

# CML00

## Control, Measurement and Data Logging System



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# 1 Applicability

System name	Order number
CML00 Controlboard with TCP/IP and USB	1H00004147
230VAC Power supply with power entry for CML00	D575.00373
CML00 Kit. 1H00004146 + D575.00373 with 3U/8HP front panel	1H00004170

## 1.1 Background Information

- IEC 60297-3-101, -102, -103
- PICMG 2.0 R3.0 CPCI Core Specification
- PICMG 2.01 R2.0 Hot Swap
- PICMG 2.09 R1.0 System Management Bus
- PICMG 2.10 R1.0 Keying
- IEC 1000-4-4 Electromagnetic Compatibility, Part 4, Section 4, Electrical fast transient/burst immunity test.
- EN60950-1
- Shock:  
MIL-STD-810F 1 January 2000 Annex C, U.S highway truck  
Figure 514.5C-1, vertical Shock test (Sawtooth) Figure 516.5-10
- Vibration:  
DIN EN 61373:1999, Figure 2, Category 1, Class B  
MIL-STD-810F 1 January 2000 Annex C, Shipboard: Figure 514.5C-15

## 2 Safety




### 2.1 Intended Application

CML00 are not end-products, so there is no valid approval for this unit. In Order to enable stand-alone functionality, additional elements are required.


The completion and final testing of the units have been carried out, or at least supervised, by qualified technicians. These instructions are directed exclusively to these qualified technicians i.e. engineers, trained and qualified electricians etc.

Make sure that the finished system complies with the safety regulations currently applicable in the country it is going to be used.

### 2.2 Safety Symbols

	<p><b>Hazardous voltage!</b> <i>Familiarise yourself with the danger of electrical voltages and the safety precautions before starting to work with parts that carry dangerous voltages</i></p>
	<p><b>Caution!</b> <i>This symbol indicates a condition where damage of the equipment or injury of the service personnel could occur. To reduce the risk of damage or injury, follow all steps or procedures as instructed.</i></p>
	<p><b>Danger of electrostatic discharge!</b> <i>Static electricity can damage sensitive components in a system. To avoid damage, wear ESD wrist straps or at regular intervals touch blank enclosure parts.</i></p>

### 2.3 General Safety Precautions

	<p><b>Warning!</b> <i>Voltages over 60 VDC can be present in this equipment. This equipment is intended to be accessed, to be installed and maintained by qualified and trained service personnel only.</i> <i>This equipment is designed in accordance with protection class 1!</i> <i>It must therefore be operated only with protective GND/earth connection!</i></p>
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## 2.4 Safety Instructions

The intended audience of this User's Manual is system Integrators and hardware/software engineers.

The product has been designed to meet relevant standard industrial safety requirements. It must not be used except in its specific area of office telecommunication industry and industrial control. It shall not be used in safety-critical applications, life-sustaining appliances or in aircraft.

Only trained personnel or persons qualified in electronics or electrical engineering are authorized to install, operate or maintain the product.

This section provides safety information about:

- Protection Against Electromagnetic Interference (EMI)
- Electrostatic Discharge Precautions
- System Installation

### 2.4.1 Protection Against Electromagnetic Interference (EMI)



The product has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules, EN 55022 Class A.

To ensure proper EMC shielding, operate the subrack only with all free slots populated with filler panels.

Ensure that all EMI gaskets make correct contact.

### 2.4.2 Electrostatic Discharge Precautions



Electronic components can easily be destroyed by electrostatic discharge which can occur between subrack components and a person.

- Before working on the rack make sure that you are working in an ESD-safe environment.

### 2.4.3 Location

Locate the system in a stable area free of excessive movement and jarring, dust, smoke, and electrostatic discharge (ESD). Make sure that the temperature does not exceed the operating temperature given in the environmental requirements in this guide and allow room for proper air flow for cooling.

### 2.4.4 Voltage Hazards



The system is powered with a power supply the mains voltage is 115/230VAC.  
(Voltage range 85VAC to 265VAC)

This voltage is considered hazardous.

### 2.4.5 Mounting Considerations

During the course of handling, shipping, and assembly, parts could become loose or damaged.

Do not operate a shelf in this condition, as this may cause damage to other equipment.

### 2.4.6 Electrical Hazards

The caution label on the system's rear near the grounding studs shows that you have to create an earth connection because there may be a high leakage current which is considered hazardous.



High leakage current can cause injuries.

Ensure that the system is properly grounded at all times, the following conditions shall be met:

- This equipment shall be connected directly to the AC supply system earthing



## 3 Product Description

### 3.1 General Information

#### 3.1.1 System Overview

The Control, Measurement and Data Logging system (CML) is designed to add remote control and monitoring functionality to electronic systems.

Analog measurement is done with a fast & high precision 12 bit AD converter. The 18 analog input channels are configured to measure 8 voltages, 6 temperature probes and 4 general purpose analog inputs.

The integrated supervision system compares all measured voltages with a minimum and maximum value and temperatures with a maximum value.

Exceeding the supervision threshold can switch off the system.

Fan speed measurement and speed control of up to 6 fans is provided. The fan supply voltage is generated on board, so no special fans with PWM input are required. Up to 3 fan groups can be regulated individually.

If the CMLs supplied by an external power source, it is possible to switch the main system power supply on or off with the on/off switch or via network.

All necessary functions are implemented on a small (86mm x 110mm) board. The system connections are provided on a 2mm high density connector.

For standard backplanes (e.g. VME) specific adapters are available.

The CML/adapter combination can be inserted into Hartmann electronic standard VME, VPX, cPCI systems, backplanes or power backplanes.

An optional alphanumeric display module can be connected to the CML. With this display all measured values can be visualized.

#### 3.1.2 Features

- Bus-Voltage measurement: 8 channels for 3.3V, 5V, 12V and -12V
- Temperature measurement: 1-wire-bus for up to 6 digital temperature sensors
- Fan Control: 6 Fans monitored, fan speed settable via fan supply voltage
- Fully controlled, programmable trip thresholds (min./max. Voltage & temperature)
- Generation of VME/CPCI RESET and ACFAIL
- Detection of VME/CPCI RESET and SYSFAIL
- Detection of Derating or Failure signal from CPCI Power Supplies
- Capable to switch CPCI Power Supplies (ON/OFF)
- Ethernet connection IEEE 802.3 10BASE-T and IEEE 802.3u 100BASE-TX
- WWW-Server integrated, full control via SNMP protocol
- Different security access level
- Multicolored status LED
- AC Main switch

- Remote or local switch ON/OFF
- PC-Control (connected to galvanic isolated USB or Ethernet) with free available software
- IP address settable to a fix value or configurable via DHCP
- Firmware update possible via USB.
- Automatic data logging on Windows/Linux computer possible
- Digital Signal Processor (DSP) for real-time processing of all measured data
- Powered by 5V bus voltage and independent power supply
- Configuration permanently saved in EEPROM
- Digital inputs: 8 x TTL
- Digital outputs: 8 x TTL

### **3.1.3 Optional Features**

- OPC server available
- CAN-bus (galvanic isolated)
- alphanumeric display (via I<sup>2</sup>C-Bus)
- 6 additional analog measurement channels for current, temperature or voltages
- Different Fan types supported (PWM-pulsed Fan or Fan with tachometer signal)
- PWM-Signal for external use

The system is based on a fast DSP-controller with flexible interface hardware. So it is possible to implement various custom-specific applications.

## 3.2 Front Panel Elements

### 3.2.1 CML00 3U / 8HP

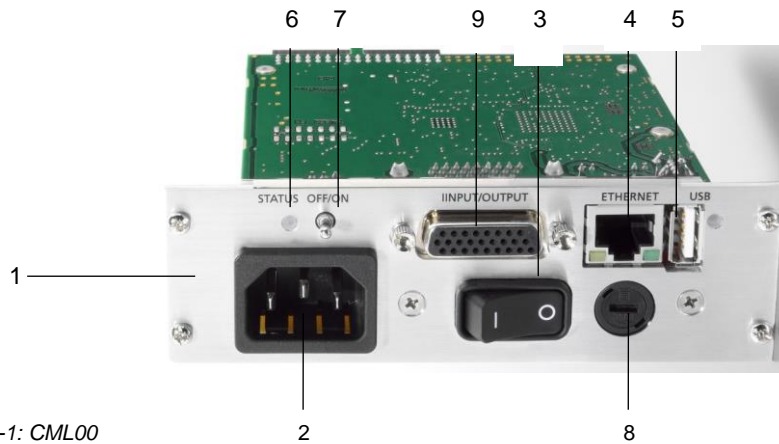



Figure 3-1: CML00

1	Front panel 3U/8HP	5	USB connector
2	VAC Power entry module	6	Status LED
3	Main power switch	7	ON / OFF soft switch
4	Ethernet connector	8	Fuse
9	I / O Connector		

### 3.2.2 Power entry module and fuse

The power entry module is provided with an IEC 320-C14 connector, contacted with fuse holder 1 pole.

	<p><b>Caution!</b></p> <p>The fuse values (6,3A T, 10A T) are only for incoming inspection.</p> <p>The final value depends on the ready configuration of the completed system. e.g. Number of power supplies.</p>
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### 3.2.3 Main Power switch.

Rocker switch 2-pole, non-illuminated, acc. to IEC 61058-1

If Power Switch "ON", the CML and PSU are active in Standby mode, but the outputs on Backplane are "OFF"

### 3.2.4 Ethernet connector


RJ45 Socket	Pin	Signal	Comment
 <p>8 1</p>	1	TX+	
	2	TX-	
	3	RX+	
	4	GND 1	
	5	GND 1	
	6	RX-	
	7	GND 2	
	8	GND 2	

Figure 3-2: Ethernet Connector Pin Assignment

This is the standard NIC configuration. You need a 1:1-cable to connect a to a HUB, or a cross-over cable to connect to another NIC (e.g. a computer).

*There is no automatic signal crossing like with some routers.*

### 3.2.5 USB connector

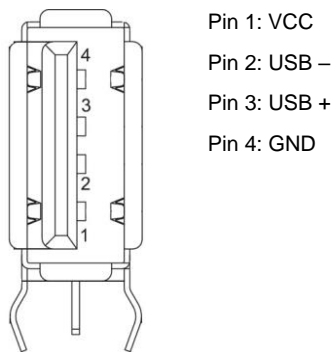


Figure 3-3: USB Connector Pin Assignment

This is the standard USB connector type A.

The USB connection is galvanic isolated from the system to prevent ground loops.

### 3.2.6 Status LED

This multi-color LED shows the global status of the system:

- YELLOW Standby state (the system power supply is off)
- GREEN System power is on, all measurement values are in limit
- RED System switched off because of any failure

### 3.2.7 ON / OFF Soft Switch

The soft switch is used to switch the system power supply (push the switch to the “ON” or position “OFF”).

### 3.2.8 Interface overview

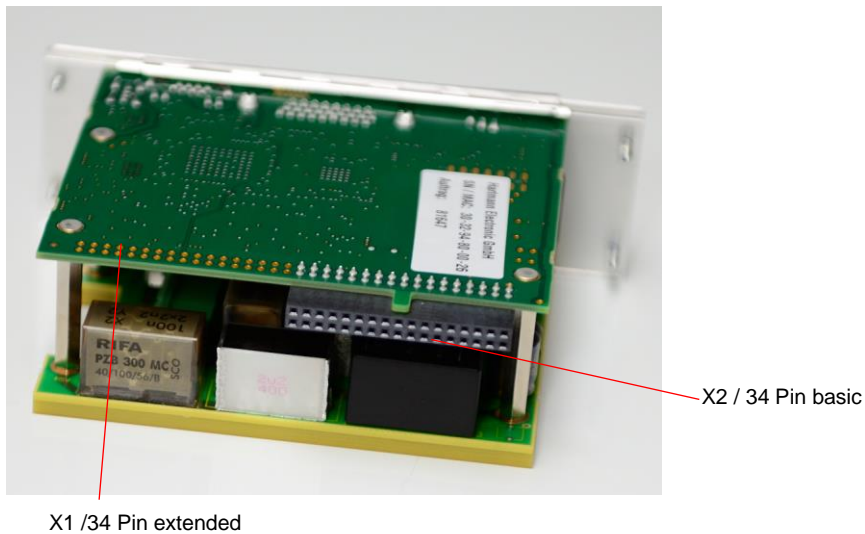


Figure 3-4: interface connector


Interface connector basic X2			
Pin	Signal	Pin	Signal
X2:A	5V Standby from Backplane (n.c)	X2:R	COMPACT_PCI_FAL_2
X2:B	5V_SENSE	X2:S	SWITCH_PS_1_OUT
X2:C	5.0V_BUS	X2:T	SWITCH_PS_2_OUT
X2:D	3.3V_SENSE	X2:U	FANTACHO1_IN
X2:E	GND	X2:V	FANTACHO4_IN
X2:F	-12V_SENSE	X2:W	FANTACHO2_IN
X2:G	GND	X2:X	FANTACHO5_IN
X2:H	12V_SENSE	X2:Y	FANTACHO3_IN
X2:I	VME_SYS_RESET	X2:Z	FANTACHO6_IN
X2:J	GND	X2:AA	FAN_PWR_SPLY (Connect to 12V)
X2:K	FAN_PWM_EXTERN_OUT	X2:AB	FAN_PWR_SPLY (Connect to 12V)
X2:L	I2C_SCL_EXTERN	X2:AC	FAN+ (Connect to Fan)
X2:M	1-WIRE-BUS_DATA	X2:AD	FAN+ (Connect to Fan)
X2:N	I2C_SDA_EXTERN	X2:AE	FAN- (Connect to Gnd)
X2:O	COMPACT_PCI_DEG_1	X2:AF	FAN- (Connect to Gnd)
X2:P	COMPACT_PCI_DEG_2	X2:AG	FAN- (Connect to Gnd)
X2:Q	COMPACT_PCI_FAL_1	X2:AH	FAN- (Connect to Gnd)

<b>Interface connector X1</b>			
<b>basic</b>		<b>extended</b>	
<b>Pin</b>	<b>Signal</b>	<b>Pin</b>	<b>Signal</b>
X1:A	DIGITAL_IN_7	X1:S	U8_SENSE
X1:B	DIGITAL_OUT_7	X1:T	U9_SENSE
X1:C	DIGITAL_IN_6	X1:U	U4+
X1:D	DIGITAL_OUT_6	X1:V	U4-
X1:E	DIGITAL_IN_5	X1:W	U5+
X1:F	DIGITAL_OUT_5	X1:X	U5-
X1:G	DIGITAL_IN_4	X1:Y	U6+
X1:H	DIGITAL_OUT_4	X1:Z	U6-
X1:I	DIGITAL_IN_3	X1:AA	U7+
X1:J	DIGITAL_OUT_3	X1:AB	U7-
X1:K	DIGITAL_IN_2	X1:AC	IO_LOAD
X1:L	DIGITAL_OUT_2	X1:AD	IO_CLOCK
X1:M	DIGITAL_IN_1	X1:AE	IO_SOM
X1:N	DIGITAL_OUT_1	X1:AF	IO_SIMO
X1:O	DIGITAL_IN_0	X1:AG	GND
X1:P	DIGITAL_OUT_0	X1:AH	GNDA
X1:Q	GND		
X1:R	GNDA		

### 3.2.9 Grounding/Protective Earthing

The system contains gaskets at the subrack and board level to guard against electromagnetic interference (EMI). Each of the subrack's individual components make contact with the gaskets and to the PE-flat plug inside the rear panel.

The guide rails are also fitted with electrostatic discharge (ESD) contacts for each blade and RTM. These ESD contacts ensure that the boards are fully discharged to prevent static caused by static as they are plugged into the subrack.

	<p><b>Caution!</b> <i>The subrack is designed in accordance with protection class 1! It must therefore be operated with protective earth/GND connection. Use only a three conductor AC power cable with a protective earth conductor that meets the IEC safety standards!</i></p>
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There is a 6.3 x 0.8mm PE-flat plug at the auxiliary PSU. This flat plug is only for potential equalization. Grounding is achieved through the protective earth conductor of the power cable!

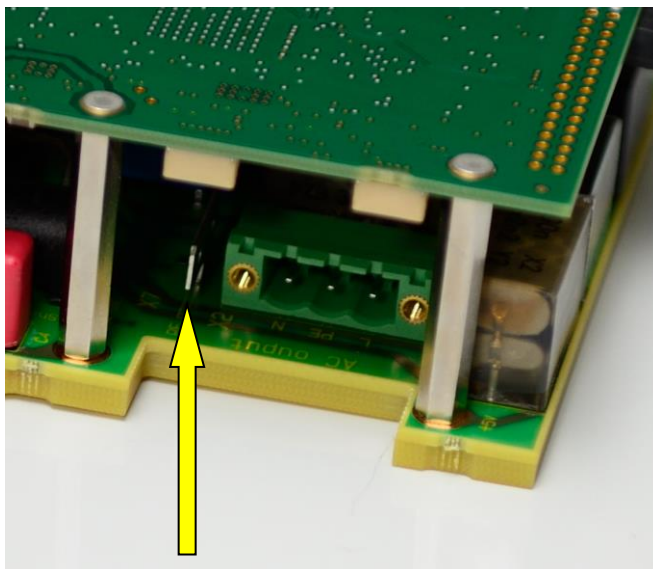


Figure 3-5: Protective Earth and Grounding

## 3.3 Fans

### 3.3.1 Fan Speed Measurement

The CLM can measure the rotation speed of up to 6 fans simultaneously.

The standard fan speed signal is the open collector pulse output provided by many fans. If such signal is not available, the fan current (measured at a small shunt resistor) can be used and the CML calculates the rotation speed by analyzing this current signal.

The fan rotation speed is accessible with SNMP network commands (crate.fantray.fanSpeed OID)

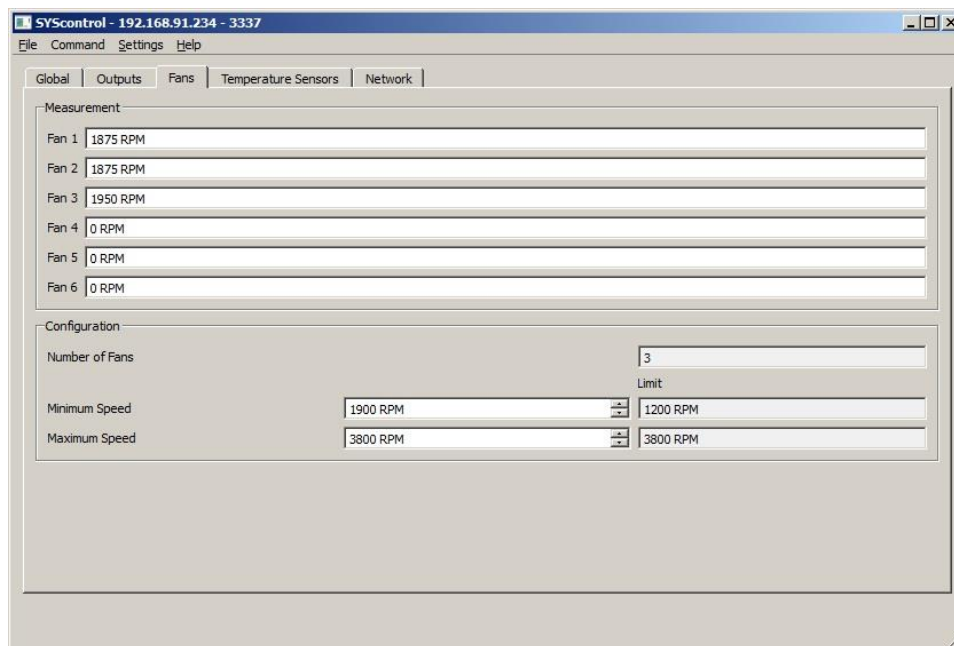


Figure 3-6: Window "Fans" in SYScontrol

### 3.3.2 Fan Speed Regulation

The CML provides 6 independent fan supply outputs. The output voltage is regulated by the CML to achieve the requested rotation speed.

The nominal fan speed is changeable with the SNMP network commands (crate.fantray.fanNominalSpeed OID) or in SYScontrol window "Global"

An automatic fan speed regulation depending on the temperature sensors is also possible.



### 3.4 Temperature Sensor Inputs

The CML has 6 temperature sensor inputs (semiconductor sensors with 1 kOhm resistance at 25°C)

In the event of an error, the status LED on the front panel will turned red.

The temperatures can be read with the SNMP network command (crate.sensor.sensorTemperature OID) or in SYScontrol window “Global”

Each temperature is compared with three threshold values.

(crate.sensor.sensorWarningThreshold, crate.sensor.sensorAlarmThreshold and crate.sensor.sensorFailureThreshold OIDs).

The temperature threshold values can be read or write in SYScontrol window “Temperature Sensors”.

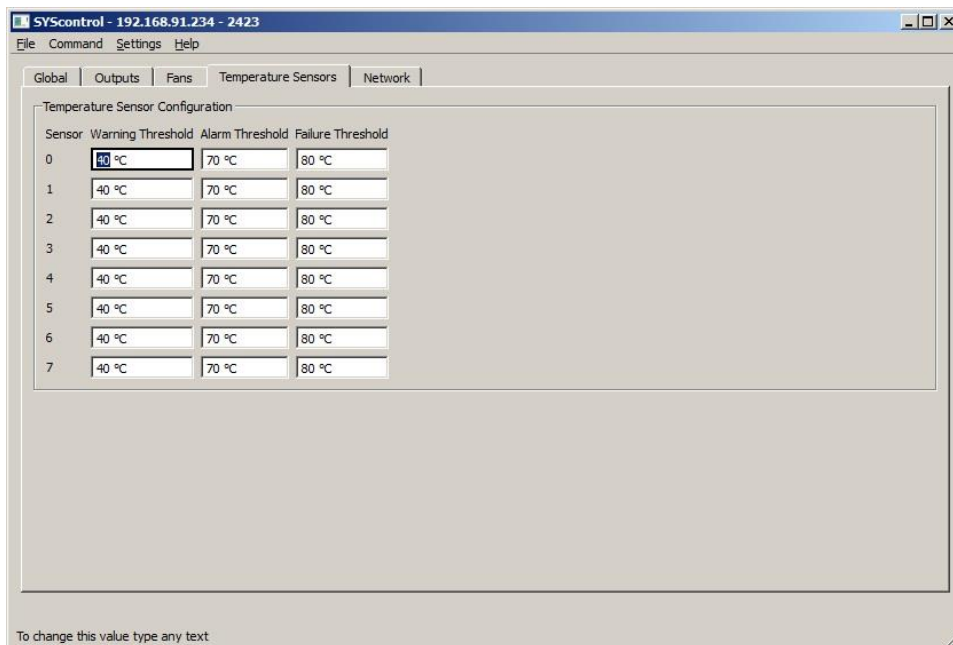


Figure 3-7: Window “Temperature Sensors” in SYScontrol

**Please set all group- thresholds to equal values.**

Two different modes can be set. Please read more about the hysteresis control mode and the linear control mode in the following paragraph.

To operate the device in the hysteresis control mode, it is necessary to swap the alarm with the warning temperature value. The alarm temperature has to be less than the warning temperature. The fan speed executes a hysteresis between the two temperature points of any connected sensor between maximum speed and the nominal and minimal speed respectively.

If the “sensorFailureThreshold” of any connected sensor is reached, the main power supply of the system is switched off.

The controlling result of fan speed is pictured in figure 3.8.

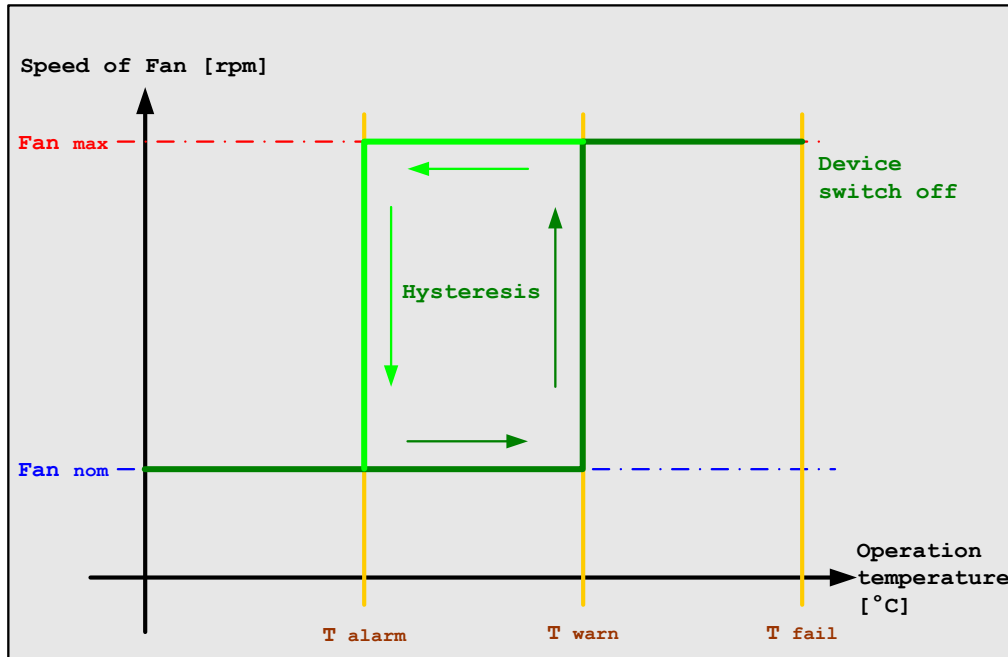


Figure 3-8: Hysteresis control mode

The second mode is the linear control mode. If the temperature of any connected sensor is under the warning threshold the fans will operate in their nominal and minimum speed respectively.

If the “sensorWarningThreshold” is reached, all fans will rotate in a calculated linear temperature-sensitive speed.

Overstepping the “sensorAlarmThreshold” they will switch to their maximum speed.

After exceeding the “sensorFailureThreshold” of any connected sensor, the main power supply of the system is switched off.

The controlling result of fan speed is pictured in figure 3.9.

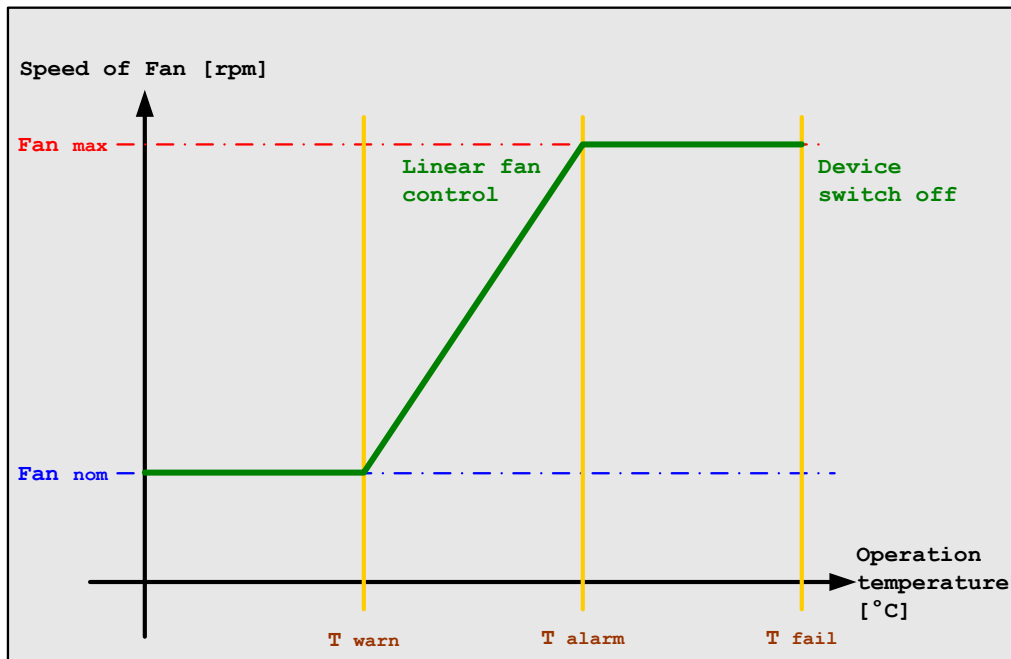


Figure 3-9: Linear control mode

If using the linear control mode it is important to know that there exists a sub mode called low noise mode. When the nominal speed set by user is under the allowed minimal speed, the device will switch off all fans.

**Linear control mode is the default setting at delivery.**

If it is not necessary to cool down the device the fans stand still. After reaching of "sensorWarningThreshold" the behavior of fan control is equal to the linear control mode.

The controlling result of fan speed is pictured in figure 3.10.

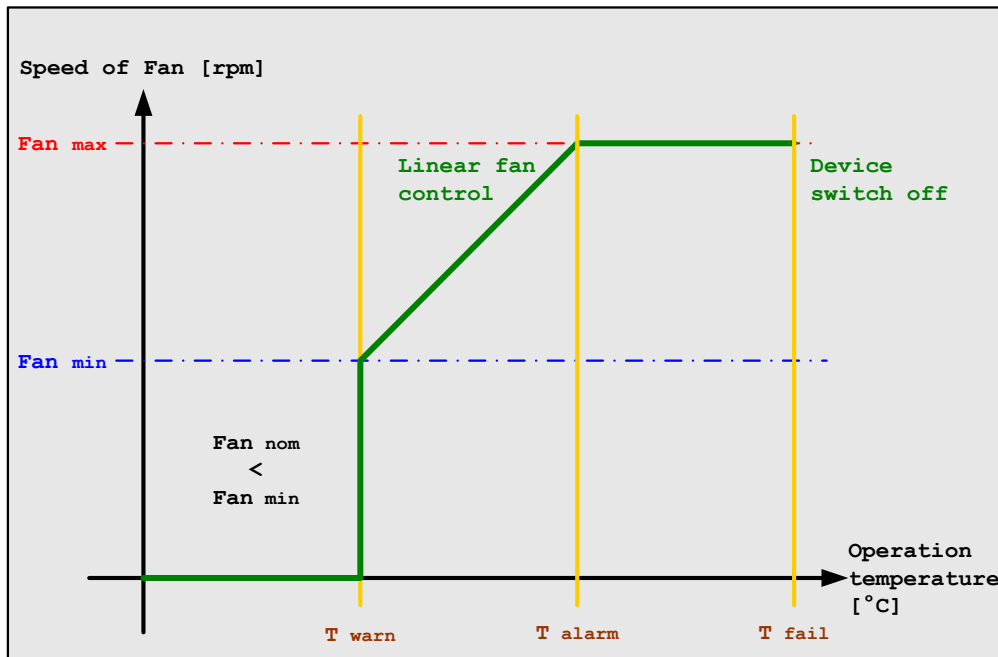


Figure 3-10: Low noise control mode

The default setting at threshold is:

- “sensorWarningThreshold” 30°C
- “sensorAlarmThreshold” 45°C
- “sensorFailureThreshold” 55°C

### 3.5 Basic Control & Measurement Signals

8 digital inputs and 8 digital outputs are on the HD-SUB-D26 connector on the front plate.



Figure 3-11: High density SUB-D DIO connector 26 Pol

SUB-D	1	2	3	4	5	6	7	8	9
DI	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	GND

<b>SUB-D</b>	11	12	13	14	15	16	17	18	26
<b>DO</b>	DO1	DO2	DO3	DO4	DO5	DO6	DO7	DO8	GND

Are DIO bits numbered: bit 0 to 7 bit.

The CML00 extension is most significant bits (MSB)

To example:

- "hex" F0 to answer "binary" 11110000,
- "hex" AA to answer "binary" 10101010

### 3.5.1 Digital Inputs

The digital inputs DI1 ... DI8 are standard TTL inputs

The inputs can be read by SNMP network commands (crate.signal.digitalInput OID)

To example:

get one byte:

- C:\>snmpget -v 2c -m +WIENER-CRATE-MIB -c guru -t 0.01 -r 10 192.168.91.234 digitalInput.0  
WIENER-CRATE-MIB::digitalInput.0 = BITS: FF d0(0) d1(1) d2(2) d3(3) d4(4) d5(5) d6(6) d7(7)

### 3.5.2 Digital Outputs

The digital outputs DO1 ... DO8 are push/pull 5V CMOS TTL outputs

The outputs can be set/reset by SNMP network commands (crate.signal.digitalOutput OID)

To example:

set one bit:

- C:\>snmpset -v 2c -m +WIENER-CRATE-MIB -c guru -t 0.01 -r 10 192.168.91.234 digitalOutput.0 x d0  
WIENER-CRATE-MIB::digitalOutput.0 = BITS: D0 d0(0) d1(1) d3(3)

set one byte:

- C:\>snmpset -v 2c -m +WIENER-CRATE-MIB -c guru -t 0.01 -r 10 192.168.91.234 digitalOutput.0 x: F0  
WIENER-CRATE-MIB::digitalOutput.0 = BITS: F0 d0(0) d1(1) d2(2) d3(3)

get one byte:

- C:\>snmpget -v 2c -m +WIENER-CRATE-MIB -c guru -t 0.01 -r 10 192.168.91.234 digitalOutput.0  
WIENER-CRATE-MIB::digitalOutput.0 = BITS: F0 d0(0) d1(1) d2(2) d3(3)

## 3.6 Additional Control & Measurement Signals

Additional analog inputs are available at connector X1 (assembled on request) see "figure 3-4"


### 3.6.1 Analog Inputs

The analog inputs U4 ... U7 have differential inputs (0-3V operating range)

The data can be accessed via SNMP (crate.signal.analogMeasurementVoltage OID)

## 4 CML Setup via USB

The CML can be controlled with the MUSEcontrol software via USB.

	<p><b>Caution!</b></p> <p><i>The USB interface is primarily to be used to configure the power supply. The Ethernet connection is designated for remote control and monitoring.</i></p>
---	--

### Requirements

- X86-Computer with USB connection (USB3 Cable required)
- Microsoft Windows XP

### Features

- Save and reload of firmware.

### 4.1 Installation MUSEcontrol

The installation software "MUSEcontrolInstall-x.x.x.x.exe" is part of delivery.

Then accept the "automatic install the software" selection by clicking "continue"

Now the USB driver software be installed. To access your CML00, execute the "MUSEcontrol" application via your start menu.

### 4.2 The Main Window MUSEcontrol

After starting the application "MUSEcontrol" the main window shows the following overview.

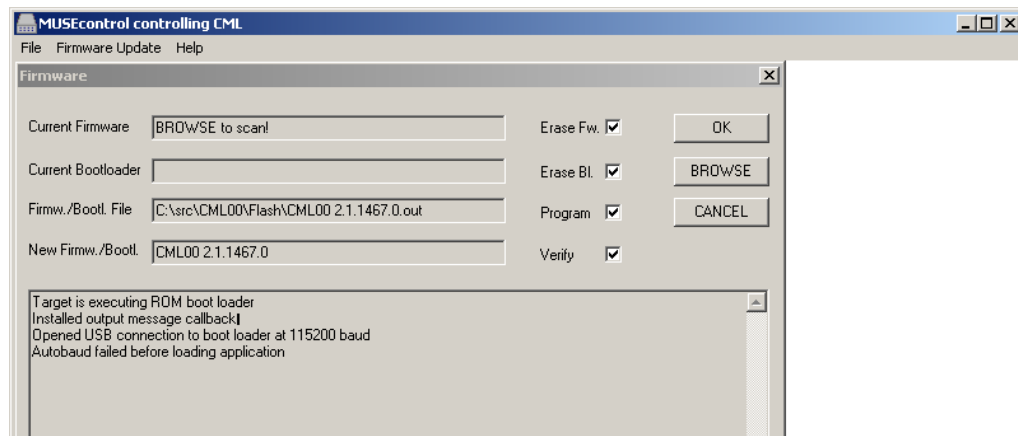


Figure 4-1: Main Window MUSEcontrol

For firmware update please click the button "browse", select your new firmware and click the button "OK"

If the firmware update is finish, you click the button "cancel"

After firmware update the CML must restart.

## 5 CML setup via Ethernet

The CML can be controlled with the SYScontrol software via Ethernet.

### Requirements

- X86-Computer with Ethernet connection
- Microsoft Windows XP, Windows 7, 32-Bit and 64-Bit version

### Features

- Setup of the TCP/IP network parameters
- Global overview of all power supply channels
- Detailed configuration of the power supply channels
- Global overview of all temperature sensors
- Detailed configuration of temperature sensor thresholds
- Global overview of Fan speed data
- Detailed configuration of all Fan data
- Switch power ON / OFF
- Bus reset
- Save and reload of configuration data

### 5.1 Installation SYScontrol

The installation is done in three steps:

1. Install "net-snmp-x.x.x.exe" NetSNMP is an open source SNMP program which can be used to access the CML via the Simple Network Management Protocol. Please see <http://net-snmp.sourceforge.net/> for more details.
2. The HEL-CRATE-MIB.txt (or old Version with WIENER-CRATE-MIB.txt) file must be stored somewhere on the PC doing the calls, by default that location should be /usr/share/snmp/mibs.
3. Install software "SYScontrolInstall-x.x.x.x.exe"

## 5.2 The Main Window “SYScontrol”

After starting the application “SYScontrol” the main window shows the following overview.

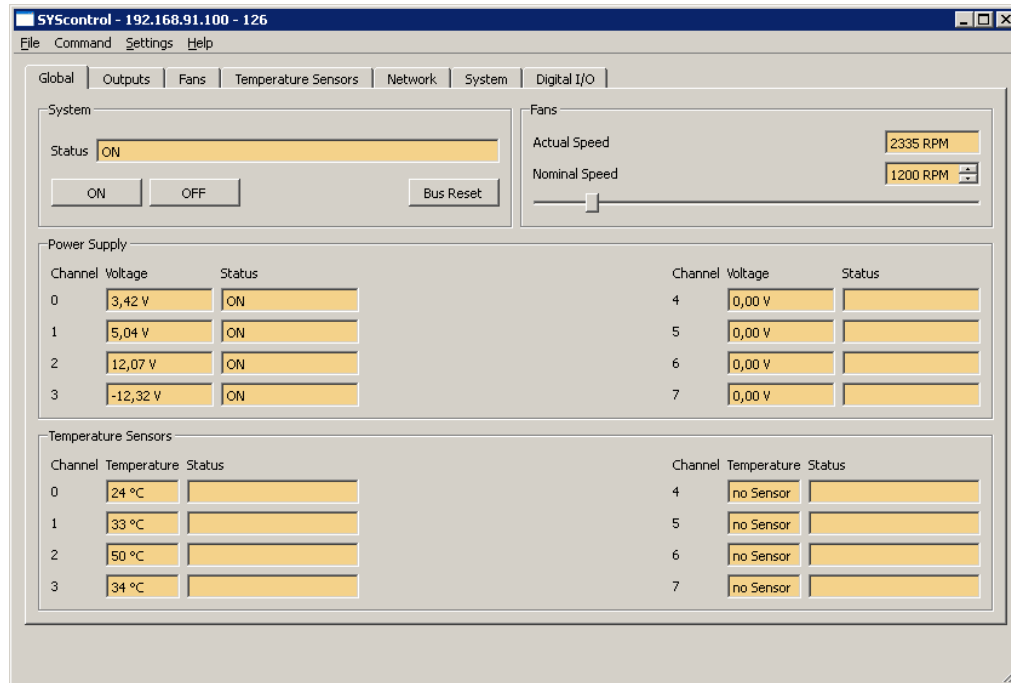


Figure 5-1: Window “Global” in SYScontrol

“SYScontrol” visualizes all relevant values such as temperature, voltage, fan speed, network address and system status.

You can change all the values needed, such as threshold of temperature, fan speed, or voltages.



## 5.2.1 SYScontrol window “Outputs”

For voltages is compared with eight threshold values.

The voltage threshold values can be read or write in SYScontrol window “Outputs”.

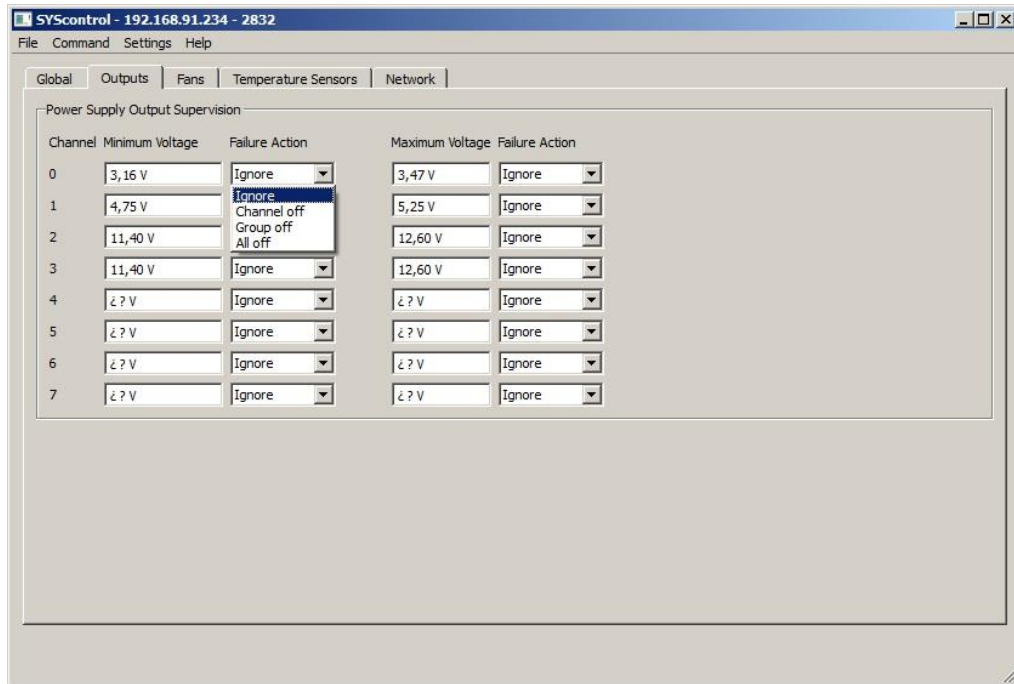


Figure 5-2: Window “Outputs” in SYScontrol

For Failure Action set “Ignore” then the errors are ignored, or set “All off” then the system turned off in case of error.

**Failure action “Channel off” and “Group off” is not valid for CML00.**

## 5.2.2 SYScontrol window “Networks”

In window “Network” you can change the network address and SNMP Community name. Go with the mouse on individual items for tool types information.

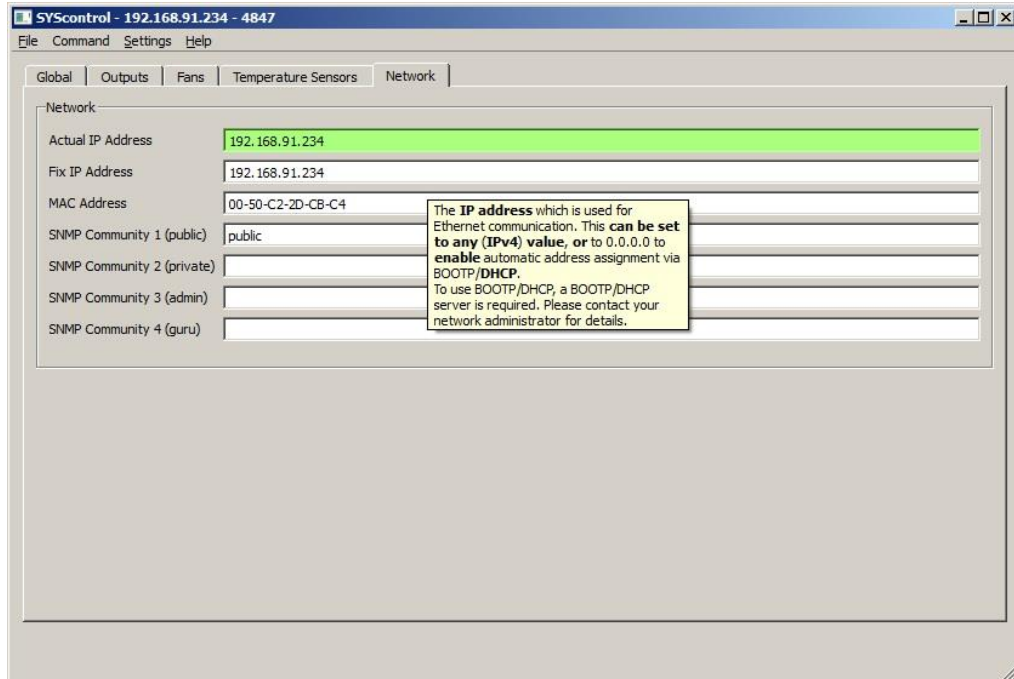


Figure 5-3: Window “Network” in SYScontrol

In window “Network” you can change the network address.

**Default network address is 192.168.1.9.**

**For DHCP active, please type 0.0.0.0**

## 5.2.3 Connect devices in your network

For search devices connected to your network, please click to “Settings” and then to “Preferences”

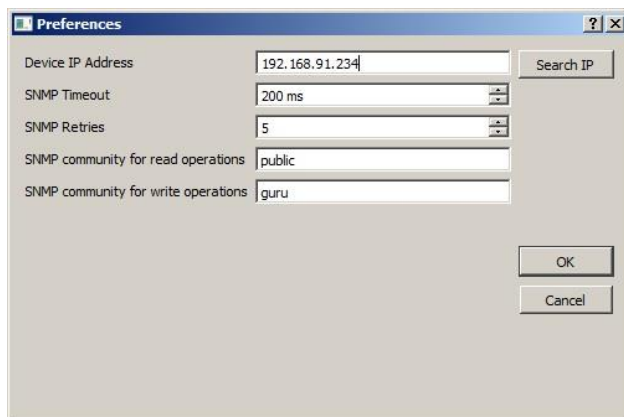


Figure 5-4: Window “Preferences” in SYScontrol

For connect to CML00 please write the true network address, or click of the “Search IP” – Button.

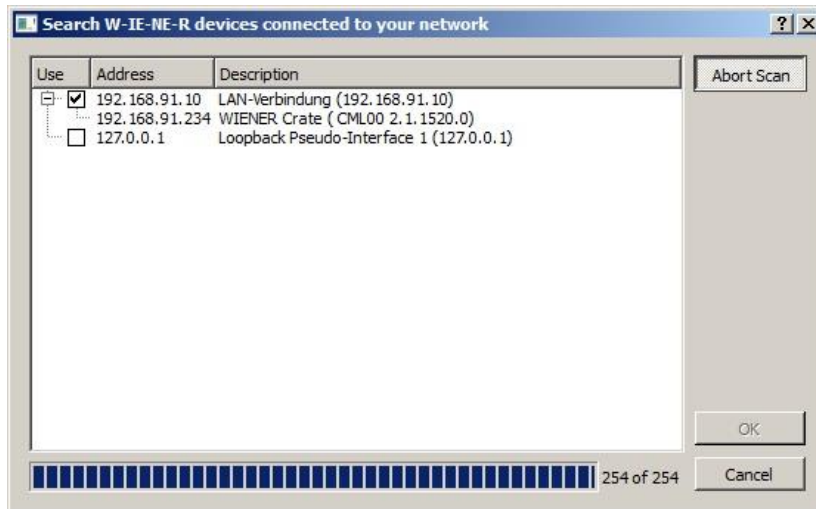


Figure 5-5: Window “Search” in SYScontrol

All CML00 located in the network are displayed.  
For connection, click on device and “OK”

## 6 CML setup via “snmp”

Only a small part of general SNMP OIDs is implemented.

For new CMLs, please use the HEL-CRATE-MIB.txt!

- With command “snmpwalk” OIDs are all listed, for example:  
C:\>snmpwalk -v 2c -m +WIENER-CRATE-MIB -c guru 192.168.1.9 crate
- With command “snmpget” is only a certain OID listed, for example:  
C:\>snmpget -v 2c -m +WIENER-CRATE-MIB -c guru -t 0.01 -r 10 192.168.1.9 sensorWarningThreshold.temp1
- With command “snmpset” is only a certain set OID, for example:  
C:\>snmpset -v 2c -m +WIENER-CRATE-MIB -c guru -t 0.01 -r 10 192.168.1.9 sensorAlarmThreshold.temp1 i: 45

A detailed description of the SNMP functionality can be found in the corresponding MIB file HEL-CRATE-MIB.txt or (old solution WIENER-CRATE-MIB.txt)

## 7 Set the default settings

For setting the default values is provided a setup routine.

The setup routine is done in following steps:

1. Main power switch (3, *figure 3-1*) turn Power OFF
2. ON/OFF switch (7, *figure 3-1*) turn right and keep right (OFF)
3. Main power switch (3, *figure 3-1*) turn Power ON
4. System setup running, status LED blinks red-green three times, then three times yellow-off, then yellow lights permanently
5. ON/OFF switch (7, *figure 3-1*) turn mean
6. ON/OFF switch (7, *figure 3-1*) turn left (ON)
7. The Crate turns on; the fan settings are automatically set. The status LED blinks yellow-off about 30s.
8. If the fans have been detected, the status LED blinks green-off as often, as the number of fans in the system. Then green lights permanently
9. The System is ready

Default IP address is 192.168.1.9

Default subnet mask is 255.255.255.0

The maximum fan speed is detected.

The minimum fan speed is set of 33% from max fan speed.

The nominal fan speed is set of 50% from max fan speed.

## 8 Service

### 8.1 Technical support and Return for Service Assistance

Please return the complete subrack system. For all product returns and support issues, please contact your Hartmann Electronic sales distributor or [www.hartmann-electronic.com](http://www.hartmann-electronic.com)

Please use the original packing material. Shipping without the original packing material might void the warranty.



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