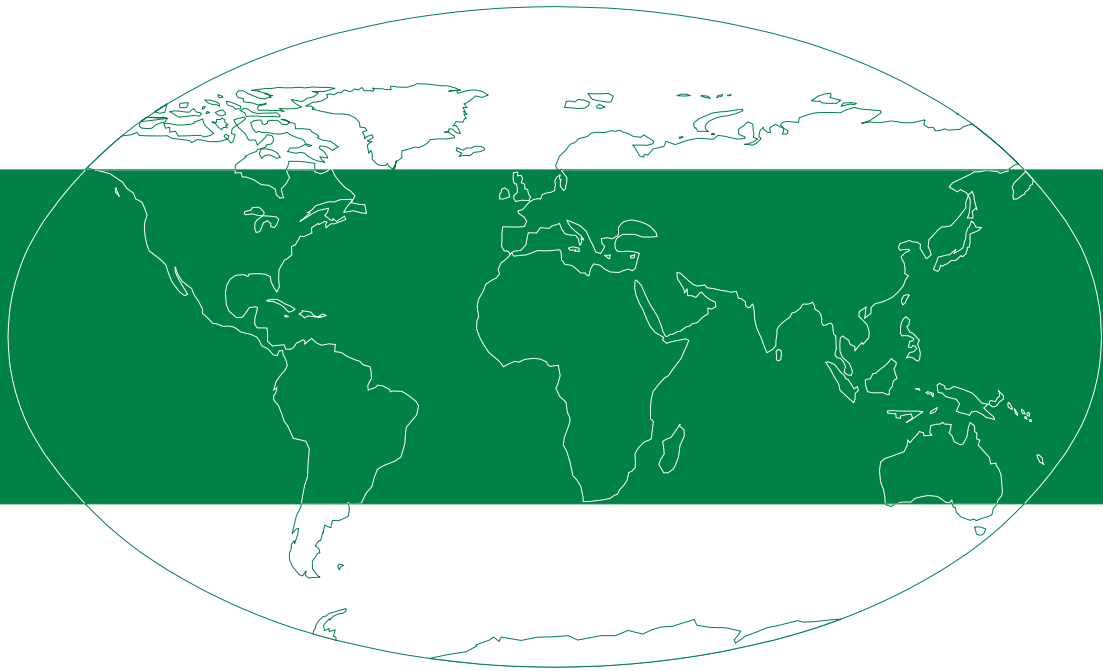


SAILOR



TECHNICAL MANUAL
FOR
COMPACT HF SSB N2164



S.P. RADIO A/S · AALBORG · DENMARK



S.P. RADIO A/S • Porsvej 2 • PO Box 7071 • DK-9200 Aalborg SV • Denmark
Phone: +45 9634 6100 • Fax: +45 9634 6101 • Telex: 69789 ECI DK
E-mail: sailor@sailor.dk • Web: www.sailor.dk

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1 INTRODUCTION

The N2164 Battery Charger is especially developed to charge the maintenance free lead-acid batteries and the Nickel Cadmium batteries.

The N2164 is designed as a stand alone charger for any 24V battery, but can easily be integrated with the HF SSB Shortwave Programme.

The N2164 has built-in shunt for amp. meter.

The N2164 is remote controlled.

The N2164 has a built-in Battery Low Detector.

1.1 PRINCIPLE OF OPERATION

The Battery Charger N2164 can operate in two ways: manual mode or automatic mode.

The manual mode is only recommended to use when the automatic module is out of order, because there is only a simple regulation of the battery charge condition. When using the manual mode the battery must be under close supervision even the N2164 from factory is limited to deliver max. 27.5V and approx. 15 A. In automatic mode the N2164 is charging in two state: Main Charge and Trickle charge.

In main charge mode the N2164 is working as a constant current generator until the battery voltage is reaching the upper level voltage (gassing voltage). At this level the N2164 is changing state to trickle charge mode and is now working as a constant voltage generator to maintain a constant voltage to the battery.

If the battery is loaded more than the charger is able to supply, the battery voltage eventually goes under the lower level voltage which again changes the N2164 into charge mode and so on (see figure for typical charge curve).

For charging Nickel Cadmium batteries, which demand a higher voltage, a strap is moved in the automatic module followed by an adjustment of the output voltage according to the battery type in question.

The N2164 is designed to be controlled from a remote switch box H2180A or from the console H2192, where the amp. meter and the volt meter are placed. The current shunt is placed inside N2164.

The built-in battery low detector will only give alarm if the battery voltage has been below the alarm set point continuously for several minutes.

1.2 TECHNICAL DATA

GENERAL

Input voltage:	110V-127V-220V-240V AC \pm 10%
Input frequency:	48 - 65 Hz
Operating temperature:	-15° C to +55° C
On/Off and MAN/AUTO control:	From external switches placed in remote box H2180A or in the console H2192 where the meters for battery voltage and charge current are placed.

AUTOMATIC MODE

Output current (factory adjusted):	15A (18A for N2164A)
Ripple voltage (rms) at 15A:	4%

For lead-acid batteries

Trickle voltage (factory adjusted):	27.3VDC at 0.5A load.
Upper level (factory adjusted) :	28.8VDC

For Nickel-Cadmium batteries

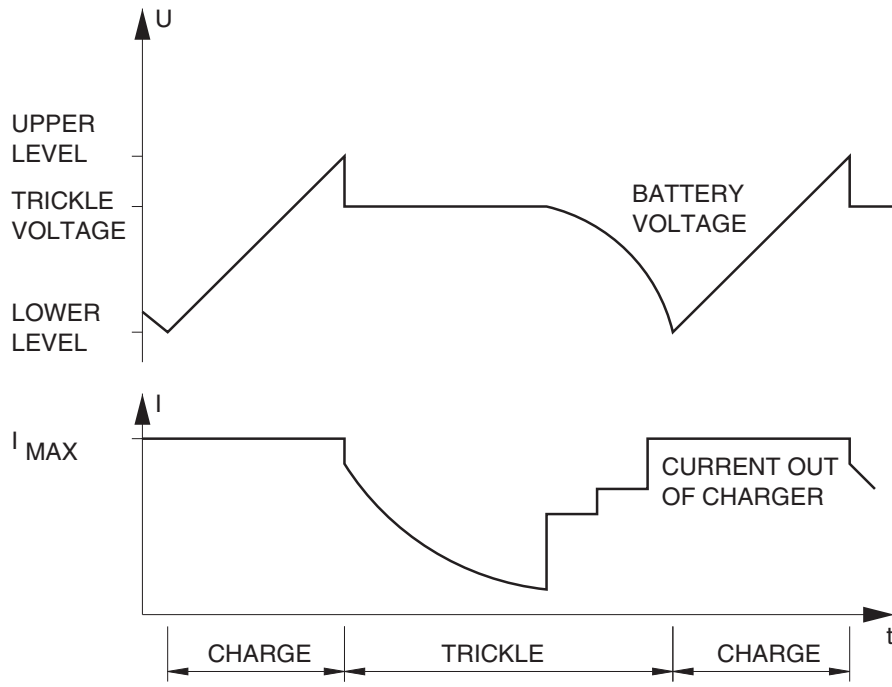
Trickle voltage (adjustable):	28.4VDC
Upper level shift (adjustable):	30.5VDC

MANUAL MODE

Output voltage (adjustable):	27.5VDC at 0.5A load.
Output current:	approx. 18A

Battery Low Detector alarm set point (factory adjusted)	24V
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TYPICAL CHARGE CURVE

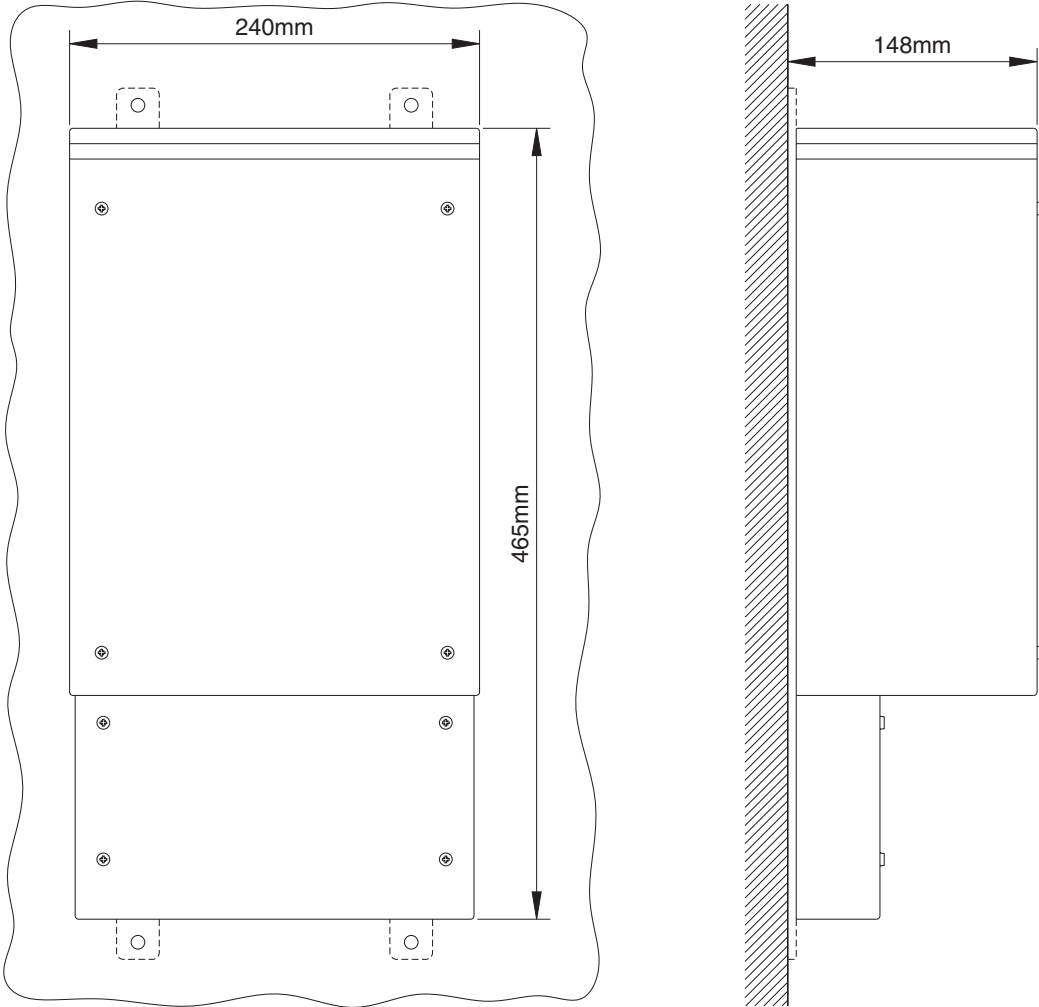


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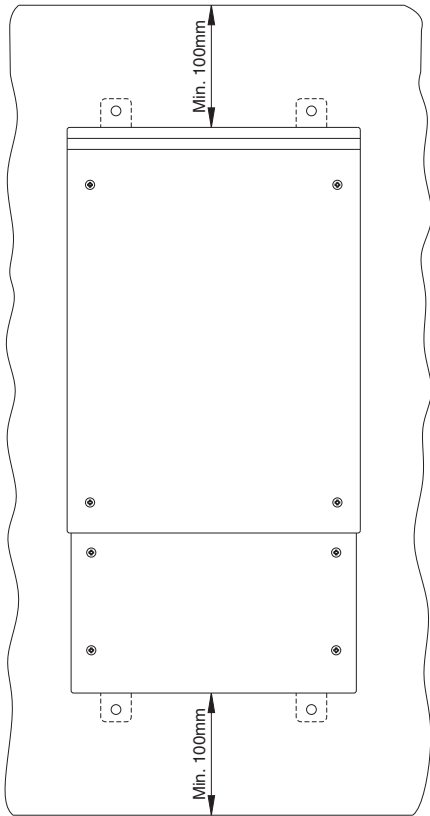
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2 INSTALLATION

2.1 MOUNTING POSIBILITIES/DIMENSIONS AND DRILLING PLAN



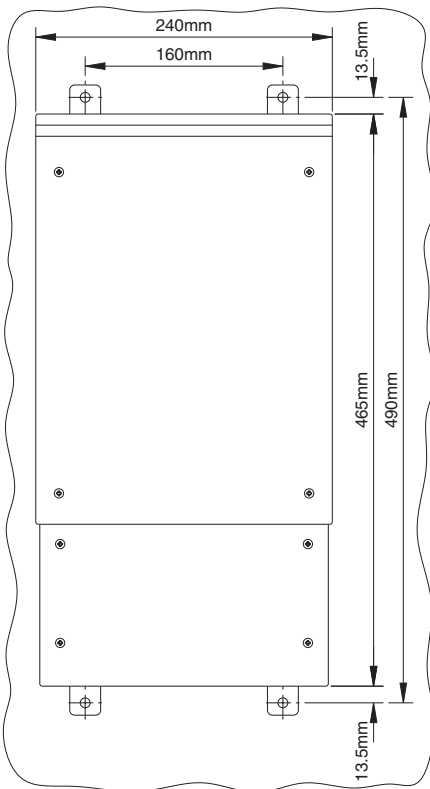
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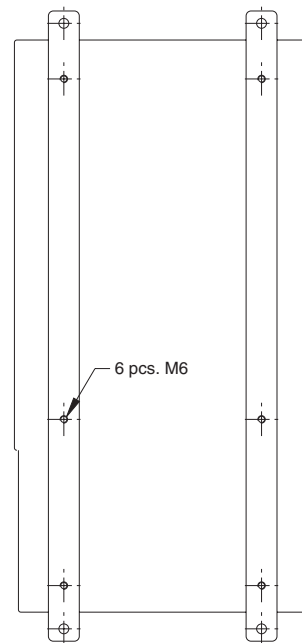
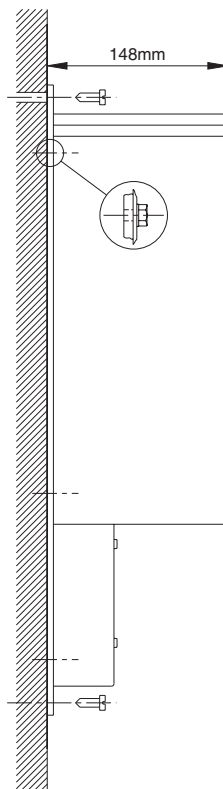
Free Space for air circulation.
 Ambient temperature: max. 40° C.
 Weight: N2164 22.5 kg

Free space for air circulation
 and cable entry.

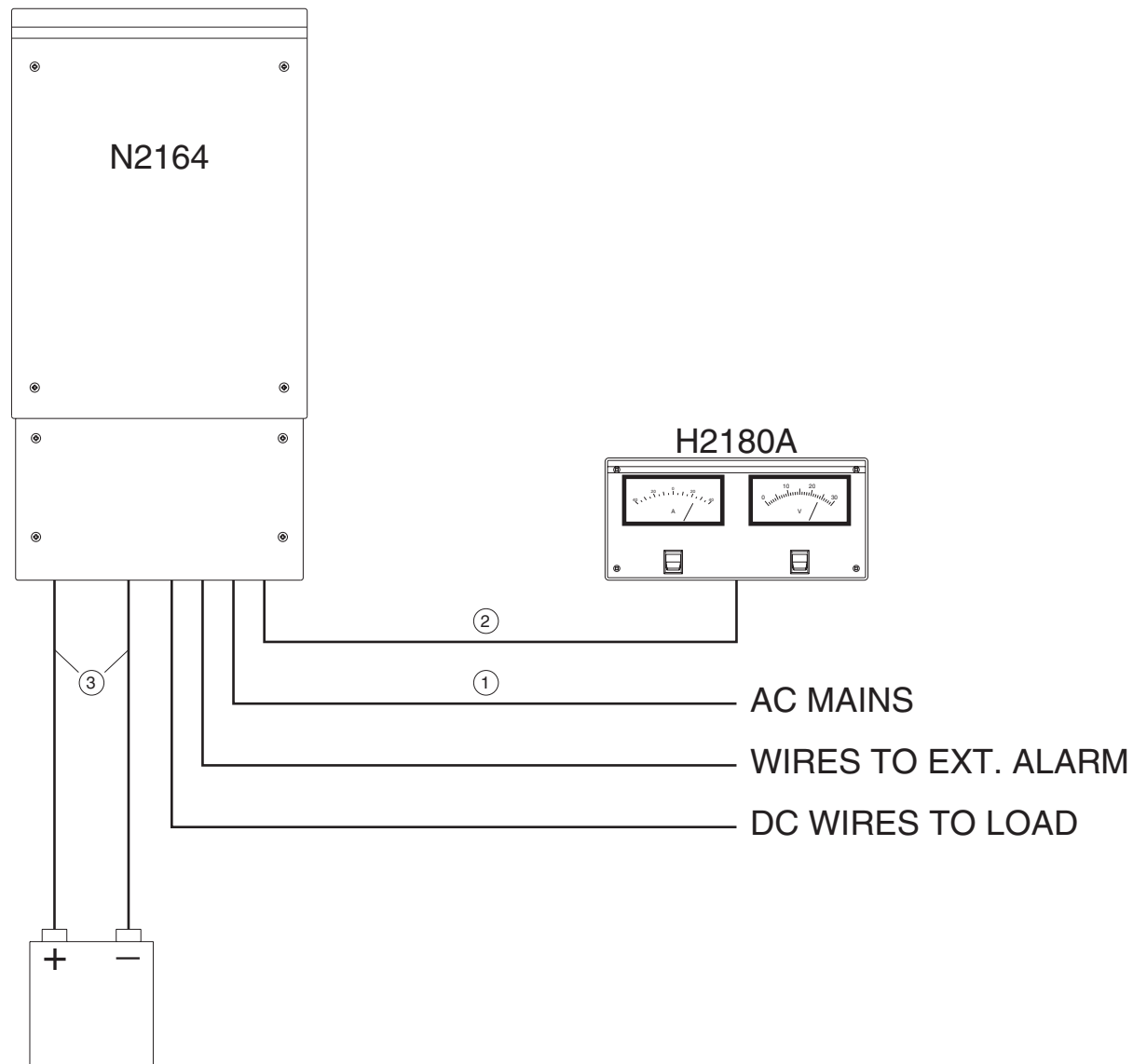
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26197A



2.2 ELECTRICAL CONNECTION



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Cable 1: MAINS to N2164:

220V MAINS Current approx. 5 Amp
Mains fuses 10 Amp
3X1.5mm² Max length 18 metres

110V MAINS Current approx. 10 Amp
Mains fuses 20 Amp
3x2,5mm² Max. length 16 metres

N2164	SIGNAL
ST2	
1	GND
2	
3	LINE
4	NEUTRAL

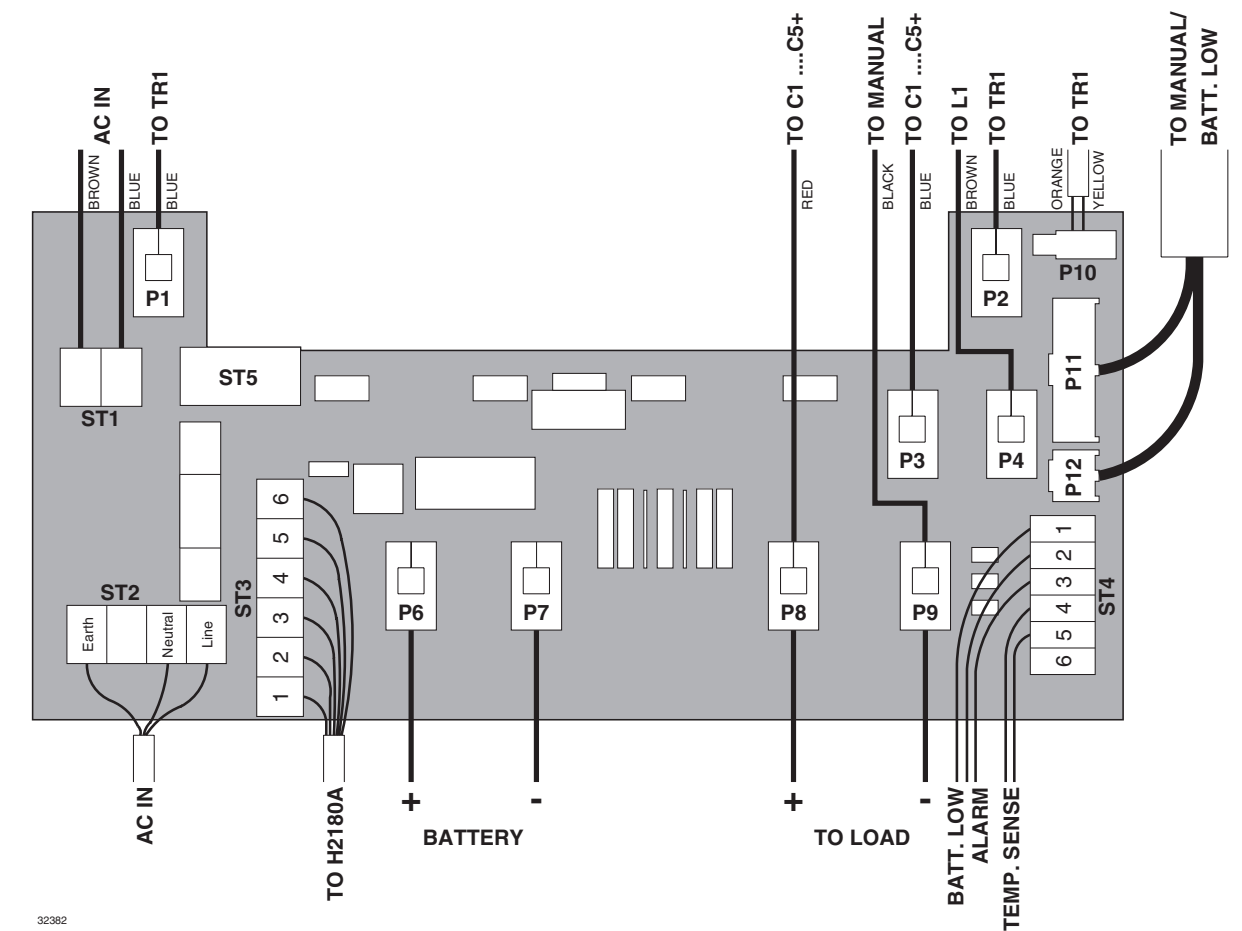
Cable 2: N2164 to H2180A:

Multicable: 6x0.75mm² Max length 15 meters
Multicable: 6x1.5mm² Max length 30 meters

N2164	H2180A	SIGNAL
ST3		
1	1	+ SHUNT
2	2	- SHUNT
3	3	- VS
4	4	MAN
5	5	26V
6	6	AUTO

Cable 3: N2164 to BATTERY

LENGTH IN METRES	2.5	4	6	10	13	19	27
CABLE DIMENSIONS	6	10	16	25	35	50	70



32382

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3 SERVICE

3.1 MAINTENANCE

When the N2164 has been correctly installed, the maintenance of the charger can, dependent on the environments and working hours, be reduced to a performance check at the service workshop at intervals not exceeding 5 years.

A performance check list is enclosed in the section 3.4 PERFORMANCE CHECK for charging Lead-Acid batteries and in the section 3.6 PERFORMANCE CHECK for charging Nickel Cadmium batteries.

Also inspect cables and plugs for mechanical defects and corrosion.

Any repair of the set should be followed by a check described in the section 3.5 NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR (Lead-Acid) or 3.7 NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR (NiCd)

3.1.1 ADJUSTMENT TO CHARGE NICKEL CADMIUM BATTERIES

See section 3.7 NECESSARY CHECK AND ADJUSTMENT AFTER REPAIR (NiCd).

3.2 RECOMMENDED TEST EQUIPMENT

OSCILLOSCOPE

Bandwidth	DC-35 MHz
Sensitivity	2mV/div
Input Impedance	1 Mohm/20pF
E.g. Philips type	PM3216

MULTIMETER

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

3.3 TROUBLE SHOOTING

Trouble shooting, repair and check of the N2164 should only be performed by persons, who have sufficient technical knowledge and the necessary test equipment at their disposal.

1. The battery is gassing:
 - a) The charging current is too high for the battery type.
 - b) The upper level voltage is too high.
 - c) The trickle charge voltage is too high.
 - d) N2164 is strapped for wrong battery type.
 - e) The battery is defective.
2. N2164 can not switch on in MANUAL mode.
 - a) Fuse F1-1 is blown out
 - b) Fuse F1-3 is blown out
3. N2164 can not switch on in AUTOMATIC mode.
 - a) Fuse F1-1 is blown out
 - b) Fuse F1-3 is blown out
 - c) The output is short circuited.
 - d) The battery voltage is below 7.5V.

3.4 PERFORMANCE CHECK FOR CHARGING LEAD- ACID BATTERIES

Any value, which differs too much from the values given in this chapter, should lead to a repair of the circuit or module in question.

Hints to locate some faults are given in the chapter 3.3 TROUBLE SHOOTING.

The given values in this chapter is basically for 24V maintenance free lead-acid batteries.

If the battery temperature sensor is connected, the values are only valid if the battery temperature is 25° degree centigrade.

3.4.1 PERFORMANCE CHECK OF MANUAL CHARGE MODE (Lead-Acid)

1. Connect the N2164 to the AC mains, which it is strapped for. See 5.3 MAIN SCHEMATIC DIAGRAM. Normally the N2164 is strapped for 220V AC.
2. Connect a small dummy load to the output. A resistor of 27 ohm/50W is sufficient to get a proper regulation.
3. On the connection boards are placed three positions for a strap. The positions are marked REMOTE, AUTO and MAN. Normally the strap is placed in REMOTE position. Now, move the strap to MAN position and the N2164 is switched on in MANUAL charge mode. The output voltage is fluctuating, but that is normal because the battery is missing.
4. With a voltmeter across the output, read the voltage to 27.5VDC \pm 0.5V.
5. Connect a new dummy load of 1.53 ohm/450W to the output. It can be made by paralleling several power resistors.
6. Read the output voltage to 23VDC \pm 2V. The output current is 18A \pm 3A. In case of no dummyload is available the charger can be connected to a slightly discharged battery through an amperemeter and then read the current to 18A \pm 3A.
7. Move the strap on the connection board back to REMOTE position.

3.4.2 PERFORMANCE CHECK OF AUTOMATIC CHARGE MODE (Lead-Acid)

1. Connect the N2164 to the AC mains, which it is strapped for. See 5.3 MAIN SCHEMATIC DIAGRAM. Normally the N2164 is strapped for 220V AC.
2. Connect a small dummy load to the output. A resistor of 27 ohm/50W is sufficient to get a proper regulation.
3. On the AUTOMATIC module check that a strap is placed in P5 in MS position, and also check a strap is placed in P3 (TS-OFF position). If the temperature sensor is connected the strap is placed in TS-ON position.
4. On the connection boards are placed three positions for a strap. The positions are marked REMOTE, AUTO and MAN. Normally the strap is placed in REMOTE position. Now move the strap to AUTO position.
5. With a voltmeter across the output, read the voltage to 0V. The N2164 is not switched on, because the battery is missing.
6. Connect to the output a small power supply capable of delivering 1.5A and adjustable up to 32V.
7. The small power supply is set to a voltage not less than 7.5V. Then the N2164 is switched on and the small power supply can be disconnected.
8. At first the output voltage is approx. 34VDC, but after approx. 10 seconds the voltage falls down to 27.3V \pm 0.2V. This is the trickle charge voltage.

9. On the connection board move the strap back to REMOTE position. The N2164 is now switched off.
10. Connect again the small power supply to the output and set it to 24.0V.
11. The AUTOMATIC module is now in charge mode. All LED on the module is alight. After approx. 10 seconds the LED D31-2 (TRICKLE) is off.
12. Turn up slowly the voltage from the small power supply until D31 (TRICKLE) turns on and then read the voltage to $28.8\text{VDC} \pm 0.2\text{V}$. This is the upper level shift and the N2164 is now in trickle charge mode.
13. Turn back the voltage from the small power supply until D30 (CHARGE) turns on and read the voltage to $25.8\text{VDC} \pm 0.2\text{V}$. This is the lower level shift and the N2164 is now in charge mode.
14. Connect to the output a new dummy load of 1.53 ohm/450W and read the output voltage to $23\text{VDC} \pm 2\text{V}$. The output current is approx. 15A.
In case of no dummyload is available the charger can be connected to a slightly discharged battery through an amperemeter and then read the current to $15\text{A} \pm 1\text{A}$.
15. Connect an oscilloscope to the output and read the ripple voltage to max. 3V_{pp} at full load.
16. An other way to start up the N2164 in AUTOMATIC charge mode while connected to a dummy load, is to short circuit R15-2 a short moment to cancel the fault-stop circuit.

3.4.3 PERFORMANCE CHECK OF BATTERY LOW DETECTOR (Lead-Acid).

Connect a small dummy load to the output. A resistor of 27 ohm/50W is sufficient to get a proper regulation.

Connect also a small power supply capable of delivering 1.5A to the load, and adjustable up to 32V.

Turn up slowly the voltage from the small power supply until U1 pin7 goes high, and read the voltage to $24.0\text{V DC} \pm 0.5\text{V}$.

After approx 5 minutes the battery low detector will give alarm.

3.5 NECESSARY CHECK AND ADJUSTMENT AFTER REPAIR (Lead-Acid)

CHANGE OR REPAIR OF THE MANUAL CONTROL (module 1).

Execute chapter 3.4.1. PERFORMANCE CHECK OF MANUAL CHARGE MODE.

Adjust if necessary the output voltage to $27.5\text{VDC} \pm 0.2\text{V}$ with R4-1.

Execute chapter 3.4.2. PERFORMANCE CHECK OF AUTOMATIC CHARGE MODE.

Adjust if necessary the output voltage to $23.0\text{VDC} \pm 0.2\text{V}$ with R60-2. (Current limiter for 15A).

CHANGE OR REPAIR OF THE AUTOMATIC CONTROL (module 2).

Execute chapter 3.4.2. PERFORMANCE CHECK OF AUTOMATIC CHARGE MODE.

Adjust if necessary the trickle voltage to $27.3\text{VDC} \pm 0.1\text{V}$ with R39-2.

Adjust if necessary the upper level voltage to $28.8\text{VDC} \pm 0.1\text{V}$ with R63-2.

This adjustment is done by turning R63-2 full clockwise. Then connect the small dummy load, and set the small power supply for 28.8VDC which turns on the LED D30-2 (CHARGE). Turn slowly R63-2 counter clockwise just until the LED D31-2 (TRICKLE) turns on.

Adjust if necessary the output voltage to $23.0\text{VDC} \pm 0.2\text{V}$ with R60-2. (Current limiter for 15A).

CHANGE OR REPAIR OF THE BATTERY LOW DETECTOR

Execute chapter 3.4.3 PERFORMANCE CHECK OF BATTERY LOW DETECTOR

Adjust if necessary the alarm set point.

This is done by turning R4 full counter clockwise. Then connect a small dummy load, and a small power supply. Set the supply to 24V, now turn R4 clockwise until U1 pin7 goes high.

3.6 PERFORMANCE CHECK FOR CHARGING NICKEL CADMIUM BATTERIES

Any value, which differs too much from the values given in this chapter, should lead to a repair of the circuit or module in question.

Hints to locate some faults are given in the chapter 3.3 TROUBLE SHOOTING.

The given values in this chapter is only valid for charging a 20 cells Nickel-Cadmium (NiCd) battery.

3.6.1 PERFORMANCE CHECK OF MANUAL CHARGE MODE (NiCd)

1. Connect the N2164 to the AC mains, which it is strapped for. See 5.3 MAIN SCHEMATIC DIAGRAM. Normally the N2164 is strapped for 220V AC.
2. Connect a small dummy load to the output. A resistor of 27 ohm/50W is sufficient to get a proper regulation.
3. On the connection boards are placed three positions for a strap. The positions are marked REMOTE, AUTO and MAN. Normally the strap is placed in REMOTE position. Now move the strap to MAN position and the N2164 is switched on in MANUAL charge mode. The output voltage is fluctuating, but that is normal because the battery is missing.
4. With a voltmeter across the output, read the voltage to approx. 28.5VDC.
5. Connect a new dummy load of 1.53 ohm/450W to the output. It can be made by paralleling several power resistors.
6. Read the output voltage to 23VDC \pm 2V. The output current is approx. 18A. In case of no dummyload is available the charger can be connected to a slightly discharged battery through an amperemeter and then read the current to approx. 18A.
7. Move the strap on the connection board back to REMOTE position.

3.6.2 PERFORMANCE CHECK OF AUTOMATIC CHARGE MODE (NiCd)

1. Connect the N2164 to the AC mains, which it is strapped for. See 5.3 MAIN SCHEMATIC DIAGRAM. Normally the N2164 is strapped for 220V AC.
2. Connect a small dummy load to the output. A resistor of 27 ohm/50W is sufficient to get a proper regulation.
3. On the AUTOMATIC module check that a strap is placed in P5 in MS position, and also check a strap is placed in P3 in NiCd position.
4. On the connection boards are placed three positions for a strap. The positions are marked REMOTE, AUTO and MAN. Normally the strap is placed in REMOTE position. Now move the strap to AUTO position.
5. With a voltmeter across the output, read the voltage to 0V. The N2164 is not switched on, because the battery is missing.
6. Connect to the output a small power supply capable of delivering 1.5A and adjustable up to 32V.
7. The small power supply is set to a voltage not less than 7.5V. Then the N2164 is switched on and the small power supply can be disconnected.
8. At first the output voltage is approx. 34VDC, but after 10 seconds the voltage falls down to 28.4V \pm 0.2V. This is the trickle charge voltage.

9. On the connection board move the strap back to REMOTE position. The N2164 is now switched off.
10. Connect again the small power supply to the output and set it to 24.0V.
11. The AUTOMATIC module is now in charge mode. All LED on the module is alight. After 10 seconds the LED D31-2 (TRICKLE) is off.
12. Turn up slowly the voltage from the small power supply until D31-2 (TRICKLE) turns on and then read the voltage to $30.5\text{VDC} \pm 0.2\text{V}$. This is the upper level shift and the N2164 is now in trickle charge mode.
13. Turn back the voltage from the small power supply until D30 (CHARGE) turns on and read the voltage to $27.5\text{VDC} \pm 0.3\text{V}$. This is the lower level shift and the N2164 is now in charge mode.
14. Connect to the output a new dummy load of 1.53 ohm/450W and read the output voltage to $23\text{VDC} \pm 2\text{V}$. The output current is approx. 15A.
15. Connect an oscilloscope to the output and read the ripple voltage to max. $3V_{pp}$
16. An other way to start up the N2164 in AUTOMATIC charge mode while connected to a dummy load, is to short circuit R15-2 a short moment to cancel the fault-stop circuit.

3.7 NECESSARY CHECK AND ADJUSTMENT AFTER REPAIR (NiCd)

CHANGE OR REPAIR OF THE MANUAL CONTROL (module 1).

Execute chapter 3.6.1. PERFORMANCE CHECK OF MANUAL CHARGE MODE.

Adjust if necessary the output voltage to $28.5\text{VDC} \pm 0.2\text{V}$ with R4-1.

Execute chapter 3.6.2. PERFORMANCE CHECK OF AUTOMATIC CHARGE MODE.

Adjust if necessary the output voltage to $23.0\text{VDC} \pm 0.2\text{V}$ with R60-2. (Current limiter for 15A).

CHANGE OR REPAIR OF THE AUTOMATIC CONTROL (module 2).

Execute chapter 3.6.2. PERFORMANCE CHECK OF AUTOMATIC CHARGE MODE.

Adjust if necessary the trickle voltage to $28.4\text{VDC} \pm 0.1\text{V}$ with R39-2.

Adjust if necessary the upper level voltage to $30.5\text{VDC} \pm 0.1\text{V}$ with R63-2.

This adjustment is done by turning R63-2 full clockwise. Then connect the small dummy load, and set the small power supply for $30.5\text{VDC} \pm 0.1\text{V}$ which turns on the LED D30-2 (CHARGE). Turn slowly R63-2 counter clockwise just until the LED D31-2 (TRICKLE) turns on.

Adjust if necessary the output voltage to $23.0\text{VDC} \pm 0.1\text{V}$ with R60-2. (Current limiter for 15A).

3.8 OPTION

N2164A 18A VERSION

The charger N2164 can be upgraded to deliver 18A in AUTOMATIC mode by installing a special blower kit.

This means the charger can supply a complete HF SSB Console H2192 as an AC power supply, but still connected to a battery. This forms a simplified AC/DC solution.

The special blower kit consists of a bigger cover with a blower and a special thermal breaker.

HOW TO UPGRADE

Switch off the AC mains to prevent electrical shock.

Remove the old cover.

Replace the four hex threaded standoffs with the prolonged types from the kit.

Mount the thermal breaker TB1 on the Connection/thyristor module, directly on the copper base. Place it between the rectifier diodes D1 and D2.

Switch on again the AC mains.

PERFORMANCE CHECK AND NECESSARY ADJUSTMENT

Execute the chapter 3.4.2 PERFORMANCE CHECK OF AUTOMATIC MODE (lead-acid) or chapter 3.6.2 PERFORMANCE CHECK OF AUTOMATIC MODE (NiCd) and for section 14 read the current to $18A \pm 1A$.

If necessary then adjust the output current to $18A \pm 1A$ with R60-2.

Then insert the blower cable into the plug P6 on the Manual module.

Short-circuit for a short moment the thermal breaker TB1 to check that the blower is running.

Assemble again the charger with the cover containing the blower.

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5 CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS

5.1 MANUAL CONTROL (MODULE 1) PART. NO. 626444

TRIGGER PULSE OSCILLATOR

This module also serves as an internal connection board, where all the cables inside N2164 are connected. The charger can work only with the MANUAL module present. If the AUTOMATIC module is out of order, it can be removed for repair while the charger is working in MANUAL mode. However, this mode is not recommended for long term charging, because of the simplified regulation of the output voltage to the battery.

In MANUAL mode the SCR's are triggered by a line synchronised relaxation oscillator performed by the in junction transistor Q2. To synchronise the circuit to the line frequency, the circuit is connected to the 46V AC output from the transformer TR1.

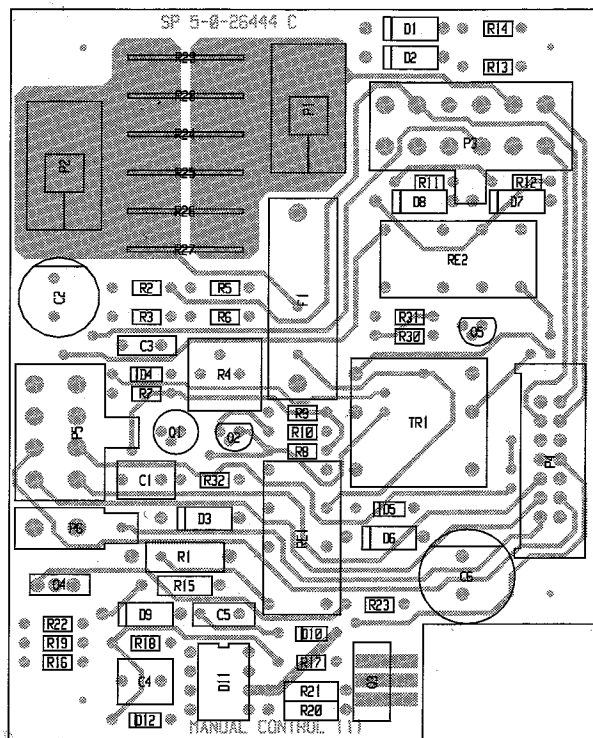
When the output voltage comes over the reference voltage from D4, the transistor Q1 is switching off the oscillator and the SCR's are shut down until the output voltage again is falling. This maximum output voltage, which is depending on battery type, is adjusted with R4.

The output current runs through the resistors R24 to R29 and generates a voltage, which also shuts down the oscillator by Q5 when the current exceeds approx. 18A.

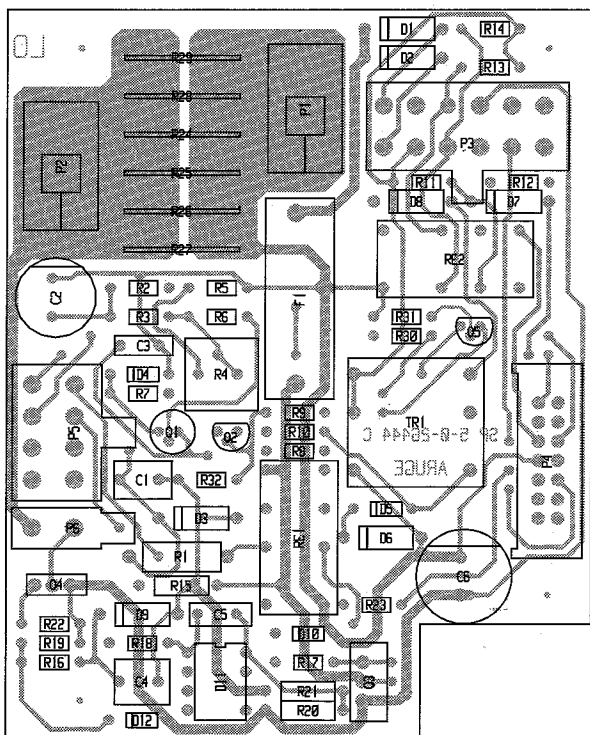
The change over from MANUAL mode to AUTOMATIC mode is done by the relay RE2.

To switch off the MANUAL charge mode the relay RE1 is switched off by a remote switch.

COMPONENT LOCATION MANUAL CONTROL MODULE 1

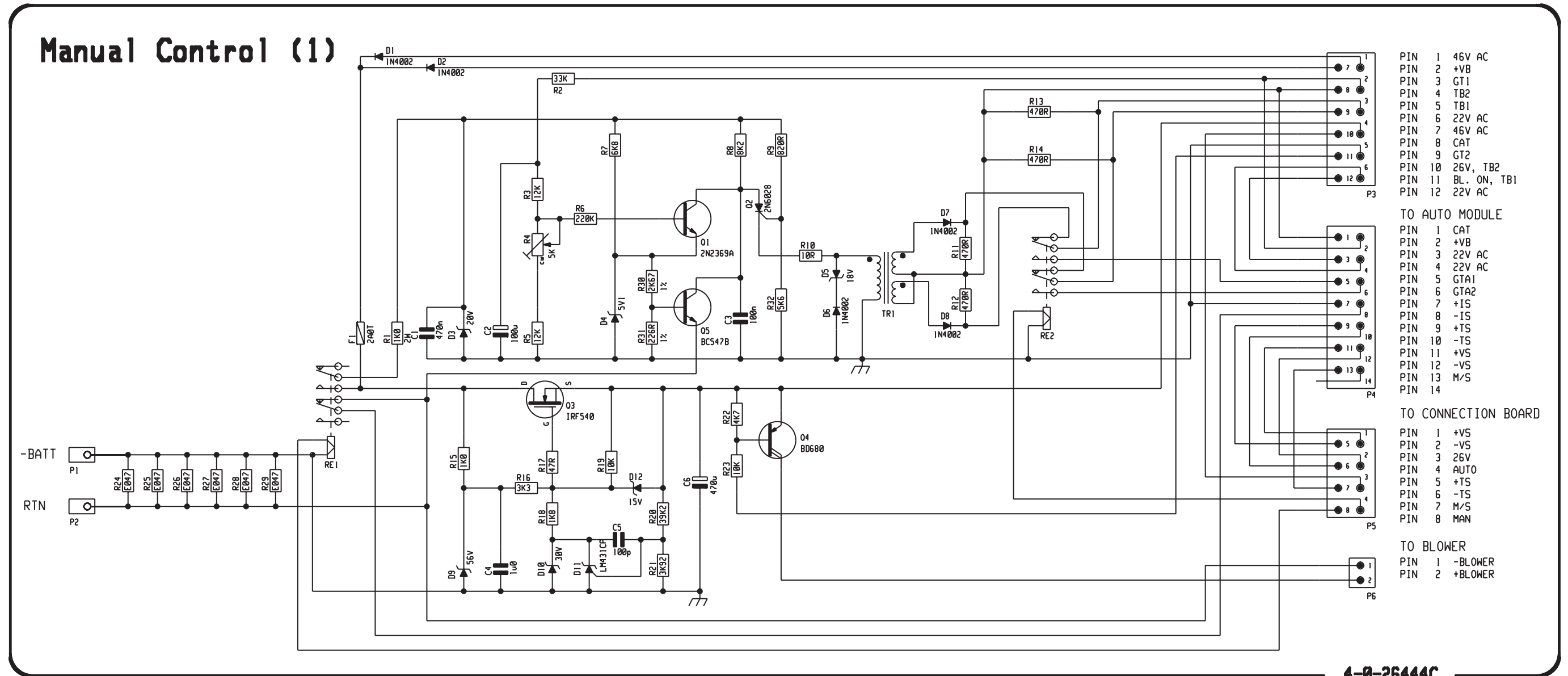


View from component side with upper side tracks.



View from component side with lower side tracks.
PCB rev. 26444C

MANUAL CONTROL MODULE 1



4-0-26444C

This diagram is valid for PCB rev. 26444C

5.2 AUTOMATIC CONTROL (MODULE 2) PART. NO. 626445

CONTROLLED REFERENCE VOLTAGE VCR

The voltage regulator U1 produces a stable 15V supply for the on board circuits. To produce a reference voltage for the output voltage regulation, a circuit is build around U3. This circuit is highly stable but is also changeable according to the charger application, which is determined by placing a strap in P2.

Strap placed in P2 (TS-ON) means the temperature correction circuit around U2.1 is connected to the reference voltage regulator U3, which means the temperature sensor is connected to N2164. The reference voltage VCR will increase with decreasing temperature and visa versa. This causes the output trickle voltage and the upper level shift voltage to follow a temperature curve, which is characteristic of lead-acid batteries. The temperature coefficient of a 24V lead-acid battery is approx. -48 mV per degree centigrade. This temperature correction circuit may be used if the battery is placed in extreme temperature environment.

Strap placed in P3 (TS-OFF) means the temperature circuit is disconnected, but the charger is now in a normal condition for charging maintenance free lead-acid batteries.

Strap placed in P4 (NiCd) means that the output voltage is higher and therefore is able to charge batteries of the Nickel-Cadmium type. Depending on battery type the trickle voltage and the upper level shift voltage has to be adjusted. This is done by R39 and R63.

FAULT-STOP

If the temperature sensor placed at the battery is short circuited or if the battery voltage is below approx. 4V, the circuit around U2.2 will shut down the automatic charge mode until the fault is removed.

SYNCHRONISED PULSE TRIGGER

The circuit consisting of Q3, Q4, D11, D12 and C8 generates a line synchronised ramp voltage. This ramp is compared with the DC level from the current limiter U5.2 or from the voltage regulation circuit U5.1. This comparison is done by U4.1, which generate a pulse width modulated signal to control the SCR trigger pulses created by the astable multivibrator of Q5 and Q6.

OUTPUT VOLTAGE REGULATION

The U4.2 is a buffer for the remote voltage sense wires, which senses the battery voltage at the battery in order to cancel voltage loss in the cable between the charger and the battery. This circuit is protected against accidentally wrong connection of the remote sense wires. The output signal of U4.2 is led to the fault stop circuit U2.2, to the level shift circuit and to the error amplifier U5.1. The error amplifier compares the battery voltage to the reference voltage VCR to create a signal to control the duty cycle of the SCR trigger pulses, which again regulates the output voltage and the current to the battery. When the charger is in the trickle charge mode, the transistor Q8 is ON, which gives a constant output voltage, which can be adjusted by R39.

When the charger is in charge mode the output voltage has to be higher to drive maximum current into the battery, this is done by turning off Q8. The state of Q8 is controlled by the level shift circuit around U7. This is called the master configuration, where the strap of P5 is placed over pin 1 and pin 2 (MS position). If it is required to control the output voltage by an other N2164 charger unit working in parallel, the strap of P5 is placed over pin 2 and pin 3 (SL position). This is called the SLAVE configuration.

CURRENT LIMITER

The current sense resistors R24-1 to R29-1 for the current limiter circuit U5.2 are placed on the manual control (module 1). The reference voltage for the current limiter comes from D29 and is compared to the current sense voltage from module 1. The current limiter can be adjusted by means of R60.

LEVEL SHIFT CIRCUIT

The output from U4.2 is led to the voltage follower and filter U6.1. When the battery voltage is exceeding the upper level, determined by R63, the comparator U6.2 goes high. This causes the gates U7 to turn off Q9 and by R79 the Q8 is turned on in order to reduce the output voltage of the charger to trickle charge level. When the battery voltage goes under the lower level, the comparator U6.2 goes low, which again turns off the Q8 and the charger goes into charge mode and so on. The lower level is approx. 10% below the upper level. The gates U7 performs delay for the shifting time. When the charger has changed to one state, it stays there for 10 seconds before it can be changed back. This is to prevent transients to unstable the shifting from one state to the other.

The LED's is indicators to tell in what state the charger is working in. That might be useful when adjusting

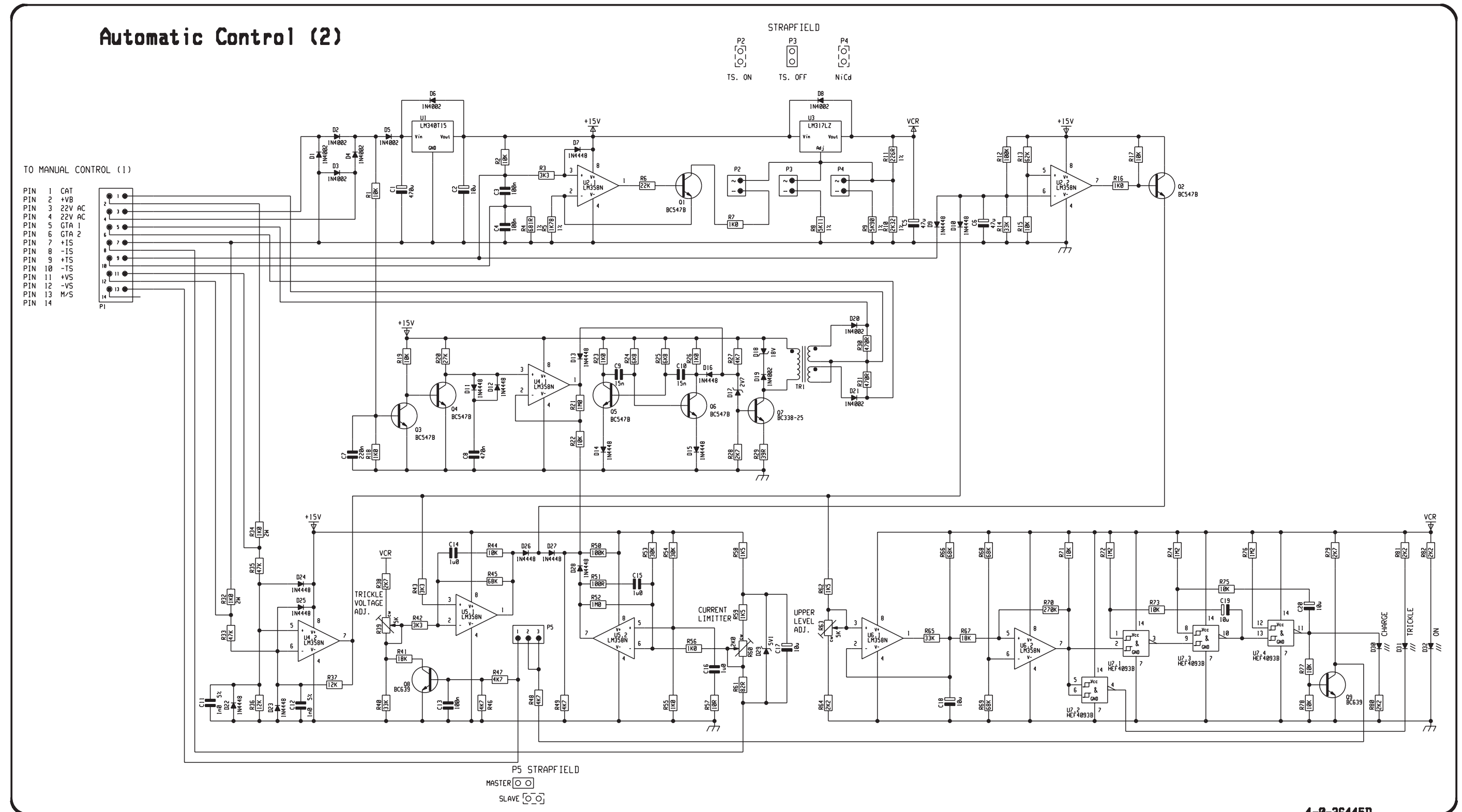
the level shift with R63. When in charge mode the D30 (marked CHARGE) is ON and when in trickle mode the D31 (marked TRICKLE) is ON. The D32 (marked ON) indicates that AC mains power is on.

COMPONENT LOCATION AUTOMATIC CONTROL MODULE 2

View from component side with upper side tracks.

Seen from component side with lower side tracks.

AUTOMATIC CONTROL MODULE 2



4-0-26445D

This diagram is valid for PCB rev. 26445C

5.3 CONNECTION / THYRISTOR UNIT (MODULE 3) PART. NO. 632137

The connection / thyristor unit also serves as a connection board for the thyristor Q1, Q2 and the diodes D1, D2 and the cable entry.

The capacitor C1 of 2.2 μ limits the dV/dT across the thyristor in order to prevent false triggering and in order to reduce the noise level into the mains.

In the connection / thyristor unit, the current sense resistors R4 to R10 and the main fuse F1 are placed together with all the main connectors for connections to the surroundings.

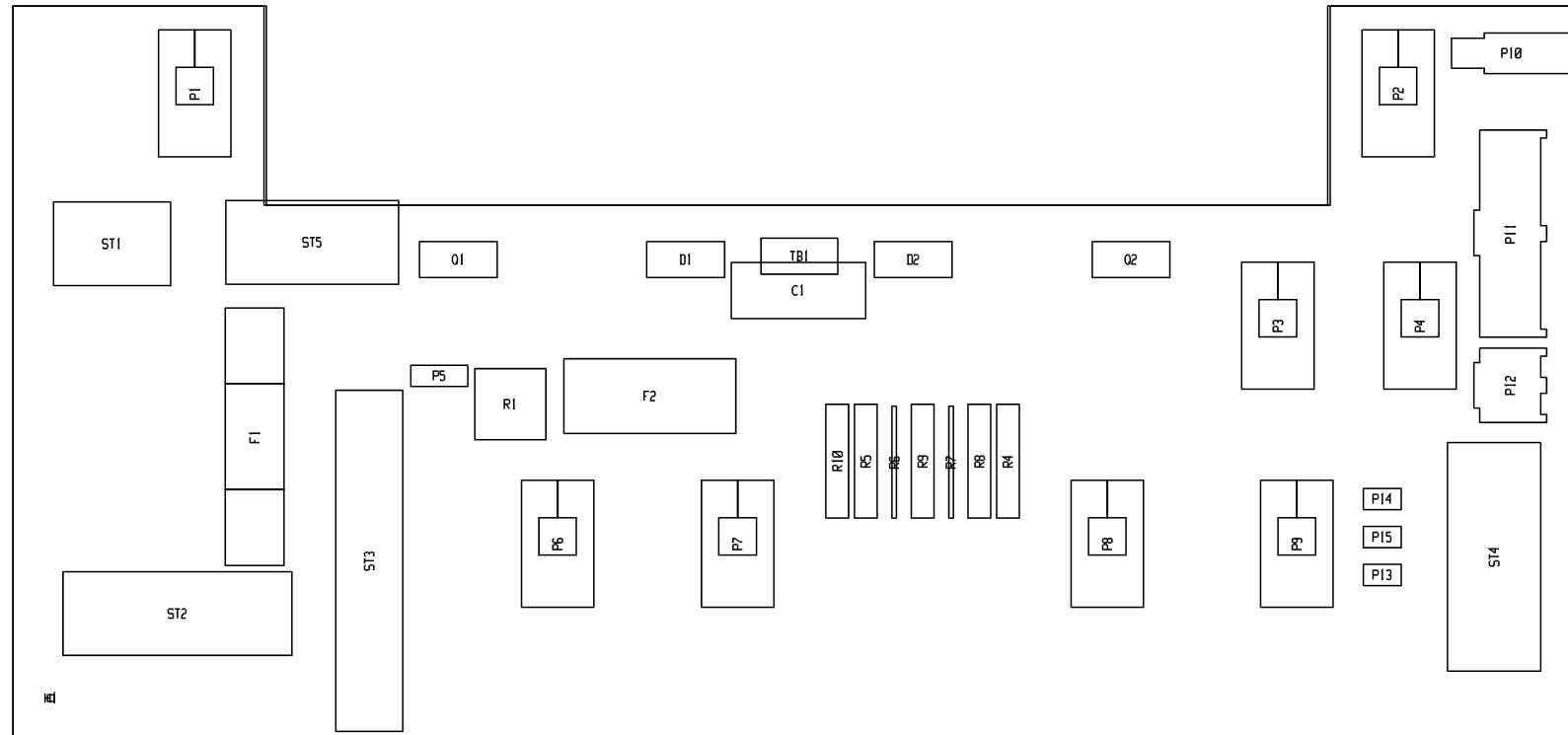
The 46V AC from TR1 is fed to the thyristor unit. The turn-on-time is controlled by the Manual/AUTO unit.

When the thyristor is turned on, a rectified AC voltage is fed to the output smoothening the capacitors C1 to C5, and through the inductor L1. When the rectified AC voltage is higher than the output voltage, the current begins to run in the inductor L1. When the rectified AC voltage again becomes smaller than the output voltage, the inductor forces the current in the thyristors to continue to zero crossing of the AC voltage. At this moment, the thyristor turns off instantly. In the next period, it is the other thyristor which is turned on by the Manual/AUTO unit. The current sense resistors R4 to R10 are used by the Amp meter to measure the output current to or from the battery.

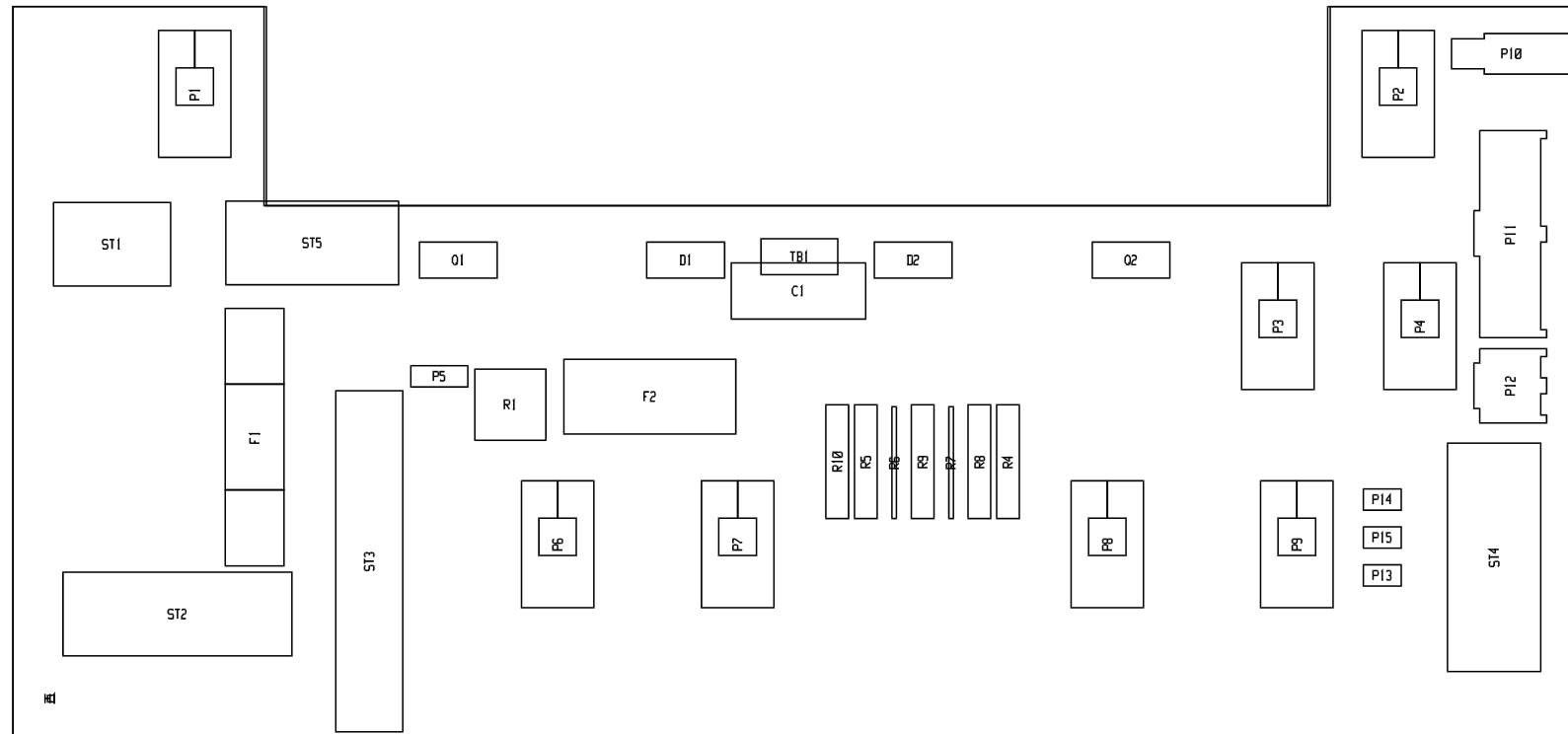
The **meter strapfield** P5 must always be set in ANALOG position.

The **service strapfield** consisting of P13, P14 and P15 might be useful during adjustment of the charger, if the REMOTE BOX H2180A is placed far away. The strapfield has the same function as the switches in H2180A. Normally the strap is placed in REMOTE position, which means the H2180A is controlling charger. Moving the strap to MAN position means that the charger is forced to charge in MANUAL mode. Moving the strap to AUTO position means that the charger is forced to charge in AUTOMATIC mode. Remember to move back the strap to REMOTE position when the adjustment of the charger is completed.

COMPONENT LOCATION CONNECTION /THYRISTOR UNIT MODULE 3

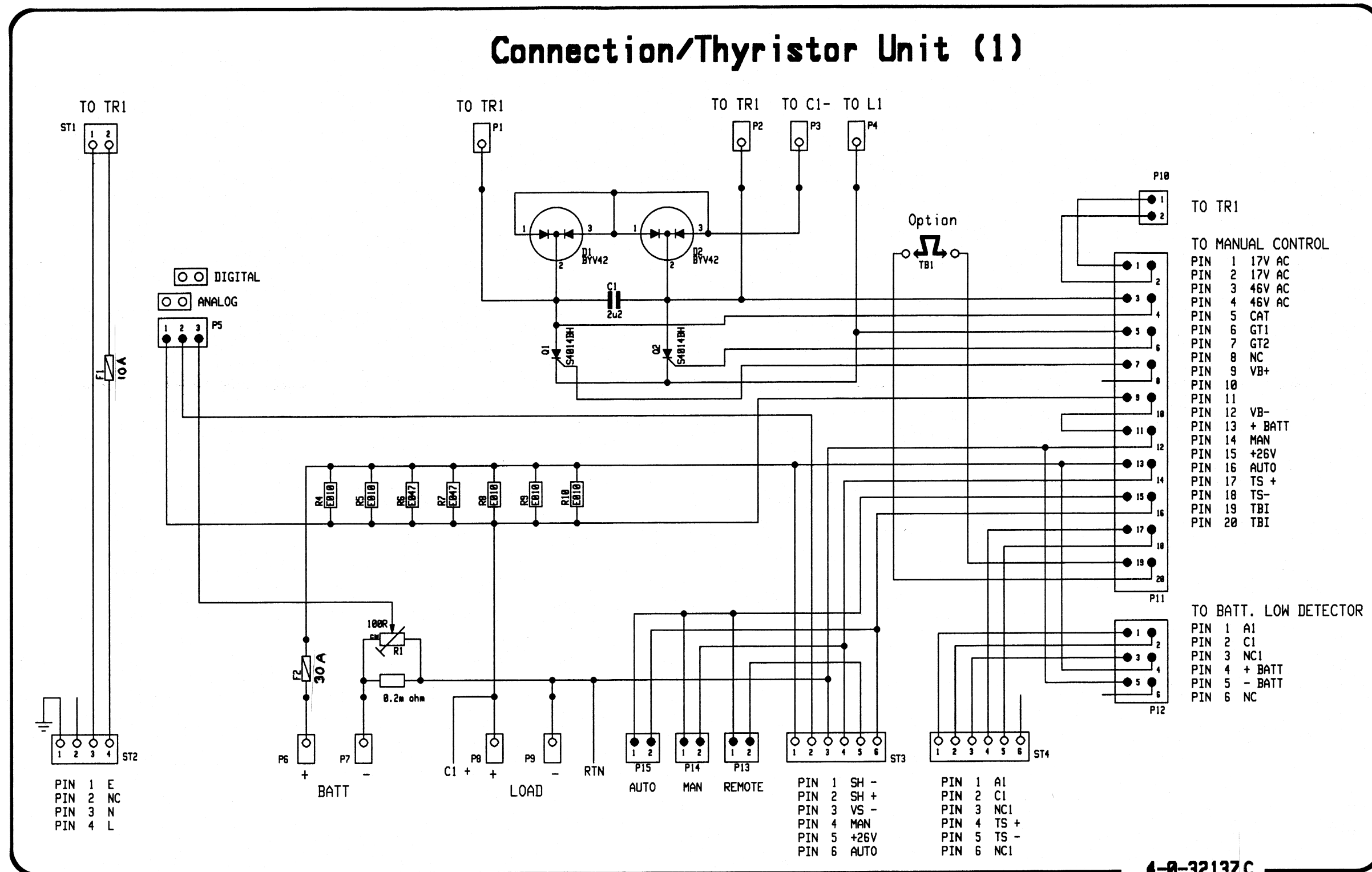


Seen from component side with upper side tracks.



Seen from component side with lower side tracks.

CONNECTION /THYRISTOR UNIT MODULE 3



This diagram is valid for PCB rev. 32137C

5.5 CIRCUIT DESCRIPTION FOR BATTERY LOW DETECTOR DUAL (MODULE 5) PART. NO. 628315

This battery low detector will only give alarm if the battery voltage has been below the alarm set point continuously for several minutes. It means it will not give alarm if the battery voltage for a short moment goes below the set point.

The circuit consists of two equal detectors that operates independent of each other. However, they can be combined to give output to one alarm unit while supervising two independent battery systems. Only one detector circuit will be described.

The detector consists of two opamps, a delay circuit and a relay output.

The first opamp acts as a level detector with a hysteresis. The hysteresis is necessary to prevent oscillating at trigger level. The upper threshold level of the hysteresis must be lower than the trigger level for the charger to start up "charge" or else the alarm is activated. On the other hand the hysteresis has to be as small as possible to ensure the battery still has some capacity left when the alarm is activated. In this case the hysteresis is approx. 0.5V.

The reference voltage is generated by the zener diode D1(D9). The alarm set point is adjusted by R4(R22) between 22.0V and 24.0V.

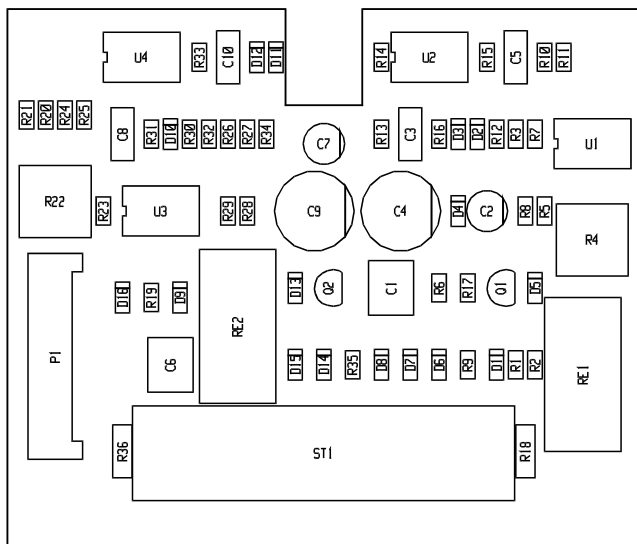
The second opamp forms a Schmitt-trigger, which delivers charge voltage for the delay circuit. The zener diode D2(D10) limits the supply voltage for the delay circuit. To ensure that the input voltage to the timer circuit is not exceeding the supply voltage the diode D3(D11) is clamping the input voltage to the supply voltage. The other diode D4(D12) is discharging the timer capacitor. It resets the delay circuit quickly when the detector is not activated.

The timer circuit has to be reset while the supply is connected. This is done by C3(C8).

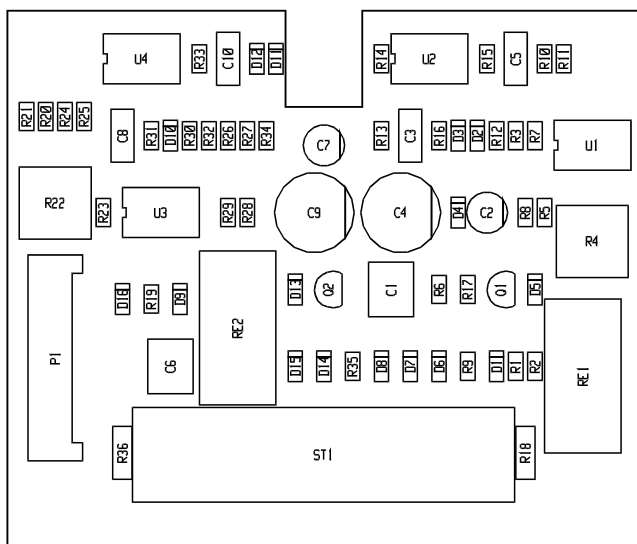
The delay time for the circuit is determined by C4(C10) and R14(R32) and is approx. 5 minutes.

If the battery voltage goes below the alarm set point determined by R4(R22) the detector U1,1(U3,1) goes low and the U1,2(U3,2) goes high. That means the timer U2(U4) is activated, but the output is not changed before the time has ran out for the timer. The timer can only change its output if the low battery voltage is constantly below the set point for several minutes. If the battery voltage for a short moment goes over the set point, the timer is instantly reset. But is the timer activated for more than 5 minutes its output goes low and the relay falls and activates the alarm connected to the relay terminals. This timer delay circuit prevents that sudden fluctuations in the battery voltage will activate the battery alarm.

COMPONENT LOCATION BATTERY LOW DETECTOR DUAL MODULE 5



Seen from component side with upper side tracks.

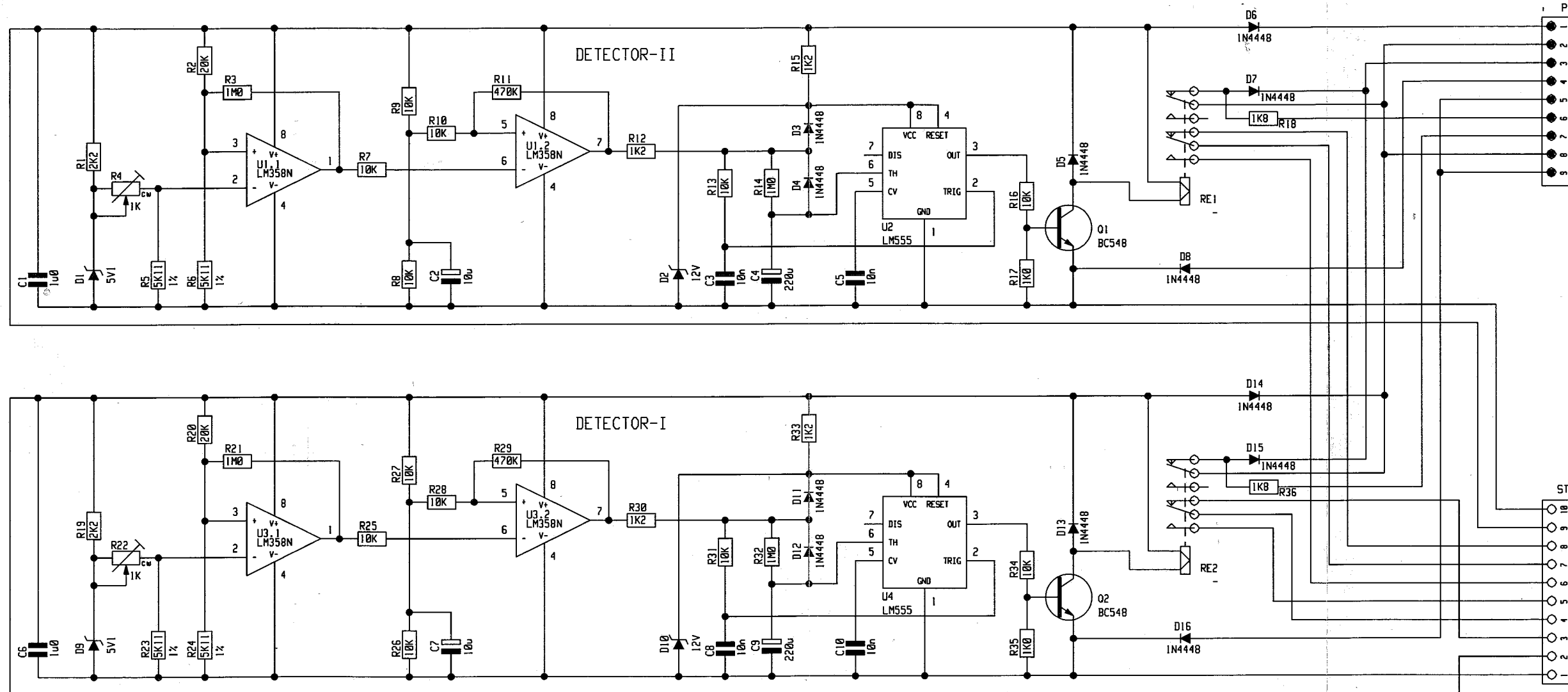


Seen from component side with lower side tracks.

PCB rev. 28315

BATTERY LOW DETECTOR DUAL MODULE 5

Battery Low Detector Dual (5)



TO INT. ALARM

- PIN 1 L1
- PIN 2 L1
- PIN 3 BUZZER
- PIN 4 L2
- PIN 5 L2
- PIN 6 AL II
- PIN 7 AL I
- PIN 8 ON/OFF
- PIN 9 COMMON

TO EXT. ALARM AND BATTERIES

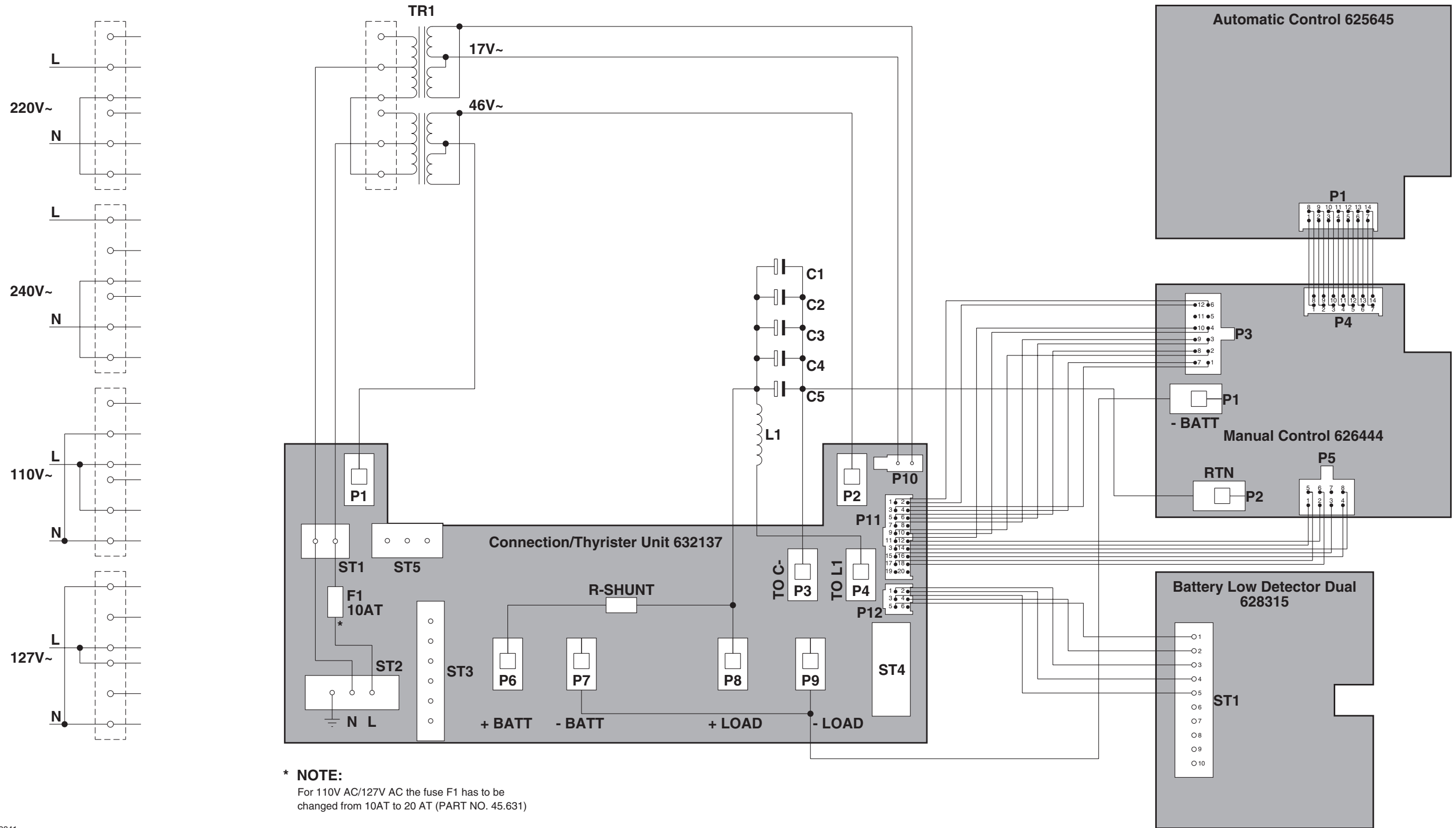
- PIN 10 -BATT. II
- PIN 9 +BATT. II
- PIN 8 A II (P3)
- PIN 7 C II (P4)
- PIN 6 NC II (P5)
- PIN 5 NC I (P5)
- PIN 4 C I (P4)
- PIN 3 A I (P3)
- PIN 2 +BATT. I
- PIN 1 -BATT. I

4-0-28315

This diagram is valid for PCB rev. 28315

5.6 MAIN SCHEMATIC DIAGRAM

VOLTAGE STRAPPING FOR TR1



* **NOTE:**
 For 110V AC/127V AC the fuse F1 has to be changed from 10AT to 20 AT (PART NO. 45.631)

CONTENTS

6 PARTSLISTS

6 PARTSLISTS

HF SSB N2164 BATTERY CHARGER		ECI A/S	802164	
POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
VARIOUS	SMALL COVER			225878
VARIOUS	COWER WITH STREAMER N2164	ECI A/S	3-0-32179	232179
VARIOUS	BASE UNIT N2164	ECI A/S		702164
VARIOUS	LASHING KIT	ECI A/S	0-0-26141	726141
VARIOUS	SCREW	HFC	1877 M5x10 PHRX-A2	87.452
VARIOUS	THUMB SCREW	O.J.D.	M3x5 DIN464	90.620
VARIOUS	MANUAL N2164 ENGLISH	S.P.RADIO A/S	4-0-32180	M2164GB

HF SSB N2164A BATTERY CHARGER 18V		ECI A/S	812164	
POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
VARIOUS	BASE UNIT N2164	ECI A/S		702164
VARIOUS	LASHING KIT FOR	ECI A/S	0-0-26141	726141
VARIOUS	BLOWER OPTION 18V	ECI A/S		73214200
VARIOUS	SCREW M5x10 PHRX-A2	HFC	HFC 1877 M5x10 PHRX-A2	87.452
VARIOUS	THUMB SCREW	O.J.D.	M3x5 DIN464	90.620
VARIOUS	MANUAL N2164 ENGLISH	S.P.RADIO A/S		M2164GB

BLOWER OPTION 18V		ECI A/S	73214200	
POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
VARIOUS	BLOWER COVER	ECI A/S	1-0-26559	226559
VARIOUS	THERMAL BREAKER ON: 70 centigrade	AIRPAX	67F070	44.056
VARIOUS	CABLES	ECI A/S	0-0-26562	526562
VARIOUS	FAN 24VDC 119x119x38mm	PAPST	4294H	60.100
VARIOUS	SPACER INSIDE THREAD	VOGT AG	M5x45x8 MS ni	63.308

BASE UNIT N2164		ECI A/S	702164	
POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
VARIOUS	INSULATION WASHER SILICONE FOIL 18x12x0.18	HAFNIA	TO-220 18x12x0.18mm	30.541
VARIOUS	INSULATION WASHER SILICONE FOIL 18x12x0.18	HAFNIA	TO-220 18x12x0.18mm	30.541
VARIOUS	MANUAL CONTROL VER. 1 (MODULE 1)	ECI A/S	626444 + VER. 1	62644401
VARIOUS	AUTO CONTROL (MODULE 2)	ECI A/S	5-0-26445C / 4-0-26445D	626445
VARIOUS	CONNECTION/THYRISTOR UNIT (MODULE 3)	ECI A/S0	5-0-32137B / 4-0-32137B	632137
VARIOUS	BATTERY LOW DETECTOR DUAL (MODULE 5)	ECI A/S	5-0-28315 / 4-0-28315	628315
C1-3	CAP. ELECTROLYTIC 10000uF -10/+50% 63VDC	ERO	EY 02 DF 510 J &	14.870
C2-3	CAP. ELECTROLYTIC 10000uF -10/+50% 63VDC	ERO	EY 02 DF 510 J &	14.870
C3-3	CAP. ELECTROLYTIC 10000uF -10/+50% 63VDC	ERO	EY 02 DF 510 J &	14.870
C4-3	CAP. ELECTROLYTIC 10000uF -10/+50% 63VDC	ERO	EY 02 DF 510 J &	14.870
C5-3	CAP. ELECTROLYTIC 10000uF -10/+50% 63VDC	ERO	EY 02 DF 510 J &	14.870
L1-3	CHOKES 2mH/20ADC	KOHSEL	Art. Nr: 96/58-5290	22.185
TR1-3	TRANSFORMER MAINS 1k3VA N2161	KOHSEL	Art. Nr.: UI120/40-5281	22.509

MANUAL CONTROL VER. 1		ECI A/S	626444 + VER. 1	62644401
POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
C1-1	CAPACITOR MKT 470nF 20% 63VDC	ERO	MKT 1826-447/06 6-G	11.188
C2-1	CAPACITOR ELECTROLYTIC 100uF -20/+50% 63VDC	CELNA	RJ2-63-V-101-M-F	14.620
C3-1	CAPACITOR MKT 100nF 5% 63VDC	PHILIPS	2222 370 79104	11.135
C4-1	CAPACITOR MKT 1u0F 5% 63VDC	ERO	MKT 1826-510/06 4-G	11.190
C5-1	CAPACITOR CERAMIC 100pF 5% NPO 50VDC	KCK	RT-HE80 SK CH 101 J	15.136
C6-1	CAPACITOR ELECTROLYTIC 470uF -20/+50% 40VDC	CERO	EKM 05 FG 347 G 05	14.650
D1-1	DIODE RECTIFIER 1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)RL	25.100
D2-1	DIODE RECTIFIER 1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)RL	25.100

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
D3-1	DIODE ZENER 20V 5%	THOMSON-CS	FBZV47C20	26.772
D4-1	DIODE ZENER 5.1V 5% 0.4W BZX79C5V1	PHILIPS	BZX79C5V1	26.527
D5-1	DIODE ZENER 18V 5% 0.4W BZX79C18	PHILIPS	BZX79C18	26.564
D6-1	DIODE RECTIFIER 1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)RL	25.100
D7-1	DIODE RECTIFIER 1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)RL	25.100
D8-1	DIODE RECTIFIER 1N4002 100V/1A	MOTOROLA	1N4002(03/04/05/06/07)RL	25.100
D9-1	DIODE ZENER 56V 5% 2WBZD23C56 BZV47C56	PHILIPS	BZD23C56	26.788
D10-1	DIODE ZENER 30V 5% 0.4W BZX79C30	PHILIPS	BZX79C30	26.578
D11-1	DIODE SHUNT REGULATORPROGRAMMABLETL431CTEXAS	TEXAS	TL431CP	26.997
D12-1	DIODE ZENER 15V 5% 0.4W BZX79C15	PHILIPS	BZX79C15	26.561
F1-1	FUSE 2AT 250V 5x20mm	LITTELFUSE	218002.	45.508
P1-1	CONNECTION ELEMENT FOR M5 SCREW	ESPERA	1-0-25860	225860
P2-1	CONNECTION ELEMENT FOR M5 SCREW	ESPERA	1-0-25860	225860
P3-1	MULTIPLUG 2x6 POLES PCB VERSION	MOLEX	39-28-1123	78.221
P4-1	PLUG 2x7 POLES	3M	3598-6002 / 7614-6002 JL	78.254
P5-1	MULTIPLUG 2x4 POLES PCB VERSION	MOLEX	39-28-1083	78.218
P6-1	PLUG 2 POLES	MOLEX	39-28-1023	78.215
Q1-1	TRANSISTOR RF SWITCH 2N2369A	MOTOROLA	2N2369A	28.315
Q2-1	TRANSISTOR PROGRAMMABLE UNIJUNCTION	MOTOROLA	2N6028	29.811
Q3-1	TRANS.POW.MOSFET N-CHANN.100V/27A/85mOHM	MOTOROLA	IRF540	29.402
Q4-1	TRANSISTOR BD680	PHILIPS	BDX47	29.338
Q5-1	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B-126	28.067
R1-1	RESISTOR PMF 1k0 OHM 5% 2W	PHILIPS	2322 194 13102	04.200
R2-1	RESISTOR MF 33k OHM 5% 0.33W	PHILIPS	2322 187 73333	02.508
R3-1	RESISTOR MF 12k OHM 5% 0.33W	PHILIPS	2322 187 73123	02.498
R4-1	PRESET CERMET 5k0 OHM 10% 0.5W	BOURNS	3386P-1-502	07.888
R5-1	RESISTOR MF 12k OHM 5% 0.33W	PHILIPS	2322 187 73123	02.498
R6-1	RESISTOR MF 220k OHM 5% 0.33W	PHILIPS	2322 187 73224	02.528
R7-1	RESISTOR MF 6k8 OHM 5% 0.33W	PHILIPS	2322 187 73682	02.492
R8-1	RESISTOR MF 8k2 OHM 5% 0.33W	PHILIPS	2322 187 73822	02.494
R9-1	RESISTOR MF 820 OHM 5% 0.33W	PHILIPS	2322 187 73821	02.470
R10-1	RESISTOR MF 10 OHM 5% 0.33W	PHILIPS	2322 187 73109	02.424
R11-1	RESISTOR MF470 OHM 5% 0.33W	PHILIPS	2322 187 73471	02.464
R12-1	RESISTOR MF470 OHM 5% 0.33W	PHILIPS	2322 187 73471	02.464
R13-1	RESISTOR MF470 OHM 5% 0.33W	PHILIPS	2322 187 73471	02.464
R14-1	RESISTOR MF470 OHM 5% 0.33W	PHILIPS	2322 187 73471	02.464
R15-1	RESISTOR MF1k0 OHM 5% 0.4W	PHILIPS	2322 181 53102	01.200
R16-1	RESISTOR MF3k3 OHM 5% 0.33W	PHILIPS	2322 187 73332	02.484
R17-1	RESISTOR MF 47 OHM 5% 0.33W	PHILIPS	2322 187 73479	02.440
R18-1	RESISTOR MF 1k8 OHM 5% 0.33W	PHILIPS	2322 187 73182	02.478
R19-1	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R20-1	RESISTOR MF 39k2 OHM 1% 0.6W	PHILIPS	2322 156 13923	03.439
R21-1	RESISTOR MF 3k92 OHM 1% 0.6W	PHILIPS	2322 156 13922	03.409
R22-1	RESISTOR MF 4k7 OHM 5% 0.33W	PHILIPS	2322 187 73472	02.488
R23-1	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R24-1	RESISTOR 47m OHM 5% 0.6W	MODULOHM I/S	98247/47U-J-MI-A-1	06.233
R25-1	RESISTOR 47m OHM 5% 0.6W	MODULOHM I/S	98247/47U-J-MI-A-1	06.233
R26-1	RESISTOR 47m OHM 5% 0.6W	MODULOHM I/S	98247/47U-J-MI-A-1	06.233
R27-1	RESISTOR 47m OHM 5% 0.6W	MODULOHM I/S	98247/47U-J-MI-A-1	06.233
R30-1	RESISTOR MF 2k67 OHM 1% 0.25W	PHILIPS	2322 157 12672	02.209
R31-1	RESISTOR MF226 OHM 1% 0.25W	PHILIPS	2322 157 12261	02.213
R32	RESISTOR MF5k6 OHM 5% 0.33W	PHILIPS	2322 187 73562	02.490
RE1-1	RELAY24VDC 2SH. 2A	OMRON	G5V-2-24 VDC	21.327
RE2-1	RELAY24VDC 2SH. 2A	OMRON	G5V-2-24 VDC	21.327
TR1-1	TRANSFORMER 3:1:1	SCHAFFNER	IT 244	22.000

AUTO CONTROL (MODULE 2)**ECI A/S****5-0-26445C / 4-0-26445D****626445**

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
C1-2	CAPACITOR ELECTROLYTIC 470uF-20/+50%40VDC	ERO	EKM 50 FG 347 G 05	14.650
C2-2	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C3-2	CAPACITOR MKT 100nF 5% 63VDC	PHILIPS	2222 370 79104	11.135
C4-2	CAPACITOR MKT 100nF 5% 63VDC	PHILIPS	2222 370 79104	11.135
C5-2	CAPACITOR ELECTROLYTIC 47uF 20% 25VDC	ELNA	RJ2-25-V-470-M-F1	14.524
C6-2	CAPACITOR ELECTROLYTIC 47uF 20% 25VDC	ELNA	RJ2-25-V-470-M-F1	14.524
C7-2	CAPACITOR MKT 220nF 10% 63VDC	PHILIPS	2222 370 78224	11.095
C8-2	CAPACITOR MKT 470nF 20% 63VDC	ERO	MKT 1826-447/06 6-G	11.188
C9-2	CAPACITOR MKT 15nF 5% 250V	ERO	MKT1818	11.170
C10-2	CAPACITOR MKT 15nF 5% 250V	ERO	MKT1818	11.170
C11-2	CAPACITOR POLYPROPYLENE 1nF 5% 10VDC	ERO	KP 1830-210/01-4-GW	13.398
C12-2	CAPACITOR POLYPROPYLENE 1nF 5% 10VDC	ERO	KP 1830-210/01-4-GW	13.398
C13-2	CAPACITOR MKT 100nF 5% 63VDC	PHILIPS	2222 370 79104	11.135

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
C14-2	CAPACITOR MKT 1uF 5% 63VDC	ERO	MKT 1826-510/06 4-G	11.190
C15-2	CAPACITOR MKT 1uF 5% 63VDC	ERO	MKT 1826-510/06 4-G	11.190
C16-2	CAPACITOR MKT 1uF 5% 63VDC	ERO	MKT 1826-510/06 4-G	11.190
C17-2	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C18-2	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C19-2	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C20-2	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
D1-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D2-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D3-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D4-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D5-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D6-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D7-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D8-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D9-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D10-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D11-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D12-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D13-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D14-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D15-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D16-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D17-2	DIODE ZENER 2V7 5% 0.4W BZX79C2V7	PHILIPS	BZX79C2V7	26.506
D18-2	DIODE ZENER 18V 5% 0.4W BZX79C18	PHILIPS	BZX79C18	26.564
D19-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D20-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D21-2	DIODE RECTIFIER 1N4002 100V/1A	THOMSON	1N4002 (03/04/05/06/07)	25.100
D22-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D23-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D24-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D25-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D26-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D27-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D28-2	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D29-2	DIODE ZENER 5.1V 5% 0.4W BZX79C5V1	PHILIPS	BZX79C5V1	26.527
D30-2	DIODE LIGHT EMITTING ø3mm RED LOW CURRENT H.P.	H.P.	HLMP-K150-OPTION 002	25.662
D31-2	DIODE LIGHT EMITTING ø3mm RED LOW CURRENT H.P.	H.P.	HLMP-K150-OPTION 002	25.662
D32-2	DIODE LIGHT EMITTING ø3mm RED LOW CURRENT H.P.	H.P.	HLMP-K150-OPTION 002	25.662
P1-2	PLUG 2x7 POLES	3M	3598-6002 / 7614-6002 JL	78.254
P2-2	PLUG 1/10" SIL SQ.PINS 2 POLES	AMP	0-826629-2	78.322
P3-2	PLUG 1/10" SIL SQ.PINS 2 POLES	AMP	0-826629-2	78.322
P4-2	PLUG 1/10" SIL SQ.PINS 2 POLES	AMP	0-826629-2	78.322
P5-2	PLUG 1/10" SIL SQ.PINS 3 POLES	AMP	0-826629-3 (0-826647-3)	78.323
Q1-2	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q2-2	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q3-2	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q4-2	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q5-2	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q6-2	TRANSISTOR AF BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q7-2	TRANSISTOR AF BC338-25 NPN TO-92	PHILIPS	BC338-25	28.058
Q8-2	TRANSISTOR AF NPN BC639 TO-92	PHILIPS	BC639	28.120
Q9-2	TRANSISTOR AF NPN BC639 TO-92	PHILIPS	BC639	28.120
R1-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R2-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R3-2	RESISTOR MF 3k3 OHM 5% 0.33W	PHILIPS	2322 187 73332	02.484
R4-2	RESISTOR MF 681 OHM 1% 0.25W	PHILIPS	2322 157 16811	02.223
R5-2	RESISTOR MF 1k78 OHM 1% 0.25W	PHILIPS	2322 157 11782	02.205
R6-2	RESISTOR MF 22k OHM 5% 0.33W	PHILIPS	2322 187 73223	02.504
R7-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R8-2	RESISTOR MF 5k11 OHM 1% 0.25W	PHILIPS	2322 157 15112	02.228
R9-2	RESISTOR MF 5k90 OHM 1% 0.25W	PHILIPS	2322 157 15902	02.220
R10-2	RESISTOR MF 2k32 OHM 1% 0.25W	PHILIPS	2322 157 12322	02.225
R11-2	RESISTOR MF 226 OHM 1% 0.25W	PHILIPS	2322 157 12261	02.213
R12-2	RESISTOR MF 100k OHM 5% 0.33W	PHILIPS	2322 187 73104	02.520
R13-2	RESISTOR MF 62k OHM 5% 0.33W	PHILIPS	2322 187 73623	02.515
R14-2	RESISTOR MF 33k OHM 5% 0.33W	PHILIPS	2322 187 73333	02.508
R15-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R16-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R17-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R18-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R19-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R20-2	RESISTOR MF 27k OHM 5% 0.33W	PHILIPS	2322 187 73273	02.506
R21-2	RESISTOR MF 1M OHM 5% 0.33W	PHILIPS	2322 187 73105	02.544
R22-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R23-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
R24-2	RESISTOR MF 6k8 OHM 5% 0.33W	PHILIPS	2322 187 73682	02.492
R25-2	RESISTOR MF 6k8 OHM 5% 0.33W	PHILIPS	2322 187 73682	02.492
R26-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R27-2	RESISTOR MF 4k7 OHM 5% 0.33W	PHILIPS	2322 187 73472	02.488
R28-2	RESISTOR MF 2k7 OHM 5% 0.33W	PHILIPS	2322 187 73272	02.482
R29-2	RESISTOR MF 39 OHM 5% 0.33W	PHILIPS	2322 187 73399	02.438
R30-2	RESISTOR MF 470 OHM 5% 0.33W	PHILIPS	2322 187 73471	02.464
R31-2	RESISTOR MF 470 OHM 5% 0.33W	PHILIPS	2322 187 73471	02.464
R32-2	RESISTOR PMF 1k0 OHM 5% 2W	PHILIPS	2322 194 13102	04.200
R33-2	RESISTOR MF 47k OHM 5% 0.33W	PHILIPS	2322 187 73473	02.512
R34-2	RESISTOR PMF 1k0 OHM 5% 2W	PHILIPS	2322 194 13102	04.200
R35-2	RESISTOR MF 47k OHM 5% 0.33W	PHILIPS	2322 187 73473	02.512
R36-2	RESISTOR MF 12k OHM 5% 0.33W	PHILIPS	2322 187 73123	02.498
R37-2	RESISTOR MF 12k OHM 5% 0.33W	PHILIPS	2322 187 73123	02.498
R38-2	RESISTOR MF 2k7 OHM 5% 0.33W	PHILIPS	2322 187 73272	02.482
R39-2	PRESET CERMET 5k0 OHM 10% 0.5W	BOURNS	3386P-1-502	07.888
R40-2	RESISTOR MF 33k OHM 5% 0.33W	PHILIPS	2322 187 73333	02.508
R41-2	RESISTOR MF18k OHM 5% 0.33W	PHILIPS	2322 187 73183	02.502
R42-2	RESISTOR MF 3k3 OHM 5% 0.33W	PHILIPS	2322 187 73332	02.484
R43-2	RESISTOR MF 3k3 OHM 5% 0.33W	PHILIPS	2322 187 73332	02.484
R44-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R45-2	RESISTOR MF 68k OHM 5% 0.33W	PHILIPS	2322 187 73683	02.516
R46-2	RESISTOR MF 4k7 OHM 5% 0.33W	PHILIPS	2322 187 73472	02.488
R47-2	RESISTOR MF 4k7 OHM 5% 0.33W	PHILIPS	2322 187 73472	02.488
R48-2	RESISTOR MF 4k7 OHM 5% 0.33W	PHILIPS	2322 187 73472	02.488
R49-2	RESISTOR MF 4k7 OHM 5% 0.33W	PHILIPS	2322 187 73472	02.488
R50-2	RESISTOR MF 100k OHM 5% 0.33W	PHILIPS	2322 187 73104	02.520
R51-2	RESISTOR MF 100 OHM 5% 0.33W	PHILIPS	2322 187 73101	02.448
R52-2	RESISTOR MF 1M OHM 5% 0.33W	PHILIPS	2322 187 73105	02.544
R53-2	RESISTOR MF 30k OHM 5% 0.33W	PHILIPS	2322 187 73303	02.507
R54-2	RESISTOR MF 30k OHM 5% 0.33W	PHILIPS	2322 187 73303	02.507
R55-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R56-2	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R57-2	RESISTOR MF 10 OHM 5% 0.33W	PHILIPS	2322 187 73109	02.424
R58-2	RESISTOR MF 1k5 OHM 5% 0.33W	PHILIPS	2322 187 73152	02.476
R59-2	RESISTOR MF 1k5 OHM 5% 0.33W	PHILIPS	2322 187 73152	02.476
R60-2	PRESET CERMET 2k0 OHM 5% 0.5W	BOURNS	3386P-1-202-11	07.887
R61-2	RESISTOR MF 82 OHM 5% 0.33W	PHILIPS	2322 187 73829	02.446
R62-2	RESISTOR MF 1k5 OHM 5% 0.33W	PHILIPS	2322 187 73152	02.476
R63-2	PRESET CERMET 5k0 OHM 10% 0.5W	BOURNS	3386P-1-502	07.888
R64-2	RESISTOR MF 2k2 OHM 5% 0.33W	PHILIPS	2322 187 73222	02.480
R65-2	RESISTOR MF 33k OHM 5% 0.33W	PHILIPS	2322 187 73333	02.508
R66-2	RESISTOR MF 68k OHM 5% 0.33W	PHILIPS	2322 187 73683	02.516
R67-2	RESISTOR MF 18k OHM 5% 0.33W	PHILIPS	2322 187 73183	02.502
R68-2	RESISTOR MF 68k OHM 5% 0.33W	PHILIPS	2322 187 73683	02.516
R69-2	RESISTOR MF 68k OHM 5% 0.33W	PHILIPS	2322 187 73683	02.516
R70-2	RESISTOR MF 270k OHM 5% 0.33W	PHILIPS	2322 187 73274	02.530
R71-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R72-2	RESISTOR MF 1M2 OHM 5% 0.33W	PHILIPS	2322 187 73125	02.546
R73-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R74-2	RESISTOR MF 1M2 OHM 5% 0.33W	PHILIPS	2322 187 73125	02.546
R75-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R76-2	RESISTOR MF 1M2 OHM 5% 0.33W	PHILIPS	2322 187 73125	02.546
R77-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R78-2	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R79-2	RESISTOR MF 2k7 OHM 5% 0.33W	PHILIPS	2322 187 73272	02.482
R80-2	RESISTOR MF 2k2 OHM 5% 0.33W	PHILIPS	2322 187 73222	02.480
R81-2	RESISTOR MF 2k2 OHM 5% 0.33W	PHILIPS	2322 187 73222	02.480
R82-2	RESISTOR MF 2k2 OHM 5% 0.33W	PHILIPS	2322 187 73222	02.480
TR1-2	TRANSFORMER 3:1:1	SCHAFFNER	IT 244	22.000
U1-2	POS. VOLTAGE REG. 15V/1A	MOTOROLA	MCT7815CT (MCT7815BT)	31.090
U2-2	DUAL OP AMP LM358N	TEXAS	LM358P	31.100
U3-2	VOLTAGE REG. ADJUSTABLE I _o =0.1A LM317L	TEXAS	TL317CLP	31.145
U4-2	DUAL OP AMP LM358N	TEXAS	LM358P	31.100
U5-2	DUAL OP AMP LM358N	TEXAS	LM358P	31.100
U6-2	DUAL OP AMP LM358N	TEXAS	LM358P	31.100
U7-2	QUAD 2-INP.NAND SCHM.TRI	MOTOROLA	MC14093BCP	33.300

CONNECTION/THYRISTOR UNIT (MODULE 3)**ECI A/S****5-0-32137B / 4-0-32137B****632137**

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
VARIOUS	FUSE CLIP 1/4" PCB TYPE	LITTELFUSE	102 071	78.389
VARIOUS	FUSE HOLDER 1 POLE ATO BLADE FUSES	PUDENZ	178.6165.0002	78.499

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
C1-3	CAPACITOR MKT 2.2uF 5% 63V	ERO	MKT1822	11.141
D1-3	DIODE DUAL 2x15A/200VDC TO-220 BNYV42-200	PHILIPS	BYV42-200	27.161
D2-3	DIODE DUAL 2x15A/200VDC TO-220 BNYV42-200	PHILIPS	BYV42-200	27.161
F1-3	FUSE 10AF 6.3x32mm	LITTELFUSE	314010.	45.634
F2-3	ATO BLADE FUSE 30AF COLOURED GREEN	LITTELFUSE	257030	45.667
P1-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P2-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P3-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P4-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P5-3	PLUG 1/10" SIL SQ.PINS 3 POLES	AMP	0-826629-3 (0-826647-3)	78.323
P6-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P7-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P8-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P9-3	CONNECTION ELEMENT FOR M5 SCREW	ECI A/S	1-0-25860	225860
P10-3	PLUG 2POLES	MOLEX	39-28-1023	78.215
P11-3	STRAIGHT SHROUDED HEADER 2x10 POLES	MOLEX	90130-1220	78.846
P12-3	STRAIGHT SHROUDED HEADER 2x3 POLES	MOLEX	90130-1206	78.840
P13-3	PLUG 1/10" SIL SQ.PINS 2 POLES	AMP	0-826629-2	78.322
P14-3	PLUG 1/10" SIL SQ.PINS 2 POLES	AMP	0-826629-2	78.322
P15-3	PLUG 1/10" SIL SQ.PINS 2 POLES	AMP	0-826629-2	78.322
Q1-3	SCR 200V/40A rms TO-220 S4014BH/S4012BH	TAG	S4014BH	29.930
Q2-3	SCR 200V/40A rms TO-220 S4014BH/S4012BH	TAG	S4014BH	29.930
R1-3	PRESET CERMET 100 OHM 10% 0.5W	BOURNS	3386P-1-101	07.883
R4-3	RESISTOR 10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R5-3	RESISTOR 10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R6-3	RESISTOR 47m OHM 5% 0.6W	MODULOHM I/S	98247/47U-J-MI-A-1	06.233
R7-3	RESISTOR 47m OHM 5% 0.6W	MODULOHM I/S	98247/47U-J-MI-A-1	06.233
R8-3	RESISTOR 10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R9-3	RESISTOR 10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R10-3	RESISTOR 10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
ST1-3	TERMINAL BLOCK 2 POLES 2.5mm ²	PTR	AK110/2DS m.MESS.SKRUER	81.035
ST2-3	TERMINAL BLOCK 4 POLES 2.5mm ²	PTR	AK110/4DS m.MESS.SKRUER	81.038
ST3-3	TERMINAL BLOCK 6 POLES 2.5mm ²	PTR	AK110/6DS m.MESS.SKRUER	81.039
ST4-3	TERMINAL BLOCK 6 POLES 1.5mm ²	PTR	AK300/6b m.MESS.SKRUER	81.016
TB1-3	THERMAL BREAKER ON: 70 centigrade	AIRPAX	67F070	44.056

BATTERY LOW DETECTOR DUAL (MODULE 5)	ECI A/S	5-0-28315 / 4-0-28315	628315
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POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
C1-5	CAPACITOR MKT 1uF 10% 63VDC	PHILIPS	2222 370 78105	11.137
C2-5	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C3-5	CAPACITOR CERAMIC 10nF -20/+80% 50VDC CL2	SIEMENS	B37981-F5103-M-AMMO PACK/	16.302
C4-5	CAPACITOR ELECTROLYTIC 220uF 20% 25VDC	ELNA	RJ2-25-V-221-M-T2	14.647
C5-5	CAPACITOR CERAMIC 10nF -20/+80% 50VDC CL2	SIEMENS	B37981-F5103-M-AMMO PACK/	16.302
C6-5	CAPACITOR MKT 1uF 10% 63VDC	PHILIPS	2222 370 78105	11.137
C7-5	CAPACITOR ELECTROLYTIC 10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-T34(T58)	14.512
C8-5	CAPACITOR CERAMIC 10nF -20/+80% 50VDC CL2	SIEMENS	B37981-F5103-M-	16.302
C9-5	CAPACITOR ELECTROLYTIC 220uF 20% 25VDC	ELNA	RJ2-25-V-221-M-T2	14.647
C10-5	CAPACITOR CERAMIC 10nF -20/+80% 50VDC CL2	SIEMENS	B37981-F5103-M	16.302
D1-5	DIODE ZENER 5.1V 5% 0.4W BZX79C5V1	PHILIPS	BZX79C5V1	26.527
D2-5	DIODE ZENER 12V 5% 0.4W BZX79C12	PHILIPS	BZX79C12	26.554
D3-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D4-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D5-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D6-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D7-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D8-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D9-5	DIODE ZENER 5.1V 5% 0.4W BZX79C5V1	PHILIPS	BZX79C5V1	26.527
D10-5	DIODE ZENER 12V 5% 0.4W BZX79C12	PHILIPS	BZX79C12	26.554
D11-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D12-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D13-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D14-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D15-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
D16-5	DIODE HIGH SPEED 1N4448	PHILIPS	1N4448	25.147
P1-5	PLUG (MALE) 9 POLE	AMP	0-826375-9	78.109
Q1-5	TRANSISTOR AF BC548 NPN TO-92	PHILIPS	BC548 (-A/-B/-C)	28.070
Q2-5	TRANSISTOR AF BC548 NPN TO-92	PHILIPS	BC548 (-A/-B/-C)	28.070
R1-5	RESISTOR MF 2k2 OHM 5% 0.33W	PHILIPS	2322 187 73222	02.480
R2-5	RESISTOR MF 20k OHM 5% 0.33W	PHILIPS	2322 187 73203	02.503
R3-5	RESISTOR MF 1M OHM 5% 0.33W	PHILIPS	2322 187 73105	02.544
R4-5	PRESET CERMET 1k0 OHM 10% 0.5W	BOURNS	3386P-1-102	07.886
R5-5	RESISTOR MF 5k11 OHM 1% 0.25W	PHILIPS	2322 157 15112	02.228

6 PARTSLIST

N2164

POSITION	DESCRIPTION	MANUFACTOR	TYPE	PART NO.
R6-5	RESISTOR MF 5k11 OHM 1% 0.25W	PHILIPS	2322 157 15112	02.228
R7-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R8-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R9-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R10-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R11-5	RESISTOR MF 470k OHM 5% 0.33W	PHILIPS	2322 187 73474	02.536
R12-5	RESISTOR MF 1k2 OHM 5% 0.33W	PHILIPS	2322 187 73122	02.474
R13-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R14-5	RESISTOR MF 1M OHM 5% 0.33W	PHILIPS	2322 187 73105	02.544
R15-5	RESISTOR MF 1k2 OHM 5% 0.33W	PHILIPS	2322 187 73122	02.474
R16-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R17-5	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R18-5	RESISTOR MF 1k8 OHM 5% 0.4W	PHILIPS	2322 181 53182	01.206
R19-5	RESISTOR MF 2k2 OHM 5% 0.33W	PHILIPS	2322 187 73222	02.480
R20-5	RESISTOR MF 20k OHM 5% 0.33W	PHILIPS	2322 187 73203	02.503
R21-5	RESISTOR MF 1M OHM 5% 0.33W	PHILIPS	2322 187 73105	02.544
R22-5	PRESET CERMET 1k0 OHM 10% 0.5W	BOURNS	3386P-1-102	07.886
R23-5	RESISTOR MF 5k11 OHM 1% 0.25W	PHILIPS	2322 157 15112	02.228
R24-5	RESISTOR MF 5k11 OHM 1% 0.25W	PHILIPS	2322 157 15112	02.228
R25-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R26-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R27-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R28-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R29-5	RESISTOR MF 470k OHM 5% 0.33W	PHILIPS	2322 187 73474	02.536
R30-5	RESISTOR MF 1k2 OHM 5% 0.33W	PHILIPS	2322 187 73122	02.474
R31-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R32-5	RESISTOR MF 1M OHM 5% 0.33W	PHILIPS	2322 187 73105	02.544
R33-5	RESISTOR MF 1k2 OHM 5% 0.33W	PHILIPS	2322 187 73122	02.474
R34-5	RESISTOR MF 10k OHM 5% 0.33W	PHILIPS	2322 187 73103	02.496
R35-5	RESISTOR MF 1k0 OHM 5% 0.33W	PHILIPS	2322 187 73102	02.472
R36-5	RESISTOR MF 1k8 OHM 5% 0.4W	PHILIPS	2322 181 53182	01.206
RE1-5	RELAY 24VDC 2SH. 2A	OMRON	G5V-2-24 VDC	21.327
RE2-5	RELAY 24VDC 2SH. 2A	OMRON	G5V-2-24 VDC	21.327
ST1-5	TERMINAL BLOCK 10 POLES 1.5mm ²	PTR	AK300/10b m.MESS.SKRUER	81.017
U1-5	DUAL OP AMP LM358N	MOTOTOLA	LM 358N	31.100
U2-5	TIMER „555“ DIL 8	MOTOROLA	MC 1455 P1	31.205
U3-5	DUAL OP AMP LM358N	MOTOTOLA	LM 358N	31.100
U4-5	TIMER „555“ DIL 8	MOTOROLA	MC 1455 P1	31.205