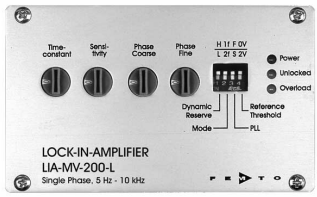
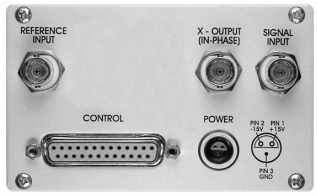
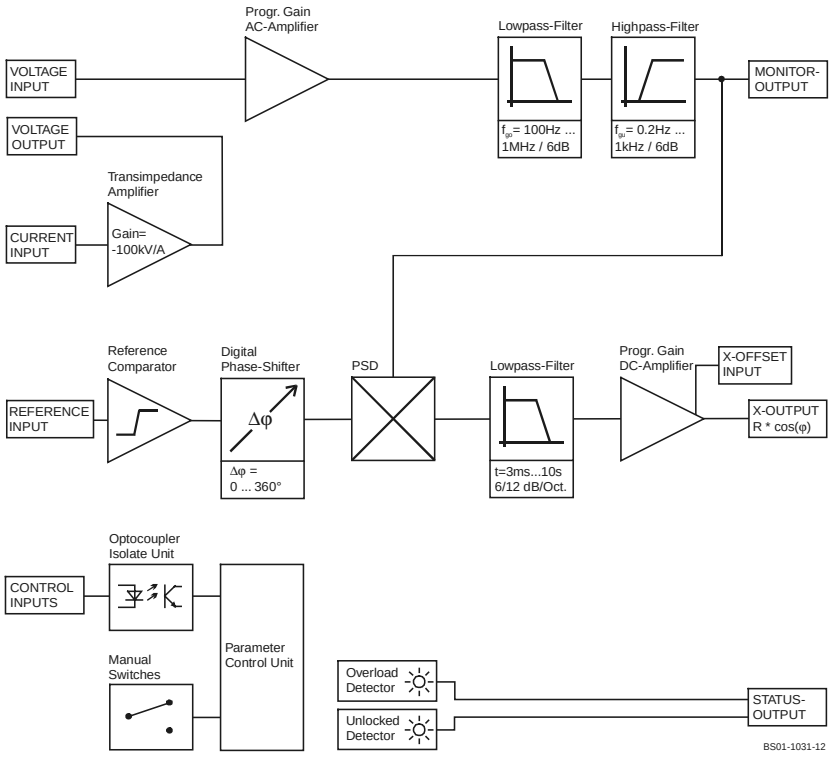
Lock-In-Amplifier Module





Features	• **BNC Connectors for Input and Output Signals** • **Rugged Aluminium Housing** • **Single Phase Detection with X Output** • **Working Frequency 5 Hz ... 10 kHz, Digital Phase Shifter 0 ... 360°** • **Parameter Control by local Switches and opto-isolated digital Inputs** • **Optional Reference Oscillator Module available**
Applications	• **Spectroscopy** • **Luminescence, Fluorescence, Phosphorescence Measurements** • **Light Scattering Measurements** • **Opto-electronical Quality Control**
Block Diagram	

Lock-In-Amplifier Module

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
	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 < 10 kHz 10 pF < 1 % 100 pF < 1 % 1 nF < 2 %
Signal Filter (without optional Bandpass-Module)	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)	0.2 Hz, 1 Hz, 10 Hz, 100 Hz, 1 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 5 Hz ... 10 kHz
	Phase Shifter Range	0 ... + 360 °
	Phase Shifter Resolution	1.4 °
	Phase Shifter Drift	< 100 ppm/K
	Phase Shifter Accuracy	< 0.3 °
Time Constants	Time Constant Range	3 ms ... 10 s in 1-3-10 steps
	Time Const. Filter Characteristic	6 dB/Oct. or 12 dB/Oct. Switchable

Lock-In-Amplifier Module

Specifications (continued)

Output	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-Output Load 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, + 100 mA
Case	Material	Aluminium anodized
	Dimension	64,4 x 105,0 x 223,0 mm (without BNC-connectors)
	Weight	1000 gr. (2.2 lbs)
Temperature Range	Storage Temperature	- 40 ... + 100 °C
	Operating Temperature	0 ... + 60 °C

Absolute Maximum Ratings

Signal Input AC Voltage	50 Vpp
Reference Input Voltage	± 15 V
Control Input Voltage	- 5 V, + 30 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.

Lock-In-Amplifier Module

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)

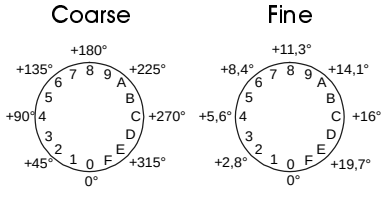
Low Drift Mode Setting	Voltage	Current	High Dynamic Mode Setting	Voltage	Current
0	100 mV	1 µA	8	10 mV	100 nA
1	30 mV	300 nA	9	3 mV	30 nA
2	10 mV	100 nA	A	1 mV	10 nA
3	3 mV	30 nA	B	300 µV	3 nA
4	1 mV	10 nA	C	100 µV	1 nA
5	300 µV	3 nA	D	30 µV	300 pA
6	100 µV	1 nA	E	10 µV	100 pA
7	30 µV	300 pA	F	3 µV	30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

Time Constant Setting

6 dB/Oct.	12 dB/Oct.	Time Constant
0	8	3 ms
1	9	10 ms
2	A	30 ms
3	B	100 ms
4	C	300 ms
5	D	1 s
6	E	3 s
7	F	10 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 2-f Mode is selected,
the resolution of digital phase control changes to 2.8 °
and the phase shift range doubles to 0 ... + 720 °.

Lock-In-Amplifier Module

Internal Jumper Settings (jumpers are accessible when top of case is removed)

Input Signal Filter Setting

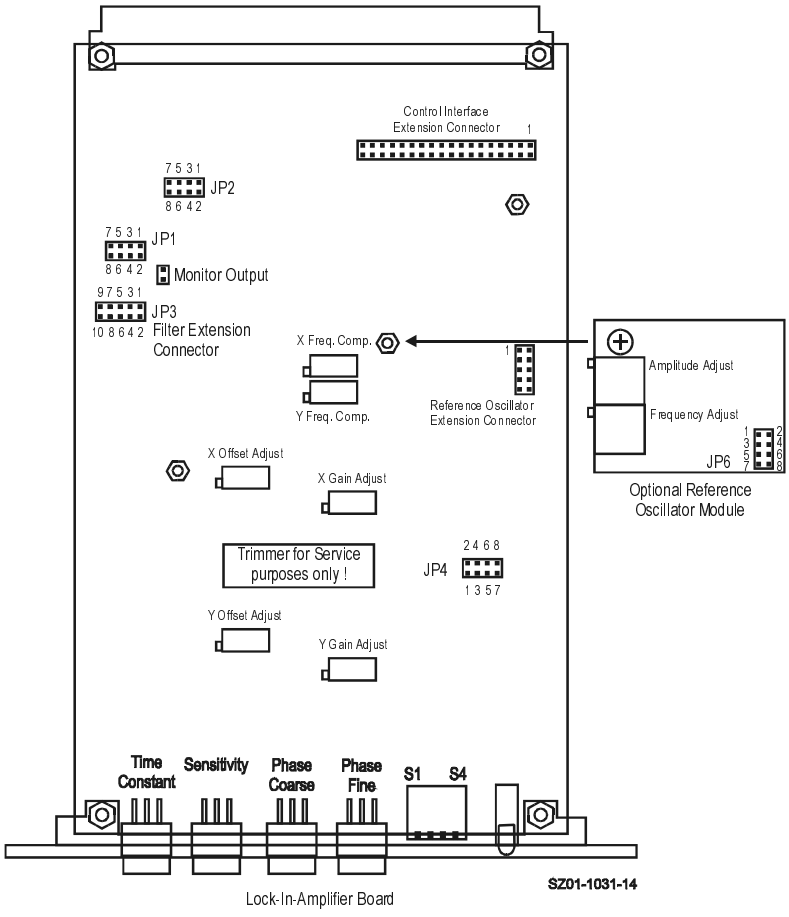
Set Cut-Off Frequency of Input Lowpass Filter with JP1 + JP2 (always same position) and Highpass Filter with JP3:

JP3	Highpass -3 dB Cut-Off	JP1, JP2	Lowpass -3 dB Cut-Off
3 – 4	0.2 Hz	1 – 2	100 Hz
1 – 3	1 Hz	3 – 4	1 kHz
2 – 4	10 Hz	5 – 6	10 kHz
3 – 5	100 Hz	7 – 8	100 kHz
4 – 6	1 kHz	none	1 MHz

Frequency Range Selection

JP4	Frequency Range
1 – 2	normal operation
3, 4, 5, 6, 7, 8	test pins, do not use

Internal Jumper Position Diagram (look at top of board when case is opened)



Lock-In-Amplifier Module

Internal Connector (of build-in Lock-In Board)

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

Lock-In-Amplifier Module

External Connectors (at backside, Standard Configuration)	Signal Input	Factory set to BNC, isolated (single ended)
	X-Output	BNC
	Reference Input	BNC
	Power Supply	LEMO Series 1S, 3-pin fixed Socket Pin 1: + 15V Pin 2: - 15V Pin 3: GND 
	Control Port	Sub-D 25-pin, female, Qual. Class 2 Pin 1: +12V (Stabilized Power Supply Output) Pin 2: -12V (Stabilized Power Supply Output) Pin 3: AGND (Analog Ground) Pin 4: +5V (Stabilized Power Supply Output) Pin 5: X-Output Pin 6: Overload Status Output Pin 7: Unlocked Status Output Pin 8: Disable Local Switch Control Input Pin 9: DGND (Ground f. Digital Control Pin 8 - 25) Pin 10: Dynamic Mode (DYN0) Pin 11: Sensitivity (SEN0) Pin 12: Sensitivity (SEN1) Pin 13: Sensitivity (SEN2) Pin 14: Time Constant Slope (TCSL) Pin 15: Time Constant (TC0) Pin 16: Time Constant (TC1) Pin 17: Time Constant (TC2) Pin 18: Phase Shift (PH0) Pin 19: Phase Shift (PH1) Pin 20: Phase Shift (PH2) Pin 21: Phase Shift (PH3) Pin 22: Phase Shift (PH4) Pin 23: Phase Shift (PH5) Pin 24: Phase Shift (PH6) Pin 25: Phase Shift (PH7)
Connector Wiring Options	General	The BNC-connector configuration can be easily changed by setting electrical jumpers at the internal I/O-adapter card. Disconnect the power supply and open the case by loosening the two upper screws at the case front and rear side. Please pay attention to the ground connection at the backplane. Now open the case by lifting the top. The jumper options and functions are described in the following table.

Lock-In-Amplifier Module

Connector Wiring Options, Jumpers on internal Adapter Board

Input Connectors (JP1)	Input wiring	Jumper installed
	IN A = Voltage Input (Single Ended, AC)	"+V-IN → IN A" "GND → IN A/SHLD" "-V-IN → IN A/SHLD"
	IN A = Voltage Input (Differential, AC)	"+V-IN → IN A" "-V-IN → IN A/SHLD"
	IN A / IN B = Voltage Input (2 BNC Differential, AC) (OUT A cannot be used)	"+V-IN → IN A" "GND → IN A/SHLD" "-V-IN → IN B"
	IN A = Current Input (Single Ended)	"C-IN → IN A" "GND → IN A/SHLD" "-V-IN → C-OUT"

Output Connectors (JP2)	Output wiring	Jumper installed
	OUT A = X-Output	"X → OUT A" (JP1) "USE OUT A/NO IN B"
	OUT B = X-Output	"X → OUT B"
	OUT A = Y-Output	"Y → OUT A" (JP1) "USE OUT A/NO IN B"
	OUT B = Y-Output	"Y → OUT B"
	OUT C = Y-Output	"Y → OUT C"
	OUT A = R-Output	"R → OUT A" (JP1) "USE OUT A/NO IN B"
	OUT B = R-Output	"R → OUT B"
	OUT C = R-Output	"R → OUT C"
	OUT B = Monitor Output	"MON → OUT B"
	OUT C = Monitor Output	"MON → OUT C"
	OUT B = Unlocked Output	"UNL → OUT B"
	OUT C = Unlocked Output	"UNL → OUT C"
	OUT B = Overload Output	"OVL → OUT B"
	OUT C = Overload Output	"OVL → OUT C"
	OUT C = Reference Output	"REF-OUT → OUT C"

Reference Connector (JP3)	Reference wiring	Jumper installed
	REF = Reference Input	"REF-IN → REF" (2 Jumper)
(Reference Output only if optional Oscillator Module is installed)	REF = Reference Output (Reference Output connected to Ref. Input)	"REF-OUT → REF-IN" (2 Jp.) "REF-IN → REF" (2 Jumper)
	REF = Refer. Sync. Input (use OUT C as Reference Output)	"REF-SYNC → REF" (2 Jp.)

Lock-In-Amplifier Module

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.

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

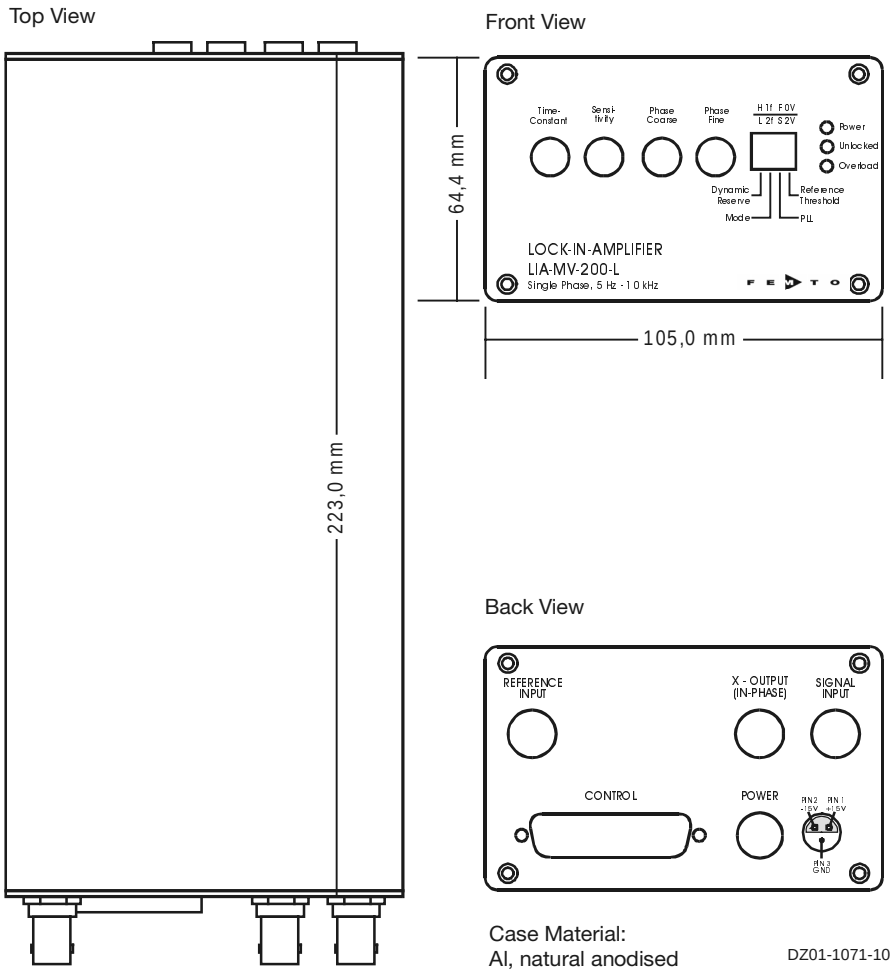
Bit	Corresponding Control Port Input	
Bit 0	PH0	(Pin A28)
Bit 1	PH1	(Pin C28)
Bit 2	PH2	(Pin A27)
Bit 3	PH3	(Pin C27)

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.

Lock-In-Amplifier Module

Dimensions



Optional Extensions

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
Factory Set	1 kHz, 1 Vrms

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