6. Operation via the serial interface

Via the serial interface on ALMEMO® measuring instruments it is possible to output all measured values either individually or automatically, to completely program both the device itself and the sensor connectors, and to call up the programmed values. The appropriate commands can be sent via a computer terminal, a data communications program, or in a programming language. These commands always comprise one letter, possibly a minus sign, and between 0 and 6 numerals. Only data and commands in this approved format will be accepted by the measuring instrument and returned to the communications device. Any command in progress will be interrupted as soon as a new command is entered. Incorrect entries will be rejected with an "ERROR" message. Each command and each output is followed automatically by a line feed. In these instructions command sequences are shown separated by spaces; however, these spaces do not actually have to be entered.

6.1 Operation via the AMR-Control software

ALMEMO® devices as of version 5 can be programmed and operated very easily using the AMR-Control software; this runs under all versions of MS-WINDOWS® as of WINDOWS 98. 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 Interface configuration

Start the AMR-Control program.
In the input list select "`Main menu`".
Click the menu "`Setup`" and then the menu item "`Interface`".
Select the COM port to which the measuring instrument is connected.
For "`Baud rate`" select the baud rate programmed for the ALMEMO® data cable.
Confirm this configuration by clicking "`OK`".
This configuration is now saved and can be used the next time AMR-Control is started.

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 ALMEMO® functions can be programmed easily and conveniently. In menu "`Measuring points`" under item "`Measured values`" the current measured values can be imported and processed; in menu "`Devices`" under item "`Measured value memory`" it is possible to completely configure and start measured data recording; these saved measured values can subsequently be read out and written to a file.

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6.1.3 Operation via a computer terminal
(for all Ahlborn devices)

The AMR-Control software 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.
For this purpose click the menu "File" and then select the menu item "Terminal". The terminal window should then open.
A list of all admissible commands is available via "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 labels can be modified at any time by right-clicking).
All data transferred to the terminal, e.g. the contents of the data logger memory, can be saved - also in file form - as follows :
In the Terminal window click the menu "File" and then the menu item "Start terminal logging".
In the window "Save terminal log as :" enter an appropriate file name and then confirm by clicking "Save". All data generated by the terminal and displayed on the screen is now saved to the file thus named.
To read out the memory content e.g. in table format (e.g. for MS-Excel), proceed as follows :

1. In the terminal window click 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 complete saving click in the terminal window on the menu "File" and then click on the menu item "Close terminal logging".
To quit the terminal program click on the menu "File" and then "Exit"

6.1.4 Importing a file into a spreadsheet program
Start the spreadsheet program, e.g. MS-Excel.
Click on the menu "File" and then the menu item "Open".
Select the saved TXT file.
In MS-Excel the "Text import wizard" should appear.
As original file type select "Delimited" and then click "Next".
As delimiter set "Semi-colon", as text qualifier set ", and then click "Next".
As column data format set "General" and then click "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 for headers.

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

6.2.1 Selecting a measuring instrument

In a network, after switching on, only that device with address 00 is active and only that device, if found, reacts to all the data output commands. To select some other device command Gxx must be used.

Command	G01
Response, device no. 00	G0
Response, device no. 01	1

6.2.3 Output of programming

An overview of all device settings and of the connected sensors can best be obtained by requesting an output of the programming details by means of command P15. With the output format as list (one below the other) or as columns (one beside the other) (see 6.5.5) this looks as follows:

Command P15

Antwort

```
Print header    AMR ALMEMO 8590-9
Heading         MEAS RANGE LIMIT-MAX LIMIT-MIN BASE D FACTOR EXP AVERAGE DESIGNATION
Sensor program  01:Ntc +035.00  - - -   - - - °C 1.0350 E+0  - - - T external
                02:NiCr  - - - +0018.0  - - - °C - - -  E+0  - - - T internal
                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 is output with the device designation. This designation can be specified individually by the user; (see 6.2.4). In the next lines, after the heading, the most important parameters for the connected sensors appear together with the active measuring channels. On V6 devices the measuring cycle is no longer available. This is followed by the measured value memory (S ...) and the free memory capacity available (F ...) - in KB for data loggers and in MB for MMC cards. This is followed by the conversion rate setting and the switches for continuous scanning. After the PRINT CYCLE come the memory activation status, the output format, and the baud rate being used.

6.2.4 Individual print header / device designation

Via the serial interface an individual print header of maximum 40 characters can be programmed. In the program header - in place of the type designation - the following text appears "AMR ALMEMO TYPE-X". If several devices are inter-networked the print header can be used as device designation.

Programming	**Command**	**Response**
Enter the print header	`f4 $ABC test field CR`	
Delete the print header	`f4 $ CR`	
Output the print header	`f1 t0`	`ABC  test field`
Output the programming	`P15`	

Printout :

```
ABC test field
RANGE. LIM.-MAX LIM.-MIN BASE D FACTOR EXP AVERAGE DESIGN.
01:Ntc +035.00  - - -   - - - °C 1.0350 E+0  - - - T external
02:NiCr  - - -  +0018.0 - - - °C - - -  E+0  - - - T internal
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 device configuration

An overview of the current device configuration, settings, and output modules can be obtained by means of command P19.

Command `P19`

Response

`DEVICE :    G00 M20 A08 P10/mm/uu`	Address, channels possible, active, primary
`ATMOSPH. PRESSURE : +01013 mbar`	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-8 -L-- B01`	Configuration, see 6.10.13, 6.10.7
`ALARM:      -1-3`	Alarm status of relays 0...3, see 6.10.8
`A1:         DK0 Un`	Output module at A1, see 6.10.9
`A2:         AA`	Output module at A2

The line DEVICE provides not only the device address Gxx but also the number of possible measuring channels (Mxx) and the number of these that are currently active (Axx).

With data acquisition systems this is followed by the configuration of the modules.

`Ppp/mm/uu:mm/uu/uu.uu,uu;`	`pp`	= primary channels
	`mm`	= channels on measuring circuit boards
	`uu`	= channels on selector switch boards

The colon is followed by a list of all modules with the number of channels and their type. The type is indicated by the following characters:

ALMEMO® sockets	/		
10x MU connector (V6, max. 40 channels)	.	(V5, max. 10 channels)	!

Miniature thermal connector	,
Clamp connector	;

The new V6 devices support further commands giving the device parameters in greater detail; (see 7.5).

	Command
Output of all fixed device parameters:	`f1 P19`
Output of all variable device parameters :	`f2 P19`
Display of all ports to the output modules:	`f3 P19`
Reset to initialize variables:	`f1 C19`
Restoration of the delivery state:	`f2 C19`

6.2.6 Atmosph. pressure compensation and temp. compensation

Some measured variables depend on the ambient atmospheric pressure (see 6.3.3 Measuring range list "with PC") with the effect that large deviations from standard pressure (1013 mbar) may lead to measuring errors:

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

It is important therefore, especially when working at significant heights above sea level, to take due account of the atmospheric pressure (approx. -11 mbar per 100 meters above mean sea level MSL). This can either be programmed or measured automatically with a sensor.

Function	**Command**	**Response**
Enter the atm. pressure in mbar	`g xxxxx`	
e.g. 1013 mbar	`g 01013`	
Output the atm. pressure in mbar	`P43 or P19`	`ATM PRESSURE: +01013. mb`

To measure atmospheric pressure an atmospheric pressure sensor (e.g. FD A612-MA) must be defined as reference by reprogramming the designation to ´*P´; (see 6.7.2). For automatic scans the atmospheric pressure sensor should be placed, in the order of measuring points, in front of the humidity sensors.

Function	**Command**
Define atmospheric pressure sensor as reference	`f2 $*P CR`

Temperature compensation

Sensors whose measured values depend heavily on the temperature of the measuring medium usually incorporate their own temperature sensor and the device performs temperature compensation automatically; (see 6.3.3 Measuring range list "with TC"). However, dynamic pressure probes and pH probes are also available without their own integrated 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

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For compensation purposes it is also possible to define an external temperature sensor as reference - either by reprogramming the designation to ´*T´ (see 6.7.2) or by explicitly programming the reference channel (see 6.3.4). The compensation temperature can also be entered directly:

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

6.2.7 Hysteresis

The alarm status in the event of a limit value being overshot persists until the measured value drops back below the limit value by the amount of the hysteresis setting (usually 10 digits); this prevents relay chatter. It may be advisable to adapt this hysteresis setting to suit the resolution of the measuring range. The alarm status hysteresis can be programmed to any number of digits between 00 and 99.

Function	**Command**	**Response**
Enter the hysteresis in digits	`Y xx`	
Output the hysteresis	`P19`	`HYSTERESIS: 10`

6.2.8 Date and time-of-day

For logging the measuring time every ALMEMO® device incorporates a clock on which the date and real time can be set. A new feature on our data loggers is that the real time is buffered by battery and is retained even when the device is switched off. On all other devices, after switching on, the clock goes to 00:00:00 and starts with effect from the first measuring point scan.

Date	**Command**	**Response**	
Program	`dddmmyy`		
Delete	`C13`		
Output	`P13`	`DATE:`	`01.02.05`
Time-of-day			
Program	`Uhhmmss`		
Stop and set to zero	`C10`		
Output	`P10`	`TIME:`	`12:34:00`
Measuring time			
Output meas. time since start	`P46`	`MAES.TIME:`	`01:23:45.67`

6.3 Sensor programming

With the ALMEMO® connector system, unlike conventional measuring instruments, all sensor parameters are saved not in the measuring instrument but in a data memory on the connector itself. Using standard series-produced sensors and connectors (programmed on leaving our factory) the measuring range and units are already saved in the connector and there is normally no need for any extra programming.

However, the 10-way connector ZA 5590-MU is only available in a few variants with programming for 10 identical sensors, although each measuring point can be individually programmed with all the parameters here described.

When programming correction values, scaling, or limit values please note that on leaving our factory all programmed parameters have the locking mode enabled to protect them against unintended alteration; therefore, if modification is required this locking mode must first be lowered to an appropriate level; (see 6.3.12). All parameters can be entered and modified easily and conveniently - providing the appropriate sensor connector is plugged in.

The capacity of the memory connector has been doubled to 4 kbit (code E4). The new V6 devices thus support multi-point calibration, user-defined linearization, or connectors with special measuring ranges; (see 6.3.13).

6.3.1 Selecting the input channel

The input channel can be used to program the measuring points or to output the measured values and programming values without affecting the selected measuring channel. If a measuring point or an input channel is stipulated, all subsequent operations will refer to that channel.

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

6.3.2 Output the programming

An overview of the programming for the selected channel can be obtained by means of command P00. This overview, just like the printout of programming details obtained by means of command P15 (see 6.2.3), lists measuring point, range, limit value - maximum, limit value - minimum, base value, units, factor, averaging mode, and measuring point designation.

Command: `P00`

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

For instructions on how to call up the other special parameters for a measuring point please refer to 6.10.1.

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6.3.3 Selecting the measuring range

For each sensor there is a connector programmed with the appropriate measuring range and units. If you want to program the connectors yourself or if you often need to change the measuring range please note that for certain transducers a special connector variant will be required (e.g. thermo, shunt, divider, frequency, etc.). During the programming process the sensor must be plugged in because all sensor parameters are saved on the connector itself.

Range		Connector	Command	Output	Unit
Pt100-1, 4 liters ITS 90	-200.. 850°C	ZA 9000-FS	B01	P104	°C
Pt100-2, 4 liters ITS 90	-200.. 400°C / 300°C*	ZA 9000-FS	B03	P204	°C
Pt100-3, 4 liters ITS 90	0.. 65.000°C*	ZA 9000-FS	B00	P304	°C
Pt1000-1, 4 liters, with element flag 1	-200.. 850°C	ZA 9000-FS	B01	P104	°C
Pt1000-2, 4 liters, with element flag 1	-200.. 400°C / 300°C*	ZA 9000-FS	B03	P204	°C
Ni100, 4 liters	-60.. 240°C	ZA 9000-FS	B63	N104	°C
Ni1000, 4 liters, 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 9021-FSL	B05	FeCo	°C
Fe-CuNi (J) ITS 90	-200..1000°C	ZA 9021-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 9021-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	E118	°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
Volts	-2.6..2.6V	ZA 9000-FS	B11	Volt	V
Difference - millivolt	-10..55mV	ZA 9000-FS	B50	D 55	mV
Difference - millivolt 1	-26..26mV	ZA 9000-FS	B51	D 26	mV
Difference - millivolt 2	-260..260mV	ZA 9000-FS	B52	D260	mV
Difference - volt	-2.6..2.6V	ZA 9000-FS	B53	D2.6	V
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
Ohms	0..500W	ZA 9000-FS	B15	Ohm	Ω
Ohms with element flag 1	0..5000W	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	%
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

Range		Connector	Command	Output	Unit
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, 40 m/s, with TC and PC	0.5..40m/s	ZA 9612-AK	B40	L840	ms
Dyn. pressure, 90 m/s, with TC and PC	0..90m/s	ZA 9612-AK	B41	L890	ms
Relative humidity, capacitive	0..100%	ZA 9000-FS	B16	% rH	%H
Relative humidity, capacitive, with TC	0..100%	FH A646-C	B42	HcrH	%H
Relative humidity, capacitive, 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 and 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					
Absolute humidity, capacitive, with PC	0..500g/kg	FH A646	B43	H AH	gK
Dew point, capacitive	-25..100°C	FH A646	B44	H DT	°C
Vapor pressure, capacitive	0..1050mbar	FH A646	B59	H VP	mb
Enthalpy, capacitive, with PC	0..400kJ/kg	FH A646	B58	H En	kJ
Relative humidity, psychrometric, with PC	0..100%	FN A846	B46	P RH	%H
Absolute humidity, psychr., with PC	0..500g/kg	FN A846	B47	P AH	gK
Dew point, psychrometric, with PC	-25..100°C	FN A846	B48	P DT	°C
Vapor pressure, psychrometric, with PC	0..1050mbar	FN A846	B49	P VP	mb
Enthalpy, psychrometric, with 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, M(t)	(Mb1)	any	B74	M(t)	f(Mb1)
Average value over measuring points	(Mb2..Mb1)	any	B75	M(n)	f(Mb1)
Total from measuring points	(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)	
Thermal coefficient*	$\overline{M}$ (q)/ $\overline{M}$ (M01-M00)	ZA 9000-FS	B79	q/dt	Wm
Wet bulb globe temperature (WBGT)*	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 (m3/h)*	$\overline{M}$ (Mb1) * Q	any	B84	Flow	mh
Timer*	0..60000/6000.0s	any	B85	Time	s

TC=Temperature compensation, PC=Atmospheric pressure compensation, b1/b2=Reference channels
* Measuring range depends on device type and version

De-activate and re-activate channel	Command
De-activate programmed measuring channel	C00
Re-activate programmed measuring channel	o00

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6.3.4 Function channels

It is now possible to output, in a measuring log on the printer or the computer, not only the current measured values from sensors / transducers but also calculated results, e.g. humidity variables and maximum, minimum, average, and differential values from particular channels; such computing functions can for this purpose be programmed and assigned to selected measuring points. All programming values, e.g. limit values, base value, factor, and units adjustments can be used on function channels in just the same way as maximum, minimum, and average values and measured value saving. The measured values are updated with each measuring point scan. It is important to observe the order of the measuring channels; those measured values from which a function is to be calculated should be acquired first.

Selecting a calculating function

The calculating function is programmed in exactly the same way as a measuring range in the RANGE function on the 2nd (Mxx_2), 3rd (Mxx_3), or 4th (Mxx_4) channel of a sensor connector. To do so locking on the 1st channel Mxx_1 must be disabled.

Reference measuring points

The calculating function refers by default to the 1st channel of the sensor connector in question Mxx_1 (reference channel b1). The differential value is calculated between the 1st channel of the sensor connector (reference channel b1) and measuring point M00 (reference channel b2); the average value and sum value over n measuring points are calculated from channels M00 (reference channel b2) up to Mxx_1 (reference channel b1). To determine the thermal coefficient or wet bulb globe temperature requires a special sensor configuration; (see 3.1.4 and 3.2).

The two reference channels Mb1 and Mb2 can also be explicitly programmed - either in absolute terms to measuring channel Mb1 or in relative terms with reference to the calculating channel (e.g. `f1 E-01` refers to the previous channel):

Programming	Commands
First select the calculating channel.	`Exx`
Program the calculating function	`Bxx` (reference channels Mxx1, M00)
Stipulate reference channel 1 Mb1 in absolute terms.	`f1 E b1`
Stipulate reference channel 1 Mb1 in relative terms.	`f1 E-b1`
Delete reference channel 1 Mb1.	`f1 E-00`
Stipulate reference channel 2 Mb2 in absolute terms.	`f2 E b2`
Stipulate reference channel 2 Mb2 in relative terms.	`f2 E-b2`
Delete reference channel 2 Mb2	`f2 E-00`

It is also possible via reference measuring point Mb1 to assign a temperature sensor to pH probes or dynamic pressure transducers for the purposes of temperature compensation. Temperature sensors for pH: NTC or Pt100 with 0.01 °C, Temperature sensors for dynamic pressure: NiCr-Ni with 0.1 °C.

6.3.5 Changing the units

As units any two letters, upper-case or lower-case, or special characters [,], %, Ω, ° , -, =, ~ can be used.

Programming	**Commands**
Stipulate the input channel	`Exx`
Program units as ´xy´	`f1 $xy CR`

Converting units

°F The units °F can be programmed to have the temperature converted automatically from °C to °F (°F = °C x 9/5 + 32).

K To convert from °C to absolute temperature K a base value of -273.15 must be entered.

FM To convert flow velocity from m/s (with 2 decimals) into feet per minute (FpM = m/s x 3.281 x 60) a factor of 1.9686 with exponent +2 must be programmed.

!C Disabling cold junction compensation for thermocouples

6.3.6 Measuring point designation

For the purposes of identifying the channels a measuring point designation, 10 characters in length, can be entered via the serial interface. This designation will appear in the program header and with each measuring point scan after the measuring range.

Stipulate the input channel by means of command Mxx or Exx.

Function	**Command**
Enter the measuring point designation	`f2 $z.B. Raum1 CR`

Function abbreviations

The first two characters of the designation may comprise one of the abbreviations enabling special sensor functions. These two characters must be retained unchanged but the remaining eight characters can be used freely:

`*J` This denotes a temperature sensor used for external cold junction compensation for all the following thermocouples; (see 6.7.3).

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

`#N` This ensures on flow sensors that values are converted to standard conditions; (see 6.7.5).

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

`*T` This denotes a temperature sensor used for temperature compensation;; (see 6.2.6).

`!` This at the end denotes a special connector with linearization; (see 6.3.13).

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6.3.7 Averaging mode

Each measuring point can be programmed to averaging over the measured values from measuring point scans. It is also possible to program to averaging over individual measuring operations, over the full measuring time, or over the cycle; (see 6.7.4). To save average values or output them via the interface the appropriate function channels M(t) must be programmed accordingly; (see 6.3.4). If only the average value is required instead of the measured value itself the output function M(t) can be used; (see 6.10.4). The averaging method to be used is defined as the averaging mode.

Averaging	Printout	Command
No averaging	- - -	m0
Averaging over time or over individual measuring operations	CONT	m1
Averaging over cycle	CYCL	m2

6.3.8 Input the programming values

Programming values must be entered after the command character either with an explicit decimal point and then RETURN or as five digits with preceding zeros and without decimal point. The position of the decimal point will depend on the measuring range and on whether there is a decimal point shift. Entering the arithmetic sign is only necessary for negative programming values.

Example:	Limit value, maximum	+100.0 °C	H100 CR	or	H01000
	Factor	1.035	F1.035 CR	or	F10350

6.3.9 Limit values

Two limit values (maximum and minimum) can be programmed per measuring channel. Exceeding one of these limit values is treated as a fault (in the same way as exceeding a measuring range limit or as sensor breakage).

To activate an alarm switch a suitable output cable ZA 1000-GK with a semiconductor relay or relay adapter ZA8000-RTA can be connected at output socket A2; (see 5.1.2/3). If a measuring channel becomes faulty the alarm relay will close. The disturbance is only considered to have cleared when all measured values have returned to within the limit value by 10 digits (hysteresis). The hysteresis setting can be modified as required; (see 6.2.7). Relays can be assigned to limit values on a selective basis (as described in 6.10.8).

It is also possible to specify an action affecting process control to be initiated in the event of a limit value being exceeded; (see 6.3.3).

Function	Commands	Response
Stipulate the channel	Exx	
Limit value - maximum (Hi)		
Program	H-xxxxx	
Delete	C08	
Output	P08	LIMIT VAL. MAX: 01: +0050.0 °C

Limit value - minimum (Lo)

Program	L-xxxxx	
Delete	C09	
Output	P09	LIMIT VAL. MIN: 01: +0010.0 °C

6.3.10 Correction values

Each measured value can be corrected for zero-point and gain with the correction values ZERO-POINT and GAIN and then scaled with BASE VALUE and FACTOR. The measured value displayed is calculated as follows:

Corrected measured value = (measured value - ZERO-POINT) x GAIN

Displayed measured value = (corrected measured value - BASE VALUE) x FACTOR

If scaling is not necessary the functions BASE VALUE and FACTOR can also be used for measured value correction; (see 6.3.11).

On V6 devices, 2390-5 and above, multi-point calibration and linearization can be performed on the connector; (see 6.3.13).

Zero-point adjustment

Use a physical variable as zero (e.g. temperature sensors in icy water, short-circuit voltage, or depressurized pressure transducer, etc.).

The displayed measured value must be programmed as zero-point correction value. This procedure can be automated by zero-point adjustment of the measured value.

On some sensors this zero-point adjustment procedure has a special function.

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

When a pH probe (pH or PH as units), conductivity probe, or O_2 probe is immersed in the appropriate calibration solution, it is possible to perform both zero point adjustment and automatic gain adjustment with the same command.

Gain adjustment

Use a physical variable as an exactly defined setpoint (e.g. temperature sensor in boiling water, applying calibration voltage, etc.).

Define the actual value in the function MEASURED VALUE.

The correction factor is calculated from setpoint / actual value.

Function	Commands	Response
Zero-point adjustment	f1 C01	
Program the zero-point correction	f1 O-xxxxx	
Delete the zero-point correction	f1 C06	
Output the zero-point correction	f1 P06	ZEROPT: 01: -0001.1 °C
Program the gain correction	f1 F-xxxxx	
Delete the gain correction	f1 C07	
Output the gain correction	f1 P07	GAIN: 01: 1.0123

Whenever the measuring range is changed the correction values are deleted.

6.3.11 Reference value, scaling, decimal point setting

One very useful function is to **zero the measured value** at certain locations or at certain times as a reference value from which subsequently only the deviations need be observed.

On transmitters with a standard output (e.g. 0/4 to 20 mA) scaling will nearly always mean subjecting the physical variable to zero-point shift and multiplication by a factor in order to correctly display the actual value.

Displayed value = (corrected meas. value - BASE VALUE) x FACTOR (s. 6.3.10)

The FACTOR can be programmed within the range -2.0000 to +2.0000. For factors below 0.2 or above 2.0 the decimal point shift should be specified by entering the EXPONENT.

Decimal point shift

Newly scaling measured values often requires not only correction by a FACTOR but also a decimal point shift in order to correctly dimension the values. The FACTOR can for this purpose be assigned an EXPONENT which can be used to shift the decimal point as far as this can be presented on the display or in the printout. An exponential view of measured values is not possible.

Decimal point shift by 1 place to the right	EXPONENT = +1
Decimal point shift by 1 place to the left	EXPONENT = -1

If the measured value is already assigned an exponent by default this must be taken into account.

Example

A temperature transmitter with 4 to 20 mA output signal for the range -100 to +400 °C should be connected to the measuring instrument and the temperature should be displayed. With the 4 to 20 mA signals the measuring range "Percent" should preferably be used; this converts the measured signal initially into values from 0.00 to 100.00 %. UNITS will be changed to °C; see 6.3.5. This is adapted to the temperature nominal values by setting the decimal point with EXPONENT and calculating the correction values BASE VALUE and FACTOR.

Actual values	Start A_I = 0.00 %	End E_I = 100.00 %
Nominal values	Start A_S = -100.0 °C	End E_S = +400.0 °C

The best approach is first to correct the decimal point according to the required resolution. In our example the actual values have 2 decimal places and the nominal values have only 1; the decimal point must therefore be shifted by one position to the right by means of EXPONENT +1.

After changing the units and shifting the decimal point the new actual values should now be as follows:

	E XPONENT = +1	Unit = °C
Actual values	Start A_I = 0.0 °C,	End E_I = 1000.0 °C

The scaling values can now be calculated using the following formula:

$$\text{FACTOR} = \frac{E_S - A_S}{E_I - A_I} = \frac{400.0\,°C - (-100.0\,°C)}{1000.0\,°C} = 0.5000$$

$$\text{BASE VALUE} = \frac{-A_S}{\text{FACTOR}} + A_I = \frac{-(-100.0\,°C)}{0.5} = 200.0\,°C$$

If the factor is above 2.0 the resolution must be lowered: if the factor is below 0.2 the resolution should be raised.
If the base value (including decimals) is greater than 65000 either the resolution must be lowered or the factor must be set as gain correction; (see 6.3.10).
The BASE VALUE will change to BASE VALUE = A_I - A_S

Functions	**Commands**	**Response**
Stipulate the channel	`Exx`	
Change the units	`Dx`	
Decimal point shift		
1 place to the right	`V1`	
2 places to the left	`V-2`	
Base value		
Set measured value to zero	`C01`	
Program	`O-xxxxx`	
Delete	`C06`	
Output	`P06`	`BASE VALUE 01: -0001.1 °C`
Factor		
Program	`F-xxxxx`	
Delete	`C07`	
Output	`P07`	`FACTOR 01: 1.0123`

Whenever the measuring range is changed the scaling values are deleted.

6.3.12 Sensor locking

Programmed values can be protected against unintended alteration by enabling the locking mode per measuring channel; this will safeguard certain functions up to the locking level selected against reprogramming. Standard sensors are set on leaving our factory to locking level 5; i.e. measuring range, units, correction values, and scaling are protected but limit values can be modified. At locking level 7 limit values too are protected. In order to modify functions protected in this way the locking mode must be lowered to an appropriate level; e.g. to change the measuring range or to program an additional channel locking must be cleared, i.e. set to zero. If the locking mode is shown with a dot, modification is not possible.

Locking level	Locked functions
0	keine
1	Measuring range, plus element flags
2	Measuring range, zero-point correction, gain correction
3	Measuring range, plus units
4	plus zero-point correction and gain correction
5	plus base value, factor, exponent
6	plus analog output start and end, and temporary zero-setting
7	plus limit values, maximum and minimum

On new devices, in locking level 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 the locking mode to level 6.

Functions	Commands	Response
Stipulate the channel	`Exx`	
Locking level x	`f1 kx`	
Program		
Check	`f1 P00`	`LOCKING 4`
or	`f1 P15`	see 6.10.1

6.3.13 Special measuring ranges, linearization, multi-point calibration

With the new ALMEMO® special connectors with extra memory for additional data (larger EEPROM, code E4) the following tasks can now for the first time be elegantly performed (V6 devices) :

1. Provision of special measuring ranges with characteristic in the connector (see 2.2)
2. Linearization of signals for voltage, current, resistance, or frequency - set by the user
3. Multi-point calibration of all sensors

With option KL it is also possible to convert measuring signals into equivalent display values based on a characteristic of up to 30 support values. These support points are programmed to the EEPROM in the ALMEMO® connector using the AMR-Control software. During a measuring operation the measured values between these points are interpolated on a linear basis. When correcting non-linear sensors (e.g. with Pt100 or thermocouple sensors) initially the original characteristic is considered; and only then are the deviations interpolated on a linear basis and inserted.

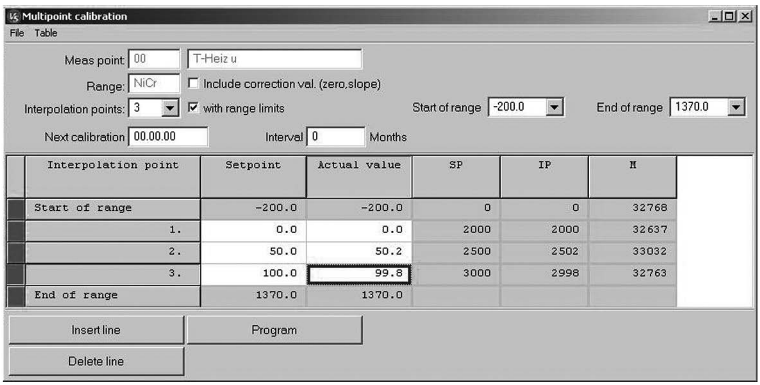
Connectors with such a characteristic can be processed as standard by all V6 ALMEMO® devices with effect from the 2390-5 (2390-5/8 from V6.23 up, and 2690 from V6.21 up, update possible). It is only for programming the characteristic that devices from 2690-8 up need the KL option. It should be noted that only ALMEMO® connectors with the larger EEPROM (code E4) can be programmed in this way.

Programming a multi-point characteristic in the ALMEMO® connector

Connect the sensor at an input socket, connect the data cable to socket A1 on the measuring instrument and to the COM port on the PC. On the PC launch the AMR-Control software (V.5.7 up).

In the “Measuring points” menu, from the list, select the desired channel and click “Program measuring point”. Under “Measuring point” there are the menus ´**Multi-point calibration**´ and ´**Special linearization**´. These two menus are almost identical - except that ´Special linearization´ also permits changing the units and shifting the decimal point. Both provide a table in which up to 35 actual values and nominal values can be entered. The number of support points can be stipulated by an appropriate entry in the input field or by appending the appropriate number of rows.

Only 1 channel per connector can be assigned a characteristic.
The other 3 channels can be used as normal.



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Measured value processing

Measuring signal	Measuring signal
Standard linearization	Standard linearization
Multi-point calibration	Measured value correction
Measured value correction	Multi-point calibration
	Correction values into account
Scaling	Scaling
Output	Output

If sensors have already been corrected for zero-point or gain (e.g. DKD calibration), these correction values can be used by clicking the option ´**Use correction values - zero-point and gain**´. The base value or factor can, when programming, be shifted in zero-point or gain (if these have not yet been programmed). In so doing, however, if the decimal point in the actual values does not match the measuring range, the decimal point shift must be taken into account. The best approach is to obtain the characteristic directly from uncorrected measured values.

The option ´**With range limits**´ in the menu ´Multi-point calibration´ ensures a smooth transition up to the measuring range start and end. The option ´Without range limits´ is only available for the measuring range between the first and the last support points. As soon as a value occurs outside the measuring range a signal is issued indicating that the measuring range has been overshot/undershot.

Clicking on the ´**Program**´ button causes the linearization table to be written to the EEPROM on the sensor connector.

☞ To read in the new characteristic either the device must be switched off and then on again or the connector unplugged and then plugged in again.

The interface log for the ´P15´ command includes the following identifier codes:

1. Devices capable of processing special characteristics display, in the header for sensor programming, a ´.´ after ´DESIGNATION´.
2. Devices with option KL, which can write special characteristics to the connector, display a ´!´ in this position.
3. All sensor channels programmed with special characteristics display a ´!´ in position 10 of the designation. This identifier code is not affected if the designation is programmed.

```
 AMR ALMEMO 2690-8
1. RANGE LIMIT MAX LIMIT MIN BASIC  D FACTOR EXP AVERAG. DESIGN.
2. RANGE LIMIT MAX LIMIT MIN BASIC  D FACTOR EXP AVERAG. DESIGN!
3. 00:NiCr  - - -   - - -   - - - °C - - -  E+0  - - - - Temp.!
```

If a channel with a characteristic is deactivated or programmed with a different range, the characteristic can subsequently be restored by programming the special range ´Lin´ using the keypad or command ´B99´.

6.4 Acquiring measured values

ALMEMO® devices provide the following possibilities for measured data acquisition :

Continuous measuring point scans of all measuring points with settable conversion rate, output of measured values on the display, and analog output, plus limit value monitoring and peak value saving.

Once-only (manual) / cyclic / continuous measured value output to a printer or computer or to the device memory (option).

6.4.1 Selecting a measuring point

The device switches channel Mxx to the measuring circuit by means of command Mxx. The measuring point can be programmed or the current and saved measured values can be called up. The measured value is output continuously to an analog output if one is available. On completion of the measuring point scan of all channels this measuring point is selected again automatically.

Command	Command	Response
Select measuring point 2	`M02`	`M02`

6.4.2 Measured values

The measured values for each channel can also be called up individually. The measured value at the selected measuring point can be set to zero by transferring the measured value to the BASE VALUE (see 6.3.11) or to ZERO-POINT CORRECTION (see 6.3.10).
On the new V6 devices 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	Command	Response
Output the measured value for measuring channel	`p`	`01:+0023.5 °C`
Output the measured value for input channel	`P01`	`12:34:00 01:+0023.5 °C`
Set the measured value to zero (base value)	`C01`	
Adjust the measured value (zero-point correction - for pH, atmospheric humidity, and O2, also gain correction).	`f1 C01`	
Switch calibration resistance on / off.	`o(-)01`	(only V6, s. 3.6.2)
Enter setpoint	`f2 gxxxxx`	(only V6)
Adjust setpoint	`f2 C01`	(only V6)
Output setpoint	`P45`	`SETPOINT: 01: 5.000 br`

6.4.3 Peak values

From the measured values per selected measuring point the highest and the lowest values are determined and stored for each. The maximum value and minimum value per channel can be output individually or all together in a list; these values can be deleted in the same way. The peak values are also deleted each time the measuring range is changed and, if so configured, at the

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start of each measuring point scan (see 6.10.13).

► On the new V6 devices the date and time-of-day of the peak values are also recorded and output.

Funcktion		**Command**	**Response**
MAXIMUM VALUE	output	P02	MAX. VALUR: 01: +0020.0 °C
	delete	C02	
MAXIMUM TIME / DATE	output	P28	MAX. TIME: 01: 12:34 01.02.
MINIMAL VALUE	output	P03	MIN VALUE: 01: -0010.0 °C
	delete	C03	
MINIMUM TIME / DATE	output	P29	MIN. TIME: 01: 12:34 01.02.

6.4.4 Output measured value list

The current measured value, maximum value, minimum value, and average value (together with the number of values averaged) can be called up for all active measuring channels; these values can be deleted in the same way.

Function	**Command**	**Response**
Measured value list	P18	MS MEAS.VAL. MAX.VAL. MIN.VAL. AVER.VAL COUNT
		00: +0012.0 +0045.1 +0009.0 - - - 00000
		01: +0023.0 +0025.0 +0019.0 +0022.1 00025
Delete all measured values	C18	

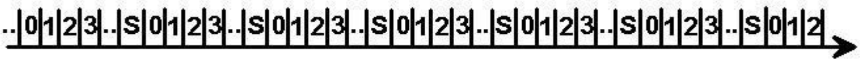
It is also possible to delete all measured values automatically whenever a measuring point scan starts; (see 6.10.13.2).

6.5 Measuring point scan and measured value output

Basically there are three different types of measuring point scan :

Continuous measuring point scan

With continuous measuring point scanning all measuring points are scanned and recorded equally often at the set conversion rate; the maximum value and minimum value are acquired, the average value is formed, and the limit values are monitored; this is caused by the switching action of semiconductor relays. On completion of each such process a special measuring operation "S" is performed - for zero-point adjustment, cold junction temperature, measuring current calibration, or supply voltage measurement.



The advantage of this scanning method is the quick and uniform data acquisition from all measuring points. A disadvantage is that in certain circumstances with a lot of measuring channels the updating rate for the selected measuring point may be slow. For this reason on V6 devices semi-continuous scanning has been introduced.

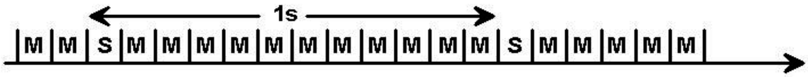
Semi-continuous measuring point scan

With semi-continuous measuring point scanning (setting = "not continuous") all measuring points are continuously scanned - but the selected measuring point “M” is assigned preferred status and is rescanned with each second measuring operation. For averaging, smoothing, or analog output this channel can thus be accessed at 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

Special case - only one active measuring point

If only one measuring point is active the special measuring operation is only performed approx. once per second and the measured value is extrapolated. This is virtually the full measuring rate.



Basic setting

On the smaller V6 devices (those with less than 5 sockets) the default setting on leaving our factory or after a reset is semi-continuous measuring point scanning; on the larger V6 devices it is continuous measuring point scanning.

6.5.1 Measured value output / saving

Data acquisition via the interface or saving to the device memory are performed primarily on the basis of the cycle. However, recording can be accelerated by using the conversion rate itself.

It is possible to stipulate separately whether the conversion rate / cycle should be used to output measured values via the interface or, with data loggers, to also save these values to memory. This is the purpose of **memory activation** parameter “**S**” for the cycle (see 6.5.2) and **software switches C, S, U** (continuous, memory, interface) for the **conversion rate** (see 6.5.4).

The **output format** can be selected to provide the desired print layout for the printer or a table format for import into a spreadsheet program.

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6.5.1.1 Once-only output / saving of all measuring points

Operating states at irregular intervals can be acquired by specifying once-only measured value outputs. These can be initiated via the keyboard, interface, or external triggering (see Section 6.6). Once-only measured value outputs of this nature can be used by computer-controlled scans with their own process control, in particular in a network. To initiate via the interface there is a dedicated command; on most key-controlled devices this will be the MANUAL key.

Function	Once-only measured value output
Command	`S1` or `s`

Response	`DATE:   01.02.06`
	`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. To also save these measured values memory activation must be enabled in the cycle.

6.5.1.2 Cyclic output / saving of all measuring points

Cyclic measured value output is based on the cycle; (see 6.5.2). This outputs measured values via the interface and to the memory and provides cyclic calculation and output of the maximum, minimum, and average values.
Flowchart and programming (see below, 6.5.1.3)

Function Start cyclic output of measured values
Command `S2`
Response
```
DATE:   01.02.06
12:34:00 01: +0008.9 °C NiCr Water.
         02: +0023.4 °C NiCr Air
12:44:00 01: +0009.5 °C NiCr Water.
         02: +0022.1 °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 this channel can be output or saved at the full conversion rate. In other cases the measuring rate per measuring point will be affected by the fact that after each measuring point scan a special measuring operation is performed

Measuring rate / channel = conversion rate / number of channels + 1

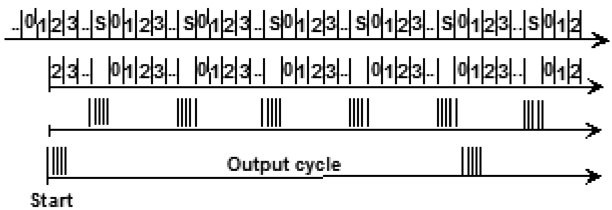
Process Diagram:

Scan continuously

Store continuously

Output continuously

Cycle output



Continuous measured value output	**WR**	**Cycle**	**AK**
Continuous scan, cyclic output	C---	hh:mm:ss	U
Ditto plus cyclic saving to memory	C---	hh:mm:ss	S
Semi-continuous scan	----	00:00:00	U
Continuous scan	C---	00:00:00	U
Continuous output	C--U	00:00:00	U
Continuous saving to memory	C-S-	00:00:00	U
Continuous output, continuous saving to memory	C-SU	00:00:00	U
Cyclic output, continuous saving to memory	C-S-	hh:mm:ss	U

Function	Start continuous measured value output
Command	`S2`
Response	`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`

► With continuous outputs the time resolution increases to 0.01 seconds; (see 6.6.1).

6.5.2 Print cycle

This cycle, with the aid of the cycle timer, permits cyclic output of measured values via the interface. The cycle can be set to any value between 00:00:01 (1 second) and 59:59:59 hh:mm:ss. The cycle timer counts down the time and on reaching zero starts again. If a measuring point scan lasts longer than the cycle time it will be omitted.

Cycle	Command	Response
Program	`Zhhmmss`	
With memory activation	`I+hhmmss`	
Without memory activation	`I-hhmmss`	
Switch memory activation on	`f1 A4`	
Switch memory activation off	`f1 A-4`	
Stop and delete	`C11`	
Output	`P11`	`PRINT CYCLE: 00:01:30`
Output the cycle timer	`f1 P11`	`PRINT TIMER: 00:01:23`
Switch sleep mode on / (off)	`o(-)11`	

6.5.3 Measuring cycle

The measuring cycle has been largely phased out and replaced by continuous measuring; it is no longer supported by V6 devices.

6.5.4 Conversion rate

Continuous measuring point scanning can be configured in terms of the conversion rate and 3 software switches for continuous scan, output, and save to memory. This setting can be called up via main programming; (see 6.2.3).

Function	Identifier	Commands	
Conversion rate 2.5 mops, switches C,S,U off	`003`	`f5 k0`	
Conversion rate 10 mops	`010`	`f5 k1`	
Conversion rate 50 mops (depending on type)	`050`	`f5 k7`	
Conversion rate 100 mops (depending on type)	`100`	`f5 k8`	
Conversion rate 400 mops (depending on type	`400`	`f5 k9`	
		On	**Off**
Continuous scanning	`C`	`f5 k2`	`f5 k-2`
Continuous saving to memory	`S`	`f5 k4`	`f5 k-4`
Continuous output	`U`	`f5 k5`	`f5 k-5`

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Conversion rate, above 10 mops

Larger V6 measuring instruments (from ALMEMO® 2690-8 up) are by default fitted with a high-speed measuring module supporting the higher conversion rates of 50 and 100 mops (measuring operations per second). It should be noted, however, that the higher the measuring rate so the lower the measuring quality and, conversely, the lower the rate, the higher the quality.

Restrictions

At conversion rates above 10 mops the shorter evaluation times may result in the following restrictions :

1. Mains hum suppression is not possible; as a result accuracy may be adversely affected by interference over the connection lines; (wherever possible use twisted wires).
2. Sensor breakage detection can be only partly supported.
3. At 100 mops recording is at present only possible with a multimedia card.

Data transmission to a computer terminal (e.g. AMR-Control)**:**

Settings on the ALMEMO® device

e.g. conversion rate 50 mops, continuous scanning and output

At conversion rate 50 mops with continuous output it is possible, during the measuring operation, to write the measured values to a file (e.g. in table format) and then, after the measuring operation has been completed, to evaluate this file (e.g. in MS-Excel).

WIN-Control measured value acquisition software

Settings on the ALMEMO® device : Conversion rate 50 mops, continuous scan

Settings in WIN-Control : Measuring cycle 00:00, high-speed data transmission

At conversion rate 50 mops with the "continuous" setting, WIN-Control acquires measured values from online measuring operations on an uninterrupted basis. WIN-Control performs approximately 40 to 50 scans per second (depending on computer hardware and baud rate) irrespective of the number of measuring points; i.e. with just **one** measuring point it might reach only 15 measured values per second but with 6 measuring points, up to 90 measured values per second.

6.5.5 Output format setting

The measured values from a measuring point scan can be output via the interface in three different formats. The command Nx is used to select from the following formats : list (one below the other), columns (one beside the other), or table format; (see 6.6.1). The abbreviation for the output format is displayed in the programming header after the print cycle. In table format data saved to memory can be imported directly into any of the usual spreadsheet calculation programs (semi-colon as field delimiter, and stop as decimal point).

Output format	Abbreviation	Command
Measured values in a list (one below the other)	U	N0
Measured values in columns (one beside the other)	Un	N1
Measured values in a table	Ut	N2

6.6 Starting and stopping a measuring operation

Measuring operations with cyclic measuring point scans can be started / stopped in many different ways - depending on the application. The first method is manual by pressing the START / STOP keys. These operations can be automated using the serial interface, the real-time clock with start time and end time or measuring duration, or the tripping of a limit value on a measuring channel. External electrical signals can also be used as the triggering event. All these methods are viable alternatives.

6.6.1 Via the interface, output protocols

The various measuring point scans produce the following output protocols, depending on the output format selected (see 6.5.5):

Once-only 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 a cyclic output without output of header

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

Start a cyclic output with output of header

```
S3
                AMR ALMEMO 8590-9
Programming     {SI}MEAS RANGE LIMIT-MAX  LIMIT-MIN  BASE  D FACTOR EXP AVERAGE
                DESIGNATION
                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:  00:00:00 S  S0500.3 F0118.5 AR  W010 C-SU
                PRINT CYCLE : 00:01:30 U  9600 baud
Start / end     START TIME 10:30:00
if programmed   END TIME    18:30:00
                END DATE :   15.01.98
Number          NUMBER:  12-001
Date            DATE :   01.02.94
```

{SI} = 0FH = condensed script, **{DC2}** = 12H = normal script (for printer)

1. List format (one below the other)

```
Cyclic             10:30:00 01: +025.31 °C Ntc  T external
                            02:!+0016.8 °C NiCr T internal
                            10: +0039.5 %H °o H humidity

Continuous         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 0.01 s  10:31:30.30 01: +025.87 °C Ntc  T external
```

2. Column format (one beside the other)

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

3. Table format

Header	"ALMEMO";"RANGE:";"Ntc ";"NiCr";;;"°o H"
	"5690-2";"DESIGNATION:":"T external";"T internal";;;"humidity"
	;"LIMIT-MAX:";;35,
	;"LIMIT-MIN:";;;18,
Title	"DATE:";"TIME:";;M01: °C";"M02: °C";;;"M10 %H"
Measured values	"12.03.06";"10:31:30";+25,31;+16,8;;;39,5
Continuous	"01.10.06";"10:31:30.10";25.8
Resolution 0.01 s	"01.10.06";"10:31:30.20";25.9
	"01.10.06";"10:31:30.30";26.1

Once-only scan without returning date and time-of-day

s ;;26.1;+16,8;;;39,5

End of cyclic output

Command : X

6.6.2 Start time - end time / measuring duration

A measuring series can be started and / or stopped automatically at specified times. The start date and time-of-day and end date and time-of-day can be freely programmed for this purpose. If no particular date has been programmed, the measuring operation will be performed every day within the set period. Or the measuring operation can be terminated automatically after a certain measuring duration.
The time-of-day must already have been programmed and started.

Start time	**Commands**	**Response**
Program	f1 Uhhmmss	
Delete	f1 C10	
Output	f1 P10	START TIME : 12:34:00
End time		
Program	f2 Uhhmmss	
Delete	f2 C10	
Output	f2 P10	END TIME : 12:34:00
Start date		
Program	f1 dttmmyy	
Delete	f1 C13	
Output	f1 P13	START DATE :01.02.05
End date		
Program	f2 dttmmyy	
Delete	f2 C13	
Output	f2 P13	END DATE : 01.02.05
Measuring duration		
Program	f2 Ihhmmss	
Output	P47	MEAS DURATION : 02:00:00

6.6.3 Actions in the event of a limit value being exceeded

Another way to automatically start or stop a measuring operation is by triggering in the event of a limit value being exceeded. With this method uninteresting measured values can be mostly suppressed. Using macros (see 6.6.5) it is also possible to implement more complex process controls. The limit values must be programmed as per Section 6.3.9.

Function	Commands	Code
Select channel	Exx	
Actions in the event of a limit value - maximum being overshot		
START a measuring operation	h1	S-
STOP a measuring operation	h2	E-
Individual measuring operation MANUAL	h3	M-
Zero-set 0.1s timer	h4	Z-
Execute macro 5 ... 9	h5..9	5-..9-
Delete action and relay assignment	h0	--
Actions in the event of a limit value - minimum being undershot		
START a measuring operation	l1	S-
STOP a measuring operation	l2	E-
Individual measuring operation MANUAL	l3	M-
Zero-set 0.1s timer	l4	Z-
Execute macro 5 ... 9	l5..9	5-..9-
Delete action and relay assignment	l0	--

In the sensor programming (see 6.10.1) a code is assembled for actions and alarm relay assignment (see 6.10.8) in the event of a limit value - maximum (AH) or limit value - minimum (AL) being exceeded.

6.6.4 External triggering

The ALMEMO® range of accessories includes trigger cables (ZA 1000-EK/ET) for alternately starting / stopping a measuring operation. Combined input-output cables (ZA 1000-EGK/EAK) are also available; these also permit alarm reports but cannot change their triggering function; (see 5.1.2). On V6 devices the available triggering functions have been extended by a series of macros (see 6.6.5) and now support selective programming of the trigger function and the relay function; (see 6.10.9). The triggering module is usually connected at output socket A2 on the ALMEMO® device.
The following trigger functions can be programmed; (see 6.10.9):

- Once-only measuring point scan
- Delete maximum - minimum values
- Print the function
- Set measured value to zero
- Execute macro

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6.6.5 Macros

This section explains how virtually all functions performed by ALMEMO measuring instruments can be automated in the form of interface commands. It can be be very useful to have a series of functions performed automatically in the event of certain criteria causing a trigger signal to be output or in the event of a limit value being exceeded.
This may be e.g. to change the cycle or the measuring rate, to activate continuous saving to memory, or to output various analog values at the analog output, etc.
This automation possibility is now supported. A series of commands with up to 30 characters can now be saved in the device as a macro, up to 5 macros are possible (codes 5 to 9). The commands must be entered one after the other (also leading fx commands) and separated from one another by a pipe character (vertical line) ´|´ (AltGr <). Standard macro length is 30 characters but it is possible to go beyond this; on reaching the end of one macro simply call up another one `(m-5..-9)`.

In macro 5 enter the V24 command xxx (<30Z)	`f-5 $xxx CR`
In macro 6 enter the V24 commands xx and yyyy (<30Z)	`f-6 $xx|yyyy CR`
In macro 7... 9 enter the V24 commands xx and zzz (<30Z)	`f-7..-9 $xx|zzz CR`
Output macro 5 ... 9	`f-5..-9 P20`
Set macro 5 ,.. 9 as trigger function for port xx (A2: xx=28)	`ixx f9 k-5..-9`
Assign macro 5 ... 9 to a limit value - maximum :	`h5..9`
Assign macro 5 ... 9 to a limit value - minimum :	`l5..l9`
Macros 5 ... 9 are called up via the interface :	`m-5..-9`

Thanks to the new timer measuring channel even time-controlled sequences can now be implemented.

Example 1 In the event of a limit value being exceeded the normal cycle is to be reduced to 5 seconds.
As soon as the reading returns to within the limit value the normal cycle of 10 minutes is to be restored.

Working steps :

Select the measuring channel e.g. M1:	`M01`
Program the limit value - maximum to e.g. 70°C :	`H70 CR`
Program the limit value - minimum to e.g. 70°C :	`L70 CR`
Program macro 5 to cycle 5 seconds :	`f-5 $Z000005 CR`
Program macro 6 to cycle 10 minutes :	`f-6 $Z001000 CR`
Check macro 5 :	`f-5 P20`
Response :	`Z000005`
Assign macro 1 to limit value - maximum :	`h5`
Assign macro 2 to limit value - minimum :	`l6`
Start the cycle :	`S2`

Example 2 In the event of a limit value being exceeded the measured values are to be saved to memory continuously at the measuring rate for a period of 20 seconds.

Working steps :

Select the virtual channel e.g. M5 (2690-8) :	`M05`
Program the timer :	`B85`
Set the limit value - maximum for the timer to 20 :	`H20 CR`
Select the measuring channel e.g. M1:	`M01`
Program the limit value - maximum to e.g. 70°C :	`H70 CR`
Program macro 5 :	`f-5 $`
Set timer to zero :	`f3|C01`
Switch continuous saving to memory on :	`|f5|k4 CR`
Program macro 6 :	`f-6 $`
Switch continuous saving to memory off :	`f5|k-4 CR`
Assign macro 5 to limit value - maximum for M1 :	`M01 h5`
Assign macro 6 to limit value - maximum for M5 :	`M05 h6`
Start the measuring operation :	`S2`

Example 3 On each trigger signal the memory content is to be output and then deleted.

Macro 7: Output memory, then delete	`f-7 $P04|C04 CR`
Assign macro 7 to trigger signal for port xx :	`ixx f9 k-7`

The trigger cables must be configured for V6 !!!

☞ The macro functions are only available on V6 devices from ALMEMO® 2490 up manufactured with effect from Autumn 2005. Older devices must be retrofitted with a 4-KB EEPROM; otherwise an ERROR message will be output.

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6.7 Measuring functions in measuring point scans

There are a number of measuring tasks and special measuring ranges requiring cyclic measuring point scans and defined sensor arrangements.

6.7.1 Pulse measuring, summation

For the purposes of pulse measuring the ALMEMO® connector spectrum includes frequency measuring module ZA 9909-AK2 which with its own small microcontroller counts the pulses in the sensor connector; (see 4.2.5). The only difference between cable ZA 9909-AK1 for frequency measuring and cable ZA 9909-AK2 for pulse measuring is their programming, i.e. `FREQ` or `PULSE`.

Pulse measuring in the `PULSE` measuring range is intended for signals with a low repetition rate that are to be acquired over a fairly long period. The 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. If a measuring cycle of 1 minute is programmed the number of pulses per minute will be displayed each minute.
To acquire the total number of pulses or the number of pulses over cyclic periods the following function channels are provided : "summation over total number of pulses" S(t) and "summation over number of pulses per print cycle S(P); (see 6.3.4). These summation values are set to zero with each new start or deleted by means of command : Zero-set measured value.
These summation values may only be scaled with a small offset or factor ! (V5 devices only)

Function	**Commands**
Stipulate the measuring channel	`Mxx`
Zero-set measured value from measuring channel	`C01`
Once-only measuring point scan and zero-set all summation values	`f1 s`

6.7.2 Atmospheric pressure compensation

Calculations of partial vapor pressure with the psychrometer, certain humidity variables such as mixture ratio and enthalpy, the dynamic pressure, and O_2 saturation all generally depend on the atmospheric pressure SP. To compensate for this the atmospheric pressure can either be programmed (see 6.2.6) or measured automatically by means of an atmospheric pressure sensor (e.g. FD A612-MA). This sensor is defined as reference by programming the first 2 characters of its designation to ´`*P`´; (see 6.3.6). If this reference sensor is disconnected the standard value of 1013 mbar will be used again automatically.

Function	**Command**
Define atmospheric pressure sensor as reference	`f2 $*P CR`

6.7.3 Measure cold junction temperature with external sensor

In existing measuring systems using thermocouples the compensation lines are often already bundled onto an isothermal cold junction bar and led from there over copper wires through to the measuring instrument. This arrangement cuts out expensive thermal lines and reduces costs. To acquire the cold junction temperature an external Pt100 sensor with ´P204´ measuring range or an NTC can be used. This must in each case be positioned upstream from the thermocouples and have the first 2 characters of its designation programmed to ´*J´; (see 6.3.6). Several cold junction sensors can be used at once. The copper wires from the thermocouples must with effect from the cold junction be connected to the measuring instrument over normal copper connectors (ZA 9000-FS).

Constant cold junction temperature

The cold junction temperature is often retained at a constant level by using icy water or by means of a thermostat. In this special case it is possible to dispense with the temperature sensor and cable and use a dummy connector instead (e.g. ZA 9000-FS); gain correction must then be set to zero and the constant temperature must be programmed with the negative base value. This measuring point will then always indicate the constant temperature being used as the cold junction.

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 2 measuring channels (one for the NTC, the other for the thermocouple). The thermocouple must have the first two characters in its designation programmed to ´#J´; this ensures that the integrated temperature sensor 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** for a measured value is needed for various applications.

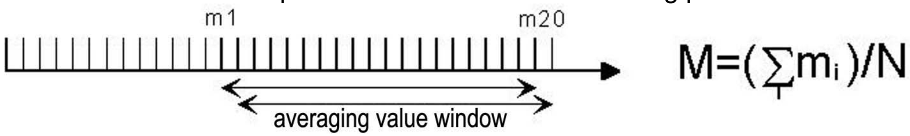
e.g. Average flow velocity in a ventilation channel
Smoothing a widely fluctuating measured value (e.g. wind, pressure, etc.)
Hourly or daily average values for weather data (temperature, wind, etc.)
Also for consumption values (electric current, water, gas, etc.)

The average value of a measured variable $\overline{M}$ is obtained by totaling a whole series of measured values (M_i) and then dividing by the number of measured values (N).

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

Smoothing measured values by means of a sliding average

The measured value smoothing function smoothes out measured values of an unstable or fluctuating nature by a process of continuous averaging; on V6 devices this is generally accessed 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 will then apply for all subsequent evaluation functions. For this function semi-continuous measuring point scanning should be selected (see 6.5) because the measuring rate - and thus the filter effect - does not depend on the number of measuring points involved.



Function	Commands	Response
Program the smoothing level (0-99)	`f1 zxx`	
Output (see 6.10.1)	`P32`	`SMOOTHING :   01:  20`

Averaging with averaging mode

All averaging processes - except measured value smoothing - are defined by the **averaging mode**.

Continuous averaging from start to stop
or over individual measuring operations, if not started with: `CONT`
Averaging over each cycle : `CYCL`

Averaging has become much more straightforward and effective compared with V5 devices - thanks to the following features :

1. Averaging is always performed after each start by means of semi-continuous or continuous measuring point scanning so long as an 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 measuring rate.
3. Measuring operations for the purposes of averaging can now also be started and stopped without the need for a cycle. On stop all measured values are now also saved; i.e. start and stop 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 (option S) or can be output via the interface.

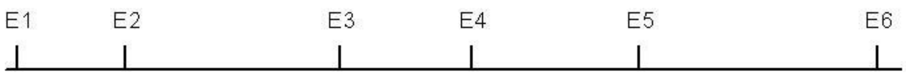
Averaging over a series of measurements is usually performed for all measuring point scans. This is activated for each measuring point by programming the averaging mode; (see 6.3.7). The average value is separately calculated and saved for each measuring point. This can be called up at any time in the function ´AVERAGE VALUE´. In ´CYCL´ mode the average value is deleted again after each cycle. So that the average values and number can also be saved or output via the interface the function channels M(t) and n(t) must have been programmed accordingly (see 6.3.4); these function channels output the average value of the reference channel to a so-called arithmetic channel. If only the average value is required instead of the measured value itself the output function M(t) can be used; (see 6.10.4).

The operating modes listed below can be configured with the following functions :

Functions	**Command**	**Response**
Program the averaging mode CONT	m1	see 6.3.7
Program the averaging mode CYCL	m2	see 6.3.7
Delete the averaging mode	m0	see 6.3.7
Program the function channel for average value M(t)	B74	see 6.3.4
Program the function channel for average value M(n)	B75	see 6.3.4
Program the function channel for number n(t)	B83	see 6.3.4
Set continuous measuring point scanning	f5 k2	see 6.5.4
Set the cycle	Zhhmmss	see 6.5.2
Start averaging	S2	
Stop averaging	X	
Output the average value of a channel	P14	AVERAGE: 01: +0021.3 °C
Delete the average value of a channel	C14	
Output all maximum, minimum, average values	P18	see 6.4.4
Delete all maximum, minimum, average values	C18	see 6.4.4

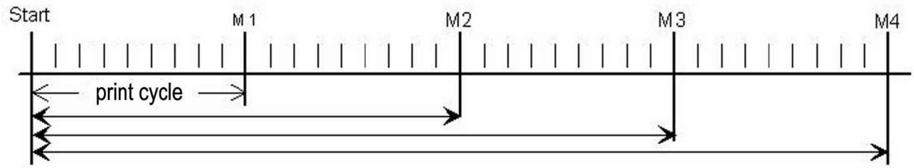
1. Averaging over several manual measuring point scans $\overline{M}=(\sum E_i)/N$

Functions		**Commands**
Stop measuring operation :		X
Function channel :	M(t)	B74
Averaging mode :	CONT	m1
Measuring point scan :	manual / once-only	S1
Average value output :	At end of measuring operation	P14, P18



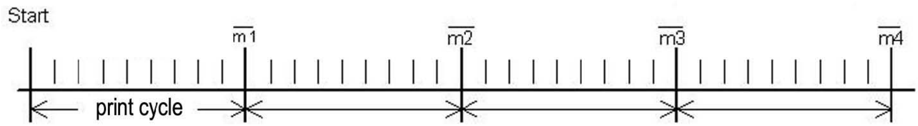
2. Continuous averaging over time $\overline{M}=(\sum M_i)/N$

Averaging mode :	CONT	m1
Function channel :	M(t)	B74
Measuring point scan : continuous		f5 k2
Start / stop measuring operation :		S2, X
Average value output Mx: In cycle		Zhhmmss
With function channel M(t), output function M(t)		
Final average value at end of measuring operation		P14, P18



3. Cyclic averaging over print cycle $\overline{m_i}=(\sum m_i)/N$

Averaging mode :	CYCL	m2
Function channel s:	M(t)	B74
Measuring point scan : continuous		f5 k2
Start / stop measuring operation :		S2, X
Average value output m_x: In print cycle		Zhhmmss
	With function channel M(t), output function M(t)	



4. Averaging over measured values from several measuring points Myy to Mxx on each measuring point scan $\overline{M}=(\sum M_i)/n$

Averaging mode :	not necessary	
Function channels :	M(n)	B74
Reference channels :	from b2=Myy to b1=Mxx (see 6.3.4)	f1 Eb1, f2 Eb2
Measuring point scan : every		Zhhmmss
Start / stop measuring operation :		S2, X
Average value output : In print cycle with function channel M(n)		

6.7.5 Volume flow measuring

For details regarding volume flow measuring 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 6.7.4).
To display the volume flow a function channel ´Flow´ is needed.

Function	Command	Response
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 cm² :	Qxxxxx	
Output the cross-section (see 6.10.1)		
Acquire measured value of function channel in m³/h :	p	10:+00834. mh

Converting to standard conditions

With all flow sensors it is possible to convert to standard conditions, i.e. temperature = 20°C and atmospheric pressure = 1013 mbar. The actual measuring conditions are defined in the functions ´Temperature compensation´ and ´Atmospheric pressure´; (see 6.2.6). To convert to standard conditions ´#N´ must be programmed in the designation (see 6.3.6) <u>either</u> in the velocity channel <u>or</u> in the volume flow channel; this then automatically produces the **standard volume flow**.

6.8 Assigning numbers to measuring operations

To identify measuring operations or series of measuring operations these can be assigned numbers which for the next measuring point scan will then be printed out or saved to memory. In this way stored single masuring operations can be assigned to certain measuring locations or measuring points. during read-out. The number can be entered using 6 digits. Digits 0 to 9 and characters -, , A, F, N, P can be used. Once entered number output is activated.

The number will be printed out automatically when activated once on the next measuring point scan. After that the number output is deactivated again.

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

The **number is saved to memory**, similarly, on the next measuring point scan if saving to memory is switched on. Output of the memory can be either its complete content together with numbering or just those measuring operations with a certain number; (see 6.9.3).

Function	Command	Response
Enter and activate number ´012001´	n012001	
or with letters ´A1-001´	f3 $A1-001 CR	
Delete and deactivate number	C05	
Number increases by one	n+	
Output number	P05	NUMBER: A1-001
Output the numbers list	f1 P05	NUMBER 012001 A1-00

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6.9 Measured value memory

ALMEMO® data loggers incorporate an internal memory, ranging from 32 KB to 2 MB, for saving measured values. The memory requirement per measuring point scan is 4 bytes for the time-of-day and 4 bytes for each measured value; i.e. with more than 2 measuring points over 100,000 measured values can be saved. Data can be saved to memory either automatically per cycle or per conversion rate or manually. Individual measuring operations or whole series of measuring operations can be assigned a 6-character number (memory requirement 3 bytes) and selectively read out according to this number. They can also be selected according to date and time-of-day.

Please note :

The first time data acquisition is started the configuration of the connected sensors is saved to memory. If the next time it is started certain sensors have been added in the meantime these will also be incorporated in the saved configuration. However, during subsequent measuring operations sensors must not be exchanged because this would probably cause incorrect assignment of range, units, decimal point, and designation. If the sensor configuration is changed, the previous measuring operation must be read out and the memory must be cleared before the new configuration is saved (exception Memory connector with Micro SD card or MM card, see 6.9.1).

Functions of the internal memory

Only one sensor configuration is possible.
Recording to ring memory
Sleep mode
Data output in any normal format
Selective data output according to date and time-of-day
Selective data output by number

6.9.1 Saving data to external storage media (ALMEMO® memory connectors, Micro-SD card, MMC 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-only interface. These external memories are detected automatically and, so long as they remain connected, they are used instead of the internal memory. This can also be seen in the display in terms of the available memory.

1. ALMEMO® memory connector ZA1904-SD for memory card

Measuring instruments : V6 ALMEMO® 2590-2/3/4, 2690, 2890, 4390, 8590, 5690 ff.
Capacity : 128 MB up to 2 GB (approx. 30000 measured values per MB)

2. ALMEMO® memory connector ZA1904-SD/MMC for memory card

Measuring instruments : V6 ALMEMO® 2590-2/3/4, 2690, 2890, 4390, 8590, 5690 ff

Capacity : From 128 MB to 2GB(approx. 30,000 meas. values / MB)

Newly developed memory connector ZA 1904-SD with a conventional micro SD flash memory card can make a data logger out of a device with no internal memory of its own. Measured data is written to this memory card via the memory connector; this data is in table mode and standard FAT16 format. The memory card can be formatted and its contents can be read out and / or deleted on any normal PC using any standard card reader. (see 6.9.4.2)

This data can then be imported into MS-Excel or into Win-Control. The memory connector works in a completely different way to the device-internal memory; this brings both restrictions and advantages.

Functions of the memory connector

Virtually unlimited memory capacity
With each new connector configuration a new file is created.
No ring memory recording
Sleep mode possibly
Data can be evaluated using any reader on site or elsewhere.
Very high-speed data transfer via the reader
Data recording and output in table format only
Via the ALMEMO device itself only the last file can be read.
No selective data output according to date and time or by number

Before starting any measuring operation an 8-character file name can be entered. In the absence of a user-assigned file name, the default name ´ALMEMO.001´ or the name most recently used will be suggested automatically. So long as the connector configuration is not altered, any number of measuring operations can be saved - either manually or cyclically, also with numerical assignment, all in the same file.

If, however, the **connector configuration** has been **changed** since the last measuring operation and if no new file name has been programmed, then a new file is always created and in so doing the index in the file name extension is automatically incremented by 1, e.g. ´ALMEMO.002´. Similarly, if the file name entered already exists, then a new file will be created with the same file name prefix but with a new index.

For the purpose of long-term recording it is possible, as and when the date changes, to close the file currently running and open a new one. To activate this function a file name must be used beginning with the character ´&´ (e.g. ´&Test´). The file name extension will be incremented automatically by +1 from ´000´ up to maximum ´999´. The complete file names will thus be ´&Test.000´ up to ´&Test.999´.

Function	**Command**
Enter file name (maximum 8 characters)	$NAME CR
File names for automatic generation of daily files	$&NAME CR

This applies for all external storage media.

For data acquisition purposes the memory connectors are plugged into socket

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A2; (the trigger and relay cables can also be plugged into socket A1). 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.

6.9.2 Measured data recording

For measured value saving it is sufficient in most cases to simply enter a cycle (see 6.5.2) and press the start button. It is advisable to just check whether date and time-of-day are correctly set; (s. 6.2.8).
However, to properly handle more complex tasks a series of special configurations are possible.

Rapid recording
Or for particularly high-speed recordings the conversion rate can be used; (see 6.5.4). The various operating modes are described in detail in Section 6.5.

Starting and stopping
To start / stop automatic saving various methods can be used; these are explained in Section 6.6.

Scanning modes
For the various types of application (long-term recording, autonomous operation, and / or scanning by computer) there are 4 scanning modes to choose from; (see 6.9.2.1).

Ring memory mode
If, during long recordings, only the most recent data is of interest, the operating parameters can be set to ring memory mode; (see 6.10.13.2).

Number
To ensure that measuring operations or series of measuring operations can be more easily recognized or selectively read out later, these should each be assigned a number; (see 6.8).

File name
If a memory card is being used you can create a new file for each measuring operation and assign it a suitable 8-character file name.

Memory configuration
The most important parameters for memory configuration are available as follows :

Command	`f4 P19`	
Response	`SI:0512.4k R`	Memory capacity, internal (R = ring memory)
	`SE:256.00M`	Memory capacity, external
	`SF:0324.5k`	Memory available
	`SZ:0001.18:20`	Remaining memory time : tttt.hh:mm
	`U3:07:00:00`	Start time for memory output
	`D3:01.02.06`	Start date for memory output
	`U4:17:00:00`	End time for memory output
	`D4:02.02.06`	End date for memory output
	`DT:FILENEW.001`	File name of new file
	`FI: ALMEMO.001`	File name of current file in memory

6.9.2.1 Scanning modes

For autonomous operation and / or for scanning by computer there are 4 scanning modes available.

Normal :	Internal cycle or cyclic scan by the computer
Sleep :	Internal cycle only, automatically switching off for long-term monitoring
Monitor :	Internal cycle, not disturbed by computer scanning activity
Fail-safe :	Cyclic scanning by the PC; after any failure, internal cycle resumes

Sleep mode

For long-term monitoring involving long measuring cycles data loggers from ALMEMO® 2590 up can also be operated in sleep mode. In energy-saving sleep mode the measuring instrument is completely switched off after each measuring point scan (please note when using sensors with own power supply) and switched on again automatically after the cycle expires ready for the next measuring point scan. In battery mode this drastically prolongs the overall running time.

Function	**Command**
Switch sleep mode on	`o11`
Switch sleep mode off	`o-11`

The sleep cycle must be at least 2 minutes.

Recording in sleep mode can only be terminated by switching the device off and on again. The measuring operation must then be stopped.

☞ Stopping based on end time or according to limit values is not possible in sleep mode; sleep mode must therefore be switched off.

Delay warming up after sleep mode

Some sensors, e.g. all rotary vanes or impellers, digital humidity sensors or sensors for measuring moisture in materials, chemical sensors etc., need a certain time after being switched on before they provide a stable measured value. To ensure that such sensors can also be used with sleep mode a delay can be set for measuring operations started in sleep mode. At present this delay period can only be set via the interface. On devices incorporating a display the indication 'sleep' will, if such a delay period has been programmed, be followed by '`D`' . When the device is woken from sleep mode the display will show ´`SLEEP DELAY`´ and below this the delay period will be seen being counted down.

The delay period of 'xxx' seconds can be set by means of command	`f2 uxxx`
The delay period of 'xxx' seconds can be output by means of command	`f1 P19` (see 7.5)
	`...SD: xxx s`

☞ When programming sleep mode this is if necessary set automatically at the minimum cycle, i.e. 2 minutes, plus the delay period, continuous output is switched off, and any current measuring operation is stopped.

Monitor mode
If a data logger being operated on a cyclic basis is to be monitored occasionally by computer this new ´monitor mode´ should be used. Internal cyclic scanning is not influenced in any way by software scanning; (´safe initialization´ in Win-Control must be switched off).
The internal cycle is started with the software start; it may also have been started previously. Scanning by the internal cycle outputs no data to the interface. To save data the memory must have been activated.

Function	Command
Switch monitor mode on	`f1 A1`
Switch monitor mode off	`f1 A-1`

Fail-safe mode
Fail-safe mode is suitable where purely software-based scanning is used and merely ensures in the event of computer failure that scanning continues on an internal cyclic basis. In this mode the cycle programmed in the device must be longer than that needed for software scanning (e.g. device cycle 20s, software cycle 10s). Software scanning keeps resetting the internal cycle with the effect that this cycle is only actually used as and when software scanning fails; (here too ´safe initialization´ in Win-Control must be switched off).
The internal cycle is started with the start of the Win-Control software; it may also have been started previously. Scanning by the internal cycle outputs no data to the interface. To save data the memory must have been activated.

Function	Command
Switch fail-safe mode on	`f2 A1`
Switch fail-safe mode off	`f2 A-1`

6.9.3 Measured data output

The measured value memory can be output via the serial interface with its complete contents or by time frames or by numbered blocks.
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 via the serial interface

Output via the serial interface can be performed with any of three different output protocols in the output formats ´list´, ´columns´, or ´table´; (for print layout see 6.6.1). The memory content is then output in the same print layout as in printer mode; it can, if so required, also be output several times and in different output formats. The output of memory content can be interrupted or aborted at any time without deleting it.

With **external memory cards** measuring operations are usually saved in table mode with each different configuration in its own separate file. From the device it is thus only possible to read out the full measured data content of the file most recently used 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 6.9.4.2). These files can then be imported either into MS-Excel or into Win-Control (as of V.4.9).

6.9.3.3 Selective memory output

Numbered measuring operations (not with memory card)
A series of measuring operations that has been assigned a number can be selectively output by simply activating that number. If a number has been activated only those measuring operations are output for which that number is found in the memory up until another number follows. This may be the data from a particular series of measuring operations or just individual measuring operation at recurring measuring points with the same numbers.

Time frame (not with memory card)
The memory functions **start time** and **end time** and **start date** and **end date** can be used to define a particular excerpt of memory delimited by time and to output only that content. ***Please note :*** A search through 500 KB may last up to approx. 1 minute.

Function	Commands	Response

Read out memory in full (so long as sensor configuration remains unchanged) (connector number 12, if this exists) (in all output formats)	`P04`	`MEMORY: 12`
		`DATE : 01.01.97`
		`07:00:00 01: +0123.4 °C NiCr`
		`..`

Abbreviated table format at 115 Kbaud Date only if changed, none "	`P04`	`12.03.99;12:30:00;12,;9,9` `;12:31:00;12,1;9,8`
Read out measuring operation identified by number		

Output a list of numbers contained in the memory	`f1 P05`	`NUMBER`
		`01-001`
		`01-002`
		`02-001`
		`....`

Activate number	`n01-001`	
Check whether it exists or not	`t4`	`OK or ERROR`

Measuring operation with number Read out (in all output formats)	`P04`	`NUMBER 01-234`
		`17:20:00 01: +0087.5 °C NiCr`
		`.....`

Read out time frame		
Enter start time	`f3 Uhhmmss`	
Enter start date	`f3 dttmmyy`	
Enter end time	`f4 Uhhmmss`	
Enter end date	`f4 dttmmyy`	
Delete start time	`f3 C10`	
Delete start date	`f3 C13`	

Delete end time	f4 C10	
Delete end date	f4 C13	
Output start time	f3 P10	START TIME 07:30:00
Output start date	f3 P13	START DATE 01.02.06
Output end time	f4 P10	END TIME 08:00:00
Output end date	f4 P13	END DATE 01.01.06
Check memory capacity	f1 P04	MEMORY S0500.3 F0118.5
Read out excerpt (in all output formats)	f3 P04	MEMORY DATE 01.02.06 07:30:00 01: +0123.4 °C NiCr .....
Clear the memory	C04	

6.9.4 Reading out external memory cards via a USB reader

For the purpose of reading out data from a memory card the memory connector ZA 1904-SD/MMC is supplied with a USB reader. However, any other drive is equally suitable for removable storage media of this kind. With micro SD cards it may suffice to simply plug in the appropriate adapter supplied. 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 is in table format and can be viewed as ASCII using any standard editor and be imported into MS-Excel (using semi-colon as delimiter). The files can also be evaluated (and if necessary updated) using our Win-Control measured value acquisition software (from V6) by means of 'File - Import'.

6.10 Special functions

ALMEMO® devices also support a number of additional functions which, although rarely needed in routine operation, may be very useful in special applications. These additional functions, however, are only suitable for technically advanced users who have fully and properly understood their potential effects and consequences. Some of the programming steps are only possible on certain devices or require a defined connector configuration or a special piece of hardware. If, for example, the input multiplexer does not match the pin assignment or a reference channel is not fitted with the correct sensor, no reasonable measured values will appear - and inexperienced users may waste a long time wondering why.

6.10.1 Output extended sensor programming

Command f1 P15 can be used to view the special parameters per measuring point other than the standard function values (see 6.2.3). These are basically as follows :

ZERO-POINT	Zero-point correction	see 6.3.10
GAIN	Gain correction	see 6.3.10
LM	Locking mode	see 6.3.12
P	Current decimal point position, including exponent	
FUNC	Output function	see 6.10.4
CALOFS	Calibration offset	
CALFA	Calibration factor	
A-START	Analog output - start	see 6.10.7
A-END	Analog 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 functions - limit value maximum	see 6.10.8
AL	Alarm functions - limit value minimum	see 6.10.8
CF	Print cycle factor	see 6.10.6
UMIN	Minimum sensor voltage	see 6.10.5

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With the output format as list (one below the other) or as columns (one beside the other) (see 6.5.5) this looks as follows :

Commands `f1 P15`

Response
```
CH ZERO GAIN 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
```

The parameters per measuring point obtained with commands P15 and f1 P15 can be viewed all in one line by means of command f2 P15.

Commands `f2 P15`

Response
```
CH RANGE LV-MAX GAIN 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
```

On V6 devices yet more parameters and thus also new output commands have been added :

TC	Time constant, smoothing	see 6.7.4
XS	Cross-section for volume flow measuring	see 6.7.5
RH	Relay assignment for limit value - maximum	see 6.10.8
RL	Relay assignment for limit value - minimum	see 6.10.8

Commands `f3 P15`

Response
```
MEAS RANGE LIMIT-MAX LIMIT-MIN BASE D FACTOR EXP AVERAGE DESIGN. TC XS RH RL
01:NiCr +0123.4 -0012.0 +0000.0°C 1.0000 E+0 - - -  Temperat. 10 00078. 20 --
```

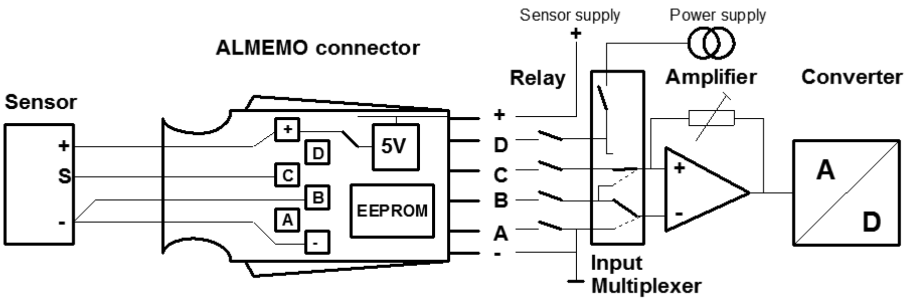
The following command can be used to call up data per connector :

Commands `f4 P15`

Response
```
ST SENSOR            SERIAL  NUMBER CAL-DAT. CY
01:FHA6461.........  12345678 01.10.06 12
```

6.10.2 Change input multiplexer

Usually the input multiplexer is set automatically to the correct pin assignment per measuring range. With ground signals the - input of amplifier is present at A and the + input is present at B (millivolt, thermocouples), C (volt) or D (NTC). With powered sensors (Pt100 or pressure, etc.) a zero-current sense wire is led from the - pole to input B and the differential voltage is then measured between C and B.



It may, in certain circumstances, be useful to modify the default multiplexer position.

e.g. Differential voltage measuring using humidity sensors with long wires
Differential voltage measuring using sensors with internal power supply and current output (connector ZA 9601-FS5/6 with differential shunt B-C)
Double sensors with two identical measuring ranges, etc.

The required multiplexer position can be programmed when selecting the range and saved to the connector EEPROM as follows :

Function	**Commands**	**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 position can be stipulated in the sensor programming (see 6.10.1) using the above code; on measuring instruments with a 7-segment display it can be viewed in the locking mode in second position x4xx.

6.10.3 Element flags

To be able, with several standard measuring ranges, to activate an additional function the appropriate flags can be programmed :

Function	ON	OFF	Code
1. Measuring current for resistance sensors 0.1mA instead of 1mA	f2 k1	f2 k-1	01
2. Emission and background temperature for infra-red sensors	f2 k2	f2 k-2	02
3. Activation of measuring bridge switch for final value simulation	f2 k3	f2 k-3	04
4. Cyclic only scanning for sensors with DIGI range	f2 k4	f2 k-4	08
5. Deactivating electrical isolation in the measuring module *	f2 k5	f2 k-5	10
7. Deactivating sensor breakage detection	f2 k7	f2 k-7	40
8. Analog output 4-20 mA instead of 0-20 mA	f2 k8	f2 k-8	80

* Only 2890-9, 8590-9, 8690-9A, 5690

Explanation

1. Reducing the measuring current to one tenth has the effect of extending the measuring range of resistance sensors to ten times the resistance value. With measuring ranges P104, P204, N104 it is possible to use Pt1000 and Ni1000 sensors instead of Pt100 and Ni100 sensors. The ohms range extends to 5000.0 Ω. The decimal point must be set accordingly.
2. To calculate measured values with infra-red radiation transmitters it is necessary to know the emission factor of the measured object's surface and the background temperature. If flag 2 is programmed the zero-point parameter is used as background temperature and the gain parameter is used as emission factor. However, the standard function for measured value correction is then no longer available; (this is no longer supported on new devices with effect from 2007).
3. Force transducers have integrated calibration resistances that simulate the final value if activated accordingly. Bridge voltage measuring module ZA 9612-FS has an integrated electronic switch which, if flag 3 is activated,will be used for final value correction.
4. Digital sensors in some cases calculate the maximum, minimum, and average values or summated values autonomously from one scan to the next (e.g. measuring modules, weather sensors). To receive these values referred to the cycle rather than to the measuring rate, flag 4 must be set (with effect from ALMEMO 2490).
5. On the newest devices, 2890-9, 8590-9, 8690-9A, and new 5690 systems 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 - pole of the power supply system. This

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is necessary for sensors with their own power supply and differential voltage measurement because the inputs would otherwise have no reference potential; (this is usually set automatically).

7. For sensor breakage detection all measuring inputs are led briefly over high-impedance resistors (11MΩ) to 5V; this takes place at periodic intervals while the A/D converter is not operating. On sensors with a low-impedance output (up to 1kΩ) this does not affect the measured value. On high-impedance sensors (e.g. chemical cells) or electronic calibrators the switching processes involved may lead to incorrect or mutilated measured values. This form of sensor breakage detection can therefore be switched off - with flag 7.
8. Analog outputs which can be connected externally or which are optional can, by means of the parameters analog output - start and analog output - end, be scaled to the standard values 0-2V, 0-10V, or 0-20mA. To set current outputs to 4-20mA flag 8 must be programmed.

Element flags can be viewed in the sensor programming under the abbreviation EF and on measuring instruments with a 7-segment display in the locking mode in third position xx2x.

6.10.4 Change the output function

If the current measured value is not actually needed but only the maximum, minimum, average, or alarm value, this function can be programmed as output function. Limit value monitoring, saving to memory, analog output, and digital output will then only process the appropriate function value.

Examples

1. If measured values are being averaged with the aid of the measuring cycle over the print cycle the only output value of interest is the average value itself, not the last measured value. With a data logger this saves memory capacity.
2. The analog measured value from dew sensor FH A946-1 is not really significant. If limit value - maximum is set to approx. 0.5 V and the alarm value function is programmed, the only values received are 0.0% for dry and 100.0% for dew.

Measuring function	**Abbreviation**	**Commands**
Measured value	`Meas`	`f1 m0`
Difference	`Diff`	`f1 m1`
Maximum value	`Max`	`f1 m2`
Minimum value	`Min`	`f1 m3`
Average value	`M(t)`	`f1 m4`
Alarm value	`Alrm`	`f1 m5`

6.10.5 Minimum sensor supply voltage

ALMEMO® devices usually monitor the sensor supply voltage; this is usually the same as the measuring instrument's own operating voltage. If, on battery or rechargeable battery devices, the voltage drops below 6.8V this is reported as LoBat status in the display, by an LED, or in the device configuration (see 6.2.5). However, certain sensors at this voltage actually stop operating and no longer provide any usable measured values. To prevent errors of this nature the minimum sensor voltage needed can be entered individually per sensor in the sensor programming. If the voltage drops below this value the measured value will be treated as a sensor breakage.

Function	**Command**
Program the minimum sensor supply voltage xx.x V	`uxxx`

If the programming is 00.0 V (see 6.10.1) ´- -´ is displayed and monitoring is not performed.

6.10.6 Print cycle factor

To adapt data recording to the speed of change at individual measuring points a print cycle factor can be programmed to between 00 and 99; this will cause certain measuring points to be recorded (i.e. saved or output via the interface) less frequently or not at all. This print cycle factor is by default set to 01 (display ´- -´) for all measuring points; i.e. all activated measuring points are printed out in each print cycle. If some other factor e.g. 10 is entered, the measuring point in question will only be output every 10th cycle; if 00 is entered it will not be output at all. With data loggers it is thus possible to suppress measured values that are unnecessary and to save on memory capacity. To program the print cycle factor between 00 and 99 the measuring point in question must first be selected. In the extended sensor programming the print cycle factor appears under CF.

Function	**Command**
Enter the print cycle factor xx	`zxx`
Delete the print cycle factor	`z01`

6.10.7 Analog output functions

The analog output modules described in Chapter 5 can not only be operated with the specified output signal/ digit but can also be scaled down to small sub-ranges. With continuous measuring point scanning it is possible, instead of the measuring channel, to output a freely selectable channel in analog form. Or the analog output can be accessed directly via the interface. On V6 output modules a number of analog outputs can be used.

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Scaling

The output signal from the possible analog outputs (0-2 V, 0-10 V, 0-20 mA, 4-20 mA) can be stipulated for each sensor to any partial range (providing this covers more than 100 digits) (e.g. 0 to 20 mA for -30.0 to 120.0 °C).
For this purpose, for the appropriate measuring channel, the values for **analog output - start** and **analog output -- end** plus, if necessary, the **analog output type** (0-20mA or 4-20mA) must be programmed.

Function	Command	Response
Analog output start		
Program	a-xxxxx	
Delete	C16	
Output	P16	ANALOG START 01: -0030.0 °C
Analog output end		
Program	e-xxxxx	
Program (4-20mA)	f1 e-xxxxx	
Delete	C17	
Output	P17	ANALOG END 01: +0120.0 °C

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

Stipulating a channel for analog output, 2nd analog output

Usually at the analog output it is the measured value of the selected channel that is output. However, with continuous measuring point scanning, it is possible, by programming a reference channel, to stipulate any channel for the 1st analog output at socket A2. Simultaneously the 2nd analog output at socket A1 outputs the measured value of the 1st channel from the selected sensor . For the programming of the reference channel please refer to device configuration (see 6.2.5 CONFIG).

Function	Command
Stipulate reference channel xx for analog output at A2	f9 Exx
Switch back to the measuring channel	f9 E-00
Stipulate reference channel xx for 2nd analog output at A1	f8 Exx

On **V6 devices** (from ALMEMO 2490) **with V6 output modules** the port must first be set; (see 6.10.9.2).

Stipulate reference channel xx for analog output at port pp ipp f9 Exx

External control

The analog output can also be controlled via the interface and thus provide a programmed voltage output (-1.2...+2.0 V or -6.0...+10.0 V) or current output (0.0...20.0 mA). The output value, specified at -12000...+20000 digits (0.1mV, 0.5mV, 1µA, depending on the analog output), is intended for controlling peripheral equipment by computer (e.g. setpoint specification).

Function	Command
Analog output of xxxxx digits	f9 a±xxxxx
e.g. Voltage (2V) - 0.5 V	f9 a-05000
Voltage (10V) + 6.40 V	f9 a12800
Current (20 mA) + 19.0 mA	f9 a19000
Switch back to the measuring channel	f9 E-00
Switch back to last setpoint	f9 E-01
The reference channel and analog output value can be called up via the device configuration; (see 6.2.5).	P19
	CONFIG: xxxxxx-- -x-- B-1 a+12345

On **V6 output modules** the port must first be set; (see 6.10.9.2).

Stipulate reference channel xx for analog output at port pp.	`ipp f9 Exx`
Switch outputs DAx analog type to 10 V.	`ipp f9 A1`
Switch outputs DAx analog type to 20 mA.	`ipp f9 A2`
Analog output of xxxxx digits at port pp	`ipp f9 a±xxxxx`

6.10.8 Assigning alarm relays to limit values

For reporting alarms both limit values are by default used for all measuring points; (see 6.3.9); e.g. on relay module ZA1000-EGK (see 5.2/3) relay 0 picks up if the maximum value is overshot and relay 1 if the minimum value is undershot.
To ensure that disturbances can be reliably recognized and selectively evaluated it is possible to assign individual relays to specific limit values. This mode must be set in the output module as variant 2 (assigned internally); (see 6.10.9).

On V5 devices only one output module with one variant is possible.

Function	**Commands**	**Code**
Assign relay x to limit value - maximum of channel yy :	`Eyy f1 hx`	`-x`
Assign relay x to limit value - minimum of channel yy :	`Eyy f1 ly`	`-y`
Delete relay assignment and action of limit value - maximum :	`Eyy h0`	`--`
Delete relay assignment and action of limit value - minimum :	`Eyy l0`	`--`

In the sensor programming (see 6.10.1) a code is assembled for alarm relay assignment to limit value - maximum (AH) and limit value - minimum (AL) and for the actions in the event of these limit values being exceeded (see 6.6.3).

New V6 devices support several output modules each with one function variant per relay; (see 6.10.9.2). Systems can thus theoretically drive up to 100 relays.

Function	**Command**
Assign relay with port address pp to limit value - maximum of channel yy :	`Eyy f2 Rpp`
Assign relay with port address pp to limit value - minimum of channel yy :	`Eyy f3 Rpp`
Delete relay assignment of limit value - maximum channel yy :	`Eyy f2 R-pp`
Delete relay assignment of limit value - minimum channel yy :	`Eyy f3 R-pp`

The extended relay assignment can be called up in the extended sensor programming by means of command `f3 P15` ; (see 6.10.1).

6.10.9 Configuration of output modules

Various output modules with relays, trigger inputs, or analog outputs can be connected at output sockets A1, A2 etc.; the functions of these modules can be configured. Whereas V5 devices and V5 modules permitted only one module with just one function variant, V6 devices can have several V6 output modules connected and all elements (relay, trigger input, or analog output) can be individually configured in all their function variants.

6.10.9.1 V5 output modules

Here it is primarily the trigger cable functions and the operation of relays over alarm cables that can be configured (relay assignment to limit values, see 6.10.8). The connected module can be output in the device configuration (command P19) together with abbreviation and variant number (see table) in lines A1 and A2; (see 6.2.5).

Module	Type	No.	Abbre-viation	Designation
Recording cable	RK		RK	Analog 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	Measuring point scan, once-only
	EK	2	EK2	Delete maximum / minimum values
	EK	3	EK3	Print the function
	EK	4	EK4	Start / stop, level-triggered
	NKNK	8	EK8	Set measured value to zero
Alarm cable	GK	0	AK0	Relay R0 - total alarm for all channels
	GK2	1	AK1	Relay R0 - total alarm, maximum, relay R1 - alarm, minimum
	GK3	2	AK2	Relay Rx - assigned internally (see 6.10.8)
	AK	8	AK8	Relay Rx - driven externally
Trigger alarm	EGK	0	EA0	Start / stop, relay R0 - alarm for all channels
	EGK	1	EA1	Start / stop, relay R0 - alarm maximum, relay R1 - alarm minimum
	EAK	2	EA2	Start / stop, relay Rx - assigned internally
	EAK	8	EA8	Start / stop, relay Rx - driven externally

If the user wants to change the function the module in question must be connected at socket A2 and the desired variant number must be entered using the following command :

Function	**Command**
Program output module variant number x	`f9 kx`

6.10.9.2 V6 output modules

New V6 output modules, e.g. relay trigger analog adapter ZA 8006-RTA3 (see 5.1.2/3), offer up to 10 relays for driving peripheral equipment. Trigger inputs and analog outputs are also available as options in place of of the relays.

With output modules connected to V6 devices please observe the following :

- V5 output cables can only be connected at sockets A1 and A2.
- V5 output cables can using AMR-Control be recoded to V6 format.
- V6 output cables can be connected at all output sockets.
- V6 output cables incorporate 2 separate trigger inputs.
- V6 trigger cables can also be used to execute command macros.
- V6 relay trigger adapters have a relay watchdog.

At present the following interface elements are available :

Interface elements			**Abbreviation**
Relay Normally open	Semiconductor relay 0.5A		NO0
Relay Normally closed	Semiconductor relay 0.5A		NC0
Relay Changeover	Semiconductor relay 0.5A		CO0
Relay ditto	Relay 2A		xx2
Trigger inputs			
Deactivated	TR0		
With key in the output module	TR1		
With optocoupler activated when current flows			TR2
With key or optocoupler activated when current flows			TR3
Analog outputs			
PWM signal generated in the device, V5 method		2V	A00
		10 V	A01
		20 mA	A02
D/A converter in the module, switchable 10 V / 20 mA		10 V	DA1
		20 mA	DA2

V6 output modules can be connected at alle, auch mehrere output sockets, also some at the same time. To ensure that all elements are addressed, each of these sockets is assigned 10 port addresses pp.

Socket	Interface elements	Port addresses
P0	Device-internal elements, connection via socket P0	00..01
A1	V6-output modules at socket A1	10..19
A2	V6-output modules at socket A2	20..29
A3	V6-output modules at socket A3 (if available)	30..39
A4/B4	V6-output modules at socket A4 or in slot B4	40..49
A5/B5	etc.	

The functions of the various elements can be viewed and programmed as follows

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Output the output modules and their configuration	**f3 P19**
Socket P0 Option - with internal analog output	P0.OA2490R02
D/A converter 10 V Selected measuring channel B10	06:DA1 M00 +08.234V
D/A converter 20 mA Driven via COM port	07:DA2 COM +08.234mA
Socket A1 USB data cable	A1.ZA1919DKU
	DK0
Socket A2 Relay trigger analog adapter V6	A2.ZA8006RTA3
Normally open 0.5 A Variant 0 Passive Open	20:NO0 0 0 O
Normally closed 0.5 A Variant 8, inverted Active Open	21:NC0-8 1 O
Changeover 0.5 A Variant 2 Passive Open	22:CO0 2 0 O
Changeover 0.5 A Variant 2 Active Closed	23:CO0 2 1 C
D/A converter 10 V Reference channel B10	26:DA1 B10 +08.234V
D/A converter 20 mA Driven via COM port	27:DA2 COM +08.234mA
Trigger Key Variant 1 Manual	28:TR1 1

Trigger Optocoupler Variant -5 Macro 5	28:TR2-5
Programming the output modules	
First set V6 peripheral port pp (A1=1p, A2=2p)	ipp
Set variant x of port address pp.	ipp f9 kx
Relay variant 0 Summated alarm	ipp f9 k0
Relay variant 2 Assigned internally	ipp f9 k2
Relay variant 3 Summated alarm - maximum	ipp f9 k3
Relay variant 4 Summated alarm - minimum	ipp f9 k4
Relay variant 8 Driven externally	ipp f9 k8
Relay variant -x ditto but inverted	ipp f9 k-x
Switch watchdog for relay activation ON / OFF	i20 o(-)19

Power failure can be detected more easily if the process of relay activation is inverted; i.e. in normal circumstances (with power) the relay is activated and the contacts remain open - but in the absence of current (power failure) the relay drops out, the contacts close, and an alarm is triggered. For this purpose the function variant is entered in inverted or negative form.

Trigger functions

Trigger variant 0:	Start-Stop	`ipp f9 k0`
Trigger variant 1:	Measuring point scan, once-only	`ipp f9 k1`
Trigger variant 2:	Delete maximum / minimum values	`ipp f9 k2`
Trigger variant 3:	Print the function	`ipp f9 k3`
Trigger variant 4:	Start / stop, level-triggered	`ipp f9 k4`
Trigger variant 8:	Set the measured value to zero	`ipp f9 k8`
Trigger variant -5..-9:	Macro 5 to 9 (s. 6.6.5)	`ipp f9 k-5..k-9`

6.10.10 Driving the output relays

The relays on all output modules can also be driven via the interface. For this purpose variant 8 (driven externally) must be programmed; (see 6.10.9).

The output contacts are operated by the following commands :

Function	**Commands**
<u>V5 output modules</u>	
Activate relay y (variant 8)	`R0y`
Deactivate relay y (variant 8)	`R-0y`
<u>V6 output modules</u>	
Activate relay port address pp (variant 8)	`f1 Rpp`
Deactivate relay port address pp (variant 8)	`f1 R-pp`

The current relay status can be called up; (V5, see 6.2.5, V6, see 6.10.9.2).

6.10.11 Output of device version

ALMEMO® devices have been steadily further developed ever since they were originally introduced. Even the new V6 devices continue to have new functions added with completely new hardware and software. And there have always been options and special variants. When it comes to updates and connecting new sensors or peripheral equipment it is very important to know the exact version status. This can be called up by means of the following command :

Function	**Command**	**Response**
View software version	`t0`	`8590-9KL 6.24`

Options : KL Connector linearization R Special ranges for refrigerants

This shows the ALMEMO® 8590-9 with the option connector linearization and the 1st digit of version 6.24 indicates that it is a V6 device.
For further commands (serial number, functions, etc.). see 7.6

6.10.12 Change the baud rate

The **baud rate** is stored in the connectors on the interface cables plugged in at sockets A1; it is usually set on leaving our factory to 9600 baud; unless absolutely necessary this should not be changed. If cables with a different baud rate are used in a network there will be no communication. High baud rates of 57.6 up to 230.4 kilobaud may drastically shorten the time needed to read out from memory but are not necessarily compatible with all data cables, all devices, and all computers; (see 5.3.5 concerning the baud rate and its effects on current consumption on various interface modules).

While data is being read from memory at 57.6 kilobaud and above, measured data acquisition is interrupted.

While data is being read from memory at 115.2 kilobaud and above, output in table format is reduced; (see 6.9.3).

Data format Cannot be changed 8 data bits, 1 stop bit, no parity

In a network, if the connected devices are switched on, a command via the interface has the effect of changing all interface cables at once. The baud rate must also be changed accordingly in the communication device; otherwise transmission will be interrupted. A pause of at least 20 ms must be observed before sending the next command.

Change the baud rate	**Commands**
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`
230400 bd	`f1 b9`

6.10.13 Device configuration

There are a number of device settings (see 6.2.5) by means of which users can program earlier options. This configuration, as with the already familiar entry for device designation, is permanently stored in the device EEPROM and is retained intact even after a reset.

6.10.13.2 Operating parameters

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

1. Mains frequency noise suppression

Mains hum, familiar perhaps from the humming noise heard in repeater systems, is a noise voltage caused by the frequency of the mains voltage. On particularly sensitive measuring instruments this noise can be minimized by means of the integration time of the A/D converter if the measuring time exactly matches a period in the mains frequency. To apply mains frequency noise suppression the frequency of the mains voltage on site must be known and must be configured in operating parameter 1 (F). This is always set on leaving our factory to 50 Hz. At measuring rates above 10 mops noise suppression is no longer possible.

2. Delete all measured values at the start of a measuring operation

In many cases it may be useful to delete all maximum, minimum, and average values existing at the start of a cyclic measuring operation in order to have these parameters available at its end. However, if such measuring operations are often interrupted and restarted, the existing values must not be lost. Configuration flag 2 (C) can be used to adapt the settings to all tasks of this nature.

3. Ring memory on data loggers

The measured value memory on data loggers is usually organized as a linear memory; i.e. as soon as its total capacity is occupied, it will duly terminate recording and report ´memory full´. The memory mode is always displayed at the beginning of any measuring operation considered indispensable. In many other cases, however, e.g. prophylactic long-term monitoring, it is sufficient if one can review the previous history for a particular event over a limited period of time. This problem can be solved in configuration parameter 3 (R) by organizing the memory as a ring memory; i.e. as soon as it is full, it will simply start overwriting the oldest data; one can, however, always read out the whole memory content up till the present moment.

5. Oversampling the measured data output

It is usually possible in a continuous measuring operation to call up the measured data more frequently than it is actually being measured. If output is to be limited to the measuring rate flag 5 must be switched off.

Function		**ON**	**OFF**	**Code**
1	Mains frequency noise suppression 60 Hz instead of 50 Hz	f6 k1	f6 k-1	F
2	Delete all measured values at the start of a measuring operation	f6 k2	f6 k-2	C
3	Ring memory on data loggers	f6 k3	f6 k-3	R
4	Display year in date with 4 digits instead of just 2 (V5 only)	f6 k4	f6 k-4	D
5	Oversampling the measured data output	f6 k5	f6 k-5	A
6	Switch off signal transmitter (devices with beeper)	f6 k6	f6 k-6	S
7	Date and time-of-day in MS-EXCEL format ´dd.mm.yy hh:mm:ss´	f6 k7	f6 k-7	E