PROFIBUS DP

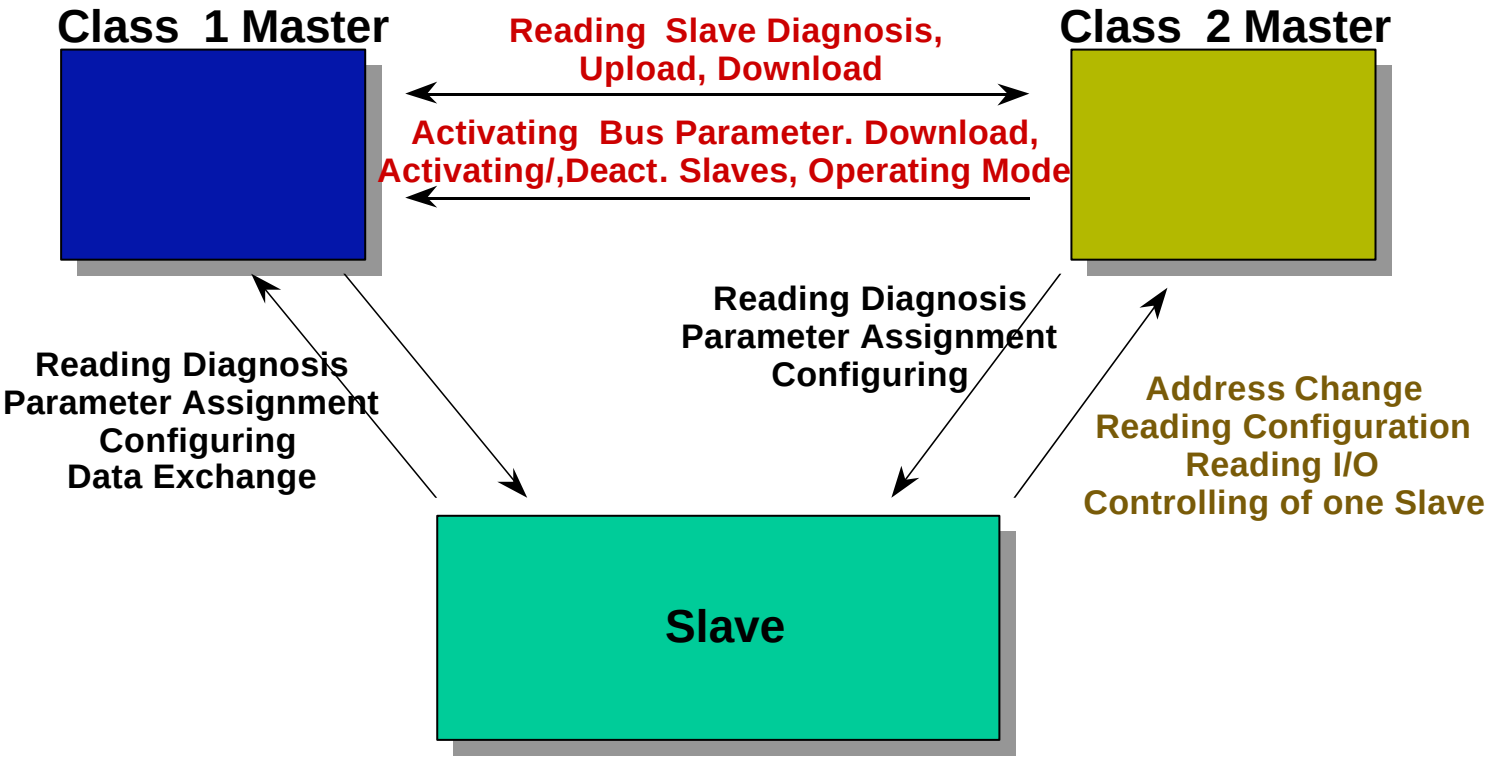
PROFIBUS DP the fastest field bus system

DP Details

- class 1 master -
  - central controller which exchanges data with the connected I/O devices (slaves)
  - determines the baudrate
  - handles the Token
  - several class1 masters are permitted, typical devices are PLC, PC
- class 2 master -
  - diagnostic and startup tool, typically a configuration tool
  - can control one slave at a time
- slave station -
  - passive station which acknowledges messages or answers per request

DP Details

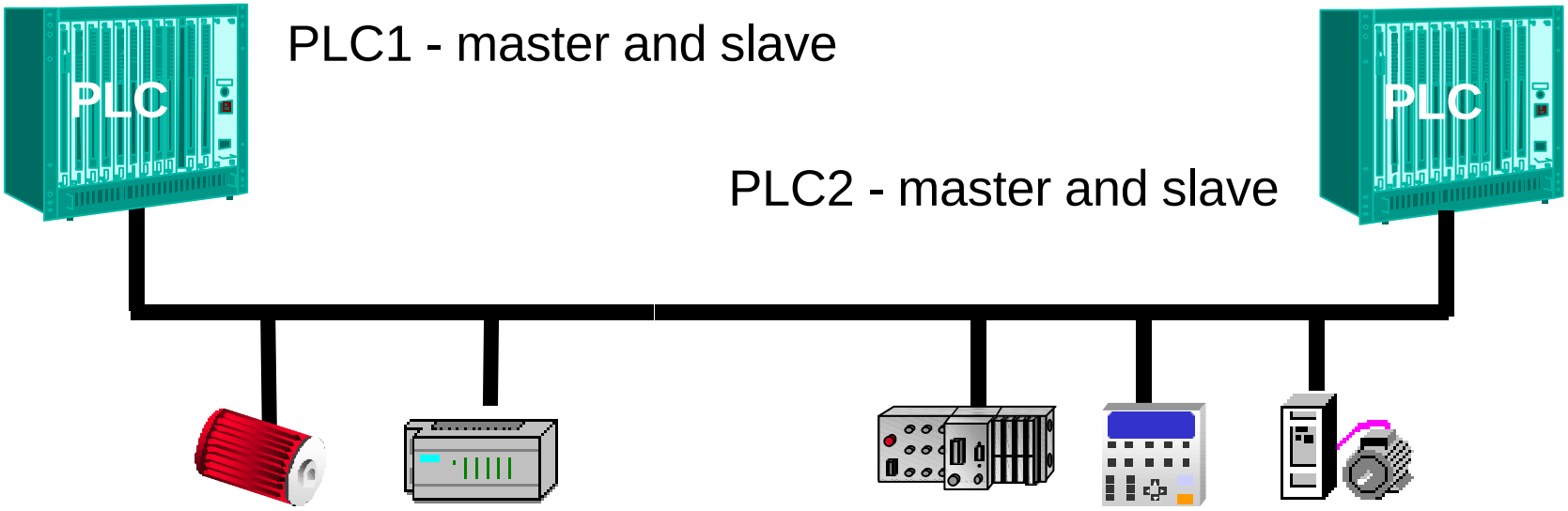
- master- master, master- slave communication



a device can consist of multiple functions, e.g.... class1 and class2, class1 and slave

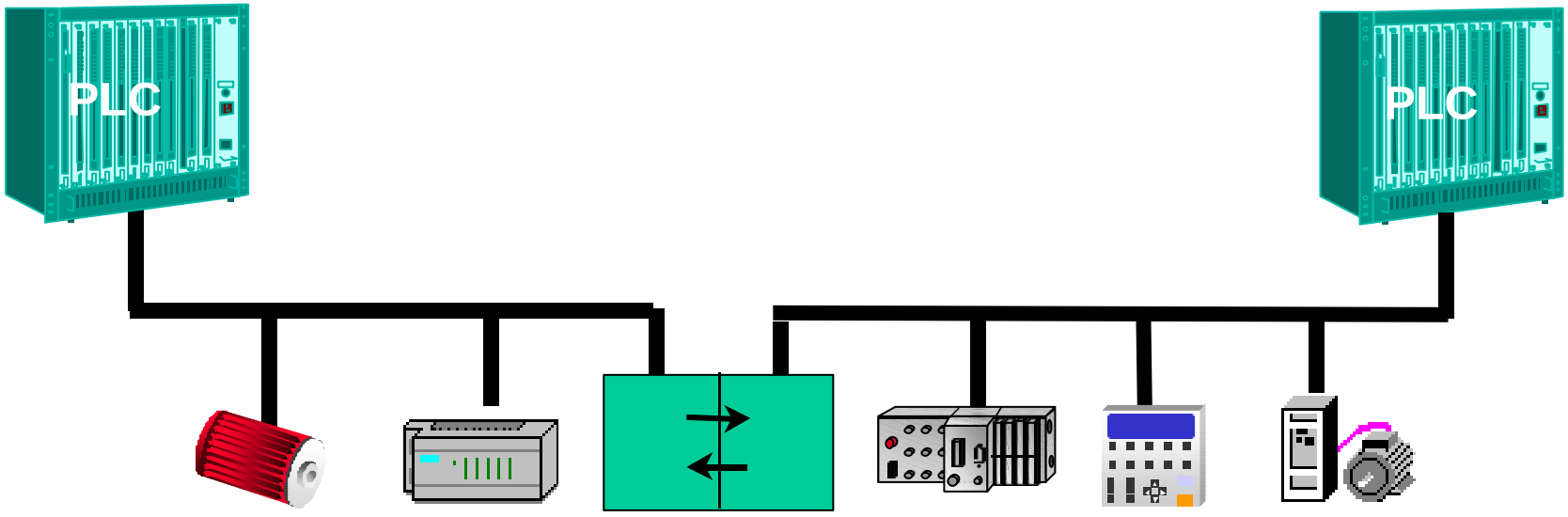
DP Details

- A device can consist of multiple functions, e.g... class1 and class2, class1 and slave, which allows:
  - a simple master master communication via the master - slave combination
  - whenever one master has the token the other PLC can be a slave to this master



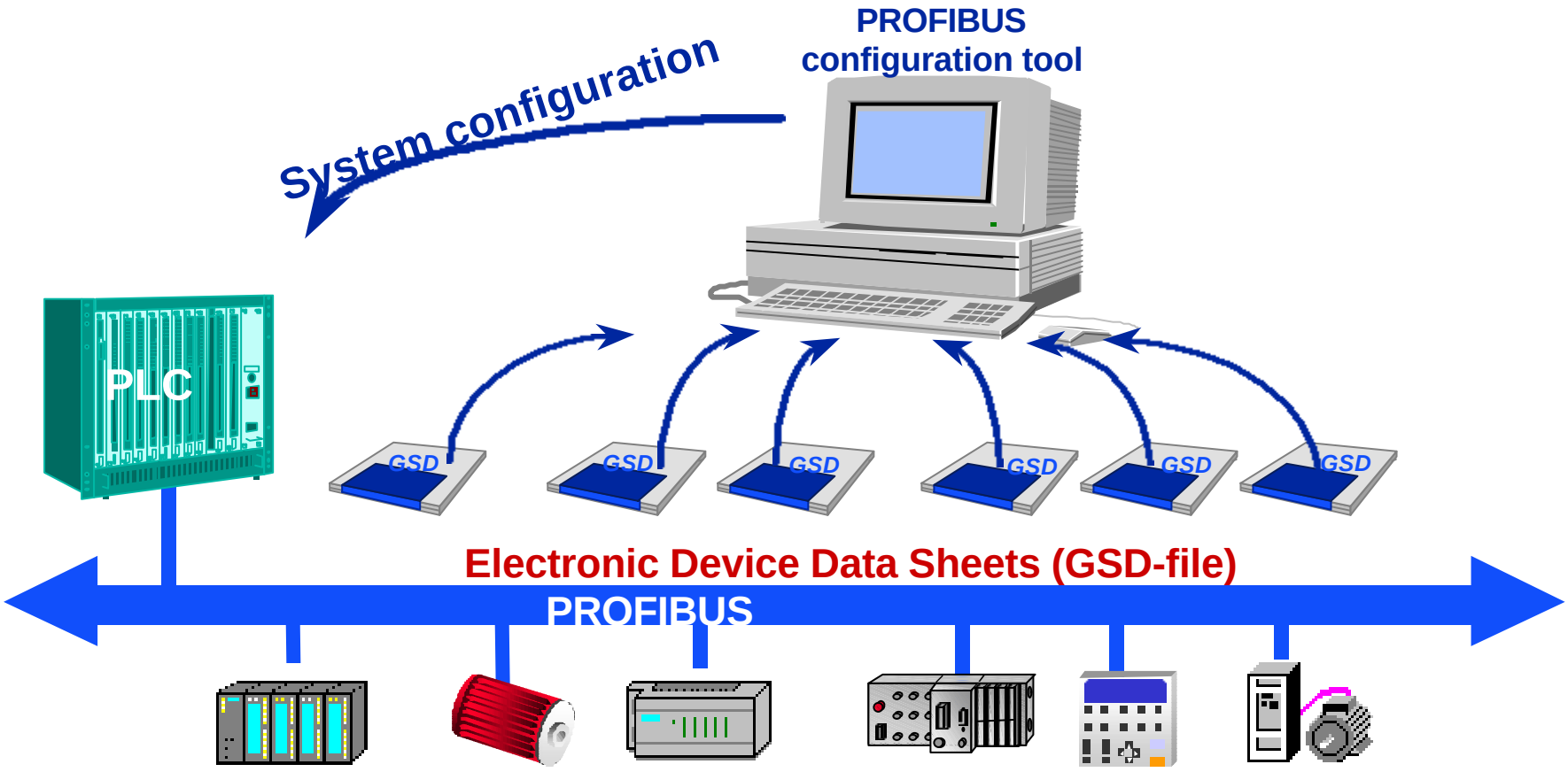
DP Details

- Master - Master communication by using a DP-DP gateway
  - combination of two mono master systems
  - simple data exchange between the two masters up to 244 byte



Interoperability

- Open Configuration permits Plug and Play



Device Description

- **GSD file**
  - **each slave or master class 1 device on PROFIBUS DP needs to have a device description file, the characteristic of each PROFIBUS-DP device is described in the GSD-File**
  - **the GSD-file contains all device specific parameters e.g.:**
    - **Supported Baudrate**
    - **Supported Message Length**
    - **Number of input / output data**
    - **Meaning of diagnostic messages**
    - **Options for modular devices e.g. which are available**
  - **text file (ASCII-format)**
  - **each configuration tool relates to the GSD information**

Device Description

- GSD-Files are created by the device vendors
- the PROFIBUS Trade Organization provides an GSD-Editor which makes it very easy to create GSD-Files
- the GSD-Editor contains a GSD-Checker which guarantees the conformance of the GSD-Files to the PROFIBUS standard
- a library of GSD-Files is provided at the PROFIBUS web page: http://www.profibus.com

Device Description

#Profibus_DP	(M)	
:<PRM-Text_Def_List>	(O)	
PrmText = 펠 .. EndPrmTExt		⟸ Parameter text (O)
;<Ext-User_Prm_Data_Def_List>	(O)	
ExtUserPrmData = 펠 EndExtUserPrmData		⟸ ext. user parameter data (O)
;<Unit_Definition_List>	(M)	
GSD_Revision=1 Vendor_Name= 펠 .. 펠 .		⟸ mandatory general data (M)
;Slave specific data	(M)	
Freeze_mode_supported= 펠 .. 펠		⟸ generic slave data (M)
;User_Prm_data		
펠 .		⟸ device related slave data (O)
;Unit_diagnostic		
펠 ..		
;<Module_Definition_List	(M)	
Module = 펠 . EndModule		⟸ I/O definition (M)

GSD Details

General Data

#Profibus_DP	Identifier for a DP GSD file
GSD_Revision=1	version of the GSD file regarding the standard
Vendor_Name="Company"	vendor name
Model_Name="Product name"	device name (which will be displayed in the configuration tool.
Ident_Number=0x0000	- unique Identification number, each slave and master class 1 device needs to have - a DP-master can identify the slave without a significant protocol overhead - control function, the master will only start with data transfer if the ident number matches the device ident number - ident number is issued by the PTO

GSD Details

General Data

Protocol_Ident=0	defines supported protocols, 0- DP, 1- DP/FMS
Station_Type=0	type of device, 0- Slave, 1- Master
Hardware_Release="V1.0"	HW version of the device
Software_Release="V1.1"	SW version of the device
9.6_supp=1 1.5M_supp=1	all supported baudrates, between 9.6kBaud and 12 MB
MaxTsdr_9.6=60	max. answering time related to the baudrate

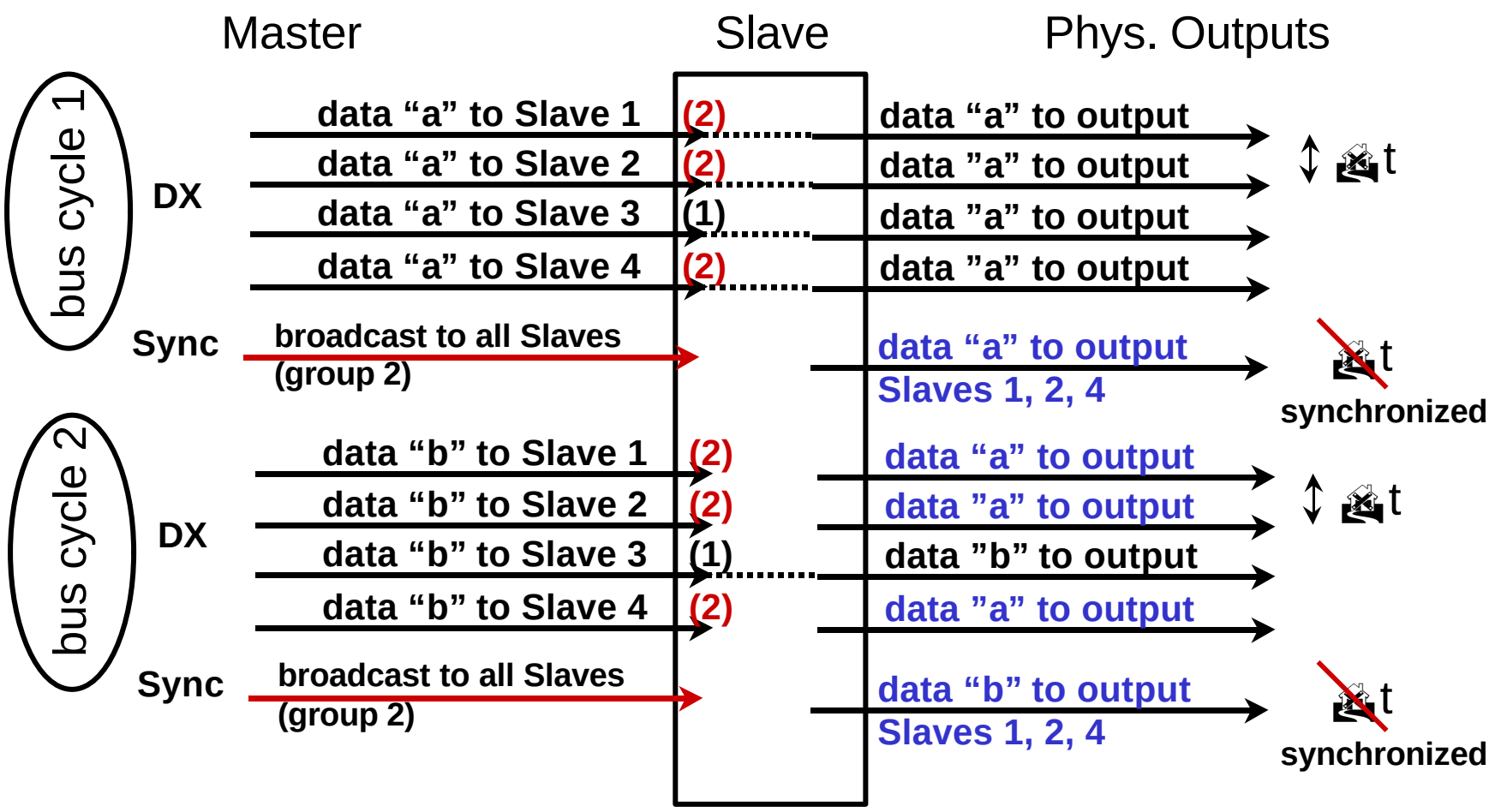
GSD Details

Generic Slave Data

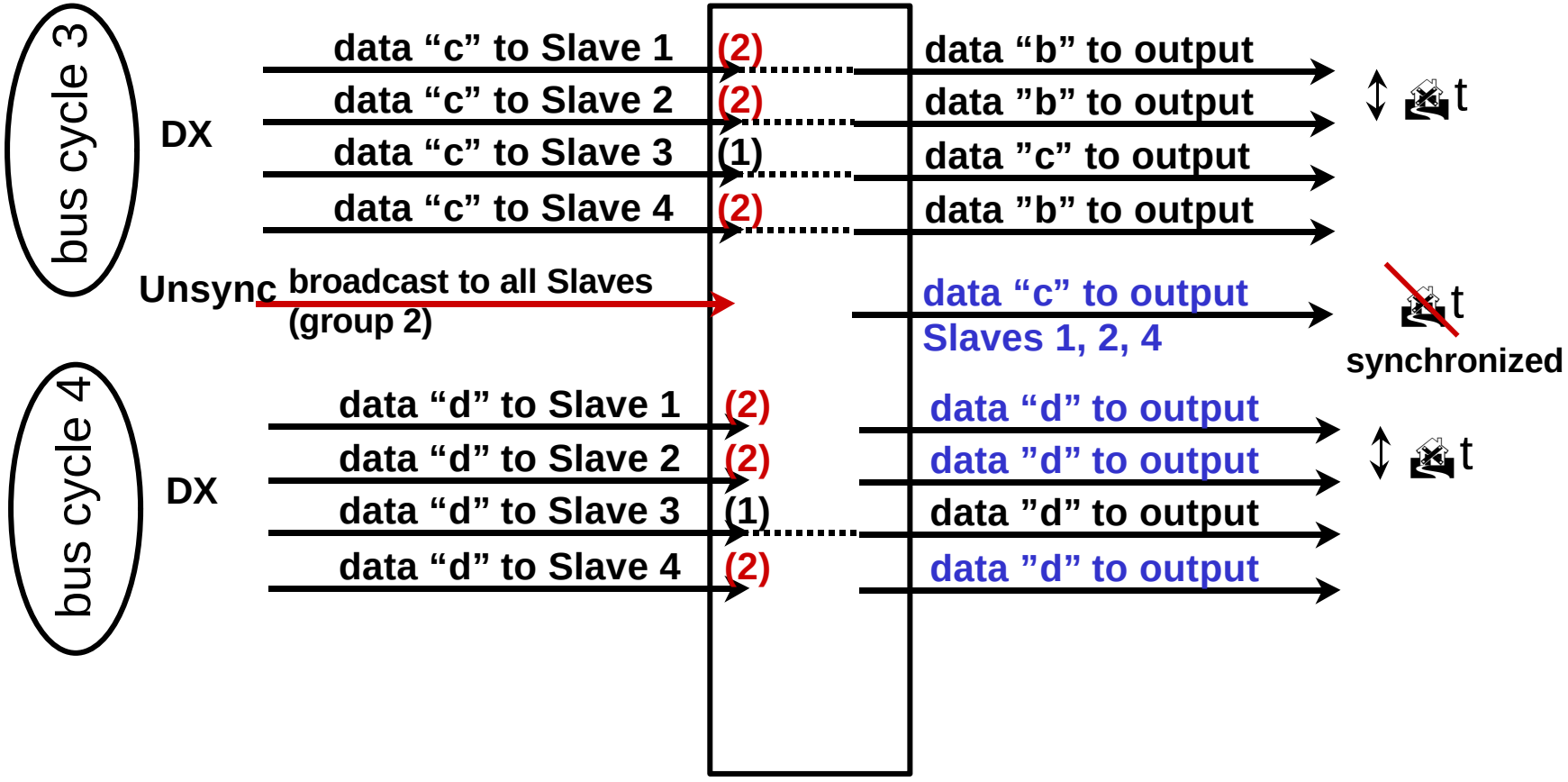
Freeze_Mode_supp=1	**synchronization of Input data** **snap shot of Inputs / grouping**
Sync_Mode_supp=1	**Synchronization of output data** **e.g. drives start at the same moment**

- **Sync and Freeze is application driven**
- **The application interface needs to offer a capability for the user to activate these commands on demand**
- **Sync and Freeze commands are related to groups**

Sync and Freeze



Sync and Freeze



GSD Details

Generic Slave Data

Auto_Baud_supp=1	device is able to detect the baudrate automatically
Set_Slave_Add_supp=0	station address can be set via the PROFIBUS
Min_Slave_Intervall=10	time base is 100µs e.g 100 x 10 = 1ms
Max_Diag_Data_Len=10	6 mandatory bytes + device related diagnostic

GSD Details

Generic Slave Data

Slave_Family=0	definition for the configuration tool
Modular_Station=0	defines a expandable or a fixed station, 0-compact; 1-modular
Max_Input_length=10	only for modular stations defines the max. length of Input data
Max_Output_length=10	only for modular stations defines the max. length of Output data
Max_Data_length=10	only for modular stations defines the max. length of Input and Output data

GSD Details

Generic Slave Data

Fail_Safe=1

- 1 means slave supports fail safe function
indicates the behavior of the slave in case of a failure (interrupted communication, watchdog expired, the fail state is usually for outputs, in case of a fail safe device the device is either keeping the last value or is switching to a defined dummy value

Parameterize: ET 200M (IM153-1) #3 <>

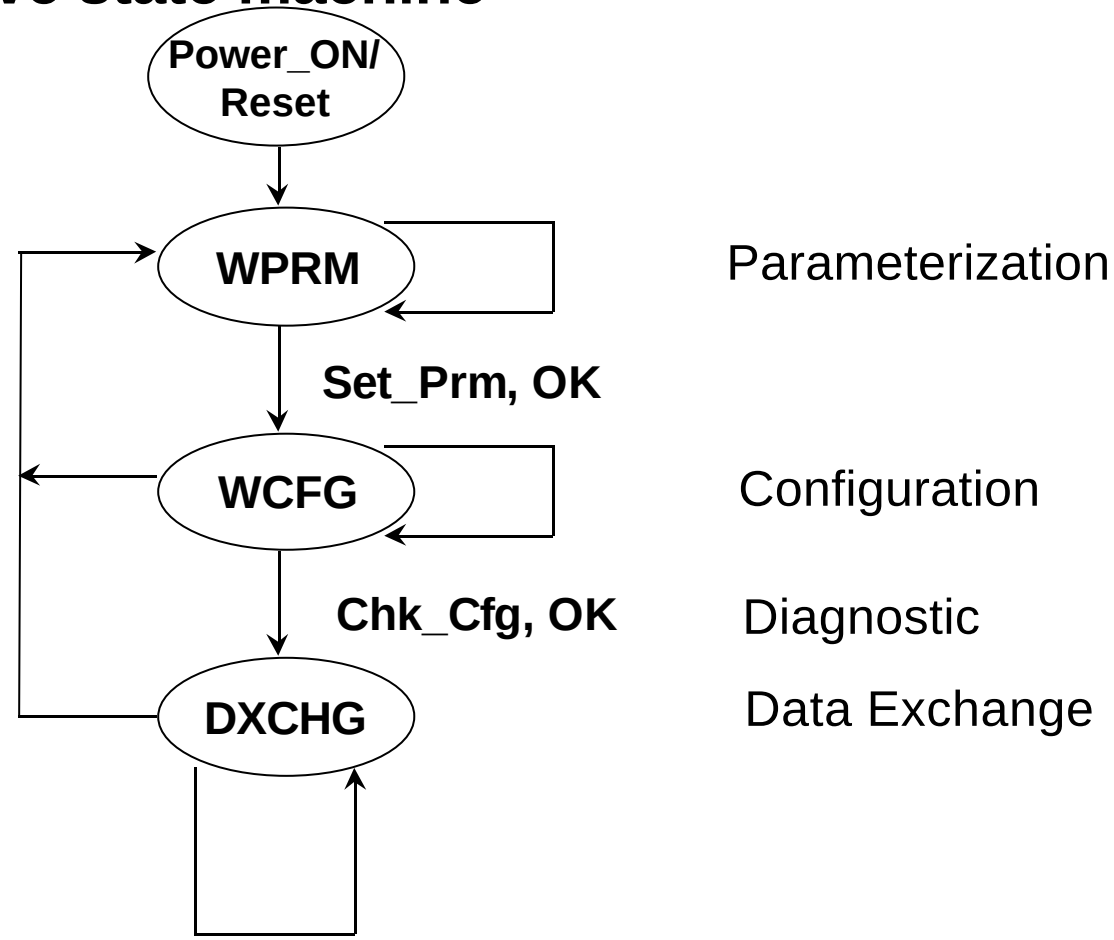
	Parameter Name	Value
17	Lim:hold last value	No
17	Lim:dummy value output	Yes
17	Lim:diagnostic alarm enable	Yes
18	Lim:dummy value channel 0	1
18	Lim:dummy value channel 1	0
18	Lim:dummy value channel 2	1
18	Lim:dummy value channel 3	0
18	Lim:dummy value channel 4	1

OK
Cancel
Select...
Hex...
Delete
Help

DP - Master / Slave

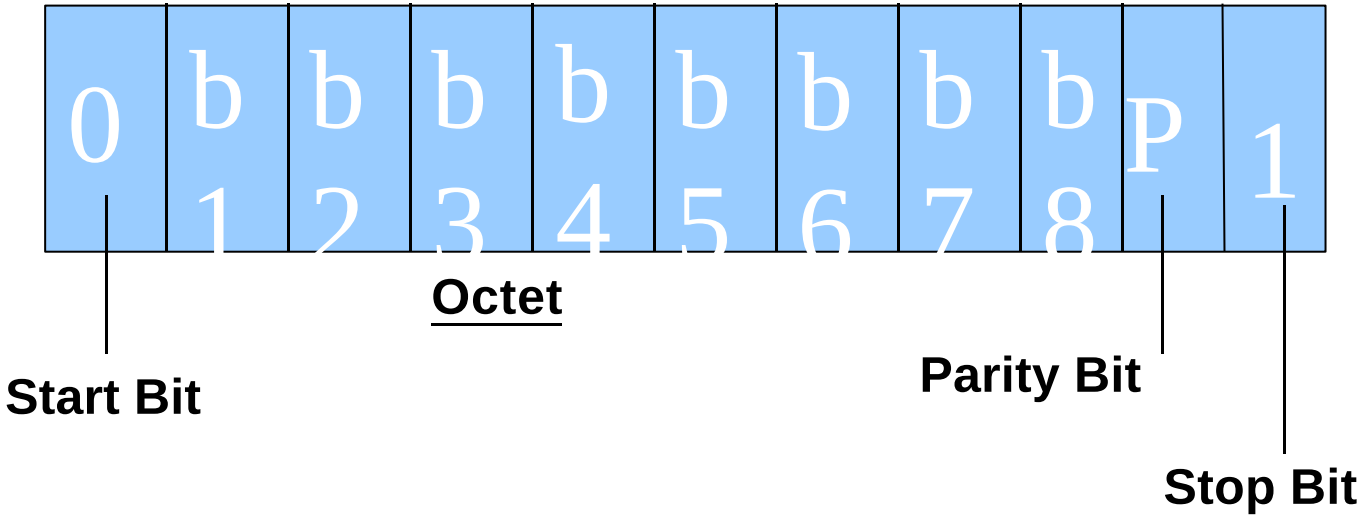
Interactions

- **Slave state machine**



Frame Format

- **Character Format**



Each character is 11 bits, Start-, Stop-, Parity- and 8 data bits

Frame Format

- Character/Message attributes
  - 1 character consists of 11 bits
  - the message header consists of 11 bytes
  - 1 T_{Bit} at 1. 5 MBaud = 0,6667µs
  - 1 T_{Bit} at 12 MBaud = 83 ns

Frame Format

Message structure

SD	LE	LEr	SD	DA	SA	FC	DSAP	SSAP	DU..	FCS	ED
68H	x	x	x	x	x	x	62/3E	60/3C	x ..	x	16H

SD: Start Delimiter
LE: Net Data Length + DA, SA , FC, DSAP, SSAP
DA: Destination Address
SA: Source Address
FC: Function Code (FC=0A in Response Signals Diagnostic Data)

DSAP: Destination Service Access Point
SSAP: Source Service Access Point
FCS: Frame Checking Sequence
ED: End Delimiter

Included in FCS

DP - Master / Slave

Interactions

- DP Communication “Ports”

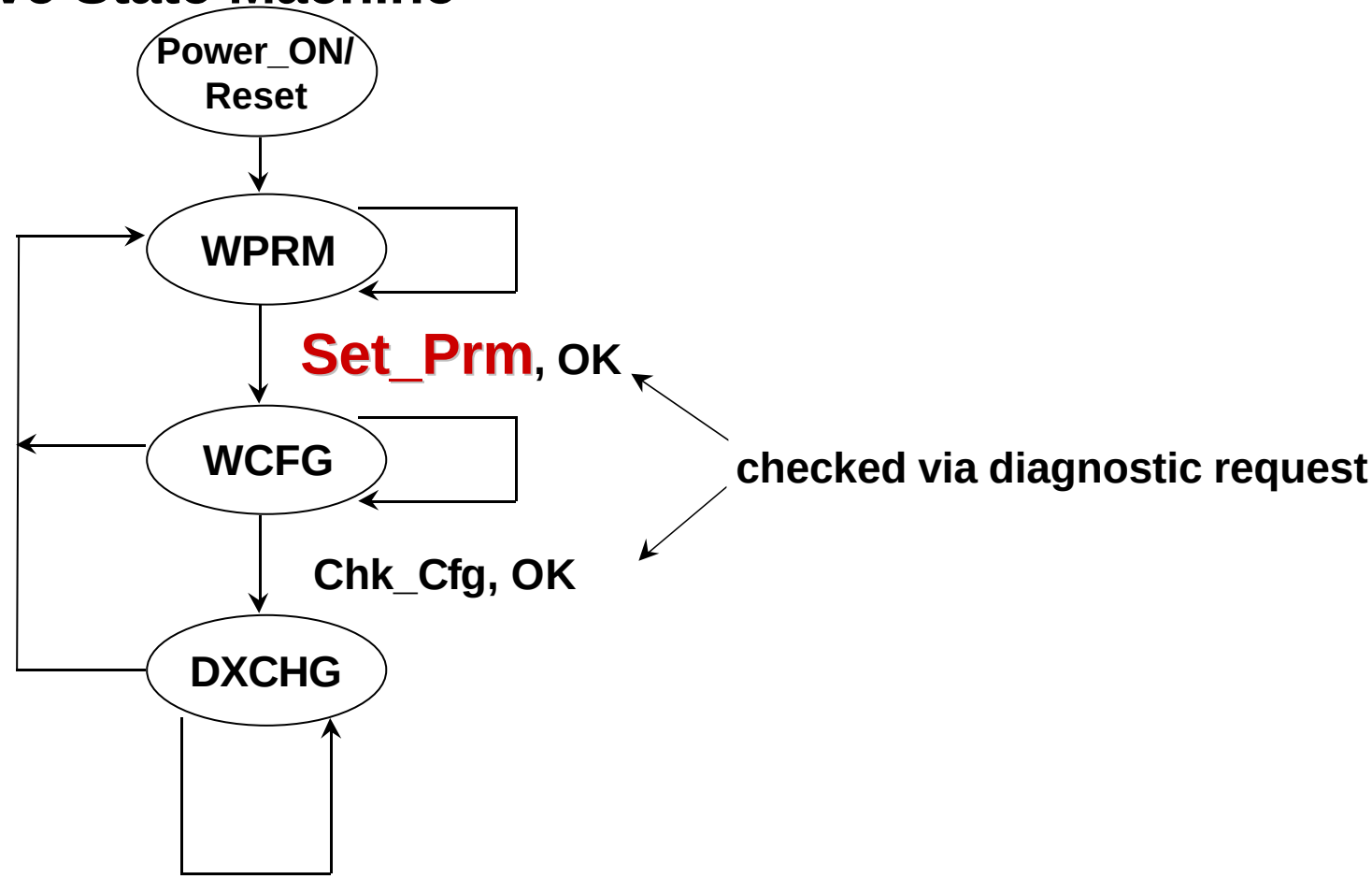
Function	DP Master		DP Slave	
	SSAP	SA	DSAP	DA
Data_Exchange	-	xx	-	xx
RD_Inp	62	xx	56	xx
RD_Outp	62	xx	57	xx
Slave_Diag	62	xx	60	xx
Set_Prm	62	xx	61	xx
Chk_Cfg	62	xx	62	xx
Get_Cfg	62	xx	59	xx
Global_Control	62	xx	58	xx
Set_Slave_Add	62	xx	55	xx

Source & Destination Address (SA & DA):
Bit 0-6: Address 0-127
Bit 7=“0”: No address extension
Bit 7=“1”: Address extension (SAPs used)

DP - Master / Slave

Interactions

- Slave State Machine



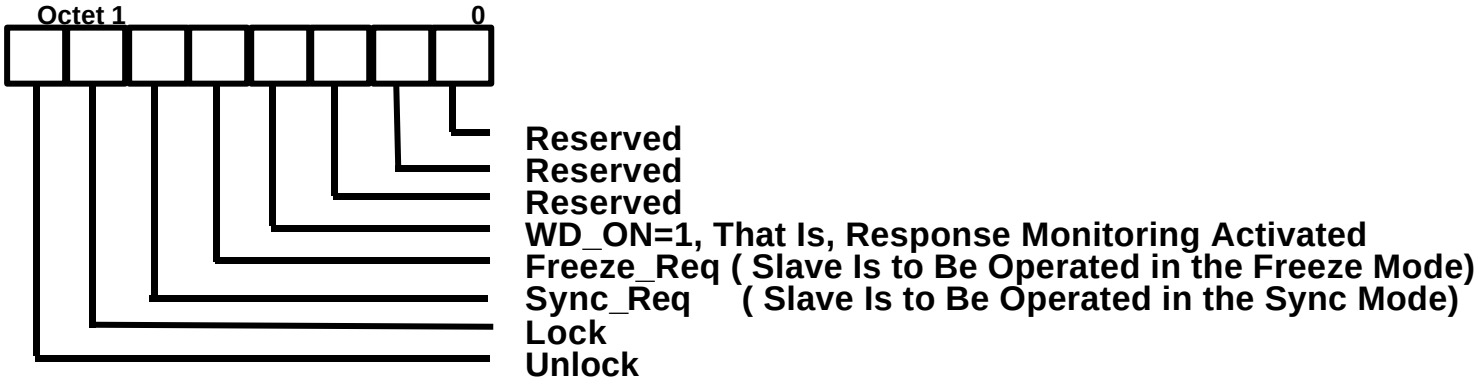
Parameterization

- **Parameterization**
  - **parameterization will be sent once after Power On or Reset**
  - **first 7 bytes are mandatory for every Slave**
  - **mandatory parameterization consists of:**
    - **Response Monitoring Time**
    - **T_{SDR} Time for Master/Slave Timing**
    - **Freeze / Sync Mode**
    - **Lock or Unlock Slave for This Master**
    - **Assignment of Group Allocation (Group Ident Number)**
    - **Master Address**
    - **Ident Number**
  - **Slave response with short acknowledge as confirmation**

Parameterization

Mandatory Parameterization

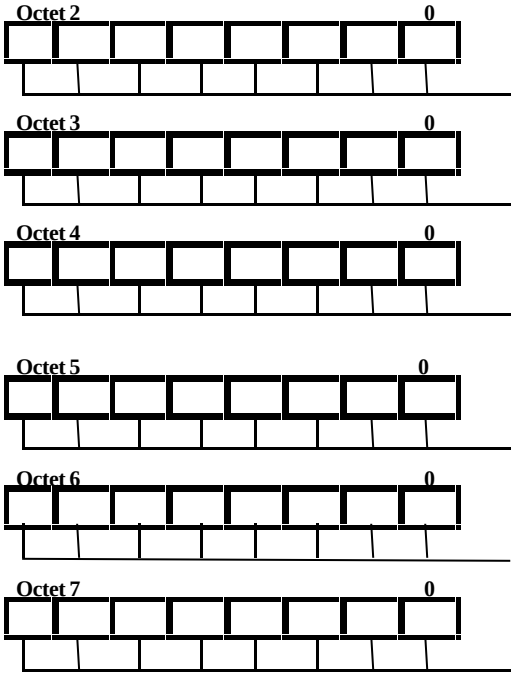
SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	DU..	FCS	ED
68H	x	x	x	8x	8x	x	61/3D	62/3E	X ..	x	16H



Lock	Unlock	Meaning
0	0	Min TSDR and User Parameters Are Allowed to Be Overwritten
0	1	DP-Slave Is Unlocked for Other Masters
1	0	DP-Slave Is Locked for Other Masters; All Parameters Are Accepted
1	1	DP- Slave Is Unlocked for Other Masters

Parameterization

Mandatory Parameterization



WD_Fact_1

WD_Fact_2 **TWD (s) = 10ms * WD_Fact_1 * WD_Fact_2**

TSDR

Ident Number high

Ident Number low

Group_Ident

Parameterization

- **Device Related Parameterization**
  - **each device can use Octets 8 - 244 for device/module-related information**
  - **can include startup information**
  - **can be used for adjusting values or levels (takes the place of DIP switches)**

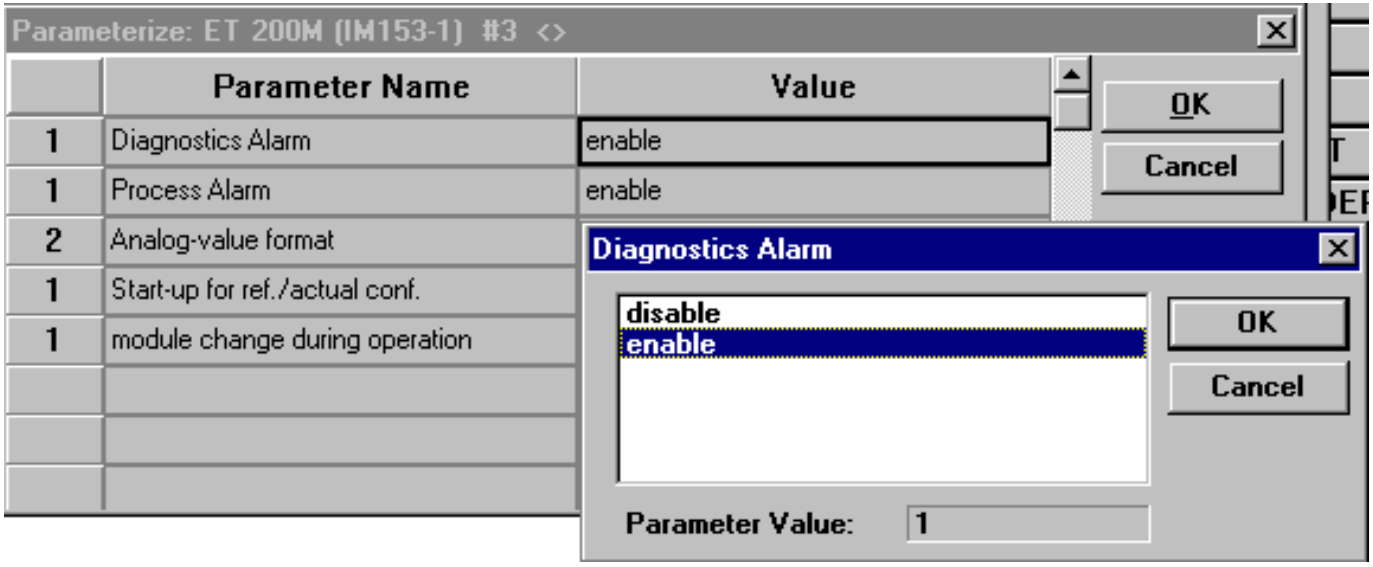
Parameterization

GSD Information

- GSD file parameterization information
  - only device related information

```
;Text Definition 1 for User_Prm_Data
Prmtext=1
Text(0)="disable"
Text(1)="enable"
Endprmtext
; <Ext-User-Prm-Data-Def-List>
Extuserprmdata=1 "Diagnostics Alarm"
Bit(5) 1 0-1
Prm_Text_Ref=1
Endextuserprmdata
; Userprmdata: Length and Preset:
Max_User_Prm_Data_Len=171
Ext_User_Prm_Data_Const(0)= \
0x40,0x20,0x00
Ext_User_Prm_Data_Ref(1)=1
```

Parameterization



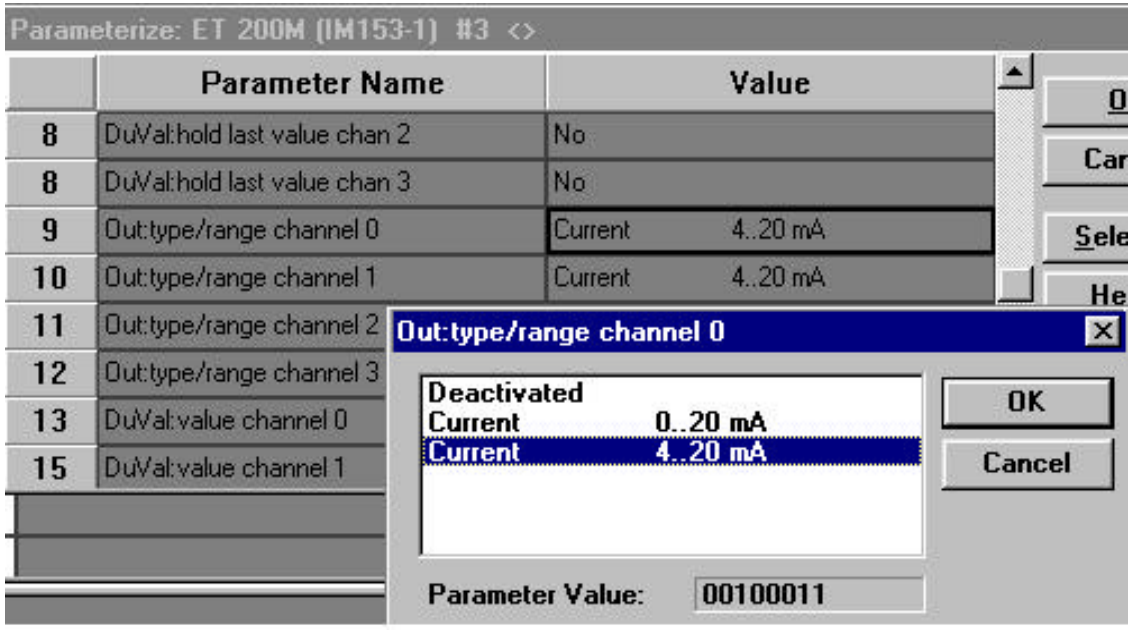
Parameterization

GSD Information

- GSD file parameterization information
  - only module related information

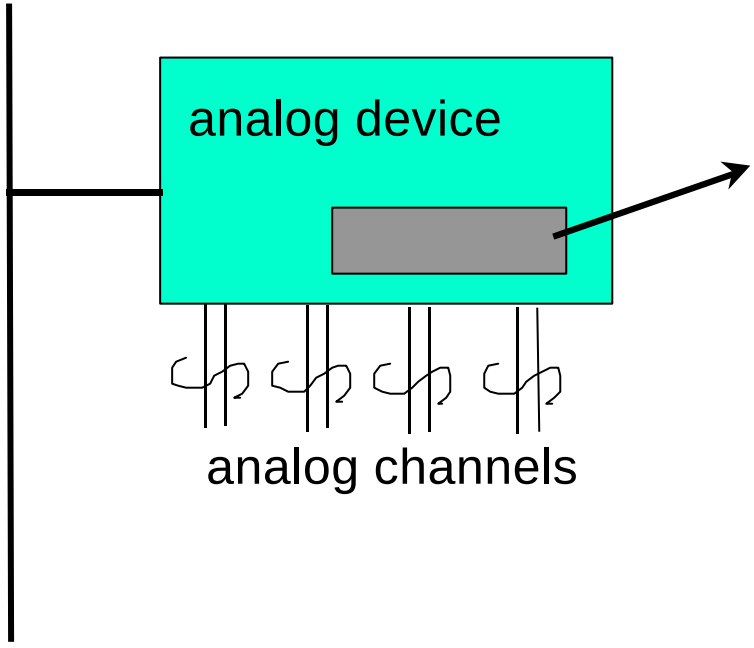
```
PrmText=9
Text(0)="Deactivated"
Text(34)="Current                0..20 mA"
Text(35)="Current                4..20 mA"
EndPrmText
ExtUserPrmData=207 "Out:type/range channel 0"
BitArea(0-7) 35 000-035
Prm_Text_Ref=9
EndExtUserPrmData
Module="6ES7 332-5RD00-0AB0        2AO" 0x83,0x41,0x00,0x25,0xD8
Ext_Module_Prm_Data_Len=21
Ext_User_Prm_Data_Const(0)= \
0x15,0x5F,0x04,0x00,0x10,0x00,0x00,0x00,0x00,0x23,0x23,0x23,0x23,0xE5,0x00,\
0x00,0x00,0x00,0x00,0x00,0x00
Ext_User_Prm_Data_Ref(9)=207
EndModule
```

Parameterization

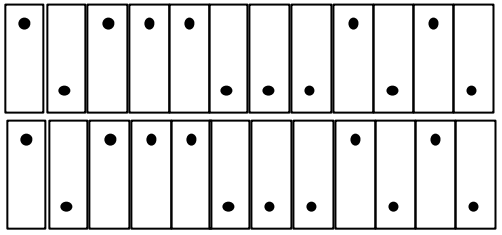


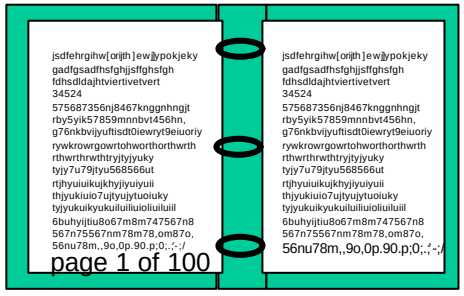
Parameterization

- **conventional way**



DIP switches to determine the function per channel

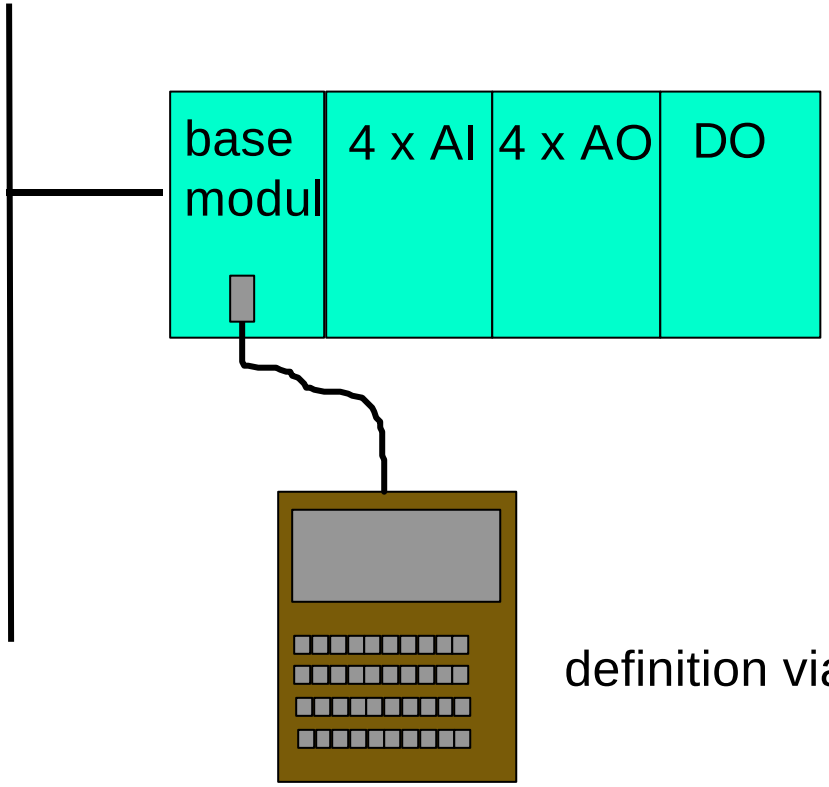


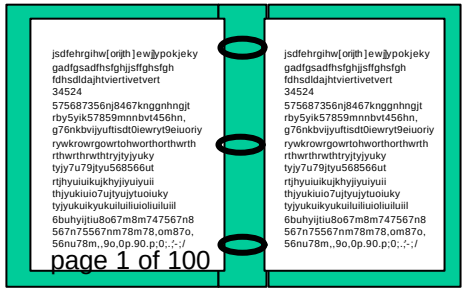


If DIP switches are used, the must open the device & needs tools to set the DIP switches; also must study a manual in order to set the DIP switches for the determined use.

Parameterization

- conventional way with smarter devices

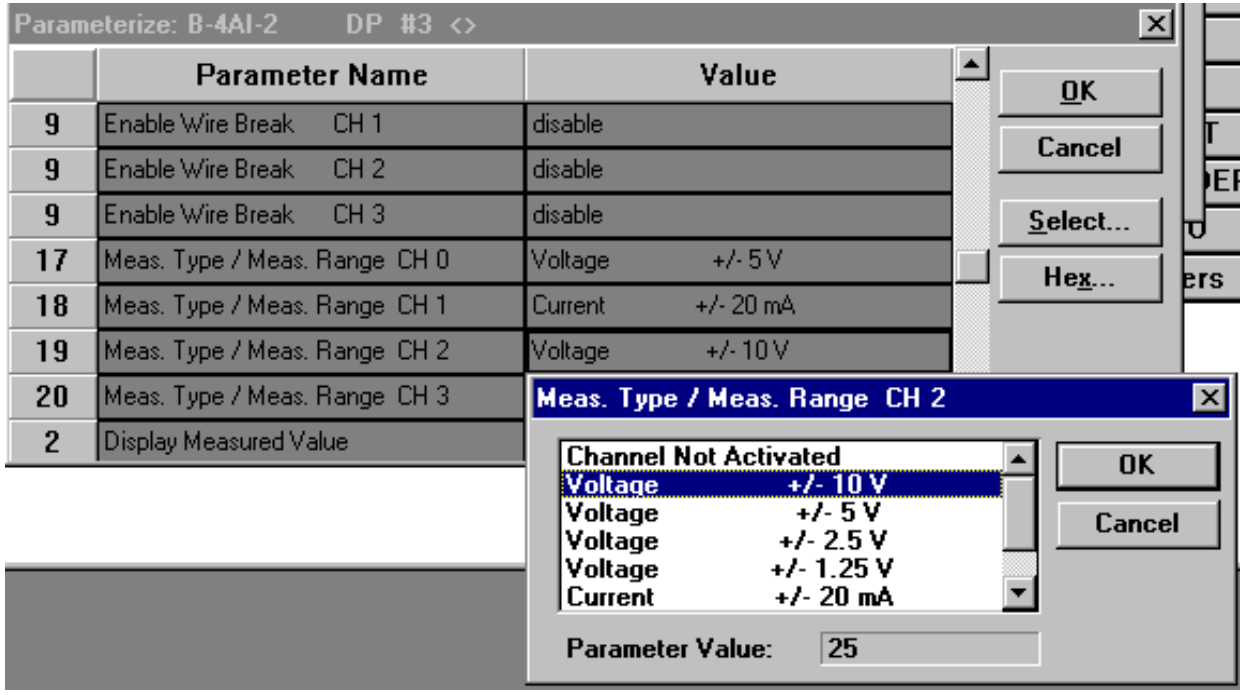


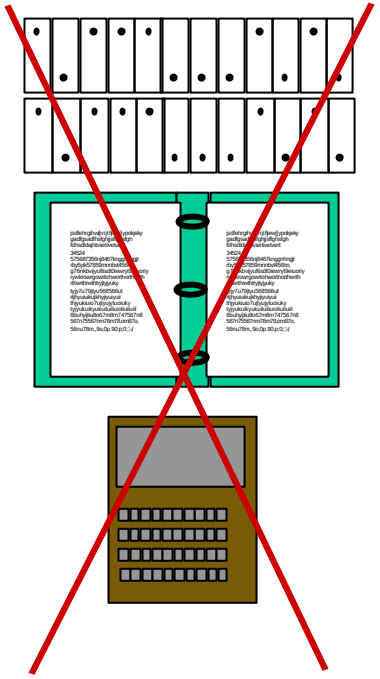


definition via Handheld terminal

Parameterization

with PROFIBUS





You get rid of the DIP switches or the handheld and the additional documentation and the end customer defines every function in <u>one</u> tool.

Parameterization

- SPC 3 Code for Parameterization
  - needs to be checked if more than 7 bytes are used
  - check parameters contained in message (OK or Not OK)
  - check for device related information

Parameterization

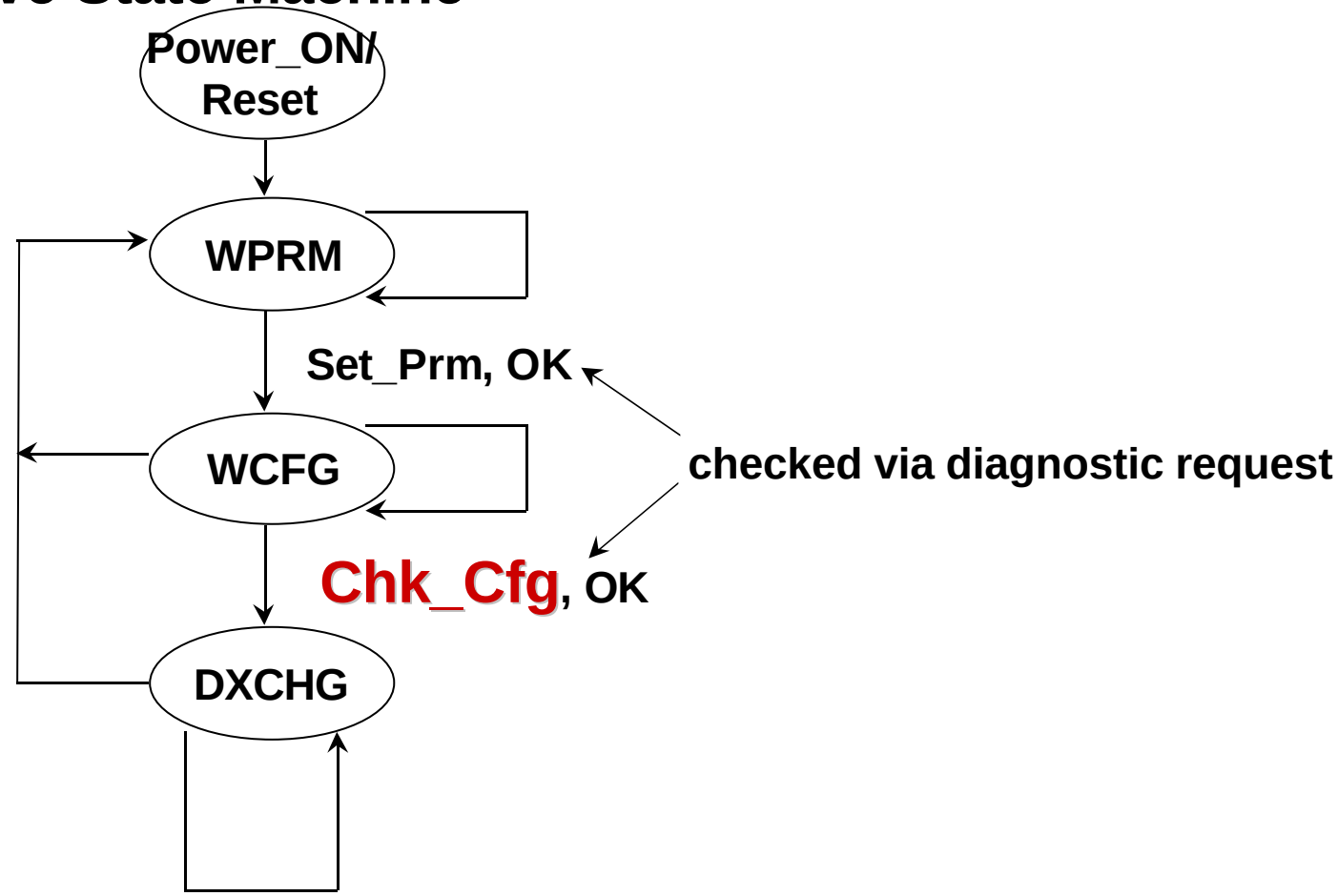
SPC 3 code for parameterization check (example)

```
if(DPS2_GET_IND_NEW_PRM_DATA())
        {   /*=== New parameter  data ===*/
        UBYTE   SPC3_PTR_ATTR * prm_ptr;
        UBYTE   param_data_len, prm_result;
        UBYTE   ii;
        prm_result = DPS2_PRM_FINISHED;
        do
                { /* Check parameter until no conflict behavior */
                prm_ptr = DPS2_GET_PRM_BUF_PTR();
                param_data_len = DPS2_GET_PRM_LEN();
                /* data_length_netto of parametration_telegram > 7 */
                if (param_data_len > 7)
                        {
                        if (( *(prm_ptr+8) == 0xAA)  && ( *(prm_ptr+9) == 0xAA))
                                prm_result = DPS2_SET_PRM_DATA_NOT_OK(); /* as example !!! */
                        else
                                {
                                for (ii= 0; ii<param_data_len & ii <10; ii++)   // store in the buffer
                                        prm_tst_buf[ii] = *(prm_ptr+ii+7);
                                prm_result = DPS2_SET_PRM_DATA_OK();
                                }
                        }
                else
                        prm_result = DPS2_SET_PRM_DATA_OK();
                } while(prm_result == DPS2_PRM_CONFLICT);
```

DP - Master / Slave

Interactions

- Slave State Machine



Configuration

- **Configuration**
  - **Configuration will be sent once after power on or reset**
    - **Master sends configurations to Slaves**
      - **any device-specific configuration**
      - **I/O configuration**
  - **Slave response with short acknowledge as confirmation**
    - **acknowledge configuration (Short Acknowledge “E5”h)**
    - **check configuration information for validity**

Configuration

Configuration

SD	LE	LEr	SD	DA	SA	FC	DSAP	SSAP	DU..	FCS	ED
68H	x	x	x	8x	8x	x	62/3E	62/3E	x ..	x	16H

7	6	5	4	3	2	1	0

Identifier Byte

Length of Data
00 1 Byte or Word ….
15 16 Bytes or Words

Input/Output
00 Special Format
01 Input
10 Output
11 Input-Output

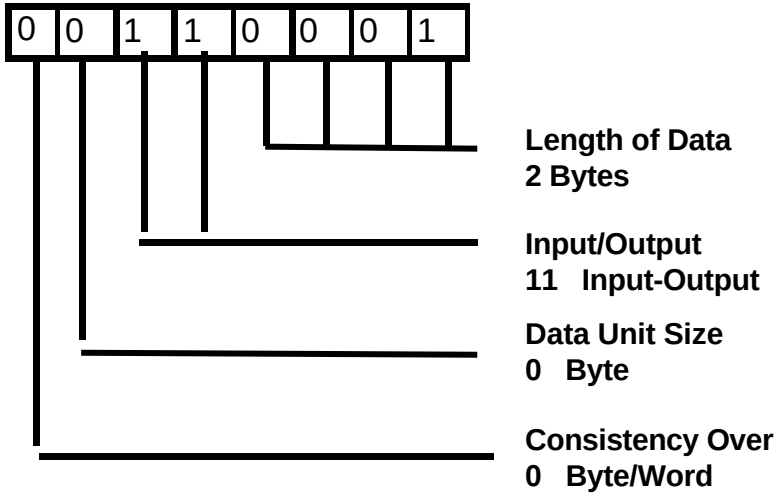
Data Unit Size
0 Byte
1 Word

Consistency Over
0 Byte/Word
1 Whole Length

1. simple format

Configuration

- simple format configuration
  - max. 16 discrete Input/16 discrete Output in one format



Configuration

Configuration

SD	LE	LEr	SD	DA	SA	FC	DSAP	SSAP	DU..	FCS	ED
68H	x	x	x	8x	8x	x	62/3E	62/3E	x ..	x	16H

2. special format

7	6	5	4	3	2	1	0

Special Identifier Byte

Length of Vendor Specific Data
0 No Data
1-14 No. Of Bytes of Vendor Specific Data
15 No Data

Fixed
00 Special Format

Input/Output
00 No I/O
01 One Length Byte for Inputs Follows
10 One Length Byte for Outputs Follows
11 One Length Byte for Outputs and Inputs

7	6	5	4	3	2	1	0

Length of Data
00 1 Byte or Word ….
63 64 Bytes or Words

Data Unit Size (byte or word)

Consistency

Configuration

- special format - no vendor specific information

7	6	5	4	3	2	1	0

Special Identifier Byte

Length of Vendor Specific Data
0 No Data
1-14 No. Of Bytes of Vendor Specific Data
15 No Data

Fixed
00 Special Format

Input/Output
00 No I/O
01 One Length Byte for Inputs Follows
10 One Length Byte for Outputs Follows
11 One Length Byte for Outputs and Inputs

7	6	5	4	3	2	1	0

Length of Data
00 1 Byte or Word ….
63 64 Bytes or Words

Data Unit Size (byte or word)

Consistency

1	1	0	0	0	0	0	0

•Output & Input Description Bytes Follow,
•No Vendor-Specific Information

1	1	0	0	0	0	0	1

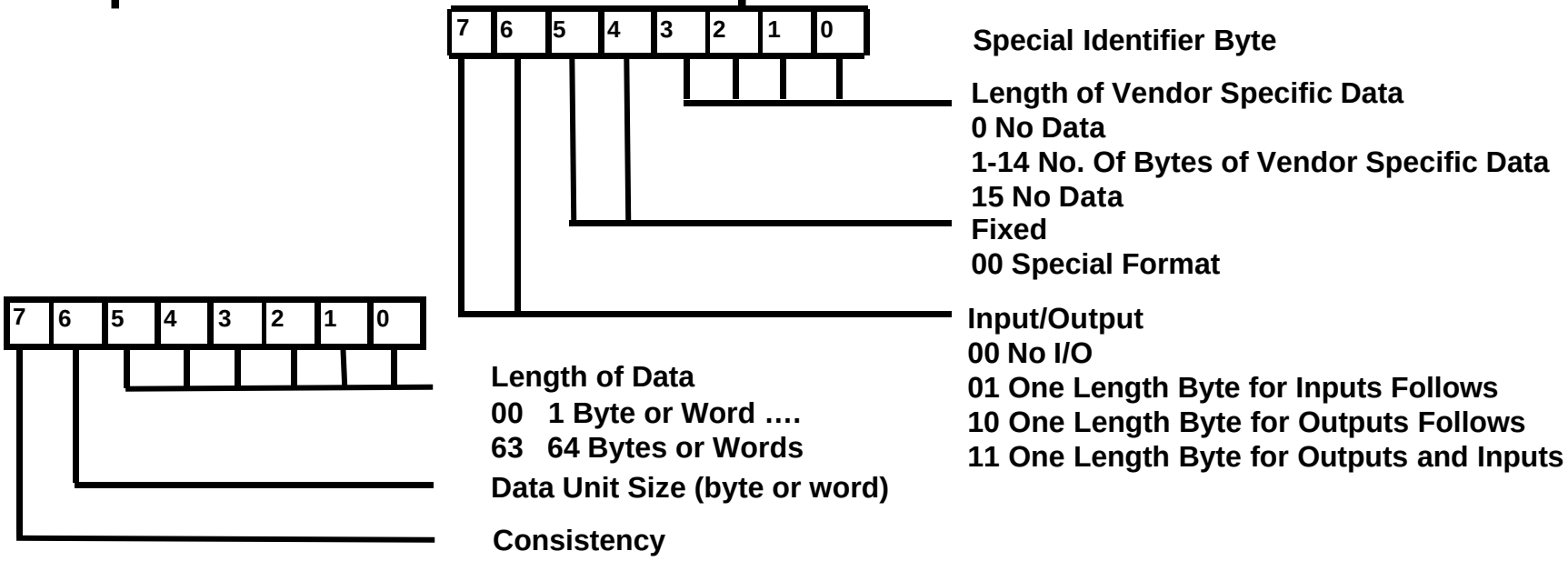
•2 Word Outputs, Consistent Over Whole

1	1	0	0	0	0	1	1

•4 Word Inputs, Consistent Over Whole

Configuration

- special format - vendor specific information



1	0	0	0	0	0	0	1	•Output with 1 vendor specific byte
1	1	0	0	0	0	0	1	•2 Word Outputs, Consistent Over Whole
x	x	x	x	x	x	x	x	•Device specific

Configuration

GSD Information

Module=뱬ext” 0x04,0x00,0x00,0xAD,0xC4	module definition, text will be displayed configuration definition (e.g. only information)
Module=뭎ext 0x22 EndModule	module definition, text will be displayed defines simple format with 3 output bytes
Module=뱬ext” 0x43,0x41,0x00,0x15,0xC3 Ext_Module_Prm_Data_Len=1 Ext_User_Prm_Data_Const(0)= \ 0x15 Ext_User_Prm_Data_Ref(2)=237	module definition, text will be displayed defines special format, 2 byte input and 3 byte additional information including module related parameterization

Configuration

GSD Information

- GSD file configuration information
  - simple configuration information

Module = "1 Byte DI " 0x10

EndModule

Module = "2 Byte DO" 0x21

EndModule

Module = "3 Byte DX" 0x32

EndModule

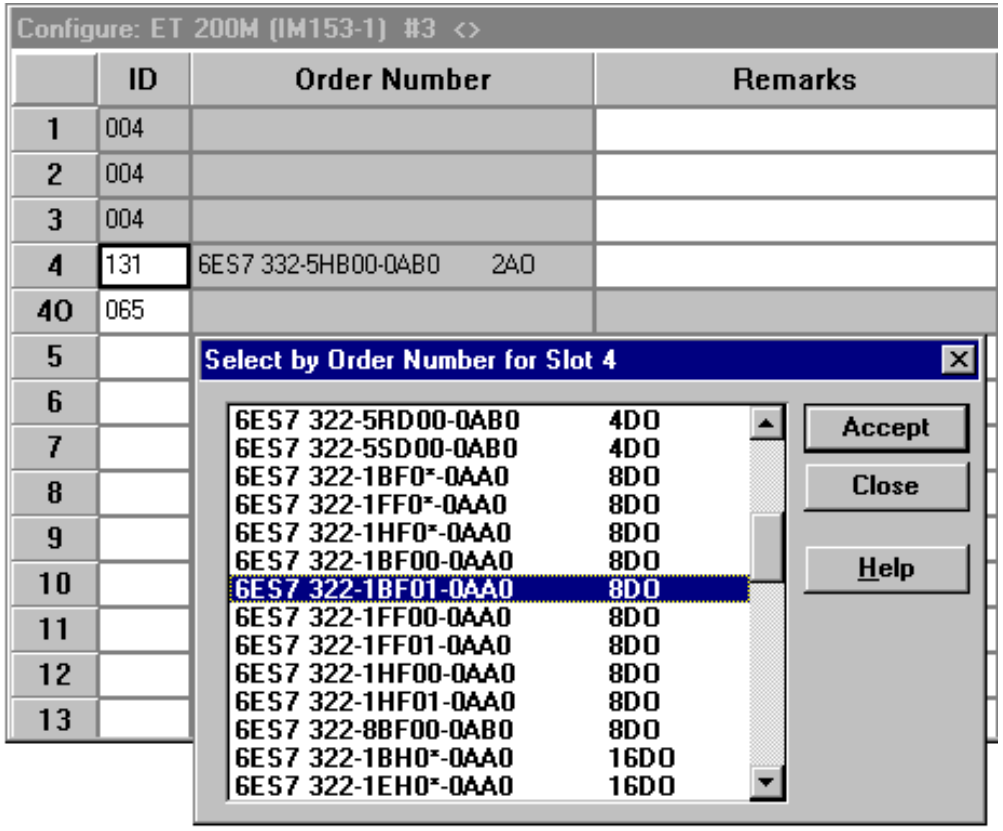
Configuration

GSD Information

- GSD file configuration information
  - special configuration information with module related parameterization

```
Module="6ES7 322-8BF00-0AB0      8DO" 0x83,0x00,0x00,0x2F,0xC8
Ext_Module_Prm_Data_Len=21
Ext_User_Prm_Data_Const(0)= \
0x15,0x5F,0x04,0x00,0x10,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0x00,0x00,0x00,0x00,0x00,0x00
Ext_User_Prm_Data_Ref(2)=28
Ext_User_Prm_Data_Ref(6)=29
Ext_User_Prm_Data_Ref(7)=30
Ext_User_Prm_Data_Ref(8)=31
Ext_User_Prm_Data_Ref(9)=32
Ext_User_Prm_Data_Ref(10)=33
Ext_User_Prm_Data_Ref(11)=34
```

Configuration



Configuration

- SPC 3 code for sample configuration
  - must check for overall length
  - must check for I/O data length correct
  - must check for any device related configuration information correct
  - confirms O.K..., not O.K... or update (adapt) configuration

Configuration

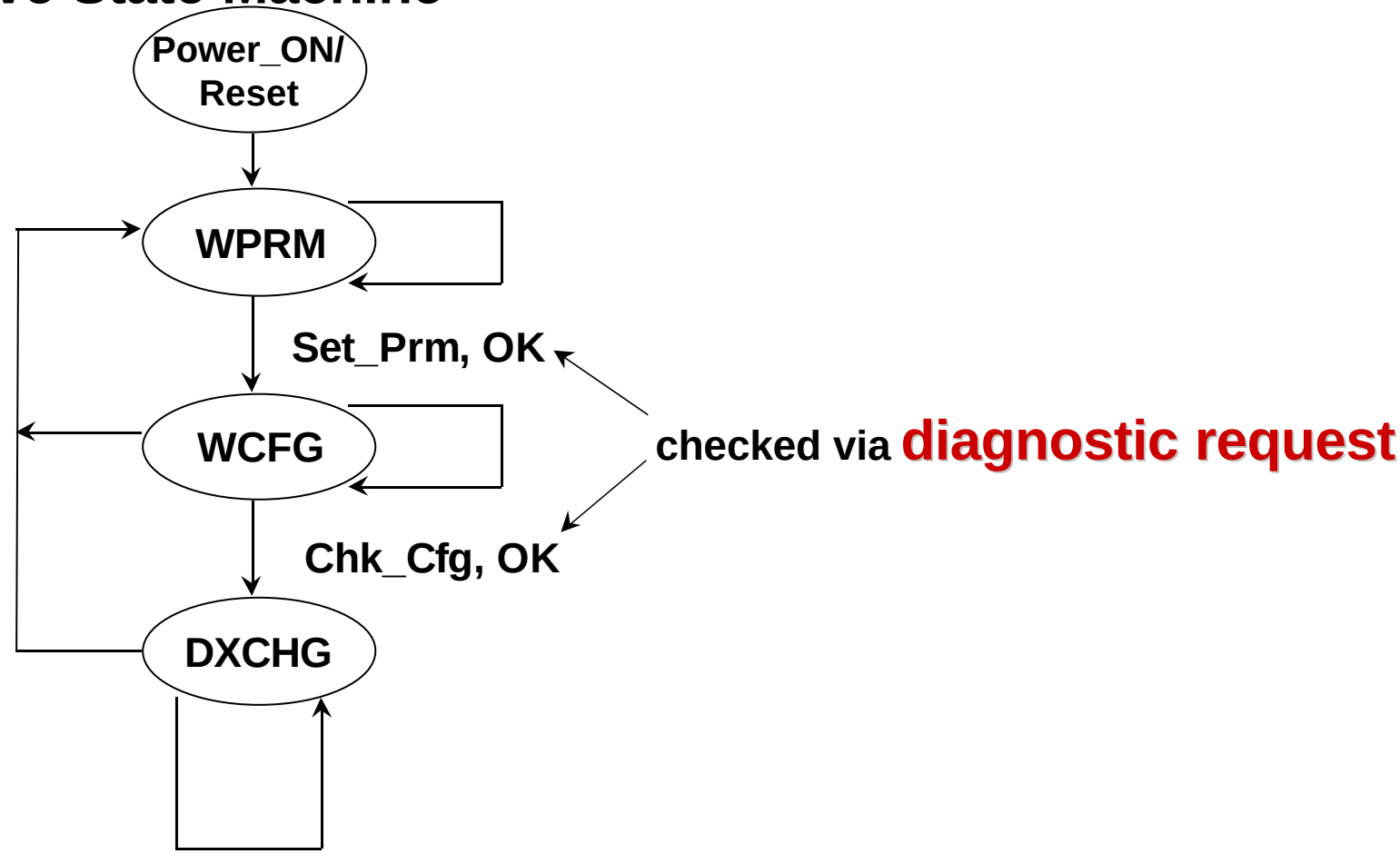
SPC 3 code for sample configuration (example)

```
if(DPS2_GET_IND_NEW_CFG_DATA())
  {  /*=== New Configuration data ===*/
  UBYTE DPS2_PTR_ATTR * cfg_ptr;
  UBYTE i, config_data_len, cfg_result, result;

  cfg_result = DPS2_CFG_FINISHED;
  result = DPS_CFG_OK;
  do
    {  /* check configuration data until no conflict
       behavior m*/
    cfg_ptr = DPS2_GET_CFG_BUF_PTR();
      /* pointer to the config_data_block */
config_data_len = DPS2_GET_CFG_LEN();
/* check the received configuration data  */
        /*        result = DPS_CFG_OK;
                  result = DPS_CFG_UPDATE;
                  result = DPS_CFG_FAULT ;        */
if (result == DPS_CFG_UPDATE)
              {
user_io_data_len_ptr = dps2_calculate_inp_outp_len
(cfg_ptr,(UWORD)config_data_len);
if (user_io_data_len_ptr != (DPS2_IO_DATA_LEN *)0)
                  {
DPS2_SET_IO_DATA_LEN(user_io_data_len_ptr);
                  }
else
result = DPS_CFG_FAULT;
                }
              }
switch (result)
              {
case DPS_CFG_OK: cfg_result = DPS2_SET_CFG_DATA_OK();
break;
case DPS_CFG_FAULT: cfg_result = DPS2_SET_CFG_DATA_NOT_OK();
break;
case DPS_CFG_UPDATE: cfg_result = DPS2_SET_CFG_DATA_UPDATE();
break;
              }
            }

} while(cfg_result == DPS2_CFG_CONFLICT);
  }
```

DP - Master / Slave

Interactions

- Slave State Machine



Diagnostics

- diagnostics
  - diagnostic will be sent twice after power on or reset (at the beginning and after the configuration is sent) and per slave request
  - first 6 bytes are mandatory for every slave
  - slave replies with diagnostic information
    - Lock,Sync, Freeze Enabled
    - Parameter Faults
    - Configuration Faults
    - Master Address
    - Profibus ID
    - Device Diagnostics

Diagnostics

- diagnostic data structure
  - diagnostic data is high-priority data
  - system-wide diagnostic data is standardized (octets 1-6)
  - user-specific diagnostic data may also be defined using octets 7... 244
  - user-specific diagnostic data is broken down into:
    - device-related diagnosis
    - identification-related diagnosis
    - channel-related diagnosis
  - external diagnosis or status information possible starting with octet 7

Diagnostics

diagnostic request/reply structure

Request

SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	FCS	ED
68H	x	x	x	8x	8x	x	60/3C	62/3E	x	16H

Reply

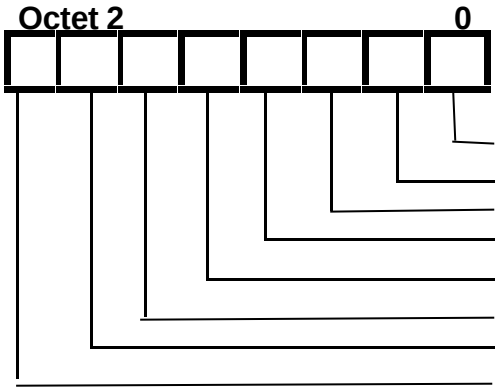
SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	DU..	FCS	ED
68H	x	x	x	8x	8x	x	62/3E	60/3C	X ..	x	16H

Octet 1 **0**

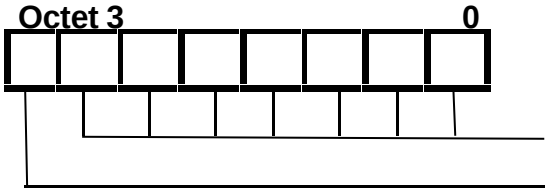
Diag.Station_Non_Exist Set by Master
Diag.Station_Not_Ready Slave Not Ready for Data Exchange
Diag.Cfg_Fault Configuration Error
Diag.Ext_Diag Slave Has Extended Diagnostic Data
Diag.Not Supported Slave Does Not Support Requested Function
Diag.Invalid_Slave_Response Set by Master
Diag.Prm_Fault Parameterization Error (Ident Number Etc.)
Diag.Master_Lock Slave Parameterized by Another Master

Diagnostics

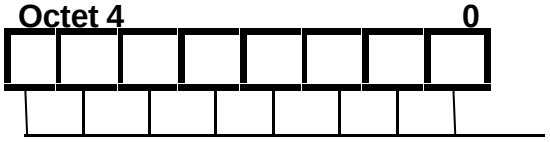
diagnostic data structure



Diag. Prm_Req Slave Needs to be Parameterized
Diag. Stat_Diag Static Diagnosis - Slave Cannot Provide Valid Data
Set to 1
Diag.WD_ON/OFF Response Monitoring Active/Inactive
Diag. Freeze_Mode Received Freeze Command
Diag.Sync_Mode Received Sync Command
Reserved
Diag.Deactivated Set by Master



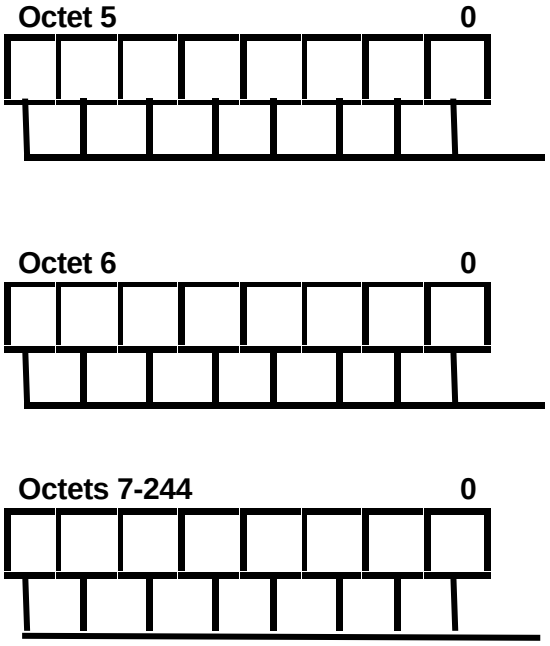
Reserved
Diag.Ext_Overflow Too Much Extended Diag. Data



Diag.Master_Add Master Address After Parameter Assignment
(FFh Until Parameterization)

Diagnostics

- diagnostic data structure(cont'd)



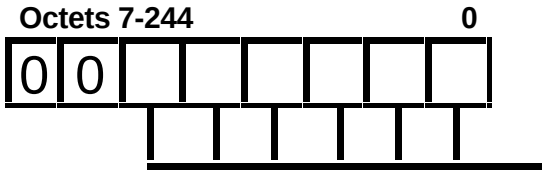
Ident Number High

Ident Number Low

Extended Diagnostic Data

Diagnostic

- **device-related diagnosis**

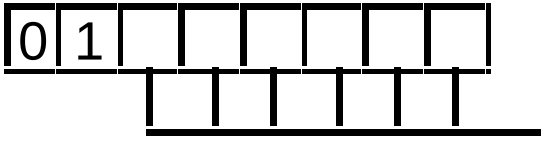


length in bytes, including header

  - **vendor needs to define the diagnosis**
  - **diagnosis needs to be described in the GSD file**
  - **up to 62 bytes can be defined**

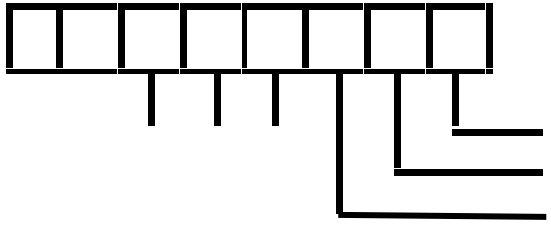
Diagnostic

- **identifier related diagnostic**



length in bytes, including header

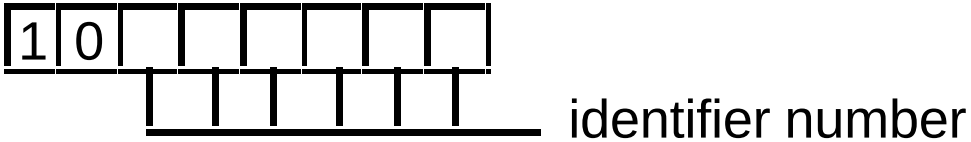
- **is based on a modular system, each module has one identifier (configuration byte)**
- **defect or wrong module can be easily detect**
- **based on the standard, therefore no additional description necessary**



identifier byte 0 (module 1) has diagnostic
identifier byte 1 (module 2) has diagnostic
identifier byte 2 (module 3) has diagnostic

Diagnostic

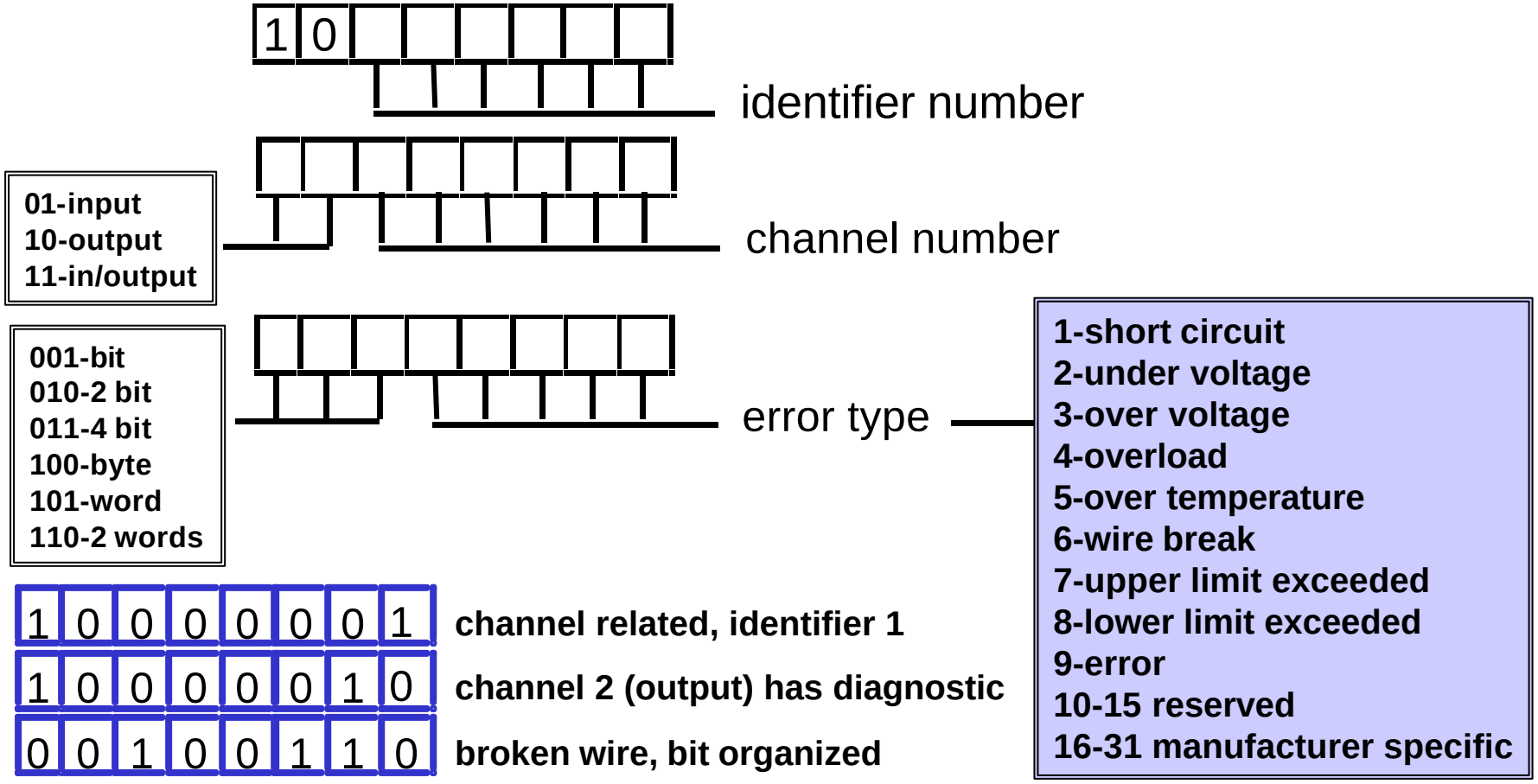
- **channel related diagnostic**



  - **pre defined failure types**
  - **additional device specific definition possible**
  - **definition per module and per channel**

Diagnostic

- **channel related diagnostic**



1	0	0	0	0	0	0	1	**channel related, identifier 1**
1	0	0	0	0	0	1	0	**channel 2 (output) has diagnostic**
0	0	1	0	0	1	1	0	**broken wire, bit organized**

Diagnostic

GSD information

```
Unit_Diag_Bit(086)="failure channel 7"
Unit_Diag_Bit(087)="failure channel 8"
Unit_Diag_Bit(090)="channel 1 - short circuit to P"
Unit_Diag_Bit(091)="channel 1 - short circuit to M"
Unit_Diag_Bit(092)="channel 1 - broken wire"
Module="6ES7 322-8BF00-0AB0       8DO" 0x83,0x00,0x00,0x2F,0xC8
Ext_Module_Prm_Data_Len=21
Ext_User_Prm_Data_Const(0)= \
0x15,0x5F,0x04,0x00,0x10,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,\
0x00,0x00,0x00,0x00,0x00,0x00
Ext_User_Prm_Data_Ref(2)=28
Ext_User_Prm_Data_Ref(6)=29
Channel_Diag(16)=“over load channel 1”
EndModule
```

Diagnostic

COM PROFIBUS slave diagnostics view

```
0 :  00  0C  00  01  80  1D  43  10  00  14
10:  01  05  00  0D  1F  00  00  72  08  08
20:  05  08  00  10  00  00  00  00  00
```

Standard-specific diagnostics

PNO number of the slave: 32797 (0x801D)
Slave parameterized by DP master no.: 1
Response monitoring activated

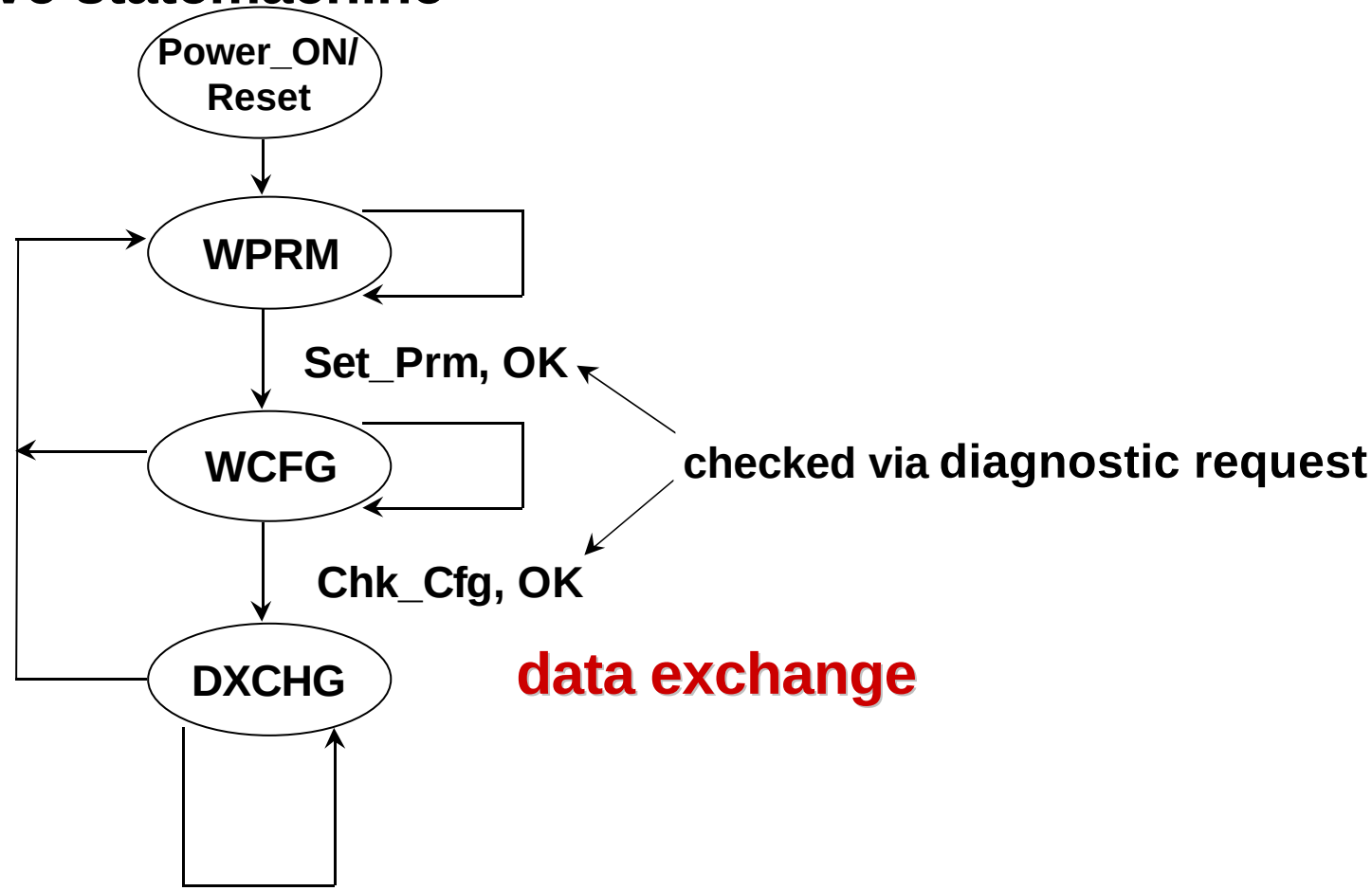
Device-specific diagnostics

channel 1 - short circuit to M
channel 3 - broken wire

; Unit Diagnostics
.....
Unit_Diag_Bit(106)="channel 2 - short circuit to P"
Unit_Diag_Bit(107)="channel 2 - short circuit to M"
Unit_Diag_Bit(108)="channel 2 - broken wire"
Unit_Diag_Bit(110)="channel 2 - load voltage missing"

Data Exchange

- Slave statemachine



Data Exchange

- first the master sends a control telegram to signal the change into mode “OPERATE”
- the control command is a broadcast telegram sent to address 127, which will be received by every device

SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	DU..	DU..	FCS	ED
68H	x	x	68H	FF	xx	x	62/3E	58/3A	00	00	x	16H

- this telegram will be sent cyclically in an interval of 6 x Watchdog for control function
- “OPERATE” means that application driven data are send to output devices

Data Exchange

- data are sent back and forth

SD	LE	LER	SD	DA	SA	FC	DU	FCS	ED
68H	x	x	x	xx	xx	x	data	x	16H

Reply

SD	LE	LER	SD	DA	SA	FC	DU..	FCS	ED
68H	x	x	x	xx	xx	08	data	x	16H

length of data is determined through the configuration

- if Slave responds with high priority

SD	LE	LER	SD	DA	SA	FC	DU	FCS	ED
68H	x	x	x	xx	xx	x	data	x	16H

ALARM

Reply

SD	LE	LER	SD	DA	SA	FC	DU..	FCS	ED
68H	x	x	x	xx	xx	0A	data	x	16H

- which indicates to the master that the Slave has a diagnostic

Data Exchange

- **in the next bus cycle, the master requests diagnostic data from the particular Slave**

Request

SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	FCS	ED
68H	x	x	x	8x	8x	x	60/3C	62/3E	x	16H

Reply

SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	DU..	FCS	ED
68H	x	x	x	8x	8x	x	62/3E	60/3C	X ..	x	16H

- **the following bus cycle reverts to data exchange**

SD	LE	LER	SD	DA	SA	FC	DU	FCS	ED
68H	x	x	x	xx	xx	x	data	x	16H

Reply

SD	LE	LER	SD	DA	SA	FC	DU..	FCS	ED
68H	x	x	x	xx	xx	08	data	x	16H

Data Exchange

- in between the bus data cycles, control commands for sync and freeze can be sent (per user demand)

SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	DU..	DU..	FCS	ED
68H	x	x	68H	FF	FF	x	62/3E	58/3A	xx	xx	x	16H

bit 0 - not used
bit 1 - clear
bit 2 - unfreeze
bit 3 - freeze
bit 4 - unsync
bit 5 - sync
bit 6 - not used
bit 7 - not used

group definition 0-8

Data Exchange

AUTOCLEAR: if a master detects a network problem (broken wire, programmer defines stop, slave response with certain diagnosis, e.g..) and the function "AUTOCLEAR" is configured, then the master state switches from data exchange mode (="OPERATE") to "CLEAR" mode

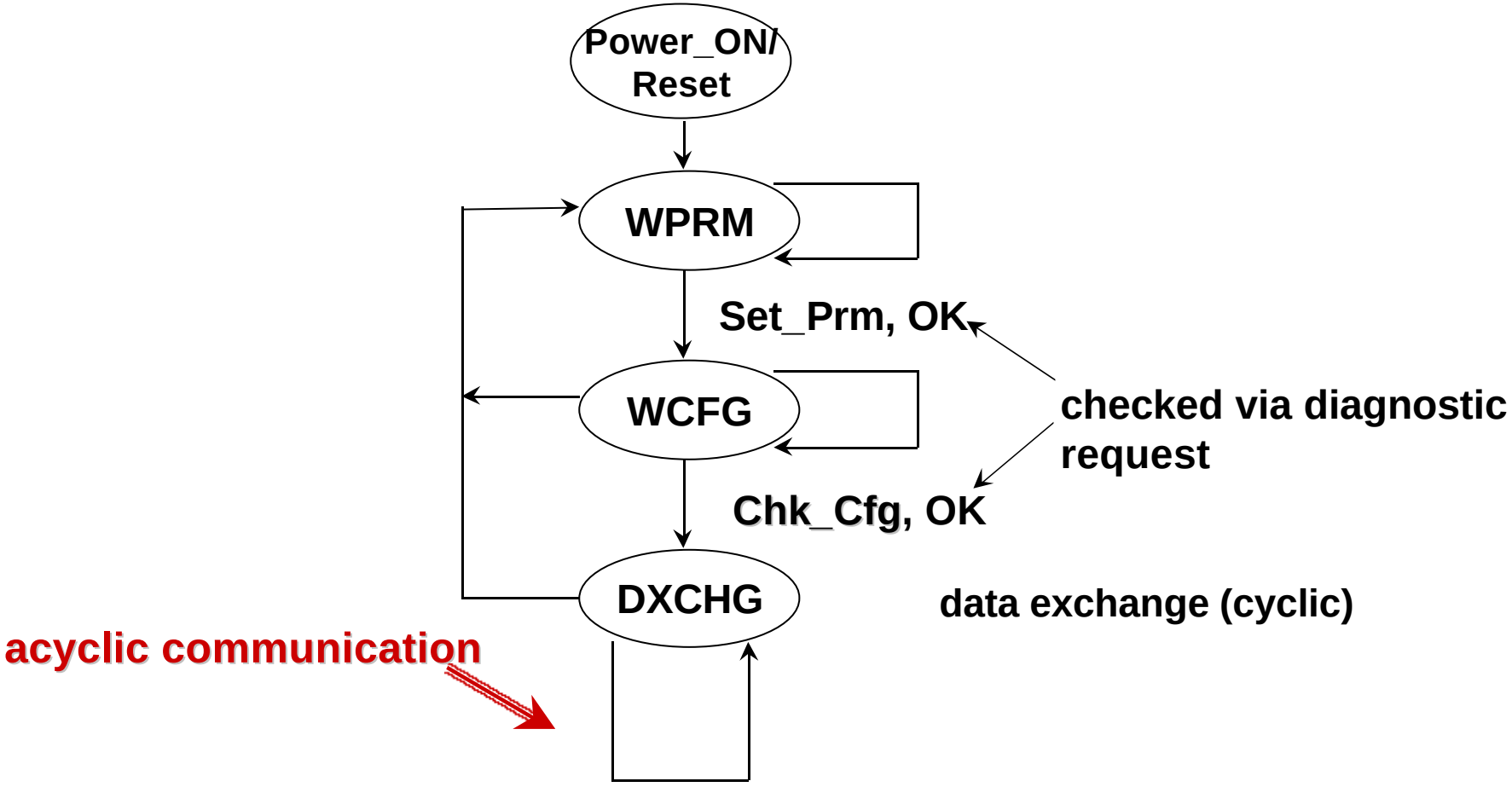
SD	LE	LER	SD	DA	SA	FC	DSAP	SSAP	DU..	DU..	FCS	ED
68H	x	x	68H	8x	8x	x	62/3E	58/3A	02	00	x	16H

- **which is indicated through a control command**
- **in clear mode data with "0" are sent to outputs or no data in case of a fail-safe Slave**

DP Interactions

DP Extension

- Slave State Machine



DP Interactions

DP Extended

- Why DP extended?
  - the requirements of the process industry are included
  - selecting and changing parameters of a field device from several DP-Masters, e.g.. CPU, PG or HMI Devices
    - provides for higher flexibility in operation
  - Interrupts from Field Devices, e.g.. for diagnostics, have to be accepted by the DP-Master
    - allows for greater security
  - time stamping of events, e.g.. for interrupts, accurate history of special events
  - additional data formats are necessary for transmitting data, e.g.. floating-point-radix

DP Extended

New extended PROFIBUS-DP-Standard

DP-Extension

- Additional acyclic messages between Master and Slave by reading and writing of data blocks
- Acknowledgment of field device interrupts
- Time synchronization for an exact time stamping
- Extension of data types, floating-point-radix

PROFIBUS-DP-Standard !

Ⓟ every station that handles the DP-extensions must meet the previous PROFIBUS-DP-Standard-Functions!

DP Extended

- the implementation of the DP-Extensions in the Master and/or the Slave is optional
- a Master or Slave can implement only a fraction of the DP-Extensions, e.g.. read/write data
- every DP-Slave without DP-Extension runs with every DP-Master (with or without DP-Extension)
- every DP-Slave with DP-Extensions runs with every DP-Master with DP-Extensions without any restrictions. (Warning: Non-DPV1 Master can only offer a fraction of the Extensions!)
- a DP-Slave with DP-Extensions must operate with limited functionality with a DP-Master without the DP-Extensions

DP Extended

- Acyclic communication connections between Class 1 Master and Slave via Slave SAP 51
  - Read data set (DDLM_Read)
  - Write data set (DDLM_Write)
  - Acknowledge alarms (DDLM_Alarm_Ack)
  - Only the master that parameterized and configured the slave can utilize the SAP 51 for these services also
  - Alarm can only be acknowledged by the Class 1 Master via SAP 51 (access protection)

DP Extended

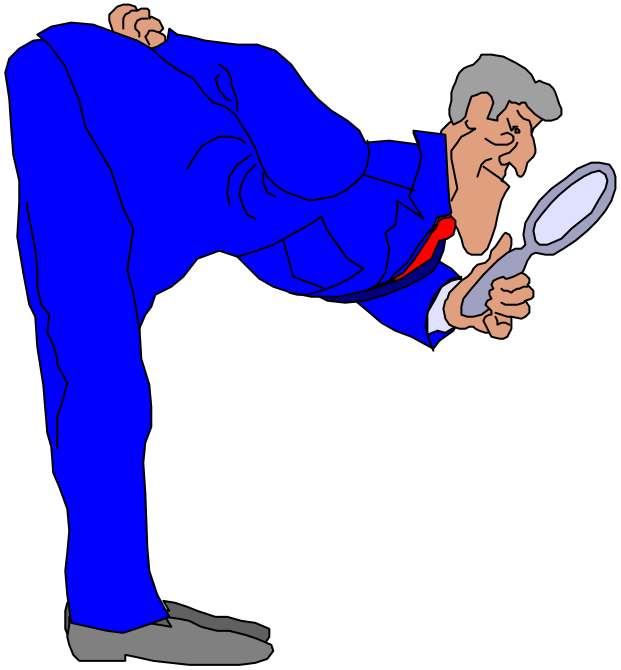
- Acyclic communication relations between Class 2 Master and Slave via SAP 0…49
  - Initiate (MSAC2_Initiate) - SAP 49
  - Abort (MSAC2_Abort)
  - Read Data Set (MSAC2_Read)
  - Write Data Set (MSAC2_Write)
  - Data Transport (MSAC2_Data_Transport)

DP Extension

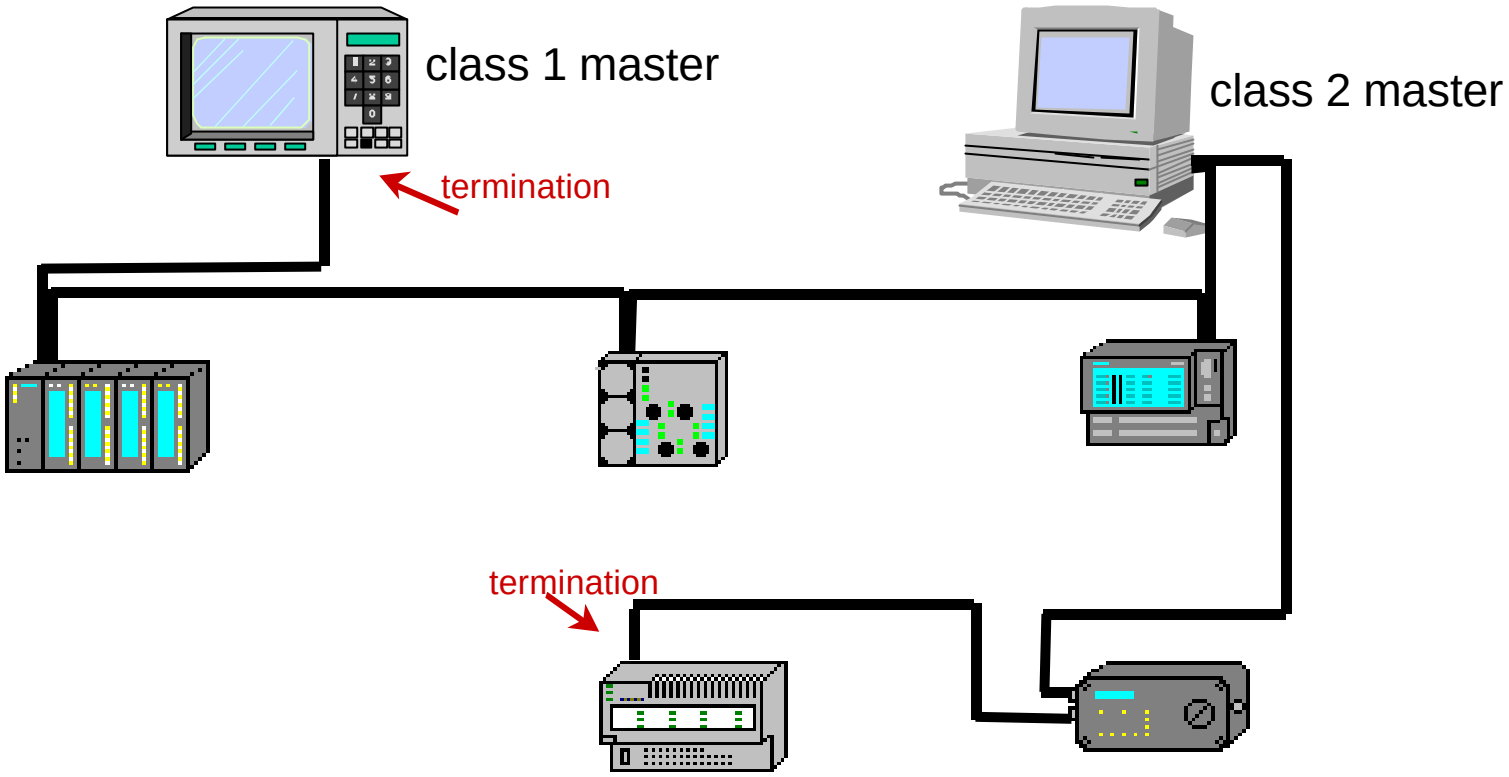
- additional data type definitions
  - Currently, only 8 and 16 bit types are defined
  - With DP extensions, all the following formats are defined:
    - Integer (8,16,32 bits) DPV1
    - Unsigned (8,16,32 bits) DP
    - Floating Point (4 Octets, IEEE Std 754) DPV1
    - Visible String (ISO 646 and ISO 2375 DP
    - Octet String DP
    - Date(ms,min,hour,dow,dom,month,year) DPV1
    - Time of day(ms from 12 AM, days from 1/1/84) DPV1
    - Time Difference(ms[0 - 2^{32}-1], days [0 - 2^{16}-1]) DPV1

Practical Touch On

- **Practice Confirms the Theory**



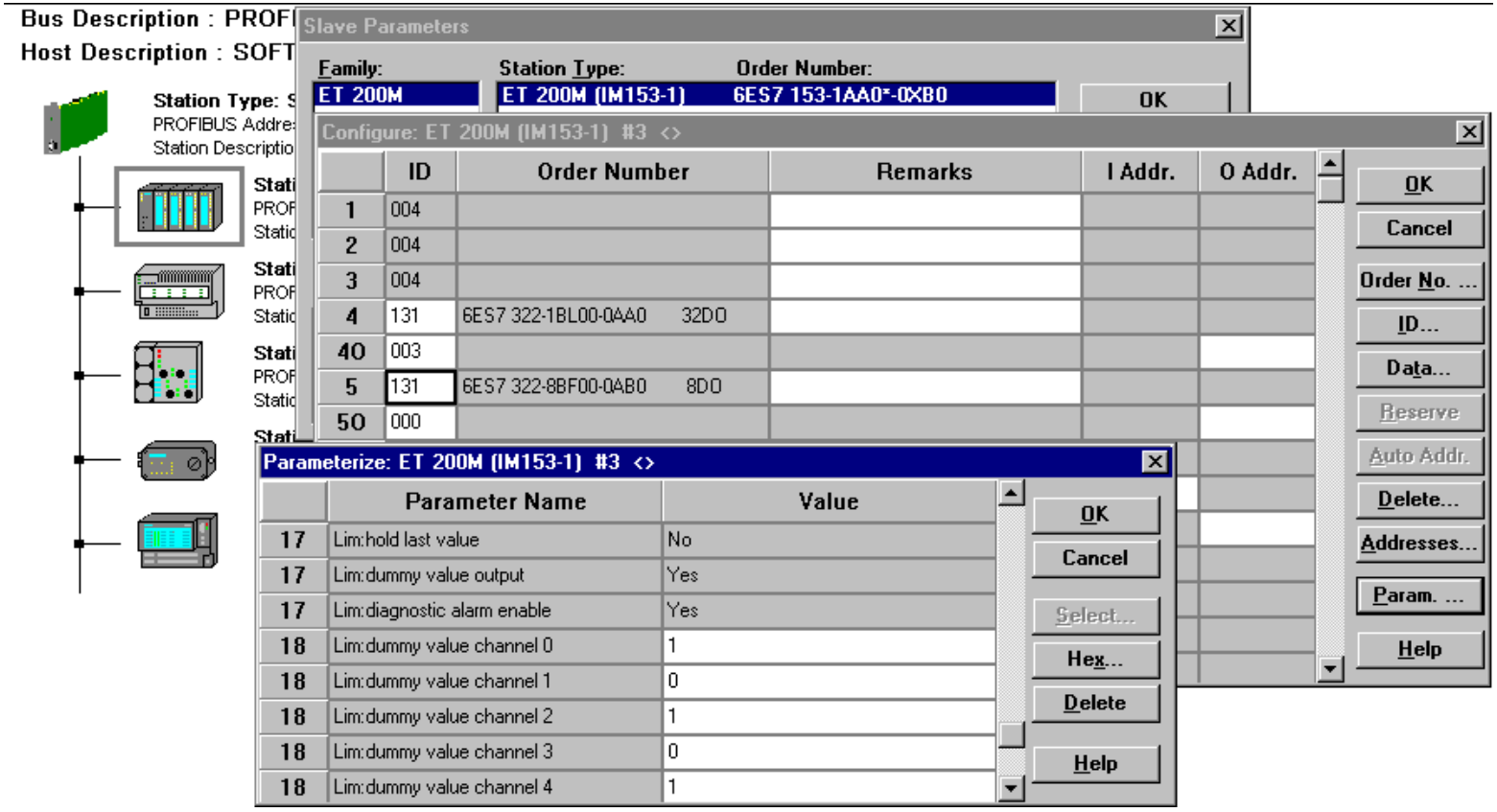
Network Setup



Network Setup

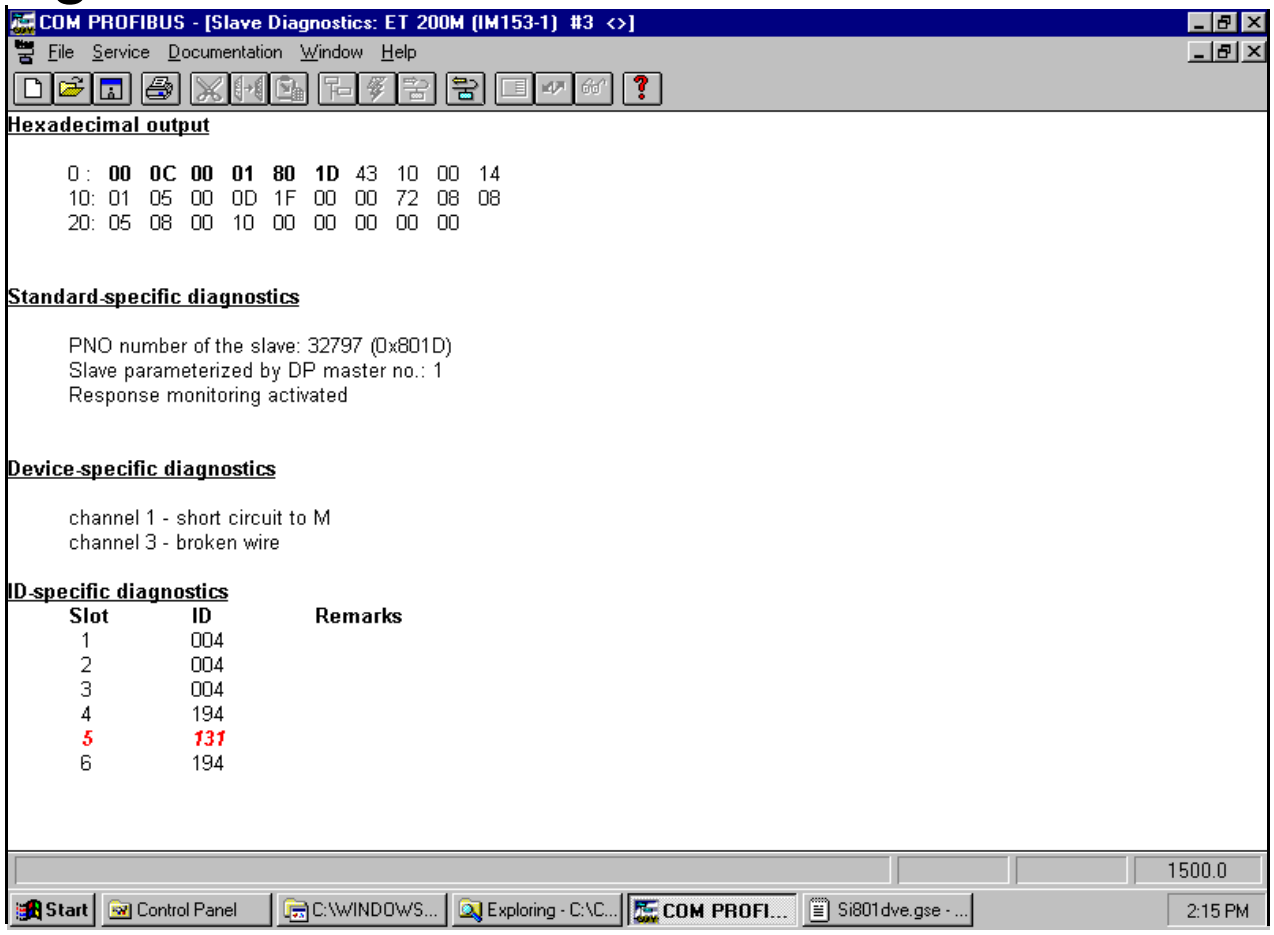
- select your devices
- setup your network (cabling, proper termination)
  - a-line green wire, b-line red wire
  - set termination “on” at the beginning and end of your segment
  - set your station addresses
- configure your system
  - select devices and station address
  - select specific functions
  - define baudrate
- load your master systems
- startup the network
- trouble shooting and diagnostic

Network Setup



Network Setup

diagnostic view

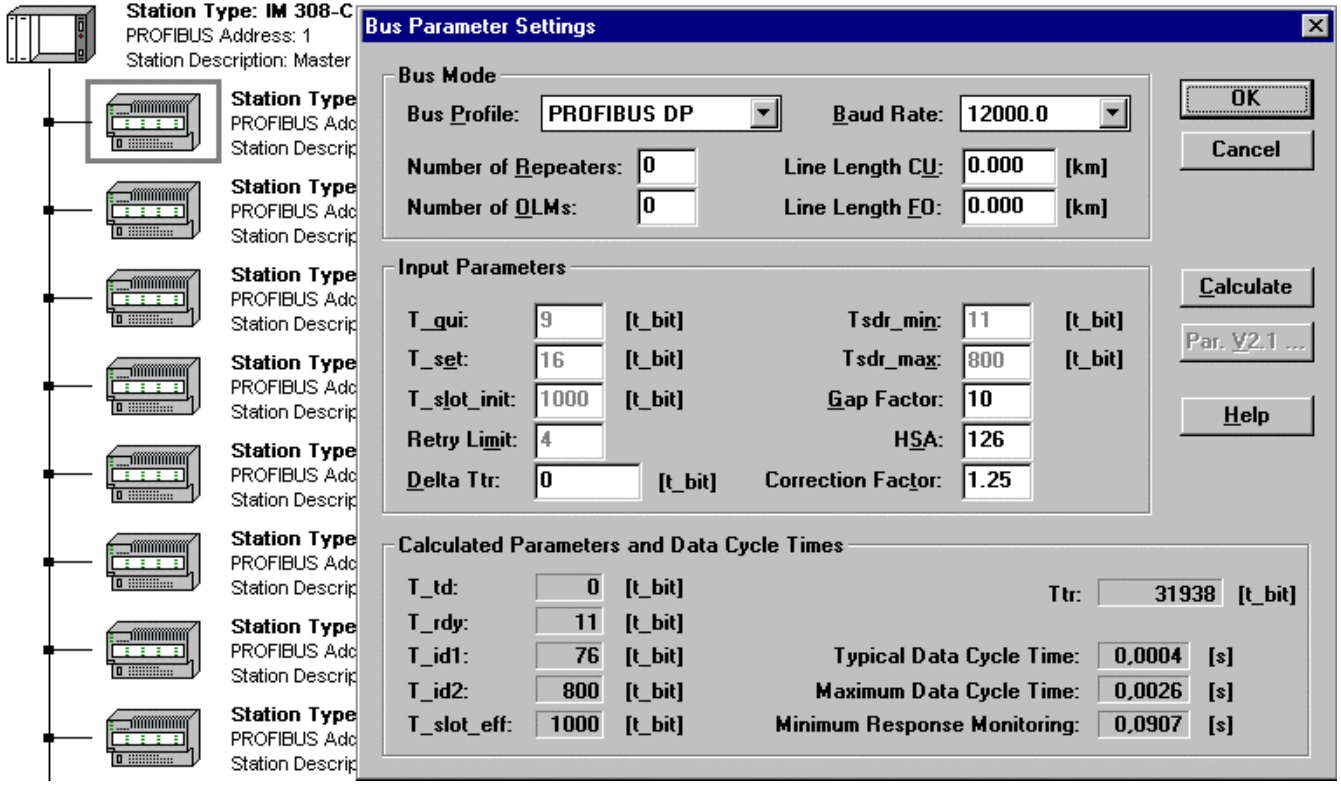


Network Setup

- diagnostic
  - missing station or wrong address
  - wrong configuration, wrong device
  - device related information
- fail safe
  - setup and behavior
- disconnection and replacement
- timing
- tools - bus monitor, master class 2

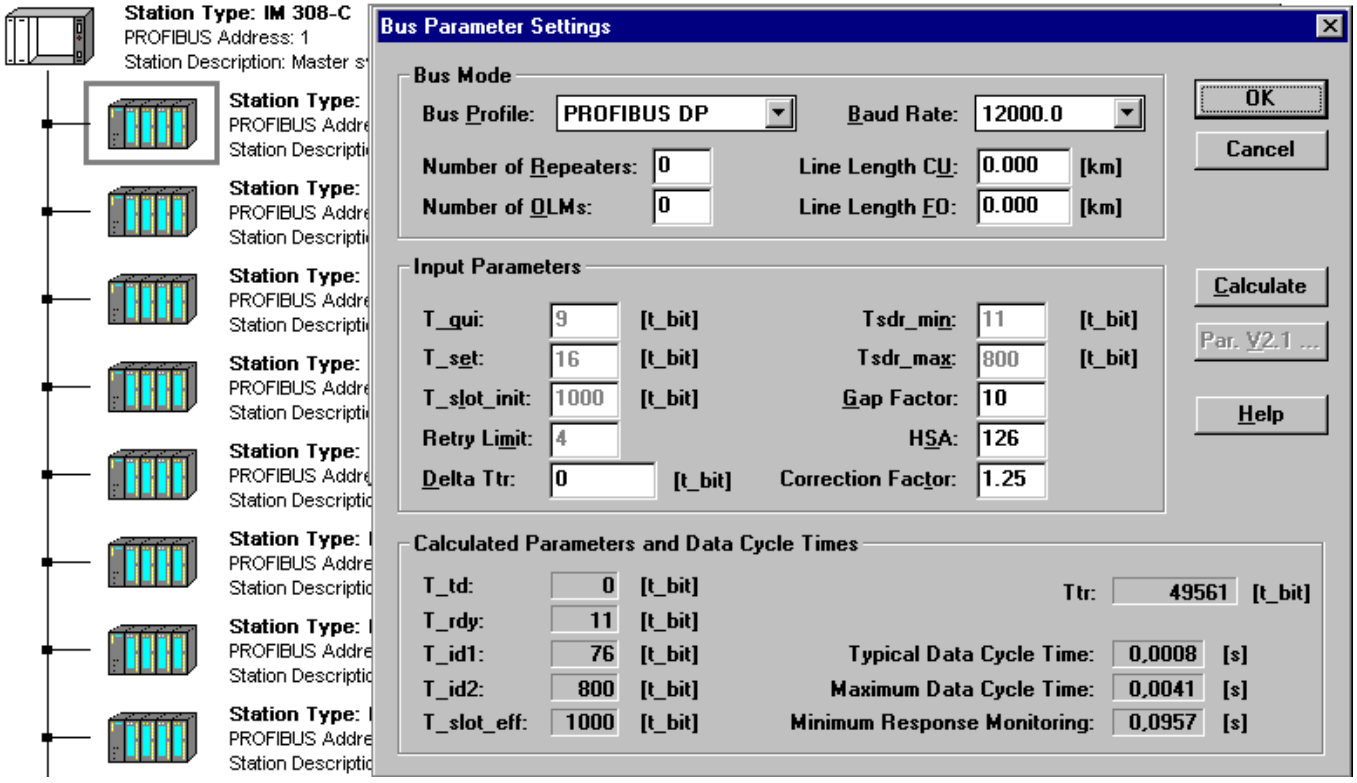
Timing

- 10 stations with each 2byte I/O (160 In/ Output signals)
- bus cycle time 0.4ms



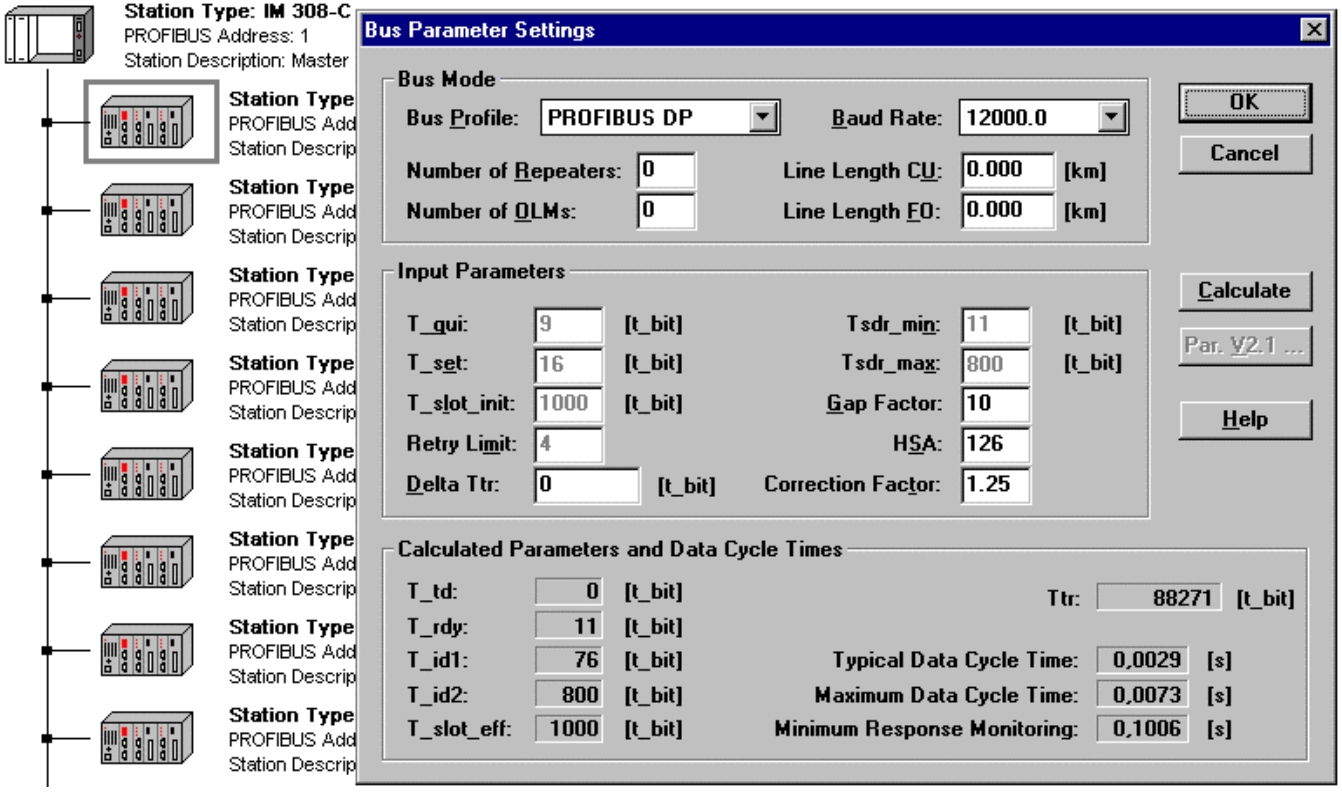
Timing

- 10 stations with each 16byte I/O (1280 In/ Output signals)
- bus cycle time 0.8ms



Timing

- 10 stations with 128 byte I/O (10240 In/ Output signals)
- bus cycle time 2.9ms



Compare With Other Fieldbus Systems

- extensive diagnostic possibilities
- failure and fail safe behavior
- sync and freeze broadcast
- deterministic
- extensions for acyclic communication
- speed
- safe and reliable setup
- easy configuration
- setup for your complete plant solution from cell to bit level

Questions

- What additional information do you need?