3. Panel Face and Basic Operations

3.1 Name and operation of panel parts

This section describes the part names, how to operate controls, and how the system responds in the order of the item numbers that appear in Fig. 3-1 "Front and Rear Panels".

3.1.1 Front panel

On the front panel some keys have two functions. The second function is activated when you press the SHIFT key and then press that key.

☞ For details ➡ Refer to Item ② SHIFT key.

The characters enclosed by a [ ] in the caption line indicate the name of the key.

① DATA1 and DATA2 Analog meters

The pointer indicates the same parameter as the parameter shown on the DATA1 or DATA2 digital indicator. When the digital indication is at 1V full scale, for example, the analog meter shows 10 full scale. Then, the analog output voltage of DATA1 and DATA2 will be +10V full scale. Since phase θ is not provided, take the meter full scale as $\pm 180^{\circ}$.

If the digital indication is at the full scale regardless of the setting, then the analog meter is also at the full scale.

② [SHIFT] Shift key

If the user presses the SHIFT key, the key lamp will light up, enabling the second function of each key. When the SHIFT key is pressed while the SHIFT lamp is lighting, the shift function is released, turning off the lamp.

The second function is shown in blue characters below the key. If the SHIFT lamp is lit, then press the key located above blue characters, for example "LAMP". In this instruction manual, the above operation is expressed: press the SHIFT + LAMP key.

The above operation enables the second function, and then the SHIFT lamp is turned off.

Pressing a key having no second function during the SHIFT lamp is lighting will result in only turning off the SHIFT lamp; the (first) function shown on the key will not be activated.

For further information on the second functions, see the description of each key.

NOTE : If a parameter other than phase offset, frequency, amplitude of OSC OUT or the order (nF) of the harmonics is shown on the REFERENCE indication section resulting from an operation such as pressing the SHIFT + FAN keys, then press ⑯ SHIFT + EXIT keys to return the indication to the previous one.

If you do not need to return the parameter on the REFERENCE indication to the previous state, then use the FREQ or other key to change the direct display. It is convenient as SHIFT operation is not required.

③ AUTO SET Automatic setting key

When the AUTO SET key is pressed, the following parameters will be automatically set and the system will be ready for a next measurement:

- Input coupling (AC/DC)
- Dynamic reserve (DYNAMIC RESERVE)
- Sensitivity (SENSITIVITY)
- Time constant (TIME CONSTANT)
- Synchronous filter (SYNC)
- Attenuation slope (SLOPE)
- Phase offset of reference signal (PHASE)
- Measurement parameter (DATA1 and DATA2)

While the system is engaged in automatic setting, "Auto" appears on the REFERENCE digital display. When a proper setting is defined, the automatic setting is completed. To discontinue the operation halfway, press the AUTO SET key once again. Pressing DYNAMIC RESERVE key or SENSITIVITY ▽ or △ key may also discontinue the operation. If the frequency is 1Hz or lower, automatic setting would take time; manual setting would be preferable.

☞ For details ➡ Refer to Section 3.4 "Basic operation" and Section 3.2.2 "Initial setting".

For selection of input signal (SIGNAL) and reference signal (SOURCE, EDGE), use manual operation.

③ SHIFT + INITIALIZE Initial setting key

Press the SHIFT + INITIALIZE keys to set measurement-related setting parameters to the initial values.

☞ For details ➡ Refer to Section 3.2.2 "Initial setting".

④ RATIO ON Ratio indication key and indication lamp

Once the key is pressed and the ON lamp is lit, X, Y and R measurements will be shown in proportion to the voltage supplied to AUX IN1 on the rear panel.

$$\text{Ratio} = K \times \frac{\text{Percentage of Y, Y and R to the sensitivity}}{|\text{AUX IN1}|\ [\text{V}] \times 10}$$

Indication range: ±2.4

☞ For K constant ➡ Refer to the description of ④ SHIFT + K key.

Supply a voltage as close to the full scale as possible to AUX IN1 in order to improve the accuracy.

☞ For details ➡ Refer to Section 4.9 "Ratio indication".

④ SHIFT + K K constant setting key

This function sets the proportional constant K used in ratio calculation.

Press these keys, and the K lamp of the REFERENCE indication section will light up, showing the K constant. An arbitrary value ranging from 0.1000 to 9.999 may be selected for K setting. Using the ◀ and ▶ keys to specify the digit, and make setting with the MODIFY dial. Press ⑯ SHIFT + EXIT keys to return to the previous indication.

⑤ DATA1 DISPLAY DATA1 display parameter switching key and indication lamp

By pressing this key, the user can select the parameter shown in DATA1 in the following order:

→ X → R → NOISE → AUX IN1→

X : The signal component of the same phase as the reference signal (= Rcos θ)

R : The magnitude of the signal (=$\sqrt{X^2+Y^2}$)

NOISE : The noise density of input signal

AUX IN1 : The DC voltage of the signal supplied to the AUX IN1 connector on the rear panel

If "R" is used, unlike using X or Y, we can obtain the signal magnitude without adjusting the phase offset.

☞ For details ➡ Refer to Section 4.8.2 "Selection of measurement parameters".

If NOISE is selected, AUX IN1 will be forced to appear on DATA2

To set the sensitivity for selected NOISE, use the noise density.

☞ For details ➡ Refer to Section 4.10 "Measurement of noise density (NOISE)".

⑥ SHIFT + LPF THRU Low-pass filter ON/OFF switching key

Press the key to toggle between enabling and or disabling the anti-aliasing filter that removes unnecessary components in the signal system. When ㉚ LPF THRU lamp is lighting, the filter is disabled. If you do not need quick response, keep the lamp unlit.

☞ For details ➡ Refer to Section 4.4 "Operation of anti-aliasing filter".

⑥ NORMALIZE Normalizing function switching key

Press the key and the display will change in the following order:

→ Initial value → dB → % →

The user can display the ratio of the measurement (X or R) to the standard value (STD) for reference in dB or %.

☞ For details ➡ Refer to the description of ⑥ SHIFT + STD.

If NOISE or AUX IN1 has been selected on DATA1, the previous measurement is displayed even when dB or % lamp is lighting.

dB : The displayed value = 20 LOG_{10} | X or R measurement/standard value |
Display range of ±120.00dB

% : The displayed value = (X or R measurement/standard value) × 100
Display range of ±199.99%

The values of 100 dB and 200% in the above two correspond to 10V of the DATA1 OUTPUT output voltage, respectively.

☞ For details ➡ Refer to Section 4.8.5 "Normalize (dB, %)".

⑥ SHIFT + STD Standard value setting key

This operation sets the standard value to be used when determining dB and % with the normalize function. Press these keys and a standard value will appear on the DATA1 digital display.

Voltage can be set in the range between 1.0000nV and 1.0000V and current between 1.0000fA and 1.0000 μA. Use the ◀ and ▶ keys to specify the digit and make setting with the MODIFY dial. If the user uses the ◀ and ▶ keys to blink the unit lamp, the value can be adjusted in ten-time units using the MODIFY dial. Press ⑯ SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE
1.2345 μ	Std	

⑦ DATA1 Digital display

OVER: Over-level indication lamp

This display shows the measurement of the parameter selected by the DISPLAY key in numbers.

The OVER lamp lights up on the following conditions:

- Indication over-level : The range of measurement or indication is exceeded.
- Intermediate over-level : The range of band-limiting filter etc. is exceeded during processing.
- Input over-level : The range is exceeded in the first amplifier of SIGNAL INPUT.

A correct measurement is not available when the OVER lamp is lighting.

Intermediate stage or input over-level does not affect measurement of AUX IN1 and AUX IN2.

If the OVER lamp lights up in X or R, increase the sensitivity setting and/or dynamic reserve.

⑧ DATA1 OFFSET [ON] X output offset ON/OFF key

Pressing this key to light the ON lamp enables the user to cancel the X offset. Another press on the key will turn off the X offset.

☞ For details ➡ Refer to the description of ⑨ DATA1 OFFSET key.

⑧ [SHIFT] + [LINE] Power frequency specifying key

This key specifies the power frequency in order to eliminate the power frequency noise. Pressing this key will show the current set value on the REFERENCE digital display. Select 50 (Hz) or 60 (Hz) using the MODIFY dial. If the actual power frequency is different from the value specified here, sufficient noise attenuation cannot be achieved. Press ⑯ SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE
	Lin	50

⑨ DATA1 OFFSET [MODIFY] X output offset modify key

Press this key to display and/or set the offset value to be subtracted from X.

When the key is pressed, the X OFFSET lamp of the REFERENCE indication section lights up and the X offset value appears on the REFERENCE digital display. The offset value is expressed in percentage in relation to the sensitivity full scale for 100%.

The offset can be set in the range of ±100.00% using the MODIFY dial. If the X offset is ON at the moment, X indication value immediately changes according to the change of the offset value. Therefore, the X value can be manually adjusted to zero easily

☞ For details ➡ Refer to Section 4.8.3 "X and Y offset".

⑨ [SHIFT] + [LAMP] Lamp ON/OFF key

Pressing the SHIFT + LAMP keys turns off all lamps and digital displays. This will prevent light of lamps from giving noise during optical measurement. Press the SHIFT + LAMP keys when all lamps are off to return to the previous lighting condition.

Buttons are operable even when the lamps are turned off.

⑩ DATA1 [EXPAND] X and R indication expand key

Press this key to light up the ×10 or ×100 lamp to increase the X and R effective sensitivity and resolution. For example, set the sensitivity to 100 μV and select ×10 in EXPAND, and the effective sensitivity (full scale) will be 10 μV. However, this function is not available to expand NOISE or AUX IN1.

To monitor small change, adjust OFFSET to decrease the displayed value first, then use EXPAND for enlarging.

⑩ SHIFT + FAN Fan ON/OFF key

Use this function to stop the cooling fan provided inside the rear panel. This will prevent the fan sound from giving noise during acoustic measurement.

When the SHIFT + FAN keys are pressed, the current setting appears on the REFERENCE digital display. Select ON or OFF using the MODIFY dial. Press ⑯ SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE
	FAn	oFF

Do not keep the fan turned off for an extended time if the ambient temperature is higher than 30℃ because stopped fan will permit the internal temperature to rise.

⑪ DATA2 DISPLAY DATA2 indication parameter switching key

Pressing the key enables the user to select the parameter to be shown on the DATA2 display in the following order:

→ Y →θ→ AUX IN1→ AUX IN2→

Y : The signal component of the phase orthogonal to the reference signal (= R sin θ)

θ : The phase difference between the signal and the reference signal

AUX IN1 : DC voltage supplied to the AUX IN1 connector on the rear panel

AUX IN2 : DC voltage supplied to the AUX IN2 connector on the rear panel

☞ For details ➡ Refer to Section 4.8.2 "Selection of measurement parameter".

⑪ SHIFT + SPECIAL Special operation key

Use this key when to operate infrequently used functions or optional functions.

Follow the procedure below:

1) Press the SHIFT + SPECIAL keys.
2) Using the MODIFY dial, select the type of the parameter to be operated.
   Available types are external interface, noise measurement smoothing time constant, and spare control signal
3) Use the ▶ key to move to the value or selection item on the REFERENCE digital display. (Use the ◀ key to return to the type selection.)
4) Using the MODIFY dial, set or select the value.
5) Press ⑯ SHIFT + EXIT keys to return to the previous indication.

a) Selection of external interface

Select the external interface for use, either GPIB (GPib) or RS-232 (232). Both GPIB and RS-232 cannot be used at the same time.

DATA1	DATA2	REFERENCE
	intFc	Gpib
	Type	Selection item (or value)

b) Noise measurement-smoothing filter

Specify the response time constant for the smoothing filter used in measurement of noise density. Choose one out of 1, 4, 16 and 64. The factory default setting is "1". With this setting, the standard deviation will be 5% or so when measuring broadband white noise. The setting is based on an assumption that a recorder is used for data recording. Every four-time magnification of the value specified here will halve the dispersion of the measurement. However, the response time will be increased in proportion to the setting.

	noiSe	4

☞ For details ➡ Refer to Section 4.10.1 "Measurement of noise density (NOISE)".

c) Spare control signal

This function sets the spare control signal to be used for options or modification work by the manufacturer.

If this signal is operated during measurement, noise may be admitted. Therefore, do not operate this signal if the operation procedure is not contained in the instruction manual for the option or modification work.

	cnt00	2

⑫ DATA2 Digital display

OVER: Over-level indication lamp

The measurement of the parameter selected by the DISPLAY key will be shown in numbers.
The OVER lamp lights up on the following conditions:

- Indication over-level : The range of measurement or indication is exceeded.
- Intermediate over-level : The range of band-limiting filter etc. is exceeded during processing.
- Input over-level : The range is exceeded in the first amplifier of SIGNAL INPUT.

A correct measurement is not available when the OVER lamp is lighting.
Intermediate step or input over-level does not affect measurement of AUX IN1 and AUX IN2.
If the OVER lamp lights up in Y or θ, increase the sensitivity setting and/or dynamic reserve.

⑬ DATA2 OFFSET [ON] Y output offset ON/OFF key

Pressing this key to light the ON lamp enables the user to cancel the Y offset. Another press on the key will turn off the Y offset.

☞ For details ➡ Refer to the description of ⑭ DATA2 OFFSET key.

⑬ [SHIFT] + [BAUD] Baud rate setting key

This function sets the communication speed (baud rate) for performing RS-232 serial communication. Press the SHIFT + BAUD key, and the current baud rate setting will appear on the REFERENCE digital display. When to use RS-232, select the rate in the range between 1200 and 19200 using the MODIFY dial.

DATA1	DATA2	REFERENCE
	bAud	4800

⑭ DATA2 OFFSET [MODIFY] Y output offset modify key

Press this key to display and/or set the offset value to be subtracted from Y.

When the key is pressed, the Y OFFSET lamp of the REFERENCE indication section lights up and the Y offset value appears on the REFERENCE digital display. The offset value is expressed in percentage in relation to the sensitivity (full scale) for 100%.

The offset can be set in the range of ±100.00% using the MODIFY dial. If the Y offset is ON at the moment, Y indication value immediately changes according to the change of the offset value.

☞ For details ➡ Refer to Section 4.8.3 "X and Y offset".

⑭ [SHIFT] + [PARITY] Parity and character length setting key

This function sets the parity bit and the character length for RS-232 serial communication.

Follow the procedure below:

1) Change to RS-232 according to the description of ⑪ SHIFT + SPECIAL keys.
2) Press the SHIFT + PARITY keys.
3) Select one out of N/A (no), odd number (odd) and even number (Evn) for parity bit using the MODIFY dial.
4) Using the [▶] key, move to selection of character length.
5) Select the character length from 7 bits and 8 bits using the MODIFY dial.
6) Press ⑯ SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE	If GPIB has been selected:
	Prt c	no 7	GPib will appear.

Parity — Character length

⑮ DATA2 OFFSET [AUTO X, Y] Automatic X and Y offset setting key

Pressing the AUTO X, Y key will automatically set the offset values for X and Y so that both X and Y indication values will be approximately zero, and X and Y offset will be turned on.

☞ For details ➡ Refer to Section 4.8.3 "X and Y offset".

⑮ [SHIFT] + [ADDRESS] Address and terminator setting key

This function specifies the address of this instrument and the message terminator for sending in GPIB.

Follow the procedure below:

1) Switch to GPIB according to the description of ⑪ SHIFT + SPECIAL keys.
2) Press the SHIFT + ADDRESS keys.
3) Set the address in the range between 0 to 30 using the MODIFY dial.
4) Using the [▶] key, move to selection of terminator.
5) Select one out of CR+LF (cL), CR (cr) and LF (LF) for sending terminator using the MODIFY dial. Any of these terminators works when LI5640 receives.
6) Press ⑯ SHIFT + EXIT keys to return to the previous indication.

DATA1	DATA2	REFERENCE	If RS-232 has been selected:
	Adr d	2 cL	232 will appear.

Address Terminator

⑯ DATA2 OFFSET [EXPAND] Y indication expand key

Press this key to light up the ×10 or ×100 lamp to increase the Y effective sensitivity and resolution. To monitor small change, first adjust OFFSET to decrease the displayed value, then use EXPAND for enlarging.

However, this function is not available to expand θ , AUX IN1, AUX IN2.

⑯ [SHIFT] + [EXIT] Return key

Press the SHIFT + EXIT keys to return indication of the previous frequency and measurement if the digital display was used in setting of K constant, GPIB address etc.

⑰ PHASE Phase offset display/setting key

AUTO Automatic phase offset setting key

Pressing the PHASE key will show the value of phase offset on the REFERENCE digital display. To achieve the desired value, move the θ measurement towards negative side by the specified value by shifting the ZERO phase point from the reference signal. Accordingly X and Y values will be changed.

The phase offset can be set in the range between -180.00° and +179.99° using the MODIFY dial.

When the AUTO key is pressed, phase offset is automatically set so that the θ and Y measurements will be zeroed.

If the UNLOCK lamp is lighting, automatic phase offset setting is not available because phase θ measurement is not obtained.

⑰ SHIFT + RECALL Call setting memory key

This function retrieves stored setting from the setting memory.

Follow the procedure below:

1) Press the SHIFT + RECALL keys.
2) Using the MODIFY dial, select the desired setting memory number in the range between 1 and 9.

   Selection of number 0 will return to the setting when power was turned off last.
3) Another press on the SHIFT and RECALL keys will call the setting.

   To abort the calling, press ⑯ SHIFT + EXIT keys.

DATA1	DATA2	REFERENCE	
	rcL	1	← Memory number

⑰ SHIFT + STORE Store setting memory key

This function stores the current setting values in the setting memory.

Follow the procedure below:

1) Press the SHIFT + STORE keys.
2) Using the MODIFY dial, select the desired setting memory number in the range between 1 and 9.
3) Another press on the SHIFT and STORE keys will store the setting values.

   To abort the storing, press ⑯ SHIFT + EXIT keys.

DATA1	DATA2	REFERENCE	
	Str	1	← Memory number

⑱ REFERENCE Reference system indication section (digital display and related indication lamp)

This section mainly displays reference system parameter settings selected by PHASE key etc. Additionally, X offset value, Y offset value, GPIB address and others are also displayed.

UNLOCK Out-of-step indication lamp

This UNLOCK lamp lights up when the system is not synchronized with the reference signal, or the frequency of the signal to be measured is out of the measurement range.

The following causes may be suspected as the reason for not being synchronous with the reference signal.

- The reference signal is not connected properly.
- The reference signal has too small amplitude.
- The waveform of the reference signal differs from the specification (SINE/TTL).
- The frequency is out of the measurement range.
  (If the nF setting is 2 or greater, determination will be made by the harmonics frequency.)
- Frequency or waveform of the reference signal is unstable.

X OFFSET X offset indication lamp

The lighting lamp indicates that the X offset is now displayed.

The offset is expressed in percentage to the sensitivity full scale.

Y OFFSET Y offset indication lamp

The lighting lamp indicates that the Y offset is now displayed.

The offset is expressed in percentage to the sensitivity full scale.

K K-constant indication lamp

The lighting lamp indicates that the K-constant in ratio indication is now displayed.

⑲ FREQ Frequency display/setting key

If the FREQ key is pressed, the frequency of the reference signal will appear on the REFERENCE digital display.

Display resolution is 4-1/2 digits (19999 max).

In harmonics measurement, the frequency of the fundamental wave is displayed.

Even if frequencies are out of synchronism, the frequency that is in action inside is displayed.

When the internal oscillator (INT OSC) is used, the set frequency is displayed. Setting can be made in the range from 0.0005Hz to 105.00kHz using the ◀ and ▶ keys and the MODIFY dial.

To keep synchronization with the measured signal input SIGNAL, first set the frequency near the signal frequency using the MODIFY dial. Once the set value comes near the signal frequency to a certain degree, then it will automatically approach the signal frequency until synchronization is achieved.

☞ For details ➡ Refer to Section 4.1.5 "Synchronization with measured signal (SIGNAL)".

⑲ SHIFT + AUX OUT1 Auxiliary output 1 setting key

This function sets a DC voltage (±10.000V) to be supplied to the AUX OUT1 connector on the rear panel.

Follow the procedure below:

1) Press the SHIFT and AUX OUT1 keys.
2) Using the ◀ and ▶ keys and the MODIFY dial, set the voltage.
3) Press the SHIFT + EXIT keys to return to the previous indication if necessary.

⑳ AMPTD Amplitude display/setting key

Pressing the AMPTD key will display the amplitude of sine wave reference signal output OSC OUT on the REFERENCE digital display. Amplitude setting is available in the range from 0.0000V to 5.00Vrms (up to 100kHz in no-load condition) using the ◀ and ▶ keys and the MODIFY dial.

Three ranges are provided: 5.00V, 0.500V and 0.0500V for full scale. The range can be selected manually. Using the ◀ and ▶ keys, move the blinking digit to the unit indication lamp V, and range selection is available with the MODIFY dial.

⑳ SHIFT + AUX OUT2 Auxiliary output 2 setting key

This function sets a DC voltage (±10.000V) to be supplied to the AUX OUT2 connector on the rear panel.

Follow the same procedure as that for SHIFT + AUX OUT1.

㉑ nF Harmonic order display/setting key

Pressing the nF key will display the order of the harmonic to be measured on the REFERENCE digital display. If the user wants to change the value, specify the desired value in the range from 1 to 19999 using the ◀ and ▶ keys and the MODIFY dial.

If "1" is set for the order, the component of the fundamental wave, or the reference signal frequency, will be measured.

If "2" or larger number is set for the order, the nF lamp blinks if the system is in any of the following states:

- Amplitude or other parameter than harmonic order is displayed (for evocative warning)
- SOURCE has been set in SIGNAL (Fundamental wave will be measured regardless of the set order.)

㉑ SHIFT + KEY LOCK Key lock operation key

This function locks key operation on the panel.

Pressing the SHIFT + KEY LOCK keys will toggle ON/OFF of the KEY LOCK lamp. When the KEY LOCK lamp is lighting, panel operation is disabled except SHIFT + KEY LOCK key operation.

㉒ KEY LOCK Key lock status indication lamp

When the KEY LOCK lamp is lighting, panel operation is disabled except SHIFT + KEY LOCK key operation. If the user wants to enable all operations, press the SHIFT + KEY LOCK keys to turn off this lamp.

㉒ REMOTE Remote status indication lamp

When the REMOTE lamp is lighting, panel operation is disabled except SHIFT + LOCAL key operation. Generally, if remote control is performed via GPIB, panel operation is disabled, turning on the REMOTE lamp.

Pressing the SHIFT + LOCAL keys will turn off the REMOTE lamp, bringing the system back to local control status. However, if the controller is demanding local lock out, SHIFT + LOCAL key operation will be invalid.

㉓ POWER Power switch

Press the top of this switch ("|" side), and the system will be energized. Press the bottom ("○" side), and the power will be turned off.

㉔ MONITOR OUT Monitor signal output connector

The subject signal, which is applied to the SIGNAL INPUT connector, will be amplified and supplied to the MONITOR OUT connector. To view the signal change, observe the monitor signal on an oscilloscope or other device.

Monitor output is isolated from the signal input system and the signal ground is connected to the chassis.

☞ For details ➡ Refer to Section 4.1.3 "Monitor output".

㉕ I, A, B Signal input connectors ⚠

These connectors are used to supply measured signals.

Signal ground is isolated from the chassis in the range of ±1V.

The GROUND key may be used to switch the impedance between the connector and the chassis if necessary.

⚠CAUTION

If a voltage exceeding ±1V is applied between the signal ground and the chassis, a high current will flow, breaking the internal circuit.

- I: Current input connector

Connecting a signal with remarkably high signal source impedance such as current output and charge output to the voltage input connector may cause signal attenuation, or deterioration of frequency characteristics due to connection cable and other capacitance (or electrostatic capacity). In such cases, it is better to connect them to the current input connector.

If current input is not used, attach the supplied protection cap to the current input connector.

⚠CAUTION

If any instrument with low output impedance that can supply high current is connected to the current input connector, excessive current will flow, damaging the current input section. Voltage output instrument, such as general oscillator, should not be connected directly.

- A: Voltage input connector

To connect a signal source and LI5640 with a single coaxial cable, select A with the SIGNAL key and connect the signal to this connector.

- B: Voltage input connector (reverse input)

If the ground potential fluctuates between the signal source and LI5640, affecting the measurement, then select A-B (differential) with the SIGNAL key and connect the reference potential to B connector and the measured signal to A connector. Inverse A/B connection will reverse the phase.

㉖ SIGNAL Signal selection key and indication lamp

This key switches between current input and voltage input, and also specifies current-voltage conversion gain of the current input.

Pressing the SIGNAL key will select in the following order:

→ I (10^6) → I (10^8) → A → A-B →

Setting should be made together with the connection to the signal input connector.

- I (10^6) : Current input; conversion gain 10^6 V/A, sensitivity 50fA to 1 μArms, frequency band up to 50kHz
- I (10^8) : Current input; conversion gain 10^8V/A, sensitivity 5fA to 10nArms, frequency band up to 500Hz
- A : Voltage input; single end, sensitivity 2nV to 1Vrms, frequency band up to 100kHz
- A-B : Voltage input; differential.

㉗ COUPLING Input coupling selection key and indication lamp

Pressing the COUPLING key enables the user to change AC and DC of input coupling.

- AC (AC coupling)

Elimination of the DC components amplifies subtle AC signal sufficiently to ensure high accuracy measurement.

AC is used for frequencies of approximately 1Hz and greater. Since lower frequency would cause measurement error to increase, select DC for 0.1Hz or lower frequencies.

The current/voltage converting section for current input is DC coupling. Since it changes to AC coupling after conversion to voltage, saturation with DC components may occur even if AC setting is selected.

- DC (DC coupling)

Even low frequency does not cause signal attenuation or increase of phase error.

DC is used in frequencies of approximately 1Hz or lower.

DC components are also taken as noise. If the DC components are high, dynamic reserve and sensitivity setting should be increased.

㉘ GROUND Signal ground selection key and indication lamp

Press the GROUND key, and the impedance between the signal ground and the chassis will be changed as follows:

- FLOAT

This mode isolates between the signal ground and the chassis with high impedance (about 10kΩ).
If grounding is made on the signal source side, noise interference due to ground loop may be avoided by setting the LI5640 side to FLOAT.

- GROUND

This mode connects between the signal ground and the chassis with low impedance (about 10Ω).
If the signal source is not grounded, set the LI5640 side to GROUND in order to stabilize the signal ground potential, which will assure little noise interference. At the same time, shield the signal source with the signal ground to produce more effects.

㉙ (SIGNAL INPUT) OVER Input over-level indication lamp

This lamp lights up if the first voltage amplifier or the current/voltage converter is saturated with signal peak. If this happens, try the following operations to manage avoidance.

- Increase the dynamic reserve (→ MEDIUM → HIGH).
- Increase the sensitivity setting.
- Change to I (10^6) if I (10^8) is used.

If the OVER lamp persists lighting even if the above measures are taken to the limit, then it is because the maximum LI5640 allowable input voltage (or current) is exceeded. Reduce the input signal.

㉚ FILTER

LPF THRU Low-pass filter indication lamp

It the anti-aliasing filter to eliminate unnecessary high frequency components in the signal system is disabled and not used, the LPF THRU lamp lights up.
To switch between "to use" or "not to use", press the SHIFT + LPF THRU keys.
If the user needs especially high response with less noise, quick response can be ensured by not using the anti-aliasing filter.
This lamp should usually be turned off because high noise increases measurement error.

LINE/LINE×2 Power frequency noise elimination filter ON/OFF key and indication lamp

Pressing the LINE/LINE×2 will change the notch filter that eliminates the power frequency (LINE) and its twofold frequency (LINE×2) noise in the following order, turning on the lamp of the valid filter.

→ Invalid (Lamp unlit) → LINE → LINE×2 → LINE and LINE×2 →

Noise can be attenuated by 20dB or more at the center frequency of each notch filter. However, around the center frequency, the very signal to be measured is also attenuated.
The power frequency (50Hz/60Hz) should be set in advance.

☞ For details ➡ Refer to the description of ⑧ SHIFT + LINE keys.

㉛ DYNAMIC RESERVE HIGH MEDIUM LOW

Dynamic reserve selection key and indication lamp

The dynamic reserve is an allowance against noise, indicating the level of the greatest noise in relation to the sensitivity full scale where measurement is still possible with that noise.

Pressing the DYNAMIC RESERVE key changes the level in the following order, which is indicated by the lamp:

→ HIGH → MEDIUM → LOW →

☞ For the actual value (in dB) of dynamic reserve ➡ Refer to Table 4-2 "Actual value of Dynamic Reserve".

Unnecessarily increasing the dynamic reserve would deteriorates measurement stability and accuracy. Minimum dynamic reserve should be selected for better operation.

㉜ SENSITIVITY ▽ △ Sensitivity selection keys and indication lamps

Select voltage and current sensitivity (full scale) with these keys. Sensitivity of voltage and that of current are independent of each other. Setting is available in the following range:

Voltage: 2 nV to 1Vrms (1-2-5 sequence)

Current: 5 fA to 1 μArms (1-2-5 sequence)

In measurement of noise density (NOISE), specify the value in the units of $V/\sqrt{Hz}$ and $A/\sqrt{Hz}$. Read V and A as $V/\sqrt{Hz}$ and $A/\sqrt{Hz}$, respectively because "$/\sqrt{Hz}$ " is not shown on the panel.

When either of thee keys is pressed, automatic sensitivity setting process will end halfway.

㉝ (SENSITIVITY) OVER Intermediate step over-level indication lamp

This OVER lamp lights up if signal is too high and any of the LI5640 amplifiers except the first one, phase sensitive detector and subsequent band-limiting filters, and noise measurement system experiences an over-level condition. When this lamp is lighting, proper measurements cannot be obtained. Try to increase sensitivity setting or dynamic reserve in order to prevent saturation with high noise, or to increase the time constant in order to reduce the noise.

☞ For details ➡ Refer to Section 4.6 "Sensitivity operation (SENSITIVITY)".

㉞ SENSITIVITY [AUTO] Automatic sensitivity setting key and indication lamp

Pressing this AUTO key will automatically adjust the sensitivity and dynamic reserve according to the magnitude of the signal. This lamp keep lighting during automatic setting process.

When any adequate setting is found, the automatic setting is completed.

During automatic sensitivity setting, the user may abort the setting by pressing any key such as this AUTO key. If abortion is made with another key than AUTO, the function of that key works as well.

Dynamic reserve will be adjusted to the minimum necessary level.

If signals sharply fluctuate or noise cannot be eliminated sufficiently, or otherwise if the signal is too small, automatic setting will be forced to end after repeating increasing/decreasing the sensitivity. In such occasions, try to manage manual setting.

☞ For details ➡ Refer to Section 4.6 "Sensitivity operation (SENSITIVITY)".

㉟ TIME CONSTATNT [▽] [△] Time constant selection key and indication lamp

With these keys, select the time constant for the low-pass filter that eliminates noise after phase sensitive detector..

Setting is available in the range from 10 μs to 30ks.

As the longer is the time constant, the smaller the equivalent noise bandwidth becomes and thus noise will be eliminated. However, response will be slower.

☞ For details ➡ Refer to Section 4.7.3 "Equivalent noise bandwidth" and Section 4.7.4 "Response time".

㊱ TIME CONSTNT [AUTO] Automatic time constant setting ON/OFF key and indication lamp

Pressing this key will adjust the time constant and synchronous filter (SYNC) setting according to the frequency when the key is pressed.

- Attenuation slope will be set to 24dB/oct.
- The time constant will be set to such a value that the ripple due to the signal frequency will be sufficiently attenuated.
- Synchronous filter turns on at the frequency of approximately 200Hz or lower and turns off at the frequency or higher.

If the noise is high, the time constant by automatic setting may be too short. In such cases, increase the time constant manually.

The AUTO lamp usually looks unlit, which is normal.

㊲ SYNC Synchronous filter ON/OFF key and indication lamp

Pressing the SYNC key and the toggles between ON and OFF of the synchronous filter. Press the key to enable the filter, turning on the lamp, and the control will take the moving average of signal for the integer period. This reduces the ripples that emerge in the output even if a short time constant has been set at a low frequency. If noise is low and a long time constant is not necessary, the user may have a remarkably reduced response time.

☞ For details ➡ Refer to Section 4.7.5 "Synchronous filter (SYNC)".

In measurement of noise density, operation progresses in a state of synchronous filter being off in practice even if "Turn on the synchronous filter" has been specified. The SYNC lamp blinks for evocative warning.

㊳ SLOPE Attenuation slope selection key and indication lamp

This SLOPE key enables the user to select the attenuation slope for the low-pass filter that eliminates noise after phase sensitive detector. Every press on this key switches the slope in the following order, which is indicated by the lamp:

→ 6dB → 12dB → 18dB → 24dB →

The value indicates the attenuation per octave.

Compared with the same equivalent noise bandwidth, the greater the attenuation slope is, the quicker response will be obtained. Therefore, select 24dB/oct for attenuation slope and a shorter time constant if the user's measurement is significant.

To integrate a LI5640 unit in an automatic control loop, the user sometimes has to select 6dB/oct for attenuation slope in order to maintain stability of the control system.

㊴ DATA1 OUT, DATA2 OUT Measurement analog output connector

This connector supplies parameters being shown on the DATA1 display/setting section and DATA2 display/setting section in current voltage with the full scale being ±10V.

OFFSET, EXPAND, RATIO and NORMALIZE are also effective for analog output.

The highest data updating rate is 256k samples/s for X, Y, R and θ and 16k samples/s for other parameters. Amplitude resolution is approximately 16 bits equivalent.

㊵ EDGE Reference signal synchronous edge selection key and indication lamp

Pressing the EDGE key switches the synchronous edge of external reference signal REF IN in the following order:

→ SINE POS → TTL POS → TTL NEG →

SINE POS : Takes the time point at which the average value is crossed upward from below as 0° .

TTL POS : Takes the rising edge of TTL level logic signal as 0° .

TTL NEG : Takes the falling edge of TTL level logic signal as 0° .

With SINE POS, low-frequency signal will be attenuated because REF IN becomes AC coupling. Therefore, use TTL level for approximately 1Hz or lower frequencies. Although the amplitude of sine wave that works properly is 0.3 to 30Vp-p, a sine wave of 2Vrms or so, or a square wave is preferable from the stability viewpoint.

㊶ ◀ Modify digit left shift key

Press this key, and the blinking digit on the indication section moves to the left. Then, in the case of a number, turning the MODIFY dial will increase or decrease the number in the blinking digit and upper.

㊶ SHIFT + CLEAR Right clear key

When the user is setting a number, pressing this key will zero the number in the digits right to the blinking digit (lower digits excluding the blinking one).

㊷ MODIFY Modify dial

The user can specify a number or select a parameter by turning this dial. The blinking portion is changeable. Turning the dial adds 1 to or subtracts 1 from the figure in the blinking digit, increasing or decreasing the number in that digit and higher. The blinking digit can be moved with the ◀ and ▶ keys.

㊸ ▶ Modify digit right shift key

Press this key, and the blinking digit on the indication section moves to the right. Then, in the case of a number, turning the MODIFY dial will increase or decrease the number in the blinking digit and upper.

㊸ SHIFT + LOCAL Local key

When the system is in a remote control state operated by GPIB, the user can return the system to a local control state for panel operation by pressing this key. However, if the system is in a local lockout state, this operation cannot return the system to local.

When the system is in a remote control state, the REMOTE lamp keeps lighting.

㊹ SOURCE Reference signal selection key and indication lamp

This key selects the reference signal that plays the role of reference for frequency and phase. Pressing the SOURCE key changes the reference signal source in the following order, which is indicated by the lamp:

→ REF IN → INT OSC → SIGNAL →

- REF IN (external reference signal):
  Takes the signal supplied to the REF IN connector as the reference signal.
- INT OSC (internal oscillator):
  Takes the output of the internal oscillator as the reference signal.
- SIGNAL (measured signal input):
  Takes the measured signal supplied to the SIGNAL INPUT connector as the reference signal.

☞ For details ➡ Refer to Section 4.1.5 "Synchronization with measured signal (SIGNAL)".

㊺ REF IN External reference signal input connector ⚠

If external signals are used, connect to this connector.

A 0.3 to 30 Vp-p sine wave or square wave, and a TTL level square wave are available for reference signal. Using the EDGE key, select the synchronous edge for the reference signal according to the signal type.

If the noise is too high, normal synchronization may not be ensured.

㊻ OSC OUT Internal oscillator output connector ⚠

A sine wave reference signal can be taken from this connector.

If internal oscillator "INT OSC" is selected for reference signal source "SOURCE", the output of the internal oscillator is available from this connector.

If external reference signal input "REF IN" or measured signal input "SIGNAL" is selected for reference signal source, a sine wave signal synchronous with the reference signal is available. If out of synchronization, it will be the internal frequency at the moment.

When harmonics are under measurement, fundamental wave signal will be supplied.

☞ For amplitude setting ➡ Refer to the description of ⑳ AMPTD key.

3.1.2 Rear panel

㊼ ~ LINE Power supply inlet

Use the supplied power cord to supply power to the unit.

☞ For details ➡ Refer to Section 7.12 "Specifications".

㊽ FUSE Power supply fuse ⚠

Use the supplied power supply fuse. Never use nonstandard fuses, which may cause electric shock or fire.

1 A time lag for 100/120 V AC,

0.8 A time lag for 230 VAC,

☞ For details ➡ Refer to Section 7.12 "Specifications".

㊾ VOLTAGE SELECTOR Power supply voltage selector ⚠

Select a setting that meets your power supply voltage.

Securely make setting so that the central line of the slide control will come just to the position of 100/120/230 V indication line.

☞ For details ➡ Refer to Section 7.12 "Specifications".

㊿ Cooling fan

This is the suction port of the cooling fan. If the filter is found to be dirty, remove the fan guard and clean the dust.

☞ For fan ON/OFF ➡ Refer to the description of ⑩ SHIFT + FAN key.

(51) REF OUT Reference signal output connector

This connector supplies a TTL-level square signal synchronous with the reference signal. The rising edge of this signal approximately corresponds to the 0° (synchronous edge) of the reference signal. The signal can be used as the square wave output of the internal oscillator or the trigger signal for the oscilloscope.

(52) X OUT/Y OUT X output, Y output connectors

X signal and Y signal are supplied at these connectors regardless of selection of DATA1 and DATA2 parameters. OFFSET, EXPAND, RATIO and NORMALIZE are also effective for these outputs.

If the measurement is sensitivity full scale, output voltage is ±10V, and data updating rate is 16k samples/s. Amplitude resolution is approximately 16 bits equivalent.

(53) AUX OUT1/AUX OUT2 Auxiliary output connectors 1 and 2 ⚠

The user may supply output of arbitrary DC voltage in the range of ±10.000V at these connectors. Press SHIFT + AUX OUT1 keys or SHIFT + AUX OUT2 keys to display voltage of auxiliary output on the REFERENCE digital display, and the voltage will be ready for change using the MODIFY dial.

⑭ AUX IN1/AUX IN2 Auxiliary input connectors 1 and 2 ⚠

The user may supply input of arbitrary DC voltage in the range of ±12V to these connectors for measurement.

The voltage of AUX IN1 can be viewed on DATA1 or DATA2 and the voltage of AUX IN2 on DATA2. Frequency bandwidth is about 130 Hz, and data updating rate is 16k samples/s.

AUX IN1 is also used as the reference input for ratio indication.

☞ For details ➡ Refer to Section 4.9 "Ratio indication".

⑮ ⏚ Grounding terminal for guard (chassis ground)

Use this terminal in order to shield the signal source etc. by using the chassis potential of lock-in amplifier as the reference potential.

⑯ ±24V OUT ±24V power supply output connector ⚠

This power output connector supplies power to external preamplifier etc. The ground (0V line) of this power supply is connected to the SIGNAL INPUT I, A, B connector's ground.

⚠CAUTION

Do not apply a voltage that exceeds ±1V between the power supply ground and the chassis. This would cause continuity through the diode that limit the ground-to-ground voltage, allowing great current to flow and LI5640 and connected devices may be damaged.

⑰ TRIG IN Trigger signal input connector

To this TRIG IN connector, provide TTL-level signal that defines the timing of recording data in the data memory. The timing will be defined by the falling edge of this signal. The data memory can be operated only by external interface.

⑱ GPIB GPIB connector

This connector is a 24-pin connector for GPIB interface stipulated in the IEEE-488.1 standard. This connector can be overlaid for use in multistage coupling. However, limit the number of stages to three because it may be damaged by great load.

☞ For details ➡ Refer to Section 5. "GPIB Interface".

⑲ RS-232 Serial communication connector

This connector is a 9-pin female connector for RS-232 serial communication.

☞ For details ➡ Refer to Section 6. "RS-232 Interface".

3.1 Name and operation of panel parts

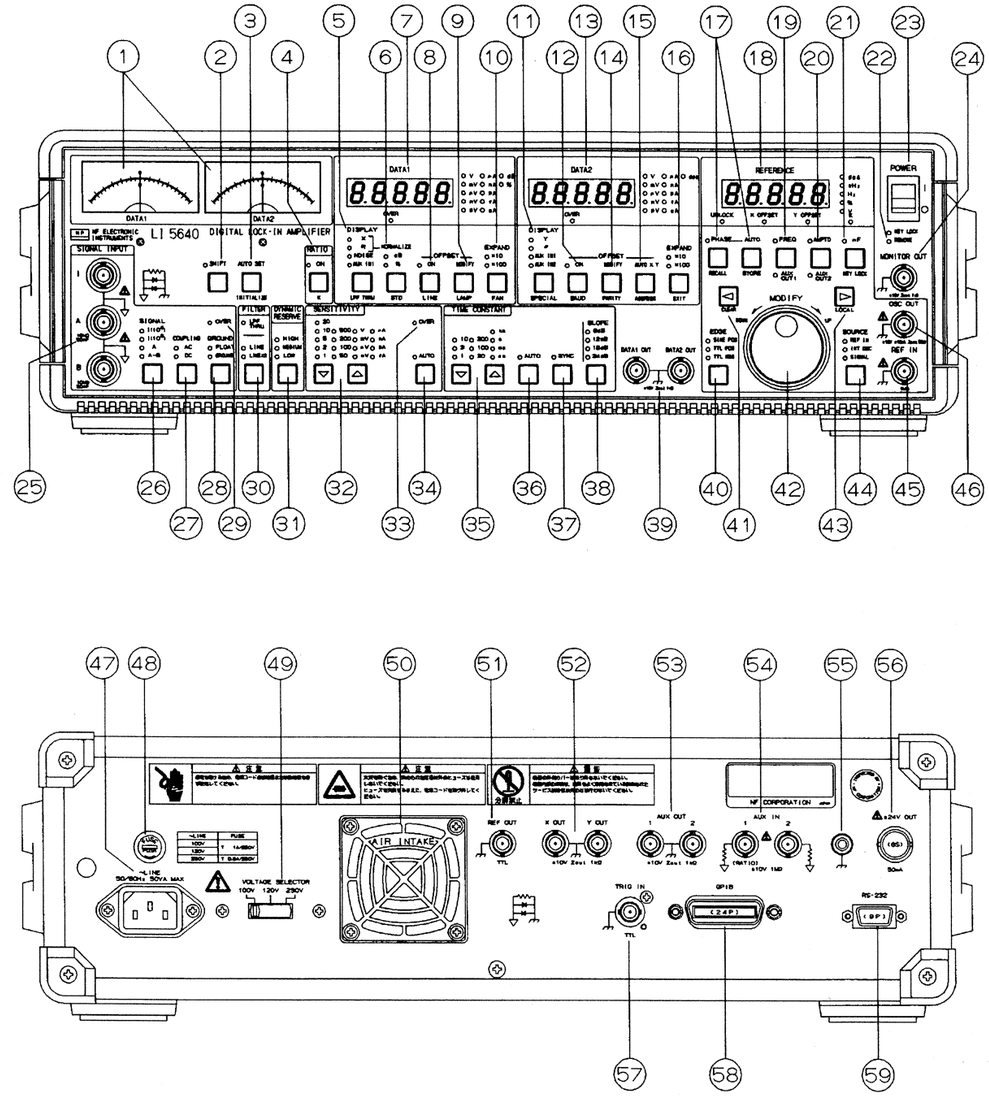


Fig. 3-1 Front and Rear Panels

3.2 Operation at power on and initial setting

3.2.1 Startup

First, make preparation for use according to Section 2 "Preparation before Use".
Turn on the power switch and the system will execute self check. If the check is successful, the system returns to the setting of last power off, or to a specific setting.

☞ For details ➡ Refer to "Automatic resetting" in Table 3-2 "List of Initial Values".

During the self check, the version number of the installed software appears on the REFERENCE digital display.

If any of backed-up settings or contents of setting memory is found to be lost, backup error E 3 appears on the REFERENCE digital display. The user can press the key EXIT with blue characters at the bottom to release the error indication in order to start the system. However, the factory default settings will be used.

☞ For details ➡ Refer to "Factory default settings" in Table 3-2 "List of Initial Values".

Other error indications than E 3 cannot be released, disabling further operation.

If it is the first use of this instrument, please make setting or confirmation of power supply frequency.

☞ Refer to Section 3.2.3 "Setting of power supply frequency".

Table 3-1 Operation at Power ON

Operations	Indications				Error indication on REFERENCE
	DATA1	DATA2	REFERENCE	Other lamps	
All lamp lighting check	All lit	All lit	All lit	All lit	
ROM check	1	Unlit	Version No.	Unlit	E1
RAM check	2	Unlit	Version No.	Unlit	E2
Backup check	3	Unlit	Version No.	Unlit	E3
Internal initialization	4	Unlit	Version No.	Unlit	E4
Internal initialization (continued)	5	Unlit	Version No.	Unlit	E5

3.2.2 Initial setting

The following are initially set statuses summarized in Table 3-2 "List of Initial Values":

- Settings on factory shipment
- Settings on automatic resetting immediately after power turning on
- Settings after initialization by SHIFT + INITALIZE keys

The following information is also shown:

- Settings after automatic setting by AUTO SET key
- Provision for data storage and retrieval to/from the setting memory (No. 1 to 9)

a) Settings immediately after power on

When the unit is powered on, the system retrieves the settings when power was turned off last except for the case in which stored data has been destroyed for any reason.

b) Operation to return to known settings

- Resetting to factory default settings
  While holding down the AUTO SET key, turn on the power. Keep depressing the AUTO SET key until a measurement appears.

- Resetting only measurement-related settings to factory default settings
  Press the SHIFT + INITIALIZE key.
  For settings that relate to measured signals and reference signal selection, make setting separately by manual.

- Resetting to pre-stored settings
  Store settings in the setting memory in advance, and call the data by specifying the number.
  To call the data, press the SHIFT + RECALL keys, then select the number in the setting memory No. 1 to 9 using the MODIFY dial, and again press the SHIFT + RECALL keys.
  To store data, use STORE instead of RECALL.

- Resetting to the settings of the last power off
  After changing the settings, to reset to the settings when power was turned off last (on this power turning on), specify No. 0 and call the setting memory.

Table 3-2 List of Initial Values

Items		Range of value	Factory default	INITIALIZE	AUTO SET	Setting memory	Automatic resetting
SIGNAL INPUT	SIGNAL	I(10^6), I(10^8), A, A-B	A	no change	no change	○	○
	COUPLING	AC, DC	AC	no change	AUTO	○	○
	GROUND	GROUND, FLOAT	GROUND	no change	no change	○	○
FILTER	LINE	OFF, ON	OFF	OFF	no change	○	○
	LINE x2	OFF, ON	OFF	OFF	no change	○	○
	LINE FREQ	50Hz, 60Hz	50Hz	no change	no change	—	◇
	LPF THRU	OFF, ON(THRU)	OFF	OFF	OFF	○	○
DYN RESERVE	DR	HIGH, MEDIUM,LOW	LOW	LOW	AUTO	○	○
SENSITIVITY	V	2nV to 1V (1-2-5)	1V	1V	AUTO	○	○
	I	5fA to 1μA (1-2-5)	1μA	1μA	AUTO	○	○
TIME CONSTANT	TIME CONSTANT	10μs to 30ks (1-3)	100ms	100ms	AUTO	○	○
	SYNC	OFF, ON	OFF	OFF	AUTO	○	○
	SLOPE	6,12,18,24dB/oct	24dB/oct	24dB/oct	24dB/oct	○	○
RATIO	RATIO ON/OFF	OFF, ON	OFF	OFF	OFF	○	○
	K FACTOR	0.1000 to 9.999	1.0000	1.0000	1.0000	○	○
DATA1	DISPLAY	R, X, NOISE, AUX IN1	R	R	R	○	○
	NORMALIZE PARAM.	OFF, dB, %	OFF	OFF	OFF	○	○
	NORMALIZE STD V	1.0000nV to 1.0000V	1V	1V	no change	○	○
	NORMALIZE STD I	1.0000fA to 1.0000μA	1μA	1μA	no change	○	○
	X OFFSET ON/OFF	OFF, ON	OFF	OFF	OFF	○	○
	X OFFSET VALUE	0.00 to±100.00%	0%	0%	0%	○	○
	EXPAND	1(OFF), 10, 100	1	1	1	○	○
DATA2	DISPLAY	θ ,Y,AUX IN1,AUX IN2	θ	θ	θ	○	○
	Y OFFSET ON/OFF	OFF, ON	OFF	OFF	OFF	○	○
	Y OFFSET VALUE	0.00 to±100.00%	0%	0%	0%	○	○
	EXPAND	1(OFF), 10, 100	1	1	1	○	○
REFERENCE *1	DISPLAY	PHASE, FREQ, AMPTD, nF etc.	FREQ	FREQ	FREQ	○	○
	PHASE	-180.00 to +179.99°	0°	0°	0°	○	○
	FREQ (INT OSC)	0.0005 to 10500kHz	1kHz	no change	no change	○	○
	AMPTD	0.0mV to 5.00V (3 RANGE)	0.00V	no change	no change	○	○
	nF	1 to 19999	1	1	1	○	○
	SOURCE	REF IN, INT OSC, SIGNAL	REF IN	no change	no change	○	○
	EDGE	SINE POS, TTL POS, TTL NEG	SINE POS	no change	no change	○	○
KEY LOCK	KEY LOCK	FREE, LOCK	FREE	no change	no change	—	FREE
LAMP		ON, OFF	ON	no change	no change	—	ON
FAN		ON, OFF	ON	no change	no change	—	◇
AUX OUT	OUT1	±10.000V	0V	no change	no change	○	○
	OUT2	±10.000V	0V	no change	no change	○	○
GPIB	ADDRESS	0 to 30	2	no change	no change	—	◇
	TERMINATOR (TX)	CR, LF, CR+LF	LF	no change	no change	—	◇
RS-232	BAUD RATE	1200 to 19200	1200	no change	no change	—	◇
	PARITY	NO, ODD, EVEN	NO	no change	no change	—	◇
	CHAR LENGTH	7, 8	7	no change	no change	—	◇
SPECIAL	INTERFACE	GPIB/RS-232	GPIB	no change	no change	—	◇
	NOISE SMOOTHING	1,4,16,64	1	1	no change	○	○
	OPTION CONTROL	0 to 3 or 0 to 1	0	0	no change	○	○

Complement to Table 3-2 "List of Initial Values"

◇: These parameters return to the original setting when the power is turned on. However, they are stored separately from setting memory 0. Once these parameters are altered, the original setting cannot be retrieved even if the No. 0 setting memory is called by using the SHIFT + RECALL key operation.

*1: If the user turns off the power then turns on the power when any parameter other than PHASE, FREQ, AMPTD and nF appears on the REFERENCE digital display, the system will return to the previous state that was either of PHASE, FREQ, AMPTD and nF.

☞ For external control (GPIB or RS-232) proper initial values ➡ Refer to Section 5 "GPIB Interface".

3.2.3 Setting of power supply frequency

Be sure to make setting or confirmation of power supply frequency on any of the following conditions:

- Immediately after instrument purchasing
- If the unit is moved to a location in where power supply frequency is different
- If the system is reset to the factory default settings

Set the power supply frequency in the following procedure:

- Press the SHIFT + LINE keys to display the set value of power supply frequency.
- Turn the MODIFY dial to select 50 (Hz) or 60 (Hz).
- Press the SHIFT + EXIT keys to complete the setting of power supply frequency.

The above operation is essential to eliminate the noise of power supply frequency and its double frequency mixed in measured signals.

3.2.4 Warm-up

After power turning on, it requires approximately the following time period until the internal temperature stabilizes:

About 30 minutes if cooling fan is in operation

About 45 minutes if cooling fan is not in operation

Before perform precise measurement, wait for twice as long as the above period to ensure sufficiently stabilized temperature.

a) Measured signal input and ±24V power outputs ⚠

These input and power supply have a common ground. This signal ground is insulated from the chassis by ±1V or less. The signal ground is connected to the chassis via an about 10kΩ resistor if FLOAT is selected, and via an about 10Ω resistor if GROUND is selected. If a voltage exceeding ±1V is applied, this insulation cannot be maintained.

⚠CAUTION

If a voltage exceeding ±1V is applied between this signal or power supply ground and the chassis, a great current is allowed to flow, damaging the internal circuit.

☞ For the method of connecting measured signal ➡ Refer to Section 3.4.5 "Connection of measured signal and related setting" or Section 4.2 "Operation of measured signal system".

1) Voltage signal input (A and B) ⚠

Input impedance	: 10MΩ ±1.5%; about 50pF in parallel
Maximum allowable input voltage	:±7V (DC coupling) 5Vrms (AC coupling, sine wave)
Maximum nondestructive input voltage	: 10Vrms AC and ±50V DC for AC coupling ±14V for DC coupling

Application of a voltage exceeding the maximum allowable input voltage will saturate the amplifier, causing distortion. The actual maximum allowable input voltage is the sensitivity plus the value of the dynamic reserve. This value is smaller than the above value.

⚠CAUTION

In the case of AC coupling, application of sine wave greater than 10Vrms or DC voltage greater than ±50V will break the internal circuit. In the case of DC coupling, DC voltage greater than ±14V will do the same.

2) Current signal input (1) ⚠

Input impedance	: <1kΩ (for 500Hz, conversion gain of 10^6V/A) <20kΩ (for 500Hz, conversion gain of 10^8V/A)
Maximum nondestructive input current	: 10mA

⚠CAUTION

Application of ±10mA or greater current will break the internal circuit. Do not connect the voltage source. When it is not used, attach the supplied protection cap.

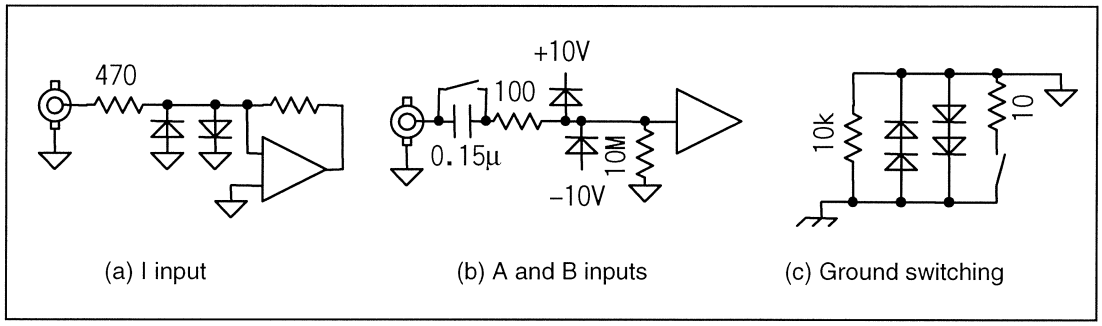


Fig. 3-2 SIGNAL INPUT (I, A and B) Input Circuit and Ground

3) ±24V power supply output (±24V OUT) ⚠

Current capacity : 50mA

±24V power output (±24V OUT on rear panel) is provided for the purpose of supplying power to an external preamplifier. Do not use this for other purposes, which may affect the measurement.

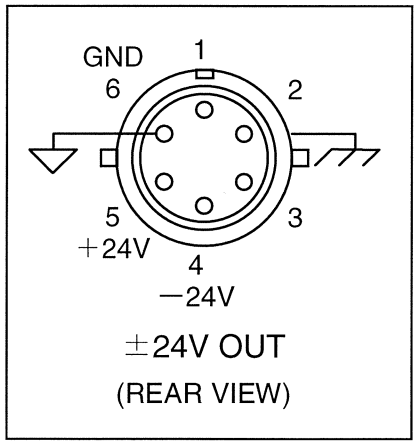


Fig. 3-3 ±24 V Power Supply Output

b) Auxiliary input (AUX IN1 and AUX IN2 on rear panel)

Maximum allowable input voltage : ±12V
Maximum nondestructive input voltage : ±40V
Input impedance : approx. 1MΩ,100pF or less in parallel

The ground for auxiliary input is isolated from the ground of the chassis and measured signal input (I, A and B). Connection may be made at the potential different from the ground of the chassis and measured signal input and within the range of maximum allowable input voltage. However, keep the voltage within ±1V because high potential difference increases measurement error of auxiliary input.

Supply of signals with frequency of 1kHz or greater and high amplitude or signals that suddenly change sharply may affect measurement of I, A or B input

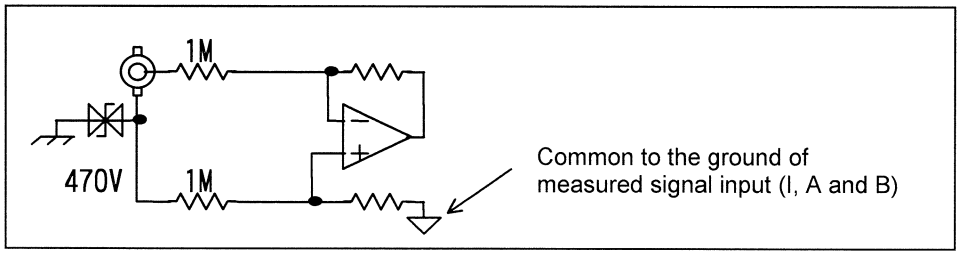


Fig. 3-4 AUX IN1/AUX IN2 Input Circuit

c) Reference signal input (REF IN) ⚠

Input impedance : approx. 1MΩ (1kHz), 100pF or less in parallel
Range of input voltage : 0.3 to 30Vp-p (SINE POS, sine wave)
0 to 5V (TTL POS/TTL NEG)
Maximum nondestructive input voltage : ±40V

The ground of REF IN is connected to the chassis.

If the user takes the point at which the reference signal wave crosses their average value as the phase reference point, set the EDGE to SINE POS. If it contains a DC component, keep the peak value from exceeding ±40V.

The range of input voltage for the case in which a square wave that has a remarkably different proportion between the high-level period and the low-level period is used will be 15Vp-p.

If a TTL-level logic signal is used, set to TTL POS or TTL NEG. The threshold voltage is about 1.5V.

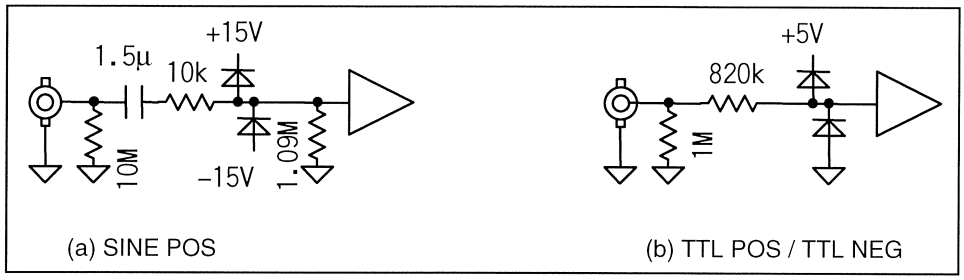


Fig. 3-5 REF IN Input Circuit

d) Reference signal output (internal oscillator) ⚠

The unit provides the output of the internal oscillator, or a signal that is synchronous with the external signal at the OSC OUT connector or at the rear panel REF OUT connector. At OSC OUT, available is a sine wave whose amplitude cab set in the range of 0 to 5Vrms and at REF OUT available is a TTL-level square wave. The signal ground is connected to the chassis.

OSC OUT output voltage : 0.0000 to 5.00Vrms (when no-load)

OSC OUT maximum output current : ±10mA

OSC OUT output impedance : 50Ω ±3 % (1kHz)

⚠CAUTION

Do not apply external voltage to the output connectors, which breaks the internal circuit.

OSC OUT has a limit for output current. 50Ω load cannot be connected.

Keep the load to the REF OUT ground or to +5V to 500Ω or higher.

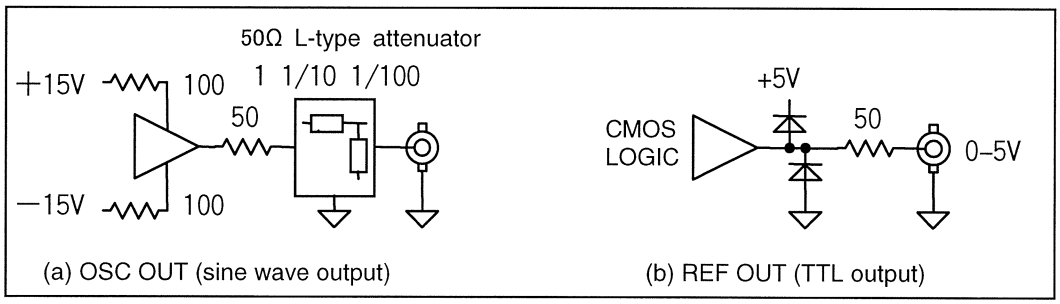


Fig. 3-6 Reference Signal Output Circuit (internal oscillator)

e) Output of measurement result, auxiliary output and monitor output

The following shows about connectors of DATA1 OUT, DATA2 OUT and rear panel X OUT, Y OUT, AUX OUT1, AUX OUT2 and MONITOR OUT.

Maximum output voltage : ±12V

Maximum output current : ±6mA

Output impedance : approx.1kΩ (DC)

The grounds of the above outputs are connected to the chassis.

Since the output impedance is approximately 1kΩ, connection of a low input impedance device will increase the error. For load, connect device with high input impedance such as recorder, multi-meter and oscillator.

⚠CAUTION

Do not apply external voltage to the output connectors, which breaks the internal circuit.

The connectors have a limit for output current. Keep the load impedance to 1kΩ or higher.

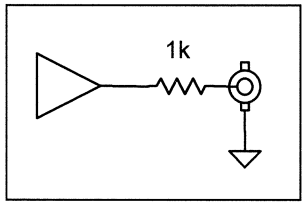


Fig. 3-7 Data1/2 OUT, X/Y OUT, AUX OUT1/2, and MONITOR OUT Output Circuits

f) Trigger input

Signal level	: TTL level (falling edge)
Input impedance	: approx. 10kΩ (pull up to +3.3V)
Maximum nondestructive input voltage	: ±40V

The ground of TRIG IN is connected to the chassis.

With a voltage exceeding approximately +4V, the input impedance will be decreased to about half level.

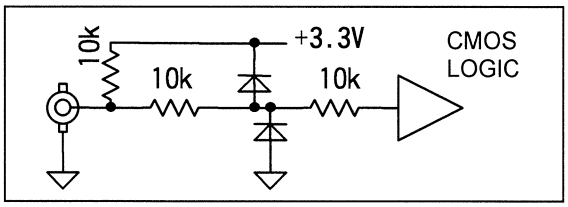


Fig. 3-8 TRIG IN Input Circuit

g) Others

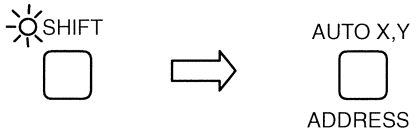
☞ For allotment of RS-232 connector signal ➡ Refer to Section 6.1.4 "Connection of RS-232 cables".

3.4 Basic operation

3.4.1 Shift and Modify operations

[Shift operation]

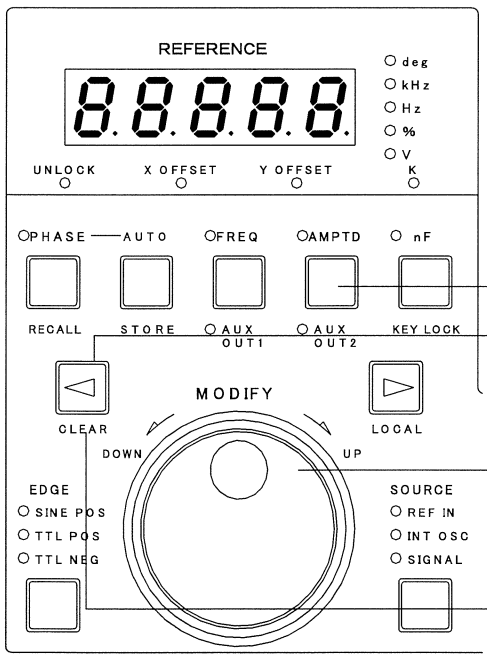
In the following sections, expression such as [SHIFT + ADDRESS] means: press the SHIFT key to turn on the SHIFT lamp, then press the key that has ADDRESS indicated in blue characters at the bottom.



[Modify (setting and selection of value)]

Press the key that correspond the parameter that the user wants to modify, and the value of that parameter will appear on the REFERENCE digital display. As you turn the MODIFY dial, the number in the blinking digit and upper changes. The blinking digit can be selected with the "Move modify digit" keys ◀ and ▶. For FREQ and AMPTD, move the blinking digit to the unit lamp, then you can change the number by ten times units (or change the range).

The value of some types of parameter is shown on the DATA1 or DATA2 displays and some other parameters should be selected by using the MODIFY dial.



Example: Changing the amplitude of internal oscillator

1) Display the amplitude.

2) Select the digit for change (the blinking digit).
To change the value by 10 times units
(change the range), make the unit lamp blink.

3) Alter the value or the range

4) If the user wants to zero the number in the blinking digit and lower, press: SHIFT + CLEAR

3.4.2 Operation when using the unit for the first time

Before using the instrument, read Section 2. "Preparation before Use".
If the settings on the previous occasion are unknown, it may be easy to turn the system to the initial state.

☞ For details ➡ Refer to Section 3.2.2 "Initial setting"

- Press the SHIFT + INITIALIZE keys. → Returns the measurement conditions to a specific setting.
- While holding down the AUTO SET key, turn on the power. → Returns to the factory default setting.

Operation should follow the procedure below:

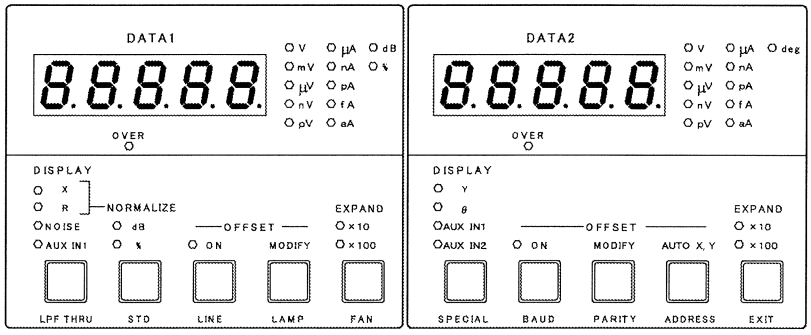
1. Select the parameter for measurement.
   Select the desired parameter for display such as X, Y, R and θ .

2. Connect the reference signal.
   Supply the reference signal from outside in order to give the frequency and the reference phase of the signal for measurement.
   It is also possible to generate reference signal using the internal oscillator.
   Automatic setting is not available for switching the reference signal.

3. Connect the measured signal.
   Connect the desired signal for measurement to the signal input connector of voltage or current.
   Automatic setting is not available for switching signal input.
   Also make setting for processing of ground according to measurement environment.

4. Set the measurement conditions.
   Select the sensitivity (or the meter full scale) to meet the magnitude of the signal to be measured.
   Select the dynamic reserve, time constant etc. to meet the intensity of the noise.
   The above can be automatically set using the AUTO SET key etc.
   Make automatic setting once, and then make fine adjustment so that a proper condition will be achieved.

3.4.3 Selection of measurement parameter



LI5640 can display two measurement parameters at the same time.

For selection, use the DISPLAY keys of DATA1 and DATA2.

- DATA1

X : The signal component of the same phase as that of the reference signal (phase of 0°)

R : The magnitude of signal ($=\sqrt{X^2+Y^2}$)

NOISE : The noise density (DATA2 indicates AUX IN1 regardless of setting.)

AUX IN1 : The DC voltage of AUX IN1 on the rear panel (up to ±12V)

- DATA2

Y : The signal component orthogonal to the reference signal (phase of 90°)

θ : The phase of the signal in relation to the reference signal

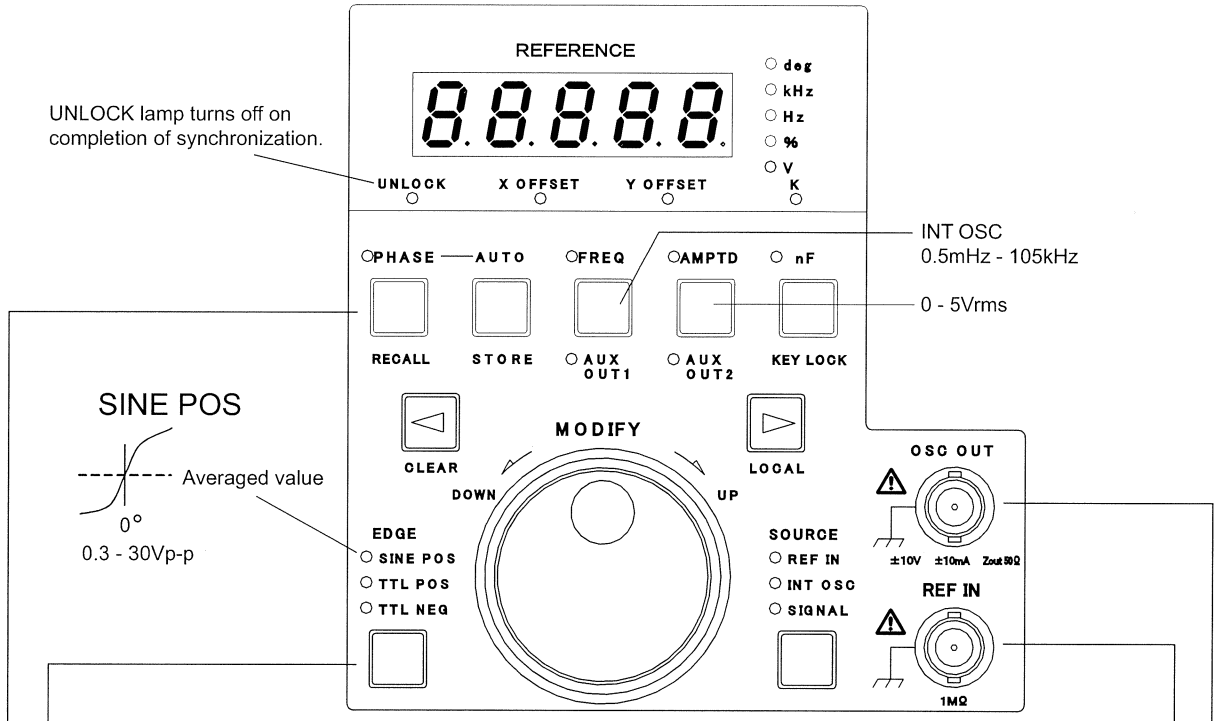
AUX IN1 : The DC voltage of AUX IN1 on the rear panel (up to ±12V)

AUX IN2 : The DC voltage of AUX IN2 on the rear panel (up to ±12V)

Two measurements can be obtained in the following three forms:

- Digital expression
- Analog meter indication
- Analog voltage (DATA1 OUT, DATA2 OUT; 16 bits, maximum 256k samples/s)

3.4.4 Connection and setting of reference signal



Connect to the REF IN connector an external reference signal having the same frequency as the measured signal in order to give the frequency and the reference phase of the signal for measurement. Select REF IN with the SOURCE button.

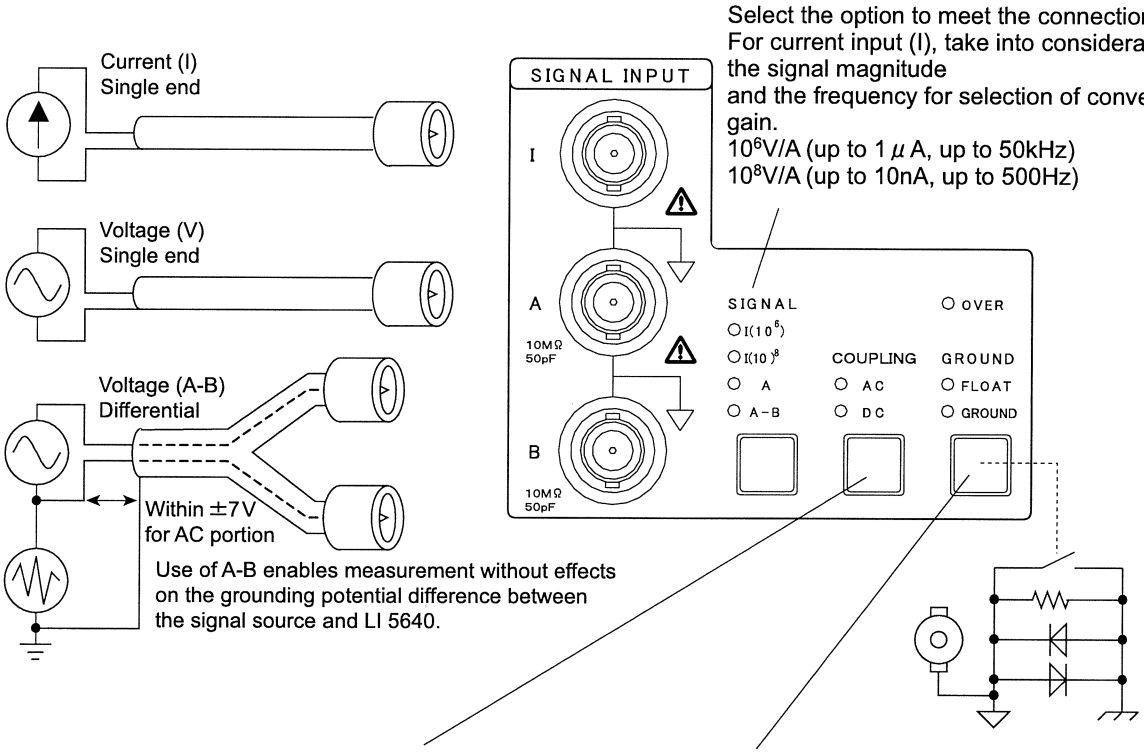
This button specifies the phase reference point to meet the external reference signal. If the user takes the point at which a sine wave or square wave crosses the mean average level upward from below as the reference point for the phase, select SINE POS with the EDGE button. When using a TTL-level square wave, the user can select either point of the rising edge (TTL POS) or the falling edge (TTL NEG).

The user may generate a sine wave reference signal of an arbitrary frequency (0.5 mHz to 105 kHz) and amplitude (0 to 5 Vrms) by means of the internal oscillator (INT OSC). To use the internal oscillator, select INT OSC with the SOURCE button. A TTL-level square wave is also obtained from REF OUT on the rear panel.
Set the frequency and amplitude of sine wave output after pressing the FREQ button or AMPTD button, respectively.

The user may shift the reference phase (position of 0 degree) from the reference signal.
To read the signal magnitude from the X measurement, first press the PHASE button, and then adjust the phase offset so that the Y measurement will be zero. The user can also use the AUTO button for automatic setting.

3.4.5 Connection of measured signal and related setting

Connect the signal for measurement to I, A and B connector of SIGNAL INPUT.
Also specify the conversion gain because the current will be converted into voltage for reference.



Select AC (AC coupling) for approximately 1Hz or higher frequencies and select DC (DC coupling) for frequencies lower than 1Hz. AUTO SET enables automatic selection.
Selection of AC will eliminate DC current, so you can measure signals that contain high DC current. However, measurement error is conspicuous for frequencies of 1Hz and lower.
If AC is selected with current input (I), DC current will be eliminated after conversion into voltage. Use this function in the following range of the peak value containing DC current.
±7 μA for 10^6 V/A
±70 nA for 10^8 V/A

Select FLOAT if the signal source is grounded, and select GROUND if it is not.
Grounding both the signal source and the LI5640 input may create a ground loop, admitting noise current in the system, which in turn affects measurement.
If the signal source is not grounded, select GROUND and connect the input signal ground to the enclosurechassis in order to stabilize the potential.

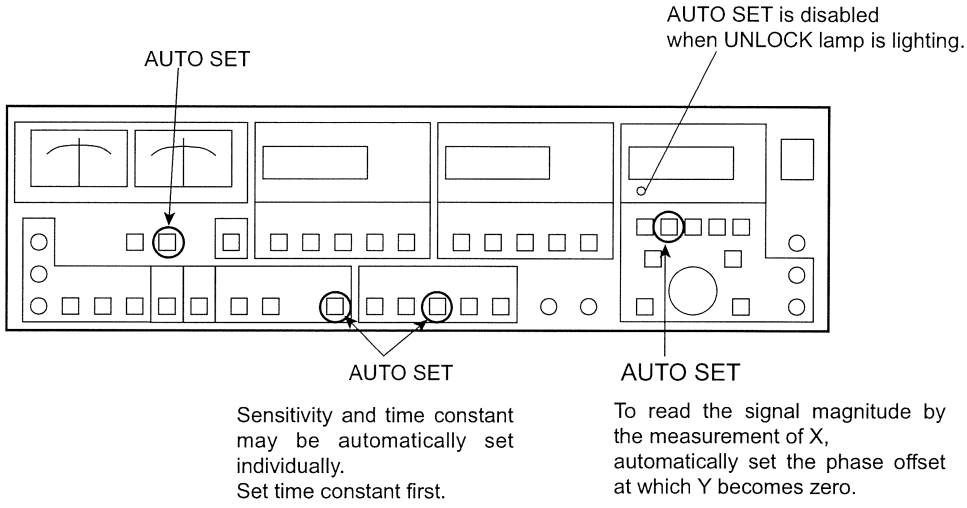
⚠CAUTION

If a voltage exceeding ±1V is applied between the I, A and B input sign ground (outer conductor of the connector) and the LI5640 chassis, a high current flows in the internal circuit and breaks it.

3.4.6 Setting measurement conditions (for makeshift measurement)

If the user is not yet familiar with the setting procedure, follow the procedure below:

- Connect the signal for measurement, set the ground and connect and set the reference signal. Selection of the measured signal and selection of reference signal should be set manually.
- Press the AUTO SET key.
  This step will set the sensitivity and time constants automatically, and the signal magnitude R and the phase θ will appear.



If AUTO SET could not measure satisfactorily, then modify only necessary settings to continue measurement.

For 1 Hz or lower, manual setting is preferable because automatic setting takes time.

AUTO SET displays the measurement in R and θ. To view X and Y, change the indication using the DISPLAY key of DATA1 and DATA2.

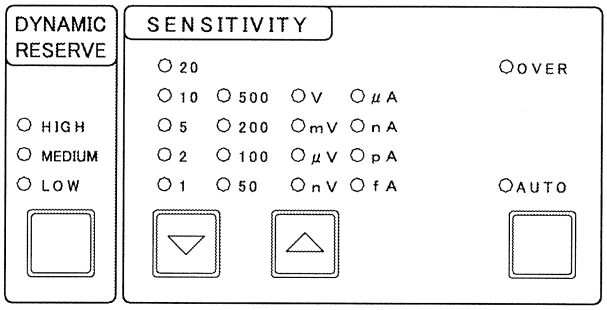
Instead of using the AUTO SET function, measure values broadly following the procedure below to figure out the situation:

- Set the attenuation slope (SLOPE) to 24dB/oct.
- If the frequency is several 10Hz or lower, press the SYNC key to light up the lamp.
- Set the time constant (TIME CONSTANT) to about three times the signal period. However, it must be 30 ms or higher. For frequencies of several 10Hz or lower, select a lower value to expedite response.
- Select HIGH for dynamic reserve.
- Adjust the sensitivity (SENSITIVITY) so that the OVER lamp will not light up and the measurement will come to near full-scale value. However include a margin in the value.
- Reduce the dynamic reserve insofar as the OVER lamp does not turn on.
- If the measurements have a large dispersion, increase the time constant.
- If the dispersion is small, shorten the time constant to have quicker response.
- Fine adjusts the sensitivity, dynamic reserve and time constant.

3.4.7 Optimizing the sensitivity

a) Indication value is too small, or too large causing OVER

If the measurements of X, Y and R are too small in relation to the meter full scale to read easily, or if they exceed the display range, causing the DATA1 and DATA2 OVER lamps to light up, adjust the sensitivity setting using the ▽ key and the △ key of SENSITIVITY.



b) OVER lamp of SIGNAL INPUT turns on

This is because the input circuit is set to an over-level value. Operate as follows:

- Increase the dynamic reserve (LOW → MEDUM → HIGH).
- Increase the sensitivity setting with the SENSITIVITY △ key.

If the OVER lamp tends to light up even with the dynamic reserve set to HIGH, it is because the input is exceeding the maximum LI5640 level. Input signal must be reduced. If the input signal contains a large number of DC components, select AC coupling (AC).

c) OVER lamp of SENSITIVITY turns on when the indication does not reach the full scale

This is because an over-level condition has occurred due to noise during signal processing.

If the OVER lamp of SENSITIVITY tends to turn on even when X, Y or R measurement does not reach the sensitivity full scale, try the following steps:

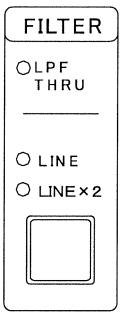
- Increase the time constant (TIME CONSTANT) and the attenuation slope (SLOPE).
- Increase the dynamic reserve (LOW → MEDUM → HIGH).
- Increase the sensitivity setting with the SENSITIVITY △ key.

(When the measurement lowers to 1/10 or less of the sensitivity full scale, you may still use the EXPAND key for enlarging.)

3.4.8 Narrowing the dispersion, or quicken the response

a) To narrow the dispersion

If X, Y, R or θ measurement is not readable because of dispersion due to noise, make adjustment shown below.



- If noise of power supply frequency (hum) interferes:

Press the LINE/LINEx2 key of FILTER to turn on the LINE or LINEx2 lamp in order to attenuate the power supply frequency components and their two-time frequency components.

☞ For setting of power supply frequency ➡ Refer to Section 3.2.3 "Setting of power supply frequency".

However, if the desired signal for measurement is close to these frequencies, the very signal will be attenuated, and also the phase will be changed.

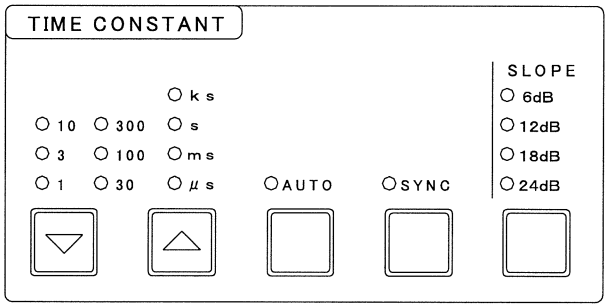
- If high noise comes from other than power supply frequency:

Increase the time constant (TIME CONSTANT) and the attenuation slope (SLOPE), and decrease the equivalent noise bandwidth.

If the SLOPE is low, use the SLOPE key for increasing.

If it is already 24 dB/oct, use the TIME CONSTANT △ key to increase the time constant.

The above measures can narrow the dispersion although the response is slowed.



In addition, if the reference signal is unstable, measurement dispersion becomes greater. Use stable and noise-free reference signal.

b) Quicken response

If noise is low, the user can quicken X, Y, R and θ response.

Decrease the time constant with the TIME CONSTANT ▽ key.

The above measure can quicken the response although the dispersion becomes greater.

In addition, a steeper attenuation slope and a shorter time constant will quicken the response if comparison is made on the same noise elimination performance (equivalent noise bandwidth).

c) Reduce ripples

Even if the noise is low, too much shortening of time constant (with low SLOPE, in particular) will leave ripples of the measured signal frequency and its two-time frequency in the

measurements. In such cases, press the SYNC key to light the lamp in order to control the ripples. However, effects will be low if the frequency is high.

3.4.9 Monitoring minor changes (magnitude of signals)

To monitor small changes in X, Y and R, or to remove signal leak-in, the user may subtract a certain amount from the X and Y measurements to display the values. Further, for X, Y and R, the user may magnify the result of subtraction to improve the apparent sensitivity and resolution.

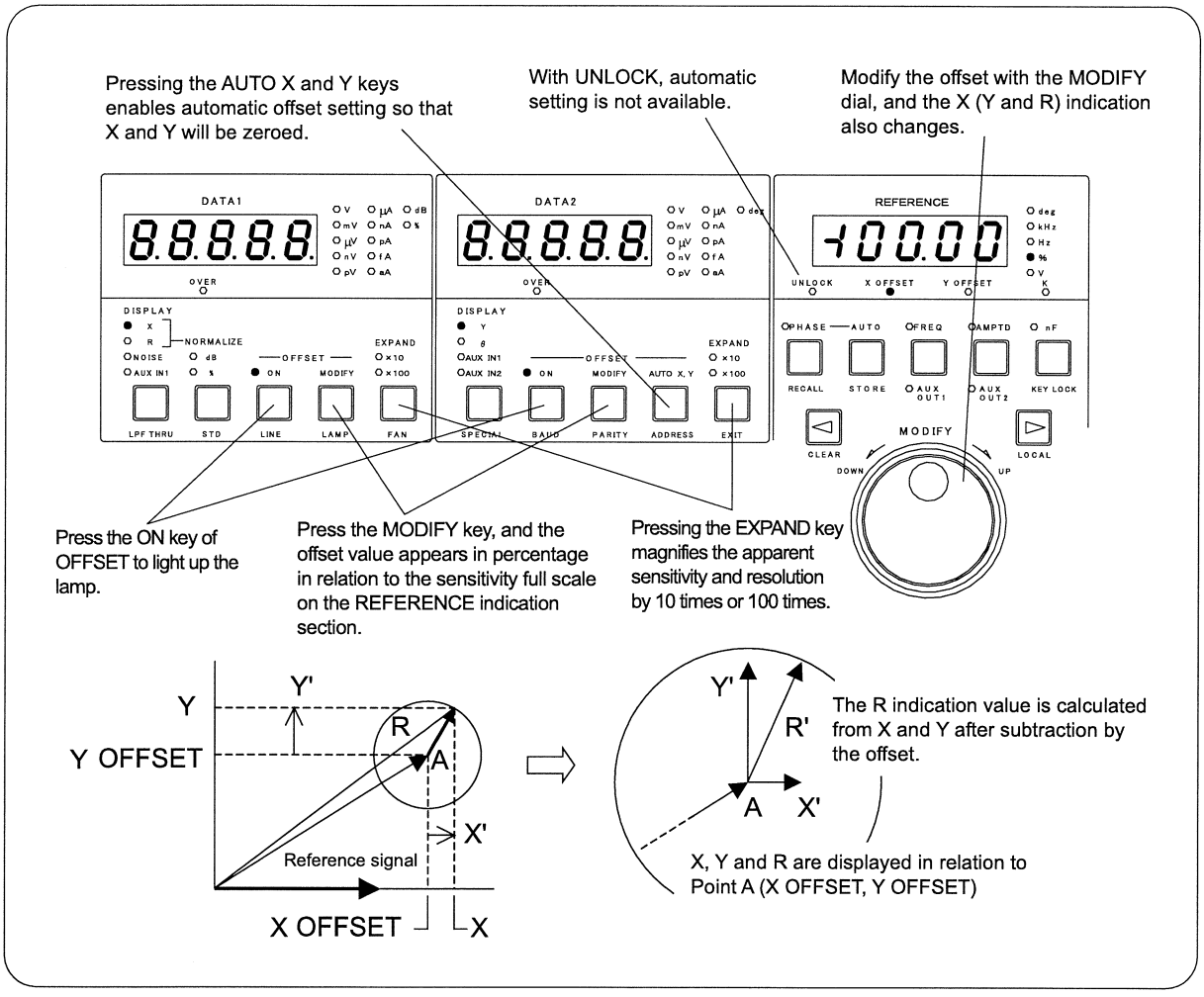


Fig. 3-9 Offset and Enlarging (EXPAND)

3.4.10 Monitoring minor changes (phase)

To monitor small change in phase, give the phase offset in relation to the reference signal.
The display resolution of phase is 0.01° . If further precise resolution is required, give a phase offset so that Y will be almost zero, and then view the Y value by magnifying it with the EXPAND key.
The measurement of the phase viewed from the new reference phase (0°)can be determined from the signal magnitude R and Y by means of the function $\sin^{-1}$ (Y/R).

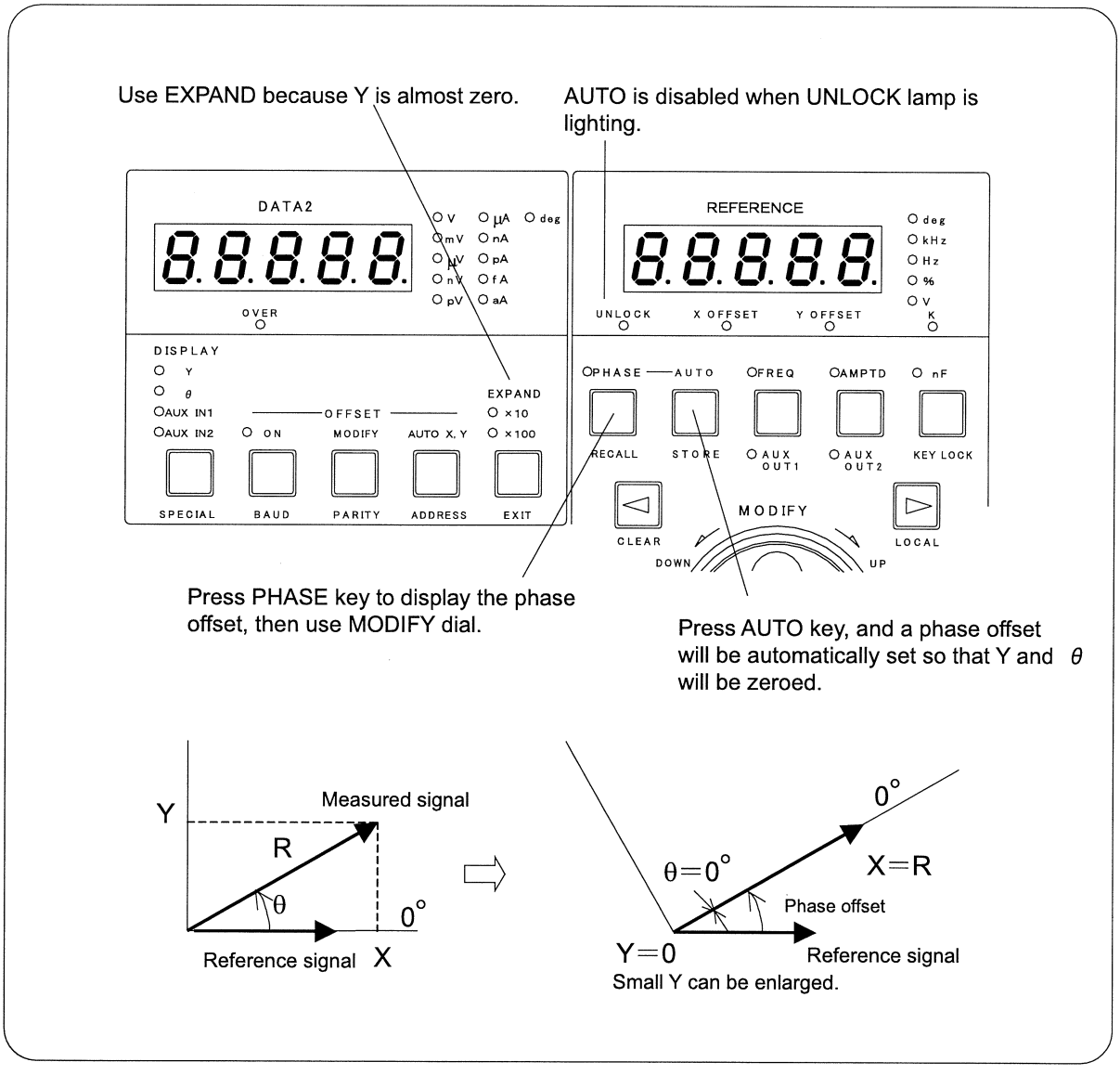


Fig. 3-10 Phase Offset and Phase Resolution Improvement