator** is 32.768kHz, which is controlled by means of the crystal X1. The oscillator is build-up around the **14-Stage Binary Ripple Counter U15**, which include the gate used as the active element. The function of the oscillator is described by means of the circuit diagram below.



The active element in the oscillator is an OR-gate with inverted inputs, which gives a phase shift of 180° . To obtain oscillation, the phase shift around the entire loop must be 360° , which means that the phase shift through the feed back element must be 180° . This phase shift is obtained by the crystal X1, which forms a parallel resonance circuit together with the series connection of the two capacitors C18 and C19. At resonance the crystal acts as a coil and the current will then ripple between this "coil" and the series connection of C18 and C19. This is indicated in the figure above by the loop current called I_{RES} . It can now be seen that the voltage drop across C18 is shifted 180° compared to the voltage drop across C19, because the current I_{RES} runs through both C18 and C19.

The resistor R62 limits the power, which is dissipated in the effective series resistor of the crystal.

5 CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM

SP3911

The capacitor C20 and the two resistors R60 and R61 forms an low pass filter by which the input is biased from the output.

DIVIDER CIRCUIT

The **Divider Circuit** consist of the **14-Stage Binary Ripple Counter** U15 and the **12-Stage Binary Ripple Counter** U14. These circuits divide the frequency of the **Gate Oscillator** by $2^{15} = 32768$ and $2^{19} = 524288$, which gives the two clock signals, called CLK1 and CLK2.

The clock signal CLK1 has a periode length of one second and is used to control the flashing of the green LED's.

The clock signal CLK2 has a periode length of 16 seconds and is used as clock signal for the two **14 Hours Counters**.

AC/DC CONVERTER AND STRAP FIELD

The **AC/DC Converter** is constructed as a conventional converter, which use a transformer for down-conversion. This transformer can be used for both 110/120V and 220/240V, due to appropriate strapping.

The output AC voltage from the transformer is rectified by means of the diode brigde, which consist of the four diodes D1, D2, D3 and D4. The rectified voltage is then led to the **AC/DC Strap Field**, where the selection between AC and DC power source is performed. The selected power source is passed through the **Power ON/OFF Switch** to give an internally supply voltage, called: **+SUPPLY**.

8V SUPPLY

The **8V Supply** is generated from the **+SUPPLY** voltage by means of the series voltage regulator, which is build-up around the transistor Q1 and the voltage reference device, named U1.

The principple function of the regulator is that the output voltage is divided by the two resistors R2 and R3, which gives a voltage of 2.5V. If now the load current is reduced, the output voltage will increase, which will force the divided voltage to increase as well. The voltage reference device will then sink a higher current, which will decrease the voltage at the base of Q1 - due to higher voltage drop across R1. The lower voltage at the base of Q1 will then finally decrease the emitter

5 CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAM

SP3911

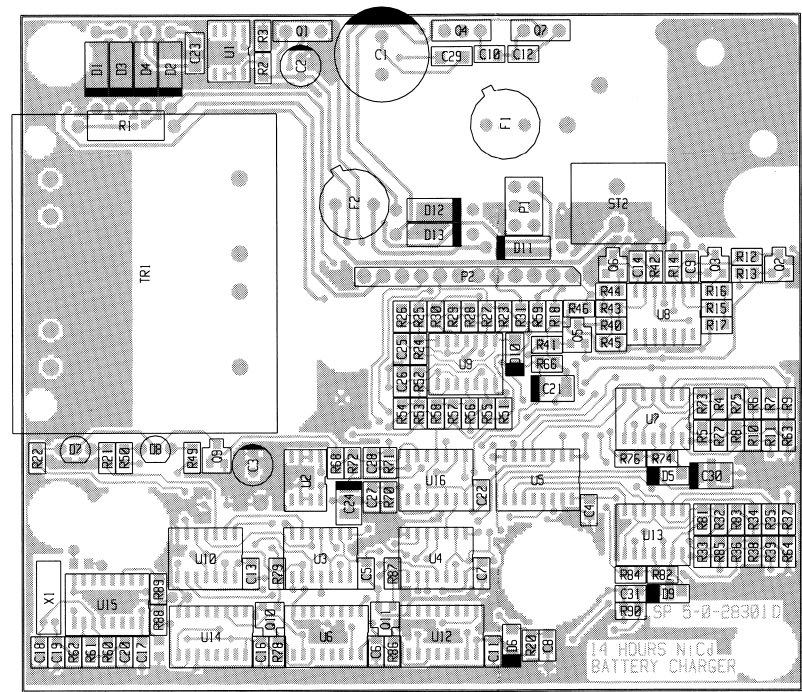
voltage and thereby the output voltage, because the base-emitter voltage is fixed to 0.7V.

5V SUPPLY

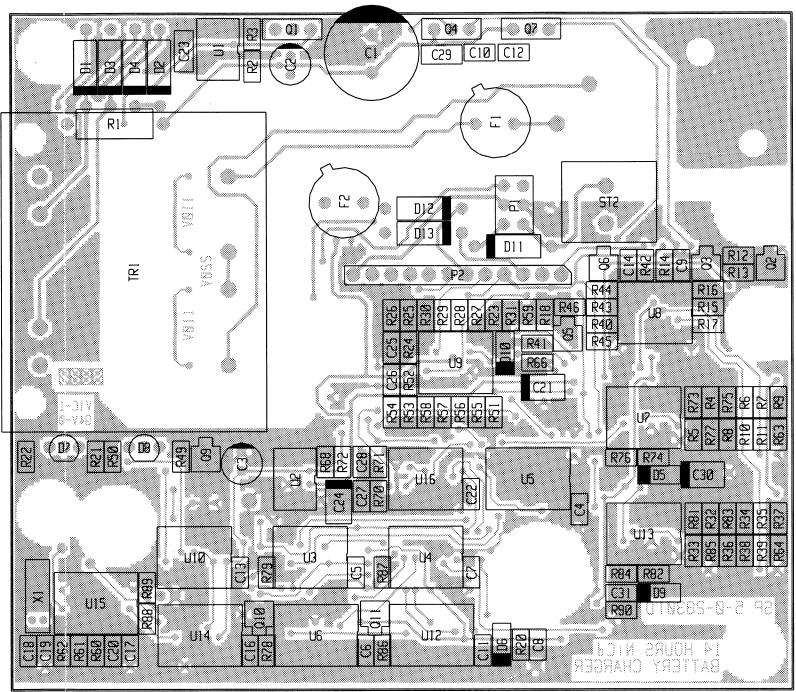
The 5V supply is generated from the **8V Supply** by means of the series voltage regulator U2.

This regulator is of the type 78L05AC, which is able to deliver a current of approx. 50mA without any heat sink.

COMPONENT LOCATION

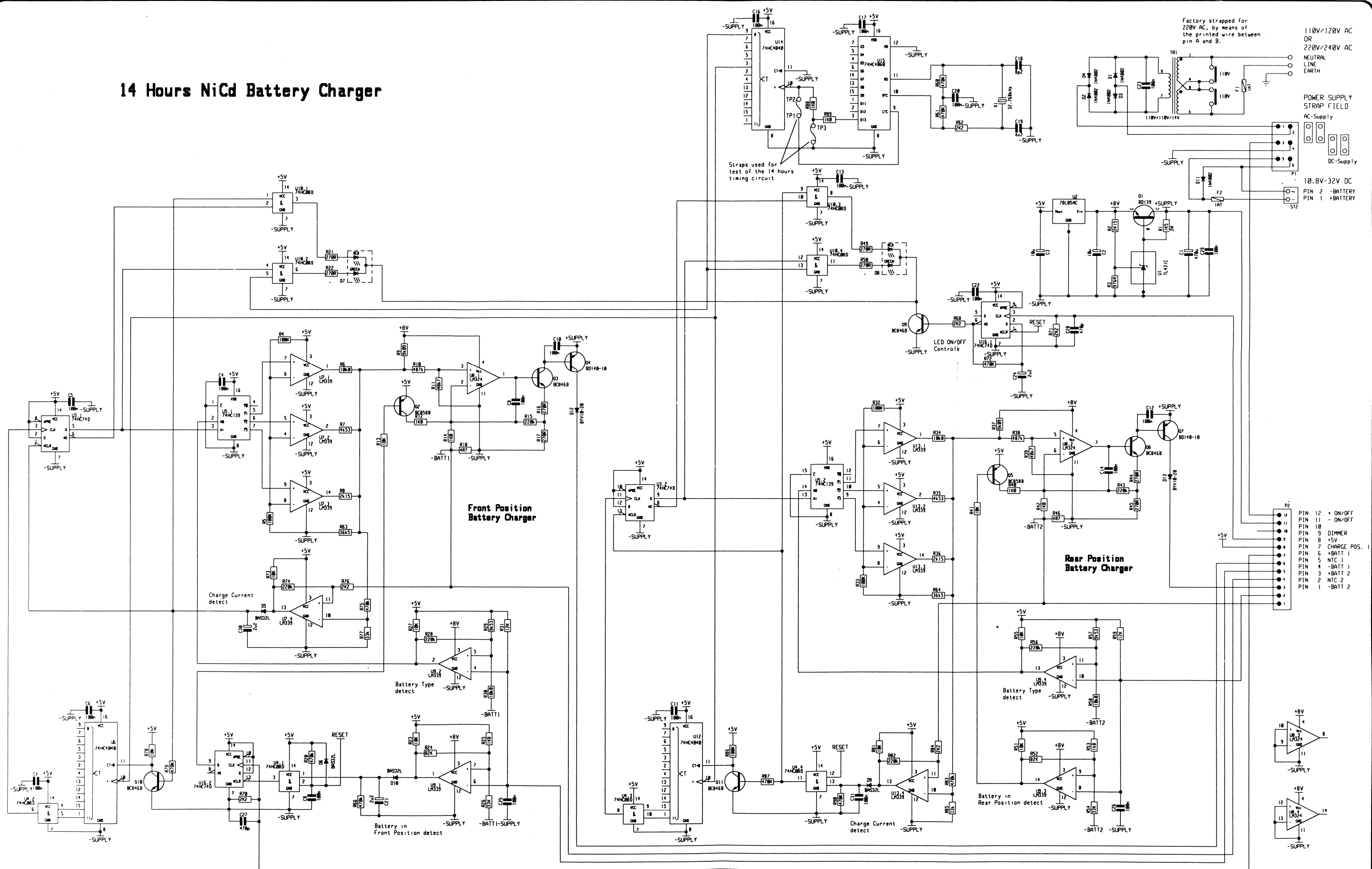


Seen from primary side with primary side tracks.
PCB rev. 28301D



Seen from primary side with secondary side tracks.

14 Hours NiCd Battery Charger

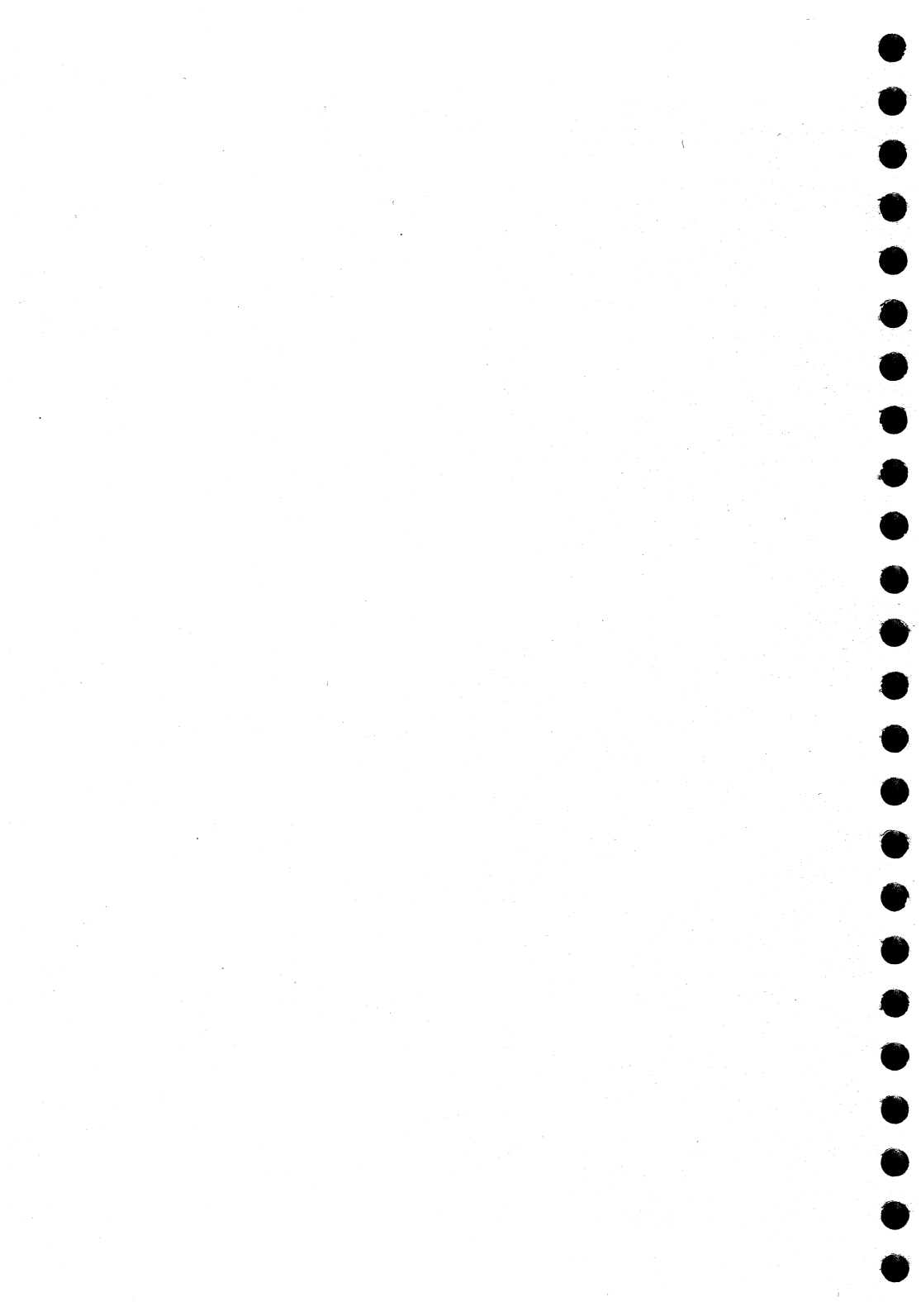


4-8-28301H

CONTENTS

6	PARTS LIST
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6-1



6 PARTS LIST

14 HOURS, 7.2V NiCd CHARGER, MODULE 1, SP3911

ECI A/S

4-6-28301E/4-0-28301H

628301

POSITION	DESCRIPTION		MANUFACTURER	TYPE	PART NO.
VARIOUS	SHUNT CONNECTOR	FEMALE 2 POLES	AMP	142270-1	78.325
VARIOUS	SOCKET 2 POLES FOR	TR5 TYPE FUSE	WICKMANN	Art.No.: 19 560	78.387
VARIOUS	SOLDER LUG		OJD	01016C	82.006
C1-1	CAPACITOR ELECTROLYTIC	470uF -20/+50% 40VDC	ERO	EKM 05 FG 347 G 05	14.650
C2-1	CAPACITOR ELECTROLYTIC	10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C3-1	CAPACITOR ELECTROLYTIC	10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C4-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C5-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C6-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C7-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C8-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C9-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C10-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C11-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C12-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C13-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C14-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C16-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C17-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C18-1	CAPACITOR CERAM. SMD 0805	8p2F +/-0.25pF NPO 50VDC	MURATA	GRM40 COG 8R2 C 50 PT	323.073
C19-1	CAPACITOR CERAM. SMD 0805	4n7F 10% X7R 50VDC	TDK	C2012 X7R 1H 472 K T NiBa	328.332
C20-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C21-1	CAPACITOR TANTALUM 3528	2u2F 20% 16VDC	ERO	CB 225020 M E17	334.028
C22-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C23-1	CAPACITOR CERAM. SMD 1206	100nF 10% X7R 50VDC	MURATA	GRM42-6 X7R 104 K 50 PT	328.648
C24-1	CAPACITOR TANTALUM 3528	2u2F 20% 16VDC	ERO	CB 225020 M E17	334.028
C25-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C26-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
C27-1	CAPACITOR CERAM. SMD 0805	470pF 10% X7R 50VDC	MURATA	GRM40 X7R 471 K 50 PT	328.320
C28-1	CAPACITOR CERAM. SMD 0805	470pF 10% X7R 50VDC	MURATA	GRM40 X7R 471 K 50 PT	328.320
C29-1	CAPACITOR CERAM. SMD 1206	100nF 10% X7R 50VDC	MURATA	GRM42-6 X7R 104 K 50 PT	328.648
C30-1	CAPACITOR TANTALUM 3528	2u2F 20% 16VDC	ERO	CB 225020 M E17	334.028
C31-1	CAPACITOR CERAM. SMD 0805	100nF 10% X7R 25VDC	MURATA	GRM40 X7R 104 K 25 PT	328.348
D1-1	DIODE RECTIFIER	1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)JRL	25.100
D2-1	DIODE RECTIFIER	1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)JRL	25.100
D3-1	DIODE RECTIFIER	1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)JRL	25.100
D4-1	DIODE RECTIFIER	1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)JRL	25.100
D5-1	DIODE SMALL SIGNAL	SOD-80 BAS32L	PHILIPS	BAS32L	340.032
D6-1	DIODE SMALL SIGNAL	SOD-80 BAS32L	PHILIPS	BAS32L	340.032
D7-1	DIODE LIGHT EMITTING	DUAL RED/GREEN *3mm	STANLEY	VRPG3312X	25.690
D8-1	DIODE LIGHT EMITTING	DUAL RED/GREEN *3mm	STANLEY	VRPG3312X	25.690
D9-1	DIODE SMALL SIGNAL	SOD-80 BAS32L	PHILIPS	BAS32L	340.032
D10-1	DIODE SMALL SIGNAL	SOD-80 BAS32L	PHILIPS	BAS32L	340.032
D11-1	DIODE RECTIFIER	1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)JRL	25.100
D12-1	DIODE SCHOTTKY	20VDC/1A	MOTOROLA	1N5817 (1N5818 1N5819)JRL	27.610
D13-1	DIODE SCHOTTKY	20VDC/1A	MOTOROLA	1N5817 (1N5818 1N5819)JRL	27.610
F1-1	FUSE TIME LAG 100mA	PCB VERSION	WICKMANN	TR5-T No. 19372K 100mA	45.704
F2-1	FUSE TIME LAG 315mA	PCB VERSION	WICKMANN	TR5-T No. 19372K 315mA	45.707
P1-1	PLUG	1/10" DIL SQ.PINS 6 POLES	AMP	826656-3	78.340
P2-1	2.5mm SIL SQ.PINS	12 POLES	MOLEX	22-03-1121	78.354
Q1-1	TRANSISTOR AF POWER NPN	BD139-10	PHILIPS	BD139-10	29.062
Q2-1	TRANSISTOR AF SMALL SIGN	SOT23 BC858B	MOTOROLA	BC858BT1 (T3)	345.058
Q3-1	TRANSISTOR AF NPN SOT-23	BC846B	MOTOROLA	BC846B	345.046
Q4-1	TRANSISTOR	BD140-10	PHILIPS	BD140-10	29.066

6 PARTSLIST

SP3911

POSITION	DESCRIPTION	MANUFACTUR	TYPE	PART NO.
Q5-1	TRANSISTOR AF SMALL SIGN	SOT23 BC858B	MOTOROLA	BC858BT1 (T3) 345.058
Q6-1	TRANSISTOR AF NPN SOT-23	BC846B	MOTOROLA	BC846B 345.046
Q7-1	TRANSISTOR	BD140-10	PHILIPS	BD140-10 29.066
Q9-1	TRANSISTOR AF NPN SOT-23	BC846B	MOTOROLA	BC846B 345.046
Q10-1	TRANSISTOR AF NPN SOT-23	BC846B	MOTOROLA	BC846B 345.046
Q11-1	TRANSISTOR AF NPN SOT-23	BC846B	MOTOROLA	BC846B 345.046
R1-1	RESISTOR PMF	1k5 OHM 5% 2W	PHILIPS	2322 194 13152 04.204
R2-1	RESISTOR SMD 0805	2k15 OHM 1% 50mW	PHILIPS	2322 734 2/62152 302.402
R3-1	RESISTOR SMD 0805	976 OHM 1% 50mW	PHILIPS	2322 734 2/69761 302.365
R4-1	RESISTOR SMD 0805	100k OHM 5% 0.1W	ROHM	MCR 10 EZH J 104 302.072
R5-1	RESISTOR SMD 0805	100k OHM 5% 0.1W	ROHM	MCR 10 EZH J 104 302.072
R6-1	RESISTOR SMD 0805	10k0 OHM 1% 50mW	PHILIPS	2322 734 2/61003 302.470
R7-1	RESISTOR SMD 0805	4k53 OHM 1% 50mW	PHILIPS	2322 734 2/64532 302.433
R8-1	RESISTOR SMD 0805	2k15 OHM 1% 50mW	PHILIPS	2322 734 2/62152 302.402
R9-1	RESISTOR SMD 0805	9k09 OHM 1% 50mW	PHILIPS	2322 734 2/69092 302.462
R10-1	RESISTOR SMD 0805	487k OHM 1% 50mW	PHILIPS	2322 734 2/64874 302.636
R11-1	RESISTOR SMD 0805	48k7 OHM 1% 50mW	PHILIPS	2322 734 2/64873 302.536
R12-1	RESISTOR SMD 0805	1k0 OHM 5% 0.1W	ROHM	MCR 10 EZH J 102 302.048
R13-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103 302.060
R14-1	RESISTOR SMD 0805	1k0 OHM 5% 0.1W	ROHM	MCR 10 EZH J 102 302.048
R15-1	RESISTOR SMD 0805	220k OHM 5% 0.1W	ROHM	MCR 10 EZH J 224 302.076
R16-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R17-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R18-1	RESISTOR SMD 0805	4R7 OHM 5% 0.1W	ROHM	MCR 10 EZH J 4R7 302.020
R20-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474 302.080
R21-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R22-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R23-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103 302.060
R24-1	RESISTOR SMD 0805	82k OHM 5% 0.1W	ROHM	MCR 10 EZH J 823 302.071
R25-1	RESISTOR SMD 0805	1k8 OHM 5% 0.1W	ROHM	MCR 10 EZH J 182 302.051
R26-1	RESISTOR SMD 0805	33k OHM 5% 0.1W	ROHM	MCR 10 EZH J 333 302.066
R27-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103 302.060
R28-1	RESISTOR SMD 0805	220k OHM 5% 0.1W	ROHM	MCR 10 EZH J 224 302.076
R29-1	RESISTOR SMD 0805	9k53 OHM 1% 50mW	PHILIPS	2322 734 2/69532 302.464
R30-1	RESISTOR SMD 0805	10k0 OHM 1% 50mW	PHILIPS	2322 734 2/61003 302.470
R31-1	RESISTOR SMD 0805	12k OHM 5% 0.1W	ROHM	MCR 10 EZH J 123 302.061
R32-1	RESISTOR SMD 0805	100k OHM 5% 0.1W	ROHM	MCR 10 EZH J 104 302.072
R33-1	RESISTOR SMD 0805	100k OHM 5% 0.1W	ROHM	MCR 10 EZH J 104 302.072
R34-1	RESISTOR SMD 0805	10k0 OHM 1% 50mW	PHILIPS	2322 734 2/61003 302.470
R35-1	RESISTOR SMD 0805	4k53 OHM 1% 50mW	PHILIPS	2322 734 2/64532 302.433
R36-1	RESISTOR SMD 0805	2k15 OHM 1% 50mW	PHILIPS	2322 734 2/62152 302.402
R37-1	RESISTOR SMD 0805	9k09 OHM 1% 50mW	PHILIPS	2322 734 2/69092 302.462
R38-1	RESISTOR SMD 0805	487k OHM 1% 50mW	PHILIPS	2322 734 2/64874 302.636
R39-1	RESISTOR SMD 0805	48k7 OHM 1% 50mW	PHILIPS	2322 734 2/64873 302.536
R40-1	RESISTOR SMD 0805	1k0 OHM 5% 0.1W	ROHM	MCR 10 EZH J 102 302.048
R41-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103 302.060
R42-1	RESISTOR SMD 0805	1k0 OHM 5% 0.1W	ROHM	MCR 10 EZH J 102 302.048
R43-1	RESISTOR SMD 0805	220k OHM 5% 0.1W	ROHM	MCR 10 EZH J 224 302.076
R44-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R45-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R46-1	RESISTOR SMD 0805	4R7 OHM 5% 0.1W	ROHM	MCR 10 EZH J 4R7 302.020
R49-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R50-1	RESISTOR SMD 0805	270 OHM 5% 0.1W	ROHM	MCR 10 EZH J 271 302.041
R51-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103 302.060
R52-1	RESISTOR SMD 0805	82k OHM 5% 0.1W	ROHM	MCR 10 EZH J 823 302.071
R53-1	RESISTOR SMD 0805	1k8 OHM 5% 0.1W	ROHM	MCR 10 EZH J 182 302.051
R54-1	RESISTOR SMD 0805	33k OHM 5% 0.1W	ROHM	MCR 10 EZH J 333 302.066
R55-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103 302.060
R56-1	RESISTOR SMD 0805	220k OHM 5% 0.1W	ROHM	MCR 10 EZH J 224 302.076

POSITION	DESCRIPTION	MANUFACTUR	TYPE	PART NO.	
R57-1	RESISTOR SMD 0805	9K53 OHM 1% 50mW	PHILIPS	2322 734 2/69532	302.464
R58-1	RESISTOR SMD 0805	10k0 OHM 1% 50mW	PHILIPS	2322 734 2/61003	302.470
R59-1	RESISTOR SMD 0805	12k OHM 5% 0.1W	ROHM	MCR 10 EZH J 123	302.061
R60-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R61-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R62-1	RESISTOR SMD 0805	2k2 OHM 5% 0.1W	ROHM	MCR 10 EZH J 222	302.052
R63-1	RESISTOR SMD 0805	36k5 OHM 1% 50mW	PHILIPS	2322 734 2/63653	302.524
R64-1	RESISTOR SMD 0805	36k5 OHM 1% 50mW	PHILIPS	2322 734 2/63653	302.524
R66-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R68-1	RESISTOR SMD 0805	2k2 OHM 5% 0.1W	ROHM	MCR 10 EZH J 222	302.052
R70-1	RESISTOR SMD 0805	2k2 OHM 5% 0.1W	ROHM	MCR 10 EZH J 222	302.052
R71-1	RESISTOR SMD 0805	2k2 OHM 5% 0.1W	ROHM	MCR 10 EZH J 222	302.052
R72-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R73-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103	302.060
R74-1	RESISTOR SMD 0805	220k OHM 5% 0.1W	ROHM	MCR 10 EZH J 224	302.076
R75-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R76-1	RESISTOR SMD 0805	2k2 OHM 5% 0.1W	ROHM	MCR 10 EZH J 222	302.052
R77-1	RESISTOR SMD 0805	33k OHM 5% 0.1W	ROHM	MCR 10 EZH J 333	302.066
R78-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103	302.060
R79-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R81-1	RESISTOR SMD 0805	10k OHM 5% 0.1W	ROHM	MCR 10 EZH J 103	302.060
R82-1	RESISTOR SMD 0805	220k OHM 5% 0.1W	ROHM	MCR 10 EZH J 224	302.076
R83-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R84-1	RESISTOR SMD 0805	2k2 OHM 5% 0.1W	ROHM	MCR 10 EZH J 222	302.052
R85-1	RESISTOR SMD 0805	33k OHM 5% 0.1W	ROHM	MCR 10 EZH J 333	302.066
R86-1	RESISTOR SMD 0805	100k OHM 5% 0.1W	ROHM	MCR 10 EZH J 104	302.072
R87-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
R88-1	RESISTOR SMD 0805	1k0 OHM 5% 0.1W	ROHM	MCR 10 EZH J 102	302.048
R89-1	RESISTOR SMD 0805	1k0 OHM 5% 0.1W	ROHM	MCR 10 EZH J 102	302.048
R90-1	RESISTOR SMD 0805	470k OHM 5% 0.1W	ROHM	MCR 10 EZH J 474	302.080
ST2-1	TERMINAL BLOCK	2 POLES 1.5mm2	PTR	AK300/2b m.MESS.SKRUER	81.023
TR1-1	TRANSFORMER MAINS	110+110:14 VAC 5VA	DANTRAF	8-3-28326A	22.514
U1-1	VOLTAGE SHUNT REGULATOR	ADJUSTABLE TL431	TEXAS	TL431CD/ACDR	340.480
U2-1	VOLTAGE REGULATOR	5V/0.1A 78L05A	MOTOROLA	MC78L05ACD R2	350.100
U3-1	DUAL D-FF SET/RESET	MC74HC74, SN74HC74	MOTOROLA	MC74HC74D R2	355.223
U4-1	INTEGRATED CIRCUIT	74HC08D	TEXAS*	SN74HC08DR(TAPE&REEL)	355.208
U5-1	DUAL 2-TO-4 LINE DECODER	74HC139D	TEXAS	SN74HC139DR	355.236
U6-1	INTEGRATED CIRCUIT	74HC4040	TOSHIBA	TC74HC4040AFN	355.307
U7-1	QUAD COMPARATOR LOW POW.	SO14, LM339 LM239	TEXAS	LM339DR (LM239DR)	350.540
U8-1	QUAD OP. AMP.	LM324	MOTOROLA	LM324D R2	350.530
U9-1	QUAD COMPARATOR LOW POW.	SO14, LM339 LM239	TEXAS	LM339DR (LM239DR)	350.540
U10-1	INTEGRATED CIRCUIT	74HC08D	TEXAS*	SN74HC08DR(TAPE&REEL)	355.208
U12-1	INTEGRATED CIRCUIT	74HC4040	TOSHIBA	TC74HC4040AFN	355.307
U13-1	QUAD COMPARATOR LOW POW.	SO14, LM339 LM239	TEXAS	LM339DR (LM239DR)	350.540
U14-1	INTEGRATED CIRCUIT	74HC4040	TOSHIBA	TC74HC4040AFN	355.307
U15-1	14-STAGE BIN.COUNTER	WITH OSC. 74HC4060	PHILIPS	PC74HC4060T	355.314
U16-1	DUAL D-FF SET/RESET	MC74HC74, SN74HC74	MOTOROLA	MC74HC74D R2	355.223
X1-1	CRYSTAL 32.768kHz		NDK	MU-206S	39.765

