ProfiBus DP Communication Adapter

Table of Contents

Figures

Tables

1. ProfiBus DP Overview

The following topics will be reviewed in this chapter:
- Introduction to ProfiBus DP
- General Information on the DSC0-05000-000-0-00 Communication Adapter
- ProfiBus DP Configuration
- Configuration Limits

1.1 Introduction to ProfiBus DP

ProfiBus DP is an open industry standard for integrated communications. It is a serial field bus that connects sensors, actuators, and I/O modules distributed on the plant floor to higher level control systems. ProfiBus DP is the performance optimized version of ProfiBus, specifically designed to meet time critical communication requirements between the control system and its distributed I/O and field devices.

The ProfiBus DP network supports multiple communications master devices and multiple slave devices. A master device can be a PLC, a computer system, or another control device. A I/O module with a DSC0-05000-000-0-00 communication adapter on it is a typical distributed ProfiBus DP slave device.

A ProfiBus network supports a data rate of 12 Mbps over distances to 333 ft. (100 m) and a data rate of 93.75 k bps over distances to 4000 ft. (1200 m). The medium is twisted pair cable.

A ProfiBus DP network can support up to 126 devices (one master per network recommended) with up to 32 devices on each network segment.

1.2 General Information

- Compatibility
- Environmental Specification
- Mounting the Communication Adapter
- Isolation
- Scope of Data and Data Transfer
- Error Control

The DSC0-05000-000-0-00 ProfiBus DP Communication Adapter is compatible with all I/O bases. It plugs into an I/O base to form a functional distributed I/O slave unit on the ProfiBus DP network. I/O can be on the same network as other ProfiBus DP compatible devices.

Figure 1.1. I/O Base with ProfiBus DP Communications Adapter Attached

DSC0-05000-000-0-00 ProfiBus DP Communications Adapter

I/O Base
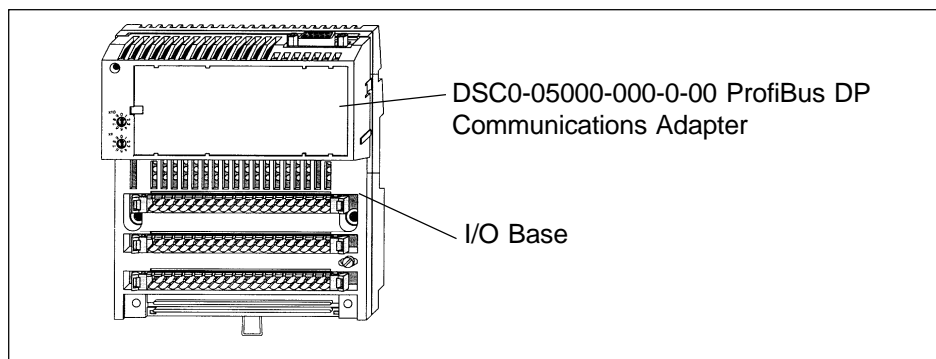
1.2.1 Identifying the Distributed I/O Units

The DSC0-05000-000-0-00 ProfiBus DP Communication Adapter has a PNO Idnet number (7512 hex). This number is used for internal ProfiBus administration.

The ProfiBus DP master is able to distinguish the location of all its distributed I/O bases by checking their addresses. Every I/O base on the ProfiBus DP network needs to be assigned a unique address via the addressing switches on the front of the communications adapter.

The ProfiBus DP Communications Adapter is able to evaluate the ident number of the I/O base on which it is placed and to return that identity to the ProfiBus DP master over the bus. For more information on how the system can take advantage of the I/O base ident numbers, see Appendix B2.

1.2.2 Compatibility with Existing TIO Modules

If you replace ProfiBus enabled Modicon Terminal Block I/O (TIO) module with an I/O module, appropriate re-configuration is necessary (i.e. the modules have different ident numbers). The user data remains the same.

Also be aware that the I/O module and TIO represent I/O errors differently. If you have swapped out TIO for an I/O module, the byte must be scanned for values that are greater than zero so as to remain compatible with the TIO. See Appendix B.1.2.

1.2.3 Environmental Specification

The ProfiBus DP Communication Adapter conforms to the environmental specifications of the I/O base on which it is installed.   See the I/O Bases User Manual for further information.

1.2.4 Mounting the Communication Adapter

Snap-on tabs on the communication adapter (safety type IP20) allow it to attach easily to the I/O base. The adapter can be removed from the base with a screwdriver. Detailed assembly instructions are in the I/O Bases User Manual.

A lexan fill-in label is shipped with each I/O base. This label fits into an area on the face of the adapter. A clear window on the right side of the label allows you to identify the communication adapter. See I/O Bases User Manual.

1.2.5 Architecture and Functionality

The ProfiBus DP Communication Adapter consists of four functional hardware areas:

RS-485 Interface   RS-485 is the standard field bus interface for the ProfiBus DP. This interface complies with the ProfiBus DP standards per EN 50170 (DIN 19245 Parts 1 and 3 are integrated).

I/O Base Interface   This interface allows the communication adapter to be installed on any I/O base.

Protocol Execution   ProfiBus DP supports either a single [master] or multi-master system. The transfer mode in either case is half duplex. Solid state circuitry in the ProfiBus DP adapter executes the protocols between the I/O module and the master as follows:

- After voltage is applied, or reset is activated, the communication adapter receives information regarding the data (size) requirements of the I/O base and the I/O base group type. This information is provided by the I/O base

- The master sends the configuration data to each of the slaves (I/O modules). Typical configuration data include identification of the I/O base, I/O data size,, etc. The I/O module compares the configuration information with its own actual data. If the data match, the master will parameterize the I/O module and communication can be established.

- If the I/O base detects and I/O error, that error signal is sent to the master as part of a (non-cyclic) diagnostic message. (See Appendix B.1).

Voltage Supply

The internal voltage supply (Vcc) is provided by the I/O base. Vcc is monitored and a reset signal is generated if and when Vcc is not within tolerance. The isolated voltage (Vcx) for the ProfiBus DP interface is generated via a DC–DC converter and is not monitored.

1.2.6 Isolation

The bus interface always is isolated, as shown below.
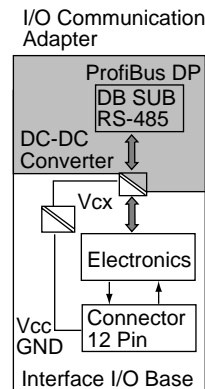
1.2.7 Message Types and Data Transfer

The ProfiBus DP Communication Adapter recognizes three types of messages:
- User Data (input/output data and parameters)
- Diagnostic Data
- Bus Configuration

These messages are transferred in different cycles between the ProfiBus DP master and the I/O module (slave). The communication adapter handles the transfer for the I/O module in the following manner:

Transfer Cycle	Description
Cyclic transfer of user data:	Transfer sequence in which input data is read from DP slaves, then output data is written to DP slaves. Parameterization data for the analog modules is included.
Non-cyclic transfer of status information for diagnostic purposes:	If any new diagnosis data are detected, a flag is set by the ProfiBus DP slave. This causes the ProfiBus DP Master to poll the data.
One time transfer of ProfiBus DP internal parameters:	Examples include the ident number of the DP Master that configures the slaves.

1.2.8 Error Control

A serial microprocessor controls all operations within the DSC0-05000-000-0-00 Communication Adapter. Operations include:

- Sending an error signal to the ProfiBus DP master whenever an I/O base reports an I/O error
- Upon detection of a fault, turning on the Bus Fault (BF) LED indicator to provide a visual indiction of a network fault
- Setting the data control timer (DCT) for the DP master, which must take into consideration all the slave watchdog settings (e.g., if slave time-out is set for 250 ms, the DCT may be set to 1500 ms, a ratio of 6 to 1).

For mor information refer to the special software documentation of your ProfiBus master.

2. Communication Adapter Register Mapping

The following topics will be reviewed in this chapter:

- I/O Data Format and Size
- Mapping Data to I/O Base Terminals
- Configuration and Addressing Example

2.1 I/O Data Format and Size

The I/O data consist of the discrete input/output points and, for special I/O bases such as analog, the module parameters.

After voltage is applied, each I/O base is identified. Data exchange can then take place. In the process, messages of discrete and analog I/O modules are handled using different data formats:

- Modules with only discrete I/O bases use the byte data format
- Modules with analog I/O bases use the word data format

Table 2.1. I/O Base Word Number (analog I/O bases)

Description	Function	Input Words	Output Words
DSG0-01000-000-0-00	16 Input Channels	16	4 (for parameters)
DSG0-02000-000-0-00	4 Input Ch, RTD, T/C	4	4 (for parameters)
DSG0-04000-000-0-00	4 Output Channels	0	5 (1 for parameters)
DSG0-05000-000-0-00	4 Output Channels	0	5 (1 for parameters)

Table 2.2. I/O Base Byte Number (> 24 Vdc discrete)

Description	Function	Input Bytes	Output Bytes
DSD0-01000-000-0-00	16 Inputs/120 Vdc	2	0
DSD0-03000-000-0-00	10 In, 8 Out/ 120 Vdc	2	2
DSD0-04000-000-0-00	8 Outputs/ 115 Vac	0	2
DSD0-05000-000-0-00	16 Outputs/120 Vdc	0	2
DSD0-06000-000-0-00	8 Outputs/230 Vac	0	2
DSD0-07000-000-0-00	16 Outputs/230 Vdc	0	2

Table 2.3. I/O Base Byte Number (24 Vdc)

Description	Function	Input Bytes	Output Bytes
DSD0-08000-000-0-00	16 Inputs	2	0
DSD0-09000-000-0-00	32 Inputs	4	0
DSD0-10000-000-0-00	16 Inputs/16 Outputs	2	2
DSD0-11000-000-0-00	16 Inputs/16 Outputs	2	2
DSD0-12000-000-0-00	10 Inputs/8 Outputs	2	2
DSD0-14000-000-0-00	16 Inputs/8 Outputs	2	2
DSD0-15000-000-0-00	16 Outputs	0	2
DSD0-16000-000-0-00	32 Outputs	0	4

2.2 Mapping Data to I/O Base Terminals

- Data Mapping for Discrete I/O Bases
- Data Mapping for Analog I/O Bases

2.2.1 Data Mapping for Discrete I/O Bases

The discrete I/O modules map the various I/O data to or from the terminals in the following manner:

- Mapping in each case is done to bytes (max. 4 bytes for 32 I/O points).
- The least significant byte (LSB) is transmitted first.
- The bytes sent by the communications adapter to the I/O base represent the outputs (O-bytes), the bytes sent by the I/O base to the communications adapter represent the inputs (I-bytes).
- I/O Data mapping is compatible with the standard TIOs.

The following message structures illustrate the data exchange between the master and the slave (I/O module), using 2 modules in this example:

Input Data for DSD0-09000-000-0-00		Output Data for DSD0-16000-000-0-00	
LSB = Byte 0	Inputs 8 . . . 1	LSB = Byte 0	Inputs 8 . . . 1
Byte 1	Inputs 16 . . . 19	Byte 1	Inputs 16 . . . 19
Byte 2	Inputs 24 . . . 17	Byte 2	Inputs 24 . . . 17
MSB = Byte 4	Inputs 32 . . . 25	MSB = Byte 4	Inputs 32 . . . 25

Within the bus, the I/O bits are mapped as follows:

2.2.2 Data Mapping for Analog I/O Bases

The analog I/O modules map the I/O values in the following way:

- Every analog value is mapped to a word
- In each case, the least significant word (LSW) is transmitted or received first.
- The words sent from the communication adapter to the I/O base represent the output values and parameters (output words), the words sent from the I/O base to the communication adapter represent the input values and the status (input words).
- The analog value structure follows the IDS 3000 specification. Sign and value are left aligned (nominal range of ±32000). The resolution depends on the chosen measurement resp. output range. Negative values are formed as 2s complement.

2.3 Configuration and Addressing Example

Note: a ProfiBus terminating connector must always be employed at the front and back ends of the bus.

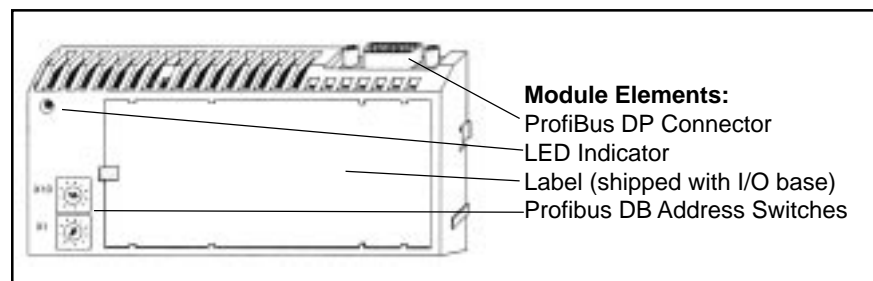To make a ProfiBus DP network run, you must execute the following steps:

- Selecting the bus cable (refer to Building the Cable section 3.2.4)
- Setting a unique ProfiBus address on each node (refer to the Address Settings section 3.2.1)
- Loading the device data base (DDB) (refer to the Loading the Device Data Base section 2..3.1)

2.3.1 Loading the Device Data Base

For the ProfiBus DP, the performance features of the equipment are documented by the manufacturers and made available to the users in the form equipment data sheets and a device data base (DDB). The contents and codes of the DDB are standardized so that they are independent of the make of the master. The DDB allows you to configure any DP slaves with the configuration tools of different manufacturers.

The DDB is on a diskette and includes a README with additional information. DDB importation takes place during bus master parameterization and is documented there.

3. Hardware Description DSC0-05000-000-0-00

Module Elements:
ProfiBus DP Connector
LED Indicator
Label (shipped with I/O base)
Profibus DB Address Switches

The following topics will be reviewed in this chapter:
- Communication Adapter Overview
- Configuration
- LED Indicators
- Technical Specifications

3.1 Communication Adapter Overview

The DSC0-05000-000-0-00 ProfiBus DP Communication Adapter provides the communication interface between I/O base and the ProfiBus network. It can be used with any I/O base.

Basic Data

Module Type:	ProfiBus DP Communication Adapter
Power Supply:	5 Vdc/250 mA (from I/O base)
Transfer Rate:	9.6 kbits . . . 12 Mbits
Bus Length:	Max. 4000 ft. (1200 m) ... max. 333 ft. (100 m)

3.2 Configuration

3.2.1 Address Settings

ProfiBus DPs nodes are identified by addresses assigned to them by the user. Each node must have a unique address in the range 1 to 99. Duplicate addresses are not allowed. Addresses are assigned logically and are not dependent upon the physical locations of the node devices.

The address setting on the adapter's front panel switches must correspond to the address defined for that adapter in application program to ensure that messages are sent and received properly at the correct notes across the network.

Setting the ProfiBus DP Address to 36 is illustrated below

Table 3.1. Possible ProfiBus DP Addresses

ProfiBus DB Address	Upper Rotary (X10)	Lower Rotary (X1)
1 to 9	0	1 to 9
10 to 19	1	0 to 9
20 to 29	2	0 to 9
30 to 39	3	0 to 9
40 to 49	4	0 to 9
50 to 59	5	0 to 9
60 to 69	6	0 to 9
70 to 79	7	0 to 9
80 to 89	8	0 to 9
90 to 99	9	0 to 9
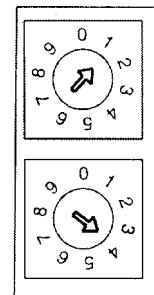
Caution!
Do not install any adapter unless you have set its network address for your application. See your network administrator to get the node address for each adapter.

3.2.2 Device Master Data (DMD) for Open Configuration

For integrating the I/O base into the user application, a device master file is needed. (See Technical Specifications, sub-section 3.4). It contains a README file with additional information.

3.2.3 Connecting the ProfiBus DP

To connect the ProfiBus DP, you will need cables with standard conductor assignments.

Terminal	Signal	Function
3	RxD/TxD P	Incoming Data (RxD) positive
		Outgoing Data (TxD) positive
5	DGND	Reference potential for terminations (supplied by the I/O module)
6	VP	Supply voltage for terminations (+5 V from I/O module)
8	RxD/TxD N	Incoming Data (RxD N) negated
		Outgoing Data (TxD N) negated
1, 2, 4, 7, 9		Pins not connected

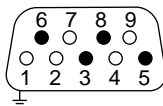Connector Housing: Internally connected with cable shield

Figure 3.1.
Communications Adapter
Interface Connector

3.2.4 Building the Cable

The bus cable for connecting ProfiBus DP nodes must be built by the user. EIA RS-485, two conductor copper wire twisted pair with optional shielding is commercially available.

1. Cut cable to required length
2. Prepare the cable ends as shown in Figure 3.1.

Figure 3.2. Preparing Cable for ProfiBus DB Connector
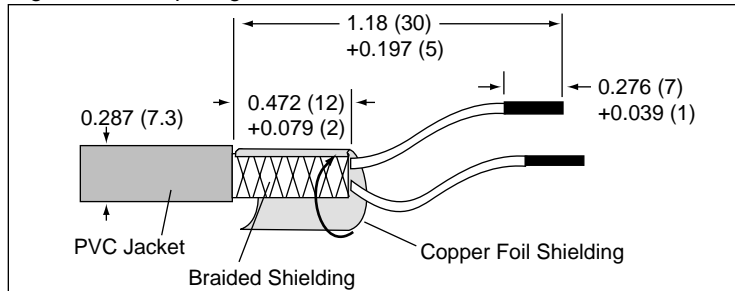
Note: Dimensions in inches; mm in parenthesis ( ).

3. Remove the PVC jacket to the length shown.
4. Wrap the braided shield with the supplied copper foil shielding as shown.
5. Attach the cables in the area of the copper foil, firmly connecting the shielding sections.

Figure 3.3. Terminal Assignment for ProfiBus DB Connector

A: Bus connector screws
B: Terminals
C: Cable cleat
D: Cable KAB PROFIB

E: Piece of dummy cable or other
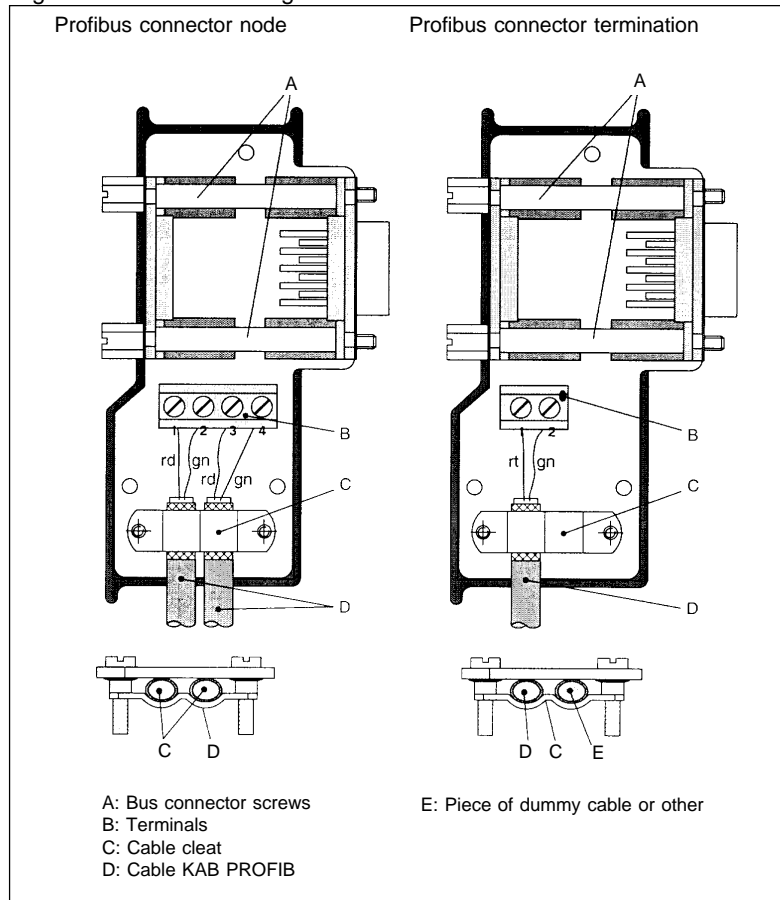
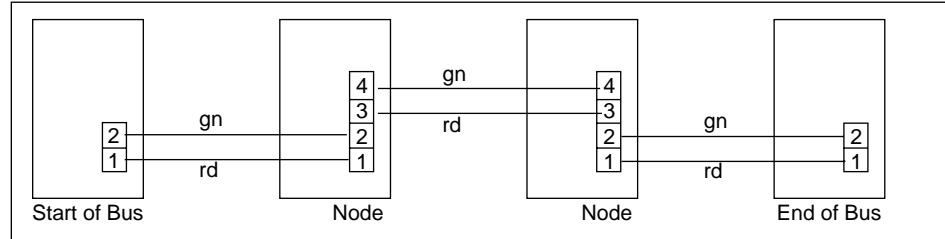6. The shielding of each cable is internally connected to the respective connector.

7. At both the front and back ends of the bus, install a ProfiBus terminating connector (to emulate line impedance).

Figure 9. Wiring Diagram for ProfiBus DP Cable

8. After remounting the enclosure, plug the ProfiBus DP connector into the appropriate module and secure it with the screws.

9. Perform the central discharge function for the shielding in accordance with Appendix A.1 before connecting the bus cable to the modules.
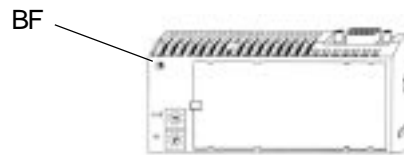
3.3 LED Indicator

BF

Table 3.2. LED Indicator

LED	Status	Function
BF	Red	Bus Fault. The internal watchdog was triggered or a reset signal received.
	Off	The module is cycling in the data exchange mode.

3.4 Technical Specifications

General

PNO Number:	7512 hex
Power Consumption:	250 mA @ 5 V (supplied by I/O base) w/out fiber-optic adapter

Potential Isolation

RS-485:	Isolated from remaining logic

Error Detection

Data Exchange:	Red LED for bus errors (BF) and message "I/O Error" at the master for discrete I/O; message "pm_control" at the master for complex I/O

Fuses

Supply Voltage:	Internal (for communication adapter) – None

ProfiBus DP Data Interface

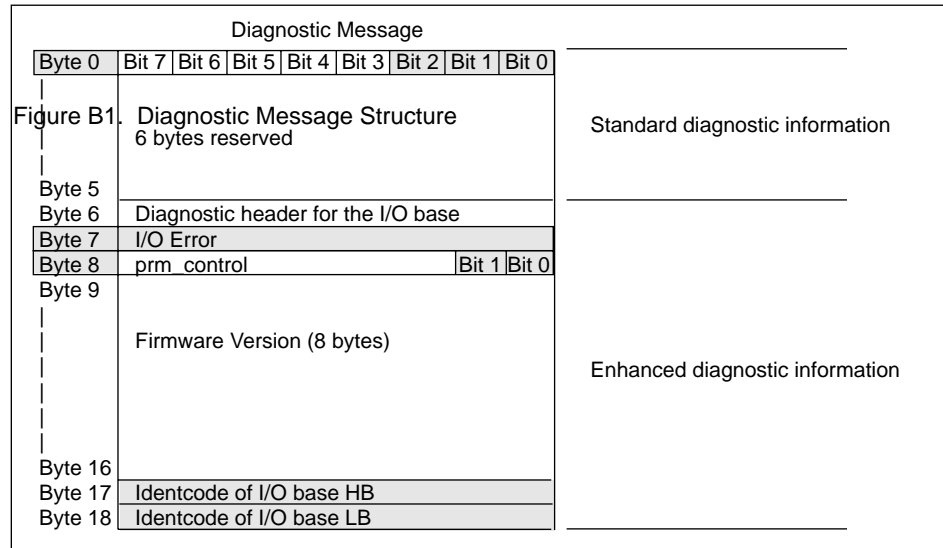|		
RS-485:	See Configuration/Connecting the ProfiBus DP	
Transfer Mode:	Half duplex	
Protocol Transfer:	ProfiBus DP per DIN 19245 Parts 1 and 3	
Transfer Rate:	Max. 4000 ft. (1200 m):	9.6 ... 19.2 ... 93.75 kbit/s
	Max. 3333 ft. (1000 m):	187.5 kbit/s
	Max. 1667 ft. (500 m):	500 kbit/s
	Max. 667 ft. (200 m):	1.5 Mbit/s
	Max. 333 ft. (100 m):	3 ... 6 ... 12 Mbit/s

B. Diagnostics

This appendix contains diagnostics data of ProfiBus DP:
- Evaluation of the diagnostic message
- Troubleshooting via Ident Number

B.1 Evaluation of the Diagnostic Message

When new diagnostic data is present, the ProfiBus DP slave device (e.g., the I/O module) sets a bit. If the bus master recognizes this bit, it will automatically request diagnosis.

For every I/O module, the diagnostic message occupies 19 bytes. You can decide under which address you want to store the diagnostic message. Here is an illustration of the message structure:

Diagnostic Message									
Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
|									Standard diagnostic information
Byte 5	6 bytes reserved								
Byte 6	Diagnostic header for the I/O base								
Byte 7	I/O Error								
Byte 8	prm_control						Bit 1	Bit 0	
Byte 9									
|	Firmware Version (8 bytes)								Enhanced diagnostic information
Byte 16									
Byte 17	Identcode of I/O base HB								
Byte 18	Identcode of I/O base LB								

Figure B1. Diagnostic Message Structure

To conserve memory space, you may choose to bypass the display of bytes 9 . . . 18 in memory.

B.1.1 Evaluation of Standard Diagnostic Data

According to the ProfiBus standard (DIN 19245, Part 3), it is possible to analyze the standard diagnostic data. The following is an excerpt relative to byte 0.

- Bit 0 is established by the master and indicates whether the master is communicating with the I/O modules: 0 = yes; 1 = no.

- Bit 1 is established by the I/O module and indicates whether the I/O module is ready to communicate (for instance, during initialization): 0 = yes; 1 = no.

- Bit 2 is established by the I/O module and indicates whether the configurational data of the master agree with those of the I/O module: 0 = yes; 1 = no.

B.1.2 Evaluation of the I/O Error (Byte 7)

The ProfiBus DP Communication Adapter receives an I/O error signal from the I/O base. This I/O error signal is sent to the bus master as part of a diagnostic message which contains error status (I/O error) information. It is one byte wide, and all bits are either 0 or 1. 0 = no error occurred; 1 = error occurred. Therefore, you need only scan the byte for values that are greater than zero.

Note: Whether or not an I/O error can be analyzed is indicated in the data register of the particular I/O base.

B.1.3 Evaluating prm_control

The prm_control byte is not analyzed by discrete I/O bases; for discretes the value is always 0. The byte is used to mark the parameters of complex (e.g., analog) I/O modules as valid or invalid after module parameterization.

Bit 0 = 0 when I/O base is operational; = 1 when I/O base is not operational.
Bit 1 = 0 when new valid parameters have been received; = 1 when not received.

Bits 0 and 1 are held by the I/O base until they are changed by operation or by parameterization.

B.2 Troubleshooting Via Ident Number

B.2.1 General Specifications

All I/O bases have an internal ident number. It is required so that a DP bus master can identify the device type. The master compares byte 1 of the connected DP bus device's ident number with the ident numbers in the configuration data prescribed by the service terminal. Application data transmission begins only when the proper device types with the correct station addresses are connected to the bus. In this way, a relatively high degree of security from configuration errors is maintained.

The ident number is visible to you only if it has been entered in the appropriate files (diskette 381 SWA 000 00, the file for modules on the diskette is named ASA_7512.GSD). You should always make use of the current GSD file.

The ident number determines which module type has been sent a diagnostic message. The following table lists the available I/O bases with their ident numbers:

Table B1. I/O Base Word Number (analog I/O bases)

Description	Function	Input Words	Output Words	Intent No Byte17*	Indent No. Byte 18**
DSG0-01000-000-0-00	16 Input Channels	16	4	C1 hex	04 hex
DSG0-02000-000-0-00	4 In Ch, RTD, T/C	4	4	C2 hex	04 hex
DSG0-04000-000-0-00	4 Output Channels	0	5	C3 hex	01 hex
DSG0-05000-000-0-00	4 Output Channels	0	5	C4 hex	01 hex

Table B2. I/O Base Byte Number (> 24 Vdc discrete)

Description	Function	Input Bytes	Output Bytes	Intent No Byte17*	Indent No. Byte 18**
DSD0-01000-000-0-00	16 Inputs/120 Vdc	2	0	03 hex	00 hex
DSD0-03000-000-0-00	10 In, 8 Out/ 120 Vdc	2	2	09 hex	00 hex
DSD0-04000-000-0-00	8 Outputs/ 115 Vac	0	2	16 hex	00 hex
DSD0-05000-000-0-00	16 Outputs/120 Vdc	0	2	14 hex	00 hex
DSD0-06000-000-0-00	8 Outputs/230 Vac	0	2	17 hex	00 hex
DSD0-07000-000-0-00	16 Outputs/230 Vdc	0	2	15 hex	00 hex

Table B3. I/O Base Byte Number (24 Vdc)

Description	Function	Input Bytes	Output Bytes	Intent No Byte17*	Indent No. Byte 18**
DSD0-08000-000-0-00	16 Inputs	2	0	02 hex	00 hex
DSD0-09000-000-0-00	32 Inputs	4	0	01 hex	00 hex
DSD0-10000-000-0-00	16 Inputs/16 Outputs	2	2	08 hex	00 hex
DSD0-11000-000-0-00	16 Inputs/16 Outputs	2	2	08 hex	00 hex
DSD0-12000-000-0-00	10 Inputs/8 Outputs	2	2	0A hex	00 hex
DSD0-14000-000-0-00	16 Inputs/8 Outputs	2	2	0B hex	00 hex
DSD0-15000-000-0-00	16 Outputs	0	2	06 hex	00 hex
DSD0-16000-000-0-00	32 Outputs	0	4	09 hex	00 hex

*Byte 17 is required for unique identification on the ProfiBus
**Byte 18 is applied to internal data administration

B.2.2 Troubleshooting Examples

For troubleshooting purposes, a differentiation is made based on the bus master involved. In general, byte 0 provides information about the communication. For demonstrative purposes, different defect possibilities follow:

Case 1: Communication Is Not Initiated

If communication cannot be initiated with a ProfiBus DP slave (e.g. if an incorrect module type has been configured), the module can send only standard diagnostic data. Since you allocate the diagnostic data address range, you can evaluate these data yourself

Byte 0 Evaluation
Bit 0 = 1 Master cannot communicate with the I/O module
Bit 1 = 1 I/O module is not ready for communication
Bit 2 = 1 Master and I/O module configuration data do not match

Case 2: Communication Is Interrupted

When a slave has already exchanged data and communication is interrupted (e.g., a line break), the master regenerates the standard diagnostic data. The extended diagnostic data retain the conditions that existed prior to the interruption. You can analyze the diagnostic data under the known address range:

Byte 0 Evaluation
Bit 0 = 1 Master cannot communicate with the I/O module
Bit 1 = 1 I/O module is not ready for communication
Bit 2 = 0 Master and I/O module configuration data match

Through byte 17 of the extended diagnostic data, you can distinguish which module type has failed. See Tables B2 and B3. (e.g., byte 17 = 01 hex means that a module of type DSD0-09000-000-0-00 is affected.)

Case 3: Error Message of a Discrete I/O Module

If a short circuit or overload occurs on the outputs of a discrete module, a complete diagnostic message is sent. You can analyze the diagnostic data under the known address range:

Byte 0 Evaluation
Bit 0 = 0 Master communicates with the I/O module
Bit 1 = 0 I/O module is ready for communication
Bit 2 = 0 Master and I/O module configuration data match

Byte 7 Evaluation
Evaluation of byte 7 (I/O Error) must be carried out in a user program. Byte 7 = 1 (all 8 bits) means there is a short circuit or overload on one or more outputs. See sub-section B.1.2.

Case 4: Error Message of An Analog Module

In the same way for an invalid parameter specification of intelligent module types (e.g., an analog module), a complete diagnostic message is sent. You can analyze the diagnostic data under the known address range:

Byte 0 Evaluation
Bit 0 = 0   Master communicates with the I/O module
Bit 1 = 0 I/O module is ready for communication
Bit 2 = 0 Master and I/O module configuration data match

Byte 8 Evaluation (prm_control)
Bit 0 = 1 I/O device not running
Bit 1 = 1 New invalid parameters have been received