FANUC

GE Fanuc Automation

Computer Numerical Control Products

Series 0
Series 00

Descriptions Manual (Remote Buffer)

GFZ-61392EN-1/01 *July 1997*

Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

WARNING

Applied when there is a danger of the user being injured or when there is a damage of both the user being injured and the equipment being damaged if the approved procedure is not observed.

CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE

The Note is used to indicate supplementary information other than Warning and Caution.

❍ **Read this manual carefully, and store it in a safe place.**

PREFACE

Applicable models

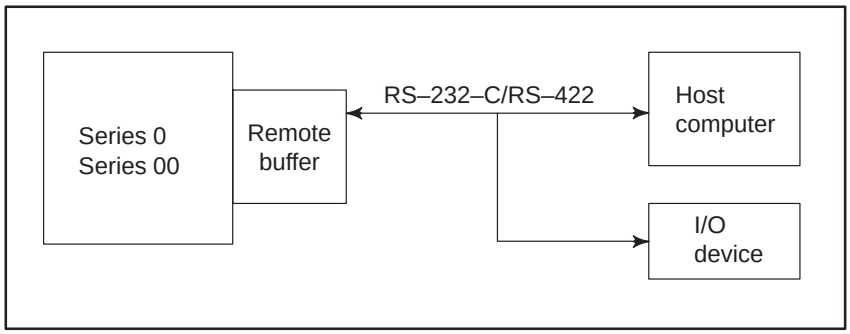
The models covered by this manual, and their abbreviations are :

Product Name	Abbreviations	
FANUC Series 0–TC	0–TC	Series 0
FANUC Series 0–TF	0–TF	
FANUC Series 0–MC	0–MC	
FANUC Series 0–MF	0–MF	
FANUC Series 0–GCC	0–GCC	
FANUC Series 0–GSC	0–GSC	
FANUC Series 00–TC	00–TC	Series 00
FANUC Series 00–MC	00–MC	
FANUC Series 00–GCC	00–GCC	

Table of Contents

1 GENERAL

The remote buffer for Series 0/00 is an option and is used to allow a large number of data to be continuously supplied to the CNC at high speed by connecting it to the host computer or I/O device through a serial interface.



The followings can be performed by the remote buffer.

1) It is used to perform DNC operation at high speed and with high reliability by performing on–line connection to the host computer.
2) It is used to download the NC program and parameters from the host computer.
3) It is used to perform DNC operation and download various kinds of data by connecting to the I/O device. The following I/O devices can be connected.
   (1) FANUC PPR
   (2) FANUC BUBBLE CASSETTE
   (3) FANUC FLOPPY CASSETTE
   (4) FANUC PROGRAM FILE
   (5) FANUC PROGRAM FILE Mate
   (6) FANUC Handy File

   Hereafter, the destination where the remote buffer is connected to be called “Host computer” for ease of explanation.

2 INTERFACE BETWEEN REMOTE BUFFER AND HOST COMPUTER

2.1 ELECTRICAL INTERFACE

The following two interfaces are provided as standard specifications.

1) RS–232–C interface
2) RS–422 interface (Note)

	RS–232–C	RS–422
Interface	Serial voltage interface (start–stop system)	Balance transmission serial interface (start–stop system)
Baud rate	50–19200 baud rate	50–76800 baud rate (Note)
Cable length (MAX.)	100 m (4800 baud or less) 50 m (9600 baud) It differs depending on I/O devices.	Approximately 800 m (9600 baud or less) 50 m (19200 baud or more)

NOTE
When the baud rate exceeding 38400 BPS is used, the synchronization of reception clock is required. Prepare the TT (*TT) and RT (*RT) signals.

2.2 SOFTWARE INTERFACE

The following three protocols for communication between the remote buffer and host computer are provided. The protocol meeting the requirement of specifications of connection device can be selected by setting a parameter.

Protocol	Features of protocol	Interface used	Transfer rate (Max.)
Protocol A	It is the handshake system where transmit/receive is repeated between the both.	RS–232–C	19200 BPS
		RS–422	76800 BPS
Expansion protocol A	It is nearly the same as the protocol A. However, the NC program can be transferred at high–speed so that it can be applied to the high–speed DNC operation.	RS–422	76800 BPS
Protocol B	It is the system for controlling the communication between the both by the control code output from the remote buffer.	RS–232–C	19200 BPS
		RS–422	76800 BPS

NOTE
The average data transfer speed becomes smaller than the maximum transfer speed.

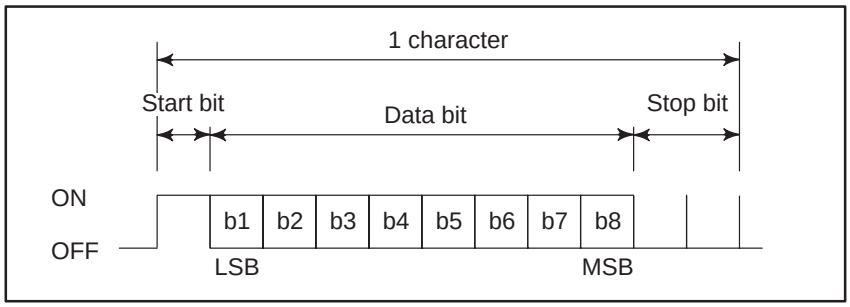
3 ELECTRICAL INTERFACE

3.1 TRANSMISSION SYSTEM

It is the start–stop system for adding the start bit before and stop bit sfter the information bits, respectively.

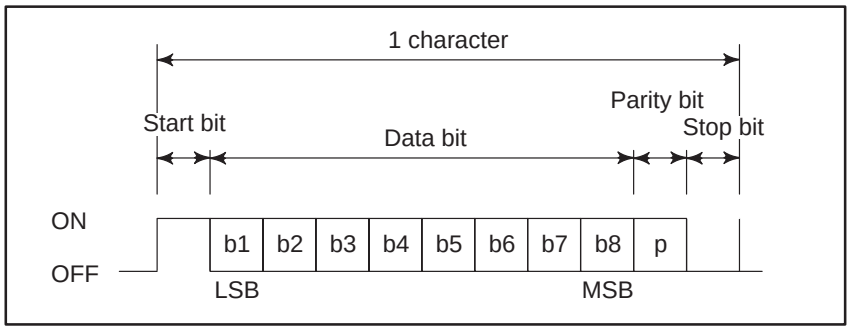
The format for adding one parity bit to each byte of data to be transmitted is also allowed.

1) Format with no parity bit



Data bit is sent starting form the LSB.

2) Format with parity bit



Data bit is sent starting from the LSB.

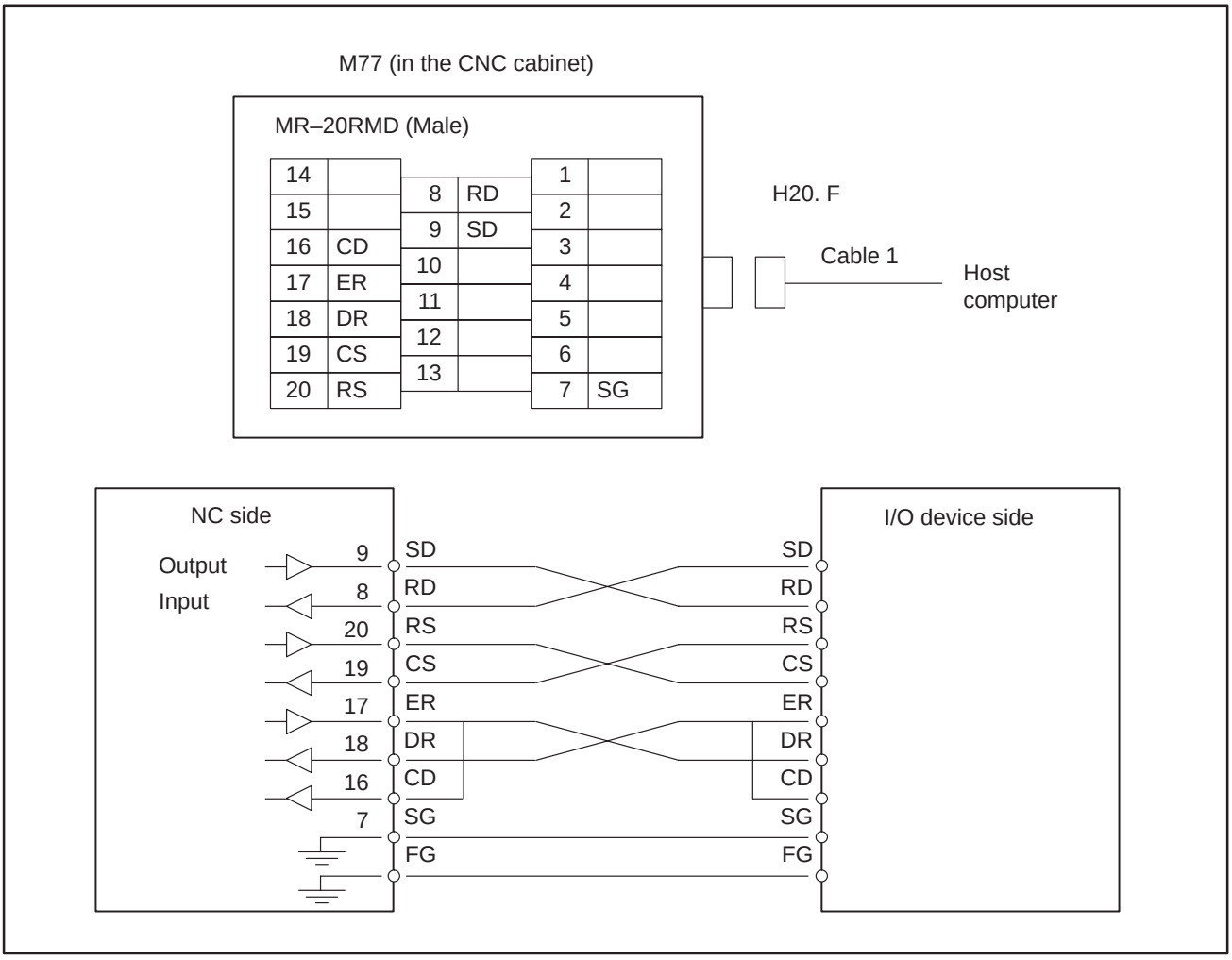
Parameter STP2 (bit 0 of No. 0051) specifies the number of stop bits.

In the format with a parity bit, a parity bit is used so that the total number of 1s in the data bits and parity bit is an even number.

Parameter PARTY (bit 1 of No. 0051) specifies whether the parity bit is provided.

3.2 RS–232–C INTERFACE

1) Connection between devices



When no CS is used, short–circuit it with the RS. However, when the protocol A or expansion protocol A is used, perform connecting as shown in the figure above for use as busy control.

When DR is not used, short–circuit is with ER.

Always short–circuit CD to ER.

2) Signal description

Signal name	RS–232–C circuit number	Input/ output	Description	
SD	103	Output	Send data	See “3.1” for the bit configuration.
RD	104	Input	Receive data	
RS	105	Output	Request to send It is used to inform whether the remote buffer is ready to receive data or not. When the ER signal is on and this signal is on, the remote buffer is ready to receive data.	
CS	106	Input	Clear to send It is used to know the busy status at the host computer. When the DR signal is on and this signal is on, the host computer is regarded as being ready to receive data.	
DR	107	Input	Data set ready When this signal is on, it is considered that the preparation at the host computer has been completed. Generally, it is connected to the ER signal of the host computer. When this signal is off during data transmission, an alarm occurs. Always connect it to the ER signal of CNC side when this signal is not used.	
ER	108.2	Output	Data terminal ready When this signal is on, it is considered that the remote buffer is in ready condition. In general, it is connected to the ER signal at the host computer. If it is turned off during transmission of data, an alarm occurs. If this signal is not used, always connect this to the ER signal at the CNC side.	
CD	109	Input	Received line signal detector This signal is not used for connection to the host computer. Thus, connect it to the ER signal of remote buffer side.	
SG	102		Grounding for signal	
FG	101		Grounding for protection	

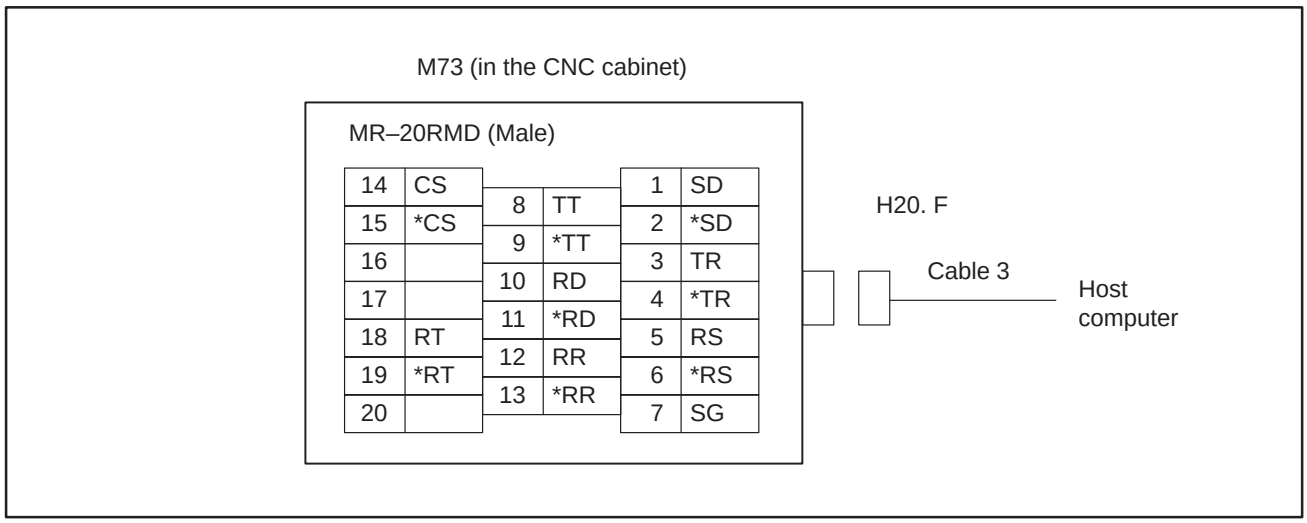
NOTE

Turn on or off signal according to the following:

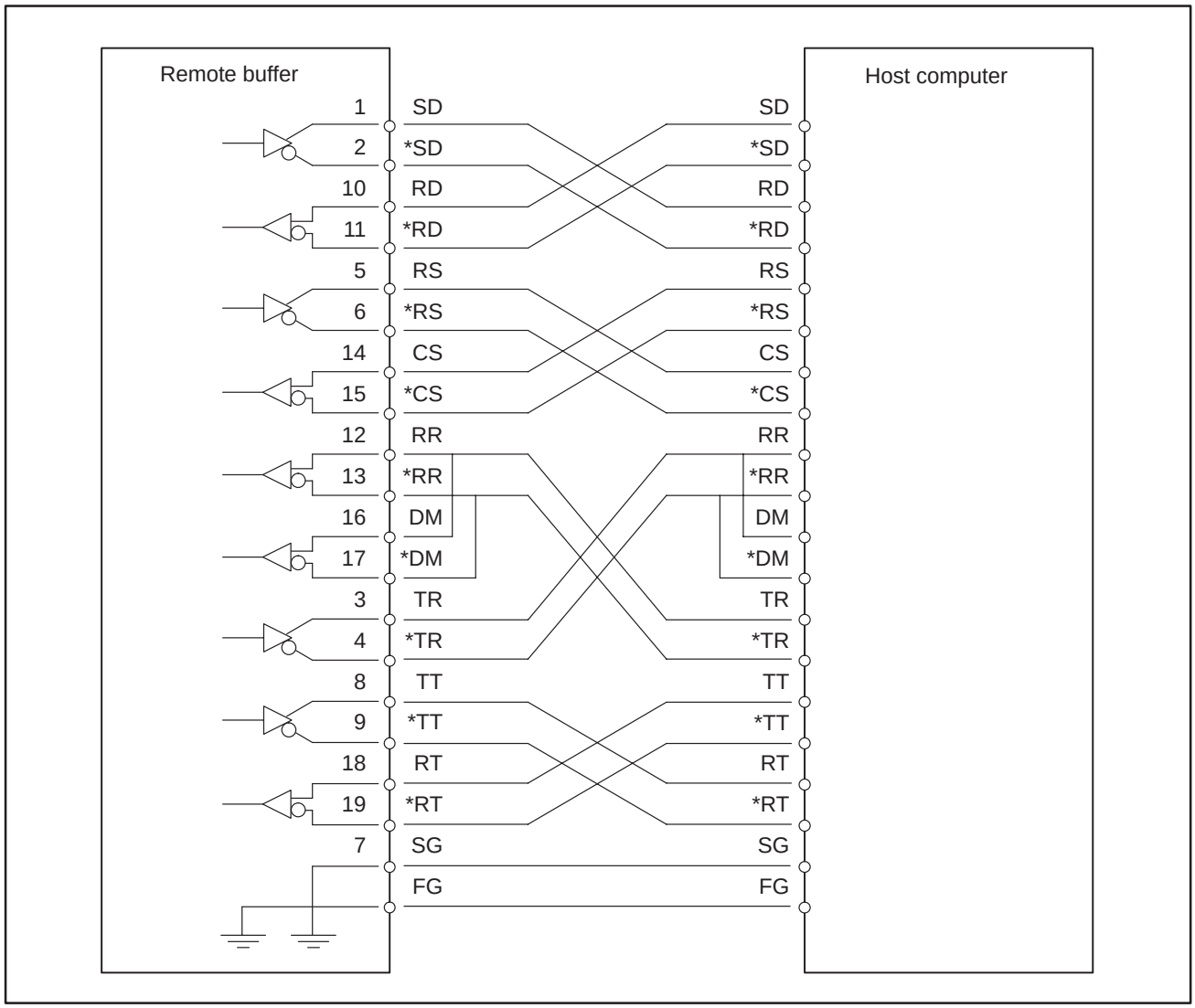
	–3V or less	+3V or more
Function	OFF	ON
Signal Condition	Marking	Spacing

3.3 RS–422 INTERFACE

1) Connection between devices



Simplified figure showing the signal connection



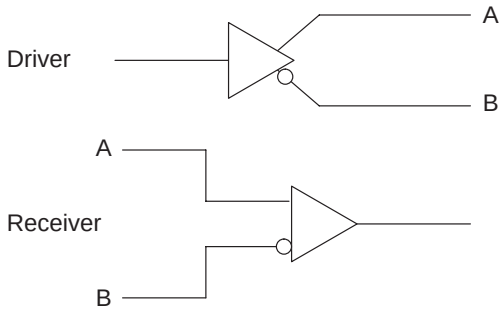
2) Signal description

Signal name	RS–232–C circuit number	Input/ output	Description	
SD	103	Output	Transmission data	See “3.1” for the bit configuration.
RD	104	Input	Reception data	
RS	105	Output	Transmission request It is used to inform whether the remote buffer is ready to receive data or not. When the TR signal is on and this signal is on, the remote buffer is ready to receive data.	
CS	106	Input	??? It is used to know the busy status at the host computer. When the DM signal is on and this signal is on, the host computer is regarded as being ready to receive data.	
TR	108.2	Output	Terminal Ready When this signal is on, it is considered that the operation of remote buffer has been completed. In general, it is connected to the ER signal at the host computer. If it is turned off during transmission of data, an alarm results. If this signal is not used, always connect this to the ER signal at the CNC side.	
RR	109	Input	Receiver Ready When this signal is on, it indicates that the host computer is ready to transmit data to the remote buffer. If this signal is not used, always connect it to the TR signal at the remote buffer side.	
TT	113	Output	Transmission timing Transmission clock transmission terminal at the remote buffer side. When 38400 baud or more is used, always connect it to the RT signal at the host computer side.	
RT	115	Input	Reception timing Reception clock input terminal at the remote buffer side. When 38400 baud or more is used, always connect it to the TT signal at the host computer side.	
SG	102		Grounding for signal	
FG	101		Grounding for protection	

NOTE

The signal turn on/off according to the following:

	A<B	A>B
Function	OFF	ON
Signal Condition	Marking	Spacing

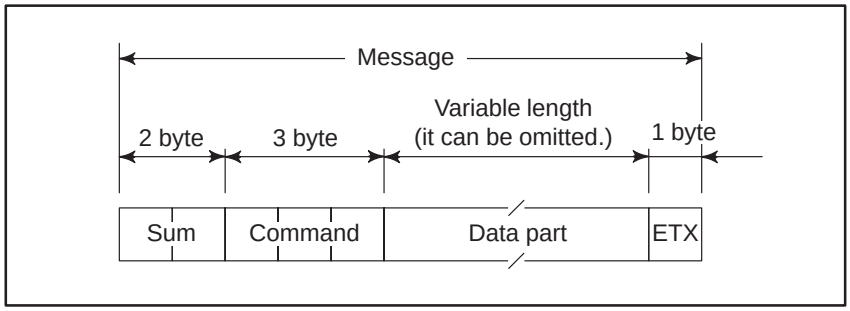


4 PROTOCOL A

It is used for the handshake system where the communication between the remote buffer and host computer repeats transmission/reception each other.

4.1 MESSAGE FORMAT

The information (character–string) exchanged between the remote buffer and host computer is called “message”. The general type of message is shown as below:



Field	Byte length	Abbre–viation	Meaning	Remarks
Checksum	2	No	It is used to indicate the lower 8 bits of binary sum of all bytes from the command field to end code by two–digit hexadecimal number (0 to 9 and A to F).	Transmit the MSB before the LSB.
Command	3	No	It is used to display the type of message (functions) and to specify the operation and response of the partner.	
Data	0 to n	Yes	It is the data part corresponding to a command. Abbreviate it when a command without data part is used. Details are described later.	SAT, SET, DAT, RTY, SDI, SDO
End code (ETX)	1	No	It indicates the end of message. Not transmit a code which is the same as an end code to data part.	

4.2 CODE SYSTEM

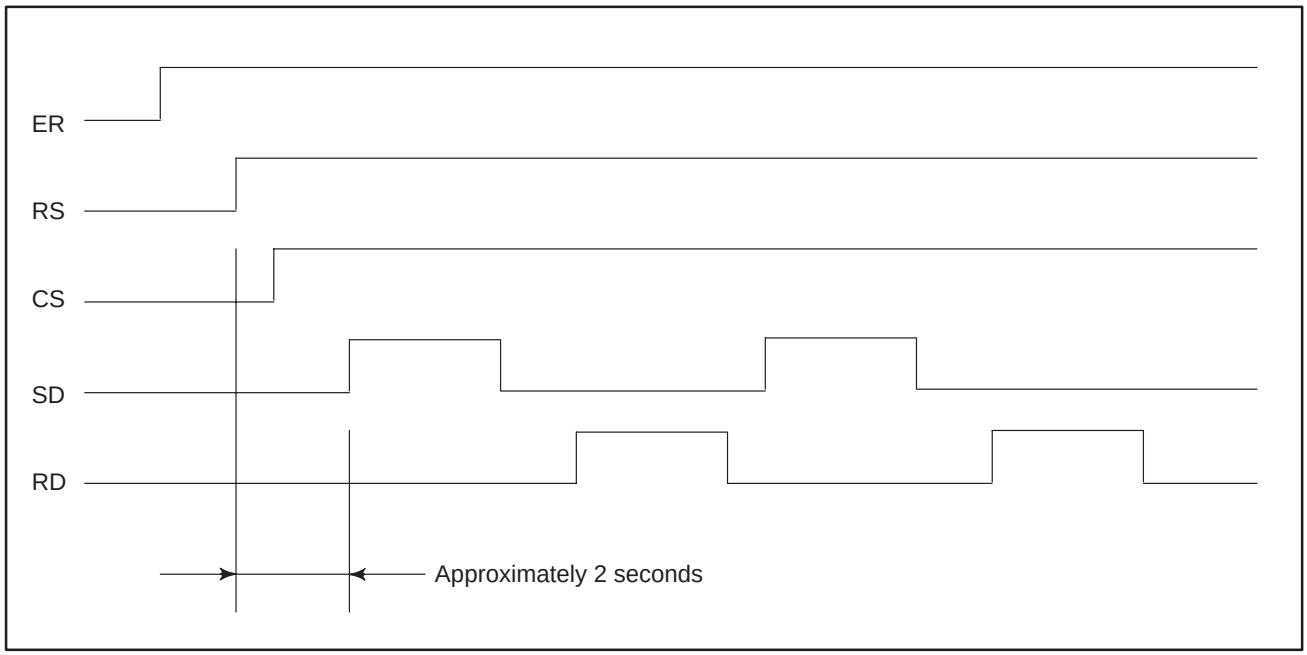
The communication codes between the remote buffer and host computer are described below:

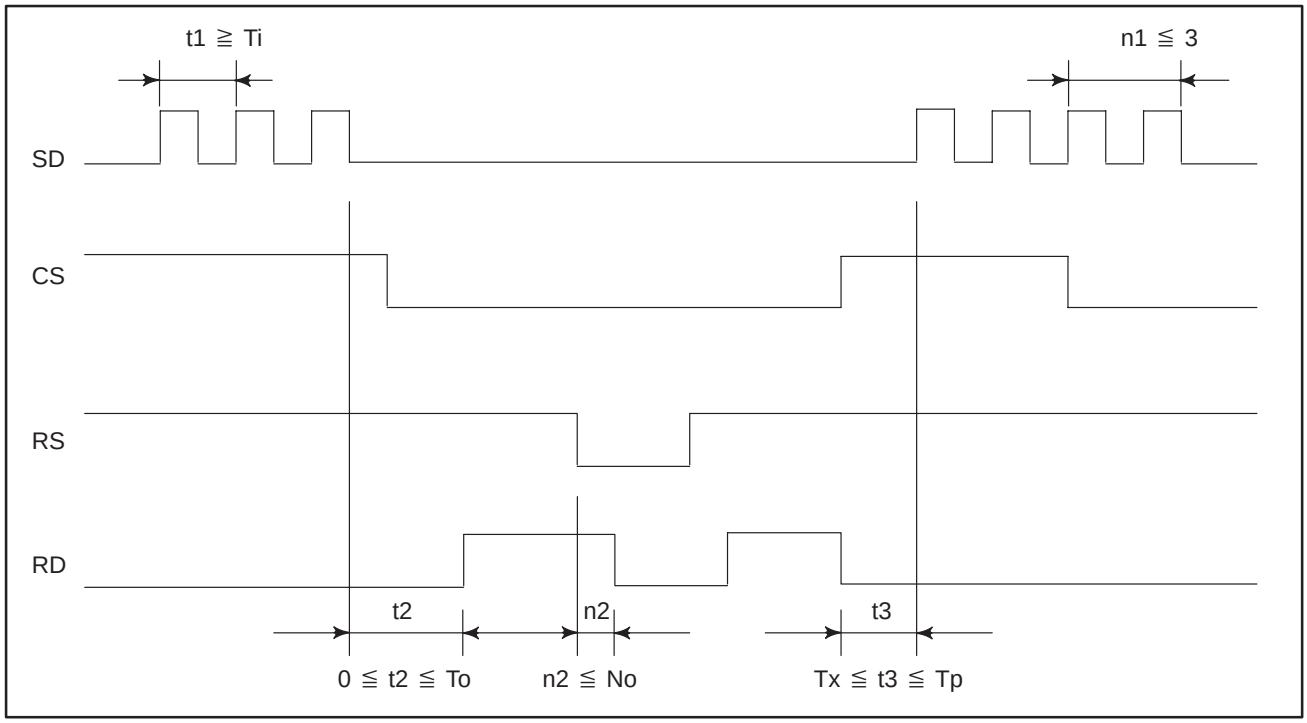
Field	Command	Code		Related parameters
Checksum	——	ISO/ASCII		No.0055#0 (ASCII)
Command name	——	ISO/ASCII		No.0055#0 (ASCII)
Data part	DAT	ISO/ASCII/EIA/Bin		No.0051#3 (RSASC)
	Commands other than DAT	ISO/ASCII		No.0055#0 (ASCII)
End code	——	CR	ISO/ASCII	No.0055#0 (ASCII) No.0055#1 (EXT)
		EXT	ISO/ASCII	

4.3 COMMUNICATION SYSTEM

It is used to perform communication between the remote buffer and host computer.

When the both are ready to operate after power on, the communication starts from the transmission of remote buffer and reception of host computer and then the transmission/reception is repeated.





(1) Approximately two seconds are required for the first request after both of remote buffer and host computer are ready. However, when the CS signal is off, the first transmission is performed after turning on the CS signal.

(2) The minimum time period between bytes is determined by the parameter Ti (msec) of SET command. There is no prescription of minimum time period between reception bytes.

(3) Switching from transmission to reception
Immediately the remote buffer side can be ready to receive signal. Start transmission within the parameter setting time (To sec) at the host computer side. When no response is obtained for the time period (To or more), an error occurs in the host computer. (Overtime)

(4) Switching from reception to transmission
The remote buffer waits for Tx msec (parameter setting time) and moves to the transmission process after completion of reception. When there is no transmission after waiting another parameter (Tp seconds), it is considered that an error occurred in the remote buffer.

(5) Overrun on reception
When the RS signal is turned off by the remote buffer on reception of signal, stop the transmission within the overrun parameter number bytes by the host computer. Request for retransmission is transmitted when the above number is exceeded.

(6) Overrun on transmission
When the CS is turned off on transmission of remote buffer, the transmission is suspended within 3 bytes including that which is currently being transmitted.

4.4 COMMAND

4.4.1 Command Table

Commands used in the protocol A are described below:

Origin station R: Remote buffer H: Host computer

Command	Origin station	Functions	Data part	Executed command at CNC side
SYN	R	Initialization command It is used to command the initialization of host.	Meaningless	SYN
	H	Response of SYN Response when the initialization does not end yet Initialization command It is command to initialize the remote buffer.	Meaningless	
RDY	R	Notice of initialization end The host should respond the RDY in the case of end of initialization or the SYN when the initialization has not ended.	Meaningless	RDY, SYN
	H	Notice of initialization end It is used to notice that the initialization of host has ended.	Meaningless	
RST	R	Notice of CNC reset Immediately after the CNC is reset, transmit this command when it is possible to transmit signal.	Meaningless	ARS
ARS	H	Response corresponding to the RST	Meaningless	
ALM	R	Notice of CNC alarm occurrence When an alarm occurs in CNC, transmit this command when it is possible to transmit immediately after that.	Meaningless	AAL
AAL	H	Response corresponding to the ALM	Meaningless	
SAT	R	Notice of remote buffer status It is used to notice the status of remote buffer by transmitting it when there is no data to be especially transmitted while the Tp sec has passed after receiving the command.	Status	SET ••• Normal CLB RDI SDO SYN
SET	H	Response corresponding to the SAT It is used to modify the setting parameter of remote buffer by specifying the data part.	Modification parameter	
GTD	R	Transmit command of NC data Transmit this command when the space of remote buffer exceeds Nb bytes of parameter setting value in the remote operation status.	Meaningless	DAT ••• Normal EOD ••• End WAT ••• Busy RDI SDO
DAT	H	Response corresponding to the GTD Transmit this command with the NC data.	NC data	
WAT	H	Response corresponding to the GTD Transmit this command if the NC data cannot be transmitted within to when the GTD has been received. The GTD is transmitted again by the remote buffer after a parameter setting time of Tw.	Meaningless	
EOD	H	Response corresponding to GTD Transmit this command when the GTD has been received while the transmission of NC data has been completed.	Meaningless	
CLB	H	Buffer clear It can be transmitted as the response of SAT when the buffer at the remote buffer side is to be cleared.	Meaningless	

Command	Origin station	Functions	Data part	Executed command at CNC side
RDI	H	DI reading request It is used to request transmission of image of specified 8–bit DI. The DI image at that time is responded by the SDI command in the remote buffer. This command can be transmitted as responses of SAT and GTD.	Meaningless	
SDI	R	Notice of DI It is used to transmit the signal status of DI as the response of RDI command. The host should transmit the response of command received immediately before transmitting the RDI after receiving this command.	DI image	Response corresponding to the DAT/SAT
SDO	H	Do output request It is used to command that the 8–bit image of data part should be output to the DO. It can be transmitted as responses of SAT, GTD, and SDI.	DO image	
RTY	R/H	Request of retransmission It is used to request the retransmission of the same message as before. Immediately transmit this command when a transmit error is detected during reception of messages.	Reason for retransmission	Command transmitted immediately before

4.4.2 Description of Data Part

Data part of message is of variable length. Up to 4096 and 72 bytes can be received/transmitted in the case of <DAT> and the others, respectively.

1) Data part of SAT

Byte position	Meaning and code	Default value (hexadecimal)
1	Switching of remote/tape operations According to parameter RMSTS (No. 0055#7) setting.	0
2	Status of remote buffer 0 : Non–completion status of operation preparation 1 : Reset status 2 : Operation status 3 : Alarm status 4 : Open line	0
3	Causes of shift to alarm status 0 : NC alarm 1 : Checksum error (retry over) 6 : Reception of unexpected response (command error) A: Overrun error (retry over)	0
4	Not used	——
5 to 8	Number of bytes currently stored in the buffer (Four–digit hexadecimal number)	0000
9 to 12	Current value of parameter Nb Empty area limit of buffer (Four–digit hexadecimal number)	07D0
13 to 16	Current value of parameter No Amount of maximum overrun on reception (Four–digit hexadecimal number)	0032
17 to 20	Current value of parameter Ne Number of times of retry on detecting a transmission error (Four–digit hexadecimal number)	000A

Byte position	Meaning and code	Default value (hexadecimal)
21 to 24	Current value of parameter Tp Polling time interval (Four–digit hexadecimal number)	0005
25 to 28	Current value of parameter To Time–out time (Four–digit hexadecimal number)	0014
29 to 32	Current value of parameter Ti Minimum time interval between bytes transmitted (Four–digit hexadecimal number)	000A
33 to 36	Current value of parameter Tx Minimum switching time from reception to transmission (Four–digit hexadecimal number)	0064
37 to 40	Current value of parameter Tw Waiting time on reception of (WAT) (Four–digit hexadecimal number)	0005
41 to 44	Always set 0. (Four–digit hexadecimal number)	0000
45 to 46	Code to be converted (Two–digit hexadecimal number)	00
47 to 48	Code after conversion (Two–digit hexadecimal number)	00
49 to 54	Reserve	——
55 to 56	Packet length parameter n of expansion protocol A (Two–digit hexadecimal number) 00: Normal protocol A 01: Expansion protocol A NC data length = 256 bytes Packet length = 260 bytes 02: Expansion protocol A NC data length = 512 bytes Packet length = 516 bytes 04: Expansion protocol A NC data length = 1024 bytes Packet length = 1028 bytes	00
57 to 72	Not used	——

2) Data part of SET

The format of data part of command <SET> is the same as that of data part of <SAT> except the following points.

Data part can be abbreviated when no parameter is modified.

Byte position	Meaning and code	Remarks
1	Switching request of remote/tepe operations	
2	Status of host computer	Ignore
3 to 8	Not used	
9 to 48	Modifies value of parameter	
49 to 54	Not used	
55 to 56	Parameter for expansion protocol	
57 to 72	Not used	

3) Data part of DAT

Up to 4096 bytes of NC data can be received at the data part of command <DAT>.

In general, the number of NC data bytes should be less than or equal to the value specified with parameter Nb–No of the SET command.

Transmit the NC data depending on the specifications of NC since no data process is performed in the remote buffer other than the conversion code set by the parameter.

Also, always add the EOR code to the end of NC program.

4) Data part of SDI

Byte position	Meaning
1 to 2	2–byte hexadecimal display of 8–bit contents of DI (PMC address: G239)
3 to 72	Not used (it can be omitted.)

5) Data part of SDO

Byte position	Meaning
1 to 2	2–byte hexadecimal display of 8–bit contents of DO (PMC address: F289)
3 to 72	Not used (it can be omitted.)

6) Data part of RTY

Byte position	Meaning
1	Reason for requesting retransmission 1 : Checksum error 3 : Overrun error
2 to 72	Not used (it can be omitted.)

7) Data part of other commands

Byte position	Meaning
1 to 72	Not used (it is generally omitted.)

4.5 PARAMETER TABLE

Parameters which can be set in the data part of SET command are shown as below:

Parameter	Meaning	Unit	Range	On turning on power
Nb	Number of bytes of minimum buffer empty area on transmission of GTD	Byte	1 to 4000	2000
No	Maximum amount of overrun on reception of data	Byte	2 to 2000	50
Ne	Number of retry times on detection of transmission error	Times	0 to 100	10
Tp	Polling time interval	Sec	1 to 99	5
To	Time–out time	Sec	1 to 999	20
Ti	Minimum time interval between transmission bytes	msec	0 to 10 (Note)	10
Tx	Minimum switching time from reception to transmission	msec	0 to 100	100
Tw	Wait time on reception of WAT	Sec	0 to Tp	5

NOTE
2 msec step

4.6 ERROR PROCESS

1) Open–line error

   When the following error occurs, it may be an open line error. Restart the initialization of remote buffer for recovering the line.

   When the line is recovered, it waits for transmission of SYN and is SYN wait status.

   The procedures are the same as those of initialization on power on other than continuation of SYN of host computer.

   (1) Framing error
   (2) Overrun error
   (3) Parity error
   (4) Data Set Ready off
   (5) Buffer full (the transmission stop request is unacceptable.)
   (6) Time out
   (7) Number of retry times has been exceeded.

2) Reception error

   Ignore the reception data and restart the reception of SAT command at the remote buffer side when the following errors occurs.

   (1) Number of retry times exceeded
   Number of RTY reception times + Number of retransmission by checksum error > Ne

   (2) Command error
   Message format error
   Reception of undefined command
   Reception of unexpected command

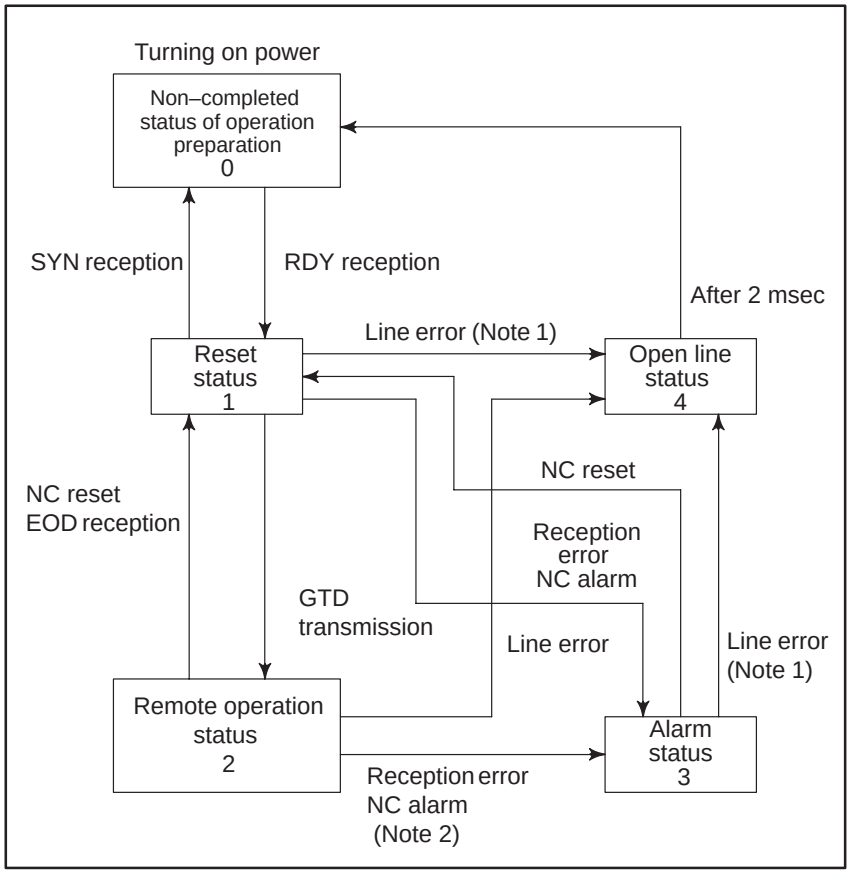
   (3) Overrun
   This results if the transmission stop request is not accepted and the reception buffer is overflown.

3) Reception during transmission

   Data received during transmission is ignored.

4.7 STATUS TRANSITION

The status transition diagram of remote buffer is shown as below:



NOTE

1 Causes of line error
   (1) DR off
   (2) Number of retry times over
   (3) Time out
   (4) Buffer full

2 Reception error
   (1) Undefined command
   (2) Unexpected command
   (3) Number of retry times over by sum error
   (4) Overrun

5 EXPANSION PROTOCOL A

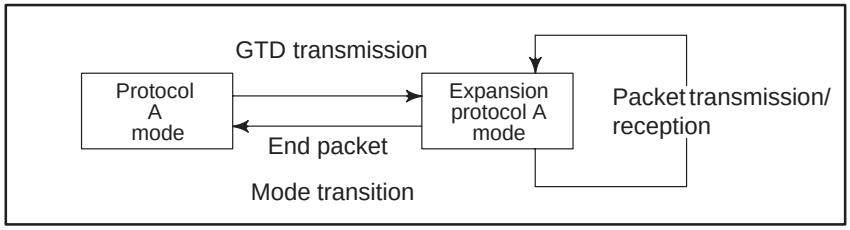
It allows the NC data between the remote buffer and host computer to be efficiently transferred by adding the high–speed reception function to the protocol A.

5.1 COMMUNICATION SYSTEM

The expansion protocol A is the same as the protocol A excluding the transmission of NC data.

The expansion protocol A mode is initiated after the <GTD> is output to the host computer by the remote buffer according to the data request from the CNC side.

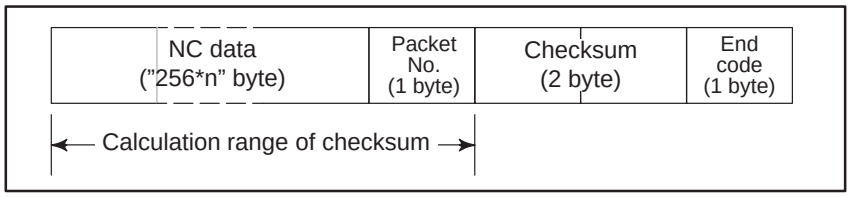
The communication system is performed in the full duplex mode in the expansion protocol A. The NC data transmitted is packeted and is transmitted to the remote buffer by the host computer. Also, perform the reception process of monitor packet from the remote buffer.



5.2 DATA PACKET FORMAT

The NC data is transferred to the remote buffer using the following format by the host computer after receiving the <GTD>.

When the NC data transmitted becomes multiple packets, the packets can be transmitted in order without waiting the response from the remote buffer by the host computer.



1) NC data

The NC data is the fixed length of "256*n" bytes and the n is specified with the parameter (byte position 55 to 56) by the <SET> command.

The default value of n is 0. In the case of " = 0", the normal protocol A is used.

n = 0: Normal protocol A

N = 1, 2, 4: Expansion protocol A

CAUTION

Note that n is set to 0 automatically even if n is set to the values other than listed above.

2) Packet No.

a) Effective packet: 30h – 39h (ASCII code)

Always set the first packet No. to 30h. In other cases, the packet No. 30h is transmitted to the host computer with the monitor packet <NAK> of retransmission request by the remote buffer.

When data is sent by only one packet, set the packet No. to OFFh (end packet).

Hereafter, the value incremented by 1 should be the packet No.

However, the value next to 39h becomes 30h.

Also, when the loss or improper order of packet No. is detected, the improper packet No. is transmitted to the host computer slong with the monitor packet <NAK>.

When the checksum error is detected, the improper packet No. is transmitted to the host computer with the monitor packet <NAK> of retransfer request by the remote buffer.

b) End packet: FFh

The end packet is transmitted by setting the packet No. to FFh. The data part of end packet is considered to be the effective data. However, the end packet received after transmitting <CAN> ignores the data part.

This allows the expansion protocol A mode to be ended and the normal protocol A mode is initiated.

However, when the checksum error is detected at the end packet, the before packet No. +1 is transmitted as the end packet No. to the host computer with monitor packet <NAK> of retransmission request.

The host computer should shift to the protocol A when the command of protocol A is received after transmitting the end packet.

c) Invalid packet: Other than above

Transmit this invalid packet with the dummy data of “256*n” bytes when the time out may occur since time is required for editing of NC data transmitted by the host computer.

The remote buffer is processed as an invalid packet.

3) Checksum

The checksum is obtained by adding the NC data to the packet No. in units of byte and then expressing the 1 byte data produced by neglecting the overflow above 8 bits out of the total value above using ASCII 2–byte code.

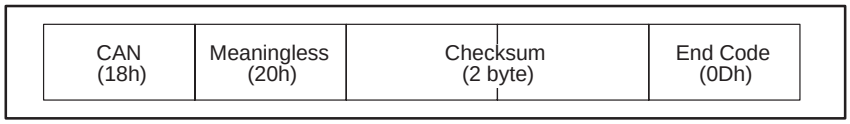
4) End code

The end code should be the ASCII code CR (0Dh).

5.3 MONITOR PACKET FORMAT

The monitor packets transmitted from the remote buffer to the host computer are shown as below. All packets have the fixed length consisting of 5 bytes.

1) Stop request



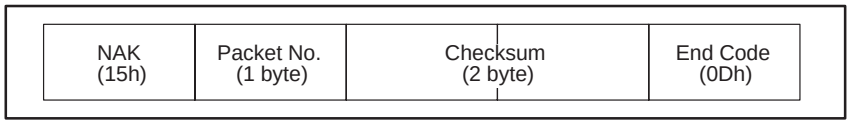
The stop request is transmitted to the host computer by the remote buffer when resetting the NC and stopping data reception by an alarm.

Transmit the end packet (the NC is dummy) after transmitting the packet which is currently being transmitted and move to the normal protocol A mode when this packet is received by the host computer.

When the packet being transferred is the end packet, an additional end packet need not be transferred for acknowledgment of the CAN signal.

Transmit the end packet even in the DC3 reception status.

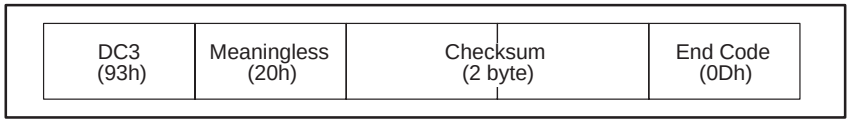
2) Retransmission request



When a check sum error is detected in the received packet, the retransmission request corresponding to the packet is transmitted by the remote buffer.

The host computer should perform retransmission from the corresponding packet immediately after ending the transmission of packet which is currently being transmitted when it receives this packet.

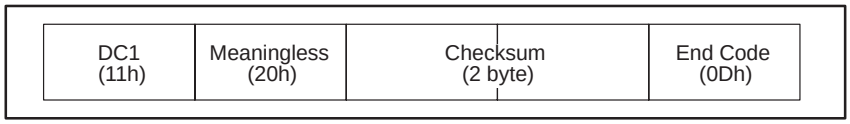
3) Interruption request



The interruption request is transmitted to the host computer by the remote buffer when the reception buffer may become overflown.

The host computer should interrupt the transmission and wait until the next monitor packet is received after completing the transmission of packet which is currently being transmitted when it receives this packet.

4) Restart request



The restart request is transmitted to the host computer by the remote buffer when there is space in the reception buffer after requesting interruption.

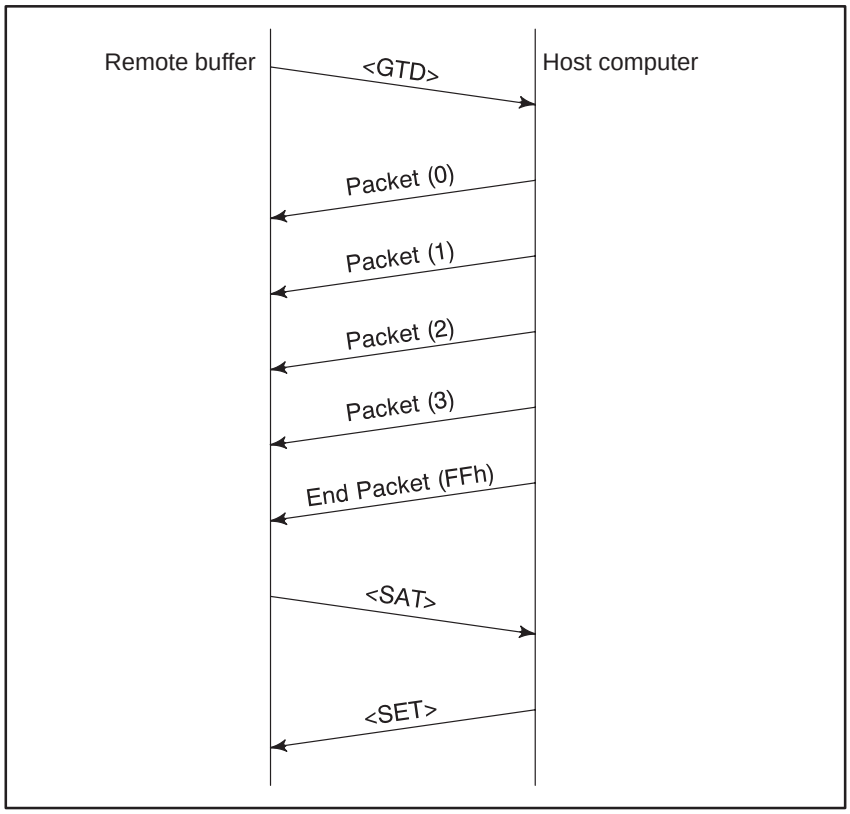
The host computer should restart the transmission from the next packet following the interrupted one when this packet is received.

NOTE

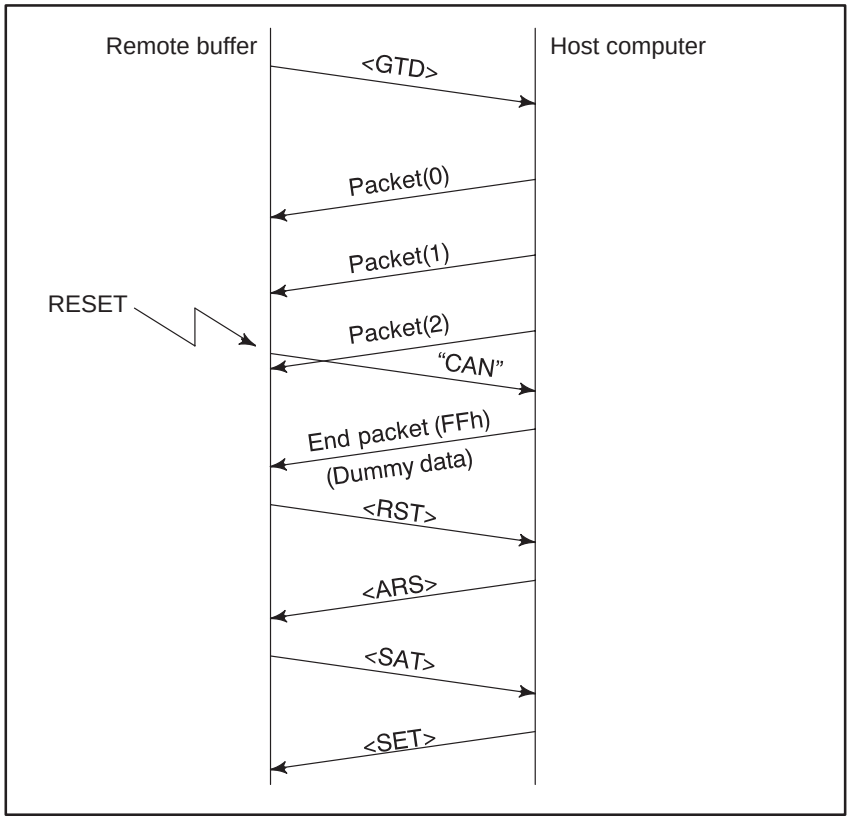
If the end packet is currently being transmitted, end packet transmission in response to CAN is not necessary.

5.4 COMMUNICATION EXAMPLE

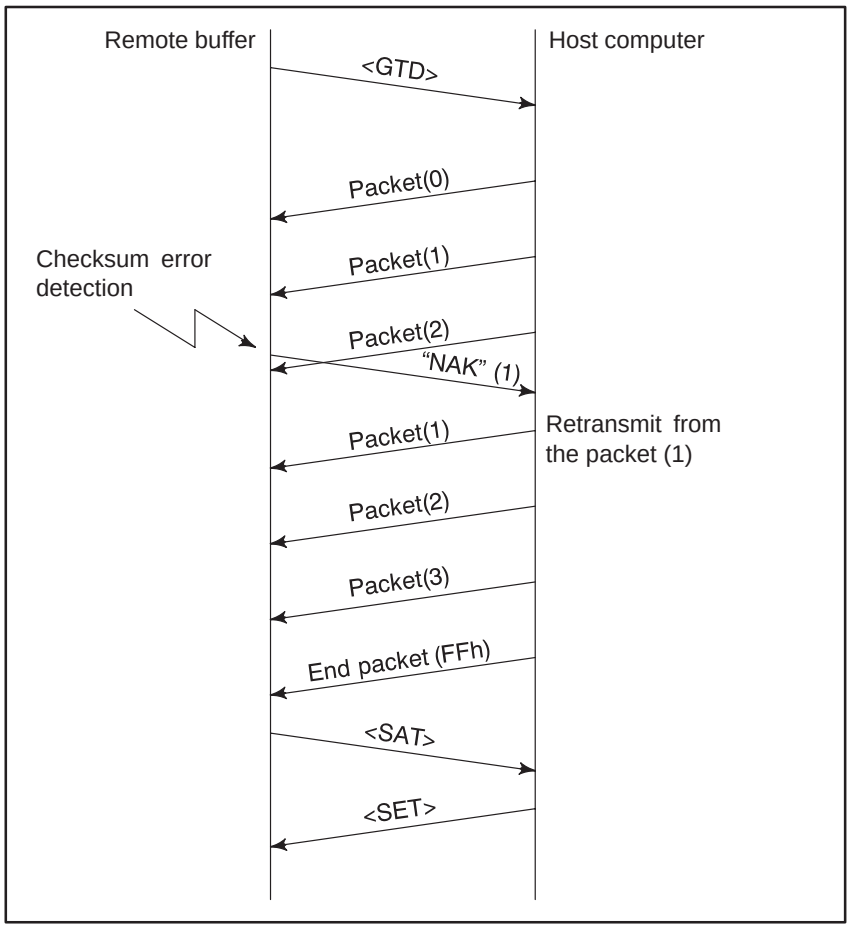
1) Normal



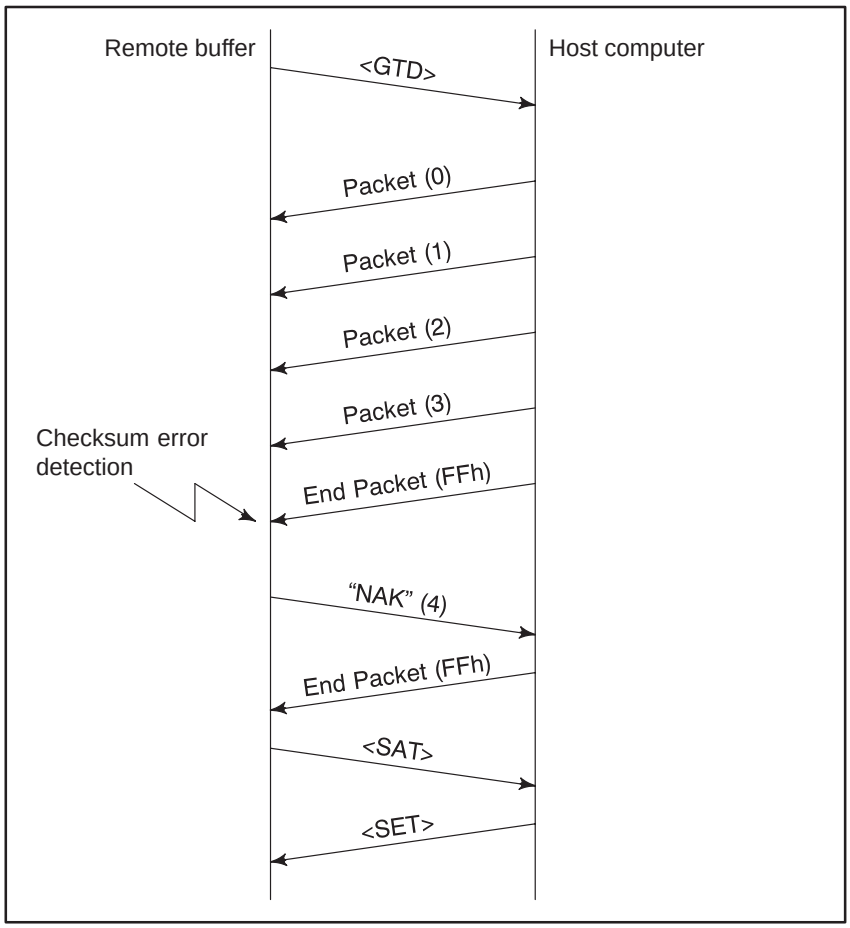
2) Stop request



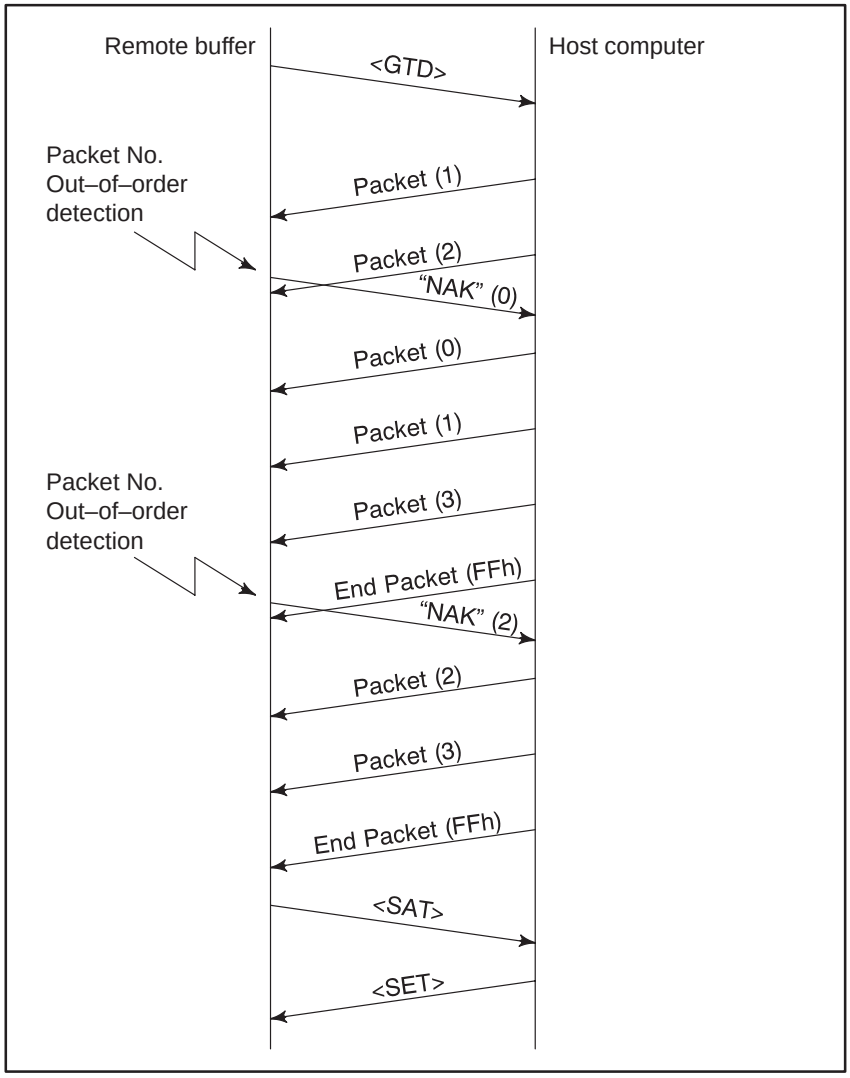
3) Retransmission (i)



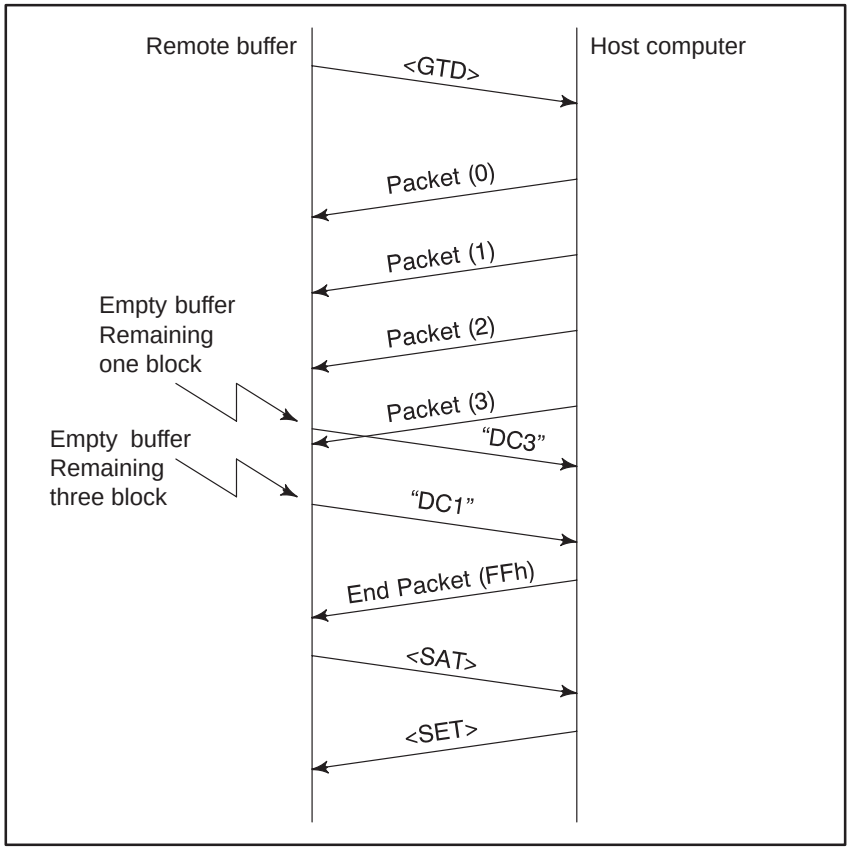
3) Retransmission (ii)



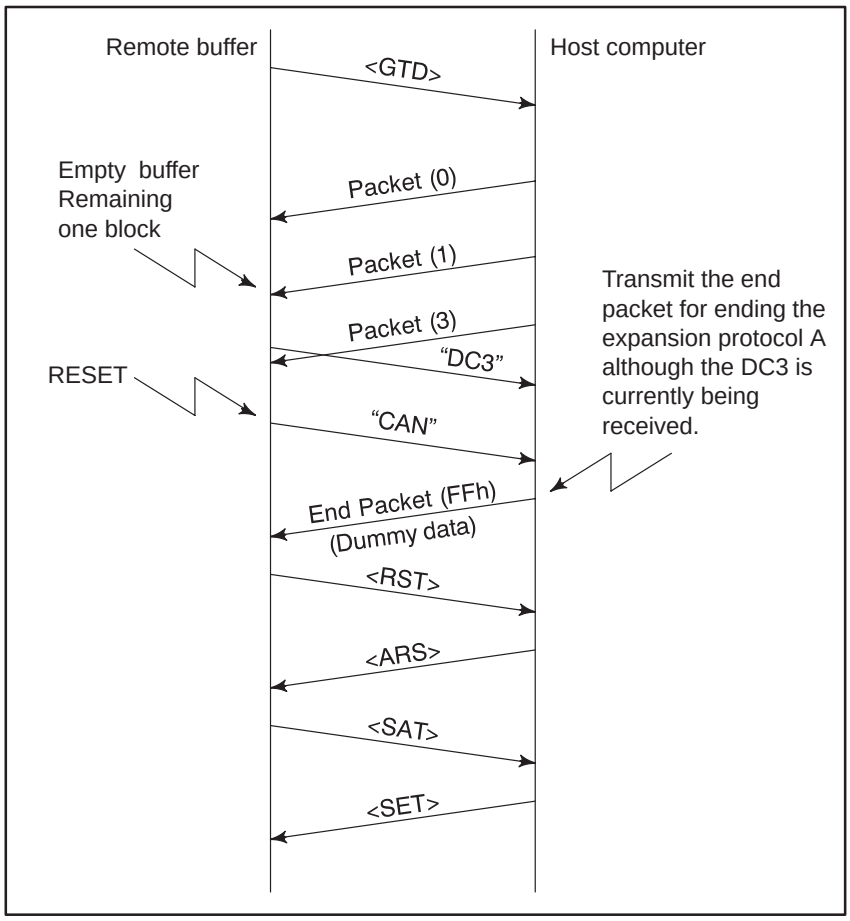
3) Retransmission (iii)



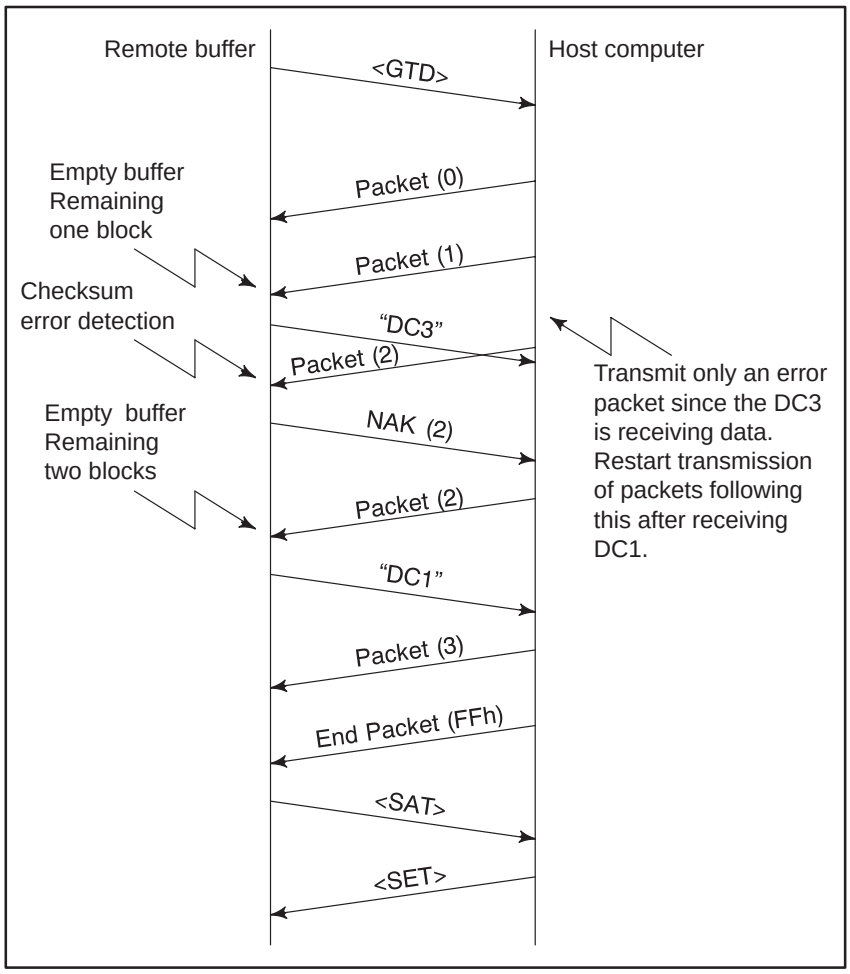
4) Interruption –> Restart



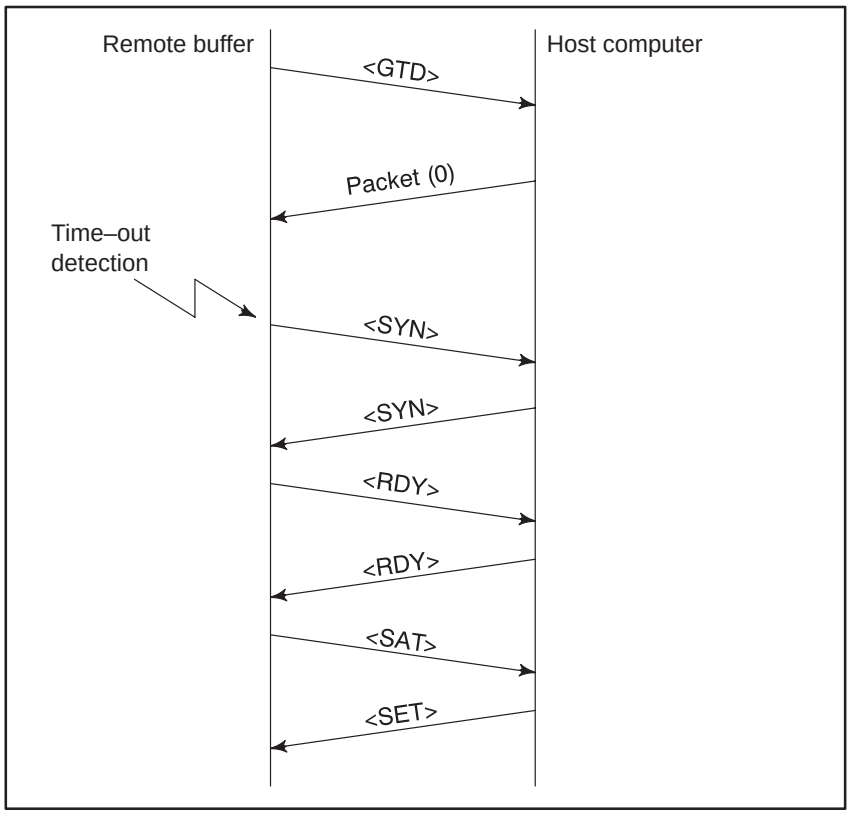
5) Interruption –> Stop



6) Interruption –> Retransmission



7) Time–out detection



NOTE

The time–out monitoring period lasts until the next one packet is received immediately after output of <GTD>. After that, it is the time between reception of one packet and that of another.

6 PROTOCOL B

Protocol B controls the communication between a remote buffer and a host computer with control codes.

One of two communication modes can be selected by setting parameter SYNAK (bit 2 of No. 0051).

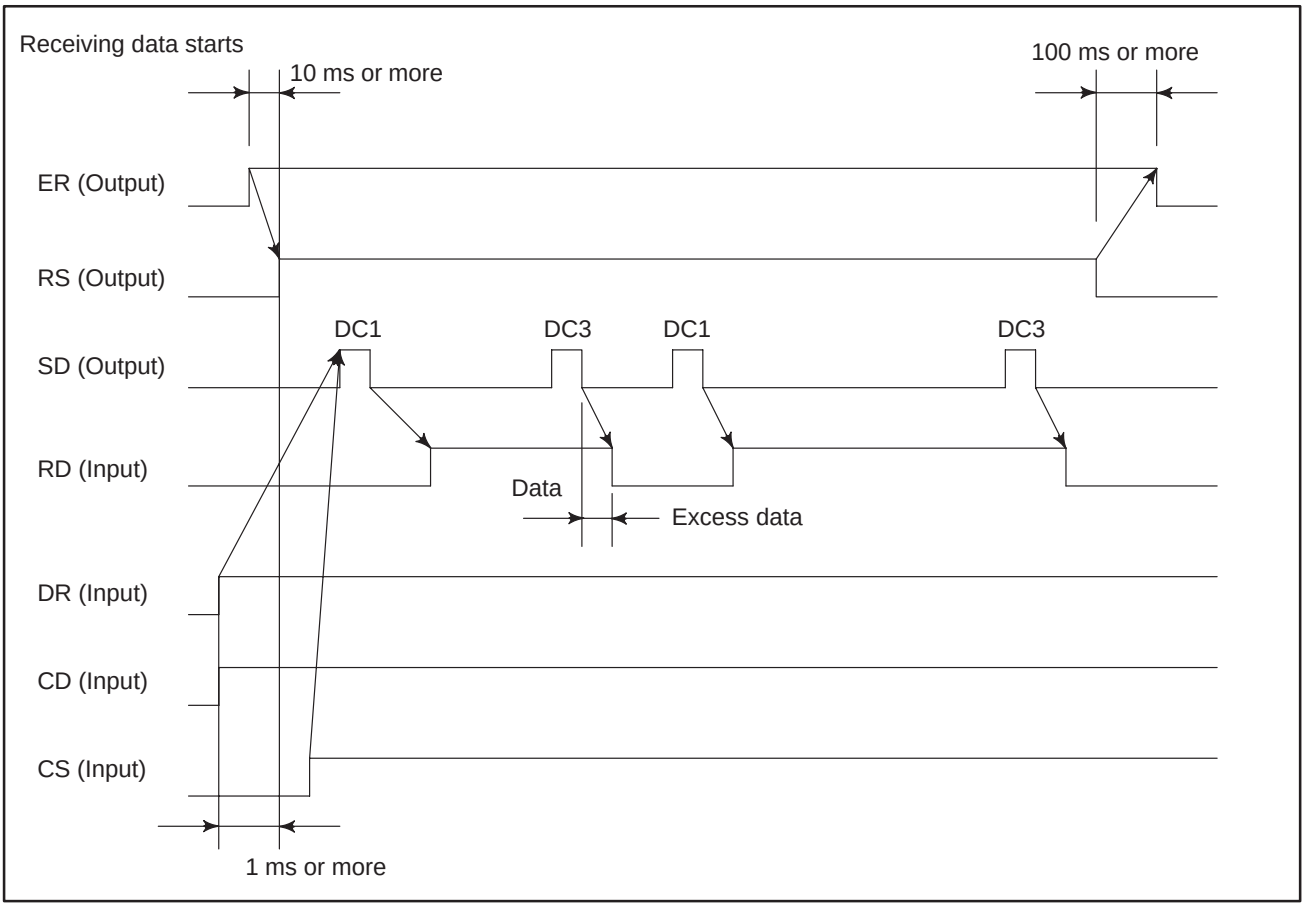
6.1 COMMUNICATION MODES

1) When parameter SYNAK is set to 0

The remote buffer turns on the ER signal and sends the DC1 code to receive data from the host computer when the DNC operation starts or NC programs start to be entered. When the buffer receives the EOR code, it sends the DC3 code and turns off the ER signal to terminate the data receiving process.

While the remote buffer receives data, if an alarm is issued in the NC unit or if the NC unit is reset, the buffer sends the DC3 code and turns off the ER signal to terminate the data receiving process.

a) Timing chart when SYNAK is set to 0



NOTE
The CD signal is checked only when the RS–232C interface is used and when parameter NCKCD (No. 0051#4) is set properly.

(1) The remote buffer transmits the DC1 code.

(2) The host computer starts to transmit the DC3 code to the remote buffer by the DC1 code,

(3) When the empty area of remote buffer area becomes the value specified, the DC3 code is transmitted.

(4) The host computer should stop transmission to the remote buffer by the DC3 code. The overrun value is specified later.

(5) The remote buffer transmits the DC1 code when the remainder of buffer data becomes less than the level specified and requests the host computer to start transmitting data.

(6) The host computer should start transmitting data again by the DC1 code. The transmission data is a continuation of previous data.

(7) The remote buffer transmits the DC3 code when the data read is completed.
The end of data read is indicated by the detection of ER or NC reset.

(8) The host computer stops transmission of data.

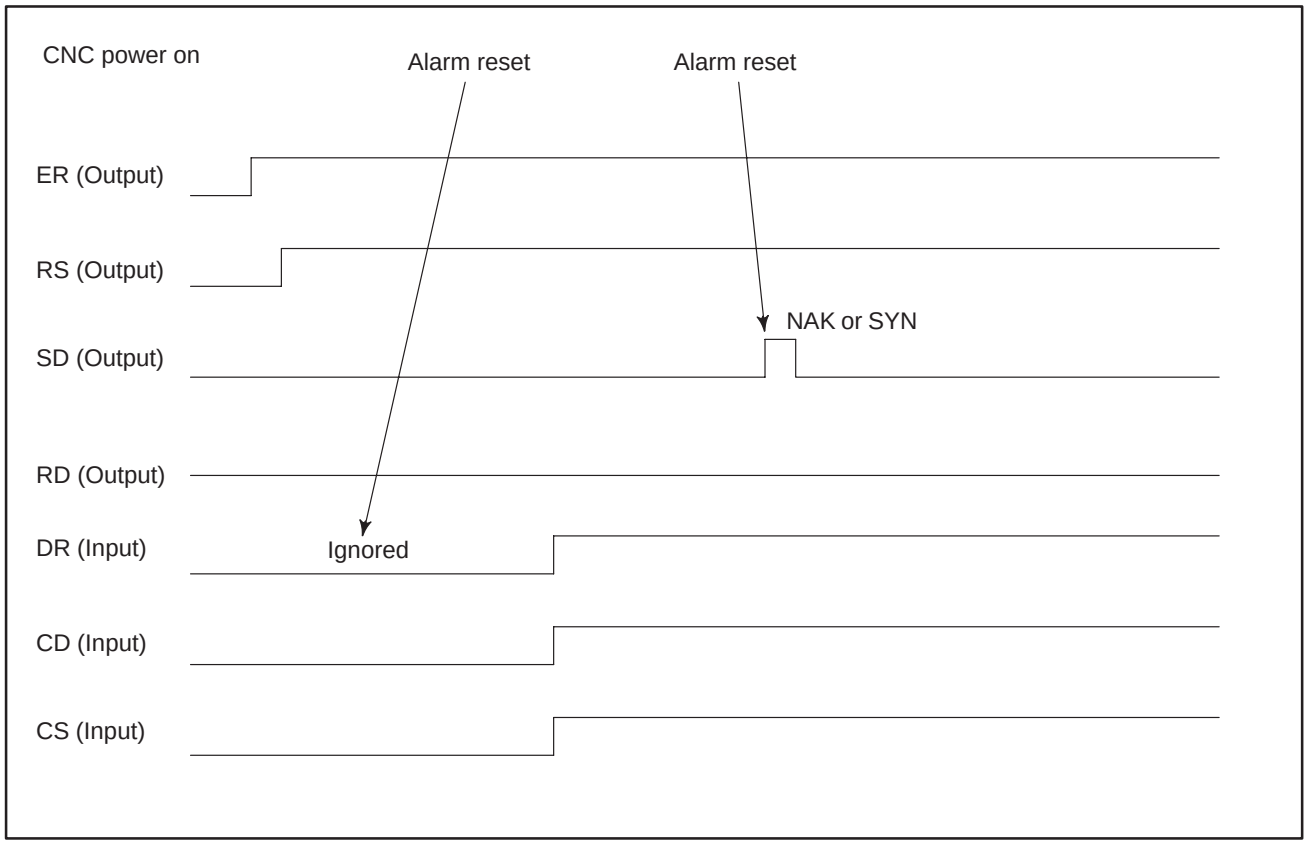
2) When parameter SYNAK is set to 1

When the remote buffer becomes ready after the power is turned on, the buffer turns on the ER signal, which remains in the on state until the power is turned off.

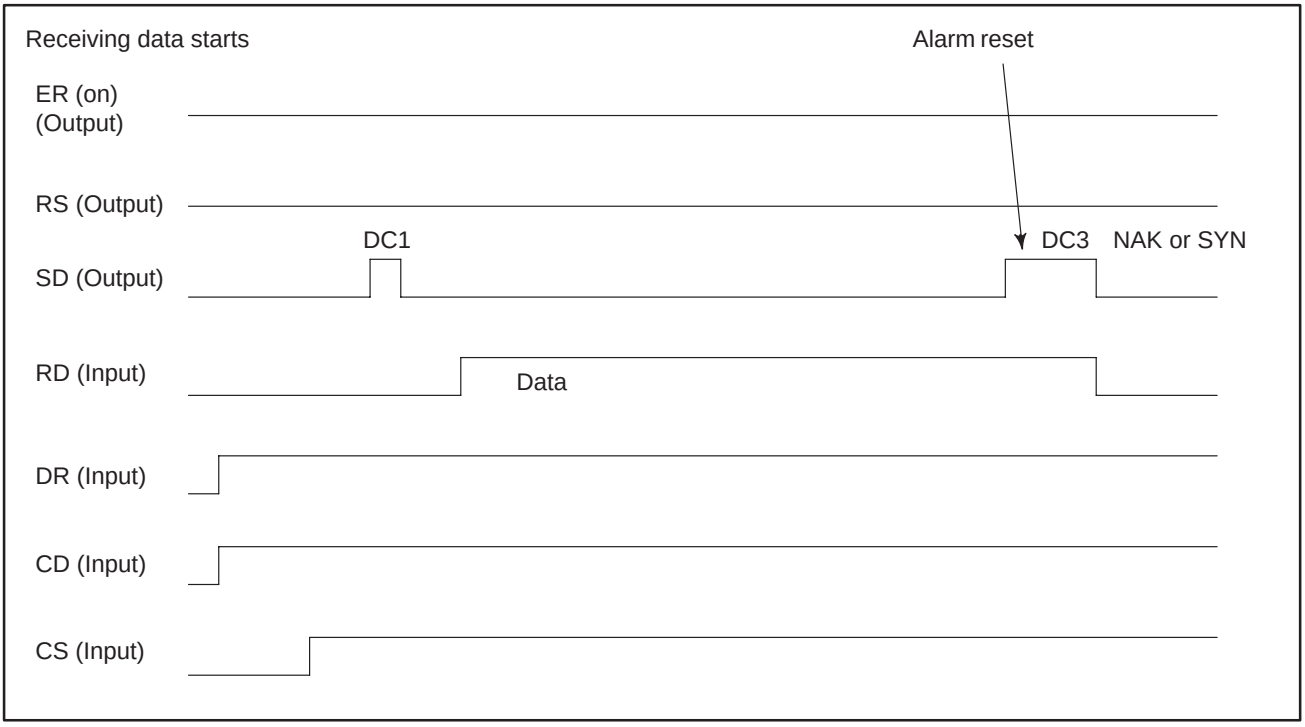
While the remote buffer does not receive data, and when the host computer is ready for receiving signals, i.e. signals DR, CD and CS are on, the buffer sends a signal as follows: If an alarm is issued in the NC unit, the buffer sends the NAK code to the host computer. If the NC unit is reset, the buffer sends the SYN code to the computer.

When the situation described above occurs while the remote buffer is receiving data, the buffer sends the DC3 code to the host computer before it sends the NAK or SYN code.

a) Timing chart when the NAK or SYN code is sent



b) Timing chart when the NAK or SYN code is sent while the buffer is receiving data



6.2 RECEIVING DATA

(1) The remote buffer transmits the DC1 code.

(2) The host computer starts to transmit the DC3 code to the remote buffer by the DC1 code,

(3) When the empty area of remote buffer area becomes the value specified, the DC3 code is transmitted.

(4) The host computer should stop transmission to the remote buffer by the DC3 code. The overrun value is specified later.

(5) The remote buffer transmits the DC1 code when the remainder of buffer data becomes less than the level specified and requests the host computer to start transmitting data.

(6) The host computer should start transmitting data again by the DC1 code. The transmission data is a continuation of previous data.

(7) The remote buffer transmits the DC3 code when the data read is completed.
The end of data read is indicated by the detection of ER or NC reset.

(8) The host computer stops transmission of data.

6.3 CONTROL CODE

The control code is as shown below regardless of the ISO, EIA, and Binary data:

Control code	Function	Code (Hexadecimal)	
		Parameter ASCII (No. 0055#0) = 0	Parameter ASCII (No. 0055#0) = 1
DC1	Host transmission start	11H	11H
DC3	Host transmission stop	93H	13H
NAK	Information of NC alarm	95H	15H
SYN	Information of NC reset	96H	16H

6.4 BUFFER CONTROL

The buffer control method for the remote buffer is as follows:

DC3 transmission condition

Free b\loch\f19 uffer space ≦ 1024 characters

DC1 transmission condition

Free buffer space ≧ 2048 characters

Allowable overrun

Less than 1024 characters

6.5 CNC ALARM AND RESET

If the CNC enters the alarm or reset condition, the remote buffer transmits the DC3 code, then clears the entire contents of the buffer.

7 DATA INTERFACE

7.1 DATA PART

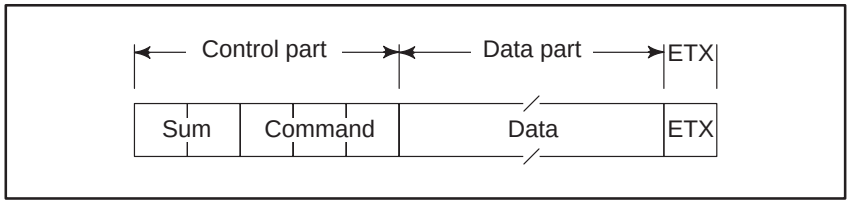
Data received from the host computer is largely classified into two parts, namely the control part and data part.

With the protocol B/expansion protocol B, all data received from the host computer become the data part.

See the following figure for the data part of protocol A/expansion protocol A.

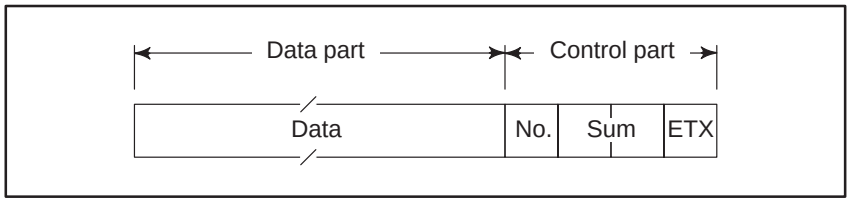
1) Protocol A

   Packet configuration of <DAT>



2) Expansion protocol A

   Configuration of response packet for <GTD>

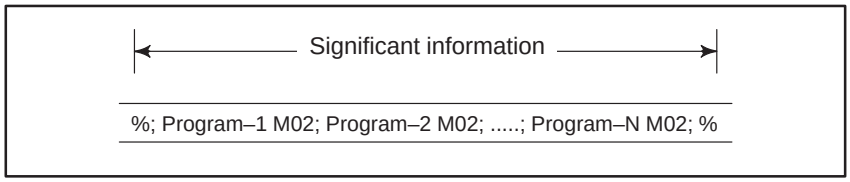


7.2 INTERFACE OF DATA PART

The interface of data part is in conformity the provisions of data which can be handled through the serial port by the Series 0/00.

The end of data part is judged by the detection of EOR code. Also, all data after EOR code is ignored.

In general, the data part configuration is as shown below. However, in the case of DNC operaiton , the data already received will be lost by the CNC reset.



The remote buffer performs the following processes by the parameter setting for the data of data part.

Protocol	Process outline
Protocol B Expansion protocol B	The Remote buffer supplies the received data to the CNC without machining it at all. It is completely.
Protocol A Expansion protocol A	Converting the code specified with bytes 45 and 46 in the <SET> data section to the code specified with bytes 47 and 48.

8 DISTRIBUTION PROCESSING FUNCTION (HIGH–SPEED REMOTE BUFFER B FUNCTION)

In distribution processing, the remote buffer converts the NC program, received from the host computer, to distribution data, then supplies the converted distribution data to the CNC. The use of this function enables the high–speed DNC operation of an NC program which contains consecutive commands specifying a minute amount of travel.

The remote buffer can perform distribution processing for up to three axes.

Only the M series supports this function. It cannot be used with the T series.

8.1 NC PROGRAM FORMAT

This function uses the same format as that for ordinary NC programs. Some sections of a program are, however, to be subjected to distribution processing while other sections are passed directly to the CNC.

The sections to be subjected to distribution processing are called high–speed machining sections. High–speed machining sections are defined using the following commands:

Command	Description
G05P1;	Start of high–speed machining section
G05P0;	End of high–speed machining section

NOTE
Each of these commands must be specified using a single separate block.

8.2 COMMANDS IN HIGH–SPEED MACHINING SECTIONS

The following table lists the commands which can be specified in high–speed machining sections. During distribution processing (within a distribution section), any addresses other than those listed in the table are ignored.

Command address	Description
G00	Stop of distribution processing\loch\f19 (Note 2)
G01	Restart of distribution processing
First–axis address	Amount of travel along the first axis
Second–axis address	Amount of travel along the second axis
.	.
Nth–axis address	Amount of travel along the Nth axis
F	Cutting feedrate (Note 3)

NOTE
1 N ≦ 3
2 Even in a high–speed machining section, specifying G00 stops distribution processing until G01 is specified.
3 F ≦ 1500 mm/min or F ≦ 600 inch/min
Decimal places are ignored.

[Program example]

```
O1234 ;
    .
G05P1 ;  ———————  Start high–speed machining
  X__Y__Z__F__ ;                          Distribution
    .                                     section
    .
G00 X__Y__Z__ ;  ———  Stop high–speed machining
    .                                     High–speed
    .                                     machining section
    .
G01 F__ ;  ———————  Restart high–speed machining
  X__Y__Z__ ;                             Distribution
    .                                     section
    .
G05P0 ;  ————————————————————————————————
    .
M02 ;
```

8.3 MODAL MANAGEMENT

Any modal command specified in a distribution section is valid only within that distribution section, with the exception of the feedrate. After the end of the high–speed machining section (G05P0;), therefore, specify a command for restoring the modal information.

(1) Absolute/incremental

All move commands in a distribution section are assumed to be incremental commands.

(2) Any command executed while distribution is stopped can vary the modal state.

(3) Normal modal management is applied to the feedrate.

8.4 FEEDRATE OVERRIDE

(1) Feedrate

When distribution by the remote buffer is used, the following restrictions are imposed on the feedrate command:

1. Maximum cutting feedrate
   Metric system : 1500 mm/min
   Inch system : 600 inch/min
2. Any decimal places are ignored.

(2) Override

The cutting feedrate override is valid. The override, however, requires slightly longer to become effective because a buffer exists between the remote buffer and CNC. If such a delay would cause a problem, the override should not be modified during operation.

8.5 NOTES

(1) Single block stop cannot be specified in a high–speed machining section.

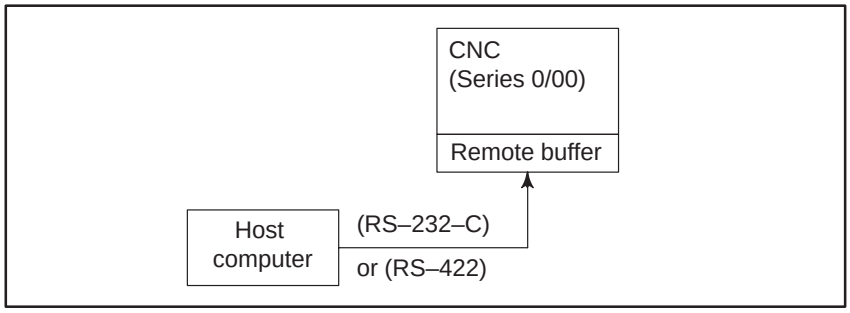
(2) When the high–speed remote buffer function is used, the TV check setting parameter must be set to disable TV check, regardless of whether high–speed machining will be performed.

9 BINARY INPUT OPERATION FUNCTION (HIGH–SPEED REMOTE BUFFER)

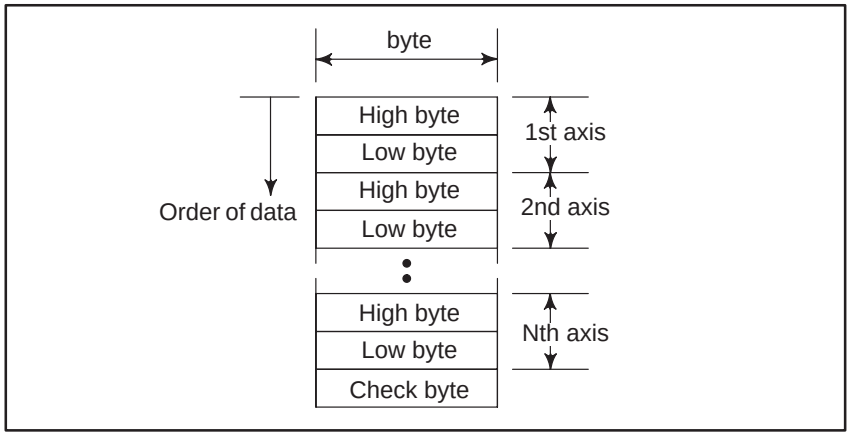
9.1 DESCRIPTIONS

Command the “G05;” single block by the normal NC command format without any other NC commands in the block, and then command the move data and auxiliary functions using the following format to perform the binary input operation function. Set the “0” to both the move distance of all axes and auxiliary functions to return to the normal NC command format thereafter.

- Binary input operation On: G05;
- Binary input operation Off: Sets the move distance of all axes to and auxiliary functions ”0”.



- Data format for binary input operation



1) Layout the move distance per unit time for each axis (2 bytes) to all axes starting from the 1st axis and then add check byte (1 byte). (The data length of one block should be (2*N+1) bytes.)
2) Select the unit time (ms) using parameters.
3) Indicate all data in binary format.
4) Command the move distance of each axis using the following units. (The negative move distance is indicated using 2’s compliment.)

Setting unit	IS–B	IS–C	Unit
Machine using mm system	0.001	0.0001	mm
Machine using inch system	0.0001	0.00001	inch

Also, the move distance data fromat is as below. (Command the move distance per unit time using the “*” bit.)

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

Example) when the move distance is 700 μ per unit time (mm system setting unit IS–B):

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

5) The check byte is obtained by adding the other bytes, namely (2 * N), in units of bytes and then by discarding the overflow exceeding the 7th bit.

9.2 TRANSFER SPEED

The CNC reads the data for 2 * N + 1 bytes (N: number of axes) from the remote buffer. Thus, the transfer BAUD rate between the host and remote buffer should be at least (2 * N + 1) * 11 / T * 1000 BAUD (T: unit time) for the NC unit to continue machining without stopping halfway.

For example, the BAUD rate which is at least required when the unit time is set to 16 ms is as shown below:

(2 * N + 1) bytes * 11 / 16 ms * 1000 (BAUD)

9.3 CAUTIONS

1) All modal commands are invalid during binary input operatin mode. Only the linear interpolation based on the command data format can be executed (it is equivalent to the linear incremental command).
2) An alarm results when the G05 is commanded during cutter compensation mode.
3) An alarm results when the G05 is commanded during custom macro interruption mode.
4) The single block, feedrate override, and cutting feed maximum speed clamp are invalid.
5) The feed hold and interlock are valid.
6) The mirror image is valid in the status of the time when the G05 is commanded and the on/off during binary input operation mode is invalid (modification during feed hold stop is valid).
7) The program restart, block restart, and high–speed machining function cannot be used.
8) No registration to memory can be made.
9) To perform binary input operation with a unit time of 2 ms:
   – The total number of controlled axes must not exceed 3.
   – The system must have a sub–CPU.
10) In binary input operation mode, acceleration and deceleration at the start and end of movement are as follows:

    Acceleration/deceleration
    Unit time : 8 ms: Same as cutting feed mode (G01)
    4 ms or less: No acceleration or deceleration

10 PARAMETERS

Setting parameter

I/O = 3: Remote buffer channel selection

	#7	#6	#5	#4	#3	#2	#1	#0
0038						RSCMD3	DEVFL3	

RSCMD3, DEVFL3 Devices connected to remote buffer

0	0	FANUC Bubble Cassette
0	1	FANUC Floppy Cassette (B1/B2) FANUC Program File
1	0	FANUC PPR
1	1	FANUC Program File Mate FANUC FA Card Adapter

NOTE
Set this parameter if any FANUC device is connected to the remote buffer. Otherwise, set both RSCMD3 and DEVFL3 to 0.

	#7	#6	#5	#4	#3	#2	#1	#0
0051			ECLK	NCKCD	RSASC	SYNAK	PARTY	STP2

ECLK 0 : The internal clock signal is used for the RS–422 interface connection.
1 : External synchronization is used for the RS–422 interface connection. (Use external synchronization if the RS422 interface is used at 38400 bps or higher. Signals IT, *TT, RT and *RT are required.)

NCKCD 0 : Control signal CD used in the RS–232C interface is checked. If the CD signal switches to 0 during transfer, alarm P/S 086 is issued.
1 : Control signal CD used in the RS–232C interface is not checked.

RSASC 0 : The ISO or EIA code is used in the NC data sent from the host computer.
1 : The ASCII code is used in the NC data sent from the host computer.

SYNAK 0 : In protocol B, if the NC unit is reset or if an alarm is issued in the NC unit, neither event is reported to the host computer.
1 : In protocol B, if the NC unit is reset, the SYN code is sent. If an alarm is issued in the NC unit, the NAK code is sent.

PARTY 0 : The parity bit is not added.
1 : The parity bit is added. Even parity is used.

STP2 0 : One stop bit is used.
1 : Two stop bits are used.

	#7	#6	#5	#4	#3	#2	#1	#0
0055	RMSTS	IT2	IT1	IT0	RS42	PROTA	EXT	ASCII

RMSTS 0 : In protocol A, data 0 is always sent by the SAT command for the state of remote/tape operation.
1 : In protocol A, the state of remote/tape operation reported by the SET command is sent by the SAT command.

IT2, IT1, IT0 Interpolation period for high–speed remote buffer A/B

1	0	0	G05 data is interpolated every 16 ms.
0	0	0	G05 data is interpolated every 8 ms.
0	1	0	G05 data is interpolated every 4 ms.
0	0	1	G05 data is interpolated every 2 ms.
0	1	1	G05 data is interpolated every 1 ms.

RS42 0 : The RS–232C interface is used.
1 : The RS–422 interface is used.

PROTA 0 : Protocol B is used.
1 : Protocol A or extended protocol A is used.

EXT 0 : The end code used in protocol A or extended protocol A is the CR code. The other codes are specified in parameter ASCII.
1 : The end code used in protocol A or extended protocol A is the EXT code. The other codes are specified in parameter ASCII.

ASCII 0 : The ISO code is used except for NC data.
1 : The ASCII code is used except for NC data.

* Protocol A is used for transferring the sum, end code, data, and commands except for the DAT command.
Protocol B is used for transferring the SYN and NAK codes, as well as codes DC1, DC2, and DC3.

0251	Remote buffer baud rate

1 :	50 BPS	2 :	100 BPS	3 :	110 BPS
4 :	150 BPS	5 :	200 BPS	6 :	300 BPS
7 :	600 BPS	8 :	1200 BPS	9 :	2400 BPS
10 :	4800 BPS	11 :	9600 BPS	12 :	19200 BPS
13 :	38400 BPS	14 :	76800 BPS		

0597	Number of controlled axes for high–speed remote buffer

11 ALARMS

No.	Message	Description
085	COMMUNICATION ERROR	An excess data error, parity error, or framing error occurred while the remote buffer was reading data. The number of input bits is incorrect, or the baud rate is not specified correctly.
086	DR SIGNAL OFF	The line was disconnected while the remote buffer was reading data. Signals DR and DCD went off.
087	BUFFER OVERFLOW	Data continued to be input beyond the allowable number of characters even when stopping reading data was specified while the remote buffer was reading data.
177	CHECK SUM ERROR (G05 MODE)	The check sum error occurred for binary data in the high–speed remote buffer operation.
178	G05 NOT ALLOWED IN G41/G42 MODE	The command (G05) for high–speed remote buffer operation was specified while in the cutter compensation mode (G41/G42).
179	PARAM (NO. ????) SETTING ERROR	The number of controlled axes specified in parameter 597 exceeded the maximum number of controlled axes.
180	COMMUNICATION ERROR (REMOTE BUF)	An error related to the line used by the remote buffer occurred. (Remote buffer alarm in protocol A)

12 CONNECTION

12.1 OUTLINE

The remote buffer is an optional function used to supply a large amount of data to the CNC continuously and at high speed. The remote buffer is connected to the host computer or an input/output device via a serial interface.

Table 12.1 (a) lists the types of remote buffer printed circuit boards. Three types are available, according to their location in the control unit.

Table 12.1 (a) Types of remote buffer printed circuit boards

Type	Name	Remarks	Connection slot
A	SUB CPU card (A16B–2200–0320)	Included in the multiaxis card. The fifth and sixth axes can be controlled as PMC axes. Supported only by control unit B. Software : A02B–0098–J542#0692	SUB
	Remote buffer card for control unit B (A16B–1211–0930)	The fifth and sixth axes cannot be connected. Supported only by control unit B. Software : A02B–0091–J542#0643	
B	Remote buffer card for control unit A/B (A16B–2200–0770:16bit) (A16B–2200–0775:32bit)	Can also be used for the DNC2 interface. Type B requires a metal plate for mounting. Software : A02B–0098–J543#0689	Expansion connector JA1, JA2 (Control unit A)
C			SP (Control unit B)

Table 12.1 (b) lists three remote buffer software functions.

Table 12.1 (b) Software functions of remote buffer

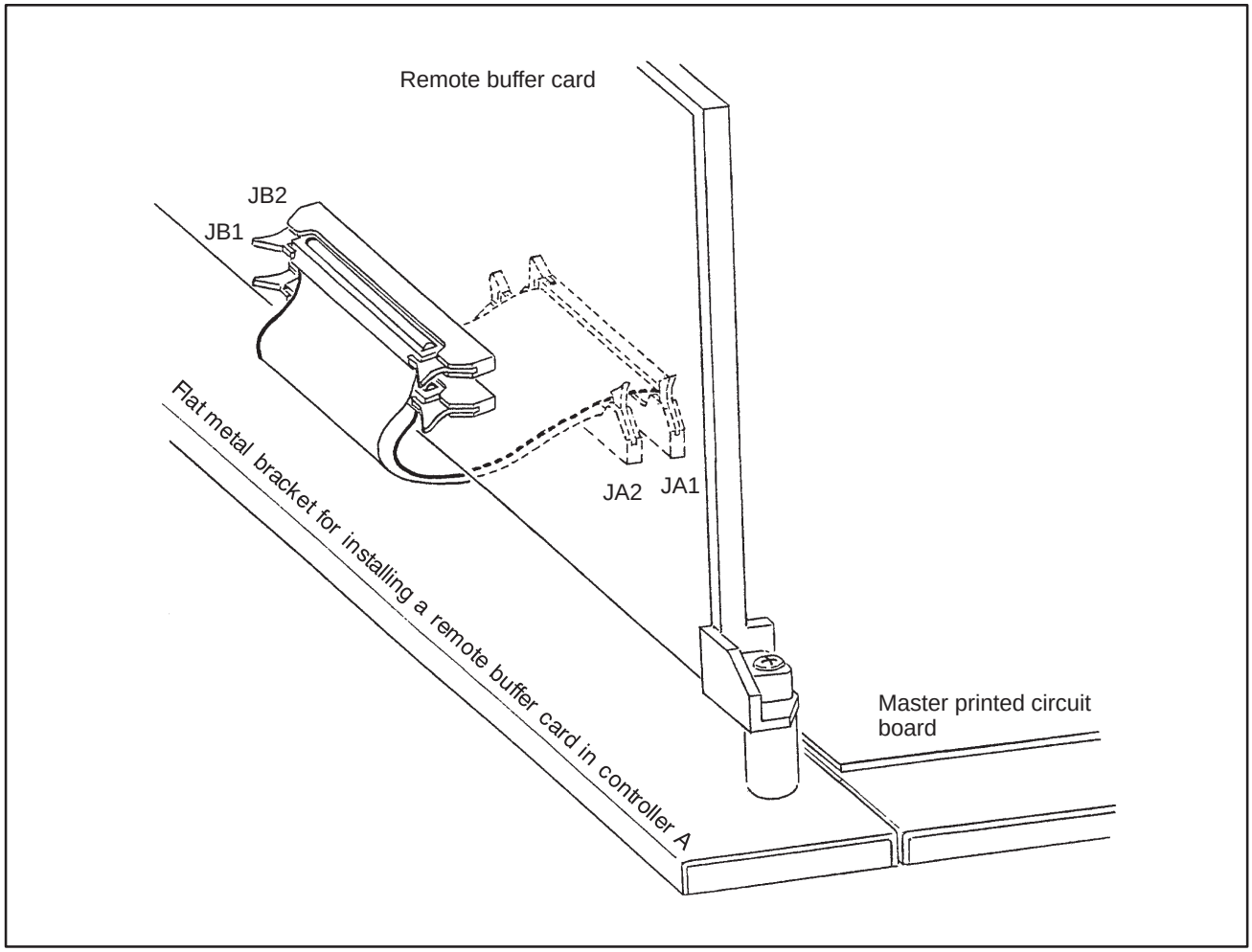
	Remote buffer	High–speed remote buffer A	High–speed remote buffer B
Protocol A	Available	Available	Available
Extended protocol A	Available	Available	Available
Protocol B	Available	Available	Available
Data format	NC format data	Binary data	NC format data
Interface	RS–232–C or RS–422	RS–422	RS–422
RS–232–C baud rate	50 bps to 19.2 kbps		
RS–422 baud rate	50 bps to 76.8 kbps	50 bps to 76.8 kbps	50 bps to 768 kbps
Maximum cable length	For RS–232–C 100m (4800 bps max.) 50m (9600 bps min.) For RS–422 800m (9600 bps max.) 50m (19.2 kbps min.)	For RS–422 800m (9600 bps max.) 50m (19.2 kbps min.)	For RS–422 800m (9600 bps max.) 50m (19.2 kbps min.)
Maximum machining speed (for execution of 1–mm continuous block commands)	Same as the speed when using memory	15m/min	12m/min

NOTE
1 Protocol A is the handshake system that repeats data transfer between two communicating devices.
2 Extended protocol A is almost the same system as protocol A except that it can transfer the NC program at high speed.
3 Protocol B is the system that controls communication between two devices by control codes output from the remote buffer.

12.2 INSTALLING TO THE P.C. BOARD

12.2.1 Installing to the P.C. Board in Case of Control Unit A

As shown in the figure below, install the remote buffer card into the left side of the master printed circuit board. The (A02B–0098–K121) flat metal bracket for the remote buffer card (A02B–0098–K121) contains the two flat cables and bracket.



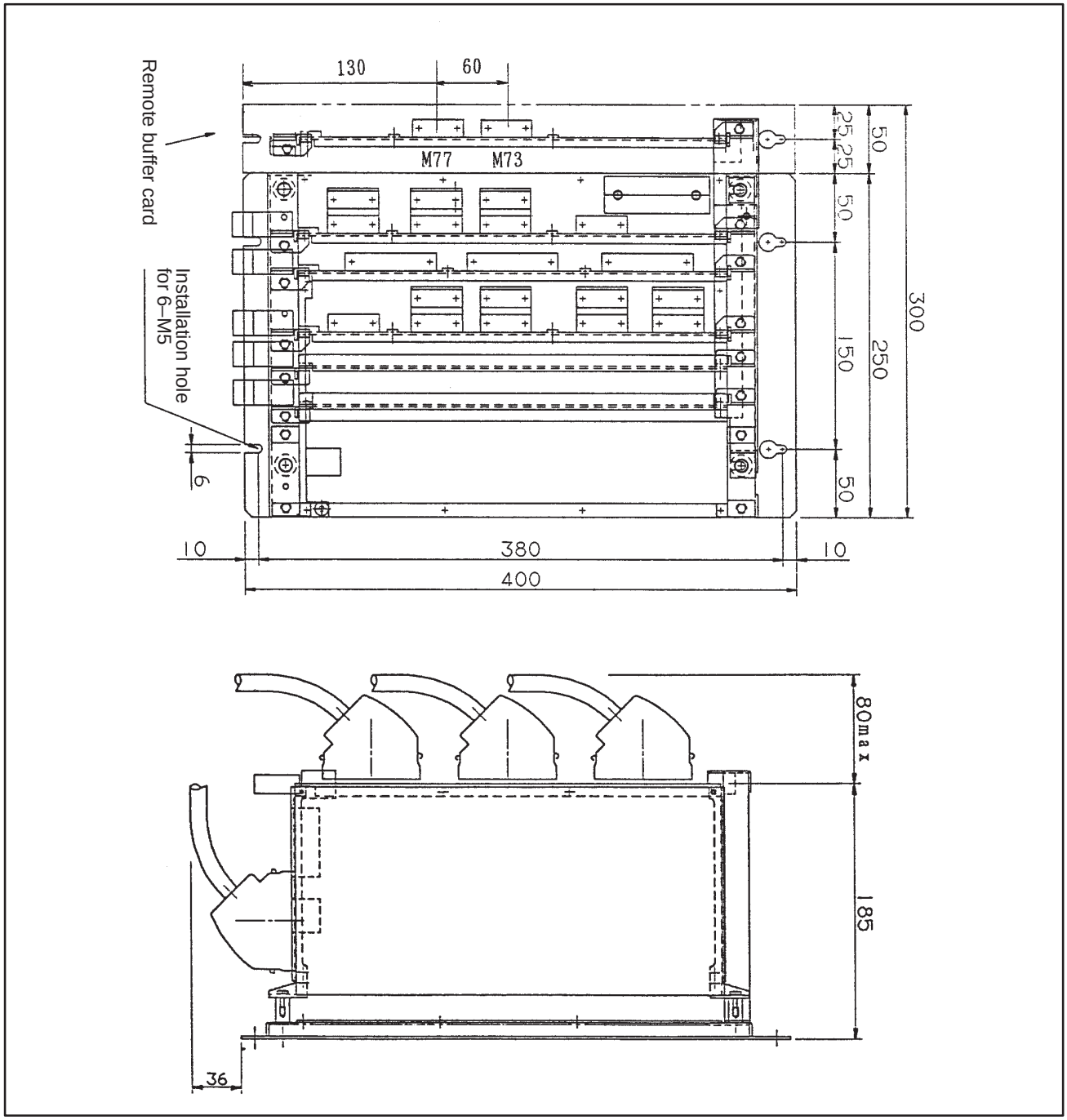
12.2.2 Installing to the P.C. Board in Case of Control Unit B

Install the remote buffer card to the slot SP (CS1) according to above mentioned Table 12.1 (a).

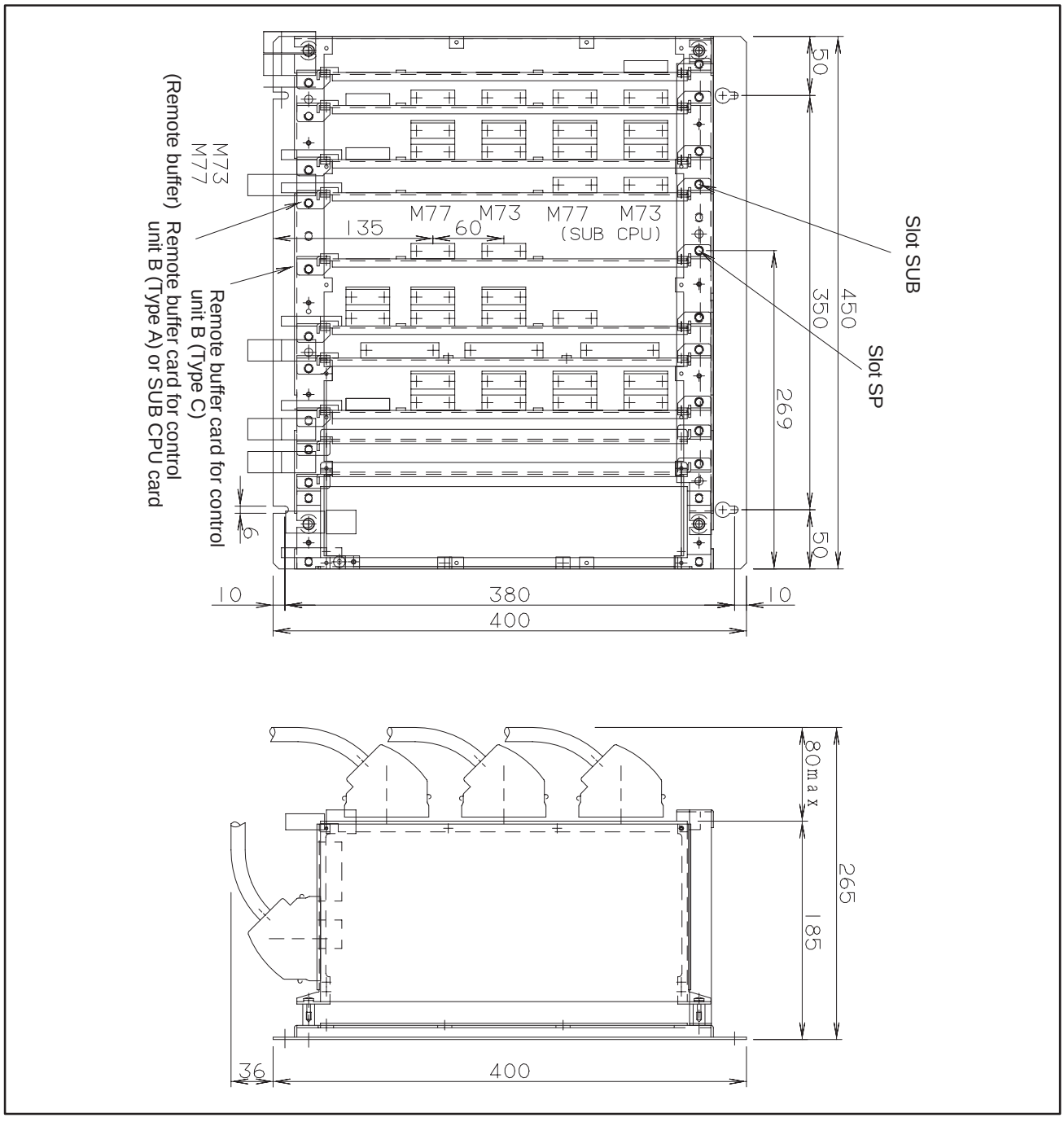
12.3 OUTLINE DRAWING

12.3.1 Outline Drawing in Case of Control Unit A

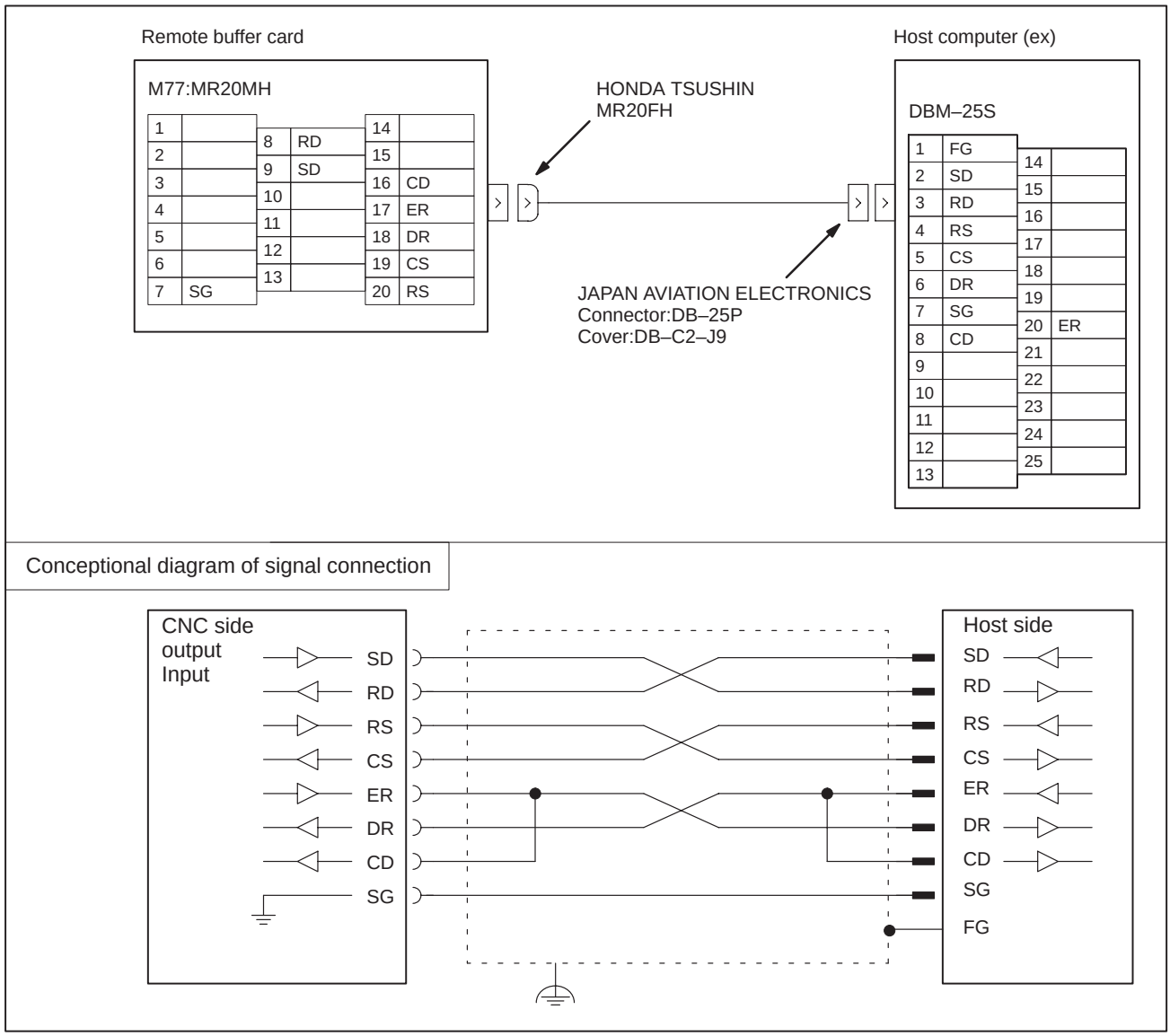
The following illustration is an outline drawing for installing the remote buffer card into controller A.



12.3.2 Outline Drawing in Case of Control Unit B



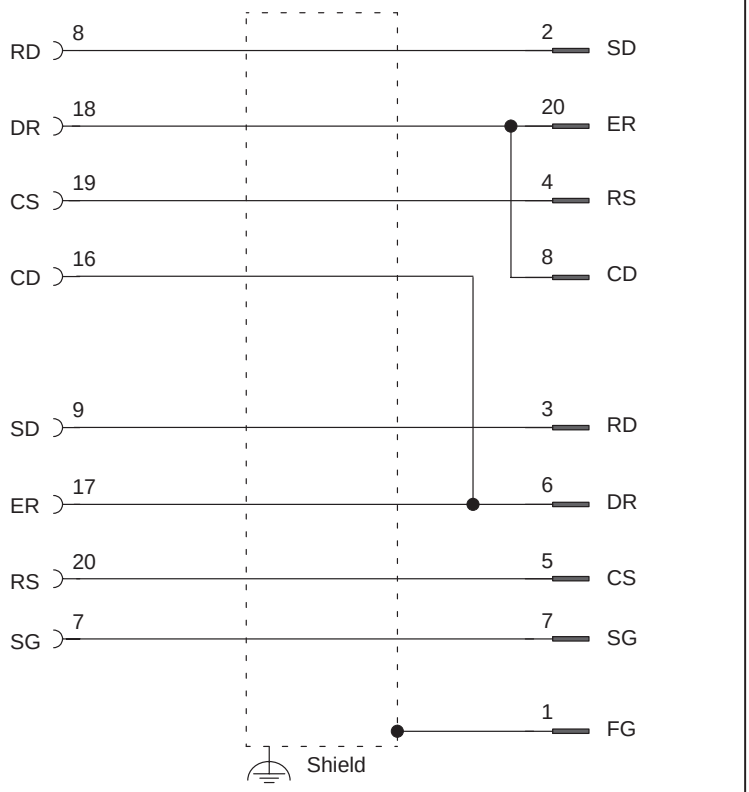
12.4 REMOTE BUFFER INTERFACE (RS–232–C)



NOTE

When using the FANUC DNC2 interface with an IBM PC–AT as the host computer, the host computer negates its RS (to low) upon transition to the reception phase. In this case, therefore, CS on the CNC side must be connected to ER on the CNC side.

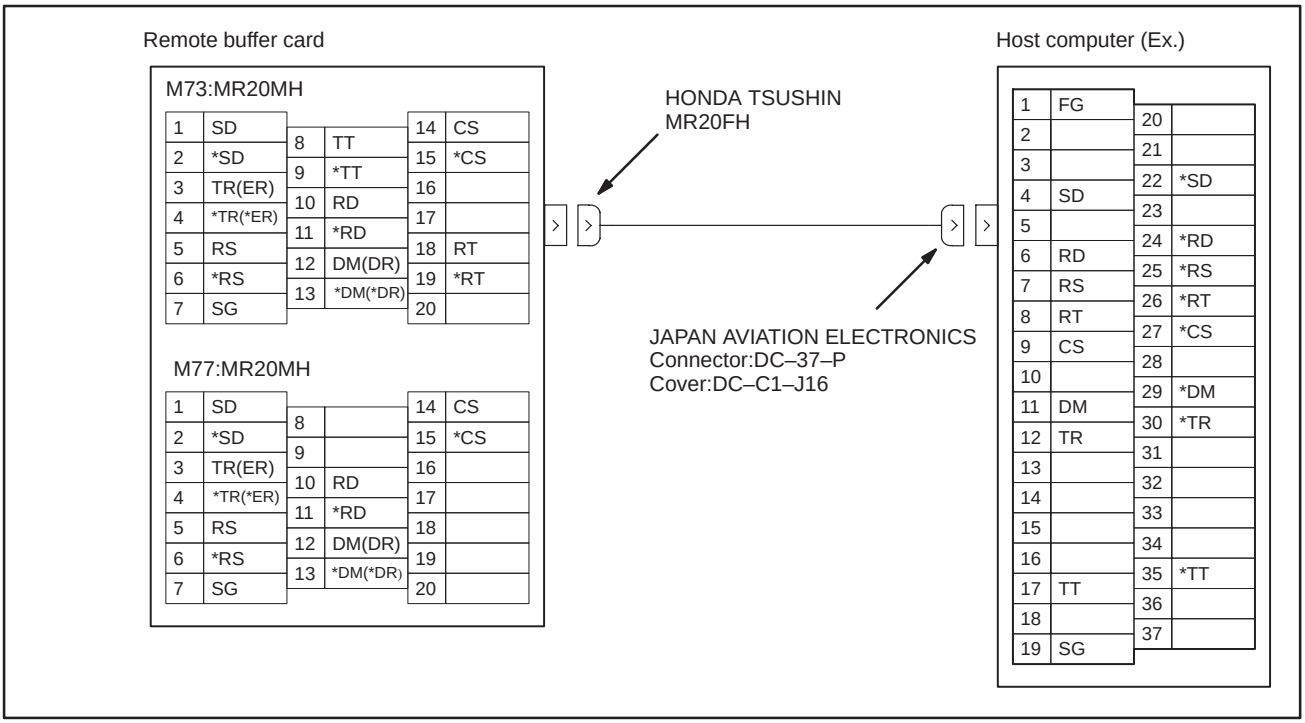
Cable wiring



Connect CS to RS if CS is not used. However, when protocol A or expanded protocol A is used, connect as shown above because CS is used for busy control. Connect DR to ER when DR is not used. Be sure to connect CD to ER.

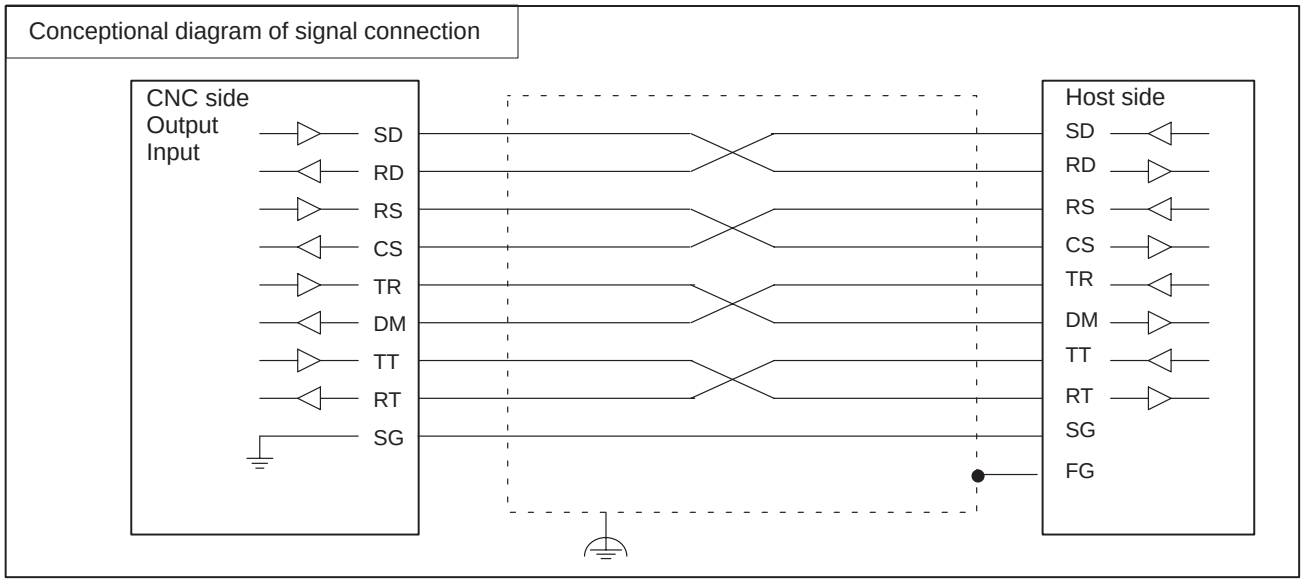
The M77 connector is also used for the RS–422 interface. Those pins for which nothing is indicated in the connector table must be left open.

12.5 REMOTE BUFFER INTERFACE (RS–422)



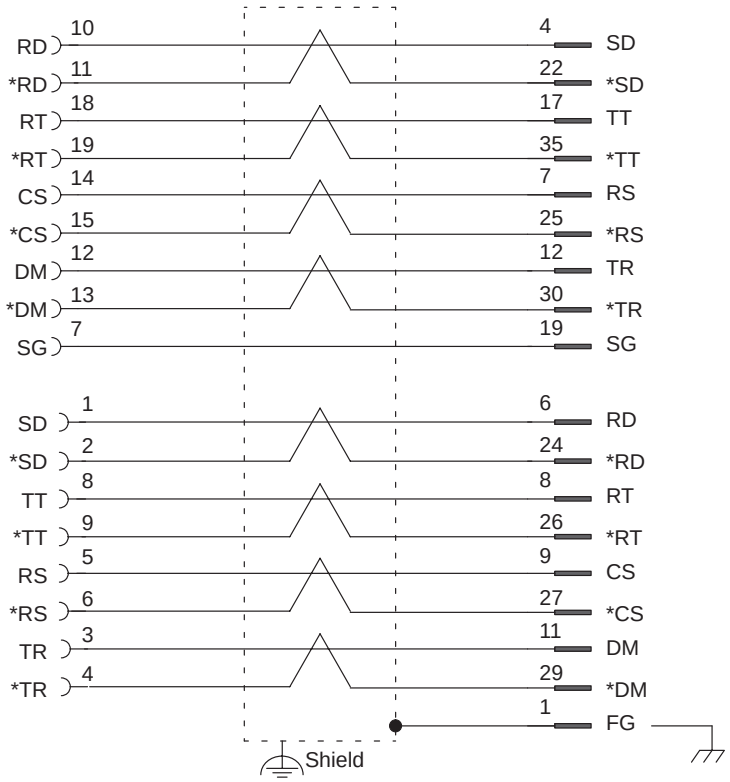
Conceptional diagram of signal connection

The figure below shows a signal connection between CNC and host computer. Since signals other than FG and SG perform differential signal transmission standard RS–422, two wires of signal lines are used for those signals.



Actual example of RS–422 signal wiring

Cable wiring



NOTE

1 Be sure to use twisted pair cable.
2 The connection of TT, *TT, RT, and *RT is required only when an external clock is used.
3 When using an external clock, connect the cable to the M73 connector. Either the M73 or M77 connector can be used if an external clock is not used.
4 The M77 connector is also used for the RS–232C interface. Those pins for which nothing is indicated in the connector table must be left open.

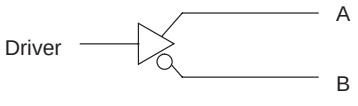
● Description of RS–422 interface signals

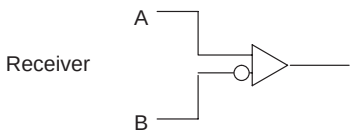
Signal name	RS–422 circuit No.	Input/output	Description
SD	103	Output	Transmitted data
RD	104	Input	Received data
RS	105	Output	Request to send The remote buffer uses this signal to post reception enabled status. The remote buffer can receive data while both this signal and the TR signal are set to ON.
CS	106	Input	Clear to send This signal is used to check whether the host computer is busy. The remote buffer assumes that the host computer can receive data if both this signal and the DM signal are set to ON.
TR	108.2	Output	Terminal ready This signal, if set to ON, indicates that the remote buffer is ready for operation. In other words, the SD signal is valid only while this signal is set to ON.
RR	109	Input	Receiver ready This signal, if set to ON, indicates that the host computer can transmit data to the remote buffer. When this signal is not used, always connect it to the TR signal on the remote buffer.
TT	113	Output	Transmission timing The transmission clock for the remote buffer is output using this signal. When a baud rate of 38400 or higher is used, always connect this signal to the RT signal on the host computer.
RT	115	Input	Reception timing The reception clock for the remote buffer is input using this signal. When a baud rate of 38400 or higher is used, always connect this signal to the TT signal on the host computer.
SG	102		Signal ground
FG	101		Protective ground

NOTE

The ON and OFF states of the signals are defined as follows:

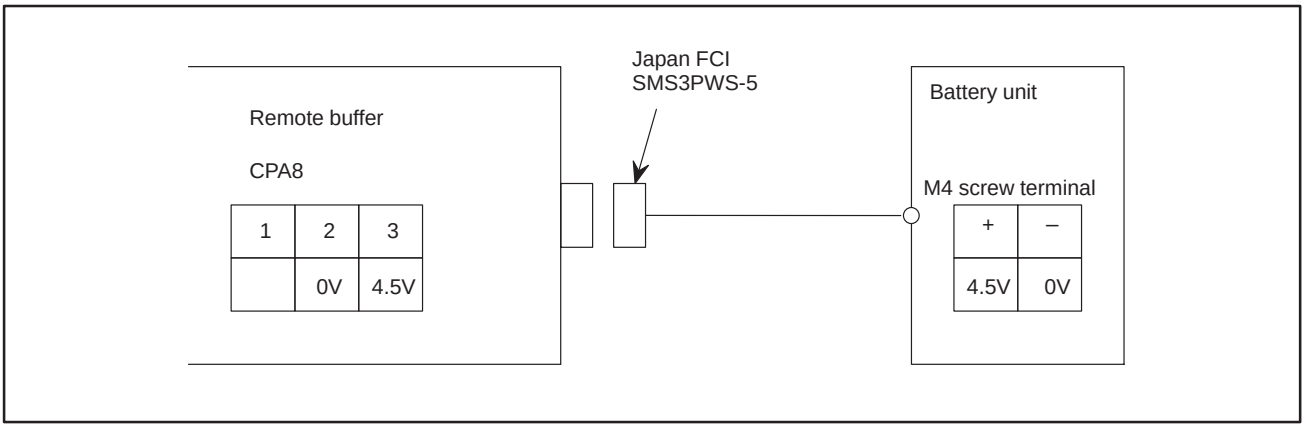
	A < B	A > B
Function	OFF	ON
Signal Condition	Marking	Spacing





12.6 CONNECTION TO BATTERY UNIT

The remote buffer of type A is required to connect to a buttery unit.



Connect the remote buffer to the battery unit on the memory printed circuit board, using the supplied cable.

CAUTION

The terminal block on the battery unit uses screw terminals. To connect the battery cable for the remote buffer to these terminals, first disconnect the battery cable for the memory printed circuit board or other components, with the CNC power turned on. Disconnecting the battery cable while the CNC power is turned off will result in the loss of the data, such as programs, stored on the memory printed circuit board.

Index

[S]

[T]

Revision Record

FANUC Series 0/00 Supplement for Remote Buffer DESCRIPTIONS (B–61392EN–1)

Edition	Date	Contents	Edition	Date	Contents
01	Jul., '97				