MITSUBISHI Mitsubishi Industrial Robot

CRn-500 series INSTRUCTION MANUAL

PROFIBUS Interface



- CE マーキング対策部品取付要領
- EMC Component Installation Procedure

PROFIBUS ケーブルへのフェライトコア取付要領 Procedure for Coupling a Ferrite Core with PROFIBUS Cable

コントローラと PROFIBUS ユニット間の PROFIBUS ケーブルに、 添付のフェライトコアを下図のように取り付けてください。 また、フェライトコアを接続端子部から 30cm 以内に配置ください。 それ以外はノイズによる誤動作を起こす可能性があります。

The ferrite core should be connected to the PROFIBUS cable at a location between the controller and the other PROFIBUS unit, with the controller being within 30 cm of the Ferrite core (see figure below).

If the ferrite core is not connected to PROFIBUS cable in this manner, emission noise could cause malfunction.



*1 もしノイズによる影響を受けやすい環境下でご使用の場合は、PROFIBUS ケーブ ルのカバーを剥き、金属クランプを利用して、シールドを直接筐体のアースに落と してください。

If the device is operating in an environment where it can be easily affected by emission noise, strip off the covering of the PROFIBUS cable and, using the metal clamp, connect the shield directly to the unit's ground.

CR1/CR2A/CR2B コントローラへの PROFIBUS ケーブル取付要領 PROFIBUS Cable Installation Procedure for CR1/CR2A/CR2B Robot Controllers

下図のように PROFIBUS ケーブルを折り返して、ナイロンバンドで束ねて使用してください。

Fold the PROFIBUS cable back onto itself, and bind the cable with a nylon band as pictured in the figure below.



CR1/CR2A/CR2B/CR3 コントローラへの CE マーキング対策による PROFIBUS ケーブル取付実施例 Examples of installing PROFIBUS cables with CE marking measure to CR1/CR2A/CR2B/CR3 robot controllers

PROFIBUS ケーブルの被覆を剥き、金属クランプを利用して、シールドを直接筐体のアースに落としてください。 Strip off the coverings of both PROFIBUS cables, and connect them directly to the grounds of the robot controller cabinet using metal clamps.



(1) CR1 controller

外部の安全なアースを使用した例 Example of connecting cables to external safe grounds.



コントローラ内部のアースを使用した例 Example of connecting cables to grounds inside the controller



被覆を剥き、金属クランプによって接地してください。 Strip off the coverings of both PROFIBUS cables, and connect them to the external safe grounds using metal clamps.

被覆を剥き、金属クランプによって接地してください。 Strip off the coverings of both PROFIBUS cables, and connect them to the grounds inside the controller using metal clamps.

(2) CR2A/CR2B controller

外部の安全なアースを使用した例

Example of connecting cables to external safe grounds.



被覆を剥き、金属クランプによって接地してください。 Strip off the coverings of both PROFIBUS cables, and connect them to the grounds inside the controller using metal clamps.

コントローラ内部のアースを使用した例 Example of connecting cables to grounds inside the controller



被覆を剥き、金属クランプによって接地してください。 Strip off the coverings of both PROFIBUS cables, and connect them to the grounds inside the controller using metal clamps.

(3) CR3 controller



被覆を剥き、金属クランプによって、筐体のアースプレートに 接地してください。

Strip off the coverings of both PROFIBUS cables, and connect them to the grounds on the plate of the robot controller cabinet using metal clamps.

(4) CR4/CR8 controller



被覆を剥き、金属クランプによって、筐体のアースプレートに 接地してください。

Strip off the coverings of both PROFIBUS cables, and connect them to the grounds on the plate of the robot controller cabinet using metal clamps.

■Revision History

Print date	Instruction manual No.	Revision content			
2004-03-22	BFP-A8348Z	First print.			
2004-04-13	BFP-A8348-*	Formal style.			
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2004-09-01	BFP-A8348-B	Error in writing correction.			
2004-01-31	BFP-A8348-C	Error in writing correction.			
2009-09-30	BFP-A8348-D	The EC Declaration of Conformity was changed.			
		(Correspond to the EMC directive; 2006/42/EC)			

Introduction

Thank you very much for purchasing this product for Mitsubishi Electric Corporation's CR-500 series industrial robots. PROFIBUS interface is an add-on option that is used in combination with CR-500 series controllers to add PROFIBUS field network functionality to robot controllers. Please make sure to read this document thoroughly and understand its information before start using the PROFIBUS interface.

This PROFIBUS interface card functions as a slave station of PROFIBUS-DP.

This manual is described with the assumption that the reader has an understanding of the basic operations and functions of Mitsubishi Electric Industrial Robot CR-500 Series. For details of the basic operations, refer to the "Detailed explanations of functions and operations BFP-A5992."

• No part of this manual may be reproduced by any means or in any form, without prior consent from Mitsubishi.

- The details of this manual are subject to change without notice
- An effort has been made to make full descriptions in this manual. However, if any discrepancies or unclear points are found, please contact your dealer.
- The information contained in this document has been written to be accurate as much as possible.

Please interpret that items not described in this document "cannot be performed." or "alarm may occur".

• This Instruction Manual is original

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Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

	All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.) Enforcement of safety training
▲CAUTION	For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.) Preparation of work plan
	Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.) Setting of emergency stop switch
▲CAUTION	During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.) Indication of teaching work in progress
	Provide a fence or enclosure during operation to prevent contact of the operator and robot. Installation of safety fence
	Establish a set signaling method to the related operators for starting work, and follow this method. Signaling of operation start
	As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc. Indication of maintenance work in progress
	Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors. Inspection before starting work

The points of the precautions given in the separate "Safety Manual" are given below. Refer to the actual "Safety Manual" for details.

Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)
Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.
Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.
Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.
Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.
Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque. Exceeding these values could lead to alarms or faults.
Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.
Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.
Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.
When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.
Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.
After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.
Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.
Never carry out modifications based on personal judgments, or use non-designated maintenance parts. Failure to observe this could lead to faults or failures.
When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.
Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF. If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected. Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.
Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters. If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

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1 Before Using the PRIFUBUS Interface

This chapter describes items that need to be checked and precautions before using the PROFIBUS interface.

1.2 How to Use the Instruction Manual

This document describes the functions that have been added to or changed in the PROFIBUS interface according to the following chapter organization. For more details of the functions and operating procedures available for the standard robot controller, refer to the " Detailed explanations of functions and operations BFP-A5992." that comes with the robot controller.

Chapter	Title	Description
1	Before Using the PROFIBUS Interface	This chapter describes how to use this document (PROFIBUS Interface Instruction Manual). Please read this chapter before actually using the PROFIBUS interface.
2	Flow of Operations	This section describes the work required to build a PROFIBUS system. Please follow the procedure completely.
3	Functions and Specification of the PROFIBUS Interface	This section describes the functions and specifications of the PROFIBUS.
4	Items to Be Checked Before Using This Product	Check whether all products required for building a system are available, and the version of the controller for compatibility.
5	Hardware Settings	This product does not require any hardware setting.
6	Connections and Wiring	This chapter describes how to connect the PROFIBUS interface and the master station via a cable.
7	Parameter Settings	This chapter describes the settings of parameters on the master station and robot controller sides.
8	Starting use	This chapter introduces simple procedures and examples for using the PROFIBUS interface.
9	Troubleshooting	When the additional axis interface is used, a poor motion or error may occur. For the solving methods, refer to this chapter as necessary.
10	Appendix	This chapter provides the explanation of the system variables used to reference the detailed information on the PROFIBUS interface network using the robot language MELFA-BASIC IV.

Table 1.1 Contents of the Instruction Manual

2 Flow of Operations

The flow of the works for the PROFIBUS interface is shown below. Referring to the following, proceed with the works without excess and shortage.

2.1 Flowchart

1. Determining Specification for PROFIBUS Control
2. Checking Products
↓
3. Hardware Settings and Wiring Refer to Chapters 5 and 6 of this manual. The PROFIBUS interface card does not require any hardware setting. Mount the PROFIBUS interface card to the robot controller. Wire between the PROFIBUS interface card mounted and the master station.
₽
4. Master Station Parameter Settings Refer to Section 7.1 of this manual. Sets the signal assignment and the slave station number from the master station.
₽
 Robot Controller Parameter Settings
Ł
6. Creating Robot Programs
₽
7. Actions to Take When Troubles Occur Refer to Chapter 9 of this manual.
Ł
8. End of work.

3 Functions and Specification of the PROFIBUS Interface

3.1 What Is PROFIBUS?



Fig. 3-1 PROFIBUS Network Configuration Diagram

PROFIBUS is one of field network standards.

PROFIBUS is available in two types: PROFIBUS-DP for factory automation and PROFIBUS-PA for process automation.

This PROFIBUS interface card functions as a slave station that is connected to PROFIBUS-DP.

(*1) For details of PROFIBUS,

check the Web site of the International PROFIBUS Organization (http://www.profibus.com/).

3.2 Specification of the PROFIBUS Interface Card

The following sections describe the PROFIBUS interface card.

3.2.1 General Layout of the Card



Fig 3-2 General Layout of the Card

3.2.2 LED Explanation



Fig. 3-3 Layout of LEDs

There are seven LEDs on the printed circuit board (PCB), each of which indicates the operating status by ON/OFF. The operating status of each LED is shown in the table and figure below.

Table 3-1 LED Explanation

LED name	ON condition
TEST	ON: Executing self-diagnostics
RUN	ON: Normally running
	OFF: A watchdog timer error has occurred.
ERR	ON: A parameter setting error or unit error has occurred.
	OFF: Normally running
SYNC	ON: In SYNC mode
DIA	ON: There is extended failure information.
	OFF: There is no extended failure information.
FREEZE	ON: In Freeze mode
BF	ON: Before communicating data, or a data communication
	error has been detected
	OFF: Communicating data

3.2.3 Hardware Specification

Table 3-2 shows the hardware specification of the PROFIBUS interface card.

Item		Specification				
Туре		2A-RZ577				
PROFIBUS-DP station type		Slave station (compliant to EN50170 Volume 2 (Parts 1, 2, 3, 4, 8))				
Valid setting st	ation numbers	0 to 125 Note2)				
Maximum num	ber of communicable	Total of 192 words for input/	output data			
data		(Maximum of 122 words for input or output data)				
Number of mo	untable cards	1, There is no restriction on	the slot to which	the card is inserted.		
(per controller)		However, it cannot be used	together with a C	CC-Link card.		
	Electrical standard or characteristic	Conform to EIA-RS485				
	Media	Shielded twist-pair cable (Type A)				
	Network configuration	Bus type (tree type if a repeater is used, however)				
	Data link method	Polling method				
	Transmission coding method	NRZ				
Transmission	Transmission speed per second/maximum transmission distance Note1), Note2)	Transmission speed	Transmission distance [m/segment]	Maximum transmission distance when 3 repeaters are used [m/network]		
specification		9.6/19.2/45.45/93.75 kbps	1,200	4,800		
-		187.5 kbps	1,000	4,000		
		500 kbps	400	1,600		
		1.5 Mbps	200	800		
		3Mbps/6Mbps/12Mbps	100	400		
	Maximum number of repeaters/network	3 units Note3)				
	Maximum number of stations/segment	32 stations (including repeaters)				
	Number of connected nodes/segment	32				

Table 3-2 PROFIBUS Interface Card Hardware Specification

Note1) Transmission speed control is within $\pm 0.3\%$ (compliant to EN50170 Volume 2).

Note2) The station number is preset to 126 when shipped from factory (compliant to EN50170 Volume 2). Note3) The transmission distance can be extended using repeaters.

Maximum transmission distance [m/network] = (number of repeaters + 1) x transmission distance [m/segment]

Note4) To make the transmission speed of the master station's slave parameters slower, set a larger value for the communication WDT. (Example: Transmission speed of 93.75 kbps, communication WDT of 200 msec) If the communication WDT unsuitable for the transmission speed is set, the ERR and BF LEDs on the card flicker. Be careful that, in such a case, the input signals cause chattering, and normal communication cannot be performed.

3.2.4 Software Specification

This section describes the software specification of the PROFIBUS interface card.

Robot controller	CR-500 Series Supported by software version "J7" or higher
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The software specification is classified into the following two items.

- 1) Parameters used to set modes, station numbers and so forth.
- 2) Input/output variable for accessing PROFIBUS using robot language (MELFA-BASIC IV).

3.2.1.1 Robot Parameter Specification

The following describes the parameters relating to the PROFIBUS interface card.

Parameter name	No. of arrays	Description	Factory preset value
PBMODE	Integer 1	 This parameter switches the operational mode of the PROFIBUS interface card between Normal mode and Self-diagnostics mode. 0: Normal mode / 2: Self-diagnostics mode 9, 10, 11: Reservation (Cannot be used) Values other than 0, 2, 9, 10 and 11 will generate errors when the power supply is turned ON. If self-diagnostics results in a fault, it will generate an error. If the Self-diagnostic mode is set, the LEDs on the operation panel repeatedly display "7 7 7" - "7. 7. 7." for about 3 seconds in addition to regular displays when the power supply is turned ON, and then the system is started normally. 	0
PBNUM	Integer 1	This parameter sets the station number of the PROFIBUS interface card. -1 to 125 Set the station number before use. -1: Clears the station number saved in the flash ROM on the PROFIBUS Interface. (Set up by master station class-2.) If the power supply is turned off, this value will be 126. (Un-setting the station number.) 0 to 125: Station number (When setting up the station number, set the "PBMC" parameter to "1". It is written also in the flash ROM.) 126: Un-setting the station number. (Factory preset value)	126
PBMC	Integer 1	This parameter sets the class of the PROFIBUS master station. 1: Class 1 The station number requires the setup by the slave parameter of the master station, and the "PBNUM" of the slave station. 2: Class 2 The station number change from the master station class-2 is possible. The setting value of "PBNUM" is invalid. The station number is saved into the flash ROM on the PROFIBUS Interface.	1
E8500	Integer 1	This parameter ignores errors of the PROFIBUS interface card. It is used when starting the system. It prevents errors of the PROFIBUS interface card from being issued. It is valid only once while the power supply is ON. When the power supply is turned OFF, it reverts to the initial value of " Enable errors." 0: Enable errors / 1: Ignore errors	0
PBCNT	Integer 1	Specify the error detection interval of the PROFIBUS interface card. Normally, use the factory default setting (0). (0 to 32767 in units of msec) Change this value only if a communication error occurs frequently due to the adverse effect of noise in your surrounding environment. (Example: 50 to 70 msec) When changing this value, be sure to set a minimum of 10 msec.	0

3.2.1.2 Specification Relating to Robot Language

The following describes the robot language (MELFA-BASIC IV) relating to the PROFIBUS interface card.

Table 3-4	List of System Status Variables Used in PROFIBUS
-----------	--

Item	Function	Remarks
M_IN	Reads 1-bit data from the specified input signal.	Example: IF M_IN(2000)=1 THEN
M_OUT	Writes 1-bit data to the specified output signal.	Example: M_OUT(3000)=1
M_INB	Reads 8-bit data from the specified input signal.	Example: IF M_INB(2000)=7 THEN
M_OUTB	Writes 8-bit data to the specified output signal.	Example: M_OUTB(3000)=&HFF
M_INW	Reads 16-bit data from the specified input signal.	Example: IF M_INW(2500)=30000 THEN
M_OUTW	Writes 16-bit data to the specified output signal.	Example: M_OUTW(3500)=-30000

For more details of MELFA-BASIC IV, refer to the "Detailed explanations of functions and operations BFP-A5992."

Specification Relating to PROFIBUS Signal Numbers 3.2.1.3

The following shows the specification relating to the PROFIBUS signal numbers.

CR-500 Series Entire Signal Assignment 3.2.1.3.1

The signal assignment of the CR-500 Series is shown below. Among these signal numbers, 2000 through 5071 are assigned to PROFIBUS.



* Signal numbers enclosed with a thick border are present.

* Signal numbers are identical between input and output.

Fig. 3-4 CR-500 Series Entire Signal Assignment

3.2.1.3.2 PROFIBUS Robot Input Signal Assignment

Output 0 to 191 words of the PROFIBUS master station correspond to input 2000 to 5071 of the robot controller (slave station). Table 3-5 shows the correspondence between the I/O buffer memory (word = 16-bit units) of PROFIBUS and I/O bits of the robot.

Output word of master station	Input bit number of robot	Output word of master station	Input bit number of robot	Output word of master station	Input bit number of robot	Output word of master station	Input bit number of robot
0	2000 ~ 2015	48	2768 ~ 2783	96	3536 ~ 3551	144	4304 ~ 4319
1	2016 ~ 2031	49	2784 ~ 2799	97	3552 ~ 3567	145	4320 ~ 4335
2	2032 ~ 2047	50	2800 ~ 2815	98	3568 ~ 3583	146	4336 ~ 4351
3	2048 ~ 2063	51	2816 ~ 2831	99	3584 ~ 3599	147	4352 ~ 4367
4	2064 ~ 2079	52	2832 ~ 2847	100	3600 ~ 3615	148	4368 ~ 4383
5	2080 ~ 2095	53	2848 ~ 2863	101	3616 ~ 3631	149	4384 ~ 4399
6	2096 ~ 2111	54	2864 ~ 2879	102	3632 ~ 3647	150	4400 ~ 4415
7	2112 ~ 2127	55	2880 ~ 2895	103	3648 ~ 3663	151	4416 ~ 4431
8	2128 ~ 2143	56	2896 ~ 2911	104	3664 ~ 3679	152	4432 ~ 4447
9	2144 ~ 2159	57	2912 ~ 2927	105	3680 ~ 3695	153	4448 ~ 4463
10	2160 ~ 2175	58	2928 ~ 2943	106	3696 ~ 3711	154	4464 ~ 4479
11	2176 ~ 2191	59	2944 ~ 2959	107	3712 ~ 3727	155	4480 ~ 4495
12	2192 ~ 2207	60	2960 ~ 2975	108	3728 ~ 3743	156	4496 ~ 4511
13	2208 ~ 2223	61	2976 ~ 2991	109	3744 ~ 3759	157	4512 ~ 4527
14	2224 ~ 2239	62	2992 ~ 3007	110	3760 ~ 3775	158	4528 ~ 4543
15	2240 ~ 2255	63	3008 ~ 3023	111	3776 ~ 3791	159	4544 ~ 4559
16	2256 ~ 2271	64	3024 ~ 3039	112	3792 ~ 3807	160	4560 ~ 4575
17	2272 ~ 2287	65	3040 ~ 3055	113	3808 ~ 3823	161	4576 ~ 4591
18	2288 ~ 2303	66	3056 ~ 3071	114	3824 ~ 3839	162	4592 ~ 4607
19	2304 ~ 2319	67	3072 ~ 3087	115	3840 ~ 3855	163	4608 ~ 4623
20	2320 ~ 2335	68	3088 ~ 3103	116	3856 ~ 3871	164	4624 ~ 4639
21	2336 ~ 2351	69	3104 ~ 3119	117	3872 ~ 3887	165	4640 ~ 4655
22	2352 ~ 2367	70	3120 ~ 3135	118	3888 ~ 3903	166	4656 ~ 4671
23	2368 ~ 2383	71	3136 ~ 3151	119	3904 ~ 3919	167	4672 ~ 4687
24	2384 ~ 2399	72	3152 ~ 3167	120	3920 ~ 3935	168	4688 ~ 4703
25	2400 ~ 2415	73	3168 ~ 3183	121	3936 ~ 3951	169	4704 ~ 4719
26	2416 ~ 2431	74	3184 ~ 3199	122	3952 ~ 3967	170	4720 ~ 4735
27	2432 ~ 2447	75	3200 ~ 3215	123	3968 ~ 3983	171	4736 ~ 4751
28	2448 ~ 2463	76	3216 ~ 3231	124	3984 ~ 3999	172	4752 ~ 4767
29	2464 ~ 2479	77	3232 ~ 3247	125	4000 ~ 4015	173	4768 ~ 4783
30	2480 ~ 2495	78	3248 ~ 3263	126	4016 ~ 4031	174	4784 ~ 4799
31	2496 ~ 2511	79	3264 ~ 3279	127	4032 ~ 4047	175	4800 ~ 4815
32	2512 ~ 2527	80	3280 ~ 3295	128	4048 ~ 4063	176	4816 ~ 4831
33	2528 ~ 2543	81	3296 ~ 3311	129	4064 ~ 4079	177	4832 ~ 4847
34	2544 ~ 2559	82	3312 ~ 3327	130	4080 ~ 4095	178	4848 ~ 4863
35	2560 ~ 2575	83	3328 ~ 3343	131	4096 ~ 4111	179	4864 ~ 4879
36	2576 ~ 2591	84	3344 ~ 3359	132	4112 ~ 4127	180	4880 ~ 4895
37	2592 ~ 2607	85	$3360 \sim 3375$	133	4128 ~ 4143	181	4896 ~ 4911
38	2608 ~ 2623	86	$3376 \sim 3391$	134	4144 ~ 4159	182	4912 ~ 4927
39	2624 ~ 2639	87	3392 ~ 3407	135	$4160 \sim 41/5$	183	4928 ~ 4943
40	2640 ~ 2655	88	3408 ~ 3423	136	4176 ~ 4191	184	4944 ~ 4959
41	2656 ~ 2671	89	3424 ~ 3439	137	4192 ~ 4207	185	4960 ~ 4975
42	2072 ~ 2687	90	$3440 \sim 3455$	138	4208 ~ 4223	186	4976 ~ 4991
43	$2088 \sim 2/03$	91	$3456 \sim 34/1$	139	4224 ~ 4239	187	4992 ~ 5007
44	2/04 ~ 2/19	92	$34/2 \sim 348/$	140	4240 ~ 4255	188	5008 ~ 5023
45	$2/20 \sim 2/35$	93	3488 ~ 3503	141	4256 ~ 42/1	189	5024 ~ 5039
46	2/36 ~ 2/51	94	3504 ~ 3519	142	4272 ~ 4287	190	5040 ~ 5055
47	2/52 ~ 2/67	95	3520 ~ 3535	143	4288 ~ 4303	191	5056 ~ 5071

Table 3-5 PROFIBUS vs. Robot Input Signal Table

3.2.1.3.3 PROFIBUS Robot Output Signal Assignment

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Intput word of master station	Output bit number of robot	Input word of master station	Output bit number of robot	Input word of master station	Output bit number of robot	Input word of master station	Output bit number of robot
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	0	2000 ~ 2015	48	2768 ~ 2783	96	3536 ~ 3551	144	4304 ~ 4319
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1	$2016 \sim 2031$	40	$2784 \sim 2799$	97	3552 ~ 3567	145	4320 ~ 4335
3 2048 \sim 2063 51 2816 \sim 2831 99 3584 \sim 3595 147 4352 \sim 4 2064 \sim 2079 52 2332 \sim 2847 100 3600 \sim 3615 148 4356 \sim 5 2080 \sim 2075 53 2848 \sim 2879 102 3652 \sim 3631 144 4354 \sim 7 2112 \sim 2127 55 2800 \sim 2895 103 3648 \sim 3679 153 4440 \sim 9 2144 \sim 2190 57 2912 \sim 2927 105 3680 3995 153 4448 \sim 10 2160 2175 58 2928 2943 106 3680 3711 154 4448 \sim 11 2176 \sim 2131 59 2944 \sim 2995 108 3728 3743 156 4440 \sim 12 2192 2207 60 2960 2975 108 3722 3807 166 <t< td=""><td>2</td><td>$2032 \sim 2047$</td><td>50</td><td>$2800 \sim 2815$</td><td>98</td><td>$3568 \sim 3583$</td><td>146</td><td>$4336 \sim 4351$</td></t<>	2	$2032 \sim 2047$	50	$2800 \sim 2815$	98	$3568 \sim 3583$	146	$4336 \sim 4351$
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	3	$2048 \sim 2063$	51	$2816 \sim 2831$	99	$3584 \sim 3599$	147	4352 ~ 4367
5 2080 2095 63 2248 \sim 2873 101 3616 \sim 3647 150 4304 \sim 6 2096 \sim 2111 64 2864 \sim 2879 102 3532 \sim 3647 150 4400 \sim 7 2112 \sim 2127 65 2880 \sim 2927 105 3864 \sim 3679 152 4432 9 2144 \sim 2175 58 2928 2921 105 3869 \sim 3743 156 4486 \sim 10 2160 \sim 2175 58 2928 2943 106 3728 \sim 3743 156 4486 \sim 11 2176 \sim 2176 60 2960 \sim 2975 108 3728 \sim 3733 156 4486 \sim 13 2208 2223 62 2992 \sim 3007 1110 3760 \sim 3715 158 4528 \sim 14 2224 2287 65 3040 \sim 3055 113 3808 \sim 3839 162 45	4	$2064 \sim 2079$	52	$2832 \sim 2847$	100	$3600 \sim 3615$	148	$4368 \sim 4383$
62086211154226422710236323647150440072112 \sim 217155228022951033648 \sim 36631514416821282143562296229111043664 \sim 3679152443292144 \sim 215957291229271053680 \sim 36951534448102160 \sim 217558222829431063696 \sim 37111544464112167219159294422951073712 \sim 37271554480122192220760296029751083728 \sim 374315644961322082223612976 \sim 299110937443759157451214222422396229071103760 \sim 37711584528152400225563300830231113760 \sim 379115945441622562271643024 \sim 30391123792 \sim 38071604600172272228765304030551133808380316245922023042391673072 \sim 30711143824 \sim 3839162459221233623367031123135118 <t< td=""><td>5</td><td>$2080 \sim 2095$</td><td>53</td><td>$2848 \sim 2863$</td><td>101</td><td>3616 ~ 3631</td><td>149</td><td>4384 ~ 4399</td></t<>	5	$2080 \sim 2095$	53	$2848 \sim 2863$	101	3616 ~ 3631	149	4384 ~ 4399
721122127552882895103384836631514416821282143562896291110436643679152443292144215957291229271053680369515344481021602175582928294310638963711154444611217621915929442959107371237271554480122192220760296029751083728374315644961322082233612976299110937443759157451214224422396229923007110376037751584544152240225563300830231113776377115945441622562271643024303911237923807160456017227222876530403055113380838231614576202320233568306830711143866387116446242123362351693104311911738723871164462422235223677031203135118388639931664666 </td <td>6</td> <td>$2000 \sim 2000$</td> <td>54</td> <td>$2864 \sim 2879$</td> <td>102</td> <td>$3632 \sim 3647$</td> <td>150</td> <td>$4400 \sim 4415$</td>	6	$2000 \sim 2000$	54	$2864 \sim 2879$	102	$3632 \sim 3647$	150	$4400 \sim 4415$
8 2128 \sim 2143 56 2896 \sim 2927 104 3664 \sim 3679 152 4432 \sim 9 2144 \sim 2155 58 2928 \sim 2927 105 3680 \sim 3679 153 4448 \sim 10 2160 \sim 2175 58 2928 \sim 2943 106 3666 \sim 3711 154 4464 \sim 11 2168 \sim 2191 59 2944 \sim 2991 107 3712 \sim 3727 155 4480 \sim 12 2192 \sim 2207 60 2960 \sim 2971 108 3728 \sim 3727 155 4464 \sim 13 2208 \sim 2223 61 2976 \sim 2991 109 3776 \sim 3775 158 4528 \sim 14 22240 \sim 2235 63 3008 \sim 3033 112 3792 \sim 3807 160 4560 \sim 17 2272 \sim 2335 66 3056 \sim 3071 114 3824 \sim	7	$2112 \sim 2127$	55	$2880 \sim 2895$	102	$3648 \sim 3663$	151	4416 ~ 4431
92144 \sim 2159572912 \sim 29271053680 \sim 36951534448 \sim 102160 \sim 2175582928 \sim 29431063686 \sim 37111544464 \sim 112176 \sim 2191592944 \sim 29591073712 \sim 37271554480 \sim 122192 \sim 2207602960 \sim 29751083728 \sim 37431564496 \sim 132208 \sim 2223612976 \sim 29911093744 \sim 37591574512 \sim 142224 \sim 2239622992 \sim 30071103760 \sim 37751584528 \sim 162256 \sim 2271643024 \sim 30391123792 \sim 38071604560 \sim 172272 \sim 2287663040 \sim 30551133840 \sim 38551634608 \sim 202302 \sim 2335683088 \sim 31191173872 \sim 38711644624 \sim 212366 \sim 2351693104 \sim 31191183888 \sim 39031664666 \sim 222352 \sim 2367703120 \sim 31351183888 \sim 39031664668 \sim 232368 \sim 2384713168 \sim 31351183888 \sim 39031664666 \sim <td>8</td> <td>$2128 \sim 2143$</td> <td>56</td> <td>$2896 \sim 2911$</td> <td>104</td> <td>$3664 \sim 3679$</td> <td>152</td> <td>4432 ~ 4447</td>	8	$2128 \sim 2143$	56	$2896 \sim 2911$	104	$3664 \sim 3679$	152	4432 ~ 4447
102160 ~ 2175 582928 ~ 2943 1063686 ~ 3711 1544464112176 ~ 2175 582944 ~ 2959 1073712 ~ 3727 1554480122192 ~ 2207 602960 ~ 2975 1083728 ~ 3734 1564496132008 ~ 2223 612976 ~ 2991 1093744 ~ 3759 1574512142224 ~ 2239 622992 ~ 3007 1103760 ~ 3775 1584528152240 ~ 2255 633008 ~ 3023 1113776 ~ 3807 1604560162256 ~ 2271 643024 ~ 3039 1123792 ~ 3807 1604560172272 ~ 2287 653040 ~ 3055 1133808 ~ 3823 1614576182288 ~ 2339 663056 ~ 3071 1143824 ~ 3839 1624592202320 ~ 2335 683088 ~ 3103 1163856 ~ 3871 1644624212336 ~ 2351 693104 ~ 3119 1173872 ~ 3887 1654640222352 ~ 2367 703120 ~ 3135 1183888 ~ 3993 1664656232368 ~ 2383 713166 ~ 3135 1183966 ~ 3967 170<	9	$2144 \sim 2159$	57	2912 ~ 2927	105	3680 ~ 3695	153	4448 ~ 4463
112176 \sim 2191592944 \sim 29551073712 \sim 372711554480122192 \sim 2207602960 \sim 29751083728 \sim 37331564496132208 \sim 2223612976 \sim 29911093744 \sim 37591574512142224 \sim 2239622992 \sim 30071103760 \sim 37751584528152240 \sim 2255633008 \sim 30231113776 \sim 37911594544162256 \sim 2271643024 \sim 30391123792 \sim 38071604560172272 \sim 2287653040 \sim 30551133808 \sim 38231614576182288 \sim 2301663056 \sim 30711143824 \sim 38391624592192304 \sim 2319673072 \sim 30871153840 \sim 38451634608202320 \sim 2335683088 \sim 31351183888390316646562123622367703120 \sim 31351183888390316646562323682383713168 \sim 31831213936393516846882424402447753200 \sim 321512339683983171472024	10	$2160 \sim 2175$	58	2928 ~ 2943	106	$3696 \sim 3711$	154	4464 ~ 4479
122192 \sim 2207602960 \sim 29751083728 \sim 37431564496132208 \sim 2223612976 \sim 29911093744 \sim 37591574512 \sim 142224 \sim 2239622992 \sim 30071103760 \sim 37751584528 \sim 152240 \sim 2255633004 \sim 30231113776 \sim 37911594544162256 \sim 2271643024 \sim 30391123792 \sim 38071604560172272 \sim 2287653040 \sim 30551133806 \sim 38231614576182288 \sim 2339663056 \sim 30711143824 \sim 38391624592192304 \sim 2319673072 \sim 30871153840 \sim 38551634608202320 \sim 2335683088 \sim 31311163856 \sim 38711644624212336 \sim 2367703120 \sim 313511838871654600232368 \sim 2383713136 \sim 31511193904 \sim 39191674672242384 \sim 23837131683183121393639511684888252400 \sim 241573316831831213936239511694704<	11	2176 ~ 2191	59	2944 ~ 2959	107	3712 ~ 3727	155	4480 ~ 4495
132208 \sim 2223612976 \sim 2991109 3744 \sim 37591574512 \sim 142224 \sim 2239622992 \sim 30071103760 \sim 37751584528 \sim 152240 \sim 2255633008 \sim 30231113776 \sim 37911594544 \sim 162256 \sim 2287653040 \sim 30391123792 \sim 38071604560 \sim 172272 \sim 2287653040 \sim 30551133808 \sim 38231614576 \sim 182288 \sim 2303663066 \sim 30711143824 \sim 38391624592 \sim 202320 \sim 2335683088 \sim 31031163866 \sim 38711644624 \sim 212366 \sim 2381693104 \sim 31191173872 \sim 38871654640 \sim 232368 \sim 2383713166 \sim 31511193904 \sim 39191664656 \sim 242384 \sim 2399723152 \sim 31671123920 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262446 \sim 2447753200 \sim 3215123396839831714736<	12	2192 ~ 2207	60	$2960 \sim 2975$	108	3728 ~ 3743	156	4496 ~ 4511
142224 \sim 2239622992 \sim 30071103760 \sim 37751584528 \sim 152240 \sim 2255633008 \sim 30231113776 \sim 37911594544 \sim 162256 \sim 2271643024 \sim 30391123792 \sim 38071604660 \sim 172272 \sim 2287653004 \sim 30551133808 \sim 38231614576 \sim 182288 \sim 2303663056 \sim 30711143824 \sim 38391624592 \sim 192304 \sim 2319673072 \sim 30871153840 \sim 38551634608 \sim 202320 \sim 2335683088 \sim 31031163856 \sim 38711644624 \sim 212336 \sim 2351693104 \sim 31191173872 \sim 38871654640 \sim 222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 232368 \sim 2383713136 \sim 31511193904 \sim 39191674672 \sim 242384 \sim 2399723152 \sim 31671203920 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213968 \sim 39611704720 \sim </td <td>13</td> <td>2208 ~ 2223</td> <td>61</td> <td>2976 ~ 2991</td> <td>109</td> <td>3744 ~ 3759</td> <td>157</td> <td>4512 ~ 4527</td>	13	2208 ~ 2223	61	2976 ~ 2991	109	3744 ~ 3759	157	4512 ~ 4527
152240 \sim 2255633008 \sim 30231113776 \sim 37911594544 \sim 162256 \sim 2271643024 \sim 30391123792 \sim 38071604560 \sim 172272 \sim 2287653040 \sim 30551133808 \sim 38231614560 \sim 182288 \sim 2303663056 \sim 30711143824 \sim 38391624592 \sim 192304 \sim 2319673072 \sim 30871153840 \sim 38551634608 \sim 202320 \sim 2335683088 \sim 31031163856 \sim 38711644624 \sim 212336 \sim 2331693104 \sim 31191173872 \sim 38871654640 \sim 222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 232368 \sim 2383713136 \sim 31511193904 \sim 39191674772 \sim 242384 \sim 2399723152 \sim 31671203920 \sim 39351684688 \sim 252400 \sim 244174743184 \sim 31991223952 \sim 39671704720 \sim 272432 \sim 2447753200 \sim 32151233986 \sim 39831714736 <td< td=""><td>14</td><td>2224 ~ 2239</td><td>62</td><td>2992 ~ 3007</td><td>110</td><td>3760 ~ 3775</td><td>158</td><td>4528 ~ 4543</td></td<>	14	2224 ~ 2239	62	2992 ~ 3007	110	3760 ~ 3775	158	4528 ~ 4543
162256 ~ 2271 64 3024 ~ 3039 112 3792 ~ 3807 160 4560 172272 ~ 2287 65 3040 ~ 3055 113 3808 ~ 3823 161 4576 182288 ~ 2303 66 3056 ~ 3071 114 3824 ~ 3339 162 4592 192304 ~ 2319 67 3072 ~ 3087 115 3840 ~ 3855 163 4608 202320 ~ 2335 68 3088 ~ 3103 116 3856 ~ 3871 164 4624 212336 ~ 2351 69 3104 ~ 3119 117 3872 ~ 3887 165 4640 222352 ~ 2367 70 3120 ~ 3135 118 3886 ~ 3903 166 4656 232368 ~ 2383 71 3136 ~ 3151 119 3904 ~ 3919 167 4672 242384 ~ 2399 72 3152 ~ 3167 120 3920 ~ 3951 168 4688 252400 ~ 2415 73 3168 ~ 3183 121 3936 ~ 3951 169 4704 262416 ~ 2431 74 3184 ~ 3199 122 3952 ~ 3967 170 4720 292464 ~ 2463 76 3216 ~ 3231 124 3984 ~ 3999 172 4752 292464 ~ 2479 77 3232 <td>15</td> <td>2240 ~ 2255</td> <td>63</td> <td>3008 ~ 3023</td> <td>111</td> <td>3776 ~ 3791</td> <td>159</td> <td>4544 ~ 4559</td>	15	2240 ~ 2255	63	3008 ~ 3023	111	3776 ~ 3791	159	4544 ~ 4559
172272 \sim 2287653040 \sim 30551133808 \sim 38231614576 \sim 182288 \sim 2303663056 \sim 30711143824 \sim 38391624592 \sim 192304 \sim 2319673072 \sim 30871153840 \sim 38551634608 \sim 202320 \sim 2335683088 \sim 31031163856 \sim 38711644624 \sim 212336 \sim 2351693104 \sim 31191173872 \sim 38871654640 \sim 222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 2323682383713136 \sim 31671203904 \sim 39191674672 \sim 242384 \sim 2399723152 \sim 31671203902 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262416 \sim 2447753200 \sim 32311243984 \sim 39991724752 \sim 272432 \sim 2447753200 \sim 32311243984 \sim 39991724752 \sim 292464 \sim 24797732243247125400040151734768 \sim 3	16	2256 ~ 2271	64	3024 ~ 3039	112	3792 ~ 3807	160	4560 ~ 4575
182288 \sim 2303663056 \sim 30711143824 \sim 38391624592 \sim 192304 \sim 2319673072 \sim 30871153840 \sim 38551634608 \sim 202320 \sim 2335683088 \sim 31031163856 \sim 38711644624 \sim 212366 \sim 2351693104 \sim 31191173872 \sim 38871654640222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 232368 \sim 2383713166 \sim 31511193904 \sim 39191674672 \sim 242384 \sim 2399723152 \sim 31671203920 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262416 \sim 2431743184 \sim 31991223952 \sim 39671704720 \sim 2724322447753200 \sim 32151233968 \sim 39831714736<	17	2272 ~ 2287	65	3040 ~ 3055	113	3808 ~ 3823	161	4576 ~ 4591
192304 \sim 2319673072 \sim 30871153840 \sim 38551634608 \sim 202320 \sim 2335683088 \sim 31031163856 \sim 38711644624 \sim 212336 \sim 2351693104 \sim 31191173872 \sim 38871654640 \sim 222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 232368 \sim 2383713136 \sim 31511193904 \sim 39191674672 \sim 242384 \sim 2399723152 \sim 31671203920 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262416 \sim 2431743184 \sim 31991223952 \sim 39671704720 \sim 272432 \sim 2447753200 \sim 32151233968 \sim 39831714736<	18	2288 ~ 2303	66	3056 ~ 3071	114	3824 ~ 3839	162	4592 ~ 4607
202320 \sim 2335683088 \sim 31031163856 \sim 38711644624 \sim 212336 \sim 2351693104 \sim 31191173872 \sim 38871654640 \sim 222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 232368 \sim 2383713136 \sim 31511193904 \sim 39191674672 \sim 242384 \sim 2399723152 \sim 31671203920 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262416 \sim 2431743184 \sim 31991223952 \sim 39671704720 \sim 272432 \sim 2447753200 \sim 32151233968 \sim 39831714736 \sim 282448 \sim 2463763216 \sim 32311243984 \sim 39991724752 \sim 302480 \sim 2495783248 \sim 3263126401640631764816 \sim 312496 \sim 2511793264 \sim 3279127403240471754800 \sim 332528 \sim 2543813296 \sim 33111294064 \sim 40791774832 \sim <	19	2304 ~ 2319	67	3072 ~ 3087	115	3840 ~ 3855	163	4608 ~ 4623
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	20	2320 ~ 2335	68	3088 ~ 3103	116	3856 ~ 3871	164	4624 ~ 4639
222352 \sim 2367703120 \sim 31351183888 \sim 39031664656 \sim 232368 \sim 2383713136 \sim 31511193904 \sim 39191674672 \sim 242384 \sim 2399723152 \sim 31671203920 \sim 39351684688 \sim 252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262416 \sim 2431743184 \sim 31991223952 \sim 39671704720 \sim 272432 \sim 2447753200 \sim 32151233968 \sim 39831714736<	21	2336 ~ 2351	69	3104 ~ 3119	117	3872 ~ 3887	165	4640 ~ 4655
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	22	2352 ~ 2367	70	3120 ~ 3135	118	3888 ~ 3903	166	4656 ~ 4671
242384 \sim 2399723152 \sim 31671203920 \sim 39351684688252400 \sim 2415733168 \sim 31831213936 \sim 39511694704 \sim 262416 \sim 2431743184 \sim 31991223952 \sim 39671704720 \sim 272432 \sim 2447753200 \sim 32151233968 \sim 39831714736 \sim 282448 \sim 2463763216 \sim 32311243984 \sim 39991724752 \sim 2924642479773232 \sim 32471254000 \sim 40151734768 \sim 3024802495783248 \sim 32791274032 \sim 40471754800 \sim 3124962511793264 \sim 32791274032 \sim 40471754800 \sim 322512 \sim 2527803280 \sim 33251284048 \sim 40631764816 \sim 3325282543813296 \sim 33111294064 \sim 40791774832 \sim 342544 \sim 2559823312 \sim 33271304080 \sim 40951784848 \sim 362576 \sim 2591843344 \sim 33591324112 \sim 41271804880 \sim 382608 </td <td>23</td> <td>2368 ~ 2383</td> <td>71</td> <td>3136 ~ 3151</td> <td>119</td> <td>3904 ~ 3919</td> <td>167</td> <td>4672 ~ 4687</td>	23	2368 ~ 2383	71	3136 ~ 3151	119	3904 ~ 3919	167	4672 ~ 4687
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	24	2384 ~ 2399	72	3152 ~ 3167	120	3920 ~ 3935	168	4688 ~ 4703
262416 \sim 2431743184 \sim 31991223952 \sim 39671704720 \sim 272432 \sim 2447753200 \sim 32151233968 \sim 39831714736 \sim 282448 \sim 2463763216 \sim 32311243984 \sim 39991724752 \sim 292464 \sim 2479773232 \sim 32471254000 \sim 40151734768 \sim 302480 \sim 2495783248 \sim 32631264016 \sim 40311744784 \sim 3124962511793264 \sim 32791274032 \sim 40471754800 \sim 322512 \sim 2527803280 \sim 32951284048 \sim 40631764816 \sim 332528 \sim 2543813296 \sim 33111294064 \sim 40791774832 \sim 342544 \sim 2559823312 \sim 33271304080 \sim 40951784848 \sim 362576 \sim 2575833328 \sim 33431314096 \sim 41111794864 \sim 382608 \sim 2623863376 \sim 33911344144 \sim 41591824912 \sim 392624 \sim 2639873392 \sim 34071354160 \sim 41751834928<	25	2400 ~ 2415	73	3168 ~ 3183	121	3936 ~ 3951	169	4704 ~ 4719
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	26	2416 ~ 2431	74	3184 ~ 3199	122	3952 ~ 3967	170	4720 ~ 4735
282448 ~ 2463763216 ~ 32311243984 ~ 39991724752 ~292464 ~ 2479773232 ~ 32471254000 ~ 40151734768 ~302480 ~ 2495783248 ~ 32631264016 ~ 40311744784 ~312496 ~ 2511793264 ~ 32791274032 ~ 40471754800 ~322512 ~ 2527803280 ~ 32951284048 ~ 40631764816 ~332528 ~ 2543813296 ~ 33111294064 ~ 40791774832 ~342544 ~ 2559823312 ~ 33271304080 ~ 40951784848 ~352560 ~ 2575833328 ~ 33431314096 ~ 41111794864 ~362576 ~ 2591843344 ~ 33591324112 ~ 41271804880 ~372592 ~ 2607853360 ~ 33751334128 ~ 41431814896 ~382608 ~ 2623863376 ~ 33911344144 ~ 41591824912 ~392624 ~ 2639873392 ~ 34071354160 ~ 41751834928 ~402640 ~ 2655883408 ~ 34231364176 ~ 41911844944 ~412656 ~ 2671893424 ~ 34391374192 ~ 42071854960 ~	27	2432 ~ 2447	75	3200 ~ 3215	123	3968 ~ 3983	171	4736 ~ 4751
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	28	2448 ~ 2463	76	3216 ~ 3231	124	3984 ~ 3999	172	4752 ~ 4767
30 $2480 \sim 2495$ 78 $3248 \sim 3263$ 126 $4016 \sim 4031$ 174 $4784 \sim 4784$ 31 $2496 \sim 2511$ 79 $3264 \sim 3279$ 127 $4032 \sim 4047$ 175 $4800 \sim 3295$ 32 $2512 \sim 2527$ 80 $3280 \sim 3295$ 128 $4048 \sim 4063$ 176 $4816 \sim 4816 \sim 4079$ 33 $2528 \sim 2543$ 81 $3296 \sim 3311$ 129 $4064 \sim 4079$ 177 $4832 \sim 4832 \sim 4848$ 34 $2544 \sim 2559$ 82 $3312 \sim 3327$ 130 $4080 \sim 4095$ 178 $4848 \sim 4848 \sim 4863$ 35 $2560 \sim 2575$ 83 $3328 \sim 3343$ 131 $4096 \sim 4111$ 179 $4864 \sim 4880 \sim 4880$	29	2464 ~ 2479	77	3232 ~ 3247	125	4000 ~ 4015	173	4768 ~ 4783
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	30	2480 ~ 2495	78	3248 ~ 3263	126	4016 ~ 4031	174	4784 ~ 4799
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	31	2496 ~ 2511	79	3264 ~ 3279	127	4032 ~ 4047	175	4800 ~ 4815
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	32	2512 ~ 2527	80	3280 ~ 3295	128	4048 ~ 4063	176	4816 ~ 4831
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	33	2528 ~ 2543	81	3296 ~ 3311	129	4064 ~ 4079	177	4832 ~ 4847
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	34	2544 ~ 2559	82	3312 ~ 3327	130	4080 ~ 4095	178	4848 ~ 4863
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	35	2560 ~ 2575	83	3328 ~ 3343	131	4096 ~ 4111	179	4864 ~ 4879
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	36	2576 ~ 2591	84	3344 ~ 3359	132	4112 ~ 4127	180	4880 ~ 4895
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	37	2592 ~ 2607	85	3360 ~ 3375	133	4128 ~ 4143	181	4896 ~ 4911
39 2624 ~ 2639 87 3392 ~ 3407 135 4160 ~ 4175 183 4928 40 2640 ~ 2655 88 3408 ~ 3423 136 4176 ~ 4191 184 4944 ~ 41 2656 ~ 2671 89 3424 ~ 3439 137 4192 ~ 4207 185 4960 ~	38	2608 ~ 2623	86	3376 ~ 3391	134	4144 ~ 4159	182	4912 ~ 4927
40 2640 ~ 2655 88 3408 ~ 3423 136 4176 ~ 4191 184 4944 41 2656 ~ 2671 89 3424 ~ 3439 137 4192 ~ 4207 185 4960 ~ 40 2670 2671 89 3424 ~ 3439 137 4192 ~ 4207 185 4960 ~	39	2624 ~ 2639	87	3392 ~ 3407	135	4160 ~ 4175	183	4928 ~ 4943
41 2656 ~ 2671 89 3424 ~ 3439 137 4192 ~ 4207 185 4960 ~	40	2640 ~ 2655	88	3408 ~ 3423	136	4176 ~ 4191	184	4944 ~ 4959
	41	2656 ~ 2671	89	3424 ~ 3439	137	4192 ~ 4207	185	4960 ~ 4975
42 2672 ~ 2687 90 3440 ~ 3455 138 4208 ~ 4223 186 4976 ~	42	2672 ~ 2687	90	3440 ~ 3455	138	4208 ~ 4223	186	4976 ~ 4991
43 2688 ~ 2703 91 3456 ~ 3471 139 4224 ~ 4239 187 4992 ~	43	2688 ~ 2703	91	3456 ~ 3471	139	4224 ~ 4239	187	4992 ~ 5007
44 2704 ~ 2719 92 3472 ~ 3487 140 4240 ~ 4255 188 5008 ~	44	2704 ~ 2719	92	3472 ~ 3487	140	4240 ~ 4255	188	5008 ~ 5023
45 2720 ~ 2735 93 3488 ~ 3503 141 4256 ~ 4271 189 5024 ~	45	2720 ~ 2735	93	3488 ~ 3503	141	4256 ~ 4271	189	5024 ~ 5039
46 2736 ~ 2751 94 3504 ~ 3519 142 4272 ~ 4287 190 5040 ~	46	2736 ~ 2751	94	3504 ~ 3519	142	4272 ~ 4287	190	5040 ~ 5055
47 2752 ~ 2767 95 3520 ~ 3535 143 4288 ~ 4303 191 5056 ~	47	2752 ~ 2767	95	3520 ~ 3535	143	4288 ~ 4303	191	5056 ~ 5071

 Table 3-6
 PROFIBUS vs. Robot Output Signal Table

3.2.1.3.4 Bit Arrangement of One Word

Fig. 3-5 shows the bit arrangement of one word.

	One word														
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Number 2015	Number 2014	Number 2013	Number 2012	Number 2013	Number 2010	Number 2009	Number 2008	Number 2007	Number 2006	Number 2005	Number 2004	Number 2003	Number 2002	Number 2001	Number 2000

Fig. 3-5 Bit Arrangement of One Word

3.2.1.3.5 Example of PROFIBUS Signal Assignment

Both the input/output signals of PROFIBUS can freely be specified by the user by setting the parameters of the master station (slave parameters) (as shown in the following examples). For both the input/output signals, any size can be assigned up to a maximum of 122 words among 192 words. However, the total size of the input/output signals assigned must not exceed 192 words.

Example 1:

Master stationRobot (input to robot) ... 96 words from input signal numbers 2000 through 3535RobotMaster station (output from robot) ... 96 words from output signal numbers 2000 through 3535

Example 2:

Master station \rightarrow Robot (input to robot) ... 122 words from input signal numbers 2000 through 3951 Robot \rightarrow Master station (output from robot) ... 70 words from output signal numbers 2000 through 3119

Example 1:

Example 2:





4 Items to Be Checked Before Using This Product (Procedure 1)

4.1 Checking the Product

The product you purchased consists of the following items as standard. Please verify that the package contains all the items.

No.	Description	Туре	Quantity
[1]	Instruction Manual (this manual)	BFP-A8348	1
[2]	PROFIBUS interface card	RZ577A	1
[3]	Ferrite core	Equivalent to ZCAT3035	2
[4]	GSD file(floppy disk)	MELFA074D.GSD	1
[5]	Metal clamp	AL4	2

Table 4-1 List of the Standard Items in the Package

Note) Numbers in the above table correspond to those in Figure 4-1 below.



Fig. 4-1 Items Contained in the Package

4.2 Devices to Be Furnished by the Customer

When using Mitsubishi Electric CC-Link interface card, the devices listed in Table 4.2 below must be furnished by the customer.

Device to be furnished	Condition
Master station	
Communication cable	For more details, contact the International PROFIBUS Organization. <u>http://www.profibus.com/</u>
Connector	

Table 4-2 Connection Specification

5 Hardware Settings

No hardware setting is required for the PROFIBUS interface card. All settings are performed using parameters on both the master station and robot controller sides.

Connection and Wiring (Procedure 2) 6

Mounting the PROFIBUS Interface Card to the Main Body 6.1

For details of mounting method, refer to "Installing Optional Devices" in "Controller Setup and Basic Operations to Maintenance" of each controller's instruction manual.

Controller type	Installation method	Number of Instruction Manual	Remarks
CR1	1) Install the extension	BFP-A8054	There is no restriction on installation slots.
	option box. 2) Install the PROFIBUS interface card.		The PROFIBUS interface card can be installed into any of slots 1 through 3. * As for a PROFIBUS cable connector, use right-angled type (90 degree cable outlet).
CR2A/CR2B	Install the PROFIBUS	BFP-A5991	There is no restriction on installation slots.
	interface card into an option slot inside the		The PROFIBUS interface card can be installed into any of slots 1 through 3.
	controller.		* As for a PROFIBUS cable connector, use right-angled type (90 degree cable outlet).
CR2	Install the PROFIBUS	BFP-A5991	There is no restriction on installation slots.
	interface card into an option slot of the		The PROFIBUS interface card can be installed into either slot 1 or 2.
CR3	R6xCPU unit.	BFP-A8324	There is no restriction on installation slots.
CR4/CR7/CR8		BFP-A8077	The PROFIBUS interface card can be installed into either slot 1 or 2.

Table 6-1 **Robot Controller Installation Method by Type**

The PROFIBUS interface card can be installed into any slot; however, it cannot be used together with a CC-Link interface card (HR575).

6.2 PROFIBUS Connection Between the Master Station and the Robot Controller Connect the master station and the robot controller using a PROFIBUS cable.



PROFIBUS Master station

Examples of Devices Connected Fig. 6-1

6.2.1 Connector Pin Assignment (D-SUB9 pin)

Pin no.	Name	Description
1	SHIELD	Shield, Protection earth
2	Reserved	-
3	RxD/TxD-P	Receive data/Transmit data-P
4	Reserved	-
5	DGND Note1)	Data earth (0V)
6	VP Note1)	Voltage+ (+5V)
7	Reserved	-
8	RxD/TxD-N	Receive data/Transmit data-N
9	Reserved	-

Note1) These signals are used to connect terminators.

6.2.2 Connection

A terminator is required at the terminal station of each segment of a communication line. A terminator must be installed at locations between (+) and (-): 220Ω , between 5V and (+): 390Ω , and between 0V and (-): 390Ω .

Use special PROFIBUS interface connectors embedded with a terminator.



Fig. 6-2 Cable Wiring Diagram



Fig. 6-3 Terminator

Installation of the Ferrite Core 6.3

Install the ferrite core attached to the PROFIBUS cable.



Fig. 6-4 Installation image of the ferrite core

6.4 Checking Connections Before using the PROFIBUS interface card, check the following items again.

Table 6-2 Connection Check Items

No.	Check item	Check
1	Is the PROFIBUS interface card securely mounted in an option slot of the robot controller?	
2	Are the PROFIBUS interface card and your external devices correctly connected via a PROFIBUS cable? Have terminal settings been performed?	
3	Is the ferrite core correctly connected to the PROFIBUS cable?	

7 Parameter Settings (Procedure 3)

This chapter describes the settings of parameters on the master station and the robot controller.

7.1 Parameter Settings on the Master Station Side

Set the parameters of the master station by referring to the applicable manual of the master station device.

- 1) Examine the number of WORD which will be assigned to robot controllers, and set the parameter of master station.
- 2) Set the station number of the robot (slave side) to the master station's parameter.

Examine how many words will be assigned to the robot controller, then set it in a parameter of the master station. Because there are several types of master station devices, assign the applicable number of words to the robot controller according to your system configuration.

You can set the byte swap of word data. Set it if you want to swap upper and lower bytes.

7.2 Setting Parameters on the Robot Controller Side

The robot controller has the following three mutually associated parameters. To change parameter settings, refer to the "Detailed explanations of functions and operations BFP-A5992."

Parameter name	No. of elements	Name/Description	Initial value
PBMODE	Integer 1	 This parameter switches the operational mode of the PROFIBUS interface card between Normal mode and Self-diagnostics mode. 0: Normal mode / 2: Self-diagnostics mode 9, 10, 11: Reservation (Cannot be used) Values other than 0, 2, 9, 10 and 11 will generate errors when the power supply is turned ON. If self-diagnostics results in a fault, it will generate an error. If the Self-diagnostic mode is set, the LEDs on the operation panel repeatedly display "7 7 " - "7. 7. " for about 3 seconds in addition to regular displays when the power supply is turned ON, and then the system is started normally. 	0
PBNUM	Integer 1	This parameter sets the station number of the PROFIBUS interface card1 to 125 Set the station number before use. -1: Clears the station number saved in the flash ROM on the PROFIBUS Interface. (Set up by master station class-2.) If the power supply is turned off, this value will be 126. (Un-setting the station number.) 0 to 125: Station number (When setting up the station number, set the "PBMC" parameter to "1". It is written also in the flash ROM.) 126: Un-setting the station number. (Factory preset value)	126
PBMC	Integer 1	This parameter sets the class of the PROFIBUS master station. 1: Class 1 The station number requires the setup by the slave parameter of the master station, and the "PBNUM" of the slave station. 2: Class 2 The station number change from the master station class-2 is possible. The setting value of "PBNUM" is invalid. The station number is saved into the flash ROM on the PROFIBUS Interface.	1
E8500	Integer 1	This parameter ignores errors of the PROFIBUS interface card. It is used when starting the system. It prevents errors of the PROFIBUS interface card from being issued. It is valid only once while the power supply is ON. When the power supply is turned OFF, it reverts to the initial value of " Enable errors." 0: Enable errors / 1: Ignore errors	0
PBCNT	Integer 1	Specify the error detection interval of the PROFIBUS interface card. Normally, use the factory default setting (0). (0 to 32767 in units of msec) Change this value only if a communication error occurs frequently due to the adverse effect of noise in your surrounding environment. (Example: 50 to 70 msec) When changing this value, be sure to set a minimum of 10 msec.	0

 Table 7-1
 Parameters on the Robot Controller Side

7.2.1 PROFIBUS Mode Setting Parameter (PBMODE)

The PBMODE parameter sets whether the PROFIBUS card will start after performing self-diagnostics or without performing it when the power supply to the robot controller is turned ON. When in the Self-diagnostics mode, the power supply ON processing time prolongs by about 3 seconds.

7.2.2 PROFIBUS Station Number Setting Parameter (PBNUM)

The PBNUM parameter sets the station number of PROFIBUS. The initial value is 126. Please be careful not to use a station number already used by other devices when changing it.

7.2.3 PROFIBUS Master Station Class Setting Parameter (PBMC)

The PBMC parameter sets the class of master station side. The initial setting is class-1. Change this value if using by class-2.

7.2.4 PROFIBUS Error Ignore Parameter (E8500)

The E8500 parameter prevents the generation of PROFIBUS related errors from being issued while mounting and operating a PROFIBUS card to the robot when the master station has not been adjusted or set. If this parameter is set to 1 while an error in 8500's is being generated, the error can be reset. Thereafter, no more errors in 8500's will be generated. This parameter takes effect immediately after its value is changed. If the power supply is turned ON/OFF once in order to prevent PROFIBUS communication errors from not being able to be detected in case you forgot to set this parameter, the value of this parameter reverts to the initial value, thereby detecting errors again.

7.2.5 PROFIBUS Error Detection Interval Parameter (PBCNT)

Normally, use this parameter with the factory default setting (0). Change this value only if a communication error occurs frequently due to the adverse effect of noise in your surrounding environment. Setting 50 to 70 msec is sufficient in normal circumstances. If an excessively large value is set, the robot controller will not be able to detect errors if the PROFIBUS interface card generates errors intermittently. Pay extra attention when setting this value.

If a value of 10 or larger is set, the controller will generate an error only if the controller detects an error in the PROFIBUS interface card continuously for the designated duration. If an error does not occur continuously, the controller will not generate an error.

If a value less than 10 is set, the controller immediately issues an error upon detecting an error in the PROFIBUS interface card.

7.2.6 Dedicated I/O Parameters

In the robot controller, the input/output signals are divided into dedicated signals assigned to the operations specific to the robot system and general-purpose signals used in robot programs. See Fig. 7-1 below.



Fig. 7-1 Conceptual Diagram of Dedicated I/O and General-purpose I/O

PROFIBUS signals can freely be assigned to dedicated I/O and general-purpose I/O.

7.2.7 Caution When Assigning Signals

Signals from 2000 through 5071 can be assigned as PROFIBUS signals for both input and output; however, only words assigned at the master station can be used for communication. Therefore, even within 2000 and 5071, communication cannot be performed by accessing signals having numbers not assigned at the master station. But, no error will be generated even if such signal numbers are accessed by robot programs. Be sure to use signals having numbers assigned at the master station.





8 Starting use

From now on, the standard operation procedure is used. For details, refer to the "Detailed explanations of functions and operations BFP-A5992."



1) Assignment examples of dedicated input/output

Parameter	Input		Output		
name	Name	No.	Name	No.	
IOENA	Operation right input	2000	Operation right output	2000	
START	Start input	2001	Running state output	2001	
STOP2	Stop	2002	Standby state output	2002	
SLOTINIT	Program reset	2003	Program selection enabled	2003	
SRVON	Servo ON enabled	2004	In servo ON	2004	
SRVOFF	Servo OFF	2005			

Once I/O parameters have been changed, turn OFF and then ON the power supply again.

2) Create the robot program (examples of use of general-purpose input/output) 10 *LBL1:IF M IN(2010)=0 THEN GOTO *LBL1

20 M1=M_INB(2011)
30 SELECT CASE M1
40 CASE 1
50 GOSUB *LOAD
60 CASE 2
70 GOSUB *UNLOAD
80 CASE 3
90 GOSUB *GOHOME
100 CASE 4
110 GOSUB *SUB1
120 END SELECT
130 END
1000 *LOAD
•
2000 *UNLOAD

8.1 Dedicated I/O

The settings of dedicated I/O are the same as those of standard I/O. By setting signals numbered from 2000 through 5071, PROFIBUS becomes ready for use. For details of dedicated I/O, refer to Chapter 6, " Functions of External I/O " in the "Detailed explanations of functions and operations BFP-A5992."

8.2 General-purpose I/O

General-purpose I/O can be accessed using system variables for I/O, such as M_IN and M_OUT.

However, no access that crosses PROFIBUS areas, such as number 1999, using variables that access multiple bits, such as M_INB, M_INW, M_OUTB and M_OUTW, is allowed. Be sure to create programs so that access is made within an area from numbers 2000 and 5071.

Correct examples: M_IN(2000), M_INB(2010), M_OUT(3000), M_OUTB(3010) Incorrect examples: M_INB(1999), M_INW(5070), M_OUTB(1999)=200, M_OUTW(1999)=200

8.3 Sample Program for Loop back

The following describes a sample program for checking the signals of the PROFIBUS interface card. Use this sample program during startup adjustment as necessary.

Signal Assignment Conditions (Settings in Extended Service Mode)

Input on robot side (master station output)	0th to 95th words
Output on robot side (master station input)	0th to 95th words

Robot Program Specification Copy all input bits to output bits as they are.

[Program example1]
10 'Loop back the input signals to the robot to the output signals as they are (for bit check).
20 FOR M1=2000 TO 3535
30 M_OUT(M1)=M_IN(M1) 'Copy using bit variables.
40 NEXT M1
50 END
[Program example2]
10 'Loop back the input signals to the robot to the output signals as they are (for byte check).
20 FOR M1=2000 TO 3535 STEP 8
30 M_OUTB(M1)=M_INB(M1) Copy using byte variables.
40 NEXT M1
50 END
[Program example3]
10 'Loop back the input signals to the robot to the output signals as they are (for word check)
20 FOR M1=2000 TO 3535 STEP 16
30 M OUTW(M1)=M INW(M1) 'Copy using word variables
40 NEXT M1
50 FND

Execute the program shown above, and check the looped back signals on the master station side.

9 Troubleshooting

If you suspect there is a problem, check this chapter first. For errors other than those listed below, refer to the "Troubleshooting BFP-A5993."

9.1 Error List

Table 9-1 Error List

Error No. ^{Note1)}	Error message	Cause	Action to take	
H8500	PROFIBUS has not been initialized.	A hardware failure has been detected. Hardware may have been failure.	It is necessary to replace the PROFIBUS interface card.	
H8501	A PROFIBUS watchdog timer error has occurred.	A hardware failure has been detected. Hardware may have been failure.	It is necessary to replace the PROFIBUS interface card.	
H8502	A multiple number of PROFIBUS interface cards are mounted.	Only one PROFIBUS interface card can be mounted.	Mount only one PROFIBUS interface card.	
H8503	Both a PROFIBUS interface card and a CC-Link card are mounted.	Only one PROFIBUS interface card or CC-Link card can be mounted.	Mount only one PROFIBUS interface card or CC-Link card.	
H8504	An error has occurred in PROFIBUS self-diagnostics.	A hardware failure has been detected. Hardware may have been failure.	It is necessary to replace the PROFIBUS interface card.	
H8505	PBMODE parameter is illegal.	Illegal parameter (PBMODE).	Correct PBMODE parameter. (0:Normal/2:Self-diagnostics)	
H8506	PROFIBUS station number cannot be set.	Turn the power OFF and then ON once.	The hardware is failure, if recurring. It is necessary to replace the PROFIBUS interface card.	
H8507	PBMC parameter is illegal.	Illegal parameter (PBMC).	Correct PBMC parameter. (1:Class1/2:Class2)	
H8510	PROFIBUS station number error.	A value outside of the valid setting station number range is specified.	Specify a station number between –1 and 125 in the PBNUM parameter.	
H8520	PROFIBUS station number rewrite error.	An attempt was made to rewrite a station number in the station number rewrite prohibited state.	Clear the station number by setting 0.	
H8530 Note2)	PROFIBUS station number rewrite count exceeded error.	At least 60 station number rewrite operations were continuously performed to Flash ROM.	It is necessary to replace the PROFIBUS interface card.	
H8540 Note2)	PROFIBUS Flash ROM memory access error.	Hardware failure	It is necessary to replace the PROFIBUS interface card.	
H8550	Invalid PROFIBUS receive parameter error.	 The communication WDT set value is too long. The minimum response time value is outside of the settable range. 	Check the slave parameters of the master station (refer to the applicable master station manual).	
H8560	PROFIBUS communication chip failure.	Hardware failure	It is necessary to replace the PROFIBUS interface card.	
H8570 Note3)	PROFIBUS communication timeout error.	 A cable is disconnected. The power supply on the master station side has been shut down. The communication WDT parameter value of the master station is too small. It is possible that the station number settings on the master and robot sides do not match. It may be affected by noise in the surrounding environment. 	 Check cable connections. Check the power supply to the master station. Set a larger value in the communication WDT parameter of the master station. Match the station number settings on the master and robot sides. If caused by noise, set the PBCNT parameter value and check again. 	
H8580	PROFIBUS I/O configuration information error.	 The data module is not of a word type. The swap set value is out of range. The data assignment mode set value is out of range. The set value of the number of data modules is out of range. The data module setting is out of range. The parameter setting station number is invalid. 	Check the slave parameters of the master station (refer to the applicable master station manual).	

Note1) "H" prefixed to an error number indicates a high level error.

Note2) H8530 and H8540 errors do not currently occur.

Note3) If an H8570 error occurs, see Section 9.2, "When PROFIBUS cannot be Connected Due to H8570 Error" below.

9.2 When PROFIBUS cannot be Connected Due to H8570 Error

- 1) Is the power supply to the master station unit ON?
- 2) Is the master station operating normally?
- * If the master station has not been started before turning ON the power supply to the robot controller, an H8570 error occurs.
- 3) Is the master station connected correctly?
- 4) Do the parameter settings of the master station match the PROFIBUS signals on the robot side?
- 5) Is there any noise source in the peripheral devices?
- 6) To ignore the H8570 error, change the E8500 parameter.
- 7) Set the same station number of the station number of master station side and robot side. The robot side is set with the "PBNUM" parameter.

10 Appendix

10.1 PROFIBUS Robot (System) Status Variables

The following describes the robot (system) status variables relating to PROFIBUS in details. The status of the PROFIBUS Interface can be checked if the monitor of the following system status variable is carried out by robot.

Variable name	Туре	Name	Function	Read/ Write
M_PBNUM	Integer 1	Operating station number	The number of the station currently in operation	Read
M_PBFNUM	Integer 1	Station number setting in the flash ROM	The station number which saved in the flash ROM	Read

Table 10-1 List of Robot (System) Status Variables Used in PROFIBUS



Certificate

PROFIBUS Nutzerorganisation e.V. grants to

Mitsubishi Electric Corporation Nagoya Works

1-14, Yada-minami 5-chome, Higashi-ku, Nagoya 461-8670, Japan the Certificate No.: Z01027 for the following product:

Name: 2A-RZ577 Model: Robot Controller Revision: Rev. A*; SW: AA GSD: MLFA074D.gsd

This certificate confirms that the device has successfully passed the conformance tests for PROFIBUS DP Slave devices.

The tests were executed in accordance with "Test Specifications for PROFIBUS DP Slaves, Version 2.0, February 2000" based on EN 50170-2 at Tokyo PROFIBUS Test Laboratory which is an authorized test laboratory of PROFIBUS Nutzerorganisation. The detailed test procedure and the test results are recorded in the inspection report TTL-012-2.

This certificate is granted according to the PNO guideline for testing and certification (PRZ) dated August 1, 1999 and is valid for 3 years, i.e. until July 29, 2007.

Karlsruhe, December 14, 2004

PROF

(Official in Charge)

Board of PROFIBUS Nutzerorganisation e. V.

(Edgar Küster)



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