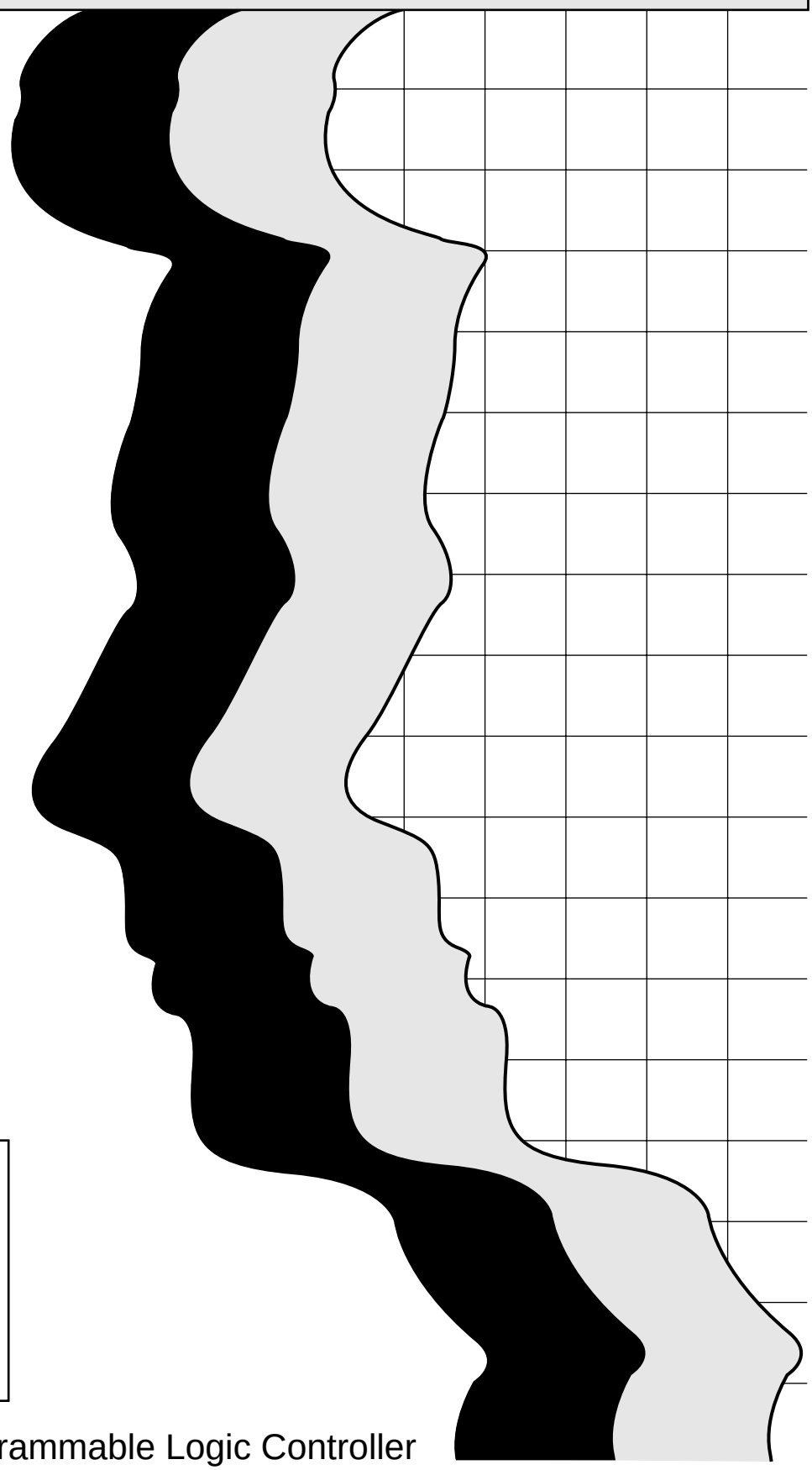
MITSUBISHI

Intelligent Communication Module type AD51-S3

User's Manual



MELSEC

Mitsubishi Programmable Logic Controller

REVISIONS

※The manual number is given on the bottom left of the back cover.

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INTRODUCTION

Thank you for choosing the Mitsubishi MELSEC-A Series of General Purpose Programmable Controllers. Please read this manual carefully so that the equipment is used to its optimum. A copy of this manual should be forwarded to the end User.

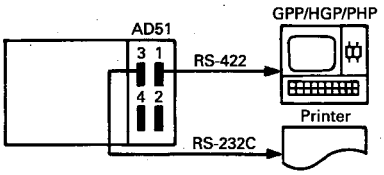
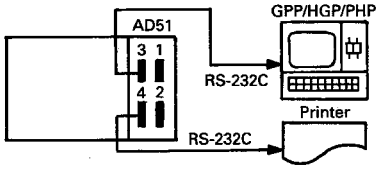
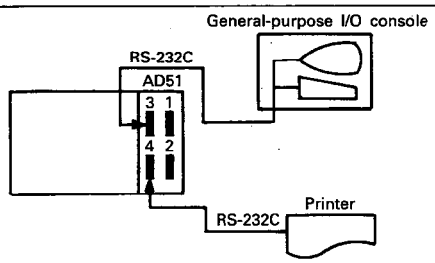
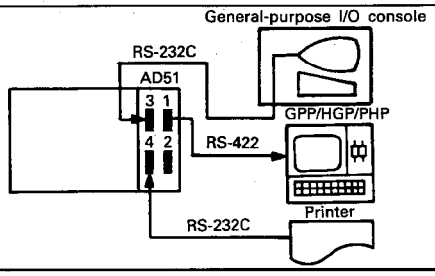
CONTENTS

1. INTRODUCTION

The AD51-S3 intelligent communication module (referred to as "AD51") has two RS-232C and two RS-422 interfaces and allows multitask processing of BASIC programs.
User application programs running in the AD51 allow the following functions:

(1) The A series peripheral devices can be shared.

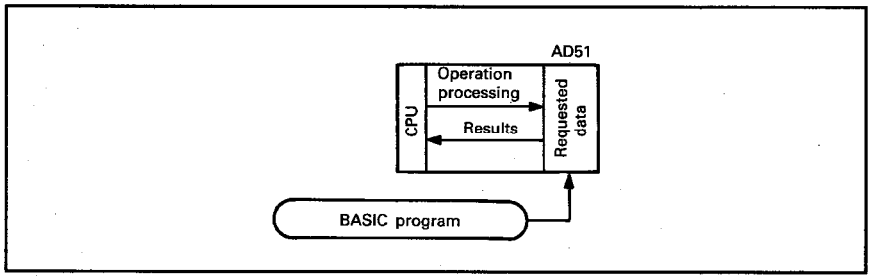
The A6GPP intelligent graphic programming panel (GPP), A6HGP LCD handy graphic programmer (HGP) or A6PHP plasma handy graphic programmer (PHP) started up by the SW-AD51P system disk (SW-AD51P) can be used the an I/O console of the AD51 and allows AD51 programs and data to be stored on disk (and ROM (GPP only)). The VT-220 terminal can also be used as an I/O console.
The above indicated units may be connected as shown below:

Connection Example	BASIC Program, Data		
	Input	Storage on disk	Storage on ROM
	GPP/HGP/PHP	GPP/HGP/PHP	GPP (disallowed for HGP/PHP)
	GPP/HGP/PHP	Disallowed	Disallowed
	General-urpose I/O console	Disallowed	Disallowed
	General-purpose I/O console GPP/HGP/PHP	GPP/HGP/PHP	GPP (disallowed for HGP/PHP)

(2) Can be used as a sub-CPU of the PC CPU.

The AD51 reads data (e.g. complicated numerical operation, function operation) from the PC and calculates and stores it as required so that the PC CPU is relieved from processing burden.

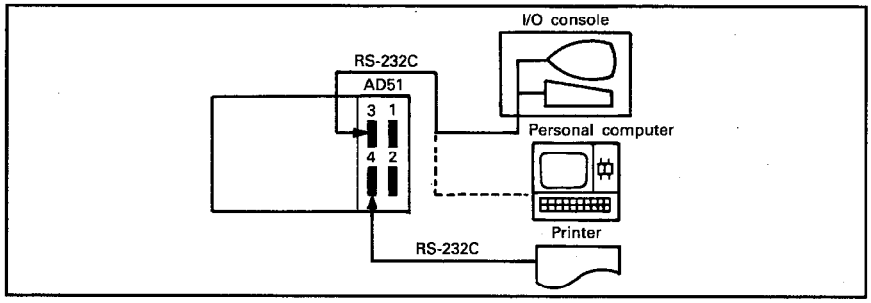
1) Storage of set value, positioning data, etc.
2) Collection, analysis and compensation of measurement data
3) Function operation of sine, log, square root, etc.
4) Logging and storage of production data
5) Logging and analysis of inspection data



(3) Can be used as a monitoring module.

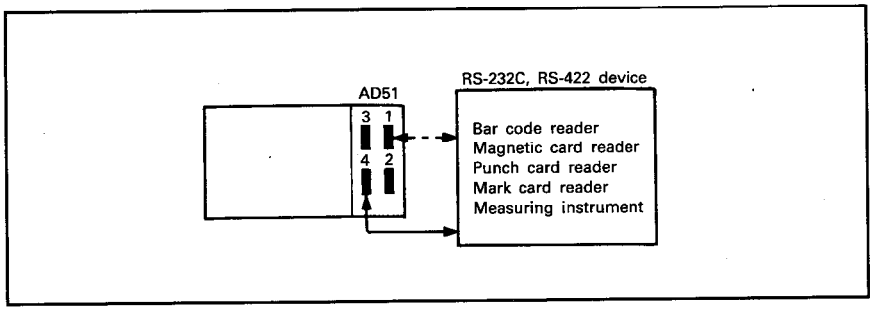
Connected with an I/O console (GPP/HGP/PHP or general-purpose I/O console), personal computer and printer, the AD51 allows the operating status to be monitored and control data to be printed out.

1) Monitor display ····· Indicates the production status, operating conditions, fault definition, etc.
2) Keyboard entry ····· Inputs the production schedule, production quantity, operating procedure and data setting.
3) Print out ····· Prints out the production program, production results, daily report, fault definition, program data, inspection results and test results.
4) Clock function ····· The AD51 includes an on-board, 24-hour, real-time clock with leap year compensation which allows data to be transferred by the BASIC program so that the time-of-the-day data may be processed easily.



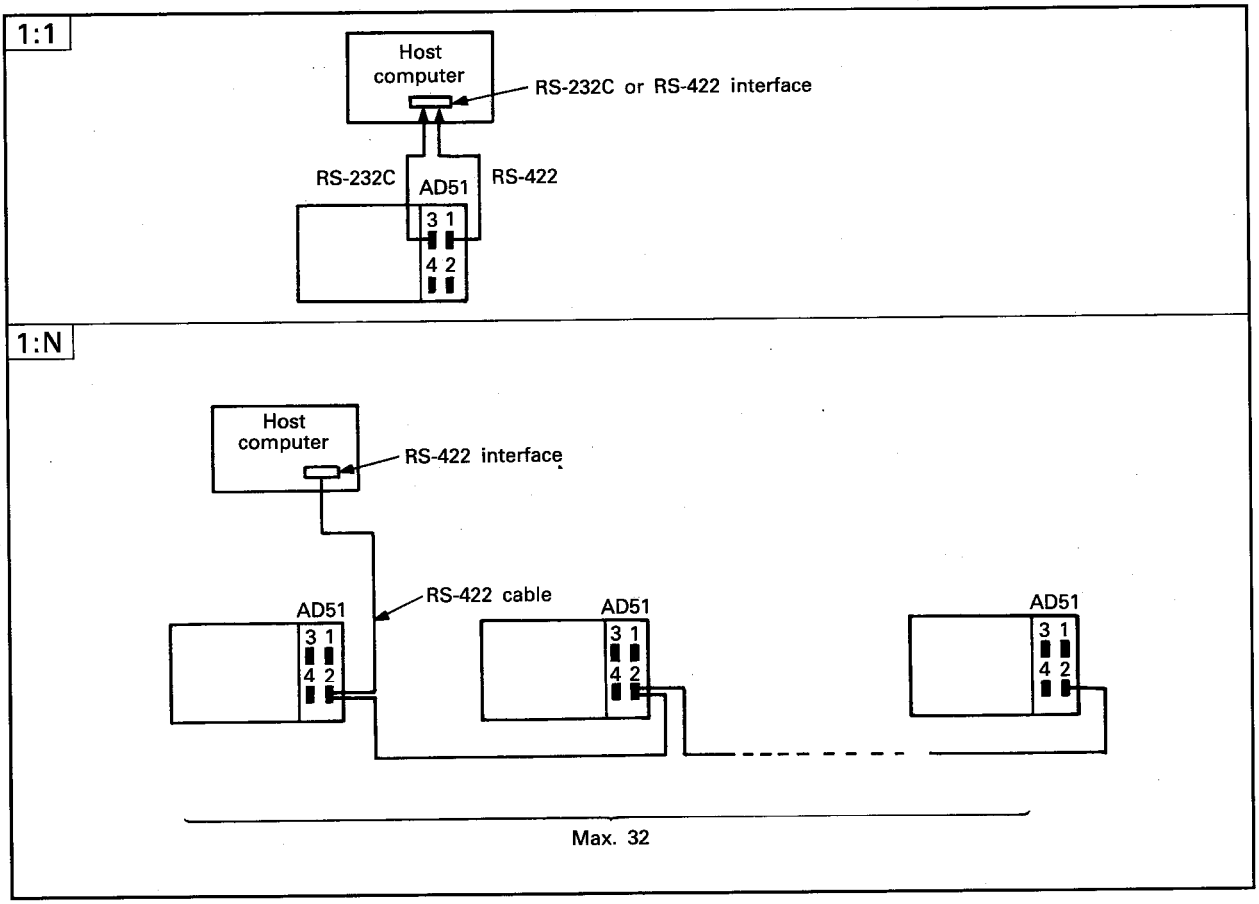
(4) Data input from bar code reader, etc.

The AD51 allows data to be entered from the bar code reader, magnetic card reader, etc. via RS-232C or RS-422.
The AD51 can be matched with the protocol of the connected device for communication by the BASIC program.
1) Entry of production lot number, product name, quantity, etc
2) Collection of measured values, test data.



(5) Connection of AD51 and external device

The AD51 has one RS-422 and two RS-232C interfaces for 1:1 link with the external device, and one RS-422 for 1:N multidrop link.
The application programs running in the AD51 allows data to be transferred via the four channels by the sequence program.
The following examples show 1:1 and 1:N link configurations of the computer and AD51s:



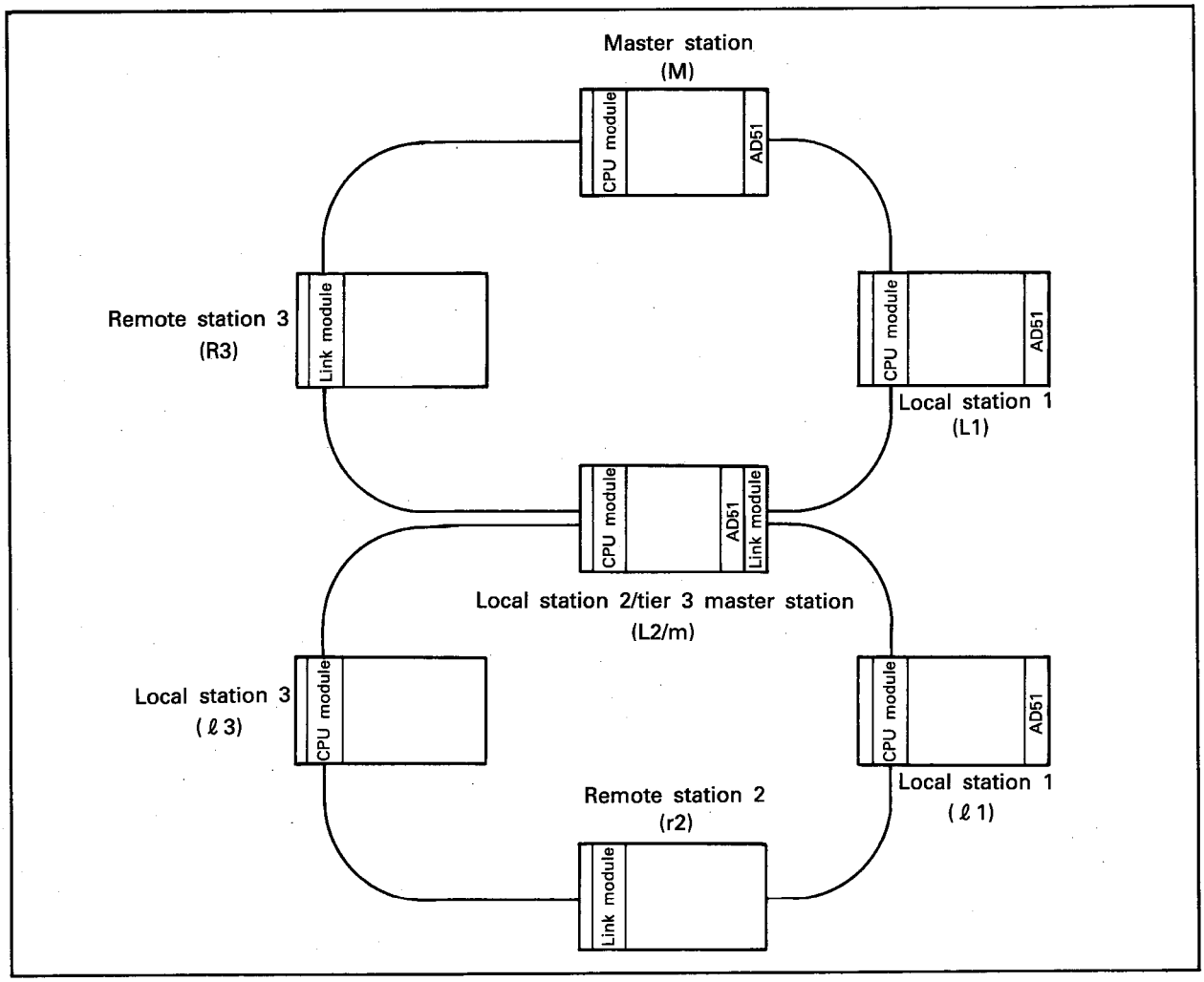
POINT

(1) In the 1:1 link configuration, RS-422 is used for distances up to 500m and RS-232C for distances up to 15m.

(2) In the 1:N link configuration, the RS-232C port may be connected with the host computer by using an RS-232C/RS-422 converter between the host computer and AD51.

(6) Communication with other stations in MELSECNET

The AD51 loaded on the PC CPU in MELSECNET allows communication with the other stations.



PC CPUs allowed for communication

(PC used with AD51)	(MELSECNET station allowed for communication)
• Station M (master station) ·····	(1) Host station (2) All local stations in tier 2 (L1, L2/m) (3) Remote I/O station used with special function module in tier 2 (R3)
• Station L (local station) ·····	(1) Host station (2) Master station in tier 2 (station M)
• Station L/m (local station/tier 3 master station) ·····	(1) Host station (2) Master station in tier 2 (station M) (3) All local stations in tier 3 (ℓ1, ℓ3) (4) Remote I/O station used with special function module in tier 3 (r2)
• Station (tier 3 local station) ·····	(1) Host station (2) Master station in tier 3 (L2/m)

1.1 Notes on Character Sets

In this manual some of the characters used may differ from those which appear on the screen, depending on the character set chosen (i.e. Japanese, English, German, Swedish).
The keyboard operations follow the standard for the character set chosen, so, for example to input @ with English characters press [SFT], [@].
Key codes are given in Appendix 4, paragraph 3.
Key operations for the different character sets are shown below.

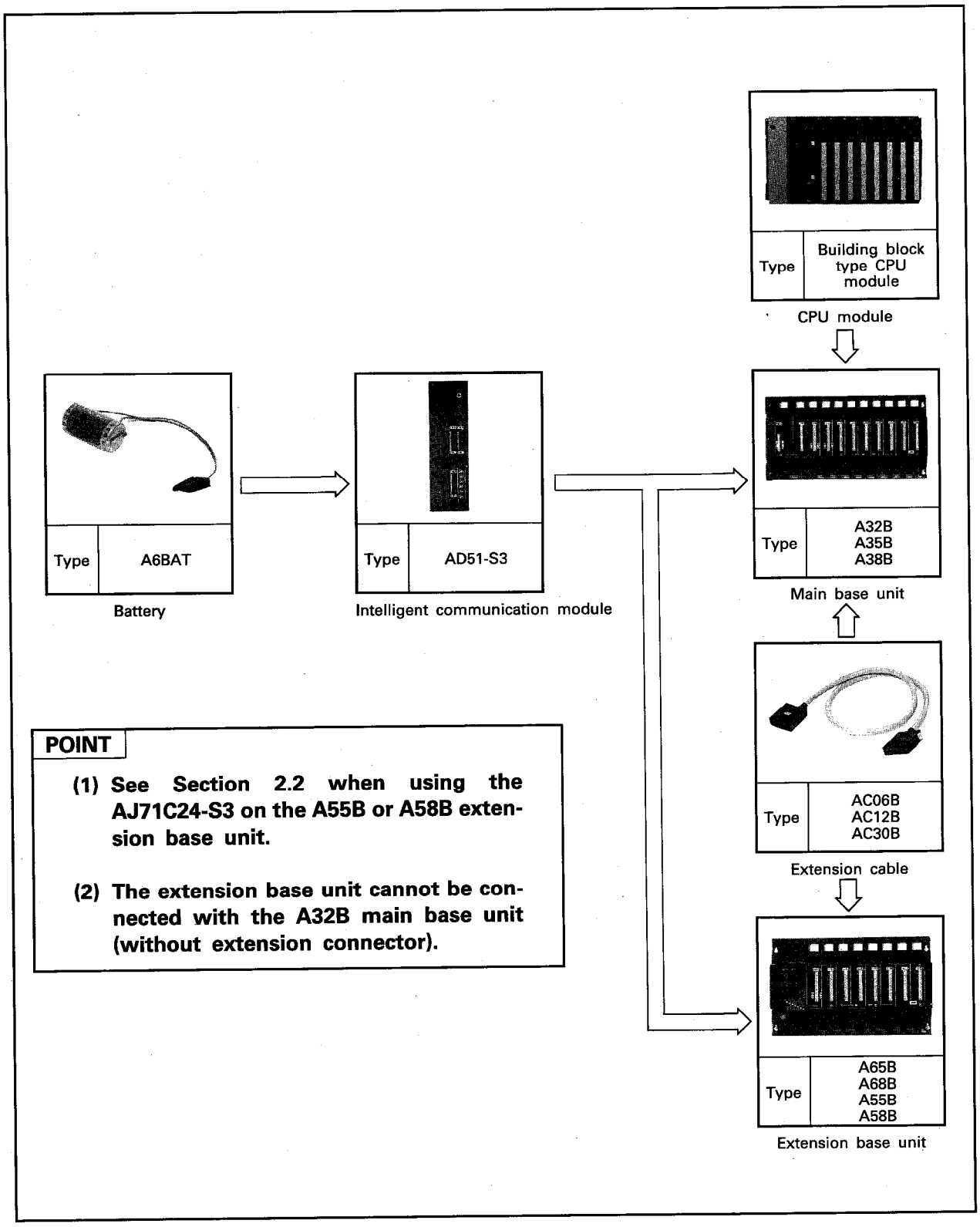
Key	Character Set			
	English	German	Swedish	Japanese
SFT ~ ^	^	^	Ü	~
SFT ~ ^	~	ß	ü	^
SFT ¦ Ö	\	Ö	Ö	¦
SFT ¦ Ö	¦	ö	ö	\
SFT @ § É	@	§	É	`
SFT @ § É	`	`	é	@
SFT [Ä	[	Ä	Ä	{
SFT [Ä	{	ä	ä	[
SFT] Ü Å	]	Ü	Å	}
SFT] Ü Å	}	ü	à	]
SFT $ 4	£	#	#	#
SFT # 3	$	$	ö	$

In this manual, all examples use the Japanese character set.

2. SYSTEM CONFIGURATION

2.1 Overall Configuration

(1) Building block type PC



POINT

(1) See Section 2.2 when using the AJ71C24-S3 on the A55B or A58B extension base unit.

(2) The extension base unit cannot be connected with the A32B main base unit (without extension connector).

Fig. 2.1 Building Block CPU Configuration

(2) Compact type PC

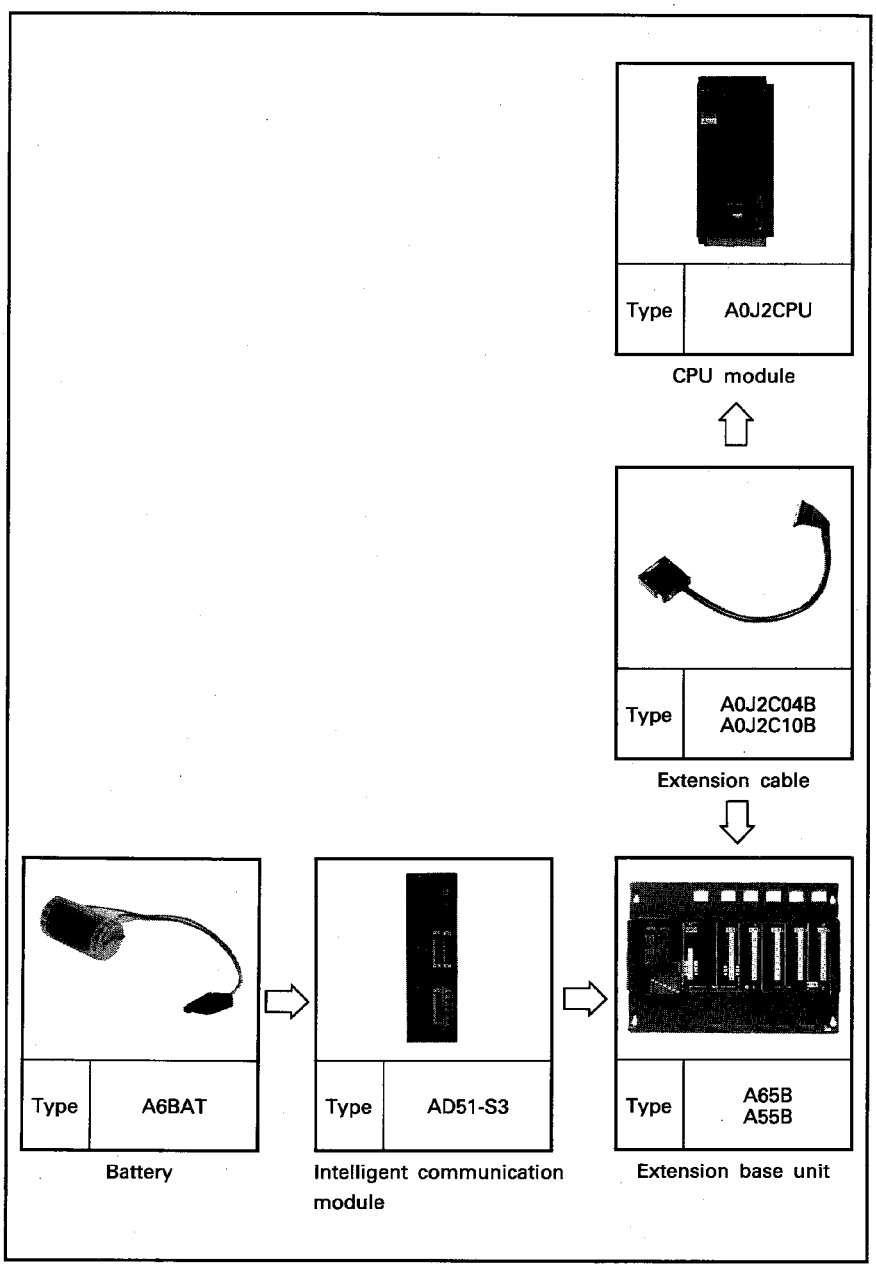


Fig. 2.2 Compact CPU Configuration

(3) Peripherals

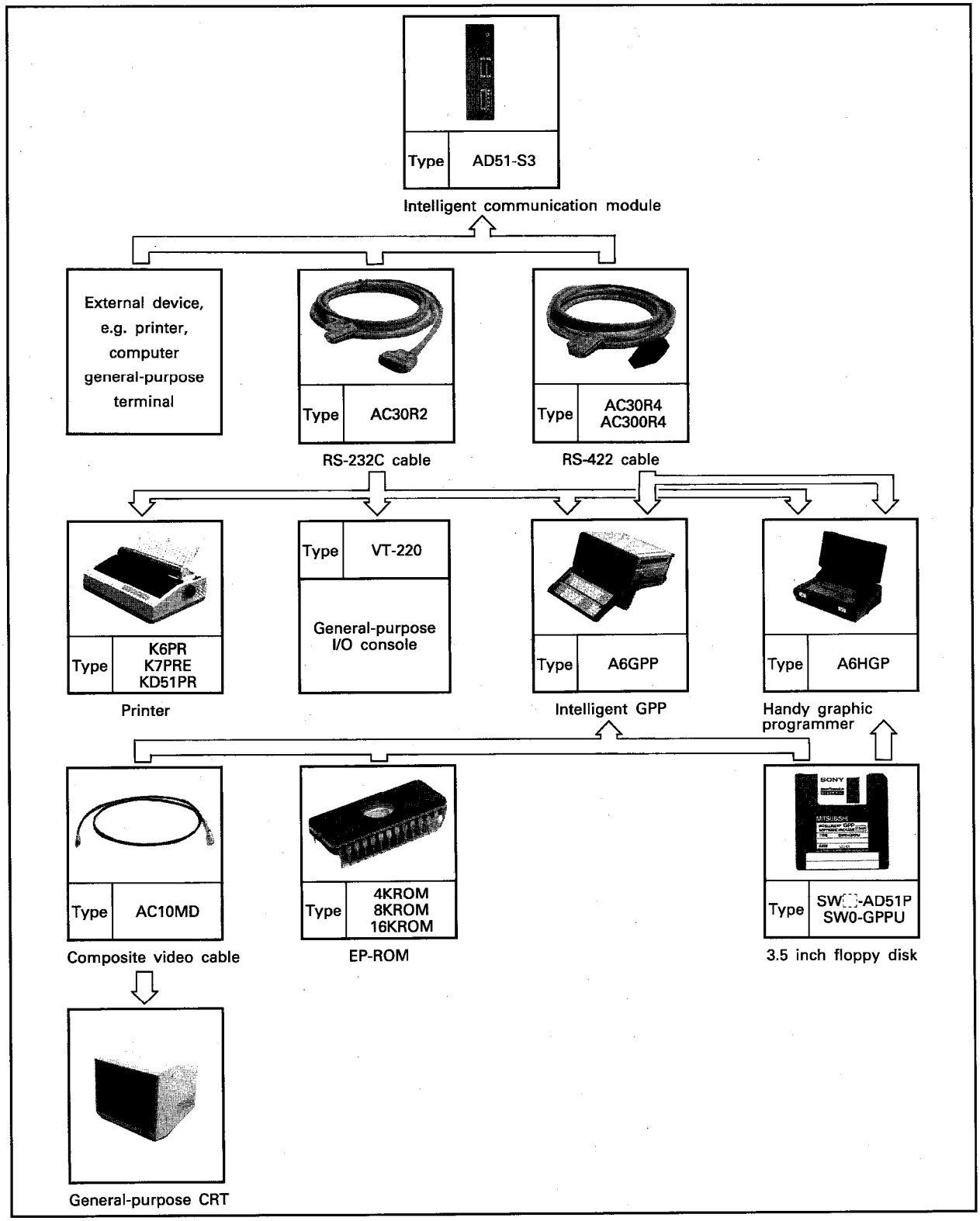


Fig. 2.3 Peripheral Device Configuration

POINT

The console select switch must be set to determine which programming terminal is to be used.

2.2 Applicable A Series Systems

The AD51 can be used with the following CPU modules.

Applicable models			
A0J2CPU	A1NCPU	A1CPU	A1ECPU
	A2NCPU	A2CPU	A2ECPU
	A3NCPU	A3CPU	A3ECPU
	A3HCPU		

The AD51 may be loaded into any slot on the base unit with the following precautions:

(1) When using the AD51 with the A55B or A58B extension bases (i.e. those without power supplies) select the power supply for the main base unit in accordance with the CPU User's manual.

(2) The AD51 may be loaded into the master station or a local station but not into a remote I/O station in a MELSECNET system. The following CPU modules are required for the MELSECNET data link system.

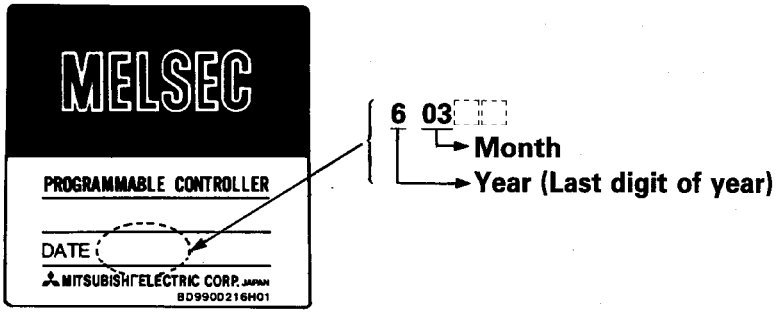
Applicable models		
Master/Local station	A1NCPUP21/R21	A1(E)CPUP21/R21
	A2NCPUP21/R21	A2(E)CPUP21/R21
	A3NCPUP21/R21	A3(E)CPUP21/R21
	A3HCPUP21/R21	
	A0J2CPUP23/R23	(local station only)

(3) One AD51 or A0J2C214 (computer/multidrop link module) may be used with the A0J2 PC. The A1, A2, A3HCPUs can accomodate two AD51s or two AJ71C24-S3s or one of each.

(4) The AD51 cannot be used in the last slot of the seventh extension stage in an A3CPU system.

POINT

The AD51 may only be used with PC CPUs manufactured in March, 1986 and thereafter. The name plate shown below indicates the date of manufacture.



2.3 Peripheral Equipment

The following table lists the peripheral equipment suitable for use with the AD51.

<table>
<tr><th>Description</th><th>Type</th><th>Remarks</th></tr>
<tr><td>Intelligent communication module</td><td>AD51-S3</td><td>Main unit
RAM support battery supplied</td></tr>
<tr><td rowspan="2">EP-ROM</td><td>8KROM</td><td>16K bytes, for channels 1 and 2</td></tr>
<tr><td>16KROM</td><td>32K bytes, for channels 1 and 2
24K bytes available to AD51
For details, refer to Section 3.4.2</td></tr>
<tr><td>Battery</td><td>A6BAT</td><td>For ICRAM support and real time clock</td></tr>
<tr><td>Intelligent GPP</td><td>A6GPPE-SET</td><td>○ Consists of the following models:
<table>
<tr><th>Type</th><th>Remarks</th></tr>
<tr><td>A6GPP</td><td>• Programming unit with CRT.
• Equipped with ROM writer, FDD, and printer interface functions.</td></tr>
<tr><td>SW□-GPPAEE/EG</td><td>A series system disk</td></tr>
<tr><td>SW□-GPPKEE/EG</td><td>K series system disk</td></tr>
<tr><td>SW□-GPPU</td><td>User disk (3.5 inch, formatted)</td></tr>
<tr><td>AC30R4</td><td>Cable for connection of AD51 and A6HGP, ACPU, AJ71C24-S3</td></tr>
</table>
Note: —EE; English version, EG; Germany version</td></tr>
<tr><td>Handy graphic programmer</td><td>A6HGPE-SET</td><td>○ Consists of the following:
<table>
<tr><th>Type</th><th>Remarks</th></tr>
<tr><td>A6HGP</td><td>• Programming unit with LCD.
• Equipped with FDD and printer interface functions.</td></tr>
<tr><td>SW□-HGPAEE/EG</td><td>A series system disk</td></tr>
<tr><td>SW□-HGPKEE/EG</td><td>K series system disk</td></tr>
<tr><td>SW□-GPPU</td><td>User disk (3.5 inch, formatted)</td></tr>
<tr><td>AC30R4</td><td>Cable for connection of AD51 and A6HGP, ACPU, AJ71C24-S3</td></tr>
</table>
Note: —EE; English version, EG; Germany version</td></tr>
<tr><td>System disk</td><td>SW□-AD51P□</td><td>System software package for the A6GPP or A6HGP
(back-up copy provided)</td></tr>
<tr><td>User disk</td><td>SW0-GPPU</td><td>User disk (already formatted) for storing programs.</td></tr>
<tr><td>Composite video cable</td><td>AC10MD</td><td>Optional cable for GPP external monitor 1m(3.28ft) length</td></tr>
<tr><td>General-purpose I/O console</td><td>VT-220</td><td>Display control codes equivalent to VT-220.</td></tr>
<tr><td rowspan="2">Printer</td><td>K6PRE
K7PRE</td><td>For program hard copy and data print out</td></tr>
<tr><td>KD51PR</td><td>For printing data</td></tr>
<tr><td>RS-422 cable</td><td>AC300R4</td><td>Cable between AD51 and A6GPP
3m(9.84ft) length</td></tr>
<tr><td>RS-232C cable</td><td>AC30R2</td><td>Connection cable between AD51 and printer and for VT-220.
3m(9.84ft) length</td></tr>
</table>

Table 2.1 System Equipment List (Continue)

Description	Type	Remarks
Ink ribbon	K6PR-R	Ink ribbon for K6PRE
	K7PR-R	Ink ribbon for K7PRE
	KD51PR-R	Ink ribbon for KD51PR
Printer paper	K6PR-Y	Printer paper for K6PR
	KD51PR-Y	Printer paper for KD51PR
Interface connector	232-CON	Connector for RS-422 and RS-232C interfaces

Table 2.1 System Equipment List

3. SPECIFICATIONS

3.1 Performance Specifications

Item		Specification
Processor		HD64180
Program language		GPC-BASIC
Number of tasks		Maximum 8
Task start conditions		Power on
		Interrupt from PC CPU
		Real time interrupt (Set in the range 0.01 to 9.99 seconds in units of 0.01 second.)
Internal memory		Maximum: 114K bytes=64K bytes+2K bytes+48K bytes Common work area Two 16KROMs loaded *For details, refer to Section 3.4.
General-purpose I/O		General-purpose input : 13 points General-purpose output: 10 points *For details, refer to Section 3.6.
Buffer memory		3K words (6K bytes) *For details, refer to Section 3.7.
Memory protect address range		4F00 to 4FFF (system data area) 8000 to DFFF (channel 1 to 4)
Interfaces	RS-422	Conforms to EIA. RS-422. Channel 1: D shell connector. Channel 2: Terminal block Transmission distance: ≦500m
	RS-232C	Conforms to EIA. RS-232C. Channel 3, 4: D shell connector. Transmission distance: ≦15m
Arithmetic and logic unit (ALU)		Performs high-speed processing of BASIC's intrinsic functions (trigonometric, inverse trigonometic, logarithm, exponential, $\sqrt{}$, absolute value).
Clock element		Year, month, day, hour, minute, second Read/write 24 hour mode, automatic leap year compensation
Power failure compensation		Internal memory, lithium battery for back-up of real time clock Total back-up time: 130 days Battery life : 5 years
Console		A6GPP, A6HGP, A6PHP VT-220
Number of I/O points occupied		48
Internal current consumption (5V)		1.3A
Size mm (inch)		250 (9.84) (H)×76 (2.99) (W)×120 (4.72) (D)
Weight kg (lb)		1.1 (2.42)

Table 3.1 AD51 Performance Specifications

3.2 Instruction Set

The AD51 is programmed in GPC-BASIC.
In addition to the BASIC commands a series of subroutines are available which can be called from the BASIC program.

3.2.1 GPC-BASIC commands

The following table lists the GPC-BASIC commands. For full information refer to the "GPC-BASIC Handbooks". The graphics commands described in the "GPC-BASIC" Handbooks are not available on the AD51.

Command			Function
Key command [KEY]	AUTO		Automatic generation of line number
	BYE		Returns to BASIC program address data screen.
	CONT		Resumes program run after BREAK
	COMPILE		Compiles multitask executable program
	DELETE		Deletes program from specified line number to specified line number
	EDIT		Corrects statement in one line
	EXECUTE		Run of program after "RUN" or "COMPILE"
	LIST	A, B, C	Displays program on screen
	LLIST		Prints out program
	NEW		Erases program
	RENUM	A, B	Renumbers line numbers
	RUN		Executes program
	ZDV		Displays I/O console
	—		Deletes line
Program command [PRG]	BREAK		Resumes program run after stop and "CONT"
	CALL		Calls machine language program
	CLS	A, B	Clears CRT screen
	CLOSE	A, B, C, D	Closes specified RS-232C/RS-422 channel.
	END		Declares end of program run
	FOR···NEXT		Repeats program run from "FOR" to "NEXT"
	GOTO		Moves to specified line number

Table 3.2 BASIC Command List (Continue)

Command			Function
Program command PRG	GOSUB ····· ····· RETURN		Moves to specified subroutine Returns from subroutine
	IF		Judges result of expression
	INPUT	A B	Input from keyboard
	INKEY		Assigns input from keyboard to variable
	LET		Assigns value of expression to variable
	LOCATE	A B C D	Moves cursor position
	LPRINT	A B C	Prints out data
	ONGOSUB		Moves to subroutine in line number specified by value of expression
	ONGOTO		Moves to line number specified by value of expression
	OPEN	A B C D	Opens specified RS-232C/RS-422 channel.
	PEEK		Reads 1-byte data from specified memory address
	POKE		Writes 1-byte data to specified memory address
	PRINT	A B	Displays data on screen
	REM		Used to write comment.
	SIZE	A B	Displays text program capacity
	STOP		Stops program run
	ZCOFF	A B	Underline Type A when the console is GPP/HGP. Type B when the console is VT-220.
	ZCON	A B	Resets underline (used after "ZCOFF"). Type A when the console is GPP/HGP. Type B when the console is VT-220.
	ZCRV		Reverses character color on CRT screen
	ZDATE		Reads year, month, day, hour, and minute
	ZIDV	A B C D	Changes input console
	ZMOV		Transfers data from memory to memory
	ZNOR		Returns the character reversed after "ZCRV" to its original color

Table 3.2 BASIC Command List (Continue)

Command		Function
Program command [PRG]	ZODV A/B/C	Changes output console
	ZRD1	Reads 1-byte data from specified channel
	ZRD2	Reads 2-byte data from specified channel
	ZTIME	Stops execution for specified interval of time
	ZWR1	Writes 1-byte data to specified channel
	ZWR2	Writes 2-byte data to specified channel
Intrinsic function [INT]	ABF	Absolute value of real number in mathematical expression
	ABS	Absolute value of integer in mathematical expression
	ACOS	Arccosine ($\cos^{-1}$) of mathematical expression
	ASIN	Arcsine ($\sin^{-1}$) of mathematical expression
	ATAN	Arctangent ($\tan^{-1}$) of mathematical expression
	COS	Cosine (cos) of mathematical expression
	EXP	Value of Exponential to base "e" (e=2.718281)
	LN	Value of natural logarithm (loge)
	LOG	Value of common logarithm ($\log_{10}$)
	NOT	Generates "1" when value of mathematical expression is "0" and generates "0" when the value is not "0".
	RND	Assigns random number to variable
	SIN	Sine (sin) of mathematical expression
	SQRT	Value of square root of mathematical expression
	TAN	Tangent (tan) of mathematical expression
Arith-metic operator [ALU]	+	Addition
	−	Subtraction
	*	Multiplication
	/	Division
	^	Exponent
	−	Sign reversion
	%	Remainder calculation

Table 3.2 BASIC Command List (Continue)

Command		Function
Com-parison operator COM	=	Is equal to
	#	Is not equal to
	<	Is less than
	>	Is greater than
	<=	Is not greater than
	>=	Is not less than
Logical operator LOG	#	Negation (NOT)
	&	Logical product (AND)
	I	Logical sum (OR)
	¥	Exclusive logical sum (EXOR)

Table 3.2 BASIC Command List

Where commands have several options (indicates as A, B, C etc.) only those shaded (■) may be used on the AD51.

3.2.2 System subroutines

System subroutines are machine code programs used for special AD51 functions (for example PC CPU transactions etc.). They are already written in channel 0 of the AD51 at specified address locations.
System subroutine operation is initiated by using the "CALL" command in the BASIC program.
System subroutines on the AD51 are shown in Table 3.3.

[Initializing the system subroutine]

1) The system subroutine is called from the GPC-BASIC program using the "CALL" command.

2) The format of the CALL statement is as follows.

A=CALL (variable 1, variable 2, [variable 3, variable 4])

Variable 1: Always 0. All system subroutines are located in channel 0.
Variable 2: Head address of system subroutine in channel 0 (see table 3.3)
Variable 3: Variable for system subroutine stored in (D)(E) registers.
Variable 4: Variable for system subroutine stored in (B)(C) registers.

3) For information on variable 3 and variable 4, refer to the GPC-BASIC Handbooks.

4) Before executing the CALL command, transfer variables to the work area.

	System Subroutine	Function	Channel	Address
1	SAI	ASCII (hexadecimal) → BIN	0	8060H
2	SIA	BIN → ASCII (hexadecimal)	0	8063H
3	SAN	ASCII (decimal) → BIN	0	8072H
4	SNA	BIN → ASCII (decimal)	0	8075H
5	SAF	ASCII → real number	0	8066H
6	SFA	Real number → ASCII	0	8069H
7	SBF	Integer → real number	0	806CH
8	SFB	Real number → integer	0	806FH
9	SFLTD	32-bit integer → 32-bit floating point number	0	80DEH
10	SFIXD	32-bit floating point number → 32-bit integer	0	80E1H
11	SBD4	BIN → 4-digit BCD	0	8042H
12	SDB4	4-digit BCD → BIN	0	8045H
13	SBD6	BIN → 6-digit BCD	0	8048H
14	SDB6	6-digit BCD → BIN	0	804BH

Table 3.3 System Subroutine List (Continue)

	System Subroutine		Function	Channel	Address
15	SBA		BIN addition (24 bits)	0	804EH
16	SBS		BIN subtraction (24 bits)	0	8051H
17	SBM		BIN multiplication (24 bits)	0	8054H
18	SBW		BIN division (24 bits)	0	8057H
19	SCA	— B	Write to clock element (year, month, day, hour, minute, second)	0	803CH
20	SCB	— B	Read from clock element (year, month, day, hour, minute, second)	0	803FH
21	SPC	— B	Discrimination of programmable controller CPU	0	8078H
22	SKC	— B	Programmable controller CPU run/stop check	0	8030H
23	SKR	— B	Remote run of programmable controller CPU	0	8033H
24	SKP	— B	Remote stop of programmable controller CPU	0	8036H
25	SRB	A B	Receives specified byte length of data sent to specified channel	0	8009H
26	SWB	A B	Sends specified byte length of data from specified channel	0	800CH
27	SRC		Reads the number of bytes of data received by specified channel	0	800FH
28	SRF		Reads the number of vacant bytes in receive buffer of specified channel	0	8012H
29	SHX	— B	Controls send/receive data of specified channel by Xon/Xoff codes	0	8015H
30	SHD	— B	Controls send/receive data of specified channel by DR terminal	0	8018H
31	SAE		Converts all send/receive data of specified channel to EBCDIC code	0	801EH
32	SEA		No code conversion of send/receive data of specified channel	0	8021H
33	STC		Reads the number of remaining bytes in send buffer of specified channel	0	801BH
34	SRP		Reads status of specified channel	0	8027H
35	SR2		Reads data from buffer memory	0	8000H
36	SW2		Writes data to buffer memory	0	8003H
37	SADR		Reads data from data memory of programmable controller CPU	0	807BH
38	SADW		Writes data to data memory of programmable controller CPU	0	807EH
39	SADT		Randomly writes data to data memory of programmable controller CPU	0	8081H
40	SADM0		Enters data randomly read from data memory of programmable controller CPU	0	8084H

Table 3.3 System Subroutine List (Continue)

	System Subroutine	Function	Channel	Address
41	SADM1	Randomly reads data from data memory of programmable controller CPU	0	8087H
42	SAAR	Reads sequence program	0	808AH
43	SAAW	Writes sequence program	0	808DH
44	SAPR	Reads programmable controller CPU parameters	0	8090H
45	SAPW	Writes programmable controller CPU parameters	0	8093H
46	SAPS	Analysis request of programmable controller CPU parameters	0	8096H
47	SIT	Interruption to programmable controller CPU	0	802AH
48	SIR	Reads error code	0	8024H
49	SC2	Sets SR2/SW2 retry time	0	8006H
50	*1 SAER	Reads data from extension file registers of PC CPU	0	80BDH
51	*1 SAEW	Writes data to extension file registers of PC CPU	0	80C0H
52	*1 SAET	Randomly writes data to extension file registers of PC CPU	0	80C3H
53	*1 SAEM0	Defines PC CPU extension file registers to be monitored	0	80C6H
54	*1 SAEM1	Monitors PC CPU extension file registers specified in monitor data entry	0	80C9H
55	*2 SAMR	Reads microcomputer program from PC CPU	0	80CCH
56	*2 SAMW	Writes microcomputer program to PC CPU	0	80CFH
57	SACR	Reads comments from PC CPU	0	80D2H
58	SACW	Writes comments to PC CPU	0	80D5H
59	SATR	Reads data from special function module buffer memory	0	80D8H
60	SATW	Writes data to special function module buffer memory	0	80DBH

Table 3.3 System Subroutine List

Where system subroutines have several options (indicated as [A], [B]) only those shaded (■) may be used on the AD51.

REMARKS

(1) System subroutines indicated as [—/B] are covered in the GPC-BASIC Handbooks.

(2) System subroutines marked *1 may only have access to the A3ECPU, A3CPU, A3NCPU and A3HCPU.
System subroutines marked *2 may only have access to the A1ECPU, A1CPU, A1NCPU, A2ECPU, A2CPU, A2NCPU, A3ECPU, A3CPU, A3NCPU and A3HCPU.

3.3 Software Configuration

The following shows a block diagram of the AD51 software configuration indicating how the various areas interact.

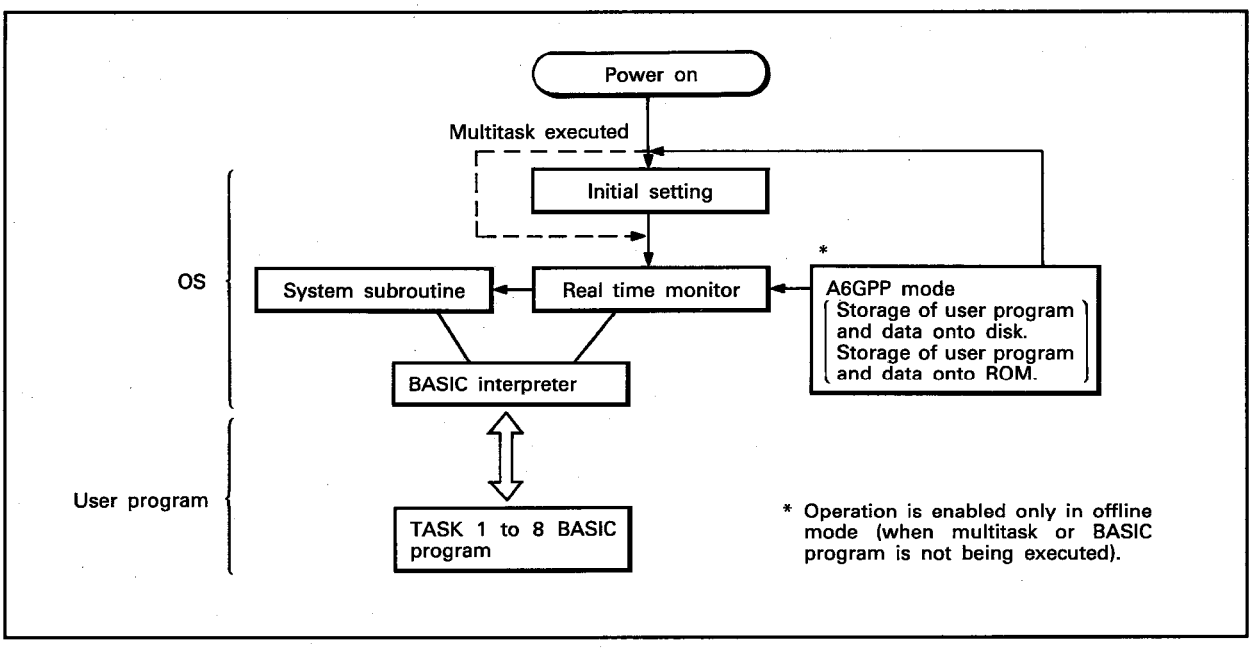


Fig. 3.1 Software Configuration

(1) As shown in Fig. 3.1, a maximum of 8 user programs may be processed in parallel under the control of the real time monitor.

(2) "Power on", "interrupt from ACPU", and "real time interrupt" are available as starting conditions for the user program.

(3) Each task can only be written in BASIC.

3.4 Memory Map

3.4.1 Memory configuration

The AD51 is a Z-80 based system. To expand the memory size from 64K bytes the second 32K bytes are duplicated in additional channels as shown in Fig. 3.2 below.

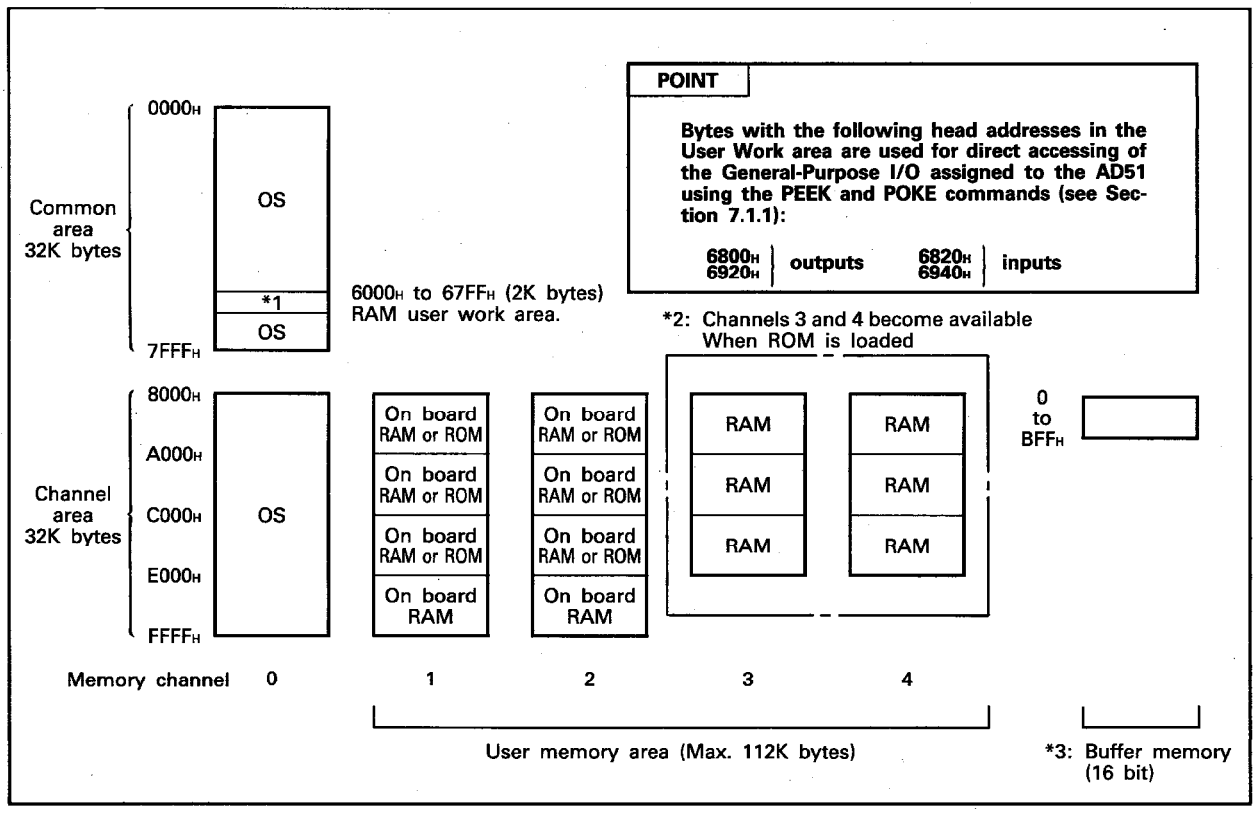


Fig. 3.2 Memory Map

POINT

***(1) The RAM user work area, (addresses 6000H to 67FFH) is in the common area and can be accessed by the user programs in any of channels 1 to 4.**

***(2) The memory area may be expanded by adding ROM to channels 1 and/or 2.**

***(3) The buffer address range is 000H to BFFH which represents 3K words (6K bytes) of buffer memory. Each buffer memory address represents 1 word. (i.e. 16 bits)**

3.4.2 Memory map with ROM loaded

The user memory area can be expanded by loading ROM into channels 1 and/or 2. The memory map will vary as shown below depending on the location and size of the ROMs.
8K and 16KROMs may be used.

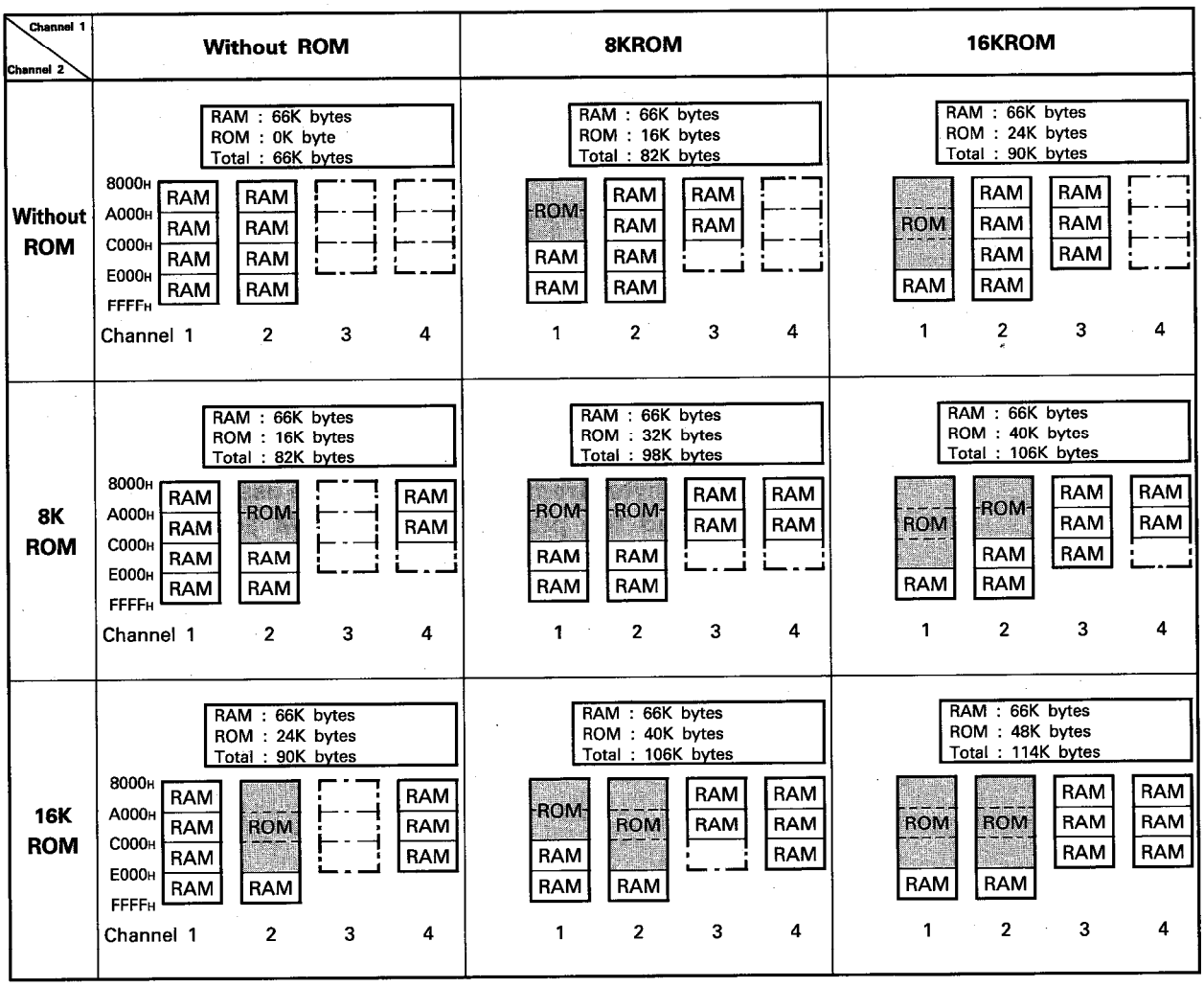


Table 3.4 Memory Map When ROM is Used.

POINT

(1) The installation of a ROM shifts the corresponding RAM address range to a different channel. (e.g. Installing 8K of ROM at channel 1 addresses 8000_H to $BFFF_H$ moves the RAM area to channel 3 addresses 8000_H to $BFFF_H$.

(2) Two shorting pins are used to specify RAM or ROM in channels 1 and 2. The RAM area is moved as follows depending on the pin setting in each channel.

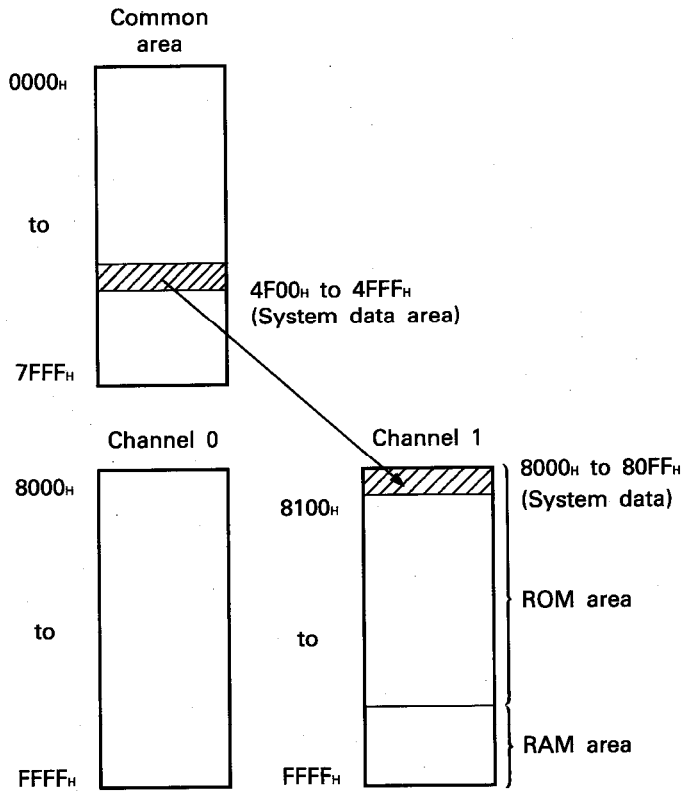
RAM/ROM setting pin \ ROM loading	With ROM	Without ROM
RAM position	RAM and ROM areas coincide.	Correct
ROM position	Correct	The RAM area changes channels as though ROM was installed.

(3) Only 24K bytes are valid (addresses 8000_H to $DFFF_H$) when 16KROM is used.
The 8K bytes from $E000_H$ to $FFFF_H$ are used in the RAM area and the program in this ROM address range cannot be executed.

(4) For RAM area memory protect, refer to Section 4.3.1.

3.4.3 Storing system data on ROM

System data (e.g. multitask set data) required for program execution of each task may be stored to ROM.
The system data located in the common area is stored to the first 256-byte area of the ROM installed on channel 1.



(1) After the system data is stored on ROM, addresses 8100H to FFFFH are used as a user memory area and 8000H to 80FFH cannot be used as a user area (program area, work area).

(2) After the system data is stored on ROM, the RAM area of channel 4 can be used as a program area but that of channel 3 may only be used as a work area.

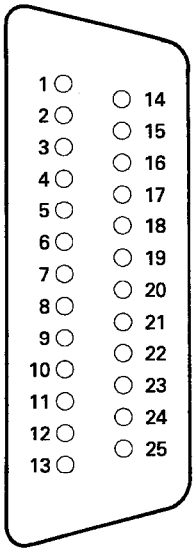
(3) With the system data transfer switch ON, multitask is executed after the system data is transferred from 8000H to 80FFH of channel 1 to the system data area (4F00H to 4FFFH) at power on.

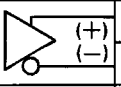
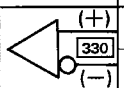
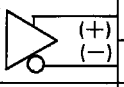
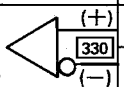
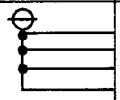
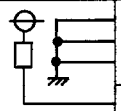
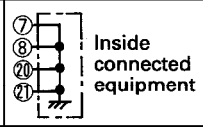
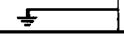
3.5 Interface Specifications

3.5.1 RS-422 connector specifications (CH1)

Item	Specifications
Connected Unit	A6GPP, printer with RS-422, personal computer, etc.
Transmission system	Conforms to EIA. RS-422.
Synchronous system	Asynchronous system
USART mode setting	Baud rate setting (300, 600, 1200, 2400, 4800, 9600 BPS selectable) Parity bit setting — Parity absent / Parity present — Even parity / Odd parity Stop bit setting — Stop bit 1 / Stop bit 2 Character data bit setting — Data 7 bits / Data 8 bits Communication control setting — XON/XOFF control / Control with DTR terminal

Connector pin outs.



Signal		Block Diagram	Pin	Signal Direction	Remarks
Send data	SDA		③	→ outside	
	SDB		⑯		
Receive data	RDA		②	← outside	
	RDB		⑮		
Data terminal ready	CSA		⑤	→ outside	
	CSB		⑱		
Data set ready	RSA		④	→ outside	
	RSB		⑰		
DC current			⑫ ⑬ ㉔ ㉕		Do not perform wiring
Signal ground	SGA		⑦ ⑧ ⑳		 Inside connected equipment
	SGB		㉑		
Frame ground	FG		①		

*Connect pin 21 to the signal ground of the external equipment.

POINT

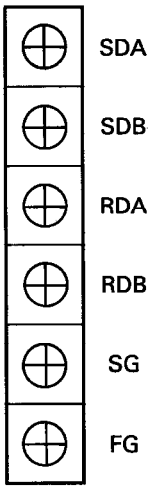
(1) The maximum transmission speed from the AD51 is 9600 BPS, the maximum receiving speed is 4800 BPS.

(2) When channel 1 has been set as an I/O console (DIP switch 16 set to ON), the AD51 operating system automatically sets the USART mode: 4800 BPS, even parity, stop bit 1, character data 8

3.5.2 RS-422 terminal block specifications (CH2)

Item	Specifications
Connected Unit	AD51, personal computer etc.
Transmission system	Conforms to EIA. RS-422.
Synchronous system	Asynchronous system
USART mode setting	Baud rate setting (300, 600, 1200, 2400, 4800, 9600 BPS selectable) Parity bit setting — Parity absent / Parity present — Even parity / Odd parity Stop bit setting — Stop bit 1 / Stop bit 2 Character data bit setting — Data 7 bits / Data 8 bits

Terminal block pin outs.



Signal	Block Diagram	Terminal Number	Signal Direction	Remarks
Send data (SDA)	(+)	TB1	→ to outside	
Send data (SDB)	(−)	TB2		
Receive data (RDA)	(+) 330	TB3	← from outside	
Receive data (RDB)	(−)	TB4		
Signal ground (SG)		TB5		
Frame ground (FG)		TB6		

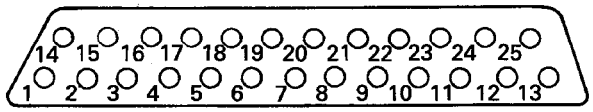
POINT

The maximum transmission baud rate from the AD51 is 9600 BPS. The maximum receiving baud rate is 4800 BPS.

3.5.3 RS-232C connector performance specifications (CH3 and 4)

Item	Specifications
Connected Unit	Console (CH3 only), computer with RS-232C interface, personal computer, printer, modem, etc.
Transmission system	Conforms to EIA. RS-232C.
Transmission speed	300, 600, 1200, 2400, 4800, 9600 selectable
Synchronous system	Asynchronous system
USART mode setting	Baud rate setting (300, 600, 1200, 2400, 4800, 9600 BPS selectable) Parity bit setting — Parity absent / Parity present — Even parity / Odd parity Stop bit setting — Stop bit 1 / Stop bit 2 Character data bit setting — Data 7 bits / Data 8 bits Communication control setting — XON/XOFF control / Control with DTR terminal *Set CH3 with the front DIP switches (SW1 to 8).

Connector pin outs.



Pin Number	Signal Abbreviation	Signal Direction Inside-outside	Description
1	FG		Frame ground
2	SD	→	Send data
3	RD	←	Receive data
4	RTS	→	Request to send
5	CTS	←	Clear to send
6	DSR	←	Data set ready
7	SG		Signal ground
20	DTR	→	Data terminal ready

POINT

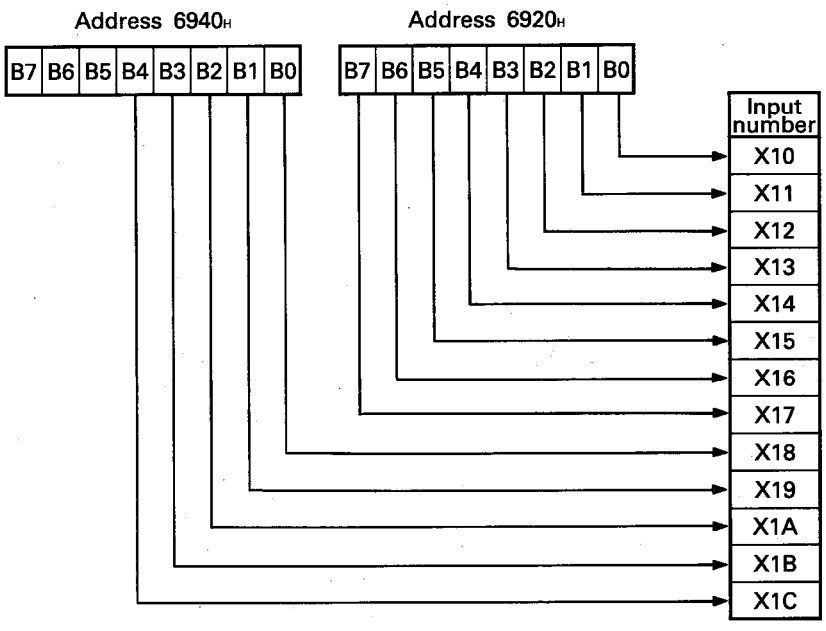
(1) The maximum transmission speed from the AD51 is 9600 BPS, the maximum receiving speed is 4800 BPS.

(2) When channel 3 has been set as an I/O console (DIP switch 16 set to OFF), the AD51 operating system automatically sets the USART mode:
4800 BPS, parity absent, stop bit 1, character data bit 8

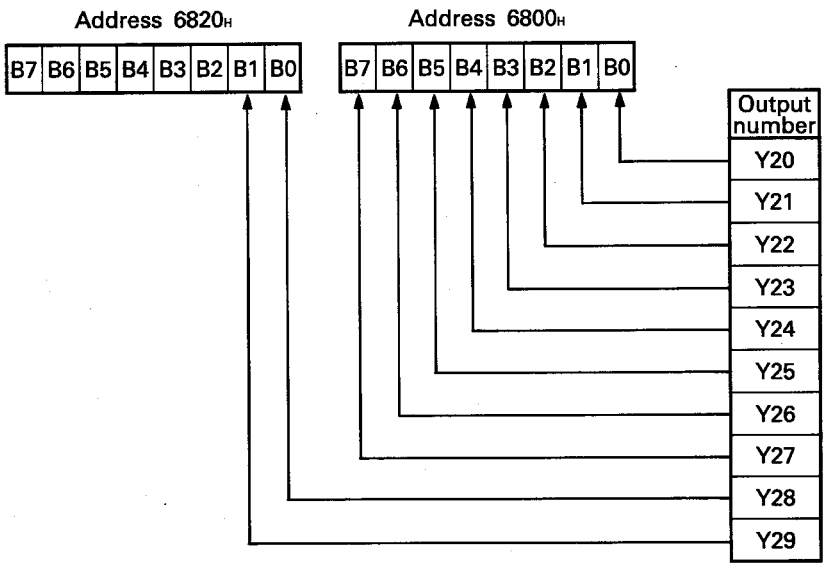
3.6 I/O Interface with Programmable Controller CPU

The digital I/O bus may be used for communication between the PC CPU and the AD51. The following table indicates the function of each signal. The drive number will vary depending on the AD51 slot location; in the table the AD51 is assumed to be in slots 0 and 1 of the main base unit.

(1) There are 48 input signals to the PC CPU (X00 to X2F) from the AD51.

<table>
<tr><th>Input Number</th><th>Description</th><th>Address</th></tr>
<tr><td>X00 to X0F</td><td>Unused</td><td></td></tr>
<tr><td>X10</td><td rowspan="12">Switched on/off by the BASIC program and the contacts used in the sequence program. (Known as General-purpose inputs)</td><td rowspan="12"> 
</td></tr>
<tr><td>X11</td></tr>
<tr><td>X12</td></tr>
<tr><td>X13</td></tr>
<tr><td>X14</td></tr>
<tr><td>X15</td></tr>
<tr><td>X16</td></tr>
<tr><td>X17</td></tr>
<tr><td>X18</td></tr>
<tr><td>X19</td></tr>
<tr><td>X1A</td></tr>
<tr><td>X1B</td></tr>
<tr><td>X1C</td></tr>
<tr><td>X1D</td><td>Switched on to indicate an AD51 CPU fault</td><td rowspan="3"></td></tr>
<tr><td>X1E</td><td rowspan="2">Unused</td></tr>
<tr><td>X1F</td></tr>
<tr><td>X20 to X2F</td><td>Unused</td><td></td></tr>
</table>

(2) There are 48 output signals from the PC CPU to the AD51.

<table>
<tr><th>Output Number</th><th>Description</th><th>Address</th></tr>
<tr><td>Y00
to
Y0F</td><td>Unused</td><td rowspan="2"></td></tr>
<tr><td>Y10
to
Y1F</td><td>May be used by the PC CPU as extra internal relays (M).</td></tr>
<tr><td>Y20
Y21
Y22
Y23
Y24
Y25
Y26
Y27
Y28</td><td>Switched on/off in the sequence program and read by the BASIC program (known as General-purpose outputs)</td><td rowspan="2"> 
</td></tr>
<tr><td>Y29</td><td>This output may be used to start one task in the AD51 designated as an interrupt program by its task start condition.</td></tr>
<tr><td>Y2A
to
Y2F</td><td>Unused</td><td></td></tr>
</table>

POINT

(1) Input X1D is switched on when an error is detected by the AD51 hardware. This signal may be used as an interlock in the PC sequence program to control PC accessing of the AD51 buffer memory (i.e. FROM /TO instructions).

(2) Switching output Y29 on will start the task which has its start condition specified as "interrupt from ACPU". The start condition is defined during "multi task setting".

(3) Output signals Y2A to Y2F are used by the operating system and must not be switched on or off.

3.7 Buffer Memory

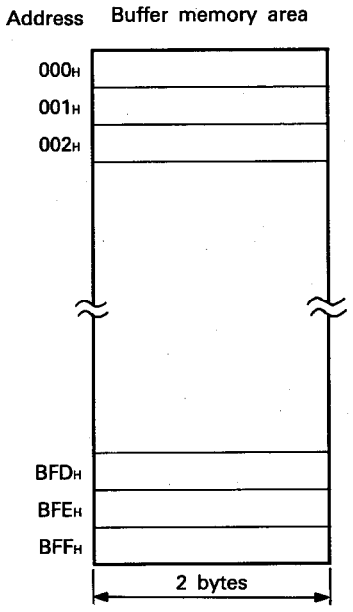
The AD51 uses a buffer memory for data communication with the PC CPU. (The buffer memory is not battery backed.)

(1) Buffer memory addresses are 000_H to BFF_H (3K words).
See the memory map in Section 3.4.

(2) Buffer memory data is made up of 16 bits per address.

(3) The buffer memory is accessed by the AD51 using system subroutines (SR2, SW2). For details, refer to Section 7.2.1.

(4) The buffer memory is accessed by the PC CPU using the FROM and TO application instructions.
For read and write procedures, refer to Section 7.2.2.
For details of the FROM/TO instructions, refer to the ACPU Programming Manual.



3.8 Communication between AD51 and PC CPU

Any AD51 initiated requests for communication transactions between the AD51 and PC CPU are processed once when the END, FEND or COM instruction is executed by the PC. The time taken to process a system subroutine and the delay times caused by multiple accessing of the PC CPU are explained in this section.

(1) The following table shows the number of scans taken by the AD51 to process PC transaction subroutines.

Item			System Subroutine	Number of Scans Required for Processing
Device memory	Batch read	Bit	SADR	1 scan (2 scans for device "R")
		Word		
	Batch write	Bit	SADW	
		Word		
	Test (random write)	Bit	SADT	
		Word		
	Monitor data entry	Bit	SADM0	Independent of scan
		Word		1 scan for device "R" only (Independent of scan for other devices.)
	Monitor	Bit	SADM1	1 scan
		Word		
Sequence program	Read	Main	SAAR	1 scan
		Sub		
	Write	Main	SAAW	2 scans (1 scan for T/C set value)
		Sub		
Parameter	Read		SAPR	2 scans
	Batch write		SAPW	2 scans
	Analysis request		SAPS	2 scans
Parameter (PC)	Remote run		SKR	1 scan
	Remote stop		SKP	
	PC type mode		SPC	
Buffer memory	Batch read		SR2	Independent of scan
	Batch write		SW2	
Extension file register	Batch read		SAER	2 scans
	Batch write		SAEW	
	Random write		SAET	
	Monitor data entry		SAEM0	1 scan
	Monitor		SAEM1	
Micro-computer program	Read	Main	SAMR	1 scan
		Sub		
	Write	Main	SAMW	2 scans
		Sub		
Comment	Batch read		SACR	2 scans
	Batch write		SACW	
Special module buffer memory	Batch read		SATR	1 scan
	Batch write		SATW	

POINT

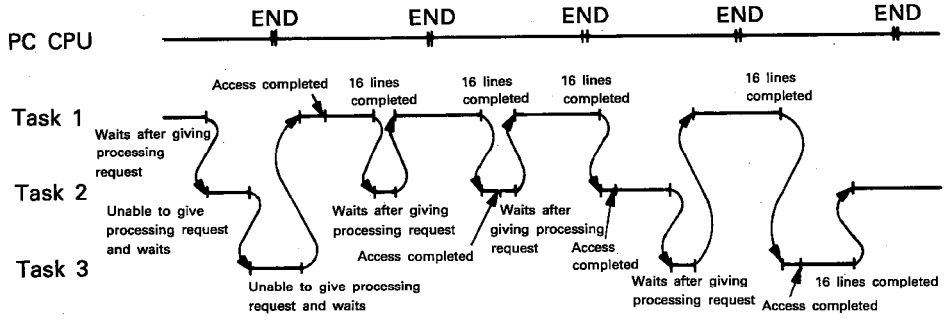
System subroutines SR2 and SW2 (buffer memory read, write) allow max. 3K words (6K bytes) to be transferred between the PC CPU and AD51 at one time independently of the END, FEND or COM instruction execution in the sequence program.

(2) Requests for communication transactions with the PC CPU may also come from other sources, these are listed below and are processed in the same way as AD51 transaction requests. Only one transaction may be processed per PC CPU scan so that a delay of 1 to 5 scans is possible before the AD51 transaction is processed if several of these requests overlap. The following list gives the transaction requests in priority order.

1. Programmable controller CPU OS program
2. Peripheral equipment (e.g. A6GPP)
3. Optical or coaxial data link unit incorporated in CPU module
4. Optical or coaxial data link module in 3 hierarchy system AJ71P22/R22
5. Processing request from AJ71C24-S3 or second AD51

Hence, if continuous processing requests are received from the A6GPP and AJ71C24-S3, communication between the AD51 and PC CPU is only made once every three scans.

(3) When a system subroutine is called which accesses the PC CPU there is a delay while the PC CPU prepares the appropriate data. During this delay time, the AD51 switches tasks to optimize scan time. In the example shown below, three tasks are executing subroutine which access the PC CPU. Task one provides the first processing request to the PC CPU which prepares the requested data. During this delay the AD51 switches to task 2 which is unable to pass its processing request to the PC which is still dealing with the one from task 1. The AD51 therefore switches to task 3 for which the same situation exists. Only after task 1s request has been fully processed can task 2s request be dealt with. Similarly task 3 must wait until task 2 been processed. For details of other task switching, refer to the GPC-BASIC Handbook.



3.8.1 Transmission time in MELSECNET

Transmission time (T_1) is calculated as follows if data transmission is made to the specified PC CPU which is not used with the AD51 in MELSECNET.

- Master station ⟷ local station

  Transmission time (T_1) = ((period equivalent to LRDP instruction processing time) + (1 scan time of station used with AD51)) × 2

- Master station ⟷ remote station

  Transmission time (T_1) = ((period equivalent to RFRP instruction processing time) + (1 scan time of MELSECNET master station)) × 2
  Read "2" marked ~~~ as "3" when communication is made to the corresponding station for the first time after power on or CPU reset.
  Read "2" as "1" from the second communication on when the number of stations communicating is 64 or less.

- Factor of transmission time (T_1) delay

  Transmission time obtained from any of the above expressions should be doubled if the command executed requires two scans for transmission (e.g. device "R" write).
  Transmission time should be multiplied by the (number of stations monitored + 1) if the other link stations are monitored by the A6GPP.
  *For more information on data link, see the Data Link System User's Manual.

Example: Reading local station device memory with the AD51 loaded on the MELSECNET master station
(Conditions: L < LS < M, M = 80ms, α1 = 10ms)

Transmission time (T_1) = (M × 4 + α 1 × 4 + M) × 2
= (80 × 4 + 10 × 4 + 80) × 2 = 880

where M = MELSECNET master station scan time
α1 = MELSECNET master station link refresh time
LS = link scan time
L = MELSECNET local station scan time

POINT

On some conditions, a considerable delay will occur for data transmission to the PC CPU which is not used with the AD51 in MELSECNET.
Transmission time can be reduced by performing communication only between the AD51 and the PC CPUs used with the AD51 (PC No. FF_H) and using MELSECNET data link (B, W) for communication with the other PC CPUs.

3.9 AD51 Communication

Data communication between the AD51 and external devices (e.g. computer, I/O console, printer) is made using RS-232C and RS-422.

Data communication is made via the transmission and receive buffers which are controlled by the OS of the AD51. The transmission and receive buffers are controlled individually for channels 1 to 4.

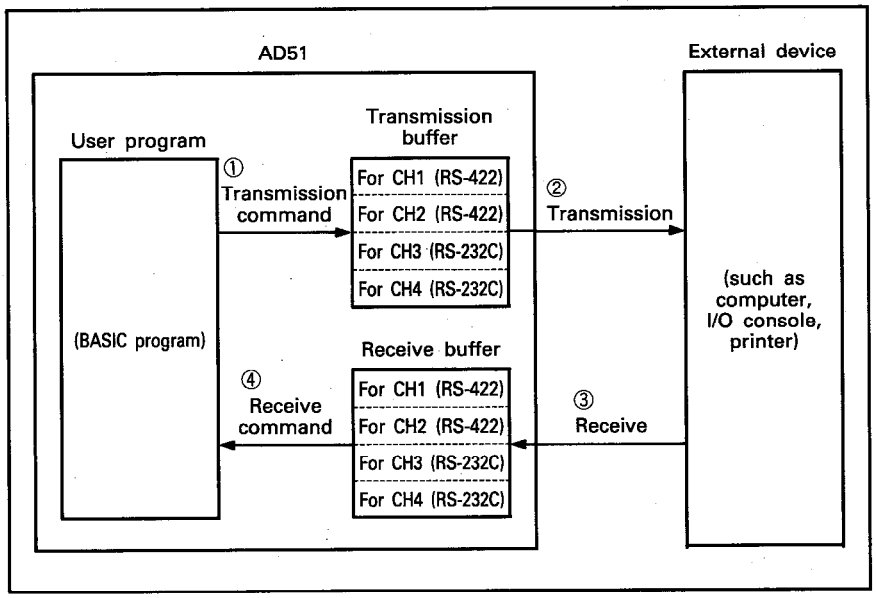
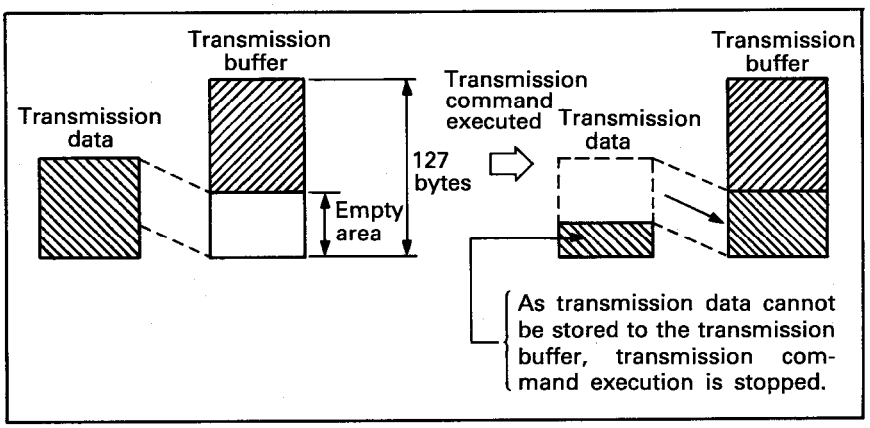


Fig. 3.3 AD51 Communication

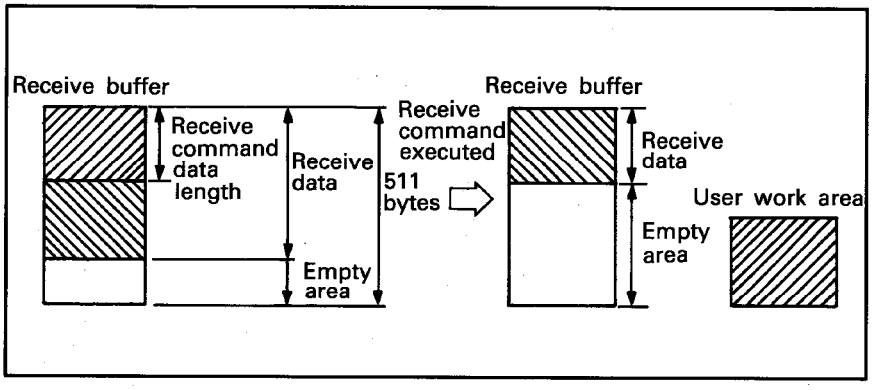
(1) When the transmission command (PRINT, LPRINT, SWB) is executed in the user program, transmission data is stored to the transmission buffer.
If the empty area of transmission buffer is less than the transmission data length, the transmission command execution is stopped after as much data is stored to the transmission buffer.
The remaining transmission data is stored when an empty area is made in the transmission buffer by data transmission to the external device.



(2) Data is transmitted in the same order as stored to the transmission buffer when the external device is enabled to receive data by communication control (DTR control or Xon/Xoff control).

(3) Data received from the external device is stored to the buffer memory.
When the empty area of the receive buffer is reduced, communication control alerts the external device to receive disable.

(4) Execution of the receive command (INPUT, INKEY, SRB) in the user program transfers data from the receive buffer to the user work area.



3.10 Communication Control

The AD51 has two types of communication control, DTR control and Xon/Xoff control. Communication control defaults to DTR control.
Either control may be selected by executing the corresponding system subroutine as follows:

- DTR control·····Execute SHD.
- Xon/Xoff control·····Execute SHX.

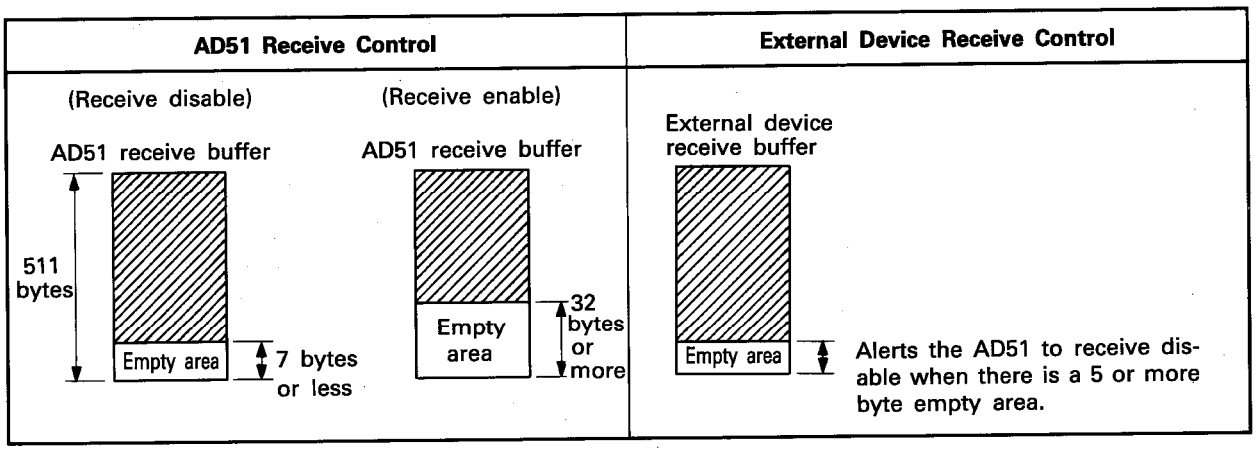
Channel 2 (RS-422 terminal block) is not allowed for communication control change.

(1) AD51 transmission

The AD51 sends data after confirming that the external device is ready to receive.
The external device used must be capable of alerting the AD51 to receive disable when there is an empty area of 5 or more bytes in the receive buffer.

(2) AD51 receive

The AD51 receive buffer has 511 bytes.
The AD51 notifies the external device of receive disable when the empty area of the receive buffer is 7 bytes or less.
The AD51 alerts the external device to receive enable when the empty area of the receive buffer is 32 bytes or more.



POINT

The external device connected to the AD51 must have a receive buffer and be capable of alerting the AD51 to receive disable when there is 5 bytes or more left as an empty area.
Any external device that performs communication handshake in units of 1 byte cannot be connected to the AD51.

3.10.1 DTR control

Performs communication control using the data device ready signal and terminal ready notice signal.

RS-422 : RSA/RSB and CSA/CSB
RS-232C: DSR and DTR

(a) The data device ready signal is switched on to send data from the transmission buffer to the external device.
The data device ready signal is switched off to stop the transmission.

(b) The terminal ready notice signal is switched off when the empty area of the receive buffer has become 7 bytes or less.
The terminal ready notice signal is switched on when the receive buffer empty area increases to 32 bytes or more after the receive command (INPUT, INKEY, SRB) is executed in the user program.

3.10.2 Xon/Xoff control

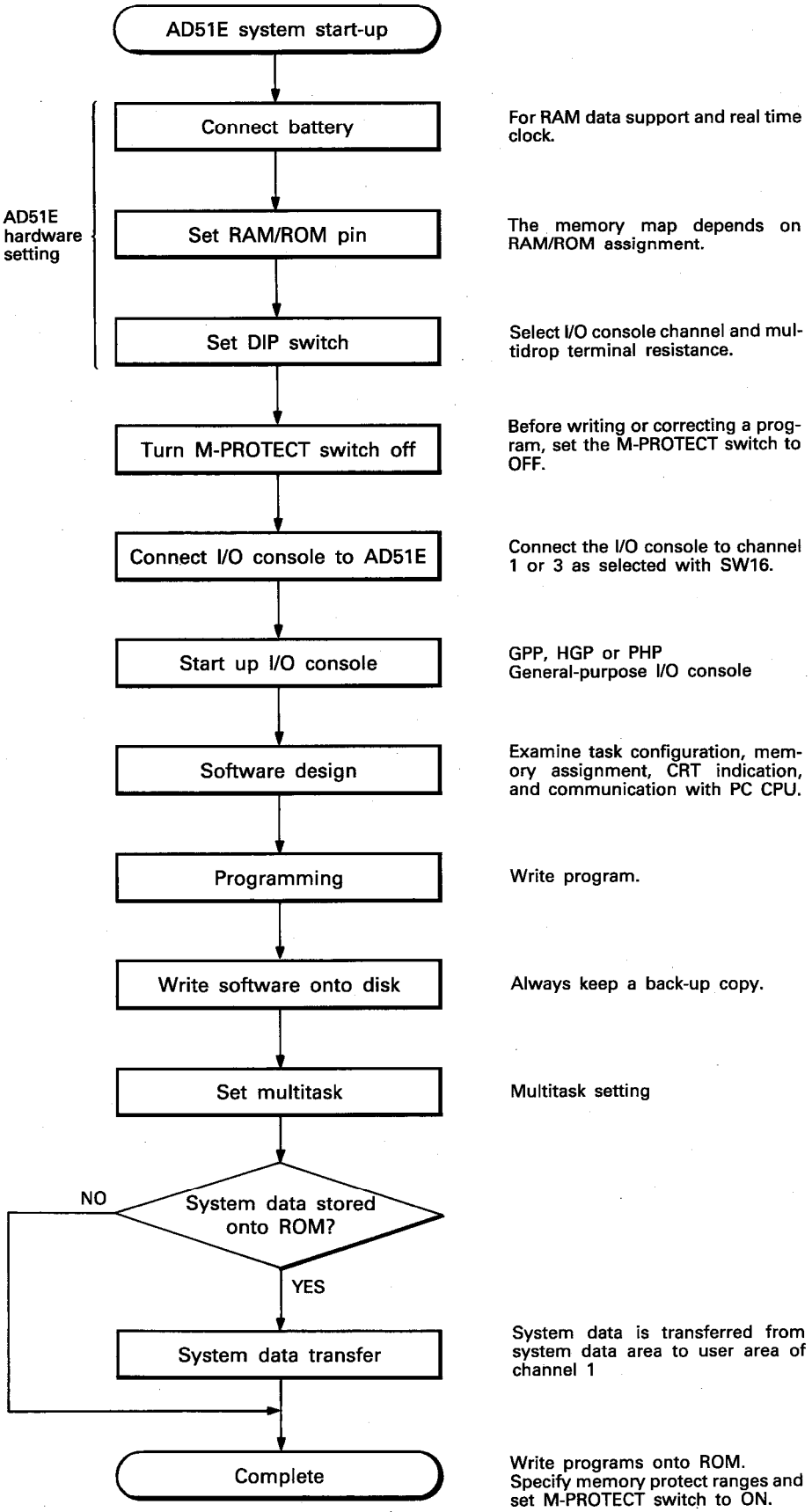
Performs communication control using the Xon code (11_H) and Xoff code (13_H).

(a) Transmission is stopped when the Xoff code is received during transmission of data from the transmission buffer to the external device.
Transmission is resumed when the Xon code is received.

(b) When the receive buffer empty area is reduced to 7 bytes or less, the AD51 sends the Xoff code to alert the external device to receive disable.
The AD51 sends the Xon code to notify the external device of receive enable when the empty area increases to 32 bytes or more after the receive command (INPUT, INKEY, SRB) is executed in the user program.

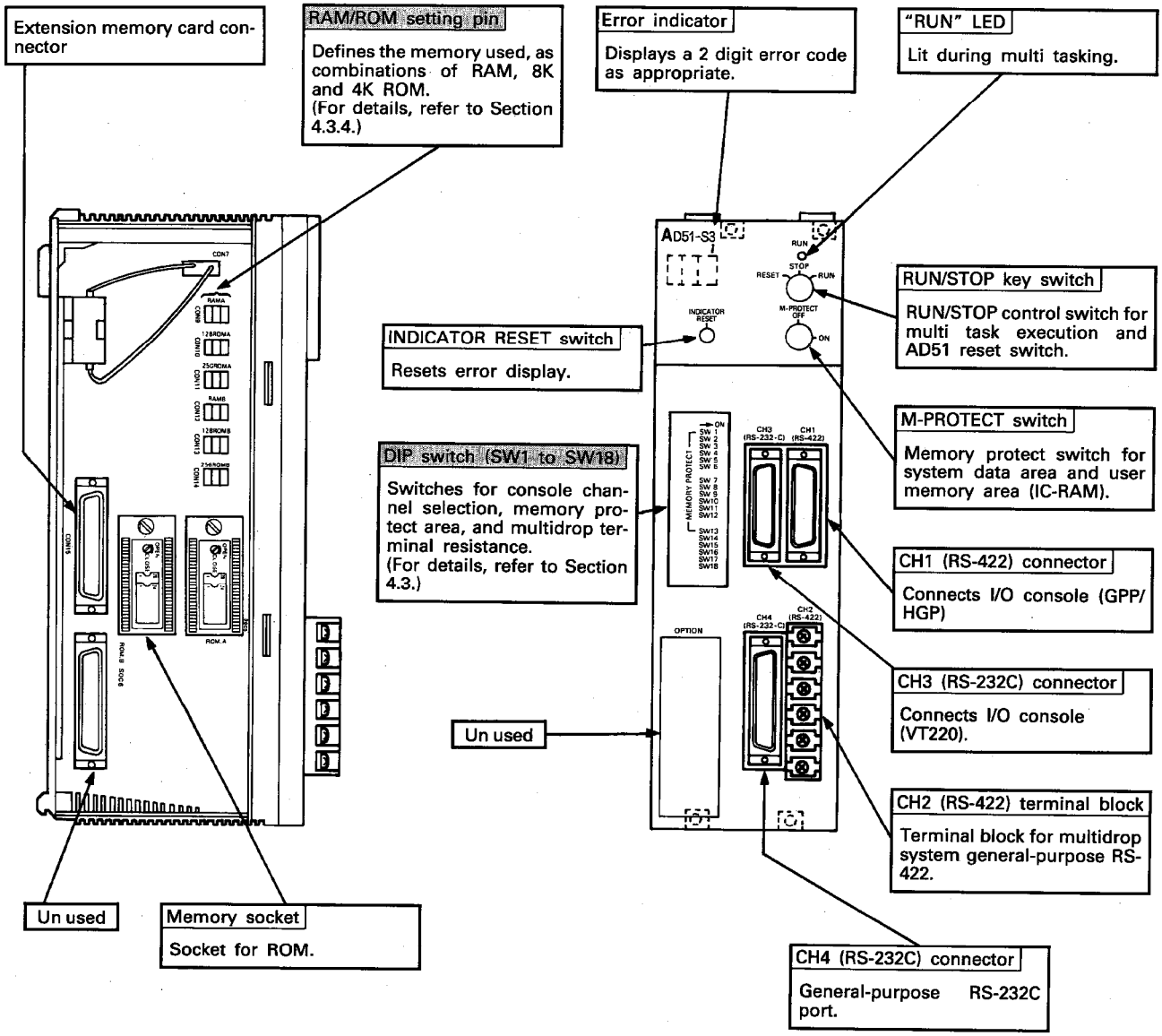
4. PRE-START UP PROCEDURES

4.1 General Procedure



4.2 Nomenclature

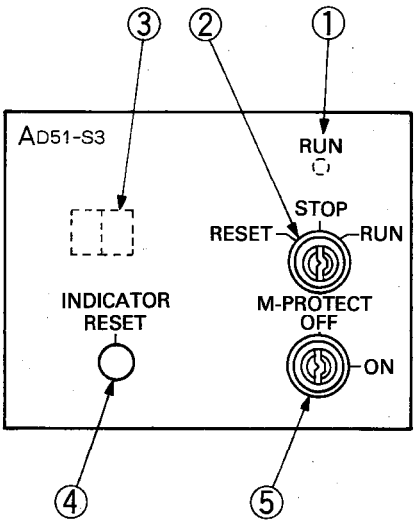
For the setting switches, refer to Section 4.3.



REMARKS

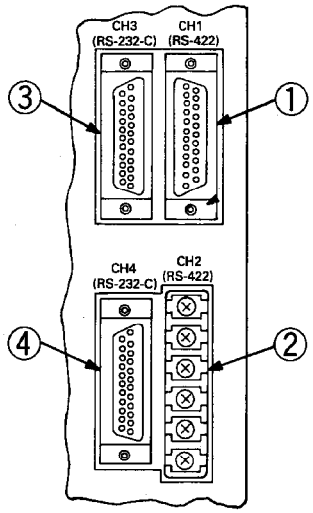
It is necessary to set or load [redacted] before starting operation.

(1) Switch details



①	"RUN" LED On·····During multi tasking Off·····AD51 is not multi tasking. (Will remain off when a single task is RUN.)
②	"RUN-STOP-RESET" switch RUN/STOP····· • Set to RUN to enable multi tasking to be started from the input console. • Set to RUN to enable a single task to be started by typing RUN during BASIC programming, debugging etc. • Set to STOP to stop program execution. RESET·····Used to reset an error or to initialize multi tasking.
③	Error indicator Displays a 2 digit error code as appropriate.
④	"INDICATOR RESET" switch • Resets the error code display after the error has been removed. The error code will remain if the error has not been cleared. • When several errors have occurred, pressing the reset switch will display consecutive error numbers in the order that they occured.
⑤	"M-PROTECT" switch • Memory protect for system data (the data entered during multi task setting and BASIC programming) and the user memory. • The memory protect range depends on the DIP switch settings on the front of the unit. For DIP switch details, refer to Section 4.3.

(2) Connector details



①	CH1 (RS-422) connector Set DIP switch SW16 ON to use this port for programming with the GPP/HGP. Set DIP switch SW16 OFF, to use this connector as a general-purpose port.
②	CH2 (RS-422) terminal block The terminal block is provided for use in the AD51 multidrop system. A maximum of 32 AD51 stations may be included in the multidrop link. This connector may also be used as a general-purpose RS-422 port.
③	CH3 (RS-232C) connector Set DIP switch SW16 OFF to use this port for programming with the VT-220 or GPP/HGP set DIP switch SW16 ON to use this connector as a general-purpose port.
④	CH4 (RS-232C) connector General-purpose RS-232C port.

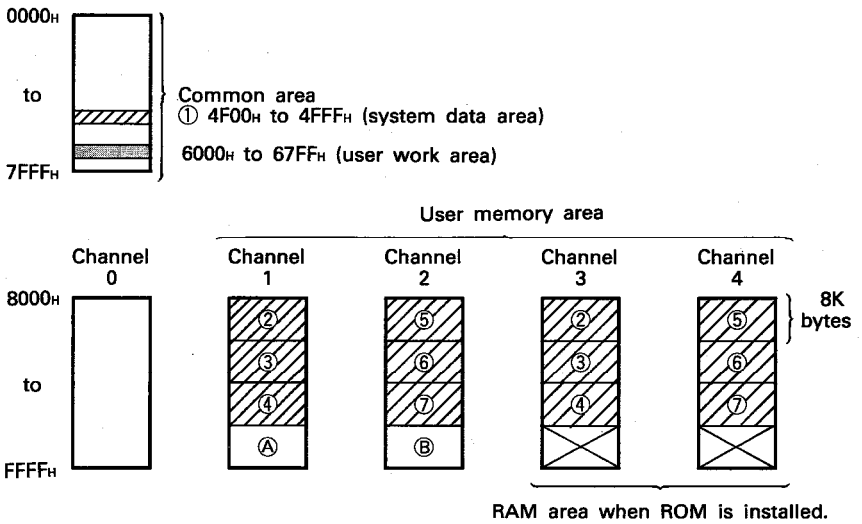
4.3 Hardware Settings

4.3.1 Memory protect range

The maximum user program memory capacity is 114K bytes (48K bytes for ROM + 66K bytes for RAM). 48K bytes of the RAM area may be memory protected in units of 8K bytes.
The system data area (for multi task setting data etc.) may also be memory protected.
To set memory protection to the required area, use the DIP switches on the front of the unit as described below:

(1) Memory protect area

Areas marked ▨ in the memory maps below can be memory protected.



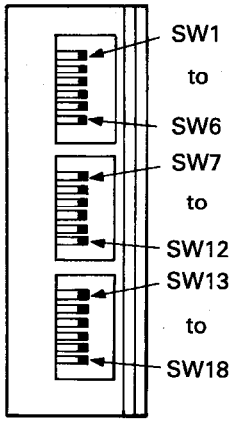
REMARKS

(1) The memory protect DIP switch number is shown as ① to ⑦ in the above memory map.

(2) The memory protect DIP switch numbers for a given RAM address range remain unchanged when ROM is loaded although the channel number has changed from channel 1 to 2 or from 3 to 4.

(2) Memory protect range

Protected RAM address ranges are shown below. The DIP switch is on when the lever points to the right, this is marked on the switch cover.

Division	DIP Switch Details	Switch Number	Memory Protect Range		
			Memory channel		Memory address
			For RAM only	ROM loaded	
①		SW1	Common area		4F00H to 4FFFH
②		SW2	1	3	8000H to 9FFFH
③		SW3	1	3	A000H to BFFFH
④		SW4	1	3	C000H to DFFFH
⑤		SW5	2	4	8000H to 9FFFH
⑥		SW6	2	4	A000H to BFFFH
⑦		SW7	2	4	C000H to DFFFH
Unused		SW8	Unused		
		SW9			
		SW10			
		SW11			
		SW12			
		SW13			

POINT

(1) BASIC program address data and multi task setting data is stored in the system data area 4F00H to 4FFFH (256 bytes).
Set memory protect with SW1 after starting multi tasking.

(2) SW1 must be set to OFF when the system data area data has been stored to ROM.

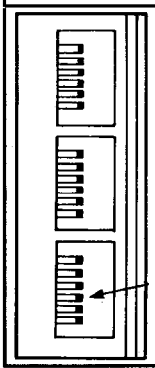
(3) Switching the memory protect key to ON protects all areas defined by the DIP switch settings.

(4) Keep the memory protect switch OFF during BASIC program writing and editing.

(5) The RAM areas marked Ⓐ and Ⓑ on the preceeding page and the user work area cannot be memory protected.

4.3.2 Console channel

DIP switch SW16 determines which of the two channels, CH1 and CH3 is to be used for the programming console.
When the VT-220 is used SW16 should be switched OFF defining CH3 (RS-232C) as the programming console port. When the GPP/HGP is used the switch is generally switched ON defining CH1 (RS-422) as the programming console port. (RS-232C may also be used)

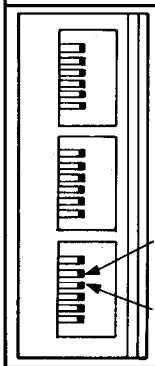
DIP Switch Details	SW16 Position	CH1 (RS-422)	CH3 (RS-232C)
	ON	GPP/HGP	General-purpose port
	OFF	General-purpose port	VT-220 (GPP/HGP)

POINT

The console setting switch is valid after the AD51 is powered up or reset.
When the console setting has been changed, reset the AD51.

4.3.3 Terminal resistor

A terminal resistor is fitted to prevent distortion of the transmission signal waveform. When a number of AD51s are connected together via an RS-422 link, the two end stations should be set with "terminal resistor present", the remainder with "terminal resistance absent." DIP switches SW14 and SW15 are used to set the terminal resistance as shown below.

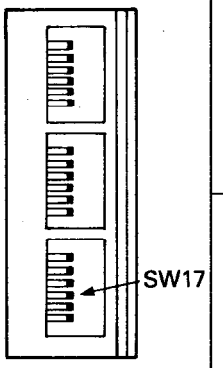
DIP Switch Details	SW14 Position	SW15 Position	Description
	ON	ON	With terminal resistor
	OFF	OFF	Without terminal resistor

POINT

Both switches should be either on or off.

4.3.4 Setting system data transfer

Set the DIP switch SW17 to ON or OFF as indicated below depending on whether or not the system data is transferred from the ROM of channel 1 to the system data area at power on.

DIP Switch	SW17 Position	8000H to 8004H Data	Description
	ON	Specific pattern	System data is transferred from channel 1 addresses 8000H to 80FFH to system data area addresses 4F00H to 4FFFH.
		Unspecific pattern	Not transferred.
	OFF	Specific pattern	Not transferred.
		Unspecific pattern	Not transferred.

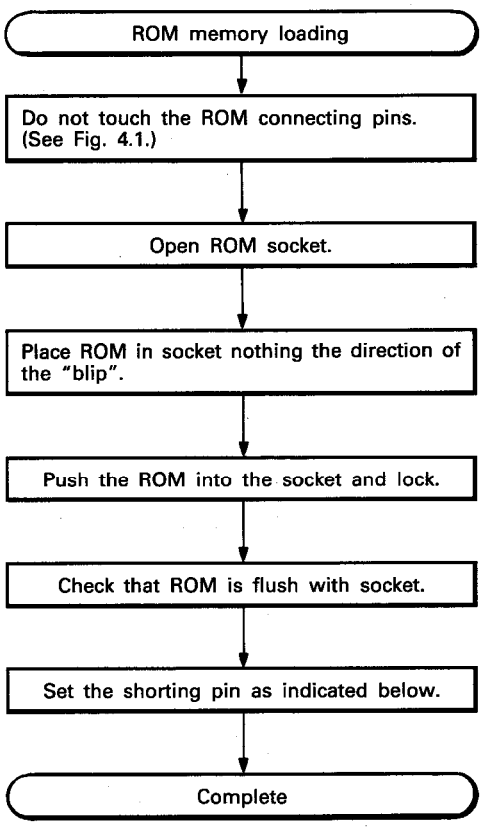
When the system data exists in channel 1 address range 8000H to 80FFH, data in 8000H to 8004H is in a specific pattern to indicate that the system data exists.

POINT

SW17 must be set to ON when the system data has been stored on ROM and set to OFF when not stored on ROM.

4.3.5 ROM installation

This section describes the installation and settings required for using the ROM.
The ROM sockets should be empty if ROM is not being used.



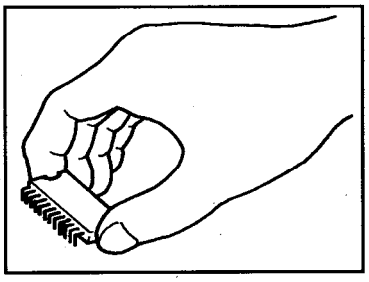


Fig. 4.1 How to Hold ROM

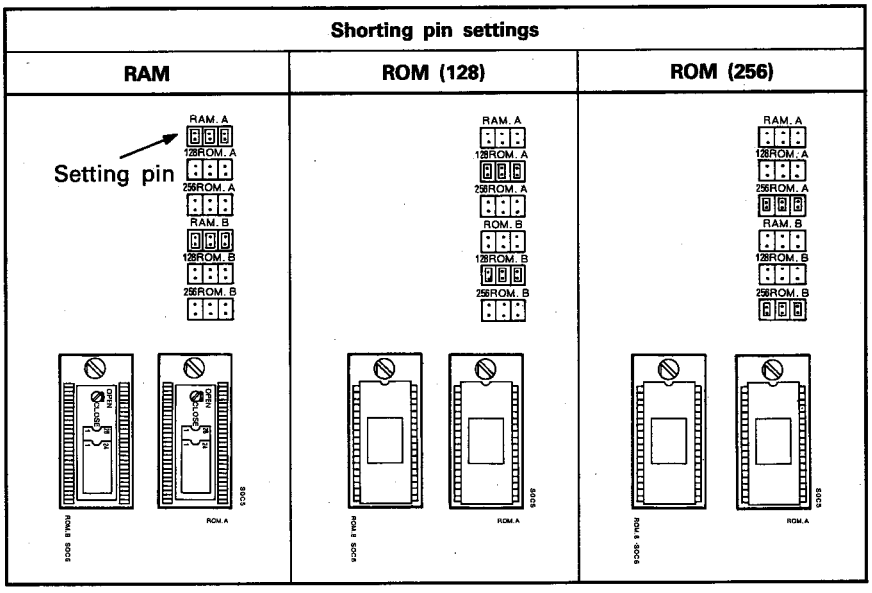


Fig. 4.2 Pin Settings Depending on Memories

IMPORTANT

(1) Before ROM is installed, the shorting pin must be set in accordance with the ROM type used.

(2) After ROM has been installed, setting the shorting pin to RAM may clear the battery backed data.

(3) ROM installation

ROM should be installed after setting the shorting pin in accordance with the ROM type used.

(4) ROM removal

After ROM has been removed, the shorting pin should be set to RAM.

POINT

(1) RAM is built into the unit, there is no need to load RAM into either socket.

(2) The correct direction of the "blip" on the ROM is indicated on the ROM socket.

(3) ROM may be loaded into either socket and ROM sizes (27128, 27256) may be mixed providing the address ranges are noted.

(4) When ROM is installed some RAM address ranges change. (For details, refer to Section 3.4.)

(5) Cover the EPROM window after it has been programmed.

(6) Ensure that ROMs are correctly stored and protected.

(7) Keep the ROM away from static electricity—use anti-static foam where possible.

(8) The shorting pin is factory-set to RAM (RAM.A and RAM.B connectors).

(9) Channel 1 shorting pins are marked RAM.A and channel 2, RAM.B.

4.3.6 Loading the battery

The battery is disconnected before leaving the factory to prevent unneccessary battery consumption. The battery plug should be connected to pins CON7 on the circuit board before the AD51 is used. The red wire is positive and the connector is keyed to prevent wrong connection.

5. WIRING

5.1 Wiring Instructions

All AD51 external wiring should be protected against noise.

(1) Keep cables carrying data at least 100mm(3.94inch) away from main circuit wiring, high voltage cables and PC input and output wiring.

(2) Ground shield wires or cable shields at one point only.

(3) Use M4 solderless terminals for connection to the RS-422 terminal block.

5.2 RS-232C Connection

RS-232C connection

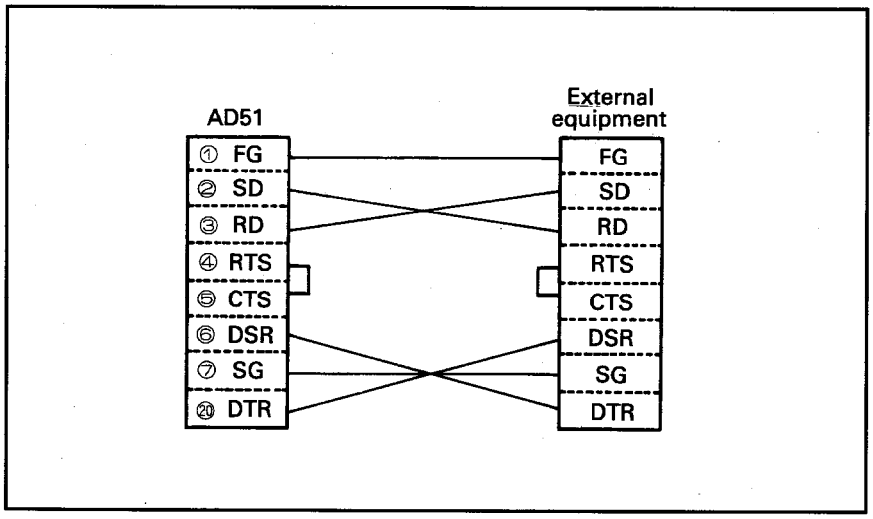


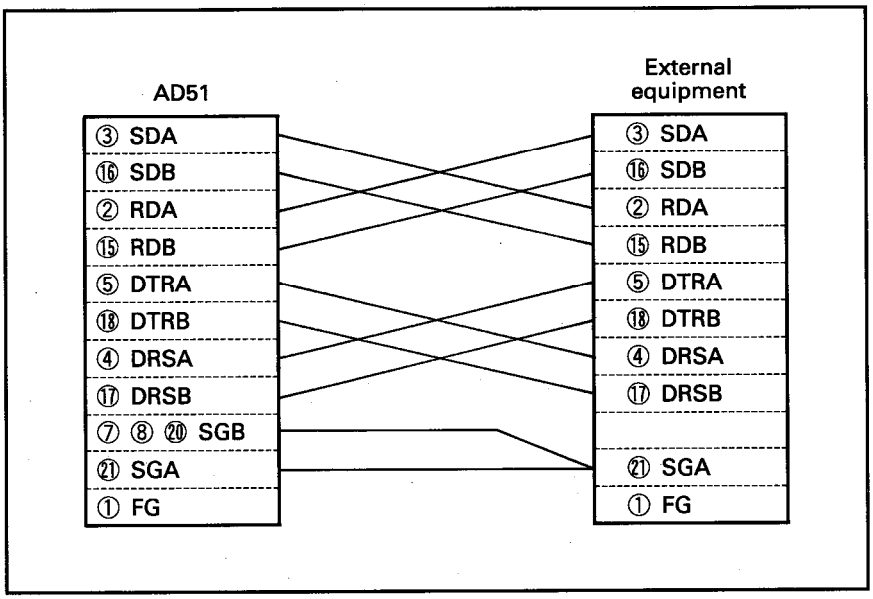
Fig. 5.1 RS-232C Connection Diagram

POINT

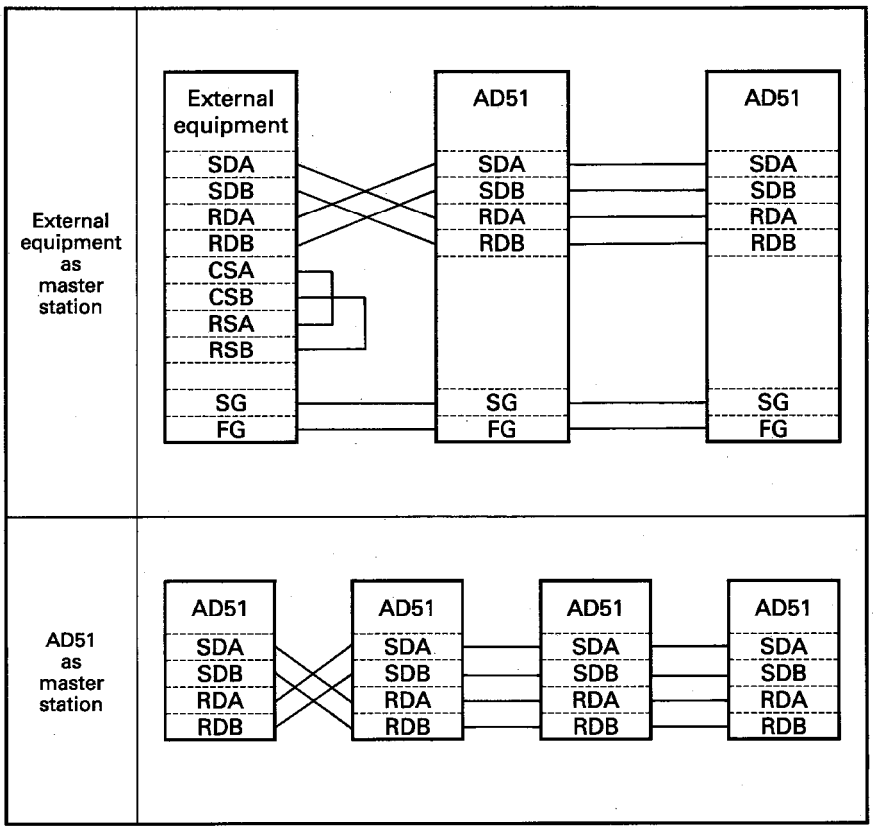
A maximum of 32 stations may be included in the multidrop system with an overall link distance of 500m(547Yd).

5.3 RS-422 Connection

(1) RS-422 connector



(2) RS-422 multidrop connection.



POINT

A maximum of 32 stations may be included in the multidrop system with an overall link distance of 500m(547Yd).

REMARKS

RS-422 multidrop cabling should conform to the following specifications.

Item	Specifications
Cable type	Shielded cable
Conductor resistance (20°C)	88.0Ω/km or less
Insulation resistance	10,000MΩ·km or less
Dielectric strength	500V DC for 1 minute
Electrostatic capacity (1kHz)	60nF/km or less on average
Characteristic impedance (100kHz)	110 ± 10Ω

6. AD51 PROGRAMMING NOTES

6.1 BASIC Program Address Data

The following information must be specified before a GPC-BASIC program can be written: program number, program head address, program last address, additional program head address, work area head address, and channel. For further details on setting the data, refer to AD51 Operating Manual.

REMARKS

The following table indicates the function of each of the addresses. Before the BASIC program can be written a BASIC text area must be defined as well as an interpreter work area. The operating system automatically asigns the additional program head address depending on how much of the BASIC text area is vacant.

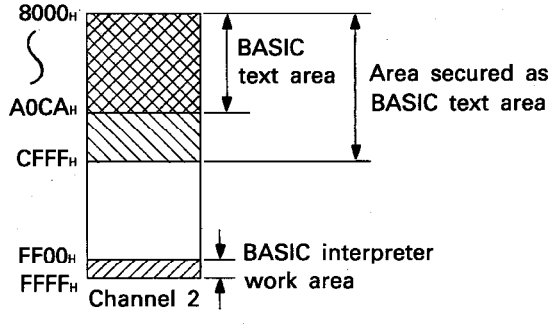
Item	Description
Program number	BASIC text number (1 to 8)
Program head address	The first address of the BASIC text area (8000_H onwards)
Program last address	The last address of the BASIC text area
Additional program head address	Head address of vacant area in BASIC text area. (Automatically set by the O.S.)
Work area head address	Work area used for BASIC interpreter. Fixed to 256 bytes. (Not available for user)
Channel	Channel for the BASIC text

(1) Direct variables (A to Z) are allotted in the BASIC interpreter work area.

(2) Use the address range $D000_H$ to $FEFF_H$ for @ array variables and indirect variables. The hatched areas in the example below may not be used.

Example:
Channel 2 (8000_H to $FFFF_H$) data has been set as follows:

1. Program head address 8000_H
2. Program last address $CFFF_H$
3. Additional program head address $A0CB_H$
4. Work area head address $FF00_H$
5. Channel 2

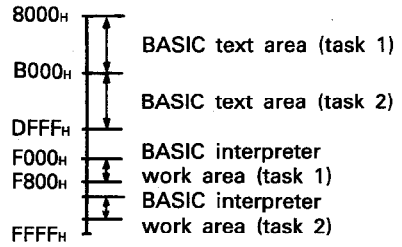
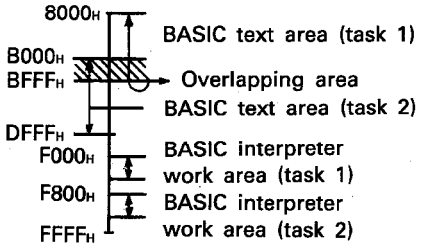
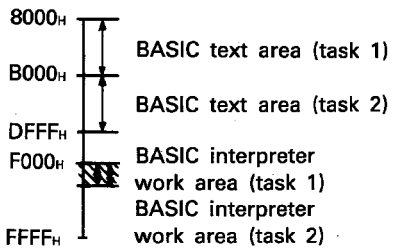


(3) The work area must come after the text area and the work area head address must have 00 in the two least significant digits. 256 bytes are used for the BASIC interpreter work area starting at the work area head address.

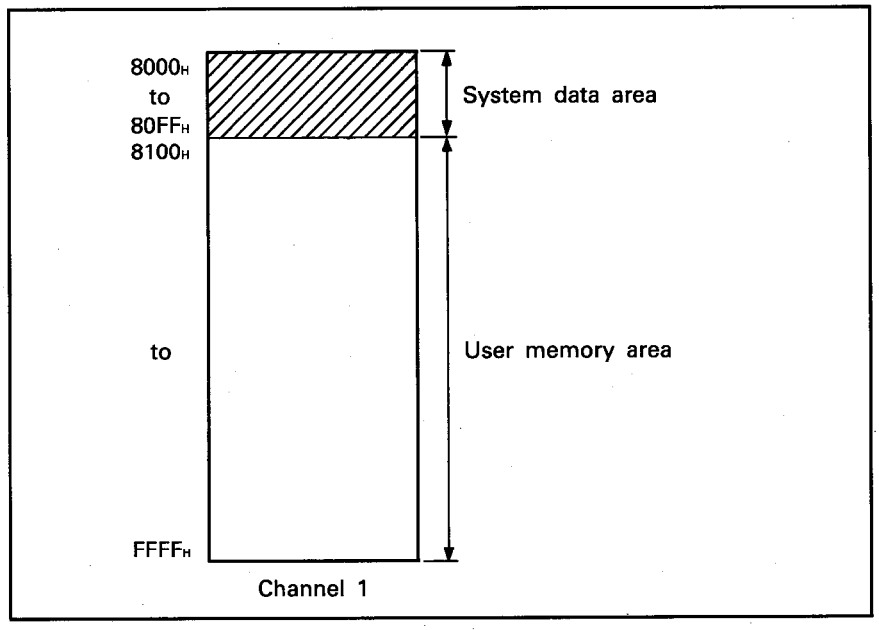
(4) When two or more tasks are written in the same channel make sure that the program areas and BASIC interpreter work areas do not overlap each other.

a) Program data will be corrupted in overlapping memory areas.

b) Multitasking results will be invalid if the BASIC interpreter work area for a given task is overlapped by program data from a different task. Independent running of that task however is valid.

	BASIC Program Addresses	TASK 1	TASK 2	Memory Map
Correct example	Task Program head address Program last address Additional program head address Work area head address Channel	1 8000H AFFFH A74CH F000H 1	2 B000H DFFFH C851H F800H 1	
Over-lapping program area	Task Program head address Program last address Additional program head address Work area head address Channel	1 8000H AFFFH A74CH F000H 1	2 A000H DFFFH B851H F800H 1	
Over-lapping interpreter work area	Task Program head address Program last address Additional program head address Work area head address Channel	1 8000H AFFFH A74CH F000H 1	2 B000H DFFFH C851H F000H 1	

(5) When the system data is stored onto ROM, the program head address must be 8100_H or a subsequent address because addresses 8000_H to $80FF_H$ of channel 1 are used as a system data area.
Setting the program head address between 8000_H and $80FF_H$ will corrupt the BASIC program and disable normal program execution.



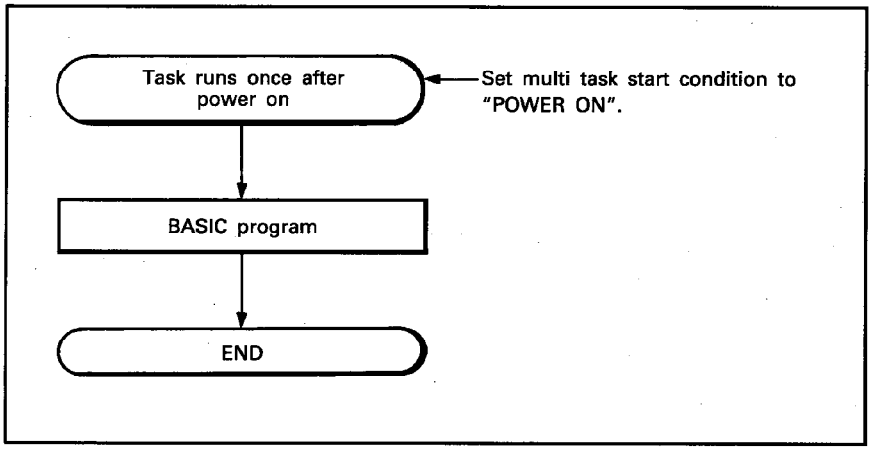
6.2 Start Conditions

There are 4 types of BASIC program execution formats:

(1) Program runs once after power on.
(2) Program runs continuously after power on.
(3) Program runs after an interrupt signal from the PC CPU.
(4) Program runs at preset intervals in real time.

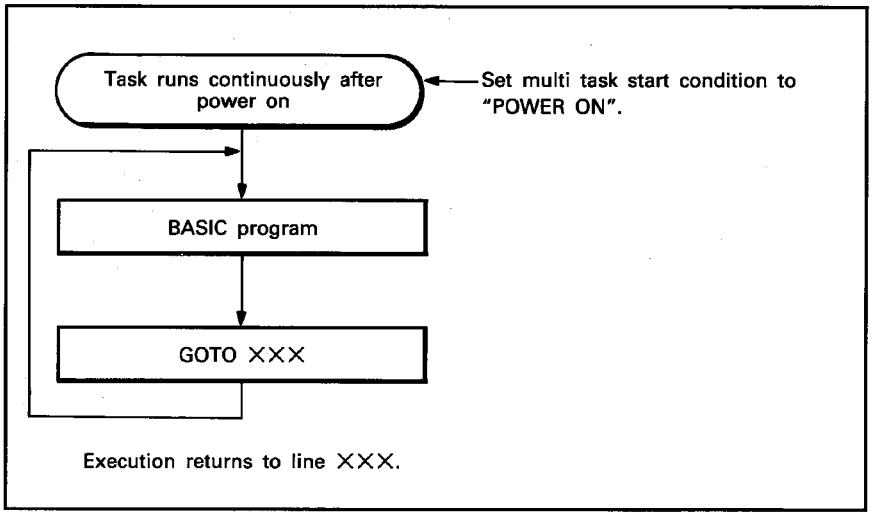
6.2.1 Program runs once after power on

Write the BASIC program so that "END" is executed as the final instruction and set the task start condition to "POWER ON".



6.2.2 Program runs continuously after power on

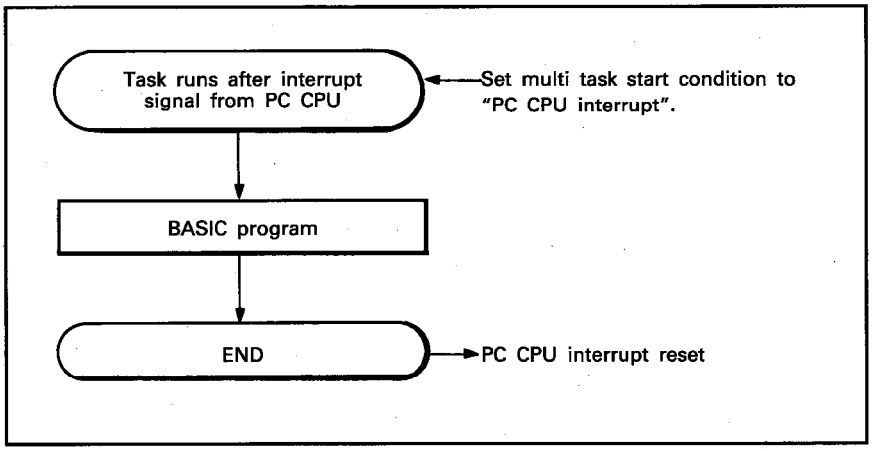
Write the BASIC program using the "GOTO" command to continue program execution and set the task start condition to "POWER ON".



6.2.3 Program runs after an interrupt signal from the PC CPU

Set the task start condition to "CPU INT" (CPU interrupt). The program is then run when the rising edge of the AD51 interrupt signal is received from the PC CPU.
For programming information see Section 7.4.

(1) Write the BASIC program so that "END" is executed as the final instruction. When "END" is executed the AD51 interrupt condition is reset. The interrupt program will not run again until the rising edge of the AD51 interrupt signal is received from the PC CPU.



(2) Only one task may be defined as PC interrupt start. More than one will generally lead to "ORST" error.

6.2.4 Program runs at preset intervals in real time

Select starting condition "REAL TIME INT" (real time interrupt).

The real time interrupt interval (i.e. the time between interrupt signals) should be longer than the total time taken for the interrupt program to reach the END instruction including the time required by other tasks. An "ORST" error is detected if a second real time interrupt signal is given before the interrupt program has executed its END command.

POINT

For tasks other than the one started by the interrupt signal from the PC CPU (Section 6.2.3), any system subroutine must not be executed to access the PC CPU within five seconds after the PC CPU is run.
A PC down error will occur if the system subroutine is executed within five seconds.

6.3 Notes on the Use of BASIC Commands

6.3.1 Key input commands

Key inputs (INPUT and INKEY commands) to the AD51 via one channel (as specified by the ZIDV command) should only be made to one task.
Since tasks are executed in order of task numbers, any data keyed in to a task can only be read at certain intervals. If a key is pressed and more than one task is waiting for data from the specified channel, only the first task to execute the INKEY or INPUT instruction will read the key input.
The other tasks will then continue waiting until a key is pressed while they are being run.

Task 1		Task 2	
100	REM "TASK 1"	100	REM "TASK 2"
	to		to
200	ZIDV 1	500	ZIDV 1
210	A=INKEY	510	B=INKEY
	to		to

Example: When both task 1 and task 2 are waiting for key input from channel 1, pressing a key will only write data to one of variables A or B.

6.3.2 Printing commands

The printing commands are "PRINT" and "LPRINT".

(1) Difference between PRINT and LPRINT commands

[PRINT]

Used when the printer is connected to the console channel (channel 1 or 3 set with DIP switch 16) or the channel specified with ZODV.

[LPRINT]

Used when the printer is connected to the channel specified in the printer setting.

(2) Sharing of a single printer between tasks.

When several tasks are sharing the use of a printer ensure that interlock flags are provided in the work area to prevent two or more tasks attempting to access the printer simultaneously.

(3) Note that with printers that use the CR code ($0D_H$) to initiate printing (K6PRE, K7PRE etc.), writing a comma (,) after the statement in the PRINT or LPRINT command, stops the AD51 from sending the CR code.
Printing is therefore not initiated.

(4)Notes on the use of the KD51PR

The KD51PR may be connected to either of the two AD51 RS-232C ports. When using the KD51PR note the following:

(a) The KD51PR will print "?" if data is sent from the AD51 while it is printing or during paper feed. This may be avoided by using the program shown in Example 2.
Example 1 shows a program which repeatedly prints the letters "ABCDE" and the resultant KD51PR print out.

[Example 1]

Use of KD51PR in "2K buffer OFF, buffer full set" mode

BASIC program

```
100 LPRINT "ABCDE"
110 LPRINT ✳ $ 03;
120 GOTO 100
```

Print data and control codes (CR code, LF code) are sent from AD51.

Print control code 03_H is sent from AD51.

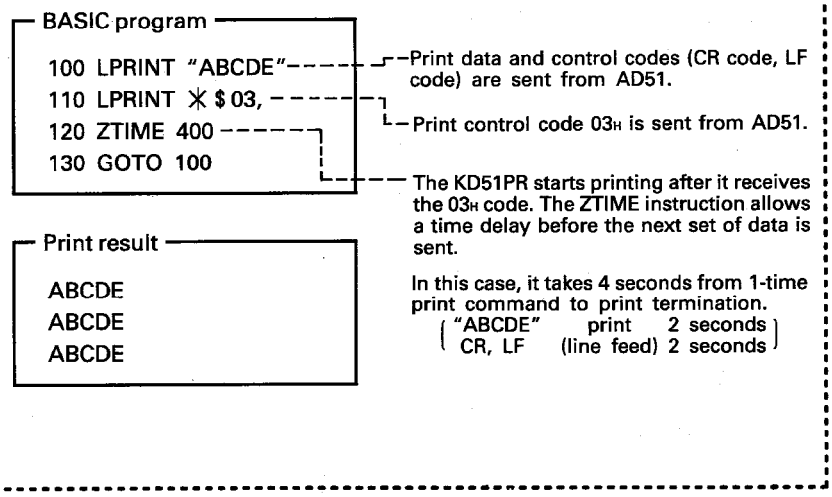
Upon execution of line 120, execution returns to line 100. Data is continuously written to the KD51PR while it is still printing.

Print result

```
ABCDE
?A?B?D?
?
?E?
?E??D?
?D?E??A?C?E?
```

[Example 2]

KD51PR setting ····· 2K buffer ON, buffer full set



(b) When the 2K buffer is set to OFF in the KD51PR, any string of characters sent which is more than one line long will lead to an overrun error when the LF code is given. (The receive buffer is 32 characters long). See below:

```
100 LPRINT "ABCDEFGHIJKLMNOPQRSTUVWXYZABCDEF"
           └──────────〈32 characters〉──────────┘
```

To overcome this, write a comma (,) after the PRINT statement to stop the LF code from being given as below:

```
100 LPRINT "ABCDEFGHIJKLMNOPQRSTUVWXYZABCDEF,"
```

6.3.3 CRT display commands

Any commands addressed to a CRT on a given channel should come from one task only.
There is no management of display commands between tasks.

[CRT display commands]

CLS, ZCON, ZCOFF, ZNOR, ZCRV, PRINT, LOCATE

POINT

Any program controlling the display on one CRT should be written in one task only.

6.3.4 OPEN and CLOSE commands

Note the following precautions when using the OPEN and CLOSE commands.

(1) The channel specified as that for the console by DIP switch SW16 and the channel selected for the printer on the printer setting screen are automatically opened by the AD51 OS. The communication mode for other channels must be set in the user program using the OPEN command. These two channels default to closed.

(2) The OPEN command is used to specify the communication control at the RS-232C or RS-422 port. It also initializes the AD51 send and receive buffers.
Executing this command therefore re-defines the communication mode for the specified port and clears both AD51 buffers at that port.

(3) The CLOSE command initializes the AD51 communication control and buffers in the same way as the OPEN command however in this case the port is left in a read/write disable state.

POINT

Before using the CLOSE command, ensure that the transmit buffer is empty be using subroutine "STC". Data will be lost if the buffer is initialized while it still contains data.

(4) OPEN and CLOSE commands are common to all tasks. Therefore, any channel opened by one task can be used in subsequent tasks without having to repeat the OPEN command.

6.3.5 Z commands

The ZMOV, ZRD1, ZRD2, ZWR1 and ZWR2 commands are not available for AD51, PC CPU transactions.
Access to the PC CPU data is via system subroutines.
For details refer to Section 3.2.2.

6.4 Transmission Commands to External Device

The PRINT, LPRINT and SWB commands are used to transmit data from AD51's RS-422 or RS-232C to the external device.

POINT

Any transmission command is complete when transmission data is stored to the transmission buffer.
Use system subroutine STC to check that the transmission data has been sent to the external device.

6.4.1 PRINT command

(1) The channel used is determined by the console channel (set with DIP switch 16) or ZODV command.

(2) Data transmitted depends on the PRINT command designation form as described below:

Designation	Processing
Expression (variable)	Value of expression (variable) is converted into a 6-digit decimal ASCII code and transmitted to the external device.
$ expression (variable)	Value of expression (variable) is converted into a 4-digit hexadecimal ASCII code and transmitted to the external device.
? expression (variable)	Value of expression (variable) is converted into a 2-digit hexadecimal ASCII code and transmitted to the external device.
. expression (variable)	Value of expression (variable) is converted into a real ASCII code and transmitted to the external device.
# expression (variable)	Value of expression (variable) is converted into a decimal ASCII code of specified digits and transmitted to the external device.
✳ expression (variable)	Value of expression (variable) is regarded as an ASCII code and transmitted unchanged to the external device.
(Character string variable)	Data stored in character string variable is regarded as an ASCII code and transmitted unchanged to the external device.

(3) The PRINT command may be used with ASCII codes 00_H to FF_H. Note that 00_H and $0D_H$ are transmitted as indicated below:

When transmission data is 00_H, $0D_H$ is sent.
When transmission data is $0D_H$, $0D_H$ and $0A_H$ are sent.

POINT

The following program should be written when sending $0D_H$ or $0D_H$ and $0A_H$ by the PRINT command.
$0D_H$: PRINT ✳0, $0D_H$, $0A_H$: PRINT ✳$D

6.4.2 LPRINT command

(1) Transmits data from the channel specified on the printer setting screen.
The LPRINT and LLIST commands cannot be used if NOTHING has been selected for the printer type.

(2) Data transmitted in accordance with the LPRINT command designation is as indicated in Section 6.4.1.

(3) Data transmitted by the LPRINT command is as indicated in Section 6.4.1.

(4) The LPRINT command is not controlled on a task basis.

6.4.3 System subroutine SWB

(1) Transmits data of the specified length from the specified channel.

(2) The transmission time can be set in increments of 10ms.
A time-out occurs if transmission is not completed (data is not stored to the transmission buffer) within the transmission period.
The error status and untransmitted data byte length can be read.

(3) Transmission data is stored to the AD51's common area 6000_H to $67FF_H$.
Data in 00_H to FF_H is regarded as an ASCII code and sent unchanged.

6.5 AD51 and PC CPU Reset

The following explains the effects of resetting the AD51 and the PC CPU.

(1) AD51 reset operation

1) The AD51 processes its programs as though the power has been switched on.

With multi task start already set···· Executes multi task.
Without multi task start ····· Displays the mode select menu on the console.

2) All the AD51 general-purpose inputs are switched off.

3) During reset, there is no accessing of the PC CPU.

4) There is no signal by which the PC CPU can know that the AD51 has been reset.

5) Any FROM or TO instructions executed by the PC CPU when the AD51 is reset will be invalidated.

(2) PC CPU reset operation

1) All the AD51 general-purpose outputs are switched off.

2) Resetting the PC CPU disables access by the AD51 to the PC CPU for about five seconds after the PC CPU is set to RUN. If the PC CPU is accessed during this period, "PC DOWN ERROR" or "TIME OUT ERROR" is detected.

6.6 Notes on BASIC Programming

(1) Before making additions or corrections to the BASIC program or changing the program to its final format with the RUN or COMPILE command, set the "M-PROTECT" switch to OFF.

(2) Before executing multi task, remove all STOP and BREAK commands.

(3) Always RUN or COMPILE the BASIC program after it has been completed.
The RUN or COMPILE commands change the program into a format suitable for multitasking. If the program is not formatted the CPU may misoperate. Remember to RUN or COMPILE programs before writing them to ROM.

7. COMMUNICATION WITH PROGRAMMABLE CONTROLLER CPU

The AD51 occupies 48 I/O points and is provided with 13 digital inputs and 10 digital outputs as well as a 3K word buffer memory. The following section describes communication between the PC CPU and the AD51. It is assumed that the AD51 is located at slot 0 and 1 of the main base unit and that any BASIC program is written in channel 1.

7.1 General-Purpose I/O Read/Write

The AD51 can access the general-purpose I/O immediately and continuously using the "PEEK" and "POKE" commands. This eliminates the need to use the data memory read/write system subroutines which are only processed when the "END" or "COM" instruction is executed in the PC CPU.
Output Y29 from the PC CPU can be used as an interrupt signal to the AD51, see Section 7.9.

7.1.1 General-purpose I/O addresses

The general-purpose I/O assigned to the AD51 are accessed via the following addresses in the user work area:

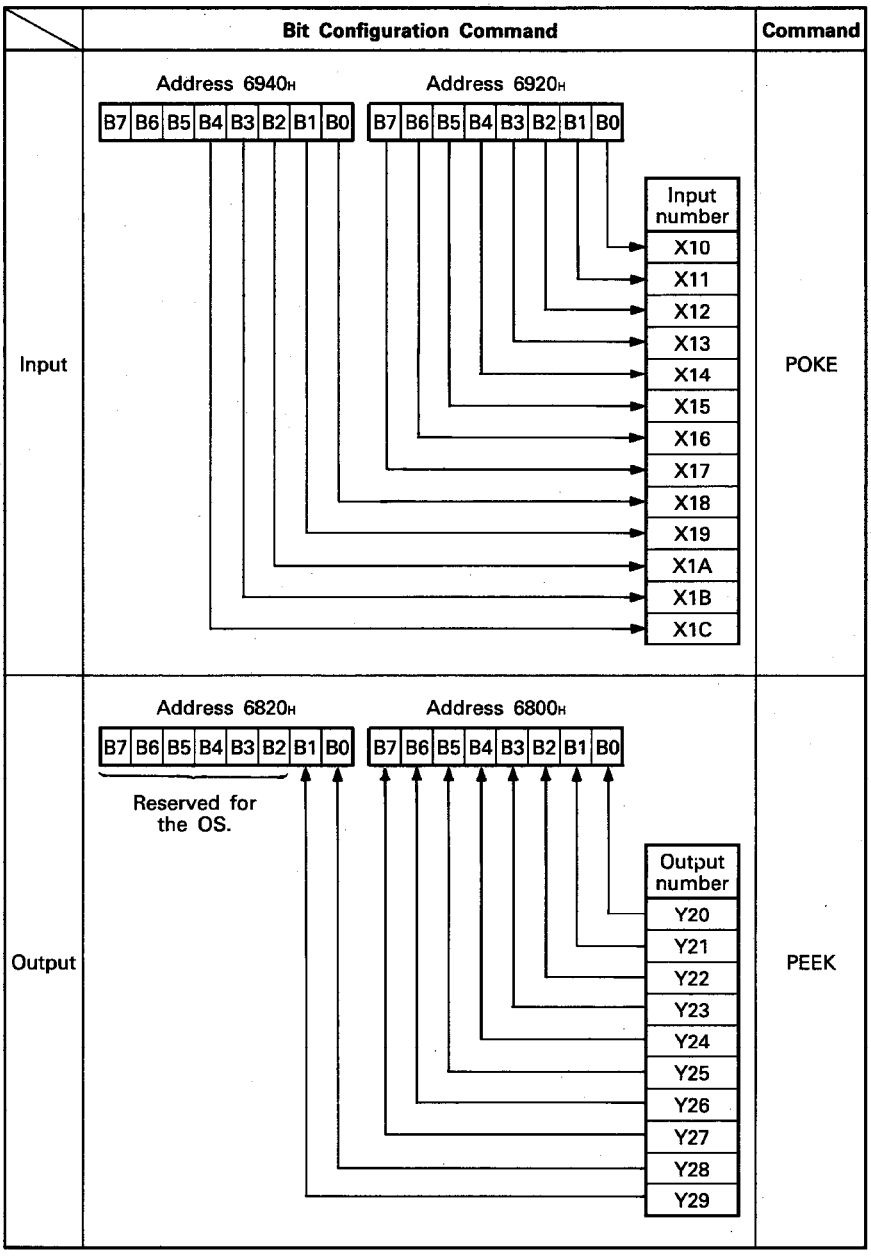
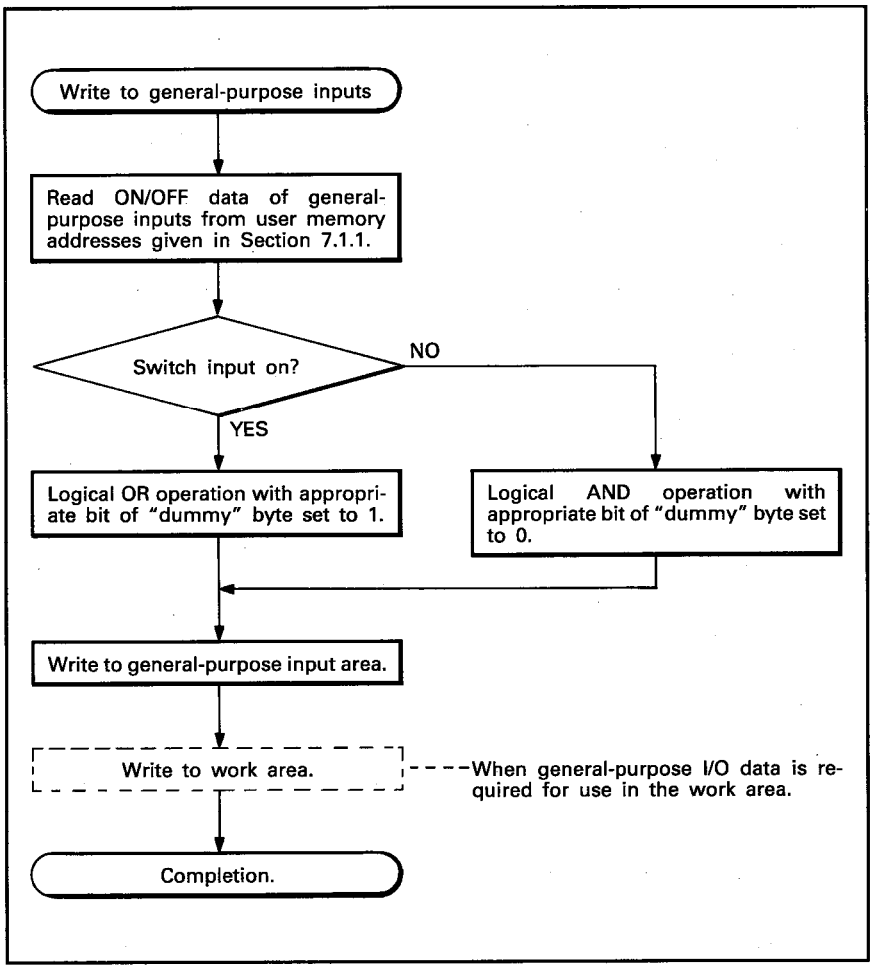


Table 7.1 General-Purpose I/O Data Configuration

7.1.2 Write to general-purpose input

To wrote to a specified general-purpose input the appropriate bit in the relevant byte of memory must be set or reset. The memory addresses for general-purpose inputs and outputs are given in Section 7.1.1.
This section describes the direct accessing of general-purpose I/O data using the PEEK and POKE commands. The system subroutine "SADR" may also be used to access this data but system subroutines are only processed after the "END" or "COM" instruction has been executed in the PC CPU.



[Program example]

Inputs X13 and X1B are turned on and off respectively and the resultant on/off condition is stored in head addresses 6000_H and 6001_H.

(1) Program to switch on X13

```
100 A=PEEK( $ 6000)·····  Reads address 6000H from the common area (This
                          byte is all '0's).
110 B=A! $ 08 ·····       Executes a logical OR operation with address
                          6000H and a "dummy" byte containing the binary
                          representation of 8 as follow:
```

	Bit pattern
Address 6000_H	00000000
8_2	00001000
OR result	00001000

The result is written to variable B.

```
120 POKE $ 6920, B ····   Variable B is written to address 6920H (i.e. the
                          user work area reserved for accessing the gener-
                          al-purpose I/O).
130 POKE $ 6000, B ····   The result is also written to address 6000H.
140 END
```

(2) Program to switch off X1B

```
100 A=PEEK( $ 6001)·····  Reads address 6001H from the common area (This
                          byte is all '0's).
110 B=A&* $ F7 ·····      Executes a logical AND operation with address
                          6000H and a dummy byte containing the binary
                          representation of F7 as follows:
```

	Bit pattern
Address 6000_H	00000000
$F7_2$	11110111
AND result	00000000

The result is written into variable B.

```
120 POKE $ 6940, B ····   Variable B is written to address 6940H (i.e. the
                          user work area reserved for accessing the gener-
                          al-purpose I/O).
130 POKE $ 6001, B ····   The result is also written to address 6001H.
140 END
```

POINT

***: X1D to 1F cannot be turned on/off in the BASIC program. The value marked * in line 110 of (2) may also be 17_H (bits 5 to 7 = 0). If AND operation is performed, the same result is obtained.**

7.1.3 Read from general-purpose output

A similar procedure may be used to read the general-purpose outputs using the logical AND operation. The work area addresses are given in Section 7.1.1. Note that bits 2 to 7 of address 6820_H are reserved for the operating system and should be masked.

[Program example]

Program for ON/OFF monitor of Y20 to 27

```
100 A=PEEK( $ 6800)····· Reads address 6800H to variable A.
110 B=1 ····· Variable B set to 1.
120 FOR I=0 TO 7
130 IF (A&B)#0 PRINT "ON" ;
    GOTO 150 ····· Performs AND operation of variable A
                   and variable B, and if relevant bit is on,
                   displays "ON".
140 PRINT "OFF"
150 B=B*2 ····· Shifts the contents of variable B one bit
                to the left.
160 NEXT I
170 END
```

7.2 Read/Write of Buffer Memory

The buffer memory can be accessed by both the BASIC program and the sequence program.
A maximum of 3K words can be transferred with one instruction.

7.2.1 Read/write with BASIC program

The following system subroutines are used to access the buffer memory.
For details refer to the GPC-BASIC Supplementary Handbook.

Read from buffer memory	SR2
Write to buffer memory	SW2
Read/write retry time	SC2

REMARKS

The buffer memory cannot be accessed by the AD51 if the PC CPU is already executing a FROM or TO instruction. In this case the AD51 will retry communication according to its retry time setting.
The retry time is set at 10ms unless changed using the SC2 system subroutine.

[Program example]

(1) Program to read 256 words from buffer memory head address 200_H to AD51 memory head address $F000_H$.

```
100 A=$E000 ..... Indirect variable head address
110 A(0)=$200 ..... Data source buffer memory head
                    address
120 A(1)=$F000 ..... Data destination head address
130 A(2)=$100 ..... Number of words
140 B=CALL(0, $8000, 1, A) ..... System subroutine SR2 reads buffer
                                 memory.
150 IF B#0 PRINT "ERROR",
    B; GOTO 140 ..... Checks for errors in SR2 execution.
160 END
```

(2) Program to write data from work area addresses $E700_H$ to $E77F_H$ in the BASIC program to buffer memory addresses 350_H to $38F_H$.

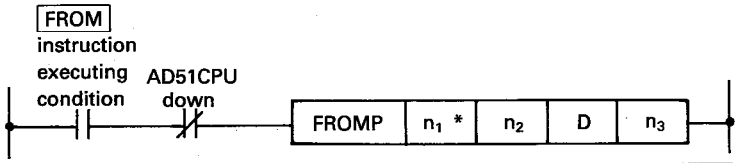
```
100 C=$E100 ..... Indirect variable head address
110 C(0)=$350 ..... Data destination buffer memory head
                    address
120 C(1)=$E700 ..... Data source buffer memory head
                     address
130 C(2)=$40 ..... Number of data words
140 D=CALL(0, $8003, 1, C) ..... System subroutine SW2 writes data to
                                 buffer memory.
150 IF D#0 PRINT "ERROR",
    D; GOTO 140 ..... Checks for errors in SW2 execution.
160 END
```

7.2.2 Read/write with sequence program

Access to the buffer memory from the PC program is via the FROM and TO application instructions.

(1) Read from buffer memory····· FROM, FROMP, DFRO, DFROP instructions

Format



Symbol	Description	Usable Devices
n_1	16th I/O address of the AD51 omitting the least significant digit.	K, H
n_2	Buffer memory head address of data source.	K, H
D	Head device number of data destination.	T, C, D, W, R
n_3	Number of words of data to be read	K, H

POINT

Note that the location specification for the AD51 is different from other special function modules. To specify the slot location use the number representing the 16th I/O point, omitting the "modules". (So for example, I/O point 120_H is represented as 12_H.)
Hence, if the AD51 is located at I/O addresses. X60 to X8F and Y60 to Y8F, n_1 is defined as H7.

[Program example]

Fig. 7.3 shows a program to read the data from buffer addresses 500_H to $54F_H$ to data registers D100 to D179 in the PC CPU. When X13 turns with system configuration shown in Fig. 7.2.

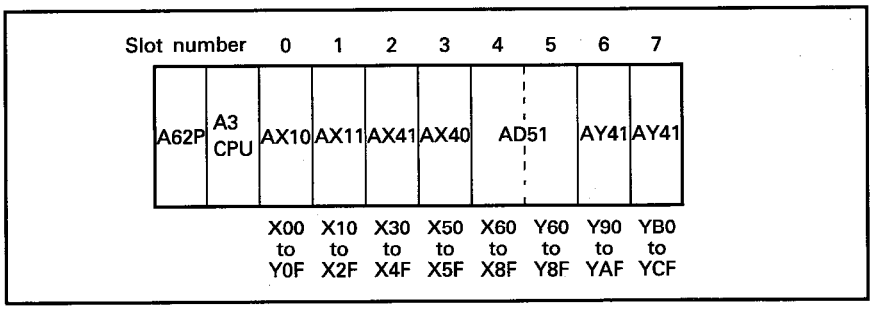


Fig. 7.2 Module Configuration

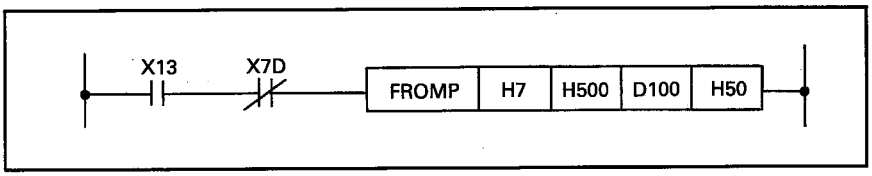
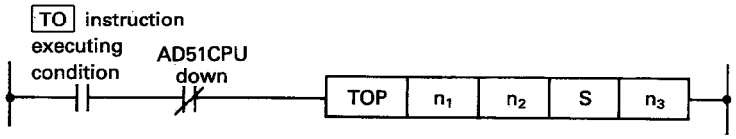


Fig. 7.3 Buffer Memory Read

(2) Write to buffer memory·····[TO], [TOP], [DTO], [DTOP] instructions

[Format]



Symbol	Description	Usable Devices
n_1	16th I/O address of the AD51 omitting the least significant digit.	K, H
n_2	Buffer memory head address of data destination.	K, H
S	Head device number of data source	T, C, D, W, R, K, H
n_3	Number of words of data to be written	K, H

[Program example]

Fig. 7.4 shows a program to write data from PC data registers D200 to D263 to buffer addresses 100_H to $13F_H$ when X1F turns on with the system configuration shown in Fig. 7.2.

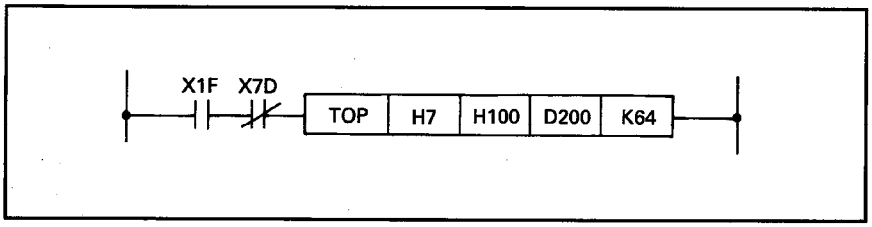


Fig. 7.4 Buffer Memory Write

7.3 Device Memory Read/Write

This section explains how the AD51 communicates with the PC CPU device memory to read present value data and to write new values.

7.3.1 System subroutines and device ranges

The following system subroutines are used by the AD51 to access the PC CPU device memory.

(1) System subroutine types and functions

Item			System Subroutine	Processing	Number of points processed per PC CPU, AD51 transaction.	PC CPU State	
						During STOP	During RUN
Device memory	Batch read	Bit	SADR	Reads data from bit device (such as Y and M) (for 1 point).	256 points	○	○
		Word		Reads data from bit devices (such as Y and M) (for 16 points).	32 words (512 points)		
				Reads data from word device (such as D and R) (for 1 point).	64 points		
	Batch write	Bit	SADW	Write data to bit device (such as Y and M) (for 1 point).	160 points	○	○
		Word		Writes data to bit devices (such as Y and M) (for 16 points).	10 words (160 points)		
				Writes data to word device (such as D and R) (for 1 point).	64 points		
	Test (During random write)	Bit	SADT	Sets/resets any specified bit device (such as Y and M) and device number (for 1 point).	20 points	○	○
		Word		Sets/resets any specified number of blocks of sixteen bit devices (such as Y and M) and device number (for 16 points).	10 words (160 points)		
				Writes data to any specified word device (such as Y and M) and device number (for 1 point).	10 points		
	Monitor data entry	Bit	SADM0	Defines the bit device (such as Y and M) to be monitored (for 1 point).	40 points*	○	○
		Word		Defines the bit devices (such as Y and M) to be monitored (for 16 points).	20 words* (320 points)		
				Defines the word device (such as D and R) to be monitored (for 1 point).	20 points		
	Monitor	Bit	SADM1	Monitors the device specified in monitor data entry.		○	○
		Word					

Table 7.2 System Subroutines and Functions

Key, ○ : indicates available.

*: When the A1(E), A2(E), A3(E), A1N, A2N or A3NCPU is used, half the number of points shown above is processed for device X.
When the A0J2 or A3HCPU is used, there is no restriction like above.

(2) Valid device ranges for device memory transactions are given below:
The device range depends on the PC CPU module used. See the corresponding CPU User's Manual.

Bit Devices			Word Devices		
Device	Device number range	Reresented in: Decimal/ Hexadecimal	Device	Device number range	Reresented in: Decimal/ Hexadecimal
Input X	X0000 to X07FF	Hexadecimal	Timer (present value) T	TN000 to TN255	Decimal
Output Y	Y0000 to Y07FF	Hexadecimal	Counter (present value) C	CN000 to CN255	Decimal
Internal relay M	M0000 to M2047	Decimal	Data register D	D0000 to D1023	Decimal
Latch relay L	L0000 to L2047	Decimal	Link register W	W0000 to W03FF	Hexadecimal
Link relay B	B0000 to B03FF	Hexadecimal	File register R	R0000 to R8191	Decimal
Step relay S	S0000 to S2047	Decimal	Special register D	D9000 to D9255	Decimal
Annunciator F	F0000 to F0255				
Special relay M	M9000 to M9255				
Timer (Contact) T	TS000 to TS255				
Timer (Coil) T	TC000 to TC255				
Counter (Contact) C	CS000 to CS255				
Counter (Coil) C	CC000 to CC255				

Table 7.3 Valid Device Ranges

POINT

(1) Bit devices and word devices are differentiated as follows.

Bit device ..... X, Y, M, L, S, B, F, T (contact), T (coil), C (contact), C (coil)
Word device .... T (present value), C (present value), D, W, R

(2) When reading 16 consecutive bit devices as word data, the bit device number must be a multiple of 16.

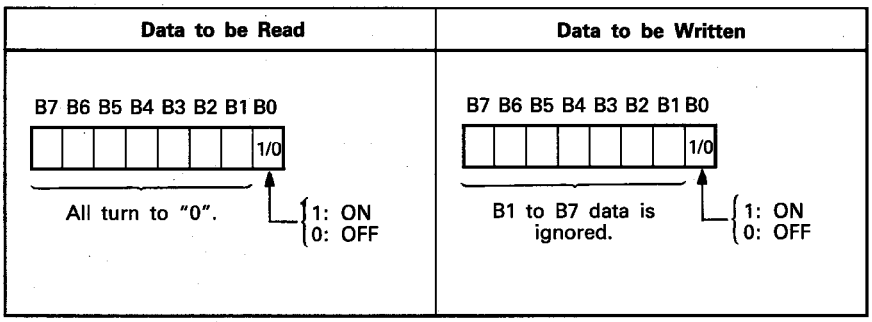
(3) The "0" in the most significant digits of the device number may be specified as spaces (20_H).

(4) M and L ranges are specified in the PC CPU parameters however AD51 device memory transactions regard the two as the same.

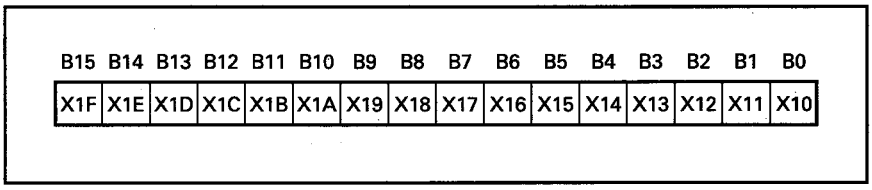
(5) Different device ranges apply when using the AD51 with the A0J2CPU. (See A0J2 Programming Manual)

(3) Bit/word specification

(a) When a system subroutine has been called with "bit" processing specified, one byte of AD51 memory is used per bit. This is illustrated below, the least significant bit indicates the state of the specified bit device for both reading and writing.



(b) When a system subroutine has been called with "word" specified, and bit devices are to be processed (i.e. in batches of 16 devices) then one word of AD51 memory is used per 16 bits.
This is illustrated below. The head device number is X10 and state of this device is indicated by the least significant bit. The states of the next 15 bits are stored in consecutive bits from Bit B1 to Bit B15.



7.3.2 BASIC program examples

This section gives some BASIC program examples which use system subroutines SADR (batch read), SADW (batch write), SADM0 (monitor data entry), SADM1 (monitor), and SADT (test). The program examples use channel 1.
For details of the system subroutines, refer to the GPC-BASIC Handbooks.

(1) Batch read from device memory (SADR)

[Program example 1]

Program to read data from 16 points, X100 to X10F, to AD51 addresses $E000_H$ to $E00F_H$ as individual bits.

```
100 A= $ F000 ..... Head address for system subroutine IN-
                     PUT data.
110 A:0)= $ FF ..... Defines PC station number as host.
120 A:1)="B" ..... Specifies bit read.
130 B= $ F002 ..... Sets indirect variable head address.
140 B $ ="X0100" ..... Sets head device to be read using char-
                     acter string variable.
150 C= $ F007 ..... Sets indirect variable head address.
160 C(0)=16 ..... Sets the number of points to be read as
                     16.
170 C(1)= $ E000 ..... Sets destination head address for data.
180 C(2)=60 ..... Sets time check period to 60 (600msec).
190 Z=CALL(0, $ 807B, 1, A) ..... Calls system subroutine SADR.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SADR execution.
210 END
```

POINT

(1) When specifying the head device using a character string variable, define the number of points to be read after setting the head device.
(Reason: The character string variable overwrites the bits at the end of the data with "0". This would delete the "number of points" data if this was written first.)
For full information, see Section 2.4.4 in the GPC-BASIC Handbook.

(2) The time check period in line 180 should be set in accordance with the "number of scans required for processing" given in Section 3.8 after taking into account any delays which may occur due to other devices accessing the PC CPU.

[Program example 2]

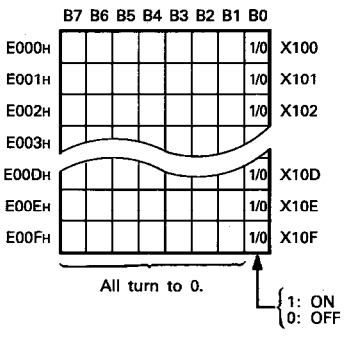
Program to read data from 16 points, X100 to X10F to AD51 addresses $E000_H$ to $E001_H$ in word units. (i.e. batches of 16 bits)

```
100 A=$F000 ..... Head address for system subroutine INPUT data
110 A:0)=$FF ..... Defines PC station number as host.
120 A:1)="W" ..... Specifies word read.
130 B=$F002 ..... Sets indirect variable head address.
140 B$="X0100" ..... Sets head device to be read using character string variable.
150 C=$F007 ..... Sets indirect variable head address.
160 C(0)=1 ..... Sets the number of points to be read as 1.
170 C(1)=$E000 ..... Sets destination head address for data.
180 C(2)=60 ..... Sets time check period to 60 (600msec).
190 Z=CALL(0, $807B, 1, A) ..... Calls system subroutine SADR.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SADR execution.
210 END
```

REMARKS

When "bit read" is specified, one byte of AD51 memory is required per bit of data. When "word read" is specified, one byte of AD51 memory contains 8 bits of data. See below:

Bit Units (Example 1)



Word Units (Example 2)

	B7	B6	B5	B4	B3	B2	B1	B0
$E000_H$	X107	X106	X105	X104	X103	X102	X101	X100
$E001_H$	X10F	X10E	X10D	X10C	X10B	X10A	X109	X108

(2) Batch write to device memory (SADW)

[Program example 1]

Program to write on/off data to Y80 to Y9F from the AD51 as individual bits.

Switch on Y80 to Y8F Switch off Y90 to Y9F

```
100 A=$E800 ..... Head address for system subroutine INPUT data
110 A:0)=$FF ..... Defines PC station number as host.
120 A:1)="B" ..... Specifies bit write.
130 B=$E802 ..... Sets indirect variable head address.
140 B$="Y0080" ..... Sets destination head device using character string variable.
150 C=$E807 ..... Sets indirect variable head address.
160 C(0)=32 ..... Sets the number of points to be written to 32.
170 C(1)=$E000 ..... Sets source data head address.
180 C(2)=30 ..... Sets time check period to 30 (300msec).
190 D=$E000
200 FOR I=0 TO 15
210 D:I)=1 ..... Generates data to be written to addresses E000H to E01FH.
220 D:I+16)=0
230 NEXT I
240 Z+CALL(0, $807E, 1, A) ..... Calls system subroutine SADW.
250 IF Z#0 PRINT "ERROR",
    Z; GOTO 240 ..... Check for errors in SADW execution.
260 END
```

[Program example 2]

Program to write on/off data to Y80 to Y9F from the AD51 as individual bits.

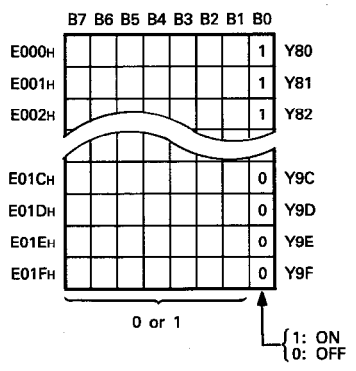
Switch on Y80 to Y8F Switch off Y90 to Y9F

```
100 A=$E800 ..... Head address for system subroutine INPUT data
110 A:0)=$FF ..... Defines PC station number as host.
120 A:1)="W" ..... Specifies word write.
130 B=$E802 ..... Sets indirect variable head address.
140 B$="Y0080" ..... Sets destination head device using character string variable.
150 C=$E807 ..... Sets indirect variable head address.
160 C(0)=2 ..... Sets the number of words to be written to 2.
170 C(1)=$E000 ..... Sets source data head address.
180 C(2)=30 ..... Sets time check period to 30 (300msec).
190 @($E000)=$FFFF
200 @($E002)=0 ..... Generates data to be written to addresses E000H to E003H.
210 Z=CALL(0, $807E, 1, A) ..... Calls system subroutine SADW.
220 IF Z#0 PRINT "ERROR",
    Z; GOTO 210 ..... Checks for errors in SADW execution.
230 END
```

REMARKS

When "bit write" is specified, one byte of AD51 memory is required per bit of data. When "word write" is specified, one byte of AD51 memory contains 8 bits of data. See below:

Bit Units (Example 1)



*Only B0 is valid and B1 to B7 are ignored.

Word Units (Example 2)

	B7	B6	B5	B4	B3	B2	B1	B0
E000H	Y87	U86	Y85	Y84	Y83	Y82	Y81	Y80
E001H	Y8F	Y8E	Y8D	Y8C	Y8B	Y8A	Y89	Y88
E002H	Y97	Y96	Y95	Y94	Y93	Y92	Y91	Y90
E003H	Y9F	Y9E	Y9D	Y9C	Y9B	Y9A	Y99	Y98

(3) Data write to any PC device data memory (SADT)

[Program example 1]

Program to write on/off data to the following random bit devices:

Switch on Y115, switch off M340. Switch off B24C, switch on L875.

```
100 A=$E000 ..... Head address for system subroutine INPUT data
110 FOR I=0 TO 3
120 A(I)=$E100+I*6 ..... Sets character string variable head address for destination device.
130 NEXT I
140 C=$E100 ..... Sets indirect variable head address.
150 A$(0)="Y0115" ..... Sets device name "Y0115".
160 C:5)=1 ..... Source data for Y115.
170 A$(1)="M0340" ..... Sets device name "M0340".
180 C:11)=0 ..... Source data for M340.
190 A$(2)="B024C" ..... Sets device name "B024C".
200 C:17)=0 ..... Source data for B24C.
210 A$(3)="L0875" ..... Sets device name "L0875".
220 C:23)=1 ..... Source data for L875.
230 B=$E200 ..... Sets indirect variable head address.
240 B:0)=$FF ..... Defines PC station number as host.
250 B:1)="B" ..... Specifies "bit write".
260 B(1)=4 ..... Specifies 4 pieces of data to be written.
270 B(2)=$E100 ..... Sets source data head address.
280 B(3)=70 ..... Sets time check period to 70 (700msec).
290 Z=CALL(0, $8081, 1, B) ..... Calls system subroutine SADT.
300 IF Z#0 PRINT "ERROR",
    Z; GOTO 290 ..... Checks for errors in SADT execution.
310 END
```

[Program example 2]

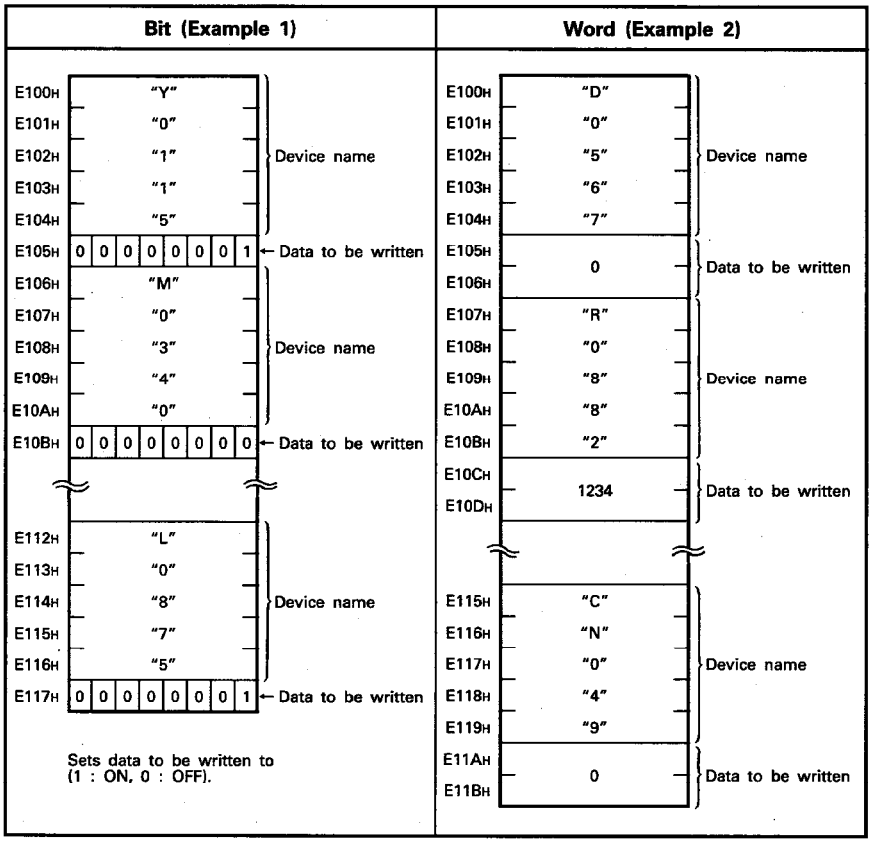
Program to write numerical data to the following random word devices.

D567 ← 0 , R882 ← 1234 W187 ← 751, C49 ← 0

```
100 A=$E000 ..... Sets indirect variable head address.
110 FOR I=0 TO 3
120 A(I)=$E100+I*7 ..... Character string variable head address for destination device.
130 NEXT I
140 C=$E100 ..... Sets indirect variable head address.
150 A$(0)="D0567" ..... Sets device name "D0567".
160 @(C+5)=0 ..... Sets source data for D567.
170 A$(1)="R0882" ..... Sets device name "R0882".
180 @(C+12)=1234 ..... Sets source data for R882.
190 A$(2)="W0187" ..... Sets device name "W0187".
200 @(C+19)=751 ..... Sets source data for W187.
210 A$(3)="CN049" ..... Sets device name "CN049".
220 @(C+26)=0 ..... Sets source data for CN49.
230 B=$E200 ..... Sets indirect variable head address.
240 B:0)=$FF ..... Defines PC station number as host.
250 B:1)="W" ..... Specifies "word write".
260 B(1)=4 ..... Specifies 4 pieces of data to be written.
270 B(2)=$E100 ..... Sets source data head address.
280 B(3)=70 ..... Sets time check period to 70 (700msec).
290 Z=CALL(0, $8081, 1, B) ..... Calls system subroutine SADT.
300 IF Z#0 PRINT "ERROR",
    Z; GOTO 290 ..... Checks for errors in SADT execution.
310 END
```

REMARKS

The data is stored in the AD51 in the following formats depending on whether "bit" or "word" has been specified.



(4) Defining device numbers to be monitored. (Before a given device can be monitored using the SADM1 subroutine, it must be specified and "entered" using the following procedure.)

[Program example 1]

Program to specify the following bit devices for monitoring (i.e. monitor data entry)

X7D , Y201 , M178 B3A0, T46 contact, C85 coil

```
100 A=$F000 ..... Sets indirect variable head address.
110 A$="X007DY0201M0178B03A0TS046CC085" .....
..... Stores device numbers into work area.
120 B=$E800 ..... Sets indirect variable head address.
130 B:0)=$FF ..... Defines PC station number as host.
140 B:1)="B" ..... Specifies "bit entry".
150 C=$E802 ..... Sets indirect variable head address.
160 C(0)=6 ..... Sets the number of points to be entered
                 to 6.
170 C(1)=A ..... Sets "entry" data head address.
180 C(2)=50 ..... Sets time check period to 50 (500msec).
190 Z=CALL(0, $8084, 1, B) ..... Calls system subroutine SADM0.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SADM0 execution.
210 END
```

[Program example 2]

Program to specify the following word devices for monitoring (or bit devices entered as 16 consecutive device numbers).

X60 to X6F, T80 to T95 contacts, C183 present value D260 , W175 , R700

```
100 A=$F000 ..... Sets indirect variable head address.
110 A$="X0060TS080CN183D0260W0175R0700" .....
..... Stores device numbers into work area.
120 B=$E800 ..... Sets indirect variable head address.
130 B:0)=$FF ..... Defines PC station number as host.
140 B:1)="W" ..... Specifies "word entry".
150 C=$E802 ..... Sets indirect variable head address.
160 C(0)=6 ..... Sets the number of points to be entered
                 to 6.
170 C(1)=A ..... Sets "entry" data head address.
180 C(2)=70 ..... Sets time check period to 70 (700msec).
190 Z=CALL(0, $8084, 1, B) ..... Calls system subroutine SADM0.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SADM0 execution.
210 END
```

POINT

The SADM0 system subroutine (Monitor data entry) is used for both bit and word device and, once entered, is valid for all tasks. These system subroutine enter the devices specified into the OS area where they remain valid until new ones are entered.

(5) Monitoring of devices (SADM1) specified by the monitor data entry (SADM0)

[Program example 1]

Program to specify and monitor the following bit devices:

X7D , Y201 , M178 B3A0, T46 contact, C85 coil

```
100 A=$F000 ..... Sets indirect variable head address.
110 A$="X007DY0201M0178B03A0TS046CC085" .....
..... Stores device numbers into work area.
120 B=$E800 ..... Sets indirect variable head address.
130 B:0)=$FF ..... Defines PC station number as host.
140 B:1)="B" ..... Specifies "bit entry".
150 C=$E802 ..... Sets indirect variable head address.
160 C(0)=6 ..... Sets the number of points to be entered
                 to 6.
170 C(1)=A ..... Sets "entry data" head address.
180 C(2)=50 ..... Sets time check period to 50 (500msec).
190 Z=CALL(0, $8084, 1, B) ..... Calls system subroutine SADM0.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SADM0 execution.
210 D=$E900 ..... Sets indirect variable head address.
220 D:0)=$FF ..... Defines PC station number as host.
230 D:1)="B" ..... Specifies "bit monitor".
230 D(1)=$EA00 ..... Data destination head address.
240 D(1)=$EA00 ..... Data destination head address.
250 D(2)=50 ..... Sets time check period to 50 (500msec).
260 Z=CALL(0, $8087, 1, D) ..... Calls system subroutine SADM1.
270 IF Z#0 PRINT "ERROR",
    Z; GOTO 260 ..... Checks for errors in SADM1 execution.
280 END
```

[Program example 2]

Program to specify and monitor the following bit devices (and bit devices entered as 16 consecutive device numbers).

X60 to X6F, T80 to T95 contacts, C183 present value D260 , W175 , R700

```
100 A=$F000 ..... Sets indirect variable head address.
110 A$="X0060TS080CN183D0260W0175R0700" .....
..... Stores device numbers into work area.
120 B=$E800 ..... Sets indirect variable head address.
130 B:0)=$FF ..... Defines PC station number as host.
140 B:1)="W" ..... Specifies "word entry".
150 C=$E802 ..... Sets indirect variable head address.
160 C(0)=6 ..... Sets the number of points to be entered
                 to 6.
170 C(1)=A ..... Sets "entry" data head address.
180 C(2)=50 ..... Sets time check period to 50 (500msec).
190 Z=CALL(0, $8084, 1, B) ..... Calls system subroutine SADM0.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SADM0 execution.
210 D=$E900 ..... Sets indirect variable head address.
220 D:0)=$FF ..... Defines PC station number as host.
230 D:1)=$57 ..... Specifies "word monitor".
240 D(1)=$EA00 ..... Data destination head address.
250 D(2)=50 ..... Sets time check period to 50 (500msec).
260 Z=CALL(0, $8087, 1, D) ..... Calls system subroutine SADM1.
270 IF Z#0 PRINT "ERROR",
    Z; GOTO 260 ..... Checks for errors in SADM1 execution.
280 END
```

REMARKS

The data is stored in the AD51 in the following formats depending on whether "bit" or "word" has been specified.

Bit (Example 1)

	B7	B6	B5	B4	B3	B2	B1	B0	
EA00H								1/0	X7D
EA01H								1/0	Y201
EA02H								1/0	M178
EA03H								1/0	B3A0
EA04H								1/0	T46 contact
EA05H								1/0	C85 coil

Word (Example 2)

	B7	B6	B5	B4	B3	B2	B1	B0	
EA00H	X67	X66	X65	X64	X63	X62	X61	X60	X60 to X6F
EA01H	X6F	X6E	X6D	X6C	X6B	X6A	X69	X68	
EA02H	T87	T86	T85	T84	T83	T82	T81	T80	T80 to T95 contacts
EA03H	T95	T94	T93	T92	T91	T90	T89	T88	
EA04H									C183 present value
EA05H									
EA06H									D260
EA07H									
EA08H									W175
EA09H									
EA0AH									R700
EA0BH									

7.4 Extension File Register Read/Write

The following procedures are used to access the extension file registers from the AD51.

7.4.1 System subroutines and functions

The following system subroutines are used by the AD51 to access the PC CPU extension file registers.

(1) System subroutine types and functions

Item	System Subroutine	Processing	Number of Points Processed per PC CPU, AD51 Transaction	PC CPU State	
				During STOP	During RUN
Batch read	SAER	Reads data from extension file register (for 1 point).	64	○	○
Batch write	SAEW	Writes data to extension file register (for 1 point).		○	○
Test (during random write)	SAET	Writes data to any specified extension file register (for 1 point).	10	○	○
Monitor data entry	SAEM0	Defines the extension file register to be monitored.	20	○	○
Monitor	SAEM1	Monitors the device specified in monitor data entry.		○	○

Key ○ : Indicates available.

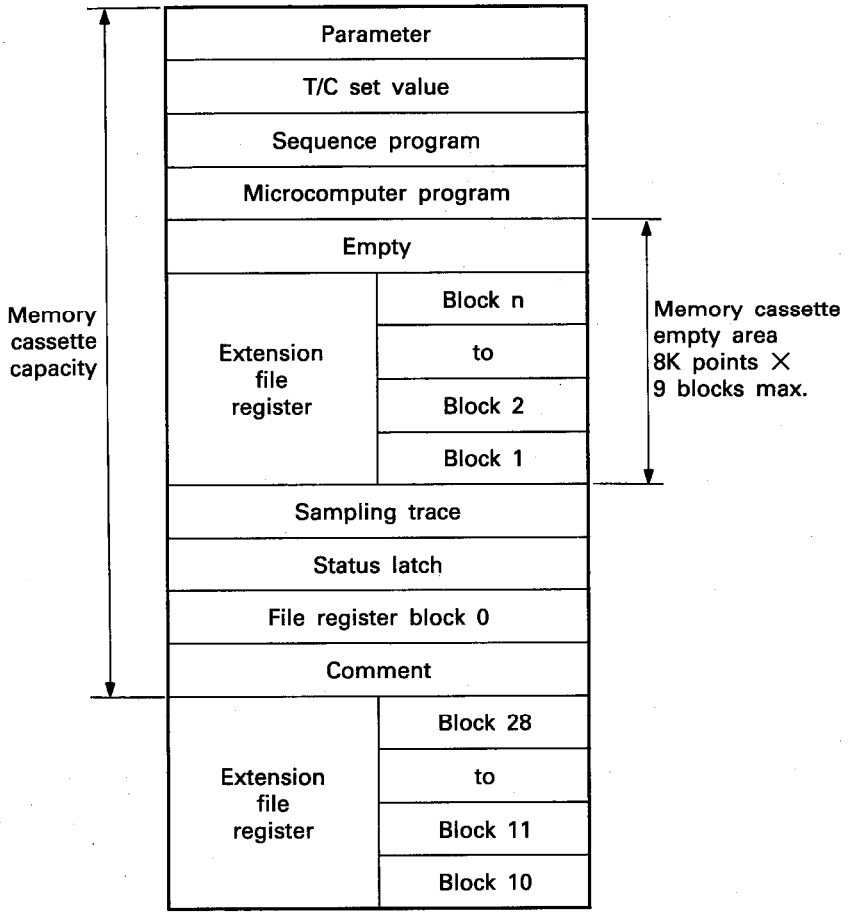
Table 7.4 System Subroutines and Functions

(2) Extension file registers

The empty area of the memory cassette has been defined for use as extension file registers in groups of 8K points (16K bytes).
To use this area as extension file registers, the SW□GHP-UTLPC-FN1 utility program must be stored to the microcomputer program area of the memory cassette.
The utility program automatically defines the empty area in blocks of 8K points as extension file registers.
For full information on the utility program, see the SW□GHP-UTLP-FN1 Operating Manual.

(3) Extension file register block numbers

When the empty area is defined as extension file registers, block numbers are automatically allocated in groups of 8K points in accordance with the used CPU, memory cassette, program capacity, etc. as shown below:



For more information, see Section 4.8.2 in the SW□GHP-UTLP-FN1 Operating Manual.

(4) Valid block numbers

The following block numbers may be used in accordance with the memory cassette and CPU used.

Memory Cassette Type		Memory Cassette Capacity	Valid Block Numbers (RAM/ROM operation)			Invalid Block Numbers
			A2N, A3NCPU	A3HCPU	A2(E), A3(E)CPU	
A3NMCA-0	A3MCA-0	16K bytes	Invalid	Invalid	Invalid	
A3NMCA-2	A3MCA-2	16K bytes	Invalid	Invalid	Invalid	
A3NMCA-4	A3MCA-4	32K bytes	Block 1 only	Block 1 only	Block 1 only	
A3NMCA-8	A3MCA-8	64K bytes	Up to block 3	Up to block 3	Up to block 3	
———	A3MCA-12	96K bytes	Up to block 5	Up to block 5	Up to block 5	Blocks 10, 11
A3NMCA-16	———	96K bytes	Up to block 5 Blocks 10, 11	Up to block 5 Blocks 10, 11	Up to block 5 Blocks 10, 11	
———	A3MCA-18	144K bytes	Up to block 9	Up to block 9	Up to block 9	Blocks 10 to 28
A3NMCA-24	———	144K bytes	Up to block 9 Blocks 10 to 12	Up to block 9 Blocks 10 to 12	Up to block 9	A2(E), A3(E)CPU : Blocks 10 to 28 A2N, A3NCPU A3HCPU : Blocks 13 to 28
A3NMCA-40	———	144K bytes	Up to block 9 Blocks 10 to 20	Up to block 9 Blocks 10 to 20	Up to block 9	A2(E), A3(E)CPU : Blocks 10 to 28 A2N, A3NCPU A3HCPU : Blocks 21 to 28
A3NMCA-56	———	144K bytes	Up to block 9 Blocks 10 to 20	Up to block 9 Blocks 10 to 20	Up to block 9	A2(E), A3(E)CPU : Blocks 10 to 28 A2N, A3NCPU : Blocks 21 to 28

Table 7.5 Valid Block Numbers

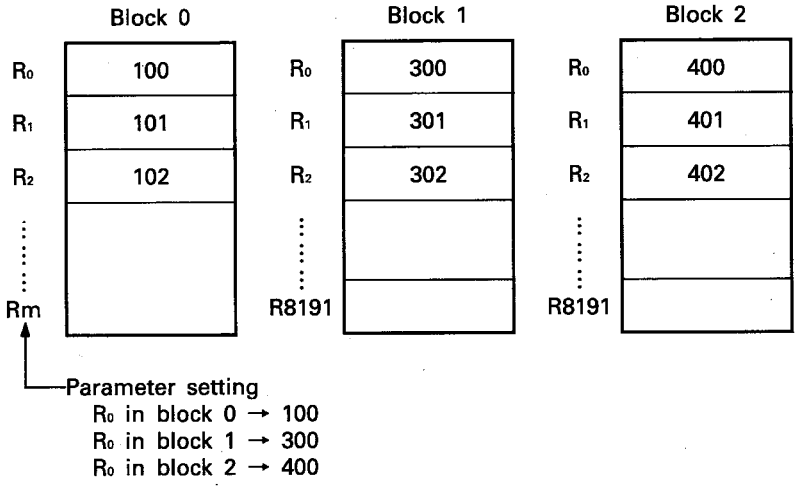
(a) As the A3NMCA-12 is processed as the A3NMCA-16, and the A3NMCA-18, A3NMCA-24 and A3NMCA-40 processed as the A3NMCA-56, specifying an invalid block number does not lead to an error but the execution result of the system subroutine is invalid.

(b) Block 9 may be accessed from the AD51 but cannot be accessed by the sequence program.

(c) The AD51 is allowed to access all valid register blocks but the sequence program is only allowed to access the number of file register points set in the parameters.

(5) Relation between file registers and block numbers

To access the file register in any block, specify the required block number and file register device number, then execute the required system subroutine.



(6) Relation between device numbers and set values

Device Number	Set Value
R0	R0000
R1	R0001
to	to
R8190	R8190
R8191	R8191

7.4.2 BASIC program examples

Some BASIC program examples are given below which use system subroutines SAER (batch read), SAEW (batch write), SAET (test), SAEM0 (monitor data entry) and SAEM1 (monitor).
The program examples use channel 1.
Full information on the system subroutines is given in the GPC-BASIC Handbook.

(1) Batch read from extension file registers (SAER)

Example: Program to read data from 16 points, file registers R100 to R115 in block 2, to addresses $E000_H$ to $E01F_H$.

```
100 A=$F000 ..... Head address for system subroutine INPUT data.
110 A:0)=$FF ..... Defines PC station number as host.
120 A:1)=2 ..... Specifies block 2.
130 B=$F002 ..... Sets indirect variable head address.
140 B$="R0100" ..... Sets head device to be read using character string variable.
150 C=$F007 ..... Sets indirect variable head address.
160 C(0)=16 ..... Sets the number of points to be read as 16.
170 C(1)=$E000 ..... Sets destination head address for data.
180 C(2)=60 ..... Sets time check period to 60 (600ms).
190 Z=CALL(0, $80BD, 1, A) ..... Calls system subroutine SAER.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SAER execution.
210 END
```

POINT

(1) When specifying the head device using a character string variable, define the number of points to be read after setting the head device. (Reason: The character string variable overwrites the bits at the end of the data with "0". This would delete the "number of points" data if this was written first.)

(2) The time check period in line 180 should be set in accordance with the "number of scans required for processing" given in Section 3.8 after taking into account any delays which may occur due to other devices accessing the PC CPU.

(2) Batch write to extension file registers (SAEW)

Example: Program to write data from addresses $E000_H$-$E01F_H$ to file registers R200-R215 in block 5 (16 points).

```
100 A=$F000 ..... Head address for system subroutine INPUT data.
110 A:0)=$FF ..... Defines PC station number as host.
120 A:1)=5 ..... Specifies block 5.
130 B=$F002 ..... Sets indirect variable head address.
140 B$="R0200" ..... Sets destination head device using character string variable.
150 C=$F007 ..... Sets indirect variable head address.
160 C(0)=16 ..... Sets the number of points to be written as 16.
170 C(1)=$E000 ..... Sets source head address for data.
180 C(2)=60 ..... Sets time check period to 60 (600ms).
190 Z=CALL(0, $80C0, 1, A) ..... Calls system subroutine SAEW.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190 ..... Checks for errors in SAEW execution.
210 END
```

(3) Data write to any specified extension file registers (SAET)

Example: Program to write 246 to file register R100 in block 5 and 1234 to R8191 in block 7.

```
100 A=$FE00 ..... Sets indirect variable head address.
110 A:0)=5 ..... Specifies block 5.
120 A:8)=7 ..... Specifies block 7.
130 B=$FE01 ..... Sets indirect variable head address.
140 B$="R0100" ..... Sets file register R100.
150 C=$FE09 ..... Sets indirect variable head address.
160 C$="R8191" ..... Sets file register R8191.
170 D=$FE06 ..... Sets indirect variable head address.
180 D(0)=246 ..... Sets data written to R100.
190 D(4)=1234 ..... Sets data written to R8191.
200 E=$F000 ..... Sets indirect variable head address.
210 E:0)=$FF ..... Defines PC station number as host.
220 F=$F001 ..... Sets indirect variable head address.
230 F(0)=2 ..... Sets the number of points to be written as 2.
240 F(1)=$FE00 ..... Sets destination head address for data.
250 F(2)=60 ..... Sets time check period to 60 (600ms).
260 Z=CALL(0, $80C3, 1, E) ..... Calls system subroutine SAET.
270 IF Z#0 PRINT "ERROR",
    Z; GOTO 260 ..... Checks for errors in SAET execution.
280 END
```

(4) Defining file registers to be monitored. (SAEM0) (Before a given file register can be monitored using the SAEM1 subroutine, it must be specified and entered using the following procedure.)

Example: Program to specify file register R50 in block 1 and R100 in block 7.

```
100 A=$FE00 ..... Sets indirect variable head address.
110 A:0)=1 ..... Specifies block 1.
120 B=$FE01 ..... Sets indirect variable head address.
130 B$="R0050" ..... Sets file register R50.
140 A:6)=7 ..... Specifies block 7.
150 C=$FE07 ..... Sets indirect variable head address.
160 C$="R0100" ..... Sets file register R100.
170 D=$F000 ..... Sets indirect variable head address.
180 D:0)=$FF ..... Defines PC station number as host.
190 E=$F001 ..... Sets indirect variable head address.
200 E(0)=2 ..... Sets the number of points to be entered
                 as 2.
210 E(1)=$FE00 ..... Sets destination head address for data.
220 E(2)=60 ..... Sets time check period to 60 (600ms).
230 Z=CALL(0, $80C6, 1, D) ..... Calls system subroutine SAEM0.
240 IF Z#0 PRINT "ERROR",
    Z; GOTO 230 ..... Checks for errors in SAEM0 execution.
250 END
```

(5) Monitoring of file registers (SAEM1) specified by the monitor data entry (SAEM0)

Example: Program to specify and monitor the file registers entered by using the program in (4).

```
100 A=$FE00
      to
230 Z=CALL(0, $80C6, 1, D)  ..... Monitor data entry in accordance with
240 IF Z#0 PRINT "ERROR",       (4).
    Z; GOTO 230
250 F=$F007 ..... Sets indirect variable head address
260 F:0)=$FF ..... Defines PC station number as host.
270 G=$F008 ..... Sets indirect variable head address.
280 G(0)=$F100 ..... Sets destination head address for data.
290 G(1)=60 ..... Sets time check period to 60 (600ms).
300 Z=CALL(0, $80C9, 1, F) ..... Calls system subroutine SAEM1.
310 IF Z#0 PRINT "ERROR",
    Z; GOTO 300 ..... Checks for errors in SAEM1 execution.
320 END
```

7.5 Special Function Module Buffer Memory Read/Write

Any special function module buffer memory is accessed by the AD51 as explained below:

7.5.1 System subroutines and functions

The following system subroutines are used by the AD51 to access the special function module buffer memory.

(1) System subroutine types and functions

Item	System Subroutine	Processing	Number of Points Processed per PC CPU, AD51 Transaction	PC CPU State	
				During STOP	During RUN
Batch read	SATR	Reads data from buffer memory (for 1 byte).	128 bytes	○	○
Batch write	SATW	Writes data to buffer memory (for 1 byte).	128 bytes	○	○

Key, ○ : Indicates available.

Table 7.7 System Subroutines and Functions

(2) Special function modules and buffer memory addresses

Any special function module buffer memory has 16 bit (1 word) locations per address. Data communication between the PC CPU and special function module is made using the FROM/TO instructions.
The buffer memory is accessed by the AD51 per address, i.e. in blocks of 8 bits (1 byte).

The address (hexadecimal) specified by the AD51 is calculated by the following expression:

Specified address (hexadecimal) = {(FROM/TO instruction address × 2)} in hexadecimal + module head address

Example: AD61 high-speed counter module's FROM/TO instruction address = 0 (present value of CH. 1)

$$\underset{82_H}{\text{Specified address}} = \underset{0_H}{\text{FROM/TO instruction address (= 0)}} \times 2 + \underset{82_H}{\text{head address}}$$

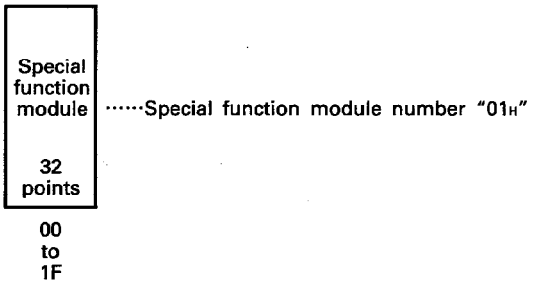
Special Function Module	Buffer Memory Head Address (Hexadecimal)
A68AD analog-to-digital converter module	80H
A62DA digital-to-analog converter module	10H
A84AD analog/digital converter module	10H
AD61(S1) high-speed counter module	82H
AD71(S1) positioning module	200H
AD72 positioning module	200H
AD51 intelligent communication module	800H
AJ71C24-S3 computer link module	1000H
A81CPU PID control module	200H

Table 7.8 Special Function Module Head Addresses

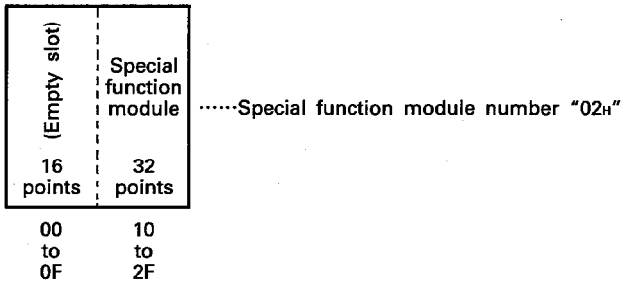
(3) Special function modules and module numbers

The special function module number (hexadecimal) specified by the AD51 is the first two digits of the three-digit final I/O address of the special function module with respect to the PC CPU.

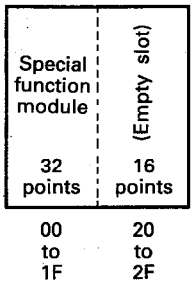
(a) Module occupying one slot (such as AD61, A68AD)



(b) Module occupying two slots and using the first slot as empty (e.g. AD72, A84AD)

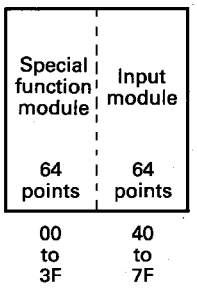


(c) Module occupying two slots and using the second slot as empty



·····Special function module number "01H"

(d) Module occupying two slots as a special function module and an input module (A81CPU)



·····Special function module number "03H"

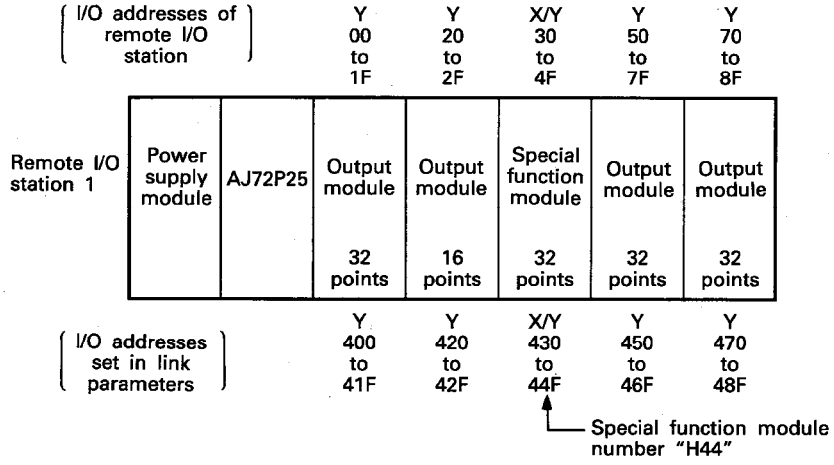
Special Function Module	Module Number of Module on Slot 0
A68AD analog-to-digital converter module	01H
A62DA digital-to-analog converter module	01H
A84AD analog/digital converter module	02H
AD61(S1) high-speed counter module	01H
AD71(S1) positioning module	01H
AD72 positioning module	02H
AD51 intelligent communication module	02H
AJ71C24-S3 computer link module	01H
A81CPU PID control module	03H

Table 7.9 Special Function Modules and Module Numbers

(4) Module number of special function module on MELSECNET remote station

The module number of the special function module used on a MELSECNET remote station depends on the link parameters set to the MELSECNET master station.

L/R NO.	M ← L		M → R	M ← R	M → L/R		M ← L/R	
	B	W	W	W	Y	X/Y	X	Y/X
R1	-----	-----	29C—309	0F9—15E	400—48F	000—08F	430—44F	030—04F
R2	-----	-----	215—24F	080—0A3	510—67F	010—17F	500—65F	000—15F
R3	-----	-----	1B6—214	15F—1B5	270—32F	050—10F	220—28F	000—06F
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—



7.5.2 BASIC program examples

The following BASIC program examples use system subroutines SATR (batch read) and SATW (batch write) to access the special function module buffer memory.
The program examples use channel 1.
For full information on the system subroutines, see the GPC-BASIC Handbook.

(1) Batch read from buffer memory (SATR)

Example: Program to read 4-byte data from buffer memory address 10_H (94_H) of the A68AD at I/O addresses 80_H-$9F_H$ to address $E000_H$.

```
100 A=$F000 ..... Head address for system subroutine INPUT data.
110 A:0)=$FF ..... Defines PC station number as host.
120 A:1)=$09 ..... Specifies module number.
130 B=$F002 ..... Sets indirect variable head address.
140 B(0)=$94 ..... Sets buffer memory head address.
150 B:2)=0
160 C=$F005 ..... Sets indirect variable head address.
170 C(0)=4 ..... Sets the number of bytes to be read as 4.
180 C(1)=$E000 ..... Sets destination head address for data.
190 C(2)=60 ..... Sets time check period to 60 (600ms).
200 Z=CALL(0, $80D8, 1, A) ..... Calls system subroutine SATR.
210 IF Z#0 PRINT "ERROR",
    Z; GOTO 200 ..... Checks for errors in SATR execution.
220 END
```

(2) Batch write to buffer memory (SATW)

Example: Program to write 4090 to buffer memory address 0_H (10_H, 11_H) of the A62DA at I/O addresses $0A_H$-$0B_H$.

```
100 A=$EE00 ..... Sets indirect variable head address.
110 A(0)=2000 ..... Sets data "2000" to be written.
120 B=$E000 ..... Sets indirect variable head address.
130 B:0)=$FF ..... Defines PC station number as host.
140 B:1)=$0B ..... Specifies module number.
150 C=$E002 ..... Sets indirect variable head address.
160 C(0)=$10 ..... Sets buffer memory head address.
170 C:2)=0
180 D=$E005 ..... Sets indirect variable head address.
190 D(0)=2 ..... Sets the number of bytes to be written as 2.
200 D(1)=$EE00 ..... Sets source head address for data.
210 D(2)=60 ..... Sets time check period to 60 (600ms).
220 Z=CALL(0, $80DB, 1, B) ..... Calls system subroutine SATW.
230 IF Z#0 PRINT "ERROR",
    Z; GOTO 220 ..... Checks for errors in SATW execution.
240 END
```

7.6 Read/Write of Sequence Program and T/C Set Values

This section describes procedures for reading and writing PC CPU sequence programs and T/C set values from the AD51.

7.6.1 System subroutines and functions

The following system subroutines are used to read and write sequence programs and T/C set values.

(1) System subroutines and functions

Item			System Subroutine	Processing	Amount of information processed per PC — AD51 transaction.	PC CPU State	
						Stop	Run
Sequence program	Read	Main	SAAR	Reads main sequence program.	64 steps	○	○
		Sub		Reads subsequence program.			
	Write	Main	SAAW	Writes main sequence program.		○	×*
		Sub		Writes subsequence program.			
Parameter	Read		SAPR	Reads parameters of PC CPU.	128 bytes	○	○
	Write		SAPW	Writes parameters of PC CPU.		○	×
	Analysis request		SAPS	Causes PC CPU to recognize and check rewritten parameters.		○	×

Key : ○ Available
× Unavailable
* For T/C only

Table 7.2 System Subroutines and Functions

* A subprogram may be written while a main program is running and vice versa using appropriate control of M9050 and M9051. The A3N and A3HCPUs are not provided with M9050.

POINT

(1) Sequence programs should be read and written in the range set in the parameters. PC CPU data may be corrupted if programs are written outside the set range.

(2) An input data error is returned if the specified parameter read/write capacity is outside the allowed range (16 bytes in the A0J2CPU, 3K bytes in the A1(E), A2(E), A3(E), A1N, A2N, A3N, and A3HCPUs).

(2) T/C set values and program addresses

Specify T/C set values and program step numbers as shown in the following table.

Sequence Program	Address
T0 set value T1 set value to T255 set value	$FE00_H$ $FE01_H$ to $FEFF_H$
C0 set value C1 set value to C255 set value	$FF00_H$ $FF01_H$ to $FFFF_H$
Step 0 Step 1 to Step 30719 (30K)	0000_H 0001_H to $77FF_H$

Calculation of specified address:

Timer Tm = $FE00_H$ + n
Counter Cm = $FF00_H$ + n

where, m = device number
n = hexadecimal value of device number

(3) T/C set value

Read/write data of T/C set values is expressed in hexadecimal as shown in the following table.

Specification with Constant	Set Value	Specification with D Register	Set Value
K0	0000_H	D0	8000_H
K1	0001_H	D1	8002_H
K2	0002_H	D2	8004_H
to	to	to	to
K32766	$7FFE_H$	D1022	$81FC_H$
K32767	$7FFF_H$	D1023	$81FE_H$

Calculation of set value:

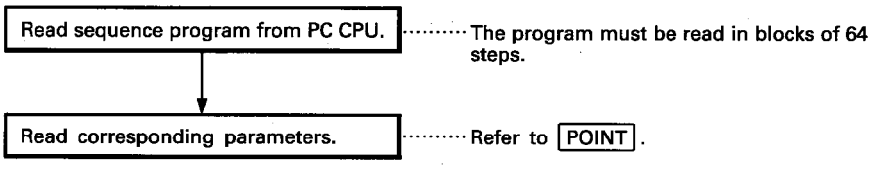
Km = 000_H + n
Dm = 8000_H + 2n

where, m = device number
n = hexadecimal value of device number

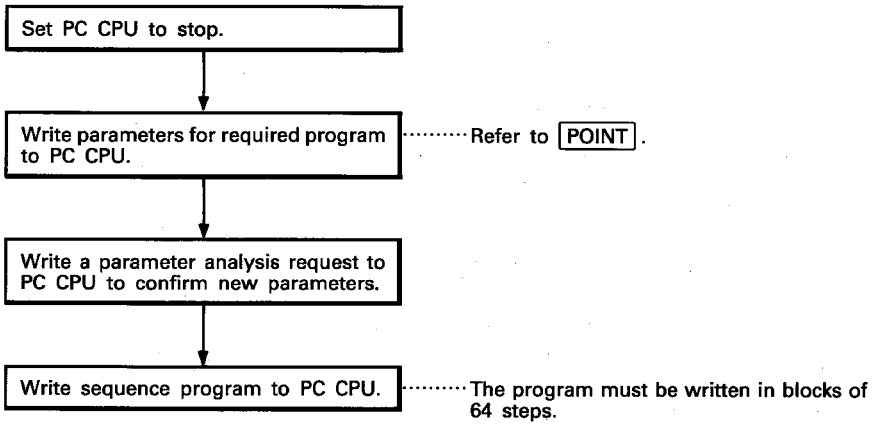
7.6.2 Read and write procedures

Parameter data should not be separated from the sequence program when it is read or written by the AD51. Use the following procedures:

(1) Sequence program read



(2) Write of sequence programs



POINT

When reading or writing sequence programs, always, ensure that the parameters match the program. Mismatches of parameters and programs will result in misoperation.

7.6.3 BASIC program example

This section gives the procedure for transferring sequence programs and T/C set values between the PC CPU and the AD51.

(1) Sequence program read (SAAR, SAPR)

[Program example]

Program to read the PC CPU main program to the following AD51 memory areas.

Sequence program (2K steps)	→ Channel 2 $E000_H$ to $EFFF_H$
Parameter (3K bytes)	→ Channel 2 $D000_H$ to $DBFF_H$

```
100 Z=ZWR1(2, $F800, $FF)·····Defines PC station number as host.
110 Z=ZWR1(2, $F801, $4D)·····Sets main, "M", sequence program.
120 Z=ZWR2(2, $F804, 64)·····Sets the number of steps to be read to
                             64.
130 Z=ZWR2(2, $F808, 60)·····Sets time check period to 60 (600m
                             sec).
140 A= $E000·····Sets data destination head address to
                 variable A.
150 FOR I=0 TO 2047 STEP 64
160 Z=ZWR2(2, $F802, I)·····Sets head step number of sequence
                            program to be read.
170 Z=ZWR2(2, $F806, A)·····Sets data destination head address.
180 Z=CALL(0, $808A, 2, $F800)·····Reads sequence program.
185 IF Z#0 PRINT "ERROR",
    Z; GOTO 180·····Checks for errors in SAAR execution.
190 A=A+128·····Adds 128 (64 steps) to head address
                of area to be read.
200 NEXT I
210 Z=ZWR1(2, $F810, $FF)·····Defines PC station number as host.
220 Z=ZWR2(2, $F814, 128)·····Sets read byte length to 128.
230 Z=ZWR2(2, $F818, 60)·····Sets time check period to 60
                            (600msec).
240 FOR I=0 TO $BFF STEP $80
250 Z=ZWR2(2, $F811, I)
260 Z=ZWR1(2, $F813, 0)  }·····Sets parameter read head address.
270 Z=ZWR2(2, $F816, $D000+I)·····Sets data destination head address.
280 Z=CALL(0, $8090, 2, $F810)·····Reads parameters.
285 IF Z#0 PRINT "ERROR",
    Z; GOTO 280·····Checks for errors in SAPR execution.
290 NEXT I
300 END
```

(2) Sequence program write

[Program example]

Program to write the main sequence program and parameters from the AD51 to the PC CPU.

Channel 2 $E000_H$ to $EFFF_H$ → Sequence program (2K steps) Channel 2 $D000_H$ to $DBFF_H$ → Parameters (3K bytes)

```
100 Z=CALL(0, $8030, $FF, 70) ·····Checks PC CPU RUN/STOP status.
110 IF Z=1 LOCATE 5, 10;PRINT
    "CPU RUN"; GOTO 100 ·····Indicates whether the CPU is running.
120 IF Z#0 GOTO
    To error processing ·····Detects any error in SKC execution
                             and moves to a suitable part of the
                             program.
130 Z=ZWR1(2, $F000, $FF) ·····Defines the PC station number as
                               host.
140 Z=ZWR2(2, $F004, 128) ·····Sets byte length to be written to 128.
150 Z=ZWR2(2, $F008, 70) ·····Sets time check period to 70
                              (700msec).
160 FOR I=0 TO $BFF STEP $80
170 Z=ZWR2(2, $F001, I)  ·····Sets parameter write head address.
180 Z=ZWR1(2, $F003, 0)  ·····
190 Z=ZWR2(2, $F006, $D000+I) ····Sets source data head address.
200 Z=CALL(0, $8093, 2, $F000) ·····Writes parameters.
210 IF Z#0 PRINT "ERROR",
    Z; GOTO 200 ·····Checks for errors in SAPW execution.
220 NEXT I
230 Z=CALL(0, $8096, $FF, 70) ·····Parameter analysis request.
240 IF Z#0 PRINT "ERROR",
    Z; GOTO 230 ·····Checks for errors in SAPS execution.
250 Z=ZWR1(2, $F010, $FF) ·····Defines the PC station number as
                               host.
260 Z=ZWR1(2, $F011, $4D) ·····Sets main, "M", sequence program.
270 Z=ZWR2(2, $F014, 64) ·····Sets the number of steps to be written
                              to 64.
280 Z-ZWR2(2, $F018, 70) ·····Sets time check period to 70
                              (700msec).
290 A= $E000 ·····Sets data source head address to
                  variable A.
300 FOR I=0 TO 2047 STEP 64
310 Z=ZWR2(2, $F012, I) ·····Sets head step number of sequence
                             program to be written.
320 Z=ZWR2(2, $F016, A) ·····Sets data source head address.
330 Z=CALL(0, $808D, 2, $F010) ·····Writes sequence program.
340 IF Z#0 PRINT "ERROR",
    Z; GOTO 330 ·····Checks for errors in SAAW execution.
350 A=A+128 ·····Adds 128 to sequence program write
                 head address.
360 NEXT I
370 END
```

(3) T/C set values read.

[Program example]

Program for reading set values of T0 to T31 and C64 to C79 to memory addresses $B000_H$ to $B03F_H$ and $B040_H$ to $B05F_H$ in channel 2.

```
100 Z=ZWR1(2, $E700, $FF)·····Defines PC station number as host.
110 Z=ZWR1(2, $E701, $4D)·····Sets main, "M", sequence program.
120 Z=ZWR2(2, $E702, $FE00)·····Sets read head step to T0.
130 Z=ZWR2(2, $E704, 32)·····Sets the number of points to be read
                             to 32.
140 Z=ZWR2(2, $E706, $B000)·····Sets data destination head address.
150 Z=ZWR2(2, $E708, 50)·····Sets time check period to 50
                             (500msec).
160 Z=CALL(0, $808A, 2, $E700)·····Reads T0 to T31 set values.
170 Z=ZWR2(2, $E702, $FF40)·····Sets read head step to C64.
180 Z=ZWR2(2, $E704, 16)·····Sets the number of points to be read
                             to 16.
190 Z=ZWR2(2, $E706, $B040)·····Sets data destination head address.
200 Z=CALL(0, $808A, 2, $E700)·····Reads C64 to C79 set values.
210 IF Z#0 PRINT "ERROR",
    Z; GOTO 200·····Checks for errors in SAAR execution.
220 END
```

7.7 Microcomputer Program Read/Write

PC CPU microcomputer programs are read and written from the AD51 in the following procedures.

7.7.1 System subroutines and functions

The following system subroutines are used to read and write microcomputer programs.

(1) System subroutine types and functions

Item		System Subroutine	Processing	Number of Points Processed per PC CPU, AD51 Transaction	PC CPU State	
					During STOP	During RUN
Read	Main	SAMR	Reads main microcomputer program.	128 bytes	○	○
	Sub		Reads sub microcomputer program.			
Write	Main	SAMW	Writes main microcomputer program.		○	× *
	Sub		Writes sub microcomputer program.			

Key, ○ : Available

Table 7.11 System Subroutines and Functions

* When the A3CPU or A3ECPU is used, a subprogram may be written while a main program is running and vice versa using appropriate control of M9050 and M9051.
The A3N and A3HCPUs are not provided with M9050.

POINT

**The M9050 circuit must be deleted if any A3CPU or A3ECPU program is utilized for the A3N or A3HCPU.
Reason: If M9050 is on, any program cannot be written during run of the A3N or A3HCPU.**

(2) Microcomputer program read/write head address

Specify the microcomputer program read/write head address using the corresponding offset address as indicated below:

Microcomputer Program	Offset Address
Step 0 Step 1 to Step 59391 (58K)	0000_H 0001_H to $E7FF_H$ *

*: This address assumes that the microcomputer program capacity has been set to 58K bytes in the parameter.

The (head address) + (number of bytes processed) should be ((microcomputer program capacity set in parameter) − 1 byte) max.

(Head address) + (number of bytes processed) ≦ ((microcomputer program capacity set in parameter) − 1 byte)

POINT

When reading or writing microcomputer programs, always ensure that the parameters match the programs. Mismatches of parameters and programs may corrupt the PC CPU data.

7.7.2 BASIC program examples

The following program examples transfer microcomputer programs between the PC CPU and AD51.

(1) Microcomputer program read (SAMR)

Example: Program to read PC CPU main microcomputer program to the following AD51 memory area:

Microcomputer program (4K bytes) → Channel 2 $E000_H$ to $EFFF_H$

```
100 Z=ZWR1(2, $F800, $FF)·····Defines PC station number as host.
110 Z=ZWR1(2, $F801, $4D)·····Sets main, "M", microcomputer
                              program.
120 Z=ZWR2(2, $F804, 64)·····Sets the number of bytes to be read
                              as 64.
130 Z=ZWR2(2, $F808, 60)·····Sets time check period to 60 (600ms).
140 A=$E000·····Sets indirect variable head address.
150 FOR I=0 TO 4095 STEP 64
160 Z=ZWR2(2, $F802, I)·····Sets head address of microcomputer
                              program to be read.
170 Z=ZWR2(2, $F806, A)·····Sets data destination head address.
180 Z=CALL(0, $80CC, 2, $F800)·····Calls system subroutine SAMR.
190 IF Z#0 PRINT "ERROR",
    Z; GOTO 180·····Checks for errors in SAMR execution.
200 A=A+64·····Adds 64 to data destination head
                address.
210 NEXT I
220 END
```

(2) Microcomputer program write (SAMW)

Example: Program to write the main microcomputer program from the AD51 to the PC CPU.

Channel 2 $E000_H$ to $EFFF_H$ → Microcomputer program (4K bytes)

```
100 Z=CALL(0, $8030, $FF, 70) ·····Checks PC CPU RUN/STOP status.
110 IF Z=1 LOCATE 5, 10;PRINT
    "CPU RUN"; GOTO 100 ·····Indicates whether the CPU is running.
120 IF Z#0 GOTO
    To error processing ·····Detects any error in SKC execution
                             and moves to a suitable part of the
                             program.
130 Z=ZWR1(2, $F000, $FF) ·····Defines PC station number as host.
140 Z=ZWR1(2, $F001, $4D) ·····Sets main, "M", microcomputer
                             program.
150 Z=ZWR2(2, $F004, 64) ·····Sets the number of bytes to be writ-
                             ten as 64.
160 Z=ZWR2(2, $F008, 60) ·····Sets time check period to 60 (600ms).
170 A=$E000 ·····Sets indirect variable head address.
180 FOR I=0 TO 4095 STEP 64
190 Z=ZWR2(2, $F002, I) ·····Sets head address of microcomputer
                             program to be written.
200 Z=ZWR2(2, $F006, A) ·····Sets data source head address.
210 Z=CALL(0, $80CF, 2, $F000) ·····Calls system subroutine SAMW.
220 IF Z#0 PRINT "ERROR",
    Z; GOTO 210 ·····Checks for errors in SAMW execution.
230 A=A+64 ·····Adds 64 to data source head address.
240 NEXT I
250 END
```

7.8 Comment Read/Write

Comments are read and written in the following procedures:

7.8.1 System subroutines and functions

The following system subroutines are used to read and write PC CPU comments from the AD51.

(1) System subroutine types and functions

Item	System Subroutine	Processing	Number of Points Processed per PC CPU, AD51 Transaction	PC CPU State	
				During STOP	During RUN
Batch read	SACR	Reads comments.	128 bytes	○	○
Batch write	SACW	Writes comments.		○	○

Key, ○ : Available

Table 7.12 System Subroutines and Functions

(2) Comment read/write head address

Specify the comment read/write head address using the offset address.
The (head address) + (number of bytes processed) should be equal to or less than the comment capacity set in the parameter.

(Head address) + (number of bytes processed) ≦ (comment capacity)

POINT

When reading or writing comments, always ensure that the parameters match the comments. Mismatches of parameters and comments may corrupt the PC CPU data.

7.8.2 BASIC program examples

The following program examples transfer comments between the PC CPU and AD51.

(1) Comment read (SACR)

Example: Program to read PC CPU comments to the following AD51 memory area:

192 comment points (4K bytes) → Channel 2 8000_H to $8FFF_H$

```
100 Z=ZWR1(2, $F800, $FF)·····Defines PC station number as host.
110 Z=ZWR2(2, $F803, 64)·····Sets the number of bytes to be read
                             as 64.
120 Z=ZWR2(2, $F807, 60)·····Sets time check period to 60 (600ms).
130 A= $8000·····Sets indirect variable head address.
140 FOR I=0 TO 4095 STEP 64
150 Z=ZWR2(2, $F801, I)·····Sets head address of comments to be
                            read.
160 Z=ZWR2(2, $F805, A)·····Sets data destination head address.
170 Z=CALL(0, $80D2, 2, $F800)·····Calls system subroutine SACR.
180 IF Z#0 PRINT "ERROR",
    Z; GOTO 170·····Checks for errors in SACR execution.
190 A=A+64·····Adds 64 to data destination head
                address.
200 NEXT I
210 END
```

(2) Comment write (SACW)

Example: Program to write comments from the AD51 to the PC CPU.

Channel 2 8000_H to $8FFF_H$ → 192 comment points (4K bytes)

```
100 Z=ZWR1(2, $F900, $FF)·····Defines PC station number as host.
110 Z=ZWR2(2, $F903, 64)·····Sets the number of bytes to be written as 64.
120 Z=ZWR2(2, $F907, 60)·····Sets time check period to 60 (600ms).
130 A=$8000·····Sets indirect variable head address.
140 FOR I=0 TO 4095 STEP 64
150 Z=ZWR2(2, $F901, I)·····Sets head address of comments to be written.
160 Z=ZWR2(2, $F905, A)·····Sets data source head address.
170 Z=CALL(0, $80D5, 2, $F900)·····Calls system subroutine SACW.
180 IF Z#0 PRINT "ERROR",
    Z; GOTO 170·····Checks for errors in SACW execution.
190 A=A+64·····Adds 64 to data source head address.
200 NEXT I
210 END
```

7.9 Interrupt from PC CPU to AD51

The interrupt signal from the PC CPU to the AD51 is valid on its rise (i.e. the AD51 waits for the leading edge of the signal).

[How to use]

To enable the interrupt facility, the relevant task should be set to "start at interrupt from PC CPU" on the multi task setting screen. The AD51 will then run that task when it receives the interrupt signal.
Once it has been started the interrupt task will operate until the END instruction is executed. The interrupt is re-enabled after the END instruction is executed.

[Program example]

The following P.C. program will call the designated interrupt task when X01 turns on.

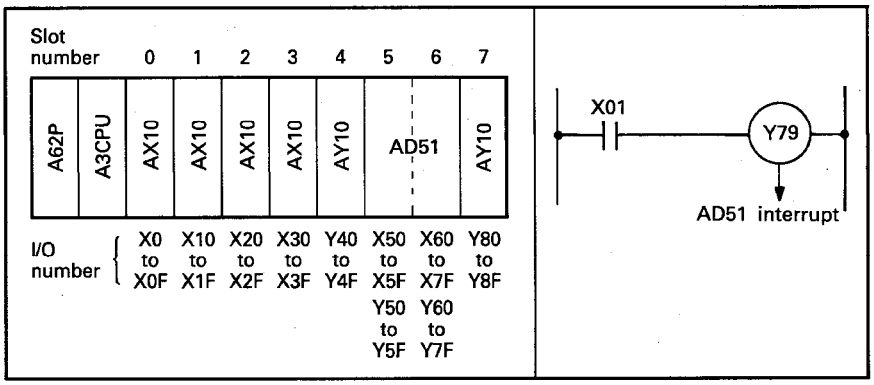


Fig. 7.5 System Configuration and Sequence Program

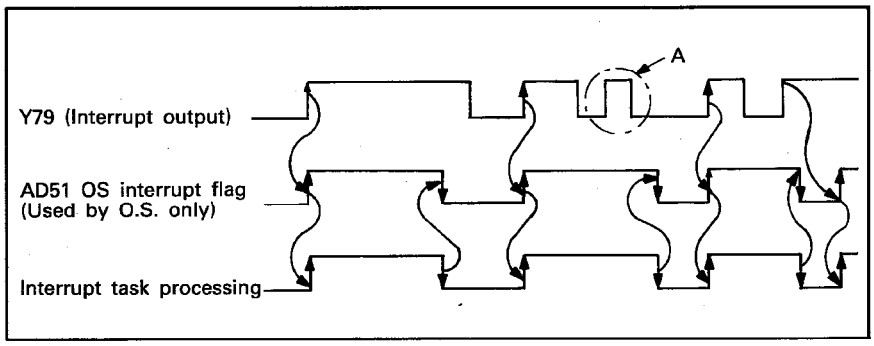


Fig. 7.6 Timing Chart

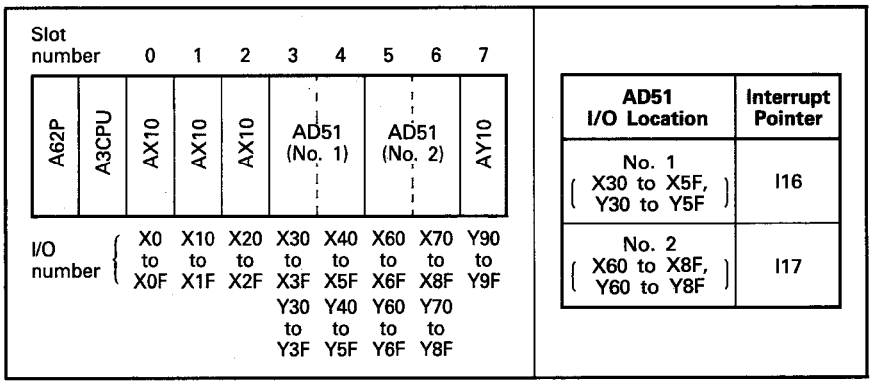
POINT

(1) Any interrupt signal given to the AD51 while an interrupt program is running (i.e. interrupt flag is ON) will be ignored (See area A in Fig. 7.6.)

(2) Only one task may be specified as "interrupt start". Setting any more generally leads to ORST error.

7.10 Interrupt from AD51 to PC CPU

System subroutine "SIT" causes the AD51 to interrupt the PC CPU and allows AD51 interrupt sequence programs to be executed. The A0J2CPU cannot be interrupted by the AD51.
The PC CPU has interrupt pointers, I16 to I23, which are assigned to interrupt signals generated by special function modules in order of I/O allocation.
For details, refer to the CPU Unit User's Manual and Programming Manual.
In the system configuration shown in Fig. 7.7, when AD51 No. 1 interrupts the PC CPU, the interrupt program designated by pointer I16 is executed. When AD51 No. 2 interrupts the PC CPU, interrupt program I17 is executed. (I16 has higher priority.)



AD51 I/O Location	Interrupt Pointer
No. 1 (X30 to X5F, Y30 to Y5F)	I16
No. 2 (X60 to X8F, Y60 to Y8F)	I17

Fig. 7.7 System Configuration and Interrupt Pointers

7.11 Remote RUN/STOP of PC CPU

The PC CPU can be switched between RUN and STOP by the AD51 using the following system subroutines.

Item		System Subroutine	Processing
PC CPU	Remote RUN	SKR	Requests remote RUN of PC CPU.
	Remote STOP	SKP	Requests remote STOP of PC CPU.

(1) Precautions for remote RUN/STOP

1) Note that a "remote error" is flagged if a remote RUN (or STOP) signal is given to a PC CPU which has already received a remote STOP (or RUN) signal from a separate unit, e.g. AJ71C24-S3.

2) Remote RUN/STOP commands from the AD51 are valid as follows for different CPU key switch positions:

		PC CPU Key Switch Position			
		RUN	STOP	PAUSE	STEP-RUN
Command from AD51	Remote RUN	RUN	STOP	PAUSE	STEP-RUN
	Remote STOP	STOP	STOP	STOP	STOP

3) The clearing of data memories on receiving a remote run instruction depends on the states of special relays M9016 and M9017.

Special Relay		Data Memory State
M9016	M9017	
OFF	OFF	CPU is run without clearing data memory.
OFF	ON	Data memory is cleared outside the latch range set in parameters. (Link image is not cleared.)
ON	ON/OFF	CPU is run after data memory is cleared.

REMARKS

Always reset special relays M9016 and M9017 where data memory clearing is not required.

4) Resetting the PC CPU during remote RUN/STOP control (either with the keyswitch or by powering down and up) causes the remote signal to be removed and the PC CPU to revert to the mode detected by its key switch.

(2) BASIC program example

[Program example]

Program for remote RUN/STOP of PC CPU through key inputs

```
100 LOCATE 20, 10 ·····Specifies cursor position.
110 PRINT "STOP PC CPU? Y/N" ·····Displays message.
120 A=INKEY·····Waits for key input.
130 IF A#"Y" GOTO 120·····Checks key input characters.
140 Z=CALL(0, $8036, $FF, 60)·····Executes remote STOP.
145 IF Z#0 PRINT "ERROR",
    Z; GOTO 140·····Checks for errors in SKP execution.
150 LOCATE 20, 10 ·····Specifies cursor position.
160 PRINT "REMOTE-RUN PC CPU?
    Y/N" ·····Dislays message.
170 A=INKEY·····Waits for key input.
180 IF A#"Y" GOTO 170·····Checks key input characters.
190 Z=CALL(0, $8033, $FF, 60)·····Executes remote RUN.
200 IF Z#0 PRINT "ERROR",
    Z; GOTO 190·····Checks for errors in SKR execution.
210 GOTO 100
```

8. TROUBLESHOOTING

This section lists error messages and troubleshooting procedures.

8.1 Screen Error Messages

The following messages may be generated during operation of the AD51 with its programming console.

Error Message	Display Screen	Description	Corrective Action
CANNOT SET	Mode select menu	1) Invalid number has been set. 2) "1" (MULTI TASK GO) or "6" (SYSTEM DATA TRANSFER) has been pressed before multitask setting, or there is an error in the multitask data.	1) Correct the number. 2) Set or correct multitask data.
	BASIC program address setting	Invalid number has been set.	Correct the number.
	Date and time setting	Invalid value has been set.	Correct.
	GPP mode	1) GPP mode selected without connecting the GPP/HGP/PHP to CH1. 2) Invalid number has been set.	Correct.
MEMORY PROTECT ERROR	Mode select menu	System data area is memory protected.	Set the memory protect switch to OFF.
DATA [n] SET ERROR	BASIC program address setting	The data indicated on the menu by the number n is wrong.	Correct.
	Printer setting		Correct.
ERROR	Multitask setting	Value above "ERROR" is wrong.	For ERROR displayed in the TYPE, START CONDITION, or INTERVAL, columns, correct the data on the screen. For other columns correct the data on the BASIC program address setting screen.
AD51 BUS ERROR	GPP mode	GPP/HGP/PHP inaccessible to AD51 buffer.	Usually causes by the PC CPU accessing the AD51 buffer memory too frequently or with too much data. STOP the PC CPU.
AD51 COMMUNICATION ERROR		Communication error between AD51 and GPP/HGP/PHP.	Check cable connection and start up again.
AD51 WRITE ERROR		Memory area is ROM or memory protected.	Select RAM area channel or reset memory protect.
ADDRESS ERROR		Address is not in the allowed range.	Correct.
CANNOT USE KANA!!		"Kana" (i.e. Japanese characters) in the system name.	Select appropriate character set and use alphanumerics for system name specification.
DISK FULL		FD capacity exceeded.	Insert new FD.
FILE NAME ERROR		Invalid file name for file directory or delete function.	Correct.
FLOPPY ERROR		1) No FD in accessed drive. 2) FD is write protected. 3) FD is defective.	1) Insert FD. 2) Set FD write protect tab to OK. 3) Change FD.
FLOPPY WRITE PROTECT		FD is write protected.	Set FD write protect tab to OK.
IDENTICAL NAME		The same file name exists.	Change the file name.
MEMORY NOTHING		Invalid area number has been specified.	Correct the area number.
NO FILE		Specified file is not on FD.	Correct.
ROM ERASING ERROR		ROM has not been erased.	Erase ROM data or use a new ROM.

Error Message	Display Screen	Description	Corrective Action
ROM WRITE ERROR	GPP mode	1) ROM is wrongly or not loaded. 2) ROM is defective.	1) Check ROM. 2) Write several times. Try again, if data cannot be written, change ROM.
SIZE UNMATCH (ROM < FILE)		ROM capacity is smaller than file capacity.	Select appropriate ROM.
SYSTEM NAME ERROR		Invalid name has been specified. (The name includes non-alphanumeric character or blank or the first character is not a letter.)	Correct.
VERIFY ERROR		Data unmatched.	Correct.
STACK ERROR! AD51 STOP!	Multitask execution	Stack has been used outside the set area.	In BASIC, a maximum of ten levels of GOSUB or FOR/NEXT instructions are allowed.
BTWF ERROR! AD51 STOP!		Task scheduling RAM data has been changed.	Check whether the system memory has been accessed by the user program.
WAIT ERROR! AD51 STOP!			
AD51 STOP! TASK NO.		There is a BASIC statement which cannot be translated by the interpreter.	Correct BASIC program.
STOP COMMAND AD51 STOP TASK NO.		STOP command executed.	Remove STOP command or change to END, GOTO, GOSUB, RETURN, ONGOTO or ONGOSUB command.
BREAK COMMAND AD51 STOP! TASK NO.		BREAK command executed.	Remove BREAK command.
TEXT END AD51 STOP! TASK NO.		BASIC program does not finish with END, GOTO, GOSUB, ONGOTO, ONGOSUB or RETURN command.	Correct.
WHAT?	BASIC programming mode	BASIC programming mode error detected in BASIC program. *1	Correct.
HOW?			
SORRY		Program area insufficient.	Expand.
ROM OR MEMORY PROTECT AREA! PLEASE DO NOT CORRECT PROGRAM		Program area is ROM or memory protected.	Alarm message *2

POINT

***1: "WHAT" and "HOW" are indicated when:**
1) An undefined command is used;
2) A command description format is wrong;
3) A line number is not specified on the left of the GOTO, GOSUB, ONGOTO, or ONGOSUB command; and
4) The RETURN command is used without the GOSUB or ONGOSUB command.

***2: When this message is indicated, never correct the program.**
Correction will corrupt the BASIC program memory area data. With this message displayed, only LIST, LLIST and BYE commands should be used.
To allow correction of a protected program, switch the memory protect off.

8.2 Error Code List

The occurance of any error during AD51 operation will cause the appropriate error code to be displayed on the two digit annunciator.
Code definitions are as follows:

Error Number	Error		Description	Location	Corrective Action
00	Battery error		Battery is not loaded. Battery voltage low.	—	Load battery. Change battery.
10	Multi task setting error		Although multi task setting is wrong, multi task has been executed.	—	Re-set multi task.
11	BASIC program error		Grammatical error in BASIC program.	Task 1	Correct program.
12				Task 2	
13				Task 3	
14				Task 4	
15				Task 5	
16				Task 6	
17				Task 7	
18				Task 8	
21	STOP error	BASIC	STOP command has been executed during multi task execution.	Task 1	Remote STOP command or change to END, GOTO, GOSUB, ONGOTO, ONGOSUB, or RETURN command.
22				Task 2	
23				Task 3	
24				Task 4	
25				Task 5	
26				Task 6	
27				Task 7	
28				Task 8	
31	BREAK error	BASIC	BREAK command has been executed during multi task execution.	Task 1	Remove BREAK command.
32				Task 2	
33				Task 3	
34				Task 4	
35				Task 5	
36				Task 6	
37				Task 7	
38				Task 8	
41	Text end error		BASIC program does not end with END, GOTO, GOSUB, ONGOTO, ONGOSUB, or RETURN command.	Task 1	Correct program.
42				Task 2	
43				Task 3	
44				Task 4	
45				Task 5	
46				Task 6	
47				Task 7	
48				Task 8	

Error Number	Error	Description	Location	Corrective Action
51	ORST error	A task has been re-started before it has completed.	Task 1	Correct task start condition.
52			Task 2	
53			Task 3	
54			Task 4	
55			Task 5	
56			Task 6	
57			Task 7	
58			Task 8	
60	Stack error	Stack used is outside the system stack area.	—	In BASIC a maximum of ten levels of GOSUB or FOR/NEXT instructions are allowed.
70	Duplex WAIT error BTWF error	RAM contents for system's task schedule have been rewritten.	—	Check whether the system memory has been accessed by the user program.
81	Receive buffer full error	511 bytes of received data in receive buffer.	RS-422 CH1	Do not send more than 512 bytes at one time.
82			RS-422 CH2	
83			RS-232C CH3	
84			RS-232C CH4	
91	Send buffer full error	127 bytes of send data in send buffer.	RS-422 CH1	Check cables. Empty the external equipment reveive buffer.
92			RS-422 CH2	
93			RS-232C CH3	
94			RS-232C CH4	
99	PC CPU error	1) PC CPU has been reset during communication. 2) Time out error has occurred during PC accessing by system subroutine. 3) PC CPU error detected by WDT and communication has stopped. *Note: Error code 99 is sometimes displayed after an instantaneous power failure.*	—	AD51 program execution not directly affected.

POINT

(1) The AD51 continues operating in the event of "battery error", "ORST error", "receive buffer full error", "send buffer full error", or "PC CPU error".

(2) The receive buffer capacity is 511 bytes per channel. Overflow data is ignored.

(3) When data is sent from one task to the buffer memory and the buffer memory becomes full, the AD51 switches tasks. After that task has run the AD51 checks the buffer, if it is now vacant the original task is allowed to continue and if it is still full the AD51 will switch to a third task (where used). This checking and switching procedure will continue for 1 minute if the buffer remains full after which 1 byte of the excess data will be deleted.
The one minute cycle is repeated until there is no excess data left (The 1 minute cycle time may be charged using the SWB system subroutine.)

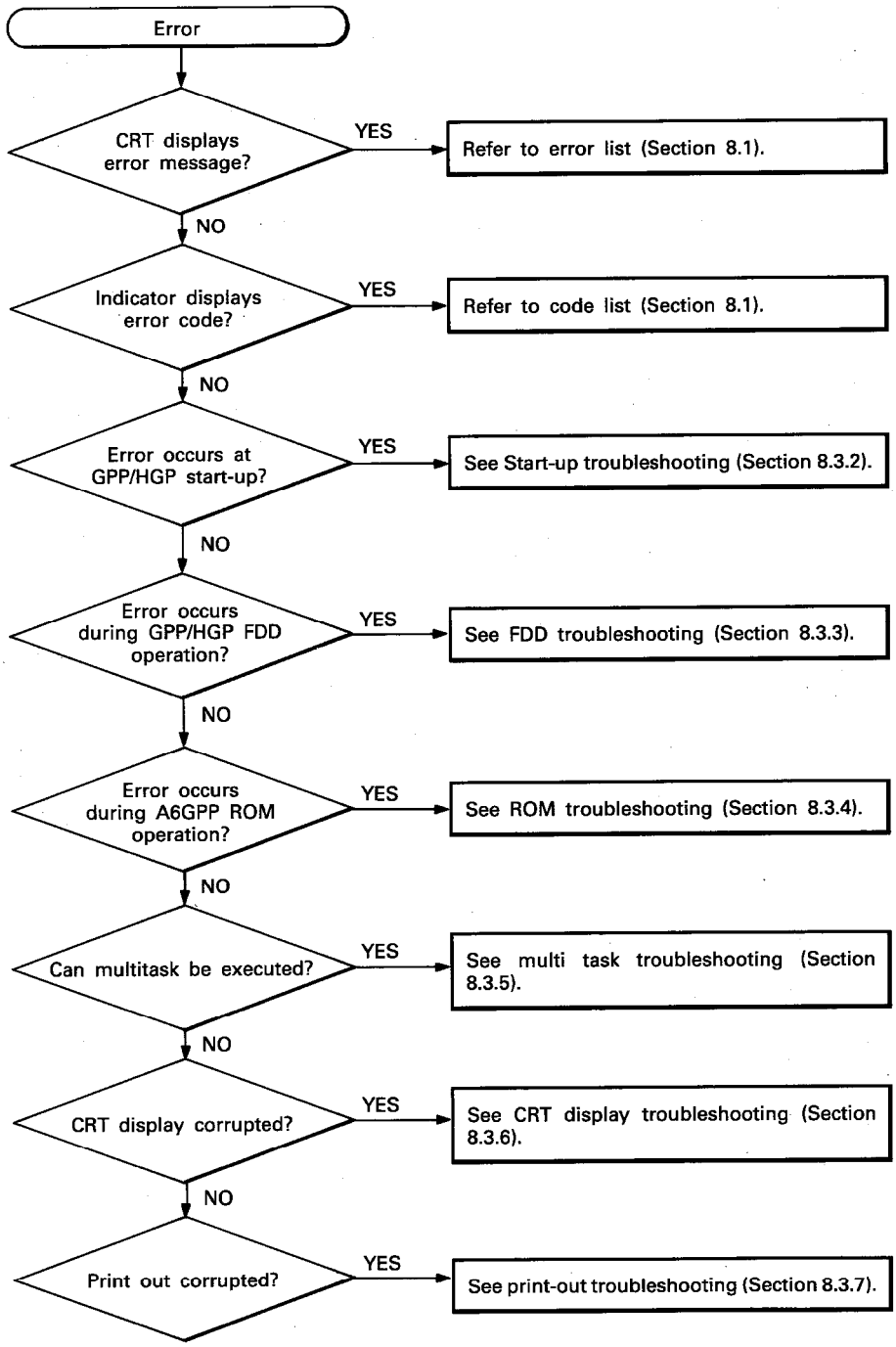
(4) Possible causes of send buffer full error are as follows:

- The DTR signal from the external equipment (Pin 6 of the RS-232C connector) is low.
- X ON code is not received from the external equipment after X OFF has been received.

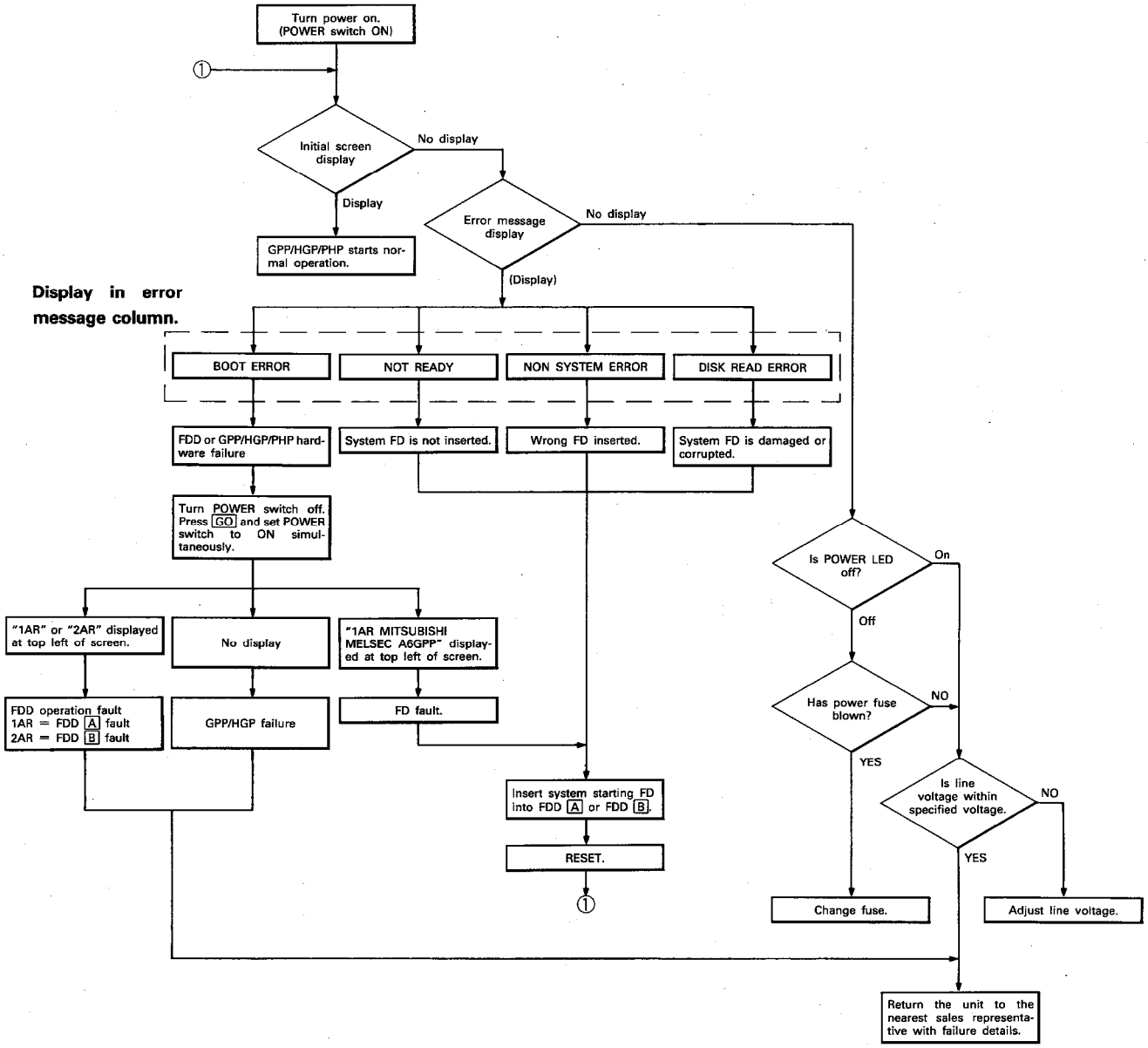
8.3 Troubleshooting

This section gives simple AD51 troubleshooting procedures. For PC CPU troubleshooting refer to the PC CPU User's Manual.

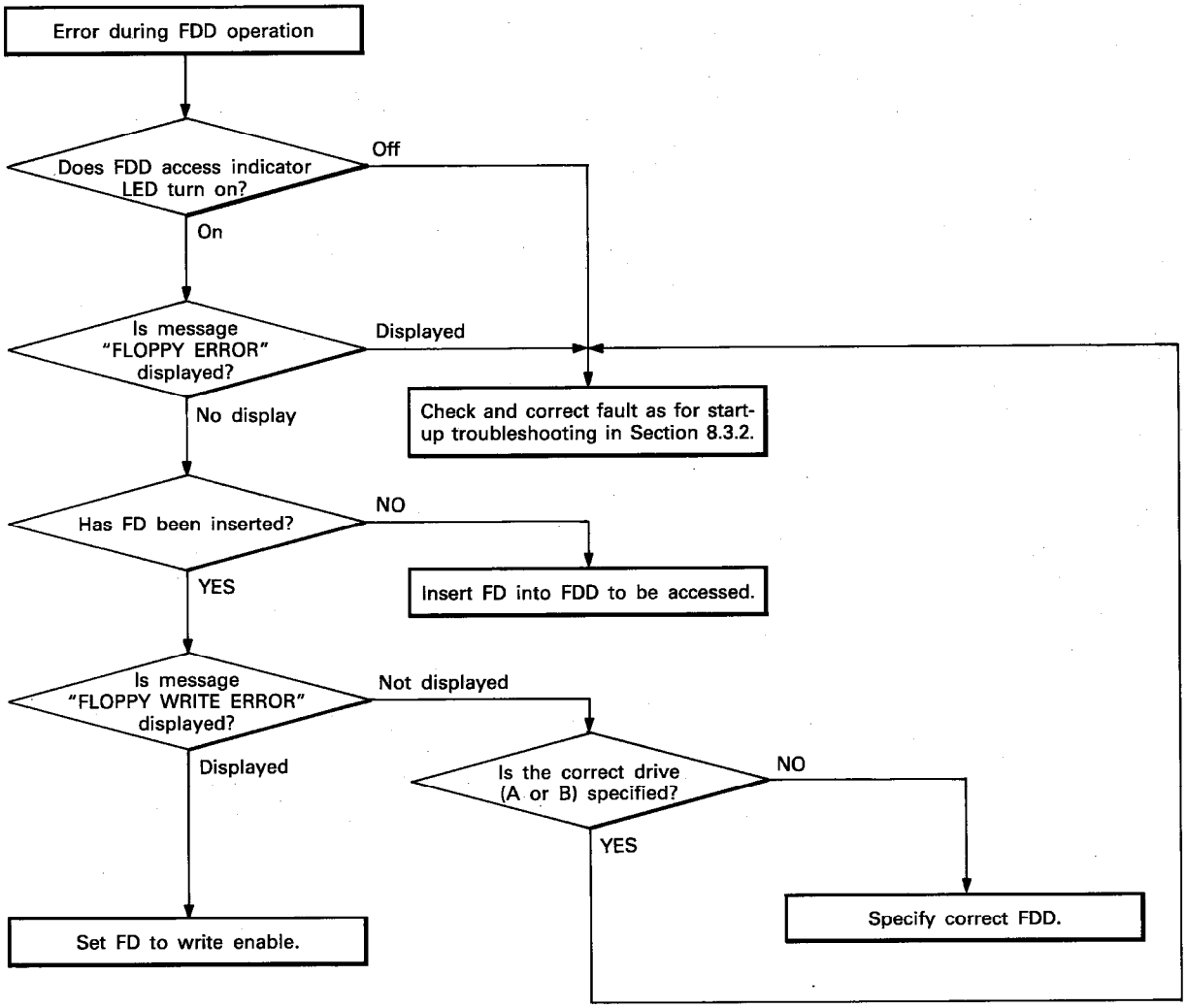
8.3.1 Troubleshooting flow chart



8.3.2 Start-up troubleshooting



8.3.3 FDD troubleshooting

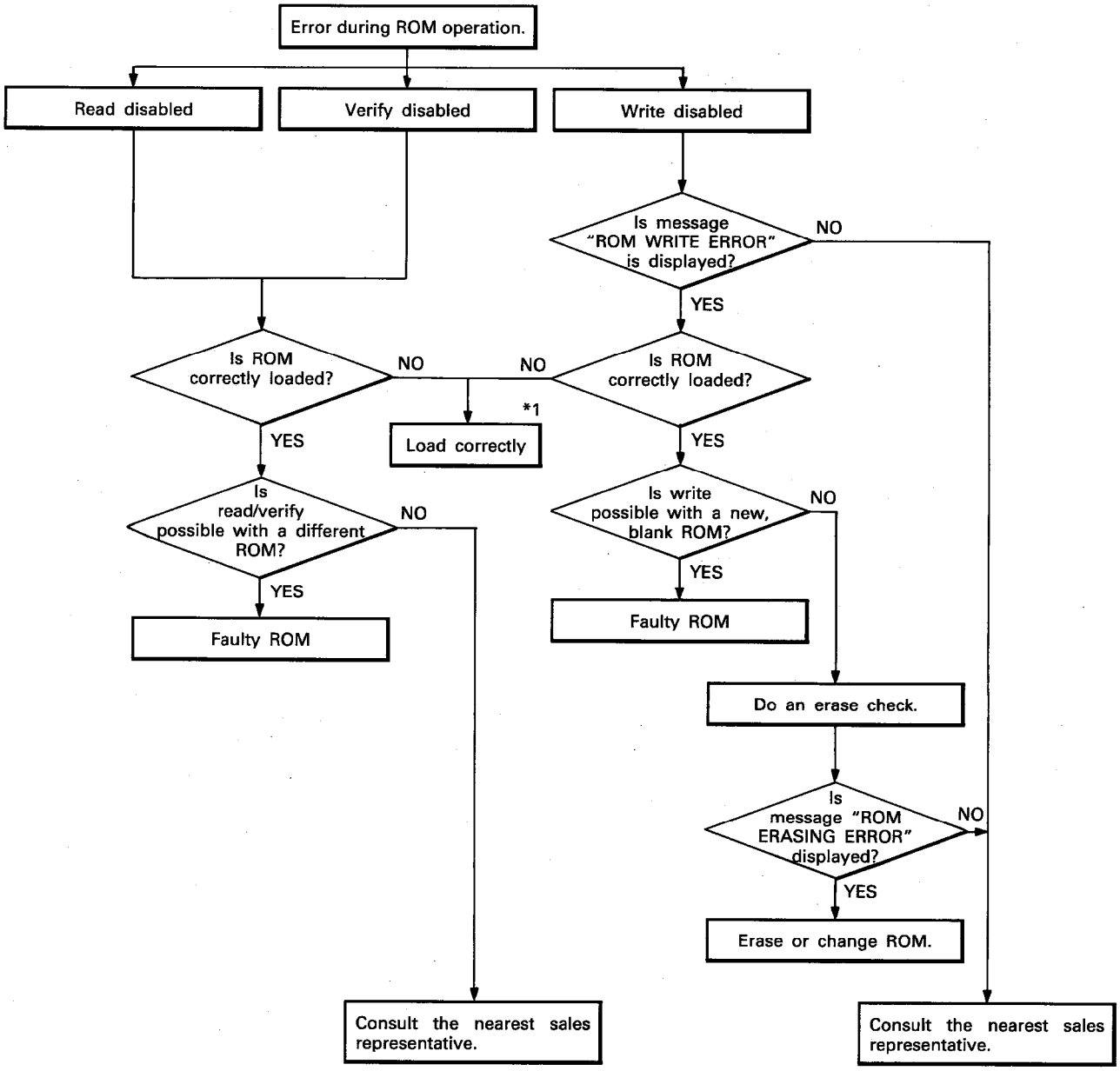


POINT

(1) Note the correct direction for inserting the disk and never force it.

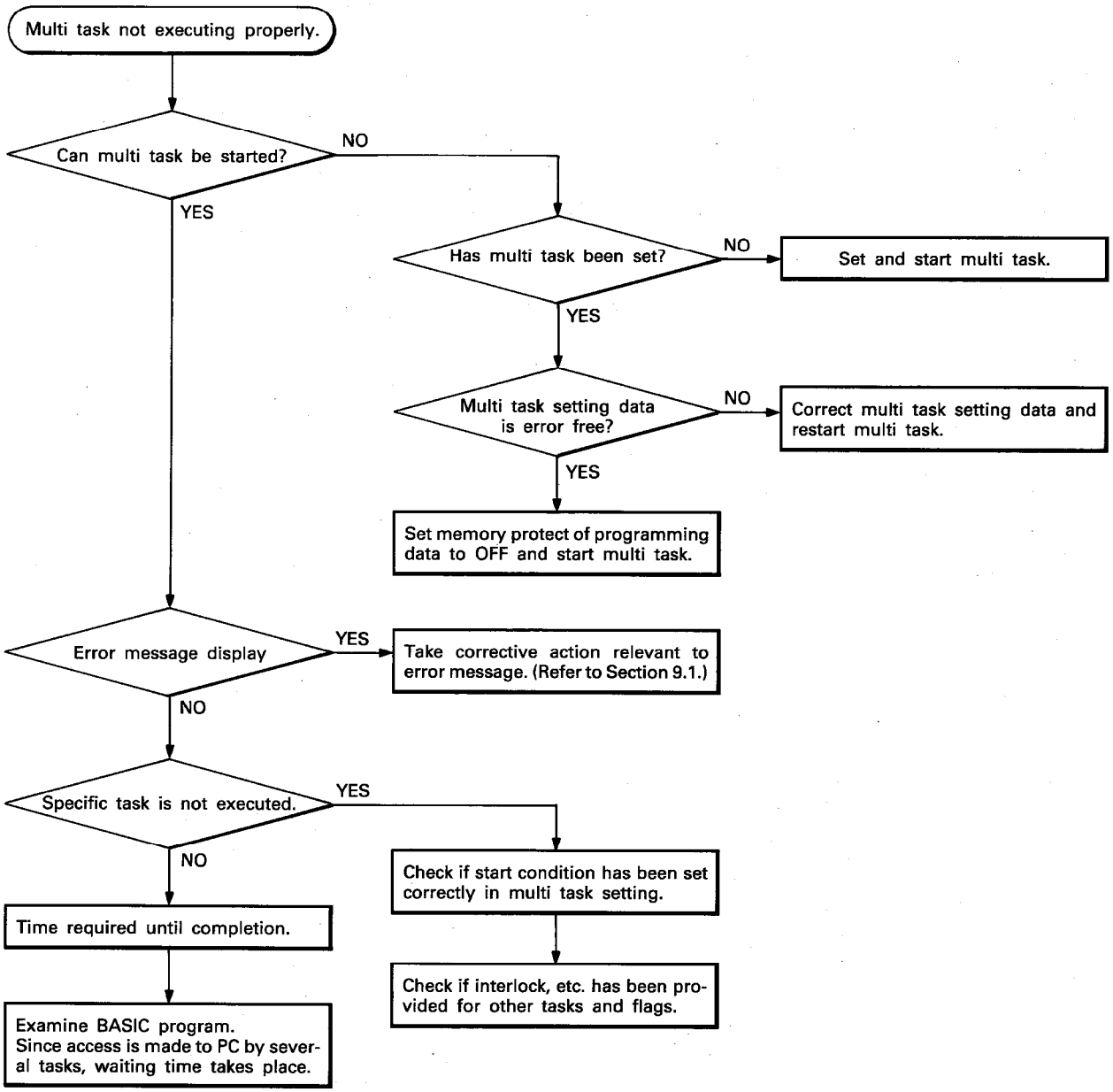
(2) Formatting a disk clears all the data on it.

8.3.4 ROM troubleshooting

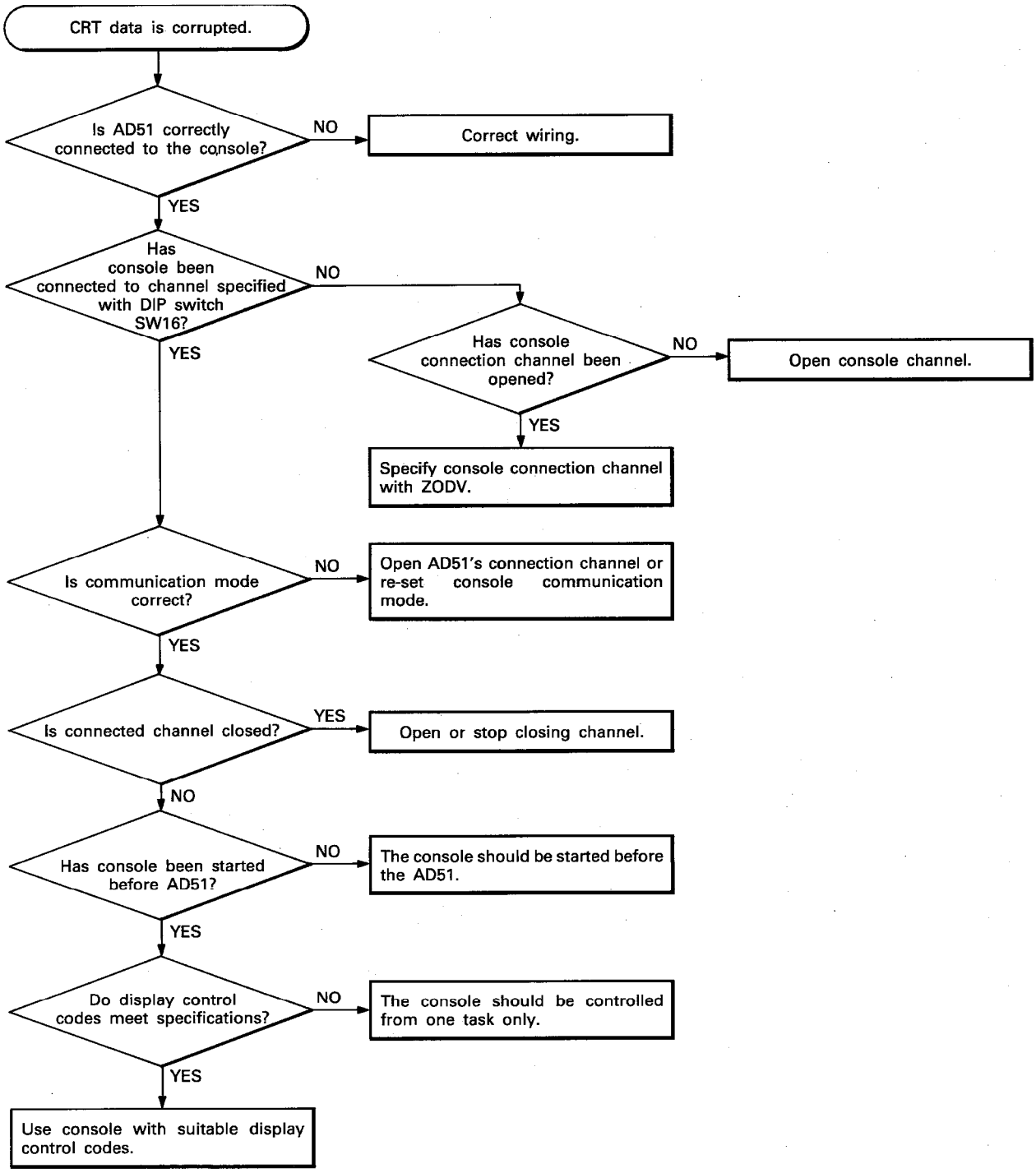


*1: Load correctly.
1) Is ROM in the right direction?
2) Is ROM securely loaded in socket?
3) Is ROM socket lever set correctly?

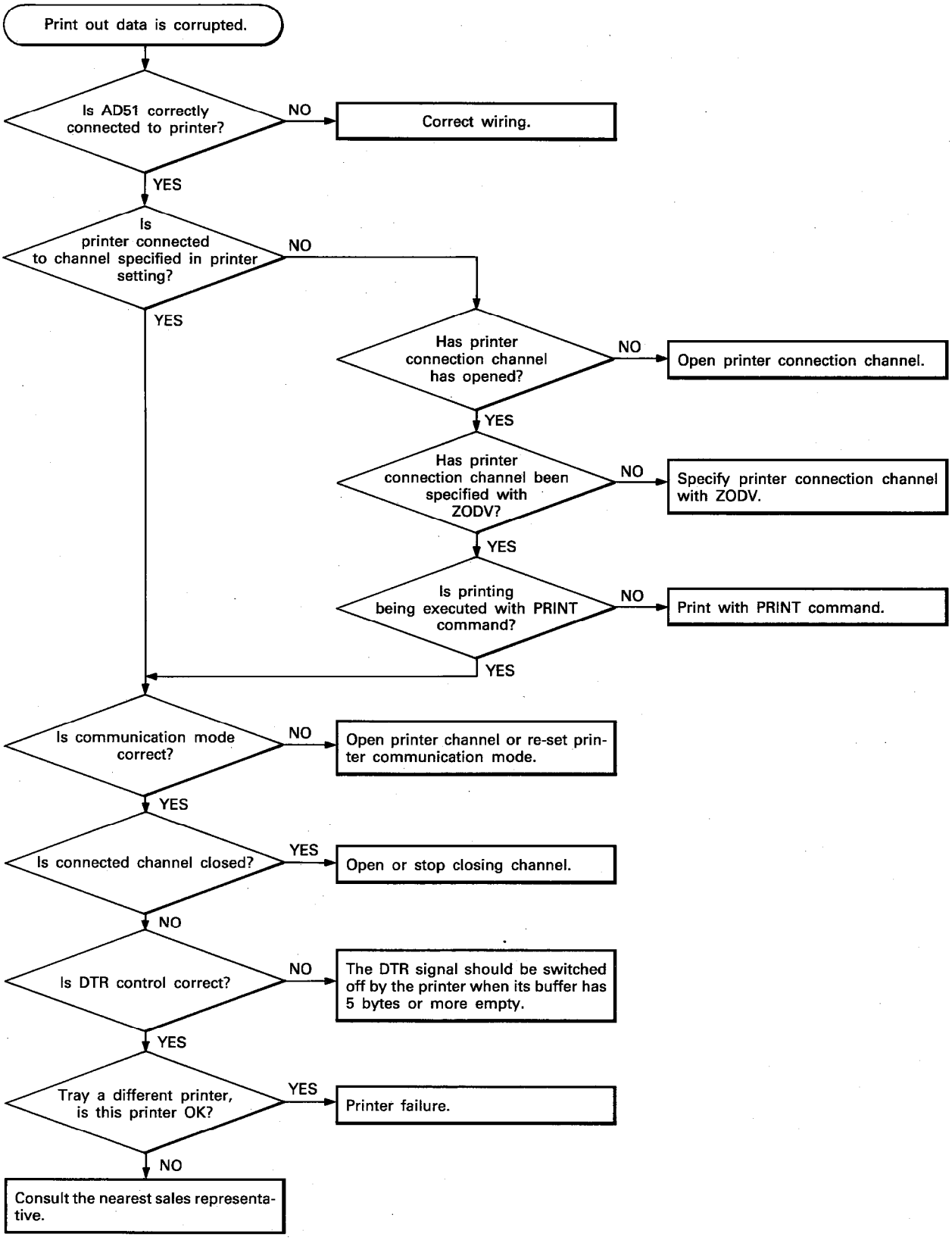
8.3.5 Multi task troubleshooting



8.3.6 CRT troubleshooting



8.3.7 Print-out troubleshooting



9. MAINTENANCE

9.1 Battery Life

When the battery voltage drops, the error indicator on the front of the AD51 displays "00". The error can also be read using the SIR system subroutine.
After this error message is displayed the battery has a further life of 65 days (1560 hours).

	Guaranteed Value	Actual Operation Period (Av.)
Back-up by battery	130 days (3120 hours)	300 days (7200 hours)
Back-up after battery error	65 days (1560 hours)	—
Back-up by capacitor	11 minutes	25 minutes

Preventitive maintenance guide.

(1) Change the battery after four years if the total battery back-up time during that period has been a maximum of 130 days.

(2) For back-up periods exceeding a total of 130 days in four years, calculate the battery life as follows:

{Example }

Assume that the power is off for 14 hours 5 days a week, and all day for the remaining 2 days per week. Under these conditions, the power is off for:

$$\begin{aligned} 14(\text{hours}) \times 5(\text{days}) &= 70 \text{ hours} \\ 24(\text{hours}) \times 2(\text{days}) &= \underline{48} \text{ hours} \\ & \quad 118 \text{ hours per week} \end{aligned}$$

The total battery life is 3120 hours which at 118 hours per week gives

$$\frac{3120}{118} = 26.4 \text{ weeks}$$

$$= \text{Approx. 6 months.}$$

Therefore,

it is necessary to change the battery every 6 months.

9.2 Battery Changing Procedure

Fig. 9.1 shows the battery changing procedure.

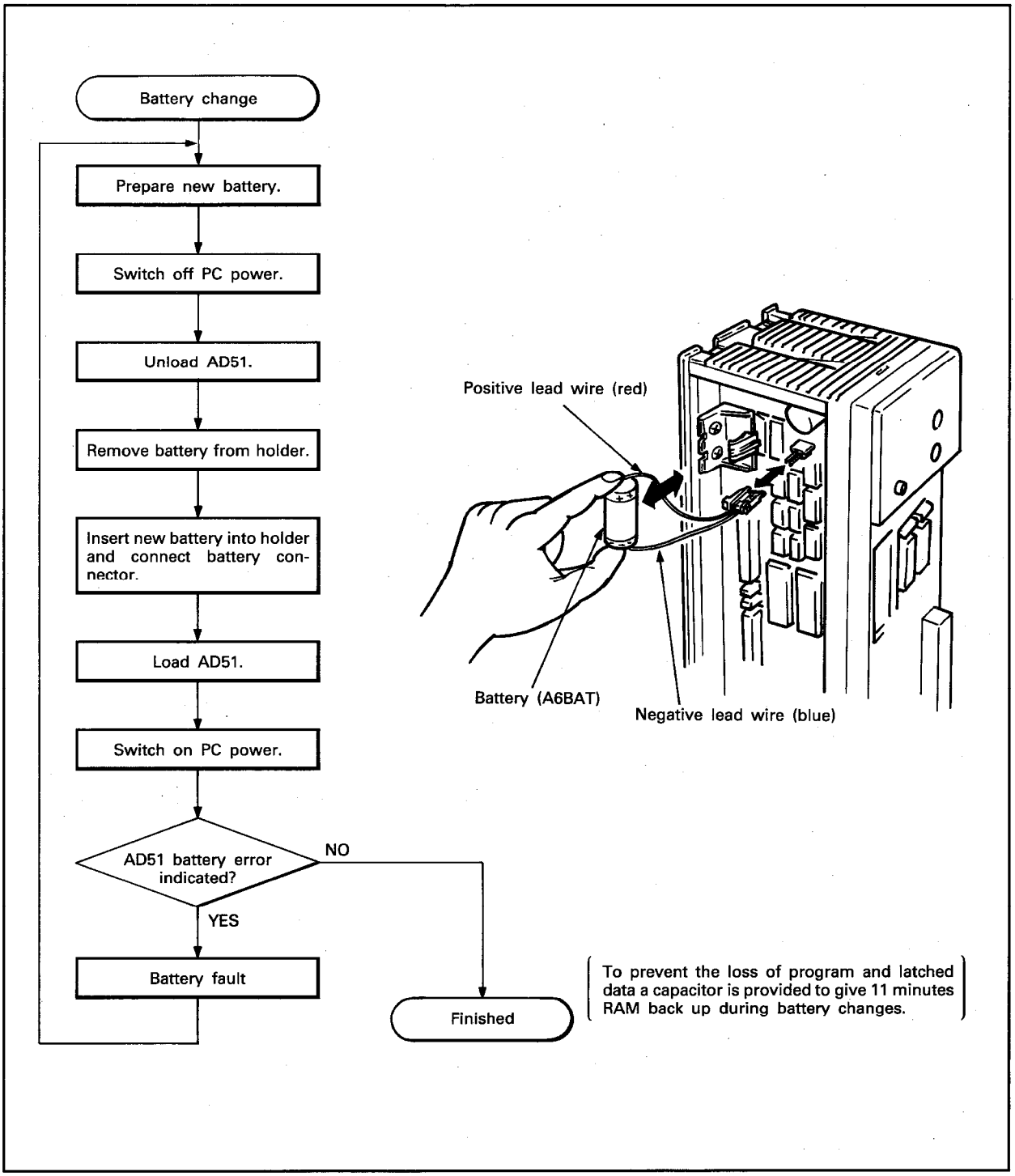


Fig. 9.1 Battery Changing Procedure

REMARKS

The battery is common to all the MELSEC-A series.
Battery storage life is 5 years. Total memory back-up guarantee period is 130 days.
Battery used is as follows.

Description :	Lithium battery
Type and rating :	Type A6BAT (3.6V with plug and leads)

Handling instructions

(1) Do not short.
(2) Do not disassemble.
(3) Do not burn.
(4) Do not heat.
(5) Do not solder electrodes.
(6) Do not measure voltage with an analog voltmeter.

APPENDICES

APPENDIX 1 Differences between AD51-S3 and AD51

The AD51-S3 differs from the AD51 in the following points:

(1) The AD51-S3 allows communication with the other stations in MELSECNET.
The other stations can be accessed by specifying the MELSECNET PC No. atthe set data head address of the system subroutine which used to access the PC CPU.

(2) In addition to the AD51 system subroutines, the AD51-S3 has the following system subroutines:

	System Subroutine	Function
1	SFLTD	32-bit integer → 32-bit floating point number
2	SFIXD	32-bit floating point number → 32-bit integer
3	SAER	Reads data from extension file registers of PC CPU.
4	SAEW	Writes data to extension file registers of PC CPU.
5	SAET	Randomly writes data to extension file registers of PC CPU.
6	SAEM0	Defines PC CPU extension file registers to be monitored.
7	SAEM1	Monitors PC CPU extension file registers specified in monitor data entry.
8	SAMR	Reads microcomputer program from PC CPU.
9	SAMW	Writes microcomputer program to PC CPU.
10	SACR	Reads comments from PC CPU.
11	SACW	Writes comments to PC CPU.
12	SATR	Reads data from special function module buffer memory.
13	SATW	Writes data to special function module buffer memory.

(3) The AD51-S3 has system data transfer mode which allows system data to be transferred from $4F00_H$-$4FFF_H$ to 8000_H-$80FF_H$ of channel 1.
This mode allows system data to be stored onto ROM.

APP

APPENDIX 2 Special Function Module Buffer Memory Address Tables

The following tables list special function module buffer memory addresses specified by the AD51 using system subroutines SATR and SATW.
For full information on the buffer memory, see the corresponding module manual.

(1) A68AD analog-to-digital converter module

Buffer Memory Assignment	Address Specified from AD51		Address for FROM/TO Instruction
	8 lower bits	8 higher bits	
Number of channels	80H	81H	0
Averaging processing specification	82H	83H	1
CH1 averaging time, count	84H	85H	2
CH2 averaging time, count	86H	87H	3
CH3 averaging time, count	88H	89H	4
CH4 averaging time, count	8AH	8BH	5
CH5 averaging time, count	8CH	8DH	6
CH6 averaging time, count	8EH	8FH	7
CH7 averaging time, count	90H	91H	8
CH8 averaging time, count	92H	93H	9
CH1 digital output value	94H	95H	10
CH2 digital output value	96H	97H	11
CH3 digital output value	98H	99H	12
CH4 digital output value	9AH	9BH	13
CH5 digital output value	9CH	9DH	14
CH6 digital output value	9EH	9FH	15
CH7 digital output value	A0H	A1H	16
CH8 digital output value	A2H	A3H	17
Write data error code	C4H	C5H	34

(2) A62DA digital-to-analog converter module

Buffer Memory Assignment	Address Specified from AD51		Address for FROM/TO Instruction
	8 lower bits	8 higher bits	
CH1 digital value	10H	11H	0
CH2 digital value	12H	13H	1
CH1 voltage set value check code	14H	15H	2
CH2 voltage set value check code	16H	17H	3
CH1 current set value check code	18H	19H	4
CH2 current set value check code	1AH	1BH	5

APP

(3) A84AD analog/digital converter module

Buffer Memory Assignment	Address Specified from AD51		Address for FROM/TO Instruction
	8 lower bits	8 higher bits	
Unused area	10H	11H	0
Averaging processing specification	12H	13H	1
CH1 averaging time, count specification	14H	15H	2
CH2 averaging time, count specification	16H	17H	3
CH3 averaging time, count specification	18H	19H	4
CH4 averaging time, count specification	1AH	1BH	5
Reserved area (must not be used)	——	——	————
CH1 digital I/O value	24H	25H	10
CH2 digital I/O value	26H	27H	11
CH3 digital I/O value	28H	29H	12
CH4 digital I/O value	2AH	2BH	13
CH1 internal setting mode flag	2CH	2DH	14
CH2 internal setting mode flag	2EH	2FH	15
CH3 internal setting mode flag	30H	31H	16
CH4 internal setting mode flag	32H	33H	17
CH1 temperature detection value	34H	35H	18
CH2 temperature detection value	36H	37H	19
CH3 temperature detection value	38H	39H	20
CH4 temperature detection value	3AH	3BH	21
CH1 set value check code	3CH	3DH	22
CH2 set value check code	3EH	3FH	23
CH3 set value check code	40H	41H	24
CH4 set value check code	42H	43H	25
Write data error code	44H	45H	26
Analog output enable signal enable/disable flag	46H	47H	27
CH1 module code	48H	49H	28
CH2 module code	4AH	4BH	29
CH3 module code	4CH	4DH	30
CH4 module code	4EH	4FH	31
CH1 temperature setting range (offset value)	50H	51H	32
CH1 temperature setting range (gain value)	52H	53H	33
CH2 temperature setting range (offset value)	54H	55H	34
CH2 temperature setting range (gain value)	56H	57H	35
CH3 temperature setting range (offset value)	58H	59H	36
CH3 temperature setting range (gain value)	5AH	5BH	37
CH4 temperature setting range (offset value)	5CH	5DH	38
CH4 temperature setting range (gain value)	5EH	5FH	39

(4) AD61 high-speed counter module

Buffer Memory Assignment	Address Specified from AD51		Address for FROM/TO Instruction	
	Channel 1	Channel 2	CH1	CH2
Preset value write (lower)	82H	C2H	1	33
Preset value write (middle)	83H	C3H		
Preset value write (upper)	84H	C4H	2	34
	85H	C5H		
Mode register	86H	C6H	3	35
	87H	C7H		
Present value read (lower)	88H	C8H	4	36
Present value read (middle)	89H	C9H		
Present value read (upper)	8AH	CAH	5	37
	8BH	CBH		
Set value read/write (lower)	8CH	CCH	6	38
Set value read/write (middle)	8DH	CDH		
Set value read/write (upper)	8EH	CEH	7	39
	8FH	CFH		

APP

IB (NA) 66189-A

(5) AD71(S1) positioning module

Buffer Memory Assignment		Address Specified from AD51	Address for FROM/TO Instruction
X axis positioning start data		200H to 391H	0 to 200
Error reset		392H 393H	201
Y axis positioning start data		458H to 5E9H	300 to 500
Positioning data	X axis positioning data	2040H to 235FH	3872 to 4271
Positioning speed	X axis positioning data	2360H to 267FH	4272 to 4671
Dwell time	X axis positioning data	2680H to 229FH	4672 to 5071
Positioning address	X axis positioning data	29A0H to 2FDFH	5072 to 5871
Positioning data	Y axis positioning data	2FE0H to 32FFH	5872 to 6271
Positioning speed	Y axis positioning data	3300H to 361FH	6272 to 6671
Dwell time	Y axis positioning data	3620H to 393FH	6672 to 7071
Positioning address	Y axis positioning data	3940H to 3F7FH	7072 to 7871
X axis parameter		3F80H to 3F9FH	7872 to 7887
Y axis parameter		3FA8H to 3FC7H	7892 to 7907
X axis zeroing data		3FD0H to 3FDDH	7912 to 7917
Y axis zeroing data		3FE4H to 3FF1H	7922 to 7928

IB (NA) 66189-A

(6) AD72 positioning module

Buffer Memory Assignment	Address Specified from AD51	Address for FROM/TO Instruction
X axis positioning start data	200H to 391H	0 to 200
Error reset	392H 393H	201
Y axis positioning start data	458H to 5E9H	300 to 500
Monitoring area	6B0H to 6BFH	600 to 607
X axis positioning data	2040H to 2FDFH	3872 to 5871
Y axis positioning data	2FE0H to 3F7FH	5872 to 7871
X axis parameter	3F80H to 3F9FH	7872 to 7891
Y axis parameter	3FA8H to 3FC7H	7892 to 7911
X axis zeroing data	3FD0H to 3FDDH	7912 to 7917
Y axis zeroing data	3FE4H to 3FF1H	7922 to 7928

(7) AJ71C24-S3

Address Specified from AD51	Address for FROM/TO Instruction
1000H to 11FFH	0 to FFH
1200H to 123FH	100H to (special application area) 11FH
1240H to 1FFFH	120H to 7FFH

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IB (NA) 66189-A

APPENDIX 3 GPP/HGP Display Control Codes

Function	Description	Code (ASCII)	BASIC Command
Line feed	Carriage return and line feed	CR, LF codes (0DH, 0AH)	——
Screen clear	All screen clear	FF code (0CH)	CLS
XON	Enable transfer from external device.	DC1 code (11H)	——
XOFF	Disable transfer from external device.	DC3 code (13H)	——
Escape	Initiate escape sequence	ESC code (1BH)	——
Back space	Cursor back one space	BS code (08H)	——
Cursor addressing	Set cursor position absolutely.	ESC + Y (59H) + line specification code (20H to 9FH) + column specification code (20H to 9FH)	LOCATE
Character qualification	Character highlight stop	ESC + O (4FH)	ZNOR
	Character highlight	ESC + R (52H)	ZCRV
	Cursor ON	ESC + S (53H)	ZCON
	Cursor OFF	ESC + T (54H)	ZCOFF
Audible alarm	Bell	BEL code (07H)	——

Display Control Code List

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APPENDIX 4 GPP/HGP/PHP Key Codes and Character Codes

(1) GPP/HGP/PHP key codes

				b_8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
				b_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
				b_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
				b_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
b_4	b_3	b_2	b_1	Column / Line	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	← HEX
0	0	0	0	0		CTRL /P	SP	0	@	P		p	INS			—					
0	0	0	1	1	CTRL /A	CTRL /Q	!	1	A	Q	a	q	↑	F1	。						
0	0	1	0	2	CTRL /B	CTRL /R	"	2	B	R	b	r	↓	F2	「						
0	0	1	1	3	BREAK	CTRL /S	#	3	C	S	c	s	→	F3	」						
0	1	0	0	4	CTRL /D	CTRL /T	$	4	D	T	d	t	←	F4	、						
0	1	0	1	5	CTRL /E	CTRL /U	%	5	E	U	e	u		F5	・						
0	1	1	0	6	CTRL /F	CTRL /V	&	6	F	V	f	v		F6							
0	1	1	1	7	CTRL /G	CTRL /W	'	7	G	W	g	w		F7							
1	0	0	0	8	BS	CAN	(	8	H	X	h	x	HOME CLR	F8							
1	0	0	1	9	HTAB	CTRL /Y	)	9	I	Y	i	y		F9							
1	0	1	0	A	LF	CTRL /Z	*	:	J	Z	j	z		F10							
1	0	1	1	B	CTRL /K	ESC	+	;	K	[	k	{									
1	1	0	0	C	CTRL /L	CTRL /¥	,	>	L	¥	l	|									
1	1	0	1	D	CR		−	=	M	]	m	}									
1	1	1	0	E	CTRL /N		.	<	N	>	n	~							゛		
1	1	1	1	F	CTRL /O	CTRL /	/	?	O	_	o	DEL							°		

↑ HEX

*For CTRL/ [ ], press [ ] and CTRL simultaneously.

Key	Key Code
MELSAP	ESC + "(" (28_H) + "M" ($4D_H$)
GPP	ESC + "(" (28_H) + "G" (37_H)

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(2) GPP/HGP/PHP character codes

	b8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
	b7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
	b6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
	b5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
b4 b3 b2 b1	Column / Line	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	← HEX
0 0 0 0	0			SP	0	@	P	`	p	┤	ニ		―			α	×	
0 0 0 1	1			!	1	A	Q	a	q	├	┌	。				β		
0 0 1 0	2			"	2	B	R	b	r	↗	■	「				ε		
0 0 1 1	3			#	3	C	S	c	s	←	▪	」				μ		
0 1 0 0	4			$	4	D	T	d	t	∠	'	、				φ		
0 1 0 1	5			%	5	E	U	e	u	≻	¸	・				θ		
0 1 1 0	6			&	6	F	V	f	v	┴	◥					ω		
0 1 1 1	7			'	7	G	W	g	w	┬	＼					Ω		
1 0 0 0	8			(	8	H	X	h	x	┤						Σ		
1 0 0 1	9			)	9	I	Y	i	y	├	―					π		
1 0 1 0	A			*	:	J	Z	j	z	↗	|					↑		
1 0 1 1	B			+	;	K	[	k	{	←	├					↓		
1 1 0 0	C			,	<	L	¥	l	|	◀	┌					▶		
1 1 0 1	D			―	=	M	]	m	}	▶	┌					+	■	
1 1 1 0	E			。	>	N	<	n	~	■	→				"	／	□	
1 1 1 1	F			/	?	O	_	o	~	|K	←				°	＼		

↑ HEX

(3) Selected character list

Key Code		English	German	Swedish	Japanese
1	5e	^	^	Ü	^
	7e	~	ß	ü	~
2	5c	＼	Ö	Ö	¥
	7c	¦	ö	ö	¦
3	40	@	§	É	@
	60	`	`	é	`
4	5b	[	Ä	Ä	[
	7b	{	ä	ä	{
5	5d	]	Ü	Å	]
	7d	}	ü	å	}
6	24	$	$	○	$
7	23	£	#	#	#

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Escape Sequence

	Function	Description	Code
1	Screen clear	All screen erase	ESC + [+ 2 + J
2	Cursor addressing	Set cursor position.	ESC + [+ (line specification) +; + (column specification) + H (*)
3	Character qualification	Character qualification OFF	ESC + [+ 0 + m
		Character highlight	ESC + [+ 7 + m
4	Cursor home	Move the cursor to home position.	ESC + [+ H

*: Line specification ····· 1 to 24
Column specification ····· 1 to 80

Example: To specify line 5 and column 10

$$\text{ESC} + [+ \underbrace{5\ (35_H)}_{\text{Line specification}} + ; + \underbrace{1\ (31_H) + 0\ (30_H)}_{\text{Column specification}} + H$$

Note: The LOCATE command counts the line and column, starting at 0. If "LOCATE 0, 0" is executed, code "ESC + [+ 1 + ; + 1 + H" is transmitted to the VT220.

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APPENDIX 5 Storing the AD51E Memory Data into ROM Using the A6WU

The AD51E internal memory and buffer memory data can be stored into the ROM with the A6WU P-ROM writer unit connected with the PC CPU.
For the operating procedure, see the A6WU Operating Manual.

The addresses must be set as follows when the AD51E data is written to the ROM using the A6WU.

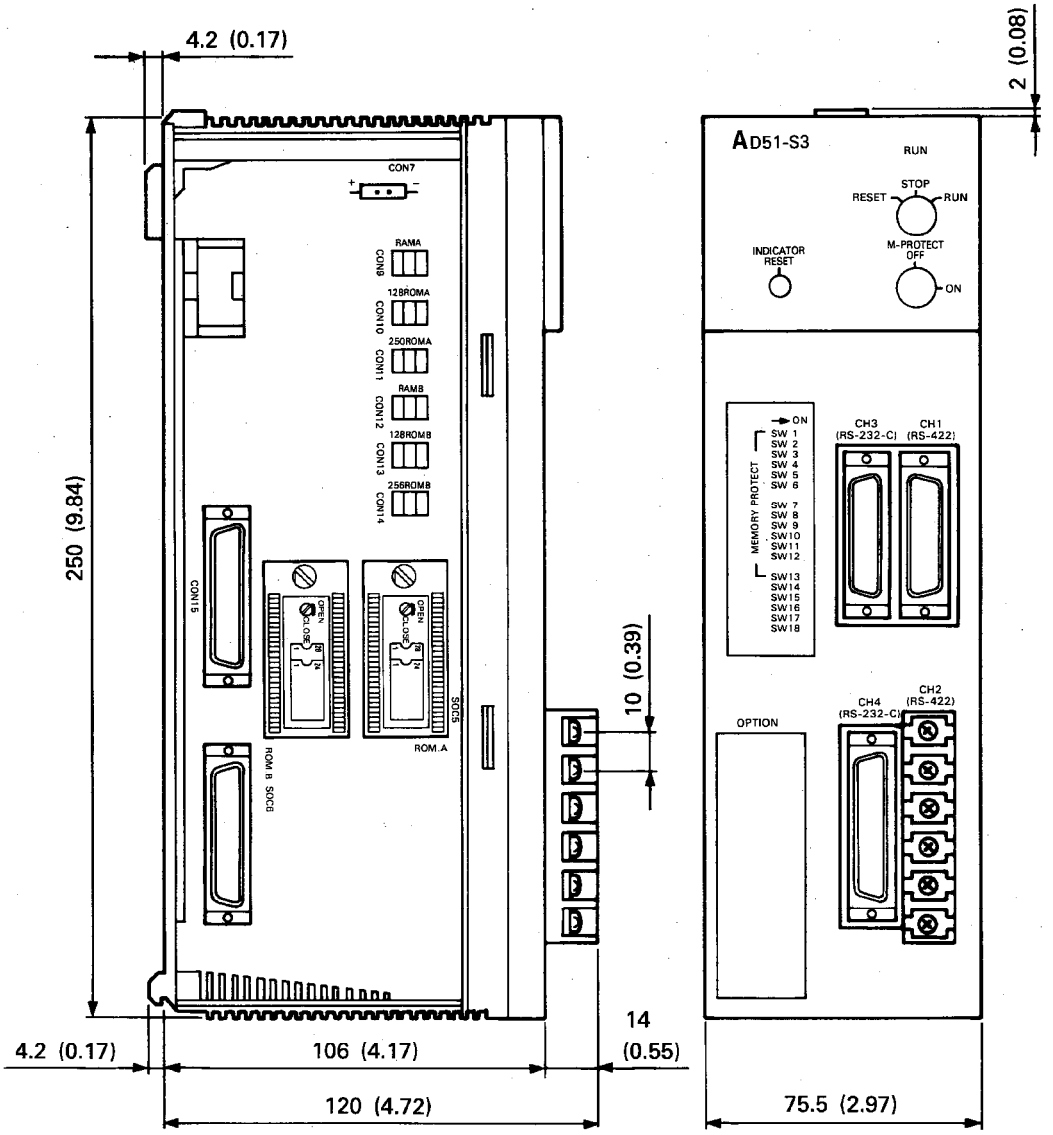
		AD51E Addresses	Addresses Set by A6WU
Programming data		$4F81_H$ to $4FD0_H$	$4F81_H$ to $4FD0_H$
Common area		6000_H to $67FF_H$	6000_H to $67FF_H$
Channel area	CH1	8000_H to $FFFF_H$	8000_H to $FFFF_H$
	CH2	8000_H to $FFFF_H$	10000_H to $17FFF_H$
	CH3	8000_H to $DFFF_H$	18000_H to $1DFFF_H$
	CH4	8000_H to $DFFF_H$	20000_H to $25FFF_H$
Buffer memory		000_H to BFF_H (0 to 3071)	0 to 3071

REMARKS

Data may only be stored to the ROM if the AD51 is connected with the A1(E), A2(E), A3(E), A1N, A2N, A3N or A3HCPU.

APP

APPENDIX 6 External View



Unit : mm (inch)

APP

IMPORTANT

The components on the printed circuit boards will be damaged by static electricity, so avoid handling them directly. If it is necessary to handle them take the following precautions.

(1) Ground human body and work bench.

(2) Do not touch the conductive areas of the printed circuit board and its electrical parts with any non-grounded tools etc.

Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.

All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.

Owing to the very great variety in possible applications of this equipment, you must satisfy yourself as to its suitability for your specific application.

Intelligent Communication Module type AD51-S3

User's Manual

MODEL	AD51E-S3-USERS-E
MODEL CODE	13J655
IB(NA)66189-A(8901)MEE	

MITSUBISHI ELECTRIC CORPORATION

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