6. RS-232 Interface

6.1 Preparation before use

6.1.1 RS-232 overview

Similarly to GPIB, the RS-232 interface allows the user to perform external control except GPIB specific functions. Setting and queries are available by using the same program messages as those for GPIB. Response messages to queries are also in the same format as for GPIB.
Parts of the descriptions that are the same as in the above GPIB sections are omitted here because of large overlapping. Before performing external control via RS-232, read the sections describing GPIB operations.

a) Functions that are available in GPIB but not available in RS-232 (GPIB specific functions)

- Switching between remote and local.
  The user can disable panel operation using a program message KLOC, which is equivalent to KEY LOCK.

- Interrupt to the controller and serial poll by service request
  The user can read status using a query message STB? etc.

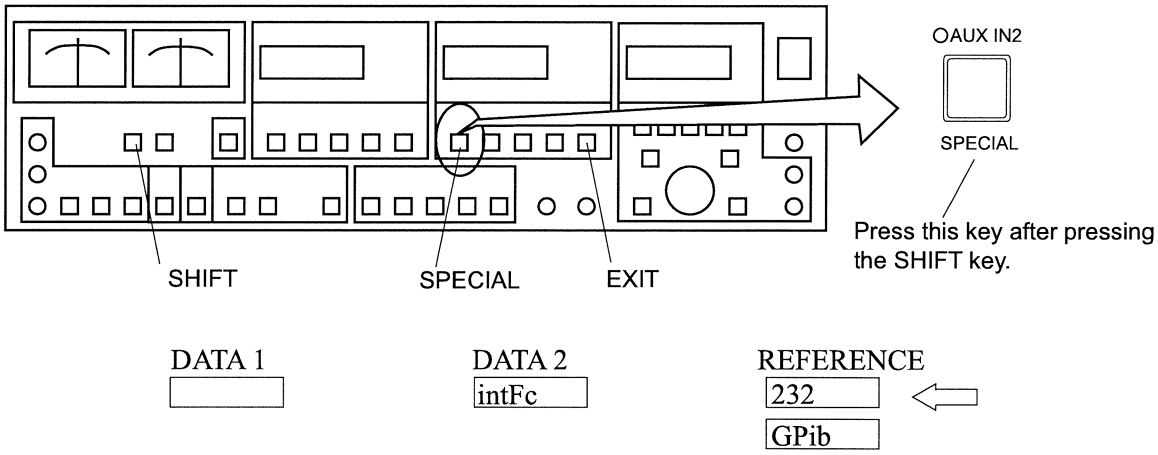
- GPIB specific commands such as Device Clear, GET etc.
  The user can use a program message *TRG in place of the trigger.

- Connection of two or more devices
  RS-232 can connect only one device to another.

b) Specifications

- Baud rate: 1200, 2400, 4800, 9600 and 19200
- Data bit length: 7 or 8 bits
- Stop bit length: fixed to 1 for reception and 2 for transmission
- Parity: Even, Odd, or None

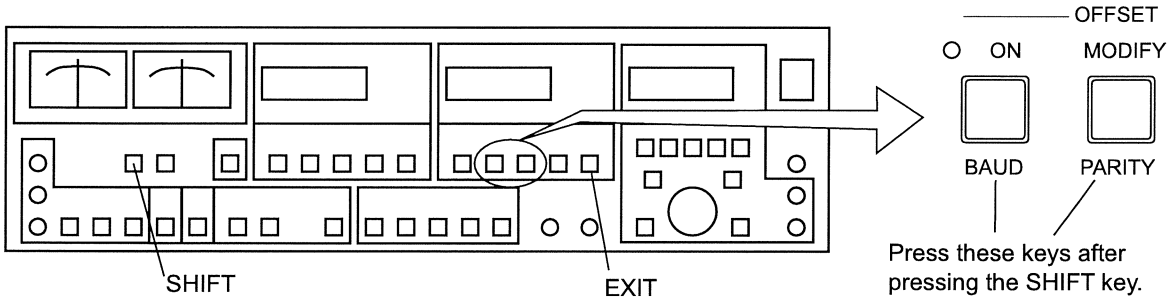
6.1.2 Switching to RS-232



Both RS-232 and GPIB cannot be used at the same time. When to use RS-232, follow the procedure below to switch the external control to RS-232:

1) Press the SHIFT + SPECIAL keys.
2) Make sure intFc appears on the DATA2 display.
   Other parameters may be selected using the MODIFY dial.
3) Use the ▶ key to move the blinking digit to the REFERENCE indication section.
   Or use the ◀ key to return to the DATA2 display.
4) Use the MODIFY dial to select 232.
5) Press the SHIFT + EXIT keys to return to the previous indication.

6.1.3 Setting the baud rate, data bit length and parity



a) Setting the baud rate

When performing serial communication via RS-232, the transmission speed (baud rate) must match at the transmitting and receiving ends. Follow the procedure below for setting on LI5640 side:

1) Press the SHIFT + BAUD keys.
   The current baud rate setting appears on the REFERENCE digital display.
2) Use the MODIFY dial to select the baud rate.
   Select from 1200, 2400, 4800, 9600 and 19200.
3) Press the SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE
	bAud	9600

b) Setting the parity and character length

When performing serial communication via RS-232, parity bit and character length must match at the transmitting and receiving ends. Follow the procedure below for setting on LI5640 side.

1) Press the SHIFT + PARITY keys.
2) Use the MODIFY dial to select parity bit.
   Select the parity bit from even, odd or none.
3) Use the ▶ key to move to selection of character length.
   The blinking digit moves to the right. (Press the ◀ key to return to parity bit selection.)
4) Use the MODIFY dial to select the character length.
   Select either 7 bits or 8 bits.
5) Press the SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE
	Prt c	no 7

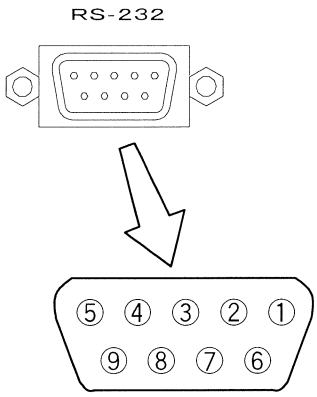
Parity Character Length

no	None
odd	Odd number
even	Even number

c) Stop bit

Stop bit length is fixed to 2 bits for transmission and 1 bit for reception. Therefore, any of 1, 1.5 and 2 is available for both transmission and reception as the stop bit length on the control side.

6.1.4 Connecting RS-232 cable



To use RS-232, connect it to the RS-232 connector on the rear panel. Specifications of this connector are D-sub, 9 pins, female, and inch screw. For connection to a PC-AT compatible device, marketed RS-232 (serial) cables with both end 9 pins, male-female and straight connection (e.g., "RS-232c extension cable") can be used. However they must have the same specifications for screws and handshake.

In order to avoid unnecessary electromagnetic field radiation, the connecting cable should be a double-shielded cable of which shield is connected to the metal shell of connector. Use of an inferior cable may interfere with the environment.

Fig. 6-1 Pin Configuration of RS-232 Connector

Table 6-1 Signal Assignment of RS-232 Connector

LI5640				PC-AT compatible device	
Pin No.	Signal name		Pin No.	Signal name
1	N.C. No Connection	→	1	CD : Carrier Detect
2	TD Transmission Data	→	2	RD : Received Data
3	RD Reception Data	←	3	TD : Transmitted Data
4	DSR Indicates that the other end is operable. If this is not active, transmission from LI5640 will be delayed.	←	4	DTR : Data Terminal Ready
5	SG Signal Ground	—	5	SG : Signal Ground
6	DTR Indicates that LI5640 is operable.	→	6	DSR : Data Set Ready
7	CTS Indicates that the other end is ready for receiving. If this is not active, transmission from LI5640 will be delayed.	←	7	RTS : Request To Send
8	RTS Indicates that LI5640 is ready for receiving.	→	8	CTS : Clear To Send
9	N.C. No Connection	→	9	RI : Ring Indicator

Signal ground of RS-232 is connected to the enclosure of LI5640.

If hardware handshake is not used, directly connect the pins of LI5640 as follows:

6 (DTR) to 4 (DSR) and 7 (CTS) to 8 (RTS)

Signal names vary depending on the standards etc. The above signal names are in accordance with PC-AT compatibles.

6.2 Handshake

GPIB uses three-line handshake to ensure always-proper communication through adjustment to the slowest device, while RS-232 does not specify only one method for handshake. For this reason, the same method must have been set for handshake at the transmitting and receiving ends; otherwise the transmitted data will not be received properly at the receiving end.

The following handshakes are available in LI5640.

- Software handshake (X-ON, X-OFF)
- Hardware handshake (DTR-DSR and CTS-RTS)

If a hardware handshake signal is not available or is not in use on the controller side, the corresponding signal lines of LI5640 must be directly connected; otherwise communication may fail. The controller is required to support either one of the above.

In respect of handshake, LI5640 performs as follows:

a) From controller to LI5640

- When the input buffer (1024 characters) is filled by approximately 2/3 or more, LI5640 executes the following steps:
  Outputs X-OFF code (11_{16}).
  Disables RTS.
  Disables DTR.
- When the input buffer is emptied by approximately 2/3 or more, LI5640 executes the following steps:
  Outputs X-ON code (13_{16}).
  Enables RTS.
  Enables DTR.

b) From LI5640 to controller

- LI5640 suspends transmission when any of the following is experienced:
  X-OFF code (11_{16}) is received.
  CTS is inactive.
  DSR is inactive.
- LI5640 resumes transmission when the following conditions are met:
  When X-OFF is in use: CTS and DSR are active and X-ON code (13_{16}) is received.
  When X-OFF is not in use: CTS and DSR are active.

6.3 Error messages of RS-232

This section describes errors that are specific to RS-232.

When an error occurs, the error number appears on the REFERENCE digital display for a few seconds.

Example : E513

The user may use a query message EROR? to see a more detailed message for this error number. However query does not work properly in the environment that produced these errors.

Table 6-2 Error Messages of RS-232

Error No.	Error Message	Descriptions
511	RS-232 framing error	A framing error is detected. Check if the settings of baud rate, data bit length and parity are correct.
512	RS-232 overrun error	An overrun error is detected. Part of data has been lost because new data was received before the previous data has been processed for some reason. Usually this error does not occur.
513	RS-232 parity error	A parity error is detected. Check if the settings of baud rate, data bit length and parity are correct.

Framing error and parity error occur when the settings of baud rate, data bit length and parity are incorrect. Or otherwise, they occur when malfunction due to noise or contact failure is detected.