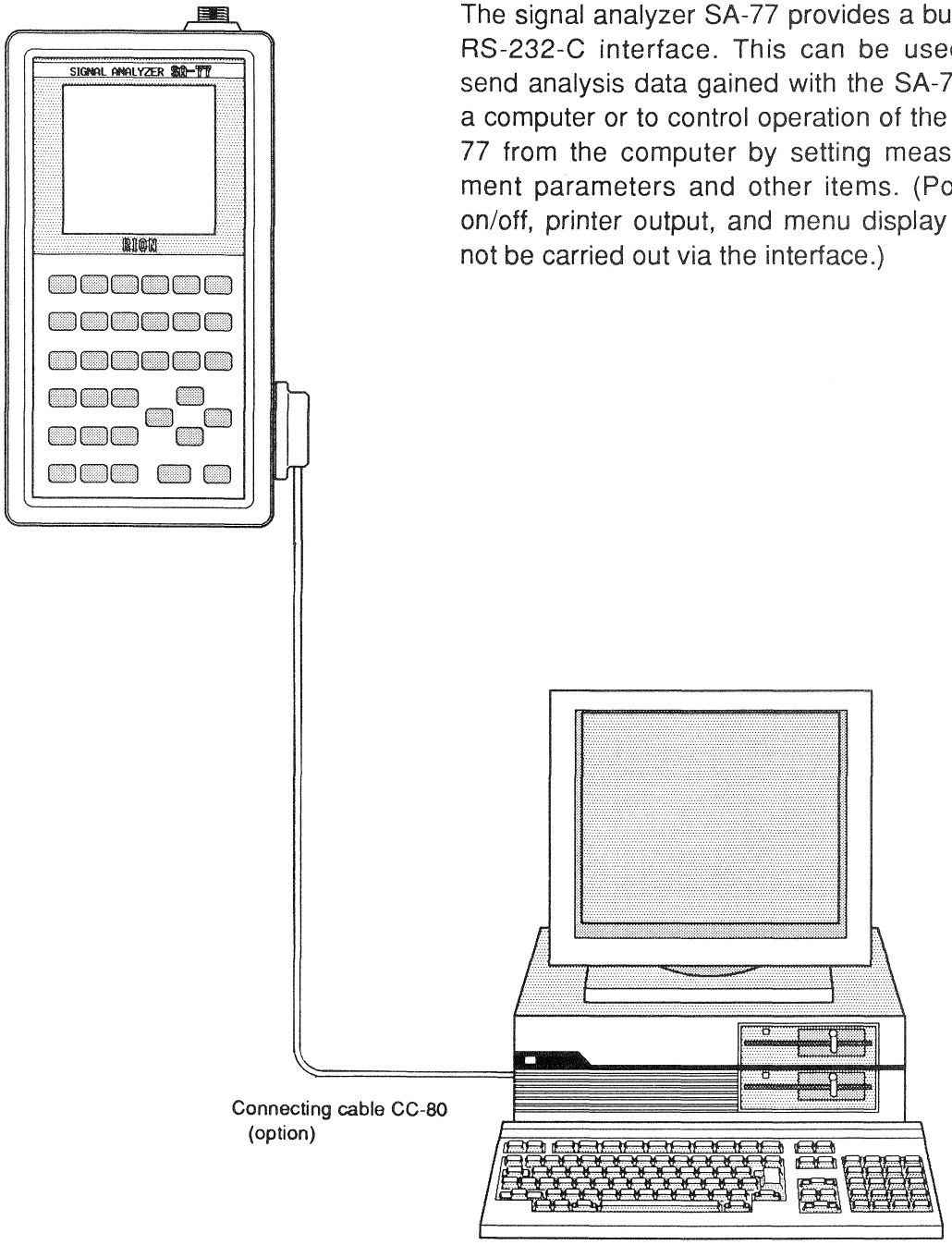
INSTRUCTION MANUAL

RS-232-C INTERFACE FOR SA-77

RION CO., LTD.

3-20-41 Higashimotomachi, Kokubunji, Tokyo 185-8533 Japan

The signal analyzer SA-77 provides a built-in RS-232-C interface. This can be used to send analysis data gained with the SA-77 to a computer or to control operation of the SA-77 from the computer by setting measurement parameters and other items. (Power on/off, printer output, and menu display can not be carried out via the interface.)



Connecting cable CC-80
(option)

CONTENTS

DATA TRANSFER PRINCIPLE

Flow control:	Yes
Transmission configuration:	Half-duplex
Data word length:	8 bit
Start bit:	1
Stop bits:	2
Parity check:	None
Baud rate:	1200, 2400, 4800, 9600 bps (selectable)
X parameter:	Enabled/disabled (selectable by command via RS-232-C interface)

• Baud rate

Can be set with menu 3 of analysis parameter setting mode (see page 52 of SA-77 instruction manual).

• X parameter

When the X parameter is enabled, data transfer from the SA-77 to the computer can be temporarily stopped with the control code DC3 and restarted with the control code DC1. When DC3 is received, the SA-77 immediately stops sending data. When DC1 is received, the SA-77 immediately resumes sending data.

DC3: Xoff (CTRL+S, 13_H)
DC1: Xon (CTRL+Q, 11_H)

When the X parameter is disabled, data flow start/stop control is not possible.
(For details on setting the X parameter, refer to page 49.)

Note: Set the X parameter to the same status at both ends (SA-77 and computer). Otherwise correct data transfer is not possible.

REMOTE MODE/LOCAL MODE

When the SA-77 is operated by commands sent from the computer, using the control keys on the SA-77 itself could interfere with proper operation. The remote mode serves to prevent this. When the remote mode is activated (by sending the command RMT from the computer), the operation keys on the SA-77 are inactive.

In the local mode, the SA-77 can be operated either by its own control keys or by commands from the computer. To set the SA-77 to the local mode after the remote mode was activated from the computer, send the command LOC from the computer or press the [EXIT] key on the SA-77.

When the SA-77 is in the local mode and a command from the computer is received, the remote mode is automatically activated. After the command has been executed, the unit reverts to local mode.

DATA TRANSFER PROCEDURE

■ Sending Commands From a Computer to the SA-77

In order to control the SA-77 from the computer and request data transfer, certain commands must be sent from the computer. To ensure that the SA-77 accepts these commands correctly, proper timing and command transfer procedure must be observed, as described below.

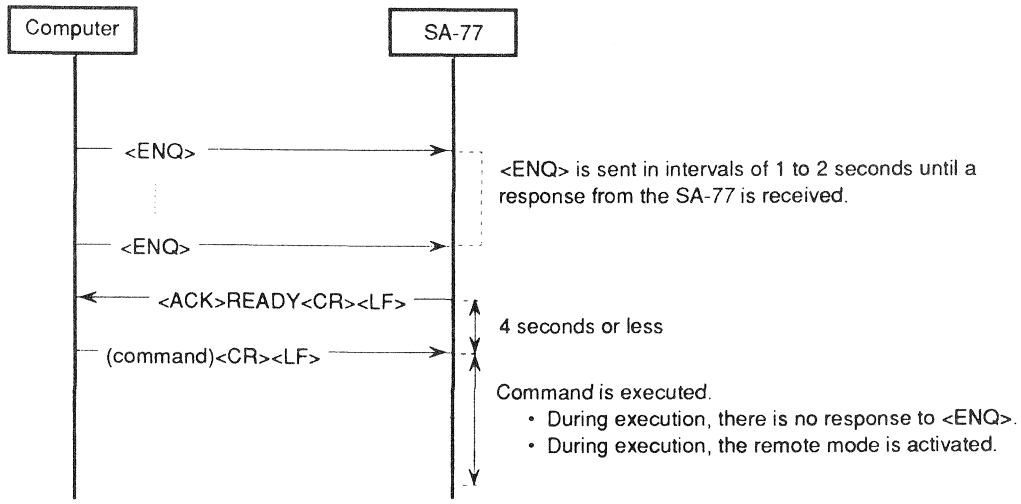
1. To initiate the transfer, the computer must first send <ENQ> to the SA-77.

2. The SA-77 responds by sending <ACK>READY<CR><LF> to the computer.

3. The computer verifies that this response string is received and then sends the command.

4. If the SA-77 receives a command from the computer within 4 seconds after sending <ACK>READY<CR><LF>, it executes the command. (The SA-77 uses the string <CR><LF> to detect the end of the command.) If no command is received within 4 seconds, a timeout error occurs. The procedure must then be repeated from the sending of <ENQ>.

Note: When an <ENQ> is sent to the SA-77 after a command, there should be a pause of at least 50 ms.



(command): single command or string of multiple commands

■ Sending Data From the SA-77 to a Computer

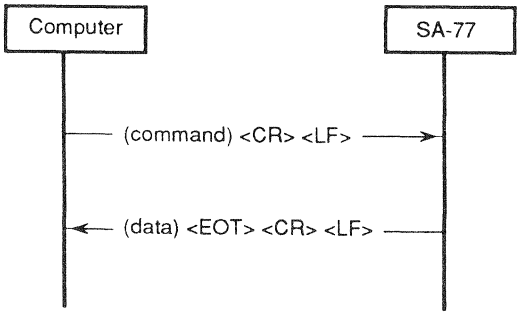
When the commands from the computer request data, the SA-77 outputs these data via the RS-232-C interface. The data transfer procedure differs depending on whether the data are longer than 251 bytes.

• Data are 251 bytes or less

Data are output in one step, in the following format:

(data)<EOT><CR><LF>

(data) : Data requested by the command (251 bytes or less)
<EOT>: Transfer control character (CTRL+D, 04H)



• Data are longer than 251 bytes

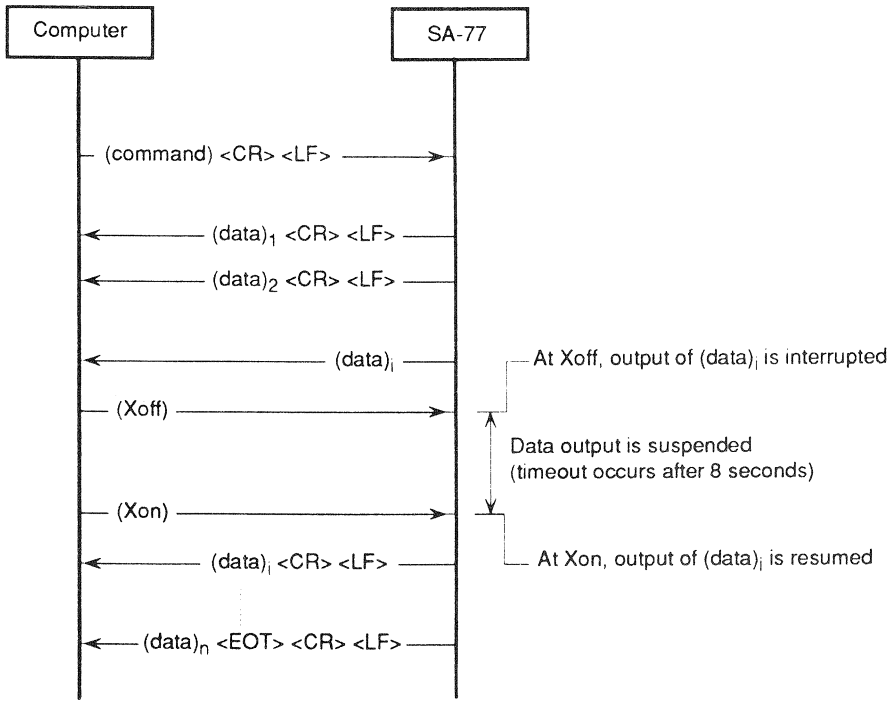
Data are separated into blocks of 254 bytes or less, including <EOT>, <CR>, and <LF>.

$(data)_1$<CR> <LF>	step 1
$(data)_2$<CR> <LF>	step 2
⋮	
$(data)_n$<EOT> <CR> <LF>	step n (last data)

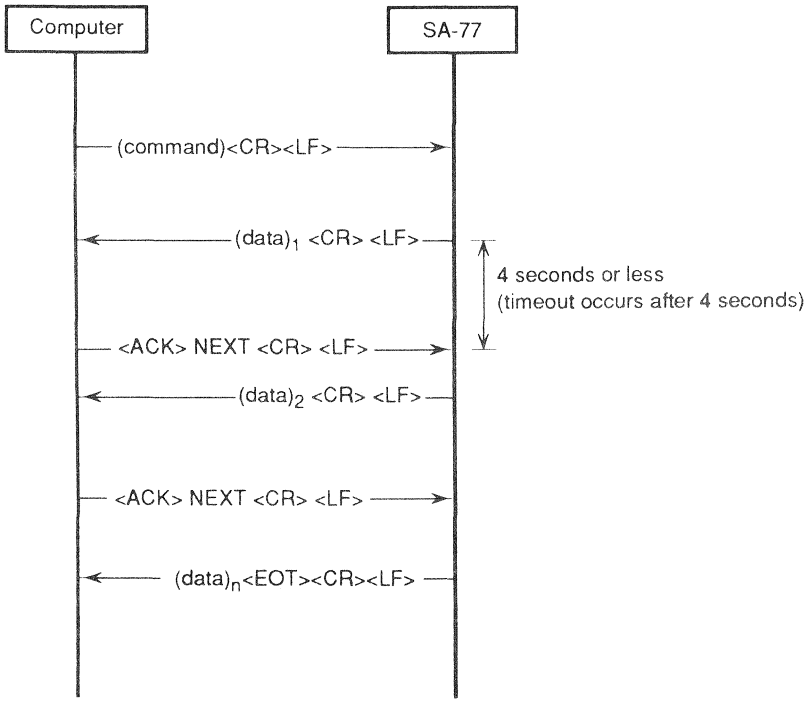
$(data)_1$ – $(data)_n$: Data requested by command

The data transfer also depends on whether the X parameter is enabled or disabled.

X parameter enabled: $(data)_1 - (data)_n$ are sent continuously. Computer can send Xon or Xoff, depending on the status of the buffer, but no other comands.
The illustration below shows the timing for a case where the computer has sent Xoff to the SA-77 to interrupt the transfer while step i is being carried out (i-th block of data is being sent).



X parameter disabled: After one block of data has been sent, the SA-77 waits until it receives an <ACK>NEXT<CR><LF> string from the computer. If data transfer is to be continued, the computer must send this string.



ERROR HANDLING

If correct transfer procedure between the SA-77 and the computer is not observed, an error occurs. In such a case, the SA-77 beeps four times, and further commands are not executed.
Error classes and countermeasures are given below.

- **The computer has sent the <ENQ> command, but there is no <ACK> READY <CR> <LF> response from the SA-77**

  Wait for 2 seconds and then send the <ENQ> command again. If the SA-77 still does not respond after several retries, the following causes are possible:

  - Transfer setup of computer and SA-77 do not match (baud rate, etc.).
  - Faulty RS-232-C cable.
  - Power to SA-77 is not turned on.
  - Execution of previous command is not completed.
    If for example the trigger standby command and data transfer command are sent together to the SA-77, the data are not output before the trigger is activated, and therefore the execution of the command is not considered complete. When wishing to execute further commands without waiting for the trigger condition, input a signal to the SA-77 which activates the trigger, or press the [EXIT] key on the SA-77.

- **Timeout**

  - If the command sending operation from the computer to the SA-77 is not completed within 4 seconds after the <ACK>READY<CR><LF> was sent, the SA-77 aborts the reception of commands. The procedure must be restarted from <ENQ>.
  - If the X parameter is disabled, the <ACK>NEXT<CR><LF> to request the next block of data must be sent from the computer to the SA-77 within 4 seconds after receiving the previous block. Otherwise the SA-77 aborts the transfer of the remaining blocks, and subsequent commands are also disregarded.
  - If the X parameter is enabled and Xoff was sent by the computer, Xon must be sent within 8 seconds. Otherwise the SA-77 aborts the transfer of the remaining blocks, and subsequent commands are also disregarded. However, by sending another Xoff

within the 8-second interval, the timeout can be extended.
If a timeout has occurred after an Xoff, it is not necessary to send Xon for the next transfer. When the SA-77 completes command execution (including error termination), it assumes receipt of an Xon.

- **Command does not have correct format**

All commands starting with the incorrect one are disregarded by the SA-77. Examples of incorrect commands are undefined commands strings or command strings not terminated by <CR> <LF>.

- **Command parameter are incorrect**

All commands starting with the incorrect one are disregarded by the SA-77. Examples of incorrect parameters are values outside the specified range or incorrect separation of commands.

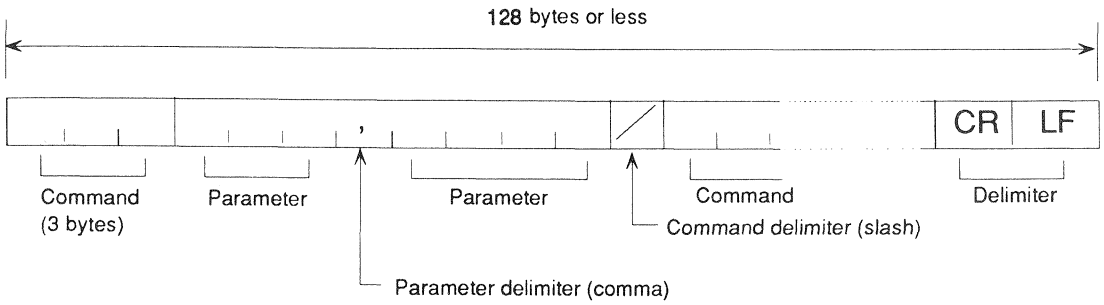
- **Commands do not match operation mode of SA-77**

Even if commands and parameters are correct, if a command does not match the current operation mode of the SA-77, that command and all subsequent ones are disregarded by the SA-77.

Examples:
- A command requesting averaging processing in the recall mode.
- A command requesting arithmetic averaging, exponential averaging or peak hold in the single trigger mode.
- A command to activate the high-pass filter or low-pass filter when input coupling is set to DC.

COMMAND FORMAT

Command must be sent to the SA-77 in the format shown below. Commands can be sent either as a single command or as a string of commands, but the maximum length must be 128 bytes or less.



- When a command can take multiple parameters, a comma must be used as delimiter.
- When several commands are sent together, a slash can be used as delimiter (optional).
- Do not insert a slash between the last command and the <CR><LF>.
- When data transfer via the RS-232-C interface is initiated while the SA-77 displays a menu, the analysis mode is automatically activated.

COMMANDS

In this manual, commands are listed and explained in the format shown below.

Command and parameters*1		Command function
	Parameter 1	Parameter function [menu settings*2]
	Parameter 2	Parameter function [menu settings*2]

*1: Parameters are shown as N_1, N_2, N_3, etc.
*2: If there is no corresponding menu, this is omitted.
Spaces within strings are indicated by "␣".

Example	HML N_1	Harmonic line display
	$N_1 = 0$	Harmonic lines not displayed [HARMONIC LINE: OFF]
	$N_1 = 1$	Harmonic lines displayed [HARMONIC LINE: ON]

When the command HML1 is sent to the SA-77, the harmonic lines are shown during spectrum and phase display.
This setting corresponds to "HARMONIC LINE: ON" on menu 3.

■ Display Commands

FNC N_1	Set data display type.
$N_1 = 0$	Spectrum
$N_1 = 1$	Time waveform
$N_1 = 2$	PDF (amplitude probability density)
$N_1 = 3$	Phase

DAV N_1	Select instantaneous or averaged data display.
$N_1 = 0$	Instantaneous data (input signal data)
$N_1 = 1$	Averaged data (result of averaging processing)

MKL N_1	Turn marker on and off.
$N_1 = 0$	Marker not displayed [MARKER LINE: OFF]
$N_1 = 1$	Marker displayed [MARKER LINE: ON]

MKP N_1 — Move marker.

N_1

When the data specified by N_1 are within the display area, the marker is moved to that position. (If such data are not within the display area, an error occurs.)

N_1 is the data pointer and serves to indicate individual data. During spectrum and phase display, data are indicated in the order 0, 1, 2, 3, etc. This means that the DC component data are 0, the data at the next frequency are 1, and so on. The maximum is 100 when the FFT zoom factor is set to 1. During time waveform display, the data pointer proceeds along the time axis, and in the PDF mode along the level axis.
The setting range depends on the type of display data and the FFT zoom factor. If a value outside the valid range is specified, an unconditional error occurs.

Display data type	FFT zoom factor	N_1 setting range	Display data type	FFT zoom factor	N_1 setting range
Spectrum	1	$0 \leqq N_1 \leqq 100$	P D F	1	$0 \leqq N_1 \leqq 63$
	2	$0 \leqq N_1 \leqq 200$		2	$0 \leqq N_1 \leqq 63$
	4	$0 \leqq N_1 \leqq 400$		4	$0 \leqq N_1 \leqq 63$
	8	$0 \leqq N_1 \leqq 800$		8	$0 \leqq N_1 \leqq 63$
Time waveform	1	$0 \leqq N_1 \leqq 255$	Phase	1	$0 \leqq N_1 \leqq 100$
	2	$0 \leqq N_1 \leqq 511$		2	$0 \leqq N_1 \leqq 200$
	4	$0 \leqq N_1 \leqq 1023$		4	$0 \leqq N_1 \leqq 400$
	8	$0 \leqq N_1 \leqq 2047$		8	$0 \leqq N_1 \leqq 800$

- Depending on the setting of the FFT zoom factor and the X axis enlargement factor, only representative data may be shown on the screen (refer to p. 25-27 of SA-77 instruction manual). When data not on the screen are specified, the marker moves on the representative data, but the marker value then shows the value of the specified data.

MVM N_1 — Select marker value type in spectrum display mode.

$N_1 = 0$ Spectrum frequency and level at marker point
$N_1 = 1$ Power sum of spectrum level data (<P.SUM>f)
$N_1 = 2$ Mean square value of time waveform data (<RMS>t)

GRD N_1 — Turn grid display on and off.

$N_1 = 0$ Grid not displayed [Y-GRID: OFF]
$N_1 = 1$ Grid displayed [Y-GRID: ON]

HML N_1 Turn harmonic line display on and off.

$N_1 = 0$ Harmonic lines not displayed [HARMONIC LINE: OFF]
$N_1 = 1$ Harmonic lines displayed [HARMONIC LINE: ON]

ORD N_1 Set base frequency of harmonic line display.

N_1 1st-order harmonic line is displayed at the position of the data specified by N_1.

N_1 is the data pointer, with a range of $1 \leqq N_1 \leqq$ (number of spectrum data - 1).

CMT N_1, N_2 Set comment display on and off and specify comment.

$N_1 = 0$ Comment not displayed [COMMENT: _____ OFF]
$N_1 = 1$ Comment displayed [COMMENT: _____ ON]
N_2 Comment string (8 characters)

Note: If $N_1 = 0$, N_2 is disregarded, but N_2 must be specified (with 8 characters) in any case, otherwise an error occurs.

EUD N_1, N_2 Select logarithmic engineering units.

$N_1 = 0$ Engineering units are not used [0dBEU = _____ OFF]
$N_1 = 1$ Engineering units are used [0dBEU = _____ ON]
N_2 0 dBEU value {(menu value) x 100, $-16000 \leqq N_2 \leqq 17999$ }

Example: $N_2 = -123.4 \times 100 = -12340$ selects the same value as a menu display of 0 dBEU = −123.4 dBV.

EUV N_1, N_2, N_3 Select linear logarithmic engineering units.

$N_1 = 0$ Engineering units are not used [1EU = _____ OFF]
$N_1 = 1$ Engineering units are used [1EU = _____ ON]
N_2 Exponential value of 1 EU {(menu value) − 2, $-10 \leqq N_2 \leqq 6$}
N_3 Mantissa value of 1 EU {(menu value) x 100, $100 \leqq N_3 \leqq 999$}

Example: $N_2 = 0 - 2 = -2$, $N_3 = 1.00 \times 100 = 100$ selects the same value as a menu display of 1 EU = $1.00E^{+0}$V.

OPE N_1 — Select spectrum differentiation and integration.

$N_1 = 0$	No differentiation or integration	[SPEC OPE: OFF]
$N_1 = 1$	Double integral	[SPEC OPE: $-1/\omega^2$]
$N_1 = 2$	Integral	[SPEC OPE: $1/j\omega$]
$N_1 = 3$	Differential	[SPEC OPE: $j\omega$]
$N_1 = 4$	Two-step differential	[SPEC OPE: $-\omega^2$]

SXU N_1 — Select frequency unit for spectrum and phase display.

$N_1 = 0$	Hz	[X-UNIT: Hz]
$N_1 = 1$	KCPM	[X-UNIT: KCPM]
$N_1 = 2$	ORD	[X-UNIT: ORD]

LIN N_1 — Select level scale for spectrum display.

$N_1 = 0$	Logarithmic	[Y-AXIS: log]
$N_1 = 1$	Linear	[Y-AXIS: lin]

DZY N_1 — Enlarge along Y axis.

N_1 — Specify enlargement factor with N_1.

The possible range for N_1 depends on the type of data. Information on range and relation of N_1 to actual enlargement factor is given in the table below.

Display data type	N_1 setting range	Actual enlargement factor
Spectrum (logarithmic)	$0 \leqq N_1 \leqq 2$	2^{N1} (1-4)
Spectrum (linear)	$0 \leqq N_1 \leqq 7$	2^{N1} (1-128)
Time waveform	$0 \leqq N_1 \leqq 7$	2^{N1} (1-128)
PDF	$N_1=0$	1 (100%) *
	$N_1=1$	2 (50%) *
	$N_1=2$	4 (25%) *
	$N_1=3$	10 (10%) *
	$N_1=4$	20 (5%) *
	$N_1=5$	40 (2.5%) *
	$N_1=6$	100 (1%) *
Phase	Not allowed	

*: The values in brackets indicate the Y axis full-scale value.

SHY N_1 Shift display area along Y axis (not allowed when Y axis enlargement factor is 1).

N_1 Specify shift destination with N_1.

The unit for N_1 is the number of dots on the data display. One dot is 1/120 of the display size in the Y axis direction. The setting range of N_1 depends on the Y axis enlargement factor and the type of data.

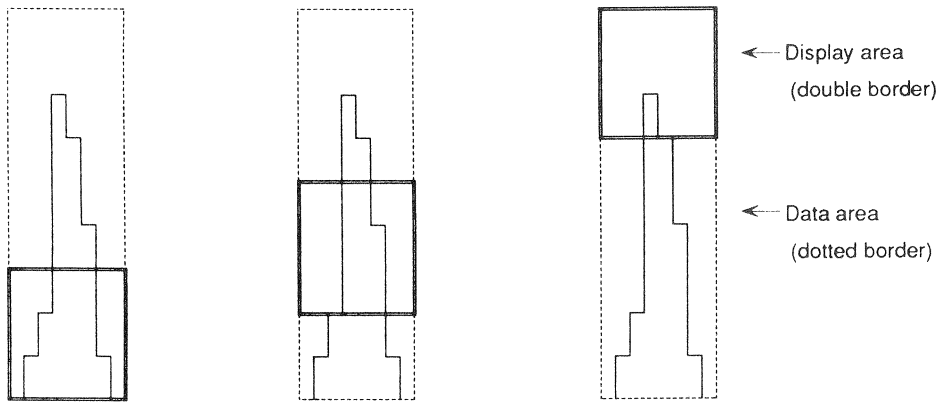
Display data type	N_1 setting range	N_1 value at home position
Spectrum (logarithmic)	$120 \leqq N_1 \leqq 120 \times 2^X$	120×2^X
Spectrum (linear)	$-(2^X-1) \times 120 \leqq N_1 \leqq 0$	0
Time waveform	$-(60 \times 2^X)+120 \leqq N_1 \leqq 60 \times 2^X$	60
PDF	$-\{\frac{k_{(0)}}{k_{(x)}} -1\} \times 120 \leqq N_1 \leqq 0$	0
Phase	Not allowed	

X: Y axis enlargement factor as determined by N_1 of DZY command (☞ p.13)

$k_{(x)}$: Y axis full-scale value depending on N_1 (=X) of DZY command ($k_{(0)} = 100$, $k_{(1)} = 50$, $k_{(2)} = 25$, $k_{(3)} = 10$ ... $k_{(6)} = 1$)

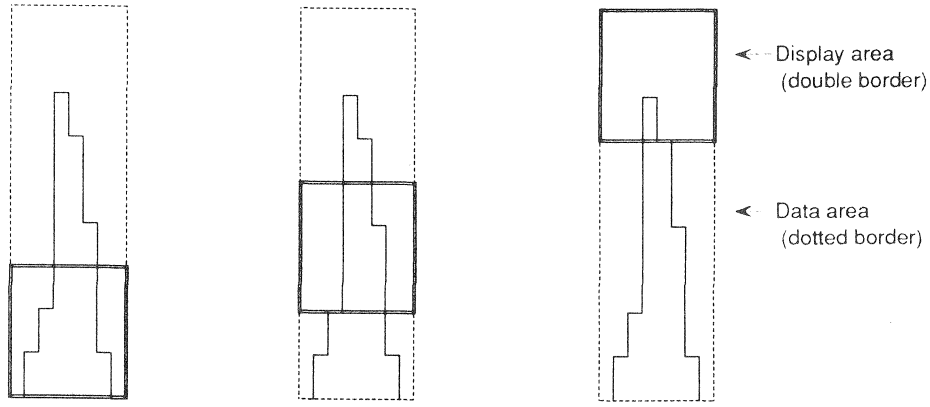
Specification of N_1 depends on the type of display data, as shown below.

• Logarithmic spectrum



The display is at the home position when the lower end of the display area and the lower end of the data area match. This is expressed by $N_1 = 120 \times 2^X$. Moving the display area by n dots from the home position is expressed by $N_1 = 120 \times 2^X - n$.

• Linear spectrum



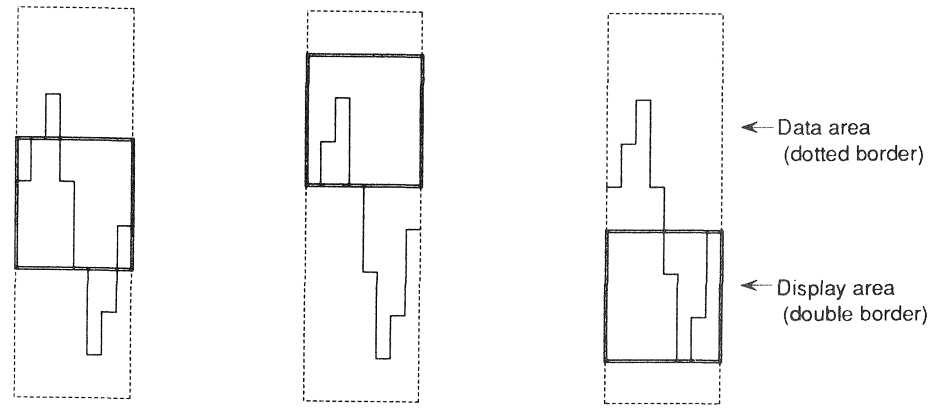
$N_1=0$
Home position

$N_1=0-n$
Move n dots up from
home position

$N_1=-(2^x-1)\times120$
Upper ends of data area
and display area match

The display is at the home position when the lower end of the display area and the lower end of the data area match. This is expressed by $N_1 = 0$. Moving the display area by n dots from the home position is expressed by $N = 0 - n$.

• Time waveform



$N_1=60$
Home position

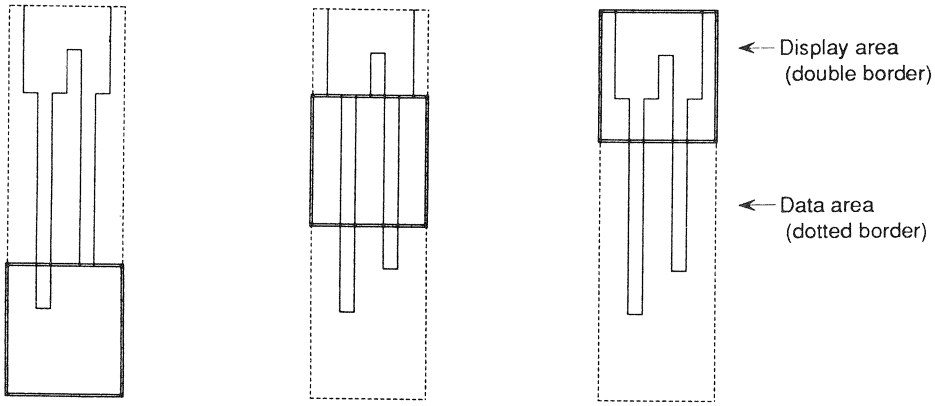
$N_1=60-n$
Move n dots up from
home position

$N_1=60+n$
Move n dots down from
home position

The display is at the home position when the display area is at the center of the data area. This is expressed by $N_1 = 60$. Moving the display area up by n dots from the home position is expressed by $N_1 = 60 - n$. Moving the display area down by n dots from the home position is expressed by $N_1 = 60 + n$.

Matching the upper end of the data area and the upper end of the display area is expressed by $N_1 = -(60 \times 2^x) + 120$, and matching the lower end of the display area and the lower end of the data area is expressed by $N_1 = 60 \times 2^x$.

• PDF



$N_1=0$

Home position

$N_1=0-n$

Move n dots up from home position

$N_1=-\{\frac{K(0)}{K(x)}-1\}\times120$

Upper ends of data area and display area match

The display is at home position when the lower end of the display area and the lower end of the data area match. This is expressed by $N_1 = 0$. Moving the display area by n dots from the home position is expressed by $N_1 = 0 - n$.

DZX N_1 Enlarge along X axis (relative enlargement)

N_1 Specify enlargement ratio with N_1.
When wishing to enlarge the current display by a factor of 2^n, set N_1 to –n.
The N_1 value is limited by the type of display data, FFT zoom factor, and current enlargement. N_1 must be set so as not to exceed the possible range, as shown below.

Display data	FFT zoom factor	Current enlargement	N_1 setting range	Enlargement after command execution
Spectrum and Phase	1	$X\ 2^0$	$N_1 = 0$	$X\ 2^0$
	2	$X\ 2^{1-N}$	$-N \leqq N_1 \leqq 1-N$	$X\ 2^{1-(N+N1)}$
	4	$X\ 2^{2-N}$	$-N \leqq N_1 \leqq 2-N$	$X\ 2^{2-(N+N1)}$
	8	$X\ 2^{3-N}$	$-N \leqq N_1 \leqq 3-N$	$X\ 2^{3-(N+N1)}$
Time waveform	1	$X\ 2^{2-N}$	$-N \leqq N_1 \leqq 2-N$	$X\ 2^{2-(N+N1)}$
	2	$X\ 2^{3-N}$	$-N \leqq N_1 \leqq 3-N$	$X\ 2^{3-(N+N1)}$
	4	$X\ 2^{4-N}$	$-N \leqq N_1 \leqq 4-N$	$X\ 2^{4-(N+N1)}$
	8	$X\ 2^{5-N}$	$-N \leqq N_1 \leqq 5-N$	$X\ 2^{5-(N+N1)}$
PDF	Not allowed			

Example
Display data: Time waveform
FFT zoom factor: 8
Current enlargement: 4 times
From $4 = 2^{5-N}$ follows that $N = 3$
Because $-N \leqq N_1 \leqq 5 - N$, the range limit is $-3 \leqq N_1 \leqq 2$.

This gives the following possible settings.
$N_1 = -3$: Current display is enlarged by a factor of 8 along X axis (X32)
$N_1 = -2$: Current display is enlarged by a factor of 4 along X axis (X16)
$N_1 = -1$: Current display is enlarged by a factor of 2 along X axis (X 8)
$N_1 = 0$: Current display does not change (X 4)
$N_1 = 1$: Current display is reduced by a factor of 1/2 along X axis (X 2)
$N_1 = 2$: Current display is reduced by a factor of 1/4 along X axis (X 1)
Figures in brackets show the enlargement after command execution.

ZMX N_1 Enlarge along X axis (absolute enlargement).

N_1 Specify enlargement factor with N_1.
The setting range for N_1 depends on the display data and the FFT zoom factor. The relationship between the N_1 value and the actual enlargement factor is as shown below.

Display data	FFT zoom factor	N_1 setting range	Actual enlargement factor	Enlargement after command execution
Spectrum and Phase	1	$N_1 = 0$	2^{N1} (1)	X 2^{N1}
	2	$0 \leqq N_1 \leqq 1$	2^{N1} (1 to 2)	X 2^{N1}
	4	$0 \leqq N_1 \leqq 2$	2^{N1} (1 to 4)	X 2^{N1}
	8	$0 \leqq N_1 \leqq 3$	2^{N1} (1 to 8)	X 2^{N1}
Time waveform	1	$0 \leqq N_1 \leqq 2$	2^{N1} (1 to 4)	X 2^{N1}
	2	$0 \leqq N_1 \leqq 3$	2^{N1} (1 to 8)	X 2^{N1}
	4	$0 \leqq N_1 \leqq 4$	2^{N1} (1 to 16)	X 2^{N1}
	8	$0 \leqq N_1 \leqq 5$	2^{N1} (1 to 32)	X 2^{N1}
PDF	Not allowed			

SHX N_1 Shifts the display area along the X axis (not allowed when X axis enlargement factor is 1).

N_1 Specify shift destination with N_1.

The data specified by N_1 will be displayed at the left edge of the screen. Display data are selected as $N_1 = 0$, $N_1 = 1$, $N_1 = 2$, $N_1 = 3$, etc. in the frequency order for spectrum and phase display and in time order for time waveform display. For example in spectrum display, $N_1 = 0$ specifies DC, $N_1 = 1$ specifies the next frequency data, and so on.

Note: Depending on the setting of the FFT zoom factor and the X axis enlargement factor, representative data only may be shown on the display (refer to **p.25 - 27** of SA-77 instruction manual). In such a case, the representative data only are numbered 0, 1, 2, 3, etc., and this number is specified by N_1.

The setting range of N_1 depends on the X axis enlargement factor and the type of data.

Display data type	X axis enlargement factor	N_1 setting range
Spectrum Phase	1	Not allowed
	2	$0 \leqq N_1 \leqq 100$
	4	$0 \leqq N_1 \leqq 300$
	8	$0 \leqq N_1 \leqq 700$
Time waveform	1	Not allowed
	2	$0 \leqq N_1 \leqq 27$
	4	$0 \leqq N_1 \leqq 155$
	8	$0 \leqq N_1 \leqq 411$
	16	$0 \leqq N_1 \leqq 923$
	32	$0 \leqq N_1 \leqq 1947$
PDF		Not allowed

HOM Return display area to home position (no parameters).

After shifting the display area along the X axis or Y axis, this command returns the display area to the home position.
When the home position is defined by the N_1 parameters of the SHX command (☞p.19) and SHY command (☞p.14), the following applies.

X axis direction (SHX command)	$N_1 = 0$
Y axis direction (SHY command)	
Spectrum (logarithmic):	$N_1 = 120 \times 2^X$
Spectrum (linear):	$N_1 = 0$
Time waveform:	$N_1 = 60$
PDF:	$N_1 = 0$

X: Y axis enlargement factor specified with DZY command parameter (☞p.13)

■ Status Verification Command

EST Get execution status of last command sent to SA-77 (no parameters).

When EST is sent to the SA-77, the SA-77 returns the execution status of the previous command in the following format.

$a_1\ a_2\ a_3\ a_4\ a_5\ a_6\ a_7\ a_8$, $b_1\ b_2\ b_3$, $c_1\ c_2\ c_3\ c_4\ c_5\ c_6\ c_7\ c_8$ <EOT> <CR> <LF>

(1) (2) (3)

(1) Error information 1

a_1 - a_8 is 1 when an error has occurred, 0, when no error has occurred.

a_1 : Undefined command or command longer than 128 bytes

a_2 : Undefined (0)

a_3 : Command could not be executed*.

a_4 : Command parameters are incorrect.

a_5 : [EXIT] was pressed, causing termination of the command execution.

a_6 : Undefined (0)

a_7 : Undefined (0)

a_8 : Undefined (0)

*: For example, if a command to alter the level range or frequency span was sent while auto store is being carried out.

(2) Command number information

If no error has occurred, the number of commands received by the SA-77 is indicated here. If an error has occurred, the number of executed commands (including error commands) is indicated. (Zeros are not suppressed for $b_1\ b_2\ b_3$.)

(3) Error information 2

c_1 - c_8 is 1 when an error has occurred, 0 when no error has occurred.

c_1: Time-out error

c_2: Break condition is detected.
(When low level state continues from start bit to stop bit.)

c_3: Frame error
(When high level state was detected where stop bit is expected.)

c_4: Overrun error
When SA-77 is receiving data and subsequent data are sent before previous data have been read completely, an overrun error occurs. (Received data are lost.)

c_5: Always 0

c_6: Undefined (0)

c_7: Data end error
When total number of commands sent from computer is too high or too low. For example more than 129 bytes of commands are sent, or number of comment characters is 7 or less or 9 or more.

c_8: Undefined (0)

■ Memory Processing Commands

ADR N_1 Specify an address to be displayed.

N_1 N_1 sets the address number.
When the SA-77 is not in the recall mode, the setting range of N_1 depends on the store type. When the SA-77 is in the recall mode, the setting range depends on which store type was used to store the data in the mass memory.

Store type	N_1 setting range
Manual store	$1 \leqq N_1 \leqq 150$
Auto store	$1 \leqq N_1 \leqq 150$
Transient store (Number of sampling points)	$1 \leqq N_1 \leqq 30720$

MTP N_1 Set store type.

$N_1 = 0$	Manual store	[STORE TYPE: MANU]
$N_1 = 1$	Auto store	[STORE TYPE: AUTO]
$N_1 = 2$	Transient store	[STORE TYPE: TRSN]

STP N_1, N_2 Set step count.

$N_1 = 0$ N_2 is used to indicate the step count in manual store and auto store.
$N_1 = 1$ N_2 is used to indicate the step count in transient store.
N_2 N_2 specifies a number for the step count. [STEP: ΔN_2]
The setting range of N_2 depends on the setting of N_1.

N_1 setting	N_2 setting range
0	$1 \leqq N_2 \leqq 50$
1	$1 \leqq N_2 \leqq 9999$

STO Start data store process (no parameters).

The type of data being stored when this command is issued depends on the store type setting. For manual store, the address must be specified with the ADR command beforehand. For auto store or transient store, storing is carried out from address 1 until the memory becomes full. (Refer to p. 63 - 71 of SA-77 instruction manual.)

RCL Activate recall mode and display stored data (no parameters).

Data are shown with the same conditions as set when the data were stored. The address of the displayed data can be changed with the ADR command.

Data can also be displayed with different conditions. During display of auto store or transient store data, changed conditions remain effective also when a new address is selected. During display of manual store data, display conditions are stored in each address together with the data. The display conditions therefore change when a new address is selected.

MDC N_1, N_2 Erase specified data from memory.

N_1 N_1 specifies the starting address for erasure.
N_2 N_2 specifies the ending address for erasure. [CLEAR: N_1 . . N_2]

This command is valid only for data stored with manual store. When this command is given for data stored with auto store or transient store, an error occurs.

Setting range: $1 \leqq N_1 \leqq N_2 \leqq 150$

STS Stop auto store or transient store (no parameters).

EDR Cancel recall mode (no parameters).

PNS N_1 Store analysis conditions in panel memory.

N_1 Stores the conditions in the panel memory number specified by N_1.
[STORE: N_1]
Setting range: $1 \leqq N_1 \leqq 4$

PNR N_1 Recall analysis conditions stored in a panel memory.

N_1 Recalls the conditions stored in the panel memory number specified by N_1.
[RECALL: N_1]
Setting range: $1 \leqq N_1 \leqq 4$

■ Information Output Commands

STI N_1	Get display data type or operation status.
$N_1 = 0$	Get display data type.
$N_1 = 1$	Get operation status.
$N_1 = 2$	Get marker value type during spectrum display.
$N_1 = 3$	Get over-range information in current measurement.

- **When $N_1 = 0$**

  Display data type is indicated by SA-77 in the following format.

  $a_1\ a_2$, b_1 <EOT> <CR> <LF>
  (1) (2)

  (1) Display data type

0: Spectrum	4: $\overline{\text{Spectrum}}$	8: $\overline{\text{Spectrum}}$
1: Time waveform	5: $\overline{\text{Time waveform}}$	9: None
2: PDF	6: $\overline{\text{PDF}}$	10: $\overline{\text{PDF}}$
3: Phase	7: None	11: $\overline{\text{Phase}}$

  The solid line indicates averaged data, and the dotted line data gained from time waveform averaged data.

  (2) Analysis mode / recall mode identification
  0: Analysis mode (currently input data)
  1: Recall mode (data stored in memory)

- **When $N_1 = 1$**

  Operation status is indicated by SA-77 in the following format.

  a_1, b_1, c_1, d_1, $e_1\ e_2\ e_3\ e_4$ <EOT> <CR> <LF>
  (1) (2) (3) (4) (5)

  (1) Pause
  0: Pause released
  1: Pause

  (2) Averaging processing
  0: Averaging off
  1: Averaging being carried out
  2: Averaging terminated (arithmetic averaging or peak hold)

(3) Trigger
0: Free-run trigger
1: Repeated or single trigger activation, or trigger standby
2: Single trigger has been activated

(4) Store
0: Auto store or transient store not being carried out
1: Auto store being carried out
2: Transient store being carried out

(5) Number of frames on which averaging was carried out (meaningful in arithmetic averaging or peak hold)

● **When $N_1 = 2$**

Marker value type is indicated by SA-77 in the following format.

a_1<EOT><CR><LF>
(1)

(1) Marker value types
0: Spectrum frequency and level
1: Power sum of spectrum level data (<P.SUM>f)
2: Mean square value of time waveform data (<RMS>t)

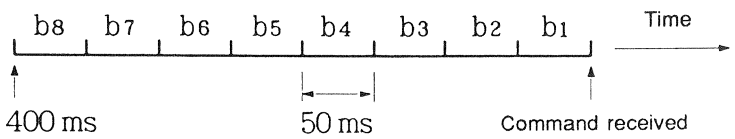
● **When $N_1 = 3$**

Over-range information is indicated by SA-77 in the following format.

$a_1a_2a_3a_4a_5a_6$, $b_1b_2b_3b_4b_5b_6b_7b_8$<EOT><CR><LF>
(1) (2)

(1) Indicates elapsed time since over-range condition occurred. Range is 50 ms to 3276.75 s, in 50 ms units.
When an over-range condition occurs, the count is incremented each 50 ms, up to 65535. After the upper limit is reached, the count returns to 0. When the command is received, the SA-77 returns the current count value.

(2) Indicates whether over-range has occurred in the last 400 ms, in 50 ms units.
bn = 0: Over-range has not occurred during 50 ms interval.
bn = 1: Over-range has occurred during 50 ms interval.



PSI N_1	Get setting status of analysis conditions.
$N_1 = 1$	Get setting status of menu 1.
$N_1 = 2$	Get setting status of menu 2.
$N_1 = 3$	Get setting status of menu 3.
$N_1 = 4$	Get setting status of menu 4.

● **When $N_1 = 1$**

Menu 1 setting status is indicated by SA-77 in the following format.

$a_1\ a_2,\ b_1\ b_2,\ \pm c_1\ c_2\ c_3.\ c_4,\ d_1.\ d_2\ d_3\ \pm d_4,\ e_1,\ f_1,\ g_1,\ h_1,\ i_1,\ j_1,\ k_1$ <EOT> <CR> <LF>

(1) (2) (3) (4) (5) (6) (7) (8) (9)(10)(11)

(1) Sampling signal (internal/external) and frequency span

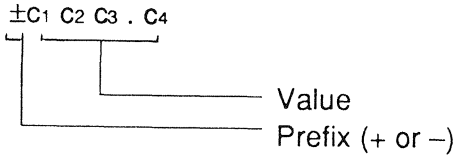
0: Internal, 100 Hz	10: External, 100 Hz
1: Internal, 200 Hz	11: External, 200 Hz
2: Internal, 500 Hz	12: External, 500 Hz
3: Internal, 1 kHz	13: External, 1 kHz
4: Internal, 2 kHz	14: External, 2 kHz
5: Internal, 5 kHz	15: External, 5 kHz
6: Internal, 10 kHz	16: External, 10 kHz
7: Internal, 20 kHz	17: External, 20 kHz
8: Internal, 50 kHz	18: External, 50 kHz

When the internal sampling signal is selected (0-8), the frequency span and the cutoff frequency of the anti-aliasing filter match. When the external sampling signal is selected (10-18), the indicated frequency is the frequency of the anti-aliasing filter.

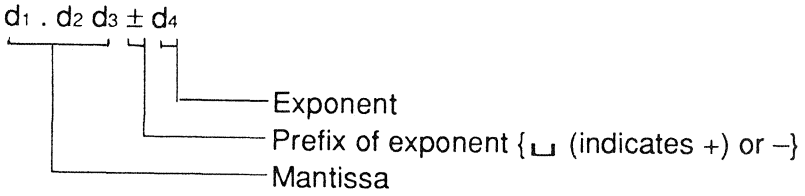
(2) Level range and unit

0: 0.003 Vrms	10: 0.004 V
1: 0.01 Vrms	11: 0.014 V
2: 0.031 Vrms	12: 0.044 V
3: 0.1 Vrms	13: 0.141 V
4: 0.316 Vrms	14: 0.447 V
5: 1.0 Vrms	15: 1.414 V
6: 3.162 Vrms	16: 4.472 V
7: 10.0 Vrms	17: 14.14 V

(3) Logarithmic EU value (menu value)



(4) Linear EU value (menu value)



(5) EU units
0: Off 1: On

(6) High-pass filter
0: Off 1: 5 Hz 2: 50 Hz 3: 1 kHz

(7) Low-pass filter
0: Off 1: 1 kHz 2: 5 kHz 3: 10 kHz

(8) Input coupling
0: AC 1: DC

(9) Envelope processing
0: Off 1: On

(10) FFT zoom factor
0: 1 1: 2 2: 4 3: 8

(11) Window type
0: Rectangular 1: Hanning 2: Flat-top

- **When $N_1 = 2$**

  Menu 2 setting status is indicated by SA-77 in the following format.

  a_1, b_1, $c_1\ c_2\ c_3\ c_4$, $d_1\ d_2\ d_3\ d_4$, $e_1\ e_2\ e_3\ e_4$, $f_1\ f_2$, $g_1\ g_2$, $\pm h_1\ h_2\ h_3\ h_4$ <EOT> <CR> <LF>

  (1) (2) (3) (4) (5) (6) (7) (8)

  (1) Averaging processing
  - 0: No averaging
  - 1: Arithmetic averaging
  - 2: Exponential averaging
  - 3: Peak hold

  (2) Averaging processing domain
  - 0: Spectrum 1: Time waveform 2: PDF

  (3) Number of frames for arithmetic averaging

  (4) Weighting for exponential averaging

  (5) Number of frames for peak hold

  (6) Trigger source (internal/external) and trigger mode
  - 0: Internal, free-run 10: External, free-run
  - 1: Internal, repeated 11: External, repeated
  - 2: Internal, single 12: External, single

  (7) Trigger slope (– /+) and trigger level
  - 0: –, –7/8 20: +, –7/8
  - 1: –, –6/8 21: +, –6/8
  - ⋮ ⋮
  - 15: –, 7/8 35: +, 7/8

  (8) Trigger point

  $-h_1\ h_2\ h_3\ h_4$: Pre-trigger $+h_1\ h_2\ h_3\ h_4$: Post-trigger

- **When $N_1 = 3$**

  Menu 3 setting status is indicated by SA-77 in the following format.

  a_1, b_1, c_1, $d_1\ d_2\ d_3\ d_4$, e_1, f_1, g_1, h_1 <EOT> <CR> <LF>

  (1) (2) (3) (4) (5) (6) (7) (8)

(1) Spectrum differentiation or integration
0: No differentiation or integration 3: Differential
1: Double integral 4: Two-step differential
2: Integral

(2) Frequency scale unit for spectrum display and phase display
0: Hz 1: KCPM 2: ORD

(3) Level scale for spectrum display
0: Logarithmic 1: Linear

(4) Position of first-order harmonic line
d_1 d_2 d_3 d_4: Data pointer

(5) Grid display
0: Off 1: On

(6) Harmonic line display
0: Off 1: On

(7) Marker display
0: Off 1: On

(8) Auto power off
0: Auto power off function not active 1: Auto power off function active

- **When $N_1 = 4$**

Menu 4 setting status is indicated by SA-77 in the following format.

a_1, b_1, c_1 c_2 c_3 c_4, d_1 d_2 d_3 d_4, e_1, f_1 f_2 f_3 f_4 f_5 f_6 f_7 f_8 <EOT> <CR> <LF>
(1) (2) (3) (4) (5) (6)

(1) Store type
0: Manual 1: Auto 2: Transient

(2) Format of data stored in mass memory
0: Manual store data
1: Auto store data
2: Transient store data

(3) Step count for manual store and auto store (1-50)

(4) Step count for transient store (1 - 9999)

(5) Comment display
0: Off 1: On

(6) Comment string (8 characters)

DPI N_1	Get enlargement factor or position of display area and maker.
$N_1 = 0$	Get enlargement factor along X axis (using parameter N of DZX command).
$N_1 = 1$	Get enlargement factor along Y axis.
$N_1 = 2$	Get display area and maker position.
$N_1 = 3$	Get enlargement factor along X axis (using parameter N_1 of ZMX command).

- **When $N_1 = 0$**

Current enlargement factor along X axis is indicated by SA-77 in the following format, according to the parameter N of the DZX command (☞ p.17).

a_1, b_1, c_1 <EOT> <CR> <LF>
(1) (2) (3)

(1) Enlargement factor for spectrum display
(2) Enlargement factor for time waveform display
(3) Enlargement factor for phase display

- **When $N_1 = 1$**

The SA-77 outputs the enlargement factor on the Y axis, corresponding to the N_1 parameter of the DZY command (☞ p.13), in the following format.

a_1, b_1, c_1, d_1 <EOT> <CR> <LF>
(1) (2) (3) (4)

(1) Enlargement factor for logarithmic spectrum display
(2) Enlargement factor for linear spectrum display
(3) Enlargement factor for time waveform display
(4) Enlargement factor for PDF display

- **When N_1 = 2**

The SA-77 outputs the display area position on the X axis and the marker position in the following format. The display area position corresponds to the N_1 parameter of the SHX command (☞ p.19), and the marker position to the N_1 parameter of the MKP command (☞ p.11).

$a_1\ a_2\ a_3\ a_4$, $b_1\ b_2\ b_3\ b_4$, $c_1\ c_2\ c_3\ c_4$, $d_1\ d_2\ d_3\ d_4$, $e_1\ e_2\ e_3\ e_4$, $f_1\ f_2\ f_3\ f_4$, $g_1\ g_2\ g_3\ g_4$,
(1) (2) (3) (4) (5) (6) (7)

$h_1\ h_2\ h_3\ h_4$ <EOT> <CR> <LF>
(8)

(1) Display area position for spectrum display
(2) Display area position for time waveform display
(3) Display area position for PDF display
(4) Display area position for phase display
(5) Marker position for spectrum display
(6) Marker position for time waveform display
(7) Marker position for PDF display
(8) Marker position for phase display

- **When N_1 = 3**

Current enlargement factor along X axis is indicated by SA-77 in the following format, according to the parameter N_1 of the ZMX command (☞ p.18).

a_1, b_1, c_1 <EOT><CR><LF>
(1) (2) (3)

(1) Enlargement factor during spectrum display
(2) Enlargement factor during time waveform display
(3) Enlargement factor during phase display

MRI N_1	Get information on data stored in mass memory.
N_1= 0	Get store type used to store data and mass memory status.
N_1= 1	Get size and type of data stored in current address.

- **When N_1 = 0**

The SA-77 outputs information on the store type used when data were stored in the mass memory and on the status of the mass memory. The store type is identified by the first character. The output format differs, depending on the store type.

0, a_1 a_2 a_3 a_4, b_1 b_2 b_3 b_4 <EOT> <CR> <LF> (manual store)

(1) (2) (3)

(1) 0 (zero) indicates manual store.
(2) Number of stored data (files)
(3) Number of empty blocks in mass memory (1 block = 16 bytes)

1, a_1 a_2 a_3 a_4, b_1 <EOT> <CR> <LF> (auto store)

(1) (2) (3)

(1) 1 indicates auto store.
(2) Number of stored data (files)
(3) Stored data type (not defined when (2) is 0)
0: Spectrum averaging result 2: PDF averaging result
1: Time waveform averaging result 3: Time waveform instantaneous data

2 <EOT> <CR> <LF> (transient store)

(1)

(1) 2 indicates transient store.

- **When $N_1 = 1$**

The SA-77 outputs information on the size and type of the data stored in current address. The output format differs, depending on the store type.

a_1 a_2 a_3 a_4, b_1 <EOT> <CR> <LF> (manual store or auto store)

(1) (2)

(1) Data size (number of blocks, 1 block = 16 bytes)

(2) Data type
0: Spectrum averaging result 2: PDF averaging result
1: Time waveform averaging result 3: Time waveform instantaneous data

a_1 a_2 a_3 a_4 a_5, 3 <EOT> <CR> <LF> (transient store)

(1) (2)

(1) Data size (number of sampling points)
(2) 3 indicates time waveform data gained with transient store.

Note: When stored data are time waveform data, use the number of digits given in (1) to determine the type of stored data.
4 digits: Manual store or auto store data
5 digits: Transient store data

■ Data Output Command

DOD N_1	Get data shown on screen in ASCII format.
$N_1 = 0$	Get data currently displayed on screen.
$N_1 = 1$	Get marker value.
$N_1 = 2$	Get data currently displayed on screen (include over-range information, power sum, mean square value).

● **When $N_1 = 0$**

All data for the frame currently shown on the SA-77 are output. The output format depends on the type of displayed data.

○ Logarithmic spectrum

Spectrum data are output sequentially, starting from lower frequencies. As the data amount exceeds 254 bytes, the data are divided into n parts. The division number depends on the FFT zoom factor.

Data in one part (25 spectrum data, 176 bytes)

Individual spectrum data (6 bytes)

$\pm a_1\ a_2\ a_3.\ a_4, \pm b_1\ b_2\ b_3.\ b_4, \cdots \pm y_1\ y_2\ y_3.\ y_4$ <CR> <LF> (1st part)

$\pm a_1\ a_2\ a_3.\ a_4, \pm b_1\ b_2\ b_3.\ b_4, \cdots \pm y_1\ y_2\ y_3.\ y_4$ <CR> <LF> (2nd part)

$\pm a_1\ a_2\ a_3.\ a_4, \pm b_1\ b_2\ b_3.\ b_4, \cdots \pm y_1\ y_2\ y_3.\ y_4$ <CR> <LF> (n-1-th part)

$\pm a_1\ a_2\ a_3.\ a_4$ <EOT> <CR> <LF> (*n-th part = end*)

• Format of individual spectrum data

$\underset{(1)}{\pm}\ \underbrace{a_1\ a_2\ a_3.\ a_4}_{(2)}$

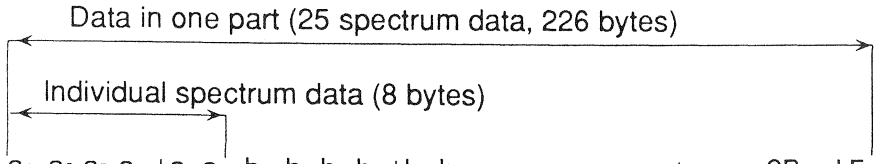
(1) Prefix {␣(indicates +) or −}
(2) Value (spectrum level)

• Individual spectrum data are separated by commas.
• 25 spectrum data are always output together in one part. The final part contains only one spectrum data.
• The relation between the FFT zoom factor, division number and final data is shown in the table below.

FFT zoom factor	Division number (n)	Data count in last part	Data size in last part
1	5	1	9 bytes
2	9	1	9 bytes
4	17	1	9 bytes
8	33	1	9 bytes

○ Linear spectrum

The general data format is the same as for logarithmic spectrum data, but the format for the individual spectrum data differs. The size of the last data is 11 bytes.



$a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots\ y_1.y_2\,y_3\,y_4\,\pm y_5\,y_6$ <CR> <LF> (1st part)
$a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots\ y_1.y_2\,y_3\,y_4\,\pm y_5\,y_6$ <CR> <LF> (2nd part)

$a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots\ y_1.y_2\,y_3\,y_4\,\pm y_5\,y_6$ <CR> <LF> (n – 1-th part)
$a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6$ <EOT> <CR> <LF> (n-th part = end)

• Format of individual spectrum data

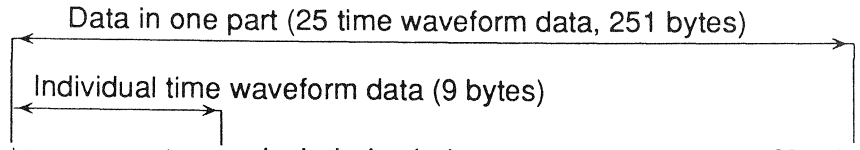
$a_1.a_2\,a_3\,a_4 \pm a_5\,a_6$

(1) (2) (3)

(1) Mantissa value
(2) Prefix of exponent (+ or –)
(3) Exponent value

○ Time waveform

Time waveform data are output sequentially for each sample point. As the data amount exceeds 254 bytes, the data are divided into n parts. The division number depends on the FFT zoom factor.



$\pm a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ \pm b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots\ \pm y_1.y_2\,y_3\,y_4\pm y_5\,y_6$ <CR> <LF> (1st part)
$\pm a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ \pm b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots\ \pm y_1.y_2\,y_3\,y_4\pm y_5\,y_6$ <CR> <LF> (2nd part)

$\pm a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ \pm b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots\ \pm y_1.y_2\,y_3\,y_4\pm y_5\,y_6$ <CR> <LF> (n–1-th part)
$\pm a_1.a_2\,a_3\,a_4\,\pm a_5\,a_6,\ \pm b_1.b_2\,b_3\,b_4\,\pm b_5\,b_6,\ \cdots$ <EOT> <CR> <LF> (n-th part = end)

• Format of individual time waveform data

$\pm\ a_1.a_2\,a_3\,a_4 \pm a_5\,a_6$

(1) (2) (3) (4)

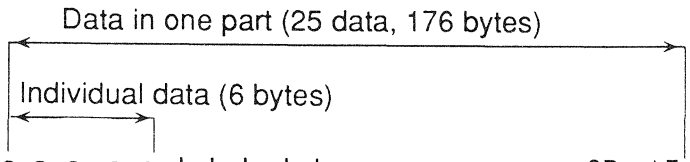
(1): Prefix of mantissa {␣ (indicates +) or –}
(2): Mantissa value
(3): Prefix of exponent (+ or –)
(4): Exponent value

- Individual time waveform data are separated by commas.
- 25 time waveform data are output together in one part. The number of data in the final part depends on the FFT zoom factor.
- The relation between the FFT zoom factor, division number and final data is shown in the table below.

FFT zoom factor	Division number (n)	Data count in last part	Data size in last part
1	11	6	62 bytes
2	21	12	122 bytes
4	41	24	242 bytes
8	82	23	232 bytes

○ PDF

PDF data are output sequentially, starting from the lowest level. As the total data size is 452 bytes, the output is divided into 3 parts.



$a_1\ a_2\ a_3.\ a_4\ a_5, b_1\ b_2\ b_3.\ b_4\ b_5, \cdots y_1\ y_2\ y_3.\ y_4\ y_5$ <CR> <LF> (1st part)

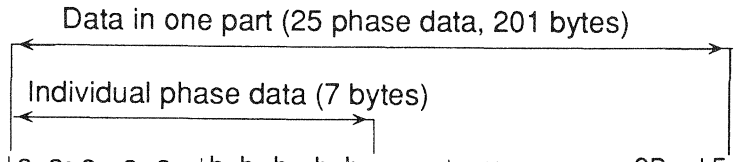
$a_1\ a_2\ a_3.\ a_4\ a_5, b_1\ b_2\ b_3.\ b_4\ b_5, \cdots y_1\ y_2\ y_3.\ y_4\ y_5$ <CR> <LF> (2nd part)

$a_1\ a_2\ a_3.\ a_4\ a_5, b_1\ b_2\ b_3.\ b_4\ b_5, \cdots m_1\ m_2\ m_3.\ m_4\ m_5$ <EOT> <CR> <LF> (3rd part = end)

- Individual data are separated by commas.
- In the first and second part, 25 PDF data are output together. The number of data in the third (final) part is 14 (100 bytes).

○ Phase

Phase data are output sequentially, starting from lower frequencies. As the data amount exceeds 254 bytes, the data are divided into n parts. The division number depends on the FFT zoom factor.



$\pm a_1\ a_2\ a_3.\ a_4\ a_5, \pm b_1\ b_2\ b_3.\ b_4\ b_5, \cdots \pm y_1\ y_2\ y_3.\ y_4\ y_5$ <CR> <LF> (1st part)

$\pm a_1\ a_2\ a_3.\ a_4\ a_5, \pm b_1\ b_2\ b_3.\ b_4\ b_5, \cdots \pm y_1\ y_2\ y_3.\ y_4\ y_5$ <CR> <LF> (2nd part)

$\pm a_1\ a_2\ a_3.\ a_4\ a_5, \pm b_1\ b_2\ b_3.\ b_4\ b_5, \cdots \pm y_1\ y_2\ y_3.\ y_4\ y_5$ <CR> <LF> (n −1-th part)

$\pm a_1\ a_2\ a_3.\ a_4\ a_5$ <EOT> <CR> <LF> (n-th part = end)

• Format of individual phase data

␣ $a_1\ a_2\ a_3.\ a_4\ a_5$
(1) (2)

(1) Prefix {␣(indicates +) or –}
(2) Value

• Individual phase data are separated by commas.
• 25 phase data are always output together in one part. The final part contains only one phase data.
• The relation between the FFT zoom factor, division number and final data is shown in the table below.

FFT zoom factor	Division number (n)	Data count in last part	Data size in last part
1	5	1	10 bytes
2	9	1	10 bytes
4	17	1	10 bytes
8	33	1	10 bytes

● **When $N_1 = 1$**
The data for the current marker value are output by the SA-77. The output format depends on the type of displayed data.

○ Logarithmic spectrum

$a_1\ a_2\ a_3\ a_4\ a_5\ a_6$ $b_1\ b_2\ b_3\ b_4$,± $c_1\ c_2\ c_3.\ c_4$ ␣␣ $d_1\ d_2\ d_3\ d_4$ <EOT> <CR> <LF>
(1) (2) (3) (4) (5) (6)

(1) Frequency
(2) Frequency unit { kHz␣, KCPM, ORD␣, EXT␣ (external sampling signal)}
(3) Level prefix {␣(indicates +) or –}
(4) Level
(5) Two spaces
(6) Level unit (dBV␣, dBVr, dBEU, dBEr)

Note: When (2) is EXT␣ (external sampling signal), (1) becomes the data pointer indicating the marker position.

○ Linear spectrum

$a_1\ a_2\ a_3\ a_4\ a_5\ a_6\ b_1\ b_2\ b_3\ b_4,\ c_1.\ c_2\ c_3\ c_4 \pm d_1\ d_2\ e_1\ e_2\ e_3\ e_4$ <EOT> <CR> <LF>

(1) (2) (3) (4) (5) (6)

(1) Frequency
(2) Frequency unit {kHz␣, KCPM, ORD␣, EXT␣ (external sampling signal)}
(3) Level mantissa
(4) Level exponent prefix (+ or –)
(5) Level exponent
(6) Level unit (V␣␣␣, Vr␣␣, EU␣␣, EUr␣)

Note: When (2) is EXT␣ (external sampling signal), (1) becomes the data pointer indicating the marker position.

○ Time waveform (internal sampling signal)

$a_1\ a_2\ a_3\ a_4\ a_5$ ␣ $b_1\ b_2,\ \pm\ c_1.\ c_2\ c_3\ c_4 \pm d_1\ d_2\ e_1\ e_2\ e_3\ e_4$ <EOT> <CR> <LF>

(1) (2) (3) (4) (5) (6) (7) (8)

(1) Time
(2) 1 space
(3) Time unit (EF_H S*, ms)
(4) Level mantissa prefix {␣(indicates +) or –}
(5) Level mantissa
(6) Level exponent prefix (+ or –)
(7) Level exponent
(8) Level unit (V␣␣␣, Vr␣␣, EU␣␣, EUr␣)

*: Hexadecimal code EF and s indicate microseconds.

○ Time waveform (external sampling signal)

$a_1\ a_2\ a_3\ a_4$ EXTs, $\pm$ $b_1.\ b_2\ b_3\ b_4$ $\pm$ $c_1\ c_2$ $d_1\ d_2\ d_3\ d_4$ <EOT> <CR> <LF>

(1) (2) (3) (4) (5) (6) (7)

(1) Data pointer indicating marker position
(2) EXTs indicates external sampling signal
(3) Level mantissa prefix {␣ (indicates +) or –}
(4) Level mantissa
(5) Level exponent prefix (+ or –)
(6) Level exponent
(7) Level unit (V␣␣␣, Vr␣␣, EU␣␣␣, EUr␣)

○ PDF

$\pm$ $a_1.\ a_2\ a_3\ a_4$ $\pm$ $b_1\ b_2$ $c_1\ c_2\ c_3\ c_4$, $d_1\ d_2 d_3.\ d_4\ d_5$ %<EOT> <CR> <LF>

(1) (2) (3) (4) (5) (6) (7)

(1) Level mantissa prefix {␣ (indicates +) or –}
(2) Level mantissa
(3) Level exponent prefix (+ or –)
(4) Level exponent
(5) Level unit (V␣␣␣, Vr␣␣, EU␣␣␣, EUr␣)
(6) Amplitude probability density
(7) Amplitude probability density unit

○ Phase

$a_1\ a_2\ a_3\ a_4\ a_5\ a_6$ $b_1\ b_2\ b_3\ b_4$, $\pm$ $c_1\ c_2\ c_3.\ c_4\ c_5$ deg <EOT> <CR> <LF>

(1) (2) (3) (4) (5)

(1) Frequency
(2) Frequency unit {kHz␣, KCPM, ORD␣, EXT␣ (external sampling signal) }
(3) Prefix {␣ (indicates +) or –}
(4) Phase
(5) Phase unit

Note: When (2) is EXT␣ (external sampling signal), (1) becomes the data pointer indicating the marker position.

- **When $N_1 = 2$**

Besides the data which are output in response to $N_1 = 0$, power sum (<P.SUM>f), mean square value (<RMS>t), and over-range information are also output. (For spectrum data only, power sum and mean square value are appended.)
These data are placed immediately before the <EOT> of the last data block. The format of the power sum and mean square value data is the same as for other data. However, over-range information is expressed as one byte, unlike the data format in response to STI3.

The data format for the last block during logarithmic spectrum indication is shown below.

$\pm a_1a_2a_3.a_4, \pm b_1b_2b_3.b_4, \pm c_1c_2c_3.c_4, d_1$ <EOT> <CR> <LF> (last block)

(1) (2) (3) (4)

(1) Last increment of spectrum data
(2) Power sum
(3) Mean square value
(4) Over-range information

Definition of over-range information

0: When output data are instantaneous data, no over-range condition has occurred.
When output data are averaged data, no over-range condition has occurred in the instantaneous data which were used to calculate the average value, or any over-range condition had no relevant influence* on the output data.

1: Output data are averaged data.
An over-range condition which has relevant influence* on the output data has occurred in the instantaneous data which were used to calculate the average value.
No over-range condition has occurred in the most recent instantaneous data used to calculate the average value.

2: Output data are instantaneous data.
An over-range condition has occurred.

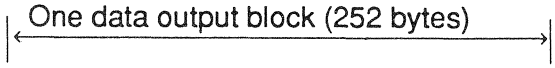
3: Output data are averaged data.
An over-range condition which has relevant influence on the output data has occurred in the instantaneous data which were used to calculate the average value.
The over-range condition has occurred in the most recent instantaneous data used to calculate the average value.

* "Relevant influence on the output data" is defined as over-range in any of the instantaneous data used for arithmetic average or peak-hold.
When an over-range condition occurs during exponential averaging, it has relevant influence only if the data were collected before the number of averaging counts is reached, otherwise it has no relevant influence.
When there is no over-range condition, there is no relevant influence.

DOB N_1 Get data shown on screen in binaly format.

All data for the frame currently shown on the SA-77 are output in binary format. The data output order is the same as for command DOD2. Each data is output as a 2-byte block (16 bit).
The transfer time for the data is only a fraction of DOD2, but to determine the real value from the output data, additional processing is required, based on the output data type.

The parameter N_1 determines the upper byte/lower byte order.
$N_1 = 0$: Lower byte → upper byte
$N_1 = 1$: Upper byte → lower byte
The size of the output data block is 252 bytes (except for the last block), regardless of the data type.
For spectrum data, the power sum and mean square value data are appended at the end.
Over-range information is also appended at the end, regardless of the output data type (identical data are output twice).



$B_{11}B_{12}B_{21}B_{22}B_{31}B_{32}$ ... Bn_1Bn_2<CR><lf> (1st block)
$B_{11}B_{12}B_{21}B_{22}B_{31}B_{32}$ ... Bn_1Bn_2<CR><lf> (2nd block)
⋮
$B_{11}B_{12}$ $B_{f1}B_{f2}B_{t1}B_{t2}O_1O_2$<EOT><CR><LF> (last block)

Bn_1Bn_2 :Individual data
$B_{f1}B_{f2}$:<Power sum>f data (only for spectrum data)
$B_{t1}B_{t2}$:<Mean square value>data (only for spectrum data)
O_1O_2 :O_1=O_2, over-range information (same format as for DOD2)

- Derivation of real value from binary data

The binary data have not been processed for level range, level unit, engineering unit, differentiation, and integration. When these are to be determined through subsequent processing, the data type must be taken into consideration to achieve correct results. Use the PSI command to get the necessary information. Depending on the display data type, the binary data (16 bit) consist of one of the following two integer types.

Logarithmic spectrum/time waveform/phase:
Twos complement integer from –32768 to 32767
Linear spectrum/PDF:
Unsigned integer from 0 to 65535

In the following, B is used for the twos complement integer expression derived by taking the upper byte/lower byte order of Bn_1 Bn_2 into consideration, regardless of the display data type. The final result (real value) is expressed as M.

◇ Logarithmic spectrum

B is a value in the range from –32768 to 0.

M = B/100 + Level range + Differentiation or integration factor –EU value

Level range:
Use logarithmic level range value which matches the level unit (dBVr or dBV).
Differentiation or integration factor:
Use 20 log (absolute value for differentiation factor or integration factor). Omit for DC component. When an external sampling signal is used, omit for all components.
EU value:
Use logarithmic EU value. Omit it when engineering unit is not used.

◇ Linear spectrum

B is a value in the range from –32768 to 32767. Convert into the real number B' with a range from 0 to 65535 before calculating M.

$B \geqq 0$: $B' = B$

$B < 0$: $B' = 65536 + B$

M = (B'/65535) x Level range x Differentiation or integration factor / EU value

Level range:
Use linear level range value which matches the level unit (Vr or V)
Differentiation or integration factor:
Use absolute value for differentiation factor or integration factor. Omit for DC component. When an external sampling signal is used, omit for all components.
EU value:
Use linear EU value. Omit when engineering unit is not used.

◇ Time waveform

B is a value in the range from –32752 to 32752. Convert into the real number B' with a range from –32767 to 32767 before calculating M. (Rarely, B may become –32768. Use B' = 32767 in such cases.)

B' = Integer of {(B / 32752) x 32767}

The sign depends on the negative or positive condition of the input signal.

M = (B' / 32767) x Level range / EU value

Level range:
Use linear level range value which matches the level unit (Vr or V)
EU value:
Use linear EU value. Omit when engineering unit is not used.

◇ Amplitude probability density

M = B / 100

◇ Phase

M = B / 100

Numeric reference	65536 : 2^{16} 65535 : 2^{16}–1, (highest value for 16-bit binary expression) 32768 : 2^{15} 32767 : 2^{15}–1, (highest value for 15-bit binary expression) 32752 : (Positive maximum value for 12-bit A/D conversion) x 16

● Processing example for calculating actual value from binary data
The following settings are assumed.

Level range	: 20 dBVr (10.0 Vr)
	: 23 dBV (14.1 V)
Frequency range	: 50 kHz
Logarithmic EU value	: 47.9 dBVr
	: 50.9 dBV
Linear EU value	: 2.50×10^2 Vr
	: $2.50 \times 10^2 \times \sqrt{2}$ V
Differentiation, integration	: OFF

◇ Logarithmic spectrum

B = –1991 (0F839 hex)

M = –1991 / 100 + 20 –47.9 = –47.8 dBVr

◇ Linear spectrum

B = 5000 (1388 hex)

Engineering unit: ON

M = (5000 / 65535) x 10 / 2.50×10^2 = 3.052×10^{-3} EUr

M = (5000 / 65535) x 10 x$\sqrt{2}$ / $2.50 \times 10^2 \times \sqrt{2}$ = 3.052×10^{-3} EU

Engineering unit: OFF

M = (5000 / 65535) x 10 = 7.630×10^{-1} Vr

M = {(65536 – 5000) / 65536} x 10 x$\sqrt{2}$ = 1.306×10^1 V

B = –5000(0EC78 hex)

Engineering unit: OFF

M = {(65536–50000) / 65536} x 10 = 9.237×10^0 Vrms

M = {(65536 – 5000) / 65536} x 10 x$\sqrt{2}$ = 1.306×10^1 V

◇ Time waveform

B = 30228 (7614 hex)

B' = integer of {(30228 / 32752) x 32767} = 30241

Engineering unit: OFF

M = (30241 / 32767) x 10 x$\sqrt{2}$ = 1.305×10^1 V

◇ Amplitude probability density

B = 3413 (0D55 hex)

M = 3413 / 100 = 34.13%

◇ Phase

B = –4500 (0EDE8 hex)

M = –4500 / 100 = 45.0 deg

■ Analysis Parameter Setting and Control Commands

SRT Start averaging processing (no parameters).

PSE N_1 Pause control

$N_1 = 0$ Release pause condition.

$N_1 = 1$ Set unit to pause condition.

When the pause command is given, averaging is paused. Averaging resumes when the release pause command is given.

AVE N_1, N_2, N_3 Set conditions for averaging processing.

$N_1 = 0$	No averaging	[MODE: INST]	Averaging processing modes
$N_1 = 1$	Arithmetic averaging	[MODE: LIN]	
$N_1 = 2$	Exponential averaging	[MODE: EXP]	
$N_1 = 3$	Peak hold	[MODE: PEAK]	
$N_2 = 0$	Spectrum domain	[DOMAIN: SPEC]	Averaging processing domain
$N_2 = 1$	Time waveform domain	[DOMAIN: TIME]	
$N_2 = 2$	PDF domain	[DOMAIN: PDF]	
N_3	Averaging counts		

- Even when $N_1 = 0$ (no averaging) is selected, valid values must be specified for N_2 and N_3. These will be disregarded by the SA-77 during actual processing, but they are required to prevent an error during the format check.

- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

- If the trigger mode is set to single trigger, the settings $N_1 = 1$ (arithmetic averaging), $N_1 = 2$ (exponential averaging), and $N_1 = 3$ (peak hold) are not allowed.

- When $N_2 = 1$ (time waveform domain) or $N_2 = 2$ (PDF domain) is selected, the settings $N_1 = 2$ (exponential averaging) and $N_1 = 3$ (peak hold) are not allowed.

- The setting range for N_3 (averaging counts) is $2 \leqq N_3 \leqq 8000$. When $N_1 = 3$ (peak hold) is selected, $N_3 = 0$ (averaging count = ∞) can be selected.

TRG N_1, N_2, N_3 Set trigger conditions.

$N_1 = 0$	Internal, free-run	[SOURCE: INT MODE: FREE]
$N_1 = 1$	Internal, repeated	[SOURCE: INT MODE: REPT]
$N_1 = 2$	Internal, single	[SOURCE: INT MODE: SNGL]
$N_1 = 10$	External, free-run	[SOURCE: EXT MODE: FREE]
$N_1 = 11$	External repeated	[SOURCE: EXT MODE: REPT]
$N_1 = 12$	External, single	[SOURCE: EXT MODE: SNGL]
$N_2 = 0$	Trigger level – 7/8, negative slope	[LEVEL: – 7/8 SLOPE: –]
$N_2 = 1$	Trigger level – 6/8, negative slope	[LEVEL: – 6/8 SLOPE: –]
$N_2 = 15$	Trigger level + 7/8, negative slope	[LEVEL: + 7/8 SLOPE: –]
$N_2 = 20$	Trigger level – 7/8, positive slope	[LEVEL: – 7/8 SLOPE: +]
$N_2 = 21$	Trigger level – 6/8, positive slope	[LEVEL: – 6/8 SLOPE: +]
$N_2 = 35$	Trigger level + 7/8, positive slope	[LEVEL: + 7/8 SLOPE: +]
N_3	Trigger point	[N: +/– N_3]

- Even when $N_1 = 0$ or $N_1 = 10$ (free-run) is selected, valid values must be specified for N_2 and N_3. These will be disregarded by the SA-77 during actual processing, but they are required to prevent an error during the format check.

- When arithmetic averaging, exponential averaging or peak hold is selected, the settings $N_1 = 2$, $N_1 = 12$ (single trigger) are not allowed.

- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

- The setting range for N_3 (trigger point) depends on the FFT zoom factor.

FFT zoom factor	N_3 setting range
1	$-255 \leqq N_3 \leqq 2000$
2	$-511 \leqq N_3 \leqq 2000$
4	$-1023 \leqq N_3 \leqq 2000$
8	$-2000 \leqq N_3 \leqq 2000$

$0 \leqq N_3$: post-trigger
$N_3 < 0$: pre-trigger

FRQ N_1 Set sampling frequency and frequency span.

$N_1 = 0$	100 Hz [FREQ SPAN: 100Hz]	Internal sampling signal (command sets the frequency span and frequency of the anti-aliasing filter)
$N_1 = 1$	200 Hz [FREQ SPAN: 200Hz]	
$N_1 = 7$	20 kHz [FREQ SPAN: 20kHz]	
$N_1 = 8$	50 kHz [FREQ SPAN: 50kHz]	
$N_1 = 10$	100 Hz [FREQ SPAN: EXT]	External sampling signal (command sets the frequency of the anti-aliasing filter)
$N_1 = 11$	200 Hz [FREQ SPAN: EXT]	
$N_1 = 17$	20 kHz [FREQ SPAN: EXT]	
$N_1 = 18$	50 kHz [FREQ SPAN: EXT]	

- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

ATT N_1 Set level range and unit.

$N_1 = 0$	0.003 Vrms	[LEVEL RANGE: 0.003Vr]
$N_1 = 1$	0.01 Vrms	[LEVEL RANGE: 0.01 Vr]
$N_1 = 6$	3.162 Vrms	[LEVEL RANGE: 3.162Vr]
$N_1 = 7$	10.0 Vrms	[LEVEL RANGE: 10.0 V]
$N_1 = 10$	0.004 V	[LEVEL RANGE: 0.004 V]
$N_1 = 11$	0.014 V	[LEVEL RANGE: 0.014 V]
$N_1 = 16$	4.472 V	[LEVEL RANGE: 4.472 V]
$N_1 = 17$	14.14 V	[LEVEL RANGE: 14.14 V]

- When input coupling is DC, the following settings (level range less than 0.03 Vrms) are not allowed.

  $N_1 = 0$ (0.003 Vrms) $N_1 = 10$ (0.004 V)
  $N_1 = 1$ (0.01 Vrms) $N_1 = 11$ (0.014 V)

- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

ENV N_1 Set envelope processing.

$N_1 = 0$	Envelope processing disabled. [ENVELOPE: OFF]
$N_1 = 1$	Envelope processing enabled. [ENVELOPE: ON]

- When input coupling is DC, the setting $N_1 = 1$ (envelope processing on) is not allowed.
- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

AXD N_1 Set input coupling type.

$N_1 = 0$	AC [COUPLING: AC]
$N_1 = 1$	DC [COUPLING: DC]

- When $N_1 = 1$ (DC coupling) is selected, the following items are automatically set:

High-pass filter:	Off
Low-pass filter:	Off
Envelope processing:	Off
Level range:	If setting is less than 0.031 Vrms (0.044 V), setting is automatically changed to 0.031 Vrms (0.044 V).

- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

HLP N_1, N_2 Set high-pass and low-pass filter frequencies.

$N_1 = 0$	OFF	[HPF: OFF]	High-pass filter
$N_1 = 1$	5 Hz	[HPF: 5]	
$N_1 = 2$	50 Hz	[HPF: 50]	
$N_1 = 3$	1 kHz	[HPF: 1K]	
$N_2 = 0$	OFF	[LPF: OFF]	Low-pass filter
$N_2 = 1$	1 kHz	[LPF: 1K]	
$N_2 = 2$	5 kHz	[LPF: 5K]	
$N_2 = 3$	10 kHz	[LPF: 10K]	

- When input coupling is DC, only the settings $N_1 = 0$ and $N_2 = 0$ (filter off) are allowed.
- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

ZOM N_1 Set FFT zoom factor.

$N_1 = 0$	1 [ZOOM: *1]
$N_1 = 1$	2 [ZOOM: *2]
$N_1 = 2$	4 [ZOOM: *4]
$N_1 = 3$	8 [ZOOM: *8]

- When arithmetic averaging, exponential averaging or peak hold is selected, averaging automatically starts after this command is executed.

WIN N_1 Set window type.

$N_1 = 0$	Rectangular	[WINDOW: RECT]
$N_1 = 1$	Hanning	[WINDOW: HANN]
$N_1 = 2$	Flat-top	[WINDOW: FTOP]

- When arithmetic averaging, exponential averaging or peak hold for the spectrum domain is selected, averaging automatically starts after this command is executed. Averaging does not start if averaging is selected for the time waveform or PDF domain.

RMT Activate remote mode (no parameters).

To cancel the remote mode and return the unit to the local mode, send the LOC command or press the [EXIT] key on the SA-77.

LOC Release remote mode and activate local mode (no parameters).

POF N_1 Select auto power off function.

$N_1 = 0$	Auto power off disabled.	[POWER SAVE: OFF]
$N_1 = 1$	Auto power off enabled.	[POWER SAVE: ON]

XON N_1 Set X parameter.

$N_1 = 0$	X parameter invalid.
$N_1 = 1$	X parameter valid.

VRV N_1 Set level unit (rms value or amplitude value).

$N_1 = 0$	rms value
$N_1 = 1$	Amplitude value

As opposed to the ATT command, this command does not cause averaging to start and can therefore be used to simply change the level unit.

COMMAND INDEX

■ Display Commands

■ Status Verification Command

■ Memory Processing Commands

■ Information Output Commands

■ Data Output Command

■ Analysis Parameter Setting and Control Commands

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