MAC 500 (MicroSmart)
Servicing Instructions

Version 2.xx

227 470 35 Revision D

marquette

A GE Medical Systems Company

Caution:
During repairs/service interventions, observe the protective measures against damage due to ESD.

* Marquette Hellige GmbH considers itself responsible for the effects on safety, reliability, and performance of the equipment, only if:

  - assembly operations, extensions, readjustments, modifications, or repairs are carried out by Marquette Hellige GmbH or by persons authorized by Marquette Hellige GmbH,

  - the electrical installation of the relevant room complies with the applicable national and local requirements, and

  - the instrument is used in accordance with the instructions for use.

* This manual contains service information; operating instructions are provided in the operator's manual of the instrument.

* This manual is in conformity with the instrument at printing date.

*

Printed in Germany

Contents

Revision History

Each page of this manual has the document number followed by a revision letter, located at the top of the page. This letter identifies the manual update level. The latest letter of the alphabet corresponds to the most current revision of the document.

The revision history of this manual is summarized below.

Date	Revision	Remarks
September 1997	A	Initial release of Dervicing Instructions
November 1997	B	Update type of appliance, changed part number of the PCBs
March 1999	C	ECO no.: 061918; new logo/firmname, serial number entry via keypad
May 2000	D	ECO 064 689, Changed name from MicroSmart to MAC 500

1 Documentation and nomenclature of Marquette Hellige instrument part Nos

1.1 Configuration of instrument part No

The instrument part No comprises 8 digits, the first 6 digits determining the instrument type, the last 2 digits the instrument version. The language is determined by configuration, thus having no influence on the part No.

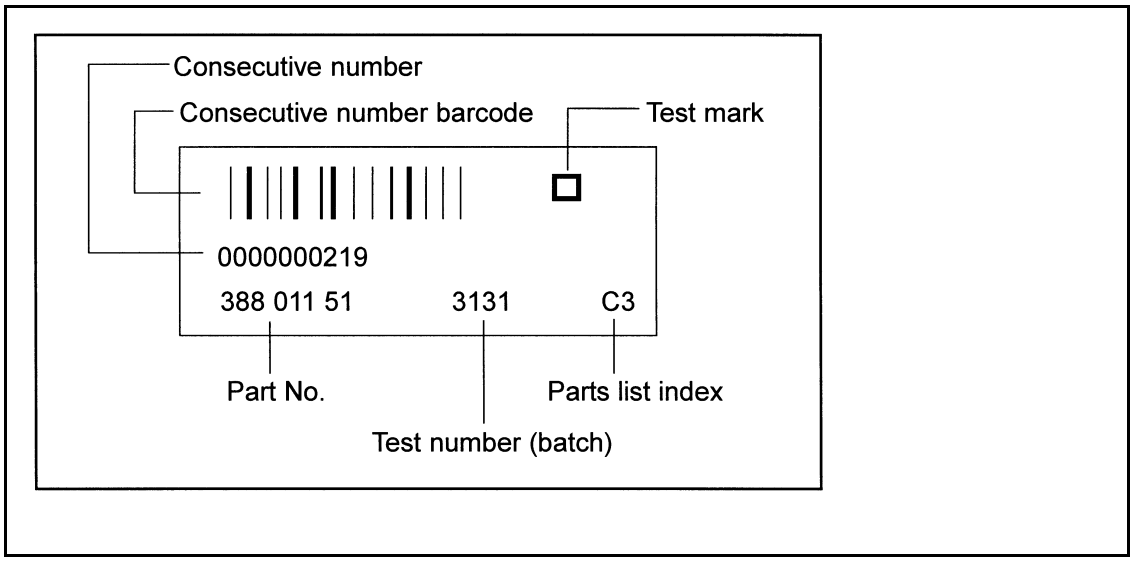
E.g.	**Instrument Type**	**Version**
	MAC 500, intern.	101 134 09
	MAC 500, intern. with measurement, IR	101 134 10
	MAC 500 USA	101 134 11
	MAC 500 USA with measurement, IR	101 134 12

1.2 Configuration of the PCB part Nos

388 xxx yy Spare part numbers for the operative PCBs.

The instrument documentation, e.g., reference diagrams, circuit diagrams and parts lists are listed under this part No.
The 388 number is located on the barcode label.

Configuration of the barcode labels:



303 xxx yy Spare part numbers for PCBs tested especially thoroughly

303 numbers are only given to PCBs where the level of testing applied to 388 PCBs is inadequate for implementation when servicing in the field, or where only a complete set of PCBs can be replaced in the field.
In addition to a barcode label (388 number) 303 part Nos also have an additional label with a 303 number and are to be found in the spare parts list under this number.

389 xxx yy Replacement numbers for defective PCBs

Where servicing is required 389 PCBs are available for the replacement of some PCBs. When using a replacement PCB (389 part No) the defective PCB is to be returned to the Freiburg factory. Replacement PCB part Nos are included in the spare parts list.
389 PCBs have an additional adhesive label.

1.3 Instrument status documentation (nominal status)

Due to the hardware and software combination unambiguous documentation of the instrument assembly status is necessary, also in the event of repairs.

This documentation comprises the following documents and measures:

Master Record Index (MRI)

This document is a component of this instrument documentation.

This document states the combination of permissible hardware and software for a particular instrument version. The permissible PCB Index is given in the “Index” column with each update delivered. Further permissible PCB Indexes are given in the “compatible” column. The PCB Index can be found in the PCB barcode label.

Product Status Index

This document is created during manufacture. The Product Status Index documents the hardware/software product status.

2 Description of the unit

These service instructions for the V2.x version of the unit describe both the MAC 500 (MicroSmart) as well as the MAC 500 with measurement and communication (101 134 10). Unless a note appears to the contrary, this description applies to both the MAC 500 (MicroSmart), and the MAC 500 with measurement and communication (101 134 10).

MAC 500 (MicroSmart) is a portable cardiograph with integrated printer drive. It is designed to record, register and process ECG signals. It is designed both for mains and battery operation, operation without battery is also possible. A power supply unit and battery are integrated in the unit.

MAC 500 with measurement and communication (101 134 10) also includes in the "Auto" mode the measurement of the ECGs and registration of the measurement results.

MAC 500 (MicroSmart) and MAC 500 with measurement and communication are based on the same hardware platform.

The following versions of MAC 500 (MicroSmart) are available:

101 134 01	MicroSmart (international)	100...240V~
101 134 02	MicroSmart MC (international), measurement + IR	100...240V~
101 134 03	MicroSmart (Asia)	100...240V~
101 134 04	MicroSmart M (USA), measurement	100...240V~
101 134 05	MicroSmart MC (Asia), measurement + IR	100...240V~
101 134 06	MicroSmart (USA)	100...240V~
101 134 07	MicroSmart (inter. 5-pin)	100...240V~
101 134 08	MAC 500 (USA), measurement	100...240 V~

standardization since May 2000

101 134 09	MAC 500 (international)	100...240V~
101 134 10	MAC 500 (international), measurement + communication	100...240V~
101 134 11	MAC 500 (USA)	100...240V~
101 134 12	MAC 500 (USA), measurement	100...240V~

The hardware consists of the following function blocks:

- MAC 500 (MicroSmart) PCB
- power supply module
- battery
- keyboard
- printer drive

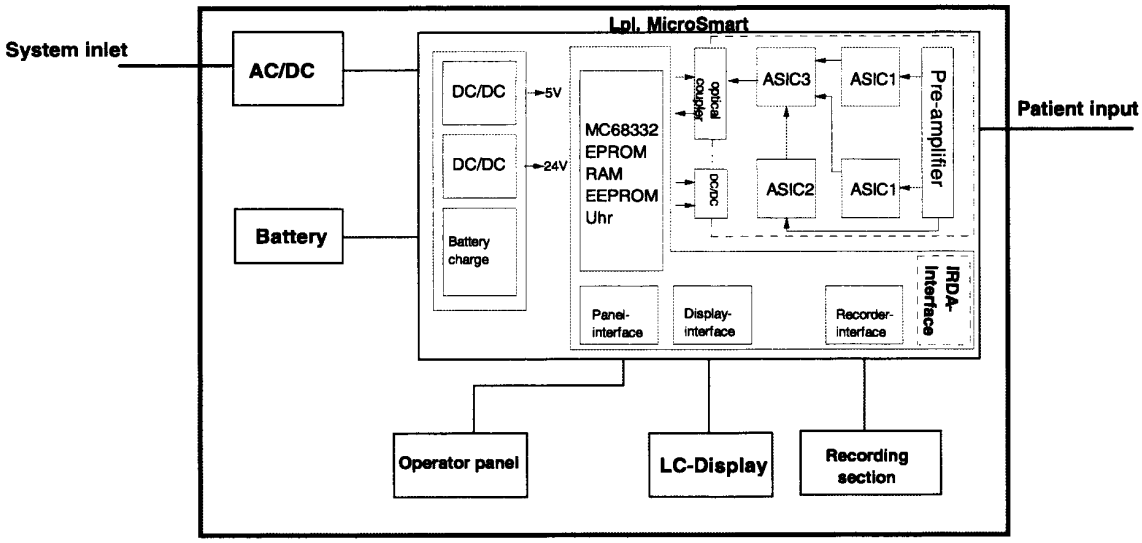
The following function blocks are implemented as PCBs.

- MAC 500 (MicroSmart) PCB
- power supply

The patient input, which is a component of the MAC 500 (MicroSmart) PCB, is mounted on the power supply module and connected to the MAC 500 (MicroSmart) PCB via a flexible supply line.

The intended use, the functions available and operation of MAC 500 (MicroSmart) are described in the instructions for use.

2.1 Block diagram, total unit



2.2 Mechanical structure

The major mechanical components of MAC 500 (MicroSmart) are the **top and bottom shell.** The bottom shell is the basic element carrying the following sub-assemblies:

- Power supply module with system inlet, power supply unit and patient input.
- Battery
- Thermal array drive with paper magazine
- PCB MAC 500 (MicroSmart) with display

The top shell holds the keyboard which is linked to the PCB MAC 500 (MicroSmart) via a flexible cable.

The 15-pin inlet plug for **connecting the patient lead** is located at the power supply module. It is linked to the PCB MAC 500 (MicroSmart) via a flexible cable.

3 Description of the function

The description of the individual function blocks follows the **Block diagram** of the total unit **in chapter 1.1** and the **function blocks of the P plans.**

3.1 Power supply module

The power supply module comprises the following functions:

- System inlet with fuses
- Extended range power supply
- Patient input

These components are mounted on a carrier plate bolted into the bottom shell of the enclosure.

3.1.1 System inlet

The system inlet is defined as a system inlet module. It includes a three-pin IEC plug and two size 5 X 20 fuses accessible from the outside. The module is a component with snap-type function.

The system inlet is designed as "Universal Input", with the effect that no adjustment to the system voltage ranges 100V~ ... 120V~ or 220V~ ... 240V~ is required.

3.1.2 Extended range power supply

The AC/DC power supply is designed as a universal extended range power supply. The power supply unit is purchased complete and mounted on the carrier plate. The power supply supplies an output voltage of 15.6V, from which all required voltages are generated.

- Input voltage range:	90VAC...264VAC
- Frequency range:	49Hz...65Hz
- Output:	40W max.
- Efficiency	≥ 70%
- Output voltage:	+15.6V ± 2%
- Output current:	2.6A max.
- Short-circuit-proof	
- Approvals:	IEC601, UL544, CSA22.2-125, VDE750

The connection between the AC/DC power supply and the PCB MAC 500 (MicroSmart) is implemented with a 2-pin lead as follows:

- on the AC/DC power supply: plugged
-on the PCB MAC 500 (MicroSmart): plugged

3.2 Battery

The battery is a rechargeable, maintenance-free lead battery. The battery is purchased complete and mounted on the bottom shell of the enclosure.

- Rated voltage: 12V
- Rated capacity: 1.2Ah

The connection between the battery and the PCB MAC 500 (MicroSmart) is implemented with a 2-pin lead as follows:

- on the battery: plugged
- on the PCB MAC 500 (MicroSmart): plugged

3.3 Printed circuit board (PCB) MAC 500 (MicroSmart)

The PCB MAC 500 (MicroSmart) holds the entire electronics of the unit. The electronics comprise the following function groups:

- Voltage supply and monitoring

  On-Off electronics
  Battery charge
  Input voltage monitoring
  Voltage supply +5V

- Computer

  Controller (Motorola 68332)
  EPROM 512KByte
  RAM 256KByte (MAC 500) or 512KByte (MAC 500 with measurement and communication)
  Configuration memory (EEPROM) 256Byte
  Reset Generation
  Alarm signal output
  Real-time clock, buffered
  Keyboard interface
  IR interface (MAC 500 with measurement and communication (101 134 10) only)

- ECG recording and pre-processing (floating side)

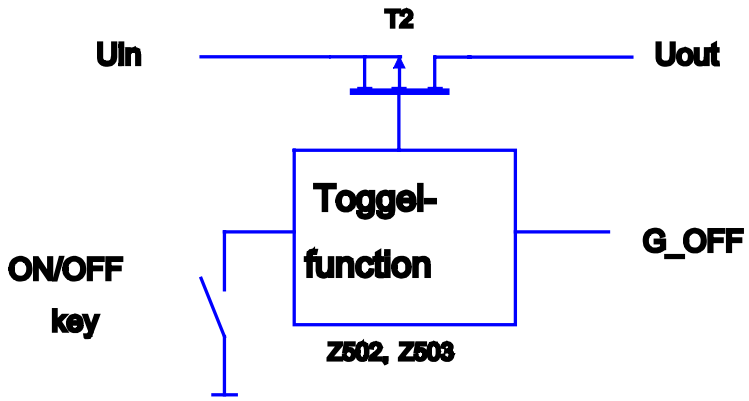
  - Protective input circuit
  - Pre-amplifier
  - AD converter
  - PACE identification
  - Electrode label
  - Conductor label
  - Filter and interface module
  - Current supply
  - Reference edit

- Drive electronics and display

  Array control
  Temperature monitoring
  Motor control
  Voltage supply +24V
  Photoelectric barrier analysis

3.3.1 Voltage supply and monitoring

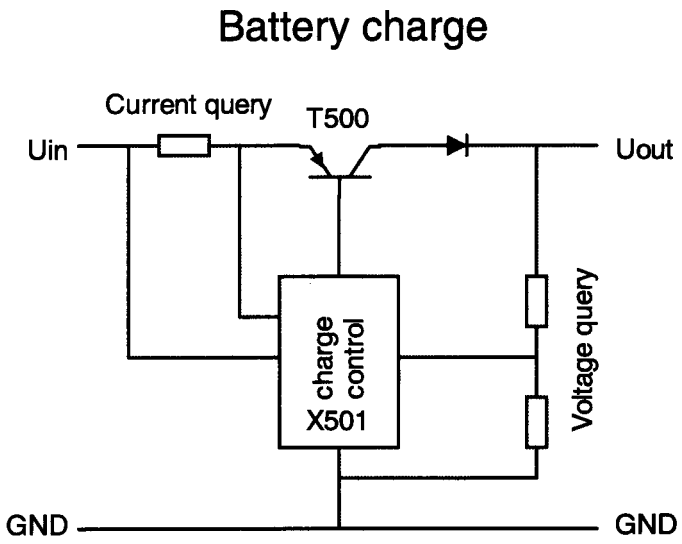
On-Off electronics



The unit is switched on and off via the ON/OFF key (on the membrane keypad). Enabling and disabling operates via a toggle function: if the unit is switched off, press the ON/OFF key to switch the unit on. If the unit is switched on, press the ON/OFF key to switch the unit off. The processor can switch the unit off via the signal lead "G_OFF" if:

- the input voltage is too low (exhaustive discharge protection for the battery)
- the unit is not operated for any length of time (approx. 5 minutes)

Battery charge



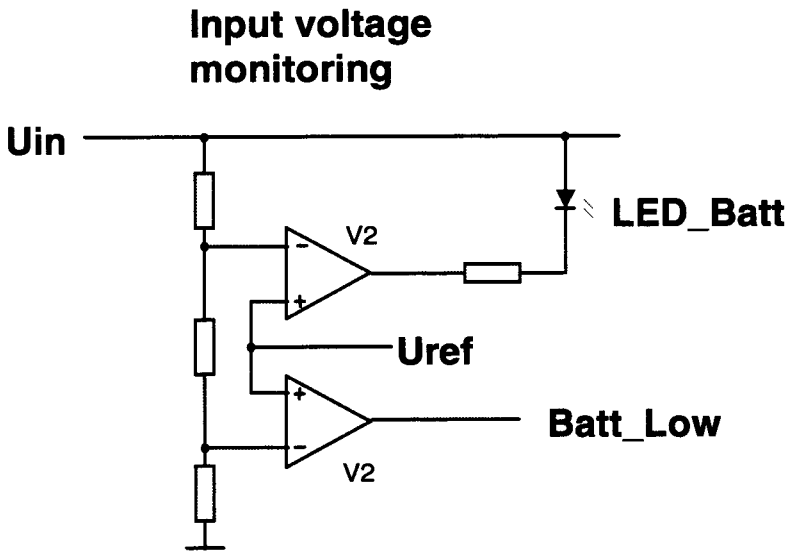
The battery is charged by means of a special charging IC (UC3906) for lead batteries. The circuitry monitors the charging current and the charge voltage. The charging IC has the same "temperature coefficient" as a lead battery, with the effect that the battery charge is optimized over the specified temperature range. The circuit operates as a "DUAL LEVEL FLOAT CHARGER", with three distinct charging states:

- high current bulk charge state
- over-charge state
- float state

A charging cycle begins with "high current bulk charge state". In this state the battery is charged with a constant current (I_{max}) while the battery voltage is monitored. The "over-charge state" sets in as soon as a certain voltage value (U_{12}) is reached. In this state the battery voltage is kept at a certain value (U_{OC}), while the charging current is monitored. If the charging current drops to a certain value (I_{OC}), the "float state" sets in. At this point in time the battery capacity has risen to almost 100%. In the "float state" the battery voltage is regulated to a precise value (U_F).
The following values for voltage and current are selected when charging the 12V lead battery:

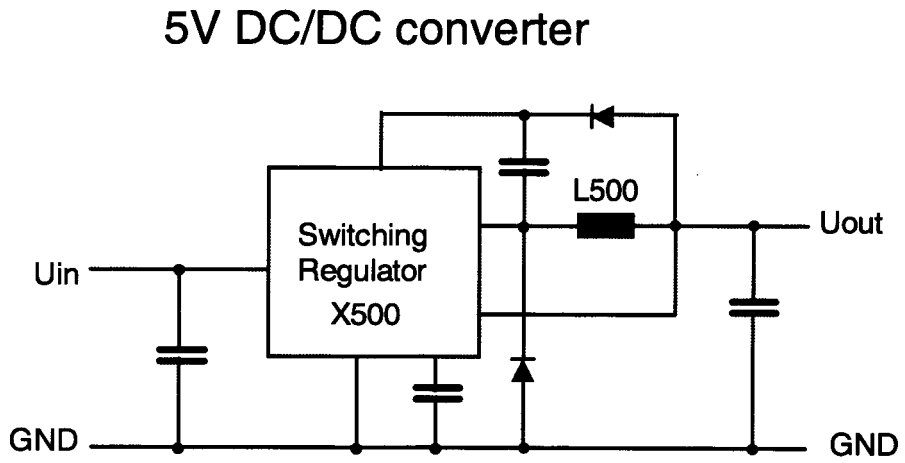
I_{max} = 250mA
U_{12} = 13.5V
U_{OC} = 14.2V
I_{OC} = 25mA
U_F = 13.7V

Input voltage monitoring



The input voltage is monitored. If it drops to 11.3V, the LED_Bat lights up. This indicates that the battery is in need of recharging. If the input voltage drops further to 10.3V, the signal "Batt_low" will be activated. This signal is scanned by the processor. If it is active, the processor will deactivate the unit (exhaustive discharge protection for the battery).

Voltage supply +5V

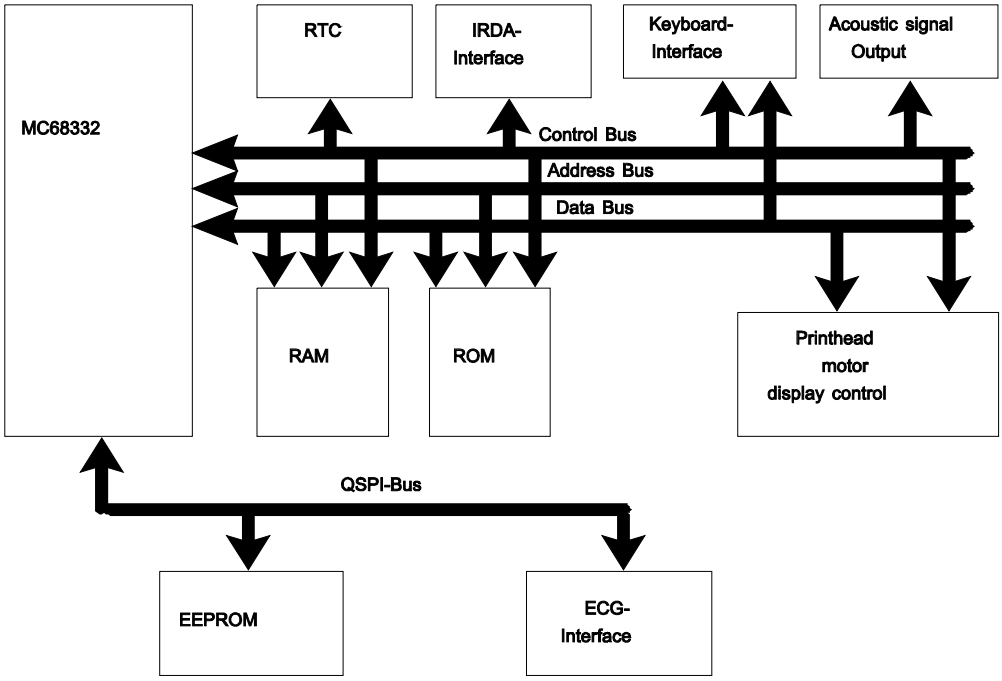


A 500KHz step-down switching regulator is used to generate the 5V voltage. The high-rate switching frequency allows the entire circuit to be built up with SMD components. The switching regulator is the module type LT1376. All the functions necessary for a step-down regulator are integrated in this module.

Input voltage	10V...16V
Output voltage	+5 V ± 2%
Output current	min. 100 mA, max. 700 mA
Efficiency	> 80%
Short-circuit-proof	

3.3.2 Computer

Controller



At the actual core of the unit is the **Motorola Controller 68332** with the following integrated components:

- CPU32, computer core, internal 32 bit register, external 16 bit processing
- TPU, independent timing processor
- QSM with SCI for the implementation of a single RS 232 interface and a serial QSPI port with up to 16 channels.
- SIM with Chipselect generation, system monitoring, clock synthesizer

EPROM

ROM comprises one 4MBit EPROM module (= 512KByte). The data bus width is 16Bit. Chipselect is the CSBOOT of the 68332.

RAM

RAM comprises a maximum of four static RAM modules with 128KByte each. The data bus width is 16Bit. Each RAM chip receives its own chip-select signal (separate chip-select for High and Low Byte) from the controller. This means that the RAM address is software-configurable. The basic MAC 500 (MicroSmart) unit is only equipped with two RAMs, corresponding to a memory area of 256KByte. The memory capacity can be extended to 512KByte by adding two more RAMs. Access time is 70 ns, this means that access is allowed **without Wait States.**

EEPROM

A serial EEPROM is used for the non-volatile memory. This is connected to the QSPI interface of the 68332. The EEPROM has a memory area of 2048 Bit. (= 256Byte)

Reset Generation

Reset Generation is implemented with an integrated monitor module. It includes the voltage monitoring with Reset Generation.

Acoustic signal output

The MAC 500 (MicroSmart) has a sound output for acoustic status/alarm signals. The pitch is selected via a TPU channel of the 68332 (signal name: Beep). In addition, the volume can be varied in 3 stages. Volume is set via the 3 signals LAUT1, LAUT2 and LAUT3.

Real-time clock

Provides the time and date. During operation it is supplied by the Supply logic; when the unit is turned off, the unit switches over automatically to a 3V lithium cell which preserves the data. The control signals for the clock (chipselect- read/write signal) are generated directly by the controller (MC68332).

Keyboard interface

MAC 500 (MicroSmart)´s keyboard interface comprises a 5x5 matrix, although only a 4x4 matrix is required and led to the keyboard. This allows 16 keys to be implemented. The keys are polled in cycles. To do so, bit combinations are written into a buffer module (column) in cycles. An input module (row) polled in cycles identifies if a key has been pressed (the combination of output pattern and input pattern allows the pressed key to be determined).
The keyboard interface is located on the top byte of the data bus. The bits D8..D12 are used for the keyboard (both input and output).
Both the output buffer and the input buffer are selected via a separate chipselect signal (chipselect signal of the 68332).

The top two bits (D13...D15) of the input buffer are assigned with additional functions:

D13:	Hardware configuration bit (function undetermined) for future extensions Default: 0	
D14:	Battery monitor bit:	D14 = 1 ==> battery voltage < 11.3V D14 = 0 ==> battery voltage > 11.3V
D15:	Battery monitor bit:	D15 = 1 ==> battery voltage < 10.3V D15 = 0 ==> battery voltage > 10.3V

In addition to the 16 keys of the 4x4 matrix, the keyboard includes a key for switching the unit on and off. Due to its special hardware configuration, this key is not integrated in the matrix.

The keyboard also includes 4 LEDs which are selected via the keyboard interface.

Line LED: This LED is supplied directly from the 15V of the power supply. It shows whether the unit is mains-operated (LED on) or supplied from battery (LED off).

LED LOBAT: This LED is switched on and off by the controller. It shows that the battery is in need of a recharge. A LOW level at the signal LED_LOBAT_ activates the LED.

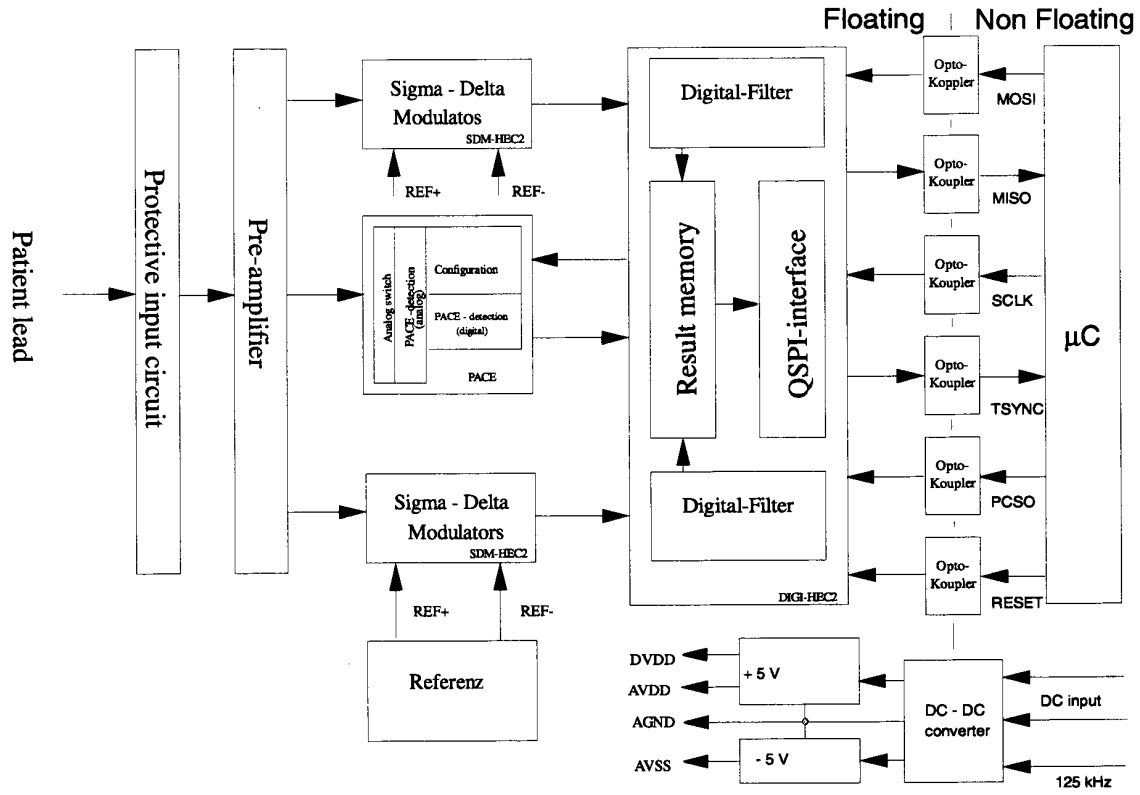
LED START: This LED indicates the status of the unit. It means that the unit is in an active state ! (processing, printing, etc. in progress). A LOW level at the signal LED_START_ activates the LED.

LED STOP: This LED indicates the status of the unit. It means that the unit is in a passive state ! (processing, printing, etc. not in progress). A LOW level at the signal LED_STOP_ activates the LED.

IR interface

The MAC 500 with measurement and communication is equipped with an IRDA interface.
The IRDA interface is selected via the RS232 interface of the 68332.
(Signals TXD and RXD of the '332).
In addition, an output port of the '332 determines if the IRDA module (TOI3232) is in the configuration or in the communication mode.
Configuration signal: IR_BR_D = 0 ==> communication mode
IR_BR_D = 1 ==> configuration mode

3.3.3 ECG recording and pre-processing



The ASIC chipset HECTOR, consisting of 3 Ics, is used for ECG editing on the floating side. The MAC 500 (MicroSmart) uses 2 ICs type SDM_HEC2 as AD converters and one IC type DIGI_HEC2 as filter and interface module. Together with the protective input circuit, a floating power supply and an interface insulated via optical coupler, the ECG editing is the floating section of MAC 500 (MicroSmart) and is part of the PCB MAC 500 (MicroSmart). Discrete analog components and a PIC processor are used for PACE detection.

ECG pre-processing comprises the following functional groups:

- Protective input circuit
- Pre-amplifier
- AD-converter
- PACE detection
- Electrode label
- Lead label
- Filter and interface module
- Power supply
- Reference editing

Protective input circuit

The protective input circuit is designed for the connection of 9 input electrodes and a push-pull modulation, and includes 2 surge diverters and 18 high voltage diodes attached directly behind each patient lead, as well as a hybrid (ECG input) which ensures the safety of the patient and of the electronic components. Protection is only assured if a patient lead with series resistors of ≥ 8 kΩ is used.

Overvoltages reaching the input are limited in the first stage to 90 V through surge diverters and high voltage diodes. The voltage then passes via a 47 KΩ resistor from each input electrode on the hybrid to 2 silicon diodes which limit the voltage to 1.2 V before it reaches the downstream operations amplifier via 100 Ω. The overvoltages reaching the push-pull modulation output are also limited to 1.2 V by two high voltage diodes over 3.3 KΩ and by two more diode line sections, while the downstream operations amplifier is protected by 6.8 KΩ.

Patient safety is assured by the above two diodes on the hybrid 'ECG Input' and by the serial resistance of 47 KΩ. In case of a defective input amplifier, the supply voltage of ± 5 V can reach the input. The 100 Ω resistor on the hybrid limits the current flow to the diode, preventing damage to the diode and limiting the supply voltage to 1.2 V. These 1.2 V are transmitted to the patient over 47 KΩ. The current flowing through it is limited to < 50 µA by the 47 KΩ.

Pre-amplifier

The 9 connectable electrode signals are transmitted to 9 low-noise operations amplifiers behind the protective input circuit. These operations amplifiers amplify the input signals by the factor 3.8. This pre-amplification is necessary in order to maintain the maximum noise value of 15 µVpp over the entire system.

The R electrode is used as reference for the other electrodes, with the effect that the difference to the R electrode always applies after each input amplifier. This means that the signal L-R is available at the output of the operations amplifier for the L electrode. This configuration is necessary in order to obtain a common-mode rejection in addition to the push-pull modulation. The signal for the push-pull modulation is taken from the R electrode. The lead-offs are computed in the software from these differential signals, with the R electrode being ignored through the renewed differential formation in the appropriate lead-offs. The 8 differential signals which remain from the original 9 electrode signals are transmitted to the ΣΔ modulators via a first order low pass with 1 kHz cut-off frequency.

AD converter

After the pre-amplifiers the signals are transmitted to analog-digital converters. The AD converters are the ΣΔ modulator type. Two ICs of type SDM_HEC2 are used, each of which include 5 converters. The components for the internal integrators, used to adapt the modulators to their task, are connected to the pins IM2x, OUT2x, REFx, OUT1x and IM1x. Each differential signal at the output of the AD converter is resolved to 18 bit. With reference to the patient input, one LSB corresponds to 5µV. Conversion is parallel in all channels, i.e. without any time offset. The scanning frequency is 1kHz. Using the appropriate control words, it can also be set for 500 Hz and 2 kHz.

A square-wave signal is visible at the outputs OUT1 thru OUT5, which occurs synchronous with the SWITCH signal. The duty factor of this square-wave signal depends on the input signal. This data stream reaches the IC of type Typ DIGI_HEC2.

PACE detection

After the pre-amplifiers the 8 electrode signals lead to a multiplexer 1:8. Using the 3 outputs OP1, OP3 and OP4 of the chip Chips DIGI_HEC2 the multiplexer selects the electrode to be used for PACE detection. The selected signal is routed via a first order high pass with 23 Hz cut-off frequency and amplified by the factor 1,000. The signal then reache a window comparator with a 4,5 mV threshold with reference to the input.

The 2 outputs of the window comparator are put to a PIC processor for further PACE analysis. This processor supplies a PACE bit if the appropriate signals of the window comparators apply and if the pulse duration is ≤ 2ms. The overshoot of the PACE pulse is suppressed by the PIC processor.

Electrode labeling

The 18 bit result of the analog-digital conversion shows if one or more differential signals are overloaded, i.e. if the differential voltage with reference to the patient input is greater than 0.6V. A hysteresis of 15 mV (0.6 - 0.615 V) is provided for the query. The query takes place simultaneously for all 8 channels. The information (1 bit/channel) is transferred to the CPU via the serial port in the word Electrode label.
The overload of a channel can be caused by excessive polarization voltage (>600 mV) or by a detached electrode. In the latter case a voltage of 1 V is transmitted to the amplifier inputs via the 100 MΩ resistors on the protective input circuit.
One more circuit section is provided which handles the electrode error signal for the R and N electrodes, because these cannot be detected individually with the converter overload. The information is transmitted via INP1 and INP2 of the input port of ASIC DIGI_HEC2 in the status word.

Lead labeling

Different leads can be connected to the patient input. The MAC 500 (MicroSmart) is designed for use with a 5 and 10 wire patient lead. Lead labeling is identified by means of different voltage values. For this purpose the 10 wire lead holds a 402 Ω resistor which, together with the series resistor, generates a voltage in the range of 8.66 mV - 9.19 mV. A voltage in the range of 4.76 mV - 5.05 mV with a resistance of 221 Ω is generated through the 5-wire lead. The voltage is measured with the ninth ΣΔ modulator of the ASIC SDM_HEC2. This means that the chip set must be configured for the transmission of 9 channels.

Current supply

A DC-DC converter is used which generates two alternating secondary voltages from the primary 5V with 125 kHz cycle. Two stabilized direct voltages of +5V and -5V are then generated from both of these alternating voltages. The 125 kHz cycle is delivered by the CPU. To suppress radiated noise, a reactor is provided in the current supply.

Reference voltage editing

The reference voltage has values between + 2.5 V and - 2.5 V. Special emphasis is placed on low intrinsic noise because it directly affects the results of the ΣΔ modulator. The low pass immediately following the reference element with a cut-off frequency of 8 Hz serves the same purpose. A compromise had to be found between low noise and rapid stability of the reference voltage immediately after enabling.

Filter and interface module

This IC (DIGI_HEC2) essentially incorporates the filter functions and the serial interface.

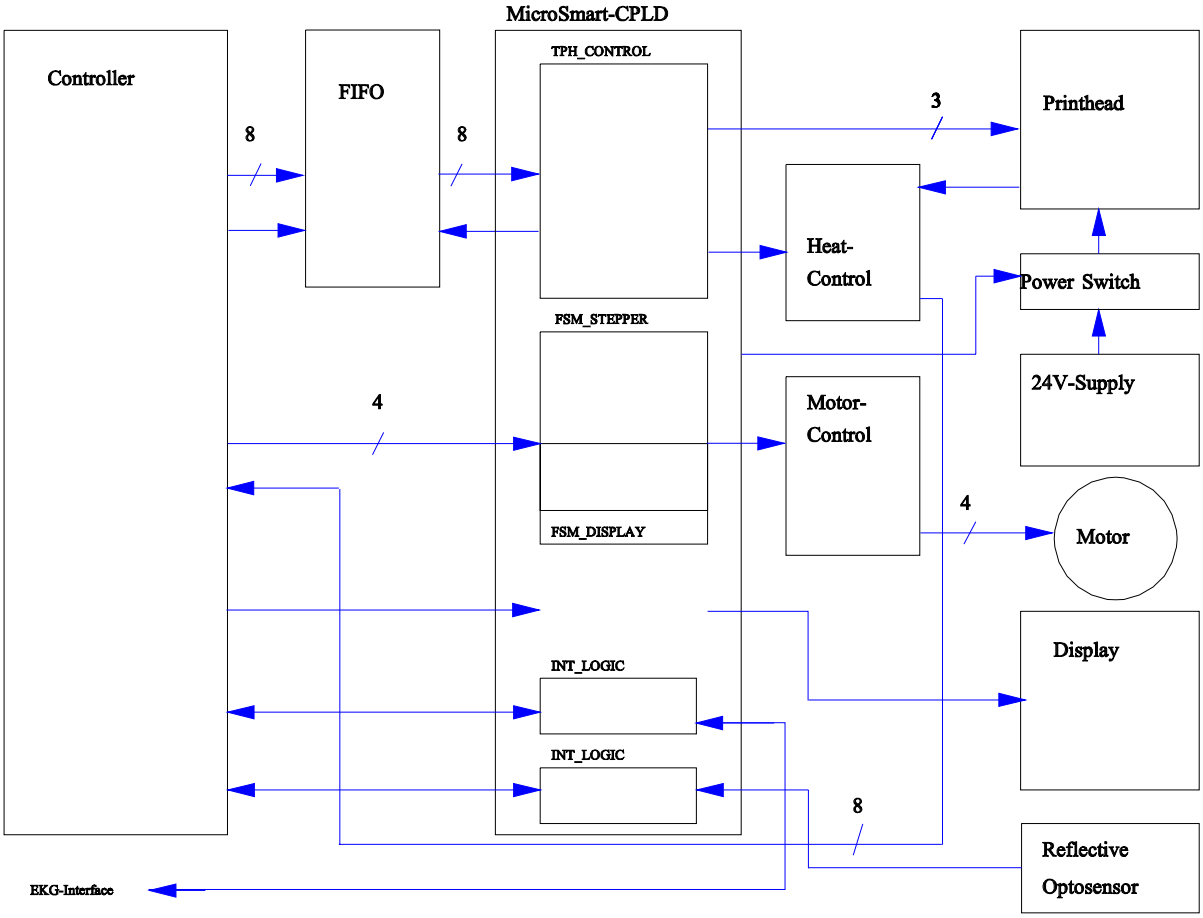
Fundamentally, the transfer bandwidth is 0 - 250 Hz for a scanning frequency of 1 kHz and 500 Hz, with the upper cut-off frequency determined by a sinc filter of the 3rd order. The lower cut-off frequency can be set within the range of 0.039 - 79.6 Hz (4.08 - 0.002s) by selecting the time constant. Selecting this time constant also causes the separation of the DC content, which may be superimposed over the ECG signal as polarization voltage. An IIR filter algorithm is used. The algorithm only captures the lower 12 bits of the 18 bit result. This means that any sudden changes at the input are always represented as changes with amplitudes < 20 mV. Limiting the display range to ± 10 mV and selecting a suitable value query prevents sudden changes over the entire display range when exceeding the range limits. A saturation value is delivered at about 10 mV, until the measuring signal returns to within the display range.

For the useful signal transfer (ECG signal) the lower 12 bits are transferred with the selected scanning frequency. However, there is also the option of using the appropriate control words for special function tests to transfer the upper 12 bits without DC separation. In this case 1 LSB corresponds to 320 µV. Possible function checks include testing the signal path, measuring the polarization voltage, measuring the electrode impedance and testing the serial data transfer, all by activating these functions by using the appropriate control words.

Measurements of the polarization voltage are allowed by transferring the upper 12 bits of the converter result (1 LSB = 320 µV).

During the serial data test, a test word transmitted by the CPU will be returned immediately thereafter by the ASIC DIGI_HEC2.

3.3.4 Drive electronics and display



Thermal array control

As the data output to the printhead is relatively time-consuming, special hardware has been provided which relieves the processor of this task.
To drive the printhead, the CPU data for a printline are written block by block and at high speed into a FIFO. A start signal generated by the CPU informs the printhead control TPH_CONTROL (seated in a CPLD) that output to the thermal printhead can begin. Several "state machines" within the TPH_CONTROL read 80 bytes from the FIFO and transmit the serialized data to the printhead. At the end of the transfer the CPLD generates the latch signal for the array and the trigger signal for the heat duration generation.

The speed-related heat duration is software-selected. The heat duration value is gained via the pulse-pause ratio of a TPU channel functioning as PWM channel. After the PWM signal has been routed via a low pass, a DC voltage proportional to the PWM ratio which is used for setting the heat duration. With each trigger pulse for the heat duration generation, a capacitor charged via a constant current source is discharged and a heat duration cycle is started. The linear voltage increase at the capacitor is compared in a comparator with the analog value supplied by the PWM channel. If the analog value is exceeded, the heat duration pulse is terminated. In addition, the heat duration is adjusted as a factor of the printhead substrate temperature. The temperature-dependent voltage obtained via the array thermistor is added to the PWM voltage supplied by the TPU channel in a summing amplifier.

The supply voltage of the thermal array can be switched off via the power switch if:
- array voltage < 19.2V
- reset active
- motor not running
- array overheated

Temperature monitoring

An array excess temperature monitoring device is fitted to protect the thermal array. Using a comparator, the voltage of the thermistor is compared with a reference value. If the array temperature of 60°C is exceeded, the comparator signals this to the processor.

Motor control

The stepping motor is controlled in three stages. A TPU channel is used in the controller 68332 which generates the frequency of the stepping sequence. Using this frequency, the "state machine" FSM_STEPPER generates the sequence for the quater step operation of the stepping motor in the complex PLD. From the control sequence the motor driver module generates the signals for both motor windings in two full bridges. To reduce power loss, the windings are controlled with constant current.
The motor speed is set via the frequency of the stepping sequence. To avoid stepping loss, the software changes the frequency of the stepping sequence when the motor is started.
The "state machine" has one input allowing the direction of rotation to be changed.
Once the motor is started, the processor does not require any more processing power for the motor. No compensation is required for the motor. The internal TPU stepping motor control is not used because it is designed for a positioning system and would constantly require CPU power for continuous operation. To save energy during printing breaks, the motor driver is released or locked via the lead MOTOR_INH_.

Photoelectric barrier analysis

The reflective light barrier has several functions:

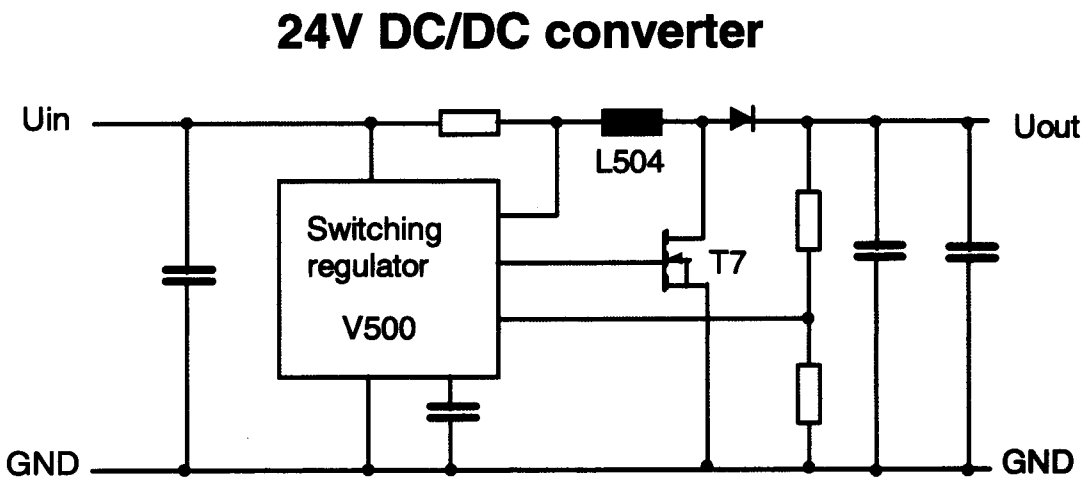
- checks if paper is available
- mark reader in case of Z-fold paper
- identifying an open paper
- monitors if motor runs when using Z-fold paper

The paper signal PAPER_ERR_ reaches the CPLD via a comparator. The error state is stored in the CPLD (signal PAPER_).

PAPER_ERR_ = PAPER_ = low no paper, flap open, or mark below sensor

The processor polls the lead PAPER_ and resets the signal PAPER_ back to high via the lead PAPER_RES.

Voltage supply +24V



Besides the logic supply, the thermal array needs a 24V power supply to current-activate the dots. This 24V voltage is also used for the stepping motor. The voltage is generated by the switching regulator MC33063. The switching regulator works in step-up operation in connection with the external power MOSFET. For brief peak loads, the electrolytic storage capacitor supplies the necessary power.

Input voltage	10V...16V
Output voltage	+23.5 V ± 5%
Output current	min. 0 mA, max. 600 mA
Efficiency	≥ 80%

3.4 Internal interfaces

This chapter deals with the pinning, the function and meaning of the signals of the internal interfaces of the function components. These interfaces include:

- Interface, power supply
- Interface, display
- Interface, thermal array
- Interface, motor
- Interface, photoelectric barrier
- Interface, keyboard
- Interface, ECG port

3.4.1 Interface, power supply

Plug designation: **PSCON/**

Plug connector **4-pin, horizontal** (90 °), reverse voltage protection implemented mechanically.

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Meaning	Level	Polarity	Pin No.
PSCON1	I	batt +	12V	---	1
PSCON2	I	batt -	GND	---	2
PSCON3	I	power supply +	+15.6V	---	3
PSCON4	I	power supply -	GND	---	4

3.4.2 Interface, display

Plug designation: **AE/**

Socket connector **1 x 14-pin, upright** (180 °)**,** reverse voltage protection implemented mechanically.

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Meaning	Level	Polarity	Pin No.
Vss	---	Ground	0V	---	1
VDD	---	Supply	+5V	---	2
V0	---	Contrast voltage	0-5V	---	3
RS	O	Register select	TTL		4
R/W	O	Read/Write	TTL	---	5
E	O	Enable	TTL	active-high	6
DB8	I/O	Data	TTL	---	7
DB9	I/O	Data	TTL	---	8
DB10	I/O	Data	TTL	---	9
DB11	I/O	Data	TTL	---	10
DB12	I/O	Data	TTL	---	11
DB13	I/O	Data	TTL	---	12
DB14	I/O	Data	TTL	---	13
DB15	I/O	Data	TTL	---	14

3.4.3 Interface, thermal array

Plug designation: **AA/**

Socket connector **2 x 15-pin upright** (180 °)**,** Caution! No reverse voltage protection!

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Meaning	Level	Polarity	Pin No.
V_H	---	+24V	+24V	---	1
V_H	---	+24V	+24V	---	2
GND	---	+24V	0V	---	3
V_H	---	Ground	+24V	---	4
GND	---	Ground	0V	---	5
GND	---	Ground	0V		6
DATA IN 1	I	Data input 1	TTL	---	7
DATA OUT 1	O	Data input 1	TTL	---	8
DATA IN 1	I	Data input 2	TTL	---	9
DATA OUT 2	O	Data output 2	TTL	---	10
STROBE 1	I	Strobe 1	TTL	active high	11
STROBE 2	I	Strobe 2	TTL	active high	12
THERMISTOR 1	---	NTC resistor	---	---	13
LATCH	I	Array latch	TTL	active high	14
VDD		Logic Supply	+5V	---	15
NC	---	---	---	---	16
THERMISTOR 2	---	NTC resistor	---	---	17
CLOCK	I	Array clock	TTL	L->H	18
STROBE 3	I	Strobe 3	TTL	active high	19
STROBE 4	I	Strobe 4	TTL	active high	20
DATA IN 3	I	Data input 3	TTL	---	21

DATA OUT 3	O	Data output 3	TTL	---	22
DATA IN 4	I	Data input 4	TTL	---	23
DATA OUT 4	O	Data output 4	TTL	---	24
GND	---	Ground	0V	---	25
GND	---	Ground	0V	---	26
GND	---	Ground	0V	---	27
V_H	---	+24V	+24V	---	28
V_H	---	+ 24V	+24V	---	29
V_H	---	+ 24V	+24V	---	30

3.4.4 Interface, motor

Plug designation: **AC/**

Plug connector **6-pin, upright** (180 °)**,** reverse voltage protection implemented mechanically.

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Meaning	Level	Polarity	Pin No.
Q11	O	Field coil 1	+24V	---	1
Q12	O	Field coil 1	+24V	---	2
Q21	O	Field coil 2	+24V	---	3
Q22	O	Field coil 2	+24V	---	4

3.4.5 Interface, photoelectric barrier

Pin designation: **AB/**

Zero power flat membrane connector **4-pin, upright** (180 °)**,** reverse voltage protection implemented mechanically.

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Bedeutung	Level	Polarity	Pin No.
SENSOR_TR	I	Collector Phototrans.	0-5V	---	1
SENSOR_GND	---	Ground	0V	---	2
SENSOR_LED	O	Anode LED	2.5V	---	3
---	---	Free	---	---	4

3.4.6 Interface, keyboard

Plug designation: **AS/**

Zero force flat membrane connector **18-pin, upright** (180 °)**,** reverse voltage protection implemented mechanically.

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Meaning	Level	Polarity	Pin No.
LED_LOBAT	O	Anode battery LED	+5V	---	1
LED_NETZ	O	Anode system LED	+15V	---	2
GND	O	Ground	GND	---	3
COLUMN4	O	Matrix column 4	+5V	---	4
COLUMN3	O	Matrix column 3	+5V	---	5
ROW4	I	Matrix row 4	+5V	---	6
COLUMN2	O	Matrix column 2	+5V	---	7
COLUMN1	O	Matrix column 1	+5V	---	8
COLUMN5	O	Matrix column 5	+5V	---	9
ROW5	I	Matrix row 5	+5V	---	10
ROW3	I	Matrix row 3	+5V	---	11
ROW2	I	Matrix row 2	+5V	---	12
ROW1	I	Matrix row 1	+5V	---	13
ON_OFF	O	Key ON/OFF	+15V	---	14
GND	O	Ground	GND	---	15
LED_STOP	O	Anode STOP LED	+5V	---	16
LED_START	O	Anode START LED	+5V	---	17
GND	O	Ground	GND	---	18

3.4.7 Interface, ECG input

Plug designation: **AH/**

Socket connector **16-pin, horizontal** (90 °)**,** reverse voltage protection implemented mechanically.

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart).

Signal name	I/O	Meaning	Level	Polarity	Pin No.
C2	I	Input C2	---	---	1
R	I	Input R	---	---	2
C3	I	Input C3	---	---	3
L	I	Input L	---	---	4
C4	I	Input C4	---	---	5
F	I	Input F	---	---	6
C5	I	Input C5	---	---	7
C1	I	Input C1	---	---	8
C6	I	Input C6	---	---	9
---	---		---	---	10
AGND	O	Screen	---	---	11
N	O	N-pp modulator	---	---	12
---	---		---	---	13
---			---	---	14
PL	I	Lead label	---	---	15
---	---		---	---	16

3.5 External interfaces

MAC 500 (MicroSmart) has only three interfaces to the outside:

- Line inlet
- Patient input

3.5.1 Line inlet

The interface of the **line inlet** has been implemented in the unit by a 3-pin, standardized connector for non-heating appliances. Line connection via a 3-pin line cable with protective conductor.

Plug designation: **D/**

3.5.2 Patient input

Patient input and **plug of the patient lead** have been redesigned because the MAC 500 (MicroSmart) guarantees the required defibrillation protection only in connection with the patient lead. This means that all previously used patient leads **can no longer** be used. This also applies to the suction system with integrated pump.

Plug designation: **AF/**

Sub-D socket casing, 15-pin

The function of the individual pins is shown in the following table. The definition in terms of input/output is as seen from the PCB MAC 500 (MicroSmart) (patient input).

PinNo.	I/O	Designation	Function
1	Input	C2	Input electrode C2
2	Input	C3	Input electrode C3
3	Input	C4	Input electrode C4
4	Input	C5	Input electrode C5
5	Input	C6	Input electrode C6
6	Output	S	Screen
7	---	NC	---
8	Input	PL	Label of patient lead used

9	Input	R	Input electrode R
10	Input	L	Input electrode L
11	Input	F	Input electrode F
12	Input	C1	Input electrode C1
13	---	NC	---
14	Output	N	Output electrode N (pp-modulator)
15	---	NC	---

3.5.3 IR interface

The MAC 500 with measurement and communication is equipped with an IrDA interface. This interface has the following properties:

* Transmission rate: 9600 Baud
* Data bits: 8
* Stop bits: 1
* Parity: no
* no hardware handshake
* half duplex
* Range max. 3 meters (direct visual connection to receiver)

3.6 Delimitations

The following operating modes have not been implemented in MAC 500 (MicroSmart):

- No Ergometrics
- No spirometry
- No Late Potentials, no RR variability
- No phono, no US doppler

A scope output is not available.

No analog inputs.

No ECG trigger output.

Use of NC batteries not allowed.

Use of primary batteries not allowed.

4 Unit test functions

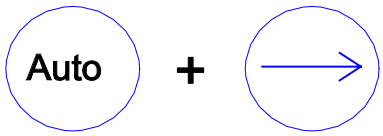
The self-test is presented in English in all versions except the D version in which the self test is presented in German.

4.1 General

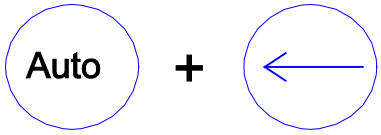
The unit test functions are in most cases controlled with menu-assistance.

Some tests require special utilities to be completed. These include signal generator, etc. The items required for the individual tests will be explained in the description of the various tests.

The test mode allows various unit tests to be carried out. This unit test is initiated by pressing the current operating mode key and the "arrow key right" at the same time. E.g.:



Quit the test mode by pressing any operating mode key and the "arrow key right" at the same time.



The following test can be carried out:

- Key test and loudspeaker test
- Display test
- Motor test
- Recording test
- IR test (MAC 500 (MicroSmart) with measurement and communication)
- Recording the results

4.2 Key test and loudspeaker test

By pressing a key, its appropriate function is shown on the display. Example:

Key	Display
Auto	KEY_AUTO
5 (speed)	5 mm/s
10 (sensitivity)	10 mm/mV
→	CUR_RIGHT
etc.	

The Start/Stop key is tested automatically by activating/deactivating the test. An alarm signal is triggered when pressing the "loudspeaker key". By continuously pressing the key the volume changes in the following rhythm:

- soft-medium-loud-soft-medium ... etc.

4.3 Display test

After activation, the active test will be displayed. Using the arrow control keys (←,→) all pixels of the display can now be switched on and off in alternation. Pressing the Start/Stop key will end the test and display the next one.

4.4 Motor test

After activating the motor test, the current state (STOP) and the preselected speed will be displayed. In this state the motor test can either be started or the preselected speed can be changed. Once the test has been started, a mark will be printed on the paper every second during operation. The spacing between these marks allows conclusions to be drawn on speed and its accuracy. The speed can also be modified without "Stop". Position of the mark: top and bottom of the sheet.

Height of mark: 5mm
Width of mark: 1 dot

Quit the test by pressing any arrow key (←,→). The next test will be displayed.

4.5 Recording test

After activating the recording test, the preselected speed and the sensitivity will be displayed. In this state (STOP) the parameters can be modified using the appropriate keys. After the start the first two channels will be recorded with the selected parameters. Other channels cannot be selected. Recording is continuous and must be aborted by pressing the Start/Stop key. Quit the test by pressing any arrow key (←,→). The next test will be displayed.

4.6 IR test (MAC 500 with measurement and communication only)

After activating, test the IR interface as follows:

Arrow key ->: a test string is continuously transferred until the Start/Stop key is activated

Arrow key <-: data can be received from a remote station and be shown on the display. Initiate data acceptance with the arrow key " <- ". The interface is set for the receiving mode when striking this key. From this point on the operator has 20 seconds for an entry (data transfer). Always conclude a transfer by striking the carriage return key. Note that there is a minimum and maximum number of transferable characters. At least two valid characters plus carriage return must be transferred to make them show on the display. If more than 200 characters are transferred before carriage return, a buffer overflow will be signaled. If there is no overflow, the first 16 of the transferred characters will appear on the display. If, after activating data acceptance, no characters have been received within 20 seconds, an appropriate error message will be shown.

Quit the test by pressing the Start/Stop key again.

4.7 Recording the results

After activating, the test results will be written out. This output supplies data on the software contained in the unit (reference number, version number, date of preparation of the firmware), the results of the tests carried out during power-up, and details on the connected patient lead.

The sector listed under RAM has the following meaning:

MAC 500 (MicroSmart)

0	-	040000h
256KByte		RAM sector on the PCB MAC 500 (MicroSmart)

MAC 500 with measurement and communication

0	-	080000h
512KByte		RAM sector on the PCB MAC 500 (MicroSmart)

The sector listed under EPROM has the following meaning:

MAC 500 (MicroSmart) and MAC 500 with measurement and communication

800000	-	880000h
512KByte		ROM sector on the PCB MAC 500 (MicroSmart)

The test results explained under 3.1.6 are determined during the self-test which is always performed after power-up. If any errors are detected, a display message appears after the test, indicating the possible error. The following error codes are used to localize the error:

4.7.1 Error codes

The following error codes are shown on the display in connection with the message "Test failed!":

CODE:	0	IRAM	error in the internal RAM of the 68332
	1	VECTOR	error in the vector table
	2	RAM1 RAM	error in the sector 0-256KByte
	3	RAM2 RAM	error in the sector 256-512KByte
	4	EPROM	Checksum error in the EPROM
	5	ASIC	error interface to ASIC
	6	E2PR	error EEPROM

4.8 Additional functions for final test

A number of additional functions can be selected in the test mode by striking certain key combinations. These functions are primarily intended for final testing. This is why they are not explicitly available as selectable items within the test mode. Instead, they can be reached via certain key combinations. These are:

- setting time and date
- reading in the serial number

Setting time and date

This mode can be reached from the selection level for appliance tests with the key combination "Man + Config".
Use the "-->" key to select the setting for the date, and the key "<--" to select the setting for the time. The setting steps which follow are designed for an automated setting. Instead of showing the current data, the unit will display the setting returned to "zero".

Reading in the serial number for determining the option key
(MAC 500 with measurement and communication only)

Necessary equipment for reading in the serial number:
Hardware
- PC or Laptop
- Interface Cable PC - Irda Adapter (Partnumber 223 426 01)
- Irda Adapter (Partnumber 930 117 72)

Software
- use Terminal-Program (Windows 3.11) or
  Hyperterminal-Program (Windows 95and Windows NT)

Transfer parameters: 9,600 baud rate, 1 stop bit, no parity, 8 data bits

Preparation

MAC 500 with measurement and communication
The serial number is read in via the Irda interface. Starting from the selection level for the appliance test, the read-in function for the serial number is reached via the key combination "Arrhy + Config". Only numerical characters (maximum 9) will be accepted.

PC or Laptop
Connect the Interface Cable to a free COM port. Connect the Irda Adapter to the Cable. Start the Terminal-Program for Windows 3.11 and Hyperterminal-Program for Windows 95/98/NT..
Select the transfer parameter and the COM port.

Transferring the serial number

1. MAC 500 (MicroSmart):
Press the keys Arrhy and Config simultaneous. The unit immediately moves into the receiving mode.
On the display appears
Trans. Ser No !
Receive Data ...
Important: Within 20sec, you have to type in the serial number

2. PC:
Type in the serial number and press CR-key

3. MAC 500 (MicroSmart):
If no serial number is transferred or the receiving-time is passed before the serial number is transferred, an ERROR-message ("Receive Error") appears on the display.
After a short time the message "Ser No false" appears on the display. You have to start again from step 1.
If the transfer was successful, the transferred serial number appears on the display. After a short time, the unit comes back to the unit test mode. Switch Off the unit. Switch On the unit and activate again the unit test mode. Activate "Results". The transferred serial number must appear on the printout.

A second possibility to enter the serial number into the MAC 500 (MicroSmart) is via keypad.

Note: This performance is only possible from version 2.2 and higher.

The following procedure is required to enter the serial number into the MAC 500 (MicroSmart):

- Switch off the unit
- Switch on the unit while holding the key combination BEEP +10 mm/mV
- On the display appears the following text **<Enter Ser. No.>**
- Enter the serial number with the keys ← →
- Confirm every digit with the start/stop key
- After enter the last digit, the following text appears **<Ser. No stored>**
- Switch off and on the device to activate the new serial number

If no serial number is entered, the unit will show an appropriate 5 second visual and acoustic signal each time the unit is switched on.

4.9 Re-locking option

The open option can only be re-locked by deleting the entered option key. To re-lock the open option, proceed as follows:

- switch off the unit
- press the key combination "BEEP + 20/35" and switch on the unit at the same time
- the unit signals "option cleared"

Explanation:

BEEP:	loudspeaker key
20/35:	filter key 20/35 Hz

5 Selecting the type of appliance

5.1 General

The unit provides functions for selecting the type of appliance. The type of appliance defines certain performance features of the unit. The following types of appliances are available:

Type: International	After power-up the unit displays "MAC 500 (MicroSmart)". The company name "GE marquette" is printed on the recordings. The electrodes are labeled "R, L, F, N, C1, C2, C3, C4, C5, C6". The date format is "dd.mm.yy". The following languages can be selected in the configuration: German, English, French, Netherlands, Italian, Spanish, Portuguese, Danish, Norwegian, Swedish, Finnish, Russian, Polish, Czech, Hungarian, Bulgarian, Macedonian. The line filter is set for 50 Hz.
Type: USA	Keyboard with text instead of icons. Company name "GE marquette" appearing on the unit and on the type plate. The company name "GE marquette" is printed on the recordings. A place holder for Name instead of the name of the unit is printed on the real-time recordings (Man/Arrhy). Default (works) setting the notation (electrode labels) is AAMI. The date format is "mm.dd.yy". Languages: English, français, español, português. No data communication, i.e. the following items are not displayed in the configuration: copy function, data transfer, tel. No. Default (works) setting for override function is On. The line filter is set for 60 Hz. Default (works) setting for paper format is Roll (cannot be altered). The time format is "am" and "pm". Default (works) setting for the recording format is: sequential, rhythm record Yes. Lead group definitions: **Stnd** (standard) in place of **Eint** (Einthoven) **Aug** (augmented) in place of **Gold** (Goldberger) **V1-3** (chest V1-3) in place of **Wil1** (Wilson 1) **V4-6** (chest V4-6) in place of **Wil2** (Wilson 2) Program designation on recording and on display: **12Ld** in place of **Auto** **3Ld** in place of **Man** **HR^** in place of **Arrh**
Type: USA2	Device name **MAC 500** in place of **MicroSmart**. Otherwise as type "USA"

Type: Asia	Company name "GE marquette" appearing on the unit and on the type plate. The company name "GE marquette" is printed on the recordings. The following languages can be selected in the configuration: German, English, French. Default (works) setting the notation (electrode labels) is AAMI. Otherwise as type "International"

5.2 Selecting the type of appliance

The following procedure is required to select the type of appliance:

- switch off the unit
- switch on the unit while holding the key combination for "delete Configuration" down (see table below)
- the unit signals Config cleared
- switch off the unit
- switch on the unit while holding the key combination for the type of appliance down.

Key codes for selecting the type of appliance

Key combination	Appliance type
Key loudspeaker + 5 mm/mV	delete Configuration (EEPROM)
Key loudspeaker + 50 mm/mV	International
Key loudspeaker + 25 mm/mV	USA
Key loudspeaker + 5 mm/mV	USA2
Key loudspeaker + 20 mm/mV	ASIA
Key loudspeaker + 10 mm/mV	Enter Serial number ***
Key loudspeaker + 20/35	Delete Option Codes

***only important for MAC 500 with measurement and communication (MicroSmart MC)
The possibility to enter the serial number via keypad is only available from version 2.2 and higher.
In version 2.1 and version 2.0 the serial number can entered only by Irda Interface, refer to service manual section 4.8 (Reading in the serial number).

Explanatory notes:

BEEP:	loudspeaker key
5mm/mV:	sensitivity key 5mm/mV
20mm/mV:	sensitivity key 20mm/mV
10 mm/V:	sensitivity key 10 mm/mV
50mm/s:	speed key 50mm/s
25mm/s:	speed key 25mm/s
5mm/s:	speed key 5mm/s
20/35 mm/s:	Filter key (20/35 Hz)

6 Repair notes

6.1 Safety notes

WARNING!

Shock hazard. Always switch off he unit and disconnect the power plug before opening the MAC 500 (MicroSmart).

WARNING!

Shock hazard. Before replacing the primary fuses in the line inlet module, always switch off the unit and disconnect the power plug.

When replacing electronic components, always implement **ESD protection.**
Return replacement PCBs only in **ESD packagings.**
Return defective or exhausted batteries to the factory for **proper disposal.**

6.2 Component replacement

For the following items, observe the safety notices in chapter 4.1.

Caution: To avoid damage to the thermal array, always fully discharge with a resistor approx. 68 Ω the condenser C1 (located on the PCB) before replacing/exchanging the PCB or the thermal array.

Opening the unit

To open the MAC 500 (MicroSmart), remove the 4 attachment screws on the base of the unit, open the paper flap, carefully lift off the upper shell of the enclosure, disconnect the keyboard. When reassembling the unit, make sure that none of the cables are pinched.

Replacing the Lithium battery

By replacing the Lithium-Battery heed on the polarity.

Caution: Use only original Marquette Hellige batteries (see chapter 8, Spare Parts List)

Return empty batteries to the factory for proper disposal.

Replacing the battery

Open (do not cut) the two reusable cable ribbons by pressing on the attachment latch. Detach the plug connection **G** and replace the battery.

Caution: Use only original Marquette Hellige batteries (see chapter 8, Spare Parts List)

Return defective batteries to the factory for proper disposal.

Place the battery in the compartment, tighten the cable ribbons and reconnect the plug connection **G**

Replacing the recorder unit:

Open the recorder lid and take out the two screws on the base of the recorder enclosure. Detach the plug for motor, array control and flat ribbon cable for the mark reader from the PCB MAC 500 (MicroSmart). Disconnect the protective circuit connection on the power supply.
The complete recorder enclosure can now be removed.

Replacing the thermal array:

The thermal array can only be removed from the bottom of the recorder enclosure.
Carefully push the side wall of the recorder enclosure to the outside. At the same time push the array holder forward until it detaches from its locking mechanism. Then remove the thermal array from the top. The two springs will come undone. When re-installing the thermal array, use pincers to lock the springs back in position.

Replacing the PCB MAC 500 (MicroSmart)

Before replacing the PCB, print out the configuration selected by the user, if possible.
With the unit open, first disconnect the plug connection **PSCON** to the power supply, then disconnect the remaining plugs to the drive (plug connection **AB, AA, AC)** and to the ECG input (plug connection **AH**). Then remove the two attachment screws.
Check if the solder bridge of the lithium battery of the real-time clock (BA 500) is properly soldered. Install the new PCB and reconnect the plugs.
Setting the clock is described in the operating instructions.
Accept the configuration selected by the user (if known). If not, use the works settings.
Set the contrast with the display used.

Important Service Note

Valid for Pcb. With Part No.: 303 445 45
303 445 44
389 004 24
389 004 23

After the installation of the exchange Pcb. MicroSmart and after having switched on the Device, the message <Device unknown> might appear on the display.
The Reason: The required Device Version

(International / USA / USA2 / ASIA)

is not stored up on the EEPROM.

If the Device is working in the user mode, the required Device must be entered.

Please follow the instruction in section 5.2.

Replacing the display

With the unit open, first detach the two attachment screws of the display. Pull the display off the plug connection **AE**. Plug in the new display and re-attach.

Set the contrast with new display

Replacing the power supply

First remove the PCB MAC 500 (MicroSmart) (see above). Detach the four attachment screws on the metal carrier base (power supply module). Take out the power supply module. The power supply is bolted to the metal carrier base with 3 attachment screws. Disconnect the plug connections **CB** and **CA**. Detach the three attachment screws. Replace the power supply.

Replacing the patient input

First remove the PCB MAC 500 (MicroSmart) (see above). Detach the four attachment screws on the metal carrier base (power supply module). Take out the power supply module. The patient input is bolted to the metal carrier base with 2 attachment screws. Detach the attachment screws.

7 Troubleshooting

Mains plug connected; the unit cannot be switched on

- green LED of power indicator light fails to light up and unit cannot be switched on:
- line power lead defective or not connected properly?
- primary fuses in line inlet module defective?
- plug CB on power supply properly connected?
- plug CA on power supply properly connected?
- plug PSCON on PCB MAC 500 (MicroSmart) properly connected?
- keyboard properly connected via plug AS on PCB MAC 500 (MicroSmart)?
- if all items above are OK: ===> power supply unit defective
- green LED of power indicator light lit, unit still cannot be switched on:
- On/off key of unit defective?
- fuses SI500 on PCB MAC 500 (MicroSmart) defective?
- if all items above are OK: ===> PCB MAC 500 (MicroSmart) defective

Battery operation selected; unit cannot be switched on

- plug connection G on battery properly connected?
- battery exhausted/discharged?
- connect mains plug, green LED of power indicator lights must light up and unit can be activated. If not, see above under "Mains plug connected; unit cannot be switched on".
- battery charge activated when connecting the mains plug
- after 10 minutes charging, disconnect the mains plug, can the unit be switched on and a recording be triggered?
- ===> battery defective or capacity too low
- ===> or battery charge on PCB MAC 500 (MicroSmart) defective

Blank display

- after power-up, does the yellow Stop LED on the keyboard light up?
- if not: - see under "Unit cannot be ..... switched on".
- Contrast bad? (change contrast)
- Alarm signal approx. 5 sec. after power-up of the MAC 500 (MicroSmart)? (indicates that the self-test is complete).
- if yes; - display properly connected?
- if yes: ===> display defective?
  ===> or control on the PCB MAC 500 (MicroSmart) defective.

Error detected during self-test

If an error is detected during the self-test, the display shows the message "Test failed !" in addition to the error code and a brief description. The error codes are described in chapter 3.7.1.

MAC 500 (MicroSmart) fails to print, no paper feed

Carry out the following test in the "Man" mode.

- paper available? paper correctly inserted? paper feed disruption?
- paper flap properly latched in both locking mechanisms?
- green Start LED must light up after pressing the Start/Stop key
- if not: ===> PCB MAC 500 (MicroSmart) defective
- motor supply lead defective? plug AC properly connected?
- motor blocked? (check drum, transmission)
- measure the voltage +24V on diode D506 (cathode). 24V available?
  - if yes: ===> motor defective?
    ===> or PCB MAC 500 (MicroSmart) defective (motor control)

Paper feed works, nothing printing out

- paper flap properly latched in both locking mechanisms?
- plug connection **AA** properly connected?
- measure the voltage +24V on diode D506 (cathode). 24V available?
- a great deal printed recently, array still over-heated? allow to cool off
- none of the above malfunctions applies:
  ===> PCB Control defective?
  ===> or thermal array defective

MAC 500 (MicroSmart) only prints in top or bottom part of record

- paper flap engaged only on one side

MAC 500 (MicroSmart) prints, only zero lines are written

- electrodes correctly attached?
- patient lead defective? (e.g. N-lead defective)
- contact problems on patient input of MAC 500 (MicroSmart)?
- none of the above malfunctions applies: ===> PCB MAC 500 (MicroSmart) defective

8 Maintenance and care

8.1 Technical inspection

Technical inspections must be carried out once every year.

Note!
The following checks and tests must be carried out by personnel who are qualified to maintain this equipment.

Note:
Check the operational safety and the functional safety of the unit using the following check lists. They serve the experienced technician to check the appliance.
The person carrying out checks and inspections must be familiar with the operation of the unit as specified in the operating instructions.

The test items are based on the following measuring and test equipment:
The tests should be carried out with customer´s accessories. This will ensure that any defective accessories are automatically identified.
If measuring and test equipment other than the above is used, the test items and the tolerance values may have to be modified accordingly.

8.1.1 Visual checks

Check unit and accessories to make sure that:

- safety insets comply with the values specified by the manufacturer
- safety notices attached to the unit are readable
- the mechanical condition allows the continued use of the unit
- no pollution reducing the safety standards are found

8.1.2 Function checks

Recommended measuring and test equipment and tools:

1 x multiparameter simulator Lionheard

1x customer´s patient lead, or 1x patient lead, 10-pin 223 387 01

Test preparation

Essentially, the unit test functions implemented in MAC 500 (MicroSmart) are used for the tests. These are described in chapter "3. Unit test functions".

Connect the MAC 500 (MicroSmart) to the mains power supply; the green standby LED must light up.
Activate the unit. The self-test will be carried out, no error messages must appear. After completing the self-test the unit is in the "Auto" mode, the yellow LED for the inactive operating mode must be lit.

Function test of the operating and display elements

- carry out the key test as specified in chapter 3.2
- carry out the display test as specified in chapter 3.3

Testing the recording speeds 5, 25 and 50 mm/s

- carry out the motor test as specified in chapter 3.4

Checking the unit test results

- writing out the test results as specified in chapter 3.7

focus: all memories free of errors?
ASIC test OK?
printout well legible and without problems?

Analyzing the ECG signal and the HR value

Select the following settings at the ECG simulator:

- amplitude	1 mV
- heart rate (RATE)	60 P/min

Connect the electrode leads in the following assignment:

R	red	----->	RA
L	yellow	----->	LA
F	green	----->	LL
N	black	----->	RL
C1	white/red	----->	V1
:	:		:
C6	white/purple	----->	V6

Switch to the **"Man" mode** and start recording by pressing the Start/Stop key. Check by pressing the lead stepping keys if all leads **are registered.**

The ECG waveforms must be **free of noise.**
Record two pages in the "Man" mode. The following lettering must be visible:

- text in the line in the top margin:
  first sheet
    Device name
    Software Version
  second sheet
    Company name
    Date
    Time
- text in the line in the bottom margin:
  first sheet
    error messages
    operating mode
    speed
    sensitivity
    ADS
  second sheet
    error messages
    line filter
    frequency range
    heart rate

The **heart rate** of 60 P/min +/- 2 P/min is shown in the display and printed on the recording.
Activate the function Square-Wave pulse with 1 mV on the ECG sensor.
Use the lead stepping keys to select Lead II. The square-wave pulse curve must correspond to the 1 mV reference pulse in its **amplitude** (only valid for specified sensor). Return the ECG sensor back to the ECG signal. Check if the HR control (configuration) is switched on.
Increase the heart rate on the ECG sensor to 200 P/min. The acoustic **signal** must sound. Reduce the heart rate back to 60 P/min; the signal no longer sounds.

Checking the pacemaker detection

Select the following settings at the multifunction simulator:

- Pace setting
- Pace amplitude 6 mV
- Pace duration 0.2 ms

Select the "Man" mode at the equipment under test and select the lead group Einthoven (Eint) at the equipment under test. Start recording. The pace pulses must be visible in the record as spikes.

Checking the electrode drop-off detection

Set the simulator back to ECG signal with a heart rate of 60 P/min.
Remove one electrode after the other from the ECG sensor.

Select the "Auto" mode without activating it by pressing the Start key.
Check if each dropped off electrode is shown correctly on the display and if an acoustic warning signal is given.

Checking the battery condition

The lead battery can be checked as follows:
Discharge the battery fully, then recharge fully (duration 6 h) and finally discharge in stand-by operation without recording.
If the operating period is below 2.5 h, the battery should to be replaced.

8.2 Safety Analysis Test

8.2.1 General Information

The suggested Safety Analysis Test refer to the international Standard IEC 601-1.
The tests are generally performed with Safety Testers, on most of them, the measuring circuits according IEC 601 are already implemented.
The tests which have to be performed are described generally, for the handling of your Safety Tester follow the user manual.

The tests may be performed under normal ambient conditions of temperature, humidity and pressure and with line voltage.
The leakage currents correspond to 110 % of rated voltage for the tested unit. Most Safety Testers take this into account, otherwise the measured values have to be calculated.

Recommended test equipment

- Safety Tester for measurements according IEC 601.
- Testing connector according the following description.

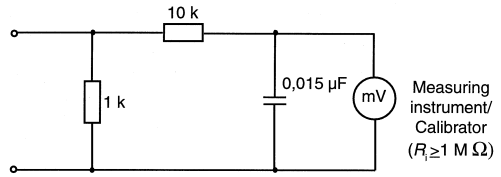
Testing connector for measuring patient leakage current.

For testing the ECG input a patient cable with all leads connected together is used.

8.2.2 Protective earth resistance test

The protective earth resistance test has to be performed including its power cord.
This test determins whether the device has a power ground fault.

- The protective earth resistance from power connector to any protective earth connected exposed conductive part is measured.
- Specs. of test circuit: AC current source 50 Hz/60 Hz of at least 10 A up to 25 A with limited output voltage of 6 V.
- If resistance is greater than 100 mOhm



8.2.3 Measuring of leakage current

To proceed the suggested measurements, the unit under test has to be separated from any interconnection to a system. If the unit is part of a system, extended tests according IEC 601-1-1 have to be performed. The following diagram shows the
needed Measuring Circuit [M] for leakage current. The reading in mV corresponds to µA (leakage current). The Safety Testers generally work with this Measuring Circuit [M] and the displayed values are already converted to leakage current.

8.2.4 Enclosure Leakage Current Test

This test is performed to measure leakage current from chassis to ground during normal conditions (N.C.) and single fault conditions (S.F.C.).
In any case, the leakage current is measured from any exposed conductive parts to ground, the unit under test has to be switched on and off.

Connect the unit under test to your Safety Tester.

- During normal conditions (N.C.), referring to the electrical diagram, measurements have to be done under following conditions:

* Polarity switch Norm and RVS
* GND switch GND closed
* S1 closed and open

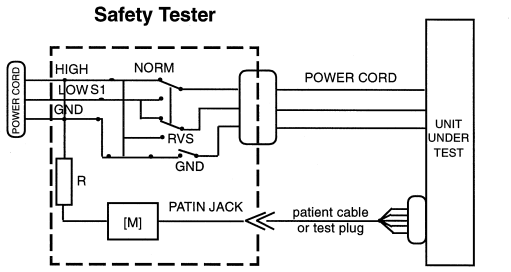
- During single fault conditions (S.F.C.), referring to the electrical diagram, the measurements have to be done under following conditions:

* Polarity switch NORM and RVS
* GND switch GND open
* S1 closed

Test has failed if the measured values are greater than:

N.C.	S.F.C
100 µA	500 µA
	300 µA (U.L. requirements)

Electrical diagram for Enclosure Leakage Current Test



8.2.5 Patient Leakage Current Test

This test performs a leakage current test under single fault conditions (S.F.C.) dependent of domestic power outlet with 115 or 230 V AC as source into the floating inputs.

In any case, the leakage current is measured from Input Jack, of unit under test, to ground.

For testing the ECG input, a patient cable, with all leads connected together, is used.

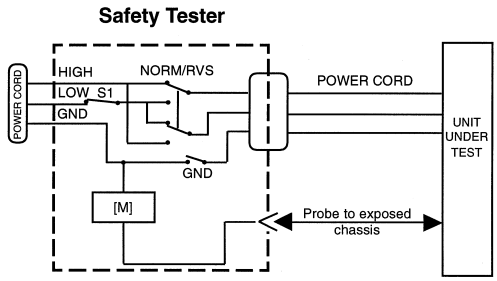
Connect the unit under test to your Safety Tester.

- Referring to the electrical diagram, measurements have to be done under following conditions

* Polarity switch NORM and RVS
* GND switch GND closed
* S1 closed

Test has failed if the measured values are greater than 50 µA

Electrical Diagram for Patient Leakage Current Test



For protection of the test person the following values of resistor R may be used:

Typ BF	22 kOhm (120 to 130 V)
	47 kOhm (220 to 240 V)
Typ CF	100 kOhm (220 to 240 V)

8.3 Maintenance, cleaning, disinfection

MAC 500 (MicroSmart) maintenance, cleaning, disinfection is performed in accordance with the MAC 500 (MicroSmart) or MAC 500 with measurement and communication. User’s Manual, Chapter 12, "Cleaning, disinfection and maintenance", as applicable.

Applications requiring extensive recordings may result in deposits on the thermal array printhead which normally do not, however, have any adverse effect on the printing quality. This can be removed with a soft, fluff-free cloth soaked in an alcohol-based cleaning agent (e.g., surgical spirit).

9 Technical description

Recording

Direct recording of curves, waveforms and alphanumerical characters in rectangular coordinates using the thermal dot printing method on thermo-sensitive paper.

* Recording channels 3 or in "Man" mode 3 or 1, overlapping recording allowed
* Trace spacing with 3-channel: 25 mm
* Writing width max. 80 mm
* Printout of unit setting data, date and time, on the margins of the recording paper
* With appropriate variation, printout of measuring results on separate sheet
* Resolution of recording:
  vertical 8 dots/mm
  horizontal 25 µm at 25 mm/s

Recording paper

Z-fold paper with 350 sheets Marquette Hellige CONTRAST®
Paper width 90 mm
Sheet length 90 mm
or
Paper rolls Marquette Hellige CONTRAST®
Paper width 90 mm
Length approx. 35m
To avoid damage of the thermal array, use only original Marquette Hellige CONTRAST® recording paper.

Paper feed

* Paper speed
  5 - 25 - 50 mm/s reversible via function key.
  error limits typ. ±1% max. ±5%
* Acoustic signal and shutdown of recording when paper end is reached.
  Before end of paper, red mark on lower margin of paper sheet.

Membrane keyboard

Pushbuttons with tactile feedback
Function keys for all important routine operations

Display

Alphanumeric LCD, 2 x 16 characters, contrast setting allowed

Control lights (LED)

For mains voltage applied, battery condition and Start/Stop function.

Lead selection

Manual selection of individual lead groups or automatic stepping keys for the lead groups using the "Auto" mode.

* Lead programs:
  EINTHOVEN, GOLDBERGER, WILSON and CABRERA lead sequence

Automatic modes

To support and simplify operation by:

* Automatic blocking function
* Automatic control, of lead selection, paper feed, calibration
* Formatted output
* Automatic zero position
* Anti-drift system to compensate fluctuations in polarization voltage

Detection of pacemaker pulses

* Pulse duration between 0.1 and 2.5 ms
* Marking irrespective of sign
* Pulse amplitude between ± 5 mV and ± 700 mV

Heart rate indication

Determining the heart rate from all ECG signals.
* Display range 30 ... 300 P/min
* Display cycle with each heart beat, max. 2 s

Signal inputs

Insulated patient connection type CF in compliance with IEC; all pickup electrode connections and N-connectors high voltage resistant (only in connection with original Marquette Hellige patient lead), interference compensation via neutral electrode (N), electrode monitoring for breaks.
* Electrode connections for R, L, F, N, C1 ... C6
* Input impedance for differential signals between any two electrode connections at 10 Hz > 10 MOhm
* Input impedance for common-mode signals against N up to 60 Hz > 50 MOhm
* Operating range for differential signals between any electrode connections at alternating voltage ±10 mV, for superimposed direct voltage (polarization voltage) ±600 mV

* Operating range for common-mode signals against N ±1 V, against ground (chassis) effective alternating voltage 263 V
* Input bias current over any electrode connection for termination with 1 kOhm after N < 50 nA
* Patient lead current (effective) in compliance with IEC Class CF: under standard conditions < 10 µA, at first error if patient is on line voltage < 20 µA
* Limits for continuous load of the pickup electrode connections and of the N-terminal against N ±50 V; against ground (chassis) ±1500 V
* Pulse voltage strength of all pickup electrode connections and of the N-terminal against ground in any polarity (e.g. defibrillation) 5000 V
* Electrode break monitoring for individual electrodes: R, L, F, N, C1,C2, C3, C4, C5, C6, acoustic break signal upon start of program.

Data interface

An infrared interface for data exchange with adapted auxiliary appliances.
(MAC 500 with measurement and communication only).

* Transmission rate: 9600 Baud
* Data bits: 8
* Stop bits: 1
* Parity: no
* no hardware handshake
* half duplex
* Range max. 3 meters (direct visual connection to receiver)

Patient input for recording:

Simultaneous transfer of all electrode signals after lead formation and digital conversion in digital processing system; common muscle filter and mains frequency compensation for all leads, Pace detection, automatic or manual sensitivity control, automatic tic zero line positioning, drift compensation via anti-drift system (A.D.S.), digital output of the conditioned signals via thermal array recorder.

* lower cutoff frequency (-3 dB-limit) 0.04Hz or 0.08Hz or 0.16Hz (configurable) corresponding to a time constant of 4 s or 2 s or 1 s
* upper cutoff frequency (-3 dB-limits) 150 Hz (IEC/AHA)
* signal scanning frequency: 1000/s
* resolution, with reference to input 5 µV
* output rate for recording 1000/s
* sensitivity adjustable jointly for all leads in 3 steps 20–10–5 mm/mV
* 3-dB drop of the amplitude frequency response with activated muscle filter (low pass characteristics) at approx. 35 Hz or 20 Hz
* with activated automatic line filter, detection and compensation of cyclical 50- or 60-Hz-frequency contents (configurable): attenuation > 40 dB
* non-linear distortion better than IEC- and AHA recommendations
* coincidence error limits between any channels ±0,5 mm

* detection of Pace pulses in C2 or other C-electrode and marking in all channels of signals with reference to the patient input:
  duration > 0.1 ms, amplitude > 5 mV
* noise in signal transmission path less than required in IEC- and AHA recommendations: < 2,5 µV rms
* common-mode rejection for signals with 50 or 60 Hz (depending on design of unit) with activated line frequency compensation > 140 dB

Calibrating the ECG

Automatic recording of a defined voltage jump, applicable to all channels.

* calibration voltage, with reference to the ECG signal input: 1 mV. Pulse width independent of paper speed approx. 200ms

Zero position

Automatic setting into the best possible operating range, as factor of the signal amplitude.

Anti-drift system (ADS)

Automatic compensation of zero line fluctuations caused by fluctuations in the polarization voltage at the pickup electrodes.

Blocking

Automatic rapid charge shift of the coupling capacitors in the pre-amplifiers after applying the electrodes.

Electrode control

Acoustic or visual signal message after electrode failure off or open circuit in LCD display panel. Individual electrode monitoring.

Copy function

After recording an ECG, the unit allows in the "Auto" mode to record copies from the memory and/or to transfer these to a connected PC.

Test

Automatic function control during power-up of the unit, with tests of the signal path from the patient input.

Power supply

From line voltage or via built-in rechargeable battery, automatic switchover function, battery charged during mains system operation via built-in charger.

Mains operation:

* Structural unit design in Protection Class I in compliance with IEC 601-1
* Rated voltage range 100…240V
* Operating voltage range 90V…264V; 49…65Hz
* Current input 0.12...0.3A
* typical power input:
  charging the battery 13VA
  Unit on + battery charging 17VA
  Recording + battery charging 22VA

Operation via built-in battery

* Type: lead battery
* Rated battery voltage 12V
* Rated battery capacity 1.2Ah
* Operation with fully charged battery sufficient for minimum 50 ”ECGs", if unit is activated only for recording.
* Charge duration for completely discharged battery approx. 6h
* Minimum charging time for 1 "Auto" ECG 20 min
* Battery life approx. 3 years, replacement by Service Unit only
* Lithium battery for built-in clock, approx. life 5 years, replacement by Service Unit only.
* Automatic unit shutdown after approx. 5 minutes, if no electrodes are connected and no operations are carried out (only if HR control is switched off) or in case of supply voltage too low (during battery operation: if battery voltage too low).

Operational readiness

After successful self-test, about 5 seconds after power-up.

Position in service

horizontal

Ambient conditions

Operation

* ambient temperature between +10 and +40 °C
* relative air humidity between 25...95 % non-condensating
* air pressure between 700 and 1060 hPa

Storage and transportation

* ambient temperature between -20...+60 °C (w/o battery)
  -15...+50 °C (with battery)
* relative air humidity between 20 and 95%
* air pressure between 500 and 1060 hPa

Dimensions of enclosure

*	Width	290	mm
*	Height	80	mm
*	Depth	200	mm

Weight

Unit design with battery approx. 2.2 kg

10 Spare parts list

Part number	Description
227 470 21	User's Manual (Ger)
227 470 22	User's Manual (Eng)
227 470 23	User's Manual (Fre)
227 470 25	User's Manual (Ita)
227 470 26	User's Manual (Spa)
227 470 27	User's Manual (Asia)
227 470 28	User's Manual (Rus)
227 470 35	Servicing Instructions

Housing

432 523 88	Upper Case Part
432 523 89	Lower Case Part
432 523 90	Holder for ECG Input
432 519 68	Plexi window
432 523 92	Washer
432 524 09	Firm Label "Marquette Hellige"
432 524 10	Firm Label "GE marquette"
432 524 14	Instrument Label " MicroSmart"
432 524 15	Instrument Label "MicroSmart MC"
432 524 17	Instrument Label "MAC 500 "
924 017 14	Rubber foot
432 524 30	Insulating Part
504 659 02	Retaining Plate
927 230 38	conductive Sealing

Keypad

390 001 50	Keypad
390 001 51	Keypad (USA)

Recorder

218 114 01	Drive complete
303 444 66	Transport Roller
303 444 67	Mark Reader
303 445 09	Stepper Motor
303 445 16	Printer Head
383 273 62	Wire set Drive
480 159 56	Gear 17 mm diameter
480 159 57	Gear 14,5 mm diameter
480 159 66	Gearwheel

480 159 69	Gearwheel 45 / 14 Z
432 524 22	Key
432 524 21	Cover
432 524 20	Drive Chassis
432 524 19	Flap
416 118 41	Spring
415 155 09	Pressure Spring
432 524 32	Fastening
919 203 23	Cable
430 519 05	Label Rec. Paper

Printed circuit boards

303 445 45	PCB MAC 500 (MicroSmart) with IR
389 004 24	Exchange PCB MAC 500 (MicroSmart) with IR
303 445 44	PCB MAC 500 (MicroSmart) without IR
389 004 23	Exchange PCB MAC 500 (MicroSmart) without IR
303 445 55	PCB ECG Connector
930 117 69	LCD Display with connector
927 230 36	Spacing Socket for Display
801 777 75	Screw
801 777 20	Screw
929 167 17	Lithium-Battery 3V 0,255 Ah

Power supply

930 117 88	Switching Power Supply
927 230 32	Spacer
915 419 36	Power Plug with Fuseholder
912 084 50	Fuse T 2A
915 412 86	Flat Plug
929 167 29	Battery lead 12 V 1.2 Ah
923 096 88	Cable Strap for Battery fixing

Accessories

223 388 01	Patient Cable, 5-wire, IEC std. 4 mm plug, for MAC 500 (MicroSmart)
223 388 02	Patient Cable, 5-wire, AHA std. 4 mm plug, for MAC 500 (MicroSmart)
223 387 01	Patient Cable, 10-wire, IEC std. 4 mm plug, for MAC 500 (MicroSmart)
223 387 02	Patient Cable, 10-wire, AHA std. 4 mm plug, for MAC 500 (MicroSmart)
432 524 62	Mandrel
226 167 01	Chart Paper 90mm, 360 sh.
226 167 02	Chart Paper 90 mm, 10x360 sh.
226 168 01	Chart Paper 90mm, roll 35m
226 168 02	Chart Paper 90 mm, roll 10x35m

930 117 72	IRDA-Adapter Infrared RS232
223 426 01	Interface Cable for CardioSys (PC) - IRDA Adapter
220 107 01	IRDA Interface Box for Mobil-Telephone with Modem
929 031 00	Battery for IRDA Interface Box

11 Appendix

Mechanical Drawing MAC 500 (MicroSmart)	101 134 01...12
Mechanical drawing of the drive	218 114 01
Complete Wiring Diagram	101 134 01...12 Sheet 1
Master Record Index	101 134 01...12 Sheet 3, 4
PCBs	388 032 73 P Sh. 0 (388 032 00 P changed to 388 032 73 P)
PCBs	388 032 73 R Sh. 1/2 u. 2/2 (388 032 00 R changed to 388 032 73 R)
PCBs	388 032 74 P Sh. 0 (388 032 16 P changed to 388 032 74 P)
PCBs	388 032 74 P Sh. 1...7(388 032 16 P changed to 388 032 74 P)
PCBs	388 032 74 R Sh. 1/2 u. 2/2 (388 032 16 R changed to 388 032 74 R)
IRDA Interface Box	220 107 01
Interface Cable	223 426 01

Schutzvermerk nach DIN 34 beachten


432 524 14
nur in Variante 01/03/07
for version 01/03/07
432 524 15
nur in Variante 02/05
for version 02/05
432 524 17
nur in Variante 04/06/08...12
for version 04/06/08...12
432 524 09
nur in Variante 01/02/07
for version 01/02/07
432 524 10
nur in Variante 03/04/05/06/08...12
for version 03/04/05/06/08...12
B - B
927 229 55 08
siehe Besch. Blatt
see labels catalog
Gehäuseoberschale von Innen M 1:2
inside view of top shell, scale 1:2
927 230 38 0,87lg.
umlaufend in Nut eingelegt
inserted in groove on all sides
A - A
2x 2,5 x 8 Linsenkopf Plastite,oval head Plastite
von Lpl 388 032 00/16
432 523 90
432 524 30
2x 2,5 x 8 Linsenkopf Plastite,oval head Plastite
915 419 36
912 084 50 2x
Sicherung T2A,fuse,slow blow,2A
929 166 23
gegn Schutzleiter, yellow/green grounded wire
2x durch Ferritkern gewickelt
2 windings through ferrite core
430 519 05 nur in Variante 01...03/05/07/09/10 13
for version 01...03/05/07/09/10
430 519 78 nur in Variante 04/06/08/11/12 14
for version 04/06/08/11/12
innen auf Laufwerksklappe geklebt
glued to the inside of the printer housing flap
mittig und bündig an Steg
centered and flush with crosspiece
916 189 25
C
1x B3 DIN127
504 659 02
3 x10 Linsenkopf Plastite
oval head Plastite
A
A
388 032 73
nur in Variante 01/03/06/07/09/11
for version 01/03/06/07/09/11
M3 x 6 DIN7985
388 032 74
nur in Variante 02/04/05/08/10/12
for version 02/04/05/08/10/12
M3 x 6 DIN7985
B
C - C
218 114 01
3 x 10 Linsenkopf Plastite
oval head Plastite
430 519 47 06
nur in Variante / for Version
01/02/03/05/07/09/10
430 519 46
nur in Variante 04/06/08/11/12
for version 04/06/08/11/12 05
416 118 42
2,2 x 4,5 DIN7981
432 519 68
423 202 72 1/2
B
930 117 88
4x M3 x 6 DIN7985
829 074 12 40 lg.
2x 2 Polster 10lg.
aufeinander und auf
Geh.unterteil geklebt
2x2 padding, 10 layers,
glued together and on
lower shell
390 001 50
nur in Variante / for Version
01/02/03/05/07/09/10
390 001 51
nur in Variante 04/06/08/11/12
for version 04/06/08/11/12
383 273 61
A4,3 DIN6798
B4 DIN127
915 420 21
M4 x 6 DIN7985
C
929 167 29
923 096 88
430 519 44 10
nur in Variante 04/06/08/11/12
for version 04/06/08/11/12
924 017 14
432 523 92
nur in Variante 02/05/10
for version 02/05/10
432 525 10
nur in Variante / for version
01/03/04/06/07...09/11/12
430 501 00 04
nur in Variante 04/06/08/11/12
for version 04/06/08/11/12
432 523 89
M3 x 30 DIN7985 mit Schaft
M3 x 30 DIN7985 with shank
432 523 88
430 519 45 07
nur in Variante 04/06/08/11/12
for version 04/06/08/11/12
Typenschild
siehe Besch. Blatt
name plate
see labels catalog
01 02 15

Hierzu: also see:

Drahtsatz wire set	383 273 61	
Verpackungszeichnung packaging drawing	101 134 01...12 V	
Schaltzeichnung wiring diagram	101 134 01...12 S Bl.1 ...4	
Gerätespiegel Product Status Index	440 082 96	

Marquette Hellige GmbH
Munzinger Str. 3
D-79111 Freiburg

Werkstoff - Material

Rohteil

Änderungs-Index	Anzahl	ECO No.	Änderungsbeschreibung - Change Description	Datum - Date	Name
i	--	064204	engl. Text hinzu, Varianten geändert	07.02.00	G.Kaltenbach
h	--	062581	Varianten 09...12 hinzu	15.06.99	G.Krieg

Freimaßtoleranz - Tolerance

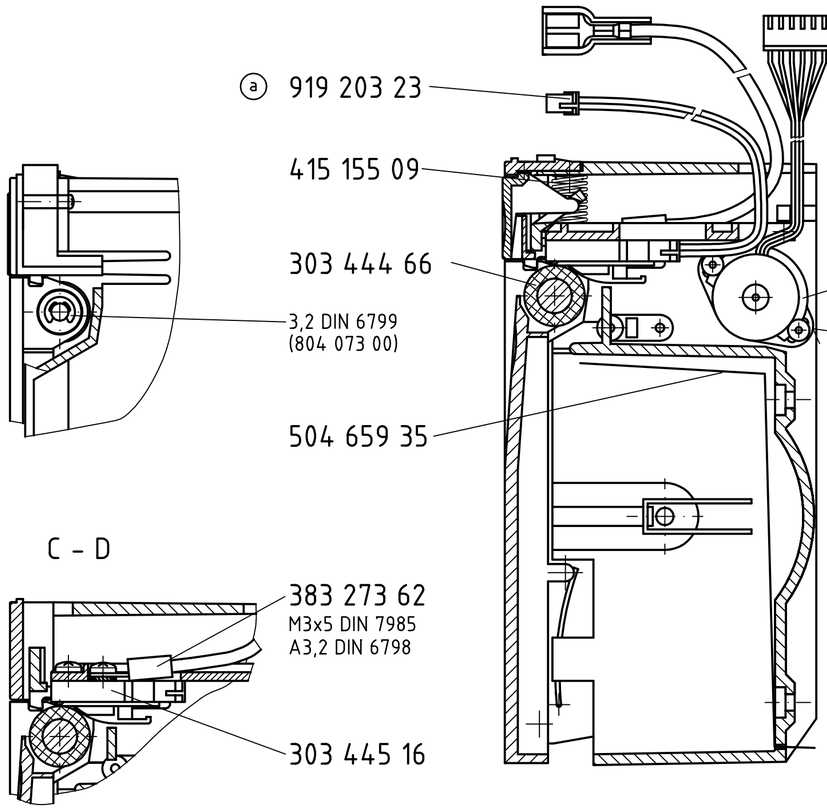
Projektion | Format: A1 | Maßstab - Scale: 1:1 | Oberfläche - Finish: ---

Entworfen-Drawn: 22.01.97 G.Krieg
Geprüft-Approved: 04.03.97 G.Krieg

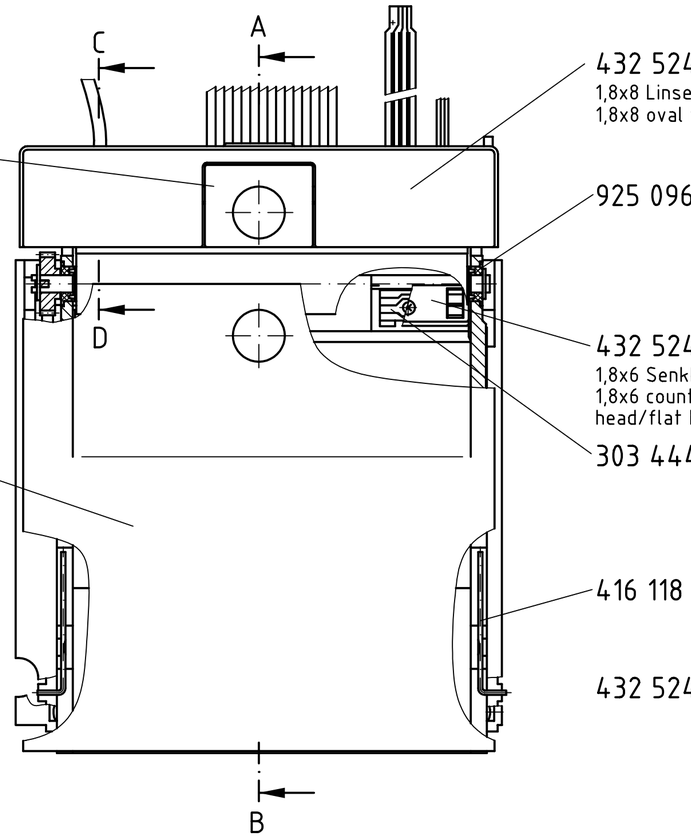
File Name: 10113401-D04__ZM01
Dokument Bezeichnung - Document Description: doc mech dwg ZM01
Dokument Nr. - Document No.: 10113401-D04

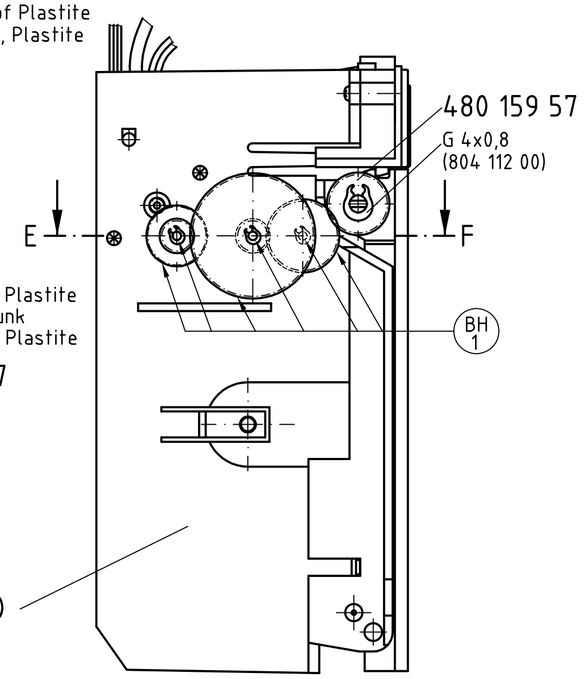
Zeichn.Art/Blatt Nr.: ZM/01
Teil Bezeichnung - Part Description: MAC500
Teil Nr. - Part Number: 101 134 01...12

A - B

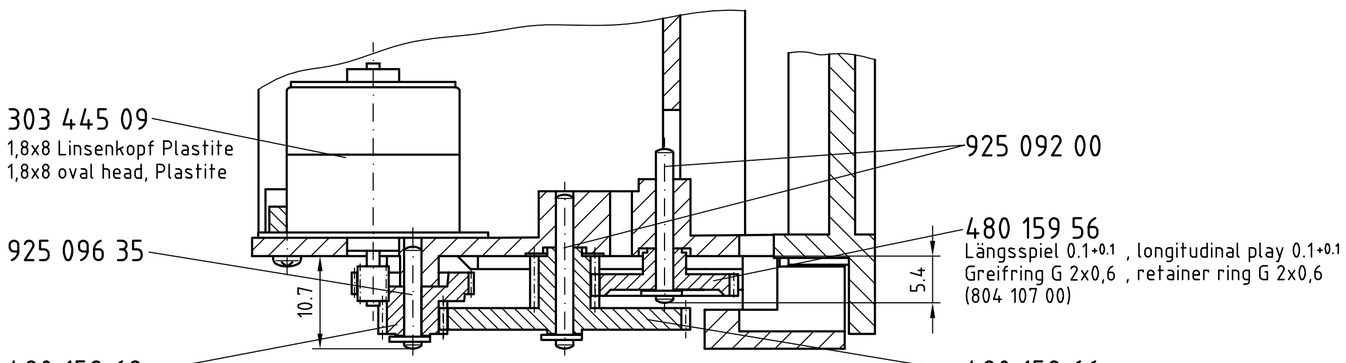


C - D





E - F 2:1



Marquette Hellige GmbH Munzinger Str. 3 D-79111 Freiburg						
Werkstoff - Material						
Rohteil	b	-	064204	engl. Text hinzu	09.02.00	G.Kaltenbach
	a	1x	203301	Sach-Nr. 919 202 23 in 919 203 23 geändert	16.04.98	Deimel
	Änd.Index Revision	kommt vor numbers	ECO No.	Änderungsbeschreibung - Change Description	Datum - Date	Name
Freimaßtoleranz - Tolerance	Projektion		Format	Maßstab - Scale	Oberfläche - Finish	Datum - Date / Name
File Name 21811401-D02_ZM01			A2	1:1	Entworfen-Drawn 06.03.97 Deimel Geprüft-Approved 12.03.97 Deimel Geprüft-Approved	
Dokument Bezeichnung - Document Description doc mech dwg ZM01	Zeichn.Art/Blatt Nr.		Teil Bezeichnung - Part Description		Teil Nr. - Part Number	
Dokument Nr. - Document No. 21811401-D02	ZM/01		Recorder		218 114 01	

Diese Tabelle definiert die gültigen Konfigurationen von MAC500 V2.21

This table defines the valid configurations of MAC500 V2.21

Komponente Component			Sach-Nr. Part No.	Index (Prod.)	Referenz Reference	kompatibel(Service) Compatible(Service)	in Variante in Device Variation
MAC500	Lpl. MicroSmart Ersatzteil-Nr. Austausch Nr.	PCB MicroSmart Spare Part No. Replacement No.	388 032 73 303 445 44 389 004 23	H		D, E, F, G	01,03,06,07,09,11
MAC500	Lpl. MicroSmart Ersatzteil-Nr. Austausch Nr.	PCB MicroSmart Spare Part No. Replacement No.	388 032 74 303 445 45 389 004 24	I		D, E, F,G, H	02,04,05,08,10,12

Marquette Hellige GmbH
Munzinger Str. 3
D-79111 Freiburg

Änd.Index Revision	kommt vor numbers	ECO No.	Änderungsbeschreibung - Change Description	Datum - Date	Name
i	--	064204	Benennung geändert	16.02.00	G.Kaltenbach
h	--	064113	388 032 73 - Index auf "H" 388 032 74-Index auf "I"	19.01.00	G.Kaltenbach
g	--	063099	388 032 73 - Index auf "G" 388 032 74-Index auf "H"	18.08.99	T.Kaltenbach
f	--	063018	388 032 74 - Index auf "G"	02.08.99	G.Kaltenbach
e	--	062581	Varianten 09...12 hinzu	14.06.99	G.Krieg

Werkstoff - Material

Rohteil

Entwickler C.Spitznagel

Freimaßtoleranz - Tolerance: --

File Name: 10113401-D03__SZ04

Dokument Bezeichnung - Document Description: doc schem SZ04

Dokument Nr. - Document No.: 10113401-D03

Projektion | Format: A4 | Maßstab - Scale: -- | Oberfläche - Finish: --

	Datum - Date	Name
Entworfen-Drawn	03.11.97	G.Kaltenbach
Geprüft-Approved	03.11.97	C.Spitznagel
Geprüft-Approved		

Zeichn.Art/Blatt Nr.: SZ/04

Teil Bezeichnung - Part Description: MRI MAC500 V2.21

Teil Nr. - Part Number: 101 134 01...12

NICHT BESTUECKT:
NOT EQUIPPED:

Sheet 2: C122, D48, D49, R208, R232, R234, R235, R236, R658, R664, Z514

Sheet 4: AD

Sheet 5: AI, C135, C136, C137, C549, LED500, LED501, LED502, QU502, R237, R243, R665, R240, R241, R242, X508, X2, R239, R187

Sheet 6: C547, C548, R212, R215, R219, R220, R32, Z5, Z6, R56, Z512, R160, R161

SIEHE HIERZU :
SEE ALSO :

388 032 74 SHEET 1 TO 7

Schutzvermerk nach DIN 34 beachten

Marquette Hellige GmbH D-79007 Freiburg						388 032 73 - D02	Sheet: 0 of 7
Not equipped in Version :		REVISIONS Revision-No	Index	Date / Name	A04	42267208	SCHEMATIC MICROSMART
x1		063789	A	26.01.00 / MSG		Date / Name	
x2					DRAWN	04.11.97/MSG	
x3					APPROVED	04.11.97/JOK	
x4							
x5					ISSUED	MUELLER	

[1995, 3, 22, 4]
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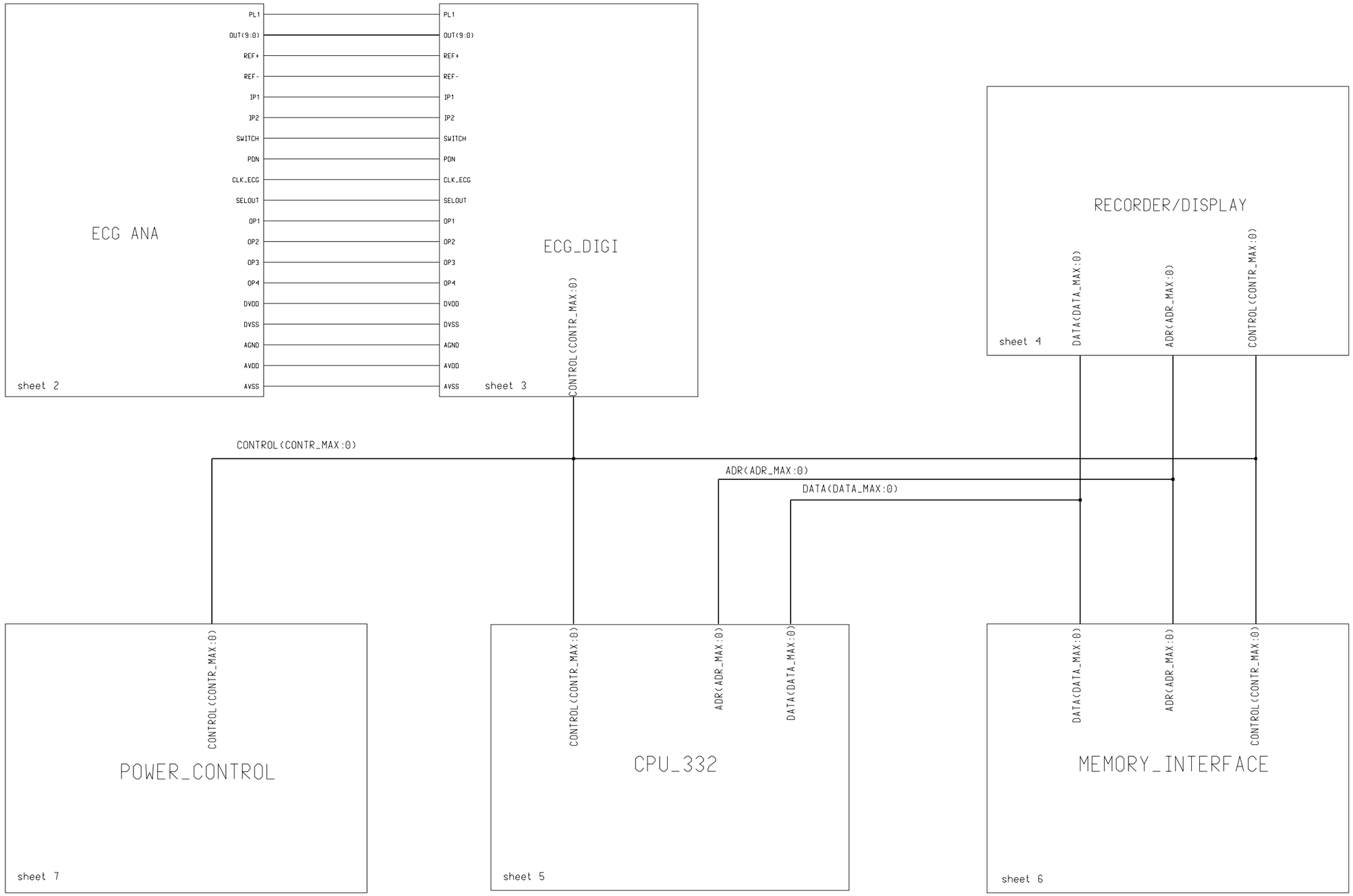
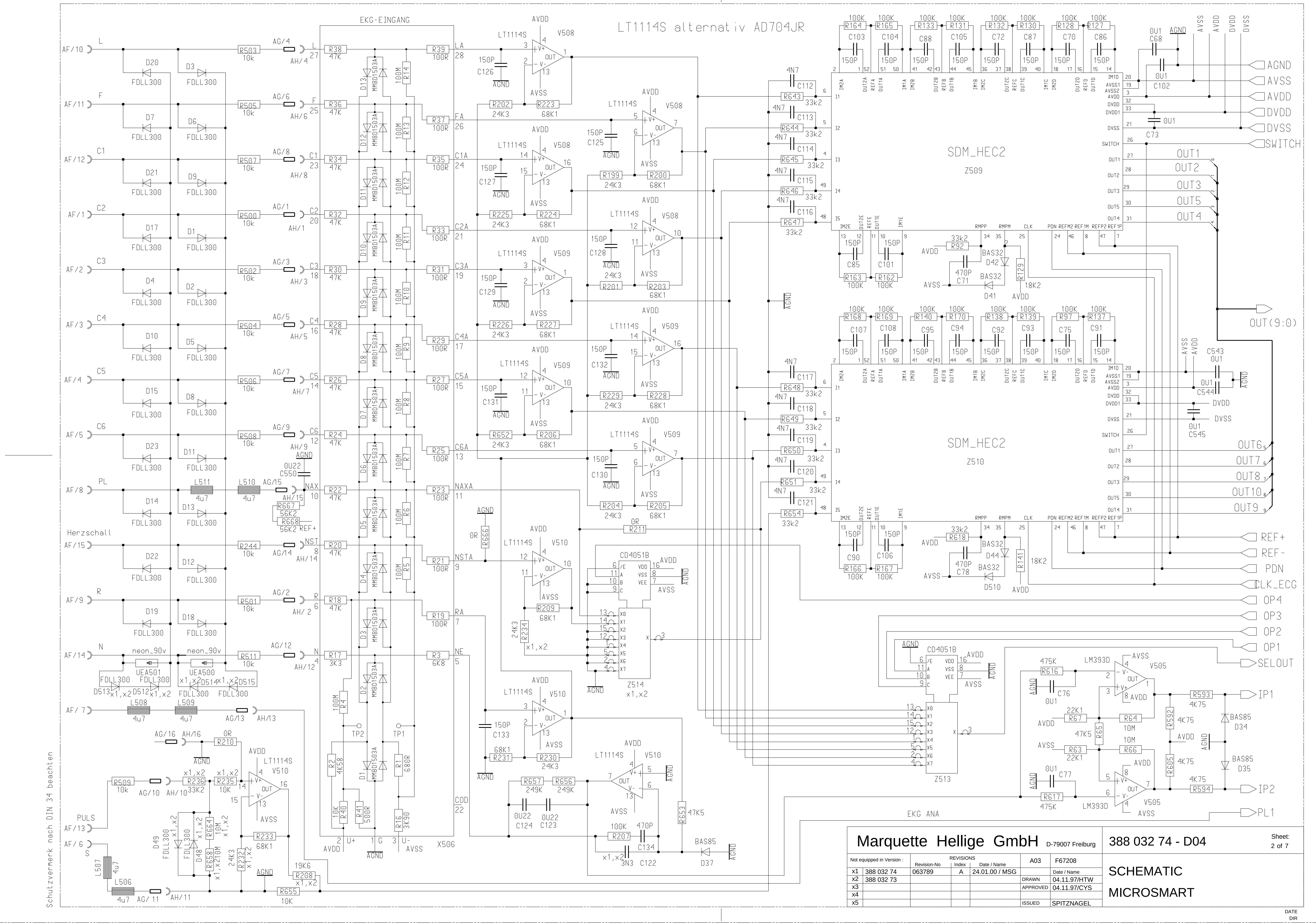


Schutzvermerk nach DIN 34 beachten

Marquette Hellige GmbH D-79007 Freiburg						388 032 74 - D03	Sheet: 1 of 7
Not equipped in Version :		REVISIONS Revision-No	Index	Date / Name	A03	F67208	
x1	388 032 74	063789	A	24.01.00 / MSG		Date / Name	SCHEMATIC MICROSMART
x2	388 032 73				DRAWN	04.11.97/MSG	
x3					APPROVED	04.11.97/JOK	
x4							
x5					ISSUED	SPITZNAGEL	



LT1114S alternativ AD704JR
EKG-EINGANG
SDM_HEC2
Z509
Z510
CD4051B
Z514
Z513
LM393D
EKG ANA
Schutzvermerk nach DIN 34 beachten
Marquette Hellige GmbH D-79007 Freiburg
388 032 74 - D04
Sheet: 2 of 7
Not equipped in Version :
REVISIONS
Revision-No
Index
Date / Name
A03
F67208
x1 388 032 74
x2 388 032 73
x3
x4
x5
063789
A
24.01.00 / MSG
Date / Name
DRAWN 04.11.97/HTW
APPROVED 04.11.97/CYS
ISSUED SPITZNAGEL
SCHEMATIC
MICROSMART

OUT(9:0)
AVSS
AVDD
AGND
DVSS
DVDD
SWITCH
OP1
OP2
OP3
OP4
PL1
IP1
IP2
CLK_ECG
PDN
REF+
REF-
DIGI_HEC2
Z506
CIN1
CIN2
CIN3
CIN5
CIN4
CIN6
CIN7
CIN8
CIN10
CIN9
SCLK
MOSI
KARDMON
RESETIN
NCSO*
MISO
OSCIN
OSCOUT
CLKIN
DVSS
DVDD
TSYNC
PACE2
PACE1
PDNOUT
CLKOUT
RESOUT
4.096MHz
QU500
22p
C50
C51
0U1
C64
C49
R68
0R
PACE_PIC
PIC16
Z507
MCLRN
OSC1
OSC2
RA0
RA1
RA2
RA3
RA4
RB0
RB1
RB2
RB3
RB4
RB5
RB6
RB7
VDD
VSS
+5VF
GNDF
R99
R100
R103
R104
R102
R146
R98
10K
R589
R588
R590
R591
1K
hcpl2630
X505
X504
X503
R569
R570
R567
R568
R586
R587
475R
SCLK_
MOSI_
RESET
PCS0
MISO_
TSYNC_
GND
C47
C48
C29
R566
R565
L6
+5V
C525
C526
C33
C34
C30
C32
C31
100p
LMC6484
V506
100R
R135
15N
C546
1U
C552
AGND
AVSS
AVDD
OUT
V506
LMC6484
10K
R134
BAS32
D43
R136
R627
1K87
C541
C542
C74
R93
R59
19K6
R94
TL431ACD
D508
C539
C58
R95
C551
L502
100U
470U
C519
FE_125KHZ
CONTROL(CONTR_MAX:0)
68K1
R174
124K
R175
R172
4K75
22K6
R176
R145
PACE1N
BAS85
D39
BAS85
D40
PACE1P
10K
R635
115K
R143
49K9
R636
R101
R177
18K2
R173
LM339
V507
18K2
R181
150K
R179
R182
49K9
R638
R142
PACE2N
BAS85
D38
BAS85
D45
PACE2P
10K
R171
47K5
R180
24K3
R178
R628
16K2
R144
R637
SELOUT
1M5
R62
0U22
C62
LMC6484
V506
AVSS
R60
24K3
1n
C60
1K
R61
30K1
R615
C61
R96
19K6
R614
4K75
2.25mV
4.5mV
TL750L05CLP
V503
V504
47U
C57
C538
0U1
C534
C532
220U
C537
C540
D33
D36
BAS85
C56
C69
R585
R39
1K
100P
C46
C533
30344281
TR500
L2/
L3/
L1/
C523
0u1
C18
R553
2K21
68M
R564
IRLR024
BAS85
D504
74HCT14
Z500
470p
C10
100K
R4
BAS85
D24
100P
C512
DVSS
AGND
DVDD
AVDD
AVSS
-5VF
EKG DIGI
Schutzvermerk nach DIN 34 beachten

Marquette Hellige GmbH D-79007 Freiburg						388 032 74 - D05
Not equipped in Version :		REVISIONS Revision-No	Index	Date / Name	A03	F67208
x1	388 032 74	063789	A	24.01.00 / MSG		Date / Name
x2	388 032 73				DRAWN	04.11.97/HTW
x3					APPROVED	04.11.97/CYS
x4						
x5					ISSUED	SPITZNAGEL
SCHEMATIC MICROSMART						Sheet: 3 of 7

DATE
DIR

CONTROL(CONTR_MAX:0)
ADR(ADR_MAX:0)
DATA(DATA_MAX:0)
CPLD(CPLD_MAX:0)

CPLD

MICROSMART_CPLD

KDATA
KCLOCK
KLATCH
TRIG_STRB_
PAPER_ERR_
DISPLAY
TSYNC_
CSDISPLAY_
QE_
KDATA
PAPER_RES_
MOT_EN_
STEP
MOT_INH_
PHASE2
I21
I20
PHASE1
I11
I10
DIR
ISP_MODE
INT_EKG_
FIFO_07
FIFO_06
FIFO_05
FIFO_04
FIFO_03
FIFO_02
FIFO_01
FIFO_00
TRIG_STRB_
PAPER_
START
RES_INT_
KLATCH
KCLOCK
FIFO_RD_
CLKOUT
RESET_
ISP_SCLK
ISP_EN_
ISP_SDI
ISP_SDO
R25 475R
Z504

ISP

ISP_SCLK AD/1
GND AD/2
ISP_MODE AD/3
NC AD/4
ISP_EN_ AD/5
ISP_SDI AD/6
ISP_SDO AD/7
+5V AD/8
x1,x2
R37 10k
R52 10k
R54 10k
R51 10k
R38 10k
C527 47n

DISPLAY

GND AE/1
+5V AE/2
V0 AE/3
RS AE/4
RW_ AE/5
E AE/6
DATA8 AE/7
DATA9 AE/8
DATA10 AE/9
DATA11 AE/10
DATA12 AE/11
DATA13 AE/12
DATA14 AE/13
DATA15 AE/14
ADR_0
RW_
CSFIFO_
CONTRAST
DISPLAY
R26 475R

FIFO

IDT7201

FIFO_RD_
TRIG_STRB_
R_
W_
RS_
XI_
FL_RT_
XO_HF_
VCC
GND
FF_
EF_
C54 47n
D0 D1 D2 D3 D4 D5 D6 D7 D8
Q0 Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8
FIFO_00 FIFO_01 FIFO_02 FIFO_03 FIFO_04 FIFO_05 FIFO_06 FIFO_07
Z2

CONTRAST

+12VR
+5V
74HCT14
R36 200k
C52 47n
V501 LMC660
Z500
R48 475R

THERMAL PRINT HEAD

Z501 74HCT244
R13 475R
R541 100R
R5 100R
R543 100R
C6 100p
C4 100p
C3 100p
C7 470p
AA/23 PH_DAT_IN4
AA/18 PH_CLK
AA/14 PH_LATCH
AA/ 3 GNDI
AA/ 5 GNDI
AA/ 6 GNDI
AA/25 GNDI
AA/26 GNDI
AA/27 GNDI

HEATING CONTROL

C535 4n7
R595 10k
R597 100R
T10 BSS84
R35 1k
C44 6n8
T11 BC847B
TL 431ACD D32
R596 100k
+12VR
+5VREF
LMC660
R22 10k
R23 10k
47k5 R24
R41 100k
R34 200k
R599 100k
47n C53
R611 10k
R542 100R
C510 100p
MP5011
MP5001
LM339
AA/16 NC
AA/24 PH_DAT_OUT4
AA/21 PH_DAT_IN3
AA/22 PH_DAT_OUT3
AA/ 9 PH_DAT_IN2
AA/10 PH_DAT_OUT2
AA/ 7 PH_DAT_IN1
AA/ 8 PH_DAT_OUT1
AA/11 KSTRB
AA/12 KSTRB
AA/19 KSTRB
AA/20 KSTRB

TEMPERATURE MONITORING

HEAT
74HCT14
Z500
R40 10k
C65 47n
R601 35k7
R600 536k
OVHEAT_6
OVHEAT_
R47 10k
C35 47n
R571 22k1
R572 56k2
L5 0u1
C509 100p
C13 47n
C12 0u1
C5 470p
C508 470p
AA/15 K_+5V
AA/13 THERM1
AA/17 THERM2

SENSOR

R598 4k75
R42 150k
R46 100k
R43 4k02
R44 10k
R546 392R
R547 2k21
C1 100000u
C513 47n
C507 470p
R45 36k5
C516 100p
C515 100p
C517 100p
AB/4
AB/3 SENSE_LED
AB/2 SENSE_GND
AB/1 SENSE_TR
AA/ 1 +V0
AA/ 2 +V0
AA/ 4 +V0
AA/28 +V0
AA/29 +V0
AA/30 +V0
GNDI

+24V VOLTAGE SUPPLY

+12VJ
0R1 R557
L504 68u
D506 BYV28/100
21k5 R544
221R R556
MC33063
V500
C22 0u1
C521 220u
R545 1k21
C514 150p
C529 1u
R20 499R
R21 499R
C520 220u

POWER SWITCH

+24V
10u L503
C21 47n
R554 100k
T1 IRFR9024
R555 475R
T7 IRFR024
T4 BC847B
R15 47k5
R14 47k5
R74 10k
D25 BAS85
D26 BAS85
R75 100k
R76 35k7
MOT_INH_

MOTOR DRIVER

TCA3727G
C20 47n
C11 0u22
C524 10u
I10
I11
PHASE1
I20
I21
PHASE2
INHIBIT
GND1
GND2
GND3
GND4
+VL +VS
Q11
Q12
Q21
Q22
GND8
GND7
GND6
GND5
OSC R2 R1
C19 2n2
R11 5R62
R12 5R62
L4 0u1
L3 0u1
L2 0u1
L1 0u1
MOTOR
AC/ 1 Q11
AC/ 2 Q12
AC/ 3 Q21
AC/ 4 Q22
AC/ 5
AC/ 6

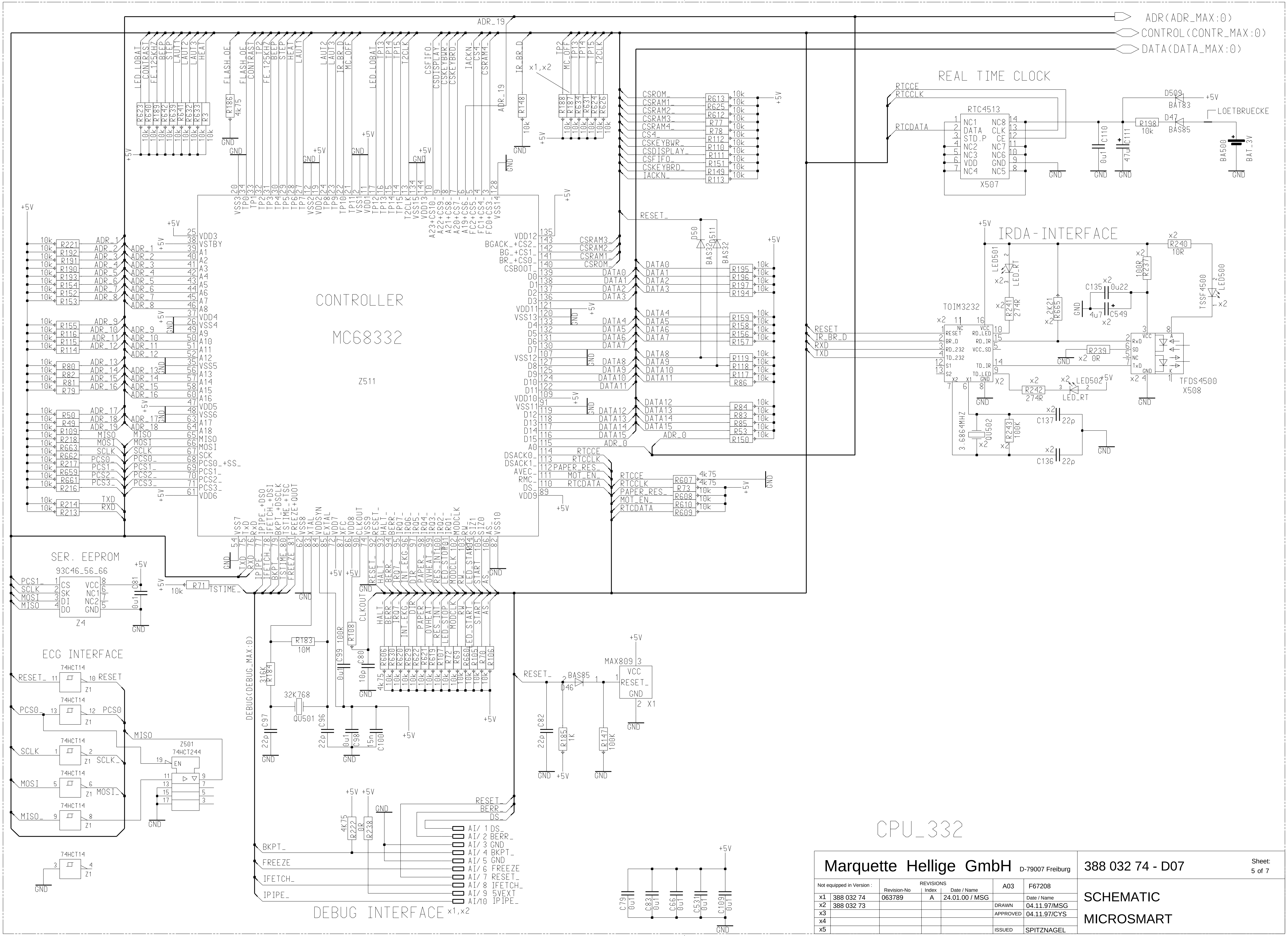
RECORDER/DISPLAY

PAPER_ERR_

Schutzvermerk nach DIN 34 beachten

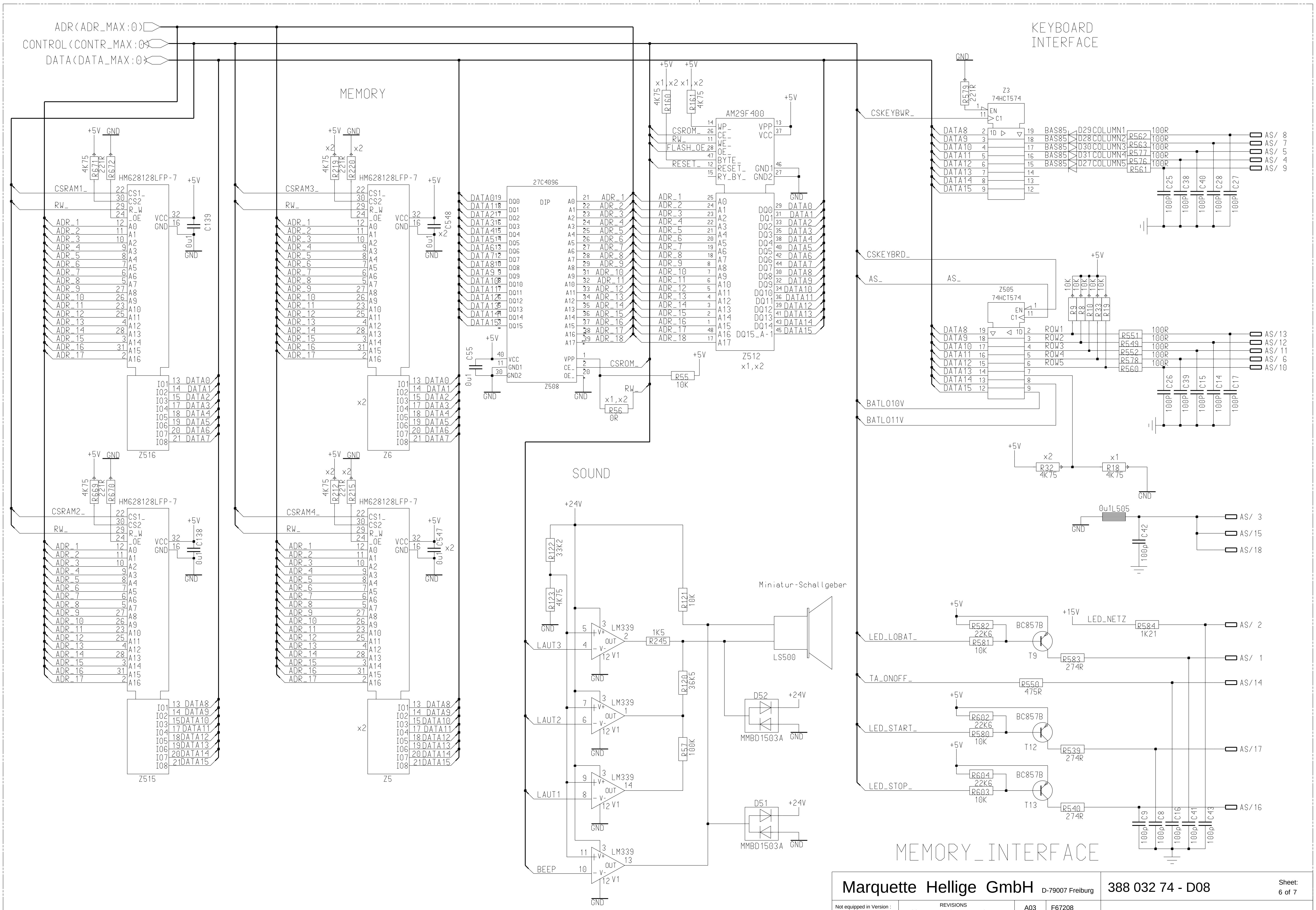
Marquette Hellige GmbH D-79007 Freiburg						388 032 74 - D06	Sheet: 4 of 7
Not equipped in Version :		REVISIONS Revision-No	Index	Date / Name	A03	F67208	
x1	388 032 74	203309	A	06.05.98/MSG		Date / Name	
x2	388 032 73	063099	B	23.08.99/MSG	DRAWN	04.11.97/MSG	SCHEMATIC
x3		063789	C	24.01.00/MSG	APPROVED	04.11.97/MLM	MICROSMART
x4							
x5					ISSUED	SPITZNAGEL	

DATE
DIR



Marquette Hellige GmbH D-79007 Freiburg						388 032 74 - D07 — Sheet: 5 of 7
Not equipped in Version :	REVISIONS Revision-No	Index	Date / Name	A03	F67208	SCHEMATIC MICROSMART
x1 388 032 74	063789	A	24.01.00 / MSG		Date / Name	
x2 388 032 73				DRAWN	04.11.97/MSG	
x3				APPROVED	04.11.97/CYS	
x4						
x5				ISSUED	SPITZNAGEL	

DATE
DIR



Marquette Hellige GmbH D-79007 Freiburg					388 032 74 - D08	Sheet: 6 of 7
Not equipped in Version :		REVISIONS Revision-No	Index	Date / Name	A03	F67208
					Date / Name	
x1	388 032 74	203288	A	30.03.98 / MSG		SCHEMATIC
x2	388 032 73	060204	B	06.05.98 / MSG	DRAWN 04.11.97/MSG	
x3		063789	C	24.01.00 / MSG	APPROVED 04.11.97/CYS	MICROSMART
x4						
x5					ISSUED SPITZNAGEL	

Schutzvermerk nach DIN 34 beachten

DATE DIR

ONOFF-INTERFACE

PSCON/3
PSCON/4
PSCON/1
PSCON/2
L501 430n
C2 0u1
C511 3n3
R2 1K
+15V
GNDP
D502 STPS340S
D503 STPS340S
2.5AT SI1500

CHARGE_CONTROL

R1 1R
BCP69 T500
D16 BYM13-30
R517 4k02
R516 200K
R518 19K6
R519 44K2
R537 1K21
R538 475R
C504 0u1
C503 0u1
GND
1M R520

UC3906
SINK SOURCE COMPENSATION
C_L
C_S_OUT
C_S+
C_S-
+Vin
GND
POWER_INDICATE_
OVER_CHARGE_TERM
VOLTAGE_SENSE
TRICKLE_BIAS
CHARGE_ENABLE
STATE_LEVEL_CONTROL
OVER_CHARGE_INDICATE_
X501

VOLTAGE_CONTROL

+5V
+12V
+5VREF
R124 4K75
R125 100k
R126 475r
R58 499K
C84 10n
R90 47k5
C67 10u1
R87 4K75
R88 100k
R89 475r
C536 10n
R91 453k
LM393D
V2
BATL010V
BATL011V

IRFR9024
T2
R558 100k
D505 BAS32
C522 0u1
C23 0u47
R548 100k
TA_ONOFF_
MC_OFF
R574 47K5
T8 BC847B
R573 22K6
C140 0u1
T5 BC847B
R16 6k81
R30 44K2
R575 10K
R27 10K
R29 10K
D507 BAS32
C36 0u1
R31 100k
R28 1K
C37 1u
R5 1K
C24 0u1
C528 0u1
4093
4013
Z503
Z502
+12V
+12VL
+12VJ
+12VR
GNDI
GNDJ
GNDL
GNDP
C518 470p
R559 4K75
CONTROL(CONTR_MAX:0)

+5V GENERATOR

BAS32 D501
+12VL
+5V
BOOST
VIN
VSW
LT1376-5
BIAS
SHDN_
GND VC FB
X500
L500 10u
C506 0u1
C505 10u
C508 3n3
BYM13-30 D500
C501 47u
C500 47u
GNDL

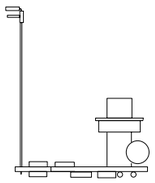
POWER_CONTROL

Marquette Hellige GmbH D-79007 Freiburg					388 032 74 - D09	Sheet: 7 of 7
Not equipped in Version :		REVISIONS Revision-No	Index	Date / Name	A03	F67208
x1	388 032 74	063789	A	24.01.00 / MSG		Date / Name
x2	388 032 73				DRAWN	04.11.97/MSG
x3					APPROVED	04.11.97/CYS
x4						
x5					ISSUED	SPITZNAGEL
SCHEMATIC MICROSMART						

Schutzvermerk nach DIN 34 beachten

DATE
DIR

BT - AS = 465
BT - BS = 319
LOET - AS = 1433
LOET - BS = 1228



MARK
MARKIERUNG

two fixations with sealing glue 829 073 00
2x fixiert mit Dichtungskleber 829 073 00

91541938 91541932 91541930 3/91618903

91541937

91541940

91541931

92722744

82907488

91541670

90812222

91541939

91541926

43367208

2 × 92723036

2 × 80402500

93011769

2 × 80177783

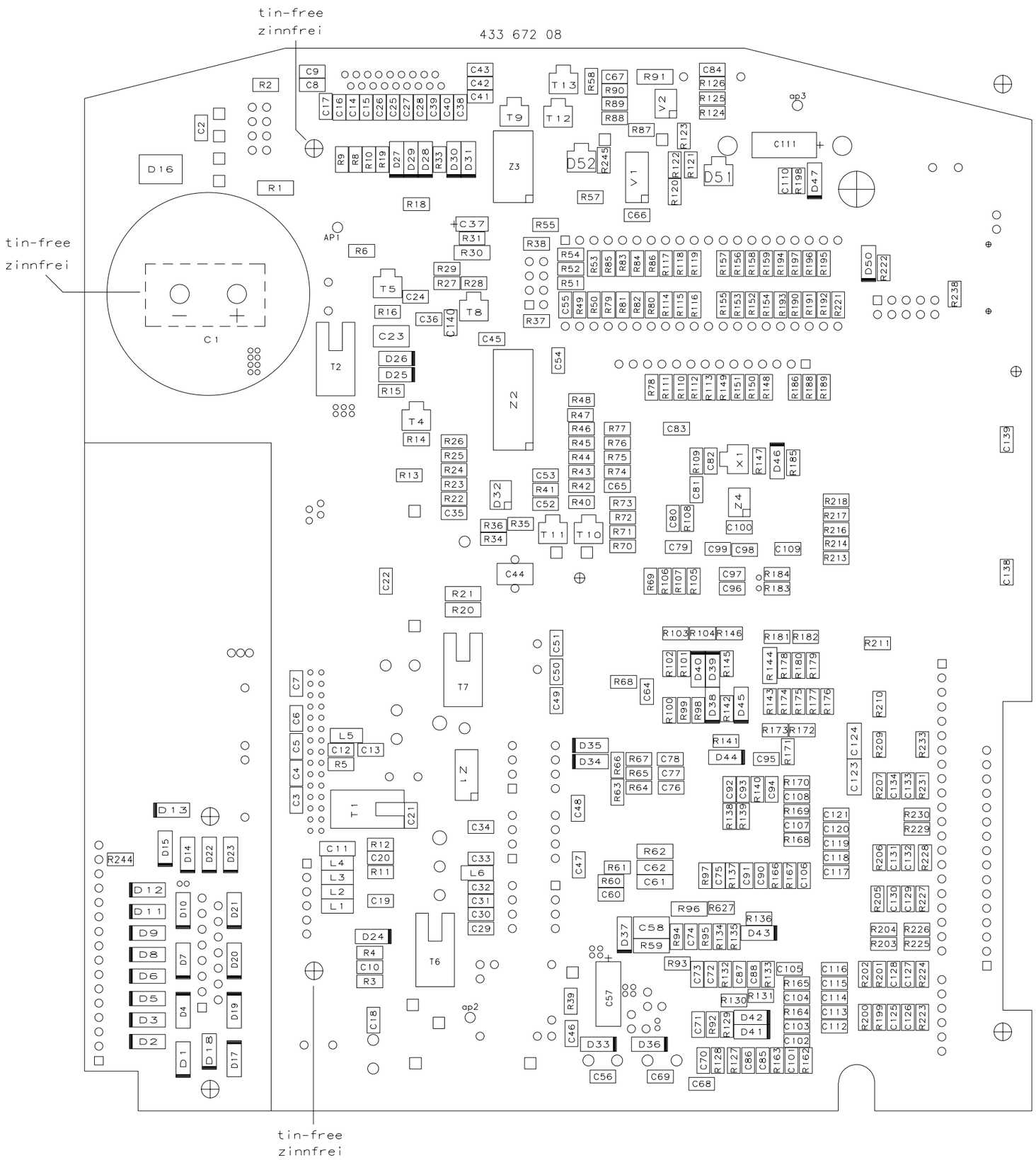
REFLOW
WAVE

Schutzvermerk nach DIN 34 beachten.

Marquette Hellige GmbH D-79007 Freiburg					38803273-D10 1 / 2
REVISIONS				A03	
Revision-No	Index	Date/Name		F67208	REF DWG
063789	A	25.01.00/MSG		Date/Name	
			Drawn	04.11.97/MSG	MICROSMART
			Approved	04.11.97/JOK	
			Issued	SPITZNAGEL	

tin-free
zinnfrei

433 672 08



Marquette Hellige GmbH D-79007 Freiburg				38803273-D11 2 / 2
REVISIONS			A03 F67208	
Revision-No	Index	Date/Name	Date/Name	
203288	A	30.03.98/MSG		
060204	B	06.05.98/MSG	Drawn	04.11.97/MSG
063789	C	25.01.00/MSG	Approved	04.11.97/JOK
			Issued	SPITZNAGEL

REF DWG
MICROSMART

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