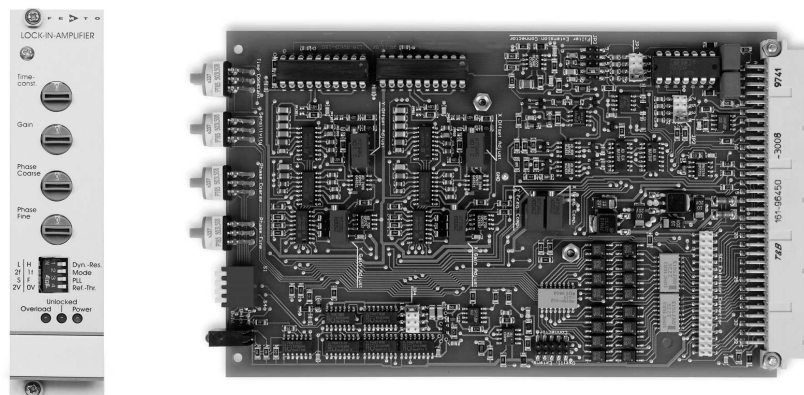


# Single-Board Lock-In-Amplifier



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

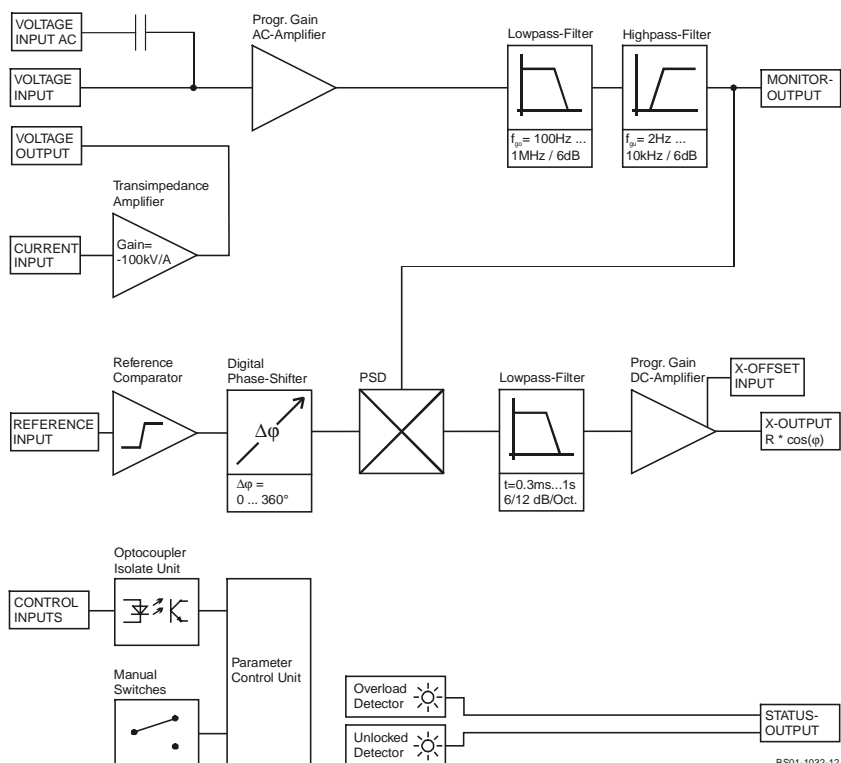
Features

- 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	<i>Test Conditions</i>	<i>V<sub>s</sub> = ± 15 V, T<sub>a</sub> = 25°C</i>																
Voltage Input	Voltage Input Characteristic Voltage Input Range Voltage Input Coupling Voltage Input Impedance Voltage Input Noise Voltage Input CMRR Voltage Input Gain Drift	True Differential Instrumentation-Amplifier 3 μV ... 1V in 1-3-10 steps (for Full Scale Output) AC or DC (selectable at Connector) 1 MΩ // 4 pF 12 nV/√Hz 110 dB @ 1 kHz, 100 dB @ 10 kHz 100 ppm/K																
Current Input	Current Input Characteristic Current Input Range Current Input Noise Current Input Source- Capacit. Current Input Gain Error vs. Source Capacitance	Transimpedance-Amplifier, -100 kV/A (inverting) 30 pA ... 10 μA in 1-3-10 steps (for Full Scale Output) 0.4 pA/√Hz 10 pF – 500 pF (recommended) <table border="1" style="margin-left: 20px;"> <thead> <tr> <th style="text-align: left;">C<sub>s</sub></th> <th style="text-align: left;">f &lt; 20 kHz</th> <th style="text-align: left;">f = 50 kHz</th> <th style="text-align: left;">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>	C <sub>s</sub>	f < 20 kHz	f = 50 kHz	f = 100 kHz	10 pF	< 1 %	1 %	4 %	100 pF	< 1 %	1 %	3 %	500 pF	< 1 %	4 %	3 %
C <sub>s</sub>	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) Signal Filter Highpass (-3 dB BW) Signal Filter Cutoff accuracy Max. Dynamic Reserve	1 MHz, 100 kHz, 10 kHz, 1 kHz, 100 Hz; 6 dB/Oct. selectable per jumper 2 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz; 6 dB/Oct. selectable per jumper ± 20 % 80 dB																
Signal Monitor Output	Signal Monitor Output Gain Signal Monitor Output Voltage Signal Monitor Output Impedance Signal Monitor Output Current  Note	1 ... 3333 (depends on Gain-Setting) ± 8 V max. 100 Ω ± 10 mA max.  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 Reference Input Impedance Reference Acquisition Time	± 100 mV ... ± 5 V @ bip. Mode (0 V Comparator Threshold) - 5 V / +10 V @ TTL Mode (+2 V Comparator Threshold) 1 MΩ max. 2 s @ Fast Setting max. 4 s @ Slow Setting																
Phase Shifter	Phase Shifter Type Phase Shifter Range Phase Shifter Resolution Phase Shifter Drift Phase Shifter Accuracy	Digital, Working Frequency 50 Hz ... 120 kHz 0 ... + 360 ° 1.4 ° @ f < 60 kHz, 2.8 ° @ f > 60 kHz < 100 ppm/K < 0.3 °																
Time Constants	Time Constant Range Time Const. Filter Characteristic	300 μs ... 1 s in 1-3-10 steps 6 dB/Oct. or 12 dB/Oct. switchable																

## Single-Board Lock-In-Amplifier

Specifications (continued) Output	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Output Channels</td> <td>X = In Phase</td> </tr> <tr> <td>Output Voltage Range</td> <td>± 10 V (@ 2 kΩ Load)</td> </tr> <tr> <td>Output Current</td> <td>± 5 mA max.</td> </tr> <tr> <td>Output Impedance</td> <td>50 Ω</td> </tr> <tr> <td>Output DC-Stability</td> <td>5 ppm/K @ Ultra Stable Setting 50 ppm/K @ Low Drift Setting 500 ppm/K @ High Dynamic Setting</td> </tr> <tr> <td>Output Basic Accuracy</td> <td>2 % @ sinusoidal input signal</td> </tr> <tr> <td>Output Voltage Offset Range</td> <td>± 100 % Full Scale by ± 10 V Control Voltage</td> </tr> <tr> <td>Output Voltage Offset Control-Voltage Impedance</td> <td>&gt; 2 kΩ</td> </tr> </table>	Output Channels	X = In Phase	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 % @ sinusoidal input signal	Output Voltage Offset Range	± 100 % Full Scale by ± 10 V Control Voltage	Output Voltage Offset Control-Voltage Impedance	> 2 kΩ																			
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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																																			
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# Single-Board Lock-In-Amplifier

Switch Settings (continued)

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

Ultra Stable Mode  
Setting Voltage Current

Low Drift Mode  
Setting Voltage Current

0	1 V	10 $\mu$ A	8	100 mV	1 $\mu$ A
1	300 mV	3 $\mu$ A	9	30 mV	300 nA
2	100 mV	1 $\mu$ A	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 $\mu$ V	3 nA
6	1 mV	10 nA	E	100 $\mu$ V	1 nA
7	300 $\mu$ V	3 nA	F	30 $\mu$ V	300 pA

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

Low Drift Mode  
Setting Voltage Current

High Dynamic Mode  
Setting Voltage Current

0	100 mV	1 $\mu$ A	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 $\mu$ V	3 nA
4	1 mV	10 nA	C	100 $\mu$ V	1 nA
5	300 $\mu$ V	3 nA	D	30 $\mu$ V	300 pA
6	100 $\mu$ V	1 nA	E	10 $\mu$ V	100 pA
7	30 $\mu$ V	300 pA	F	3 $\mu$ V	30 pA

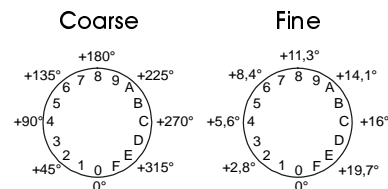
Time Constant Setting

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  $^{\circ}$ . One step with switch marked "Coarse" changes phase shift by 22.5  $^{\circ}$ . The "Fine"-switch changes phase shift by 1.4  $^{\circ}$  - steps:



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

# Single-Board Lock-In-Amplifier

Jumper Settings

Input Signal Filter Setting

Set Cut-Off Frequency of Input Lowpass Filter 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 *

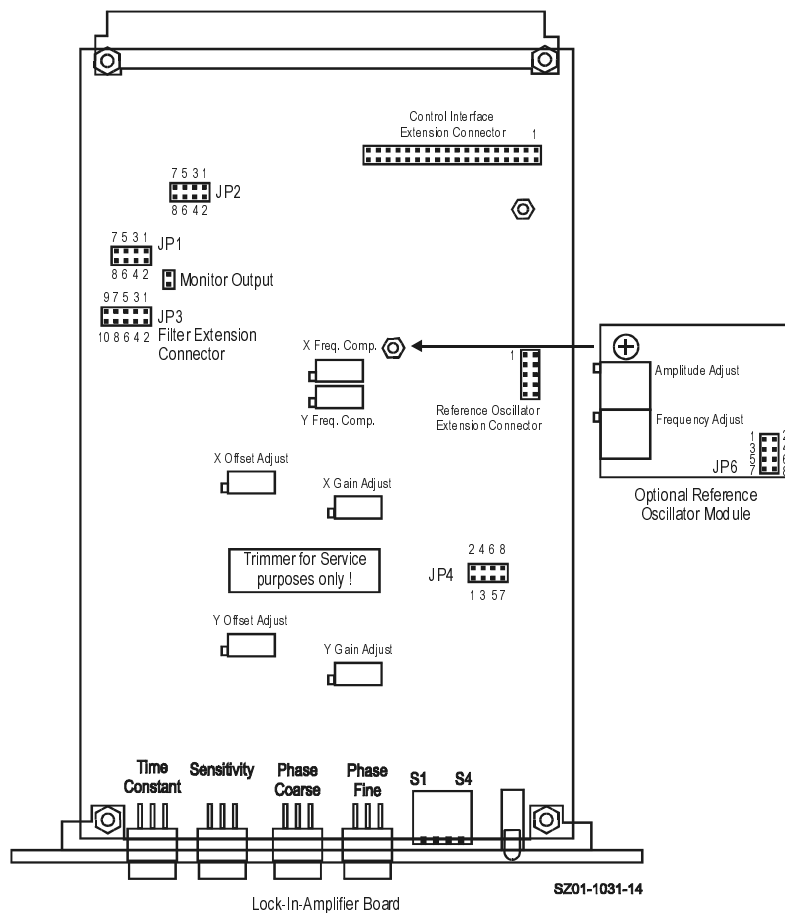
\* (At Sensitivity Settings 6,7 & E,F max. 200 kHz)

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

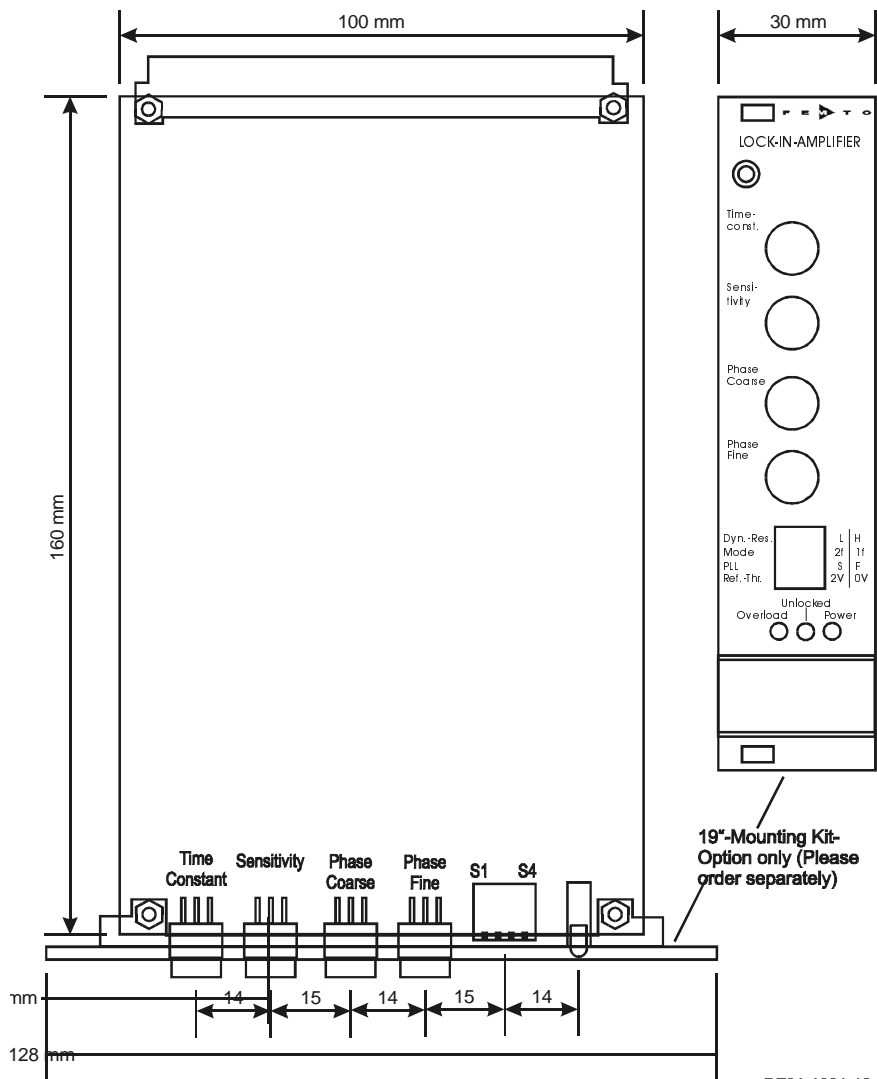
Remote Control Operation	General	<p>Remote Control Input Bits are opto-isolated and connected by logical OR to local switch setting. The 4 hexadecimal switches are 4 Bit-coded as shown in the following table:</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="border-bottom: 1px solid black;"></th> <th style="border-bottom: 1px solid black;">MSB Bit 3</th> <th style="border-bottom: 1px solid black;">Bit 2</th> <th style="border-bottom: 1px solid black;">Bit 1</th> <th style="border-bottom: 1px solid black;">LSB Bit 0</th> </tr> </thead> <tbody> <tr><td>0</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td></tr> <tr><td>1</td><td>Low</td><td>Low</td><td>Low</td><td>High</td></tr> <tr><td>2</td><td>Low</td><td>Low</td><td>High</td><td>Low</td></tr> <tr><td>3</td><td>Low</td><td>Low</td><td>High</td><td>High</td></tr> <tr><td>4</td><td>Low</td><td>High</td><td>Low</td><td>Low</td></tr> <tr><td>5</td><td>Low</td><td>High</td><td>Low</td><td>High</td></tr> <tr><td>6</td><td>Low</td><td>High</td><td>High</td><td>Low</td></tr> <tr><td>7</td><td>Low</td><td>High</td><td>High</td><td>High</td></tr> <tr><td>8</td><td>High</td><td>Low</td><td>Low</td><td>Low</td></tr> <tr><td>9</td><td>High</td><td>Low</td><td>Low</td><td>High</td></tr> <tr><td>A</td><td>High</td><td>Low</td><td>High</td><td>Low</td></tr> <tr><td>B</td><td>High</td><td>Low</td><td>High</td><td>High</td></tr> <tr><td>C</td><td>High</td><td>High</td><td>Low</td><td>Low</td></tr> <tr><td>D</td><td>High</td><td>High</td><td>Low</td><td>High</td></tr> <tr><td>E</td><td>High</td><td>High</td><td>High</td><td>Low</td></tr> <tr><td>F</td><td>High</td><td>High</td><td>High</td><td>High</td></tr> </tbody> </table> <p>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.</p>		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
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Phase Switch Fine - Corresponding Inputs		<table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="border-bottom: 1px solid black;">Bit</th> <th colspan="2" style="border-bottom: 1px solid black;">Corresponding Control Port Input</th> </tr> </thead> <tbody> <tr><td>Bit 0</td><td>PH0</td><td>(Pin A28)</td></tr> <tr><td>Bit 1</td><td>PH1</td><td>(Pin C28)</td></tr> <tr><td>Bit 2</td><td>PH2</td><td>(Pin A27)</td></tr> <tr><td>Bit 3</td><td>PH3</td><td>(Pin C27)</td></tr> </tbody> </table>	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)																																																																						
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# 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





**Single-Board  
Lock-In-Amplifier**

Optional Extensions	<p>Mounting Kit</p> <p>Reference Oscillator Module</p>	<p>Model No.: MK-LIA-2</p> <ul style="list-style-type: none"> <li>- 19" – Frontpanel, printed</li> <li>- EMI – shielding Board-Backplane</li> </ul> <p>Model No.: SOM-1</p> <ul style="list-style-type: none"> <li>- Frequency Range 5 Hz ... 130 kHz, User adjustable</li> <li>- Output Voltage 0 ... 2 Vrms, User adjustable</li> <li>- 100 ppm/K Amplitude Accuracy</li> </ul>

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