8

GPIB Interface

■ In this chapter, we will discuss the GPIB interface.
I will firstly explain about preparation and setting to those users who use programs.
Secondly, I will give elucidation to those who create programs.

Outline of GPIB

P-STATION/EPO can control most of functions that are operated from the panel using GPIB.

If functions can be controlled by GPIB, then they can be controlled also by RS-232 except some other functions.

Actual operation or programming depends on the programming language on the contorller side or the GPIB driver.

For further information, see their respective instruction manual and related documents together with this manual.

Functions that cannot be operated via GPIB

- Turning ON/OFF of power supply
- Initialization to on-shipping settings
- Switching between GPIB and RS-232
- Setting of GPIB address and message terminator on sending occasion
- Setting of baud rate, parity and character length of RS-232

Functions that can be controlled via the GPIB but cannot be operated from the panel

- GPIB proper functions (e.g., status byte, remote/local etc.)

Applicable specifications

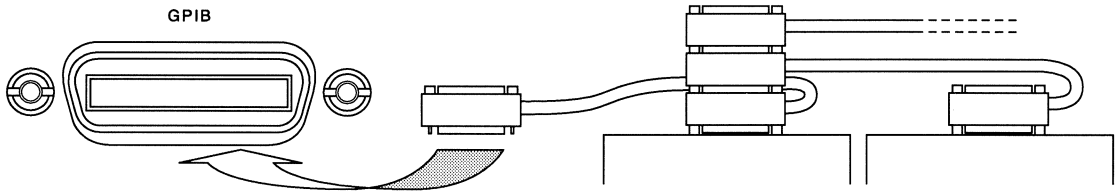
- Conforming to IEEE standard 488.1-1987
- Interface functions (See the table below.)

SH1	Provides all functions of source handshake
AH1	Provides all functions of acceptor handshake
T6	Provides functions of basic talker, serial poll and listener-defined talker-releasing; does not provides talk-only function
L4	Provides functions of basic listener and listener-defined listener-releasing; does not provide listen-only function
SR1	Provides all functions of service request
RL1	Provides all functions of remote/local
PP0	Does not provide parallel poll function
DC1	Provides all functions of device clear
DT1	Provides all functions of device trigger
C0	Does not provide controller functions

Connection of GPIB cable

Connect a GPIB cable that meets the specifications to the GPIB bus line.

With a GPIB cable that meets the specifications, connect the GPIB bus lines. Before connection to the bus, turn off power to all devices connected. Securely tighten the connector fixing screws to prevent loosening.



Connection of GPIB cable

Attention!

When two or three EPO2000X units are connected to enhance the system, connect the GPIB connector to the master.

Instructions on use of GPIB

When using GPIB, follow the general instructions listed below.

- Connection or disconnection of GPIB connector with the power supply turned on may damage the equipment. Turn off the power to all devices that are (to be) connected to the bus.
- To enable GPIB functions, turn on the power to all devices connected to the bus.
- Up to 15 devices can be connected to the bus including the controller.
- When determining the cable length, make sure it does not exceed the following length:

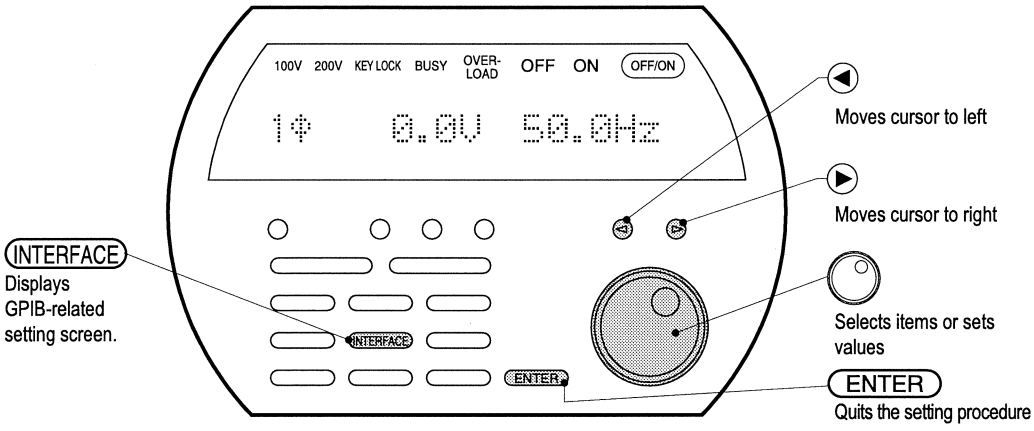
  The length of a cable between devices must be 4m or less.

  Total length of cables must be 2m multiplied by the number of devices or 20m whichever is shorter.
- Assign a different address to each device connected to a bus.

  Assigning the same address to two or more devices may not only cause the devices to operate abnormally but also damage the devices.
- A terminator (delimiter of message) must be unified in a system.

  If the terminator is different between the talker and the listener, the system may not function properly.

Setting for GPIB use

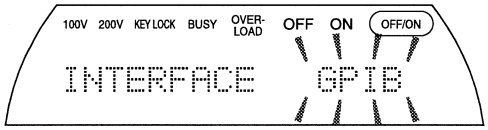


To use the GPIB interface, connect to the unit to the computer with the GPIB interface cable and carry out “Selection of interface”, “Setting of GPIB address” and “Setting of terminator”.

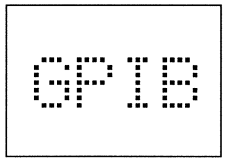
Selecting the interface

1 Press (INTERFACE) to show the interface setting screen.

* "GPIB" is selected on shipping.

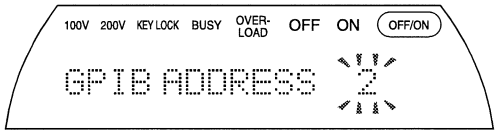


2 Turn the dial to select "GPIB".

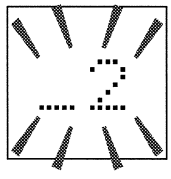


Setting the GPIB address

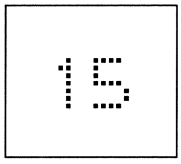
1 Press (INTERFACE) to show the GPIB address setting screen.



2 Press ◀ and ▶ to locate the cursor.



3 Turn the dial to specify the address.

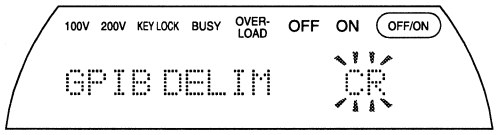


Select a desired one out of 0 to 30 addresses.

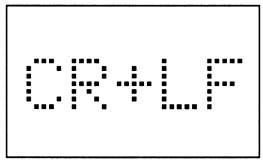
Number "2" is set on shipping.

Setting a terminator

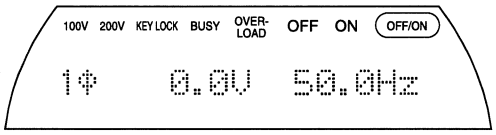
1 Press (INTERFACE) to show the GPIB terminator setting screen.



2 Turn the dial to select the desired terminator.



3 Press (INTERFACE) or (ENTER) to establish the selection and the display returns to the normal screen.

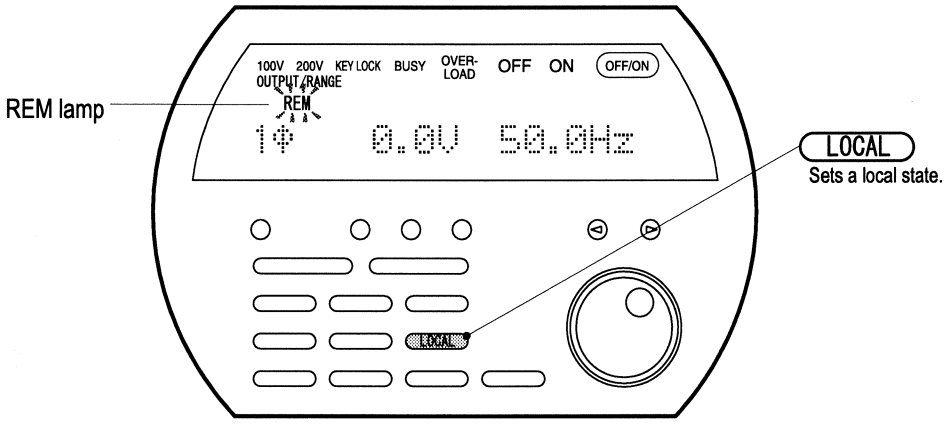


Select one out of terminators: CR+LF, CR and LF.

Attention!

- GPIB and RS-232 cannot be used simultaneously. Select one interface to be used.
- GPIB is selected as the default interface (on-shipping setting).
- During a remote operation using GPIB, any keys other than (LOCAL) (local mode) and (OFF/ON) on the operation panel cannot be operated. (OFF/ON) can only be used when the output is OFF for an emergency stop.

Remote status and release from remote condition



Remote state

With REN (Remote ENable) set to TRUE, sending a program message from the GPIB controller will put the unit in a remote state and cause the REM lamp on the panel to light up.

Local state

This unit remains in a local state until it receives control from the GPIB controller. All keys can be operated from the panel in the local state.

To set the unit in a local state from the GPIB controller, select either of the following two:

- Specify the GPIB address and send a GTL interface message.
- Set REN (Remote ENable) to FALSE.

Setting the system to "Local lockout"

It is also possible to operate LOCAL from the panel to set a local state, but the operation varies depending on whether "Local lockout" (LLO) is set or not.

- When LLO is not set.

In a remote state, only LOCAL on the panel is accepted and operating LOCAL puts the unit in a local state.

- When LLO is set.

In a remote state, no key operations from the panel are accepted.

To set LLO, send an LLO interface message in the remote state. To release LLO, set REN (Remote ENable) to FALSE.

Attention!

- The method of using interface messages varies depending on the GPIB controller (GPIB driver). See their respective instruction manuals.
- LLO is generally used when it is inconvenient to carry out operations from the panel during GPIB control, but if it is preferable to enable panel operations in the case of abnormalities, etc., it is recommendable not to use LLO.

Service request and status structure

Outline of status report

When various events occur, a GPIB device can generally send a service request (SRQ) to the controller for interrupt processing. The user can see the status at that moment by reading the contents of each register.

Status byte

A GPIB device has some pieces of status data and they are summarized in the status byte of the device.

Sending a service request

If a bit of the service request enable register is set to 1, then the system will send a service request (SRQ) when the corresponding status bit of the status byte becomes 1.

Capture of an event

The situation of a GPIB device is shown in the condition register and its change is recorded in the event register. If the corresponding bit of the event enable register is set to 1, each bit of the event register will be summarized in the specific one bit of the status byte.

Grasp of queue situation

A GPIB device has a queue to retain the information of output waiting. The status byte contains a status bit that indicates whether the queue has information or not.

P-STATION/EPO provides an MAV bit that indicates the queue situation of response message.

Memo

When a user wants to monitor the condition of a GPIB device, the user sometimes performs serial poll or sends a querying message. These methods, however, are not preferable because they apt to affects the operating speed of the controller (computer) and the GPIB device.

In such situations, the user can extend the interval of query or use a service request in order to enhance the performance.

Status byte register and sending a service request

A status byte register contains a summarized data of the situation of a GPIB device.

If a bit of a service request enable register is set to 1, then the system will send a service request (SRQ) when the corresponding status bit becomes 1.

The user can read the status byte by using either of the following two methods:

- Serial poll
- Query via a command "?STB" (the response message will be in a decimal integer.)

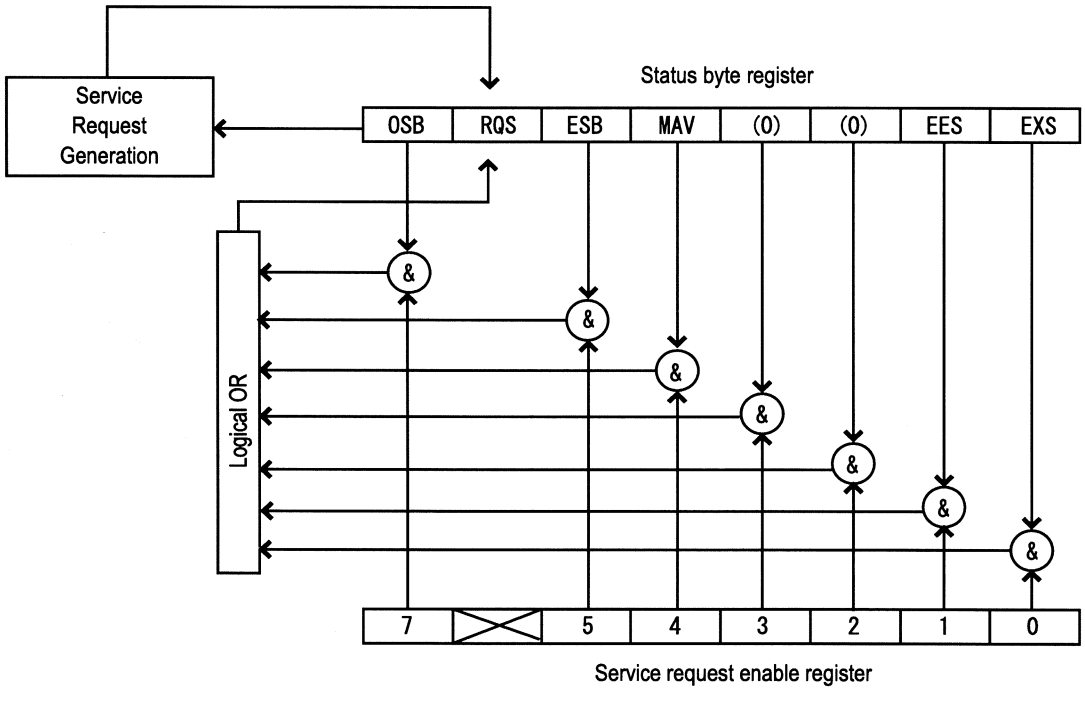
Reading a status byte register will not clear the bits (except that the RQS bit is reset when serial poll is performed).

Serial poll is a GPIB function in which the controller assigns an address to read the status byte of each GPIB device. The method of describing a program depends on the language on the controller side and the GPIB driver software.

In P-STATION/EP0, the service request enable register can execute setting and query using the following message:

- Setting: by a command "SRE" (the data to be set is in a decimal integer and initial value is "0".)
- Query: by a command "?SRE" (the response data will be in a decimal integer.)

The data to be set and the response data are decimal integers with addition of the weight of the bit that was set to 1 of each register.

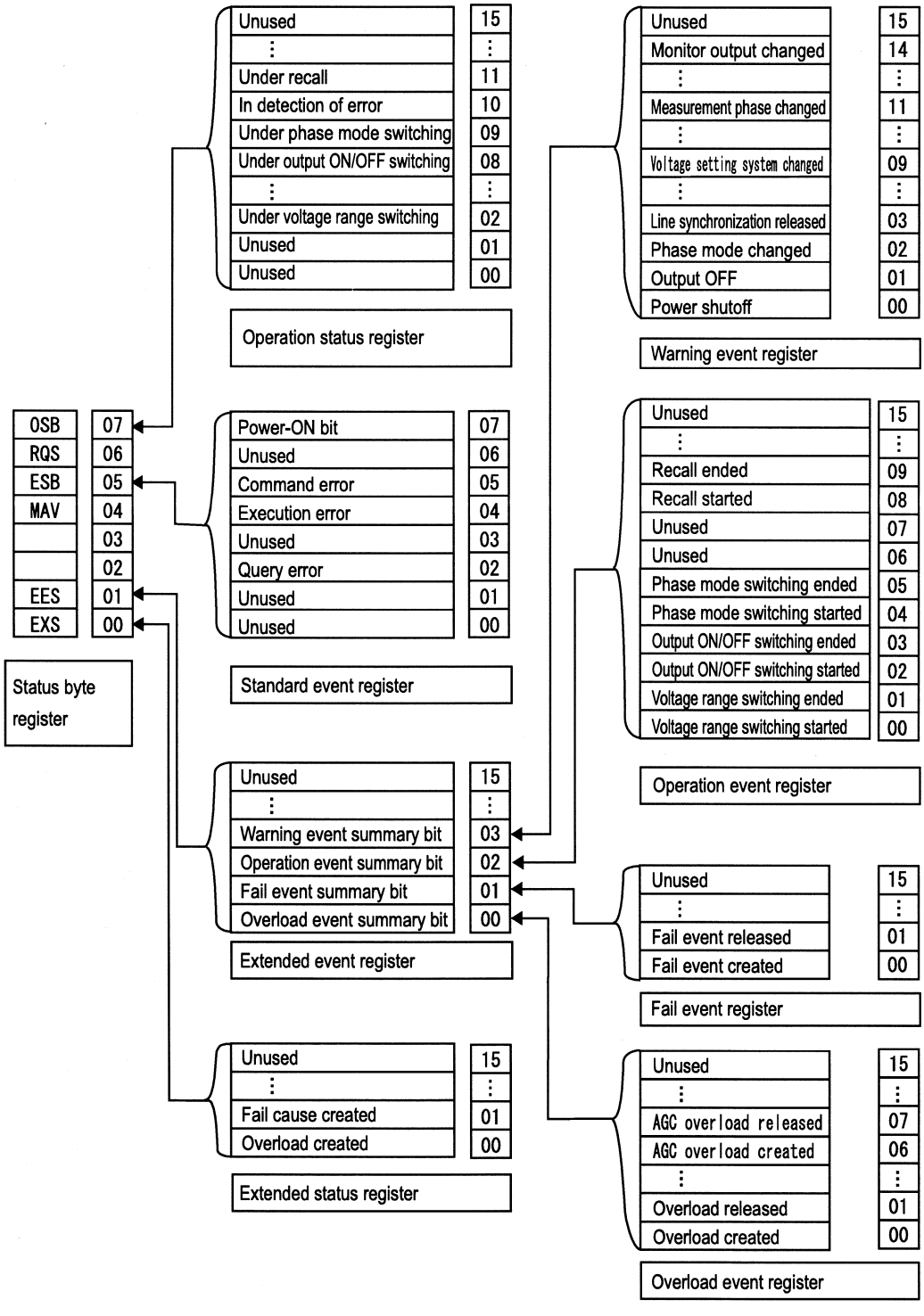


Bit	Weight	Description
OSB (7)	128	**Operation event status register summary bit** If any of the effective bits of the above register becomes 1, this will be set to 1, and if all of them become 0, then this will be cleared to 0.
RQS (6)	64	**Request service bit** If a service request takes place, this will be set to 1 and if serial poll is performed, this will be cleared to 0.
ESB (5)	32	**Standard event status register summary bit** If any of the effective bits of the above register becomes 1, this will be set to 1, and if all of them become 0, then this will be cleared to 0.
MAV (4)	16	**Response message output enabled** If, answering to the querying message, a response is written in the queue, enabling the output, this will be set to 1, and if the queue becomes empty, this will be cleared to 0.
3	8	**Always 0 (not used)**
2	4	**Always 0 (not used)**
EES (1)	2	**Extended event register summary bit** If any of the effective bits of the above register becomes 1, this will be set to 1, and if all of them become 0, then this will be cleared to 0.
EXS (0)	1	**Extended status register summary bit** If any of the effective bits of the above register becomes 1, this will be set to 1, and if all of them become 0, then this will be cleared to 0.

Detailed structure of status

The previous status prior to summarizing in a status byte register exists in several event registers. In every event register, exists a corresponding enable register, and summary into status byte can be permitted or prohibited by bits.

Further, the event register will not be cleared to 0 even if the status byte register is read by serial poll.



Standard event status register and related registers

The standard event status register is a register that is commonly given to every GPIB device that conforms to IEEE-488.2 standards. This register expresses the condition of a device. (See "Bit assignment of the standard event status register".)

A standard event status register can be queried with the following message:

- ?ESR (the response data will be in a decimal integer.)

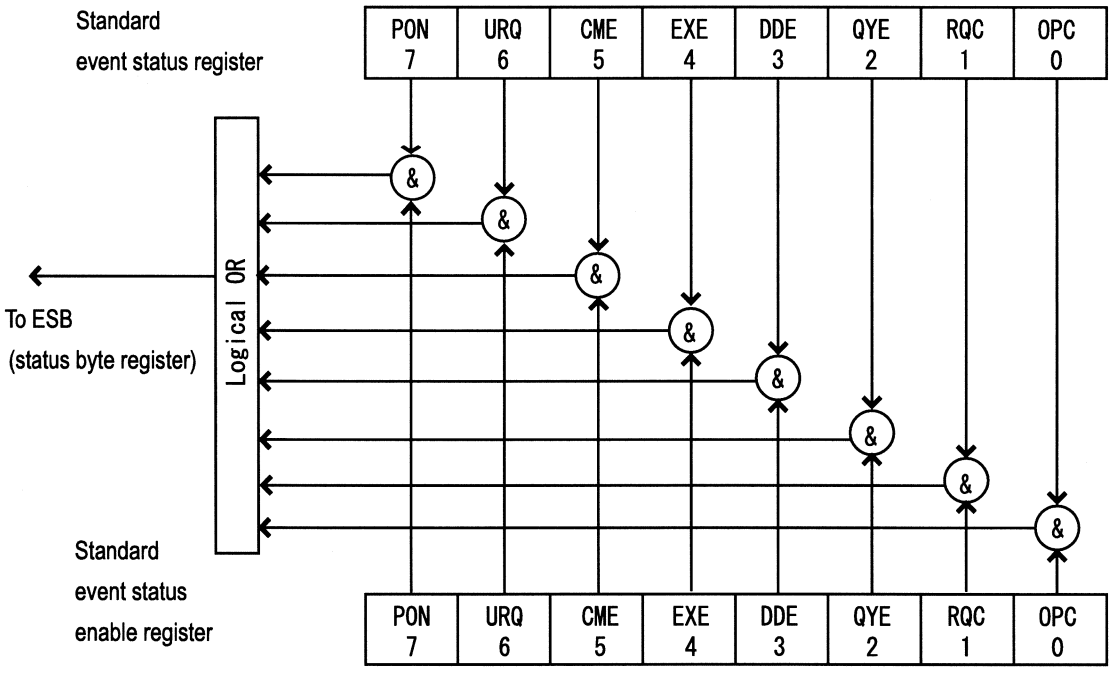
  Every bit of a standard event status register will be cleared to 0 when:

- A standard event status register is read.

Every bit of a standard event status register can be summarized into an ESB bit of the status byte register by setting the corresponding bit of the standard event status enable register to 1.

A standard event status enable register can be set or queried using the following messages where the data is the total of the weight of factors that are set to 1.

- Setting: ESE (the data to be set is in a decimal integer and initial value is "0".)
- Query: ?ESE (the response data will be in a decimal integer.)



Bit assignment of standard event status register

Bit (weight)	Mnemonic	Description
7 (128)	PON	Power-ON This is set to 1 when power is charged. When it is read and cleared to 0, it remains 0 until the power is charged again.
6 (64)	URQ	User request Always 0 (not used)
5 (32)	CME	Message error This will be set to 1 if any syntax error is detected in the program message.
4 (16)	EXE	Execution error This will be set to 1 if the program data is out of the setting range or specified setting is not possible due to the current situation.
3 (8)	DDE	Device definitive (or proper) error Always 0 (not used)
2 (4)	QYE	Query error This will be set to 1 if any of the following occurs: • Reading is attempted when the queue contains no response message (RS-232 does not yield this error.) • Queue capacity limit (256 characters) is exceeded. • A next program message was received when sending of a response message to a query has not been completed.
1 (2)	RQC	Request for control authority Always 0 (not used)
0 (1)	OPC	Operation completed Always 0 (not used)

Operation status register and related registers

The operation status register is a register that indicates that internal processing is in progress. This register can be queried by the following message:

- ?OSC (the response data will be in a decimal integer.)

Every bit of the operation status register changes from 0 to 1 when its cause or operation starts and changes from 1 to 0 when its cause or operation ends.

Every bit of the operation status register is cleared to 0 when the following event occurs:

- Its cause corresponding to each bit or operation ends.

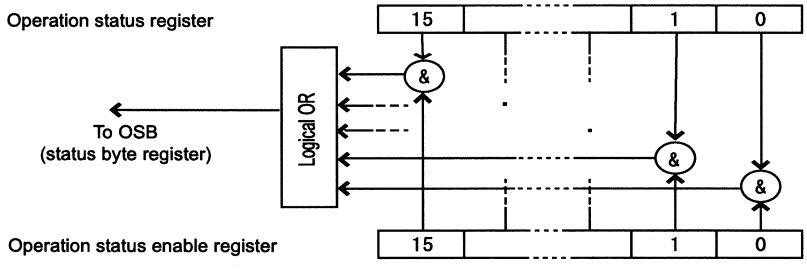
Every bit of the operation status register can be summarized into the OSB bit of the status byte register by setting the corresponding bit of an operation status enable register to 1.

An operation status enable register can be set or queried using the following messages where the data is the total of the weight of factors that are set to 1.

- Setting: OSE (the data to be set is in a decimal integer and initial value is "0".)
- Query: ?OSE (the response data will be in a decimal integer.)

Bit assignment of operation status register

Bit (weight)	Description
15	Always 0 (not used)
14	
13	
12	
11 (2048)	Under recall
10 (1024)	Under detection of fail cause Some causes may shut off the power to the power section in order to protect the system. This indicates some causes have been detected.
9 (512)	Under switching of phase mode
8 (256)	Under switching of output ON/OFF
7	Always 0 (not used)
6	
5	
4	
3	
2 (4)	Under switching of output voltage range
1	Always 0 (not used)
0	



Extended event register and related registers

The extended event register is a register to organize contents of several event registers. This register can be queried by the following message:

- ?XEC (the response data will be in a decimal integer.)

When the logical sum of the warning event register, operation event register and fail event register changes from 0 to 1, the corresponding bit of the extended event register will be set to 1.

Every bit of the extended event register is cleared to 0 when any of the following occurs:

- When a warning event register is read (corresponding bit only).
- When an operation event register is read (corresponding bit only).
- When a fail event register is read (corresponding bit only).
- When an overload event register is read (corresponding bit only).
- When a message CLS (Clear Status related registers) is sent.

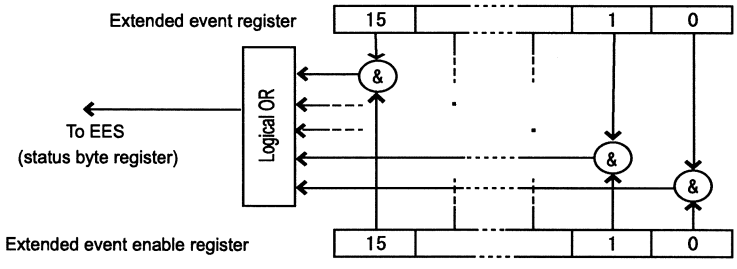
Every bit of an extended event register can be summarized into an EES bit of the status byte register by setting the corresponding bit of the extended event enable register to 1.

An extended event enable register can be set or queried using the following program messages where the data is the total of the weight of factors that are set to 1.

- Setting: XEE (the data to be set is in a decimal integer and initial value is "0".)
- Query: ?XEE (the response data will be in a decimal integer.)

Bit assignment of extended event register

Bit (weight)	Description
15	Always 0 (not used)
14	
⋮	
⋮	
4	
3(8)	Warning event register summary bit
2(4)	Operation event register summary bit
1(2)	Fail event register summary bit
0(1)	Overload event register summary bit



Warning event register and related registers

The warning event register is a register that indicates an especially important operating state of a device such as shutdown. This register can be queried by the following message:

- ?WSC (the response data will be in a decimal integer.)

Every bit of the warning register is cleared to 0 when either of the following events occurs:

- A warning event register is read
- A message CLS (Clear Status related registers) is sent

Every bit of the warning event register can be summarized into the corresponding bit (bit 03) of the extended event register by setting the corresponding bit of the warning event enable register to 1.

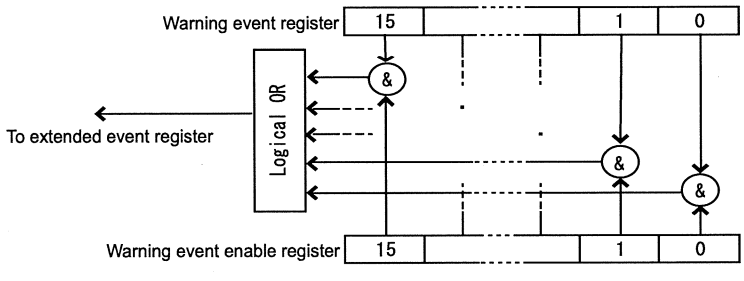
A warning event enable register can be set or queried using the following program messages where the data is the total of the weight of factors that are set to 1.

- Setting : WSE (the data to be set is in a decimal integer and initial value is "0".)
- Query : ?WSE (the response data will be in a decimal integer.)

Bit assignment of warning event register

Bit (weight)	Description
15	Always 0 (not used)
14(16384)	After switching phase mode, sets monitor output to initial value. *1
⋮	Always 0 (not used)
11(2048)	When switching phase mode, changes selection of measurement phase to L1 phase. *1
⋮	Always 0 (not used)
9(512)	When switching phase mode, sets AC voltage setting system to phase voltage. *1
⋮	Always 0 (not used)
3(8)	Line synchronization released
2(4)	Phase mode switched *1
1(2)	Output OFF Output is turned OFF for protection when an overload condition lasted for a long time or similar cases.
0(1)	Power supply to the power section is shut off for protective measure.

*1 In the case of EP02000S or EP02000X, always set to 0.



Operation event register and related register

The operation event register is a register to notify the start or end of processing of a cause whose internal processing time is relatively long. This register can be queried by the following message:

- ?OPC (the response data will be in a decimal integer.)

Every bit of the operation event register is cleared to 0 when either of the following events occurs:

- An operation event register is read
- A message CLS (Clear Status related registers) is sent

Every bit of the operation event register can be summarized into the corresponding bit (bit 02) of the extended event register by setting the corresponding bit of the operation event enable register to 1.

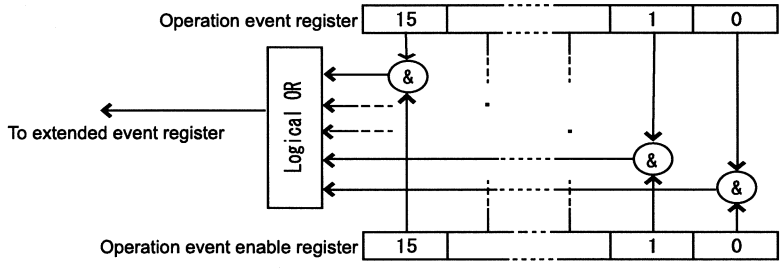
An operation event enable register can be set or queried using the following program messages where the data is the total of the weight of factors that are set to 1.

- Setting : OPE (the data to be set is in a decimal integer and initial value is "0".)
- Query : ?OPE (the response data will be in a decimal integer.)

Bit assignment of operation event register

Bit (weight)	Description
15	Always 0 (not used)
14	
⋮	
11	
10	
9 (512)	Memory recall operation ended
8 (256)	Memory recall operation started
7	Always 0 (not used)
6	
5 (32)	Phase mode switching ended *1
4 (16)	Phase mode switching started *1
3 (8)	Output ON/OFF ended
2 (4)	Output ON/OFF started
1 (2)	Range switching ended
0 (1)	Range switching started

*1 In the case of EP02000S or EP02000X, always set to 0.



Fail event register and related registers

The fail event register is set when especially important problems (fail causes) are detected to protect the internal circuit. This register can be queried by the following message:

- ?FLC (the response data will be in a decimal integer.)

Every bit of the fail event register is cleared to 0 when either of the following events occurs:

- A fail event register is read
- A message CLS (Clear Status related registes) is sent

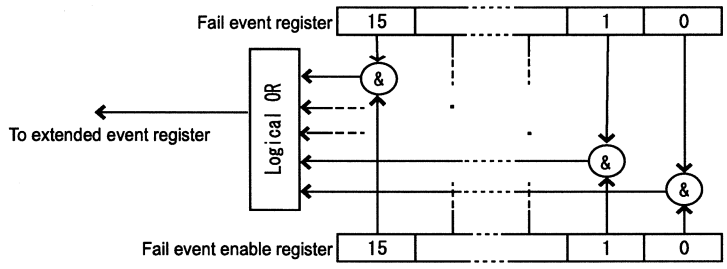
Every bit of the fail event register can be summarized into the corresponding bit (bit 01) of the extended event register by setting the corresponding bit of the fail event enable register to 1.

A fail event enable register can be set or queried using the following messages where the data is the total of the weight of factors that are set to 1.

- Setting : FLE (the data to be set is in a decimal integer and initial value is "0".)
- Query : ?FLE (the response data will be in a decimal integer.)

Bit assignment of fail event register

Bit (weight)	Description
15	Always 0 (not used)
14	
⋮	
⋮	
2	
1 (2)	Recovery from fail (shutoff of power supply to the power section) cause
0 (1)	Detection of fail (shutoff of power supply to the power section) cause



Overload event register and related registers

The overload event register is a register that reflects the output overload situation. This register can be queried by the following message:

- ?OVC (the response data will be in a decimal integer.)

Every bit of the overload event register is cleared to 0 when either of the following events occurs:

- An overload event register is read
- A message CLS (Clear Status related registers) is sent

Every bit of the overload event register can be summarized into the corresponding bit (bit 00) of the extended event register by setting the corresponding bit of the overload event enable register to 1.

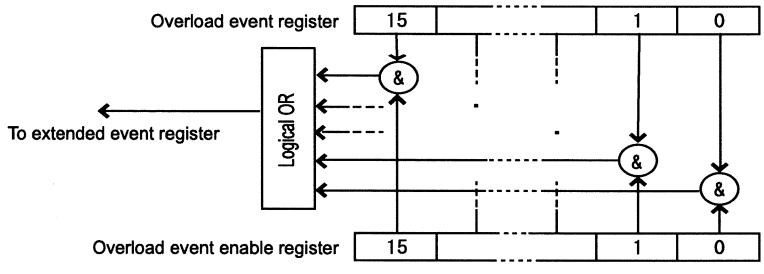
An overload event enable register can be set or queried using the following program messages where the data is the total of the weight of factors that are set to 1.

- Setting : OVE (the data to be set is in a decimal integer and initial value is "0".)
- Query : ?OVE (the response data will be in a decimal integer.)

Bit assignment of overload event register

Bit (weight)	Description
15	Always 0 (not used)
⋮	
7(128)	Release from AGC overload condition. Remote sensing AGC changed the condition of the unit from outside the correction range to within the correction range.
⋮	
6 (64)	Occurrence of AGC overload condition Remote sensing AGC put the unit outside the correction range.
⋮	Always 0 (not used)
1 (2)	Releases from overload condition
0 (1)	Occurrence of overload condition

* Remote sensing AGC is not available in the EP02000X or EP02000S.
  Related bits are always set to 0.



Extended status register and related registers

The extended status register is provided with bits indicating fail causes or overload condition. This register can be queried by the following message:

- ?XSC (the response data will be in a decimal integer.)

Every bit of the extended status register changes from 0 to 1 when its cause or operation begins and changes from 1 to 0 when its cause or operation ends.

Every bit of an extended status register is cleared to 0 when the following event occurs:

- The cause corresponding to each bit or operation ends.

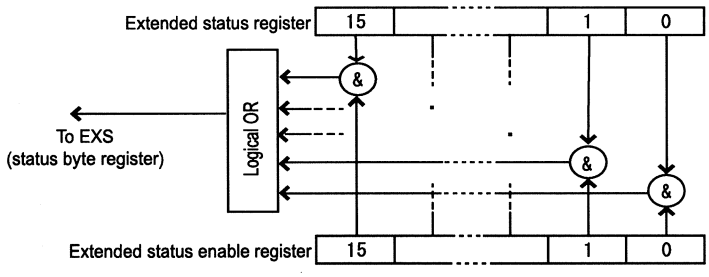
Every bit of an extended status register can be summarized into the EXS bit of the status byte register by setting the corresponding bit of the extended status enable register to 1.

An extended status enable register can be set or queried using the following messages where the data is the total of the weight of factors that are set to 1.

- Setting : XSE (the data to be set is in a decimal integer and initial value is "0".)
- Query : ?XSE (the response data will be in a decimal integer.)

Bit assignment of extended status register

Bit (weight)	Description
15	Always 0 (not used)
14	
⋮	
⋮	
2	
1 (2)	A fail (shutoff of power supply to the power section) cause being produced
0 (1)	An overload being produced



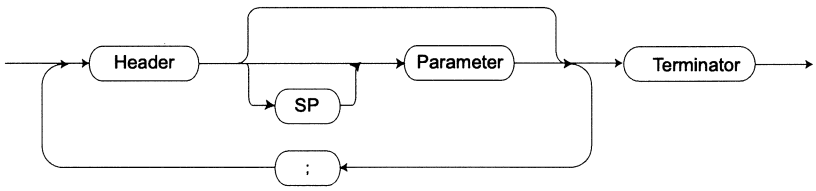
Program messages

A program message is tentatively stored in the input buffer. When a terminator is received, the message is interpreted and executed in the FIFO order. The input buffer has a capacity of 256 characters (i.e., 256 bytes) and nulls (00H) and terminators are not accepted in the input buffer.

When interpretation and execution are completed, the input buffer is emptied to admit the next coming data.

If a program message that exceeds 256 characters is sent, only valid part of the message included in the first 256 characters is executed, then an error occurs.

A program message consists of a header and a parameter. Messages can be sent successively if each of them does not exceed the character capacity of the input buffer. The format of a program message is shown below.



To send two or more program messages at a time, a semicolon ";" must be inserted between the program messages.

Program messages are broadly classified into two categories of "setting messages" that execute setting or operation directive and "querying messages" that query status or settings.

Program message basic form

A basic format of setting message is shown below. This example sets frequency to 50 Hz and output voltage to 100Vrms.

(Example of setting message) Sets frequency to 50 Hz and output voltage to 100Vrms.

FRQ	_	50	;	VLT	_	100
a	b	c	d	a	b	c

(Example of query message) Query of voltage measured value or current measured value

?MVR	_	;	_	?MCR
a	b	d	b	a

a: This is called a header. Both upper and lower case alphabets are available and even mixture of them may be used. A query message is headed by "?".
b: This is a space to improve legibility. Any number of spaces or a null space may be used.
c: Parameter section. This begins with a sign (+ or -), number, or a decimal point. When a sign is omitted, control recognizes it as a positive value.
d: This is a semicolon (or a message terminator) to divide two or more setting messages.

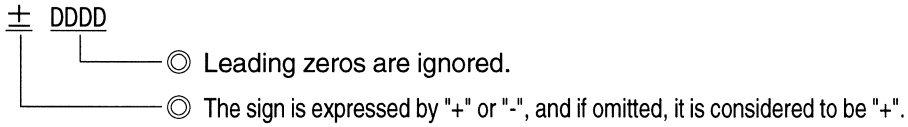
Setting messages

Data form in setting message

The following two parameter data forms are available:

- NR1 form

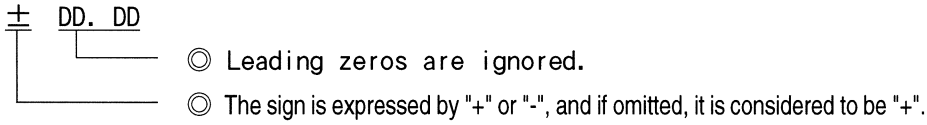
This is an integer type. A virtual decimal point is deemed to be placed at the end of the digits.



Examples: +01234
−50001
18

- NR2 form

This is a real number type. A decimal point is expressed with a period ".". Digits in the decimal places may be omitted, and omitted digits are taken to be all "0". An exponential form can also be used.



Examples: +0.1234
−50.001
1.8
1.00E+2
200

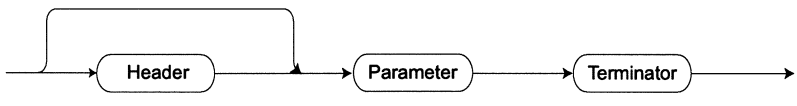
Querying message

This is a program message to query the status of selection, setting and other items. This is always headed by a question mark "?".

If "talker" is specified after sending a querying message, the response to it will be output.

When two or more queries are made at a time, two or more responses will be output each divided with a semicolon ";". A response character string exceeding 255 characters in total will produce an error and no response is returned. If a query is made without specifying the talker (receiving a response) and a further query(ies) is made, then up to five responses will be stored. However, other excessive data will be deleted from the oldest response.

Output format for response is shown below.



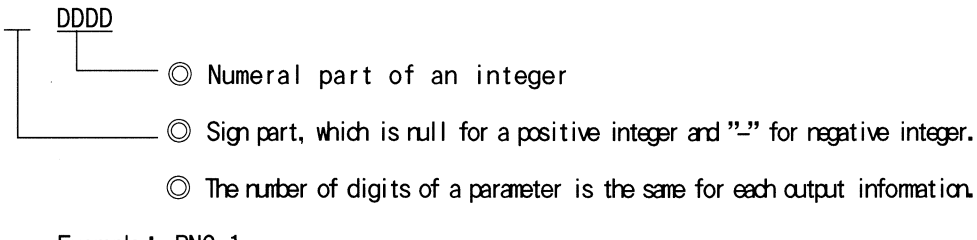
It is possible to set ON/OFF of the header included in response data by a setting message of "HDR 1" or "HDR 0". When power is turned on, the header is set to ON (to output the header).

Form of response data to a querying message

The following three types of response parameter data forms are available:

- NR1 form

  This is an integer type.

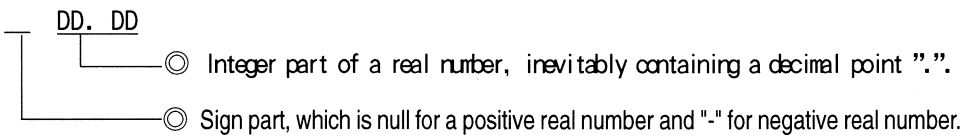


  Example : RNG 1

  This indicates that the output voltage range is set to the 200 V range.

- NR2 form

  This is a real number type.



  Example : FRQ 50.0

  This indicates that the output frequency is set to 50.0 Hz.

- STRING form

  This is character string data using ASCII (ISO 7-bit) codes

Situation in which no message is accepted (BUSY)

In general, a computer serving as the GPIB controller, etc. is expected to be free from the constraints by specific processing and able to perform various kinds of processing simultaneously.

When a GPIB device under the control of the GPIB controller spends a long time for its internal processing, if it stops communication (handshake) by attaching greater importance to message exchange processing, the GPIB device can no longer perform other processing in the meantime, resulting in reduced throughput on the GPIB controller side.

From this standpoint, when a specific message is sent from the GPIB controller, P-STATION/EP0 continues to perform handshake as it is and stores the message in the internal buffer temporarily, but does not interpret or execute it, which results in an execution error. Such a situation is called "BUSY".

Duration of BUSY varies depending on the processing content, but is at least approximately 700ms.

BUSY is indicated by a BUSY lamp on the panel and it is possible to recognize BUSY by referencing the status related register from the GPIB controller.

To continue setting after sending a BUSY-related message, refer to the contents of these registers in the program and be careful not to send messages during BUSY.

BUSY related messages

Header	Function	BUSY duration	Caution
OUT	Output ON/OFF switching	Approx. 700ms	During overload, etc., the output may be forcibly turned OFF for internal protection and BUSY occurs in this case.
RNG	Selection of output voltage range	Approx. 700ms	The output voltage range can be set for AC and DC separately. When AC/DC switching is performed, if the voltage range changes before and after the switching, a range switching may occur producing BUSY.
DCM	AC/DC output switching	Approx. 700ms	
PMD	Phase mode switching	Max. approx. 2s	BUSY duration varies depending on phase mode state before and after switching and system capacity.
RCL	Memory recall	Approx. 700ms	A change to any one of the settings above before and after a recall may produce BUSY.

To recognize BUSY state from controller

It is possible to recognize the start and end of the BUSY state by referencing the operation event register. Likewise, it is possible to know whether BUSY is in place or not by referencing the operation status register.

Attention!

Also see a processing example included in the sample program.

List of program messages

Commands are used in common when GPIB and RS-232 interfaces are used.

However, the function indicated by a header "STB" would be ineffective if the RS-232 interface is used.

In addition, a space " " can be inserted between the header and the parameter of a command in order to improve the legibility.

Setting of output voltage and output range

Header	Function	Parameter	Data Form		Default
			Setting	Query	
RNG	To select AC output voltage range	0 : 100 V range 1 : 200 V range	NR1	NR1	100 V range
	To select DC output voltage range	0 : 100 V range 1 : 200 V range	NR1	NR1	100 V range
VLT	To set AC output phase voltage	0.0 to 300.0 Unit: [Vrms] Resolution: 0.1 [Vrms]	NR2	NR2	0.0 [Vrms]
	To set AC output line-to-line voltage (three-phase)	0.0 to 519.6 Unit: [Vrms] Resolution: 0.2 [Vrms]	NR2	NR2	0.0 [Vrms]
	To set AC output line voltage (single-phase three-wire)	0.0 to 600.0 Unit: [Vrms] Resolution: 0.2 [Vrms]	NR2	NR2	0.0 [Vrms]
	To set DC output voltage	0.0 to 424.0 Unit: [Vdc] Resolution: 0.1 [Vdc]	NR2	NR2	0.0 [Vdc]
VMD	To select AC output voltage setting method	0: phase voltage setting method 1: line-to-line voltage setting method	NR1	NR1	Phase voltage setting method

RNG:Range

VLT:Voltage

VMD:Voltage Mode

Example : To set the output voltage range to 100 V range and output voltage to 100 Vrms.

Setting of output voltage range to 100 V range RNG 0

Setting of output voltage to 100 Vrms VLT 100.0

Attention!

- With the output voltage range set to 100 V, a setting that exceeds the following value will cause an error:
  150 Vrms in AC mode 212 Vrms in DC mode
  In the above case, select 200 V for the output voltage range. In addition, if the set voltage sent from the voltage setting is higher than the voltage limit level, an error will be caused. If this is the case, check the voltage limit value.
- When the system is switching the output voltage range, any command will not be interpreted. If a subsequent command is sent at this moment, this will also cause an error. Confirm that the range has been switched by the status byte before sending a subsequent command.

Setting of output frequency

Header	Function	Parameter	Data Form		Default
			Setting	Query	
FRQ	To set an output frequency	5.0～550.0 Unit: [Hz] Resolution: 0.1 [Hz]	NR2	NR2	50.0 [Hz]

FRQ : Frequency

Example : To set an output frequency to 60 Hz.

To set output frequency to 60.0 Hz FRQ 60.0

Switching ON/OFF the output

Header	Function	Parameter	Data Form		Default
			Setting	Query	
OUT	To switch ON/OFF the output	0: Output OFF 1: Output ON	NR1	NR1	Output OFF

OUT:Output

Example : To set ON/OFF of output

To set the output to ON OUT 1

To set the output to OFF OUT 0

Measuring function

Header	Function	Parameter	Data Form		Default
			Setting	Query	
MVR	To query result of RMS AC voltage measurement		None	NR2	None
	To query result of DC voltage measurement		None	NR2	None
MVP	To query result of peak AC voltage measurement		None	NR2	None
MCR	To query result of RMS AC current measurement		None	NR2	None
	To query result of DC current measurement		None	NR2	None
MCP	To query result of peak AC current measurement		None	NR2	None
	To query result of peak hold		None	NR2	None
MWT	To query result of effective power measurement		None	NR2	None
MVA	To query result of apparent power measurement		None	NR2	None
MPF	To query result of power factor measurement		None	NR2	None
MSL	To select measurement parameter indication	0: RMS voltage, current 1: Peak voltage, current 2: Effective, apparent power 3: Power factor	NR1	NR1	RMS voltage, current
CPH	To change ON/OFF of current peak hold measurement	0: OFF 1: ON	NR1	NR1	OFF
MPH	To select phase of measurement	0: L1 phase 1: L2 phase 2: L3 phase 3: L1-L2 line-to-line 4: L2-L3 line-to-line 5: L3-L1 line-to-line	NR1	NR1	L1 phase

```
MVR:Measurement Voltage RMS
MVP:Measurement Voltage Peak
MCR:Measurement Current RMS
MCP:Measurement Current Peak
MWT:Measurement Wattage
MVA:Measurement VA
MPF:Measurement Power_Factor
MSL:Current Select
CPH:Current Peak Hold
MPH:Measurement Phase
```

Attention!

- To a query of measurement, returned will be the measurement for the phase that was selected for measurement, or the line-to-line measurement.
- The response data when queried with a message "MCP" varies depending on the setting state of the message "CPH" (current peak hold measurement ON/OFF).
  When CPH 0 (peak hold OFF) has been selected: Result of peak AC current measurement
  When CPH 1 (peak hold ON) has been selected: Result of peak hold measurement

Setting limit values

The user may put a limit(s) to the setting range of the output voltage and output frequency.

Header	Function	Parameter	Data Form		Default
			Setting	Query	
VUP	To set an upper limit to AC output phase voltage	0.0 to 300.0 Unit: [Vrms] Resolution: 0.1 [Vrms]	NR2	NR2	300.0[Vrms]
	To set an upper limit to DC output voltage	0.0 to 424.0 Unit: [Vdc] Resolution: 0.1 [Vdc]	NR2	NR2	424.0[Vdc]
	To set an upper limit to AC output line-to-line voltage (three-phase)	0.0 to 519.6 Unit: [Vrms] Resolution: 0.2 [Vrms]	NR2	NR2	519.6[Vrms]
	To set an upper limit to AC output line voltage (single-phase three-wire)	0.0 to 600.0 Unit: [Vrms] Resolution: 0.2 [Vrms]	NR2	NR2	600.0[Vrms]
FUP	To set an upper limit to output frequency	5.0 to 550.0 Unit: [Hz] Resolution: 0.1 [Hz]	NR2	NR2	550.0[Hz]
FLW	To set a lower limit to output frequency	5.0 to 550.0 Unit: [Hz] Resolution: 0.1 [Hz]	NR2	NR2	5.0[Hz]

VUP:Voltage Upper limit

FUP:Frequency Upper limit

FLW:Frequency Lower limit

Example : To limit the output voltage to 220 V at the maximum, and limit the frequency to 65 Hz at the maximum.

To set the output voltage upper limit to 220 V	VUP 220.0
To set the output frequency upper limit to 65 Hz	FUP 65.00

Attention!

- An error will be caused if the user attempts to set a value lower than the already set output voltage in the course of upper voltage limit setting procedure.
- An error will be caused if the user attempts to set a value lower than the already set output frequency in the course of upper frequency limit setting procedure. Also, an error will be caused if the user attempts to set a value lower than the already set lower frequency limit.
- An error will be caused if the user attempts to set a value higher than the already set output frequency in the course of lower frequency limit setting procedure. Also, an error will be caused if the user attempts to set a value higher than the already set upper frequency limit.
- An upper limit to the output in a three-phase system and in a single-phase three-wire system will be effective to the phase voltage of all phases.

Setting a Power-ON phase

The user may set the Power-ON phase on output turn-on moment.

Header	Function	Parameter	Data Form		Default
			Setting	Query	
SPH	To set a Power-ON phase	0: 0[deg] 1: 90[deg] 2: 180[deg] 3: 270[deg]	NR1	NR1	0[deg]

SPH:Start Phase

Precision mode and high stability mode setting

This function sets the condition of the output compensation.

The user can select the precision mode to minimize the fluctuation of output voltage against the change of load current. On the contrary, the user can select the high stability mode to maintain good stability against the capacitive load although the fluctuation of output voltage is a little higher.

Header	Function	Parameter	Data Form		Default
			Setting	Query	
PRC	To switch the mode between precision and high stability	0: High stability 1: Precision	NR1	NR1	Precision

PRC:Precision

Example: To set the status of output compensation to high stability.

To set the mode to high stability PRC 0

Line synchronization

The user can synchronize the output frequency to the frequency of the commercial input power line to which the P-STATION/EPO is connected. The user can also set the frequency for the time of disabling the synchronization function.

Header	Function	Parameter	Data Form		Default
			Setting	Query	
LSY	To switch ON/OFF of line synchronization	0 : Line synchronization OFF 1 : Line synchronization ON	NR1	NR1	Line synchronization OFF
LSF	To set the frequency for line synchronization OFF moment	0 : 50[Hz] 1 : 60[Hz]	NR1	NR1	50[Hz]

LSY:Line Sync

LSF:Line Sync off Frequncy

AC/DC selection

Header	Function	Parameter	Data Form		Default
			Setting	Query	
DCM	To switch AC/DC output	0: AC output 1: DC output	NR1	NR1	AC output

DCM:Direct Current Mode

Attention!

Setting of AC/DC selection will be accepted only when single-phase has been set in the phase mode. When single-phase three-wire or three-phase has been set in the phase mode, this attempt will result in an error.

Phase mode

Header	Function	Parameter	Data Form		Default
			Setting	Query	
PMD	To switch phase mode	0: Single-phase 1: Single-phase three-wire 2: Three-phase	NR1	NR1	Single-phase

PMD:Phase Mode

Attention!

- This setting will be accepted when AC has been set in AC/DC selection. When DC has been set in AC/DC selection, this attempt will result in an error.
- This message is invalid in the EP02000S or EP02000X.

Beep

Header	Function	Parameter	Data Form		Default
			Setting	Query	
BEE	To switch ON/OFF of beep	0: OFF 1: ON	NR1	NR1	ON

BEE:Beep

Remote sensing AGC

Header	Function	Parameter	Data Form		Initial value
			Setting	Query	
AGC	Remote sensing AGC ON/OFF switching	0: OFF 1: ON	NR1	NR1	OFF

Monitor output

Header	Function	Parameter	Data Form		Initial value
			Setting	Query	
M01	Setting of monitor output CH1 output source	0: L1-phase voltage 1: L1-phase voltage x1 2: L1-phase voltage x10 3: L2-phase voltage 4: L2-phase voltage x1 5: L2-phase voltage x10 6: L3-phase voltage 7: L3-phase voltage x1 8: L3-phase voltage x10	NR1	NR1	L1-phase voltage
M02	Setting of monitor output CH2 output source	0: L1-phase voltage 1: L1-phase voltage x1 2: L1-phase voltage x10 3: L2-phase voltage 4: L2-phase voltage x1 5: L2-phase voltage x10 6: L3-phase voltage 7: L3-phase voltage x1 8: L3-phase voltage x10			L1-phase voltage x1

Attention!

Messages related to the remote sensing AGC and monitor output are invalid in the EP02000S or EP02000X.

Memory

The user can store and recall set values and statuses in the battery-backup memory incorporated in the unit. Eleven memory addresses from 0 to 10 are provided.

Header	Function	Parameter	Data Form		Default
			Setting	Query	
STO	To store data	1~10	NR1	None	None
RCL	To recall data	0~10	NR1	None	None

STO:Store

RCL:Recall

Example: To store the current setting in memory address 2 and recall the data in memory address 2.

To store the current setting in memory address 2 STO 2

To recall the data in memory address 2 RCL 2

⚠ CAUTION

Once a setting by a message from GPIB is stored in memory, the setting stored in memory will not be changed even when operation is performed from the panel. Therefore, unexpected operation may occur when it is recalled.

If the user wants to change from interface control to manual operation, it is recommended to execute "Recall of Address 0" in order to return the memory to the initial status before doing so.

Attention!

In the EPO2000S or EPO2000X if system cable connection is altered, settings stored in the master unit's memory will be erased, and all data in every memory address will turn into the same initial setting values as that at address 0.

Attention!

- Memory address 0 contains default values, and it permits only recalling access. In addition, these default values cannot be modified. Memory address 1 is read on every occasion of power charging to the unit. Thus the user can store the normally used settings at this address so that the user will not have to set them every time at the beginning of operation.
- The GPIB address and other interface parameters are not the subject of memory store/recall function.
- Also some other settings are not the subject of memory store/recall function.

Hardware structure

Header	Function	Parameter	Data Form		Default
			Setting	Query	
IDX	To query the model name	"P-STATION/EPO"	None	String	None
VER	To query the ROM version number	"1.00"	None	String	None
OPR	To query the hardware structure status	0～32767	None	NR1	None

D15 - D14 Unused (always 0)

D13 - D08 System capacity (Note 2)

Capacity	Value
2kVA	1
4kVA	2
≀	≀
36kVA	18

D07 - D06 Unused (always 0)

D05 Monitor output option (Note 1)

0	Yes
1	No

D04 Remote sensing AGC option (Note 1)

0	Yes
1	No

D03 Phase system type (Note 2)

0	Single-phase system
1	Multi-phase system

D02 EP02000 type

0	EPO 2000S
1	EPO 2000X

D01 - D00 Unused (always 0)

IDX : ID code X VER : Version OPR : Operation

(Note1) Always 0 in the case of EPO2000s / EPO2000X.

(Note2) The correspondence between a product model name and response data is shown below.

Capacity		D15	～	D13	D12	D11	D10	D09	D08	～	D03	D02	～
EPO36000M		These bits are irrelevant to the product model name.		0	1	0	0	1	0	These bits are irrelevant to the product model name.	1	0	D00 - D01 are always 0.
EPO24000M				0	0	1	0	1	0		1	0	
EPO18000M				0	0	1	0	0	1		1	0	
EPO12000M				0	0	0	1	1	0		1	0	
EPO6000M				0	0	0	0	1	1		1	0	
EPO12000S				0	0	0	1	1	0		0	0	
EPO10000S				0	0	0	1	0	1		0	0	
EPO6000S				0	0	0	0	1	1		0	0	
EPO4000S				0	0	0	0	1	0		0	0	
EPO2000S				0	0	0	0	0	1		0	0	
EPO2000X	(1 unit)			0	0	0	0	0	1		1	1	
	(2 units)			0	0	0	0	1	0		1	1	
	(3 units)			0	0	0	0	1	1		1	1	

Interface and Status related

Header	Function		Parameter	Data Form		Default
				Setting	Query	
HDR	To select header ON/OFF		0: Header OFF 1: Header ON	NR1	NR1	Header ON
CLS	To clear status-related registers Specify 0 for the following register: • Standard event register • Warning event register • Operation event register • Fail event register • Overload event register		None	Only header	None	None
STB	Status byte register	Query	0～255	None	NR1	None
SRE		Enable register setting/query		NR1		0
ESR	Standard event status register	Query	Same as above			
ESE		Enable register setting/query				
OSC	Operation status register	Query	0～32767	None	NR1	None
OSE		Enable register setting/query		NR1		0
XEC	Extended event register	Query	Same as above			
XEE		Enable register setting/query				
WSC	Warning event register	Query	Same as above			
WSE		Enable register setting/query				
OPC	Operation event register	Query	Same as above			
OPE		Enable register setting/query				
FLC	Fail event register	Query	Same as above			
FLE		Enable register setting/query				
OVC	Overload event register	Query	Same as above			
OVE		Enable register setting/query				
XSC	Extended status register	Query	Same as above			
XSE		Enable register setting/query				

- Each status/event register is provided with an enable register, which can enable/disable a detection cause bit by bit.
- The enable register can not only set but also read a status. However, each status/event register can, by nature, only read a state by a query.

  For details of the register-related messages, see "Detailed structure of status".

Response to interface message

Responses to interface message sent from the GPIB controller are listed below.

IFC	< Interface Clear > Initializes GPIB interface. Releases specified listener and talker.
DCL SDC	< Device Clear > < Selected Device Clear > Clears the input buffer and aborts interpretation and execution of command. Clears the input buffer and also clear bit 4 (MAV) of the status byte register. Releases SRQ sending.
LLO	< Local Lockout > Disables operation of the (LOCAL) button in the operation section.
GTL	< Go To Local > Puts the unit in a local status.

Usage of interface messages varies with the GPIB driver on the controller side.

For details, refer to the manual for the GPIB driver.

Sample GPIB program

Outline of sample program

The following section introduces samples of remote control that uses GPIB interface.

Here, the following two cases are shown:

- Case where Microsoft's Visual Basic and Keithley's (Keithley Instruments Inc.) GPIB interface board are used
- Case where Visual Basic and National Instruments' GPIB interface board are used

The following two programs are presented for explanation.

a) Setting

This is a simplest program of initialization followed by setting of arbitrary voltage and frequency, then turning on the output.

b) Use of Query and SRQ

This program uses SRQ to detect range selection and turn-on/off operation while conducting the setting of arbitrary voltage and frequency.

In both examples, parameter range check etc. are omitted. When the user prepares a practical program, take into consideration error processing and initialization procedure.

In addition, these sample programs are prepared assuming a situation in which the unit is energized in the on-shipping condition. Note that the program may not operate properly in other conditions.

These sample programs can be downloaded from our homepage:

http://www.nfcorp.co.jp/

Case where Visual Basic and Keithley's GPIB interface board are used

When receiving (entering) a response message using Keithley's GPIB interface board and driver software, the length of the reception buffer character string variable is changed appropriately. The maximum number of characters to be received and the number of characters actually received are set by parameters different from those of the buffer.

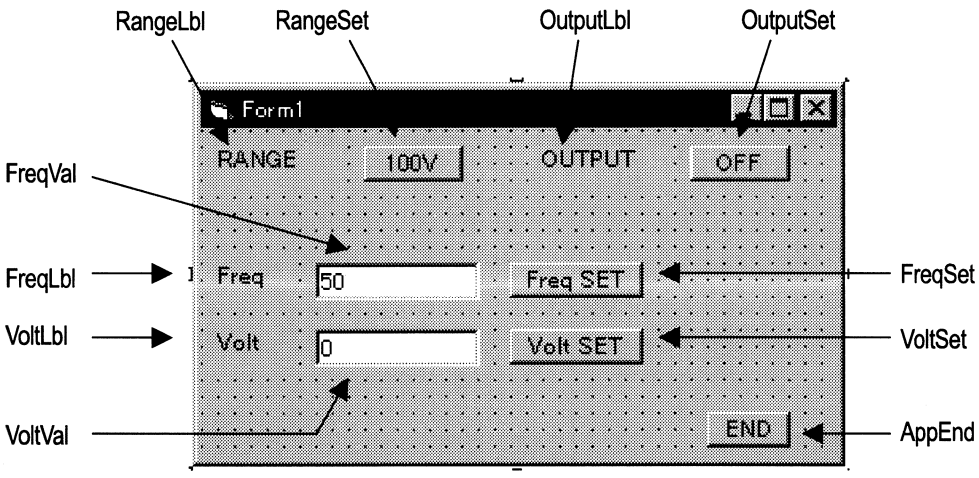
a) Setting -KI

If the button of range or output is pressed, the system changes its status and displays the set status.

The values entered in the text box of frequency and voltage will be set when the setting button of each item is pressed.

Necessary initialization is executed by load of form.

Here, the device descriptor (Dev) is opened with the timeout of 200ms, GPIB address 2, E01 valid and terminator LF.




```
Option Explicit
Const Adr As Integer = 2
Dim Rng As Boolean
Dim Out As Boolean

Private Sub AppEnd_Click()
    Dim stat As Integer
    transmit "UNL LSTEN" & CStr(Adr) & "GTL", stat 'Go To Local
    End
End Sub

Private Sub Form_Load()
    Dim stat As Integer

    initialize 0, 0                    ' Open the device
    settimeout (300)                   ' Set time out
    transmit "DCL", stat               ' Clear the device


    Rng = False
    Out = False
End Sub
```

```
Private Sub FreqSet_Click()
    Dim stat As Integer
    send Adr, "FRQ" & FreqVal.Text, stat  ' Set the frequency
End Sub

Private Sub OutputSet_Click()
    Dim stat As Integer
    If Out = False Then
        send Adr, "OUT 1", stat           ' Set the output to ON
        OutputSet.Caption = "ON"
        Out = True
    Else
        send Adr, "OUT 0", stat           ' Set the output to OFF
        OutputSet.Caption = "OFF"
        Out = False
    End If
End Sub

Private Sub RangeSet_Click()
    Dim stat As Integer
    If Rng = False Then
        send Adr, "RNG 1", stat           ' Set the range to 200V
        RangeSet.Caption = "200V"
        Rng = True
    Else
        send Adr, "RNG 0", stat           ' Set the range to 100V
        RangeSet.Caption = "100V"
        Rng = False
    End If
End Sub

Private Sub VoltSet_Click()
    Dim stat As Integer
    send Adr, "VLT" & VoltVal.Text, stat  ' Set the voltage
End Sub
```

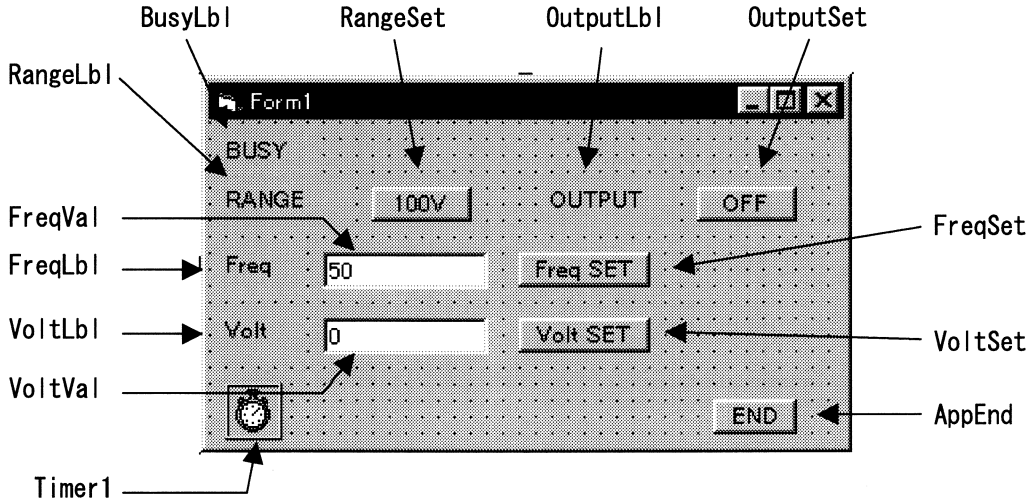
b) Use of Query and SRQ -KI

This operation is similar to that of the above sample a) except that the control detects that the system enters a BUSY condition on the point of range selection and output ON/OFF switching and queries related status and then temporarily disables command sending.

In the case of Keithley's GPIB driver, use the method by polling monitoring using a timer.

Polling can query the content of the event register or status register every time, but serial poll can reduce the load of the firmware of the device more than polling. To shorten polling intervals, use of serial poll is recommended.

Note that before and after the serial poll routine spoll of Keithley's GPIB driver, universal commands SPE and SPD are required.




```
Option Explicit
Const Adr As Integer = 2
Dim Rng As Boolean
Dim Out As Boolean

Private Sub AppEnd_Click()
    Dim stat As Integer
    transmit "UNL LSTEN" & CStr(Adr) & "GTL", stat ' Go To Local
    End
End Sub

Private Sub Form_Load()
    Dim stat As Integer
    Dim rbbuf As String
    Dim I As Integer
    initialize 0, 0                          ' Open the device
    settimeout (300)                         ' Set time out
    transmit "DCL", stat                     ' Clear the device
    send Adr, "SRE 2;XEE 14;OPE 15", stat ' Set the SRQ enable register
    send Adr, "?OPC", stat
    enter rbbuf, 256, I, Adr, stat
    send Adr, "?stb", stat
    enter rbbuf, 256, I, Adr, stat
    Rng = False
    Out = False
    BusyLbl.Enabled = False
    Timer1.Enabled = False
    Timer1.Interval = 500
End Sub
```

```
Private Sub FreqSet_Click()
    Dim stat As Integer
    send Adr, "FRQ" & FreqVal.Text, stat  ' Set the frequency
End Sub

Private Sub OutputSet_Click()
    Dim stat As Integer
    If Out = False Then
        send Adr, "OUT 1", stat           ' Set the output to ON
        OutputSet.Caption = "ON"
        Out = True
    Else
        send Adr, "OUT 0", stat           ' Set the output to OFF
        OutputSet.Caption = "OFF"
        Out = False
    End If
    Timer1.Enabled = True                 ' Because RQS occurs on occasion of output setting
End Sub

Private Sub RangeSet_Click()
    Dim stat As Integer
    If Rng = False Then
        send Adr, "RNG 1", stat           ' Set the range to 200V
        RangeSet.Caption = "200V"
        Rng = True
    Else
        send Adr, "RNG 0", stat           ' Set the range to 100V
        RangeSet.Caption = "100V"
        Rng = False
    End If
    Timer1.Enabled = True                 'Because RQS occurs on occasion of range selection
End Sub

Private Sub Timer1_Timer()
    Dim stat As Integer
    Dim stb As Integer
    Dim rbbuf As String
    Dim I As Integer
    Dim opc As Integer
    transmit "SPE", stat                  ' Required in KI board
    spoll Adr, stb, stat                  ' Serial poll
    transmit "SPD", stat                  ' Required in KI board
    If stb And 64 Then                    ' RQS cause check
        If stb And 2 Then
            send Adr, "?OPC", stat
            enter rbbuf, 256, I, Adr, stat
            opc = CInt(Right(rbbuf, 1))
            If (opc And 1) Or (opc And 4) Then
                BusyLbl.Enabled = True
                RangeSet.Enabled = False
                OutputSet.Enabled = False
                FreqSet.Enabled = False
                VoltSet.Enabled = False
            Else
                BusyLbl.Enabled = False
                RangeSet.Enabled = True
                OutputSet.Enabled = True
                FreqSet.Enabled = True
                VoltSet.Enabled = True
                Timer1.Enabled = False
            End If

            If (Out = True) And (opc = 9) Then
                OutputSet.Caption = "OFF"
                Out = False
            End If
        End If
    End If
End Sub

Private Sub VoltSet_Click()
    Dim stat As Integer
    send Adr, "VLT" & VoltVal.Text, stat  'Set the voltage
End Sub
```

Case where Visual Basic and National Instruments' GPIB interface board are used

When using National Instruments' GPIB interface board and driver software, a EOS character needs to be added to a character string to be sent.

Moreover, when receiving a response message (ibrd), the number of characters to be received is limited to the capacity of the reception buffer. The sample program presented here uses fixed-length character strings. If the user wants to use variable-length character strings, it is necessary to secure the capacity of the reception buffer using space(), etc. in front of ibrd. The number of received characters can be obtained by means of the global variable ibcnt.

a) Setting -NI

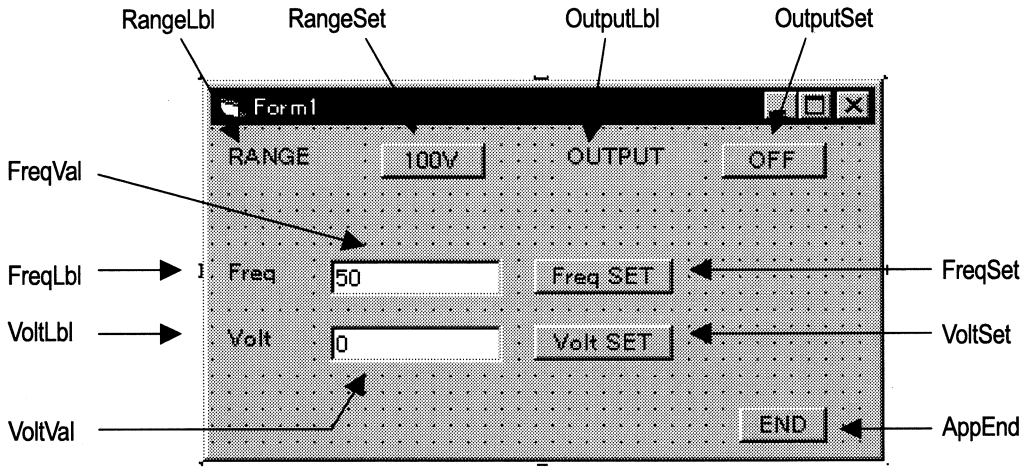
If the button of range or output is pressed, the system changes its status and displays the set status.

The values entered in the text box of frequency and voltage will be set when the setting button of each item is pressed.

Necessary initialization is executed by load of form.

Here, the device descriptor (Dev) is opened with the timeout of 200ms, GPIB address 2, E01 valid and terminator LF.

Pressing the [END] button reinstates the system into a local status and closes the program




```
Option Explicit
Const Adr As Integer = 2
Const EOSCHAR As Integer = &HA
Const EOS As Integer = XEOS + REOS + EOSCHAR
Dim Dev As Integer
Dim Rng As Boolean
Dim Out As Boolean

Private Sub AppEnd_Click()
    Dim v As Integer
    v = 0
    ibloc Dev                          'Go To Local
    ibonl Dev, v                       'Set the device off line
    End
End Sub

Private Sub Form_Load()
```

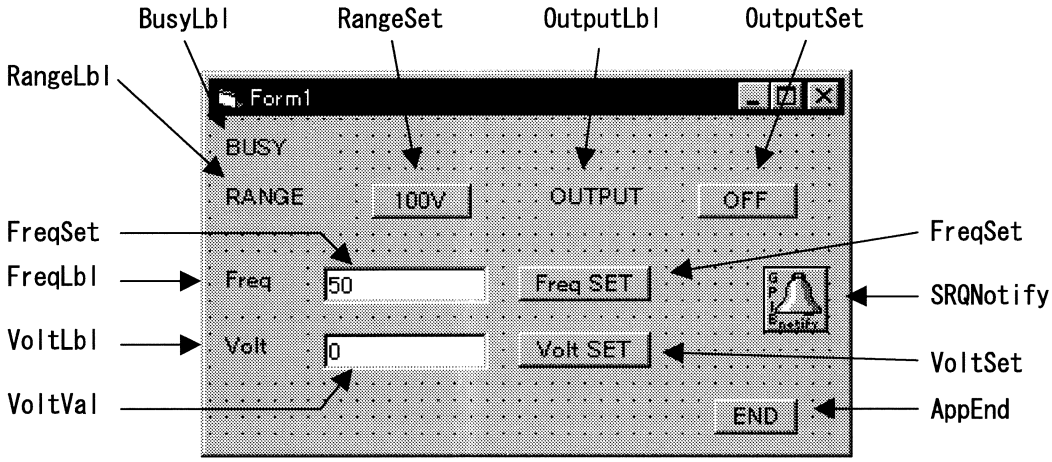
```
    ibdev 0, Adr, 0, T300ms, 1, EOS, Dev 'Open the device
    ibclr Dev                             'Clear the device

    Rng = False
    Out = False
End Sub

Private Sub FreqSet_Click()
    ibwrt Dev, "FRQ" & FreqVal.Text & Chr(EOSCHAR) 'Set the frequency
End Sub

Private Sub OutputSet_Click()
    If Out = False Then
        ibwrt Dev, "OUT 1" & Chr(EOSCHAR) 'Set the output to ON
        OutputSet.Caption = "ON"
        Out = True
    Else
        ibwrt Dev, "OUT 0" & Chr(EOSCHAR) 'Set the output to OFF
        OutputSet.Caption = "OFF"
        Out = False
    End If
End Sub

Private Sub RangeSet_Click()
    If Rng = False Then
        ibwrt Dev, "RNG 1" & Chr(EOSCHAR) 'Set the range to 200V
        RangeSet.Caption = "200V"
        Rng = True
    Else
        ibwrt Dev, "RNG 0" & Chr(EOSCHAR) 'Set the range to 100V
        RangeSet.Caption = "100V"
        Rng = False
    End If
End Sub

Private Sub VoltSet_Click()
    ibwrt Dev, "VLT" & VoltVal.Text & Chr(EOSCHAR) 'Set the voltage
End Sub
```

b) Use of Query and SRQ -NI

This operation is similar to that of the above sample a) except that the control detects that the system enters a BUSY condition on the point of range selection and output ON/OFF switching and queries related status and then temporarily disables command sending.

To monitor SRQ and generate an event, use the GPIBNotify control. The GPIBNotify control is made available by selecting "gpibNotify OLE Control Module" from "Component" in the "Project" menu of Visual Basic.

Event procedure (SRQNotify_Notify), which is started by SRQ, detects the BUSY condition by querying the serial poll and operation event register.



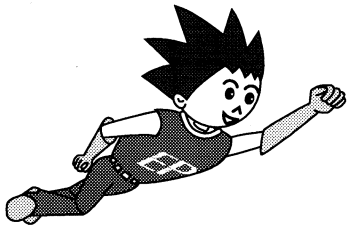

```
Option Explicit
Const Adr As Integer = 2
Const EOSCHAR As Integer = &HA
Const eos As Integer = XEOS + REOS + EOSCHAR
Dim Dev As Integer
Dim Rng As Boolean
Dim Out As Boolean

Private Sub AppEnd_Click()
    Dim v As Integer
    v = 0
    ibloc Dev
    ibonl Dev, v
    End
End Sub

Private Sub Form_Load()
    Dim x As Long, y As Long
    Dim stat As Integer
    Dim rdbuf As String * 10

    ibdev 0, Adr, 0, T300ms, 1, eos, Dev 'Open the device
    ibclr Dev                            'Clear the device

    ibwrt Dev, "SRE 2" & Chr(EOSCHAR)
    ibwrt Dev, "XEE 14" & Chr(EOSCHAR)
    ibwrt Dev, "OPE 15" & Chr(EOSCHAR)
```

```
    ibwrt Dev, "?OPC" & Chr(EOSCHAR)
    ibrd Dev, rdbuf
    ibwrt Dev, "?STB" & Chr(EOSCHAR)
    ibrd Dev, rdbuf
    stat = SRQNotify.SetupNotify(Dev, RQS)
    Rng = False
    Out = False
    BusyLbl.Enabled = False
End Sub

Private Sub FreqSet_Click()
    ibwrt Dev, "FRQ" & FreqVal.Text & Chr(EOSCHAR) 'Set the frequency
End Sub

Private Sub SRQNotify_Notify(ByVal LocalUd As Long, ByVal Locallbsta As Long, ByVal
Locallberr As Long, ByVal Locallbcntl As Long, RearmMask As Long)
        Dim stb As Integer
        Dim opc As Integer
        Dim rdbuf As String * 10
        If (Locallbsta And RQS) Then
            ibrsp Dev, stb
            If (stb And 2) Then
                ibwrt Dev, "?OPC" & Chr(EOSCHAR)
                ibrd Dev, rdbuf
                opc = CInt(Right(rdbuf, 6))
                If (opc And 1) Or (opc And 4) Then
                    BusyLbl.Enabled = True
                    RangeSet.Enabled = False
                    OutputSet. Enabled = False
                    FreqSet. Enabled = False
                    VoltSet. Enabled = False
                Else
                    BusyLbl. Enabled = False
                    RangeSet. Enabled = True
                    OutputSet. Enabled = True
                    FreqSet. Enabled = True
                    VlotSet. Enabled = True
                End If
            End If
            If (Out = True) And (opc = 9) Then
                OutputSet.Caption = "OFF"
                Out = False
            End If
            RearmMask = RQS
        End If
    End Sub

Private Sub OutputSet_Click()
    If Out = False Then
        ibwrt Dev, "OUT 1" & Chr(EOSCHAR) 'Set the output to ON
        OutputSet.Caption = "ON"
        Out = True
    Else
        ibwrt Dev, "OUT 0" & Chr(EOSCHAR)  'Set the output to OFF
        OutputSet.Caption = "OFF"
        Out = False
    End If
End Sub

Private Sub RangeSet_Click()
    If Rng = False Then
        ibwrt Dev, "RNG 1" & Chr(EOSCHAR) 'Set the range to 200V
        RangeSet.Caption = "200V"
        Rng = True
    Else
        ibwrt Dev, "RNG 0" & Chr(EOSCHAR) 'Set the range to 100V
        RangeSet.Caption = "100V"
        Rng = False
    End If
End Sub

Private Sub VoltSet_Click()
    ibwrt Dev, "VLT" & VoltVal.Text & Chr(EOSCHAR) 'Set the voltage
End Sub
```

9

RS-232 Interface

■This chapter describes RS-232 interface. I will first explain those who uses programs about preparation and setting. Then I will explain how to create a program.



Outline of RS-232

With RS-232 interface, the system can perform external control similarly to the case of GPIB except for GPIB proper functions. It can perform setting and query using the same program messages as GPIB. Response messages to queries have the same format as that for GPIB.

Since much overlapping is found between the two, the same contents as those for GPIB are omitted here. When the user is to use RS-232 for external control, also refer to materials for GPIB.

a) Functions that GPIB does have but RS-232 does not (GPIB proper functions)

- Selection of remote/local
- Interrupt to controller by means of service request and serial pole

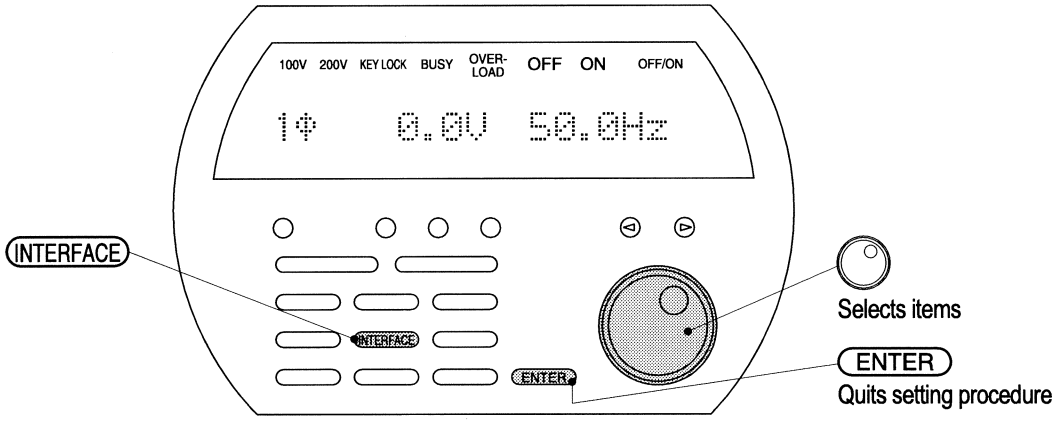
  The user can read status using a querying message (?STB) etc.
- GPIB proper command such as "Device Clear"
- Connection of multiple devices

  RS-232 supports only one-to-one connection.

b) Specifications

- Baud rate : 1200, 2400, 4800, and 9600
- Length of data bit: 7, 8
- Length of stop bit: 1, 2
- Parity: none, even, odd

Settings for using RS-232

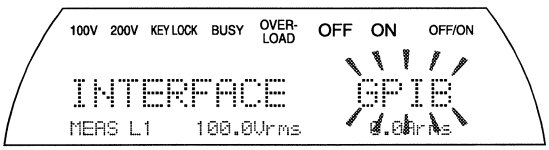


To use an RS-232 interface, connect the system to a computer for use with an RS-232 straight cable and carry out settings of "Selection of interface", "Transfer rate", "Delimiter for sending", "Parity", "Stop bit" and "Character length".

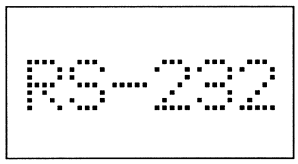
Selecting the interface

1 Press (INTERFACE) to show the interface setting screen.

* "GPIB" is set on shipping.

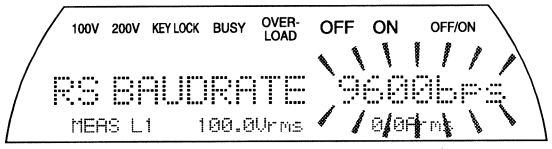


2 Turn the dial to select "RS-232".

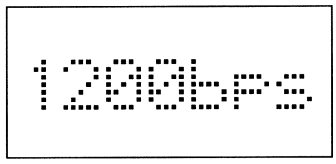


Setting the transfer rate

1 Press (INTERFACE) to show the transfer rate setting screen.



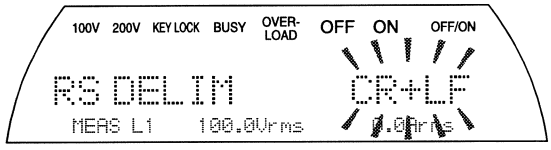
2 Turn the dial to select the transfer rate.



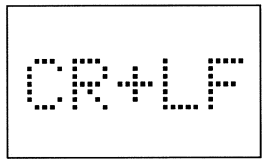
Select a transfer rate out of 1200, 2400, 4800, 9600 bps.

Setting a delimiter for sending

1 Press (INTERFACE) to show the delimiter setting screen.



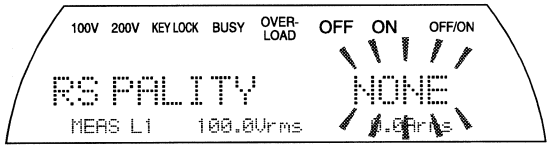
2 Turn the dial to select the delimiter.



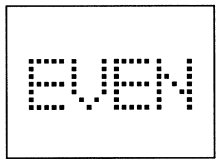
Select one out of delimiters: CR+LF, CR and LF.

Setting the parity

1 Press (INTERFACE) to show the parity setting screen.



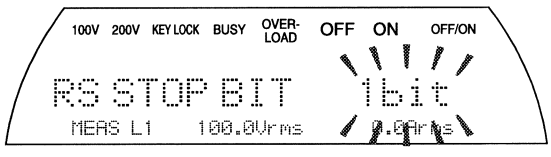
2 Turn the dial to select the parity.



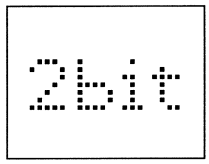
Select parity out of NONE, EVEN and ODD.

Setting the stop bit

1 Press (INTERFACE) to show the stop bit setting screen.



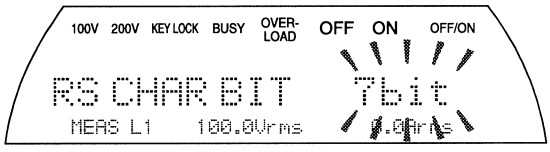
2 Turn the dial to select the stop bit.



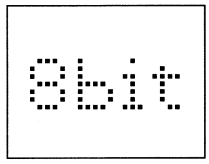
Select either of 1bit and 2bit for the stop.

Setting the character length

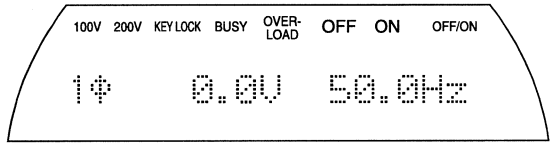
1 Press (INTERFACE) to show the character length setting screen.



2 Turn the dial to select the character length.



3 Press (INTERFACE) or (ENTER) to quit the setting procedure, and the display returns to the normal screen.



Select either of 8bit and 7bit for the character length.

Attention!

Once RS-232 is selected, an REM indication appears and the system disables operations other than (INTERFACE) and (OFF/ON) button operations. The [OFF/ON] button is available only to turn off the output for emergency stop.

Memo

[Difference between RS-232 and GPIB]
Control of RS-232 interface differs from that of GPIB interface as listed below:

- Does not support parallel connection of devices.
- Does not specify addresses because the system performs one-to-one data communications.
- Does not have the service request (SRQ) function.
- Does not have the remote/local function.

Attention!

- Both GPIB and RS-232 cannot be used simultaneously. The user must select either of them.
- The initial state (on-shipping condition) has GPIB set for default.

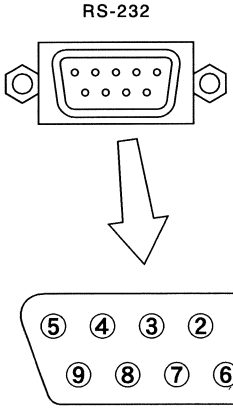
Attention!

Interface related parameters are stored in the battery-backup memory.
When the backup battery deteriorates, the voltage lowers and as a result, backup data may be erased or destroyed. Such a failure is checked when the system power is turned on and the system is initialized to the state of factory default.
For further information, refer to the section titled "Backup battery" in Chapter 10 "Maintenance".

Attention!

- When RS-232 is under selection, only the (INTERFACE) and (OFF/ON) buttons are operable. The (OFF/ON) button is available only to turn off the output for emergency stop.

Connection of RS-232 cable



Pin array of RS-232 connector

Connect with a cable the controlling computer and the unit at the RS-232 connector on the rear panel of the unit.
The RS-232 connector of P-STATION/EPO, which conforms to common PC-AT compatible computers, accepts marketed straight cables.

Select a cable protected with double shield that is connected to the metallic shell of its connector in order to avoid unnecessary radiation of electromagnetic fields. Use of an inferior cable may give disturbances to the surroundings.

Connection of cable available for connection is shown below.

P-STATION EPO			PC-AT compatible machine	
Pin No.	Name of signal		Pin No.	Name of signal
1	N.C. No connection	→	1	CD Carrier Detect
2	TD Transmitted data	→	2	RD Received Data
3	RD Received data	←	3	TD Transmitted Data
4	DSR Indicates the partner is active. If not active, sending from this device will be kept waiting.	←	4	DTR Data Terminal Ready
5	SG Signal ground (connected to chassis)	—	5	SG Signal Ground
6	DTR Indicates this device is active.	→	6	DSR Data Set Ready
7	CTS Indicates the partner is receptive. If not active, sending from this device will be kept waiting.	←	7	RTS Request To Send
8	RTS Indicates this device is receptive.	→	8	CTS Clear To Send
9	N.C. No connection	→	9	RI Ring Indicator
DSUB type 9-pin male (fixing screw: inch)			DSUB type 9-pin female	

Handshake

The user can make use of hardware handshake in a P-STATION/EPO system.

Handshake is performed by DTR-DSR/CTS-RTS through connection via straight cable described in "Connection of RS-232 cable".

Details of handshake operation

a) Reception from controller

- Depending on the condition of reception buffer (255 characters), this product performs the following processing:

  - If about 2/3 or more is used → disables RTS and DTR.
  - If about 2/3 or more is emptied → enables RTS and DTR.

b) Transmission to controller

- Suspends transmission temporarily if either of the following condition is entered:

  - CTS is disabled.
  - DSR is disabled.

Sample RS-232 program

The following section introduces samples of remote control that uses RS-232 interface. Presented here is a case of simple setting in which Visual Basic (excluding Learning EDITION) is used.

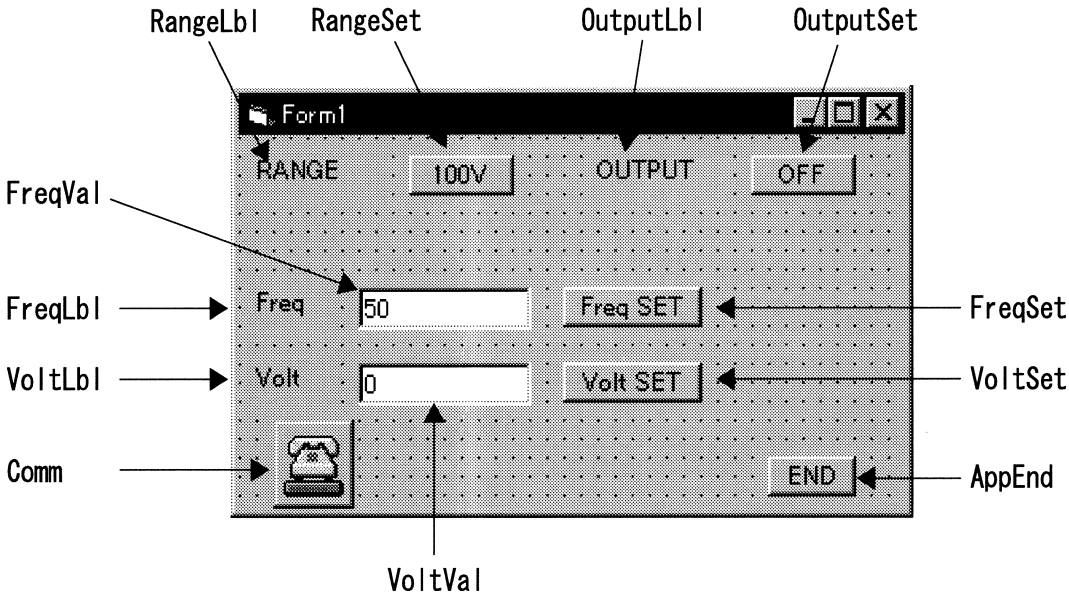
The contents of program is almost the same as "a) Setting" of the sample GPIB program, a "Case in which Visual Basic and National Instruments' GPIB interface board are used" in Chapter 8.

For the use of program messages, which is similar to GPIB, also refer to "Sample GPIB program" of Chapter 8 "GPIB Interface".

Example of Visual Basic (Setting)

This is a simplest program of initialization followed by setting of arbitrary voltage and frequency, then turning on the output.

To use RS-232 with Visual Basic, it would be easy to resort to communication control (MSComm). From "Component" of Visual Basic "Project" menu, select "Microsoft Comm Control" to reach this communication control.




```
Option Explicit
Dim DELIM As String
Dim Rng As Boolean
Dim Out As Boolean

Private Sub AppEnd_Click()
    Comm1.PortOpen = False              ' Close the port
    End
End Sub

Private Sub Form_Load()
    Comm1.Settings = "9600,N,8,1"       ' Set communications conditions
    Comm1.Handshaking = comNone             ' Set conditions of handshake
    Comm1.CommPort = 1                      ' Specify Port 1
    Comm1.PortOpen = True                   ' Open the port

    Rng = False
    Out = False
    DELIM = Chr(&H13) & Chr(&HA)
End Sub

Private Sub FreqSet_Click()
    Comm1.Output = "FRQ" & FreqVal.Text & DELIM ' Set the frequency
End Sub
```

```
Private Sub OutputSet_Click()
    If Out = False Then
        Comm1.Output = "OUT 1" & DELIM        ' Set the output to ON
        OutputSet.Caption = "ON"
        Out = True
    Else
        Comm1.Output = "OUT 0" & DELIM        ' Set the output to OFF
        OutputSet.Caption = "OFF"
        Out = False
    End If
End Sub

Private Sub RangeSet_Click()
    If Rng = False Then
        Comm1.Output = "RNG 1" & DELIM        ' Set the range to 200V
        RangeSet.Caption = "200V"
        Rng = True
    Else
        Comm1.Output = "RNG 0" & DELIM        ' Set the range to 100V
        RangeSet.Caption = "100V"
        Rng = False
    End If
End Sub

Private Sub VoltSet_Click()
    Comm1.Output = "VLT" & VoltVal.Text & DELIM          'Set the voltage
End Sub
```