ALMEMO®

Operating Instructions

Data Acquisition System
ALMEMO® 5990-2

V1.0
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Operating devices front side

(1) LCD display

Status line

C	Cont. measuring point scan
▸, ⏸	Start, stop measurement
REC	Memory record
COM	Output of meas. val.
|>, >|	Meas. start, end progr.
R01	Alarm relay status
✸,	Light on, pause
	Mains/batt. oper./charge stat.

13 lines für functions
function of softkeys F1, F2, F3, F4

(2) Control Lamps

START	meas. point scan in process
REC	Memory record
COM	meas. values output
AVG	averaging
ALARM	limit value exceeding or sensor breakage
LOCKED	locked keys

(3) Control keys

HOTKEY	user menu selection
PROG	function selection, input
ESC	function abort, menu
F1...F4	function keys (soft keys)

(4) ON Switch

Rocker switch	on to the right
Lamp **ON**	device on
Lamp **PWR**	Net supply ready
Option Akku:	shine at accumulator cargo load flash if full of accu.

(5) Rotary knob (▲▼ turn, ▸ press)

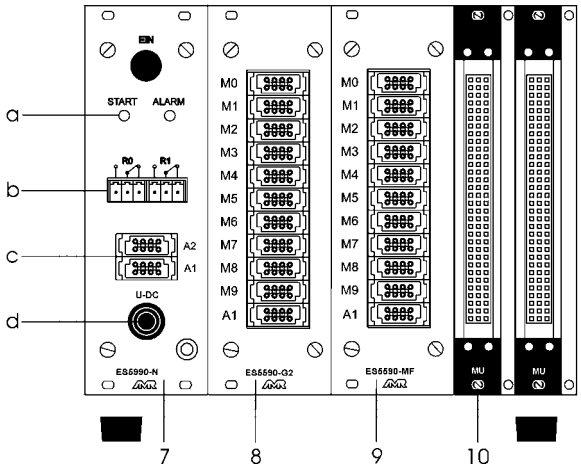
M▲▼	meas. pt. select.
P▸, F▲▼	function select.
P▸, ▲▼, ▸...	data input

(6) Smart-Media-Memorycard

(Option ZB 1904-SC8)

MEM	plug-in place for Smart-

Operating devices back



(7) Plug in module Power supply ES 5990-N

d	conn. U-DC	11,5..14V DC, for netw. adapter ZB 5090-NA3
	Option A:	8.4V DC recharg. batt., recharg. with ZB 5090-NA3
	Option U:	10..36V DC electr. isol. with DC/DC converter, 12V, 1A
c	A1	V24-interface with cable ZA1909DK, optic-fiber with ZA1909-DKL
		RS422-Networking with network distributor ZA 5099-NVB/L
		Centronics with cable ZA1936-DK
	A2	Networking w. netw. cable ZA1999NK, optic-fiber w. ZA1999NKL
		Trigger iputs with cable ZA1000-EK, relay outputs ZA 1000-EGK
b	R0 and R1	alarm relay (see 11.2)
a	START, ALARM	Control lamps

(8) Plug in module Measuring circuit board ES 5590-G2 (for ALMEMO-single connector)

M00 bis M09	10 meas. inputs for analog and digital sensors
M10 bis M39	30 add. chann. f. double sensors and arithm. chann.
A1	analog output with cable ZA 1601-RK, alarm local w. ZA1000EAK

Extension with Passive Selector Switch Boards:

(9) Plug in module Selector Switch Board ES 5590-MF (for ALMEMO-single connector)

Mx0-Mx9	10 meas. inputs for analog and digital sensors
$Mx0_{+10}$ bis $Mx0_{+39}$	30 add. chann. f. double sensors and arithm. chann.
A1	analog output with cable ZA 1601-RK
	2 alarm outputs with cable ZA 1000-EGK2
1 CODE SWITCH	board number 0 to 7 internally on-board

(10)Plug in mod. Selector Switch Board ES5590MU (ALMEMO®-10-fold MU conn. ZA5590MU)

Mx0 bis Mx9	10 meas. inputs for analog sensors
GW max, GW min	2 alarm outputs f. all meas. points of the plug-in module
1 CODE SWITCH	board number 0 to 7 internally on-board

Operating Instructions

Data Aquisition System

ALMEMO® 5990-2 V5

For reference with the ALMEMO® Manual

Table of Contents

1. INTRODUCTION

The data logger **ALMEMO**® 5990-2 is a new instrument from the unique product range of measuring devices that are all equipped with the ALMEMO® connector system, which has been patented by Ahlborn GmbH. The intelligent ALMEMO® connector provides important advantages with regard to the connection of sensors and peripherals as all parameters are stored in an EEPROM within the connector. As a result, the programming that usually has to be performed for the connection is not required. All sensors and output modules can be connected to all ALMEMO® measuring devices in the same way. The operation and programming is identical with all units. Therefore, all of the ALMEMO® measuring system items listed below are described, in detail, in a separate ALMEMO® manual that is supplied with every device:

- Detailed description of the ALMEMO® system (manual section 1)
- Overview of the device functions and measuring ranges (manual section 2)
- All sensors with basic principles, operation, technical data (man. section 3)
- The options for connecting existing sensors (manual section 4)
- All analog and digital output modules (manual section 5.1)
- The interface module RS232, fiber optics, Centronics (manual section 5.2)
- The entire ALMEMO® networking system (manual section 5.3)
- All functions and their control via the interface (manual section 6)
- A complete interface command list with all print outputs (manual section 7)

These operating instructions only cover features and controls that are specific for a certain device. As a result, many sections will often provide a note referring to the more detailed description within the manual (man. sect. x.x.x).

1.1 Function Range

The ALMEMO® 5990-2 data logger has max. 90 electrically isolated measuring inputs with up to 100 measuring channels for more than 65 measuring ranges, a real time clock and a 500kB memory for approximately 100000 measured values. Memory cards up to 32MB can be attached. The device can be operated by means of the LCD graphic display, a softkey keypad and an control key. User menus can be configured to adapt the display for any application. Two output sockets allow for connecting any ALMEMO® output modules, for example, the analogue output, digital interface, trigger input or alarm contacts. Several devices can be networked by simply connecting them with network cables.

SENSOR PROGRAMMING

The measuring channels are automatically programmed by the ALMEMO® connectors. However, the user can easily complete or modify the programming via keyboard or via interface.

Measuring Ranges
There are corresponding measuring ranges for sensors with a non-linear characteristic such as 10 thermocouple types, Ntc and Pt100 sensors, infrared sensors, and flow sensors (rotating vanes, thermoanemometers, pitot tubes). Humidity sensors are available with function channels that also calculate humidity data such as dew point, mixture ratio, vapour pressure and enthalpy. Even complex chemical sensors can be used. The acquisition of measured data from other sensors is easily possible by using the voltage, current and resistance ranges with individual scaling in the connector. Existing sensors can be used without problems. Only the corresponding ALMEMO® connector has to be connected using its terminals. Furthermore, there are adapter connectors with an own microcontroller for digital signals and for measuring frequencies and pulses. This way, nearly all sensors can be connected to any ALMEMO® measuring instrument and are interchangeable without requiring any settings.

Function Channels
Maximum, minimum, average values and differences of certain measuring junctions can be programmed as function channels and can be processed and printed like normal measuring junctions. Furthermore, function channels for special measuring tasks zur Pulse and volum flow measuring are provided to determine the temperature coefficient Q/ΔT and wet bulb globe temperature.

Dimension
The 2 digit dimension can be altered for each measuring channel so that the display and the printout will always indicate the correct dimension, for example when a transmitter is connected. The conversion from °C to °F is automatically performed according to the dimension.

Name of Measured Values
For identification of the sensors a 10-digit alphanumeric name is provided. It is entered via the keypad or the interface and appears on the display, the printout or the computer display.

Correction of Measured Values
For correcting measured values a zero point and slope (gain) correction can be applied to the measured value of each measuring channel. This also allows for sensors to be interchanged that usually, at first, require an adjustment (expansion, force, pH). The zero point and the slope (gain) correction are virtually performed by the push of a button.

Scaling
The base value and the factor allow for a further scaling of the corrected measured value of each measuring channel for zero point and slope (gain). The decimal point position can be set by the exponent. By setting to zero and entering the nominal value the scaling values can be automatically calculated.

Limit Values and Alarm
Two limit values (1 max and 1 min) can be set for each meas. channel. An alarm value printout can be performed if a limit value is exceeded and, by means of relay output modules, alarm contacts are provided that can be individually allocated to limit values. As a standard, the hysteresis is set to 10 digits; however, it can also be adjusted between 0 and 99 digits. Furthermore, limit value exceeding can also be used to start or stop a data logging.

Sensor Locking
All sensor data stored in the EEPROM of the connector can be protected against undesired access by means of a graded locking function.

MEASUREMENT
Of up to 4 meas. channels are available for one transducers, i.e. it is also possible to evaluate double sensors, individually scaled sensors, or sensors with function channels. The meas. channels can be successively selected forwards or backwards via keypad or operating dial. As a standard, the meas. values of all active meas. channels are continuously acquired at a rate of 10 meas.points/sec and indicated on the display or, if available, provided on the analog output. In case of a large number of meas. points the rate can be raised to 50 measuring points / second or the meas. point scan can be limited to one selectable meas. point to increase the response speed.

Measured Values
The measured values of 1 to 20 measuring points can be indicated on the display in 7 different menus (that can also be configured) in three font sizes, as bar graph or as line chart. They are automatically acquired with auto zero and self calibration and can also be arbitrarily corrected and scaled as required. A sensor breakage condition is, with most sensors, automatically detected.

Analog Output and Scaling
By means of analog start and analog end any measuring point can be scaled so that the resulting measuring range covers the full range of the bar graph or line chart or of an analog output (2V, 10V or 20mA). The measured value of any measuring point as well as a programmed value can be output to the analog output

Measuring Functions
Special measuring functions are required for some sensors to achieve an optimal data acquisition. The cold junction compensation is available for thermocouples, a temperature compensation for dynamic pressure and pH and conductivity probes, and an atmospheric air pressure compensation for humidity sensors, dynamic pressure sensors and O2 sensors. With infrared sensors the parameters zero point and slope correction are used for background temperature and emissivity factor.

Max and Min Value
Each measurement involves an acquisition and storage of the Max value and the Min value including the time and date. The values can be displayed, printed or cleared.

Average Value of a Channel
A manual averaging over a particular period or over single measurements is available for the selected channel. For the purposes of measuring the volume flow, the channel diameter or cross-section can be specified.

PROCESS FLOW PROGRAMMING
A cyclic measuring point scan with a time-based process flow control is required to register the measuring data of all connected sensors. For this purpose, the real time clock, the print cycle and the measuring cycle are available and, if fast processing is required, the conversion rate is available. The measurement can be started and stopped by using the keyboard, the interface, an external trigger signal, the real time clock or an exceeding of limit values.

Time and Date
The real time clock with date function or the pure measuring time are used for an accurate recording of any measurement. Start and end time/date can be programmed in order to start or stop a measurement.

Print Cycle
The print cycle is programmable between 1s and 59h/59min/59s and provides a cyclic output of measured values to the interfaces or memories and also provides a cyclic averaging.

Print Cycle Factor
If necessary, the print cycle factor allows for limiting the data output of particular channels so that an excessive data flow can be limited, especially during data storage.

Measuring Cycle
The measuring cycle, also programmable between 1s and 59h/59min/59s, is for a cyclic scanning with limit value monitoring, alarm message, output of alarm values, averaging and, possibly, data storage.

Average Value over Measuring Point Scans
The measured values resulting from scanning measuring junctions can be averaged as desired either over the total measuring time or over the print cycle time. Function channels are available for a cyclic output and storage of these average values.

Conversion Rate
With the ALMEMO® 5990-2 all measuring points can be continuously scanned with the conversion rate (2.5 or 10 M/s). To realize a high recording speed it is possible to store all measured values in the memory and/or to perform an output via the interface.

Data Memory
During the measuring or print cycle, all measured values or alarm values can be manually or automatically stored in a buffered RAM. The memory capacity is, as standard, 500kB, which allows up to 100000 measured values. The memory organisation can be configured as linear or ring memory. A Smart Media Memory

Card can be used as storage device. The programming is saved with each change of the configuration. The output can be carried out via the display or the interface. It is possible to specify a selection according to a time interval, number or alarm value.

Numbering of Measurements
By entering a number, single scans or entire series of measurements can be identified and selectively read out from the memory.

Control Outputs
The interface allows to individually trigger up to 4 output relays and one analog output.

Operation
All measuring and function values can be displayed in different menus on the dot matrix LCD display. 3 user menus can be individually configured from nearly 50 functions for your specific applications. Using texts, lines and blank lines allows to format the printout in an application-specific style. 7 keys (four of them are soft keys) and an operating dial can be used to operate the device. This also allows you to fully program the sensors, the device and the process control. A graded locking function including a password lock is available to limit the access to the menu and the operating keys, as required.

Output
All data logs, menu functions and stored measured values and programmed parameters can be provided as output to any peripheral equipment. Various interface cables can be used to provide a RS232, RS422 or Centronics interface. The output of measuring data can be selected in list format, columns or spreadsheet format. Files in spreadsheet format can be processed by each spreadsheet software. The print header can be programmed specifically to the company or application.

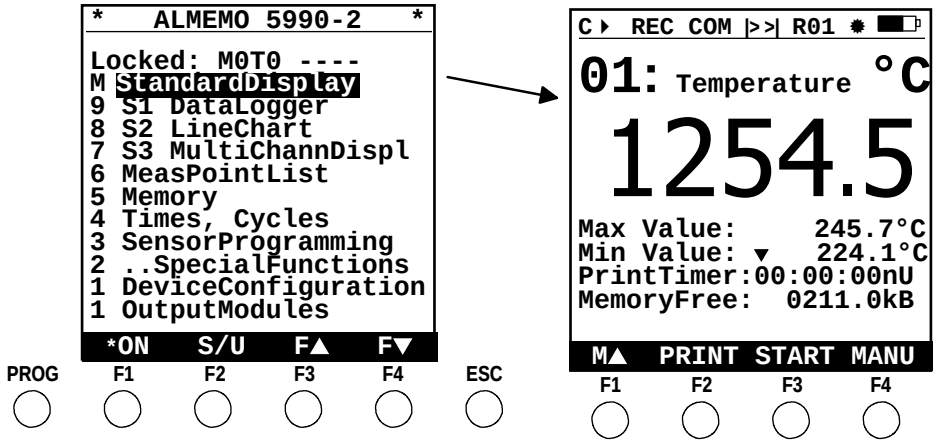
Networking
All ALMEMO® devices can be addressed and can be easily networked by simply linking them using network cables, or RS422 network distributors for longer distances.

Software
The AMR-Control software, which allows for the entire programming of the sensors, the configuration of the measuring instrument and the read-out of the data memory is supplied with each ALMEMO® manual. The integrated terminal also allows for online measurements. The WINDOWS® software package, WIN-Control, are available for data acquisition of networked devices, graphical presentation and complex data processing.

2. INITIAL OPERATION

Sensor connection Connect transducers to the sockets **M0** to **Mx** (8,9), s. 4.
Power supply mains adapter or battery (option A), see 3.1, 3.2
Switch-on with rocker switch (4), so that lamp ON shines s. 3.4

Displaying meas. data	**Keys**
Call up the main menu ´**ALMEMO 5990-2**´ if required	**ESC**
Select menu **StandardDisplay**	**F3** or <**F▲**>...
Call up menu **StandardDisplay**	**PROG**
Select meas. point. Meas. value, max/min value will be displayed.	**F1** or <**M▲**>
Clear max/min values: Select function **Max/MinVal**	**PROG**, **F4**<**F▼**>...
- Clear single value	**F1** or <**CLR**>
- Clear max/min and average values of all channels, s. 6.1.2	**F2** or <**CLRA**>



For output of measuring data or memory via interface:
- Connect peripheral device, via data cable, to socket A1 (ES5990-N), see man. 5.2
- Set 9600bd, 8 data bits, 1 stop bit, no parity at peripheral device
- Set output format ´ ´, columns ´n´ or table ´t´, as required, see 7.2

Output and storage of measuring data	**Keys**
Single output/storage of all measuring points, see 6.2.1	**F4** or <**MANU**>
Enter print cycle for cyclic measurement, see 7.2	
Enter the current time and date, as required, see 7.1	
Start/stop the cyclic measurement, see 6.2.2	**F3** /<**START/STOP**>
Output of memory data to printer or computer	
Select the function **MemoryFree**	**PROG**, **F4** / <**F▼**>...
Memory data output, s. 6.2.6	**F2** or <**PRINT**>
Clear memory	**PROG**, **F1**/ <**CMEM**>

3. POWER SUPPLY

The following options are available for the power supply of the instrument:

- Mains supply unit or battery charger 12V/2A (s. 3.1) ZB 5090-NA3
- NiCd batt. pack 7.2V built-in (Option A, s. 3.2) OA 5990-A
- galv. getr. DC Voltage Supply (Option U, s. 3.3) OA 5990-U

3.1 Mains Operation

The mains adapter ZB 5090-NA3 to 12VDC, 2A, is used for the power supply of the measuring instrument. It is connected to the socket U-DC (7d) and is locked by turning it to the right.
It is also possible to insert the banana plug (with the protective ground connector for interference suppression) into the adjacent bare socket.
It is only in exceptional cases (e.g. in an industrial environment) that the protective ground may itself be subject to such high voltage peaks that it is better to dispense with this connection.

3.2 Accu. battery mode, supply voltage monitoring

With option A, a rechargeable NiCd accumulator battery, 7.2 V with 1.5 Ah, is installed; at a power draw of approx. 65mA, this gives uninterrupted operation of around 23 hours. If selector switch boards (approx. 12mA) are installed or sensors are connected that need additional power (e.g. humidity sensor FH-A646 2mA, or rotating vanes, approx. 3mA) or the serial interface is active (4mA), this operating time will be accordingly shorter. If lighting is left switched on permanently, the operating period will be reduced to approx. 14 hours.

One way of prolonging the operating time is to switch off the display; (see Section 8.6). As soon as the battery's residual capacity drops to around 10 percent, the "▭" symbol appears in the status line of the display. Normally at this juncture the battery should be recharged using the mains adapter supplied with the device; further delay may result in critically low discharge and this may damage the battery. The battery voltage (and thus an estimate of the operating time left) can be determined using a ´Batt´ measuring channel.
So long as the device is running on battery only, the green indicator lamp PWR (4) does not light up at all. The battery should be charged using the 12V network adapter ZB-5000-NA3; this can completely recharge an empty battery in 2.5 hours. During this charging time the green lamp lights up continuously to indicating that charging is in progress.

Please note that during the charging process the build-up of heat in the device may result in thermocouple measuring operations with internal cold junction compensation being falsified.

As soon as the battery is fully charged, the green indicator lamp starts blinking and the device switches over to trickle charge. The mains unit can thus be left permanently connected to the measuring instrument in float mode.

Tips regarding the correct handling of rechargeable batteries:

- In most cases, the batteries supplied are not charged when delivered!
- If NiMH cells are only partly discharged, the full capacity cannot be reached by a normal recharging.
- Therefore,use the device until the batteries are nearly totally discharged.
- Completely recharge the batteries afterwards.
- As a result, the life of the batteries is significantly increased.
- Completely recharged batteries will slowly discharge during storage, therefore, they should be charged at least once per month.
- The current battery voltage can be checked in the device configuration, allowing an estimation of the remaining operating time.

3.3 External Power Supply (Option U)

If the instrument is intended to have an external voltage supply the power supply plug-in module with option U (OA 5590-U) is required. It has a wide input voltage range from 10 to 36V DC and an electrical isolation allowing that the instrument can be operated with 12V or 24V mains supply. The cable ZB 5090-EK with 2 banana plugs (1e) must be used for the connection. However, the mains adapter ZB 5090-NA3 still allows for operation with mains supply.

3.4 Switch On/Off, Reinitialisation

As soon as a suitable voltage supply has been connected, the green indicator lamp PWR on the front panel (4) lights up. If an accumulator battery is installed, this lamp also functions as charge indicator; (see Section 3.2).

The device is switched on by actuating the rocker switch (4); the red “ON” lamp then lights up indicating that it is ready-to-operate.

After switch-off the real time clock continues its operation and all stored data remains available by a buffer battery (see 3.5). If the device was operating in a measurement menu before switch-off it will return to the corresponding menu after switch-on, otherwise the main menu will be displayed.

If the device shows an irregular behaviour due to interference influences (e.g. electrostatic charging or discharged buffering battery) or if incorrect programming must be avoided, the device can be reinitialised. The **reset** can be achieved if the key F1 is pressed during switch-on. All internal data such as maximum and minimum values and the data memory will be cleared and the user menus will be set to the delivery defaults. Furthermore, cycles, time, date and device address are set to zero and the conversion rate and atmospheric pressure will be set to the standard values. However, the device configuration and the sensor programming within the ALMEMO® connectors will not be affected by the reset.

3.5 Data Buffering

To ensure an uninterruptible power supply (UPS) for the real-time clock and the memory, a rechargeable lithium battery (3 V) is installed; this ensures that, in the event of the mains supply being interrupted, the date and time-of-day and all stored values over several years are saved.

4. CONNECTION OF THE TRANSDUCERS

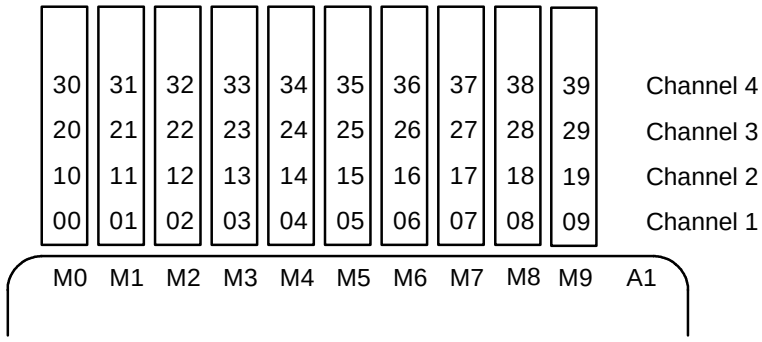
Any ALMEMO® sensors can be connected to the ALMEMO® input sockets Mxx of the plug-in modules (8) and (9). For connecting existing sensors it is only necessary to connect a corresponding ALMEMO® connector.

4.1 Transducers

A detailed description of the comprehensive ALMEMO® sensor range (see manual section 3) and the connection of existing sensors (see manual section 4) to the ALMEMO® instruments are provided in the ALMEMO® manual. All standard sensors with ALMEMO® connector usually have the measuring range and dimension already programmed and can be immediately connected to any input socket. A mechanical coding ensures that sensor and output modules can only be connected to the correct sockets. Furthermore, each ALMEMO® connector has two locking levers that snap in when the insertion into the socket is established and that prevent a disconnection caused by pulling the cable. Both levers must be pressed on the sides for disconnecting the connector.

4.2 Measuring Inputs and Additional Channels

The Measuring Circuit Board ES 5590-G2 of the system ALMEMO 5990-1 has 10 input sockets with, at first, the meas. channels M0 to M9 being allocated to them. However, ALMEMO® sensors can, if required, provide up to 4 channels so that 40 channels are available with 10 input sockets. The additional channels can be especially used with humidity sensors with 4 meas. variables (temperature, humidity, dew point, mixture ratio) or used for function channels. If required, the sensor can also be programmed with several ranges or different scaling or, depending on the pin assignment, 2 or 3 sensors can be combined in one connector (e.g. TE/Ntc, mV/V, mA/V etc.).
The additional meas. channels of a connector are increased in steps of 10 (e.g. the first sensor has the channels M0, M10, M20, M30, the second sensor has the channels M1, M11, M21, M31 etc.).



The analog inputs are electrically isolated by using photovoltaic relays and a potential difference of 50V DC or 60V AC, at maximum, is permissible between them. However, sensors combined within one connector and sensors with an own power supply are electrically connected to each other and must, therefore, be operated in isolation. The voltage applied to the measuring inputs must not exceed +/-5V (between B,C,D and A or - respectively).

The cold junction compensation for thermocouple measurement is integrated in socket M3 of the device.

As an option the system can be fitted with a measuring circuit board ES5590G3 for the 10-fold sensor connector ZA-5590-MU. There are no additional channels here.

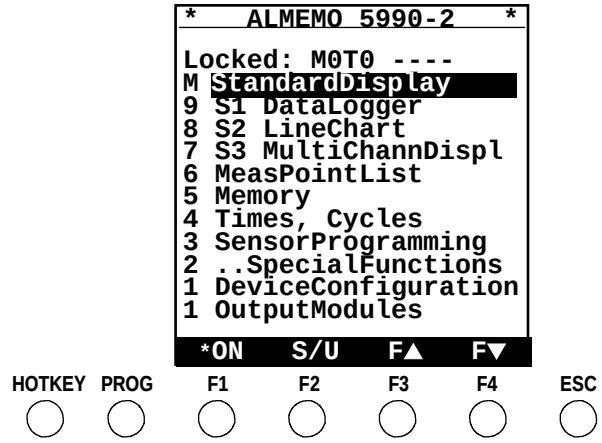
The measuring circuit boardcan trigger up to 8 passive selector switch boards, each with 10 photovoltaic relays. However, the total number of meas. channels is limited to 100 at max. To be able to adapt the number of sensors and channels to the individual requirements, the number of channels of the meas. circuit board and the selector switch boards can be independently configured to 10, 20, 30 or 40 (s.man. 6.10.13.1). The numbering of meas. points starts and continues from the last meas. point of the master board. The selector switch boards can be coded from 0 to 7 by the on-board code switches. The duration of a meas. point scan proportionally increases to the number of meas. channels. Analogue output cables can only be connected to the measuring circuit board.

1. With the selector switch boards ES 5590-MF (9) for ALMEMO® flat connector the number of measuring points is increased in steps of 10 electrically isolated ALMEMO® inputs. Limit value relay cables can be connected to all boards. The plug-in module requires 2 PCB slots in the housing.
2. The selector switch boards ES 5590-MU (10) also have 10 inputs, which are guided to a 64-pole socket terminal strip. The connection of the sensors is performed via a 10-fold plug ZA 5590-MU each having 4 screw-type terminals A, B, C and D, as each single ALMEMO® connector (see man. 4.1). Double sensors and sensors that require a power supply or an ALMEMO® connector with logic control (e.g. humidity sensors, rotating vanes etc.) cannot be connected. Independent from the configuration of the channel number, 10 channels are only available. The programming can be individually entered for each sensor, however, it is stored in a common EEPROM that is located in the connector. Two limit value relays, separately for Max and Min, are already mounted on the board and can be connected via the MU connector. The plug-in modul requires one PCB slot in the housing.

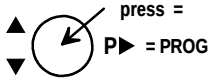
5. DISPLAY AND KEYPAD

5.1 Display and Menu Selection

The display (1) of the measuring instrument ALMEMO 5990-2 consists of a dot matrix LCD display with 128x128 dots, or 16 lines with 21 characters each, respectively. 11 standard menus and 3 user-definable ´user menus´ U1, U2, U3 are available and can be selected at the main menu for the acquisition of measuring data in connection with the required functions and for the programming of the process control, the sensors and the device parameters.



If necessary, call up the main menu using the key **ESC**
Switch-on of the display illumination (see 10.5) **F1** <***ON**>
Selection among standard or user menus (S1..S3/U1..U3) **F2** <**S/U**>
Selection of the menus **F3** <**F▲**> , **F4** <**F▼**>
Calling up the selected menu **PROG**
Alternatively one can the use the control button (5) on the right, turning it to the left or to the right and then pressing it down to confirm.



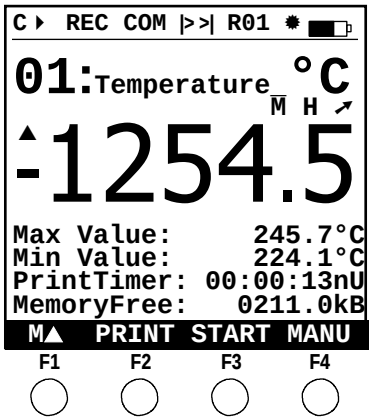
Specify the desired menu by keeping the HOTKEY pressed down for a while. **HOTKEY** long
Return to the desired menu from any menu by pressing the **HOTKEY**
Returning to the main menu is only possible by using the key **ESC**


A graded locking function incl. a password lock is available to limit the access to the menu and the operating keys as required (s. 5.6). The setting is indicated in the 1st line of the main menu.


The device designation in the header line (see 10.1) can be as easily programmed as the menu titles of the user menus (see 6.6).

5.2 Function Keys

The function of the keys F1 to F4 can be different in the various menus. It is indicated by abbreviations in the bottom line of the display (soft keys). In the manual the soft key abbreviations are set in angle brackets, e.g. <START>.



Next to the meas. value, control symbols for the meas.value are displayed (s. below).

The following keys are available in the standard display:

Selection of measuring points	**F1** <M▲>
Output of menu functions via the interface	**F2** <PRINT>
Starting a cyclic measurement	**F3** <START>
Stopping a cyclic measurement	**F3** <STOP>
Single manual output/storage of all measured value	**F4** <MANU>
Returning back to the main menu	**ESC**

5.3 Control Symbols in the display (1) and Control-LEDs (2)

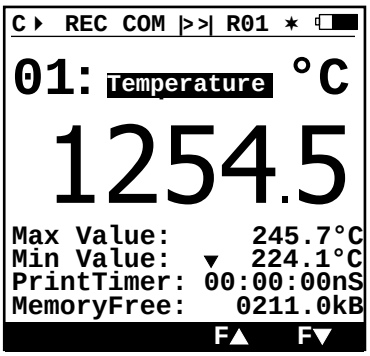
Control of device condition:	**Status line**	**LEDs**
Continuous measuring point scan:	**C**	
Measurement stopped or started:	**II** or ▸	**START**
Measuring point scan started including storing:	**REC**	**REC**
Measuring point scan started incl. output via interface:	**COM**	**COM**
Start/end time of measurement is programmed:	**|>** or **>|**	
Relay status (external output module) off or on:	**R--** or **R01**	
Keyboard operation reduced by locking:		**LOCKED**
Display illumination switched on:	✶	
Batt. charge state:100% charged,discharged (connect charger):	, flashes	
Charger connected:		

Symbols for checking the measured value (see above)

No sensor, measuring point deactivated:	´-----´
Measured value altered by sensor correction or scaling:	↗
Averaging in progress:	M
Output function altered (see 9.10.5):	**D, H, L, M, A**
Exceeding of limit value Max or Min:	▲ or ▼ flashes
Exceeding of measuring range: display of max. value	**O** flashes ALARM
Undershooting of meas. range: display of min. value	**U** flashes ALARM
Sensor breakage: display ´-.-.-´	**B** flashes ALARM
Supply voltage too low for measurement:	display switched off

5.4 Function Selection

Each menu consists of a number of functions that, possibly, have to be used or programmed during operation.



Selection of the functions. First changeable parameter is highlighted as inverse coloured font on a black bar. **PROG** → `Temperature`

Switching to the next function — **F4** <F▼> or **F3**<F▲>

Depending on the function, the keys F1 or F2 provide the corresponding functions, e.g. Clear Function — **F1** <CLR>

Set meas. value to zero, calibrate meas. value — **F1** <ZERO>, **F2**<ADJ>

Memory data output — **F2** <PRINT>

Clear memory — **PROG, F1** <CMEM>

It is also possible to **select the function** by using the **operating dial** - first press (**P** ▸), then turn (▼▲) to select (see 5.5).

5.5 Data Entry

If a programmable parameter is selected (see 5.4) you can enter or clear the value.

Starting from a **measurement menu**, the device firstly switches to the corresponding programming menu where the parameter can be programmed.

For example:

If the print timer is selected in the standard menu, for entering the print cycle press: **PROG**

`PrintTimer:00:00:00 S`

The menu ´`* Times-Cycles *`´ indicates

`PrintCycle: 00:00:00`

Programming using the keys

For programming, press the key **PROG**

Then you are in the **input mode**, the cursor flashes below the first cursor position

`PrintCycle: 00:00:00`

The **function keys** indicate, e.g. the symbols:

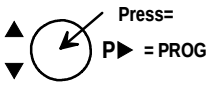
`CLR` ▲ ▼

Increasing the selected number with	<▲>...
Decreasing the selected number	<▼>...
Changing the sign of numerical values	<**+/-**>
Clearing the programmed values	<CLR>
Selecting the next position	**PROG** ▸
the cursor flashes below the second digit	PrintCycle: 00:00:00
Switching back to the previous digit	press and hold **PROG** ▸
Each digit is programmed analogously to the first one	<▲>..., **PROG** ▸
Quitting the data entry	
After setting the last digit confirm with	**PROG** ▸
Cancelling the programming process	**ESC**

The input of letters, measuring ranges etc. can be carried out accordingly.

Programming using the Rotary knob

As an alternative to the keys a ´mouse-like´ operating dial (7) is available for data entry. This method is significantly faster, particularly regarding the input of letters and measuring ranges.



First press the rotary knob (corresponds to pressing the key PROG), then select the correct value of the digit by turning (▲▼) the rotary knob.
To select the next digit, press the dial again, and repeat as above.

5.6 Locking of the Menus and the Keypad

The data logger ALMEMO® 5990-2 allows an extensive programming of the sensors, the measuring instrument and even of the presentation of functions within the measurement menus. However, for many measuring tasks it is very important that constraints cannot be inadvertently changed. On the other hand, the application must provide corresponding operating options. Therefore, extensive configuration options for locking are available to protect the measurement environment:

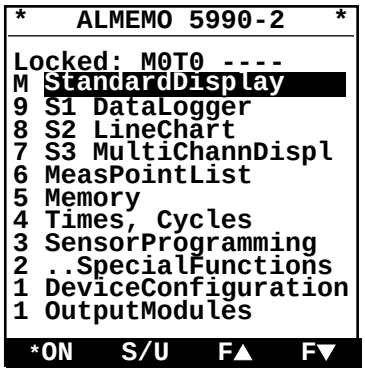
- Graded locking of the menu access
- Graded locking of the key functions
- Graded locking of the sensor programming, see 9.4

Furthermore, the configuration can be password protected.

If the keyboard is locked, then the control lamp shines. **LOCKED**.

Locking of the menu access

The menus are configured in a hierarchical form and their locking level is indicated at the first digit. The first line provides the function ´Locked: MxTx´ for locking of menus and keys. If the ´M´ is followed by a number from 1 to 9, the menus starting from the bottom line up to this level are locked and cannot be selected, e.g. in case of ´M1´ the menus ´**Device Configuration**´ and ´**Output Modules**´ are locked, while ´M9´ indicates that all menus, except the ´**Standard Display**´, are locked.



Locking of the operating keys

Depending on the menu the keys provide different functions. The following functions can be locked using the corresponding locking level ´T´.

T	Locked Functions	Keys
9	Selection of measuring points	**M▲**
8	Data output	**PRINT, DISP**
7	Manual output, storage	**MANU**
6	Start/stop measurement	**START/STOP**
5	Function selection	**PROG, F▲, F▼**
4	Clear measuring data	**CLR, CLRA**
3	Clear memory	**CMEM**
2	Switch on/off of parameters	**OFF/ON**
1	Data input, menu programming	**PROG,▲,▼,PROG** press and hold

Key operation:

Locking function:	**Locking: M0T0 ----**
Function Locked:	**Locked: M1T1 ******
Selecting the function ´Locking´:	<**F▲**>
Selecting the parameter ´Menu Locking´:	**PROG**
Selecting the parameter ´Key Locking´:	**PROG**, <**F▲**>
Selecting the password:	**PROG**, <**F▲**>, <**F▲**>
Programming:	**PROG**, <▲>..., **PROG** (see 5.4)

To also protect the locking configuration it is possible to enter a four-digit password (see 5.3), for control purposes the display will only indicate ´****´. The configuration will only be accessible if the same password is entered again. However, in case of a reinitialisation the whole locking will also be cleared (see 3.4).

6. MEASURING USING THE MEAS. MENUS

The ALMEMO® 5990-2 provides the following options for the data acquisition:

Output to the display:

Exclusive measurement of the selected measuring point, see manual 6.4
Output of measuring data to the analog output, see manual 5.1.1
Continuous meas. point scan of all measuring points, see 7.4 man. 6.5.1.3

Output to the interface or to the memory:

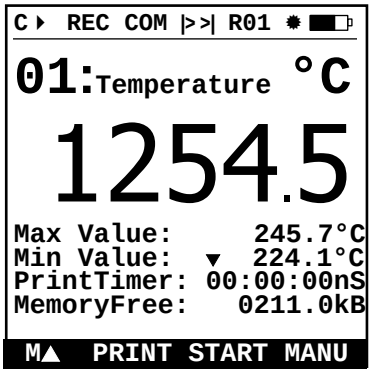
Single manual output of the selected measuring point, see manual 6.4.2
Single manual output/storage of all measuring points, see 6.2.1
Cyclic output/storage of all measuring points, see 6.2.2
Continuous output/storage of all measuring points, see 6.2.5

Display options for measured values

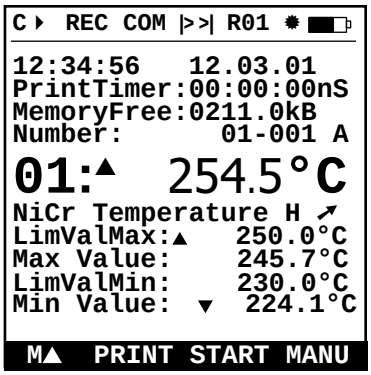
The measurement menus are different with regard to the number of available meas. points, the height of the digits and the additional measuring functions:

StandardDisplay	1 meas. point	13mm digit height
S1 DataLogger	1 meas. point	8mm digit height
S2 LineChart	1 meas. point	line chart
S3 MultiChannDispl	max. 4 meas.points	8mm digit height
U3 4 BarChart	max. 4 meas.points	4mm digits, analog bars
MeasValList	max. 20 meas.points	4mm digit height

StandardDisplay:



DataLogger:



A few symbols (see 5.3) identify the status of the measured value.

The standard menus for meas. values are configured with specific functions to cover the most frequent tasks. The menu ´Line Chart´ can be found in section 6.2.4, ´Multi Channel Display´ in 6.5.1. Furthermore, for your specific applications you can self-configure individual menus including the preferred display of meas. data and the functions you require (s. 6.6).

6.1 Display of a Measuring Point

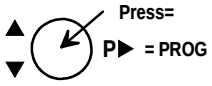
Different from previous instruments, the continuous measuring point scan (e.g. after a reinitialisation, see 3.4) is the standard default setting of the ALMEMO 5990-2, i.e. all meas. points are continuously acquired and the meas. values can be retrieved at any time, even if they are related to other channels (e.g. with function channels, temperature or atmospheric pressure compensation).

6.1.1 Selecting the Measuring Point

The key <**M▲**> allows for successively selecting all active meas. points including the display of the current meas. value. If the key <**M▲**> is pressed and held (approx. 1s) the previous channel is again indicated. By selecting the meas. channel the input channel is, at the same time, also selected (see 9.1).

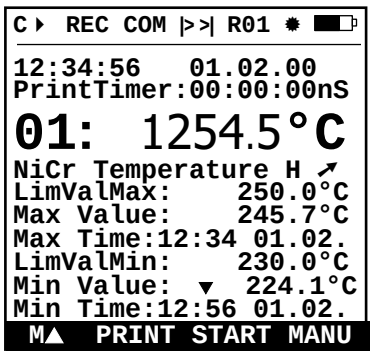
Increasing the meas. channel using the key: <**M▲**>
Decreasing the meas. channel using the key: <**M▲**> press and hold

The measuring points, as well, can very easily be increased or decreased by turning the **rotary knob**.



6.1.2 Peak Value Memory with Time and Date

The highest and lowest value, including the time and date, will each time be determined and stored from the acquired measured values of each measuring point. The functions listed below are available to display these values.
The software AMR-Control can be used to easily load or configure the menu ´Monitoring´ with Max/Min times (illustrated on the right) as a user menu (see 6.6).



Function max value:	MaxVal:	245.7°C
Function min value:	MinVal:	224.1°C
Function time and date of max value:	MaxTime:	12:34 01.02.
Function time and date of min value:	MinTime:	12:56 01.02.
To clear, select function (see 5.4):	MaxVal:	245.7°C
Clear single value:		<CLR>
Clear max, min and average values of all channels:		<CLRA>

If the cleared channel is also the selected measuring channel, the current measured value will be immediately displayed after the clearing process.
Furthermore, the peak values are cleared at each start of a measurement, if the device has been correspondingly configured (standard setting, see 10.8).

6.1.3 Output of Menu Functions

Each data menu, together with all displayed functions, can be output via interface to a printer or computer (connection of peripheral devices, see manual 5.2). If you have selected the standard display, pressing the key <PRINT> leads to a printout of the following listing:

Print data menu: **<PRINT>**

Meas. point, meas. value, designation:
```
01: +0023.5 °C Temperature
MAXVAL: 01: +0020.0 °C
MINVAL: 01: -0010.0 °C
PRINTTIMER:  00:01:23
```
Total memory capacity, free mem. in kB
```
MEMORY:  S0512.1 F0324.4 A
```
The listing of the individual functions is given in section 6.6.1.

6.2 Measuring Point Scans and Output

Measuring point scans allow measured values of all measuring points to be acquired, stored (if necessary) and recorded through a printer or computer (see manual 6.5). If continuous measuring point scan has been selected (the letter ´C´ will be indicated at the first digit of the status line), the available measured values, on command, will only be stored or output.

6.2.1 Single Output/Storage of all Measuring Points

Single manual measuring point scans for acquiring the momentary measured values of all active measuring points can be triggered by the key <MANU> (see manual 6.5.1.1). The time will be started if it had been set to zero. If the true time of day has to be indicated, it must first be set (see 7.1). The output format can be set in the function ´PRINT CYCLE´ (see 7.2, list of printouts in manual section 6.6.1).

Single manual measuring point scan: **<MANU>**

The following symbols will, **for a short period**, be indicated in the **status line**:

The start arrow will light up and then go off again ´▸´
Lightening up in case of a data output via interface ´**COM**´
Indicated when meas. values are being stored (see 8.2), ´**REC**´

With each press of the key the measured values are equally processed with the corresponding measuring time.

6.2.2 Cyclic Output/Storage of all Measuring Points

The print cycle (see 7.2) must be programmed for cyclic outputs of measured values (see man. 6.5.1.2) and recording. The measurement can be started using the key <START> and stopped using the key <STOP>. At each start of a measurement the max, min and average values of all meas.points are cleared, if the device has been correspondingly configured (standard setting, see 10.8).

Starting a cyclic meas. point scan: **<START>**

For control purposes the following symbols will **continuously**, i.e. for the whole meas.period, be indicated in the **status line**:

The start arrow lights up **´▸´**
Lightening up in case of a data output via interface **´COM´**
Indicated when measured values are being stored (see 8.2): **´REC´**

Stopping a cyclic meas. point scan: **<STOP>** **´II´**

6.2.3 Print Cycle, Timer, Output Format

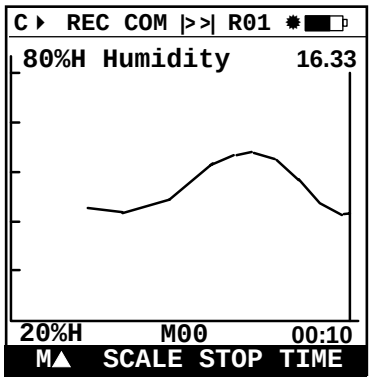
The function ´Print Timer´ in the standard menu indicates the print cycle, as log as a measurement has not been started. After starting a measurement the timer counts down to the next cycle. If the function has been selected (see 5.4) the print cycle can be programmed (see 5.5) or the key <FORM> can be used as the quickest way to set the required output format (see 7.2).

Function ´Print Timer´, ´Format List´, ´Memory On´:

PrintTimer: 00:02:00 S

Change format: **<FORM>**
Format columns side by side ´n´: **PrintTimer: 00:02:00nS**
Change format: **<FORM>**
Format table ´t´: **PrintTimer: 00:02:00tS**

6.2.4 Displaying Measured Values as a Line Chart



When using the menu ´Line Chart´ the meas. value of the selected channel is indicated as a line chart with 100x200 dots as soon as a measurement is started. The curve continuously moves from the right to the left, the time resolution is determined by the **print cycle**, each scan involves one point (dot). Therefore, time data for the whole t axis is given as (days) hours:minutes in the bottom right corner. In the upper right corner the time of day is indicated. In this mode, the curve is also updated during an active measurement, if the user leaves the menu (in this case, do not change themeas.point!). Limit values, if activated,

are entered as dotted lines. In addition, another fast display mode is available with indicating and overwriting all measured values at the **conversion rate** from left to right.

The functions ´**Analog Start**´ and ´**Analog End**´ of the menu ´Special Functions´ can be used to set the display range of the y axis (see 9.10.4). They can be directly called up using the key ´SCALE´.

Displaying a measured value as line chart:

Enter the print cycle in the menu ´Cycles-Times´.	PrintCycle: 00:00:05
Time axis 120 x 5s = 10min:	00:10
Scaling of the y axis in the menu ´Line Chart´:	<SCALE>
In the menu ´Special Functions´ set the analog	Analog-Start: 20.0%H
start and analog end of the measuring channel.	Analog-End: 80.0%H
Returning to the menu ´Liniengrafik´ :	ESC, ESC
In menu ´Line Chart´ select the meas. channel:	<M▲>
Starting the measurement:	<START> ´▸´
Stopping the measurement:	<STOP> ´II´
Changing to **fast display** using the key:	<TIME>
Check the conv. rate in the menu ´Cycles-Times´.	ConvRate: 10 Cont: -
Time axis 120 x 0.1s= 012s	012s

Channel switching is blocked during the measurement!
At each start and at each channel switching the line chart will be cleared!

6.2.5 Continuous Output/Storage of all Measuring Points

The highest recording speed can be achieved using a continuous measuring point scan (see manual 6.5.1.3), by activating the switches ´Memory ON´ or ´Output ON´ in the function ´Conversion Rate´ (see 7.4) of the menu ´Times-Cycles´, logging all measured values that have been acquired at the conversion rate.

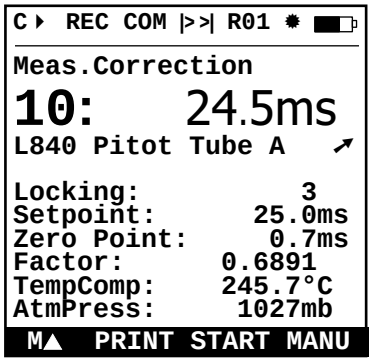
6.2.6 Memory Space, Memory Output, Clearing the Memory

The function ´MemoryFree´ allows, during recording of measuring data, to continuously monitor the available memory space given in kilobytes. By selecting this function, two soft keys are available for a direct output and clearing of the memory. The output format corresponds to the setting in the print cycle (see 6.2.3 and 7.2).

Function ´MemoryFree´, e.g.:	MemoryFree:0211.0kB
Memory data output:	<PRINT>
Clear memory:	PROG, <CMEM>

6.3 Correction of the Meas. Value and Compensation

To achieve maximum accuracy of measurements it is possible to correct all sensors with regard to zero point and slope (gain) in the ´Standard Menu´, by the push of a button. Additional correction functions are provided in the ´User Menu U1´ (selection see 5.1) ´Meas. Correction´. By entering a setpoint the correction value will be automatically calculated and stored in the sensor connector. A corresponding compensation is provided for sensors, which are affected by the ambient temperature or the atmospheric pressure.



6.3.1 Setting the Meas.Val. to Zero, Zero Point, Sensor Adjustment

The user can zero the measured value at certain locations or at certain times in order to check the deviation from this reference value. After selecting the function ´Meas. Value´ (see 5.4) the key <ZERO> can be used to store the displayed measured value as base value and, as a result, to set it to zero.

Function ´Meas. Value´: `00: 23.4 °C`

Function ´Set Meas. Value To Zero´: <ZERO>

Meas.Val.: `00: 00.0 °C` ↗

Base value: `BaseValue: 23.4°C`

Please note that this function is only available if the locking code is set below 5 (see 9.4).

As long as the deviation from the base value is indicated (instead of the actual measured value) the symbol ↗ appears in the display.

The base value must be cleared in order to re-obtain the actual measured value (see 9.6).

Zero Point Adjustment

Many sensors must be adjusted at least once or at regular intervals to compensate for instabilities. For this purpose, a specific **zero point adjustment** is available, in addition to the ´Set Meas. Value to Zero´ mentioned above, as some sensors require an additional scaling (e.g. pH probes). In this function the zero point error is not stored as base value but as zero point correction (see 9.7). In this case, the locking mode must be set below 4 (see 9.4).

Function ´Zero Point Adjustment´ using the key: <ADJ>

Meas.Val:	00: 00.0 °C ↗
Zero Point:	ZeroPoint: 23.4°C

The meas. value is not indicated as zero but as the negative base value after the adjustment, if a base value has been programmed.

For some sensors the same key can be used to **adjust the sensor** with the following specific functions:

1. **Dynamic pressure probes** are very delicate and should be adjusted in an unpressurized state before each use (i.e. disconnected hoses or Pitot tube out of flow). The correction value must be entered before the conversion 'pressure-to-velocity' is performed. For the ranges L840 and L890 an adjustment is possible even if the channel is locked. The zero point error is temporarily being written into the calibration offset until the switch-off is performed.
2. With the following sensors, a **slope adjustment** is performed in the same way for the corresponding calibration value:

pH probe:	ZA 9610-AKYx:	pH4 or pH10
Conductivity:	FY A641-LF:	2.77 mS/cm,
	FY A641-LF2:	147 uS/cm
	FY A641-LF3:	111.8 mS/cm
O_2 saturation:	FY A640-O2:	101 %

6.3.2 Setpoint Entry

For the correction of sensor errors the zero point adjustment has already been introduced in section 6.3.1. For a two-point adjustment it is further necessary to correct the slope (gain) by performing a comparison with a second measuring point. With the function ´Setpoint Entry´ the correction factor is automatically determined and stored as factor in the sensor connector.

1. Set sensor to the ´**zero state**´
   (ice water, unpressurized etc.),
   Set the meas. value to zero by using the keys (s. 6.3.1). **<ZERO>** or **<ADJ>**
2. Put sensor to a defined **setpoint**
   (boiling water, known weight etc.),
   Enter the **setpoint** in function ´Setpoint´: SetPoint: 100.0 °C
3. Calibrate the measured value in function ´Setpoint´: **<ADJ>**

Afterwards, the measured value, as well, should indicate the set point.
In this case, as well, the locking level must be set below 5 to allow a programming of the factor (see 9.4).

6.3.3 Temperature Compensation

Sensors with measured values that are strongly depending on the temperature of the measuring medium are, in most cases, equipped with a specific temperature sensor and the instrument will automatically perform a temperature compensation (see sensor list, manual 3. ´TC´).However, dynamic pressure probes and pH probes are also available without a temperature sensor. If the temperature of the medium deviates from 25°C the following measuring errors must be considered:

e.g. error per 10 °C:		**Compensation range:**	**Sensor:**
Dyn. press:	approx. 1.6%	-50 to 700 °C	NiCr-Ni
pH probe:	approx. 3.3%	0 to 100 °C	Ntc or Pt100

The temperature compensation can either be performed automatically using the reference channel and external temperature sensors or manually by using the function ´Temp Comp´, e.g. in the ´Measurement correction´ menu, and entering the temperature:

Entering the compensation temperature in the function: **TempComp: 31.2**

If a temperature sensor is available and continuously measured, the temperature will be continuously indicated. This allows to display both measured values for any double sensors.

6.3.4 Atmospheric Pressure Compensation

Some measuring variables depend on the environmental atmospheric pressure (see 9.9 measuring range list ´w. PC´). As a result, higher deviations from the normal pressure of 1013mbar can cause corresponding measuring errors:

e.g. error per 100 mbar:		**Compensation range:**
Rel. humidity psychrometer	approx. 2%	500 to 1500 mbar
Mixture ratio, cap.	approx. 10%	vapour pressure VP to 8 bar
Dynamic pressure	approx. 5%	800 to 1250 mbar (error < 2%)
O_2 saturation	approx. 10%	500 to 1500 mbar

Therefore, the atmospheric pressure should be considered (approx. -11mb/100m over mean sea level, MSL) especially during use in a corresponding height above sea level. It can either be programmed or measured with a sensor (see manual 6.7.2).

The function ´Atmospheric Pressure´ can be integrated into any user menu or be set in the standard menu ´Device Configuration´:

Entering the atm. pressure in function ´Atm. Press.´: **AtmPress: 1013mb**
With each reset the atmospheric pressure is set to 1013mb. It can be set to the current value by the usual data entry (see 5.5). If it is measured, the measured value will be displayed.

Please note that the last measured value will be retained when a reference sensor is being disconnected.

6.4 Averaging

The **average value** of the measured value is required for various applications:

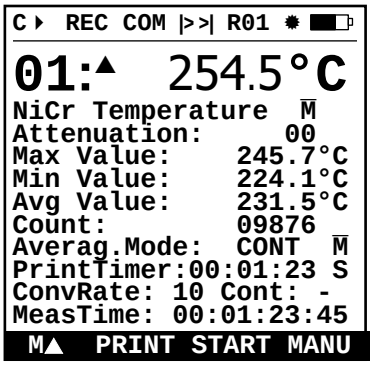
e.g. Smoothing of a largely varying measured value (wind, pressure etc.).
The average flow velocity in a ventilating channel.
Hourly or daily average values of weather data (temp., wind etc.).
As above, of consumption values (current, water, gas etc.).

The average value $\overline{M}$ of a measured value results when a number of measured values M_i are added together and then divided by the number N of the measured values:

Average value $\overline{M} = (\sum_i M_i)/N$

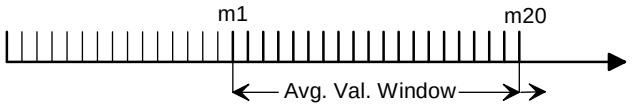
All averaging functions can be found in the ´User Menu´ U2 (see 5.1) ´Average Value´:

For the calculation of the volume flow from the average velocity and the cross section of a flow conduit the menu ´Flow´ can be used and easily loaded with the software AMR-Control (V3.00 and higher) or can be manually generated (see 6.6).



6.4.1 Attenuation of Meas. Values through Moving Averaging

The first possibility of averaging exclusively affects the measured value of the displayed channel and serves, in case of unstable measured values, e.g. when measuring turbulent flows, to attenuate or smooth the meas. values by a moving averaging. Using the function ´Attenuation´ the **level of attenuation** can be adjusted over the averaged values within the range from 0 to 99 (see 5.5). The smoothed measured value is also valid for all following evaluation functions. Therefore, the attenuation can also be used in a combination with the averaging over individual measured values (see 6.4.3), e.g. for net measurements.



$M=(\sum_i m_i)/N$

Smoothing of meas.values using the function ´Attenuation´: **Attenuation: 20**

The continuous measuring point scan should be switched off as, otherwise, for many measuring points the conversion rate will largely drop: **ConvRate: 10/s -**

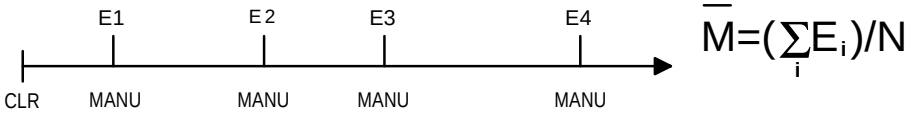
6.4.2 Averaging Mode

A detailed description of averaging over measuring point scans is given in the manual section 6.7.4. The type of averaging is determined through the function ´Averaging Mode´. If a sensor with an ALMEMO® connector is connected the following modes can be set (see 5.5):

Function no averaging:	**Averag.Mode:-----**
Averaging over all measuring point scans:	**CONT** $\overline{M}$
Averaging over all scans of a print cycle:	**CYCL**
Average value of all measurements from start to stop:	**STSTP**
Lightening up for control purposes if averaging is in progress:	$\overline{M}$

6.4.3 Averaging over Manual Single Measurements

Single manual meas. point scans Ex are performed for an averaging of isolated measurements at certain points or times (e.g. net measurements according to VDI/VDE 2640, see manual 3.5.5). At all measuring points where measured values must be averaged the averaging must be switched on by using the averaging mode ´CONT´, a measurement in progress must be stopped.

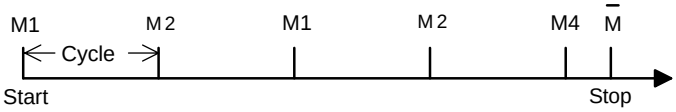


$$\overline{M}=(\sum_{i} E_i)/N$$

1. Set the averaging mode: **Averag.Mode: CONT**
   For smoothing a measured value
   select attenuation, if required: **Attenuate: 20**
   In addition, switch the continuous measurement off: **ConvRate: 10 Cont: -**
2. Clear the average value by selecting it and using: **<CLR>**
   Function ´Average Value´ $\overline{M}$ displays: **AverageVal: -----ms**
   Function ´Count´ displays: **Count: 00000**
3. Manual scans of measured values: **<MANU>**
   Function ´Average Value´ $\overline{M}$ displays: **AverageVal: 12.34ms**
   Function ´Count´ displays: **Count: 00001**
4. Repeat step 3 for each measuring point.
5. Output of all function values of the menu by using: **<PRINT>**

6.4.4 Averaging over Cyclic Measuring Point Scans

Again, the averaging mode ´CONT´ must be used if the average value over the whole measurement is only required at the end of cyclic meas. point scans.



$$\overline{M}=(\sum_{i} M_i)/N$$

Setting the averaging over all measuring point scans: **Averag.Mode: CONT**

Programming the print cycle (see 7.2): **PrintCycle: 00:15:00U**

Automatic clearing of average val. on start (see 10.8)
or, after selecting the average value, by using: <**CLR**>

		Check:
Start measurement, averaging in progress:	<**START**>	▸ $\overline{M}$
Stopping the measurement:	<**STOP**>	**II**

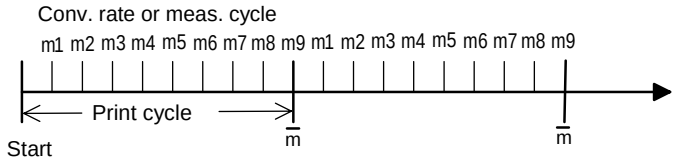
Reading the average value $\overline{M}$ in function ´Average Value´: **AverageVal:13.24ms**

Reading the number of averaged values in function: **Count: 00123**

Output of all function values of the menu by using: <**PRINT**>

Cyclic Average Values

The averaging mode ´CYCL´ must be used if average values have to be acquired in cyclic periods over these periods. This ensures that the average values are cleared after each print cycle. Furthermore, either the continuous measuring point scan or a measuring cycle must be activated to obtain measured values within the print cycle for determining average values.



$$\overline{m}=(\sum_{i} m_i)/N$$

Setting the averaging over cycles: **Averag.Mode: CYCL**

Programming the print cycle (see 7.2): **PrintCycle: 00:15:00 U**

Switching on the continuous measurement: **ConvRate: 10 Cont: ✓**

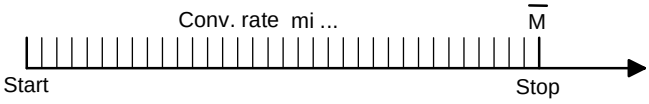
or programming the measuring cycle (see 7.2): **Meas.Cycle: 00:00:30 U**

For recording the average values an additional **function channel** with the range M(t) (see manual 6.3.4) or the corresponding **output function** M(t) (see manual 6.10.4) is required instead of the measured value.

6.4.5 Averaging over Time

To acquire the average value of all meas. values over a defined period without cycle, the averaging mode ´STSTP´ must be set for the selected measuring channel. For example, by uniformly scanning an area, this mode also allows to determine the average flow velocity in a ventilating channel (see manual 3.5.5).

A measuring point scan will be performed on start and stop allowing to record the start and end values including the time of day. Again, a function channel M(t) is required for the average value $\overline{M}$.



$$\overline{M}=(\sum_{i} m_i)/N$$

If the continuous meas. point scan (see 8.3) is activated, all sensors will be considered with a correspondingly reduced conversion rate, if it is switched off, only the selected channel will be acquired with the actually set conv. rate:

As required, de-/activation of cont. meas. point scan: **ConvRate:10Cont: -**

Set the averaging mode: **Averag.Mode: STSTP**

Automatic clearing of average val. on start (see 10.8) **Check:**
or, after selecting the average value, by using: **<CLR>**

Starting the averaging using the key: **<START>** ▸ $\overline{M}$

Reading the meas. time (see 6.4.6) in function: **MeasTime:00:01:23.40**

Stopping the averaging using the key: **<STOP>** **II**

Reading the average value $\overline{M}$ in function: **AverageVal: 13.24ms**

Output of all function values of the menu by using: **<PRINT>**

6.4.6 Measurement Time

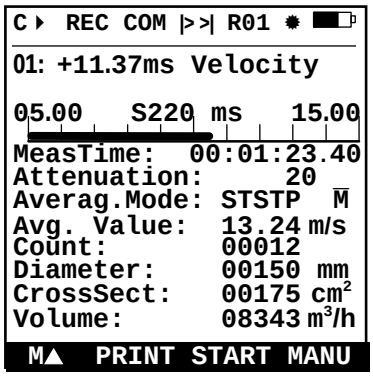
For the averaging over time (see above) and for many other measurement experiments, in many cases, the actual measurement time, from start to stop, is required. The function ´Meas.Time´ has a resolution of 0.10s and is available to allow a continuous monitoring of the measurement time without clearing the real time. If the function ´Clear Meas. Values On Start of a Measurement´ is activated within the operating parameters (see 10.8), the measurement time will also be automatically cleared on each start.

Function ´Measurement Time´: **MeasTime: 00:00:00.00**

Clearing the meas. time in function ´Meas.Time´ by using: **<CLR>**

The time of day must be cleared before start (see 7.1) if the measurement time should also be displayed at measuring point scans with output to the interface or memory.

6.4.7 Volume Flow Measurement



To calculate the volume flow in a flow conduit the extra functions ´Diameter´, ´Cross Section´ and ´Volume´ are available. Together with the averaging functions they are organised in the menu ´Flow´, which can easily be loaded or individually configured as a user menu by using the software AMR-Control (see 6.6).
As unstable measured values can be easier read out when an analog display is used, this menu, besides a small digital display, also provides a **bar chart**.

The display range of the bar chart can be set by using the functions ´**Analog Start**´ and ´**Analog End**´ in the menu ´Special Functions´ (see 9.10.4). The menu is automatically called up if the corresponding values below the scale are selected.
For **determining the volume flow** VF in ventilating channels the average flow velocity $\overline{v}$ has to be multiplied with the cross section area CS:

$$VS = \overline{v} \cdot QF \cdot 0.36 \qquad VS = m^3/h,\ \overline{v} = m/s,\ QF = cm^2$$

For rough air volume measurements at air vents the **average flow velocity** $\overline{v}$ can be determined by a **time-based averaging** (see 6.4.5 and manual 3.5.5). The rotating vane must be applied at one end, the averaging has to be started and it is necessary to proceed uniformly over the whole cross-sectional area and to stop the averaging when the other end of the cross-sectional area is reached.

Alternatively, the average flow velocity can also be determined by single **net measurements** according to VDI/VDE 2640 (see 6.4.3 and man. 3.5.5) (e.g. 13.24 m/s). If no averaging mode has been programmed, the measured value will be used. The measured value can also be used as a rough estimate with a factor of 0.8 (average point method).

The average velocity $\overline{v}$ can be displayed through function: **AverageVal:13.24ms**

Input of the cross section area CS directly in cm^2: **CrossSection:00175cm**
(max. 32000 cm^2)
or input of the diameter in mm: **Diameter: 00150mm**
(max. 2000 mm)
Display of the volume flow VF in m^3/h in function: **Volume: 00834mh**

Output of all function values of the menu by using: **<PRINT>**

For outputting and storing the number of measuring operations and the volume flow, the function channels ´**n(t)**´ and ´**Flow**´ also provided; (see Section 9.9).

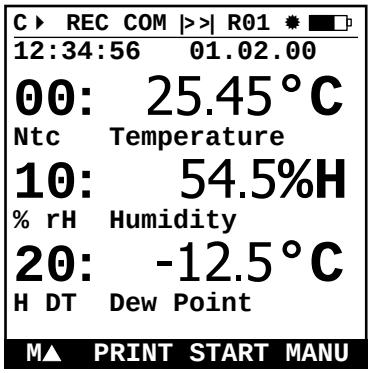
6.5 Display of Several Measuring Points

The first three measurement menus allow, on principle, only the selection and display of one measuring point. This chapter provides a description on how you can get up to four measuring points with your selection of functions, or even up to 20 measuring points simultaneously on the display.

6.5.1 Menu Multi Channel Display

After the first call the standard menu ´S3 Multi Channel Display´ indicates the first three channels of the first connector:

In the user menu U3 ´4 Bar Chart´ four channels will be displayed with measured value and bar chart.



Remember to switch on the continuous measuring point scan (´C´) to ensure that the measured values will be continuously updated.

Measuring point selection :

The 1st measuring channel is always the selected measuring point.

This can be selected directly in any menu, by means of : <**M▲**>.

To change the other channels, the measuring point must be selected as function, by means of keys (see above) : **PROG**, <**F▲**>.

The selected measuring point can now be changed by means of : <**M▲**>.

The process of measuring point selection is terminated by pressing key : **ESC**.

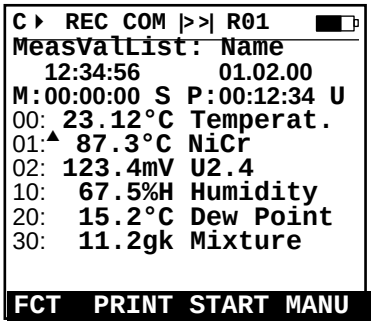
In the standard menu S3 only three of the four measuring points are displayed. This is because of the size of the measured value display and the additional functions. As described in Section 6.6, this menu can also be configured individually by the user as U3 to include other measured value displays and / or other functions.

With all measured value functions (e.g. maximum, average, and bar chart), the measured value of the measuring point must always be entered first and then the associated functions !

The functions ´**Setpoint**´ and ´**Attenuation**´ are available for the selected measuring point (1st channel) once only.

The functions ´**Set to zero**´ and ´**Adjust**´ cannot be accessed via this menu.

6.5.2 Menu List of Measured Values



The best overview of the meas. system incl. all meas. points, time of day, date, meas.cycle and print cycle is obtained with the menu ´**MeasValList**´.

Remember to switch on the continuous measuring point scan (´C´) to ensure that the measured values will be continuously updated.

This menu cannot be individually configured, it can only be combined with some selected functions:

At the first call a list with max meas. points is displayed `MeasValList:20MPts`
It is not possible to display more than 20 channels. 00: `23.12°C`

Functions can be allocated to a measured value by using: <FCT>
This reduces the max. number of channels to 10.

The following function: <FCT> .....

Measured value including **comment**:
`MeasValList: Name`
00:`23.12°C Temperature`

Measured value including **max value**:
`MeasValList: MaxVal`
00: `23.12°C 32.67°C`

Measured value including **min value**:
`MeasValList: MinVal`
00: `23.12°C 19.34°C`

Measured value including **average value**:
`MeasValList: AvgVal`
00: `23.12°C 25.45°C`

Measured value including **limit value Max**:
`MeasValList: LV-Max`
00: `23.12°C 32.67°C`

Measured value including **limit value Min**:
`MeasValList: LV-Min`
00: `23.12°C 19.34°C`

Measuring range only (max. 20 channels):
`MeasValList: Range`
00: `NTC °C`

Switching to the previous function: press and hold <FCT>

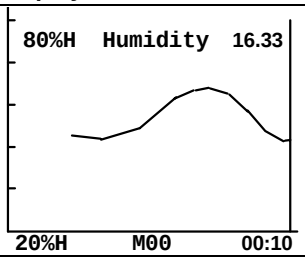
Further channels can be displayed by leafing through the list : PROG, <M▲>, or <M▼>.

The programming functions can be accessed as follows : PROG, <F▲/▼>, PROG.

6.6 Configuration of User Menus

When studying the measurement menus you may have noticed that the display of the measured value and the combination of functions does not always match your applications in an optimum way. Therefore, the ALMEMO® 5990-2 allows you to freely configure three individual user menus, U1 to U3, in addition to the three standard menus, S1 to S3. You can use the following list of functions to individually place the functions you require, in any sequence, on your display up to the available space of 13 lines. In addition to the measuring functions that have been described before, it is possible to use times and cycles for the process control (see 7.) and most of the sensor programming functions (s. 9.).

Functions:	**Display:**	**Keys:**		**Command:**
Limit value Max (s. 9.5)	LimValMax:1234.5°C	OFF	ON	o 00
Limit value Min	LimValMin:-0123.4°C	OFF	ON	o 01
Base value (s. 9.6)	BaseVal: ------	OFF	ON	o 02
Factor	Factor: 1.12345	OFF	ON	o 03
Zero point (s. 9.7)	ZeroPoint: -------	OFF	ON	o 04
Slope (gain)	Slope(Gain):-------	OFF	ON	o 05
Analog start (s. 9.10.4)	AnalogStart: 0.0°C	OFF	ON	o 06
Analog end	AnalogEnd: 100.0°C	OFF	ON	o 07
Range (s. 9.9)	Range: NiCr			o 08
Max value (s. 9.1.3)	MaxVal: 1122.3°C	CLR	CLRA	o 09
Min value	MinVal: 19.3°C	CLR	CLRA	o 10
Average value (s. 6.4)	AverageVal: -------	CLR	CLRA	o 11
Print cycle (s. 7.2)	PrintCycle:00:00:00nU	CLR	FORM	o 12
Meas. cycle (s. 7.3)	MeasCycle:00:00:00 S	CLR		o 13
Time, date (s. 7.1)	12:34:56 01.02.00	CLR		o 14
Meas.value small (s. 6.4)	00:234.5°CTemperature	ZERO	ADJ	o 15
Meas. value medium (s. 6.) 3 lines	00: 1234.5°C	ZERO	ADJ	o 16
Meas. value large (s. 6.) 7 lines	00: Temperature °C 1234.5	ZERO	ADJ	o 17
Meas. value bar (s. 6.4) 2 lines (meas. range s. 9.10.4)	 5 00 S220 ms 15 0			o 34

Functions:	Display:	Keys:		Command:
Graphic (see 6.2.4) full screen		TIME	SCALE	o 35
Averaging mode (s. 6.4.2)	Averag.Mode: CONT	CLR		o 18
Conversion rate: (s. 7.4)	ConvRate: 10 Cont: ✓	OFF	ON	o 19
Print timer: (s. 6.2.3)	PrintTimer:00:00:00nU	CLR	FORM	o 20
Meas. timer:	MeasTimer: 00:00:00 S	CLR		o 21
Averaging count (s. 6.4.3)	Averag.Count: 00000.			o 22
Number (s. 8.3)	Number: 123456	OFF	ON	o 23
Range, comment:	NiCr Temperatur M̄ H↗			o 24
Diameter mm (s. 6.4.7)	Diameter: 00000mm	CLR		o 25
Cross section cm^2 (s. 6.4.7)	CrossSect: 00000cm	CLR		o 26
Volume m^3/h (s. 6.4.7)	Volume: 00000mh			o 27
Max-time-date (s. 6.1.2)	MaxTime: 12:34 01.02.			o 28
Min-time-date (s. 6.1.2)	MinTime: 13:45 01.02.			o 29
Blank line:				o 30
Line:	————————			o 31
Attenuation (s. 6.4.1)	Attenuation: 10	CLR		o 32
Memory free (s. 8.2)	MemoryFree: 502.1kB	CMEM	PRINT	o 33
Device designation (s.10.1)	SampleMan Corporation	CLR		o 36
Text1: (s. 6.6.2)	1: CommentLine	CLR		o 37
Text2:	2: CommentLine	CLR		o 38
Text3: (s. 6.6, 6.6.2)	U1 MenuTitle	CLR		o 39
Text4:	U2 MenuTitle	CLR		o 40
Text5:	U3 MenuTitle	CLR		o 41
Locking (s. 9.4)	Locking: 5	CLR		o 42
Atm. pressure (s. 6.3.4)	AtmPress: 1013mb	CLR		o 43
Temperature comp.(s. 6.3.3)	TempComp: 25.0°C	CLR		o 44
Setpoint (s. 6.3.2)	SetPtVal: 1100.0°C	OFF	ADJ	o 45
Meas. time: (s. 6.4.6)	MeasTime: 00:00:00.00	CLR		o 46
End of menu:				o 99

How do I configure my menu?

Activate the user menus U1 to U3 by using the key: <S/U>

Select the user menu U1, U2 (for one measuring point only) or U3 (for max. 4 meas. points), which suits your application best. <F▲> / <F▼>, PROG

Then, the easiest way to configure the menu is to use a PC and the drag and drop function of the AMR-Control **software**. The selection is based on the device list.

Devices
List
Program user menus

Alternatively, you can program the menu using the **keypad**:

Firstly, you press and hold the key: press and hold PROG

E.g, with menu U1 the following list is displayed:

```
00:  Blank line
01:  Text 3
02:  Meas. val. average
03:  Range, comment
04:  Blank line
05:  Locking
06:  Setpoint
07:  Zero point
08:  Factor
09:  TempComp
10:  AtmPress
11:  End
12:
```

Selection of the first function using the key: PROG

Programming the function: PROG

```
Blank line
```

Selection of the functions using the keys: <▲> or <▼>

Storing the function using the key: PROG

Selection of the next line, programming, as above: <F▼>, PROG etc.

Terminating the menu configuration using the keys: ESC, ESC

After the configuration of the user menus is complete the **main menu** provides the following options:

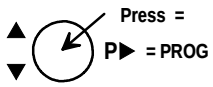
Programming of the title of the selected user menu: press and hold PROG

Text input in main menu or user menu, see 5.5

```
U1 MeasCorr.
```

Switching over between **s**tandard and **u**ser menus: <S/U>

In most cases, by using the **Rotary knob** the whole configuration can be performed much faster.



6.6.1 Function Printouts

The functions of all measurement menus can be printed out in the listed sequence by using the key: **<PRINT>** (cf. 6.1.3)
The print format of the individual functions is given in the following table:

Function	Printout
Meas. Val. all	01: +0023.5 °C Temperature
Maxvalue	MAXIMUMVALUE: 01: +0020.0 °C
Maxtime	MAXTIME: 01: 12:32 01.02
Minvalue	MINIMUMVALUE: 01: -0010.0 °C
Mintime	MINTIME: 01: 12:32 01.02
Average Value	AVERAGEVALUE: 01: +0017.8 °C
Averaging Mode	AVERAG.MODE: 01: CONT
Averaging Count	AVERAG.COUNT:01: 00178.
MemoryFree	MEMORY: S0512.1 F0324.4 A
Number	NUMBER: 01-012
Range (Comment)	RANGE: 01: NiCr
Limit Value Max	LIMVAL MAX: 01: -0100.0 °C
Limit Value Min	LIMVAL MIN: 01: +0020.0 °C
Base	BASEVAL: 01: -0273.0 °C
Factor	FACTOR: 01: +1.0350E-1
Zero Point Correct.	ZEROPOINT: 01: -0000.7 °C
Slope Correction	SLOPE: 01: +1.0013
Analog-Start	ANALOGSTART:01: +0000.0 °C
Analog-End	ANALOGEND: 01: +0100.0 °C
Druckzyklus	PRINTCYCLE: 00:06:00
Meas. Cycle	MEASCYCLE: 00:01:30
Print Timer	PRINTTIMER: 00:06:00
Meas. Timer	MEASTIMER: 00:01:30
Time, Date	TIME: 12:34:00 01.02.00
Start Time	STARTTIME: 07:00:00
End Time	ENDTIME: 17:00:00
Start Date	STARTDATE:01.02.99
End Date	ENDDATE: 02.02.99
Meas. Time	MEASTIME: 00:00:00.00
Attenuation	ATTENUATION: 01: 10
Diameter	DIAMETER: 01: 00100 mm
Cross section	CROSSSECTION: 01: 00078 cm2
Volume flow	VOLUME: 01: 00000 m3/h
Atm. pressure	ATMPRESS: 01: +01013.mb
Temp. compensation	TempComp: 01: 25.0°C
Setpoint	Setpoint: 01: 1100.0°C
Device designation	Fa.Ahlborn,Holzkirchen
Line	----------
Blank line	
Text1	CommentText 1

Function	Printout
Text2	CommentText 2
Text3	MenuTitle U1
Text4	MenuTitle U2
Text5	MenuTitle U3
Locking	Locking: 5

6.6.2 Programming via the Serial Interface

Only new commands, which are not covered by the manual section 6, will be listed in the following.

Selecting the line xx:		ixx
Selection of menu u and function yy:		fu oyy
Entering the texts:	Text 1:	f5 $Text1
	Text 2:	f6 $Text2
	Text 3=MenuTitle U1:	f7 $Text3
	Text 4=MenuTitle U2:	f8 $Text4
	Text 5=MenuTitle U3:	f9 $Text5
Output of the texts 1 to 5:		f5 P20 Text1 etc.
Output of the menu configurations:		fu P20
	Menu title of the menu u	U1:MenuTitle U1
	In line 00: function yy	00:30
	In line 01: function yy	01:39
	....	02:16 03:24 04:30 ...
Output of all functions of the selected menu (print format see 6.6.1):		P20
Menu title		Meas.Correct.
Meas. value average		00: +025.67 °C RANGE: 00: Ntc
Blank line		
		LOCKING:0. SETPOINT: 00: +0000.0 øC COMPENSATION 00: +0000.0 øC ATM.PRESS.: +01013. mb
Input of the cross-section area for the input channel in cm^2 :		Qxxxxx (max. 32000, see 6.4.7)
Input of the attenuation for the input chan. :		f1 zxx (s. 6.4.1)
Input of temp. compensation in 0.1 °C :		f1 gxxxxx (f1 G00150=15.0 °C)

7. Times and Cycles

Some time functions for the process control have been introduced. All associated functions are combined in the menu ´**Times-Cycles**´ and can also be programmed there.

```
*   Times-Cycles   *
12:34:56     01.02.00
PrintCycle:  00:00:00
 Storing:- Sleep: -
 Output Format:List
Meas.Cycle:  00:12:34
 Storing:-
ConvRate:  10 Cont: ✓
 Storing:-
 Output:  -
StartTime:   07:00:00
StartDate:   01.02.00
EndTime:     17:30:00
EndDate:     01.02.00
      PRINT
```

7.1 Time and Date

The ALMEMO® 5990-2 is equipped with a real time clock with date function for recording the measuring time. It has a NiCd battery so the time and date are maintained after a switch-off. By selecting the function (see 5.4) the time can be programmed in the specified format in the first line on the left side and the date on the right side (see 5.5).

Function ´Time and Date´: `12:34:56  01.05.00`
Format of time and date (e.g. 1. May 2000) `hh:mm:ss  dd.mm.yy`

The year number can also be provided with 4 digits via interface (see 10.8 and manual 6.10.13).

7.2 Print Cycle with Storage Activation and Output Format

In most cases the print cycle is used for cyclic storage and outputs of measuring data. The storage activation, i.e. the recording of data in the memory within the print cycle is automatically switched on after a reinitialisation but it can also be switched off, if required.
Of course, it is not necessary that a peripheral device is connected to the socket A1 if the print cycle is used, e.g. for storing data.

The **output format** (see manual 6.6.1) determines the print format at measuring point scans and at the memory output. It is programmed by using the function ´Output Format´. Apart from the standard format ´List´, with all measured values given in a list, the output format ´Columns´ allows for a clear and space-saving printout in columns. For this purpose, a printer will automatically switch to the condensed character mode. Alarm lists during the measuring cycle are not available for this format. The **format** ´Table´ is available to further process measuring data by means of spreadsheet applications (see manual 6.1).

Function ´Print Cycle´ (format hh:mm:ss see 5.5): `PrintCycle:00:15:00`
Clear print cycle, terminate current scan: `<CLR>`

Function ´Storage Activation´ in print cycle: Store:- Sleep:-
Switch on storing: <ON> ✓
Switch off storing: <OFF> -

Switch on function ´Sleep Mode´, see 8.6: <ON> ✓

Output format ´ ´ measured values in list format: OutputFormat:List
Output format ´n´ columns side by side: OutputFormat:Columns
Output format ´t´ table with semicolon separation: OutputFormat:Table
Output of date and time in Excel number format, see 10.8.

In the meas. menus the format abbreviations ´n´ or ´t´ and ´S´ (with storage activation) or ´U´ (without storage activation) are displayed next to the print cycle: PrintCycle: 00:15:00nS

7.3 Measuring Cycle and Storage Activation

Generally, the measuring cycle is used for data acquisition within a print cycle, e.g. for the following applications:

1. Frequent data storage in measuring cycle, printing in print cycle only
2. Limit value monitoring and alarm value output in measuring cycle
3. Cyclic averaging (see manual 6.7.4)

Function ´MeasCycle´ (format hh:mm:ss s. 5.5)**:** MeasCycle: 00:00:30
Clear meas. cycle, terminate current scan: <CLR>

Function ´Storage Activation´ in meas. cycle: Store: -
Switch on storing: <ON> ✓
Switch off storing: <OFF> -

7.4 Conversion Rate, Continuous Measuring Point Scan

If required, for measuring point scans the conversion rate can in function ´Conv.Rate´ be increased from 2.5 to 10M/sec (see manual 6.5, 6.5.4).

The **continuous measuring point scan** (previously introduced) can at this point, be switched on or off by using the function ´CONT´, i.e. either the selected measuring point will only be scanned, or all active measuring channels will be continuously and successively scanned (see manual 6.5.1.3). The following two functions can be used to activate the continuous storage and the continuous output of measuring data at the conversion rate.

Function ´Conv.Rate´, cont. meas. point scan: ConvRate: 10Cont:✓
Continuous storage: Store: -
Switch on the continuous storage: <ON> ✓
Continuous output: Output: -
Switch on the continuous output: <ON> ✓

At the conversion rate of 50 measuring operations per second, the shorter evaluation times result in the following restrictions:

1. The increased conversion rate only takes effect after a measuring operation has been initiated; before this, the device remains set at 10 measuring operations per second.
2. During measuring operations at a higher measuring rate, the ALMEMO connectors are no longer monitored; i.e. the connector configuration can only be modified when the measuring device has stopped.
3. The printout of alarm values is not provided.
4. Analog output is no longer provided.
5. At rates above 10 measuring operations per second, mains hum suppression is no longer provided; and as a result, accuracy may be adversely affected by interference over the connection lines; (wherever possible used twisted wires!).

7.5 Time and Date of Start, Time and Date of End

A sequence of measurements can, at certain points in time, be automatically started and stopped. For this purpose the start time and date and the end time and date can be programmed. If a date has not been specified the measurement will be performed every day in the defined period. The current time must be programmed beforehand.

Function ´Start Time´:	**StartTime: 07:00:00**
Function ´End Time´:	**EndTime: --------**
Input (see 5.5) in format:	hh:mm:ss
Function ´Start Date´:	**StartDate:01.05.00**
Function ´End Date´:	**EndDate: --------**
Input (see 5.5) in format:	dd:mm:yy

To clear values, select function and then use: <**CLR**>

If the start time of a measurement has been programmed, the status line will include the symbol: ´ ⏵I ´

If the end time of a measurement has been programmed, the status line will include the symbol: ´ I⏵ ´

8. Data Memory

The basic information with regard to data storage in ALMEMO® devices is given in the manual section 6.9. The memory organisation can be reconfigured from linear to ring memory (see manual 6.10.13.2).

As a new option several measurements can be stored even if they have different configurations. At each start the configuration is checked and newly saved, if it has been changed, and the measurement is provided with a number (see 8.3). Each configuration requires 2008 bytes of memory space. As, on principle, only one configuration can be allowed in a measurement file, the memory output into a table format is cancelled with each new configuration. The next measurement must then be selected by its number or the time/date.

8.1 Memory Extension through Smart Media Card

The data logger 5990-2 provides a slot for a standard Smart Media Memory Card with min. 8MB memory space. As a result, the memory capacity is extended to 1,600,000 measured values. Furthermore, it is often useful when the data logger can remain at one measuring location and data can just be taken on a memory device and evaluated somewhere else.

Please consider the following characteristics when using external memories:

- Plugging the Smart Media Card in right layer in
- If the internal data memory contains data when connecting the external memory the message ´CMEM´ will be displayed in the function ´No: -- Free´ and prompt the user to delete the internal memory by using the key <CMEM>.If the data needs to be rescued the external memory must be removed again and the data must first be read out.
- New or alien Smart Media Cards must be formatted by erasing.
- Additionally, the external memory modules can be identified with a two-digit number.
  It can easily be entered in function ´No: 00 Free:´
- The function ring memory will not be supported when storing data on the memory connectors.
- All measuring operations, including manual scans, must be terminated with <**STOP**>. Data not thus terminated may be saved in incomplete form or may be overwritten with the next measuring operation.
- Therefore, the external memory must not be removed when a measurement is in progress!

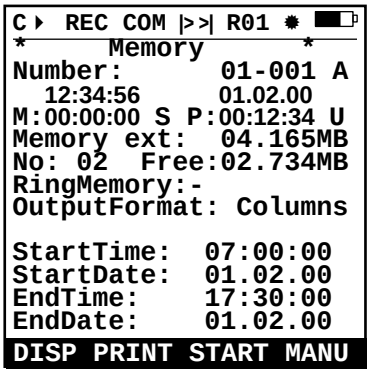
8.2 Data Acquisition

The parameters, which are required for the recording of measuring data, have already been described in the menu ´Times-Cycles´ (see section 7). .

1. Time and date
2. Print cycle with storage activation, sleep mode, see 8.6
3. Measuring cycle with storage activation
4. Conversion rate with storage activation
5. Time of start and end of a measurement

Most functions are listed in the menu ´Memory´.

However, here the start/end time/date are used to define a time frame at the memory output, not for the data recording!



Menu ´**Memory**´:

Number : (e.g. room 12, measuring point 1) (see Section 8.3)	**NUMBER: 12-001 A**
Time and date:	**12:34:56 01.05.00**
Meas. cycle and print cycle with storage activation :	**M:00:00:00 S P:00:12:34 S**
Internally available memory capacity:	**Memoryint: 0507.3kB**
Available free memory space:	**No:-- Free:0217.5kB**
or when external memories are connected:	
Externally available memory capacity:	**Memory ext:08.165MB**
Number and memory space of the ext. memory:	**No:02 Free:02.734MB**
Linear memory without overwriting of data:	**RingMemory:-**
Activate ring memory with overwriting:	**<ON> ✓**
Starting the recording using the key:	**<START>**
Manual single storing with key:	**<MANU>**
For control purposes the status line will indicated:	**´REC´**
Stopping the cyclic recording:	**<STOP>**
Displaying the data memory (see 8.4):	**<DISP>**
Output of the memory via interface (see 8.5):	**<PRINT>**

The configuration is checked at each start and if it has changed a number is automatically allocated, indicating the current configuration with the first two digits (e.g. 02-000, see 8.3).

8.3 Numbering of Measurements

For the identification of measurements or series of measurements it is possible to individually enter a number before starting. It will be used automatically (see above) if the configuration has changed. With the next measuring point scan it will be output or stored, respectively. This allows to also assign single measurements during a read-out to specific measurement locations or measuring points (see manual 6.7).

After selecting the function ´NUMBER´ the 6-digit number is entered in the usual way (see 5.5). In addition to the figures 0 to 9 the characters A,F,N,P,- or _ (space) can be used. After the input the number is activated and next to it an ´A´ will be indicated until the next cyclic or manual measurement will be stored.

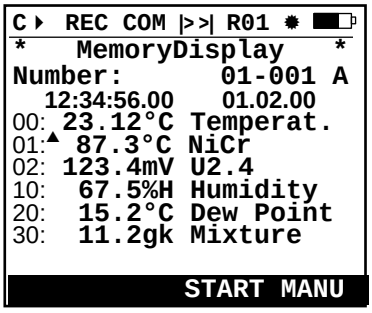
Function Number: (e.g. room 12, meas. point 1)	**NUMBER: 12-001 A**
Zero setting and deactivating the number with:	**<CLR>**
Activating the number with the key:	**<ON>**, **<OFF>**
Deactivating the number with the key:	**<▲>**

8.4 Memory Display

One measuring point scan at a time can be indicated in list format on the display. During a measurement in progress you can either follow the latest one or jump to particular points in time and successively navigate through the record. If required, the parameters ´Number´ or ´Start Time/Date´ must first be entered in the menu ´Memory´.

Calling the memory display from the menu ´Memory´:	**<DISP>**
Selecting the function ´Memory Display´:	*** MEMORYDISPLAY ***
Soft keys:	**BEGIN NO TIME END**
Jump to the start of the data memory:	**<BEGIN>**
Jump to the number from menu ´Memory´:	**<NO>**
Find start time/date (menu ´Memory´):	**<TIME>**
Jump to the end of the data memory:	**<END>**

Menu ´**MemoryDisplay**´:
At the end of the data memory the measurement in progress can be followed and, by using the keys <START>, <STOP> and <MANU> it can be started, stopped or single measurements can be performed.



8.5 Memory Output

The content of the data memory can, completely or in parts, be output to the serial interface. For each output one of the three available output formats ´List´, ´Columns´ or ´Table´ can be used. The option to specify partial ranges is available as it is possible to set the start and end time of measurements and also possible to select the number of corresponding identified measurements. Furthermore, it is possible to selectively read just the alarm values (e.g. exceeding of limit values) out of the overall memory.

At the output format ´Table´ the output will be cancelled, if the configuration has changed. For the output of the remaining data the corresponding number must be activated!

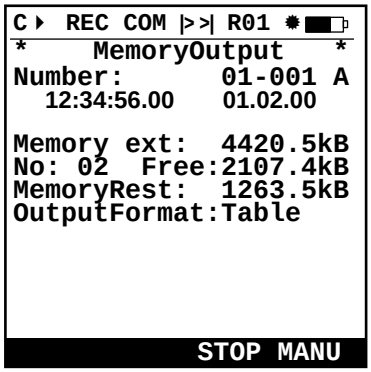
Menu ´**Memory**´:

Setting the output format:	**OutputFormat: List**
In case of selecting a numbered measurement:	
Enter number in function ´NUMBER´ (see 8.3):	**NUMBER: 12-001 A**
To select a time interval:	
Enter the start time using the format ´hh:mm:ss´:	**StartTime:07:00:00**
Enter the end time using the format ´hh:mm:ss´:	**EndTime: 17:00:00**
Enter the start date using the format ´dd:mm:yy´:	**StartDate:01.05.00**
Enter the end date using the format ´dd:mm:yy´:	**EndDate: 01.05.00**
Selecting the memory output:	**<PRINT>**
Selecting the function ´Memory Output´:	*** MEMORY OUTPUT ***
Soft keys:	**ALL NO TIME ALARM**
Perform complete output of data memory:	**<ALL>**
Output of a numbered measurement:	**<NO>**
Output of a time interval from start to end:	**<TIME>**
Output of alarm values only:	**<ALARM>**

Menu ´Memory Output´:

During the output of the data memory the parameters ´Number´, ´Time´ and ´Date´ will be continuously updated.

In the function ´MemoryRest´ the remaining memory content (in kB) to be output is continuously indicated.



Cancelling the memory output using the key: **ESC**
Interrupting the memory output using the key: **<STOP>**
The following options are available after an output interruption:
Recall individual measured values: **<MANU>**
Re-start the automatic output: **<START>**
Cancelling the memory output using the key: **ESC**

After the memory output the device returns to the menu ´Memory´.

The memory contents will be output with the same print format as with a printer operation, including multiple printouts and different formats (see manual 6.6.1).

Print Format:

```
MEMORY: 03                                  (evtl. connector number)
NUMBER:      12-001                         (if activated)
DATE:        12.03.00
12:30:00 01: +0012.0 °C NiCr Designation
         02:!+0008.8 °C NiCr Water
         03:>+125.00 °C Ntc  MotorOil
```

List format below each other

The connector number of an external memory will be printed after each headline ´MEMORY´.
For reading Smart-Media-Cards an own reader ZA1904SLG is available. Commercial reader aren't usable on reason of the memory format!

Clear Memory

Menu ´Memory´:
Select function ´MemoryFree´ (see 5.4): **No:-- Free:0217. kB**
To clear the memory, first press the key: **PROG**
the memory capacity is highlighted: **No:-- Free:0217.5 kB**
then the key: **<CMEM>**
Full mem. capacity is indicated as avail. mem. space: **No:--Free:0507.5kB**
Or cancel by using the key: **ESC**

8.6 Sleep Mode

For the purposes of long-term unattended monitoring, the display can be switched off in order to save energy. In this energy-saving mode the device's operating time is prolonged to approx. 60 hours per accumulator battery charge.

The following steps must be carried out in the menu ´TIMES-CYCLES´ to perform a **data recording in the true sleep mode:**

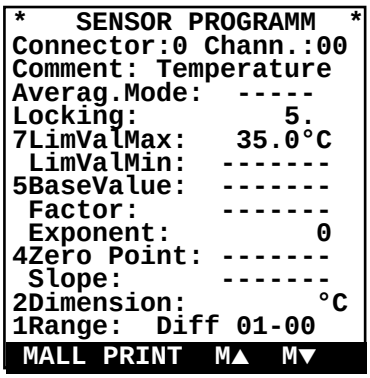
1. Select the sleep mode: `Store:✓ Sleep:-`
2. Switch on the sleep mode using the key: `Store:✓ Sleep: ✓`
3. In a meas. menu, start Measure by pressing key : **<START>**
   The display switches off in 30 secund, for control purposes lamp ´START´ flashes
   only the lamp ´**START**´ flashes regularly.
4. Switching the display on again by using the key: **ESC**

   If 30 second expires without any key being pressed the display will switch off again!

9. SENSOR PROGRAMMING

As all ALMEMO® instruments contain the whole sensor programming stored in the ALMEMO® connector plug, the user, usually, does not need to perform any programming. Only if, for example, sensor errors must be corrected or existing sensors must be scaled or limit values need to be specified the comprehensive programming options have to be used.

If the corresponding sensor connector is connected all parameters of a channel can be checked and entered or changed via keypad in the menu ´Sensor Programming´. It must be considered that standard sensors are, by a locking mode, protected against unintentional modification and that the locking level must first be reduced before desired changes can be performed (see 9.2).



Output of the sensor programming of all active measuring points (command P15 see man. 6.2.3) by using the key: <PRINT>

9.1 Selecting the Input Channel

To query or to program the parameters of a sensor, it is first necessary to select the menu ´Sensor Programming´ and then to set the required input channel by using the key M▲ or M▼. For this, only connected sensors and activated channels will be considered. To be able to activate new channels, the key ´MALL´ must be used to enable the selection of **all** channels. The key ´MACT´ can be used to reduce the selection back to the **active** channels only. The corresponding connector number will be displayed with each input channel.

When changing the input channel, the selected meas. point will not be changed, i.e. a measurement in progress will not be interrupted.

Menu ´SensorProgramming´ * SENSORPROGRAMM *
Indication of connector number and input channel: Connector:0Channel:00
Selecting the next input channel using the key: <M▲>
Selecting the previous input channel using the key: <M▼>
Enabling the selection of all available channels: <MALL>
Reducing the selection to all active channels: <MACT>

9.2 Measuring Point Designation

Each measuring point can be given a 10-digit alphanumeric designation to optimally identify the type of sensor, the measuring location or the purpose of the application. This comment will be indicated with all standard displays of measured values. If it has not been programmed, the abbreviation of the measuring range will be indicated. In case of outputs via interface the measuring point designation appears in the program header as ´COMMENT´ and in the list of measured values (see man. 6.6.1).

Input in function ´Comment´, see 5.5 **Comment: Temperature**

9.3 Averaging Mode

The types of averaging, which are defined through the function ´Averaging Mode´, are described in section 6.4.2.

Function ´Averaging Mode´ no averaging: **Averag.Mode: -----**

9.4 Locking the Programming of the Sensor see man. 6.3.12

The function parameters of each measuring point are protected by the locking mode up to an adjustable locking level. Before any programming is performed the locking mode must be correspondingly lowered. If a dot is indicated following the locking mode on the display then a modification is not possible.

Locking Level	Locked Functions
0	none
1	Meas. range + element flags
3	+ Dimension
4	+ Zero point and gain (slope) correction
5	+ Base value, factor, exponent
6	+ Analog output, start and end
7	+ Limit values, max and min

Function ´LockingMode´: **Locking: 5**

In the menu ´Sensor Programming´ the functions are arranged from top to bottom so that the locked functions cannot be selected. The menu and keypad locking must be used to protect the programming and the process control during a measurement against unauthorised modification (see 5.6).

9.5 Limit Values

Two limit values (MAX, MIN) can be programmed and allocated to each measuring channel. An exceeding of limit values is handled as a fault, similar to an exceeding of meas. range limits and sensor breakage. On the display a corresponding arrow ▲ or ▼ will appear next to the measured value, the alarm relays will respond and the alarm values will be provided as output during the measuring cycle (see manual 6.3.9). The alarm condition will persist until the measured value has dropped below the limit value by the hysteresis. Generally, the hysteresis is set to 10 digits, however, it can be adjusted to values between 0 and 99 digits (see 10.7). The exceeding of a limit value can also be used to start or stop a measurement (see 9.10.3).

Function:

Limit value Max:	**LimVal.Max: 123.4°C**
Limit value Min:	**LimVal.Min: -----°C**
Switching off the limit value:	<**OFF**>
Switching on the limit value:	<**ON**>

9.6 Scaling, Decimal Point Setting

For indicating the electrical signal of a sensor as a measured value of a physical variable it is, in most cases, necessary to set a zero point shift and to perform a multiplication with a certain factor. The functions BASE and FACTOR are available for this. A detailed description of the scaling, including an example, can be found in the manual section 6.3.11.

Indicated value = (corrected measured value - BASE) x FACTOR.

The FACTOR can be programmed in the range from -2.0000 to +2.0000. For factors over 2.0 or under 0.2 a corresponding decimal point setting must be considered by entering the EXPONENT. The EXPONENT allows to shift the decimal point to the left (-) or right (+) as far as it can be indicated on the display and printer. An exponential presentation of the measured values is not possible.

Function ´Base Value´ (input see 5.5):	**BaseValue: ------**
Function ´Factor´:	**Factor: ------**
Function ´Exponent´:	**Exponent: 0**

The correction arrow ↗ will be indicated as status of the measured value, if scaling values have been programmed and the actual measured value has been altered.

9.7 Correction Values

The correction values ZERO POINT and SLOPE (GAIN) allow for correcting sensors with regard to zero point and slope (gain) (see manual 6.3.10). .

Corrected Meas. Value = (Meas.Value - ZERO POINT) x SLOPE (GAIN)

Function:

Zero Point Correction:	**ZeroPoint: -----°C**
Slope correction:	**Slope: -----°C**
Switch on/off keys:	**< OFF>** or **<ON>**

The correction arrow ↗ will be indicated as status of the measured value, if scaling values have been programmed and the actual measured value has been altered.

9.8 Changing the Dimension

Each measuring channel allows to replace the standard dimension of the measuring range by any other dimension that has two digits (see manual 6.3.5). In addition to all capital and normal letters, the characters ?(ohm), %, [,], *, -, =, ~ and spaces (_) are available. The dimension is indicated by two characters that are indicated next to the measuring and programming values.

The **dimension can be changed** using the function: **Dimension: °C**

When the dimension °F is entered a temperature value in degreeCelsius will be converted into degrees Fahrenheit. The cold junction compensation can be switched off by using the characters ´!C´.

9.9 Selecting the Measuring Range

If users want to program the connectors on their own or if they frequently change the measuring range, it must be considered that the locking must be cleared, i.e. set to zero (see 9.4), and that special connectors may be required for some transducers (e.g. thermo, shunt, divider etc., see table). To activate a new measuring channel, activate all channels by using the key ´MALL´, select the corresponding input channel (see 9.1) and then enter the measuring range. With the input acknowledgement of the new measuring range all programming values of the input channel will be cleared.

Function ´Meas. Range Selection´:	**RANGE: NiCr**
Possibly, enabling the selection of all avail. meas. chann.:	**<MALL>**
Switch-off, i.e. deactivating a channel:	**<CLR>**
Switch-on, i.e. re-activating the channel:	**PROG**, **PROG**
Programming of range as with data input, see 5.5	**PROG**, <▲>.... , **PROG**
In the input window all abbreviations of the following table are indicated successively:	**RANGE: FECO**

Transducer	Conn./Cable/ Sensor	Meas. Range	Dim	Display
Pt100-1	ZA 9000-FS	-200.0... +850.0	°C	**P104**
Pt100-2	ZA 9000-FS	-200.00...+400.00	°C	P204
Pt1000-1 (element flag 1)	ZA 9000-FS	-200.0... +850.0	°C	P104
Pt1000-2 (element flag 1)	ZA 9000-FS	-200.00...+400.00	°C	P204
Ni100	ZA 9000-FS	-60.0... +240.0	°C	N104
NiCr-Ni (K)	ZA 9020-FS	-200.0...+1370.0	°C	**NiCr**
NiCroSil-NiSil (N)	ZA 9020-FS	-200.0...+1300.0	°C	NiSi
Fe-CuNi (L)	ZA 9000-FS	-200.0... +900.0	°C	FECO
Fe-CuNi (J)	ZA 9000-FS	-200.0...+1000.0	°C	IrCo
Cu-CuNi (U)	ZA 9000-FS	-200.0... +600.0	°C	CUCO
Cu-CuNi (T)	ZA 9000-FS	-200.0... +400.0	°C	CoCo
PtRh10-Pt (S)	ZA 9000-FS	0.0...+1760.0	°C	Pt10
PtRh13-Pt (R)	ZA 9000-FS	0.0...+1760.0	°C	Pt13
PtRh30-PtRh6 (B)	ZA 9000-FS	+400.0...+1800.0	°C	EL18
Au-FeCr	ZA 9000-FS	-270.0... +60.0	°C	AUFE
Ntc Type N	ZA 9000-FS	-30.00...+125.00	°C	**Ntc**
Millivolt 1	**ZA 9000-FS**	**-26.000...+26.000**	**mV**	**U 26**
Millivolt	ZA 9000-FS	-10.000...+55.000	mV	U 55
Millivolt 2	ZA 9000-FS	-260.00...+260.00	mV	U260
Volt	ZA 9000-FS	-2.6000...+2.6000	V	U2.60
Differential Millivolt 1	ZA 9050-FS	-26.000...+26.000	mV	d 26
Differential Millivolt	ZA 9050-FS	-10.000...+55.000	mV	d 55
Differential Millivolt 2	ZA 9050-FS	-260.00...+260.00	mV	d260
Differential Volt	ZA 9050-FS	-2.6000...+2.6000	V	d2.60
Sensor voltage	ZA 9000-FS	0.00...20.00	V	UbAt
Milliampere	ZA 9601-FS	-32.000...+32.000	mA	**I032**
Percent (4-20mA)	ZA 9000-FS	0.00... 100.00	%	P420
Ohm	ZA 9000-FS	0.00... 400.00	Ω	Ohn
Frequency	ZA 9909-AK	0... 25000	Hz	FrEq
Pulse	ZA 9909-AK	0... 65000		PULS
Digital input	ZA 9000-EK2	0.0... 100.0	%	Inp
Digital interface	ZA 9919-AKxx	-65000... +65000		diGi
Infrarot 1	ZA 9000-FS	0.0... +200.0	°C	**Ir 1**
Infrared 4	ZA 9000-FS	-30.0... +100.0	°C	Ir 4
Infrared 6	ZA 9000-FS	0.0... +500.0	°C	Ir 6
Snap-on head Normal 20	FV A915-S120	0.30... 20.00	m/s	**S120**
Snap-on head Normal 40	FV A915-S140	0.40... 40.00	m/s	S140
Snap-on head Micro 20	FV A915-S220	0.50... 20.00	m/s	S220
Snap-on head Micro 40	FV A915-S240	0.60... 40.00	m/s	S240
Macro	FV A915-MA1	0.10... 20.00	m/s	L420
Water-Micro	FV A915-WM1	0.00... 5.00	m/s	L605
Dyn. press. 40m/s wth TC a. PC	FD A612-M1	0.50... 40.00	m/s	L840

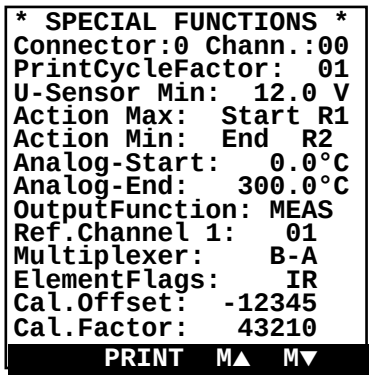
Transducer	Conn./Cable/ Sensor	Meas. Range	Dim	Display
Dyn. press. 90 m/s wth TC a. PC	FD A612-M6	1.00... 90.00	m/s	L890
Rel. humidity cap.	FH A646	0.0... 100.0	%H	**°o rH**
Rel. humidity cap. wth TC	FH A646-C	0.0... 100.0	%H	HcrH
Rel. humidity cap. wth TC	FH A646-R	0.0... 100.0	%H	H rH
Mixture ratio wth PC	FH A646	0.0 ... 500.0	g/kg	H AH
Dew point temperature	FH A646	-25.0... 100.0	°C	H dt
Partial vapour pressure	FH A646	0.0...1050.0	mbar	H UP
Enthalpy wth PC	FH A646	0.0 ... 400.0	kJ/kg	H En
Humid temperature	FN A846	-30.00...+125.00	°C	P Ht
Rel. humidity psychr. wth PC	FN A846	0.0 ... 100.0	%H	P RH
Mixture ratio wth PC	FN A846	0.0 ... 500.0	g/kg	P AH
Dew point temperature wth PC	FN A846	-25.0 ... +100.0	°C	P dt
Partial vapour pressure wth PC	FN A846	0.0 ...1050.0	mbar	P UP
Enthalpy wth PC	FN A846	0.0 ... 400.0	kJ/kg	P En
Conductivity probe wth TC	FY A641-LF	0.0 ...20.000	mS	**LF**
CO_2 sensor	FY A600-CO2	0.0 ... 2.500	%	CO2
O_2 saturation wth TC a. PC	FY A640-O2	0 ... 260	%	O2-S
O_2 concentration wth TC	FY A640-O2	0 ... 40.0	mg/l	O2-C
Function channels				
Difference (Mb1-Mb2)	any			**diFF**
Maximum value (Mb1)	any			Hi
Minimum value (Mb1)	any			Lo
Average value over time (Mb1)	any			A[t]
Av. val. over meas.pts (Mb1..Mb2)	any			A[n]
Sum over meas.pts (Mb1..Mb2)	any			S[n]
Total pulse count (Mb1)	ZA 9909-AK2	0... 65000		S[t]
Pulse count/print cycle (Mb1)	ZA 9909-AK2	0... 65000		S[P]
Alarm value (Mb1)	any			Alrm
Thermal coeff. $\overline{M}(q)/\overline{M}(M01\text{-}M00)$	ZA 9000-FS		W/m^2K	q:dt
Wet bulb globe temp.	ZA 9000-FS		°C	UbGt

TC Temperature Compensation, PC Atmospheric Pressure Compensation

The **use of the function channels** for the output of measuring and calculated variables with the corresponding reference channels, Mb1 and Mb2, is described in the manual section 6.3.4. After the programming of the range the standard reference channels (1st channel in connector) are used: The individual configuration of the reference channels is described in the sections 9.10.6 and 9.10.7.

9.10 Special Functions

The data logger 5990-2 has a separate menu allowing access to all ALMEMO® special functions, which despite only rarely being required during routine operation, are very useful for some applications (see manual 6.10). These functions can (to a certain extent) be very complex and should only be used if their operation is completely understood.



9.10.1 Print Cycle Factor

For the adaptation of the data recording to the update speed of the individual measuring points it is possible to program a print cycle factor between 00 and 99 to print measuring points less often or not at all (see manual 6.10.6). Only disturbed measuring points, e.g. on exceeding of limit values will always be output. Generally, the print cycle factor of all measuring points is cleared or set to 01, i.e. all activated measuring points will be printed at each print cycle. If a different factor, e.g. 10 is programmed, the corresponding measuring point will only be printed once in ten times, however, if 00 is programmed it will not be printed. The data recording within the print cycle also allows to suppress unnecessary measured values and, as a result, saves memory space.

Enter the print cycle factor (see 5.5) in function: **PrintCycleFactor: 01**
Clearing the print cycle factor with the key: **<CLR>**

9.10.2 Minimum Sensor Supply Voltage

Generally, the ALMEMO® devices monitor the sensor supply voltage, which, in most cases, corresponds to the operating voltage of the measuring instrument. It is also displayed in the device configuration (see 10.8). However, there are also sensors, which require for a correct operation a supply voltage, which requires a charged battery or a power supply unit. TO avoid measuring errors, the sensor programming allows to individually program the required minimum sensor voltage for each transducer. In case of falling below this voltage the measured value is treated as sensor breakage.

Entering the minimum sensor supply voltage: **U-Sensor Min: 12.0 V**
Switching off the voltage control, clearing the value: **<CLR>**
U-Sensor Min: ---- V

9.10.3 Limit Value Responses

Relay Allocation

As standard, both limit values of all measuring points of a device or of a measuring circuit board are used for fault alarms (see 9.5), i.e. if an exceeding of a limit value occurs at any measuring point, the relay 0 responds if an alarm relay cable or the corresponding relay adapter (see manual 5.2/3) is used. It only opens again, after all measured values have dropped below the limit values by as much as the hysteresis. If a limit value has not been defined, the measuring range limit will be used as limit value. A sensor breakage will always cause a fault alarm.
To distinguish between max value exceeding and min value undershooting the alarm signal generators can be re-programmed to variant 1 (see manual 6.10.9).
However, if it is necessary to selectively identify and evaluate faults, the function ´Response Max´ or ´Response Min´ can be used to allocate individual relays to the limit values. It is also possible to allocate several limit values to one relay. For this purpose the relay cables provide 2 relays (0 and 1) and the relay adapter (ZA 8000-RTA) provides 4 relays (0 to 3). This mode also has to be set as variant 2 in the output module (see manual 6.10.9).

	`Socket A2:`
Setting the relay module to variant 2:	`EA Trigger-Alarm`
(relay int. allocated)	`2: Rx int. allocated`
Activating relay x at limit value exceeding Max:	`Action Max: ----- Rx`
Activating relay y at limit value undershooting Min:	`Action Min: ----- Ry`
Clearing the relay allocation using the key:	<**CLR**>

Starting and Stopping a Measurement

Exceeding of limit values can not only be used for fault alarms but also to start or stop a measurement (see manual 6.6.3). The start command or stop command is assigned to a limit value - by means of the ´Special functions´ menu and function ´**`Action Max`**´ or ´**`Action Min`**´.

Starting the meas. at exceeding of limit value Max:	`Action Max:--Start`
Stopping the meas. at undershooting of lim.value Min:	`Action Min:--End`
Clear response by using the key:	<**CLR**>

Beim Ausdruck der Fühlerprogrammierung (s. Hb. 6.10.1) erscheint bei Aktion Max (AH) und Min (AL) ein zusammengesetzter Code für Start/Ende **S/E** (s. Hb. 6.6.3) und Relaiszuordnung **x** (s. Hb. 6.10.8).

9.10.4 Analog Output Start and End

In most cases the analog output of measured values to the analog output modules (see manual 5) or the display as bar or line chart must be scaled to a specified sub-range. For this, it is just necessary to specify the start and end value of the display range required by you. This range is then mapped to the analog range 2V, 10V, 20mA or, for the display, to 100 dots.

Programming the **analog output start**: `AnalogStart: 0.0°C`
Programming the **analog output end**: `AnalogEnd: 100.0°C`

These two parameters, analog output start and analog output end, are also stored in the EEPROM of the sensor and can, therefore, be individually programmed for each channel, i.e. during a manual switch through the channels an individual scaling is available for each measuring variable.
The flag for switching over from 0-20mA to 4-20mA can be programmed through the element flags (see 9.10.8).

9.10.5 Output Function

If not the real measured value but only the Max, Min, Average or Alarm value is required, then this function can be programmed as output function (see manual 6.10.4). As a result, only the corresponding function value will be considered for storing and analog or digital output. For control of the changed output function the symbol below is displayed next to the measured value (see 5.3).

Example:

1. If meas. values are averaged over the print cycle by means of the meas. cycle, only the average value is relevant as output value, but not the last measured value. This way, memory space can be saved in a data logger.
2. The analog measured value of the dew sensor FH A946-1 has no meaning. If the limit value Max is set to approximately 0.5V, and the measuring function ´Alarm Value´ is programmed only the relevant values 0.0% for dry and 100.0% for ´dew´ will be displayed.

Output Function	**Control Symbol**	**Menu**
Meas. value		**`OutputFunction: Meas`**
Difference	`D`	**`OutputFunction: Diff`**
Max value	`H`	**`OutputFunction: Max`**
Min value	`L`	**`OutputFunction: Min`**
Average value	`M`	**`OutputFunction: M(t)`**
Alarm value	`A`	**`OutputFunction: Alrm`**

9.10.6 Reference Channel 1

The arithmetic functions of the function channels, generally, refer to a particular measuring channel (or 2 meas. channels) (see manual 6.3.4). During the programming of a function channel the first channel of the corresponding sensor connector Mxx1 is automatically set as reference channel Mb1. The 2nd reference channel Mb2 (for difference etc.) is, initially, the measuring point M00. In function ´Ref. Channel 1´ it is possible to set other measuring points as reference channel, either absolutely by specifying a particular measuring point or by specifying the ´distance´ referred to the function channel (e.g. -01 identifies the channel preceding the function channel).

Programming of the ref. channel 1 absolute:	**RefChannel 1: 01**
Programming of the ref. channel 1 relative:	**RefChannel 1: -10**

9.10.7 Reference Channel 2 or Multiplexer

In case of function channels, which require a second reference channel, the function ´Ref Channel 2´ will automatically be displayed in the line after ´Ref Channel 1´. In all other cases it is possible to change the pin assignment in the connector by changing the input multiplexer (see manual 6.10.2).

Programming of the ref. channel 2 absolute:	**RefChannel 2: 00**
Programming of the ref. channel 2 relative:	**RefChannel 2: -01**
Measuring inputs B+ and A-, GND-referred	**Multiplexer: B-A**
Measuring inputs C+ and A-, GND-referred	**Multiplexer: C-A**
Measuring inputs D+ and A-, GND-referred	**Multiplexer: D-A**
Differential measuring inputs C+ and B-	**Multiplexer: C-B**
Differential measuring inputs D+ and B-	**Multiplexer: D-B**

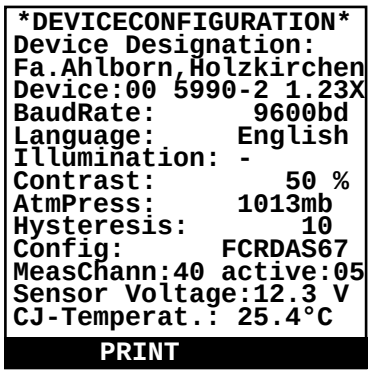
9.10.8 Element Flags

For a realization of sensor-specific additional functions, element flags can be activated at each measuring channel (see manual 6.10.3).

Meas. current 1/10 for Pt1000, 5000Ω:	**ElementFlags: I 1/10**
Emission and background temp. for IR sensors:	**ElementFlags: IR**
Meas. bridge with switch for final value simulat.:	**ElementFlags: Bridge**
(Activation base value:) *	ElementFlags: Base
(Activation of all averaging functions:) *	ElementFlags: Avg On
(Element flag 6:) *	ElementFlags: Flag 6
Switch-off of the sensor breakage detection:	**ElementFlags: Br Off**
Analog output 4-20mA instead of 0-20mA:	**ElementFlags: A 4-20**

* At the ALMEMO 5990-2 these element flags have no meaning.

10. DEVICE CONFIGURATION



Some fundamental settings can be taken in the menu ´Device Configuration´. The device designation serves as print header in log printouts and facilitates the assignment within a network. Furthermore, the device address is imperative in a network. The baud rate can be adapted to external devices. Three modes are available for the illumination of the display. The setting of the atmospheric pressure for the compensation of certain sensors is particularly suitable at corresponding altitudes. The standard value of the hysteresis of alarm relays can be changed. For checking the device the channel number, sensor supply voltage and cold junction temperature are indicated.

10.1 Device Designation

The function ´Device Designation´ (see manual 6.2.4) allows to enter any text with max 21 digits (see 5.5). The text appears in the main menu, in the print header of a measurement and in device lists (software).

Function ´**Device Designation**´: `Device Designation:`
`Fa.Ahlborn,Holzkirchen`

10.2 Device Address and Networking

All ALMEMO® instruments can be very easily networked to centrally acquire the measured values of several instruments that are located at different places (see manual 5.3). For communicating with networked devices it is mandatory that all devices have the same baud rate and an own individual address as only one device is allowed to respond to each command. Therefore, before any network operation it is necessary that all connected devices are set to different device numbers. For this, the function ´Device´ is available. Generally, the device number 00 is set as the factory default value in this function. It can be changed by the usual data entry (see 5.5). For checking purposes it is followed by the device type, the version number and, possibly, an option code (see manual 6.10.11).

Function ´**Device Address**´ with type and version: `Device:00 5990-2 5.50X`

Example: Address: 00, Type: 5990-2, Version: 5.50, Option: X

Only successive numbers between 01 and 99 should be entered for network operation so that the device 00 cannot be falsely addressed in case of a power supply failure.

10.3 Baud Rate, Data Format

All interface modules are factory-set and programmed to 9600 baud. To avoid unnecessary problems when networking several devices the baud rate should not be modified but the computer or printer should be set up accordingly. If this is not possible the values 300, 600, 1200, 2400, 4800, 9600bd, or 57.6, 115.2 kbd can be entered in the function ´Baud Rate´ (please consider the max. baud rate of the interface module!). The baud rate setting will be stored in the EEPROM of the interface module and will then be valid for use with all other ALMEMO® devices.

Function Baud Rate: **Baud Rate: 9600bd**

Data Format: unchangeable 8 data bits, no parity, 1 stop bit

10.4 Language

The language of the function legend and the printouts can be set to German, French or English. The soft keys are international code and are not meant to be altered:

Language selection in function ´Language´, see 5.5: **Language: English**

10.5 Illumination and Contrast

The background lighting of the display can be switched on or off in the main menu by using the key <*ON> or in the function ´Illumination´ of the device configuration. If the device is operated with rearchable battery, the illumination will switch off one minute after the last key was operated, and it will switch on again as soon as any key is operated. The following function allows to set the contrast to 10 different positions.

Switching the illumination on or off using <**ON**>, <**OFF**>: **Illumination:** ✓
Switch-on **without** function by using the key: **ESC**
The status line provides the symbol: ✶ auto off: ✶
Setting the contrast (10 to 100%), see 5.5: **Contrast: 50 %**

10.6 Atmospheric Pressure

For compensation of various sensors the atmospheric pressure can be entered (see 6.3.4). If it is measured, it will also be indicated in this function:

Entering the atm. pressure in function ´Atm. Press.´, see 5.5:**Atm.Press: 1013mb**

10.7 Hysteresis

In case of an exceeding of limit values the hysteresis of an alarm condition can, generally for all sensors, be set in the function ´Hysteresis´ (see 9.5. and manual 6.2.7) within the range from 0 to 99 digits (standard setting is 10 digits).

Change hysteresis (0 to 99), see 5.5: **Hysteresis: 10**

10.8 Operating Parameters

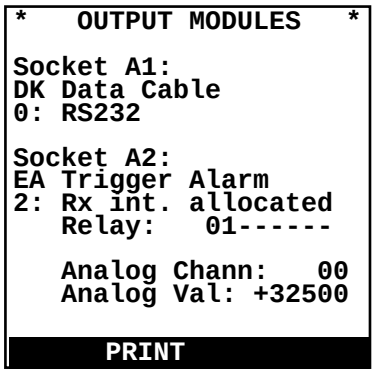
Some operating parameters are software options and can be user-configured with the function ´Config´ (see manual 6.10.13.2).

Mains frequency noise suppression 60Hz instead of 50Hz	**Config: F-------**
Clearing all measured values on start of a measurement	**Config: -C------**
Ring memory (overwriting of old data when full)	**Config: --R-----**
Year number output in date with 4-digits instead of 2-digits	**Config: ---D----**
Deactivating the alarm value/alarm printout	**Config: ----A---**
Switching off the signal transmitter	**Config: -----S--**
Date-time in Excel table format ´dd.mm.yy hh:mm:ss´	**Config: ------E-**

The ´Measuring channels´ function lists all channels; however, at input, additional channels can be masked out by setting the channel number of measuring circuit boards and selector switch boards.
Out of 40 or 36, respectively,
15 channels are activated: **Meas.Chann:40 active:15**
Sensor supply voltage 12.3V = mains operation: **SensorVoltage: 12.3 V**
Cold junction temperature = socket temperature: **CJ Temperature:25.4°C**

11. OUTPUT MODULES

The data logger ALMEMO® 5990-2 has two output sockets, A1 and A2, to allow an output of the measured values as analog or digital values or as alarm signals. Furthermore, it is possible to trigger various functions through trigger pulses. To suit all possibilities, while keeping the hardware requirements at a minimum, all necessary interfaces have been integrated into the ALMEMO® output connectors. The output modules, like the sensors, are automatically detected and displayed in the menu ´Output Modules´ so that, generally, no programming is required.



11.1 Data Cable

The serial interface can be used to output cyclic data logs, all function values of the measuring menus, as well as the whole programming of the sensors and the device to a printer or computer. The ALMEMO® data cables and the connection to the instruments are described in the manual section 5.2. Other modules for networking the instruments follow in the manual section 5.3.
All available interface modules are connected to the socket A1 on ES5990-N(7c), exception: network cables ZA1999NK to network a further instrum. are connected to A2.

Under the prevailing socket the menu indicates:	**Socket A1: DC DataCable**
Variant 0: Standard interface always active	**0: RS232**
Variant 1: Activation in case of addressing	**1: RS485**

11.2 Alarm processing, relays, and relay trigger cable

A data acquisition system is often used for monitoring,
i.e. to ensure, in the event of a specified limit being overshot / undershot, that the appropriate visual, acoustic, or electrical alarm is triggered. The 5990-2 offers a whole series of special functions, outputs, and external modules for precisely this purpose.

Alarm functions when a limit is overshot / undershot :

1. In the display an arrow SYMBOL flashes in front of the current measured value; (see Section 5.3).
2. With each subsequent alarm the integrated beeper outputs a short acoustic tone.
3. An arrow SYMBOL in front of a maximum or minimum value indicates that the maximum / minimum limit is being (or has already been) overshot / undershot. The date and time-of-day are also displayed in front of the maximum / minimum value concerned; (see Section 6.1.2).
4. The ALARM LED located on the front / rear of the unit lights up so long as any channel anywhere in the system is affected by an alarm status.
5. Internal relays R0 and R1 in slide-in unit ES 5990-N (7b) react as programmed; (see below). The resulting status of relay R0 / R1 is indicated in the status bar of the display.
6. Further alarm cables can be connected externally to the various measuring circuit boards and selector switch boards; these cables will only react to an alarm status on the channels of the slide-in unit in question. Socket A1 on the measuring circuit board (8) can be used to connect an alarm cable for each of the function variants (see below). Selector switch board ES 5590-MF (9) only supports limit value cable ZA-1000-GK2. Relay R0 energizes as soon as any maximum limit on this board is overshot; relay R1 energizes as soon as any minimum limit is undershot. On selector switch board ES-5590-MU these relays are integrated; they function in the same way.

As an alternative, socket A2 on slide-in unit ES-5990-N (7c) can be used to connect not only trigger alarm cable ZA-1000-EAK but also relay trigger adapter ZA-8000-RTA (see Manual, Section 5.1.2/3) incorporating a maximum of four mechanical switch contacts and two trigger inputs. Trigger inputs are also provided on trigger cables ZA-1000-ET/EK; (see Manual, Section 6.6.4).
External modules and internal relays can, if they are connected via socket A2, be programmed to function in various ways; (see Manual, Section 6.10.9).

However, only one functional mode is permitted at a time. The internal relays automatically assume the functional mode of the module connected. Interesting possibilities with relay modules are :
- variant 2 :
  assigning the relays to particular limit values and
- variant 8 :
  allowing the relays to be driven from the computer. The following table provides an overview of the programming options for the external modules :

Module	Type	No	Abbrev	Comment
Trigger cable	EK	0	EK0	Start/stop succession with pos. edge/contact
	EK	1	EK1	Single Measuring Point Scan
	EK	2	EK2	Clear Max/Min values
	EK	3	EK3	Print the function
	EK	4	EK4	Start/stop level-triggered
	NK	8	EK8	Setting the measured value to zero
Internal relays	GK	0	AK0	Relay R0 alarm from all channels
or	GK2	1	AK1	Relay R0 alarm Max, R1 alarm Min
Alarm cable	GK3	2	AK2	Relay Rx internally allocated (see 9.10.3)
	AK	8	AK8	Relay Rx externally triggered
Trigger alarm	EGK	0	EA0	Start/stop, relay R0 alarm from all channels
cables	EGK	1	EA1	Start/stop, relay R0 alarm Max, R1 alarm Min
	EGK	2	EA2	Start/stop, relay Rx internally allocated
	EAK	8	EA8	Start/stop, relay Rx externally triggered

To socket A2 is connected — **Socket A2:**
a limit value / alarm cable or only internal relays — **AK alarm cable**
programmed to variant 0 — **0: R0 all channels**
relay R0 is energized — **Relay: 0-------**

The functional mode can be programmed as per selection

by means of keys (see Section 5.5) — **PROG**, ▲ ... and **PROG**
programmed to variant 2. — **2: Rx assigned internally**

Alarm cable variant 2 ´Relays assigned internally´ also requires the assignment of relays to particular limit values (see Section 9.10.3) by activating maximum / minimum action in the special functions.

Variant 8 ´Relays driven externally´ makes it possible to manually control the relays via the keyboard or via the user interface; (see Manual, Sec. 6.10.10).

Limit value / alarm cable or only internal relays — **EA TriggerAlarm**
programmed to variant 8 — **8: Rx ext. triggered**
programming of relay states (see Section 5.5) — **Relay:** **0-------**

11.3 ANALOG OUTPUT

For analog acquisition of the selected measuring point either an analog output cable ZA 1601-RK (see manual 5.1.1) without electrical isolation or a relay trigger analog adapter ZA 8000-RTA (see manual 5.1.3) with electrically isolated analog output can be connected to the sockets A1 on measuring circuit boards.

Scaling

It is possible to spread any partial range to the standard output signal of the three available options 0-2V, 0-10V, 0/4-20mA if the partial range covers at least 100 digits (e.g. 0-20mA for +200.0 to +1000.0°C). To achieve this, the required measuring range must be entered by using the functions ´Analog Output Start´ and ´Analog Output End´ in the menu ´Special Functions´ (see 9.10.4).
These functions are also used to scale the line or bar chart.

Menu ´Special Functions´
Programming the analog output start: **AnalogStart: 0.0°C**
Programming the analog output end: **AnalogEnd: 100.0°C**

Selecting the Analog Channel

Usually, the measured value of the selected channel Mxx is output to the analog output. However, in case of a continuous measuring point scan a reference channel can be programmed allowing to define any channel for the analog output to socket A2. A second analog output to socket A1, simultaneously, outputs the measured value of the first channel of the selected sensor (see manual 6.10.7).

Analog output of the selected measuring channel Mxx: **AnalogChann: Mxx**
Analog output of the selected reference channel yy: **AnalogChann: yy**
Programmed analog output (see below): **AnalogChann: M--**

Programmed Analog Value Output

The analog value can also be programmed, manually or via interface, in a range from -12000...+20000 digits (see manual 6.10.7). Depending on the analog output the following output signals are available:

Voltage output	-1.2 ... +2.0 V	0.1mV/digit
Voltage output	-6.0 ... +10.0 V	0.5mV/digit
Current output	0.0 ...20.0 mA	1µA/digit

AnalogChann: M--
Output of 2.5V using the 10V output = 5000 digits: **AnalogVal: +05000**
switching back to the measuring channel by using the key: <**OFF**>
switching back to the previous programming value: <**ON**>

12. TROUBLESHOOTING

The data logger ALMEMO® 5990-2 can be configured and programmed in many different ways. It allows for a connection of many different sensors, additional measuring instruments, alarm signalisers and peripheral devices. Due to the large variety of options it is possible that, under certain conditions, it does not perform as the user would expect. In most cases this will not be related to a defective device but to operating errors such as wrong settings or an inadmissible wiring. The following tests should be performed to correct or to correctly identify the error.

Error: No display at all or faulty display, no key response.
Remedy: Check power supply, recharge battery, switch off and on again, reinitialise, if required (see 3.4).

Error: Incorrect measured values.
Remedy: Thoroughly check the entire programming of the channel (particularly base and zero point) (menu ´Sensor Programming´ and ´Special Functions´.

Error: Varying meas. values, segment test or blockage during operation.
Remedy: Check cabling for inadmissible electrical connection,
disconnect all suspicious sensors,
connect hand-held sensors and operate them in air or connect dummies (short circuit AB at thermocouples, 100 ohms at Pt100 sensors) and check,
then reconnect sensors successively and check.
If an error occurs with one sensor, check the wiring, isolate the sensor if necessary, prevent influences from disturbances by shielding or twisting.

Error: Data transmission via interface does not function.
Remedy: Check interface module, connections and setting:
Are both devices set to the same baud rate and transmission mode (see 10.3)?
Is the correct COM interface addressed at the computer?
Is a printer in ONLINE mode?
Are the handshake lines DTR and DSR active?

A small interface tester with LEDs is very useful for checking the data flow and the handshake lines (during standby mode the data lines TXD and RXD are on a negative potential of approximately -9V and the diodes are illuminated green. The handshake lines DSR, DTR, RTS and CTS have a positive voltage of approximately +9V and the LEDs are illuminated red. During the data transmission the data lines must flash red).

Test the data transmission by using a terminal (AMR-Control, WIN-Control, DATA-Control, WINDOWS Terminal):
Select output channel interface U by using the command ´A1´.
Address the device with its device number ´Gxy´ (see manual 6.2.1),
if the computer is in XOFF state, enter <Strg Q> for XON,
query the programming through ´P15´ (see manual 6.2.3).
Only check the sending line by cycle input via command Z123456 and control in the display.
Test the receiving line with the key <PRINT> and by monitor control.

Error: Data transmission within the network does not function.

Remedy: Check that all devices are set to different addresses,
address all devices individually via terminal and command ´Gxy´,
addressed device is OK when the feedback is at least ´y CR LF´.
If data transmission is still not possible, disconnect networked devices, check all devices separately using the data cable of the computer (see above), check the wiring regarding short circuit or twisting.
Are all network distributors supplied with power?
Network and check the devices successively again (see above).

If the device is, after the above inspections, still not performing as specified in the operating instructions, it must be sent to the factory in Holzkirchen, Germany, including a short report and, possibly, control printout. The AMR-Control program incorporates its own test function in the device list for this purpose, making it possible to save and to print out screen-shots and terminal operations.

ELECTROMAGNETIC COMPATIBILITY

The data logger ALMEMO® 5990-2 meets the essential electromagnetic compatibility (EMC) safety requirements specified in the relevant CE directive issued by the council for the alignment of legal regulations of the member states (89/336/EWG).

The following standards have been applied for the evaluation of the product:

EN 61326:1997/A1:1998 IEC 61000-3-2:1995, IEC 61000-4-2:1995 8kV
IEC 61000-4-3:1995 3V/m, IEC 61000-4-4:1995 1kV

The following notes must be observed when operating the instrument:

1. If the standard sensor cables (1.5m) are extended it must be considered that the measuring lines are not guided together with power mains and that they are appropriately shielded to protect against any coupling of disturbance signals.
2. If the instrument is operated within strong electromagnetic fields an additional measuring error must be expected (<50µV at 3V/m and 1.5m thermocouple transducers). After the irradiation the device operates again within the specified technical data.

Technical Data (see also section 2.2 in ALMEMO® Manual)

Housing Dimensions:

19" desktop housing 32DU:	W 179 x H 158 x D 232 mm, 6 plug-in slots
19" desktop housing 84DU:	W 468 x H 167 x D 240 mm, 19 plug-in slots
19" sub rack 84DU:	W 483 x H 132.5 x D 273 mm, 19 plug-in slots
Operating/storage temperature:	-10 ... +60 °C / -30 ... +60 °C
Humidity of ambient air:	10 ... 90 % rH (non-condensing)

Equipment:

Display:	graphics128x128 dots, 16 lines, 21 characters 4mm
Operation:	7 keys (4 soft keys) and rotary knob
Memory:	500 kB (100000 meas.val.) buffered with NiCd batt.
Time and date:	real time clock buffered with NiCd battery
Microprocessors:	HD 6303 Y, uPD 78F0034

Measuring Inputs:

Active Meas. Circ. Bd. ES 5590-G2	10 ALMEMO® sockets for flat connector 10 chann. electr. isol., 30 add. chann., 2 slots
Active Meas. Circ. Bd. ES 5590-G3	10 inputs through 10-fold MU connector 10 chann. electr. isol., 1 plug-in slot
A/D converter:	Delta-Sigma 24bit, 2.5, 10, 50 measure per s
Sensor Voltage Supply:	mains adapter: approx. 12V, max. 100mA recharg. battery: 7...9V, max. 100mA
Selector Switch Boards ES5590-MF	10 ALMEMO® sockets for flat connector 10 chann. electr. isol., 30 add. chann., 2 slots
Selector Switch Boards ES5590-MU	10 inputs through 10-fold MU connector 10 chann. electr. isol., 1 plug-in slot

Outputs:	**ES5990-N**	**ES5590-G2/MF**	**ES5590-MU**	**ES5590-G0**
Analog output:	-	A1 (only G2)	-	A1, option Rx
Limit value signals:	2 opto relays Max and Min	A1	2 opto relays Max and Min	2 opto relays Max and Min
Relay capacity:	peak voltage 50VDC or AC, 300mA			

Voltage Supply:	7 to 13V DC not electrically isolated
Mains adapter:	ZB 5090-NA3 100 ... 260V AC to 12V DC, 2.0A
Option U:	10 to 30V DC to 12V, 1A electrically isolated
Option A:	NiCd battery: 7.2 V, 1.5 Ah recharge time: approx. 2h quick and trickle charge

Current consumption:

Plug-in module ES5590-G0/G2/G3:	approx. 30 mA without I/O modules
Plug-in module ES5590-MF:	approx. 20 mA without I/O modules
Plug-in module ES5590-MU:	approx. 2 mA

Extent of the delivery: Meas.instr. ALMEMO 5990-2, mains adapter ZB 5090-NA3
Operating Instructions ALMEMO 5590-2
ALMEMO® Manual with software AMR-Control

Product Overview

	Order No.
Data Acquisition System ALMEMO® 5990-2	
LCD-graphic display, 7 keys, rotary knob, real time clock Cascadable serial interface, memory 500kB (100 000 meas. values), Plug-in place für smart media memorycard 2 output relays, mains adapter 12V/2A	
19" desktop housing 24 DU, 6 free plug-in slots	MA 5990-2TG3
19" desktop housing 84 DU, 18 free plug-in slots	MA 5990-2TG8
19" sub rack 84 DU, 19 free plug-in slots	MA 5990-2BT8
Option A rech. battery 7.2V, 1.6Ah with 2h quick charge	OA 5990-A
Option U voltage supply 10 to 30V DC electrically isolated	OA 5990-U
Option S2 memory 2 MB (400000 meas. values), real time clock	OA 5590-S2
Option Master Meas. Circuit Board G2 with 10 electrically isolated inputs for**:** ALMEMO® flat connector, 10 to 40 meas. channels, output socket for alarm cable, analog output, space requirement 2 plug-in slots	OA 5990-G2Q
Option Master Meas. Circuit Board G3 with 10 electrically isolated inputs, sensor connection via 64-pin spring contact strip and ALMEMO® 10-fold MU connector, 10 meas. chann. without power supply, space requirement 1 plug-in slots	OA 5990-G3Q
Selector Switch Board with 10 electrically isolated inputs for**:** ALMEMO® flat connector, 10 to 40 meas. channels, output socket for alarm cable, max. 8 carts, space requirement 2 plug-in slots	ES 5590-MF
Selector Switch Board with 10 electrically isolated inputs, sensor connection via 64-pin spring contact strip and ALMEMO® 10-fold MU connector, 10 meas. chann. without power supply(no frequ./double sensors), alarm contacts Max and Min, 8 boards at max., 1 plug-in slot	ES 5590-MU
ALMEMO®10-Fold MU Connector for OA5590-G3 or ES5590-MU for the connection of 10 sensors and 2 alarm devices	ZA 5590-MU
usable only about interface: **Relay output card** 6 photovoltaik-relays center-zero 50V/0.1A	ES 8000RTA2H
Smart-Media-Memorycard 8MB (up to 1.600.000 meas. values)	ZB 1904-SC8
Reader for Smart-Media-Memorycard, max. 115.2 kBd	ZA 1409-SLG
ALMEMO® Recording Cable no electr. isol. (-1.25...2.0V, 0.1mV/Digit)	ZA 1601-RK
ALMEMO® V24 Data Cable, electr. isolated, max. 115.2 kBd, 1mA	ZA 1909-DK5
ALMEMO® V24 Fiber Optic Data Cable, max. 115.2 kBd, 4mA	ZA 1909-DKL
ALMEMO® Network Cable current loop, electr. isolated	ZA 1999-NK
ALMEMO® Trigger Cable with optocoupler input 4..30V/key	ZA 1000-EK/T
ALMEMO® I/O Cable for Triggering and Limit Value Alarm	ZA 1000-EGK
ALMEMO® Relay Trigger Analog Adapter (4 relays, 2 trigger inputs)	ZA 8000-RTA
Option R1, R2, R3: electr. isol. analog output 2V, 10V or 20mA	OA 8000-Rx

Keyword Index