Single-Board
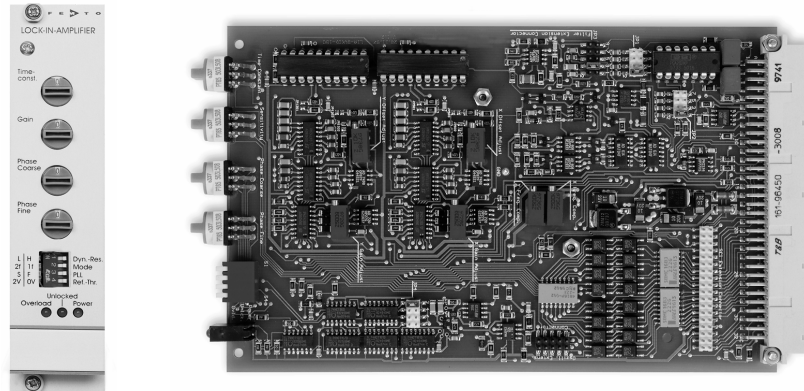# Dual Phase Lock-In-Amplifier

Picture shows Lock-in Amplifier card with optional Mounting Kit LIA- MK- 2 (to be ordered separately)
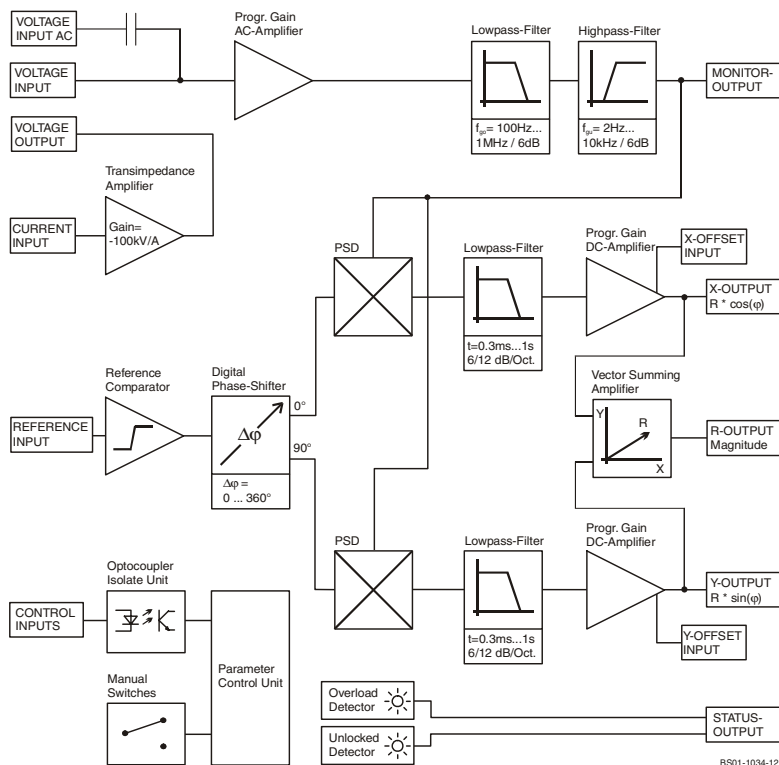
Features	
	• **Dual Phase Detection with X, Y and Magnitude Output**
	• **Working Frequency 50 Hz ... 120 kHz**
	• **Digital Phase Shifter 0 ... 360°**
	• **Current and Voltage Input**
	• **Parameter Control by local Switches and opto-isolated digital Inputs**
	• **Optional Mounting Kit and Reference Oscillator Modules available**

Applications	
	• **Spectroscopy**
	• **Luminescence, Fluorescence, Phosphorescence Measurements**
	• **Light Scattering Measurements**
	• **Opto-electronical Quality Control**
	• **Integration in Industrial and Scientific Measurement-Systems**
	• **Multi-Channel-Systems at moderate Costs**

Block Diagram

Block diagram showing: VOLTAGE INPUT AC, VOLTAGE INPUT into Progr. Gain AC-Amplifier, Lowpass-Filter (f_{gu}= 100Hz...1MHz / 6dB), Highpass-Filter (f_{go}= 2Hz...10kHz / 6dB) to MONITOR-OUTPUT. VOLTAGE OUTPUT. CURRENT INPUT into Transimpedance Amplifier (Gain= -100kV/A). PSD, Lowpass-Filter (t=0.3ms...1s 6/12 dB/Oct.), Progr. Gain DC-Amplifier, X-OFFSET INPUT, X-OUTPUT R * cos(φ). REFERENCE INPUT into Reference Comparator, Digital Phase-Shifter (Δφ = 0 ... 360°) with 0° and 90° outputs. Vector Summing Amplifier with R-OUTPUT Magnitude. CONTROL INPUTS into Optocoupler Isolate Unit, Manual Switches, Parameter Control Unit. PSD, Lowpass-Filter (t=0.3ms...1s 6/12 dB/Oct.), Progr. Gain DC-Amplifier, Y-OUTPUT R * sin(φ), Y-OFFSET INPUT. Overload Detector, Unlocked Detector to STATUS-OUTPUT. BS01-1034-12

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY — FEMTO

Single-Board
Dual Phase Lock-In-Amplifier

Specifications   *Test Conditions*   *Vs = ± 15 V, Ta = 25°C*

Voltage Input

Voltage Input Characteristic	True Differential Instrumentation-Amplifier
Voltage Input Range	3 µV ... 1V in 1-3-10 steps (for Full Scale Output)
Voltage Input Coupling	AC or DC (selectable at Connector)
Voltage Input Impedance	1 MΩ // 4 pF
Voltage Input Noise	12 nV/√Hz
Voltage Input CMRR	110 dB @ 1 kHz, 100 dB @ 10 kHz
Voltage Input Gain Drift	100 ppm/K

Current Input

Current Input Characteristic	Transimpedance-Amplifier, -100 kV/A (inverting)
Current Input Range	30 pA ... 10 µA in 1-3-10 steps (for Full Scale Output)
Current Input Noise	0.4 pA/√Hz
Current Input Source- Capacit.	10 pF – 500 pF (recommended)

Current Input Gain Error vs.
Source Capacitance

Cs	f < 20 kHz	f = 50 kHz	f = 100 kHz
10 pF	< 1 %	1 %	4 %
100 pF	< 1 %	1 %	3 %
500 pF	< 1 %	4 %	3 %

Signal Filter

Signal Filter Lowpass (-3 dB BW)	1 MHz , 100 kHz, 10 kHz, 1 kHz, 100 Hz; 6 dB/Oct. Selectable per jumper
Signal Filter Highpass (-3 dB BW)	2 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz; 6 dB/Oct. selectable per jumper
Signal Filter Cutoff accuracy	± 20 %
Max. Dynamic Reserve	80 dB

Signal Monitor Output

Signal Monitor Output Gain	1 ... 3333 (depends on Gain-Setting)
Signal Monitor Output Voltage	± 8 V max.
Signal Monitor Output Impedance	100 Ω
Signal Monitor Output Current	± 10 mA max.
Note	When using Current Input with low Input Ranges, the Monitor Output may be disabled by opening the soldering jumper at the Board (near JP1) to prevent from recoupling.

Demodulator

Demodulator Dynamic Reserve	15 dB @ Ultra Stable Setting
	35 dB @ Low Drift Setting
	55 dB @ High Dynamic Setting

Reference Input

Reference Input Voltage Range	± 100 mV ... ± 5 V @ bip. Mode (0 V Comparator Threshold)
	- 5 V / +10 V @ TTL Mode (+2 V Comparator Threshold)
Reference Input Impedance	1 MΩ
Reference Acquisition Time	max. 2 s @ Fast Setting
	max. 4 s @ Slow Setting

Phase Shifter

Phase Shifter Type	Digital, Working Frequency 50 Hz ... 120 kHz
Phase Shifter Range	0 ... + 360 °
Phase Shifter Resolution	1.4 ° @ f < 60 kHz, 2.8 ° @ f > 60 kHz
Phase Shifter Drift	< 100 ppm/K
Phase Shifter Accuracy	< 0.3 °
Phase Shifter Orthogonality	< 0.1 °

Time Constants

Time Constant Range	300 µs ... 1 s in 1-3-10 steps
Time Const. Filter Characteristic	6 dB/Oct. or 12 dB/Oct. switchable

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY   F E M T O

Single-Board
Dual Phase Lock-In-Amplifier

Specifications (continued) Output	Output Channels	X = In Phase, Y = Quadrature, R = Magnitude
	Output Voltage Range	± 10 V (@ 2 kΩ Load)
	Output Current	± 5 mA max.
	Output Impedance	50 Ω
	Output DC-Stability	5 ppm/K @ Ultra Stable Setting
		50 ppm/K @ Low Drift Setting
		500 ppm/K @ High Dynamic Setting
	Output Basic Accuracy	2 % (X and Y-Output) @ sinusoidal input signal
		4 % (R-Output) @ sinusoidal input signal
	Output Voltage Offset Range	± 100 % Full Scale by ± 10 V Control Voltage
	Output Voltage Offset Control-Voltage Impedance	> 2 kΩ
Status Indicator LED	Functions	Amplifier Overload Status
		Reference PLL Unlocked Status
Digital Control	Control Input Voltage	Low: - 0.8 V ... + 0.8 V, High: + 1.8 V ... + 12 V
	Control Input Current	0 mA @ 0V, 1.5 mA @ + 5 V, 4.5 mA @ + 12V typ.
	Digital Status Output Voltage	Active: + 4.5 V typ., Non Active: 0 V typ.
	Digital Status Output Current	10 mA max.
Power Supply	Supply Voltage	± 15 Vdc ... ± 18 Vdc
	Supply Current	- 60 mA, + 120 mA
Case	Board	19" Euro-Card, (100 mm x 160 mm Board)
	Weight	100 gr. (0.22 lbs)
Temperature Range	Storage Temperature	- 40 ... + 100 °C
	Operating Temperature	0 ... + 60 °C
Absolute Maximum Ratings	Signal Input AC Voltage	50 Vpp
	Signal Input DC Voltage	± 70 V
	Reference Input Voltage	± 15 V
	Control Input Voltage	- 5 V, + 15 V
	Power Supply Voltage	± 22 V

Switch Settings

4 Dip Switch - Presettings

Switch	OFF	ON
S1	Low Drift & High Dynamic	Ultra Stable & Low Drift
S2	1-f Mode	2-f Mode
S3	Fast PLL-Locking	Slow PLL-Locking
S4	Reference-Input- Threshold = 0 V	Reference-Input- Threshold = +2 V

Sensitivity Setting,
Output DC-Gain Modes

3 Output DC-Gain Modes are selectable:

Mode	DC-Gain	Dyn. Reserve	DC-Stability
Ultra Stable	10	Low	High
Low Drift	100	Medium	Medium
High Dynamic	1000	High	Low

If only low dynamic reserve is required, select the higher
DC-Stability settings. Use Dip switch S1 to preselect either
the two upper or the two lower DC-Gain modes, then select
best mode by Sensitivity switch settings 0–7 or 8–F.

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY   F E M T O

Single-Board
Dual Phase Lock-In-Amplifier

Switch Settings (continued)	S1 = ON: Sensitivity Setting for Full Scale (= 10 V Output)	

	Ultra Stable Mode			Low Drift Mode		
Setting	Voltage	Current		Setting	Voltage	Current
0	1 V	10 µA		8	100 mV	1 µA
1	300 mV	3 µA		9	30 mV	300 nA
2	100 mV	1 µA		A	10 mV	100 nA
3	30 mV	300 nA		B	3 mV	30 nA
4	10 mV	100 nA		C	1 mV	10 nA
5	3 mV	30 nA		D	300 µV	3 nA
6	1 mV	10 nA		E	100 µV	1 nA
7	300 µV	3 nA		F	30 µV	300 pA

S1 = OFF: Sensitivity Setting for Full Scale (= 10 V Output)

	Low Drift Mode			High Dynamic Mode		
Setting	Voltage	Current		Setting	Voltage	Current
0	100 mV	1 µA		8	10 mV	100 nA
1	30 mV	300 nA		9	3 mV	30 nA
2	10 mV	100 nA		A	1 mV	10 nA
3	3 mV	30 nA		B	300 µV	3 nA
4	1 mV	10 nA		C	100 µV	1 nA
5	300 µV	3 nA		D	30 µV	300 pA
6	100 µV	1 nA		E	10 µV	100 pA
7	30 µV	300 pA		F	3 µV	30 pA

Time Constant Setting

6 dB/Oct.	12 dB/Oct.	Time Constant
0	8	300 µs
1	9	1 ms
2	A	3 ms
3	B	10 ms
4	C	30 ms
5	D	100 ms
6	E	300 ms
7	F	1 s

Phase Shift Setting

Phase shift is adjusted by 2 phase switches with 8 Bit resolution. Values 0 ... 255 (Hex 00 ... FF) correspond to phase shift setting 0 ... +360 °. One step with switch marked "Coarse" changes phase shift by 22.5 °. The "Fine"-switch changes phase shift by 1.4 ° - steps:

If Frequency Range f > 60 kHz or 2-f Mode is selected, the resolution of digital phase control changes to 2.8 ° and the phase shift range doubles to 0 ... + 720 °.

Jumper Settings	Input Signal Filter	Set Cut-Off Frequency of Input Lowpass Filter

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY   F E M T O

Single-Board
Dual Phase Lock-In-Amplifier

Setting

with JP1 + JP2 (always same position) and
Highpass Filter with JP3:

	Highpass			Lowpass
JP3	-3 dB Cut-Off		JP1, JP2	-3 dB Cut-Off
3 – 4	2 Hz		1 – 2	100 Hz
1 – 3	10 Hz		3 – 4	1 kHz
2 – 4	100 Hz		5 – 6	10 kHz
3 – 5	1 kHz		7 – 8	100 kHz
4 – 6	10 kHz		none	1 MHz *

* (At Sensitivity Settings 6,7 & E,F max. 200 kHz)

Frequency Range
Selection

JP4	Frequency Range
1 – 2	f < 60 kHz
3 – 4 & 5 – 6	f > 60 kHz
7, 8	test pins, do not use

(if 2-f mode is used, position is always 1-2)

Jumper Position Diagram

SZ01-1031-14

Lock-In-Amplifier Board

FEMTO
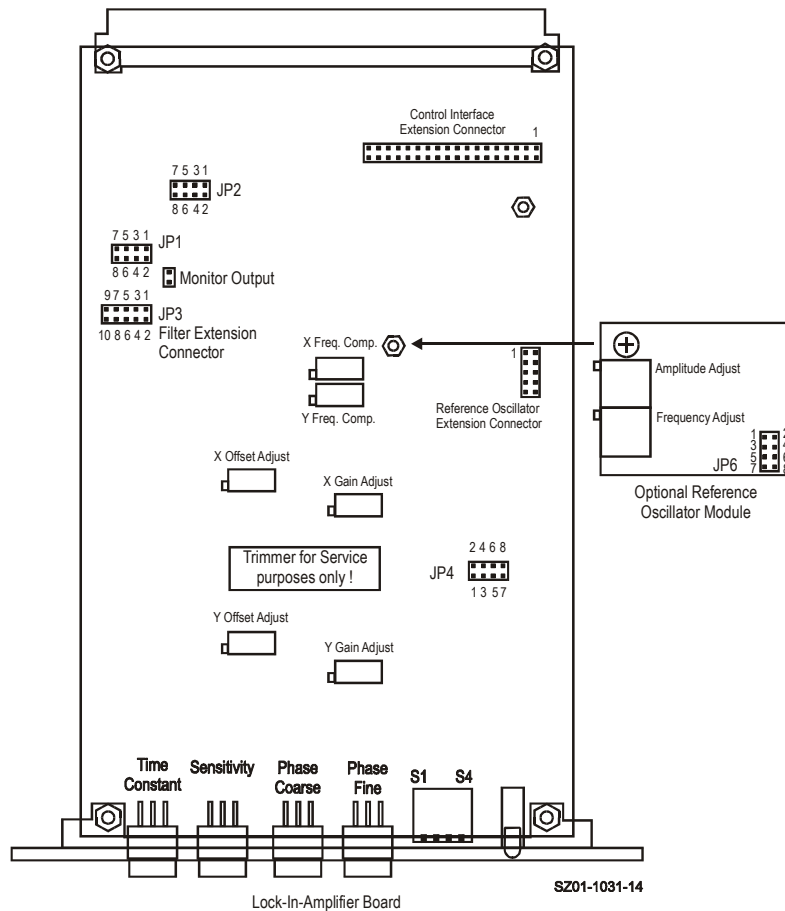
Single-Board
Dual Phase Lock-In-Amplifier

Connector			
	Connector Type	Euro-Card DIN 41612 Connector, 64 pin male, (a+c)	
	Input	Pin C2:	Voltage Input, Non Inverting, DC-Coupled
		Pin C3:	Voltage Input, Non Inverting, AC-Coupled
		Pin C4:	Voltage Input, Inverting, AC-Coupled
		Pin C5:	Voltage Input, Inverting, DC-Coupled
		Pin C7:	Current Input
		Pin C6:	Current Amplifier Voltage Output
		Pin A2- A6:	Input GND
	Monitor Output	Pin C9:	Monitor Output
		Pin A9:	Monitor GND
	Output	Pin A12:	R-Signal Output
		Pin C14:	X-Signal Output
		Pin A14:	Y-Signal Output
		Pin C15:	Output GND
	Offset Input	Pin A10:	X-Offset Input
		Pin A11:	Y-Offset Input
		Pin A13:	Offset GND
	Status Output	Pin C10:	Unlocked Status Output
		Pin C11:	Overload Status Output
		Pin C17:	Status Output GND (=Power Supply GND)
	Power Supply	Pin A16+C16:	Power Supply – 15V
		Pin A18+C18:	Power Supply + 15V
		Pin A17+C17:	Power Supply GND
	Remote Control Inputs (Opto-Isolated)	Pin C19:	Time Constant (TC0)
		Pin A19:	Time Constant (TC1)
		Pin C20:	Time Constant (TC2)
		Pin A20:	Time Constant Slope (TCSL)
		Pin A22:	Sensitivity (SEN0)
		Pin C21:	Sensitivity (SEN1)
		Pin A21:	Sensitivity (SEN2)
		Pin C22:	Dynamic Mode (DYN0)
		Pin A28:	Phase Shift (PH0)
		Pin C28:	Phase Shift (PH1)
		Pin A27:	Phase Shift (PH2)
		Pin C27:	Phase Shift (PH3)
		Pin A26:	Phase Shift (PH4)
		Pin C26:	Phase Shift (PH5)
		Pin A25:	Phase Shift (PH6)
		Pin C25:	Phase Shift (PH7)
		Pin C24:	Disable Local Switch Control
		Pin A23+A24:	Remote Control GND (Common Optocoupler Cathode)
	Reference Input	Pin A32:	Reference Input
		Pin A31:	Reference Input Ground
	Reference Output (Connected only if optional Oscillator Module is installed)	Pin A30:	Reference Output
		Pin A17:	Refer. Output GND (=Power Supply GND)
		Pin A29:	Reference Synchronization Input
	Standard Control Interface (Connected only if optional Control Interface Module (future product) is installed)	Pin C29:	Interface 0
		Pin C30:	Interface 1
		Pin C31:	Interface 2
		Pin C32:	Interface 3

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY   F E M T O

Single-Board
Dual Phase Lock-In-Amplifier

Remote Control Operation

General

Remote Control Input Bits are opto-isolated and connected by logical OR to local switch setting.
The 4 hexadecimal switches are 4 Bit-coded as shown in the following table:

Switch Code	MSB Bit 3	Bit 2	Bit 1	LSB Bit 0
0	Low	Low	Low	Low
1	Low	Low	Low	High
2	Low	Low	High	Low
3	Low	Low	High	High
4	Low	High	Low	Low
5	Low	High	Low	High
6	Low	High	High	Low
7	Low	High	High	High
8	High	Low	Low	Low
9	High	Low	Low	High
A	High	Low	High	Low
B	High	Low	High	High
C	High	High	Low	Low
D	High	High	Low	High
E	High	High	High	Low
F	High	High	High	High

For remote control a switch setting, set the local switch to "0" and select the wanted setting via the 4-Bit-code at the corresponding digital inputs.

Disable Local Switches

By forcing Input Bit "Disable Local Switch Control" (Pin C24) to "High", the LIA is set to exclusively remote control operation and the manual switches are out of function.

Sensitivity Switch - Corresponding Inputs

Bit	Corresponding Control Port Input	
Bit 0	SEN0	(Pin A22)
Bit 1	SEN1	(Pin C21)
Bit 2	SEN2	(Pin A21)
Bit 3	DYN0	(Pin C22)

Time Constant Switch - Corresponding Inputs

Bit	Corresponding Control Port Input	
Bit 0	TC0	(Pin C19)
Bit 1	TC1	(Pin A19)
Bit 2	TC2	(Pin C20)
Bit 3	TCSL	(Pin A20)

Phase Switch Coarse - Corresponding Inputs

Bit	Corresponding Control Port Input	
Bit 0	PH4	(Pin A26)
Bit 1	PH5	(Pin C26)
Bit 2	PH6	(Pin A25)
Bit 3	PH7	(Pin C25)

Phase Switch Fine - Corresponding Inputs

Bit	Corresponding Control Port Input	
Bit 0	PH0	(Pin A28)
Bit 1	PH1	(Pin C28)
Bit 2	PH2	(Pin A27)
Bit 3	PH3	(Pin C27)

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY   F E M T O

Single-Board
Dual Phase Lock-In-Amplifier

| | Remote Control Example | For example, to select a switch setting code "6", you have to connect a "High"- level signal to the corresponding control input pins Bit 1 & Bit 2. Mixed operation, e.g. local phase settings and remote controlled sensitivity setting, is also possible when "Disable Local Switch Control" (Pin C24) is not active ("Low" or just not connected). |

Dimensions

100 mm   30 mm

160 mm

LOCK-IN-AMPLIFIER

Time-const.

Sensi-tivity

Phase Coarse

Phase Fine

Dyn.-Res.   L | H
Mode   2f | 1f
PLL   S | F
Ref.-Thr.   2V | 0V

Unlocked
Overload | Power

19"-Mounting Kit-
Option only (Please
order separately)

Time   Sensitivity   Phase   Phase   S1   S4
Constant   Coarse   Fine

mm   14   15   14   15   14

128 mm
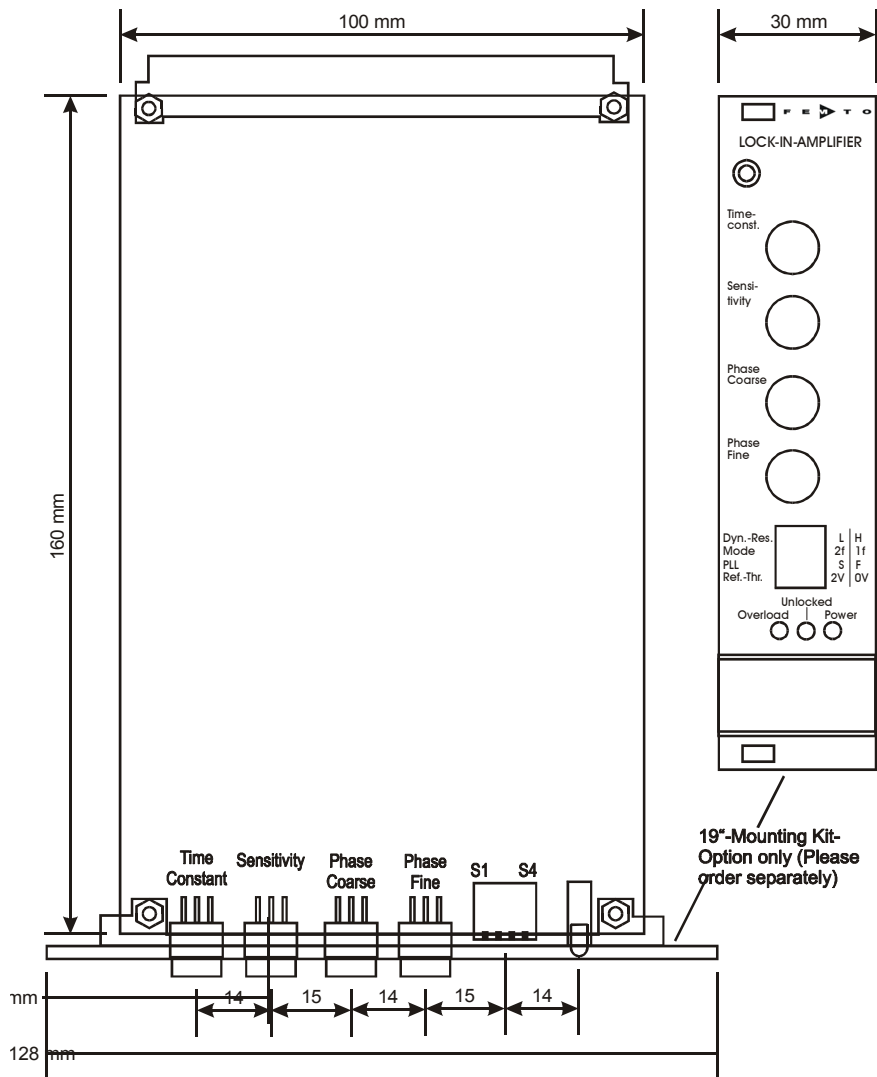
DZ01-1031-12

Single-Board
Dual Phase Lock-In-Amplifier

Optional Extensions	Mounting Kit	Model No.: MK-LIA-2 - 19" – Frontpanel, printed - EMI – shielding Board-Backplane
	Reference Oscillator Module	Model No.: SOM-1 - Frequency Range 5 Hz ... 130 kHz, User adjustable - Output Voltage 0 ... 2 Vrms, User adjustable - 100 ppm/K Amplitude Accuracy

SOPHISTICATED TOOLS FOR SIGNAL RECOVERY

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