7. Specifications

7.1 Measured signal system

a) Voltage input

Input connector	Two BNC receptacles (for A and B)
Input format	A (single end) and A-B (differential)
Voltage sensitivity	2nV to 1V full scale (1-2-5 sequence)
Voltage accuracy	±0.5% (1kHz, signal level of 1mV or greater, 23±5℃) ±2% (1kHz, signal level of 1μV or greater) (Dynamic reserve LOW, 30% or higher of full scale) ±0.5% (for DC coupling, 20kHz or less) ±1% (for DC coupling, 50kHz or less) ±2.5% (for DC coupling, 100kHz or less) (Dynamic reserve at LOW, sensitivity 1V, signal level 1V)
Gain drift	±100ppm/℃ (typically 1kHz) High dynamic reserve may deteriorate the gain drift.
Input impedance	10MΩ±1.5%, about 50pF in parallel
Input referred noise	6nV/$\sqrt{\text{Hz}}$ (max), 4.5nV/$\sqrt{\text{Hz}}$ (typically) for dynamic reserve at LOW, sensitivity set to 2mV or less, frequency at 1kHz and input short-circuited.
Maximum allowable input voltage	±7V (DC coupling) 5Vrms (AC coupling, sine wave); as allowable noise level for sensitivity at 1V and dynamic reserve at HIGH
Maximum nondestructive input voltage	For AC coupling: Sine wave 10Vrms, DC ±50V For DC coupling: ±14V
Frequency range	1mHz to 100kHz (DC coupling), 0.5Hz to 100kHz (AC coupling)
Common-mode rejection ratio	120dB (typically 1kHz), 100dB (min. 50Hz to 1kHz) for AC coupling, dynamic reserve at LOW, sensitivity set to 20mV or less, at MEDIUM and 2mV or less
Harmonic distortion	-90dBtyp (1kHz), -80dB or less (10Hz to 5kHz), -70dB or less (5 to 10 kHz) all for dynamic reserve at LOW, sensitivity at 1V, signal level at 1V

b) Current input

Input connector	BNC receptacle (I)
Input type	Single-ended
Current sensitivity	50fA to 1μA 1-2-5 sequence (for conversion gain 10^6V/A)
	5fA to 10nA 1-2-5 sequence (for conversion gain 10^8V/A)
Current accuracy	±1% (1kHz and magnitude of signal 1nA to 1μA for conversion gain 10^6V/A; 10Hz and magnitude of signal 10pA to 10nA for conversion gain 10^8V/A both for dynamic reserve at LOW and magnitude of signal at 30% or greater of sensitivity full scale and 23±5℃)
Gain drift	±150ppm/℃ typically (at 1kHz for 10^6V/A and 10Hz for 10^8V/A)
	High dynamic reserve may deteriorate the gain drift.
Input referred noise	130fA/$\sqrt{\text{Hz}}$ typically (1kHz for conversion gain 10^6V/A)
	13fA/$\sqrt{\text{Hz}}$ (125Hz for conversion gain 10^6V/A)
Input impedance	<1kΩ (500Hz for conversion gain 10^6V/A)
	<20kΩ (50kHz for conversion gain 10^6V/A, for reference)
	<20kΩ (500Hz for conversion gain 10^8V/A)
Maximum allowable input current	
	±7μA; as allowable noise level for conversion gain of 10^6V/A, sensitivity at 1μA and dynamic reserve at HIGH
Maximum nondestructive input current	
	10mA
Frequency range	1mHz to 50kHz (DC coupling, for conversion gain 10^6V/A)
	1mHz to 500Hz (DC coupling, for conversion gain 10^8V/A)
	0.5Hz or greater for both of the above in AC coupling

c) Specifications common to voltage and current

Input coupling	AC/DC (AC coupling after conversion to voltage for current input)
Input ground	Float/chassis ground
	Voltage between chassis and signal ground is ±1V max when floating
	Ground impedance is about 10kΩ (DC) when floating
	Ground impedance is about 10Ω (DC) when chassis is grounded
Line filter	Power supply frequency (50 or 60Hz) and its doubled value
	Attenuation in center frequency 20dB or greater
Anti-aliasing filter	ON/OFF
	(OFF; response speed and phase drift to be improved when not in use)

7.2 Phase sensitive detector section

Dynamic reserve	100dB or greater; the ratio of sensitivity full scale (rms) to maximum allowable noise level (rms)
Time constant	10μs to 30ks (1-3 sequence)
Attenuation slope	6, 12, 18 and 24dB/oct
Synchronous filter	ON/OFF; when filter is ON, output ripples can be reduced by moving average of integral cycle. However, ripples may not be attenuated sufficiently if 200Hz is exceeded.
Phase noise	0.001° rms typically (1kHz) Sine wave reference signal, time constant 100ms, attenuation slope 18 dB/oct 0.003° rms typically (100kHz) Sine wave reference signal, time constant 100ms, attenuation slope 12 dB/oct This specification may not be applicable if noise or jitter in reference signal is large, or amplitude is less than 1Vrms.
Phase drift	Within ±0.01°/℃ (≧100Hz, ≦10kHz) Within ±0.1°/℃ (>10kHz, ≦60kHz) Within ±0.2°/℃ (>60kHz) This specification may not be applicable if an external sine wave signal of less than 1Vrms is used as the reference signal.

7.3 Reference signal system

Reference mode	REF IN (external), INT OSC (internal oscillator), SIGNAL (measured signal)
Frequency range	0.5mHz to 102kHz for TTL input or INT OSC
	0.5Hz to 102kHz for SINE input or SIGNAL
Harmonics measurement	1 to 19999 times of the reference signal
	(frequencies of harmonics must be within the above frequency range)
Input type	Single-ended
Input impedance	Approx. 1MΩ (1kHz), 100pF or less in parallel
Input voltage range	0.3 to 30Vp-p (SINE input, sine wave)
	0 to 5V (TTL input, threshold voltage of approx. 1.5V)
Maximum nondestructive input voltage	
	±40V
External reference signal waveform	
	SINE/TTL POS/TTL NEG
SINE :	A regular waveform that crosses the mean value only twice in a cycle Duty factor is 10 to 90% for a square wave The point at which the wave crosses the mean value upward from below is defined as 0 degree.
TTL POS:	A waveform with stable cycle that crosses the threshold voltage only twice in a cycle. The point at which low level changes to high level is defined as 0 degree.
TTL NEG:	A waveform with stable cycle that crosses the threshold voltage only twice in a cycle. The point at which high level changes to low level is defined as 0 degree.
External reference signal synchronization time	
	2 cycles + 50ms typically (Synchronization time is zero when internal oscillator is used)
Phase adjustment range	-180.00° to +179.99° , resolution 0.01°
Orthogonality	Within ±0.001°
Phase accuracy	±1° (DC coupling, ≦10kHz, sensitivity 1V, signal level 1V)
	±5° (DC coupling, ≦100kHz, sensitivity 1V, signal level 1V)
Frequency display resolution	
	4 1/2 digits (maximum 19999) or 0.1mHz, whichever is greater
Frequency measurement accuracy	
	±30ppm
UNLOCK indication	Indicates that the system is not synchronized to external reference signal.
Reference signal output	Connector BNC receptacle (rear panel)
	Signal level TTL (0 to 5V)

7.4 Internal oscillator

Oscillation frequency	Range	0.5mHz to 105kHz
	Resolution	4 1/2 digits (maximum 19999) or 0.1mHz, whichever is greater
	Accuracy	±30ppm
Output voltage Range	Full scale	0.0500Vrms, 0.500Vrms, 5.00Vrms (no loaded) 3-range manual switching
	Resolution	0.1mV, 1mV, 10mV (for each range)
	Accuracy	2% of set value + 0.5% of full scale (frequency ≦1kHz) 5% of set value + 0.5% of full scale (frequency ≦10kHz) 20% of set value + 0.5% of full scale (frequency ≦100kHz) When approx. 102kHz is exceeded, the amplitude suddenly drops.
	Stability	±50ppm/℃ typically (for 1kHz, 1rms)
Maximum output current		±10mA (when 5Vrms, load impedance ≧660Ω)
Output impedance		50Ω ±3% (1kHz)
Harmonic distortion		-80dB or less (for 20Hz to 5kHz, maximum amplitude selected) -70dB or less (for frequencies ≦100kHz, maximum amplitude selected)

7.5 Measurement output section

a) Digital display

DATA1 parameter	X (= R cos θ), R, NOISE, AUX IN 1
DATA2 parameter	Y (= R sin θ), θ , AUX IN 1, AUX IN 2
X, Y and R	Indication range 0 to 120% of sensitivity setting, resolution 4 1/2 digits (maximum 19999)
	θ Indication range -180.00 to +179.99° , resolution 0.01°
NOISE	Indication range 0 to 120% of the following noise density sensitivity
	Voltage : 20nV/$\sqrt{\text{Hz}}$ to 1V/$\sqrt{\text{Hz}}$
	Current (10^6V/A) : 1pA/$\sqrt{\text{Hz}}$ to 1μA/$\sqrt{\text{Hz}}$
	Current (10^8V/A) :100fA/$\sqrt{\text{Hz}}$ to 10nA/$\sqrt{\text{Hz}}$
	(1-2-5 sequence in any case)
	Resolution 4 1/2 digits (maximum 19999)
AUX IN1 and IN2	Indication range ±12.000V, resolution 0.001V
Ratio indication	Displays the value of the ratio of X, Y and R to AUX IN1 multiplied by arbitrary coefficient K.

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

Indication range: ±1.9999, resolution 0.0001

K constant range: 0.1000 to 1.9999, and 2.000 to 9.999

Normalize — Displays the ratio of the X and R to the standard value in dB or %.

$$\text{dB value} = 20 \text{ LOG}_{10} \left| \frac{\text{X or R measurement}}{\text{Standard value}} \right|$$

$$\%\text{value} = \left(\frac{\text{X or R measurement}}{\text{Standard value}} \right) \times 100$$

Indication range: ±120.00dB, resolution 0.01dB

±199.99%, resolution 0.01%

Standard value range:

Voltage 1.0000nV to 1.0000V

(4 1/2 digits, maximum 19999)

Current 1.0000fA to 1.0000 μA

(4 1/2 digits, maximum 19999)

Offset	±100.00% of sensitivity to X and Y. Resolution 0.01%.
Expand (EXPAND)	Magnifies X, Y and R by 1, 10 or 100 times

b) Analog output

Front panel output

DATA1 OUT	Same as DATA1 display parameter
DATA2 OUT	Same as DATA2 display parameter

Update rate for the above data

X, Y, R and θ : 256k samples/s

Others : 16k samples/s

The rate may be slower depending on the measurement conditions.

Rear panel output

X OUT	Same as X of DATA1 display parameter
Y OUT	Same as Y of DATA2 display parameter

Update rate for the above data

16k samples/s. The rate may be slower depending on the measurement.

Common specifications

Connector	BNC receptacle
Maximum output voltage	±12V (θ , % is ±10V)
Maximum output current	±6mA
Output impedance	Approx. 1kΩ (DC)
Output voltage accuracy	±(Analog output voltage equivalent to 0.35% of displayed value +15mV); (in DC)

Measurement values corresponding to meter full scale (analog output ±10V)

X, Y and R	Sensitivity set value/EXPAND magnification
NOISE	Sensitivity setting
AUX IN1 and AUX IN2	±10V
θ	±180°
Ratio	±2
% indication	±200%
dB indication	±100dB

c) Analog meter

DATA1	Indicates the same parameter as DATA1 display parameter
DATA2	Indicates the same parameter as DATA2 display parameter.

7.6 Monitor output (input signal to phase sensitive detector)

Connector	BNC receptacle
Maximum output voltage	±12V
Maximum output current	±6mA
Output impedance	Approx. 1kΩ (1kHz)

7.7 Auxiliary input (DC voltage measurement)

Number of channels	2
Connectors	Two BNC receptacles (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
Accuracy	± (0.35% of reading value + 15mV)
Frequency band	DC up to approx. 130Hz (-3dB)
Sampling rate	16k samples/s

7.8 Auxiliary output (DC voltage output)

Number of channels	2
Connectors	Two BNC receptacle (AUX OUT1 and AUX OUT2 on rear panel)
Setting voltage range	±10.000V (resolution 0.001V)
Maximum output current	±5mA
Output impedance	Approx. 1kΩ
Output voltage accuracy	± (0.35% of setting + 15mV)

7.9 Data memory

Type of data	Select from the following: DATA1, DATA2, DATA1/DATA2, DATA2/AUX IN2, DATA1/DATA2 /reference signal frequency, DATA1/DATA2/AUX IN1 /AUX IN2
Data resolution	16 bits (reference signal frequency is 32 bits)
Recording capacity	64K data (total of all parameters to be recorded; assuming 16 bits per data)
Number of memory divisions	1, 2, 4, 8, 16 and 32
Sampling interval	1/16ms, 1/8ms, 1/4ms, 1/2ms, 1ms, 2ms, 5ms, 10ms, 20ms, 50ms, 100ms, 200ms, 500ms, 1s, 2s, 5s, 10s, 20s; or by trigger signal

Trigger signal	TRIG IN on rear panel or via external interface		
TRIG IN	Connector	BNC receptacle	
	Signal level	TTL level (falling edge)	
	Input impedance	Approx. 10kΩ	
	Maximum nondestructive input voltage		±40V
	Minimum trigger interval		1/16ms
Operation	Via external interface		

7.10 Automatic setting function

AUTO SET	Sets optimum sensitivity, dynamic reserve, time constant, phase etc. according to the input signal.
Sensitivity	Adjusts sensitivity of voltage or current, and dynamic reserve according to the input signal.
Time constant	Adjusts time constant corresponding to the frequency of reference signal.
Phase	Sets the phase of reference signal so that the measurement θ of phase will be zero.
Offset	Sets all offsets so that output of X and Y will be zero.

7.11 External interface (GPIB and RS-232)

Either of GPIB and RS-232 is capable of setting and reading parameters, reading statuses and reading measurement data.
In addition, various commands are provided most of which are compatible with NF's 5610B/5600A as much as practicable to ensure previous programs are available with minimal modification.

a) GPIB

Standard	Conforming to IEEE std 488.1-1987 and IEEE std 488.2-1992
Interface functions	SH1, AH1, T6, L4, SR1, RL1, PPO, DC1, DT1, CO and E1

b) RS-232

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

Please note that RS-232 does not provide the function that corresponds to service request of GPIB.

7.12 General specifications

Power output to preamplifier	±24V, ±50mA
Setting memories	9
Initializing function	Returns to specified initial setting
Key lock	ON/OFF
Lamp control	ON/OFF
Fan control	ON/OFF
Power supply voltage range	100/120/230V±10%
Power supply frequency range	50/60Hz±2Hz
Power consumption	50VA maximum
Temperature/humidity range for performance guarantee	0 to +40℃, 10 to 95%RH (no dew condensation) Some of specifications limit the temperature range.
Storage temperature/humidity range	-10 to +50℃, 10 to 85%RH (no dew condensation)
Outer dimensions	434 (W) x 132.5 (H) x 450 (D) mm (excluding protruding portions)
Mass	Approx. 10kg

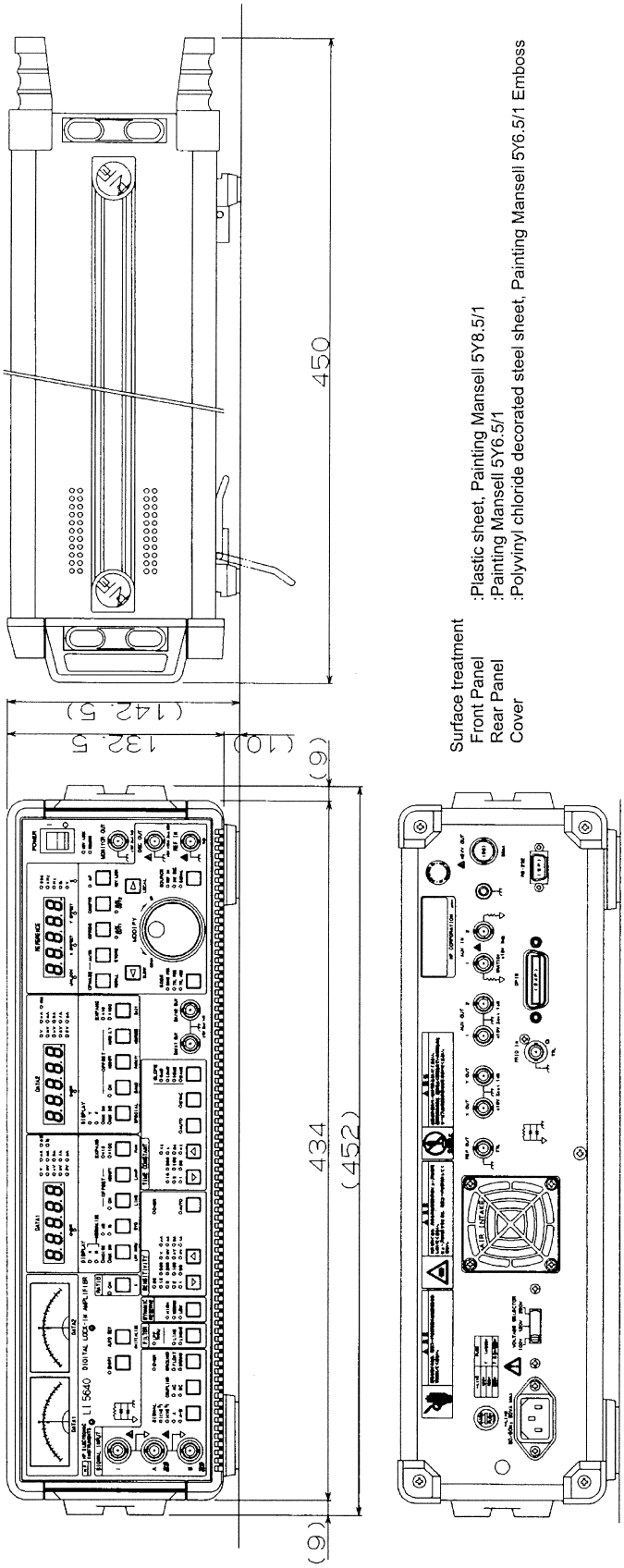

Figure 7-1 External Dimensions

WARRANTY

NF CORPORATION certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from our factory.

All **NF** products are warranted against defects in materials and workmanship for a period of one year from the date of shipment. During the warranty period of, **NF** will, at its option, either will repair the defective product without any charge for the parts and labor, or either repair or replace products which prove to be defective. For repair service under warranty, the product must be returned to a service center designated by **NF**. Purchaser shall prepay all shipping cost, duties, and taxes for the product to **NF** from another country, and *NF* shall pay shipping charge to return the product to purchaser.

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LI5640 Multi-function Digital Lock-in Amplifier Instruction Manual

NF CORPORATION
3-20 Tsunashima Higashi 6-chome, Kohoku-ku. Yokohama-shi
223-8508, JAPAN
Phone: 81-45-545-8128 Fax: 81-45-545-8187

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

NF Corporation

6-3-20, Tsunashima-higashi, Kohoku-ku,Yokohama 223-8508 JAPAN