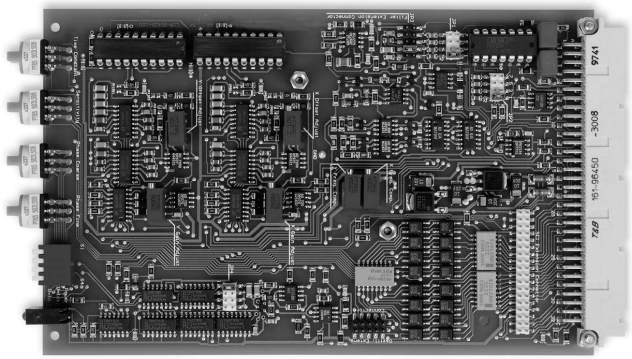
# Single-Board
# Dual Phase Lock-In-Amplifier

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

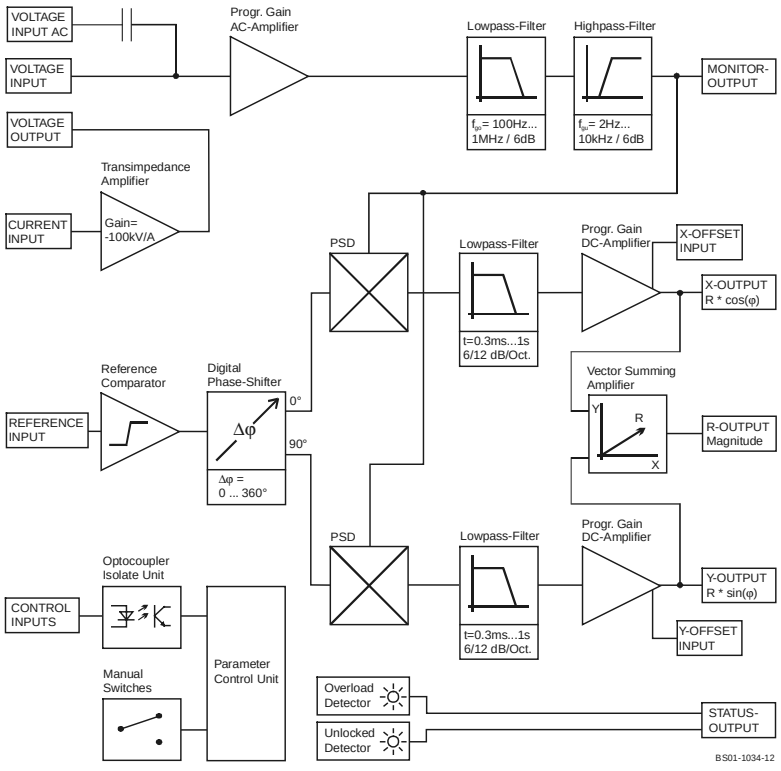
Features

- **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



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| 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: 10 pF — f < 20 kHz: < 1 %; f = 50 kHz: 1 %; f = 100 kHz: 4 %<br>Cs: 100 pF — f < 20 kHz: < 1 %; f = 50 kHz: 1 %; f = 100 kHz: 3 %<br>Cs: 500 pF — f < 20 kHz: < 1 %; f = 50 kHz: 4 %; f = 100 kHz: 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<br>35 dB @ Low Drift Setting<br>55 dB @ High Dynamic Setting |
| Reference Input | Reference Input Voltage Range | ± 100 mV ... ± 5 V @ bip. Mode (0 V Comparator Threshold)<br>- 5 V / +10 V @ TTL Mode (+2 V Comparator Threshold) |
| | Reference Input Impedance | 1 MΩ |
| | Reference Acquisition Time | max. 2 s @ Fast Setting<br>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 |

# Single-Board
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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<br>50 ppm/K @ Low Drift Setting<br>500 ppm/K @ High Dynamic Setting |
| | Output Basic Accuracy | 2 % (X and Y-Output) @ sinusoidal input signal<br>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<br>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.

# Single-Board
# Dual Phase 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 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)

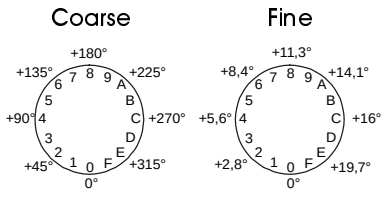
| Low Drift Mode Setting | Voltage | Current | High Dynamic Mode Setting | Voltage | Current |
|---|---|---|---|---|---|
| 0 | 100 mV | 1 µA | 8 | 10 mV | 100 nA |
| 1 | 30 mV | 300 nA | 9 | 3 mV | 30 nA |
| 2 | 10 mV | 100 nA | A | 1 mV | 10 nA |
| 3 | 3 mV | 30 nA | B | 300 µV | 3 nA |
| 4 | 1 mV | 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 °.

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## 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 * |

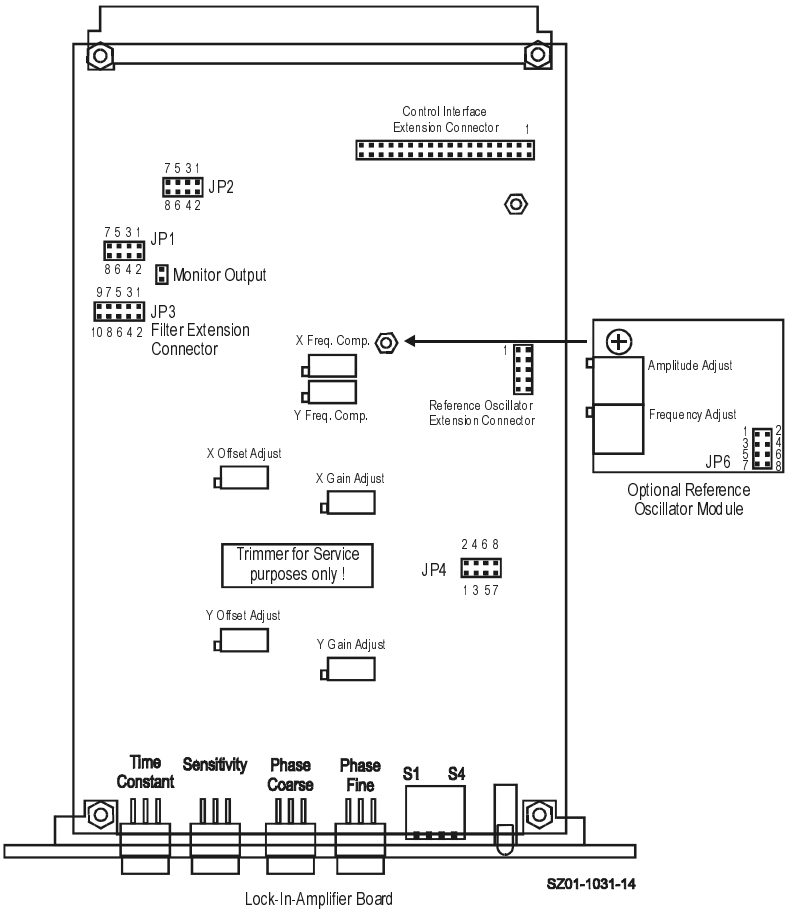
* (At Sensitivity Settings 6,7 & E,F max. 200 kHz )

### 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




Lock-In-Amplifier Board

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## 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 |

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## 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) |

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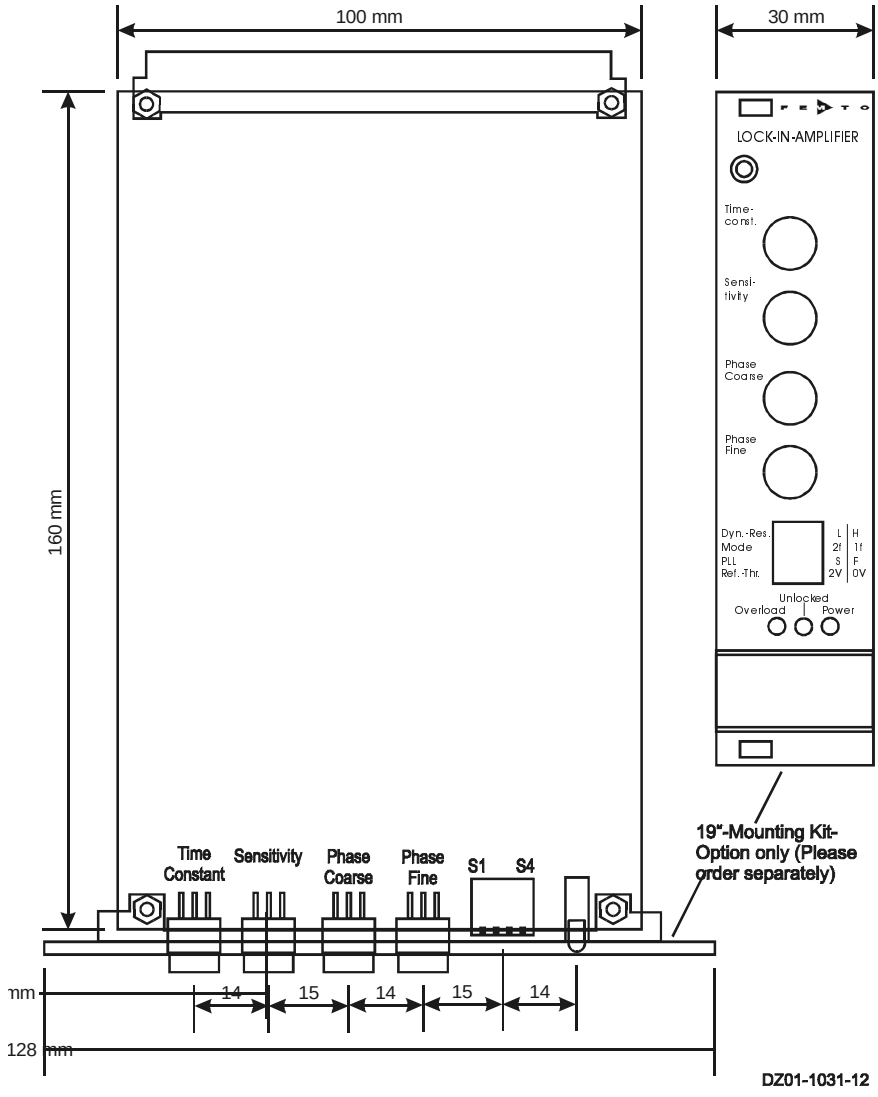
Remote Control Example

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



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

FEMTO Messtechnik GmbH
Paul-Lincke-Ufer 34
D-10999 Berlin · Germany
Tel.: +49 (0)30 – 4 46 93 86
Fax: +49 (0)30 – 4 46 93 88
e-mail: info@femto.de
http://www.femto.de