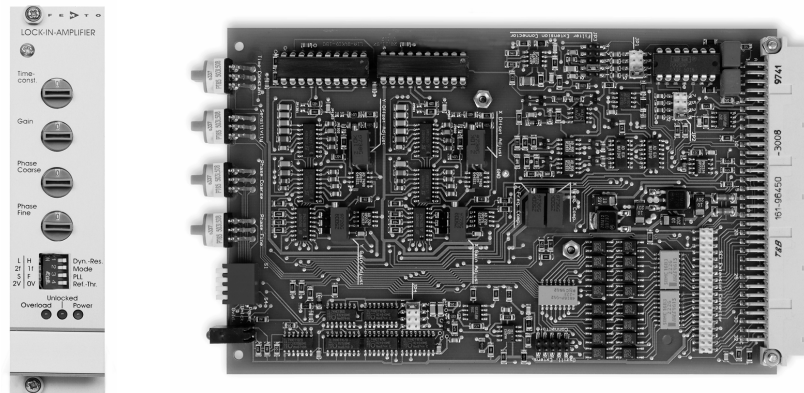


# Single-Board Lock-In-Amplifier



Picture shows Lock-in Amplifier card with optional Mounting Kit LIA- MK- 2 (to be ordered separately)

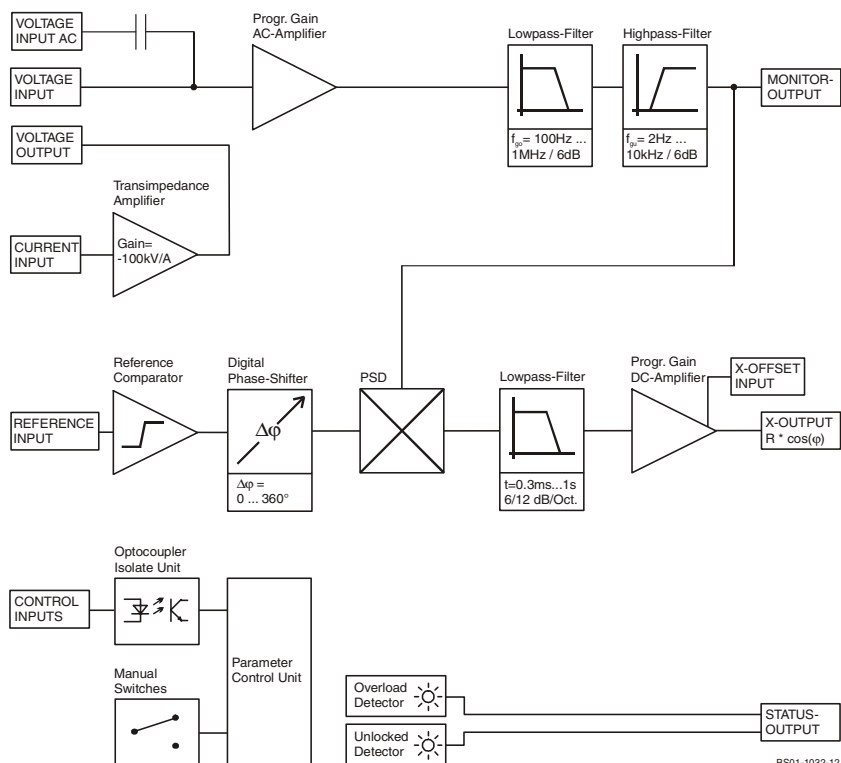
Features

- **Single Phase Detection with X 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



BS01-1032-12

## Single-Board 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	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-bottom: 1px solid black;">Cs</th> <th style="border-bottom: 1px solid black;">f &lt; 20 kHz</th> <th style="border-bottom: 1px solid black;">f = 50 kHz</th> <th style="border-bottom: 1px solid black;">f = 100 kHz</th> </tr> </thead> <tbody> <tr> <td>10 pF</td> <td>&lt; 1 %</td> <td>1 %</td> <td>4 %</td> </tr> <tr> <td>100 pF</td> <td>&lt; 1 %</td> <td>1 %</td> <td>3 %</td> </tr> <tr> <td>500 pF</td> <td>&lt; 1 %</td> <td>4 %</td> <td>3 %</td> </tr> </tbody> </table>	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 %
	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 °																
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																

## Single-Board Lock-In-Amplifier

Specifications (continued) Output	Output Channels Output Voltage Range Output Current Output Impedance Output DC-Stability  Output Basic Accuracy Output Voltage Offset Range Output Voltage Offset Control-Voltage Impedance	X = In Phase ± 10 V (@ 2 kΩ Load) ± 5 mA max. 50 Ω 5 ppm/K @ Ultra Stable Setting 50 ppm/K @ Low Drift Setting 500 ppm/K @ High Dynamic Setting 2 % @ sinusoidal input signal ± 100 % Full Scale by ± 10 V Control Voltage > 2 kΩ																															
Status Indicator LED	Functions	Amplifier Overload Status Reference PLL Unlocked Status																															
Digital Control	Control Input Voltage Control Input Current Digital Status Output Voltage Digital Status Output Current	Low: - 0.8 V ... + 0.8 V, High: + 1.8 V ... + 12 V 0 mA @ 0V, 1.5 mA @ + 5 V, 4.5 mA @ + 12V typ. Active: + 4.5 V typ., Non Active: 0 V typ. 10 mA max.																															
Power Supply	Supply Voltage Supply Current	± 15 Vdc ... ± 18 Vdc - 60 mA, + 120 mA																															
Case	Board Weight	19" Euro-Card, (100 mm x 160 mm Board) 100 gr. (0.22 lbs)																															
Temperature Range	Storage Temperature Operating Temperature	- 40 ... + 100 °C 0 ... + 60 °C																															
Absolute Maximum Ratings	Signal Input AC Voltage Signal Input DC Voltage Reference Input Voltage Control Input Voltage Power Supply Voltage	50 Vpp ± 70 V ± 15 V - 5 V, + 15 V ± 22 V																															
Switch Settings	4 Dip Switch - Presettings	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 40%;">Switch OFF</th> <th style="width: 50%;">ON</th> </tr> </thead> <tbody> <tr> <td>S1</td> <td>Low Drift &amp; High Dynamic</td> <td>Ultra Stable &amp; Low Drift</td> </tr> <tr> <td>S2</td> <td>1-f Mode</td> <td>2-f Mode</td> </tr> <tr> <td>S3</td> <td>Fast PLL-Locking</td> <td>Slow PLL-Locking</td> </tr> <tr> <td>S4</td> <td>Reference-Input-Threshold = 0 V</td> <td>Reference-Input-Threshold = +2 V</td> </tr> </tbody> </table> Sensitivity Setting, Output DC-Gain Modes <table style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 20%;"></th> <th style="width: 20%;">DC-Gain</th> <th style="width: 20%;">Dyn. Reserve</th> <th style="width: 40%;">DC-Stability</th> </tr> </thead> <tbody> <tr> <td>Ultra Stable</td> <td>10</td> <td>Low</td> <td>High</td> </tr> <tr> <td>Low Drift</td> <td>100</td> <td>Medium</td> <td>Medium</td> </tr> <tr> <td>High Dynamic</td> <td>1000</td> <td>High</td> <td>Low</td> </tr> </tbody> </table> <p style="font-size: small; margin-top: 10px;">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.</p>		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		DC-Gain	Dyn. Reserve	DC-Stability	Ultra Stable	10	Low	High	Low Drift	100	Medium	Medium	High Dynamic	1000	High	Low
	Switch OFF	ON																															
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Ultra Stable	10	Low	High																														
Low Drift	100	Medium	Medium																														
High Dynamic	1000	High	Low																														

# Single-Board Lock-In-Amplifier

Switch Settings (continued)

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

Ultra Stable Mode

Setting	Voltage	Current
0	1 V	10 $\mu$ A
1	300 mV	3 $\mu$ A
2	100 mV	1 $\mu$ A
3	30 mV	300 nA
4	10 mV	100 nA
5	3 mV	30 nA
6	1 mV	10 nA
7	300 $\mu$ V	3 nA

Low Drift Mode

Setting	Voltage	Current
8	100 mV	1 $\mu$ A
9	30 mV	300 nA
A	10 mV	100 nA
B	3 mV	30 nA
C	1 mV	10 nA
D	300 $\mu$ V	3 nA
E	100 $\mu$ V	1 nA
F	30 $\mu$ V	300 pA

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

Low Drift Mode

Setting	Voltage	Current
0	100 mV	1 $\mu$ A
1	30 mV	300 nA
2	10 mV	100 nA
3	3 mV	30 nA
4	1 mV	10 nA
5	300 $\mu$ V	3 nA
6	100 $\mu$ V	1 nA
7	30 $\mu$ V	300 pA

High Dynamic Mode

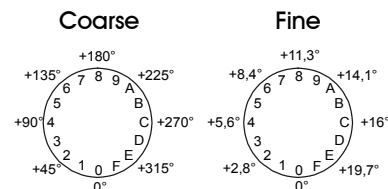
Setting	Voltage	Current
8	10 mV	100 nA
9	3 mV	30 nA
A	1 mV	10 nA
B	300 $\mu$ V	3 nA
C	100 $\mu$ V	1 nA
D	30 $\mu$ V	300 pA
E	10 $\mu$ V	100 pA
F	3 $\mu$ V	30 pA

Time Constant Setting

6 dB/Oct.	12 dB/Oct.	Time Constant
0	8	300 $\mu$ s
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

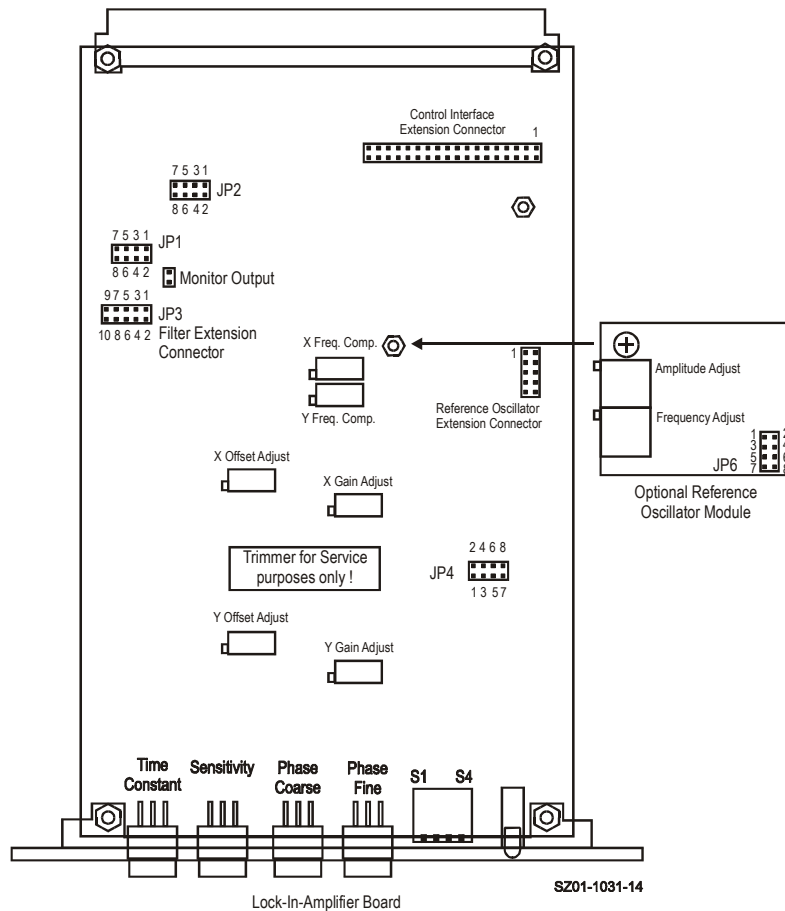
Input Signal Filter

Set Cut-Off Frequency of Input Lowpass Filter

# Single-Board Lock-In-Amplifier

Setting	with JP1 + JP2 (always same position) and Highpass Filter with JP3:			
	JP3	Highpass -3 dB Cut-Off	JP1, JP2	Lowpass -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



## Single-Board 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 C14:	X-Signal Output
		Pin C15:	Output GND
	Offset Input	Pin A10:	X-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

## Single-Board 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		LSB	
	Bit 3	Bit 2	Bit 1	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	DYNO	(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

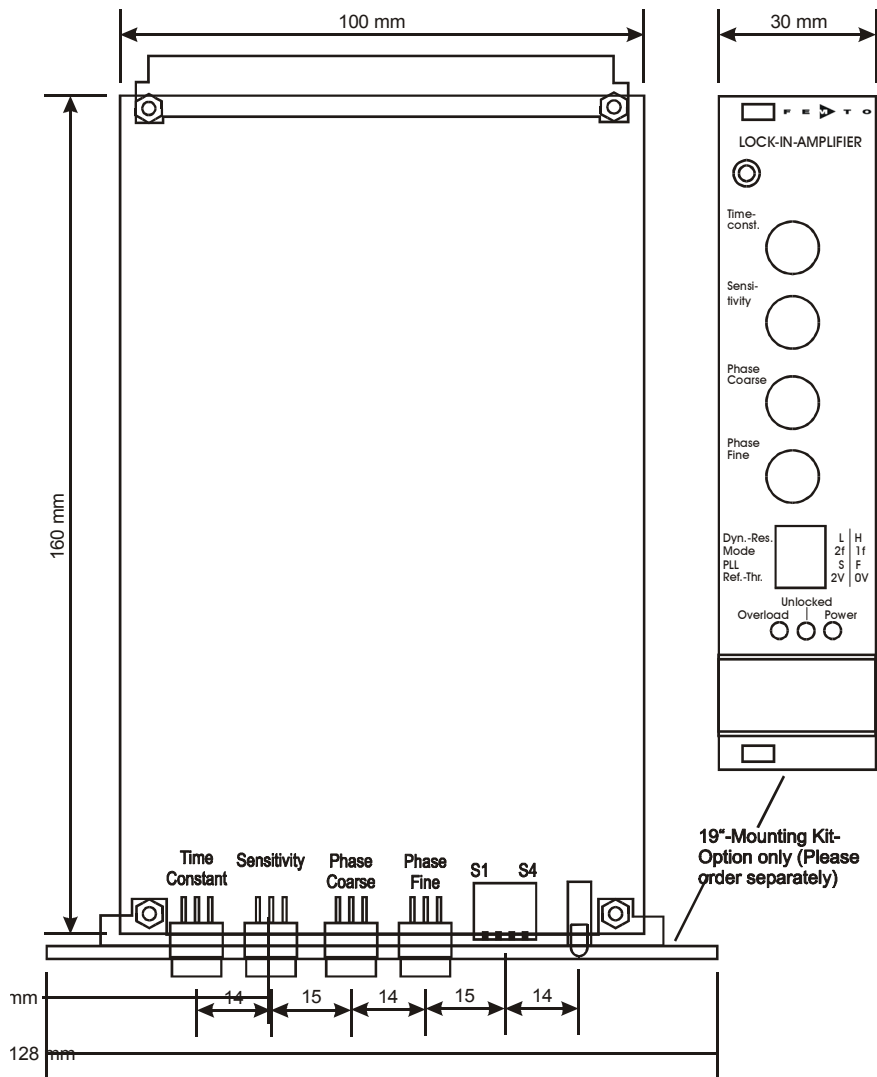
Bit	Corresponding Control Port Input	
Bit 0	PH0	(Pin A28)
Bit 1	PH1	(Pin C28)
Bit 2	PH2	(Pin A27)
Bit 3	PH3	(Pin C27)

# Single-Board 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



DZ01-1031-12



## Single-Board 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

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