FANUC Robot series

R-J CONTROLLER

Data Transfer Function

OPERATOR'S MANUAL

B-80434E/02

Before using the Robot, be sure to read the "FANUC Robot Safety Manual (B-80687EN)" and understand the content.

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In this manual we have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

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1 GENERAL

1.1 Overview of the data transfer

This manual describes the data transfer function that the host inquires , sets and controls the data of R-J through RS-232-C interface used to connect between the host device and FANUC SYSTEM R-MODEL J (hereinafter R-J or Robot).

1.2 Function to connect R-J and host

R-J has the following function that host controls the robot.

No.	Function	Description
1	Data inquiry	Inquires the contents of the data requested from the host device. The following data can be inquired: System variable(Note1), register, position register, robot status, current position and program directory.
2	Data setting	Sets the contents of the data requested to be set from the host device to R-J memory. The following data can be set: System variable(Note1) , register, position register and control commands.
3	Program inquiry (Read)	Transfers the program file requested to be set by the host device from R-J to the host device one by one. Note2)
4	Program setting (Write)	Transfers the program file requested to be set by the host device from the host device to R-J memory. Note2)
5	Program call and start	After calling the program requested to start by the host device from the R-J memory , starts it.
6	Program deletion	Deletes the program file requested to be deleted by the host device from the R-J memory.
7	Alarm occurrence report	When the alarm occurs on the R-J side, reports this to the host device.

Note1) When a system file is inquired or set, all data of the specified file is treated at the same time. Besides, the system variable can be set only at control start mode.

Note2) The type of the internal data, which is inquired or tansferred as program data, is binary.

2 TRANSFER DATA

2.1 Table of the transfer data

The following transfer data is provided.For the detailed explanation for each transfer data, refer to "2.2 Transfer data".

Abbr.	Name	Bytes	Explanation
TCC	Transfer control character	1	Character to report the details of transfer.
ALM	Alarm information	8	Indicates the occured alarm.
INF	Robot status	6	Indicates the robot status.
AXD	Current position data	?	Current position (metric value for each axis or cartesian coordinate value)
TYPE	Transfer data type	1	Indicates the type of the data to be transferred. Register Inquiry/set request .....:B0H Integer type .....:21H Real type .....:22H Position register Inquiry/set request .....:B3H Conversion expression .....:24H XYZWPR expression .....:27H XYZAES expression .....:2BH XYZ+wrist joint angle expresstion .....:2DH Conversion with the extended axes expression .....:2EH XYZWPR with the extended axes expression .....:30H XYZAES with the extended axes expression .....:33H XYZ + wrist joint angle expresstion with the extended axes .....:35H Each axis expresstion .....:36H Comment Register .....:3AH Position register .....:3CH Current position Metric value for each axis .....:A1H Cartesian coordinate value .....:A2H

Abbr.	Name	Bytes	Explanation
SNO	Start data number	3	Indicates the data number to be transferred
ENO	End data number	3	Register: 1 - The maximum element number of the register Position register : 1 - The maximum element number of the position register
DTI	Integer data	11	Indicates the contents of the register data to be inquired or set
DTR	Real data	13	Indicates the contents of the register or position register data to be inquired or set.
CCM	Control command	4	Command to control R-J from the host device.
PNAM	Program name	11	Indicates the program or system variable file name to be inquired or set.
PNT	Program byte number	10	Indicates the byte number of the program or system variable to be inquired or set.
PGNO	Number of programs registered	10	Number of programs registered in the directory to be inquired.
RPNT	Residual byte number	10	Residual byte number in the program field.
DT	Data	?	The contents of the data to be inquired or set.
RMT	Program start right	3	Indicates the value of the system variable $RMT_MASTER that indicates what has the control to start the program.

Note) **H incicates hexadecimal.

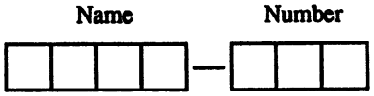
By default, the range of register number is 1 to 32 and the position register is 1 to 10. The maximum number can be changed by setting. For the setting, refer toFANUC Robot series reference manual.

2.2 Transfer data

The detailed explanation for each transfer data is the following.

2.2.1 Alarm information (ALM)

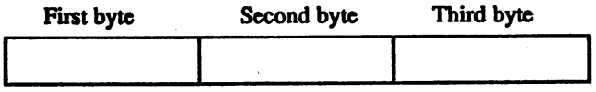
Alarm information of R-J consists of 4-character(or 5-character) for sub-system name, 1-character for the hyphen and 3-digit for subsystem number, total 8(or 9)-character(or byte).



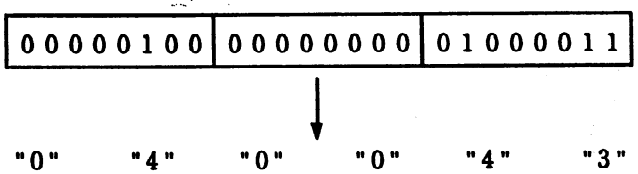
Example: TPIF-002
PROG-003

2.2.2 Robot status (INF)

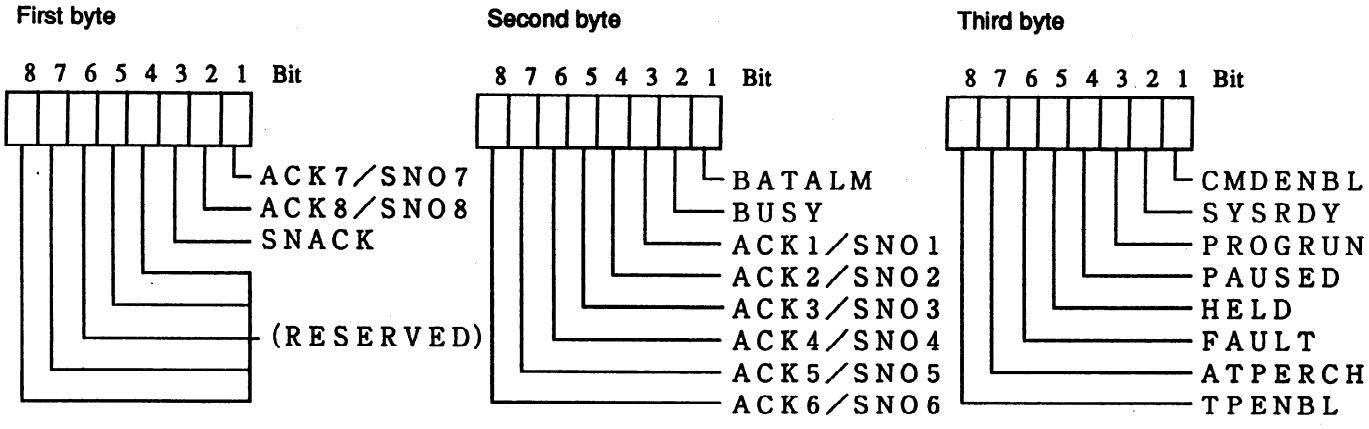
Robot status consists of 6-character(byte) that 3-byte bit image in hexadecimal is converted to in ASCII.



Example : SNACK+CMDENBL+SYSRDY+ATPERCH



<30H><34H><30H><30H><34H><33H>



Signal	Description
CMDENBL	Command acceptance enabled signal
SYSRDY	System ready signal
PROGRUN	Program run signal
PAUSED	Program paused signal
HELD	Held signal
FAULT	Alarm signal
ATPERCH	Reference point signal
TPENBL	Teach pendant enabled signal
BATALM	Battery alarm signal
BUSY	Operating signal
ACK1/SNO1	RSR acknowledge/Selected porogram number signal
ACK2/SNO2	〃
ACK3/SNO3	〃
ACK4/SNO4	〃
ACK5/SNO5	〃
ACK6/SNO6	〃
ACK7/SNO7	〃
ACK8/SNO8	〃
SNACK	PNS acknowledge signal

For the specifications of each signal, refer to FANUC Robot series R-J CONTROLLER MAINTENANCE MANUAL.

If the robot status is inquired when the process I/O PCB is not connected to R-J for example, the robot status(INF) is set "00 00 00".

2.2.3 Current position data (AXD)

Current position data is divided into two types.One is the metric value for each axis, the other is the cartesian coordinate value.

- Metric value for each axis

  The data for each axis is expressed in 13-character(or byte) of real data(DTR). Therefore, current position data is transffered in the formation that real data × axis number. The transffer order of the current postion data transferred in this case is the first axis, the second axis, ... and the nth axis.

- Cartesian coordinate value

  Transffered coordinate value consists of the value of X, Y, Z, W, P, R and extented axis (m). Each axis data is expressed in 13-character(byte) of real data(DTR), so that current position data is transferred in the formation that real data × (6+m). The transfer order of the current position data transferred in this case is X, Y, Z, W, P, R, the first extended axis, ... and the mth extended axis.

2.2.4 Data formation (TYPE)

The data that R-J can inquire or set is the following.

- System variable
- Register
- Position register
- Comment

【 System variable 】

System variable of R-J (coresponding to the parameter of R-G2) is hierarchy structure. And, the size and contents of system variable are different according to each robot and apprication. The contents of system variable is specified by variable name instead of the number and that is displayed in alphabetical order. As a result, all the data of the specified system variable is inquired or set at the same time. System variable can be set only at the control start mode.

【 Register 】

For the register of R-J, integer type data or real type data can be set to the same register. To specify whether integer type or real type, add the value indicating the type to the data when inquiring or setting the register.

	Form	Type	Data
1	Integer	21H	Integer type data (DTI)
2	Real	22H	Real type data (DTR)

【 Position register 】

For the position register of R-J, 9 types data can be set to the same position register. To specify the type of the set data, add the value indicating the type to the data.

	Expression	TYPE	DATA
1	Conversion	24H	Real type data(DTR) × 12
2	XYZWPR	27H	Real type data(DTR) × 6
3	XYZAES	2BH	Real type data(DTR) × 6
4	XYZ+Wrist joint angle	2DH	Real type data(DTR) × 6
5	Conversion with extended axis	2EH	Real type data(DTR) × 15
6	XYZWPR with extended axis	30H	Real type data(DTR) × 9
7	XYZAES with extended axis	33H	Real type data(DTR) × 9
8	XYZ+Wrist joint angle with extended axis	35H	Real type data(DTR) × 9
9	Each axis	36H	Real type data(DTR) × 9

When inquiring the data of the position register that is not set value,

"*" "u" "n" "i" "n" "i" "t" "*" " " " " " " " " " " "

<2AH><75H><6EH><69H><6EH><69H><74H><2AH><20H><20H><20H><20H><20H>

is transferred.

The formation of each type data in position register is the following.

1:Conversion expression

1	NX	Normal vector X	
2	NY	Y	
3	NZ	Z	
4	OX	Orientation vector X	
5	OY	Y	
6	OZ	Z	
7	AX	Approach vector X	
8	AY	Y	
9	AZ	Z	
10	LX	Location vector X	[mm]
11	LY	Y	[mm]
12	LZ	Z	[mm]

2:XYZWPR expression

1	X	Position X	[mm]
2	Y	Y	[mm]
3	Z	Z	[mm]
4	W	Rotation around X axis	[deg]
5	P	Rotation around Y axis	[deg]
6	R	Rotation around Z axis	[deg]

3:XYZAES expression

1	X	Position X	[mm]
2	Y	Y	[mm]
3	Y	Z	[mm]
4	A	Azimuth angle	[deg]
5	E	Elevation angle	[deg]
6	S	Spin angle	[deg]

5:Conversion with extended axis expression

1	NX	Normal vector X	
2	NY	Y	
3	NZ	Z	
4	OX	Orientation vector X	
5	OY	Y	
6	OZ	Z	
7	AX	Approach vector X	
8	AY	Y	
9	AZ	Z	
10	LX	Location vector X	[mm]
11	LY	Y	[mm]
12	LZ	Z	[mm]
13	E1	No.1 extended axis	[rad] or [mm]
14	E2	No.2 extended axis	[rad] or [mm]
15	E3	No.3 extended axis	[rad] or [mm]

6:XYZWPR with extended axis expression

1	X	Position X	[mm]
2	Y	Y	[mm]
3	Z	Z	[mm]
4	W	Rotation around X axis	[deg]
5	P	Rotation around Y axis	[deg]
6	R	Rotation around Z axis	[deg]
7	E1	No.1 extended axis	[rad] or [mm]
8	E2	No.2 extended axis	[rad] or [mm]
9	E3	No.3 extended axis	[rad] or [mm]

7:XYZAES with extended axis expression

1	X	Position X	[mm]
2	Y	Y	[mm]
3	Y	Z	[mm]
4	A	Azimuth angle	[deg]
5	E	Elevation angle	[deg]
6	S	Spin angle	[deg]
7	E1	No.1 extended axis	[rad] or [mm]
8	E2	No.2 extended axis	[rad] or [mm]
9	E3	No.3 extended axis	[rad] or [mm]

4:XYZ+Wrist joint angle expression

1	X	Position X	[mm]
2	Y	Y	[mm]
3	Z	Z	[mm]
4	J4	No.1 wrist joint angle	[deg]or[mm]
5	J5	No.2 wrist joint angle	[deg]or[mm]
6	J6	No.3 wrist joint angle	[deg]or[mm]

8:XYZ+Wrist joint angle with extended axis expression

1	X	Position X	[mm]
2	Y	Y	[mm]
3	Z	Z	[mm]
4	J4	No.1 wrist joint angle	[deg]or[mm]
5	J5	No.2 wrist joint angle	[deg]or[mm]
6	J6	No.3 wrist joint angle	[deg]or[mm]
7	E1	No.1 extended axis	[rad]or[mm]
8	E2	No.2 extended axis	[rad]or[mm]
9	E3	No.3 extended axis	[rad]or[mm]

9:Each axis expression

1	J1	No.1 axis	[rad]or[mm]
2	J2	No.2 axis	[rad]or[mm]
3	J3	No.3 axis	[rad]or[mm]
4	J4	No.4 axis	[rad]or[mm]
5	J5	No.5 axis	[rad]or[mm]
6	J6	No.6 axis	[rad]or[mm]
7	J7	No.7 axis	[rad]or[mm]
8	J8	No.8 axis	[rad]or[mm]
9	J9	No.9 axis	[rad]or[mm]

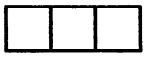
【 Comment 】

The maximum 18-character comment is added to the register or position register of R-J. You can inquire or set the comment of the register or position register.

	Form	Type	Data
1	Register	3AH	17 characters
2	Position register	3CH	18 characters

2.2.5 Start/End data number (SNO/ENO)

Start data number or end data number consists of 3-digit(byte) data. When the digit of start/end data number is below 3, the data number is made to be left-justified and the residual field is filled with the blunk(" "/20H).



0 ~ 999

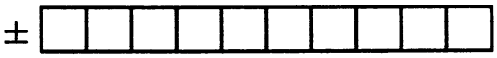
Example : In the case that the start data number is 12.

"1" "2" " "

<31H><32H><20H>

2.2.6 Integer data (DTI)

Integer type data consists of a sign and 10-digit data, total 11 characters(bytes). When the digit of the integer type data is below 10, it is made to be left-justified and the residual field is filled with the blunk(" "/20H).



−2147483648 ~ 2147483647

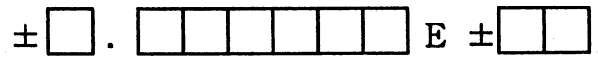
Example : In the case that the integer type data is -123456

"−" "1" "2" "3" "4" "5" "6" " " " " " " " "

<2DH><31H><32H><33H><34H><35H><36H><20H><20H><20H><20H>

2.2.7 Real data (DTR)

Real type data is 13-character(byte) data expressed in the exponentiation, it's significant figure is 7-digit, the digit below the decimal point is 6 and the exponential field is 2-digit. When the digit below the decimal point is below 6, the residual field is filled with "0"(30H). When the digit of the exponential field is below 2, it is made to be left-justified and the residual field is filled with the blunk(" "/20H). The location of "±", "." and "E" is fixed.



±1.0×10^−37 ~ ±1.0×10^38 The significant figure is 7-digit.

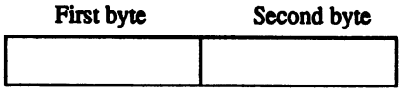
Example : In the case that the interger type data is -1.234560E+2

"−" "1" "." "2" "3" "4" "5" "6" "0" "E" "+" "2" " "

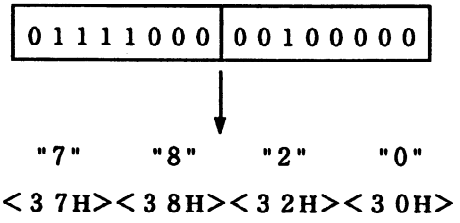
<2DH><31H><2EH><32H><33H><34H><35H><36H><30H><45H><2BH><32H><20H>

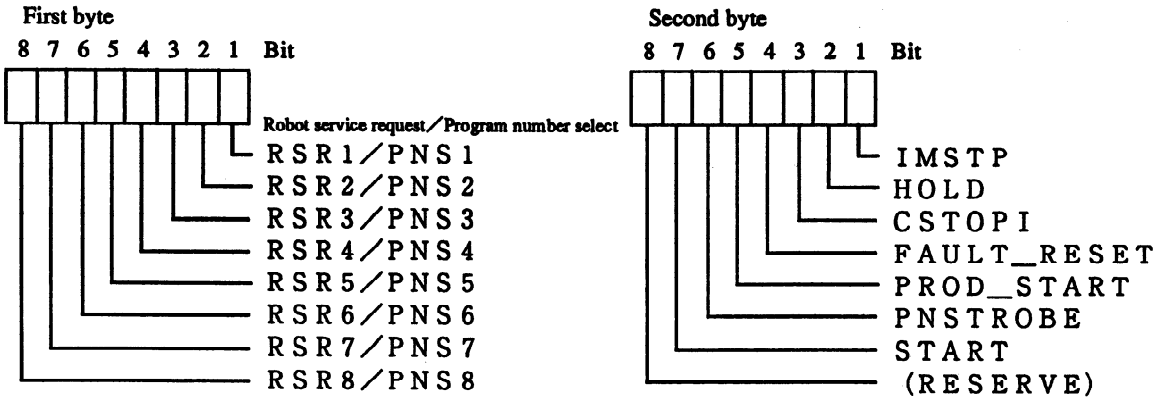
2.2.8 Control command (CCM)

Control command is the 4-character(byte) data that 2-byte bit image expressed in hexadecimal is converted to in the ASCII.



Example : In the case that PNS is set 120 and PNSTROBE signal is set on.





The control command of the highest priority in the set command is only executed.

Priority	Signal	Description
High	IMSTP	Imidiate stop
↑	HOLD	Hold signal
↑	CSTOPI	Cycle stop signal
↑	FAULT_RESET	Alarm release signal
↑	PROD_START	Automatic operation start signal
↑	Execution RSR	Execution RSR
↑	PNSTROBE	PNS strobe signal
Low	START	Cycle start signal

Notice) IMSTP and HOLD in the control command is not the reverse signal. When RSR(robot service request)1-8 is set, PNSTROBE signal needs to be set at the same time,too. For the specification of each signal, refer to FANUC Robot series R-J CONTROLLER MAINTENANCE MANUAL.

2.2.9 Program/System Variable file name (PNAM)

Progam or system variable file name consists of the file name(maximum 8-character) and file type(3-character), total 11 characters(bytes).When the number of characters in this file name is below 11, this file name is made to be left-justified and the residual field is filled with the blunk(" "/20H). The system variable file name to be set in PNAM is the following.

- SYSVARS.SV
- SYSSERVO.SV
- SYSMAST.SV
- SYSMACRO.SV

Example : In the case that the program name is "ABCDE.MN"

```
  "A"   "B"   "C"   "D"   "E"   ". "   "M"   "N"   " "   " "   " "
<41H><42H><43H><44H><45H><2EH><4DH><4EH><20H><20H><20H>
```

2.2.10 Program/System Variable byte number (PNT), Residual byte number (RPNT)

PNT or RPNT consists of 10-digit(byte) data. When the digit of the byte number or residual byte number is below 10, those byte number is made to be left-justified and the residual field is filled with the blunk(" "/20H).

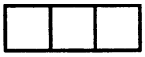
0 ~ 4294967295

Example : In the case that the program byte number is 123456

```
  "1"   "2"   "3"   "4"   "5"   "6"   " "   " "   " "   " "
<31H><32H><33H><34H><35H><36H><20H><20H><20H><20H>
```

2.2.11 Program start control (RMT)

RMT is the value which is set to the system variable $RMT_MASTER, which specifies what has the control to start program. The data of the program start control consists of 3-digit(byte) data. When the digit of the program start control data is below 3, it is made to be left-justified and the residual field is filled with the blunk(" "/20H).



0 ~ 999

Example : In the case that the program start control data is 2

"2" " " " "

<32H><20H><20H>

$RMT_MASTER= 0 : Peripheral I/O device has the control to start.

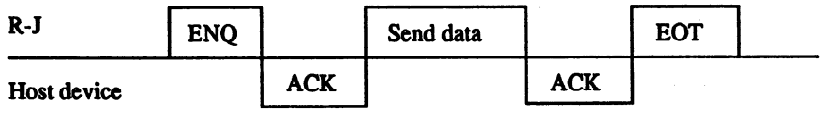
(= 1 : KCL)

= 2 : Data transfer function has the control to start.

3 TRANSMISSION SYSTEM

In this system, either R-J or the host device generating the send data issues the call request to the other party, and when the other party makes the affirmative response indicating the receive request, data starts being sent to the other party. This transmission system is called the call response system.

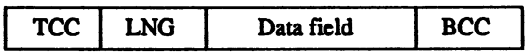
Example



This system does not distinguish data from the transmission control characters. Therefore, take a great care for the sequence and the number of characters to be transferred not to disturb transmission.

3.1 Transfer data format

The data transferred between R-J and the host device is a string of binary characters consisting of two or more bytes. This character string is given a meaning according to the protocol determined between the two parties and functions.The data to be transferred between the two parties has the following format.



1) TCC (Transmission Control Character)

1-byte data.This is used to control data transfer between R-J and the host device.

2) LNG

1-byte data.This indicates the number of characters in the data field. However, it does not include "00" to be inserted after three consecutive "FF"'s.

3) Data field (Maximum 128 bytes)

Numerical data of one or more bytes.This is the actual data field to be transferred.

4) BCC(Block Check Character)

This is the 1-byte parity check character assigned to each transfer unit and used to set the exclusive OR of the values from TCC to the data field end.

If the transfer data (from TCC to BCC) contains three consecutive "FF"'s, it is transferred by suffixing "00" to the third "FF". The receiver ignores this "00". This process is performed to distinguish transfer data caused an error from the data to be sent again. Refer to" 3.5 Data transfer retries".

<TCC><LNG>·····<" FF" ><" FF" ><" FF" ><" 00" >·····<BCC>

" FF" × 3 "00" is inserted as a dummy.

3.2 Transfer data format list

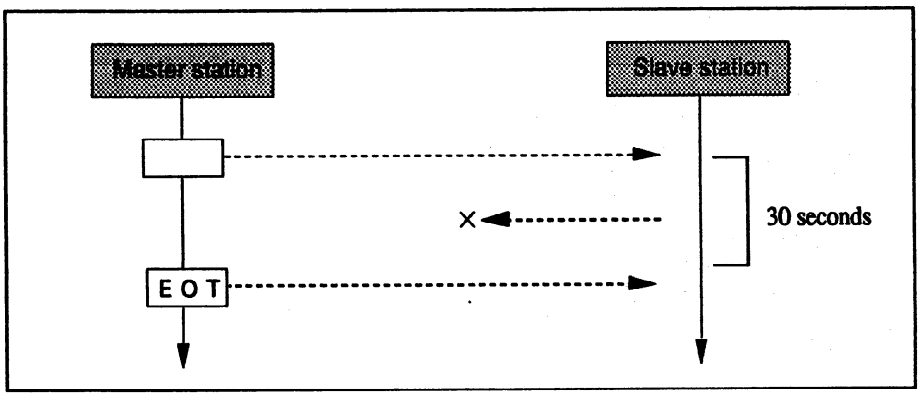
The contents of transfer data is prescribed by TCC as shown below:

Transfer data format list

TCC	Explanation	Transfer Format
05H	Enquiry (ENQ)	<ENQ>
84H	End of transmission(EOT)	<EOT>
06H	Acknowledge (ACK)	<ACK>
95H	Negative acknowledge (NAK)	<NAK>
81H	Alarm occurrence report	<81><LNG><ALM><BCC>
87H	Robot status inquiry request	<87><LNG><BCC>
88H	Robot status report	<88><LNG><INF><BCC>
8BH	Current position inquiry request	<8B><LNG><TYPE><BCC>
8DH	Current position report	<8D><LNG><AXD><BCC>
93H	Data inquiry request	<93><LNG><TYPE><SNO><ENO><BCC>
96H	Data setting request	<96><LNG><TYPE><SNO><ENO><BCC>
99H	Data transfer	<99><LNG><DT><BCC>
9AH	Control command setting request	<9A><LNG><CCM><BCC>
9CH	Program start request	<9C><LNG><PNAM><BCC>
9FH	Program deletion request	<9F><LNG><PNAM><BCC>
E1H	Program transfer(write) request	<E1><LNG><PNAM><PNT><BCC>
E2H	Program inquiry(read) request	<E2><LNG><PNAM><BCC>
E4H	Program inquiry acknowlege report	<E4><LNG><PNT><BCC>
E7H	Program data transfer	<E7><LNG><DT><BCC>
E8H	Program directory inquiry request	<E8><LNG><BCC>
EBH	Reporting the number of registered programs and residual byte number	<EB><LNG><PGNO><RPNT><BCC>
EDH	Program directory inquiry	<ED><LNG><PNAM><PNT><BCC>
82H	Program start control setting	<82><LNG><RMT><BCC>
8EH	System variable inquiry request	<8E><LNG><PNAM><BCC>
90H	System variable setting request	<90><LNG><PNAM><PNT><BCC>

3.3 Response time check, Character interval check

This function checks if a response is made to the data transferred from one party within a specific time (approx. 30 seconds). If not, "EOT" is output to terminate data transmission.



It also checks for the time interval between characters in a transfer character string. If the time interval from reception of one character to that of the next character exceeds a specific time (approx. 3 seconds), "NAK" is output to request sending of the character data again.

In the above figure, master station can be R-J or host device, and the point of view decides the master station. From the point of view of host device, the master station is host device and the slave station is R-J. In this case, if a response is not made to the data transferred from the host device within 30 seconds, output "EOT" to R-J. In the reverse case, if a response is not made to the data transferred from R-J within 30 seconds, R-J outputs "EOT".

3.4 Report when an error occurs

The following errors may occur during data transfer between the host device and R-J:

1) Transfer data process errors

For example, an error detected if R-J has already had the same program when the host device sends this program to R-J, and an error detected when R-J is executing program.

2) Hardware errors

Errors detected on the line during data transfer.

- Parity error
- Overrun error
- Framing error, etc

3) System program errors

These are the errors such as transfer of an undefined TCC.

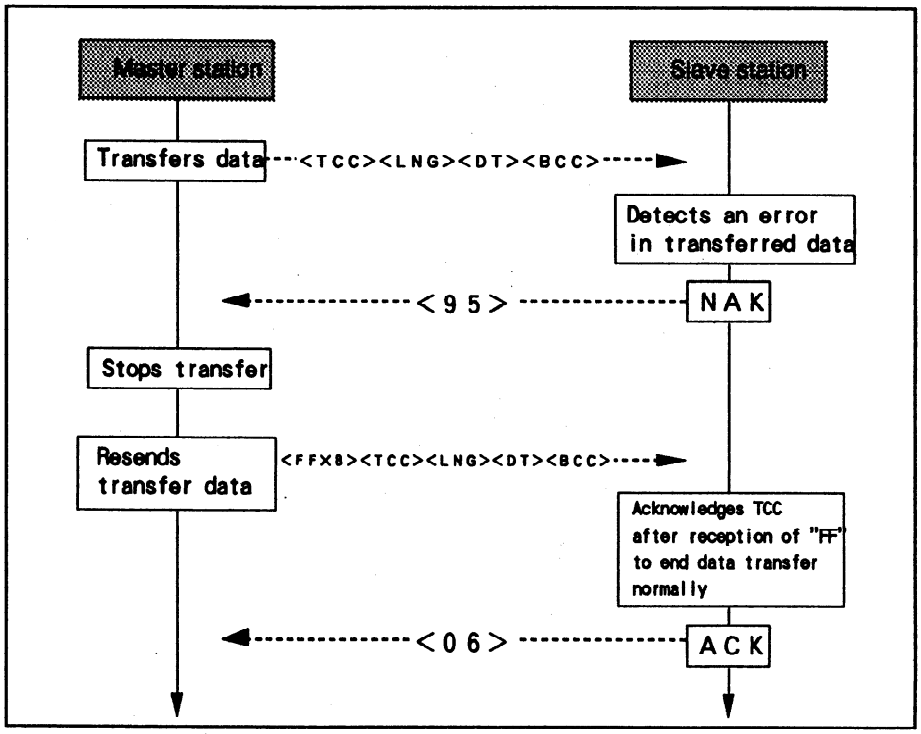
At detection of an error 1), the error occurence report sequence is executed to terminate communication and a measure is taken against the reported error.
At detection of an error 2) or 3), "NAK" is output to request sending of the data again. When the response output is "NAK" to the data trunsferred from one party, this party send the same data again as a retry. If, however, the number of retries exceeded the specified number(3 times for R-J), the alarm number corresponding to the error detected during reception of the last transfer data is reported.

3.5 Data transfer retries

If a communication error occurs, the retry is done until the retry times amount to the specified times(3 times for R-J) as described below.

1) The receiver sends "NAK" to the sender.
2) The sender stops sending the data, prefixes 8 or more "FF"s to the data to be sent again, and sends it.
3) The receiver acknowledges the data other than "FF" preceded by 4 or more consecutive "FF"s as TCC and returns to the nomal process.

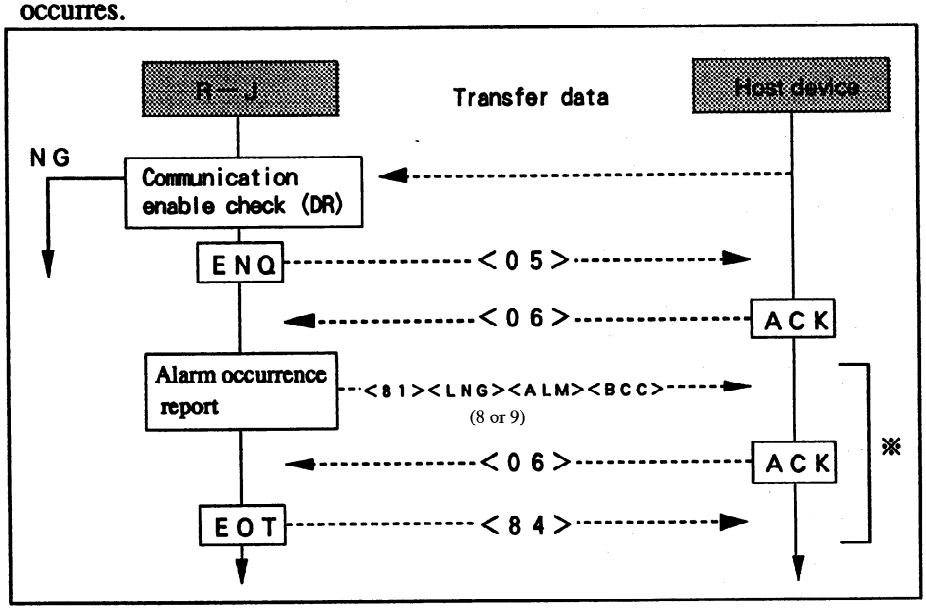
To perform this process, if send data contains 3 consecutive "FF"s, "00" needs to be suffixed the third "FF" for sending this data. This enables the data sent after occurrence of an error to be distinguished from TCC of the resend data.



4 COMMUNICATION SEQUENCE

4.1 Alarm occurrence report

This function reports the alarm occurred in R-J to the host device when it occurres.



If an alarm occurs during the transfer of the data other than the alarm occurrence report, control is transferred to the process in section * to terminate this data transfer. If, however, a communication error occurs, "NAK" is sent to request sending of data again. But, if the number of retries for sending this data exceeds the specified value(3 times for R-J), control is transferred to the process in section * to end the communication.

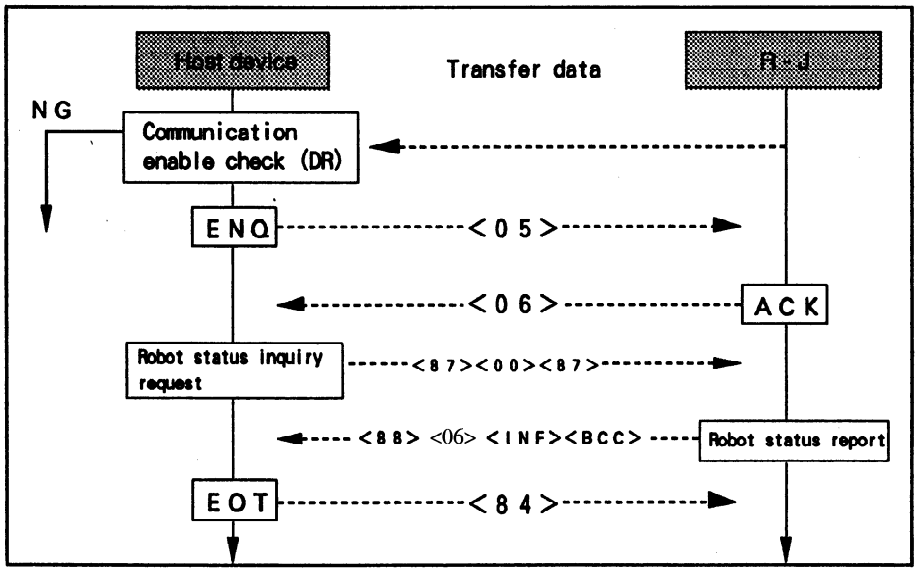
For the alarm occurrence report of the data transfer, the reported alarm contains the alarm related to the communication and the alarm except it. (For the alarm related to the communication, refer to "6 ALARM CODE AND SYSTEM VARIABLE".)

System variable $COMP_IF. $ALARM_ENB decides whether the report to the host device is done or not when the alarm other than it related to the communication is occurred.
$COMP_IF. $ALARM_ENB=ENABLE : The report is done.
DISABLE : The report is not done.

(Default: ENABLE)
Set $COMP_IF[1] for this purpose, if controller system software version is R-J 7D12/54 or earlier.
For the reported alarm information (ALM), refer to "2.2.1 Alarm information (ALM)".

4.2 Robot status inquiry

This function is used by the host device to grasp the robot status and take the appropriate measure against it.

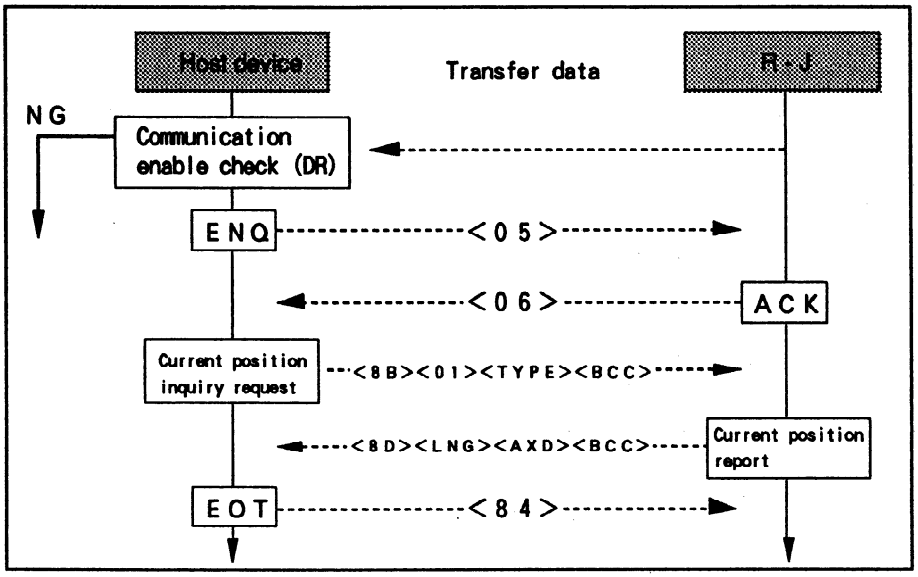


For the reported robot status(INF), refer to "2.2.2 Robot status(INF)".

If the robot status inquiry is done when the process I/O PCB is not connected to R-J, the robot status(INF) is set "00 00 00".

4.3 Current position inqury

The current position inquiry reports the host device the current position of the robot at reception of the request from the host device.



For the reported current position(AXD), refer to "2.2.3 Current position data".

4.4 Data inquiry

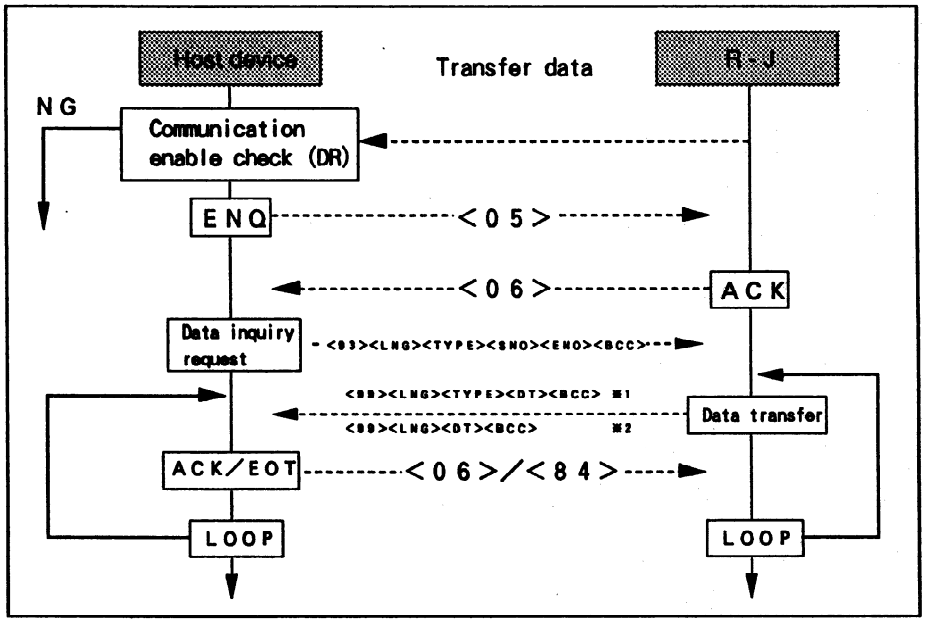
This function is used by the host device to know the contents within the specified range of the various data(specified by TYPE) stored in the memory of R-J. At this time, take care for the following points when specifying the start number SNO and end number ENO for the range:

1) SNO ≦ ENO

   When SNO equals to ENO, only one data item is set.

2) ENO can be omitted. If it is omitted, the data specified by SNO is set.

3) Both SNO and ENO can be omitted. If they are omitted, all the data items stored in the memory are transferred.



"EOT" is substituted for the acknowlegment for the transfer of the last data item.

*1 ... Register/Position register

*2 ... Comment

4.5 Data setting

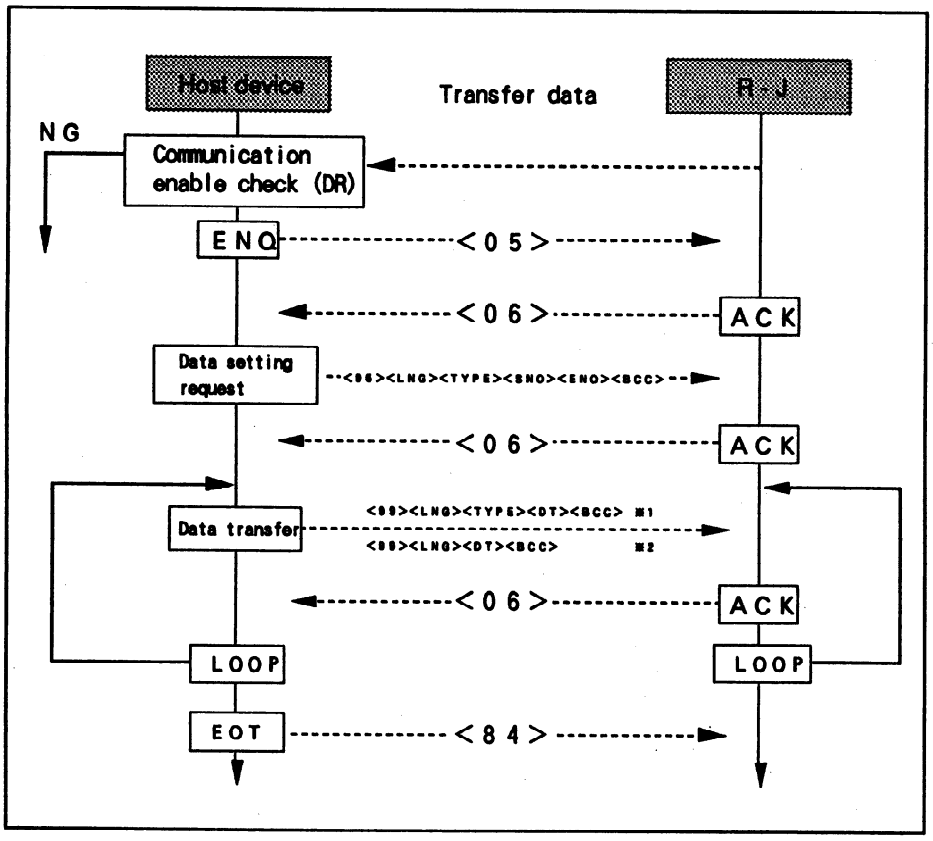
This function is used by the host device to set the various data(specified by TYPE) to the memory within the specified range of R-J.At this time, take care for the following points when specifying the start number SNO and end number ENO for the range:

1) SNO ≦ ENO

   When SNO equals to ENO, only one data item is set.

2) ENO can be omitted. If it is omitted, the data specified by SNO is set.

3) Both SNO and ENO can be omitted. If they are omitted, all the data items stored in the memory are transferred.



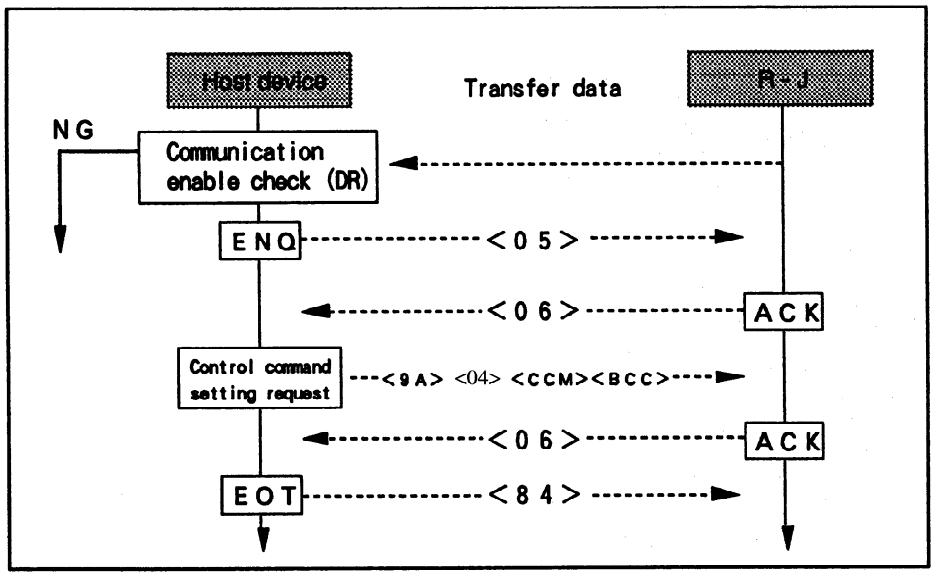
Note) When the data set of position register has been done, the configuration in the position register is not set.

*1 ... Register/Position register

*2 ... Comment

4.6 Control command setting

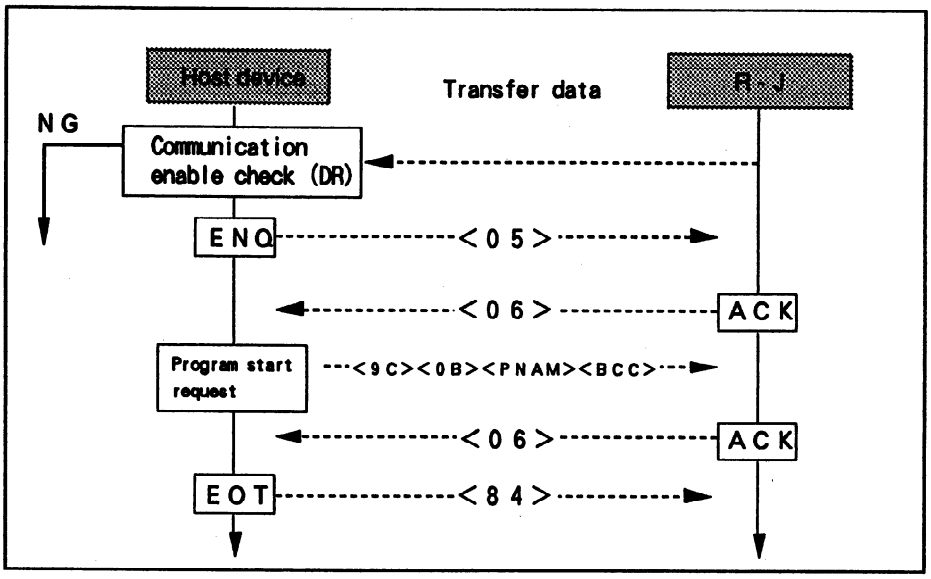
This function is used by the host device to issue the command such as start and stop program commands. This function is similar to the way that issues the command through the periheral I/O device.



For the control command, refer to "2.2.8 Control command(CCM)".

4.7 Program start

This function is used to start program after the program requested to be started is called from the host device . However, the robot actually starts the program after R-J receives "EOT".



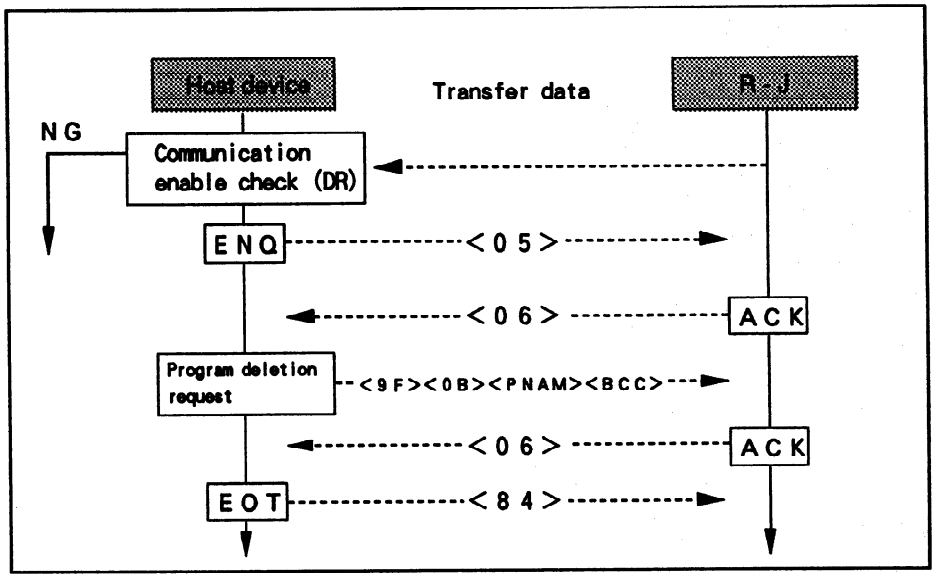
The conditions to start the program by the data transfer function are the following.

- The teachpendant ON/OFF switch is turned OFF.
- The REMOTE/LOCAL switch on the operator panel is turned to REMOTE.
- $RMT_MASTER = 2 (Data transfer function has the control to start)

Note) When the program requested to be started by the host device is being edited, the program editting is forced to be completed and this program is executed from the head line.

4.8 Program deletion

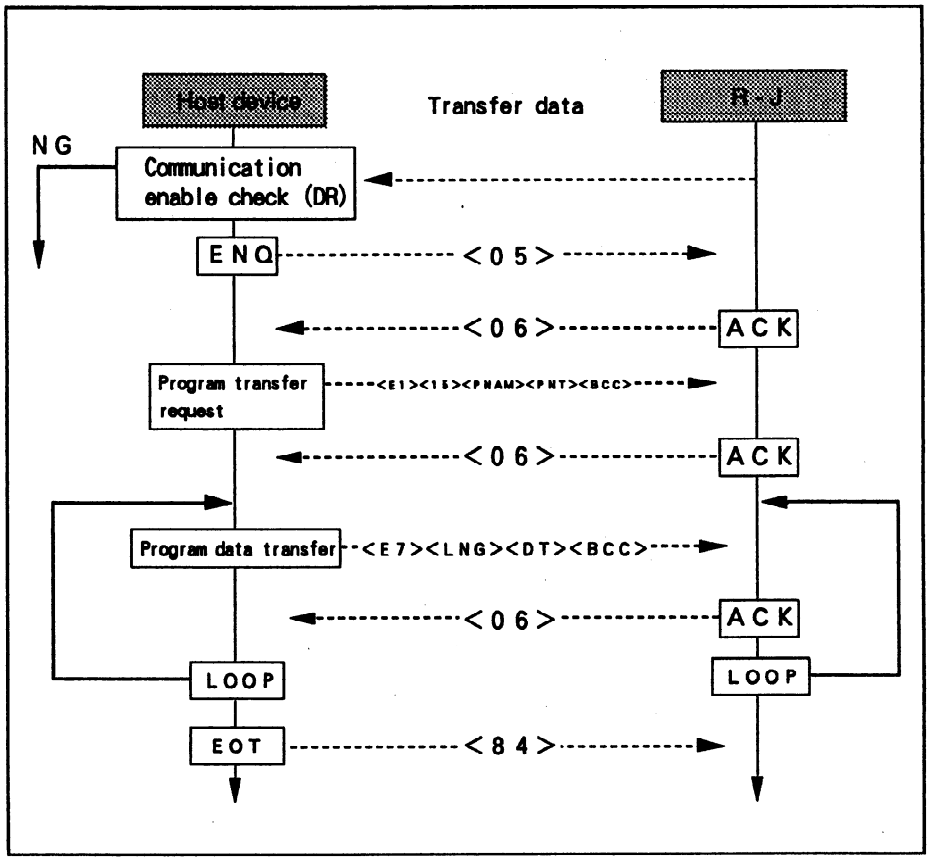
This function is used by the host device to delete the program requested to be deleted from the R-J memory.



Note) The program being selected can not be deleted.

4.9 Program transfer(write) request

This function is used by the host device to set the program in the memory of R-J in specifed program name and specified byte number.

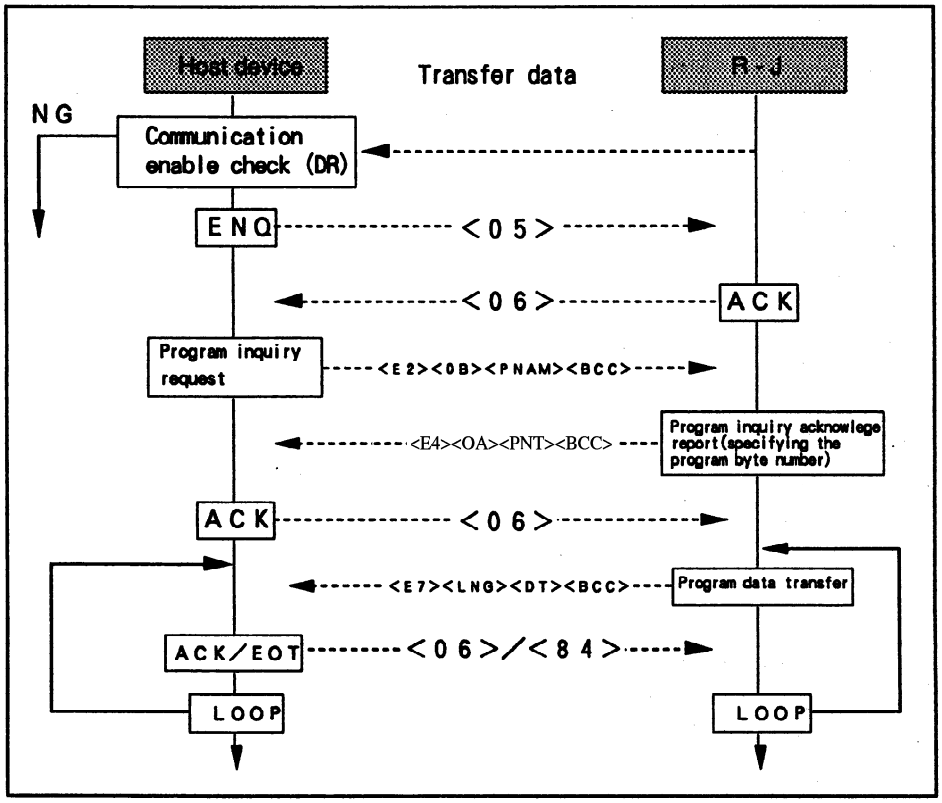


When the host device transfers the program to R-J, it adds the information for controlling program to the program. Therefore, the size of program displayed in the list of existing programs becomes larger than the size of the transferred program.

The type of internal data, which is the transferred program data, is binary.

4.10 Program inquiry (read)

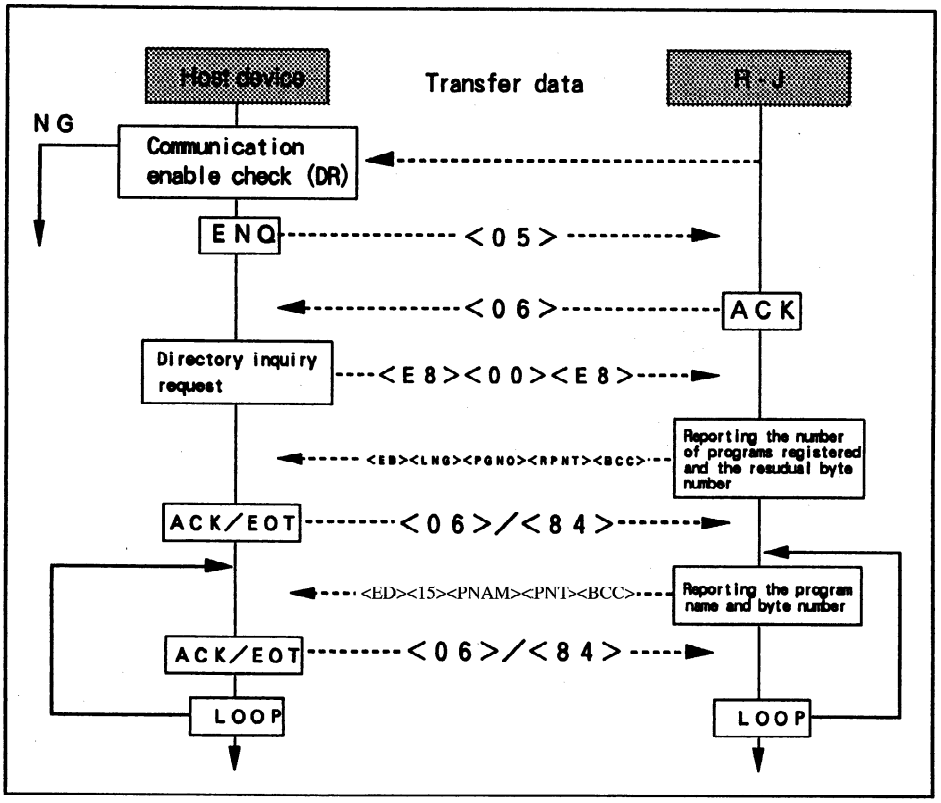
This function is used by the host device to read the program in R-J.



"EOT" is substituted for the acknowledgment for the transfer of the last data item.The program in R-J consists of the program itself and the information for controlling the program.When R-J request the host device to inquire the program, the data of program itself, which does not include the information for controlling the program, is transferred. Therefore, the program byte number transferred by the program inquiry acknowlege report is smaller than the size of program displayed in the list of existing programs in R-J.The type of internal data, which is the transferred program data, is binary.

4.11 Program directory inquiry

This function is used by the host device to know the use status of R-J program memory. This function enables the host device to know the number of program registered,the residual program memory,the program name and the memory used for each of these programs.



"EOT" is substituted for the acknowledge to the transfer of the last data item. If the number of programs registered is 0, output "EOT" to terminate the communication.

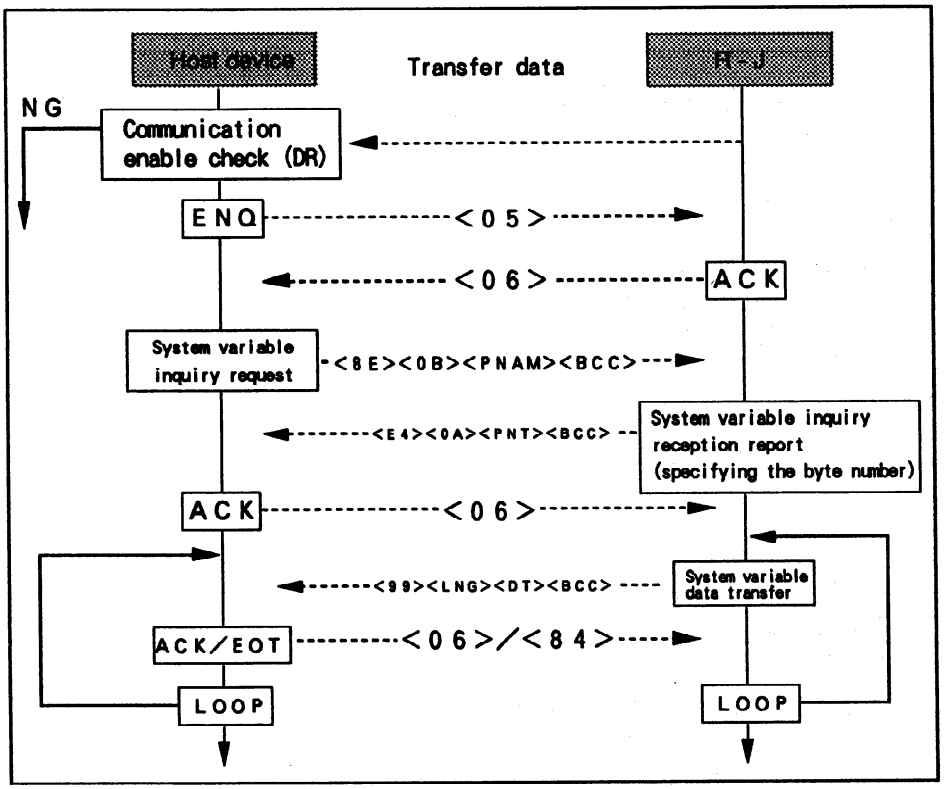
The program in R-J consists of the program itself and the information for controlling the program.When the program transfer(write) or the program inquiry(read) is executed between the host device and R-J, the data of program itself, which does not include the information for controlling the program, is transferred. Therefore, the program byte number transferred by the program directory inquiry is the size of the program itself, which is realy transferred at the program transfer/inquiry.Therefore, the program byte number transferred by program directory inquiry is smaller than the size of program displayed in the list of existing programs in R-J.

The type of internal data, which is the transferred program data, is binary.

4.12 System variable inquiry

This function is used by the host device to read the system variable in the memory of R-J. The system variable file name to be set as PNAM is the following.

- SYSVARS.SV
- SYSSERVO.SV
- SYSMAST.SV
- SYSMACRO.SV

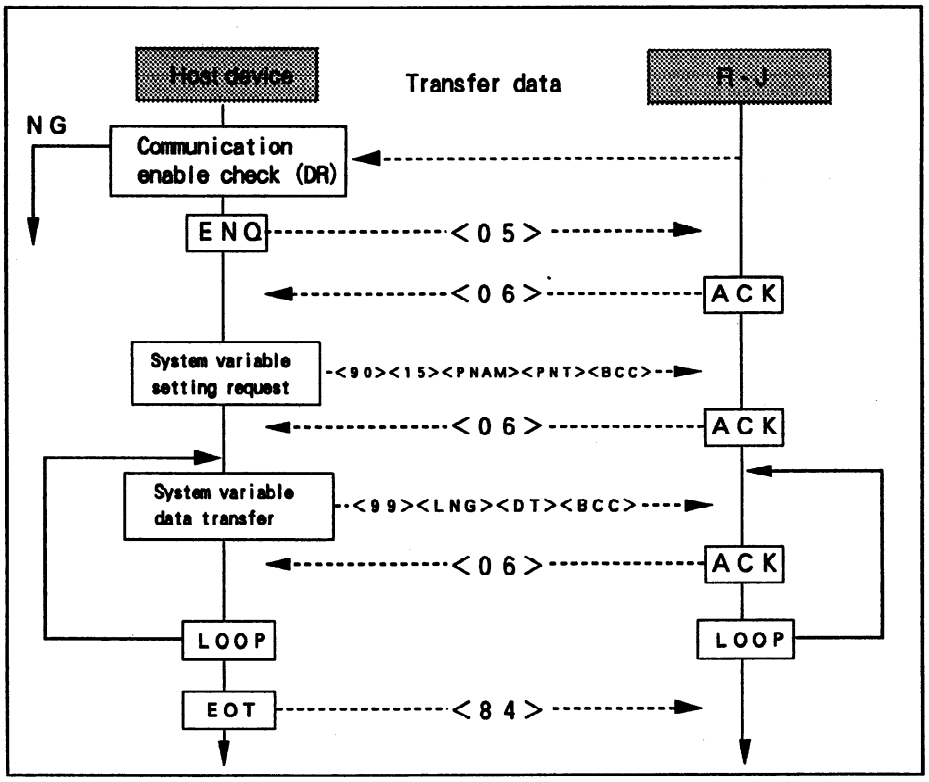


"EOT" is substituted for the acknowledge for the transfer of the last data item.

When the system variable request is executed, all the data of the specified system variable file is transferred at the same time.

4.13 System variable setting

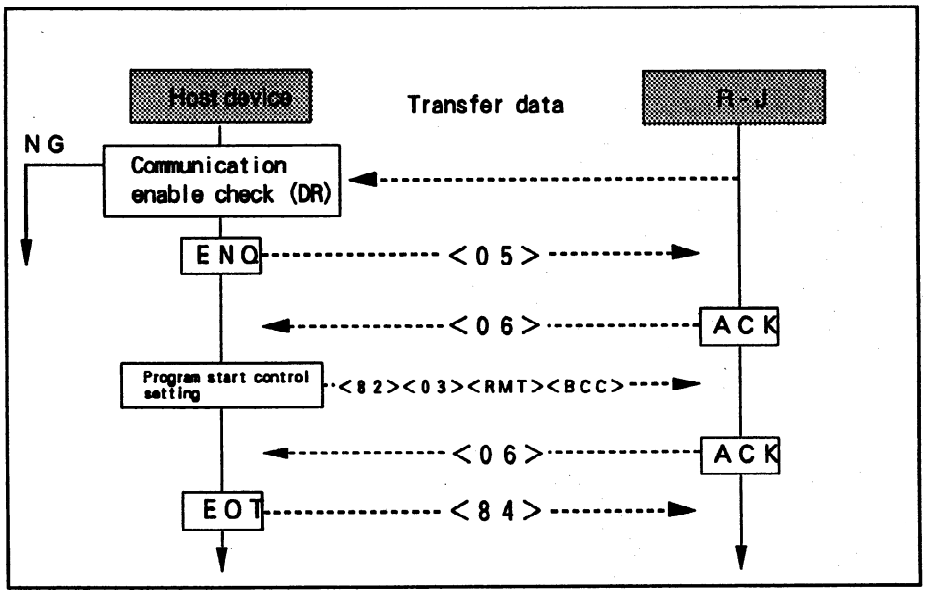
This function is used by the host device to write the system variable of the specified file and the specified byte number in the memory of R-J.



Besides,system variable can be set only at the controlled start mode. When the system variable setting is executed, all data of the specified system variable file is transferred at the same time.

4.14 Program start control setting

This function is used to set the system variable $RMT_MASTER which indicates what has the control to start program.



$RMT_MASTER = 0 : Peripheral I/O device has the control to start.

(= 1 : KCL)

= 2 : Data transfer function has the control to start.

5 CONNECTION

The interface between the host device and R-J controller is RS-232-C / RS-422. This chapter describes the connector specifications and signals of RS-232-C ports on the operator panel and main cpu PCB.

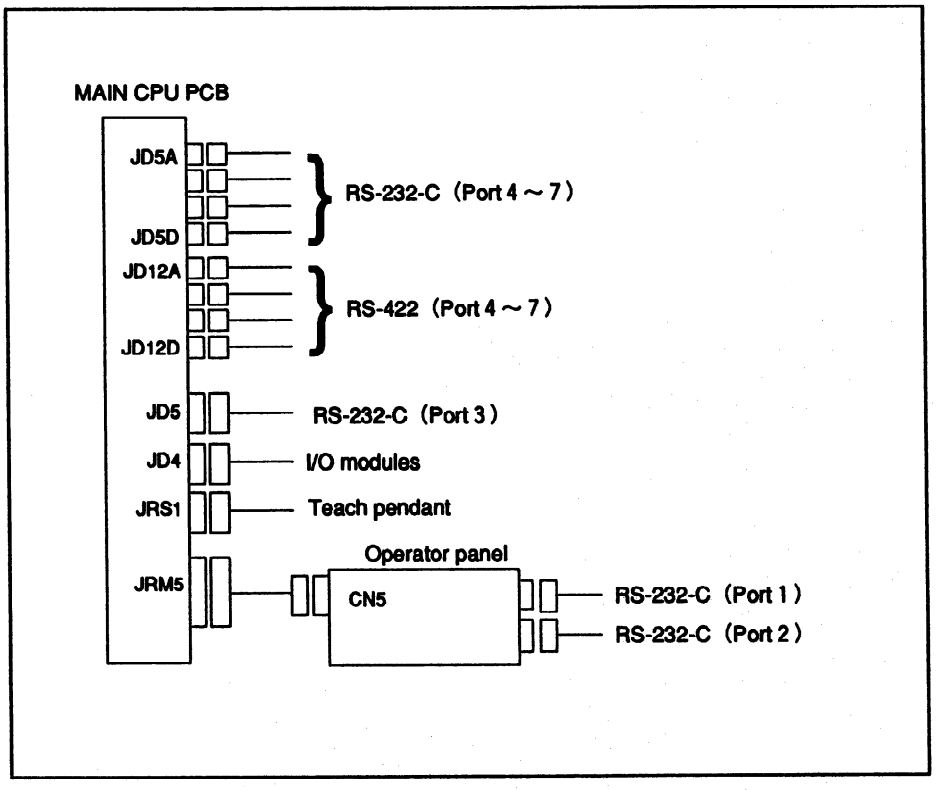
In the R-J controller side, communication ports of RS-232-C / RS-422 interface on the main cpu PCB are used to connect with host.

The communication ports include the following ports.

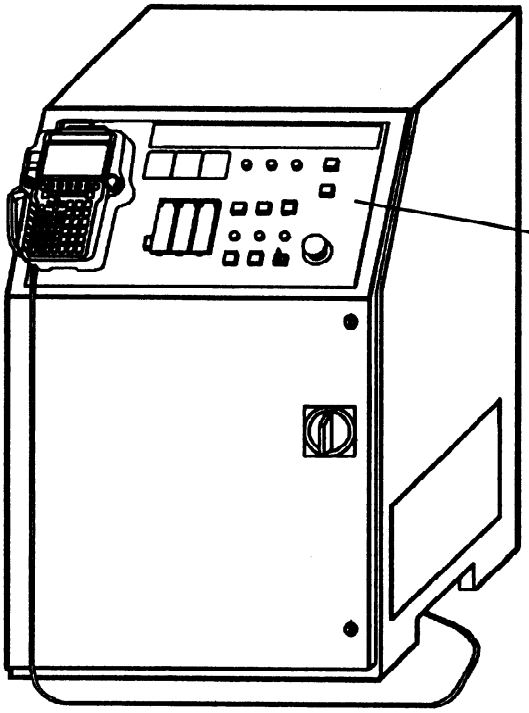
- Standard RS-232-C 3 ports (outside 2 ports, inside 1 port)
- Optional RS-232-C 4 ports or Opitional RS-422 4 ports

NOTE) For the optional ports, select the available ports from RS-232-C ports or RS-422 ports and use it. Both of them can not be used at the same time.

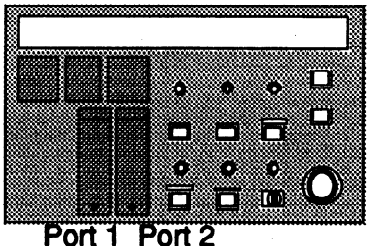
MAIN CPU PCB

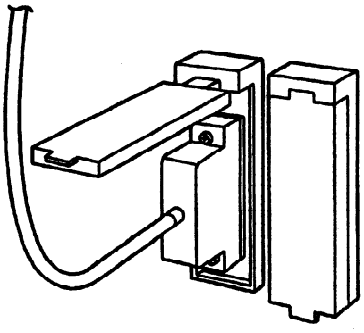


R - J controller

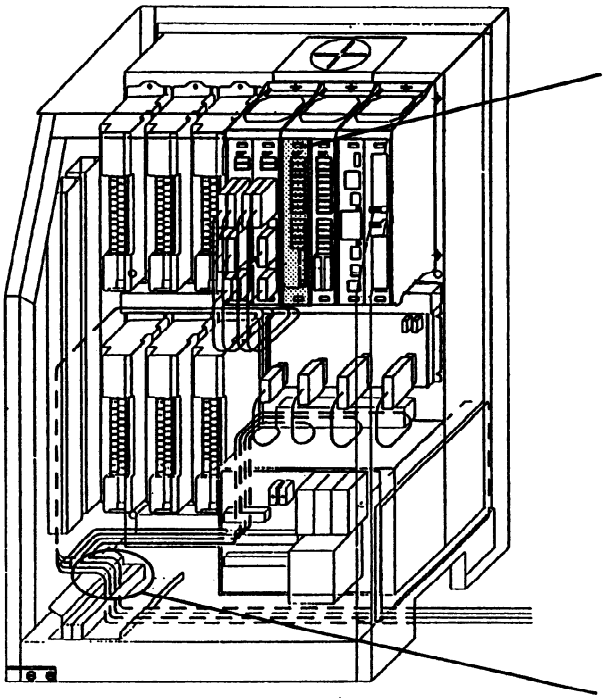


R - J Controller Operator Panel





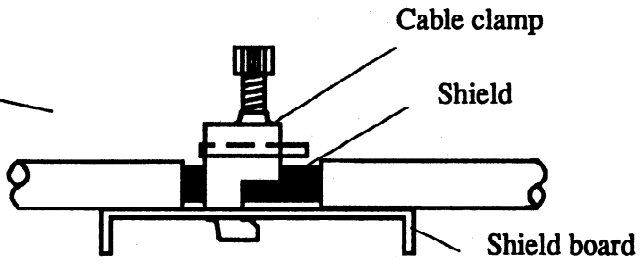
R - J controller



MAIN CPU PCB

- JD5 PORT 3 (Standard)
- JD5 A - D PORT 4 - 7 (Optional)

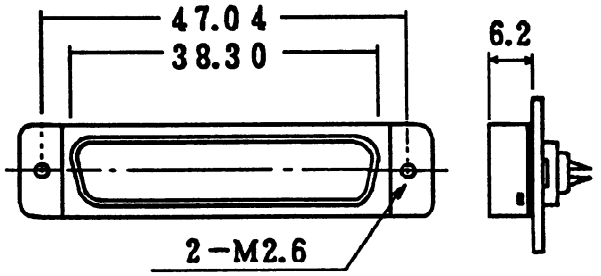
In detail, refer to FANUC Robot series CONTROLLER MAINTENANCE MANUAL



5.1 RS-232-C ports on the operator panel

Robot connector

Connector (Nippon Kokudenshi)	DBM-25S (female)
Lock (Nippon Kokudenshi)	D20418-J2



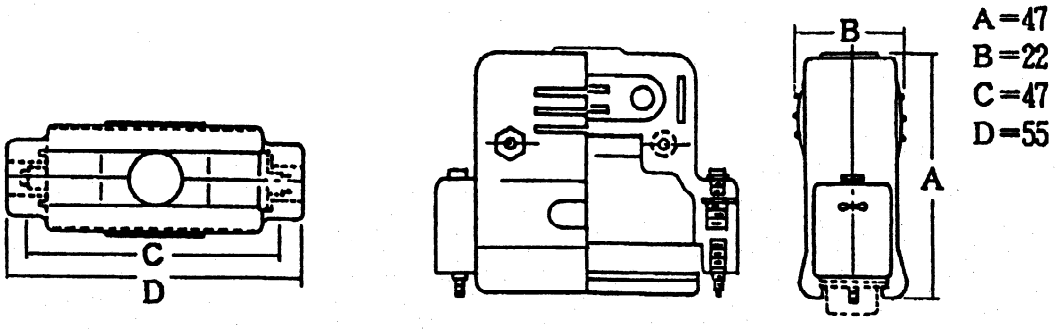
Pin definition

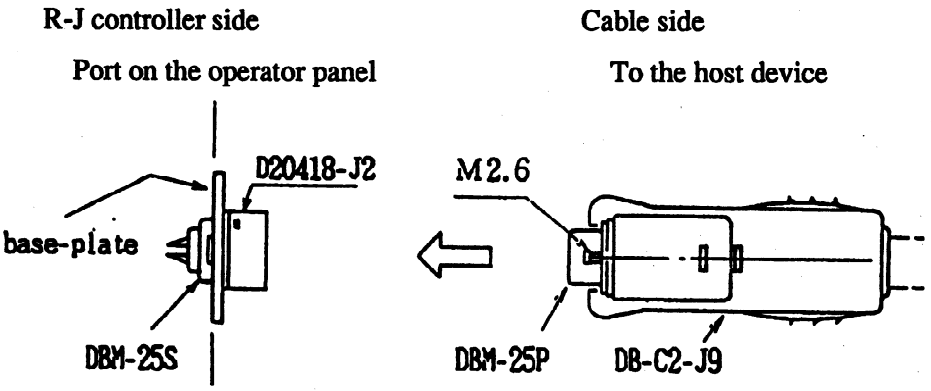
1	FG	14	
2	TXDC	15	
3	RXDC	16	
4	RTSC	17	
5	CTSC	18	
6	DSRC	19	
7	0V	20	DTRC
8		21	
9		22	
10		23	
11		24	
12		25	+24E
13			

NOTE) Don't use the pin No. 25 (+24E)

Specifications of recommended calbe connector

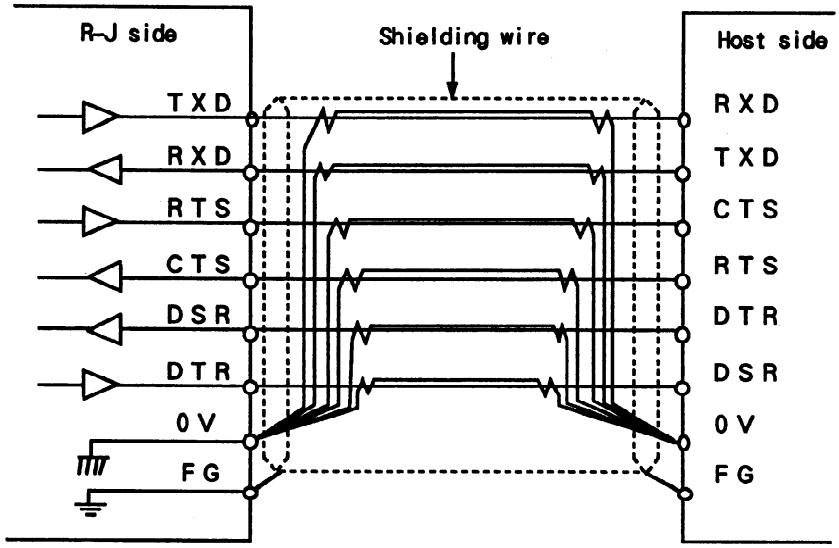
Connector (Nippon Kokudenshi)	DBM-25P (male)
Shell (Nippon Kokudenshi)	DB-C2-J9





Cable connection

Pay attention to the paired wire connection terminal and the shielding wire grounding.



Prepare the connection cable in the host device. For the connection in the host device, refer to the manual for the host device.

5.2 RS-232-C ports on main cpu PCB

RS-232-C connecting ports on main cpu PCB

- JD5 Port 3 (Standard)
- JD5 A - D Port 4 - 7 (Optional)

Specifications of robot connector

Connector (Honda Tsushin Kougyou)	PCR - EV20MDT

Pin definition

1	RXDD	11	TXDD
2	0V	12	0V
3	DSRD	13	DTRD
4	0V	14	0V
5	CTSD	15	RTSD
6	0V	16	0V
7		17	
8		18	
9		19	+24E
10	+24E	20	

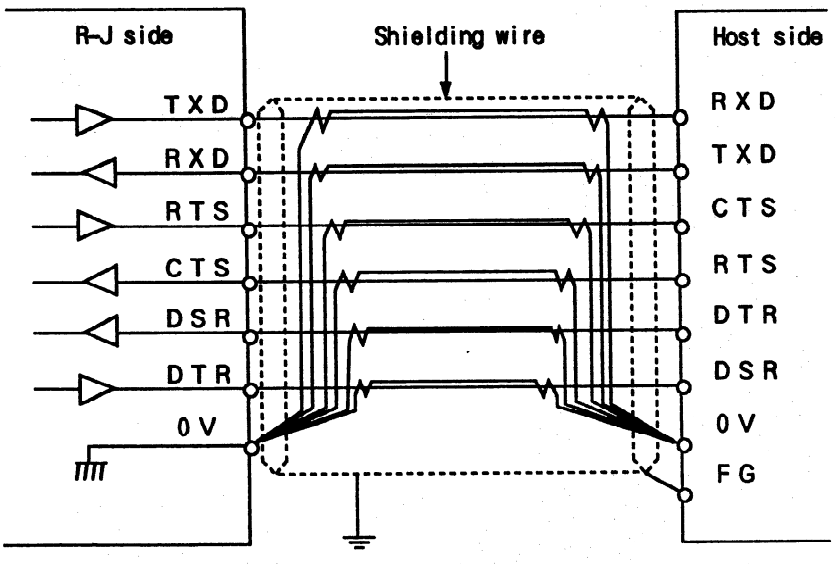
NOTE) Don't use pin No.10 and 19 (+24 E).

Specifications of recommended cable connector

Connector (Honda Tsushin Kougyou)	PCR - E20FS
Shell (Honda Tsushin Kougyou)	PCR - V20LA

Cable connection

Pay attention to the pair wire connection terminal and the shielding wire grounding. Peel the cable sheath and connect the shield directly to the shield board of R-J controller.



5.3 Recommended cable

Connect a peripheral device using a completely shielded, heavily protected cable conforming to the specifications in the following table. Alow an extra 1.5 m for routing the cable in the control unit. The maximum cable length is 15m for 20 core cable.

Specification of cable

Number of wires	Wire specifications (FANUC specifications)	Conductor		Sheath thickness	Effective outside diameter	Electrical characteristics	
		Diameter	Composition			Conductor resistance	Allowable current
20	A66L-0001-0041	ϕ1.05mm	7/0.18 AWG24	1.5mm	ϕ10.5mm	106Ω/km	1.6A

5.4 Signals

Name	Input/ Output	Description
TXD (SD)	Output	Transmitted Data Data line from R-J to host device
RXD (RD)	Input	Received Data Data line from sensor to R-J
RTS (RS)	Output	Request to Send RTS is the control line that R - J indicates there is the data to send to host device. While RTS is on, host device keeps receiving the data and translating it to the communication line. When once RTS is turned off, it can not be turned on again until CTS is turned off.
CTS (CS)	Input	Clear to Send CTS is the control line that host device indicates it can send the data to the communication line. When CTS is on, host device can receive the data from R -J.
DSR (DR)	Input	Data Set Ready DSR is the control line expressing that host device is set ready for operation. To put it concretely, it indicates that host device is connected to the communication line and it can communicate with R-J using the control line.
DTR (ER)	Output	Data Terminal Ready DTR is the control line that R-J indicates to send or receive the data to the host device. When DTR is on, sensor is connected to the communication line. When DTR is off, sensor is disconnected from the communication line.

The word in the parenthesis is the abbreviated word based on JIS C-6361.

Since DCD (CD) is processed in R-J, it need not be processed wiring the cable.

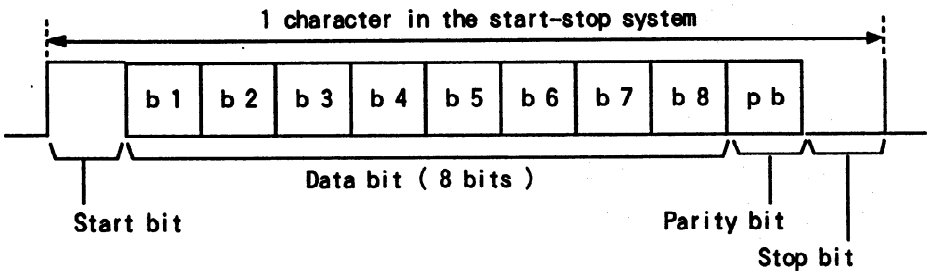
	Under -3V	Over +3V
Function	OFF	ON
Signal Condition	Marking	Spacing

5.5
Transmission System

Start-stop system

The transmission method in the RS-232-C interface has generally the synchronous system and the start-stop system. The start-stop system is adopted in the robot system.

Start-stop system ... Start and stop signals are put before and after a data bit.



Setting communication parameters

Default setting of communication parameters is shown in the following table. For the procedure to set, refer to "setting communication port" in FANUC Robot series Setup and Operations Manual.

Communication device	Baud rate	Parity	Stop bit	Ristricted time
sensor	4800	Odd numbers	1 bit	noting

6 ERROR CODES AND SYSTEM VARIABLE

This chapter describes the alarm codes related to the data transfer. For the display of alarm detail information, etc, refer to FANUC Robot series Setup and Operations Manual.

Error Message

COMP ALARM (I D=59)

COMP- 000 SYSTEM Unknown error

[Cause] System internal error

[Remedy] Notify FANUC

COMP- 001 STOP Retry count over

[Cause] The number of times that R-J send the data again for the request from the host was over the specified value (3 times).

[Remedy]

COMP- 002 STOP Retry count over (Hardware)

[Cause] In the series of data received from host, hardware error (parity / overrun / framing error) occured.

[Remedy] Check that the communication setting between R-J and host device is not wrong.

COMP- 003 STOP Retry count over (Undefind TCC)

[Cause] TCC in data series received from the host was undefined.

[Remedy] Check the data sent from the host.

COMP- 004 STOP Retry count over (Parity)

[Cause] The software parity (BCC) in data series received from the host was wrong.

[Remedy] Check the data sent from the host.

COMP- 005 STOP Retry count over (Interval)

[Cause] In the series of data received from the host, the interval of characters sent from the host exceeded the allowable time (3 seconds).

[Remedy] Check that the host side does not stop due to an error, for example.

COMP- 006 STOP DSR off when transmission

[Cause] An attempt was made for data transmission, but DSR signal at the host side is in OFF-state.

[Remedy] Check that the specification and disconnection of cable connectiong R-J and host.

COMP-007 STOP Invarid data format

[Cause] The format of the received data is wrong.

[Remedy] Check the data sent from the host.

COMP-008 STOP Response time over

[Cause] The answer from R-J is no received within the allowable time.

[Remedy] Check that the host side does not stop due to an error, for example.

System variable

$COMP_IF. $ALARM_ENB

[Changeable/Unchangeable] Changeable

[Default] ENABLE

[Valid range and unit] ENABLE/DISENABLE

[Function] Specifies whether the report to the host device is done or not when the error except that related to the communication occures.

$COMP_IF. $ALARM_ENB=ENABLE : The report is done.
DISABLE : The report is not done.

[Setting] To this system variable.

Set $COMP_IF[1] for this purpose, if controller system software version is R-J 7D12/54 or earlier.

7 DIFFERECE FROM R-G2

Taking acount of the compatibility to the system with R-G2, R-J has the specifications of the data transfer function of R-G2 basically.

R-J is the same as R-G2 basically in the transmission system such as the transfer data format, the response time check, the character interval check, error occurence report and data transfer retries.

However, there are a lot of differences between R-G2 and R-J in the data format treated as system. For example, there is difference in the format and contents of the data following TCC even if the same TCC is used in the transfer data transffered by the data transfer function of R-G2 and R-J.

For the details about the data transfer function of R-G2, refer to FANUC ROBOT series (R-G2 CONTROLLER) OPERATOR'S MANUAL (Supplement for data transfer function).

The data transfer function of R-G2 includes the following functions:

- Error occurrence report
- Warning occurrence report
- Robot status inquiry
- Current position inquiry
- S code register output (S29)
- Data inquiry
- Data setting
- Control command input
- Program number specification start
- Program deletion
- Program transfer(write)
- Program inquiry(Read)
- Program directory inquiry

The data which can be inquired or set in R-G2 and R-J is the following:

R-G2	R-J
Parameter (System)	System variable
" (Welding)	Register
" (Servo)	Position register
Setting (System)	Comment
Offset	
Register	
Self-diagnosis data	
Macro S code	
Welding data (Arc)	

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Revision Record

FANUC Robot series (R-J CONTROLLER) Data Transfer Function OPERATOR'S MANUAL (B-80434E)

02	Feb., 09	Correction of errors			
01	Sep., '93	———————————			
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