Communication Protocol FEM / STEPDOS pumps

Valid for FEM/STEPDOS pumps: FEM 03 / 08 / 1.03 / 1.08 with Firmware V2.xx or newer grades

General

The FEM / STEPDOS pumps can be controlled by using the standard RS232 serial interface (COM1, COM2, …). The RS232 serial interface allows one pump to be controlled by a PC based software tool. The **FEM control centre** software, which is included in the pump package, can be used for this purpose. A lot of basic pump control function and pump setup function are implemented in this tool. Any of the commands listed in this document can also be carried out as single commands for verification purpose. This may be of help for customers, how want to develop their own pump control tool. Just use the FEM control centre and go to Special – Communication and enter any of the listed commands into the white entry field. Execute the command it in pressing the Communication test button. There you can see the build send command string and the pump answer string as well.
If your PC no more has any RS232 serial interface, then just use an USB to RS232 Adaptor!

The **FEM control centre** delivered with the pump can be used to control **only one pump**.

The pumps can also be configured for direct operation on an RS485 serial bus system. The operation on a RS485 serial bus system can be used to set up a network with more than one pump. This allows even longer distances between the pumps and the controlling PC. The construction of such a network requires a certain amount of expertise in this field.

The communication software for an RS485 serial bus application must be written by the customer (user) according to the descriptions of the communication protocol.

Controlling more than one pump

Manual switch box for the RS 232
If several pumps are to be controlled or configured from one PC, but all at different times, then we recommend the use of a simple manual switch box with several output interface sockets. The FEM control centre software can be used to configure and control the pumps individually.

RS485 bus system
Every pump must have it's own individual address (00 to 98) which must be used for identification purposes in the RS485 bus system. Every address may only be used once!
If a PC is being used, then a RS232 to RS485 converter or an USB to RS485 converter is required to build up the RS485 serial bus system. Some PCs may have this already implemented as an internal card for supporting RS485 serial bus systems. Up to 25 pumps can be connected to the same RS485 bus system. But effectively the maximum number of pumps, which can be connected, is determined by the electrical performance of the used converter or interface card.

The use of the FEM control centre could also be of help for some functional verification tasks when building up a RS485 serial bus system. It also supports the RS484 serial communication, as it can be set to RS484 communication as well. Any of the commands listed in this document can also be carried out as single command for verification purpose. This may be of help for customers, how want to develop their own pump control tool. Just use the FEM control centre and go to Special – Communication and enter any of the listed commands into the white entry field. Execute the command it in pressing the Communication test button. There you can see the build send command string and the pump answer string as well.

Universal commands

The address number 99 has a special function. Commands, which don't require an answer, can be sent to the address 99. The command will then be carried out by all of the pumps. This allows the possibility for example that all the pumps can be started automatically.

Interface parameters

The pump is permanently set to the following values:

Baud Rate	9600 Baud
Data Bits	8
Parity	No
Stop Bit	1
Mode	Half Duplex
Handshake	There's no monitoring. The user is responsible that the pump is not overloaded.
Timing	The average reaction time of the pump is within 10 .. 20 ms. If the answer takes longer as 300 ms then there is either a problem with the communication or the pump is still busy with a long function e.g. new pump initializations.

Data format

Each transmission block consist of the following bytes:

1.	STX (02h)	Start of Text
2.	Address	Pump address '00' - '99' ASCII, can be set on the pump
3.	Data block	ASCII symbol order according to command description
4.	ETX (03h)	End of Text
5.	VRC	Checksum

Each receiver block consists of the following bytes:

1.	STX (02h)	Start of Text
2.	Data block	All data are in ASCII format
3.	ETX (03h)	End of Text
4.	VRC	Checksum

The checksum is the last byte in a command string. All bytes (except the checksum (VRC)) are linked to the XOR. The receiver of a message compares the transmitted checksum with the calculated checksum from the transmitted data; if the values are identical, the transmission is considered to be error-free.

Protocol answer

The pumps work without a protocol answer after version 1.xx. The protocol answer can be activated if necessary (see command ***SPn***). Then the pump checks if the command can be accepted, this means that the pump checks if the format and the checksum of this command are correct and if this command can be carried out.

The ASCII signs ACK(6) and NAK(21) are used. An ACK(6) is send back if the command is accepted. If an answer cannot be carried out then the NAK(21) will be send back.

The received block will look as follows:

1. #6 ACK
2. STX (02h) Start of text
3. Data block All data is in ASCII format according as commanded.
4. ETX (03h) End of text
5. VRC Check sum

If the pump is switched to RS485 then the protocol answer is automatically deactivated as this otherwise leads to problems with the communication on the RS485 serial bus communication.

☝ It is not allowed that two subscribers (pumps) can send their answers simultaneously.

Pump address und Status Byte 1

It is possible, that the pump can send back the pump address and the pump information of Status Byte 1 (see command ***SBn*** and ***SSn***) with every answer. This allows a fast supervisory of the main pump status, a kind of fast pump failure detection. In this case the pump sends back the additional data " pump address and the information of Status Byte 1 " together with the main answer. This means that every answer contains an additional five (5) bytes of information. The first two bytes contain the address and the other three bytes contains the information of Status Byte 1.

With this setting it is possible to realize fast pump failure detection. If a failure is present, then other detailed pump status can be read back by using the command ***SSn***.

The received block will look as follows:

1. STX (02h) Start of Text
2. 00 Pump address 00..98
3. 013 Status Byte 1
4. Data block All data is in ASCII format according as commanded.
5. ETX (03h) End of Text
6. VRC Check sum

Standard commands on customer level

Summary

General commands for pump control

MSn	***Mode select: Run mode / Dispense mode***
KYn	***Pump key function: START / STOP / PRIME-DRAIN***

RUN - Mode

RVnnnnnnnn	***Run mode: flow rate in µl/min***
RRnnnnn	***Run mode: flow rate in %***

Dispense - Mode

DVnnnnnnnn	***Dispense mode: dispense volume***
DThhmmssss	***Dispense mode: time for dispensing a volume***
DNnnnnn	***Dispense mode: numbers of dispense volumes***
DBnnnnn	***Dispense mode: break time between two dispense volumes***
DCnnnnn	***Dispense mode: numbers of dispense cycles***
DWhhmmss	***Dispense mode: wait time between two dispense cycles***
?DA	***Dispense mode: reads resulting % stroke range***
?DS	***Dispense mode: reads resulting number of strokes***
?DR	***Dispense mode: reads resulting % rotational speed***
?TC	***Dispense mode: reads actual running cycle of dispense cycle***
?TN	***Dispense mode: reads actual volume of dispense cycle***
?TT	***Dispense mode: reads actual time of dispense cycle***

Settings

RUN-Mode: Start conditions

RDn	***Run mode: flow rate control, setting by (keypad, PC) or by analog signal***
RCn	***Run mode: flow rate changeable with or without stop***
RAn	***Run mode: analog control, signal type selection***

DISPENSE-Mode: Start conditions

DDn	***Dispense mode: start/restart manually or by external impulse***
DPnnnnn	***Dispense mode with impulse start control: number of impulses***

Start delay

SDn	***Start delay in Run mode & Dispense mode: activate/deactivate start delay***
SThhmmss	***Start delay: time unit***

Units

UFnn	***Units: volume unit***
UTn	***Units: time unit***

Logic I/O 1 and I/O 2

L1nn	***Logic I/O 1: function***
L2nn	***Logic I/O 2: function***
SUnnnn	***Logic I/O2, flow rate jump: step***

Relay

RSn	***Relay: Relay function definition***

General

URnmmm	***General: flow range (input range)***
ARnmmm	***General: analog input signal range***
AIn	***General: analog input signal inverse***
LInn	***General: logic I/O 1, I/O 2 input signal inverse***
LOn	***General: logical combinations I/O 1 to I/O 2***

Further settings
(Password: "1234" when using keypad setting or the FEM control centre)

Language

LSn	***Further settings: Language, English / German***

Calibration

CFnnnnn	***Further settings: Calibration, Flow rate***
CRnnnnn	***Further settings: Calibration, Speed***
CDnnnn	***Further settings: Calibration, Density***
CPnnnn	***Further settings: Calibration, Pressure***

Characteristic

CSnn	***Further settings: Characteristic, pressure/suction stroke, pulsing/continuous***
CEn	***Further settings: Characteristic, stroke end point definition at pump stop***

System

LCnnn	***Further Settings: System, LCD Display Contrast***
SYhhmm	***Further Settings: System, Standby after time***
SAn	***Further Settings: System, Auto-start after power on***
ESn	***Further Settings: System, stop pump on Error***
?SV	***Further Settings: System, reads pump model and firmware version***
?SI	***Further Settings: System, communication check***
SPn	***Further Settings: System, Protocol answer***
SBn	***Further Settings: System, Address and Status Byte 1 request***
IN	***Initialisation: new pump start, like power OFF /ON***
IP	***Further Settings: System, initial pump reset to the factory settings***

Control commands

PCn	***PC control status***
?SSn	***Pump status request: reads pump status***

Summary alphanumeric

ARnmmm	***General: analog input signal range***
AIn	***General: analog input signal inverse***
CFnnnnn	***Further settings: Calibration, Flow rate***
CRnnnnn	***Further settings: Calibration, Speed***
CDnnnn	***Further settings: Calibration, Density***
CPnnnn	***Further settings: Calibration, Pressure***
CSnn	***Further settings: Characteristic, pressure/suction stroke, pulsing/continuous***
CEn	***Further settings: Characteristic, stroke end point definition at pump stop***
DDn	***Dispense mode: start/restart manually or by external impulse***
DPnnnnn	***Dispense mode with impulse start control: number of impulses***
DVnnnnnnnn	***Dispense mode: dispense volume***
DThhmmssss	***Dispense mode: time for dispensing a volume***
DNnnnnn	***Dispense mode: numbers of dispense volumes***
DBnnnnn	***Dispense mode: break time between two dispense volumes***
DCnnnnn	***Dispense mode: numbers of dispense cycles***
DWhhmmss	***Dispense mode: wait time between two dispense cycles***
?DA	***Dispense mode: reads resulting % stroke range***
?DS	***Dispense mode: reads resulting number of strokes***
?DR	***Dispense mode: reads resulting % rotational speed***
ESn	***Further Settings: System, stop pump on Error***
IN	***Initialisation: new pump start, like power OFF / ON***
IP	***Further Settings: System, initial pump reset to the factory settings***
KYn	***Pump key function: START / STOP / PRIME-DRAIN***
LCnnn	***Further Settings: System, LCD Display Contrast***
LSn	***Further settings: Language, English / German***
L1nn	***Logic I/O 1: function***
L2nn	***Logic I/O 2: function***
LInn	***General: logic I/O 1, I/O 2 input signal inverse***
LOn	***General: logical combinations I/O 1 to I/O 2***
MSn	***Mode select: Run mode / Dispense mode***
PCn	***PC control status***
RVnnnnnnnn	***Run mode: flow rate in µl/min***
RRnnnnn	***Run mode: flow rate in %***
RDn	***Run mode: flow rate control, settings by (keypad, PC) or by analog signal***
RCn	***Run mode: flow rate changeable with or without stop***
RAn	***Run mode: analog control, signal type selection***

RSn	***Relay: Relay function definition***
SAn	***Further Settings: System, Auto-start after power on***
?SI	***Further Settings: System, communication check***
?SV	***Further Settings: System, reads pump model and firmware version***
?SSn	***Pump status request: reads pump status***
SPn	***Further Settings: System, Protocol answer***
SBn	***Further Settings: System, Address and Status Byte 1 request***
SDn	***Start delay in Run mode & Dispense mode: activate/deactivate start delay***
SThhmmss	***Start delay: time unit***
SUnnnn	***Logic I/O2, flow rate jump: step***
SYhhmm	***Further Settings: System, Standby after time***
?TC	***Dispense mode: reads actual running cycle of dispense cycle***
?TN	***Dispense mode: reads actual volume of dispense cycle***
?TT	***Dispense mode: reads actual time of dispense cycle***
UFnn	***Units: volume unit***
UTn	***Units: time unit***
URnmmm	***General: flow range (input range)***

Description of commands

General commands for pump control

MSn — *Mode select: RUN mode / Dispense mode*

Target: Choose the active pump-operating mode.

Command:
- ***MS0*** Run – Mode
- ***MS1*** Dispense - Mode

Question : ***?MS*** Reads the actual pump operating mode

Answer : ***n*** Shows the number of the defined mode

KYn — *Pump key function: START / STOP / PRIME-DRAIN*

Target: By using these commands it is possible to carry out the same functions using the software as if the keys were being pressed directly on the pump.

- ***KY0*** Stop / ESC
- ***KY1*** Start / Enter
- ***KY2*** Prime / Drain
- ***KY3*** Program - key function
- ***KY4*** Up - key function
- ***KY5*** Down - key function

RUN - Mode

RVnnnnnnnn	***Run mode: flow rate in µl/min***

Target: Sets the µl/min flow rate in run-mode.

Command:	***RVnnnnnnnn***	8 digits, 00000080 .. 0080000, for FEM 08 / 1.08 pumps 8 digits, 00000030 .. 0030000, for FEM 03 / 1.03 pumps corresponds with the flow rate in micro liter (µl/min)
Question :	***?RV***	Reads the current flow rate in µl/min
Answer :	***nnnnnnnn***	8 digits, formatted on the right side

Remarks: Take notice of the limits !

RRnnnnn	***Run mode: flow rate in %***

Target: Sets the motor speed in the Run Mode as a % value of 100% flow rate.

Command:	***RRnnnnn***	5 digits, 00010 .. 10000, corresponds to 0.10 .. 100.00% flow rate
Question :	***?RR***	reads the current motor speed, 1 digit = 0.01%
Answer :	***nnnnn***	5 digits, formatted on the right side

Remarks: Take notice of the limits !

Dispense - Mode

DVnnnnnnnn — *Dispense mode: dispense volume*

Target: Sets a basic dispense volume.

Command:	***DVnnnnnnnn***	8 digits, corresponds to the dispense volume in µl
Question :	***?DV***	Reads the actual dispense volume
Answer :	***nnnnnnnn***	8 digits, corresponds to the dispense volume in µl

DThhmmssss — *Dispense mode: time for dispensing a volume*

Target: Set the time in which the basic dispense volume must be delivered

Command:	***DThhmmssss***	8 digits, [hh:mm:ss.ss]
Question :	***?DT***	Reads the actual dispense time
Answer :	***hhmmssss***	8 digits, [hh:mm:ss.ss]

Remarks: The pump will only accept this dispense time, as long as it is between the pump internal min. and max. time for dispensing a selected basic dispense volume, otherwise the pump will set the internal min. or max. time. A simple read back helps to check the actual dispense time. Time resolution is 0.01s.

DNnnnnn — *Dispense mode: numbers of dispense volumes*

Target: Sets the numbers of repetitions of the basic dispense volume being dispensed.

Command:	***DNnnnnn***	5 digits, 00001 .. 65534, endless = 65535
Question :	***?DN***	Reads the number of dispense volumes
Answer :	***nnnnn***	5 digits, formatted on the right side

DBnnnnn — *Dispense mode: break time between two dispense volumes*

Target: Sets the pause time between two dispense volumes, time units are in seconds

Command:	***DBnnnnn***	5 digits, 00000 .. 65534 [seconds]
Question :	***?DB***	Reads the actual pause time
Answer :	***nnnnn***	5 digits, formatted on the right side

DCnnnnn — *Dispense mode: numbers of dispense cycles*

Target: Sets the number of dispense cycles.

Command:	***DCnnnnn***	5 digits, 00001 .. 65534, endless = 65535
Question :	***?DC***	Reads the actual number of dispense cycles
Answer :	***nnnnn***	5 digits, formatted to the right side

DWhhmmss — *Dispense mode: wait time between two dispense cycles*

Target: Sets the waiting time between two dispense cycles.

Command:	***DWhhmmss***	6 digits, [hh:mm:ss]
Question :	***?DW***	Reads the actual wait time between two dispense cycles
Answer :	***hhmmss***	6 digits, [hh:mm:ss]

Remarks: Resolution is 1 second

?DA — *Dispense mode: reads resulting % stroke range*

Target : Reads the resulting % stroke range in dispense mode in percentage of a full stroke. It is calculated by the pump for each Dispense-mode setup of a new "Dispense Volume and Dispense Time".

Question : ***?DA*** Reads the resulting % stroke range in dispense mode.

Answer : ***nnnn*** 4 digits, 0200 … 1000 [020.0 … 100.0] % of a full stroke

Remarks: A new Dispense-mode setup results in new values for the ***?DS*** & ***?DR*** commands as well.

?DS — *Dispense mode: reads resulting number of strokes*

Target : Reads the resulting number of strokes in dispense mode. It is calculated by the pump for each Dispense-mode setup of a new "Dispense Volume and Dispense Time".

Question : ***?DS*** Reads the resulting number of strokes in dispense mode

Answer : ***nnnnn*** 5 digits, 00001 … 99999 represents the number of strokes

Remarks: A new Dispense-mode setup results in new values for the ***?DA*** & ***?DR*** commands as well.

?DR — *Dispense mode: reads resulting % rotational speed*

Target : Reads the resulting % value of the rotational seed in dispense mode. It is calculated by the pump for each Dispense-mode setup of a new "Dispense Volume and Dispense Time".

Question : ***?DR***

Answer : ***nnnnn*** 5 digits, 00008 … 12000 [00.08 … 120.00] % of full speed

Remarks: A new Dispense-mode setup results in new values for the ***?DA*** & ***?DS*** commands as well.

?TC — *Dispense mode: reads actual running cycle of a dispense cycle*

Question : ***?TC*** Reads the number of the actual running cycle of a dispense cycle

Answer : ***nnnnn*** 5 digits, formatted on the right side, see DC

Remark : If the dispense cycle has not been started, then it will show the following value: ***00000***

?TN — *Dispense mode: reads actual volume of a dispense cycle*

Question : ***?TN*** Reads the actual volume of the of a dispense cycle.

Answer : ***nnnnn*** 5 digits, formatted on the right side, see DN

Remark : If the dispense cycle has not been started, then it will deliver the following value: ***00000***

?TT — *Dispense mode: reads actual time of a dispense cycle*

Question : ***?TT*** Reads the actual time of a dispense cycle (dispense, pause, wait time)

Answer : ***hhmmssss*** 8 digits, formatted on the right hand side.

Remark : If the Dispense - Mode has not started, then it will deliver the following time: ***00000000***

Settings

RUN-Mode: Start conditions

RDn — *Run mode: flow rate control, setting by (keypad, PC) or by analog signal*

Target: The flow rate in Run-mode can be changed manually by the use of the keypad or via a PC command or it can be controlled by an analog signal.

Command: ***RDn*** 1 digit, 0 / 1

n	Meaning
0	Flow rate control manually by keypad or PC command
1	Flow rate controlled by analog signal

Question : ***?RD*** Reads the type of flow rate control

Answer : ***n*** 1 digit

RCn — *Run mode: flow rate changeable with or without stop*

Target: The flow rate in Run-mode can be changed manually by the use of the keypad or via a PC command with or without stopping the pump.

Command: ***RCn*** 1 digit, 0 / 1

n	Meaning
0	Change flow rate only after stopping the pump
1	Change flow rate without stopping the pump

Question : ***?RC*** Reads the type of flow rate changeable with or without stop

Answer : ***n*** 1 digit

RAn — *Run mode: analog control, signal type selection*

Target: The flow rate in Run-mode can be controlled by four different types of analog signals.

Command: ***RAn*** 1 digit, 0 .. 3

n	Meaning
0	Analog signal 0..10V
1	Analog signal 0..20mA
2	Analog signal 4..20mA
3	Analog signal 0..5 V

Question : ***?RA*** Reads the type of the selected Analog signal

Answer : ***n*** 1 digit

DISPENSE-Mode: Start conditions

DDn — *Dispense mode: start/restart manually or by external impulse*

Target: The default for the dispense mode must be changed manually on the keypad or via PC commands. The start of a dispense volume or a dispense cycle can be executed manually via the keypad or via PC commands. Alternatively the start can be executed via an impulse signal, with variable number of impulses per each new start (see the command DPnnnnn).

Command: ***DDn*** 1 digit, 0 / 1

n	Meaning
0	Manual start by use of keypad or via PC commands
1	Start or restart via external impulse signal

Question : ***?DD*** Reads the actually set start condition of dispense mode

Answer : ***n*** 1 digit

DPnnnnn — *Dispense mode with impulse start control: number of impulses*

Target: Sets the number of impulses which are required for a new start or restart of a dispense volume or a dispense cycle.

Command: ***DPnnnnn*** 5 digits, 00001 .. 65534

Question : ***?DP*** Reads the number of set impulses

Answer : ***nnnnn*** 5 digits, formatted on the right side

Remark: The number 0 is not possible, make sure the DD command is set to 1!

Start delay

SDn — *Start delay in Run mode & Dispense mode: activate/deactivate start delay*

Target: Activates or deactivates the start delay time in Run-mode or Dispense-mode applications. Start delay time is set by the command SThhmmss. A start for each Run-mode and Dispense-mode application is being delayed by the start delay time, if this function is activated.

Command: ***SDn*** 1 digit

n	Meaning	
0	deactivates start delay function	factory setting
1	activates start delay function	

Question : ***?SD*** Reads the actual setup of the start delay function

Answer : ***n*** 1 digit

Remarks: There is no start delay active, in case of an analog signal controlled Run-mode application. There is also no start delay active, in case of an I/O1 or I/O2 start/stop signal controlled Run-mode application. Only the first given start of such kinds of application could be delayed by this function.

SThhmmss — *Start delay: time unit*

Target: Sets the start delay time variable. See the command SDn for activating or deactivating the start delay function in Run-mode & Dispense-mode application

Command: ***SThhmmss*** 6 digits, [hhmmss],
hh: 00..24 hours mm: 00..59 minutes ss: 00..59 seconds

Question : ***?ST*** Reads the actual start delay time variable

Answer : ***hhmmss*** 6 digits, [hhmmss],

Factory setting: ***000000*** 00 hours, 00 minutes, 00 seconds

Units

UFnn — *Units: volume unit*

Target: Defines the volume units

Command: ***UFnn*** 2 digits

nn	Meaning
00	%
01	µl
02	ml
03	L
04	cu.in
05	US.gal
06	Imp. gal
07	mg
08	g
09	Kg
10	lb

Question : ***?UF*** Reads the actual setup of volume unit

Answer : ***nn*** 2 digits

UTn — *Units: time unit*

Target: Defines the time units

Command: ***UTn*** 1 digit

n	Meaning
0	Seconds (s)
1	Minutes (m)
2	Hours (h)

Question : ***?UT*** Reads the actual setup of time unit

Answer : ***n*** 1 digit

Logic I/O 1 and I/O 2

L1nn — *Logic I/O 1: function*

Target: Defines the function of the logic input I/O 1

Command: ***L1nn*** 2 digits, respectively 00 .. 10

nn	Meaning
00	Signal: Inactive
01	Signal level: Start / Stop
02	Signal level: Alarm LED
03	Signal level: Fault LED
04	Signal level: Fault LED and stops pump
05	Signal level: Flow rate jumps (Motor speed jumps) positive / negative, works together with I/O 2 set to Flow rate step (Speed step)
06	Signal edge: Start / Stop
07	Signal edge: Level Start
08	Signal edge: Level Stop
09	Signal edge: Prime/Drain
10	Signal edge: Flow control

Question : ***?L1*** Reads the actual setting of Logic I/O 1 input

Answer : ***nn*** 2 digits

L2nn — *Logic I/O 2: function*

Target: Defines the function of the logic input I/O 2

Command: ***L2nn*** 2 digits, respectively 00 .. 10

nn	Meaning
00	Signal: inactive
01	Signal level: Start / Stop
02	Signal level: Alarm LED
03	Signal level: Fault LED
04	Signal level: Fault LED and stop pump
05	Signal level: Flow direction (process pump only)
06	Signal edge: Start / Stop
07	Signal edge: Level Start
08	Signal edge: Level Stop
09	Signal edge: Flow rate step (Speed step), works together with I/O 1 set to Flow rate jumps see also command *SUnnnn* (Step unit)
10	Signal edge: Alarm / Fault Reset
11	Signal edge: Flow control

Question : ***?L2*** Reads the actual setting of Logic I/O 2 input

Answer : ***nn*** 2 digits

SUnnnn — *Logic I/O2, flow rate jump: step*

Target: Sets the value for the step unit variable. This defines the amount of each flow rate jump, executed by the I/O1 (set to Flow rate jumps) and I/O 2 (set to Flow rate step) logical input signal. See the command description L1nn and L2nn. Various flow rate jumps (positive or negative) or ramps can be implemented.

Command:	***SUnnnn***	4 digits, 0001..1000 [0.01% .. 10% of full flow range]
		1 digit = 0.01% of full flow range
Question :	***?SU***	Reads the actual value of Step unit variable
Answer :	***nnnnn***	4 digits, formatted to the right side
Factory setting:	***0001***	0.01% of full flow range

Relay

RSn — *Relay: Relay function definition*

Target : Defines the function of the Relay connected to socked A pin: 1, 2 and 3

Command: ***RSn*** 1 digit

n	Meaning
0	Alarm factory setting
1	Motor runs
2	Volume finish (Dispense-mode only)
3	Cycle finish (Dispense-mode only)

Question : ***?RS*** Reads the actual function setting of the Relay

Answer : ***n*** 1 digit

General

URnmmm — *General: flow range (input range)*

Target: Defines the flow range (input range) of witch the pump will be limited. Whereby the total flow range is taken as 100% and with two boundary values determined.

Command: ***URnmmm*** *n*: 1 digit

n	Meaning
0	Flow range minimum
1	Flow range maximum

mmm 3 digits, 000 .. 100 [%] of full flow range

Question : ***?UR0*** Reads the actual setting of flow range min.

Question : ***?UR1*** Reads the actual setting of flow range max.

Answer : ***mmm*** 3 digits

ARnmmm — *General: analog input signal range*

Target: Defines the range of analog input signal. The total analog signal will be taken as 100%. Two values determine the minimum and maximum value of the analog signal, which are processed by the bump.

Command: ***ARnmmm*** *n*: 1 digit

n	Meaning
0	analog input signal range minimum
1	analog input signal range maximum

Command: ***mmm*** 3 digits, 000 .. 100 [%] of analog input signal range

Question : ***?AR0*** Reads the actual setting of analog signal range min.

Question : ***?AR1*** Reads the actual setting of analog signal range max.

Answer : ***mmm*** 3 digits

AIn — *General: analog input signal inverse*

Target: Controlling with Analog signal, the analog input signal can be processed inverse.

Command: ***ALn*** 1 digit, 0 / 1

n	Meaning
0	Analog input signal processing normal
1	Analog input signal processing inverse

Question : ***?AI*** Reads the actual setting of analog input signal processing

Answer : ***n*** 1 digit

LInn — *General: logic I/O 1, I/O 2 input signal inverse*

Target: The logic input signal can be inversed or non-inversed processed.

Command: ***LInn*** 2 digits, 00 .. 11

nn	Meaning
0x	I/O1 signal processing normal
1x	I/O1 signal processing inverse
x0	I/O2 signal processing normal
x1	I/O2 signal processing inverse

Question : ***?LI*** Reads the processing type of the I/O 1 and I/O 2 logic input signal

Answer : ***nn*** 2 digits

LOn — *General: logical combinations I/O 1 to I/O 2*

Target: The logic inputs I/O 1 & I/O 2 signals can be processed in logical combinations.

Command: ***LOn*** 1 digit, 0 .. 3

n	Meaning	
0	no logical combination processing	factory setting
1	logical AND processing	
2	logical OR processing	
3	logical XOR (exclusive OR) processing	

Question : ***?LO*** Reads the logical combination of I/O 1 & I/O 2 signals

Answer : *n* 1 digit

Further settings

(password: “1234” when using keypad setting or the FEM control centre)

Language

LSn — *Further settings: Language, English / German*

Target: Sets the language of the pump display.

Command: ***LSn*** 1 digit, 0 / 1

n	Meaning
0	German
1	English

Question : ***?LS*** Reads the language of the pump display

Answer : ***n*** 1 digit

Calibration

CFnnnnn — *Further settings: Calibration, Flow rate*

Target: Sets the nominal (or customized) flow rate in µl/min. Together with the calibrated motor speed and the setting of the nominal (or customized) flow rate, the pump will calculate calibrated volume per stroke.

Command: ***CFnnnnn*** 5 digits, 00001 .. 99999 [µl/min], limited by the technical limits of the pump

Question : ***?CF*** Reads the actual level of the nominal (or customized) flow rate

Answer : ***nnnnn*** 5 digits, formatted to the right side.

Factory settings: ***30000*** 30.000 ml for pumps FEM 03 / 1.03

80000 80.000 ml for pumps FEM 08 / 1.08

CRnnnnn — *Further settings: Calibration, Speed*

Target: Sets the custom calibrated level for the motor speed. This is the custom calibrated motor speed, at which the pump delivers the nominal flow rate (100.00%).

Command:	***CRnnnnn***	5 digits, 00001 .. 30000 [000.01 .. 300.00 rpm] (Motor speed in rpm * 100)
Question :	***?CR***	Reads the calibrated level for the motor speed.
Answer :	***nnnnn***	5 digits, formatted to the right side.

Remarks: The pump is factory calibrated with water 25°Cel, 0 bar pressure gauche. Each Pump initialisation (command IP) brings the pump back to the factory-calibrated level (typically 150.00 … 200.00 rpm).

CDnnnn — *Further settings: Calibration, Density*

Target: Sets the density of the fluid. Standard is 0.998 kg/dm^3 for water at 20 °C.

Command:	***CDnnnn***	4 digits, 0001 … 1500, [0.001 … 1.500 kg/dm^3]
Question :	***?CD***	Reads the actual level of the nominal (or customized) density of the fluid.
Answer :	***nnnn***	4 Digits, formatted to the right side.
Factory setting:	***0998***	0.998 kg/dm^3

CPnnnn — *Further settings: Calibration, Pressure*

Target: Sets the system pressure, which eventually could be used for a flow rate correction. (For the moment, there is no function implemented up to pumps with firmware V2.20)

Command:	***CPnnnn***	4 digits, 0001 .. 6000, [0.001 .. 6.000 bar pg]
Question :	***?CP***	Reads the actual level of the nominal (or customized) system pressure.
Answer :	***nnnn***	4 digits, formatted to the right side.
Factory setting:	***0000***	0.000 bar pressure gauche

Characteristic

CSnn *Further settings: Characteristic, pressure/suction stroke, pulsing/continuous*

Target: Defines the pump stroke characteristics for the pressure and suction stroke. The first digit defines the pressure stroke, the second the suction stroke.

Command: ***CSnn*** 2 digits respectively 00, 10 or 01

n	Meaning
00	pressure stroke is pulsing, sine shaped suction stroke is pulsing, sine shaped
10	pressure stroke is continuous, rectangular shaped suction stroke pulsing, sine shaped factory setting
01	pressure stroke is pulsing, sine shaped suction stroke is continuous, rectangular shaped
11	Not relevant

Question : ***?CS*** Reads the actual setting of the pump stroke characteristics

Answer : ***nn*** 2 digits

CEn *Further settings: Characteristic, stroke end point definition at pump stop*

Target : Sets the characteristic for the stroke end point definition at pump stop. If the pump receives a STOP instruction (keypad or PC command), then depending on this setting the real stop can be proceeded like:

Pump stop right now

Pump stops on “UT – position”, this means the pump stops at the end of the last pressure stroke

Pump stops on “Disp – position”, this means the pump stops at the point, where a new dispense volume can start

Command : ***CEn*** 1 digit, 0 .. 2

n	Meaning
0	Pump stops right now Factory setting
1	Pump stops on UT - position
2	Pump stops on Disp - position

Question : ***?CE*** Reads the actual setting of the stroke end point definition at pump stop.

Answer : ***n*** 1 digit

System

LCnnn — *Further Settings: System, LCD Display Contrast*

Target :	Sets the LCD display contrast.	
Command :	***LCnnn***	3 digits, 000 ... 100
Question :	***?LC***	Reads the actual setting for the LCD display contrast.
Answer :	***nnn***	3 digits, formatted to the right side.
Factory setting:	***050***	

SYhhmm — *Further Settings: System, Standby after time*

Target : Sets the “Standby after time”. The pump will switch off the display, when the pump has passed the “Standby after time”. Criterions are:

- No active operation
- No pushing of keypad button

A wake up of a pump in Standby can simply be made by pressing one of the keypad buttons or in sending a STOP command (KY0) via the PC to the pump

Command :	***SYhhmm***	4 digits,	***hh***: 00 .. 24 hours ***mm***: 10 .. 59 minutes
Factory setting:	***0010***	00 hours, 10 minutes	

SAn — *Further Settings: System, Auto-start after power on*

Target : After a power failure or power on, the pump will start automatically if it was previously running in Run-mode applications.

Command : ***SAn*** 1 digit, 0 / 1

n	Meaning
0	Auto-start inactive
1	Auto-start active

Question : ***?SA*** Reads the actual setup of the Auto-start function

Answer : ***n*** 1 digit

Remarks : Note! We not recommend using this function in Dispense-mode application without detailed verification the restart procedure after a power failure or power on.

ESn — *Further Settings: System, stop pump on Error*

Target : Defines, if the pump has to stop in case of a pump Error. In case of a pump Error either the Fault LED will light up continuous and the pump will stop or the Fault LED is blinking and the pump tries continues to operate. In both case a pump Alarm is proceeded in: e.g. displaying an Error message and switching the Alarm Relay.

Command : ***ESn*** 1 digit, 0 / 1

n	Meaning
0	Pump Fault/Error leads just to pump alarm, the Fault LED is blinking
1	Pump Fault/Error leads to a pump stop and pump alarm, the Fault LED lights up continuous Factory setting

Question : ***?ES*** Reads the actual setting for “stop pump on Error” function

Answer : ***n*** 1 digit

?SV — *Further Settings: System, reads pump model and firmware version*

Target : To recognize the pump model setting and the implemented firmware version of the pump.

Command : ***?SV***

Answer :

FEM_03V030	pump model: FEM 03	firmware version: V2.xx
FEM103V030	pump model: FEM 1.03	firmware version: V2.xx
FEM_08V030	pump model: FEM 08	firmware version: V2.xx
FEM108V030	pump model: FEM 1.08	firmware version: V2.xx
FEM03V020	pump model: FEM 03 / 1.03	firmware version: V1.xx
FEM08V020	pump model: FEM 08 / 1.08	firmware version: V1.xx
No answer!	Pump model: FEM xx	firmware version: V0.xx

Remarks : If the answer is " ***No answer!*** ", then use also the command ***?SI*** (communication check) to make sure the communication to the pump is working!

?SI — *Further Settings: System, communication check*

Target : Allows making a communication check. It allows the search for one or more pumps in a network of different pumps in the same network like:

RS485 bus system
USB bus with RS232 or RS485 converter
Ethernet network with RS232 or RS485 interface servers

Command : ***?SI***

Answer:

KNFnn	***nn***	2 digits 00 .. 99, corresponds to the address of the pump
		In this case the communication to is correct!
No answer!		In this case the communication to the pump has failed!

Remarks : Note! Make sure the serial connections to the pump and PC are correct!

Make sure the address setup of the pump (default: 00) and the used address in the controlling software tool are at the same value!

If you are using the FEM control centre, make sure the address setup under Special – Options – Common are at the same value!
If you are using RS232 communication, make sure the communication setup of the pump and the setup of the used tool are set to RS232 as well!
If you are using RS485 communication, make sure the communication setup of the pump and the setup of the used tool are set to RS485 as well!

Make sure the used PC port (COMM1, COMM2 …) corresponds to the setup of the used tool and to the physical connections on the PC.

Each pump operated on the same network (RS485 bus system, USB bus with RS232 or RS485 converter, Ethernet network with RS232 or RS485 interface servers) must have a different pump address!

SPn — *Further Settings: System, Protocol answer*

Target : The protocol answer can be activated if necessary. Then the pump will check if the command can be accepted, this means that the pump checks if the format and the checksum of this command are correct and if this command can be carried out. So for every received command the pump emits an "ACK" = Command acknowledged or a “NAK” Command not acknowledged. If this function is deactivated then the pump will send no answer back in case of a false command.

The ASCII signs ACK (6) and NAK(21) are used.

Command : ***SPn*** 1 digit, 0 / 1

n	Meaning	
0	Protocol answer inactive	Factory setting
1	Protocol answer active	

Question : ***?SP*** Reads the actual setup for protocol answer function.

Answer : ***n*** 1 digit

SBn — *Further Settings: System, Address and Status Byte 1 request*

Target : It is possible, that the pump can send back the pump address and the pump information of Status Byte 1 with every answer. This allows a fast supervisory of the main pump status, a kind of fast pump failure detection. In this case the pump sends back the additional data “ pump address and the information of Status Byte 1 “ together with the main answer. This means that every answer contains an additional five (5) bytes of information. The first two bytes contain the address and the other three bytes contain the information of Status Byte 1.

With this setting it is possible to realize fast pump failure detection. If a failure is present, then other detailed pump status can be read back by using the commands ***SSn***

Command : ***SBn*** 1 digit, 0 / 1

n	Meaning	
0	Send Address and Status Byte 1 inactive	Factory setting
1	Send Address and Status Byte 1 active	

Question : ***?SB*** Reads the actual setup for “send Address and Status Byte 1” function.

Answer : ***n*** 1 digit

IN — *Initialisation: new pump start, like power OFF /ON*

Target : This function does the same to the pump, as a full cycle of powering the pump OFF and powering the pump ON will do. It works like a new start for the pump after powering the pump ON.

Command : ***IN***

Remarks : No pump setting and no custom setting of the pump will be changed. See the different function of ***IP***

IP — *Further Settings: System, initial pump reset to the factory settings*

Target : This function brings the pump back to the factory settings.

All the modified custom settings: Run-mode, Dispense-mode, Settings concerning: RUN-Start, DISP-Start, Units, Logic I/O 1, Logic I/O 2, Relay, General and Further Settings concerning: Language, Calibration, Characteristic and System will be set back to the factory settings.

Any custom Run-mode calibration values will be set back to the factory calibration values.

Command : ***IP***

Remarks : See the different function of ***IN***

There is no setback for the Dispense-mode calibration values! (See the Application Note: FEM Dispense-mode calibration)

Control commands

PCn — *PC control status*

Target: Activates or deactivates the PC control status function. In the active PC control status the pump knows it is being externally controlled by a PC and the pump makes the keypad buttons inactive except the STOP button. “E” for “External Controlling” appears on the display.

Command: ***PCn***

n	Meaning
0	Normal control Factory setting
1	PC control is active, just the STOP button is active, “E” for “External Controlling” appears on the display

Question : ***?PC*** Reads the actual setting for the PC control status

Answer : ***nnn*** It is the same answer as you get by using the command ***?SS1***

The answer is of type Integer, 3 digits, bit 4 shows the PC control status. By masking the bit 4 it is possible to get the PC status.

Remarks : See the command ***?SSn*** and see the answer masking on Status Byte 1, bit 4

?SSn — *Pump status request: reads pump status*

Target: Reads back the pump status: Operation - Status, System - Status, RUN-mode - Status, DISPENSE-mode - Status, Solenoid valves ON/OFF, Fault diagnoses.

Command: ***?SSn*** ***n*** = Status Bytes 1 … 6

Answer : ***nnn*** The answer is of type Integer, 3 digits, 000 … 255 (binary coded), the answer can contain combinations:

e.g. Status Byte 1 = ***010***, this is ***[2]*** Pump Fault & ***[8]*** PC controlled

Byte 1	[worth]	**Operation – Status**
Bit 1	[1]	[0] Motor don't turn, [1] Motor turns
2	[2]	[0] No pump Fault, [2] Pump Fault
3	[4]	[0] Display ON, [4] Display OFF
4	[8]	[0] NO PC control, [8] PC controlled, "E" in display
5	[16]	
6	[32]	
7	[64]	
8	[128]	

Byte 2	[worth]	**System – Status**
Bit 1	[1]	[0] motor not adjusted, [1] motor adjusted (Dispense-mode)
2	[2]	[0] I/O 1 input low, [2] I/O 1 input high
3	[4]	[0] I/O 2 input low, [4] I/O 2 input high
4	[8]	[0] motor not on UT, [8] motor on UT
5	[16]	
6	[32]	
7	[64]	
8	[128]	

Byte 3	[worth]	**RUN-mode – Status**
Bit 1	[1]	[0] RUN-mode stopped, [1] RUN-mode started
2	[2]	
3	[4]	
4	[8]	
5	[16]	
6	[32]	
7	[64]	
8	[128]	

Byte 4	[worth]	**DISPENSE-mode - Status**
Bit 1	[1]	[0] Dispense-mode stopped, [1] Dispense-mode started
2	[2]	[0] NOT in pump pause time, [2] in pump pause time
3	[4]	[0] NOT in pump wait time, [4] in pump wait time
4	[8]	[0] user stop active [8] user stop NOT active
5	[16]	
6	[32]	
7	[64]	
8	[128]	

Byte 5	[worth]	**Solenoid valves ON/OFF**
Bit 1	[1]	
2	[2]	
3	[4]	[0] Solenoid valve 1 on, [4] Solenoid valve 1 off
4	[8]	[0] Solenoid valve 2 on, [8] Solenoid valve 2 off
5	[16]	
6	[32]	
7	[64]	
8	[128]	

Byte 6	[worth]	**Fault diagnoses**
Bit 1	[1]	[1] Error No. 1: PE Error, overpressure, …
2	[2]	[2] Error No. 2: Dosing monitoring error
3	[4]	[4] Error No. 3: Impulse fault (Dispense-mode)
4	[8]	[8] Error No. 4: Analog signal under 4mA
5	[16]	[16] Power supply failure
6	[32]	[32] Motor not adjusted (Dispense-mode)
7	[64]	[64] Error No. 6: Temperature exceeded
8	[128]	[128] Error No. 8: PE(PD) Error, no hall sensor signal

Release: 2007-04-30 / R&D / Bruno Emmenegger