Contents

Chapter 1

About this manual

This manual is intended to be used both as an instructional and as a reference manual. It only briefly touches on the basics of the PROFIBUS protocol whenever it is necessary for gaining an understanding of the PROFIDRIVE implementation of the PROFIBUS Profile for Variable Speed Drives (VDI/VDE 3689) and the DANFOSS PROFIBUS Option Card for the VLT 6000 Series.

The manual is also intended to serve as a guideline when you specify and optimize your communication system.

If you are not completely familiar with PROFIBUS, FMS or the Profile for Variable Speed Drives, it may be advisable to read some of the material provided on these subjects.

Even if you are an experienced PROFIBUS programmer, we suggest that you read this manual in its intirety before you start programming, since important information can be found in all chapters.

Chapter 2 is a quick setup for the communication parameters for DP and FMS communication.

Chapter 3 gives details on the PROFIBUS Option Card and how to establish the physical connection.

Distinguishing the features of the FMS and DP is the main topic of chapter 4.

In chapter 5 you will find information about VLT response time and system update time.

Chapter 6 and 7 describe further details on DP and FMS respectively.

Chapter 8 has all the relevant VLT and PROFIBUS parameters listed.

Chapter 9 describes warning and alarm messages and chapter 10 additional display messages.

In chapter 11 you will find a glossary explaining abbreviations, words and phrases you must know to understand this manual. This chapter also contains a complete parameter list with parameter designations, default settings, setting ranges etc.

If you want to know more about the PROFIBUS protocol in general, please refer to the vast amount of literature provided for this purpose.

Assumptions

This manual assumes that you are using a DANFOSS PROFIBUS Option Card in conjunction with a DANFOSS VLT 6000 Series. It is also assumed that you, as a master, are using a PLC or PC that is equipped with a serial communication card supporting all the PROFIBUS communication services required by your application, and that all requirements stipulated in the PROFIBUS standard as well as those set up in the PROFIBUS Variable Speed Drives Profile and its company-specific implementation PROFIDRIVE, as well as those pertaining to the VLT Variable Speed Drive are strictly observed as well as all limitations therein fully respected.

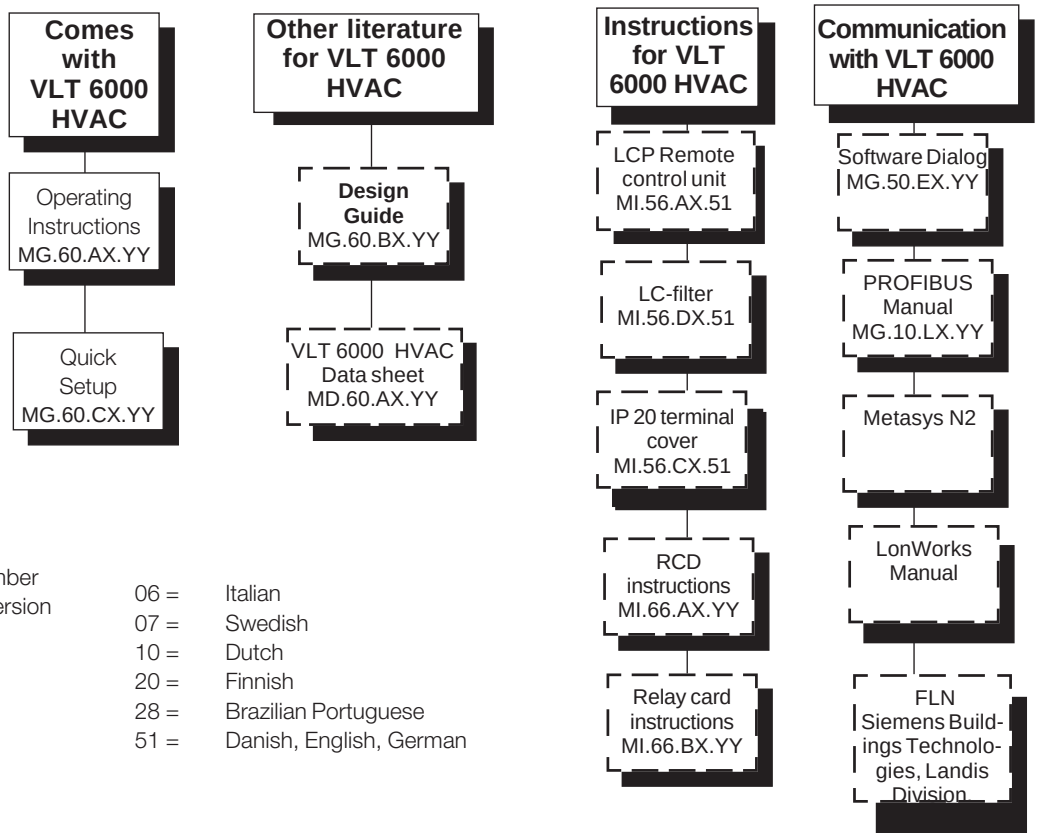
What you should already know

The DANFOSS PROFIBUS Option Card is designed to communicate with any master abiding by the PROFIBUS standard. It is therefore assumed that you have full knowledge of the PC or PLC you intend to use as a master in your system. Any question pertaining to hardware or software produced by any other manufacturer is beyond the scope of this manual and is of no concern to DANFOSS.

If you have questions about how to set up master - master communication or communication to a non-Danfoss slave, the appropriate manuals should be consulted.

■ Available literature

The chart below gives an overview of the literature available for the VLT 6000 Series.
Please note that variations may occur from one country to the next.



X =	version number
yy =	language version
01 =	Danish
02 =	English
03 =	German
04 =	French
05 =	Spanish
06 =	Italian
07 =	Swedish
10 =	Dutch
20 =	Finnish
28 =	Brazilian Portuguese
51 =	Danish, English, German

Chapter 2

For how to program the ordinary VLT parameters see the VLT 6000 Series manual.

Communication is established by setting the parameters stated below.

For how to set up the master, see the manual on the master as well as the chapters of this manual giving details on the VLT PROFIBUS interface.

■ DP

Parameter 904

Select the telegramme type (PPO) to be applied, see page 24.

Parameter 918:

Set the VLT station address, - one unique address per VLT.

Parameter 801:

Set the transmission speed in bit/sec. The default setting is *Auto*, which means that the VLT automatically detects the transmission speed of the connected bus. If you set a fixed value it must be the same as that selected in the master.

Parameter 800:

Used for choosing between DP and FMS, choose DP, see chapter 4 for a detailed description of the two forms of communication.

■ FMS

Parameter 918:

Set the VLT station address, - one unique address per VLT.

Parameter 801:

Set the transmission speed in bit/sec. The default setting is *Auto*, which means that the VLT automatically detects the transmission speed of the connected bus. If you set a fixed value it must be the same as that selected in the master.

Parameter 800:

Used for choosing between DP and FMS, choose FMS, see chapter 4 for a detailed description of the two forms of communication.

■ General information

Parameter 503 = "BUS".

Otherwise terminals 12 and 27 of the control card must be connected, before motor start. In parameters 503-508 it is possible to define how to gate the control commands from the PROFIBUS with the equivalent control commands of the digital inputs.

Chapter 3

■ Master controlled Variable Speed Drives (VSD)

The PROFIBUS Field-bus Option Card was designed to give you unprecedented flexibility and command over your VSD controlled system. The PROFIBUS Option will perform as an integrated part of your VLT VSD, giving you access to all parameters relevant to your application. The VSD will always act as a slave, and together with a master it can exchange a multitude of information and commands. Control signals such as *speed reference*, *start / stop* of motor, *reverse* operation, etc. are transmitted from the master in the form of a telegramme. The VSD acknowledges receipt by transmitting status signals, such as *running*, *on reference*, *motor stopped* and so on to the master. The VSD may also transmit fault indications, alarms and warnings to the master, such as *VLT fault* or *Current overload*.

The PROFIBUS Option Card communicates according to the *PROFIBUS Protocol Standard DIN 19245 parts 1, 2 and 3*. This means that it can communicate with all masters that comply with this standard, but it does not necessarily mean that all services available in the PROFIBUS standard are supported. The *VDI / VDE 3689 PROFIBUS Profile for Variable Speed Drives* is a subset of PROFIBUS which only supports the services relevant to speed control applications. *PROFIDRIVE* is an implementation of VDI / VDE 3689 profile created by DANFOSS and a number of other companies.

Communication partners

In a control system the VSD will always act as a slave, and as such it may communicate with a single master or multiple masters depending on the nature of the application. A master may be a PLC or a PC that is equipped with a PROFIBUS communication card.

■ Physical layer

The field of application of a field-bus system is primarily determined by the transmission media and the physical bus interface selected. The type of bus cable required for the application and its installation (physical layer) are particularly important factors, in addition to the required transmission reliability of the physical level.

Though a fundamental feature of the PROFIBUS standard is the possibility of specifying several different physical interfaces, the standard, at the time of printing, has allowed for one universal specification only, namely the EIA Standard RS 485-A, which has found acceptance both in the field of factory automation and in several areas of the processing industry.

■ Cable lengths/number of nodes

The maximum cable length in one segment is depending on the transmission speed. The total cable length includes drop cables if any. A drop cable is the connection from the main bus cable to each node if a T-connection is used instead of connecting the main bus cable directly to the nodes, see drop cable length. The table below shows the maximum allowed cable length and maximum number of nodes/VLT's with 1, 2, 3 and 4 bus segments.

Note that a repeater is a node in both of the two segments it connects. The number of VLT is based on a single master system. If there are more masters the number of VLT must be reduced correspondingly.

Max. total bus cable lenght

Transmission speed	1 segment: 32 nodes (31 VLT) [m]	2 segments: 64 nodes (1 repeater, 61 VLT) [m]	3 segments: 96 nodes (2 repeaters, 91 VLT) [m]	4 segments: 128 nodes (3 repeaters, 121 VLT) [m]
9.6-187.5 kBaud	1000	2000	3000	4000
500 kBaud	400	800	1200	1600
1.5 MBaud	200	400	600	800
3-12 MBaud	100	200	300	400

The total drop cable length for one segment is limited as stated in the table below.

Drop cable length

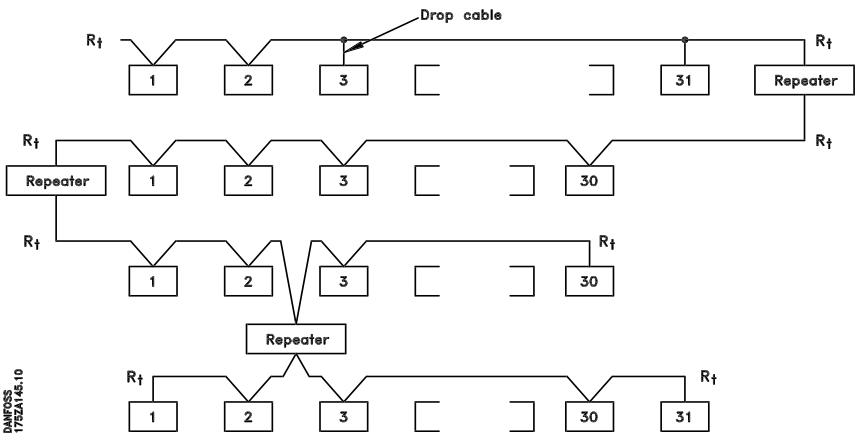
Transmission speed	Max. drop cable length per segment [m]
9.6-93.75 kBaud	96
187.5 kBaud	75
500 kBaud	30
1.5 MBaud	10
3-12 MBaud	none

The length statements in the tables above are valid provided that bus cable with the following properties is used:

- Impedance: 135 to 165 ohm at a measuring frequency from 3 to 20 MHz
- Resistance: < 110 ohm/km
- Capacitance: < 30 pF/m
- Damping: max. 9 dB over the whole wire length
- Cross section: max. 0.34 mm^2, corresponding to AWG 22
- Cable type: twisted in pairs, 1 x 2, or 2 x 2, or 1 x 4 wires
- Screening: Copper-braided screen or braided screen and foil screen

It is recommended to use the same cable type in the entire network to avoid impedance mismatch.

The numbers on the following drawing indicate the maximum number of stations in each segment. They are not the station addresses as each station in the network must have an unique address.



■ Physical connection

The PROFIBUS Option Card is connected to the bus line via MK 1A or 1B, terminals 62 and 63.

It is recommended to use a master with a galvanic isolated bus driver and with over voltage protection (e.g. zenerdiode).

EMC precautions

The following EMC precautions are recommended to obtain interference free operation of the PROFIBUS network. Additional information on EMC can be found in the VLT 6000 Series design guide (MG.60.B1.02). Please also consult the manual of the PROFIBUS master for further installation guidelines.

Relevant national and local regulations, for example regarding protective earth connection, must be observed.

- Cable routing

The PROFIBUS communication cable must be kept away from motor and brake resistor cables to avoid coupling of high frequency noise from one cable to the other. Normally a distance of 200 mm is sufficient, but it is generally recommended to keep the greatest possible distance between the cables, especially where cables are running in parallel over long distances.

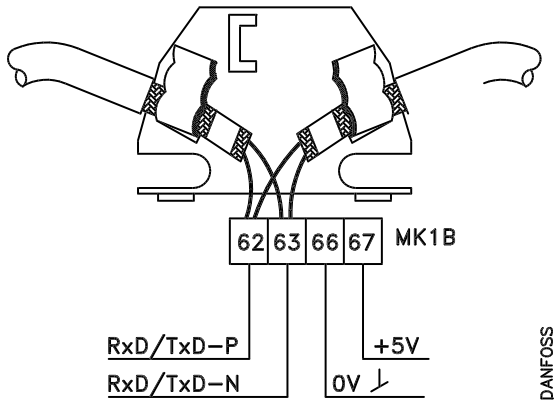
If the PROFIBUS cable has to cross a motor and brake resistor cable they must cross each other at an angle of 90°.

- Connection of the cable screen
  The screen of the PROFIBUS cable must always be connected to ground at both ends, that means the screen must be connected to ground in all stations connected to the PROFIBUS network. It is very important to have a low impedance ground connection of the screen, also at high frequencies. This can be obtained by connecting the surface of the screen to ground, for example by means of a cable clamp or a conductive cable gland.

  VLT 6000 Series is provided with different clamps and brackets to enable a proper ground connection of the PROFIBUS cable screen. The screen connection is shown in the following drawing.
- Earth connection
  It is important that all stations connected to the PROFIBUS network are connected to the same earth potential. The earth connection must have a low HF (high frequency) impedance. This can be achived by connecting a large surface area of the cabinet to earth, for example by mounting the VLT 6000 series on a conductive rear plate.

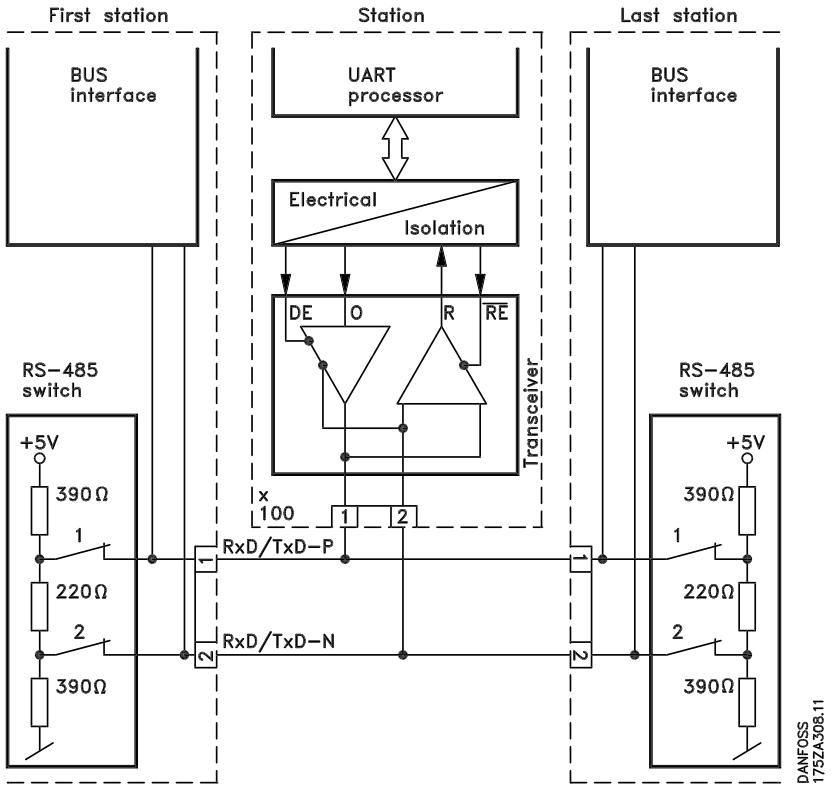
  Especially when having long distances between the stations in a PROFIBUS network it can be necessary to use additional potential equalizing cables, connecting the individual stations to the same earth potential.

Connecting the bus line



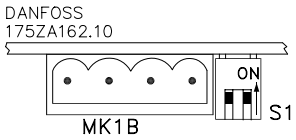
The bus termination

See drawing on page 19



It is essential that the bus line be terminated properly. A mismatch of impedance may result in reflections on the line that will corrupt data transmission.

- The PROFIBUS Option Card is provided with a suitable termination which may be activated by switches 1 and 2 of switch block S1 located just to the right of the terminal block MK 1B. The switches should be on to terminate the bus.

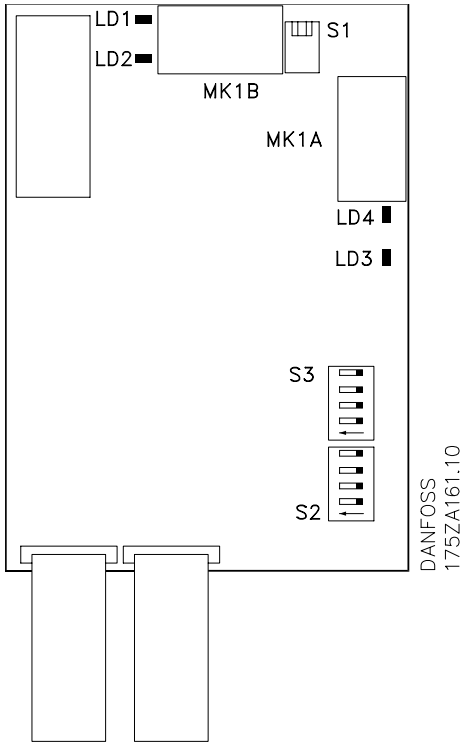


The switches should *never* be left in opposite positions. They should either both be ON or both be OFF!

- Most masters and repeaters are equipped with their own termination.

- If an external termination circuit consisting of three resistors is connected to the bus line a 5 V d.c. power supply must be used, please note that this must be galvanically isolated from the a.c. line.

The PROFIBUS option card



■ LEDs

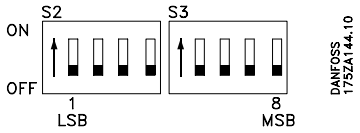
There are 4 LEDs on the PROFIBUS option card:

LD1 and LD4: Flashes when the card is communicating.

LD2 and LD3: Lights up when the card is initialized and ready to communicate. They will flash while auto baudrate detection is attempting to detect the actual baudrate.

■ Address switch

The station address can be set in parameter 918 or on a hardware switch (S2, 1-4 and S3, 5-7 on the PROFIBUS option card).



Setting of the address in parameter 918 is only possible if the address switches are set to 0 or >126.

Each slave must have a unique address. The address is the binary value set on the switches, see the table below. Change of the address switches is executed at next power up.

	Switch 1-7 (Switch 8 is not used)						
	1	2	3	4	5	6	7
Address	Switch setting (1 = ON, 0 = OFF)						
0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0
2	0	1	0	0	0	0	0
3	1	1	0	0	0	0	0
4	0	0	1	0	0	0	0
5	1	0	1	0	0	0	0
6	0	1	1	0	0	0	0
7	1	1	1	0	0	0	0
8	0	0	0	1	0	0	0
9	1	0	0	1	0	0	0
10	0	1	0	1	0	0	0
11	1	1	0	1	0	0	0
12	0	0	1	1	0	0	0
13	1	0	1	1	0	0	0
14	0	1	1	1	0	0	0
15	1	1	1	1	0	0	0
16	0	0	0	0	1	0	0
17	1	0	0	0	1	0	0
18	0	1	0	0	1	0	0
19	1	1	0	0	1	0	0
20	0	0	1	0	1	0	0
21	1	0	1	0	1	0	0
22	0	1	1	0	1	0	0
23	1	1	1	0	1	0	0
24	0	0	0	1	1	0	0

	Switch 1-7 (Switch 8 is not used)						
	1	2	3	4	5	6	7
Address	Switch setting (1 = ON, 0 = OFF)						
25	1	0	0	1	1	0	0
26	0	1	0	1	1	0	0
27	1	1	0	1	1	0	0
28	0	0	1	1	1	0	0
29	1	0	1	1	1	0	0
30	0	1	1	1	1	0	0
31	1	1	1	1	1	0	0
32	0	0	0	0	0	1	0
33	1	0	0	0	0	1	0
34	0	1	0	0	0	1	0
35	1	1	0	0	0	1	0
36	0	0	1	0	0	1	0
37	1	0	1	0	0	1	0
38	0	1	1	0	0	1	0
39	1	1	1	0	0	1	0
40	0	0	0	1	0	1	0
41	1	0	0	1	0	1	0
42	0	1	0	1	0	1	0
43	1	1	0	1	0	1	0
44	0	0	1	1	0	1	0
45	1	0	1	1	0	1	0
46	0	1	1	1	0	1	0
47	1	1	1	1	0	1	0
48	0	0	0	0	1	1	0
49	1	0	0	0	1	1	0
50	0	1	0	0	1	1	0
51	1	1	0	0	1	1	0
52	0	0	1	0	1	1	0
53	1	0	1	0	1	1	0
54	0	1	1	0	1	1	0
55	1	1	1	0	1	1	0
56	0	0	0	1	1	1	0
57	1	0	0	1	1	1	0
58	0	1	0	1	1	1	0
59	1	1	0	1	1	1	0
60	0	0	1	1	1	1	0
61	1	0	1	1	1	1	0
62	0	1	1	1	1	1	0
63	1	1	1	1	1	1	0
64	0	0	0	0	0	0	1
65	1	0	0	0	0	0	1

	Switch 1-7 (Switch 8 is not used)						
	1	2	3	4	5	6	7
Address	Switch setting (1 = ON, 0 = OFF)						
66	0	1	0	0	0	0	1
67	1	1	0	0	0	0	1
68	0	0	1	0	0	0	1
69	1	0	1	0	0	0	1
70	0	1	1	0	0	0	1
71	1	1	1	0	0	0	1
72	0	0	0	1	0	0	1
73	1	0	0	1	0	0	1
74	0	1	0	1	0	0	1
75	1	1	0	1	0	0	1
76	0	0	1	1	0	0	1
77	1	0	1	1	0	0	1
78	0	1	1	1	0	0	1
79	1	1	1	1	0	0	1
80	0	0	0	0	1	0	1
81	1	0	0	0	1	0	1
82	0	1	0	0	1	0	1
83	1	1	0	0	1	0	1
84	0	0	1	0	1	0	1
85	1	0	1	0	1	0	1
86	0	1	1	0	1	0	1
87	1	1	1	0	1	0	1
88	0	0	0	1	1	0	1
89	1	0	0	1	1	0	1
90	0	1	0	1	1	0	1
91	1	1	0	1	1	0	1
92	0	0	1	1	1	0	1
93	1	0	1	1	1	0	1
94	0	1	1	1	1	0	1
95	1	1	1	1	1	0	1
96	0	0	0	0	0	1	1
97	1	0	0	0	0	1	1
98	0	1	0	0	0	1	1
99	1	1	0	0	0	1	1
100	0	0	1	0	0	1	1
101	1	0	1	0	0	1	1
102	0	1	1	0	0	1	1
103	1	1	1	0	0	1	1
104	0	0	0	1	0	1	1
105	1	0	0	1	0	1	1
106	0	1	0	1	0	1	1

	Switch 1-7 (Switch 8 is not used)						
	1	2	3	4	5	6	7
Address	Switch setting (1 = ON, 0 = OFF)						
107	1	1	0	1	0	1	1
108	0	0	1	1	0	1	1
109	1	0	1	1	0	1	1
110	0	1	1	1	0	1	1
111	1	1	1	1	0	1	1
112	0	0	0	0	1	1	1
113	1	0	0	0	1	1	1
114	0	1	0	0	1	1	1
115	1	1	0	0	1	1	1
116	0	0	1	0	1	1	1
117	1	0	1	0	1	1	1
118	0	1	1	0	1	1	1
119	1	1	1	0	1	1	1
120	0	0	0	1	1	1	1
121	1	0	0	1	1	1	1
122	0	1	0	1	1	1	1
123	1	1	0	1	1	1	1
124	0	0	1	1	1	1	1
125	1	0	1	1	1	1	1
126	0	1	1	1	1	1	1
127	1	1	1	1	1	1	1

Chapter 4

System layout decisions

Since the PROFIBUS Option Card supports both part 2 (FMS) and part 3 (DP) of the PROFIBUS standard it is important to know before you set up your communication system what the fundamental requirements of your application are, and to know what the benefits and trade-offs of both FMS and DP are.

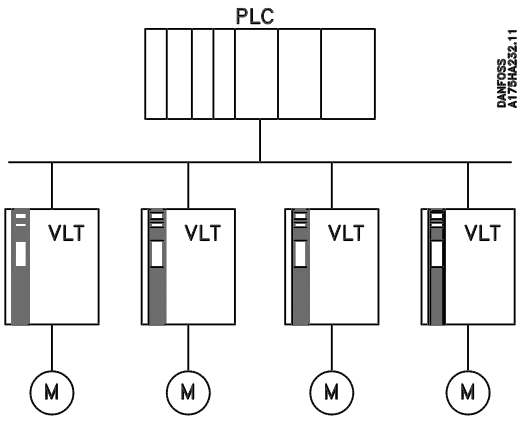
The two modes of operation were designed to serve different purposes in the application of field-busses. FMS being designed for, in the field-bus context, sophisticated applications with for example token passing between multiple masters, multiple sensors and actuators with great flexibility and a host of services available to the application.

The trade-off is mainly limitation in speed. It is, however, possible to speed up FMS considerably by reducing the number of masters and slaves and limiting the number of services used.

DP on the other hand was intended for simple, cyclical, high exchange rate operation between a single master and a number of slaves, with fixed telegram sizes and a minimum of services available.

Bus topology

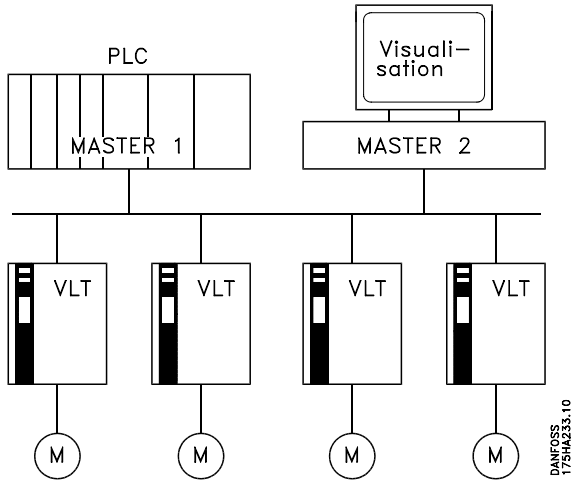
Single master operation with DP



- Single master
- PLC communicates with telegrams of constant length
- Fits to time critical requirements
- No need for equidistant transmissions of set points

Cyclical transmission
1. Set point transmission
2. Actual value feed back
3. New setpoints computed
4. New setpoint transfer

Multi master operation with FMS



- Two or more masters
- Telegrams of variable length allowed

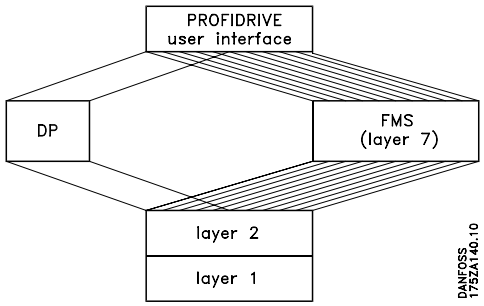
Cyclical write of set-point
Write service:
- write set-point to drive 1.
- write set-point to drive n

Synchronous set-point transmission using the Broadcast service.
Asynchronous read of actual value (feed back).

■ Features of FMS and DP

FMS is a subset of MMS (mini-MAP) and contains the full functionality of the PROFIBUS Application Layer (7).

DP is only Link Layer (2) services with an adaption to PROFIBUS Profile for VSDs.



Features of FMS (Field-bus Message Specification)

- Supports cyclical and acyclical communication.
- Broadcast service facilitates fast, cyclical transmission of e.g. reference values from a master to all slaves.
- Read and write services support acyclical transmission of parameters, up- and down-loads and non-time-critical feed-back values from the process.
- Single master and multiple masters operation is supported.
- Flexible data structure.
- Flexible telegramme size
- Occupies no I/O memory space in PLC.

Features of DP (Distributed Periphery)

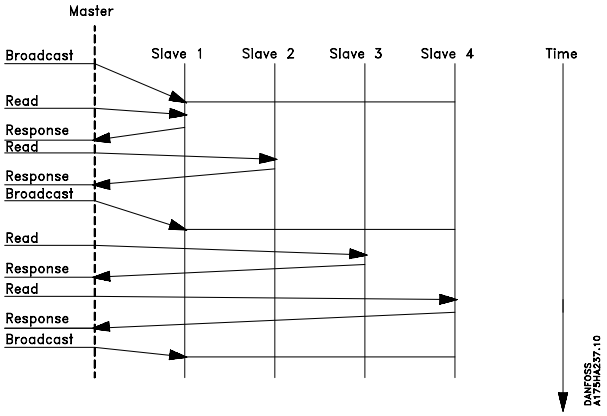
- Is used by several PLC manufacturers for remote peripheral I/O communication.
- Supports cyclical communication.
- SRD service gives fast cyclical exchange of process data between master and slaves.
- Freeze and synchronize function is supported
- Fixed data structure.
- Fixed telegramme size.
- Occupies I/O memory space in PLC proportional to the number of slaves employed, which may limit the number of participants. Additional data require additional I/O memory space.

■ Choosing FMS or DP

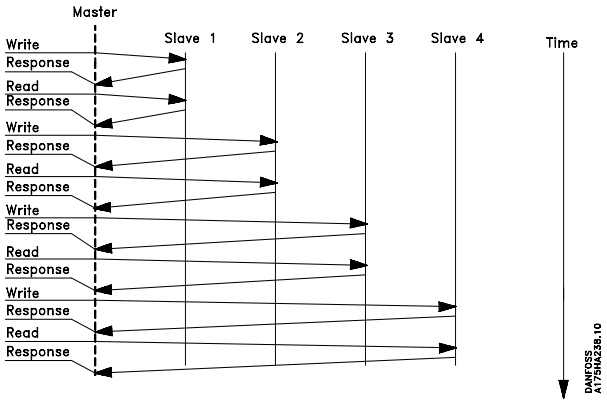
FMS should be chosen when you have a need for frequently up- and downloading parameters, fetching acyclical process data, need a flexible data structure, want to save I/O memory space in your PLC, use more masters, including visualization and master redundancy, or if one master must communicate with different types of slaves with different data structure requirements.
A fast transfer of commands and reference values from master to slaves can be achieved by means of the broadcast service, but feed-back from the process is transfered to the master on request (Read service) at a slower rate.

Priority can be given to certain slaves through polling when there is a need for frequent up-date of process parameters. It goes without saying, however, that this procedure is only effective when the number of high-priority slaves is kept low.

Broadcast followed by the number of Read cycles that can be completed before the next Broadcast is due (FMS)



Transferring large amount of data where rapid transfer of process data does not have highest priority (FMS)

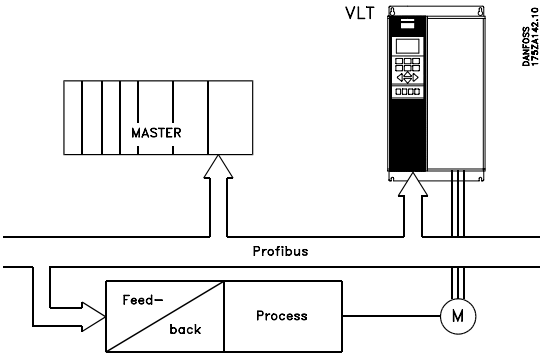


DP should be used when fast cyclical process control is needed. Such a concept would typically call for single master operation with a limited number of slave stations. (A high number of slaves will reduce the system response).

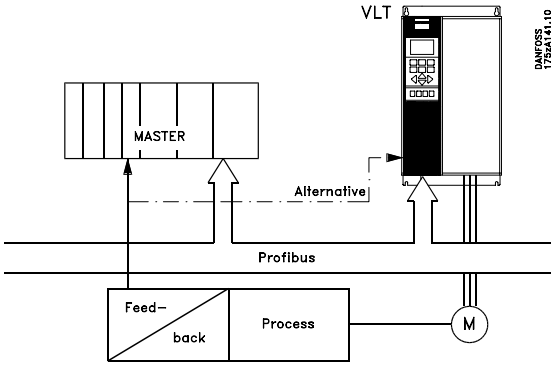
This could also be the case where control loops are closed over the bus.

As a very fast alternative it is of course possible to close the control loop outside the bus.

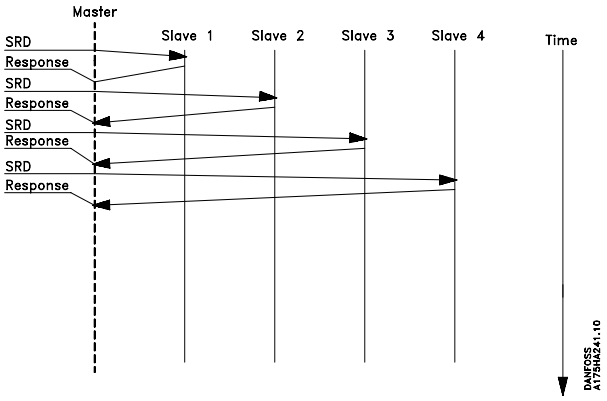
Closing the control loop over the bus



Closing the control loop outside the fieldbus for extremely fast feed-back



Rapid Cyclical transmission with PPO using DP



Parameter up-/downloads can be achieved by using the so-called Parameter / Process Objects - PPOs - of 12, 20 or 28 bytes length as specified in the VDI/ VDE 3689 profile.

This procedure, however, occupies 8 bytes additional I/O memory space in the PLC bytes per slave, and slows down the system (see also “Timing” page 21).

FMS and DP can be combined to achieve some of the advantages of both systems. Programming (up and down load of data) of the drive is normally not very time critical, but it involves a relatively high amount of data. Acyclical FMS is well suited for this purpose.

Control of the drives during normal operation is often very time critical, but it involves very few data, such as control commands and speed reference. DP is optimized for fast cyclical communication.

A system can be configurated to use FMS for up/ down load and DP for control, but that requires a master that supports both FMS and DP or two masters, one for FMS and one for DP.

It is important to notice that switching between FMS and DP in the VLT 6000 PROFIBUS option involves an initialization of the PROFIBUS interface. This means that the communication is interrupted for a period of up to 0.5 sec.

■ Features and services supported by VLT

Features available as described by the unit classification

The unit classification as layed out in the PROFIBUS Profile for VSDs describes the functionality of the unit. There are 4 classes where Class 1 signify the lowest performance class, and class 4 the highest.

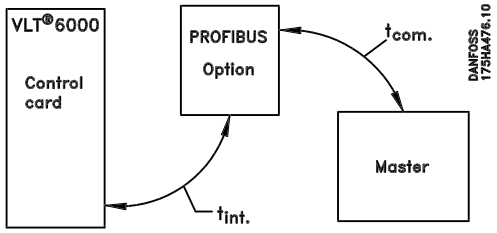
The VLT is a Class 3 unit following the class 4 features:

- Baudrate > 500 kBaud
- Event notification
- Acknowledge event
- Alter-event-condition monitoring
- Description of parameter: Modification of active parameter characteristics
- Programmable content of PCD 3 through 6 (10) of the PPO’s (according to page 31)
- PPO type 5

Timing

■ VLT response time

The update time via the PROFIBUS connection can be divided in two parts:
1) The communication time, which is the time it takes to transmit data from the master to the slave (VLT 6000 with PROFIBUS option), and 2) the internal update time, which is the time it takes to transmit data between the VLT 6000 control card and the PROFIBUS option card.



Communication time (t_{com}) depends on the actual transmission speed (baudrate) and the type of master in use. The minimum obtainable communication time with the VLT 6000 PROFIBUS option is approx. 30 µsec per slave, when using DP communication with 4 bytes of data (PPO type 3) at 12 Mbaud. More data or lower transmission speed will increase the communication time.

The internal update time (t_{int}) depends on the type of data in question as there are different channels for the data transfer where time critical data e.g. control word has highest priority. The internal update time for the different types of data are stated below.

Data	Update time, t_{int}
Control word/Main reference value (CTW/MRV) (part of PPO)	2 msec
Statusword/Main actual value (STW/MAV) (part of PPO)	2 msec
Parameter read via PCD-part of PPO	
Parameter write via PCD-part of PPO	
Parameter read via PCV-part of PPO or FMS read service	
Parameter write via PCV-part of PPO or FMS write service	

■ System update time

The system update time is the time it takes to update all the slaves in the network when using cyclical communication.

The update time for one single slave consists of the communication time (baudrate dependant) plus station delay (TSDR) in the slave plus station delay in the master.

Station delay (TSDR) is the delay time from when a station recieves the last bit of a telegram untill it sends out the first bit of the next telegram. The station delay is defined by two parameters: Minimum station delay ($TSDR_{min}$) and maximum station delay ($TSDR_{max}$).

Actual station delay in VLT 6000 PROFIBUS option:

- DP:

- FMS:

Actual master station delay:
- The information must be supplied by the manufacturer of the actual PROFIBUS master.

Example:
- DP master using 1.5 Mbaud and PPO type 3 (4 byte data), master TSDR is assumed to be 50 bit times.

Time [m sec]	Action
0	Master starts transmitting data
	Last bit recieved in slave
	Slave station delay
	Slave starts transmitting data
	Last bit recieved in master
	Master station delay (50 bit times ~ 0.033)
	Master ready to transmit data to the next slave

Chapter 6

DP

■ DP communication relations

Communication according to PROFIBUS DP, i.e. DIN 19245 part 1 & 3, is supported when *DP* or *DP with 1 byte PPO* is selected in parameter 800. Consequently a master that supports PROFIBUS DP must be used.

By DP communication one of the parameter-process data objects (PPO's) described below must be used.

■ PPO description

A special feature of the PROFIBUS Profile for VSD's is the communication object called a PPO, meaning *Parameter-Process Data Object*.

The PPO is well suited for fast cyclical data transfer, and may, as the name implies, carry both process data and parameters.

The selection of PPO type is made in parameter 904.

A PPO may consist of a parameter part and process data part. The parameter part can be used for reading and/or updating the parameters one by one.

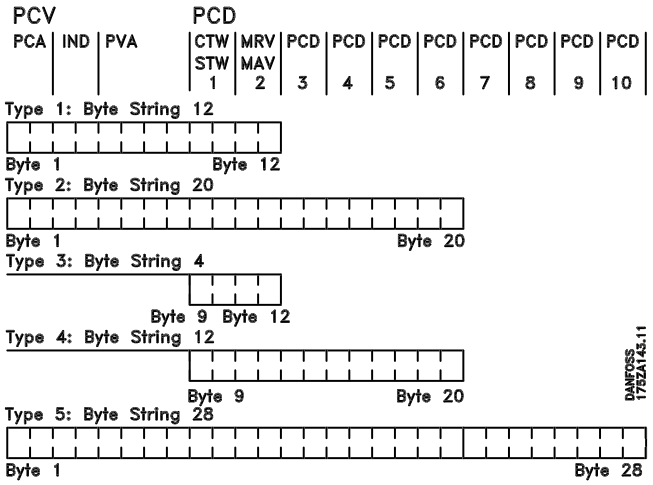
The process data part consist of a fixed part (4 bytes) and a parametrable part (8 or 16 bytes). In the fixed part control word and speed reference are transfered to the VLT while status word and actual output frequency are transfered from the VLT. In the parametrable part the user chooses which parameters has to be transfered to (parameter 915) and which from (parameter 916) the VLT.

Type 1, 2 and 5 consist of the parameter part and 4, 12 and 20 byte process data, respectively.

Type 3 and 4 consist of 4 and 12 byte process data, respectively.

PPO. Parameter-Process Data Object

By DP one of the following shown PPO's must be used:



PCD: Process Data
PCV: Parameter-Characteristics-Value
PCA: Parameter-Characteristics (Bytes 1, 2)
PCA handling below
IND: Subindex (Byte 3), (Byte 4 is not used)
PVA: Parameter value (Bytes 5 to 8)
CTW: Control word
STW: Status word
see page 38
MRV: Main reference value
MAV: Main actual value (Actual output frequency/feedback).

■ PCA handling

The PCA portion of the PPO types 1, 2 and 5 will handle a number of tasks. The master may control and supervise parameters and request a response from the slave, while the slave, apart from responding to a request from the master may transmit a spontaneous message.

Requests and responses is a handshake procedure and cannot be batched, meaning that if the master sends out a *Read/write* request, it has to wait for the response, before it sends a new request. The request or response data value will be limited to max. 4 bytes, which implies that text strings are not transferable.

PCA - Parameter Characteristics

15 14 13 12	11	10 9 8 7 6 5 4 3 2 1 0
RC	SMP	PNU

RC: Request/respons Characteristics (Range: 0..15)

SPM: Toggle-Bit for Spontanous Messages

PNU: Parameter # (Range: 1..990)

Request/response handling

The RC portion of the PCA word defines the requests that may be issued from the master to the slave as well as what other portions of the PCV (IND and PVA) are involved.

The PVA portion will transmit word-size parameter values in bytes 7 and 8, while long word size values require bytes 5 to 8 (32 bits).

If the Response / Request contains array elements, the IND will carry the Array Subindex. If parameter descriptions are involved, the IND will hold the Record Subindex of the Parameter description.

RC content

Request	Function
0	No request
1	Request parameter value
2	Change parameter value (word)
3	Change parameter value (long word)
4	Request description element
5	Change description element
6	Request parameter value (array)
7	Change parameter value (array word)
8	Change parameter value (array long word)
9	Request number of array elements
10-15	Not used

Response	Function
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (long word)
3	Transfer description element
4	Transfer parameter value (array word)
5	Transfer parameter value (array long word)
6	Transfer number of array elements
7	Request rejected (incl. fault #, see below)
8	Not seviceable by PCV interface
9	Spontaneous message (word)
10	Spontaneous message (long word)
11	Spontaneous message (array word)
12	Spontaneous message (array long word)
13-15	Not used

If the slave rejects a request from the master, the RC word in the PPO-read will indicate this by assuming the value 7.
The fault # will be carried by bytes 7 and 8 in the PVA element.

Fault #	Interpretation
0	Illegal PNU
1	Parameter value cannot be changed
2	Upper or lower limit exceeded
3	Subindex corrupted
4	No array
5	Data type false
6	Cannot be set by user (reset only)
7	Description element cannot be changed
8	IR required PPO-write not available
9	Description data not available
10	Access group
11	No parameter write access
12	Key word missing
13	Text in cyclical transmission not readable
14	Name in cyclical transmission not readable
15	Text array not available
16	PPO-write missing
17	Request temporarily rejected
18	Other fault
19	Date in cyclical transmission not readable

■ Parameter and data type structure description

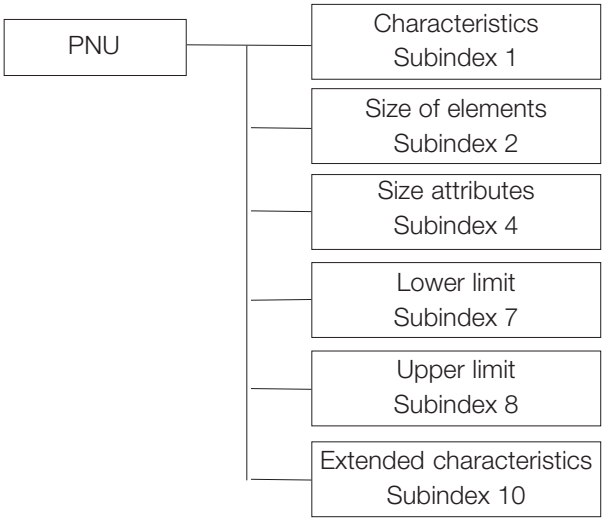
Size attribute

The *size index* and the *conversion index* for each parameter can be taken from the parameter list on page 64.

Parameter description:

Similar to FMS function, DP has a number of describing attributes (see rigth).

Read/write on parameter description is made by the PCV part using the RC commands 4/5 and subindex of the desired description element. The subindex table on page 50 shows the data types of the description elements.



Physical unit	Size index	Measuring unit	Designation	Conversion index	Conversion factor
	0	No dimension		0	1
Time	4	second	s	0	1
				-1	0.1
				-2	0.01
		millisecond	ms	-3	0.001
		minute	min	70	60
		hour	h	74	3600
		day	d	77	86400
Energy	8	watthour	Wh	0	1
		kilowatthour	kWh	3	1000
		megawatthour	MWh	6	10^6
Power	9	milliwatt	mW	-3	0.001
		watt	W	0	1
		kilowatt	kW	3	1000
		megawatt	MW	6	10^6
Rotation	11	rotation per minute	RPM	0	1
Torque	16	newtonmeter	Nm	0	1
		kilonewtonmeter	kNm	3	1000
Temperature	17	degree Celsius	°C	0	1
Voltage	21	millivolt	mV	-3	0.001
		volt	V	0	1
		kilovolt	kV	3	1000
Current	22	milliampere	mA	-3	0.001
		ampere	A	0	1
		kiloampere	kA	3	1000
Resistance	23	milliohm	mOhm	-3	0.001
		ohm	Ohm	0	1
		kiloohm	kOhm	3	1000
Ratio	24	per cent	%	0	1
Relative change	27	per cent	%	0	1
Frequency	28	hertz	Hz	0	1
		kilohertz	kHz	3	1000
		megahertz	MHz	6	10^6
		gigahertz	GHz	9	10^9

■ Object and data types supported by VLT

Data types supported by VLT

Index	Object Code	Short name	Description
3	5	I2	Integer 16
5	5		Unsigned 8
6	5	O2	Unsigned 16
7	5	O4	Unsigned 32
10	5		Byte string
13	5		Time difference[1)]
33	5	N2	Standardized value (16 bit) [1)]
35	5	V2	Bit sequence [1)]

[1)] See elaboration below

Time difference

The data type time difference is a time indication in milliseconds.

Notation: Time difference
Value range: $0 \leq i \leq (2^{32} -1)$ milliseconds
Coding: The time is presented as a binary value of 32 bits (4 bytes). The first four (MSB) bits are always zero.
Time difference is thus a byte string of 4 bytes.

Data coding of the data type time difference

Bit	Byte 1	Byte 2	Byte 3	Byte 4	
8	0 ms	2^{23} ms	2^{15} ms	2^{7} ms	MSB
7	0 ms	2^{22} ms	2^{14} ms	2^{6} ms	MSB
6	0 ms	2^{21} ms	2^{13} ms	2^{5} ms	MSB
5	0 ms	2^{20} ms	2^{12} ms	2^{4} ms	MSB
4	2^{27} ms	2^{19} ms	2^{11} ms	2^{3} ms	
3	2^{26} ms	2^{18} ms	2^{10} ms	2^{2} ms	
2	2^{25} ms	2^{17} ms	2^{9} ms	2^{1} ms	
1	2^{24} ms	2^{16} ms	2^{8} ms	2^{0} ms	

Standardized value

A liniary value.
0% = 0 (0h), 100% is 2^{14} (4000h)

Data type	N 2
Range	-200% ... 200% – 2^{-14}
Resolution	2^{-14} = 0.0061%
Length	2 bytes

Notation: 2's complement notation.
MSB is 1st bit after sign bit in 1st byte.
Sign bit = 0 = positive number
Sign bit = 1 = negative number

Bit	8	7	6	5	4	3	2	1
Byte 1	SIGN	2^{0}	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}
Byte 2	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}

Bit sequence

16 boolean values for control and presentation of user functions. Notation is binary.

Bit	8	7	6	5	4	3	2	1
Byte 1	15	14	13	12	11	10	9	8
Byte 2	7	6	5	4	3	2	1	0

■ Spontaneous messages

The Spontaneous message is activated by the active parameters i.e. 538, 540, or 953 and will be carried with the PCV response, stating PNU and PVA of the changed active parameter that triggered the message.

Spontaneous messages is generated on a change of an action parameter value. It means that a message will be sent when a warning comes, and when a warning disappears.

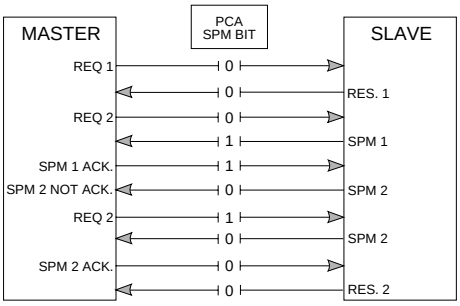
Simultaneously the VLT will toggle the SPM bit (11) of PCA word (see "PCA handling" page 33).

The Spontaneous messages will be transmitted until the master has acknowledged reception of the message by changing the SPM bit.

Spontaneous messages are only active when parameter 917 is "ON"!

Example of SPM execution

In the VLT the SPMs are temporarily stored in a FIFO buffer. This means that up to 16 consecutive SPMs can be retained. If only one SPM has entered the FIFO, the VLT will resume normal communication as soon as the SPM has been acknowledged by the master (and the condition causing the SPM been rectified). If more SPMs are in the FIFO, these will be transmitted consecutively upon acknowledgement. If more SPMs are triggered when the FIFO is full, these will be ignored.



■ Synchronize and freeze

The control commands SYNC/UNSYNC and FREEZE/UNFREEZE are broadcast functions. SYNC/UNSYNC is used to send syncronized control commands and/or speed reference to all the connected slaves (VLT 6000 Series). FREEZE/UNFREEZE is used to freeze the status feedback in the slaves to get syncronized feedback from all connected slaves.

The synchronize and freeze commands only affects Process Data (the PCD part of the PPO).

SYNC/UNSYNC

SYNC/UNSYNC can be used to obtain simultaneous reactions in several slaves, for example synchronised start, stop or speed change. A SYNC command will freeze the actual control word and speed reference, incoming Process Data will be stored but not used untill a new SYNC command or a UNSYNC command is received.

See the example below where the left column holds the speed reference send out by the master and the three right columns holds the actual speed reference used in each of the three slaves.

	Actual slave speed reference		
	VLT	VLT	VLT
From DP master to address:	Address 3	Address 4	Address 5
1. Speed reference = 50 % to address 3	⇒ 50 %	0 %	0 %
2. Speed reference = 50 % to address 4	50 %	⇒ 50 %	0 %
3. Speed reference = 50 % to address 5	50 %	50 %	⇒ 50 %
4. SYNC command to all addresses	⇒ 50 %	⇒ 50 %	⇒ 50 %
5. Speed reference = 75 % to address 3	⇒ 50 %	50 %	50 %
6. Speed reference = 75 % to address 4	50 %	⇒ 50 %	50 %
7. Speed reference = 75 % to address 5	50 %	50 %	⇒ 50 %
8. SYNC command to all addresses	⇒ 75 %	⇒ 75 %	⇒ 75 %
9. Speed reference = 100 % to address 3	⇒ 75 %	75 %	75 %
10. Speed reference = 50 % to address 4	75 %	⇒ 75 %	75 %
11. Speed reference = 25 % to address 5	75 %	75 %	⇒ 75 %
12. UNSYNC command to all addresses	⇒ 100 %	⇒ 50 %	⇒ 25 %
13. Speed reference = 0 % to address 3	⇒ 0 %	50 %	25 %
14. Speed reference = 0 % to address 4	0 %	⇒ 0 %	25 %
15. Speed reference = 0 % to address 5	0 %	0 %	⇒ 0 %

FREEZE/UNFREEZE

FREEZE/UNFREEZE can be used to get simultaneous reading of Process Data for example output current from several slaves. A FREEZE command will freeze the current actual values and on request the slave will send back the value that was present when the FREEZE command was received. The actual values will be updated when a new FREEZE or UNFREEZE command is received.

See the example below where the left column holds the current values read by the master and the three right columns holds the actual output current of the three slaves.

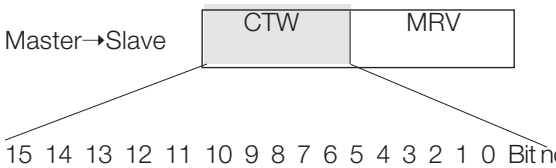
	Actual slave output current		
	VLT	VLT	VLT
DP master reads address:	Address 3	Address 4	Address 5
1. Address 3 output current = 2 A	⇐ 2 A	3 A	4 A
2. Address 4 output current = 5 A	2 A	⇐ 5 A	2 A
3. Address 5 output current = 3 A	3 A	2 A	⇐ 3 A
4. FREEZE command to all addresses	⇒ 1 A	⇒ 3 A	⇒ 3 A
5. Address 3 output current = 1 A	⇐ 4 A	2 A	5 A
6. Address 4 output current = 3 A	2 A	⇐ 2 A	2 A
7. Address 5 output current = 3 A	3 A	1 A	⇐ 2 A
8. UNFREEZE command to all adresses	⇒ 2 A	⇒ 3 A	⇒ 4 A

Reading as by 1, 2 and 3

DP

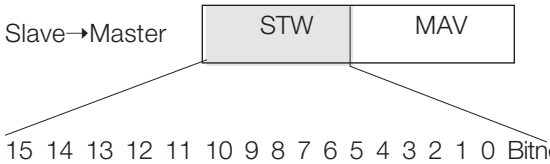
■ Control word / status word

The bits of the “Control word” tell the VLT how to react, while the “Status word” bit status will tell the master the condition of the VLT.



15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bit no.

Bit	Bit = 0	Bit =1
00		Preset ref. lsb
01		Preset ref. msb
02	DC braking	
03	Coasting stop	
04	Quick stop	
05	Freeze output frequency	
06	Ramp stop	Start
07		Reset
08		Jog
09	No function	No function
10	Data not valid	Data valid
11		Activate relay 1
12		Activate relay 2
13		Choice of setup lsb
14		Choice of setup msb
15		Reversing



15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Bitno.

Bit	Bit = 0	Bit =1
00	Trip	Control ready
01		Drive ready
02		Stand by
03	No trip	Trip
04	Not in use	
05	Not in use	
06	Not in use	
07	No warning	Warning
08	Speed ≠ ref.	Speed = ref.
09	Local operation	Serial com. control
10	Out of frequency range	
11		Running
12	No function	No function
13		Voltage warning high/low
14		Current limit
15		Thermal warning

Control word

The control words are used to send control commands to the frequency converter when the telegram is sent from the master.

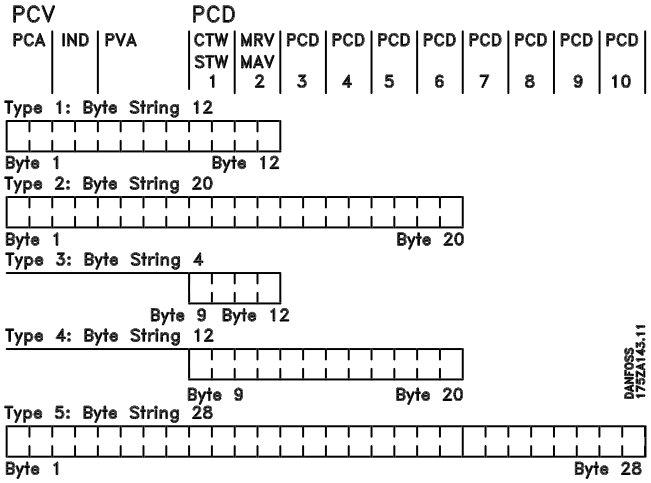
Status word

When the frequency converter returns the frame to the master, the same two bytes operate as status from the frequency converter with the following functions:

■ Example

Example to show how PPO type 1 is used for changing the ramp-up time (parameter 206) to 10 seconds and for commanding a start and speed reference of 50%.

PPO. Parameter-Process Data Object



PCD:	Process Data	PVA:	Parameter value (Bytes 5 to 8)
PCV:	Parameter-Characteristics-Value	CTW:	Control word } see page 38
PCA:	Parameter-Characteristics (Bytes 1, 2) PCA handling below	STW:	Status word } see page 38
IND:	Subindex (Byte 3), (Byte 4 is not used)	MRV:	Main reference value
		MAV:	Main actual value

PCV

PCA - Parameter Characteristics

15 14 13 12	11	10 9 8 7 6 5 4 3 2 1 0
RC	SMP	PNU

RC: Request/respons Characteristics (Range: 0..15)
SPM: Toggle-Bit for Spontanous Messages
PNU: Parameter # (Range: 1..990)

PCA part (byte 1-2)
The RC part tells what the PCV part must be used for. The functions available appear from the table, page 33.

When a parameter must be changed, choose value 2 or 3, in this example 3 is chosen, because parameter 207 covers a long word (32 bits).

SPM bit:
The function is explained on page 35, in the example the function *Spontaneous Messages* is not applied (parameter 917 = OFF), therefore SPM is set for 0.

PNU = Parameter number:
Parameter number is set for: 207 = CF Hex.
This means that the value of the PCA part is 30CF Hex.

IND (bytes 3-4):
Used when reading/changing parameters with subindex, for example parameter 915. In the example bytes 3 and 4 are set for 00 Hex.

PVA (bytes 5-8):
The data value of parameter 207 must be changed to 10.00 seconds. The value transmitted must be 1000, because the conversion index for parameter 207 is -2, this means that the value received by VLT is divided by 100, making VLT *perceive* 1000 as 10.00. Bytes 5-8 = 1000 = 03E8 Hex.

PCD

CTW:

Control words consisting of 16 bits, the meaning of the various bits appears from the table, page 30.
The following bit pattern sets all necessary start commands: 0000 0100 0111 1111 = 047F Hex.

MRV:

MRV and MAV are of data format „standardized value“, see page 27. 0%⇒ 0 Hex and 100% ⇒ 4000 Hex..

MRV:

The main reference value is set as a percentage of the reference range determined by parameter 204 „MInimum reference“ and parameter 205 „Maximum reference“.
Calculation:

$$\text{Reference} = \frac{(\text{max.ref} - \text{Min. ref}) \times \text{MRV}}{100} + \text{Min. ref.}$$

In the example 2000 Hex is used for MRV.

The whole PPO therefore gets the following value in Hex:

		Byte	Value
PCV	PCA	1	30
	PCA	2	CF
	IND	3	00
	IND	4	00
	PVA	5	00
	PVA	6	00
	PVA	7	03
	PVA	8	E8
PCD	CTW	9	04
	CTW	10	7F
	MRV	11	20
	MRV	12	00

The Process data within the PCD part is acting on the VLT immediatly, and can be updated from the master as quick as possible.

The PCV part is a “hand shake” procedure which means that the VLT has to acknowledge the command, before a new one can be written.

- A positive response of the above example may look like this:

		Byte	Value
PCV	PCA	1	30
	PCA	2	CF
	IND	3	00
	IND	4	00
	PVA	5	00
	PVA	6	00
	PVA	7	03
	PVA	8	E8
PCD	STW	9	07
	STW	10	07
	MAV	11	20
	MAV	12	00

The PCD part responds according to the state and parametration of the VLT.

The PCV part responds as:
PCA: As the request telegram, but here the RC part is taken from the response table on page 33. In this example RC is 3Hex, which is a confirmation that a parameter value of the type long word (32 bit) has been transferred.

IND is not used in this example.

PVA: 03E8Hex in the PVA part tells that the value of the parameter in question (207) is 1000 which corresponds to 10.00.

STW: 0F07 Hex means that the motor is running and there are no warnings or faults (for details see Status word table on page 30.

MAV:

The main actual value depends on the setting of parameter 100 „Configureation mode“.
The MAV is calculated as either output frequency or feedback as percentage of the reference range set by parameters 204 and 205.

$$\text{Open loop: MAV} = \frac{\text{output freq - Min. ref}}{\text{Max. ref - Min. ref}} \times 100$$

$$\text{Closed loop: MAV} = \frac{\text{Feedback - Min. ref}}{\text{Max. ref - Min. ref}} \times 100$$

- A negative response may look like this:

		Byte	Value
PCV	PCA	1	70
	PCA	2	00
	IND	3	00
	IND	4	00
	PVA	5	00
	PVA	6	00
	PVA	7	00
	PVA	8	02
PCD	STW	9	0F
	STW	10	07
	MAV	11	20
	MAV	12	00

RC is 7 Hex which means that the request has been rejected, and the fault number can be found in the PVA part. In this case the fault number is 2 which means that the upper or lower limit of the parameter is exceeded. See fault number table on page 25.

■ GSD-file

The GSD-file is a DP "standard" text file containing the necessary data for configuring DP slaves within a standard DP master.

GSD-file: DA020402.GSD
GSD-file for Danfoss VLT Series 5000/6000 with PROFIBUS Option Card

#Profibus_DP
Vendor_Name = "DANFOSS A/S";
Model_name = "VLT® 5000/6000";
Revision = "00";
Ident_Number = 0x0402;
Protocol_Ident = 0;
Station_type = 0;
FMS_supp = 0;
Hardware_Release = "4.0";
Software_Release = "1.02";
9.6_supp = 1;
19.2_supp = 1;
93.75_supp = 1;
187.5_supp = 1;
500_supp = 1;
1.5M_supp = 1;
3M_supp = 1;
6M_supp = 1;
12M_supp = 1;
MaxTsdr_9.6 = 60;
MaxTsdr_19.2 = 60;
MaxTsdr_93.75 = 60;
MaxTsdr_187.5 = 60;
MaxTsdr_500 = 100;
MaxTsdr_1.5M = 150;
MaxTsdr_3M = 250;
MaxTsdr_6M = 450;
MaxTsdr_12M = 800;
Redundancy = 0;
Repeater_Ctr_Sig =0;
24V_Pins = 0;
Freeze_Mode_supp = 1;
Sync_Mode_supp = 1;
Auto_Baud_supp = 1;
Set_Slave_add_supp = 0;
Usr_Prm_Data_Len = 0;
Min_Slave_Intervall = 40;
Modular_Station = 1;
Max_Module = 2;
Max_Input_Len = 28;
Max_Output_Len = 28;
Max_Data_Len = 56;
Max_Diag_Data_Len = 8;
Unit_Diag_Bit(1) = "Overflow SPM-FIFO";
Unit_Diag_Bit(2) = "Actual value is not updated";
Module = "PPO 1 Module consistent PCD" 0xF3, 0xF1;
EndModule;
Module = "PPO 1 Word consistent PCD " 0xF3, 0x71;
EndModule;
Module = "PPO 2 Module consistent PCD" 0xF3, 0xF5;
EndModule;
Module = "PPO 2 Word consistent PCD " 0xF3, 0x75;
EndModule;
Module = "PPO 3 Module consistent PCD" 0xF1;
EndModule;
Module = "PPO 3 Word consistent PCD " 0x71;
EndModule;
Module = "PPO 4 Module consistent PCD" 0xF5;
EndModule;
Module = "PPO 4 Word consistent PCD " 0x75;
EndModule;
Module = "PPO 5 Module consistent PCD" 0xF3, 0xF9;
EndModule;
Module = "PPO 5 Word consistent PCD " 0xF3, 0x79;
EndModule;

The VLT can also accept word concistency in the PCD modules, whereas the PCV portion must be module consistent.

Chapter 7

■ FMS communication relations

Communication according to PROFIBUS FMS i.e. DIN 19245 part 1 & 2, is supported when FMS is selected in parameter 800. Consequently a master that supports PROFIBUS FMS must be used.

Apart from knowing the characteristics of the communication objects, it is also necessary to define the communication relations under which the objects are to be exchanged.

FMS works exclusively with preconfigured connections. The connection parameters are assigned to a Communication Reference List (CRL) which is no longer altered once a bus topology has been completely initialized for the individual stations. The master can thus activate a preconfigured connection using the FMS Initiate service. It cannot, however, set up a completely new (unknown) relation.

A communication reference list must be produced specifying every type of communication relation that exists in the communication system.

Communication references

The Communication Reference (CR) is the index number that is assigned to a communication relationship. The CR describes all the parameters that constitute such a relationship. A list of CRs will form the CRL.

The standard CR should cover the following items:

- CR, Communication Reference number
- CT, Connection Type describing which one of the types shown in the above diagram should be used
- ATTR, Connection Attribute describing if it is an open or defined connection
- LSAP, Local Service Access Point in layer 2
- RSAP, Remote (partner) Service Access Point in layer 2
- RADR, Remote (partner) address
- FMS features supported
- SCC, RCC, SAC, RAC, Counters, Parallel services
- ACI, CCI, Acyclical/Cyclical Control Interval

The PROFIBUS Profile for VSDs has defined 7 standard communication relations that will satisfy most applications conceivable. To communicate with the VLTs, the master(s) must use these data channels.

For an example of a CRL for a master, see below. In the example a slave with address 2 is accepted.

; KBL Header

;

; KR Poll-SAP ASS/ABT-CI

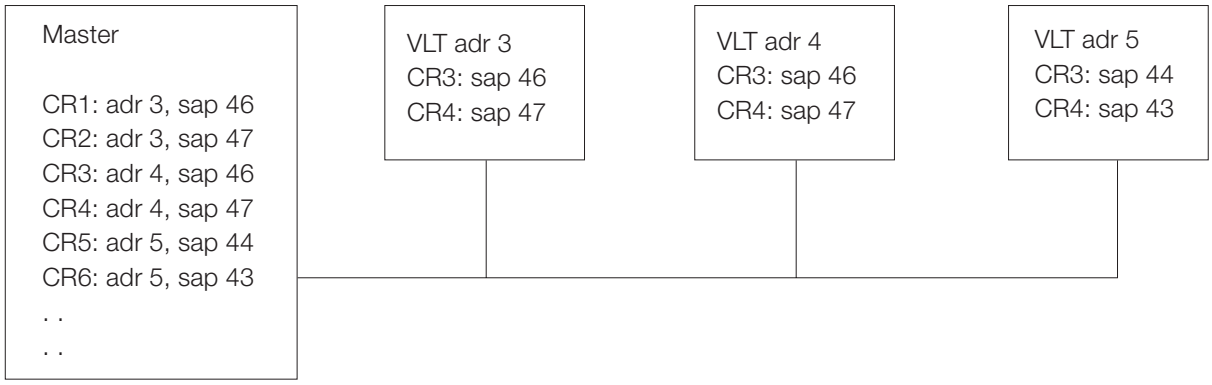
0 * 3000

; KR	OAE	TYP	ATR	PRSA		PA	PAE	. . PDU_LENGTH . .			FEATURES_SUPPORTED	SC	RC	SA	RA	CI	PW	GR
								TxHi	TxLo	RxHi	RxLo							
2	2 BRCT	D	*	127	63	241	0	0	0		00 00 80 00 00 00	0	0	1	0	0	00	00
3	* MSZY	D	*	2	46	0	50	0	50		00 20 00 00 00 00	0	0	0	0	0	00	00
4	* MSZY	D	*	2	47	0	50	0	50		00 00 10 00 00 00	0	0	0	0	0	00	00
5	* MSZY_SI	D	*	2	44	0	50	50	50		00 20 00 00 00 10	0	0	0	1	0	00	00
6	* MSZY	D	*	2	45	0	50	0	50		00 20 00 00 00 00	0	0	0	0	0	00	00
7	* MSAZ	D	*	2	43	0	241	0	241		00 30 06 00 00 00	1	0	0	0	0	00	00
8	* MSAZ	D	*	2	42	0	241	0	241		00 33 20 00 00 00	1	0	0	0	0	00	00
62	62 BRCT	D	*	127	62	241	0	0	0		00 00 80 00 00 00	0	0	1	0	0	00	00

The master CRL must be a reflection of the slave CRL.

The master may have as many different CRs as needed, and there is no correlation between the CR numbers of the master and those of the slaves.

Example of CR's in master and slaves



The Service Access Points (SAP) provide access to the individual CRs in the CRL. When a SAP # is called, the content of the CR will be interpreted.

For an example of a CRL for VLT, see below.

; KR Poll-SAP ASS/ABT-CI

0 - 0 ; = 30 sec for monitoring connection/connection release

; KR	OAE	TYP	ATR	PRSA	PA	PAE	. . PDU_LENGTH . .			FEATURES_SUPPORTED	SC	RC	SA	RA	CI	PW GR
							TxHi	TxLo	RxHiRxLo							
2	63	BRCT	D	*ALL	ALL	0	0	245	0	00 00 00 00 00 80	0	0	0	1	0	00 00
3	46	MSZY	D	*ALL	ALL	0	50	0	50	00 00 00 00 20 00	0	0	0	0	0	00 00
4	47	MSZY	D	*ALL	ALL	0	50	0	50	00 00 00 00 10 00	0	0	0	0	0	00 00
5	44	MSZY_SI	D	*ALL	ALL	0	50	50	50	00 00 10 00 20 00	0	0	1	0	0	00 00
6	45	MSZY	D	*ALL	ALL	0	50	0	50	00 00 00 00 20 00	0	0	0	0	0	00 00
7	43	MSAZ	D	*ALL	ALL	0	241	0	241	00 00 00 00 30 06	0	1	0	0	0	00 00
8	42	MSAZ	D	*ALL	ALL	0	241	0	241	00 00 00 0033 20	0	1	0	0	0	00 00

The following features apply to the various CRs defined in the VLT:

CR 2 ⇒ SAP 63, 48..56 Broadcast/Multicast

Not connection oriented. Features writing to PPOs of all slaves, using Broadcast (SAP 63). It is also possible to define eight Multicast groups using SAP 48 through 56 (see page 44)

CR 3 ⇒ SAP 46 Fast Cyclical Read

Connection oriented. Features cyclical reading of PPOs (Par. 907 - 910)

CR 4 ⇒ SAP 47 Fast Cyclical Write

Connection oriented. Features cyclical writing to PPOs (Par. 900 - 903)

CR 5 ⇒ SAP 44 Cyclical Parameter Read

Connection oriented. Features cyclical reading of parameters and reception of Event. Is to be used for fast cyclical read of parameter values and descriptions with max. datalength of 4 bytes. If an event occurs in the VLT, it will return a event notification instead of the data requested by the master. The master has to transmit an event acknowledge on CR 7

CR 6 ⇒ SAP 45 Cyclical Process Data Read

Connection oriented. Features cyclical reading of process data. Is to be used for fast cyclical read of PPO type 3 and 4 (par. 909 and 910)

CR 7 ⇒ SAP 43 Acyclical Read / Write

Connection oriented. Features acyclical Write and Read indications, acknowledging and disabling or enabling event notifications. Is to be used for acyclical read/write of para meter values and descriptions. It also supports acknowledge of events received from CR 5

CR 8.. ..42 Acyclical Read / Write

Connection oriented. Features reading or writing to parameters, handling of variable lists and aditional services. Can be used for acyclical read/write of parameter values and descriptions

The CR's can be divided in three groups:

1) CR 2, 3 and 4 are intended for a process control master
   - CR 2 (Broadcast/Multicast) can be used to set/reset control commands and to change speed reference in all (or groups) of connected VLT's simultaneously. There is no feedback from thedrives when using CR 2 alone, but CR 3 can be used to read data from the drives cyclicaly.
   - CR 8 may be used as alternative when no frequent feedback is needed.
   - Reading via CR 3 can only access parameter 907-910, i.e. only the four of the PPO types described in the DP section on page 14 can beread.

When the parameter part (PCV) of the PPO's is used for reading the read request must follow a write command to parameter 900-901 or 905 with read request in the parameter part (PCV) of thePPO.

   - Writing via CR 4 can only access parameter 900-903, i.e. only the four of the PPO types described in the DP section on page 14 can be updated.

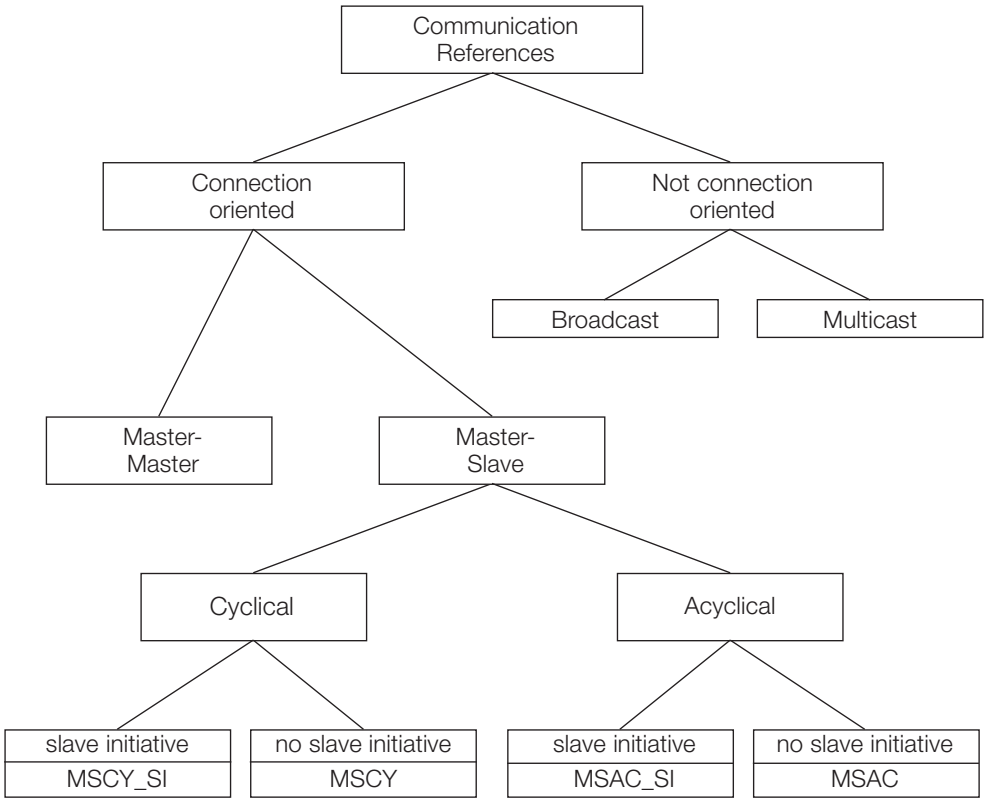
2) CR 5, 6 and 7 are intended for a monitoring/ visualization master.
   - CR 5 can be used if cyclical reading of parameters is required, reception of event notifications is supported, i.e. the master will be notified about warnings and alarms. CR 5 could be used with a process control master instead of CR 3. The difference between CR 3 and CR 5 is that CR 3 can only access the PPO's which can contain several process data, whereas CR 5 can access all parameters, but the PPO's as the data length is limited to 4 bytes.
   - CR 6 can be used to read the process data (PCD) part of PPO type 3 and 4.
   - CR 7 is needed to acknowledge event notifications when they are received via CR 5. The VLT keep's sending event notification on CR 5, untill the master sends a acknowledge on CR 7. CR 7 can also be used for acyclical reading and writing of parameter value and descriptions.

3) CR 8 is intended for pure acyclical communication, alternatively it can be used in conjunction with CR 2, 3 and 4 for setting of parameters from a process control master.

CT, connection types

The connection type you should select for your application depends on the mode of communication you have chosen. There is one CT for every mode specified in the VSD Profile, namely: Broadcast, Multicast, Cyclical transmission with slave initiative, Cyclical transmission without slave initiative, Acyclical transmission with slave initiative and finally Acyclical transmission without slave initiative.

Slave initiative does not imply that the VLT will act on its own initiative, it simply means that the slave will not necessarily respond to a Read indication by transfering the data requested, but may transmit a Spontaneous or Event Notification if an alarm or warning condition has occurred.



MSAC

Master-slave connection for acyclical data transmission without slave initiative.

- The master is always client. Sends Write requests to the slave and gets the response by means of a Read call
- The slave is always server, and cannot send a Spontaneous or Event Notification
- All confirmed FMS services are supported
- Parallel FMS services are possible
- All confirmed FMS sevices and all unconfirmed low-priority services are mapped to the CSRD service of layer 2 with low priority
- All unconfirmed high-priority services of layer 7 are mapped to the SRD service of layer 2 with high priority
- Implicit connection supervision is possible

MSAC_SI	
Master-slave connection for acyclical data transmission with slave initiative.	As MSAC with the following extension: - The slave may respond with a Spontaneous or Event Notification
MSCY	
Master-slave connection for cyclical data transmission without slave initiative.	- The master is always client - The slave is always server and cannot send Spontaneous- or Event Notifications - Only confirmed FMS services are admissible along with the unconfirmed services Spontaneous and Event Notification - No parallel FMS services are possible - Enhanced efficiency through storage of request PDUs, thus avoiding multiple transmission of identical PDUs - All confirmed FMS services and all unconfirmed low-priority services are mapped to the CSRD service of Layer 2 with low priority - All unconfirmed high priority services of layer 7 are mapped to the SRD service of layer 2 with high priority - Implicit connection supervision is possible
MSCY_SI	
Master-slave connection for cyclical data transmission with slave initiative.	As MSCY with the following extension: - The slave may respond with a Spontaneous or Event Notification
BRCT	
Master transmission without connection to all slaves.	- The broadcast will be received by all participants in a segment - The transmission is unconfirmed
MULT	
Master transmission without connection to a defined number of participants.	- The multicast will be received by all participants in a segment. However, only the participants having the right SAP # in parameter 819 will use the info - The transmission is unconfirmed

Connection attribute

The communicative relationship between a VLT and one or more masters must always be realized as a defined connection.

On the part of the VLT there is no provision for connection supervision. If you need to supervise the bus interface, this feature should be established in your program.

Service access point (LSAP, RSAP)

The SAP which is generated by the FDL (layer 2) must be included in all frames that are transporting data between the communication partners. In FMS these are closely tied in with the CR #.

Since all communicative realtions that the slave may have are open, the RSAP of the VLT will always be ALL (=255).

Remote address (RADR)

The master of course will always have to use the physical address of the VLT, except in the case of a broadcast. Address # 127 is the global that will address all units.

Parallel services (counters SCC, RCC, SAC, RAC)

The services of counters Send Confirmed request Counter (SCC), Receive Confirmed request Counter (RCC), Send Acknowledged request Counter (SAC) and Receive Acknowledged request Counter (RAC) are regarded as parallel because they are implicitly present.

Acyclical and cyclical control interval (ACI, CCI)

Time interval for supervision of the connection that is defined as a multiple of TRT (Target-Rotation-Time). ACI is zero for all communicative relations, and the same is true about CCI as far as the VLT is concerned. For the master it may vary with choice of CT.

■ FMS object directory (OD)

The Application layer of PROFIBUS is object-oriented. This means that all real process variables are so-called process objects. The variables are always assigned certain attributes such as “variable name” and “data type”.

An automation system therefore handles a number of such objects. If an object is accessible from “outside” in an open communication system it is called a “communication object”.

When addressing a parameter as an object, the object number is the PNU + 4000 (see page 50).

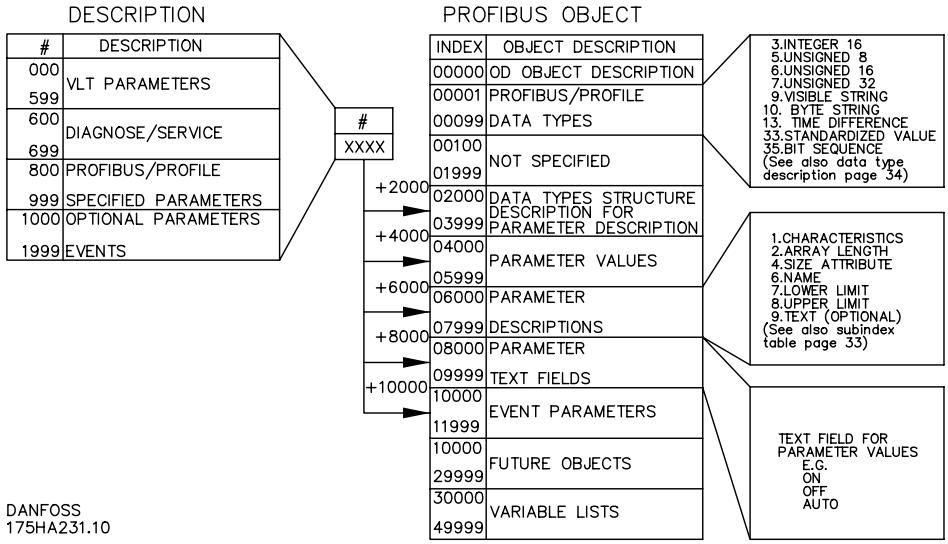
Communication objects must conform to certain rules in order to be recognized by all participants in the automation system. This means that parameters must display well defined features and are treated in a pre-defined way by all communication partners.

In order to use FMS your master needs to know the *Object Directory*, called OD, of all the slaves. You can either glean the information from the manual, or you may download the ODs of all slaves by using the “Get OD” service of FMS. To exploit all possibilities offered by the VLT, both data pertaining to the PROFIBUS standard and to the VLT must be considered.

Parameters projected on PROFIBUS objects

To keep communication efficiency high by not “loading” the bus down with an excessive amount of data, parameters are addressed by a parameter number (PNU).

All the attributes of a given parameter are indexed so that only a minimum of data is transferred over the bus. All objects with their indexes are stored in the OD which is a library of objects. The table on the next page describes how this is done.



Parameters

- Parameters consist of the Parameter value (PVA), the Parameter description (PDE), plus in some cases additional text.

- The *Parameter value* is reflected in the object type “simple variable”, or if there are more of the same category the object type “array”.

- The *Parameter description* will be reflected in the object type “Record”.

- To every parameter description is attached a “Data type structure description” that will describe the object type.

- *Additional text* is an object type “array” with the data type “Visible string”.

Active / passive parameters

Parameters are divided into *passive* and *active* parameters. Passive parameters can be addressed for reading or writing and nothing else, while an active parameter will have an Event object attached to it.

Bit 15 = [1] in “characteristics” in the parameter description indicates that it is an active parameter. The VLT has the following active parameters: 529, 531, 532 and 953.

Parameter and data type structure description

For every parameter description object (record) there is assigned an individual data type structure description.The index in the OD is 6000 + PNU. Subindexes are stated in the table below.

Subindex table

Subindex	Significance	Data type
1	Characteristics (see below)	V 2
2	Number of array elements or bitstring length	Unsigned 16
4	Size attribute (see next page)	Byte string 2
6	Name	Visible string 8/16
7	Lower limit	As parameter value
8	Upper limit	As parameter value
10	Extended characteristics	V 2

Characteristics:

The “characteristics” further adds to the definition of the parameter. The significance of bit 9-15 is TRUE [1], or FALSE [0].

The lower byte (bit 0-7) shows the data type of the parameter.

Bit	Significance
15	Active parameter
14	Array
13	Parameter value can only be reset
12	Parameter changed from factory setting
11	Text available
10	Additional text array available
9	Not accessible for writing (read only) Upper/lower limit, standard and size 8 attribute not relevant
0-7	Parameter data type according to OD (page 41)

Size attribute:
The size attribute consists of 2 bytes. Byte 1 has the physical measuring unit (size index), while byte 2 has a conversion index.

The “size index” and the ”conversion index” for each parameter can be taken from the parameter list on page 64.

Physical unit	Size index	Measuring unit	Designation	Conversion index	Conversion factor
	0	No dimension		0	1
Time	4	second	s	0	1
				-1	0.1
				-2	0.01
		millisecond	ms	-3	0.001
		minute	min	70	60
		hour	h	74	3600
		day	d	77	86400
Energy	8	watthour	Wh	0	1
		kilowatthour	kWh	3	1000
		megawatthour	MWh	6	10^6
Power	9	milliwatt	mW	-3	0.001
		watt	W	0	1
		kilowatt	kW	3	1000
		megawatt	MW	6	10^6
Rotation	11	rotation per minute	RPM	0	1
Torque	16	newtonmeter	Nm	0	1
		kilonewtonmeter	kNm	3	1000
Temperature	17	degree Celsius	°C	0	1
Voltage	21	millivolt	mV	-3	0.001
		volt	V	0	1
		kilovolt	kV	3	1000
Current	22	milliampere	mA	-3	0.001
		ampere	A	0	1
		kiloampere	kA	3	1000
Resistance	23	milliohm	mOhm	-3	0.001
		ohm	Ohm	0	1
		kiloohm	kOhm	3	1000
Ratio	24	per cent	%	0	1
Relative change	27	per cent	%	0	1
Frequency	28	hertz	Hz	0	1
		kilohertz	kHz	3	1000
		megahertz	MHz	6	10^6
		gigahertz	GHz	9	10^9

Object and data types supported by VLT

Data types supported by VLT

Index	Object Code	Short name	Description
3	5	12	Integer 16
5	5		Unsigned 8
6	5	O2	Unsigned 16
7	5	O4	Unsigned 32
9	5		Visible string
10	5		Byte string
13	5		Time difference[1)]
33	5	N2	Standardized value (16 bit) [1)]
35	5	V2	Bit sequence [1)]

[1)] See elaboration below

Time difference:
The data type time difference is a time indication in milliseconds.

Notation: Time difference
Value range: $0 \leq i \leq (2^{32} -1)$ milliseconds
Coding: The time is presented as a binary value of 32 bits (4 bytes). The first four (MSB) bits are always zero.
Time difference is thus a byte string of 4 bytes.

Data coding of the data type time difference

Bit	Byte 1	Byte 2	Byte 3	Byte 4	
8	0 ms	2^{23} ms	2^{15} ms	2^{7} ms	MSB
7	0 ms	2^{22} ms	2^{14} ms	2^{6} ms	MSB
6	0 ms	2^{21} ms	2^{13} ms	2^{5} ms	MSB
5	0 ms	2^{20} ms	2^{12} ms	2^{4} ms	MSB
4	2^{27} ms	2^{19} ms	2^{11} ms	2^{3} ms	
3	2^{26} ms	2^{18} ms	2^{10} ms	2^{2} ms	
2	2^{25} ms	2^{17} ms	2^{9} ms	2^{1} ms	
1	2^{24} ms	2^{16} ms	2^{8} ms	2^{0} ms	

Standardized value:
A liniar value.
0% = 0 (0h), 100% is 2^{14} (4000h)

Data type	N 2
Range	-200% ... 200% – 2^{-14}
Resolution	2^{-14} = 0.0061%
Length	2 bytes

Notation: 2's complement notation.
MSB is 1st bit after sign bit in 1st byte.
Sign bit = 0 = positive number
Sign bit = 1 = negative number

Bit	8	7	6	5	4	3	2	1
Byte 1	SIGN	2^{0}	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}
Byte 2	2^{-7}	2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}

Bit sequence

16 boolean values for control and presentation of user functions. Notation is binary.

Bit	8	7	6	5	4	3	2	1
Byte 1	15	14	13	12	11	10	9	8
Byte 2	7	6	5	4	3	2	1	0

■ PROFIBUS FMS services supported by VLT

The PROFIBUS Profile for VSDs defines and limits the FMS services that should be supported by a VSD according to its classification.

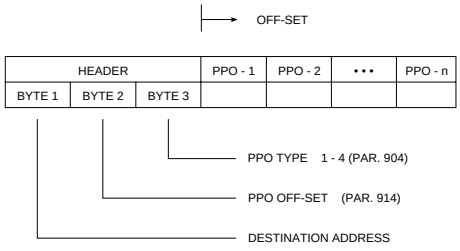
The definition represents the maximum requirements for VSDs, while it may be seen as a minimum requirement for a given master. The VLT will support the services listed in the table.

Service designation		Function
A.)	Initiate	Establish connection
B.)	Abort	Delete connection
C.)	Reject	Service request not allowed / supported
D.)	Status	Read unit / user status
E.)	Identify	Read manufaturer, type and version
F.)	Get OD (short form)	Read Object Directory
E.)	Read	Read a variable
G.)	Write	Write a variable
H.)	Information Report	Send (Broadcast) data. (unacknowledged)
I.)	Define Variable List	...
J.)	Delete Variable List	...
K.)	Event Notification	Recieve an event notification when an active parameter changes
L.)	Acknowledge Event	Acknowledge reception of an event notification
M.)	Alter - Event - Condition - Monitoring	Switch on/off event notification (extended characteristics)

■ Broadcast and multicast with PPO

In order to optimize performance in time-critical applications the PROFIBUS Profile for drives has provided for very fast cyclical transmission of process data and parameters by applying the Information Report (IR) to broadcast or multicast of these data in the PPO environment.

The information report will issue a PPO-write to all or to any number of slaves simultaneuosly, the total length of all PPO's being no more that 244 bytes. If the total number of bytes exceeds 244, the broadcast must be segmented into more multicasts. With 9 consecutive multicasts it is possible to transmit up to 1134 bytes. The IR consists of a 3 byte header and one PPO for each of the slaves addressed.



The header serves to initiate the broadcast and contains information for each individual slave. Since there is not room for the total amount of information for all the slaves in one frame, each transmission will have to carry information for one particular slave, at least until they have all received the header information once.

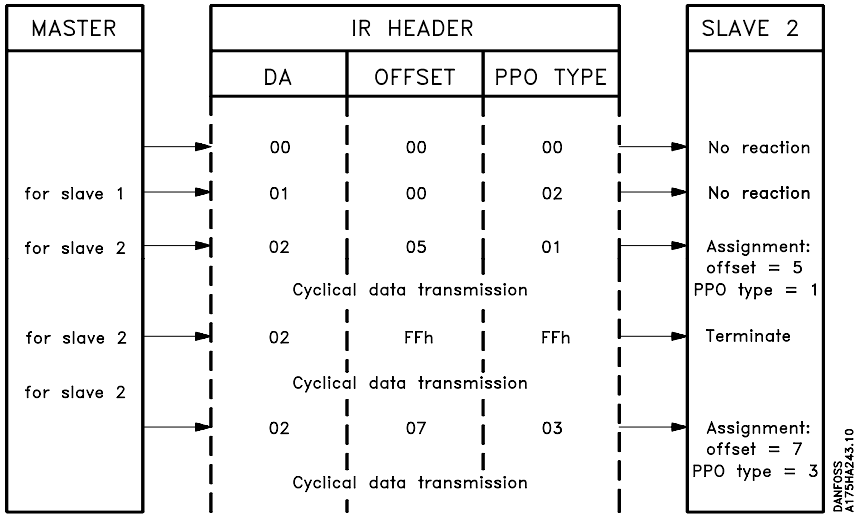
The sequence may be as follows:

1) Before a slave can be configured, it must recieve a "reset" information, telling that a configuration IR follows.
   It can be done in two ways:
   Reset all slaves is done by writing 127 within the first byte of the IR-header and FF Hex in the next two bytes, telling all slaves that each will recieve a parametrizing IR.
   Reset one slave is done by writing the slave address within the first IR byte, and the value FF Hex within the two next bytes (PPO-offset and PPO type). After that, the slave can be parametrized.
2) The master places the address of the first slave in byte 1. The selected slave will then have to know which portion of the PPO string is intended for its use. This information is given in byte 2, which holds the offset for the slave. This means that if for example the offset given is 12, then the PPO starting at byte 12, which could be PPO-2, has been assigned to this slave, it will then only look for PPO-2 and ignore all the others until it is given another offset. In header byte 3 the type of PPO is given as described in parameter 904.

3) In the following IR the next slave will have to be addressed and receive its offset and PPO type. This will go on until all slaves have received their assignments. The cyclical data exchange however is not idle while this procedure goes on. As soon as a slave has been assigned it will participate in the data exchange.

The individual PPOs are treated by the slaves in exactly the same way as if they had been issued by a PPO-write request. To receive a response from the slave, the master will have to issue a PPO-read as described in the figure below.

Function of the IR header



An individual slave may be reset by writing FFh as off-set and PPO type.
Writing 127 as DA will reset all.

■ Spontaneous messages

If connection is established via SAP 46 for fast cyclical Read, and communication takes place by means of PPOs. The Spontaneous message is activated by the active parameters i.e. 807, 953, or 954 and will be carried with the PCV response, stating PNU and PVA of the changed active parameter that triggered the message.

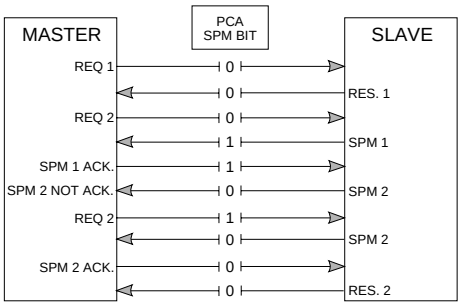
Simultaneously the VLT will toggle the SPM bit (11) of PCA word (see “PCA handling” page 33).

The Spontaneous Notification will be transmitted until the master has acknowledged reception of the message by changing the SPM bit.

Spontaneous messages are only active when parameter 917 is “ON”!

Example of SPM execution

In the VLT the SPMs are temporarily stored in a FIFO buffer. This means that up to 16 consecutive SPMs can be retained. If only one SPM has entered the FIFO, the VLT will resume normal communication as soon as the SPM has been acknowledged by the master (and the condition causing the SPM been rectified). If more SPMs are in the FIFO, these will be transmitted consecutively upon acknowledgement. If more SPMs are triggered when the FIFO is full, these will be ignored.



■ Event notifications

An Event Notification (EN) will do essentially the same job as an SPM. Only ENs are used for normal cyclical and acyclical communication that is less time-critical. The distinction between SPM and EN facilitates application of multi master systems where only one master takes care of process control, while another may take care of monitoring and visualization etc.
In the VLT the ENs are temporarily stored in a FIFO buffer. This means that up to 16 consecutive ENs can be retained. If only one EN has entered the FIFO, the VLT will resume normal communication as soon as the EN has been acknowledged by the master (and the condition causing the EN been rectified).

If there are more ENs in the FIFO, these will be transmitted consecutively upon acknowledgement. If more ENs are triggered when the FIFO is full, these will be ignored, while PNU 1999 will assume the value 3 meaning “EN FIFO overflow”.

The Event Notification will be transmitted until the master has acknowledged reception of the message by means of an Acknowledge-Event-Notification.

The Alter-Event-Condition-Monitoring service may be used to switch off event monitoring. This is posible only at SAP 43.

■ Example

How to change the *Ramp up time* to 10 seconds

Action	Comment
1. “Initiate” CR 8 (SAP 35)	Use the FMS service “Initiate” to open a communication reference for acyclical read and write (page 46)
2. “Write”	Select the FMS service “Write”
3. Index no. 4207	Specify that you want to write to parameter 215. According to the Object Directory on page 49 you have to add 4000 to the parameter number when you want to acces the parameter value
4. Data value = 1000	You have to send the parameter value 1000 to get a Ramp up time of 10.00, because this parameter has a conversion index of -2, see page 72. A conversion index of -2 means that the value received from the master is divided by 100 in order to obtain two decimals after the comma

Chapter 8

■ VLT parameters

Only the PROFIBUS specific parameters (800 - 806 and 900, 901, 9 . .) are described in this manual. All other VLT 6000 Series parameters and their functions are unaffected by the PROFIBUS option. We refer to the parameter description in the VLT 6000 Series product manual.
If the VLT is in Hand-mode control via Profibus is not possible.

Special attention must be given to the following parameters that are not described in this manual:

- 503 - 508: Selection of how to gate PROFIBUS control commands with control commands on the digital inputs of the control card

- 509 - 532: Data readout parameters that can be used to read various actual data from the VLT, as for example actual status on the analog and digital inputs of the control card thus using these as inputs to the master.

- 535 - 536: Bus feedback 1 and 2.

■ PROFIBUS specific parameters

800 Protocol select (PROTOCOL SELECT)

Selection:

	FMS	[0]
✯	DP	[1]

Function:

Selection of the PROFIBUS protocol supported by the master.

Description of selections:

- *FMS*: Communication according to DIN 19245 part 2.
- *DP*: Communication according to DIN 19245 part 3.

Updating parameter 800, even with an unchanged data value, will initialise the PROFIBUS option, meaning that all communication parameters 801, 802, . . such as slave addresses, baud rate, PPO type etc. will be updated.

801 Baud rate select (BAUD RATE SELECT)

Selection:

	Auto	(AUTO DETECTION)	[0]
	9.6 kBaud	(9.6 KBAUD)	[1]
	19.2 kBaud	(19.2 KBAUD)	[2]
	93.75 kBaud	(93.75 KBAUD)	[3]
	187.5 kBaud	(187.5 KBAUD)	[4]
	500 kBaud	(500 KBAUD)	[5]
✯	1500 kBaud	(1500 KBAUD)	[6]
	3000 kBaud*	(3000 KBAUD)	[7]
	6000 kBaud*	(6000 KBAUD)	[8]
	12000 kBaud*	(12000 KBAUD)	[9]

*only DP

Function:

Selection of the PROFIBUS transmission speed. The selection must match the transmission speed of the master and other PROFIBUS nodes.

Description of selections:

- *Auto:* The actual PROFIBUS transmission speed will automatically be detected when there is activity on the connected bus.
- *9.6 - 12000 kBaud*: Selection of a fixed baudrate will reduce the power up time as it takes a few seconds to auto detect the actual baudrate.

Change of parameter 801 is executed when parameter 800 is updated or at next power up.

802 Minimum station delay (MIN. STAT. DELAY)

Selection:

	25 - 2000 bit times	[0]
✯	1500	[1]

Function:

The minimum response time, i.e. the minimum time from receiving a telegram untill the response is send out, can be set between 25 and 1000 bit times.

Parameter 802 is only active when *FMS* is selected in parameter 800. The station delay is fixed at 11 bit times when *DP* is selected.

✯ *Factory setting*

Description of selections:

The minimum station delay must normally be as short as possible, as this gives the fastest communication, but some masters are not able to handle too short delay times. The minimum station delay must therefore be increased. Please consult your master manual for details about the performance of the master.

Change of parameter 802 is executed when parameter 800 is updated or at next power up.

803 Bus time out (BUS TIME OUT)

Selection:

1 - 99 sec ✯ 1 sec

804 Bus time out function (TIME OUT FUNCT.)

Selection:

✯	Off (OFF)	[0]
	Freeze output frequency (FREEZE OUTPUT)	[1]
	Stop with auto restart (STOP)	[2]
	Output frequency = JOG freq. (JOGGING)	[3]
	Output freq. = Max. freq. (MAX SPEED)	[4]
	Stop with trip (STOP AND TRIP)	[5]
	Control without PROFIBUS (NO COM OPT CONTROL)	[6]
	Select setup 4 (SELECT SETUP 4)	[7]

Function:

The time out counter is triggered at the first reception of a valid control word i.e. bit 10 = ok, when DP or cyclical FMS communication is used. Acyclical FMS will not trigger the time out counter.

The *time out* function can be activated in two different ways:

1. CTW is not updated within the specified time
2. Parameter 805 = "bit 10 = 0 ⇒ time out" and bit 10 = "0"

The VLT remains in time out state until one of the following four conditions is true:

1. Valid control word (Bit 10 = ok) is received and reset (Bus, terminals or local control panel) is activated (reset is only necessary when the time out function *Stop w. trip* is selected) ⇒ control via PROFIBUS is resumed with the actual control word.
2. Parameter 928 = *Disabled* Þ Normal control via terminals and RS485 is enabled.

The time out counter is reset and must be trigged by a valid control word before a new time out can be activated.

3. Parameter 804 = *Off* ⇒ control via PROFIBUS is resumed and the most recent control word is used.

Description of selections:

- *Freeze output frequency*: Freeze output frequency until communication is resumed.
- *Stop with auto restart*: Stop with auto restart when communication is resumed.
- *Output frequency = JOG freq.*: Motor will run at JOG frequency until communication is resumed.
- *Output frequency = Max. freq.*: Motor will run at max. frequency until communication is resumed.
- *Stop with trip*: Motor is stopped, reset needed for restart, see explanation above.
- *Control without PROFIBUS*: Control via PROFIBUS is disabled and control is possible via terminals and/or standard RS485 interface, until communication is resumed.
- *Select setup 4:* Set up 4 is selected in parameter 004 and the settings of set up 4 will be used. Parameter 004 is not reset to the original value when communication is resumed.

805 Function of control word bit 10

(Bit 10 function)

Selection:

	No function (NO FUNCTION)	[0]
✯	Bit 10 = 1 ⇒ CTW active (BIT 10 = 1 ⇒ CTW ACTIVE)	[1]
	Bit 10 = 0 ⇒ CTW active (BIT 10 = 0 ⇒ CTW ACTIVE)	[2]
	Bit 10 = 0 ⇒ time out (BIT 10 = 0 ⇒ TIME OUT)	[3]

Function:

According to the PROFIDRIVE profile, control word and speed reference will be ignored if bit 10 of the control word is *0*, but parameter 805 lets the user change the function of bit 10. This is sometimes necessary as some masters are setting all bits to *0* in various fault situations. In these cases it makes sense to change the function of bit 10 so that the drive is commanded to stop (coast) when all bits are *0*.

Description of selections:

- *Bit 10 = 1 ⇒ CTW active:* Control word and speed reference is ignored if bit 10 = *0*.

- Bit 10 = 0 ⇒ *CTW active:* Control word and speed reference is ignored if bit 10 = *1*. If all bits of the control word are 0 the VLT reaction will be coasting.
- *Bit 10 = 0 ⇒ time out:* The time out function selected in parameter 804 is activated when bit 1 10 is *0*.
- No function: Bit 10 is ignored, i.e. control word and speed reference is always valid.

Change of parameter 802 is executed when parameter 800 is updated or at next power.

806 SAP number select (SAP # SELECT)

Selection:

★	SAP 63 (SAP 63)	[0]
	SAP 48 (SAP 48)	[1]
	SAP 49 (SAP 49)	[2]
	SAP 50 (SAP 50)	[3]
	SAP 51 (SAP 51)	[4]
	SAP 52 (SAP 52)	[5]
	SAP 53 (SAP 53)	[6]
	SAP 54 (SAP 54)	[7]
	SAP 55 (SAP 55)	[8]
	SAP 56 (SAP 56)	[9]

Function:

The SAP number selection assigns the drive to a *Multicast* group. When the master is issuing a broadcast telegram with a multicast SAP number, only the slaves (drives) with that SAP number will read the telegram.

Broadcast/multicast is only possible when FMS is selected in parameter 800.

Description of selections:

- *SAP 63* is the broadcast SAP.
- *SAP 48-56*: Eight multicast SAP numbers which makes it possible to define eight groups of VLT's.

Change of parameter 806 is executed when parameter 800 is updated or at next power up.

900 Write PPO type 1 (PPO 1 WRITE)

Selections:

12 byte [0]

No LCP access

901 Write PPO type 2 (PPO 2 WRITE)

Selections:

20 byte [0]

No LCP access

902 Write PPO type 3 (PPO 3 WRITE)

Selections:

4 byte [0]

No LCP access

903 Write PPO type 4 (PPO 4 WRITE)

Selections:

12 byte [0]

No LCP access

Function:

When using PPO communication with *FMS* cyclic, the PPO must be sent as data value to one of the parameters 900-903 or 905, depending of the PPO type, by means of a write command.

904 PPO type select for DP(PPO TYPE SELECT)

Selections:

★	PPO type 1 (PPO TYPE 1)	900
	PPO type 2 (PPO TYPE 2)	901
	PPO type 3 (PPO TYPE 3)	902
	PPO type 4 (PPO TYPE 4)	903
	PPO type 5 (PPO TYPE 5)	905

Function:

The type of PPO to be used must be selected when *DP* is selected in parameter 800. The selection is valid for read and write, i.e. the same PPO type must be used for read and write.
Parameter 904 will indicate the last PPO type used for writing when using *FMS* communication.

Description of selections:

- PPO type 1: 12 byte PPO with parameter channel for read and write of parameters and 4 bytes of process data (control/status word and reference/actual output frequency).
- PPO type 2: 20 byte PPO as PPO type 1 with 8 additional bytes of selectable process data.
- PPO type 3: 4 byte process data (control/status word and reference/actual output frequency).
- PPO type 4: 12 byte process data, as process data part of PPO type 2.
- PPO type 5: 28 byte as PPO type 2 with 8 additional bytes of selectable process data.

A detailed description of the PPO types can be found on page 32.

Change of parameter 904 is executed when parameter 800 is updated or at next power up.

907 Read PPO type 1 (PPO 1 READ)

Selections:

Read only, 12 byte [0]

No LCP access

908 Read PPO type 2 (PPO 2 READ)

Selections:

Read only, 20 byte [0]

No LCP access

909 Read PPO type 3 (PPO 3 READ)

Selections:

Read only, 4 byte [0]

No LCP access

910 Read PPO type 4 (PPO 4 READ)

Selections:

Read only, 12 byte [0]

No LCP access

Function:

When using PPO communication with *FMS*, the PPO must be read as a data value from one of the parameters 907-910, depending of the PPO type, by means of a read command.

911 PPO type for FMS read (PPO READ TYPE)

Selections:

✯	PPO type 1 (PPO TYPE 1)	907
	PPO type 2 (PPO TYPE 2)	908
	PPO type 3 (PPO TYPE 3)	909
	PPO type 4 (PPO TYPE 4)	910
	PPO type 5 (PPO TYPE 5)	912

Function:

Parameter 911 will indicate the last PPO type used for reading when using *FMS* communication (parameter 800 = *FMS*). The parameter has no function when *DP* or *DP w. 1 byte PPO* is selected.

913 Broadcast index (PPO BRDCST IND)

Selections:

0 - 32767

✯ 0

Function:

The broadcast index can be used to divide the drives into multicast groups as only the drives with the same broadcast index as the master will read the broadcast telegramme. The same function can be obtained by means of SAP numbers in parameter 806.

Broadcast/multicast is only possible when FMS is selected in parameter 800.
Change of parameter 913 is executed when parameter 800 is updated or at next power up.

914 Broadcast off-set (PPO OFF-SET)

Selections:

0 - 244 Bytes

✯ 0

Functions:

The broadcast telegramme (information report) can hold PPO's for several drives. Parameter 914 tells the drive where to pick up the PPO from the information report.

Broadcast/multicast is only possible when *FMS* is selected in parameter 800.

Description of selections:

Selection of the number of bytes the PPO is displaced from the header (3 bytes) of the information report (see page 53). *0* means that the PPO is placed in byte 4 and onwards in the information report. Several VLT's can have the same off-set if they are supposed to use the same PPO. The off-set setting depends on the PPO length which is determined by the PPO type selection in parameter 904. The broadcast function and the information report is described on page 53.

Change of parameter 914 is executed when parameter 800 is updated or at next power up.

915 PCD config. write (PCD IN WR-)

Selections:

Sub index 1	Parameter #
Sub index 2	Parameter #
Sub index 3	Parameter #
Sub index 4	Parameter #
Sub index 5	Parameter #
Sub index 6	Parameter #
Sub index 7	Parameter #
Sub index 8	Parameter #

Function:

Different parameters can be assigned to PCD 3-10 of the PPO's (the number of PCD's depends on the PPO type). The values in PCD 3-10 will be written to the selected parameters as data values.

LCP read only, write *access* via PROFIBUS or standard RS 485.

Description of selections:

The order of the subindexes corresponds to the order of the PCD's in the PPO, i.e. subindex 1 ≈ PCD 3, subindex 2 ≈ PCD 4 and so on. Each subindex can hold the number of any of the drive parameters, but it is only possible to write 2 byte values (least significant bytes) to parameters with 4 byte data values as 1 PCD consists of only 2 bytes.

916 PCD config. read(PCD IN RD-)

Selections:

Sub index 1 (PCD 3)	Parameter #
Sub index 2	Parameter #
Sub index 3	Parameter #
Sub index 4	Parameter #
Sub index 5	Parameter #
Sub index 6	Parameter #
Sub index 7	Parameter #
Sub index 8	Parameter #

Function:

Different parameters can be assigned to PCD 3-10 of the PPO's (the number of PCD's depends on the PPO type). PCD 3-10 will hold the actual data value of the selected parameters.
LCP read only, write *access* via Profibus or standard RS 485.

Description of selections:

The order of the subindexes corresponds to the order of the PCD's in the PPO, i.e. subindex 1 ≈ PCD 3, subindex 2 ≈ PCD 4 and so on. Each subindex can hold the number of any of the VLT parameters, but it is only possible to read 2 byte values (least significant bytes) from parameters with 4 byte data values as 1 PCD consists of only 2 bytes.

917 Activate spontaneous messages (SPONT. MES)

Selections:

★	Off (OFF)	[0]
	On (ON)	[1]

Function:

The spontaneous messages and event notifications functions can be switched on if it is desired to make the drive issue a message when a warning or an alarm comes up.

Description of selections:

- *OFF*: The drive will not issue spontaneous messages or event notification in case of a warning or an alarm.
- *ON*: When using PPO's (*DP* or *FMS*) the drive will issue a spontaneous message when warnings or alarms are coming up. When using *FMS* without PPO's the drive will issue an event notification when warnings or alarms are coming up.

918 Station address (STATION ADDR)

Selections:

	1-126
★	0

Function:

All stations connected to the same bus must have a unique address. The station address can be set in parameter 918 or on a hardware switch.

The address can only be set in parameter 918 when the hardware switch is set to 0 or higher than 126. When the setting of the hardware switch is different from 0 the parameter will display the actual setting of the switch. Change parameter 918 is executed when parameter 800 is updated or at next power up.

★ *Factory setting*

927 Parameter edit

Selections:

	Disabled	[0]
✯	Enabled	[1]

Function:

This parameter enables/disables parameter editing via serial communication ports.Parameter editing is always possible from the LCP.

Description of selections:

- *Disabled*: Parameter edit via HPFB serial communication port (on option card) is diabled.
  Parameter edit via Basic serial communication port (on control card) is enabled
- *Enabled*: Parameter edit via HPFB serial communication port (on option card) is enabled.
  Parameter edit via Basic serial communication port (oncontrol card) is enabled if parameter 500 „Protocol“= „FC Protocol“ otherwise parameter edit is disabled.

928 Process control

Selections:

	Disabled	[0]
✯	Enabled	[1]

Function:

Process control (setting of control word and main reference value) is possible via either HPFB serial communication port (on option card) or the Basic serial communication port (on control card), but not at the same time. Local control is always possible via the local control panel. Control via control card terminals is possible with either bus depending on the setting of parameters 503-508.

Description of selections:

- *Disabled*: Process control via HPFB seial communication port (on option card) is disabled.
  Process control via Basic serial communication port (on control card) is enabled.
- *Enabled*: Process control via HPFB serial communication port (on option card) is enabled.
  Process control via serial communication port (oncontrol card) is disabled..

The motor may start without notice when parameter 928 is changed and start commands are present.

953 Warning parameter 1 (WARN. PARA)

Selections:

Read only

No LCP access

Function:

A 16 bit bitstring where each bit is associated with a specific warning.

Bit		Bit = “1” when:
0	LSB	Connection with DP-master is not ok
1		Connection with FMS-master is not ok
2		FDL (Field-bus Data link Layer) is not ok
3		Clear data command recieved
4		Actual value is not updated
5		Spontaneous message FIFO overflow
6		PROFIBUS ASIC is not transmitting
7		Initialising of PROFIBUS option is not ok
8		Not used
9		Not used
10		Not used
11		Not used
12		Not used
13		Not used
14		Not used
15	MSB	Not used

967 Control word

Selections:

16 bits binary code

No LCP access

Function:

Parameter 967 is devoted to sending a control word to the drive when using FMS with acyclical communication (without PPO’s). The control word is sent by means of the FMS *write* service to parameter 967 (index 4967).

968 Status word

Selections:

Read only

No LCP access

Function:

Parameter 968 is devoted to reading the status word from the drive when using FMS with acyclical communication or cyclical read on CR 5 (without PPO’s). The status word is read by means of the FMS *read* service from parameter 968 (index 4968).

970 Edit set up selection (EDIT SETUP SELECT)

Selections:

	Factory Setup (FACTORY SETUP)	[0]
	Setup 1 (SETUP 1)	[1]
	Setup 2 (SETUP 2)	[2]
	Setup 3 (SETUP 3)	[3]
	Setup 4 (SETUP 4)	[4]
✯	Active Setup (ACTIVE SETUP)	[5]

Function:

The choice is of the Setup in which programming (change of data) is to occur during operation (applies both via the control panel and via the serial communication port). It is possible to programme the 4 Setups independently of the Setup selected as the active Setup.

971 Store data values (STORE DATA VALUE)

Selections:

✯	No action (NO ACTION)	[0]
	Store active setup (STORE ACTIVE SETUP)	[1]
	Store edit setup (STORE EDIT SETUP)	[2]
	Store all setups (STORE ALL SETUPS)	[3]

[1] Store the setup selected by parameter 002.
[2] Store the setup selected by parameter 970
[3] Store all setups.

Function:

Parameter values changed via PROFIBUS is only stored in RAM meaning that the changes are lost at power down. This parameter is used to activate a function that stores all parameter values in the EEPROM thus retaining changed parameter values at power down.

Description of selections:

No action: The store function is inactive.
Store data values: All parameter values will be stored in the EEPROM. The value returns to *No action* when all parameter values have been stored.
Store edit setup: All parameter values in the setup you are editing will be stored in the EEPROM. The value returns to *No action* when all values have been stored.
Store all setups: All parameter values will be stored in the EEPROM. The values returns to *No action* when all parameter values have been stored.

980-982 Defined parameters (DEFINED PNU'S)

Selections:

Read only

Function:

The three parameters hold a list of all the parameters that are defined in the drive. Each of the three parameters can be read as an array by means of the acyclical FMS *read* service with subindex 255. It is also possible to read single elements of the list by DP and cyclical/acyclical FMS by using the corresponding subindex. The subindexes starts at 1 and follows the order of the parameter numbers.

Each parameter holds up to 116 elements (parameter numbers). The number of elements in the parameters (980, 981 and 982) depends on the actual drive version.

When a 0 is returned as parameter number the list ends.

990-992 Modified parameters (MODIFIED PNU'S)

Selections:

Read only

Function:

The three parameters hold a list of all the drive parameters that have been changed from factory setting. Each of the three parameters can be read as an array by means of the acyclical FMS *read* service. It is also possible to read single elements of the list by DP and cyclical/acyclical FMS by using the corresponding subindex. The subindexes start at 1 and follow the order of the parameter numbers. Each parameter holds up to 116 elements (parameter numbers). The number of parameters (990, 991 and 992) in use depends on how many parameters have been changed from factory setting.

Read only parameters, as for example data read out parameters, will not be registered as modified eventhough they are changing.

When a 0 is returned as parameter number the list ends.

✯ *Factory setting*

Chapter 9

■ Warning and alarm messages

There is a clear distinction between alarms and warnings. In the case of an alarm, the VLT will enter a fault condition. After the cause for the alarm has been cleared, the master will have to acknowledge the alarm message for the VLT to start operating again. A warning, on the other hand may come when a warning condition appears, and disappear when conditions return to normal without interfering with the process.

Warnings

Any warning within the VLT is represented by a single bit within a warning word. A warning word is always an active parameter. Bit status FALSE [0] means no warning, while bit status TRUE [1] means warning.

Any bit change in the warning word will result in a Spontaneous message being issued.

In addition to the warning word message the master will also be notified through a change of bit 7 in the Status Word.

Alarms

Following an Alarm message the VLT will enter Fault condition. Only after the fault has been alleviated and the master has acknowledged the alarm message by setting bit 7 in the Control word, can the VLT resume operation.

Any alarm within the VLT is represented by a single bit within an alarm word. An alarm word is always an action parameter. Bit status FALSE [0] means no fault, while bit status TRUE [1] means fault.

Any bit change in the alarm word will result in a Spontaneous message being issued.

■ Fault messages via DP Diagnosis .

The standard DP function features a on-line diag nosis which is active during DP initialisation as well as Data exchange mode. On request from master, the slave (VLT) returns diagnostic data for the DP settings, - and some user defined diagnostic data. In this implementation, only 2 faults can be indi cated by the DP diagnosis function:

a. Overflow at SPM FIFO.(increase SPM ac knowledge on master).

b. No update of Process data channel.(Software or hardware fault at VLT control card.)

The VLT communication software will return 9 bytes of diagnostic data:

Byte 0 through 6 is DP setup specific.

Byte 7 and 8 user defined diagnosis data containing the above mentioned fault messages.

Byte 7 has the value of 0x02H, telling the amount of user defined diagnostic data (in this case 2).

Byte 8 contains the Fault information represented as a bit value:

	ms. bit					ls. bit	
Byte 8:	0	0	0	0	0	b	a	0

Bit value = 1 means Fault.

Bit value = 0 means no fault.

■ Spontaneous messages/ event notification

If a fault or warning condition should occur, the VLT will, if the proper communicative relationship has been established, issue either a Spontaneous message or an Event Notification to communication partners. Instead of responding to the master's request, the VLT will exchange the requested response with the alarm or the warning message.

Warnings and alarms will trigger a Spontaneous messages/ Event Notification. The same is true with any change to an active parameter.

Depending on which RSAPs are used by the master to communicate with the VLT (see section 6) the message from the VLT will be either a Spontaneous- or Event Notification. If the VLT response is accessed via SAP 46 for fast cyclical Read, then the response will be a Spontaneous Notification with high priority. If SAP 44 is used, an Event Notification will result. This would be the case if a master 2 is used for visualization.

Additional display messages

When VLT 6000 is equipped with a PROFIBUS interface it can display the following messages in addition to the display messages described in the VLT 6000 product manual:

Warnings

WARN. 34

PROFIBUS COMM. FAULT

- There is no connection to the master. The reason could be that the master is stopped (or in a fault condition) or the PROFIBUS connection to the VLT is interrupted.

- There is overflow in the SPM (spontaneous messages) FIFO buffer, see page 27 or 46.

Alarms

ALARM

PROFIBUS OPT. FAULT

- The option card is disturbed by electrical noise or there is a fault on the option card and it must be replaced.

Chapter 11

■ Abbriviations used in this manual

English	German	Elaboration	Page
ACI	-	Acyclical Control Interval	44
ALI	-	Aplication Layer Interface	27
ATTR	-	Attribute	44
BRCT	-	Broadcast	48
CCI	-	Cyclical Control Interval	44
CR	KR	Communication Reference	44
CRL	KBL	Communication Reference List	44
CSRD	-	Cyclical Send and Request Data	47
CT	Typ	Connection Type	44
CTW	STW	Control Word	32
DA	-	Destination Address	54
DP	-	Distributed Periphery	1
EIA	-	Electronic Industries Association: Specifiers of the EIA Standard RS 485-A	18
EMC	EMV	Electromagnetic Compatibility	19
EN	-	Event Notification	55
FIFO	-	First In First Out	55
FMS	-	Field-bus Message Specification	1
HSA	-	Highest Station Address	
Hd	-	Hamming distance	
HPFB	-	High Performance Field Bus	
IND	-	Subindex	32, 39
I/O	E/A	Input/Output	27
ISO	-	International Standards Organization	
IR	-	Information Report	54
LSAP	-	Local Service Access Point	44
LSB	-	Least Significant Bit	22, 63
MSB	-	Most Significant Bit	35
MAP	-	Manufacturing Automation Protocol	27
MAV	HIW	Main Actual Value	22
MMS	-	Manufacturing Message Specification	27
MRV	HSW	Main Reference Value	32, 39
MSAC	MZAC	Master-Slave connection for acyclical transmission	47
MSAC_SI	MZAC_SI	Master-Slave connection for acyclical transmission with slave initiative	48
MSCY	MSZY	Master-Slave connection for cyclical transmission	48
MSCY_SI	MSZY_SI	Master-Slave connection for cyclical transmission with slave initiative	48
MULT	-	Multicast	49
OD	OV	Object Directory	49
PC	-	Personal Computer	4
PCA	PKE	Parameter Characteristics	32
PCD	PZD	Process Data	32
PCV	PKW	Parameter-Characteristics-Value	32
PDU	-	Protocol Data Unit	48
PLC	SPS	Programmable Logic Control	4
PNU	-	Parameter Number	33
PPO	-	Parameter-Process Data Object	8, 32
PVA	PWE	Parameter Value	32
RAC	-	Receive Acknowledged request Counter	44
RADR	-	Remote Address	44
RC	AK	Request/Response Characteristics	33
RCC	-	Receive Confirmed request Counter	44
RSAP	-	Remote Service Access Point	44

English	German	Elaboration	Page
SAC	-	Send Acknowledged request Counter	44
SAP	-	Service Access Point	45
SCC	-	Send Confirmed request Counter	44
SPM	-	Spontaneous Notification	35
STW	ZSW	Status Word	32
TRT	-	Target Rotation Time	49
VDE	-	Association of German Electrical Technicians	4
VDI	-	Association of German Electrical Engineers	4
VSD	FU	Variable Speed Drive	18

PNU #	Parameter Designation	Default value	Range	Size index[1]	Conversion index[1]	Data type[2]
800	Protocol select	DP (1)	FMS/DP	24	-1	3
801	Baud rate select	1500 kbaud (6)	0-9	28	-1	3
802	Minimum station delay	1500	25-2000	24	-1	3
803	Bus time out	1	1-99	22	-1	3
804	Bus time out function	Off (0)	0-7	24	-1	3
805	Bit 10 function	Bit 10 = 1 ⇒ CTW active (1)	0-3	9	-1	6
806	SAP select	SAP 63 (0)	0-9	0	-1	6
900	Write PPO type 1		12 bytes	0	0	10
901	Write PPO type 2		20 bytes	0	0	10
902	Write PPO type 3		4 bytes	0	0	10
903	Write PPO type 4		12bytes	0	0	10
904	PPO type select	900	900-905	0	0	6
907	Read PPO type 1		12 bytes	0	0	10
908	Read PPO type 2		20 bytes	0	0	10
909	Read PPO type 3		4 bytes	0	0	10
910	Read PPO type 4		12 bytes	0	0	10
911	PPO read type	907	907-912	0	0	6
913	Broadcast index	0	0-32767	0	0	6
914	Broadcast off-set	0	0-244	0	0	6
915	PCD config. write			0	0	6
916	PCD config. read			0	0	6
917[4]	Spontaneous messages	OFF (0)	ON/OFF	0	0	35
918	Station address	0	1-126	0	0	6
927	Parameter edit	With PROFIBUS (1)	0 - 1	0	0	6
928	Process control	With PROFIBUS (1)	0 - 1	0	0	6
953	Warning parameter 1		16 bits	0	0	35
967	Control word		16 bits	0	0	35
968	Status word		16 bits	0	0	35
970	Edit setup	Active Setup (5)	0 - 5	0	0	5
971[S]	Store data values	No action (0)	0 - 3	0	0	5*
980	Defined parameters			0	0	6
981						
982						
990	Modified parameters			0	0	6
991						
992						

* Automatic reset to (0).

4) Available in all 4 setups.

S) Only in stop mode

1) See table on page 34 or 51

2) See table on page 35 or 50