6. Operation via Serial Interface

The serial interface allows for the output of all measured values (either as single values or, automatically, all values), for the entire programming of the device and the sensor connector, and for querying the programmed values. The commands can be sent via terminal, data communication software or via programming language. They always consist of one letter, possibly a minus sign, and 0 to 6 numbers. Only data and commands that provide the specified format will be accepted by the measuring instrument and will be returned to the communication device. A command already in progress will be interrupted as soon as a new command is entered. Incorrect entries display an "ERROR" message. A line feed is automatically appended to each command and output. In this manual command sequences will be separated by space characters but they should not be entered.

6.1. Operation via the AMR-Control software

ALMEMO® V5 devices can be very easily programmed and operated using the AMR-Control software; this runs under all WINDOWS® versions as of WINDOWS 95. This software lists all device parameters and sensor parameters in a clear and understandable display; these parameters can also be modified.
With this software it is also possible to acquire and record measured data online, to read out from data logger memories, and to save measured data in files.
For the purposes of operating all Ahlborn equipment online (also devices older than V5) an additional terminal is incorporated.

6.1.1 Configuration of the AMR-Control interface

Start the AMR-Control program.
In the input distributor select “Main menu”.
Click on the menu "Setup" and then on the menu item "Interface".
Select the COM port to which the measuring instrument is connected.
Under "Baud rate" select the baud rate programmed in the ALMEMO® data cable.
Complete configuration by pressing "OK".
This configuration is now saved and can be used the next time AMR-Control is started.

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6.1.2 Programming and reading out the memory via menus

(only for ALMEMO® devices in version 5 and above)
Via the menus "Device", "Measuring points", and "Output modules" all the ALMEMO® functions can be easily and conveniently programmed. In the menu "Measuring points", under the menu item "Measured values", current measured values can be read in and further processed. In the menu "Devices", under the menu item "Measured value memory", previously saved measured values can be read out.

6.1.3 Operating via a terminal (for all Ahlborn devices)

AMR-Control incorporates a terminal via which all Ahlborn devices (even those older than V5) can be operated by means of interface commands and via which the outputs from the measuring instrument can be displayed on the screen.
This function can be accessed in the AMR-Control program by clicking on the menu "File" and then selecting the menu item "Terminal". The terminal window should then open.
You can display a list of all available commands by clicking on the menu "File" and selecting the menu item "Command list". Commands can be entered in the terminal window using the keyboard. To facilitate operation various command keys are already programmed; (the interface commands and key labeling can be modified at any time as and when required).
All data transferred to the terminal, e.g. the contents of the data logger memory, can be saved by means of the following steps - also in file form :
In the terminal window click on the menu "File" and then select the menu item "Open".
In the window "Save terminal log as :" enter an appropriate file name and then complete the action by selecting "Save". All data shown on the terminal screen is now saved in the file thus named.
If memory content is to be read out e.g. in table format (e.g. for MS-EXCEL), then :

1. click in the terminal window on the command button "Table format" (N2);
2. click on the command button "Save" (P04);
3. wait until all data (visible on the screen) has been transferred.

To terminate the saving procedure, click in the terminal window on the menu "File" and then on the menu item "Close".
To terminate the terminal program click on the menu "File" and then "Exit".

6.1.4 Reading a file into a spreadsheet program

Start the spreadsheet program, e.g. MS-EXCEL.
Click on the menu "File" and then select the menu item "Open".
Select the saved TXT file.
In MS-EXCEL the "Text import wizard" should appear.
Select the file type "Delimited" and then click on "Next".
Set the delimiter to "Semi-colon" and Text recognition " and then click on "Next".
Select "General" as the data format and then click on "Finish".
Date, time-of-day, and the measuring points should now be arranged in separate columns.
The row above the measured data can be used as legend.

6.2. Device Programming

The following section describes how to operate any ALMEMO® device via the serial interface, e.g. using a terminal (see Section 6.1.3).

6.2.1 Selecting a Measuring Instrument

In a network the measuring instrument having the address 00 is active after switch-on and only the device having the address 00, if it exists, responds to data output commands. The selection of another device can be performed with the command Gxx.

Command	G01
Response Device No. 00	G0
Response Device No. 01	1

6.2.3 Output of the Programming

An overview of **the entire setup of a device** and the connected sensors can most easily be obtained by an output of the programming using the command P15:

Entry P15

Acknowledgement

Print header

```
AMR ALMEMO 8990-8  MODULE:01
```

Header
```
CH RANGE  LIM-MAX  LIM-MIN  OFFSET  D FACTOR EXP AVG.
COMMENT
```

Sensor Program
```
01:Ntc  +035.00  - - -   - - - °C 1.0350 E+0  - - - T EXT
02:NiCr  - - -  +0018.0  - - - °C - - -  E+0  - - - T INT
11:°o H  - - -   - - -   - - - %H - - -  E+0  - - - HUMIDITY
```

Cycles
```
MEAS. CYCLE: 00:00:00 S  S0500.3 F0104.7 A   W010 C-SU-
PRINT CYCLE: 00:00:00 Un 9600 bd
```

After a line feed the print header provides the device designation. The designation can be set by the user (see 6.2.4). For device addresses that are higher than 00, the corresponding module number follows. The next lines provide, after a headline, important parameters of connected sensors, including the active measuring channels. The line MEAS. CYCLE provides information regarding the measuring cycle including the memory activation (S) and, with data loggers, the available data memory (S...) and free memory space (F...) in kB. Then, the conversion rate setting and switch for the continuous scan follows. The line PRINT CYCLE provides the output channel, the output format and the selected baud rate.

6.2.4 Individual Print Header / Device Designation

The serial interface can be used to program an individual print header with a maximum of 40 characters. This text appears in the program header instead of the type designation "AMR ALMEMO TYPE-X". The print header can be used as a device identification if several devices are networked.

Programming	Entry	Acknowledgement
Enter Print Header	`f4 $ABC Test Field CR`	
Delete Print Header	`f4 $ CR`	
Print Header Output	`f1 t0`	`ABC Test Field`
Output of Programming	`P15`	

Output:

```
ABC Test Field
CH RANGE  LIM-MAX  LIM-MIN  OFFSET  D FACTOR EXP AVG. COMMENT
01:Ntc  +035.00  - - -   - - - °C 1.0350 E+0  - - - T EXT
02:NiCr  - - -  +0018.0  - - - °C - - -  E+0  - - - T INT
05:°o H  - - -   - - -   - - - %H - - -  E+0  - - - HUMIDITY
MEAS. CYCLE: 00:00:30 S  S0500.3 F0130.4 AR  W010 C-SU-
PRINT CYCLE: 00:01:30 U  9600 bd
```

6.2.5 Output of the Device Configuration

An overview over the current device configuration, settings and output modules can be obtained by using the command P19:

Entry `P19`

Ackn. `DEVICE: G00 M20 A08 P10/20/00` Address, channels possible, active, primary

`A.PRESSURE:`	`+01013. mb`	Atmospheric pressure see 6.2.6
`CJ-TEMP:`	`+0023.5 °C`	Cold junction temperature
`U-SENSOR:`	`!  12.5 V`	LoBat and sensor voltage
`HYSTERESIS:`	`10`	Hysteresis see 6.2.7
`CONFIG:`	`FCRDAS-- -L-- B01`	Configuration see 6.10.13
`ALARM:`	`-1-3`	Alarm state of the relays 0,1,2,3
`A1:`	`DK0 Un`	Output module on A1
`A2:`	`AA`	Output module on A2

The line `DEVICE:` provides the device address `Gxx` as well as the number of possible measuring channels (`Mxx`), the number of currently active measuring channels (`Axx`) and, with data acquisition systems, the configuration (`pp/mm/uu:mm/uu/10!uu/` where, `pp` = number of primary channels, `mm` = channels of the measuring circuit, board, `uu` = channels of the selector switch board ES5590-MF. Now after the colon the measuring points of all plug-in boards are listed again. Plug-in units with 10x MU connector are represented by 10!).
The line `A.PRESSURE:` indicates either the programmed or the measured atmospheric pressure for compensation of corresponding sensors (see 6.2.6, 6.7.2). The line `CJ-TEMP:` indicates the cold junction temperature for

thermocouples. The line `U-SENSOR:` provides the current sensor voltage. If the current has reached less than 6.8V an exclamation mark "!" precedes the data and, with most devices, the LOBAT state is correspondingly signalised.
The programming of some operating parameters (mains frequency, clear mode, ring memory, presentation of the year data) can be found in line `Config:` (see 6.10.13). It is possible that this is followed by the reference channel analogue output and analogue value (see 6.10.7).
Following the term `Alarm:` the switching status of the output relays 0, 1, 2, 3 (- = OFF, 0,1,2,3 = ON) of corresponding cables or adapters (ZA 1000-AK or -GK, ZA 8000-RTA) are displayed.
The lines A1 and A2 provide information of which output modules are connected to the corresponding sockets (DK0=interface cable RS232, DK1=RS485 network branch box, AA=analogue output, EKx=trigger cable, AKx=output relay cable, EAx=trigger relay cable, PS=programming connector). Some cables provide special functions that can be identified by a subsequent number and can be modified (see 6.10.9).

6.2.6 Atmospheric pressure compensation and temperature compensation

Some measurable variables depend on the ambient atmospheric pressure (see 6.3.3 list of measuring ranges ´with PC´) so that a large deviation from the normal pressure of 1013 bar leads to a corresponding error of the measurement:

e.g. error per 100 mbar:		**compensation range:**
Rel. humidity psychrometer	approx. 2%	500 to 1500 mbar
Mixture ratio, capacitive	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

The atmospheric pressure should be considered particularly when the device is used in a corresponding mean sea level (approx. -11mbar/100m above mean sea level). It can be programmed or can be automatically measured through a sensor.

Function	**Entry**	
Enter atmospheric pressure in mbar	`g xxxxx`	
e.g. 1013 mbar	`g 01013`	
Atmospheric pressure, output in mbar	`P43 (P19)`	`Atm pressure +01013. mb`

For measuring the atmospheric pressure an atmospheric pressure sensor (e.g. FD A612-MA) is defined as a reference value by programming the comment to ´*P´ (see 6.7.2). For automatic scans the atmospheric pressure sensor must precede the humidity sensors in the sequence of measuring points.

Function	**Entry**
Define atm. pressure sensor as reference	`f2 $*P CR`

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Temperature compensation
Sensors whose measured values depend heavily on the **temperature** of the measuring medium usually incorporate their own temperature sensor; such devices perform temperature compensation automatically; (see Section 6.3.3, Measuring range list, “with TC”). However, dynamic pressure probes and pH probes are also available without their own temperature sensor. If the temperature of the medium deviates from 25 °C the following measuring errors may occur :

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

Compensation can also be performed either via the reference channel using external temperature sensors or by entering the compensation temperature (for V6, 2590-9, 5990-2 only) :

Function	**Command**
Enter compensation temperature (steps of 0.1°C)	f1 gxxxxx (f1 g02500 = 250.0 °C)

6.2.7 Hysteresis

In case of limiting values being exceeded the alarm condition remains active until the measured value has fallen (by the hysteresis, i.e. usually 10 digits) below the limiting value to avoid a fluctuation of the relays at the switch point. Depending on the measuring range, it can be useful to adjust the hysteresis accordingly. Therefore, the hysteresis can be programmed in a range from 00 to 99 digits:

Function	**Entry**	
Enter hysteresis in digits	Y xx	
Output hysteresis	P19	HYSTERESIS: 10

6.2.8 Time and Date

Each ALMEMO® device has an integrated clock that can be set to real time and date for recording the measuring time. However, only the data loggers keep a battery-backup of the time after a switch-off. With all other devices, after a switch-on the clock is set to 00:00:00 and starts the count from the first measuring point scan. The output of the year data can also be set to four digits (see 6.10.13).

Date			
program	dttmmjj		
clear	C13		
output	P13	DATE:	01.02.97
or		DATE:	01.02.1997
Time	**Entry**	**Acknowledgement**	
program	Uhhmmss		
stop and zero	C10		
output	P10	TIME:	12:34:00
Output measuring time since start	P46	MEASURING TIME 01:23:45.67	

6.2.9 Keyboard Locking

To protect all settings from unauthorised modification during a measurement , some devices (ALMEMO® 2290-8, 3290-8, 8990-8) provide, in addition to sensor locking (see 6.3.12), a password protected lock-code of the programming and process control. The lock can only be released by re-entering the same lock-code or by a new initialisation.

Function	**Entry**	**Acknowledgement**
Switch-on locking	`cxxxx`	`LOCKING ON`
Switch-off locking	`cxxxx`	`LOCKING OFF`
incorrect password	`cxyzx`	`LOCKING ERROR`

6.3. Sensor Programming

Unlike conventional measuring instruments all sensor parameters in instruments with an ALMEMO® connector system are stored in an EEPROM within the connector plug, but not in the measuring instrument. With all pre-assembled and factory-programmed connectors the measuring range and dimension is already stored in the connector and further programming is usually not required.
Only a few types of the 10-fold connectors ZA 5590-MU are available for 10 identical sensors, although each measuring point can be easily and individually programmed with all parameters listed here.
When programming correction values, scalings or limiting values, note that all factory-programmed parameters have been protected against unintended modifications by means of a locking mode. The locking level must first be reduced (see 6.3.12) before desired modifications can be performed. All parameters can be easily entered or changed if the corresponding sensor connector is connected.

V6: The capacity of the memory connector has been doubled to 4 KB (code E4). The new V6 devices thus support multi-point calibration, user-defined linea-rization, or connectors with special measuring ranges; (option KL is necessary for programming).

6.3.1 Selecting the Input Channel

The input channel allows for a programming of measuring points and an output of measured values or program parameters without affecting the selected measuring channel. If a measuring point or an input channel has been specified all subsequent operations are related to that channel.

Function	**Entry**
Select input channel 2	`E02`

6.3.2 Output of the Programming

An overview of the programming of a selected channel is provided by entering the command P00. This, similar to performing the output of the entire programming by command P15 (see 6.2.3), leads to an output of the measuring point, range, limiting value Max, limiting value Min, base value, dimension, factor, averaging mode and measuring point designation.

Entry: `P00`

Acknowledgement: `1:NiCr +0100.0 -0020.0 +0000.0°C 1.0000 E-1 - - - Design.`

See section 6.10.1 for information on how to obtain data regarding the remaining special parameters of a measuring point.

6.3.3 Selecting the Measuring Range

A connector that has been programmed with measuring range and dimension is available for each sensor. Note the special connector type of some sensors (thermo, shunt, divider, frequency etc.) that must be considered if you want to program the connectors personally or if the measuring range is often changed. The sensor must be connected during programming as all sensor parameters are stored in the connector.

Application		Connection	Entry	Print	Dim
Pt100-1 4-conductor ITS 90	-200.. 850°C	ZA 9000-FS	B01	P104	°C
Pt100-2 4-conductor ITS 90	-200.. 400°C / 300°C	ZA 9000-FS	B03	P204	°C
Pt100-3 4-conductor ITS 90	0.. 65.000°C	ZA 9000-FS	B00	P304	°C
Pt1000-1 4 with Element flag 1	-200.. 850°C	ZA 9000-FS	B01	P104	°C
Pt1000-2 4 with Element flag 1	-200.. 400°C / 300°C	ZA 9000-FS	B03	P204	°C
Ni100 4-conductor	-60.. 240°C	ZA 9000-FS	B63	N104	°C
Ni100 4-cond. with Element flag 1	-60.. 240°C	ZA 9000-FS	B63	N104	°C
NiCr-Ni (K) ITS 90	-200..1370°C	ZA 9020-FS	B04	NiCr	°C
NiCrSil-NiSil (N) ITS 90	-200..1300°C	ZA 9020-FS	B34	NiSi	°C
Fe-CuNi (L)	-200.. 900°C	ZA 9000-FSL	B05	FeCo	°C
Fe-CuNi (J) ITS 90	-200..1000°C	ZA 9000-FSJ	B35	IrCo	°C
Cu-CuNi (U)	-200.. 600°C	ZA 9000-FS	B06	CuCo	°C
Cu-CuNi (T) ITS 90	-200.. 400°C	ZA 9000-FST	B36	CoCo	°C
PtRh10-Pt (S) ITS 90	0..1760°C	ZA 9000-FS	B07	Pt10	°C
PtRh13-Pt (R) ITS 90	0..1760°C	ZA 9000-FS	B37	Pt13	°C
PtRh30-PtRh6 (B) ITS 90	+400..1800°C	ZA 9000-FS	B08	El18	°C
AuFe-Cr	-270.. 60°C	ZA 9000-FS	B38	AuFe	°C
Ntc type N	-50..125°C	ZA 9000-FS	B09	Ntc	°C
Millivolt	-10..55mV	ZA 9000-FS	B10	mV	mV
Millivolt 1	-26..26mV	ZA 9000-FS	B27	mV 1	mV
Millivolt 2	-260..260mV	ZA 9000-FS	B28	mV 2	mV
Volt	-2.6..2.6V / -2.0..2.5V*	ZA 9000-FS	B11	Volt	V
Differential-Millivolt	-10..55mV	ZA 9000-FS	B50	D 55	mV
Differential-Millivolt 1	-26..26mV	ZA 9000-FS	B51	D 26	mV
Differential-Millivolt 2	-260..260mV	ZA 9000-FS	B52	D260	mV
Differential-Volt	-2.6..2.6V / -2.0..2.5V*	ZA 9000-FS	B53	D2.6	V

Application		Connection	Entry	Print	Dim
Milliampere	-32..32mA /-26..26mA*	ZA 9601-FS	B12	mA	mA
Percent	4-20 mA	ZA 9601-FS	B13	%	%
Battery	0..25V	ZA 9000-FS	B14	Batt	V
Ohm	500Ω	ZA 9000-FS	B15	Ohm	Ω
Frequency	0..15000	ZA 9909-AK	B29	Freq	Hz
Pulses	0..65000	ZA 9909-AK	B54	Puls	
Digital interface	-65000..+65000	ZA 9919-AKx	B55	DIGI	
Digital input	0..100%	ZA 9000-EK2	B70	Inp	%
Infrared 1	0...200°C	ZA 9000-FS	B17	Ir 1	°C
Infrared 4	-30..100°C	ZA 9000-FS	B61	Ir 4	°C
Infrared 6	0...500°C	ZA 9000-FS	B62	Ir 6	°C
Rotating vane, normal	0.3..20m/s	ZA 9915-AK	B30	S120	ms
Rotating vane, normal	0.4..40m/s	ZA 9915-AK	B31	S140	ms
Rotating vane, micro	0.5..20m/s	ZA 9915-AK	B32	S220	ms
Rotating vane, micro	0.6..40m/s	ZA 9915-AK	B33	S240	ms
Rotating vane, macro	0.1..20m/s	ZA 9915-AK	B24	L420	ms
Water turbine, micro	0...5m/s	ZA 9915-AK	B25	L605	ms
Dyn. pressure sens. 40 m/s	0.5..40m/s	ZA 9612-AK	B40	L840	ms
Dyn. pressure sens. 90 m/s	0..90m/s	ZA 9612-AK	B41	L890	ms
Rel. humidity cap.	0..100%	ZA 9000-FS	B16	% rH	%H
Rel. humidity cap. with TC	0..100%	FH A646-C	B42	HcrH	%H
Rel. humidity cap. with TC	0..100%	FH A646-R	B56	H rH	%H
Humid temperature	-30..125°C	FN A846	B45	P HT	°C
Conductivity with TC	0..20mS	FY A641-LF	B60	LF	mS
CO_2 concentration	0..2.5%	FY A600-C02	B64	C02	%
O_2 saturation with TC, PC	0..260%	FY A640-O2	B65	02-S	%
O_2 concentration with TC	0..40mg/l	FY A640-O2	B66	02-C	mg
Function channels					
Abs. humidity cap. with PC	0..500g/kg	FH A646	B43	H AH	%H
Dew point cap.	-25..100°C	FH A646	B44	H DT	°C
Vapour pressure cap.	0..1050mbar	FH A646	B59	H VP	mb
Enthalpy cap. with PC	0..400kJ/kg	FH A646	B58	H En	kJ
Rel. humidity psychr. PC	0..100%	FN A846	B46	P RH	%H
Abs. humidity psychr. PC	0..500g/kg	FN A846	B47	P AH	%H
Dew point psychr. PC	-25..100°C	FN A846	B48	P DT	°C
Vapout pressure psychr. PC	0..1050mbar	FN A846	B49	P VP	mb
Enthalpy psychr. PC	0..400kJ/kg	FN A846	B57	P En	kJ
Difference	(Mb1-Mb2)	any	B71	Diff	f(Mb1)
Maximum value	(Mb1)	any	B72	Max	f(Mb1)
Minimum value	(Mb1)	any	B73	Min	f(Mb1)
Average value over time	(Mb1)	any	B74	M(t)	f(Mb1)
Average value over junctions	(Mb2..Mb1)	any	B75	M(n)	f(Mb1)
Sum over junctions	(Mb2..Mb1)	any	B76	S(n)	f(Mb1)
Total number of pulses	(Mb1)	ZA 9909-AK2	B77	S(t)	
Pulses/print cycle	(Mb1)	ZA 9909-AK2	B78	S(P)	

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Application		Connection	Entry	Print	Dim
Thermal coefficient	MW(q)/MW(M01-M00)	ZA 9000-FS	B79	q/dt	Wm
Wet bulb globe temp.	0.1TT+0.7HT+0.2GT	ZA 9000-FS	B02	WBGT	°C
Alarm value	(Mb1)	any	B80	Alrm	%
Measured value *	(Mb1)	any	B81	Mess	f(Mb1)
Cold junction temperature *		any	B82	CJ	°C
Number of averaged values*	(Mb1)	any	B83	n(t)	
Volume flow in m3/h *	MW(Mb1) * Q	any	B84	Flow	mh
Timer	0 ... 60000/6000.0s	any	B85	Flow	s

TC = Temperature Compensation, PC = Atmospheric Pressure Compensation, b1/b2 reference channels
* Measuring range depends on device type and version.

Clearing the measuring range	**Entry**
A programmed measuring channel is deactivated and is no longer included in measuring point scans.	C00

6.3.4 Function Channels

Measuring points can be programmed with arithmetic functions in order to provide the current measured values of the sensors in the output of the measurement record on a printer or computer, and also provide calculated data such as humidity variables, maximum, minimum, average values or differences of certain channels. All programming values such as the limiting value, base value and dimension change and maximum, minimum, averaging and storage of measured values are applicable to the function channels. Updating measured values is performed at each measuring point scan. The sequence of the measuring channels should be considered because measured values that are required as input data for a function should first be acquired.

Selecting the Arithmetic Function

The arithmetic function is, like a measuring range, programmed to the 2nd (Mxx_2), 3rd (Mxx_3)or 4th (Mxx_4) channels of a sensor connector using the function APPLICATION. The locking of the 1st channel must be deactivated for this purpose.

Reference Measuring Points

The arithmetic function is usually related to the 1st channel of the corresponding sensor connector Mxx_1.(reference channel b1) The calculation of the difference is performed between the 1st channel of the sensor connector and (reference channel b1) the measuring point M00 (reference channel b2). With average value and sum over n measuring points, M00 to Mxx_1 will be considered. The determination of the wet bulb globe temperature or of the temperature coefficient requires a particular sensor configuration (see 3.1.4 and 3.2).

However, the reference channels Mb1, Mb2 can also be directly programmed, i.e. either absolute and related to a measuring channel Mb1 or relative to the arithmetics channel (e.g. `f1 E-01` refers to the previous channel):

Programming	Entry
First select the arithmetic channel	`Exx`
program the arithmetic function	`Bxx`
Set reference channel 1 Mb1, absolute	`f1 E b1`
Set reference channel 1 Mb1, relative	`f1 E-b1`
Clear reference channel 1 Mb1	`f1 E-00`
Set reference channel 2 Mb2, absolute	`f2 E b2`
Set reference channel 2 Mb2, relative	`f2 E-b2`
Clear reference channel 2 Mb2	`f2 E-00`

The reference measuring point Mb1 also allows to allocate a temperature sensor for temperature compensation to pH sensors or sensors for dynamic pressure.
Temperature sensor at pH: Ntc or Pt100 with 0,01°C, at dynamic pressure:NiCr-Ni with 0,1 °C!

6.3.5 Change of Dimension

Two upper or lower case letters and the special characters [,], %, Ω, ° , -, =, ~ can be used as a dimension.

Programming	Entry
Set input channel	`Exx`
Program dimension ´xy´	`f1 $xy CR`

Conversion of Dimensions

°F	By programming the dimension °F a temperature will be automatically converted from °C into °F (°F = °C x 9/5 + 32).
K	For a conversion of °C into absolute temperature K a base value of -273.15 must be entered.
FM	For a conversion of a flow speed from m/s with 2 decimal digits into feet per minute (fpm = m/s x 3.281 x 60) a factor of 1.9686 with exponent +2 must be programmed.
	Switch-off of the cold junction compensation at thermocouples
□C	Dimension at input about the piece of device
!C	Dimension at input about terminal.

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6.3.6 Measuring Point Designation

It is possible to enter a measuring point designation of up to 10 characters via serial interface for identification of the channels. This designation appears in the program header and as a comment following the measuring range designation at measuring point scans.
Set input channel with command Mxx or Exx.

Function	Entry
Enter measuring point designation	`f2 $e.g. Room1 CR`

There are a few abbreviations in the first two characters of the comments that initiate special sensor functions. These must be retained intact but the remaining eight characters can still be used freely :

*J This denotes a temperature sensor used for external cold junction compensation (see Section 6.7.3).

#J This denotes a thermocouple with its own temperature sensor used for cold junction compensation via the reference channel (see Section 6.7.3).

*P This denotes an air pressure sensor used for atmospheric pressure compensation (see Section 6.2.6).

6.3.7 Averaging Mode

The averaging of measured values acquired from measuring point scans can be programmed for each measuring point. Depending on the programming, an averaging over single measurements, over the entire measuring time, or over a print cycle is possible (see 6.7.4). To be able to save average values or provide them as output via interface it is necessary to program corresponding function channels M(t) (see 6.3.4). If the average value is only required instead of the measured value, the output function M(t) (see 6.10.4) can be programmed. The type of averaging is determined by the averaging mode.

Averaging	Printout	Entry
no averaging	- - -	m0
Average value, continuously	CONT	m1
Average value, over print cycle	CYCL	m2
Average value, start to stop *	STSTOP	m5
Average value, over single measurements *	SINGLE	m6

* Only with ALMEMO® hand-held devices 2290-2/3/8, 2295-6

V6: On new devices averaging start / stop and single measuring operations can also be performed by means of averaging mode “CONT”.

6.3.8 Enter Programming Values

Programming values are entered with the command letter either being followed by a decimal point and RETURN, or by a five-digit number with preceding zeros and decimal digits but without decimal point. Finally, the position of the decimal point results from the measuring range and, possibly, a decimal point shifting. The input of a sign is only necessary with negative programming values.

Example:	Limit. Val. Max.	+100.0 °C	H100 CR	or	H01000
	Factor	1.035	F1.035 CR	or	F10350

6.3.9 Limiting Values

Two limiting values (MAX and MIN) can be programmed for each measuring channel. Similar to measuring range limits being exceeded or sensor breakage, the exceeding of limiting values is handled as an error. At an automatic measuring point scan, faulty measuring channels will be provided as an output to the interface in the measuring cycle.

A suitable output cable ZA 1000-GK with a semiconductor relay, or the relay adapter ZA 8000-RTA can be connected to the output socket A2 (see 5.1.2/3) for activating an alarm circuit. The alarm relay will be closed if one of the measuring channels is faulty. The fault is only rectified when all measured values have fallen below the limiting value by 10 digits (hysteresis). The hysteresis can be modified if necessary (see 6.2.7). A selective allocation of relays to limiting values is described in section 6.10.8.

Function	**Entry**	**Acknowledgement**
Set channel	Exx	
Limiting value Max (Hi)		
Program		H-xxxxx
Clear		C08
Output	P08	LIM.VAL. MAX: 01: +0050.0 °C
Limiting value Min (Lo)		
Program		L-xxxxx
Clear		C09
Output	P09	LIM.VAL. MIN: 01: +0010.0 °C

6.3.10 Correction Values

By means of the correction values ZERO POINT and SLOPE each measured value can be corrected with regard to zero point and slope and then scaled by means of BASE VALUE and FACTOR. The indicated measured value is calculated as follows:

Corrected measured value = (measured value - ZERO POINT) x SLOPE
Indicated measured value = (corrected measured value - BASE VALUE) x FACTOR

The functions BASE and FACTOR can also be used for correction of measured values (see 6.3.11) if no scaling is required.

Zero Point Correction

The physical measured variable needs to be zeroed (e.g. temperature sensor in ice water, shorten the voltage, or depressurise the pressure sensor etc.).
The indicated measured value must be programmed as zero point correction value. This process can be automated by the zero correction of the measured value.
The procedure zero correction has a special function with some sensors:

With dynamic pressure flow sensors (range L840 and L890 or units Pa) the offset value is entered as calibration offset before linearization but is not saved in the EEPROM; i.e. the correction is lost as and when you switch off.

When pH probes (units pH or PH), conductivity probes, or O2 probes are immersed in the appropriate calibration solution, it is possible to perform both zero point adjustment and automatic gain adjustment with the same command.

Slope Correction

The physical variable must be brought to an exact defined nominal value (e.g. temperature sensor into boiling water, apply calibration voltage etc.).
Determine the actual value by means of the function MEASURED VALUE.
The correction value is calculated from the ratio nominal value/actual value.

Function	**Entry**	**Acknowledgement**
Zero adjustment	f1 C01	
Program zero correction	f1 O-xxxxx	
Clear zero correction	f1 C06	
Output zero correction	f1 P06	ZERO POINT: 01: -0001.1 °C
Program slope correction	f1 F-xxxxx	
Clear slope correction	f1 C07	
Output slope correction	f1 P07	SLOPE: 01: 1.0123

The correction values will be cleared if the measuring range is changed.

6.3.11 Reference Value, Scaling, Decimal Point Setting

The user can **zero the measured value** at certain locations or at certain times in order to only check the deviation from this reference value.

At transmitters with a standard output (e.g. 0/4-20mA) a zero point shifting and a multiplication with a factor is, for scaling purposes, usually necessary in the physical variable to indicate the true measurement variable.

Indicated Value = (corrected measured value - BASE VALUE) x FACTOR (see 6.3.10)

The FACTOR can be programmed in the range -2.0000 to +2.0000. For factors over 2.0 or under 0.2 the appropriate decimal point shift must be provided by entering the EXPONENT.

Decimal Point Shift

When measured values are scaled it is often necessary for a correct dimensioning of variables to provide a decimal point shift, in addition to the correction, by means of FACTOR. For this purpose the FACTOR can be provided with an EXPONENT that allows to shift the decimal point as far as it can be presented on the display or printout. A presentation of the measured values as an exponential expression is not possible.

Decimal point shift by one digit to the right:	EXPONENT = +1
Decimal point shift by one digit to the left:	EXPONENT = -1

☞ If the measured value is, as standard, provided with an exponent (e.g. voltage divider connector 26V) this must also be considered.

Example:

A temperature transmitter -100°C to +400°C with 4-20mA output signal needs to be connected to the measuring instrument and the temperature needs to be indicated.

The measuring range "Percent" is preferable for 4-20mA signals as the measuring signal is first converted into values from 0.00 to 100.00%. The DIMENSION is, according to section 6.3.5, changed to "°C". The adaptation to the nominal temperature values is performed by setting the decimal point with the EXPONENT and calculating the correction values BASE VALUE, FACTOR:

Actual values:	Start A_A = 0.00%,	End E_A = 100.00%
Nominal values:	Start A_N = -100.0°C	End E_N = +400.0°C

It is best to correct the decimal point first, according to the resolution required. In our example the actual values have 2 decimal digits, the nominal values only one., so that the decimal point has to be shifted by one digit to the right by menas of EXPONENT +1. After changing the dimension and shifting the decimal point new actual values are provided:

	Exponent = +1	Dimension = °C
Actual values:	Start A_A = 0.0 °C	End E_A = 1000.0 °C

Now, the scaling values can be easily calculated by means of the following formula:

$$\text{FACTOR} = \frac{E_N - A_N}{E_A - A_A} = \frac{400.0^oC - (-100.0^oC)}{1000.0^oC} = 0.5000$$

$$\text{BASE VALUE} = \frac{-A_N}{\text{FACTOR}} + A_A = \frac{-(-100.0^oC)}{0.5} = 200.0\ °C$$

If a factor of more than 2.0 is calculated, the resolution has to be decreased, for factors below 0.2, it could still be increased.
If the Base Value, including the decimal points, is higher than 65000, it is also helpfull to decrease the resolution or to enter a FACTOR as SLOPE CORRECTION (see 6.3.10).
The BASE VALUE will change to: BASE VALUE = A_A - A_N

Function	**Entry**	**Acknowledgement**
Set channel	Exx	
Change dimension	Dx	
Base value		
zero measured value	C01	
program	O-xxxxx	
clear	C06	
output	P06	BASE VALUE: 01: -0001.1 °C
Factor		
program	F-xxxxx	
clear	C07	
output	P07	FACTOR: 01: 1.0123

A change of the measuring range results in the scale values being cleared.

6.3.12 Sensor Locking

If the programmed values need to be protected against unintended changes each measuring channel allows to programme a locking mode that saves functions up to a certain locking level from being re-programmed. Standard sensors are factory-set to level 5, i.e. measuring range, dimension, correction values and scaling are protected, only the limiting values can be modified. At locking level 7 even the limiting values would be protected. The locking mode must be reduced accordingly to change protected functions. To change the measuring range or to program an additional channel the locking must be cleared, i.e. set to 0. No changes can be performed if the locking mode is provided with a point.

Locking Level	Locked Functions
0	None
1	Meas. Range + Element Flags
2	Meas. Range + Zero Point and Slope Correction
3	Meas. Range + Dimension
4	+ Zero Point and Slope Correction
5	+ Base Value, Factor, Exponent
6	+ Analogue Output-Start-End + Zero the temp.
7	+ Limiting Values Max and Min

V6: On new devices, in locking mode 5, it is possible to zero-set the measured value only temporarily; i.e. the next time you switch on the original measured value will appear again. Zero-setting can be prevented altogether by programming locking mode 6.

Functions	Entry	Acknowledgement
Set channel	`Exx`	
Locking level x program	`f1 kx`	
query	`f1 P00`	`LOCKING:4`
or	`f1 P15`	see 6.10.1

6.4 Acquiring Measuring Data

ALMEMO® devices provide the following options for data acquisition:

Current measuring of a selectable measuring point or continuous measuring point scanning of all measuring points with an adjustable conversion rate (2.5 or 10 measurements/second) and with an output of measured values on a display or to an analogue output, and with a monitoring of limiting values and peak value storage.

Manual / cyclic / continuous measured value output to a printer or computer or to the device memory (option).

6.4.1 Selecting a Measuring Point

By entering the command Mxx the instrument switches the channel Mxx to the measuring circuit. The measuring point can be programmed and the current or the stored measured values can be queried. The measured value is continuously available at an analogue output, if connected.

Function	**Entry**	**Acknowledgement**
Select meas. point 2	`M02`	`M02`

6.4.2 Measured Values

The measured values of each channel can be recalled individually. By transmitting the measured value into BASE VALUE (see 6.3.11) or ZERO POINT CORRECTION (see 6.3.10) the measured value of the selected measuring point can either be set to zero or can be adjusted.

On new devices incorporating a graphics display it is also possible, with the aid of a programmable setpoint, to perform gain adjustment. This process calculates the correction factor and saves it in the connector as factor.

Function	**Entry**	**Acknowledgement**
Output of meas. value of meas. channel	`p`	`01:+0023.5 °C`
Output of meas. value of input channel	`P01`	`12:34:00 01:+0023.5 °C`
Zero measured value (base value)	`C01`	
Adjust measured value (zero point corr.	`f1 C01`	
and for pH, atmospheric humidity, and O2, also gain correction)		
Switch calibration resistance on / off	`o(-)01`	(V6 only see 3.6.2)
Enter setpoint	`f2 gxxxxx`	(V6 only)
Correct setpoint	`f2 C01`	(V6 only)
Output setpoint	`P45`	SETPOINT: 01:5.000br

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6.4.3 Peak Values

From the measured values of each selected measuring point the highest and lowest value can, on a permanent basis, be determined and stored. The maximum and minimum values of each channel can, individually or all together as a list, be read out and be cleared. The peak values will be cleared at each change of the measuring range and, if configured, on starting a measuring point scan (see 6.10.13).

On new devices incorporating a graphics display the date and time-of-day of the maximum / minimum values are also recorded and output.

Function		Entry	Acknowledgement
MAXVALUE	output	P02	MAXIMUM: 01: +0020.0 °C
	clear	C02	
MAX TIME / DATE	output	P28	MAX-TIME: 01: 12:34 01.02.
MINVALUE	output	P03	MINIMUM: 01: -0010.0 °C
	clear	C03	
MIN TIME / DATE	output	P29	MIN-TIME: 01: 12:34 01.02.

6.4.4 Output of List of Measured Values

The current measuring, maximum, minimum and average values with the number of averaged values of all active measuring channels can be recalled all together and cleared.

Function	Entry	Acknowledgement
List of measured values	P18	CH MEAS.VAL MAXIMUM MINIMUM AVG. COUNT
		01: +0023.0 +0025.0 +0019.0 +0022.0 99999
		01: +0023.0 +0025.0 +0019.0 +0022.0 99999
Clear all meas. values	C18	

All measured values can also be automatically cleared at each start of a measuring point scan (see 6.10.13.2).

☞ To acquire measured values from other than the selected measuring point a corresponding cyclic or continuous measuring point scan must be activated!

6.5 Measuring point scan and measured value output

Before a measuring operation starts there are three different types of measuring point scan :

Non-continuous measuring point scanning :

Non-continuous measuring point scanning means that, after switching on, only the selected channel is measured at the set conversion rate, the maximum value and minimum value are saved, the limit values are monitored, and the measured value is output to the analog output and to the display.

1s

10 M/s | M | M | M | M | M | M | M | M | M | M | M | M | S | M | M | M | M | M | M | M |

After 12 measurements one special measurement S is inserted for zero point correction, cold junction temperature, measuring current calibration or supply voltage measurement. If several measuring channels are activated, which also need to be acquired, then the sensors must, after certain time intervals (cycle), be switched to the measuring amplifier and the individual measured values, with the **measuring point scan**, can be determined via the AD converter.

Continuous measuring point scanning :

With continuous measuring point scanning all measuring points are scanned and recorded equally at the set conversion rate; the maximum value and minimum value are acquired, the average value is formed, and the limit values are monitored. At the end of this process a special measuring operation is performed (see above).

Continuous scanning : ..| 0 | 1 | 2 | 3 |..| S | 0 | 1 | 2 | 3 |..| S | 0 | 1 | 2 | 3 |..| S | 0 | 1 | 2 | 3 |..| S | 0 | 1 | 2 | 3 |..| S | 0 | 1 | 2 | 3 |..| S | 0 | 1 | 2

Where measured value displays are based on the results of several measuring channels (difference, compensations, function channels) or on two analog outputs, this operating mode is indispensable. For output purposes the available measured values can be output immediately. A disadvantage is that with a lot of measuring channels the updating rate of the selected measuring point may in certain circumstances be slow. It is for this reason that new V6 devices feature semi-continuous scanning, introduced to replace non-continuous scanning.

Semi-continuous measuring point scanning :

V6: With semi-continuous measuring point scanning (setting = “not continuous”) all measuring points are continuously scanned and recorded but the selected measuring point M has preferred status and is reset each second measuring operation. With averaging, smoothing, or analog output it is thus possible for this channel to obtain a constant measuring rate equal to half the conversion rate. Special measuring operation S is performed as and when scan channel X and selected measuring point M coincide.

M = 0 | M | S | M | 1 | M | 2 | M | 3 | M | 4 | M | 5 | M | S | M | 1 | M | 2 | M | 3 |

Basic setting :
The default setting on leaving the factory or after a reset : - for V5 devices (with the exception of 2590-9 and 5990-2) is non-continuous, - for the 2590-9 and 5990-2 is continuous, and - for all V6 devices is semi-continuous measuring point scanning.

6.5.1 Measured value output / saving

For the purposes of data acquisition via the interface or in the device memory primarily the print cycle or output cycle is used.
The measuring cycle as basis has to all extent and purposes been phased out and replaced by continuous measuring; it is no longer supported by the new V6 devices.
It can be separately specified for the conversion rate, measuring cycle and output cycle whether the measured values shall be read out to the interface or, with data loggers, shall be stored. Only alarm values will be read out during the measuring cycle, i.e. at measured values with exceeded limiting value, exceeded measuring range or at sensor breakage. Very different operating modes can be selected for any individual application by the parameters:
output cycle with **memory activation S**
measuring cycle with **memory activation S** and
conversion rate with **software switches C, S, U** (continuous, memory, interface).
The printing format for a printer or a spreadsheet (table) format for a read-in into data bases and spreadsheet applications can be selected by means of the **output format**.

6.5.1.1 Once-only output / saving of all measuring points

To acquire operating states at certain irregular intervals once-only measured value outputs must be performed. These can be initiated via the keyboard, interface, or external triggering (see Section 6.6). Once-only measured value outputs of this nature can also be used by computer-controlled scans with their own process control, in particular in a network. To initiate interface operation there is a dedicated command available; on some key-controlled devices this may be the MANUAL key.:

Function	Command	Output
Once-only measured value output	S1	12:34:00 01: +0008.9 °C NiCr water
		02: +0023.4 °C NiCr air

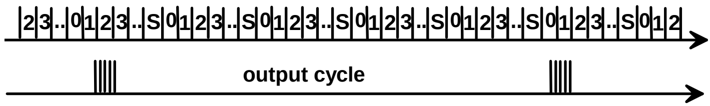
If an interface cable is connected, the measured values are usually output in the selected output format. If you want the measured values to be saved, saving to memory must be activated in the measuring cycle or print cycle.

6.5.1.2 Cyclic output / saving of all measuring points

For the purposes of cyclic measured value output the print cycle or output cycle is used. This outputs measured values to the interface and to the memory and provides cyclic calculation and output of the average value.
The measuring cycle if available is used to monitor measured values and limit values for all measuring points and to perform averaging so long as continuous measuring point scanning is not activated. The print cycle also counts as measuring cycle; i.e. if saving to memory is activated for the measuring cycle saving is also performed in the print cycle. Both cycles are assigned a timer, which at each zero-crossing performs a measured value output and then starts a new cycle.

Continuous scan

cyclic output



Cyclic Measuring Point Scan	Meas.Cycle	S	Print Cycle	AK
Output in print cycle	00:00:00	-	hh:mm:ss	U
Output and storage in print cycle	00:00:00	S	hh:mm:ss	U
Output and storage in print cycle V6	-	-	hh:mm:ss	S

Function	Command	Output
Once-only measured value output	S2	Date: 01.02.04 12:34:00 01: +0008.9 °C NiCr water 02: +0023.4 °C NiCr air

6.5.1.3 Continuous measured value output / saving

Continuous measuring point scanning (see Section 6.5) at the set conversion rate (see Section 6.5.4) permits simultaneous output and / or saving of all measured values. If only one measuring channel is active it can, with the maximum conversion rate, be stored or provided as output. However, to determine the measuring rate per measuring point it must be considered that one special measurement is inserted after each measuring point scan:
Meas. Rate / Channel = Conversion Rate / Channel No. + 1

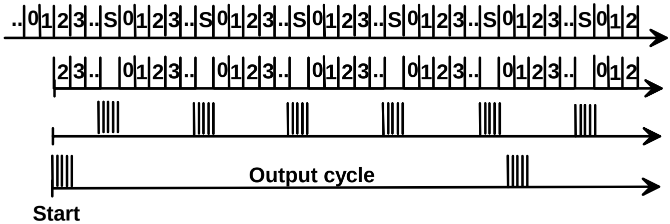
Process Diagram:

Scan continuously:

Store continuously:

Output continuously:

Cycle output:



Continuous Measuring Point Scan	WR	Meas.Cycle	S	Print Cycle	AK
non-continuous measuring point scanning	----	00:00:00	-	00:00:00	U
continuous measuring point scanning	C---	00:00:00	-	00:00:00	U
Output continuously	C--U	00:00:00	-	00:00:00	U
Save continuously	C-S-	00:00:00	-	00:00:00	U
Save and output continuously	C-SU	00:00:00	-	00:00:00	U
Save contin. and output in print cycle	C-S-	00:00:00	-	hh:mm:ss	U

Function	Command	Output
Once-only measured value output	S2	Date 01.02.04 12:34:01.00 01: +0008.9 °C NiCr 12:34:01.10 01: +0008.7 °C NiCr 12:34:01.20 01: +0008.5 °C NiCr

If continuous measuring point scan is activated the output at single or cyclic scans are performed immediately without a new measuring point sca (see 6.6.1).

6.5.2 Print Cycle

The print and output cycle allows, by means of the print cycle timer, cyclic measuring point scans with an output of the measured values to the interface. The cycle time can be between 1s and 59h, 59min and 59s. The scan is not performed if the measuring point scan takes longer than the cycle time.

Print Cycle	Commands	Acknowledgement
V5 dvices		
programming	Zhhmmss	
activate saving to memory	A4	
deactivate saving to memory	A1	
V6 dvices		
cycle with saving to memory activated	I+hhmmss	
cycle without saving to memory activated	I-hhmmss	
stop and clear	C11	
output	P11	PRINT CYCLE: 00:01:30
Print cycle timer output	f1 P11	PRINT TIMER: 00:01:23

6.5.3 Measuring cycle (no longer available on V6 devices)

In most cases the measuring cycle performs measuring point scans within a print cycle. Also here the time interval can be between 1s and 59 h, 59 min, 59s. The measured values are usually not provided via output but they are used to determine the maximum and minimum values. However, if an exceeding of the limiting values is detected, the alarm value will be provided as output to the interface.

Measuring Cycle	**Commands**	**Acknowledgement**
with memory activation	I+hhmmss	
without memory activation	I-hhmmss	
stop and clear	C12	
output	P12	MEAS. CYCLE: 00:00:30
Measuring cycle timer output	f1 P12	MEAS. TIMER: 00:00:23

6.5.4 Conversion Rate

The continuous measuring point scan can be configured by the conversion rate and 3 software switches for continuous scanning, saving and output. The setting can be recalled via the main programming (see 6.2.3).

Function	**Code**	**Entries**	**Off**
Conversion rate 2.5 M/s, switch CSU off	003	f5 k0	
Conversion rate 10 M/s (option 20 M/s)	010	f5 k1	
Conversion rate 50 M/s (option)	050	f5 k7	
Continuous scanning	C	f5 k2	f5 k-2
Continuous saving	S	f5 k4	f5 k-4
Continuous output	U	f5 k5	f5 k-5

6.5.4.1 Conversion rate : 50 measuring operat. per second

With measuring instruments ALMEMO® 3290-8, 8990-6/-8, 5990-0/-1, and ES 5590-G0 a high-speed measuring module with an additional conversion rate of 50 measuring operations per second is available as special option SA 0000-Q2. With measuring instruments ALMEMO® 2690-8, and 5990-2 this module is included as standard. Compared with the standard version, the common-mode input range is narrower and power consumption is always higher (see Section 2.3, Technical data).

Restrictions :

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 meas. operat. per second.
2. Sensor breakage detection is, however, not provided
   button remains active - for terminating the measuring operation.
3. During a measuring operation at the high measuring rate, monitoring of the

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ALMEMO® connector is not possible; i.e. the connector configuration can only be modified when the measuring operation has been stopped.
4. Alarm value printout is not provided.
5. The analog output is not used.
6. At rates above 10 meas. operations per second, mains hum suppression is not provided; as a result, accuracy may be adversely affected by interference over the connection lines; (wherever possible use twisted wires !).

Recording data to memory :

Settings on the ALMEMO® device :
Conversion rate 50, continuous scanning and saving
The conversion rate of 50 measuring operations per second is intended mainly for recording measured values in the internal memory and for offline evaluation. In this mode the timing resolution increases to 0.02 seconds.
The set measuring rate is effectively attained with one active measuring point; however, if there are several measuring points, the rate is reduced; (see 6.5.1.3) :

Data transfer to a computer with the PC terminal (e. g. in AMR-Control):

Settings on the ALMEMO® device :
Conversion rate 50, continuous scanning and output
At the conversion rate of 50 measuring operations per second with continuous output, it is possible, during measuring, to write the measured values to a file (e.g. in table format) and then evaluate this file after the measuring operation is complete (e.g. in MS-EXCEL). **with the measured value acquisition software WIN-Control** :
Settings on the ALMEMO® device : Conversion rate 50, continuous scanning
Settings in WIN-Control : Measuring cycle 00:00, high-speed data transmission
At the conversion rate of 50 measuring operations per second with the setting “continuous”, measured values for online measuring operations using WIN-Control are fetched on an uninterrupted basis. WIN-Control reaches approximately 20 to 40 scans per second (depending on computer hardware and baud rate), relatively irrespective of the number of measuring points; i.e. with just one measuring point, it might reach only 15 measured values but with 6 measuring points, up to 90 measured values per second.

Increased output speed when reading from memory :

Thanks to the higher processor clock the data transmission rate has been tripled to 57.6 kbauds. Reading out a 500-KB memory in table format takes only around four minutes.

However, at rates from 57.6 kbauds up, measured value acquisition is interrupted during memory output

Analog output:

The refresh frequency for pulse / pause modulation at the analog output (only at 2.5 or 10 measuring operations per second) is increased from 30 to 60 Hz. Firstly this reduces the residual ripple of the output signal; secondly it improves the response speed.

6.5.5 Setting of Output Form

At a measuring point scan the measured values can be provided as output to the interface in 3 different formats. The command Nx is used for selecting the presentation either in lists, columns or spreadsheet (table) format. The abbreviation for the output format appears in the program header after the print cycle data. Files that are saved in spreadsheet (table) format can be directly read-in by typical spreadsheet software packages (field separation by semicolon, comma as decimal point).

Output Form	Abbrev.	Command
Measured values in list form	U	N0
Measured values in column form	Un	N1
Measured values in spreadsheet (table) form	Ut	N2

6.6 Start and Stop of a Measuring Point Scan

Measurements with cyclic measuring point scans can, depending on the application, be started and stopped with various methods. The keys START/STOP, the serial interface, the real-time clock with start and end time or the exceeding of a limiting value of a measuring channel can all be used for automatic operating. Furthermore, external signals can be used for triggering.

6.6.1 Via Interface, Output Protocols

Depending on the output format selected (see 6.5.5) the following output protocols are available for different measuring point scans:

Single scan with possible alarm value output:

Entry:	Acknowledgement:
S0	12:30:00 02:!+0008.8 °C NiCr Water {FFH}(FFH for Alarm Value)
Exceed. limiting value	03:!+0013.2 °C NiCr Room Temp {FFH}
Exceed. meas. range	05:>+125.00 °C Ntc Motor Oil {FFH}
Sensor breakage	06: - - - °C NiCr Air {FFH}

Single output of all active measuring points:

```
S1                  12:34:00 01: +0008.9 °C NiCr Water.        (. for Manual)
                             02: +0023.4 °C NiCr Air
```

Start cycle output wihout output of the header:

```
S2                  DATE:    01.02.97
                    12:34:00 01: +0008.8 °C NiCr Water
                             06: +0025.0 °C NiCr Ait
                    12:44:00 01: +0021.0 °C NiCr Water
Sensor breakage              06:  - - -  °C NiCr Air
```

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Start of the cyclic scan of all modules with output of the header:

```
S3
                         AMR ALMEMO 8990-8
Programming              {SI}MSRANGE.  LV-MAX  LV-MIN  BASE  D FACTOR EXP AVG COMMENT
                         01:Ntc  +035.00  - - -   - - - °C 1.0350 E+0  - - - T external
                         02:NiCr  - - -  +0018.0  - - - °C - - -  E+0  - - - T internal
                         10:°o H  - - -   - - -   - - - %H - - -  E+0  - - - Humidity
Cycles                   {DC2} MEAS.CYCLE:  00:00:30 S  S0120.4 F0118.5 AR  W010 C-SU
                         PRINTCYCLE: 00:01:30 U  9600 bd
Start/End                STARTTIME:  10:30:00
 if programmed           ENDTIME:    18:30:00
                         ENDDATE:    15.01.98
Number                   NUMBER:  12-001
Date                     DATE:    01.02.94
                         {SI} = 0FH = narrow letters,   {DC2} = 12H = normal letters (for printers)
```

List

```
List                     10:30:00 01: +025.31 °C Ntc  T external
                                  02:!+0016.8 °C NiCr T internal
                                  10: +0039.5 %H °o H Humidity
Print of alarm values    10:30:30 02:!+0016.5 °C NiCr {FFH}           FFH = alarm value
Continuously             10:31:30.10 01: +025.31 °C Ntc  T external
 1 channel               10:31:30.20 01: +025.47 °C Ntc  T external
 resolution 0.01s        10:31:30.30 01: +025.87 °C Ntc  T external
```

Column Format

```
Column Format            {SI}10:31:30 01: +025.31 °C 02:!+0016.8 °C 10: +0039.5 %H
side by side             {DC2}
```

Spreadsheet (Table) Format

```
"ALMEMO";"RANGE:";"Ntc ";"NiCr";;;"°o H";;;;
                         "5590-2";"COMMENT:":"T extern";"T intern";;;"Humidity";;;;
                         ;"LV-MAX:";;35,;;;;;;;
                         ;"LV-MIN:";;;18,;;;;;;
                         "DATE:";"TIME:";;M01: °C";"M02: °C";;;"M10 %H"
                         "12.03.90";"10:31:30";+25,31;+16,8;;;39,5
Continuously             "01.11.97";"10:31:30.10";25.8
 Resolution 0.01s        "01.11.97";"10:31:30.20";25.9
                         "01.11.97";"10:31:30.30";26.1
Year data, 4-digit       "01.11.1997";"10:31:30.30";26.1          (see 6.10.13)
```

Single scan without returning time and date:

```
S                        ;;26.1;+16,8;;;39,5
```

End of the cyclic scan:

Entry: X

6.6.2 Start Time and Date, End Time and Date

A series of measurements can be started and/or stopped at certain points in time. For this purpose, the start time and date and the end time and date are programmable. If no date is specified the measurement will be taken each day in the programmed time interval.
The time must be already programmed and started.

Start Time	**Entry**	**Acknowledgement**
program	f1 Uhhmmss	
clear	f1 C10	
output	f1 P10	STARTTIME: 12:34:00
End Time		
program	f2 Uhhmmss	
clear	f2 C10	
output	f2 P10	ENDTIME: 12:34:00
Start Date		
program	f1 dttmmjj	
clear	f1 C13	
output	f1 P13	STARTDATE:01.02.05
End Date		
program	f2 dttmmjj	
clear	f2 C13	
output	f2 P13	ENDDATE: 01.02.05
measuring duration		
program	f2 lhhmmss	
output	P47	MEAS. DURATION: 02:00:00

6.6.3 Start and Stop by Limiting Values

Another possibility for automatically starting or stopping a measurement is the triggering by limiting values being exceeded. Uninteresting measured values can, to a large extent, be suppressed by this method. To start the process a relevant measured variable must be specified and the corresponding channel must be selected or a continuous measuring point scan must be set. Several channels can be alternatively used to stop the process. The limiting values need to be programmed according to section 6.3.9.

Function	Entry	Code
Select channel	Exx	
START by limiting value Max	h1	S-
STOP by limiting value Max	h2	E-
START/STOP clear at limiting value Max	h0	--
START by limiting value Min	l1	S-
STOP by limiting value Min	l2	E-
START/STOP clear at limiting value Min	l0	--

In the sensor programming (see 6.10.1) a combination code appears for Start/Stop and for the alarm relay allocation (see 6.10.8) at limiting value Max (AH) and Min (AL).

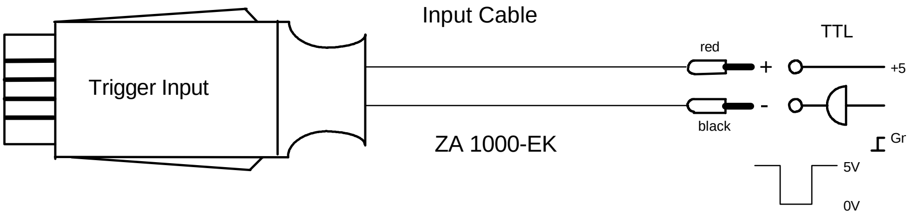
6.6.4 External Triggering

Original input/trigger cables (ZA 1000-EK/ET/NT) and combined input and output cables (ZA 1000-EGK/EAK) are available in the ALMEMO® range of accessories for triggering the scan and for alarm messages (see 5.1.2). All cables are connected to the output socket A2 of the ALMEMO® device.

There are two possible solutions if the socket A2 is already occupied by a network cable:

1. Use of the relay trigger adapter ZA 8000-RTA (see 5.1.3) with an additional A2 connector.
2. Networking with network branch boxes (see 5.3.3). Only socket A1 is required.

The trigger signal must drive an optocoupler and must therefore provide a voltage from 4 to 24V DC and a current of at minimum 2mA (at 5V). TTL signals are connected using negative logic, as shown in the figure.



The standard function of the external triggering is the alternating starting and stopping of cyclic measuring point scans. Single scans are performed if no cycle is programmed. Only original trigger cables allow to program other functions (see 6.10.9) (not available with combined cables):

- Single measuring point scan
- Max/Min value clearing
- Printout of the function
- Zero setting of function

6.7 Measuring Functions at Measuring Point Scans

There are a few measuring tasks and specific measuring ranges that require cyclic measuring point scans and defined sensor arrangements.

6.7.1 Pulse Measurement, Sum Operation

For pulse measurement the ALMEMO® connector range provides the frequency meter module ZA 9909-AK2, which contains, integrated within the sensor connector, its own small microcontroller that counts the pulses (see 4.2.5). The only difference between the cable ZA 9909-AK1 for frequency measurement and the cable ZA 9909-AK2 for pulse measurement is the programming of `FREQ` or `PULSE`.

The pulse measurement in the measuring range `PULSE` is for signals with a low rate of repetitions that are registered for a longer period of timeThe frequency module is scanned and set to zero for all measured value outputs (manual, cyclic, or continuous). The pulse count does thus not appear in the display until after the scan.
The function channels Sum over Total Pulse Count S(t) and Sum over Pulse Count/Print Cycle S(P) (see 6.3.4) are available for an acquisition of the total pulse count or the pulses in cyclic time intervals. These sums are 'zeroed' at each start or cleared by using the command 'Set measured value to zero'. The sums must not be scaled with any offset or factor! (V5 devices only)

Function	**Entry**
Specify measuring channel	`Mxx`
Set measured value of measuring channel to zero	`C01`
Single measuring point scan and set all sums to zero	`f1 s`

6.7.2 Atmospheric Pressure Compensation

The calculation of the partial vapour pressure at the psychrometer, the humidity variables mixture ratio and enthalpy, dynamic pressure and the O_2 saturation generally depend on the atmospheric pressure SP. The atmospheric pressure should be considered especially at applications in a corresponding sea level. The atmospheric pressure is either programmable (see 6.2.6) or can be automatically measured by means of an air pressure sensor (e.g. FD A612-MA). This is defined as a reference by programming the 'Comment' to ´*P´ (see 6.3.6). The air pressure sensor must be placed in the measuring point sequence so that it precedes the sensors, which need to be compensated.

Function:	**Entry**
Define air pressure sensor as reference	`f2 $*P CR`

6

6.7.3 Cold Junction Compensation with External Sensor

At existing measuring systems with thermocouples the compensation lines are often already guided to an isothermal cold junction rail to travel by copper lines to the measuring instrument. This allows for a limitation of the costs involved with expensive thermo lines. An external Pt100 sensor with the range ´P204´or an Ntc can be used for the acquisition of cold junction temperatures. It must be positioned as the first sensor a device (M00) before the thermocouples, and must be programmed with the 'Comment' ´*J´ (see 6.3.6). The copper lines of the connected thermocouples must be connected to the measuring instrument by using normal copper connectors (ZA 9000-FS).

Constant Cold Junction Temperature

Often the cold junction temperature is kept at a constant temperature by using ice water or a thermostat. In this special case the original temperature sensor with cable is not necessary and a dummy connector can be used (e.g. ZA 9000-FS), the slope correction can be set to zero and a constant temperature can be programmed with the negative base value. As a result, this measuring point will always indicate the constant temperature that is used as a cold junction temperature.

Cold junction temperature sensor in the connector

For especially exacting requirements (e.g. for thermocouples for which there is no connector made from thermo material or in the event of strong thermal irradiation) special universal thermocouple connectors (ZA 9400-FSx) are available each with its own integrated Ntc temperature sensor for cold junction compensation. These can be used easily and conveniently for all thermocouples; however, each one needs two measuring channels (one for the Ntc, the other for the thermocouple). Having ”#J” programmed in the first two positions in the comments for the thermocouple ensures that the temperature sensor integrated in the connector is indeed used for cold junction compensation; (this function is available on all devices with effect from 07/2003).

6.7.4 Averaging

The average value of the measured value is required for various applications :
e.g.

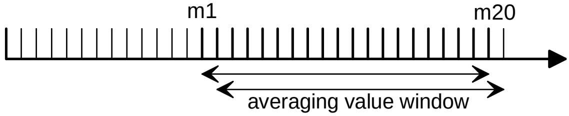
Average flow velocity in a ventilation channel
Smoothing of a widely fluctuating measured value (e.g. wind, pressure etc.)
Hourly or daily average values of weather data (temperature, wind etc.)
As above, for consumption values (current, water, gas, etc.)

The average value of a measured value is obtained by adding together a series of measured values Mi and then dividing this sum by the number N of measured values in the series.

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

Smoothing out measured values by means of a sliding average

V6: The measured value smoothing function (which smoothens out measured values of an unstable or strongly fluctuating nature by a process of continuous averaging) was, on certain V5 devices, only accessible via the keyboard; on V6 devices generally this can now also be operated via the interface. Measured value smoothing is, however, only possible for the selected channel. The level of smoothing, which specifies the number of measuring operations at the selected measuring point from which the sliding average is to be taken, can be set in the range from 0 to 99. The smoothed measured value then also applies for all subsequent evaluation functions. When a large number of measuring points is involved, continuous measuring point scanning should be switched off; otherwise the filter effect may be substantially restricted.



$$M=(\sum_i m_i)/N$$

Function	Commands	Response
Program smoothing level (0 to 99)	`f1 zxx`	
output	`P32`	`SMOOTHING : 01: 20`

Averaging with averaging mode

All averaging processes - except when smoothing a measured value - are defined by the **averaging mode** :

Continuous averaging from start to stop or over single measuring operations - if not started with : `CONT`
Averaging over each cycle with : `CYCL`
Averaging has become much more straightforward and effective compared with V5 devices - thanks to the following measures :

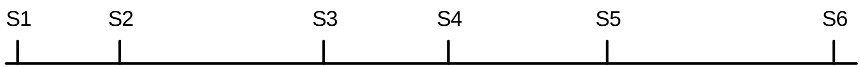
1. Averaging is always performed after each start by means of semi-continuous or continuous measuring point scanning so long as averaging mode has been programmed. For averaging between two outputs a measuring cycle is thus no longer necessary.
2. With semi-continuous measuring point scanning (default setting), the selected measuring point is always scanned at exactly half the meas. rate.
3. Measuring operations for the purposes of averaging can now also be started and stopped without the need for a cycle. When stopping, all measured values are now also saved; i.e. start, stop, and averaging with averaging mode “CONT” can now also be performed via the interface.
4. With the function channels for average value “M(t)”, number “n(t)”, and volume flow “Flow” all function values used in averaging can be saved ("S" option) or can be output via the interface.

Averaging over a series of measurements is usually performed for all measuring point scans. This is activated for each measuring point by programming the averaging mode (see Section 6.3.7). The average value is separately calculated and saved for each measuring point. This can be called up at any time via the function “AVERAGE VALUE”. In “CYCL” mode the average value is deleted again after each print cycle. So that the average values and number can also be saved or output via the interface the appropriate function channels M(t) and n(t) must have been programmed (see Section 6.3.4); these function channels output the average value of the reference channel to a so-called arithmetic channel. If the average value, instead of the measured value, is required the output function m(t) (see 6.10.4) performs this task
The operating modes listed below can be configured with the following functions :

Functions	**Commands**	**Response**
Averaging mode for a channel	`mx`	s. 6.3.7
Program function chan. for average value M(t)	`B74`	s. 6.3.4
Program function chan. for average value M(n)	`B75`	s. 6.3.4
Program function channel for number n(t)	`B83`	s. 6.3.4
Set continuous measuring point scanning	`f5 k2`	s. 6.5.4
Set cycle	`Zhhmmss`	s. 6.5.2
Start averaging	`S2`	
Stop averaging	`X`	
Output average value of a channel	`P14`	`AVERAGING: 01: +0021.3 °C`
Delete average value of a channel	`C14`	
Output all maximum values, minimum values, average values	`P18`	s. 6.4.4
Delete all maximum values, minimum values, average values	`C18`	s. 6.4.4

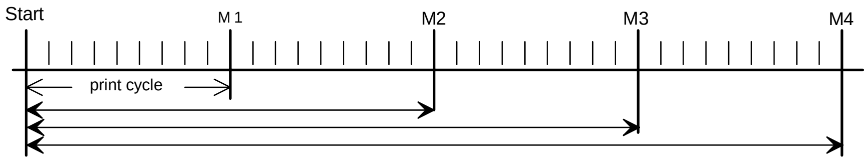
1. Average value over several manual meas. point scans: $\overline{M} = (\sum_i S_i)/N$

Functions		**Commands**
measuring operation	Stop	`X`
Function channels	M(t)	`B74`
Averaging mode:	`CONT`	`m1`
Measuring point scans:	manual/single	`S1`
Average value output:	at end of measurement with	`P14, P18`



2. Continuous averaging: $\overline{M} = (\sum_i M_i)/N$

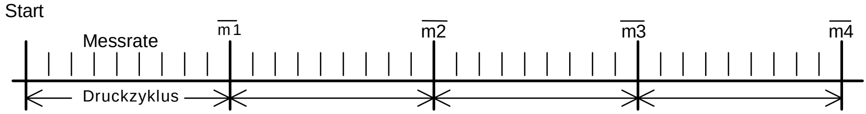
Functions		Command
Averaging mode:	CONT	m1
Function channels:	M(f)	B74
Measuring point scans:	continuously	f5 k2
Measuring operation:	Start	S2
Average value output:	print cycle with function channel M(t) or output function M(t)	Zhhmmss



Total average value at end of measurement with P14

3. Cyclic averaging over print cycle: $\overline{m_x} = (\sum_i M_i)/N$

Averaging mode:	CYCL	m2
Function channels:	M(f)	B74
Measuring point scans:	continuously	f5 k2
Measuring operation:	Start	S2
Average value output m_x:	print cycle function channel M(t) or output function M(t)	Zhhmmss



4. Average value over measured values of several measuring points Myy to Mxx at each measuring point scan: $\overline{M} = (\sum_i M_i)/N$

Averaging mode:	not required	
Function channels:	M(f)	B74
Reference channels :	from b2= Myy up to b1 = Mxx (see 6.3.4)	
Measuring point scans:	all	
Measuring operation:	Start	S2
Average value output:	print cycle with function channel M(n)	

6.7.5 Volume flow measurement

For details regarding volume flow measurement please refer to Section 3.5.5.
Average velocity M(t) is acquired by averaging isolated measurements at certain locations or at certain times in a flow channel; (see Section 6.7.4).
To display the volume flow a function channel ”Flow” is needed.

Select e.g. the 2nd channel in the flow connector.	M10
Program the function channel “Flow”.	B84
In this function channel program the cross-section xxxxx of the flow channel in cm^2.	Qxxxxx
Request the measured value of the function channel in m^3/hour	p 10:+00834. mh

6.8 Numbering of Measurements

For the identification of measurements or series of measurements a number can be entered that will be printed out or saved at the next measuring point scan. This allows stored single measurements to be assigned to certain measuring locations or measuring points during read-out. The number can be entered using 6 digits. In addition to the numbers 0 to 9 the characters -, A, F, N, P can also be used. The number output is activated after the entry.

The **printout of the number** is automatically performed once after each activation, when the next measuring point scan is performed and if the output channel "U" is switched on. Afterwards, the output of the number is deactivated again.

```
e.g. NUMBER:      000001
     DATE:       01.11.97
     08:30:00 01: +0025.3 °C NiCr
```

The **storage of the number** is also performed at the next measuring point scan if the memory is switched on. At the printout of the memory the whole content, including the numbering or measurements with a certain number, can be provided as output (see 6.9.2).

Function	Command	Acknowledgement
Enter and activate number ´01-001´ or with letter ´A1-001´	n01-001 f3 $A1-001 CR	
Clear and deactivate number	C05	
Number output	P05	NUMBER: 01-234

6.9 Data Storage

ALMEMO® data loggers provide 500KB (option 2MB)for data storage. For each measuring point scan 4 bytes of memory space are required for the time data and 4 bytes are required for each measured value, i.e. for more than 2 measuring points more than 100,000 measured values can be stored. The storage can be performed manually or automatically during the print cycle, conversion rate and measuring cycle.

It is possible to assign a 6 digits number (3 bytes of memory space) to several single measurements or to entire measuring cycles, which allows for a selective data read-out. A selection based on the timand date is also possible.

NOTE: The configuration of the connected sensors is saved at the first start of the recording. If further sensors are added at the next start, these will be added into the memory configuration. However, no sensors must be exchanged at following measurements as false assignments could occur with range, dimension, decimal point and comment. This means that the preceding measurement must be read out first and the memory must be cleared when the sensor configuration has to be changed. Exception : MA2590-9, 5990-2 and MMC (see 6.9.3)

6.9.1 Saving data to external storage media

(ALMEMO® memory connector, smart media MMC (multi-media card))

ALMEMO® data loggers (depending on type and version) also support external storage media. These external memories do not need a battery to ensure that data is retained; they can be unplugged, even sent elsewhere, and evaluated by computer on a completely device-independent basis over a read interface. These external memories are detected automatically and, so long as they remain connected, they are used instead of the internal memory. This is also shown in the display indicating the amount of free memory.

1. **ALMEMO® EEPROM memory connector ZA 1904-SS**
   Capacity : 128 KB (25,000 meas. values) or 256 KB (50,000 meas. values)
   Measuring instruments: ALMEMO® 2390-5, 2390-8 and V5 data logger from V5.73
   Ring memory : only possible with 2390-x
   Reading devices : ZA1409-SLG or ZA1409-SLG0 (for memory connectors only, s. 6.9.4)

- Only one sensor configuration is possible per memory connector.
- On V5 devices if, when an external memory is connected, the internal data memory is not empty, the device will ask whether the internal memory should be cleared. If it is important that the internal data be saved, you must disconnect the external memory again and read out this data first.

2. **ALMEMO® memory connector ZA1904-MMC for multi-media card**
   Capacity : from 32 MB and with no upper limit (approx. 30,000 meas. values / MB)
   Measuring instruments : ALMEMO® 2690-8, 2890-9, 8590-9, 5690, 5790, 5890
   Ring memory : not possible
   Reading devices : Card drive or USB card reader for MMC (included as standard)

- With each new sensor configuration a new file is created.
- For data acquisition purposes the memory connectors (1 and 2) are plugged into socket A2; (the trigger and relay cables can also be plugged into socket A1).

3. **Smart media card ZB1904SC**
   Capacity : up to 32 MB (6.4 million measured values)
   Measuring instruments : ALMEMO® 2590-9 (with SC option) and ALMEMO® 5990-2
   Ring memory : not possible

Reading device : ZA 1409-SLG

- With each new sensor configuration a new number is assigned.
- The smart media card is inserted in the plug-in slot on the measuring instrument. With media 1 and 3 the available memory capacity / location is preceded by a two-digit storage medium number. On display devices this number can be programmed between 00 and 99 to facilitate identification.

Applies for all external storage media

All measuring operations must be terminated with <STOP>; data not properly terminated in this way risks being partly lost or overwritten with the next measuring operation. For this reason, similarly, an external storage medium must not be withdrawn in the course of a measuring operation ! External memories should always be cleared using the same device type with which recording is performed.

6.9.2 Acquisition of Measuring Data

Storage switch-on and switch-off

The following activities can be switched on / off to best suit the application : - measured data saving via memory activation in the print cycle function, and - memory activation in the measuring cycle function and via software switch S in the conversion rate function. The different operating modes, from continuous data storage at the conversion rate to the recording of alarm values are described, in detail, in section 6.5.
For **starting and stopping the automatic storage** the measuring point scan must be started and stopped (see 6.6).

- On devices ALMEMO® 2590-9 and 5990-9 it is possible to save several measuring operations with different configurations one after the other in the same memory. With each new start, the configuration is checked; if it has changed, it is saved again with a new number. When reading out the memory in table format the output is interrupted for each new configuration. The next measuring operation must then be selected again with its number or with date / time-of-day; (see Section 6.9.3.3).
- With external MMC memory cards such measuring operations are usually saved in table mode with each different configuration in its own separate file. From the device it is only possible to read out all the measured data contained in the most recently used file and only in table mode. The most sensible approach is to remove the memory card and copy the files via a USB card reader directly onto the PC; (see Section 6.9.4.2). These files can then be imported either into MS-Excel or into Win-Control (as of V.4.9).

6.9.3 Output of Measuring Data

The contents of the measured value memory can be output on a cyclic basis via the serial interface. (see 6.9.2)
The memory contents can be output via the serial interface using any of a wide variety of programs (e.g. AMR-Control, see 6.1).

6.9.3.2 Memory Output to the Serial Interface

Output to the serial interface can be made in a choice of output formats : in list form one below the other, in column form one beside the other, and in table format with three different output protocols.(printing style see 6.6.1) After starting, the content of the memory will be provided as output using the same printing style as the print operation, if necessary, several times and with different output formats. The output can be aborted at any time without the memory being cleared.

6.9.3.3 Selective Memory Output

Measurements with Numbering

Series of measurements that have been identified by entering a number can be selectively read out by activating the corresponding number. If one number is active, as long as another number follows, only the measurements will be provided as output from the entire memory content if the corresponding number has been found in the memory. It can be data of a specific series of measurements or many single measurements, at always the same measuring points, having the same numbers.

Time Interval (not with MMC)

A time section can be specified and provided as output for the entire memory by the functions **Memory Start Time** and **End Time**, and **Start Date** and **End Date.** (***Note:*** At 500KB, the find process can last approximately 1 minute at maximum!)

Function	Entry	Acknowledgement
Complete read-out of memory	P04	MEMORY:
(connector no. 12 if availabel)		DATE: 01.01.97
(in all output formats)		07:00:00 01: +0123.4 °C NiCr ..
Shortenned chart at 115kB	P04	12.03.99;12:30:00;12,;9,9
date only if changed, none "		;12:31:00;12,1;9,8
Read-out of measurement with number identification:		
List output of all numbers that exist in the memory	f1 P05	NUMBER:
		01-001
		01-002
		02-001
		....
Activate number	n01-001	
Check if existing or not	t4	OK **or** ERROR
Read-out of measurement with number	P04	NUMBER: 01-234
		17:20:00 01: +0087.5 °C NiCr
(in all output formats)		. . .

6

Read-out of time interval:

Enter start time	f3 Uhhmmss	
Enter start date	f3 dttmmjj	
Enter end time	f4 Uhhmmss	
Enter end date	f4 dttmmjj	
Clear start time	f3 C10	
Clear start date	f3 C13	
Clear end time	f4 C10	
Clear end date	f4 C13	
Output start time	f3 P10	START TIME: 07:30:00
Output start date	f3 P13	START DATE:01.02.97
Output end time	f4 P10	END TIME: 08:00:00
Output end date	f4 P13	END DATE: 01.01.97
Query memory space	f1 P04	MEMORY: S0500.3 F0118.5 A
Read-out interval (in all output formats)	f3 P04	MEMORY: DATE: 01.02.97 07:30:00 01: +0123.4 °C NiCr . . .
Clear memory	C04	
Clear memory and measured values	f1 C04	

6.9.4 Reading out from external storage media without an ALMEMO® device

Reading out from external storage media without an ALMEMO device

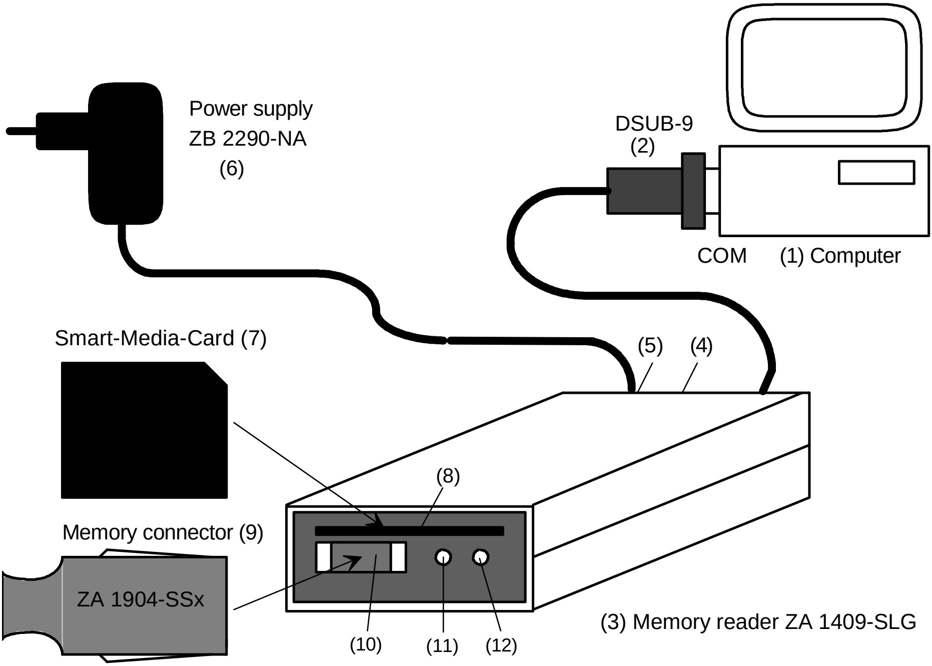
For the ALMEMO® EEPROM memory connector ZA 1904-SS and the smart media card ZB1904SC there are special reading devices with which data can, irrespective of device, be evaluated by the computer; type ZA 1409-SLG can read both memory variants, type 1409-SLG0 can read the memory connector only.

Since the measured data on the smart media card is saved in compressed form and in a special format, commercially available readers are not suitable and cannot be used for reading out.

MMC cards by way of contrast are written with files in FAT16 format, thus ensuring that any card reader can be used for reading out.

6.9.4.1 Memory reader ZA1409-SLG / SLG0

With reader ZA 1409-SLG / SLG0, any smart media cards ZB 1904-SC (not SLG0) and ALMEMO® EEPROM memory connectors ZA 1904-SS that have been written using an ALMEMO® data logger can be read out - without measuring instrument - directly on the computer. This is possible with AMR-Control, Win-Control, or any equivalent terminal program. The reader behaves very much like the device with which the data was recorded. The device designation, version number, and the sensor configuration are all stored on the storage medium



Installation

The 9-pin DSUB connector (2) on the reader (3) is connected to any free COM port on the computer (1). Network adapter ZB 2290-NA or ZB 2590-NA (6) is plugged into the supply socket (5); a smart media card (7) is connected to the plug-in slot (8); a memory connector (9) is connected to socket (10) on the reader.

Power supply

For the power supply, network adapters ZA 2290-NA or ZA 2590-NA can be used, or some equivalent with the following data :

Voltage 7.5 to 12 V DC, min. 100 mA

Extra-low-voltage connector, 2.1 mm, internal conductor = negative pole

The connector is plugged into the socket (5).

Interface

1. The baud rate is set by means of a code switch (4) located on the rear of the reader. The switch positions and baud rates are as follows :
   0 = 9600 baud 1 = 57600 baud 2 = 115200 baud
   To minimize the read-out time the highest baud rate is recommended. For a 256-kB memory connector approx. 1 minute is needed. The data volume is also reduced at this baud rate by dispensing with the date output in each row in table format (normally included in the standard protocol) - so long as the date does not change. The inverted commas " for the date and time-of-day are also omitted.
   e. g. "DATE";"TIME";"M01: °C";"M02: °C";;;;;;;;;
   12.03.99;12:30:00;12,;9,9
   ;12:31:00;12,1;9,8
   ;12:32:00;12,2;9,7
2. The baud rate must also be set accordingly for the COM port on the PC.
   8 data bits, 1 stop bit, no parity, software handshake XON-XOFF
3. With network-capable software packages device addressing must be limited to a device with the address G00.
4. In the Win-Control software, under “Settings”, “Other”, the option “High-speed measured value transmission” should be activated in order to obtain table format and minimize the reading time.

Memory

The storage media that can be read out in this way are ALMEMO® EEPROM memory connector ZA 1904-SS or smart media card ZB 1904-SC, 8 or 32 MB. The smart media card must be inserted with the angled corner rear left. The two LEDs (11) and (12) show whether this is in order :

Green LED:	short on, long off :	supply OK, no storage medium
	continuously lit :	supply OK, storage medium valid
	short on, short off :	storage medium invalid (incorrectly inserted or two memory modules at the same time)
	long on, short off :	memory data invalid (wrong size, format, etc.)
Yellow LED:	continuously lit :	data output

Data output

The contents of the memory are output in the same way as when reading out from the device memory. Table format is recommended for transmission purposes. Operation depends on which software is being used.

The following functions are always available, in particular in terminal mode (see Manual, Section 6.9.2) :

Output in list format :	`N0`
Output in column format	`N1`
Output in table format	`N2`
Output memory, 1st configuration :	`P04`
Cancel memory output :	`X`
Set start-time :	`f3 Uhhmmss`
Set start-date :	`f3 dtthmmjj`
Set end-time :	`f4 Uhhmmss`
Set end-date :	`f4 dtthmmjj`
Output start-time :	`f3 P10`
Output start-date :	`f3 P13`
Output end-time :	`f4 P10`
Output end-date :	`f4 P13`
Delete start-time :	`f3 C10`
Delete start-date :	`f3 C13`
Delete end-time :	`f4 C10`
Delete end-date :	`f4 C13`
Output memory, time excerpt only :	`f3 P04`
Output numbers list :	`f1 P05`
Input and activate number :	`nxxxxxx, f3 $xxxxxx`
Output memory labeled with number :	`P04` (assuming number is active)
Output memory location :	`f1 P04`
Output number :	`P05`
Delete and deactivate number :	`C05`
Output sensor programming :	`P15`
Output device programming :	`P19`
Output measuring instrument version :	`t0` (with memory)
Output reader version :	`t0` (without memory)
Delete or format memory :	`C04`
(Note memory delete protection sticker !)	

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6.9.4.2 USB reading device for multi-media card (MMC)

To read out memory data from an MMC a USB reading device is supplied with the memory connector. However, any other drive used for MMC removable storage media is equally suitable. The measured data files are created in standard-FAT16 format and can be transferred quickly and easily by simply copying onto the PC’s hard disk. The measured data in table format can be viewed as ASCII data using any standard editor and be imported quickly and easily into MS-Excel (using semi-colon as separator). The files can also be evaluated quickly and easily (and if necessary updated) using our data acquisition software Win-Control (from V.4.8.1) by means of “File -Import”.

6.10 Special Functions

The ALMEMO® devices provide some additional functions that are seldom used during normal routine operation, but are very useful for special applications. However, these functions should only be used by technically experienced operators who have properly understood the operation and its consequences. Some programmings are only possible at certain devices or they require a defined connector configuration or special hardware. If the input multiplexer does not match the pin wiring of the connector or if a reference channel is not provided with the correct sensor the user is often overtaxed with finding out why correct measuring data is not available anymore.

6.10.1 Output of the Extended Sensor Programming

The special parameters of each measuring point, with exception of the values of standard functions (see 6.2.3), can be queried using the command f1 P15. The following parameters are provided:

ZERO	Zero Point Correction	see 6.3.10
SLOPE	Slope Correction	see 6.3.10
LM	Locking mode	see 6.3.12
P	Current decimal point position incl. exponent	
FUNC	Output function	see 6.10.4
CALOFS	Calibration offset	
CALFA	Calibration factor	
A-START	Analogue output-start	see 6.10.7
A-END	Analogue output-end	see 6.10.7
B1	Reference channel for function channels	see 6.3.4
MX	Input multiplexer	see 6.10.2
EF	Element flags	see 6.10.3
AH	Alarm function limiting value Max	see 6.10.8
AL	Alarm function limiting value Min	see 6.10.8
CF	Print cycle factor	see 6.10.6
UMIN	Minimum sensor voltage	see 6.10.5

Entry f1 P15

Acknowledgement

```
CH ZERO    SLOPE   LM P FUNC CALOFS CALFA A-START A-END  B1  MX EF AH AL CF UMIN
01:+0000.0 +1.0000 5. 1 MEAS +00000 32000 +0000.0 +1000.0-01 -- -- S2 -0 01 12.0
```

All parameters of each measuring point in one line can be obtained by using the command f2 P15.

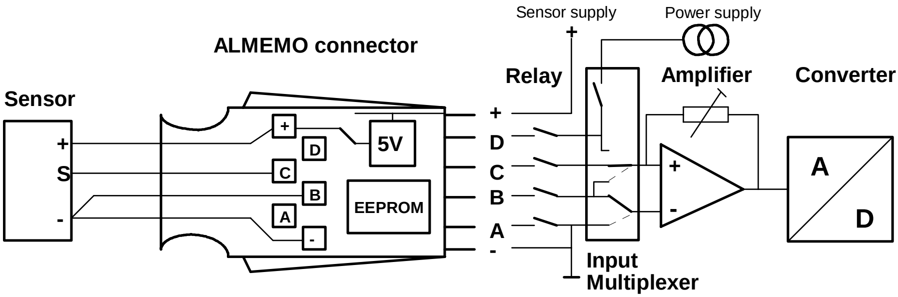
Entry f2 P15

Acknowledgement

```
CH RANGE LV-MAX  SLOPE   LM P FUNC CALOFS CALFA A-START A-END   B1 MX EF AH AL CF UMIN
01:NiCr +0123.4..+1.0000 5. 1 MESS +00000 32000 +0000.0 +1000.0-01 -- -- S2 -0 01 12.0
MEAS. CYCLE: 00:00:30 S  S0500.3 F0130.4 AR  W010 C-SU-
PRINT CYCLE: 00:01:30 U  9600 bd
```

6.10.2 Change Input Multiplexer

At each measuring range the input multiplexer is usually automatically correctly set according to the connector pin assignment. At earth-related signals the - input of the amplifier is connected to A, the + input is connected to B (millivolt, thermocouples), to C (Volt) or D (Ntc). At sensors with power supply (Pt100 or pressure etc.) a dead sense line is routed from the - pole of the sensor to the input B and the differential voltage between C and B is measured.



There are a few cases where a change of the standard multiplexer setting is desirable
e.g. Differential voltage measurement at humidity sensors with long lines,
Differential voltage measurement at internally supplied sensors with current output (connector ZA 9601-FS5/6 with differential shunt B-C)
Double sensor with two identical measuring ranges etc.

When selecting the range the multiplexer setting required can be programmed as follows and stored in the EEPROM of the connector:

Function	Entry	Code
1. Voltage measurement inputs B-A	f1 Bxx	M1
2. Voltage measurement inputs C-A	f2 Bxx	M2
3. Voltage measurement inputs D-A	f3 Bxx	M3
4. Voltage measurement inputs C-B	f4 Bxx	M4
5. Voltage measurement inputs D-B	f5 Bxx	M5

The multiplexer setting is identified in the sensor programming (see 6.10.1) by the above listed code. In the locking mode, the setting can be controlled by the second digit x4xx at devices with a display.

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6.10.3 Element Flags

Flags can be programmed to activate optional additional functions at several standard measuring ranges:

Function	on	off	Code
1. Measuring current for resistor-based sensors 0.1mA instead of 1mA	f2 k1	f2 k-1	01
2. Emission and background temperature for IR-sensors	f2 k2	f2 k-2	02
3. Activation of meas. bridge switch for simulation of final value *	f2 k3	f2 k-3	04
4. Activation of base value (e.g. for moisture sensors at brickwalls) *	f2 k4	f2 k-4	08
5. Deactivating the electr. isolation in the meas. modules *	f2 k5	f2 k-5	10
7. No automatic sensor breakage detection	f2 k7	f2 k-7	40
8. Analogue output 4-20mA instead of 0-20mA	f2 k8	f2 k-8	80

* only with hand-held devices 2290-2,3

Description:

1. By the reduction of the measuring current to one tenth, the measuring range of resistor-based sensors is extended to a higher resistance value by ten times. The measuring ranges P104, P204, N104 allow for measuring with Pt1000 and Ni1000 sensors instead of Pt100 and Ni100 sensors. The ohm range reaches up to 5000.0Ω. However, the comma must be set accordingly.
2. For infrared radiation transmitters, the emission factor of the surface of the device under test and the background temperature are required for the calculation of the measuring value. If flag 2 is programmed, the parameter 'zero point' is used for background temperature and 'slope' is used for emission factor. The standard function for the correction of the measured value will then be no longer available.
3. Force sensors include integrated calibration resistors that simulate the final value if they are switched correspondingly. The bridge voltage measuring module ZA 9612-FS includes an integrated electronic switch that is activated during the adjustment of the final value if flag 4 is activated.
4. On wall dampness sensors flag 4 is set. On older hand-held devices in the 2290 series the base value function has been activated because this function is needed for measured value acquisition.
5. On the newest devices, 2890-9, 8590-9, and new systems from 5690 to 5890 with electrical isolation in the measuring module this isolation can be deactivated by means of flag 5; i.e. terminal A on the selected sensor is connected via a semiconductor relay to the negative pole of the power supply system. This is necessary on sensors with attached power supply and on sensors with differential voltage measurement because the inputs would otherwise have no reference potential; (this is usually set automatically).
   On older hand-held devices in the 2290 series flag 5 is only used to activate averaging functions..
7. For a detection of a sensor breakage all measuring inputs are periodically, for a short time, set to 5V by using high-impedance resistors (11MΩ) if the AD converter is not measuring. With all sensors with low-impedance output (up to 1kΩ) the measured value is not influenced. With high-impedance sensors (e.g. chemical

cells) or electronic calibrators, the switch operations can lead to invalidated measuring results. For this reason, the sensor breakage detection can be switched off using flag 7.

8. The analogue outputs that can be externally connected or that are optionally available can be scaled to the standard values 0 to 2V, 0 to 10V or 0 to 20mA by the parameters analogue output-start and analogue output-end. If the current outputs need to be set to 4 to 20mA, flag 8 must be programmed.

The element flags can be controlled in the sensor programming by the abbreviation EF or at Measuring instruments with 7-segment display, in the locking mode at the third digit xx2x.

6.10.4 Change Output Function

If the maximum, minimum, average or alarm value is only required instead of the original measured value, this function can be programmed as output function. Limit monitoring, storing and analogue and digital output only consider the corresponding value of the function.

Examples:

1. If the measured values are averaged over the print cycle by means of the measuring cycle, only the average value is interesting as output value and not the latest measured value. At a data logger, memory space can be saved by this.
2. The analogue measured value of the dew point detector FH A946-1 is of no significance. Only the values 0.0% for dry or 100.0% for wet (bedewed) are provided when the limiting value 'Max' is set to approximately 0.5 V and the measuring function 'Alarm Value' is programmed.

Meas. Function	**Abbrev.**	**Entry**
Meas. value	Mess	f1 m0
Difference	Diff	f1 m1
Max value	Max	f1 m2
Min value	Min	f1 m3
Avg. value	M(t)	f1 m4
Alarm value	Alrm	f1 m5

6.10.5 Minimum Sensor Supply Voltage

The ALMEMO® instruments generally control the sensor supply voltage, which is, in most cases, the operating voltage of the instrument. If the voltage drops under 6.8V with battery-operated devices or devices with rechargeable batteries, the LoBat condition will, by means of an LED or within the device configuration (see 6.2.5), be indicated in the display. However, there are sensors that do not function at this voltage and therefore do not provide useful measuring data. To avoid such errors the minimum sensor voltage that is required can be individually programmed. If that voltage is lower than the minimum sensor voltage the measured value is regarded as sensor breakage.

Function	Entry
Program minimum sensor supply voltage in xx.x V	UXXX

If 00.0 V (see 6.10.1) is provided in the programming, then ´- -´ will be indicated and no monitoring is performed.

6.10.6 Print Cycle Factor

To match the data recording to the change rate of the individual measuring points, it is possible to print some of the measuring points by programming a print cycle factor between 00 and 99, less often or not at all. Only disturbed measuring points, e.g. in case of an exceeding of limiting values, will always be provided as output. As standard, the print cycle factor of all measuring points is set to 01, i.e. all activated measuring points will be printed at each print cycle. The corresponding measuring point will only be printed after each tenth cycle if the factor 10 is entered and it will not be printed at all if 00 is entered. Unnecessary measured values can be suppressed and memory space can be saved at data loggers by selecting the output channel ´Memory´. Before programming the print cycle factor between 00 and 99 the measuring point must be selected. In the extended sensor programming the print cycle factor appears under CF.

Function	Entry
Enter print cycle factor xx	ZXX
Clear print cycle factor	Z01

6.10.7 Analogue Output Functions

The analogue output functions described in section 5 can not only be operated with the given output signal/digit but can also be scaled to smaller partial ranges. At continuous measuring point scans an individual selectable channel, instead of the measuring channel, can be provided as analogue output. Alternatively, it is possible to trigger the analogue output directly via the interface.

Scaling

The output signal of the possible analogue outputs (0-2V, 0-10V, 0-20mA, 4-20mA) can be specified with each sensor for any partial range if the range is larger than 100 digits (e.g. 0-20mA for -30.0 to 120.0°C).
For this purpose the corresponding measuring channel must be provided with programming values for **analogue output-start** and **analogue output-end** and **analogue output type** (0-20mA or 4-20mA), if necessary.

Function	Entry	Acknowledgement
Analogue output start		
program	a-xxxxx	
clear	C16	
output	P16	ANALOGUE START:01: -0030.0 °C
Analogue output end		
program	e-xxxxx	
program (4-20mA)	f1 e-xxxxx	
clear	C17	
output	P17	ANALOGUE END: 01: +0120.0 °C

The flag for the switch from 0-20mA to 4-20mA can also be queried and programmed via the element flags (see 6.10.3).

Set Channel of Analogue Output

Usually, the meas. value of the selected channel is provided to the analog output. However, at continuous meas. point scans it is possible to specify any channel for the analog output to socket A2 by programming a reference channel. An analogue output to socket A1 provides the measured value of the 1st channel of the selected sensor at the same time. For the programming of the reference channel s. 6.2.5 (CONFIG).

Function	Entry
Set ref. channel xx for analogue output	f9 Exx
switch back to meas. channel	f9 E-00

External Control

The analogue output can also be controlled via the interface and provides a programmable voltage output (-1.25 to 2.000V or -6.250 to 10.000V) or a current output (0.0 to 20.000mA). The output value gets predefined with -12000...+20000 digits (0.1mV, 0.5mV, 1µA depending on the analogue output) and is meant to be used for the control of peripheral equipment by a computer (e.g. set point specification).

Function	Acknowledgement
Analogue output xxxxx digits	f9 a±xxxxx
e.g. voltage (2 V) -0.5V	f9 a-05000
voltage (10 V) +6.4V	f9 a12800
current + (20mA) +19.0mA	f9 a19000
switch back to meas. channel	f9 E-00
switch back to latest set point	f9 E-01
retrieval of reference channel and analogue value about the piece of device configuration.(see 6.2.5)	P19 CONFIG: xxxxxx-- -x-- B-1 a+12345

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6.10.8 Allocation of Alarm Relays to Limiting Values

Both limiting values of all measuring points of an instrument or a measuring circuit board are, as standard, used for alarm messages (see 6.3.9). For example, if a limiting value is exceeded at any measuring point the relay 0 responds at an alarm relay cable or at a corresponding relay adapter (see 5.2/3). It only drops out again when all measured values have, by the hysteresis, fallen below the limiting values. If no limiting value is set the full scale value operates as limiting value. A sensor breakage will in any case lead to an alarm.
For separating between measured values exceeding the maximum values and measured values falling below the minimum values, the alarm units can be reprogrammed to variant 1 (see 6.10.9).
However, if disturbances must be detected selectively and analysed it is possible to assign individual relays to limiting values. The relay cables provide 2 relays (0 and 1) for this purpose and the relay adapters (ZA 8000-RTA) provide 4 relays (0 to 3). This mode must also be set in the output module as variant 2 (see 6.10.9).

Function	**Entry**	**Code**
Activate alarm relay x at exceeding limit value Max	f1 hx	-x
Activate alarm relay y at falling below limit value Min	f1 ly	-y
delete Relay assignment and start/Stop of limit value Max	h0	--
delete Relay assignment and start/Stop of limit value Min	l0	--

A composed code for start/stop (see 6.6.3) and relay at limiting value Max (AH) and Min (AL) is indicated in the sensor programming (see 6.10.1).

6.10.9 Configuration of the Output Modules

Various output modules, which are partly programmable with regard to their functions, can be connected to the sockets A1 and A2:

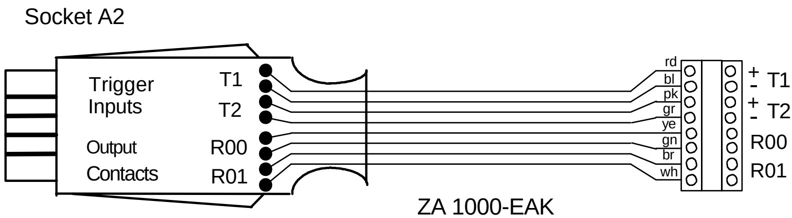
Module	**Type**	**No**	**Abbr.**	**Comment**
Recorder Cable	RK		RK	Analogue output
Data Cable	DK, NK	0	DK0	RS 232, RS 422 with hardware handshake
	5085-NV	1	DK1	RS 485 with output activation
Trigger Cable	EK	0	EK0	Start-Stop
	EK	1	EK1	Single scan of measuring points
	EK	2	EK2	Clear max/min values
	EK	3	EK3	Print function
	EK	4	EK4	Start / stop, level-triggered
	NK	8	EK8	Set measured value to zero
Alarm Cable	GK	0	AK0	Relay R0 alarm from all channels
	GK2	1	AK1	Relay R0 alarm max, R1 alarm min
	GK3	2	AK2	Relay Rx internally assigned
	AK	8	AK8	Relay Rx externally controlled
Trigger Alarm	EGK	0	EA0	Start-Stop, relay R0 alarm from all channels
	EGK	1	EA1	Start-Stop, rel. R0 alarm max, R1 alarm min
	EGK	2	EA2	Start-Stop, relay Rx internally assigned
	EAK	8	EA8	Start-Stop, relay Rx externally controlled

Generally, the functions of the trigger cables and the triggering of the alarm cable relays can be configured (Relay assignment to limit value see 6.10.8). The connected module is provided in the device configuration (command P19) in line A1 and A2 (see 6.2.5) with abbreviation and variant number (see table). The output modules can be shipped including the programming. However, if the function needs to be modified by the user the corresponding module must be connected to socket A2 and the desired variant number must be entered using the following command:

Function	Entry
Program output module variant no. x	f9 kx

6.10.10 Triggering of Output Relays

For controlling peripheral equipment, the ALMEMO® range of accessories provides a combined I/O cable (ZA 1000-EAK) and a relay trigger analogue adapter ZA 8000-RTA (see 5.2/3). They are connected to the output socket A2 of the ALMEMO® instrument and provide trigger inputs (see 6.6.4) and relays, which can be controlled via interface. Mode 8 for external control must be programmed at the output modules (see 6.10.9).



2 photovoltaic relays (approximately 1Ω, no polarity, load capacity 50V, 300mA) are available at the output cable and 4 mechanical relays (230V, 2A) are available at the relay adapter. The output contacts R00 to R03 are switched on or off by the following commands. The status can be recalled via the device configuration (see 6.2.5).

Function	Entry
Switch-on of contact xy	Rxy
Switch-off of contact xy	R-xy

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6.10.11 Output of Device Version

Since their first introduction, ALMEMO® devices have been further developed and have, with the version V5 described in this manual, reached a uniform and very comprehensive range of functions. Previous versions do not support all measuring ranges and do not have all functions listed here. However, there have always been options and special versions available. It is, therefore, very important to know the correct revision in case of updates and connection of new sensors or peripheral equipment. Revision data can be queried using the following command:

Function	**Entry**	**Acknowledgement**
Query software version	`to`	`8990-8EN3 3.51`

Some code letters:

E	English	A	recharg. battery and sleep mode	W5	Special meas.range WRe (S)
F	French	MU	board for MU connector	Y	Special meas. range YSI400
Z	Add. functions	R	ring memory	N3	Ntc resolution 0.001K

The output identifies an ALMEMO® 8990-8 instrument, English version, special measuring range 'Ntc with resolution 0.001K', version 3.51, hardware version with measuring module (from version 3.xx). With hand-held and desktop devices the version can also be indicated at the display if the 3rd key from left is pressed during switch-on.

6.10.12 Change Baud Rate

The **baud rate** is usually factory-set to 9600 bd in the connectors of the interface cables that are plugged into the sockets A1 and should not be changed. If cables with different baud rates are used in a network, no communication can be established. A lower baud rate of, for example 2400bd, is currently only necessary with radio modems. The high baud rate of 57.6 kb can shorten the readout time down to one sixth, however, this is not possible with all data cables or with any computer (see baud rate and its relationship to the current consumption of various interface modules 5.3.5).

☞ During the memory readout at 57.6kb and higher data rates the data acquisition will be interrupted!
During the memory readout at 115.2kb the output format ´table´ will be shortened (see 6.9.3).

Data format: Unchangeable 8 data bits, no parity, 1 stop bit

☞ CAUTION! If the connected devices are switched on, the command being entered via interface changes all interface cables in a network simultaneously. Afterwards, the baud rate must be changed in the communication unit as the transmission will be interrupted. A minimum interruption of 20 ms must be allowed before the next command can be sent.

Change Baud Rate	Entry
150 bd	`f1 b0`
300 bd	`f1 b1`
600 bd	`f1 b2`
1200 bd	`f1 b3`
2400 bd	`f1 b4`
4800 bd	`f1 b5`
9600 bd	`f1 b6`
57600 bd	`f1 b7`
115200 bd	`f1 b8`

6.10.13 Device Configuration

Some device settings allow for previous options to be programmed by the user. This configuration will, like the input of the device designation, be permanently stored in the EEPROM of the device and will not be cleared by a reset.

6.10.13.1 Changing the Number of Measuring Points:

With ALMEMO® 5590-2 data acquisition systems the maximum number of channels that can be managed is limited to 100. With ALMEMO® 5590-3 systems it is limited to 250. If sensor connectors with four channels (e.g. humidity sensors with temperature, humidity, dew point and mixture ratio) are to be used on a '10' type measuring circuit board, 40 channels are required for each board, which means that the maximum number of sensors is largely limited. It is, therefore, wise to keep the number of channels per board and, as a result, the number of usable channels per connector variable. For all measuring instruments with 9 or 10 sensor sockets and for the measuring point change-over boards ES5590-MF the number xx of channels can be programmed to the values 10, 20, 30, or 40, i.e. 1, 2, 3 or 4 channels per sensor. The measuring point change-over board ES5590-MU always provides, independent from the above information, only 10 channels.

Function	Entry
Set number of channels of meas. circuit boards	`f9 Mxx`
Set number of channels of meas. point change-over boards ES5590-MF	`f8 Mxx`

The set number of channels (factory setting 20) can be recalled via the device configuration (see 6.2.5). An optimum utilisation of system capacities is possible if one-channel, two-channel and multi-channel sensors are combined on corresponding boards. Another solution for this problem can be the distribution of function channels to other connectors by programming reference channels (see 6.3.4).

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6.10.13.2 Operating Parameters:

The following operating parameters or options can be configured by the user:

1. Mains frequency noise suppression

The mains hum, known for its humming noise in amplifier systems, is a disturbing voltage that is caused by the frequency of the mains voltage. This disturbance can be minimised for sensitive measuring instruments by the integration time of the AD converter. If this measuring time totals exactly one period of the mains frequency, the disturbing voltage is almost completely eliminated and, therefore, no longer effective. To achieve this mains frequency noise suppression, the frequency of the locally available mains voltage must be known and must be configured using the operating parameter 1 (F). The factory-setting of this parameter is always 50 Hz.

2. Clear all measured values at start of a measurement

In many cases it is wise to clear the maximum, minimum, and average values at the start of a cyclic scan of measuring data in order to have these parameters available at the end of the measurement. However, if measurements are frequently interrupted and restarted, the existing data must not be lost. The configuration flag 2 (C) allows for an adaptation to any task.

3. Ring memory at data loggers

The data memory of data loggers is normally organised as a linear memory that stops recording and reports ´memory full´ as soon as all memory space is occupied. This operating mode is always applicable when the start of a measurement is required. In many other cases, e.g. at prophylactic long-term monitoring it is sufficient when, in case of an event, the history can be recalled for a limited time interval. This problem can be solved using the configuration parameter 3 (R) that allows for setting a ring memory, i.e. when the memory capacity is reached, old data will be overwritten but it is always possible to perform a read-out of the whole memory up to the current point in time.

4. Displaying the year number in the date with 4 digits instead of just 2 (not on V6 devices)

The year 2000 and the change in the millennium has confronted us with the problem of two-digit year numbers in which the century is not defined. Configuration flag 4 (D) makes it possible to display four-digit year numbers for the period from 1995 to 2094. However, when programming any date the year number is still entered as just 2 digits.

5. Deactivating the alarm printout (no available on V6 devices)

During the measuring cycle, at a measuring point scan, faulty measuring points (exceeding of limiting value, sensor breakage) will always be printed out as alarm value list. If the alarm list printout is not required because the measuring cycle is, for example, only used for averaging or similar purposes, it can be deactivated using the configuration flag 5 (A).

Function	on	off	Code
1. Mains frequency noise suppression 60Hz instead of 50Hz	f6 k1	f6 k-1	F
2. Clear all measured values at start of a measurement	f6 k2	f6 k-2	C
3. Ring memory at data loggers	f6 k3	f6 k-3	R
4. Year number presentation in date 4-digit instead of 2-digit	f6 k4	f6 k-4	D
5. Deactivating the alarm printout	f6 k5	f6 k-5	A
6. Audible alarm turn off (at instruments with built-in speaker)	f6 k6	f6 k-6	S
7. Switching off automatic function activation (2390-5/8)	f6 k8	f6 k-8	8

6.10.13.3 Function Activation

On certain push-button devices the measuring and programming functions can be selected via one or two function keys (F1, F2, function). Many functions that are not really needed in normal operation can be activated and deactivated in various ways. On the new 2390-5 and 2390-8 only those functions are activated which in the applicable locking mode, averaging mode, and flow channel can actually be used. This automatic activation can, if necessary, be switched off and you can then select only those functions you feel you actually need.

Function	Abbr.	Auto	F1	on	F2	on	F1/F2 off
Range	BE2		o	f1 o00	•	f2 o00	f3 o-00
Measured value	0		-		-		
Max	MH1		o	f1 o02	•	f2 o02	f3 o-02
Min	ML1		o	f1 o03	•	f2 o03	f3 o-03
Memory	SP0		o	f1 o04	•	f2 o04	f3 o-04
Number	NR0		o	f1 o05	o	f2 o05	f3 o-05
Base	BA2	V	o	f1 o06	o	f2 o06	f3 o-06
Factor	FA2	V	o	f1 o07	o	f2 o07	f3 o-07
Limit. value Max	GH2	V	o	f1 o08	o	f2 o08	f3 o-08
Limit. value Min	GL2	V	o	f1 o09	o	f2 o09	f3 o-09
Time	ZT1		o	f1 o10	o	f2 o10	f3 o-10
Meas. cycle	MZ1		o	f1 o11	o	f2 o11	f3 o-11
Print cycle	DZ1		o	f1 o12	•	f2 o12	f3 o-12
Date	DA1		o	f1 o13	o	f2 o13	f3 o-13
Average value	MW1	M	o	f1 o14	o	f2 o14	f3 o-14
Baud rate	BR2		o	f1 o15	o	f2 o15	f3 o-15
Analogue-start	AA2		o	f1 o16	o	f2 o16	f3 o-16
Analogue-end	AE2		o	f1 o17	o	f2 o17	f3 o-17
Atmosph. pressure	mb2		o	f1 o18	o	f2 o18	f3 o-18
Device address	GA2		o	f1 o19	o	f2 o19	f3 o-19
Locking mode	VM2		o	f1 o20	•	f2 o20	f3 o-20
Diameter	DN2	F	o	f1 o21	o	f2 o21	f3 o-21
Cross section	QS2	F	o	f1 o22	o	f2 o22	f3 o-22
Volume flow rate	VS1		o	f1 o23	o	f2 o23	f3 o-23
Averaging mode	MM2		o	f1 o24	•	f2 o24	f3 o-24
Count	N1	M	o	f1 o25	o	f2 o25	f3 o-25

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Zero point correction	NK2	V	o	f1 o26	o	f2 o26	f3 o-26
Slope correction	SK2	V	o	f1 o27	o	f2 o27	f3 o-27
Exponent	EX2	V	o	f1 o28	o	f2 o28	f3 o-28

Automatic Activation: V by Locking mode, M by Averaging mode, F by flow sensor

All functions, as given in the column ´Abbr.´ including indication of the keys that activate the function (0=none, 1=F1, 2=F2, 3=F1, and F2) can be listed up using the command:

Switching off automatic function activation (2390-5/8): f6K8 (See 6.10.13.2)
Output of activation list: f9 P19

6.11 Communication with the Computer

A CR (Carriage Return: ODH), LF (Line Feed: OAH) will be appended to each command. At the end of an acknowledgement (response) an ETX (End of Text: ASCII = 03H) will be appended. At a programmed input with a computer it must be considered that an acknowledgement (response) to a command can have several lines, separated by CR LF, and a second command must only be performed if the first command has been completely processed, i.e. when the ETX code has been sent. The command `fx` for an additional function is an individual command that is also completed by 'ETX'.
The **programming example** in BASIC shows a subroutine that reads the individual lines Z into the strings R$(Z) and that returns to the main program when the ETX code has been received. It can provide the handshake function between two commands and can be used for a further processing of data entered:

```
0010 OPEN"COM1:9600,N,8,1" AS #1:       REM Initialisation of interface
0020 CLS:                               REM Clear display
0030 DIM R$(100):                       REM Maximum 100 lines per
                                            command can be read
0040 INPUT "ALMEMO 5590 V24 command:",E$: REM Enter command
0050 PRINT #1, E$:                      REM Output of command via V24
0060 GOSUB 1000:                        REM Subroutine for read-in of
                                            acknowledgement
0070 FOR I=0 TO Z-1: PRINT R$(I): NEXT I:REM Display acknowledgement
0080 GOTO 40:                           REM Start from begin
1000 REM read-in of acknowledgement
1010 Z=0:                               REM Lines =0
1020 P$="":                             REM Clear line buffer
1030 Z$=INPUT$ (1,#1):                  REM Read-in of character
1040 IF ASC(Z$)=13 GOTO 1080:           REM CR End of line
1050 IF ASC(Z$)=10 GOTO 1030:           REM Ignore LF
1060 IF ASC(Z$)=3 GOTO 1090:            REM ETX End of acknowledgement
1070 P$=P$+Z$: GOTO 1030:               REM Add character to line buffer
1080 R$(Z)=P$: Z=Z+1: GOTO 1020:        REM New line
1090 RETURN
```