Operating

Control 2000

via
G100

Edition 1.7, May 2002

This document is mainly intended for development engineers integrating Control2000 based Grundfos applications in automation systems using data communication via the gateway G100.

It contains Data Items from the Functional Profile of Control2000 with a description of how to use and interpret them. This makes the application programmer able to operate Control2000 with different applications.

Using the information for implementation of communication with Control2000 via G100 presuppose a knowledge of how to access data in G100 from the main network in question. Documents for each of the main network connections are included on the G100 Support Files CD ROM.

1. Possible PMU/PFU Constellations

1. Only one PMU together with one or two PFU's controlling 1 zone can be connected to the G100 GENIbus port. This means that all the different Hydro 2000 / Control 2000 constellations with and without PMU restricted to 1 zone are supported.
2. The first PFU must have address 40. This is done by setting switches 1, 2 1nd 3 of the PFU dip switch to 0 (it will physically control pump No. 1-4). An extra PFU with address 41..47 (lowest pump number 2 to 8) may also exist for the same zone.
3. All pumps controlled by the PFU(s) exist on the bus as *PFU Pump Objects* considered to be controlled by one *PFU Zone Object*. This will be depicted accordingly by the PC Tool G100 (see figures).
4. GENIbus devices other than PMU/PFU are allowed if their unit No. is >=18 (address is >= 49).
5. POU is supported as a "hidden" unit (won't be recognized by G100). PCU is not supported .

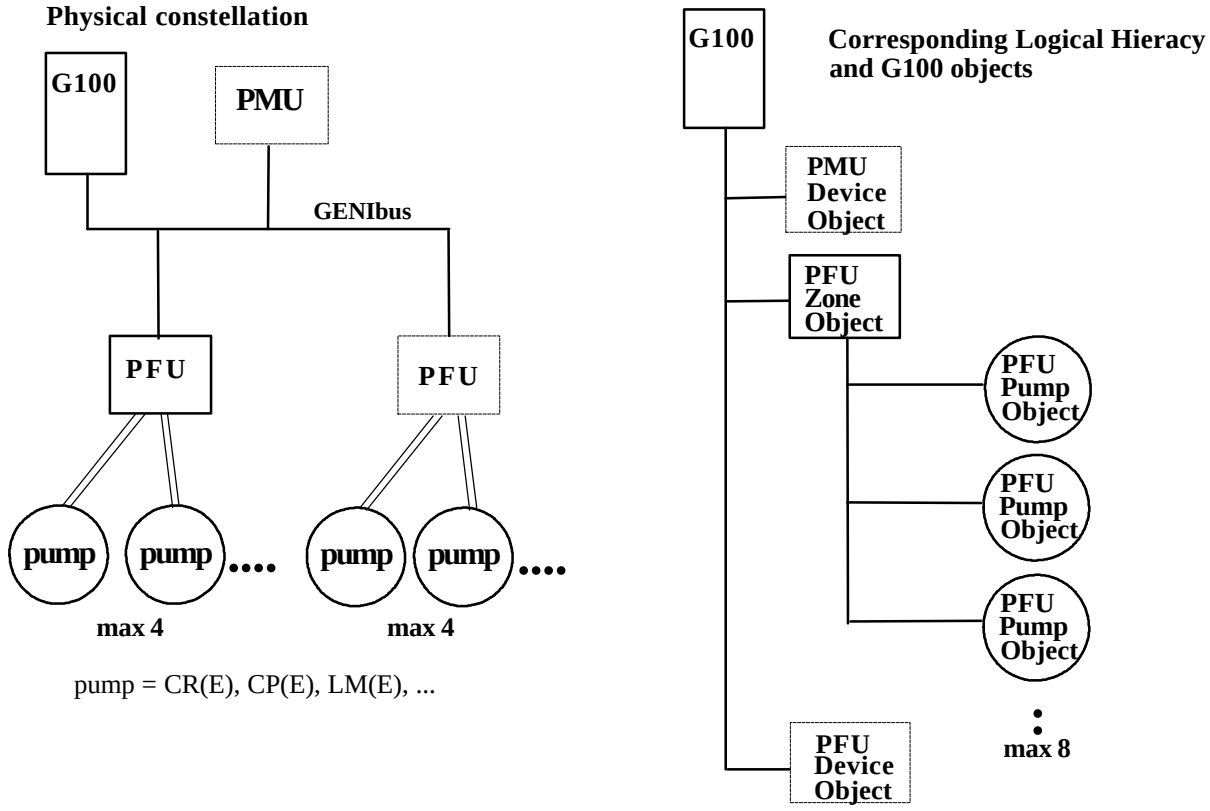

Figure 1.1: *Constellations of PMU/PFU supported by G100 and the corresponding organization of data in objects inside G100. The first PFU will make G100 build a PFU Zone Object and a PFU Pump Object to each of the PFU controlled pumps. If the pumps are E-pumps and they are connected to GENIbus, G100 will build a MGE Device Object to each of them from which a lot of additional information can be read, see /3/.*

NOTICE!
Allow up to 2 minuts for data in the system to stabilize when powerering on/off PMU/PFU devices, or connecting/disconnecting these devices to the bus.

2. The Objects

Generally all Data Objects are unsigned integer's (16 bits). A few exceptions exist. They are unsigned long's (32 bits) and are marked with an asterix.

2.1 PFU Zone Object

The PFU Zone Object shown below is the data representation of a virtual zone inside the G100 memory. The zone object is said to be virtual because a zone is not a physical device. The object together with the description of how to use it constitutes the Functional Profile of a PFU zone as seen from the Main Network.

Subindex	Data Item Identifier	Description	Scaling/interpretation	Access
1	zone_alarm_code	Alarm Code	See reference description chapt. 2.5	R
2	zone_on	Operation Mode of zone. Changeable from PMU On/Off Menu	[0, 1, 2, 3] = [Off; On, Local, Max]	R
3	pump_on	8 bits repr. Operation Mode of pumps 1..8. Changeable from PMU On/Off Menu	[0, 1] = [Off, On]	R
4	pump1_to_zone	Zone No. of pump 1..8 respectively. Changeable from PMU configuration menu	[0; 7]=[A; H], 8=not available	R
5	pump2_to_zone			
6	pump3_to_zone			
7	pump4_to_zone			
8	pump5_to_zone			
9	pump6_to_zone			
10	pump7_to_zone			
11	pump8_to_zone			
251	zone_setpoint_max*)	The PMU controlled max setpoint. Changeable from PMU Set Menu Not used if PMU is not present	0.01 * "zone_scaling_unit"	R
252	zone_setpoint_actual*)	Actual setpoint, Control loop reference	0.01 * "zone_scaling_unit"	R
253	zone_value_actual*)	Actual value, Control loop feedback	0.01 * "zone_scaling_unit"	R
12	zone_scaling_unit	Index to lookup table of physical units. Changeable from PMU Set Menu	See data item description chapt. 2.5	R
13	zone_setpoint_att	Zone setpoint attenuation via bus	0-100%	W
14	RESET_ALARM	Reset zone alarm	-	W

*) These Data Items are all unsigned long (32 bits)

2.2 PFU Pump Object

The object shown below is the data representation of a PFU connected pump inside the G100 memory. The pump is a real physical device, but on the bus it only exists as a virtual pump emulated by the PFU. The object together with the description of how to use it constitutes the Functional Profile of a PFU pump as seen from the Main Network.

Subindex	Data Item Identifier	Description	Scaling/interpretation	Access
1	pump_status	Pump status	See data item description chapt. 2.5	R
2	pump_lamp	Red and green lamp status	See data item description chapt. 2.5	R
3	pump_speed	Speed	0-100%, see also chapt. 2.5	R
4	START	Starting of pump	-	W
5	STOP	Stopping of pump	-	W

2.3 PMU Device Object

The PMU Device Object shown below is the data representation of the PMU inside the G100 memory. It represents the presence of a physical PMU Device. The only Data Item is the status of the alarm agenda in the PMU and a command to clear it. If the alarm log value is different from zero the red diode on the PMU will be on. The rest of the Functional Profile of the PMU is completely mapped into the PFU Zone Object.

Subindex	Data Item Identifier	Description	Scaling/interpretation	Access
1	alarm_log_length	No. of stored alarms in PMU alarm log	-	R
2	RESET_ALARM	Reset PMU alarm agenda (and red diode)	-	W

2.4 PFU Device Object

The PFU Device Object is the data representation of the 2'nd PFU (if present). The object is empty. Its Functional Profile is completely mapped into the PFU Zone Object and the PFU Pump Objects.

2.5 Data Item Description

zone_alarm_code

bit 0: water shortage
bit 1: speed control fault
bit 2: sensor analogue input 1
bit 3: sensor analogue input 2
bit 4: sensor analogue input 3
bit 5: minimum limit exceeded
bit 6: maximum limit exceeded
bit 7: fault any motor

zone_scaling_unit

Value	Control mode	Unit
0	open_loop	%
1	open_loop	%
2	open_loop	%
3	open_loop	%
4	pressure	bar
5	pressure	kPa
6	pressure	mbar
7	pressure	psi
8	pressure difference	m
9	pressure difference	
10	pressure difference	Pa
11	pressure difference	kPa
12	flow	m3/h
13	flow	l/h
14	flow	l/s
15	flow	gpm
16	level	m
17	level	cm
18	level	ft
19	level	in.
20	temperature	°C
21	temperature	°F
22	temperature	°C
23	temperature	°C
24	temperature difference	°C
25	temperature difference	°F
26	temperature difference	°C
27	temperature difference	°C

pump_lamp

Bits	Description
xxxx1110	Green on, red off
xxxx101x	Green blinking, red off
xxxx1101	Green off, red on

pump_status

Bits	Description
0:	1=Line contactor on (standard on/off controlled pump)
1:	1=Frequency converter or E-pump digital start on (frequency controlled pump)
7-2:	don't care

pump_speed

full size pump:	0..100%
halfsize-pump:	0..50%
jockey-pump:	0..10%

3. Hydro 2000 example

Below are the Hydro2000 Data Objects shown. If the E-pumps are connected to GENIbus and each is given (by R100) a unique number >16, they will appear as MGE Device Objects supplying a lot of extra information (see /1/). An example of an operator screen which can be made from the Hydro2000 Data Objects is also shown.

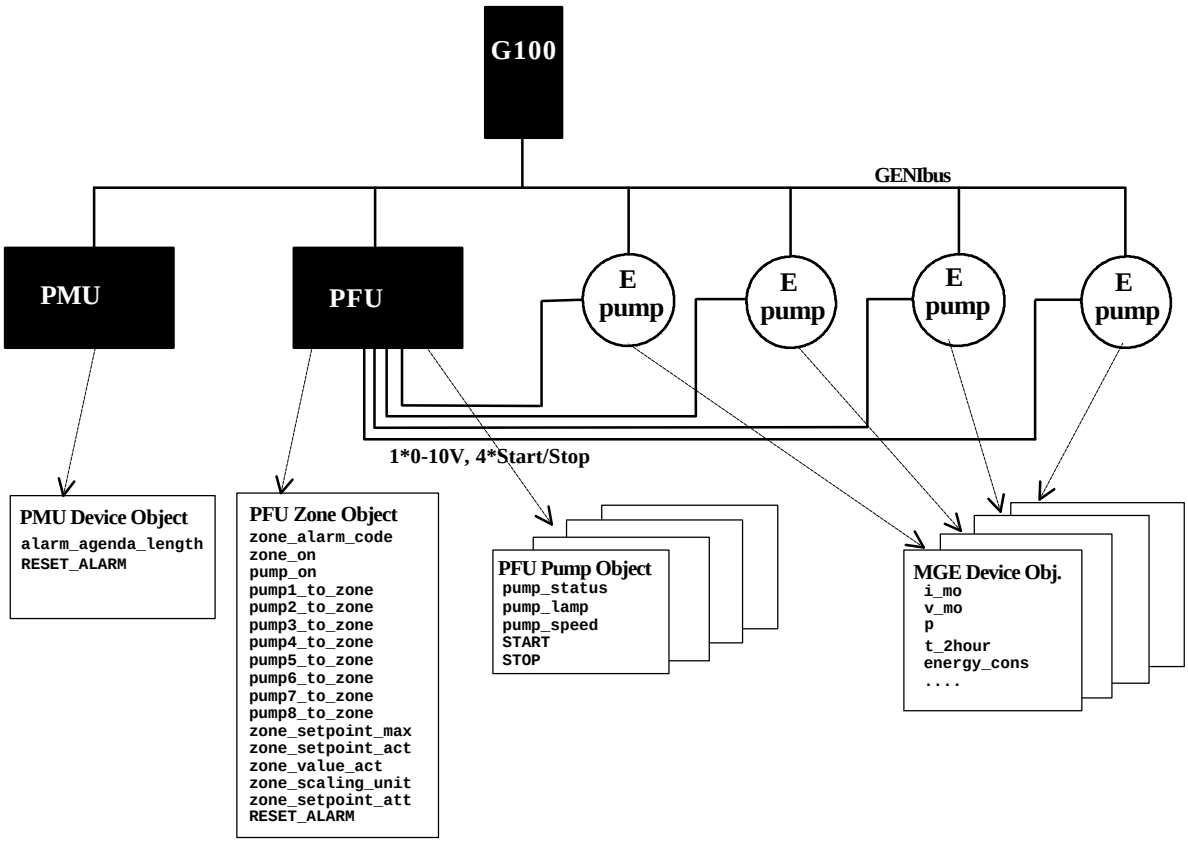

Figure 3.1: *Hydro2000 Data Objects*

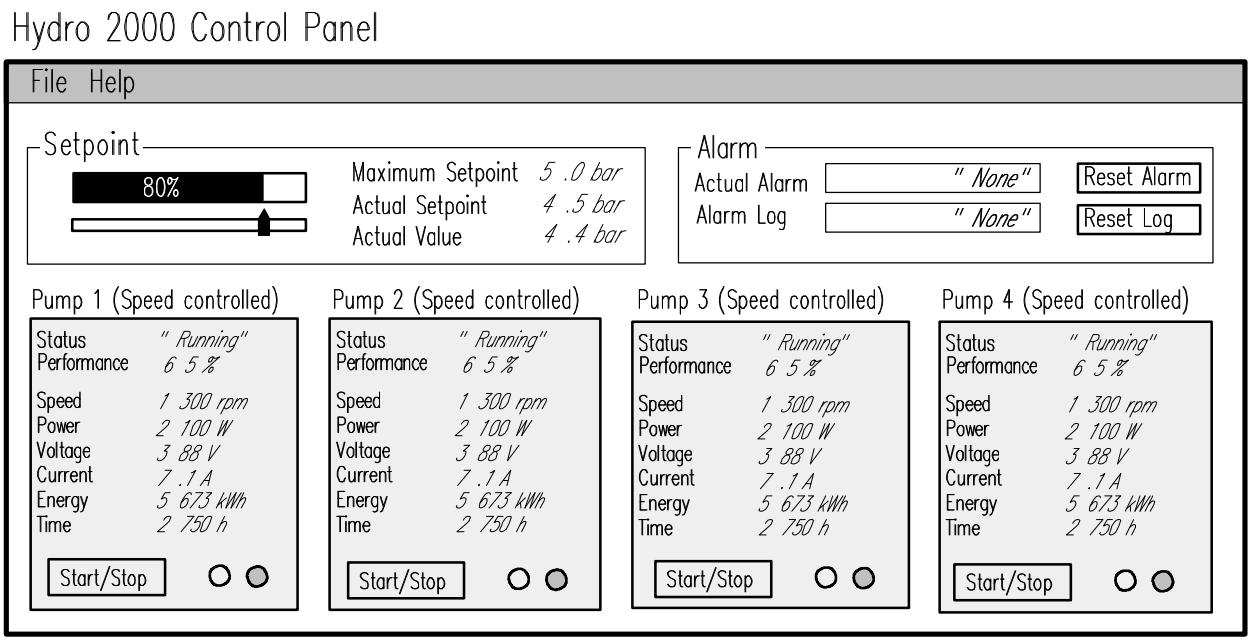

Figure 3.2: *Example of Hydro2000 control panel. Mail Henrik Amdisen (hamdisen@grundfos.com) to get a free copy of this program.*

Block read request

Position	Value [Hex]	Description
STX	2	Start delimiter
TGM_LENGTH_HI	0	
TGM_LENGTH_LO	1F	Total telegram length
COM_REF	0	G100 broadcast addr.
INVOKE_ID	0	don't care
SERVICE	E	Read multible objects
PRIMITIVE	0	Request
OBJ_LENGTH_HI	0	
OBJ_LENGTH_LO	13	Length of object field
NO_OF_INDICES	6	Total No. of indices
INDEX_HI	21	Unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	1	**zone_alarm_code**
INDEX_HI	21	Unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	2	**zone_on**
INDEX_HI	21	unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	3	**pump_on**
INDEX_HI	21	Unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	FB	**zone_setpoint_max**
INDEX_HI	21	Unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	FC	**zone_setpoint_actual**
INDEX_HI	21	Unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	FD	**zone_value_actual**
ETX	3	End delimiter
CHK_SUM_HI	FF	XOR check sum
CHK_SUM_LO	AA	always AA

Figure 3.3:
Hydro2000 example of a block reading with both 16 bit and 32 bit objects by using the G100 protocol. On the Support Files diskette is a DLL-driver which implements this protocol for Windows 95/NT

Block read reply

Position	Value [Hex]	Description
STX	2	Start delimiter
TGM_LENGTH_HI	0	
TGM_LENGTH_LO	2A	Total telegram length
COM_REF	0	G100 broadcast address
INVOKE_ID	0	don't care
SERVICE	E	Read multible objects
PRIMITIVE	1	Reply
OBJ_LENGTH_HI	0	
OBJ_LENGTH_LO	1E	Length of object field
RESULT	0	0=OK; FF=error
ERROR_CLASS	0	mmmm
ERROR_CODE	0	
ADD_CODE_HI	0	Not used, always 0
ADD_CODE_LO	0	
LENGTH	18	Length of all Objects
OBJ_1_LENGTH	2	Length of Object 1 data
OBJ_1_DATA	0	
	0	**zone_alarm_code**
OBJ_2_LENGTH	2	Length of Object 2 data
OBJ_2_DATA	0	
	1	**zone_cn**
OBJ_3_LENGTH	2	Length of Object 3 data
OBJ_3_DATA	0	
	F	**pumpe_cn**
OBJ_4_LENGTH	4	Length of Object 4 data
OBJ_4_DATA	0	
	0	**zone_setpoint_max**
	E7	
	23	
OBJ_5_LENGTH	4	Length of Object 5 data
OBJ_5_DATA	0	
	0	**zone_setpoint_actual**
	A4	
	12	
OBJ_6_LENGTH	4	Length of Object 6 data
OBJ_6_DATA	0	
	0	**zone_value_actual**
	A4	
	19	
ETX	3	End delimiter
CHK_SUM_HI	E5	XOR check sum
CHK_SUM_LO	AA	Always AA

Write request

Position	Value [Hex]	Description
STX	2	Start delimiter
TGM_LENGTH_HI	0	Total telegram
TGM_LENGTH_LO	11	length
COM_REF	0	G100 broadcast addr.
INVOKE_ID	0	don't care
SERVICE	3	write object
PRIMITIVE	0	Request
OBJ_LENGTH_HI	0	Length of object
OBJ_LENGTH_LO	5	field
INDEX_HI	21	Unit address 40
INDEX_LO	28	= PFU Zone Object
SUB_INDEX	D	**zone_setpoint_att**
LENGT	1	Length of Object data
OBJ_DATA	32	corresponds to 50%
ETX	3	End delimiter
CHK_SUM_HI	21	XOR checksum
CHK_SUM_LO	AA	Always AA

Write reply

Position	Value [Hex]	Description
STX	2	Start delimiter
TGM_LENGTH_HI	0	
TGM_LENGTH_LO	11	Total telegram length
COM_REF	0	G100 broadcast addr.
INVOKE_ID	0	don't care
SERVICE	3	Read multible objects
PRIMITIVE	1	Reply
OBJ_LENGTH_HI	0	
OBJ_LENGTH_LO	5	Length of object field
RESULT	0	0=OK; FF=error
ERROR_CLASS	0	
ERROR_CODE	0	
ADD_CODE_HI	0	Not used, always 0
ADD_CODE_LO	0	
ETX	3	End delimiter
CHK_SUM_HI	17	XOR checksum
CHK_SUM_LO	AA	Always AA

Figure 3.4:
Hydro2000 example of writing a value with the G100 protocol. Writing a command is done in the same way, but the value (OBJ_DATA) is in that case not used (only a dummy value).

	G100 Protocol INDEX_HI/LO	**GENIbus address**
PFU Pump Object No. 1	0x2120	32
PFU Pump Object No. 2	0x2121	33
PFU Pump Object No. 3	0x2122	34
PFU Pump Object No. 4	0x2123	35
PFU Zone Object	0x2128	40
PMU Device Object	0x210C	12
MGE Device Object No. 18	0x2131	49
MGE Device Object No. 19	0x2132	50
MGE Device Object No. 20	0x2133	51
MGE Device Object No. 21	0x2134	52

Figure 3.5:
Hydro2000 object indices to use when the different objects are to be read or written.
Notice: The MGE Device Object numbers refer to the number programmed with R100.

3.1 Setpoint Frame

From the Setpoint Frame you can watch and control the actual setpoint in Hydro2000.

Operating the Slider:
The slider can be dragged with the mouse. When released the percentage value which it represents is send to G100. The data item written is **zone_setpoint_att**. The value is in percent.

Maximum Setpoint:
Is the maximum value the setpoint can get. The value is obtained by reading **zone_setpoint_max**, multiplying by 0.01 and giving it the physical unit represented by **zone_scaling_unit**. The value can only be changed from the PMU and can obtain values up to the maximum sensor value.

Actual Setpoint:
Is the actual setpoint used by the Hydro2000 (pressure) control loop. The value is obtained by reading **zone_setpoint_actual**, multiplying by 0.01 and giving it the physical unit represented by **zone_scaling_unit**. The value equals the Maximum Setpoint multiplied by the reduction percentage from the user operated "slider" to the left.

Actual Value:
Is the actual (sensor) value from Hydro2000. The value is obtained by reading **zone_value_actual**, multiplying by 0.01 and giving it the physical unit represented by **zone_scaling_unit**. In a steady state situation it is expected to equal the Actual Setpoint.

3.2 Alarm Frame

From the Alarm Frame you can watch actual alarms, get an alarm log and reset the Hydro2000.

Actual Alarm:
Displays a possible Actual Alarm. The alarm code is read from **zone_alarm_code**. If this code is different from zero Hydro2000 has an alarm condition, the red led at PFU2000 is on and one or more pumps are inoperational.

Alarm Log:
Each time the actual alarm (**zone_alarm_code**) from Hydro2000 changes, a new alarm entry with time stamp is added to the Alarm Log. So, this alarm Log is solely generated by the Control Panel software.

Delete Log:
This button will delete the Alarm Log in the Control Panel and will continue sending the **RESET_ALARM** command to the PMU Device Object until all alarms recorded in the PMU alarm log are cleared. One entry is cleared each time the command is send. How many there are left is checked with **alarm_log_length**. The red diode at PMU will turn off when the log is cleared. If there are an actual alarm in the system it will not be possible to clear entries in the PMU Alarm Log.

Reset Alarm:
Will reset the latest alarm in Hydro2000.

3.3 Pump Frame

Each pump is displayed as a Pump Control Window from where you can view status values and START/STOP the pump.

The pump type bar:
Here a text describing the type of pump (speed controlled or standard) is displayed. The information comes from the data item **pump_status**. Unfortunately it is only when a pump is running that its type can be identified. This sometimes leads to situations where the display of the correct pump type is delayed until the pump is being started.

Status:
Operation status of the pump. It can obtain the following modes:

Running: The pump runs normally, **pump_lamp**=xxxx1110 (Green on, red off).

Stopped (via bus): The pump has been stopped by the Control Panel, **pump_lamp**=xxxx101x (Green blinking, red off).

Stopped (from PMU): The pump has been stopped at the PMU (in On/off Menu). The zone can be off (**zone_on**=0) or the pump can be off (its bit in **pump_on** is 0).

Stopped (zone control): The PFU has stopped the pump due to zone control, **pump_lamp**=xxxx101x (Green blinking, red off).

Alarm: The pump has a fault and is in alarm stop, **pump_lamp**=xxxx1101 (Green off, red on).

Notice that stopped from zone control or stopped via bus cannot be distinguished in the data items. The Control Panel has to keep record of the status of the Start/Stop button.

Performance:
Relative (percentage) speed of the pump. The value is obtained by reading **pump_speed** which gives the value directly in percent

START/STOP button:
This button is for starting and stopping of the pumps individually. Clicking the button sends a **START** command if the pump is stopped and a **STOP** command if the pump is started.

RED/GREEN diode: Displays a diode image of the operation status. The image is read directly from **pump_lamp**

MGE Data:
If the pump is an E-pump and if it has been given an appropriate number and is wired to the GENIbus network, additional data can be supplied to the Control Panel as shown. The data items selected in the example is **speed**, **p**, **v_mo**, **i_mo**, **energy** and **t_2hour** (see /3/).

Notice!
Under the development of the Hydro2000 Control Panel example the two inconveniences described below has been discovered

1.
If Hydro2000 is powered on while connected to a G100 which is already powered on, or if the devices are powered on simultaneously, the PMU2000 will enter a state in which it writes SLAVE in the display. The state is an error condition which lasts for 2-4min. In this state the bus control of the setpoint is unreliable and so is the read out of the actual setpoint at the PMU2000 display. The PMU2000 automatically leaves this error state and everything becomes normal except the read out of actual setpoint at the PMU2000 display.

The only way to avoid this inconvenience is to power on G100 3-5sec after Hydro2000, to delay the connection of Hydro2000 to GENIbus 3-5sec. or to let the master software send a RESTART command (index0x2002) to G100 when starting and when ever an interuption in communication has happened.

2.
Clearing of the red diode at the PFU with Reset Alarm can some times be delayed up to 2min.

3.4 Using the example for Profibus

The telegrams in figure 3.4 - 3.5 are for the G100 protocol. With the following small modifications the same telegrams can be used as (embedded) Profibus telegrams, see also /6/:

STX	is substituted with COUNT
TGM_LENGTH_HI / TGM_LENGTH_LO	is removed
COM_REF	is a don't care value
ETX	is removed
CHK_SUM_HI / CHK_SUM_LO	Added sum of the complete telegram (except the sum itself) NB! From G100 software version V04 (*profibusV04.bin*) the usage of check sum for Profibus communication is optional.

4. References

All the below documents are included on the G100 Support Files CD ROM

Reference	Document Title	Document File
/1/	G100 Object Reference Specification	objref.pdf
/2/	G100 Protocol Specification	g100prot.pdf
/3/	Operating the MGE motor via GENIbus or G100	mge.pdf
/4/	Accessing G100 via the Satt Control Comli Protocol	comli.pdf
/5/	Accessing G100 via MODbus	modbus.pdf
/6/	Accessing G100 via Profibus-DP	profibus.pdf