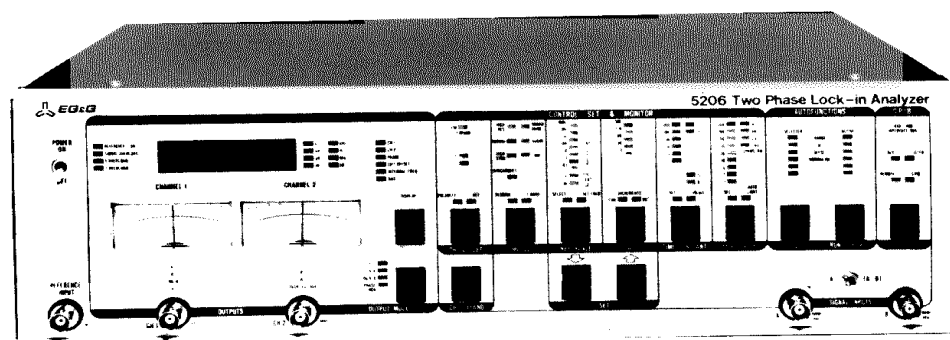
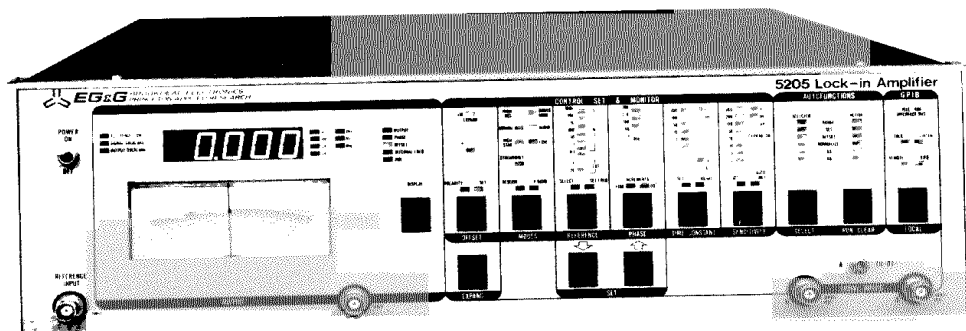


**Models 5205 & 5206
Lock-In Amplifiers**



GENERAL

The Model 5205 (single phase) and the Model 5206 (two phase) are fully programmable Lock-In Amplifiers. An optional digital interface allows total programmability of either model via the IEEE-488 or the RS232C and talk-listen operation with other devices on the bus.

Features:

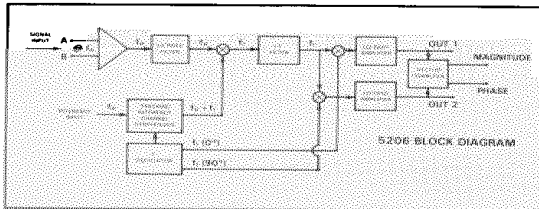
- Microprocessor-control
- Autoranging of system gain to match signal strength
- IEEE-488 & RS232C compatibility
- Remote control of every pushbutton
- 0.2 Hz–200 kHz total range
- 100 nV–5 V rms full-scale sensitivity
- Auto-phase, auto-offset, auto-normalize
- Simultaneous digital and analog metering
- Display of in-phase and quadrature voltages, phase angle & resultant magnitude or log-magnitude (Model 5206)

- "Sine-Wave" response
- No degradation of Dynamic Reserve/Output Stability at higher operating frequencies
- Plug-in options for computing signal ratios and noise

EG&G's proprietary Synchro-Het® technology has been combined with heterodyning in these new lock-in amplifiers to provide unsurpassed performance and convenience. "Sine-wave" or harmonic-free response is achieved at all operating frequencies without degrading the specifications for dynamic reserve and dc output stability. The advanced and novel design techniques used in the Models 5205 and 5206 provide these instruments with a number of other unique advantages. The three band-determining cards, for instance, can be simultaneously mounted in either model in order to cover the 0.2 Hz to 200 kHz frequency range. The appropriate band can be selected by pressing a front panel button.

OPERATION

How the Models 5205 and 5206 Work—The input signal at f_R is fed into a low-noise true-differential amplifier. Using a multipole low-pass filter, image frequencies and higher-order harmonics are stripped from the signal. The cut-off frequency for this low-pass filter is a function of the selected frequency card. The filter output is mixed with a signal whose frequency is the sum of the intermediate frequency (a function of the selected card) and the reference frequency (f_R). The resultant intermediate frequency contains the amplitude and phase information of the original signal of interest. This signal is passed through an IF filter and then demodulated using the synchro-het technique. The demodulated signal is narrow-banded and amplified in the output low-pass filter/dc amplifier which can be set as narrow as necessary for acceptable signal-to-noise performance. In the Model 5206 Two-Phase Lock-In Analyzer two output channels are provided. A vector computer calculates the vector sum of the two outputs and computes the phase angle (θ) of the input signal relative to the reference signal. All functions are under continuous control of a built-in microprocessor which has not been shown in order to simplify the explanation.



Model 5206 block diagram.

AUTOFUNCTIONS

Microprocessors built into both lock-in systems simplify their operation by assisting in measurement parameter setup. When the Autofunction mode is selected these instruments provide the following capabilities:

RANGE: Continually adjusts the full scale sensitivity to maintain the readout between 40% and 100% of full scale.

SET: Adjusts the sensitivity and phase to match the input signal.

NORMALIZE: Sets a given output amplitude to represent 100% of full scale. All subsequent readings are in % of full scale.

OFFSET: Generates an output dc offset so that a given signal amplitude will be displayed as zero volts.

DISPLAY

Digital and analog displays are provided on both instruments. A large four-digit display presents the measurement results in volts, degrees and, on the Model 5206, in dB. Other operating parameters such as internal frequency, dc output suppression and phase shifter settings can also be selectively displayed. An analog meter is provided to allow the operator to follow signal trends. A second analog meter on the two-phase Model 5206 provides quadrature signal level or vector phase angle. All display functions can be controlled either by front panel pushbuttons or by computer through the optional Digital Interface.

PROGRAMMING

An optional plug-in card allows all front-panel functions to be controlled by an external computer. Both RS232C and IEEE-488 interfaces are provided to allow the widest available flexibility. This interface provides complete talk/listen compatibility between the 5205 or 5206, an external computer, and/or other systems on the IEEE bus.

SUMMARY

The variety of operational capabilities combined with their programmability allow both the Model 5205 and the Model 5206 Lock-In Systems to be readily integrated into a broad spectrum of applications. Either in the laboratory where manual control is required or in the sophisticated turn-key research or production measurement system, the Models 5205 and 5206 will provide the researcher with extremely versatile phase-sensitive systems.

Specifications

SIGNAL CHANNEL

FULL-SCALE SENSITIVITY:

MODEL 5205: 1 μ V to 5 V rms, 1-2-5 sequence. $\times 10$ output expansion increases the overall sensitivity to 100 nV, full scale.

MODEL 5206, CHANNEL 1: Same as for Model 5205.

MODEL 5206, CHANNEL 2: 1 μ V to 5 V rms, 1-2-5 sequence.

INPUT IMPEDANCE: AC coupled, 100 megohms shunted by 40 pF. BNC connector shell is 10 ohms above chassis ground.

INPUT MODES: Single-ended (A), or true differential (A-B).

MAXIMUM DC INPUT: ± 100 V.

FREQUENCY RANGE: Determined by plug-in cards. Three cards may be fitted simultaneously—AF, BB and LF. A front-panel switch selects the card to be used.

BB (broadband): 2 Hz–200 kHz

AF (audio frequency): 10 Hz–20 kHz

LF (low frequency): 1 Hz–1 kHz (field-changeable to 0.2 Hz–1 kHz)

INTERNAL NOISE (shorted input): 7 nV rms/ $\sqrt{\text{Hz}}$, typical @ 1 kHz.

COMMON-MODE REJECTION RATIO (CMRR): 100 dB @ 1 kHz.

MAXIMUM COMMON-MODE INPUT: 15 V, pk-pk.

GAIN STABILITY: ± 200 ppm/ $^{\circ}\text{C}$; ± 200 ppm/24 hours.

REFERENCE CHANNEL

FREQUENCY RANGE: 0.1 Hz to 200 kHz; frequency coverage is determined by operator-selected cards—AF, BB or LF

MODES OF OPERATION:

EXTERNAL: Reference locks onto and tracks frequency of external reference source.

INTERNAL (optional): Reference channel is driven at frequency of internal oscillator.

INTERNAL/EXTERNAL CHARACTERISTICS:

INTERNAL REFERENCE:

Amplitude: 0–5 V rms; single-turn potentiometer adjusts amplitude.

Frequency: Continuously variable over six decade bands, 0.1–1 Hz, 1–10 Hz, 10–100 Hz, 100 Hz–1 kHz, 1–10 kHz, 10–100 kHz. Frequency resolution is determined by a 10-bit DAC (1/1024) of each selected band.

Output Impedance: 600 Ω .

EXTERNAL REFERENCE:

f: Phase-locked loop locks onto and tracks external reference signal. Demodulation occurs with respect to the reference frequency, f.

2f: Same as "f" mode, except that demodulation occurs with respect to twice the reference frequency, 2f.

Input Impedance: 10 M Ω , shunted by 30 pF.

WAVEFORM CHARACTERISTICS: Symmetrical signal (AUTO), positive pulses, negative pulses. Internal three-position switch selects mode to match external reference waveform.

EXTERNAL-REFERENCE LEVELS: 140 mV to 2 V, pk-pk. Indicator light (REFERENCE LOW) glows when external reference drive is insufficient.

ACQUISITION TIME:

5 seconds (max.) at operating frequencies ≥ 100 Hz.

18 seconds (max.) at 10 Hz.

60 seconds (max.) at 1.0 Hz.

SLEW RATE: Typically 50 s/decade (for 5 $^{\circ}$ offset from equilibrium).

PHASE-SHIFT CONTROL: 90 $^{\circ}$ steps, accurate to 0.1 $^{\circ}$, and "continuous" control in .025 $^{\circ}$ steps over the range of 0 to 359.975 $^{\circ}$. Advances phase of reference waveform relative to signal-channel input.

PHASE NOISE: 5 m $^{\circ}$ rms @ 1 kHz, 300 ms time constant (12 dB/octave).

PHASE DRIFT: 30 m $^{\circ}$ / $^{\circ}\text{C}$.

PHASE ORTHOGONALITY (Model 5206): Channel 1 and Channel 2 demodulating signals are orthogonal, nominally 90 $^{\circ}$ apart. Deviation from true orthogonality (90 $^{\circ}$) depends on the selected frequency cards—AF, BB and LF:

Card	Orthogonality
LF (Low Frequency).....	90 $^{\circ}$ \pm 0.1 $^{\circ}$
AF (Audio Frequency).....	90 $^{\circ}$ \pm 0.2 $^{\circ}$
BB (Broadband).....	90 $^{\circ}$ \pm 0.5 $^{\circ}$

PHASE-SENSITIVE DETECTORS

DYNAMIC RESERVE*/DC OUTPUT STABILITY: The following table applies to the Model 5205 and to Channel 1 of the Model 5206. When $\times 10$ Expand function is "on", increase figures by $\times 10$ (add 20 dB to Dynamic Reserve figures).

Dynamic Res. Setting	BB/LF/AF CARDS	
	Dynamic Reserve (dB)	Output Drift (ppm/ $^{\circ}\text{C}$)
High Res.	60	1000
Normal	40	100
High Stab.	20	20

*The ratio, in decibels, of the maximum rms voltage of an interfering sine wave, just before overload, to the full-scale sensitivity setting. In no case should the interfering signal (noise) exceed 14 volts, peak-to-peak. Dynamic reserve depends on the sensitivity setting and the frequency structure of interfering noise.

FILTER TIME-CONSTANTS: 1 ms to 100 s, 1-3-10 sequence.

FILTER ATTENUATION RATE: 6 or 12 dB/octave, switchable.

ZERO SUPPRESSION: The signal in the Model 5205, and the Channel 1 signal (X & R) in the Model 5206 can be offset as follows:

- $\pm 1 \times$ full scale with $\times 10$ expansion "off";
- $\pm 10 \times$ full scale with $\times 10$ expansion "on".

HARMONIC REJECTION: ≥ 55 dB.

OVERLOAD INDICATOR LIGHTS:

MODEL 5205: Signal pre-mixer channel & output.

MODEL 5206: Signal pre-mixer channel, X (in-phase) channel, Y (quadrature) channel.

AUTOMATIC FUNCTIONS AVAILABLE

AUTORANGE: Provides automatic and continuous ranging of ac & dc gain.

AUTOSET: Initially sets sensitivity and phase ranges automatically. The phase setting may be read on the digital display.

AUTO-OFFSET: Automatically sets the output voltage to zero, and holds the offset. Offset value may be read on the digital display.

AUTO-NORMALIZE: The output voltage is normalized to full scale when this function is selected. Subsequent readings are, therefore, referred to full scale.

OUTPUTS, MODEL 5205

ANALOG METER:

READINGS: The meter provides a full-scale indication for a full-scale input as determined by the combination of the input sensitivity setting and the output expansion.

METER STYLE: 3" scale, center zero, $\pm 2\%$ accuracy.

DIGITAL METER:

READINGS: Phase shifter settings (0–359.9°), .025° resolution. Internal-oscillator reference frequency. Offset, or “zero-suppress” setting, 0 to ±10 × full scale. Auxiliary outputs from plug-in options. Error signals (see Control Settings).

METER STYLE: Four-digit display (0.560" high), with sign.

BNC CONNECTOR: Parallels analog meter; full scale = ±10 V dc, 600 ohms.

OUTPUTS, MODEL 5206**ANALOG METERS (Two: Channel 1, Channel 2):**

READINGS (Channel 1):

“X” (in-phase signal component)

“R” (resultant, or magnitude of signal, $\sqrt{X^2 + Y^2}$)

Log R (dB-reading of signal magnitude relative to full scale; 0 to –60 dB useful range)

READINGS (Channel 2):

“Y” (quadrature signal component)

“θ” (phase shift of signal relative to reference at mixer inputs)

METER STYLE: 3" scale, center zero, ±2% inaccuracy

DIGITAL METER:

READINGS:

X, Y, R, Log R, θ

Phase-shifter settings (0–359.9°), .025° resolution

Internal-oscillator reference frequency

Channel 1 offset, or “zero-suppress” setting, 0 to ±10 × full scale

Auxiliary outputs from plug-in options

Error signals

BNC CONNECTORS (Channel 1 & Channel 2): The output at either of these connectors will be analogous to the chosen display on its respective analog meter; full scale = ±10 V dc, 600 ohms. During Log-R operation, the calibration factor is –10 dB/volt (–60 dB max.). Phase readings are calibrated as ±50 mV/degree (±9 volts, max.).

GENERAL

AUXILIARY POWER OUTPUT: ±15 V, 50 mA—for remote plug-in preamplifier.

OPERATING TEMPERATURE: 10° to 40°C.

POWER REQUIREMENTS: 95–130 V ac, 60 Hz; 190–260 V ac, 50 Hz; 60 Watts

SIZE: 17½" W × 22" D × 5¼" H. (44.5 × 55.9 × 13.3 cm)

WEIGHT: 25 lbs (11.3 kg)

SHIPPING WEIGHT: 30 lbs (13.6 kg)

WARRANTY: One year.

OPTIONS**CHASSIS PLUG-IN OPTIONS**

INTERNAL OSCILLATOR (Models 5205/94 & 5206/94): FREQUENCY RANGE: 0.1 Hz–100 kHz, tunable by front-panel pushbuttons—Independent of AF, BB, or LF card selection. Resolution is 0.1% of upper limit of band chosen by front-panel pushbutton. Selected frequency can be displayed on front-panel meter.

AMPLITUDE: Internal potentiometer allows adjustment of 0 to 5 V rms; rear-panel potentiometer permits attenuation from internally chosen amplitude down to zero volts.

DC OFFSET: Internal potentiometer allows dc offset from 0 V @ zero output to ±0.5 V @ full-scale output.

STABILITY:

a) Amplitude: ±0.1%/°C, typical.

b) Frequency: ±500 ppm/°C, @ f > 10 Hz, typical.

OUTPUT IMPEDANCE: 600 ohms.

SECOND-HARMONIC DISTORTION: 0.5% @ 10 Hz; 0.3% @ 1 kHz; 2% @ 100 kHz.

DIGITAL INTERFACE (Models 5205/95 & 5206/95): Provides compatibility with both RS232C & IEEE-488.

MODES: Local, listen/talk, listen only.

INTERFACE FUNCTIONS: Complete source and acceptor handshakes, basic talker with serial poll, complete service request.

INSTRUMENT FUNCTIONS CONTROLLED: Sensitivity, expand, time-constant, phase, reference mode, internal oscillator, frequency, dynamic reserve, frequency-range card, zero offset, Autofunctions, display selection, and all other front-panel settings.

BB PLUG-IN CARD (Models 5205/97 & 5206/97): See above Specifications, under FREQUENCY RANGE.

AF PLUG-IN CARD (Models 5205/98 & 5205/98): See above specifications, under FREQUENCY RANGE.

LF PLUG-IN CARD (Models 5205/99 & 5206/99): See above Specifications, under FREQUENCY RANGE.