# ILA User Manual

# ILA

**ILA Strain Gauge In-Line Analogue Amplifiers**

**mantracourt**

# Contents

## The ILA In-Line Strain Gauge Amplifier



Housed in an IP54 in-line enclosure, Mantracourt's In-Line Amplifier (ILA) converts strain gauge or load cell inputs into a high stability 4-20 mA output. Its small design enables it to be easily integrated into compact installations. The ILA is compatible with a wide range of inputs including strain gauges, load cells, pressure and torque transducers.

Gain and Offset calibration is performed by a dual 256-step non-volatile digital potentiometer allowing fast semi-automatic calibration via Mantracourt's proprietary Custom Programming Module and free ILA Toolkit.

The USB-powered Programming Module connects to the ILA via a 300 mm lead and communicates with the digital potentiometer via an $I^2C$ protocol. Windows drivers for OEM calibration are available free of charge.

For ease of connection, the ILA is fitted with Molex Lite-Trap push-in connectors. Saddle clamps provide strain relief for the cables and connectivity for the cable screens. Flexible grommets, combined with the overlap fitting of the lid ensures IP54 protection against dust and particle ingress. The lid is secured by two diagonal screws and two through-holes are provided for bulkhead-mounting.
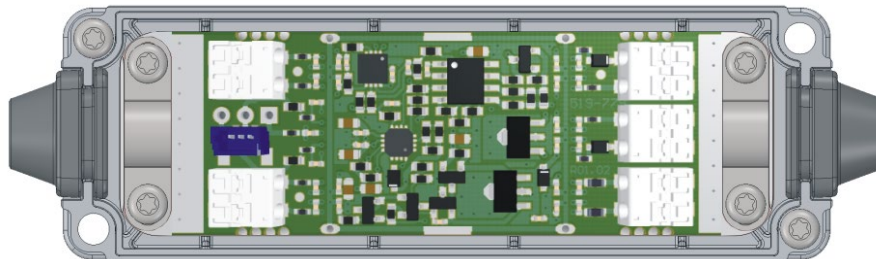


The grommets cater for cable diameters between 4 to 6 mm. Smaller diameter cables can be used at the expense of effective dust and particle sealing.

## Dimensions:
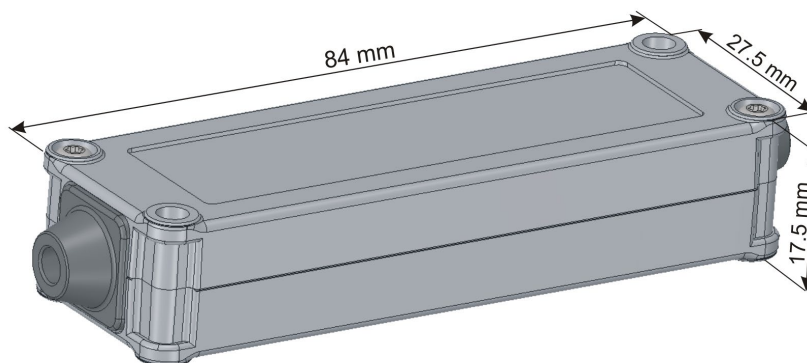


The grommets increase the overall length to 94 mm

## Diagonal Mounting holes:



3.6 mm dia - 2 places

20.3 mm

75.6 mm

## Connections:



Input Connections

In +
In -

Exc +
Exc -

Programming connector

Output and Power Connections

Source +
Source -
Sink -
Sink +
Power (+9 to 32 V)
0 V
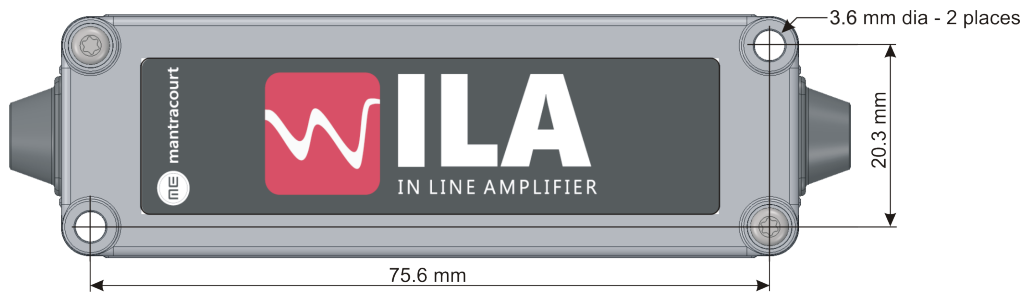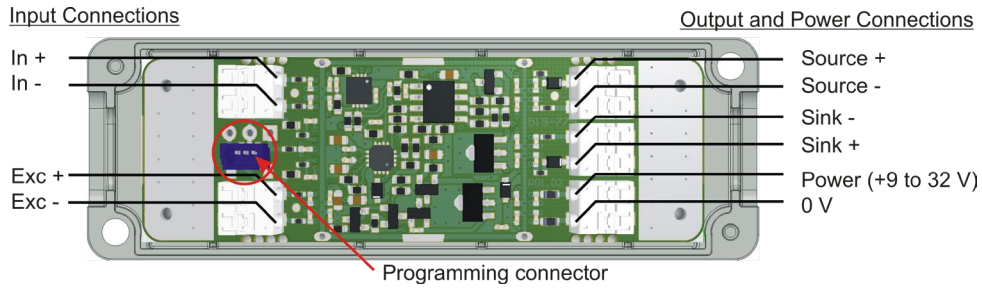
## Sink or Source Mode?

The ILA can be used in either of two modes to control a 4-20mA current loop:

## Source mode:
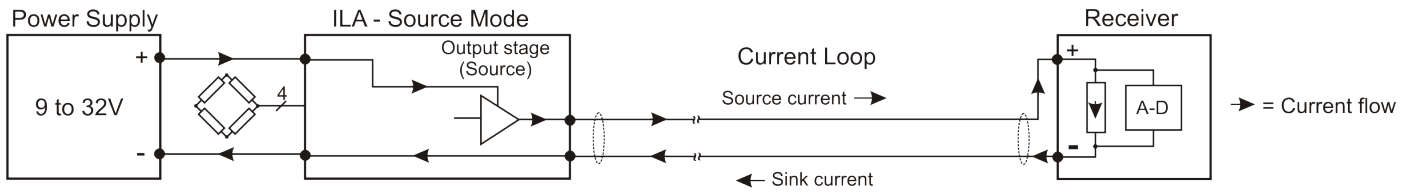


In Source mode the ILA's power supply also provides the current which flows through the loop via the ILA's output stage. The output stage 'Sources' current into the loop in proportion to the strain gauge loading.

## Sink Mode:

In Sink mode the current flow in the ILA's output stage is reversed, there are two options available:
a) The loop current is provided by the ILA's power supply:-

b) The power supply in the receiver provides the loop current:-
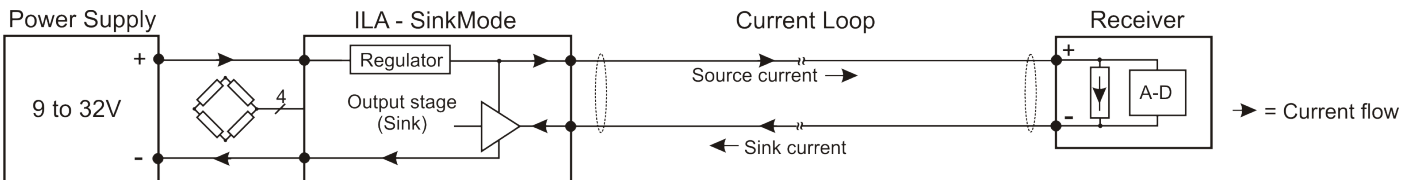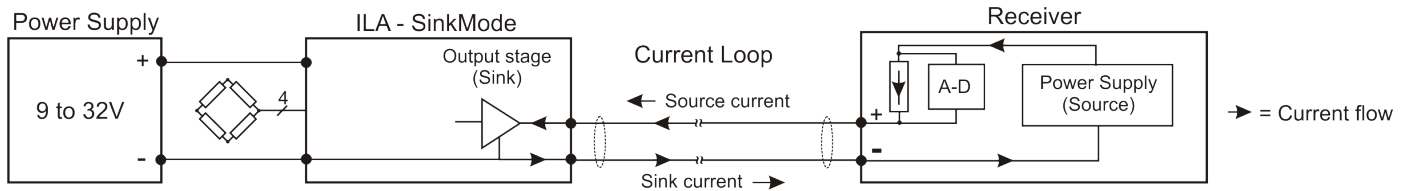


In both cases the loop current is controlled by the ILA's output stage. The ILA 'sinks' or 'returns' the current to the relevant power supply in a controlled manner relative to the loading on the load cell.

Note that in both sink and source modes an electrical connection exists between the ILA's power supply and the receiver i.e. they are *not* electrically isolated.

The ILA is configured for Sink or Source mode by connecting a shorting wire across the unused output connector block.

*Source Mode Connections:*
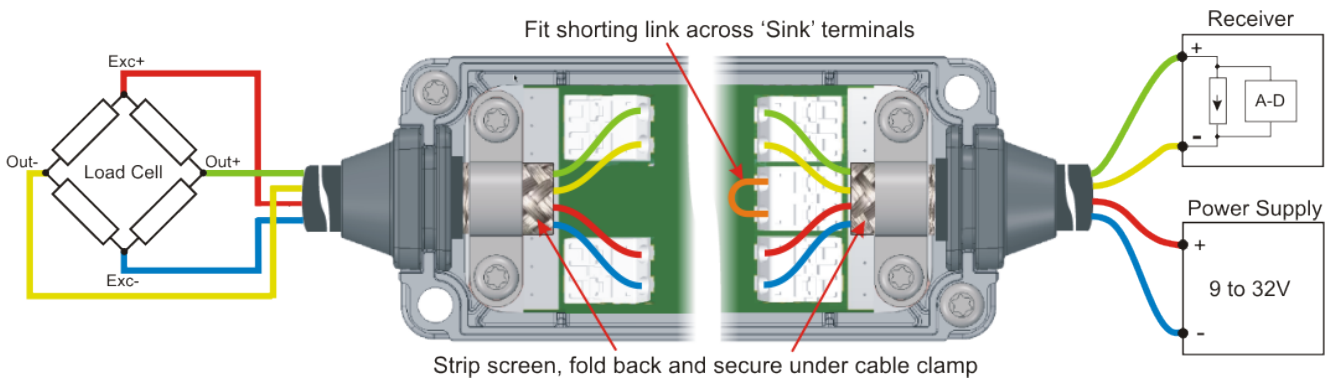


*Sink Mode Connections:*

a) ILA supplying the loop current:
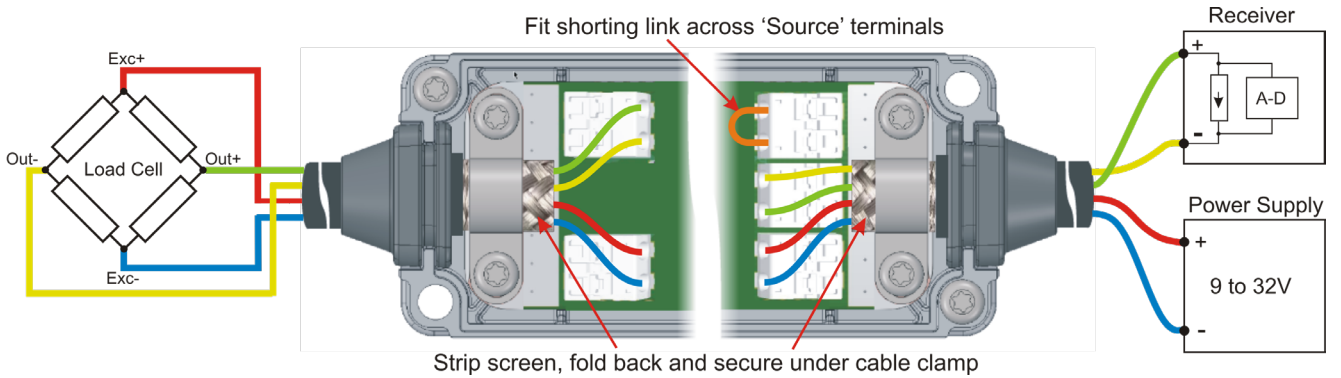


b) Receiver supplying the loop current:
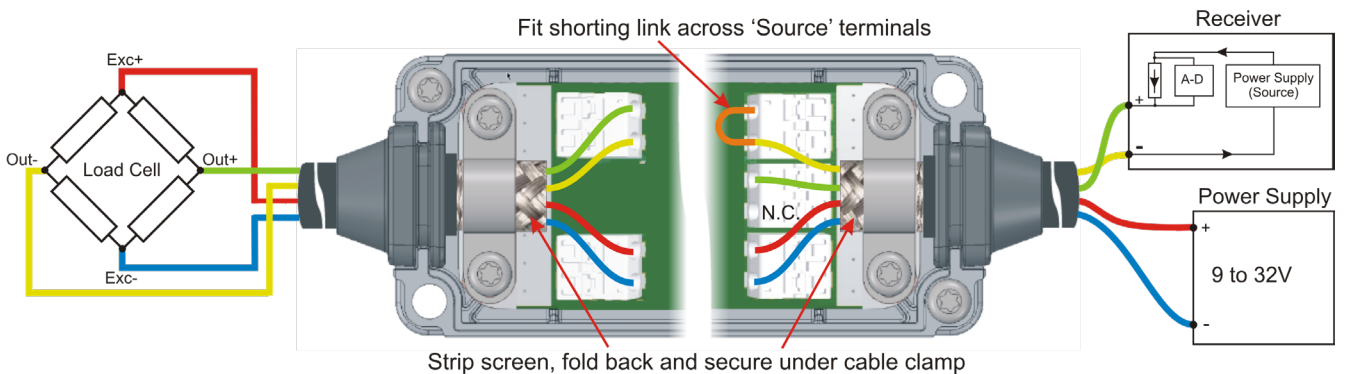
The input and output cable screens should be dressed back onto each cable respectively with 360° coverage then the cable clamps fitted to provide both screen continuity through the PCB and cable strain relief.

The cable clamps are secured with self-tapping screws directly into the PCB – *do not over tighten.*

For ease of wiring, the cabling, grommets and clamps can be fitted before the whole assembly is dropped into the case.

## Calibration using the ILA Toolkit

To Calibrate the ILA using Mantracourt's Toolkit, an ILA-PGMD USB-powered programming module and proprietary ILA-CAB cable will be required.



In conjunction with the Windows ILA Toolkit software, the programming module communicates with the ILA's dual digital potentiometer via an I$^2$C interface.

The software enables both manual and auto adjustments of the Span and Zero. On completion of the calibration process the potentiometer settings are stored in their non-volatile EEPROM memories and re-called whenever the ILA is powered up.

Download and install the free ILA Toolkit software from Mantracourt's website.
With the ILA-CAB cable plugged into the programming socket on the ILA, connect the programmer to the PC with a suitable micro USB lead. Power up the ILA and launch the toolkit software.

The programmer and ILA should be automatically detected and the following screen should appear:
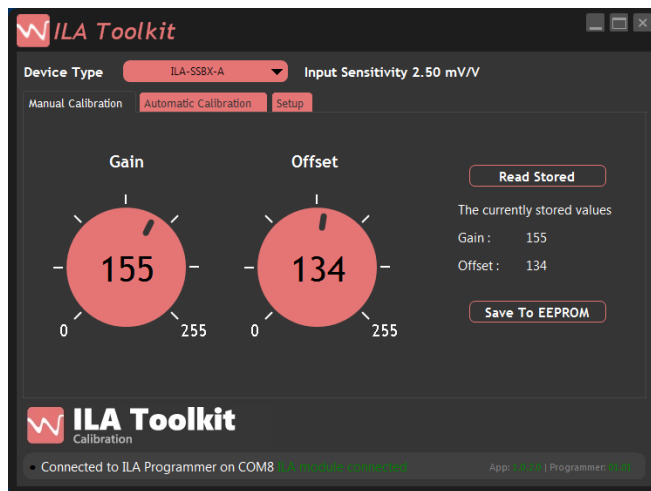


The Gain and span controls indicate the current settings of the two potentiometers within the extreme values of 0 to 255.

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If the USB connection fails the following error message will appear:
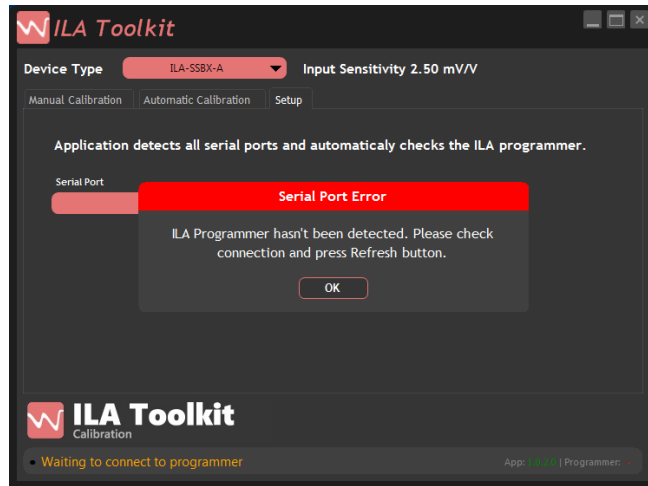


Check the USB connection and follow the on screen instructions.

If the USB connection is ok but the ILA is not powered or connected to the programmer the 'ILA module not connected' message will appear:
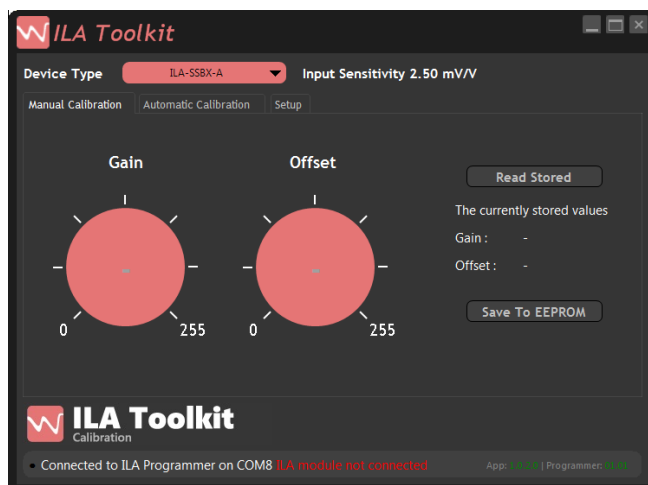


With the connections all in place, the virtual potentiometers can be 'rotated' throughout their range by first clicking on them then grab-and-dragging their pointers with the mouse or clicking and using the mouse wheel to increment or decrement their positions. The latter method allows finer control.

On the toolkit home page select the 'Device Type' from the drop-down list.

Connect a load cell or load cell simulator to the ILA and a means of measuring the loop current to the appropriate output terminals i.e. 'Sink' or 'Source'.

Connect a shorting link across the unused output terminal block to complete the current loop (see connection diagrams above).

*Manual calibration:*
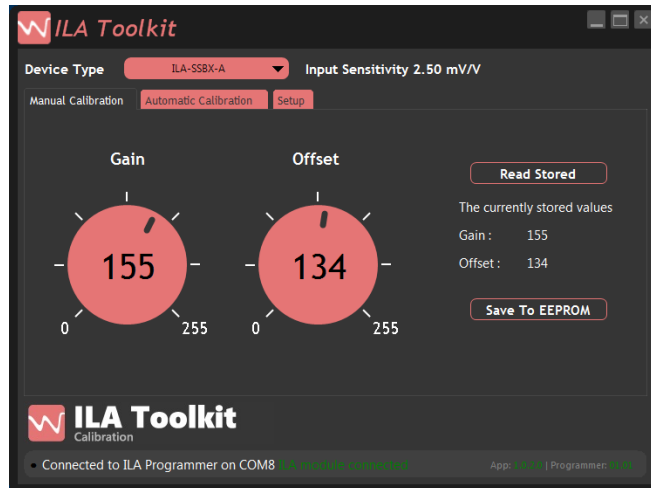


- Set the Gain and Offset potentiometers to 128 (half scale) and click on the 'Save to EEPROM' button.

- Click on the 'Manual Calibration' tab. Apply the **low** conditions for 4mA output via the load cell or simulator (usually zero loading or 0mV/V).

- Adjust the Offset potentiometer to set the output current to 4mA. Note that while increasing the Offset potentiometer's value increases its resistance, the electronic effect is to *reduce* the loop current.

  Due to the digital nature of the potentiometers the current will vary in a series of steps rather than a smooth transition throughout its range. Choose the step which is closest to 4.0mA. The resolution is approximately ±3uA for the Offset potentiometer.

- Apply the **high** conditions for 20mA output via the load cell or simulator (usually full loading or the load cell sensitivity in mV/V if using a simulator).

- Adjust the Gain potentiometer to set the output current to 20mA. As above, choose the step which is closest to 20.0mA. The resolution is approximately ±10uA for the Gain potentiometer.

- Apply the **low** conditions again and re-check the 4mA current. Adjust the Offset potentiometer if necessary.

- Re-apply the **high** conditions and re-check the 20mA current. Adjust the Gain potentiometer if necessary.

- When the calibration is complete, click the 'Save to EEPROM' button to commit the potentiometer settings to memory.

- This completes the manual calibration.

Click on the 'Automatic Calibration' tab the following screen should appear:
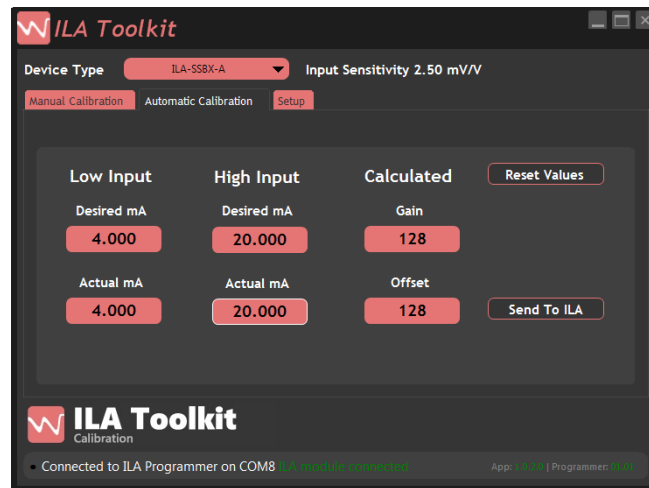


- Click on the 'Reset Values' button. The 'Desired mA' boxes should contain 4.000 and 20.000 and the 'Calculated' Gain and Offset boxes should be 128.
  Click the 'Send to ILA' button. The software will return to the 'Manual Calibration' page with the potentiometers both showing 128 i.e. mid-range.
  Click the 'Automatic Calibration' tab again.

- Apply the **low** conditions for 4mA output via the load cell or simulator (usually zero loading or 0mV/V).

- Measure the output current, double-click in the 'Actual mA' 'Low Input' box and type in the measured value.

- Apply the **high** conditions for 20mA output via the load cell or simulator (usually full loading or the load cell sensitivity in mV/V if using a simulator).

- Measure the output current, double-click in the 'Actual mA' 'High Input' box and type in the measured value.

- Click the 'Send to ILA' button. The software will return to the 'Manual Calibration' page with the potentiometers showing the calculated settings.

- Apply the **low** conditions again and re-check the 4mA current. Adjust the Offset potentiometer if necessary to get the best fit. The resolution is approximately ±3uA.

- Re-apply the **high** conditions and re-check the 20mA current. Adjust the Gain potentiometer if necessary to get the best fit. The resolution is approximately ±10uA.

- When the calibration is complete, click the 'Save to EEPROM' button to commit the potentiometer settings to memory.

- This completes the automatic calibration.

## Specifications:

### Environmental

| Parameter | Minimum | Typical | Maximum | Units | Notes |
|---|---|---|---|---|---|
| Supply voltage Range | 9 | 24 | 32 | Volts | Note 1 |
| Operating Current | - | 8 | - | mA | Note 2 |
| Operating Temperature Range | -40 | - | 85 | °C | |
| Storage Temperature Range | -40 | - | 85 | °C | |
| Reverse polarity Protection | -30 | - | - | Volts | |

Note 1: For 12 V operation, the maximum receiver input impedance is 400 ohms.
Operation at lower supply voltages is possible but limited by receiver's input impedance e.g. for operation at 10V the receiver's input impedance must not exceed 250 ohms or 150 ohms for 8V operation.

Note 2: Not including excitation current and output current
e.g. when connected to a 350 Ohm load cell:-
Total current = Operating current (8mA) + Excitation current (5/350 = 14mA) + Output current (20mA FS) = 42mA FS (typical).

### Measurement

| Parameter | Minimum | Typical | Maximum | Units | Notes |
|---|---|---|---|---|---|
| Bridge Excitation | 4.90 | 5 | 5.10 | Volts | |
| Bridge Impedance | 350 | 1000 | 5000 | Ohms | |
| Bridge Sensitivity | 0.5 | 2.5 | 150 | mV/V | Note 1 |
| Output load | - | - | 1000 | Ohms | Note 2 |
| Bandwidth | DC | - | 12 | kHz | |
| 'Zero' adjustment | - | ±2 | - | %FR | |
| 'Span' adjustment | - | ±8 | - | %FR | |
| Linearity | - | 0.02 | - | %FR | |
| Temperature stability | | | | | |
| 'Zero' Temperature Stability | - | 0.0025 | 0.005 | ±%FR/°C | At 2.5mV/V |
| 'Span' Temperature Stability | - | 0.0025 | 0.005 | ±%FR/°C | At 2.5mV/V |
| Zero trim resolution | - | 3 | - | uA | Note 3 |
| Gain trim resolution | - | 10 | - | uA | Note 3 |

FR=Full Range (16mA)
Note 1: Set at time of manufacture
Note 2: 1000 ohms max requires 24V minimum supply
Note 3: Due to 256-step digital pot resolution

## Production Programming

This section provides the information required for the user to automate the calibration procedure using their own tools and software.

## Calibration

The first step is to calculate the settings for the Gain and Offset potentiometers from a two-point calibration using the desired and actual-measured end points as shown in Appendix A.

The settings should then be downloaded to the ILA and permanently stored into its non-volatile EEPROM memory. There are three ways that this can be accomplished:

### Direct I$^2$C to ILA

The user will interface directly to the ILA module via the I$^2$C bus through a suitable interface and use the information in Appendix B to communicate with the device.

### Mantracourt Dot Net Drivers Interfacing ILA Programmer (Windows PC Only)

The user leverages the Dot Net drivers provided by Mantracourt to write software that allows any development system that can utilize Dot Net assemblies to configure the ILA via the ILA programmer connected to a USB port on a PC. See Appendix C for details.

### Virtual COM Port USB Connection to ILA Programmer

The user writes their own software to communicate with the ILA programmer via the virtual COM port that is created when the ILA programmer is connected to the USB port of a PC. See Appendix D for protocol details.
A simple terminal program e.g. Hyper Terminal, Termite etc. is sufficient to carry out the calibration procedure.

## Appendix A - Calculating the Potentiometer Settings

The ILA amplifier can be calibrated with the transducer connected provided that two calibration points can be implemented e.g. by applying known weights or forces. If this is not possible, a stable mV source or load cell simulator can be used if the precise sensitivity (mV/V) of the transducer is known.

1. Set the Offset and Gain potentiometers to **128** before starting the calibration process.
   Apply the known **low** calibration conditions e.g. zero (weight, force or mV/V) and note the output current ($I_{low}$).

2. Apply the known **high** calibration conditions (ideally between 75% and full scale) and note the output current ($I_{high}$).

Using $I_{low}$, $I_{high}$ and the range over which the output must span e.g. 4-20mA, 4-16mA etc. the following formulas can be used to determine the values for the potentiometer 'wipers'. Refer to the following Appendices for the different methods of physically writing the values to the ILA.

### Example 1:

low (e.g. 0 mV/V) = 4mA (Desired low mA)     high (e.g. 2.5 mV/V) = 20mA (Desired high mA)
$I_{low}$ = 4.01 mA (Actual mA measured)     $I_{high}$ = 19.70 mA (Actual mA measured)

Offset potentiometer value =     (128 - ((Desired low mA - Actual low mA) * 320))

i.e.     (128 – ((4 – 4.01) * 320)) = 128 – (-3.2) = **131** *

Gain potentiometer value =     (128 + ((1 – ($I_{high}$ - $I_{low}$) / (Desired high mA - Desired low mA)) * 1404.3))
i.e.     (128 + (1 – ((19.70 – 4.01) / (20 – 4)) * 1404.3)) = 128 + 27.2 = **155** *

### Example 2:

low (e.g. 0 mV/V) = 4mA (Desired low mA)     high (e.g. 2.5 mV/V) = 16mA (Desired high mA)
$I_{low}$ = 4.12 mA (Actual mA measured)     $I_{high}$ = 16.57 mA (Actual mA measured)

Offset potentiometer value =     (128 - ((Desired low mA - Actual low mA) * 320))

i.e.     (128 – ((4 – 4.12) * 320)) = 128 – (-38.4) = **166** *

Gain potentiometer value =     (128 + ((1 – ($I_{high}$ - $I_{low}$) / (Desired high mA - Desired low mA)) * 1404.3))

i.e.     (128 + ((1 – (16.57 – 4.12) / (16 – 4)) * 1404.3)) = 128 + (-52.66) = **75** *

If the ILA is supplied as a pseudo 'Bipolar' version e.g. ±4.5mV/V (–FS mV/V = 4 mA, 0mV/V = 12mA and +FS mV/V = 20mA) the following formulas should be used:

### Example 3:

low (e.g. 0 mV/V) = 12mA (Desired low mA)     high (e.g. 2.5 mV/V) = 20mA (Desired high mA)
$I_{low}$ = 12.03 mA (Actual mA measured)     $I_{high}$ = 19.70 mA (Actual mA measured)

Offset potentiometer value =     (128 - ((Desired low mA - Actual low mA) * 188.2))

i.e.     (128 – ((12 – 12.03) * 188.2)) = 128 – (-5.646) = **134** *

Gain potentiometer value =     (128 + (1 – (($I_{high}$ - $I_{low}$) / (Desired high mA - Desired low mA))) * 1404.3)
i.e.     (128 + (1 – ((19.70 – 12.03) / (20 – 12)) * 1466.9)) = 128 + 60.51 = **189** *

* Note: Rounded to nearest integer

## Appendix B – Production Programming Direct I$^2$C to ILA

The dual digital potentiometer incorporated in the ILA allows independent adjustment of the Gain and Offset during the calibration process. On completion of the calibration procedure, the positions of the potentiometer 'wipers' should be stored in their non-volatile EEPROM memory to ensure they are re-called when the ILA is next powered-up.

Unlike an analogue potentiometer where the wiper can be smoothly swept from one end to the other, a digital potentiometer's wiper position varies in a series of finite 'steps'. This sets a limit on the accuracy that can be achieved during calibration due to the 'step' size (see the Specification Table above, note 3).

The wiper position of each potentiometer is controlled by the contents of the appropriate 8-bit RDAC register in the IC allowing 256 individual steps to be set.

### ILA I$^2$C Connections:



Dual Digital Potentiometer IC

3 2 1

SDA SCL GND
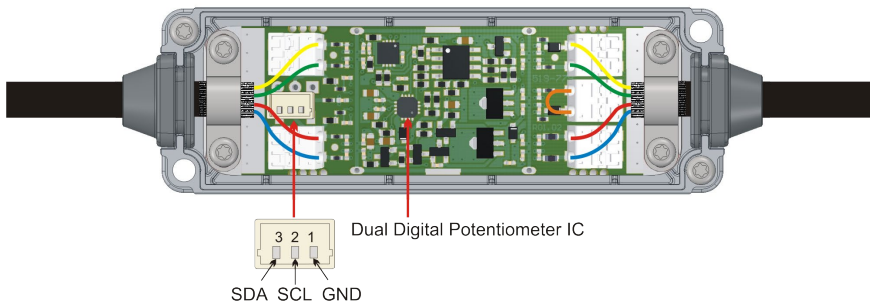
To connect to the I$^2$C programming connector on the ILA, an ILA-CAB-A cable assembly is available from Mantracourt.

Alternatively, a custom cable can be manufactured using a JST SHR-03V-S-B connector housing and three SH3-SS5-28300 crimped cables.

The I$^2$C communication runs at a low speed of 25 kHz and can tolerate over 1nF of capacitance to ground on the SCL clock line.
If a longer cable length than the 250mm ILA-CAB-A is required a 9-way 'D' to 9-way 'D' type, two-core screened extension cable can be made up. Pins 2 and 3 should be wired 1:1 and the screen connected to pin 5 at each end.

The ILA-PGMD programmer has been tested with 5m of RS 6903942 2-core screened cable with a capacitive rating of 80pF/m core-core and 215pF/m core-screen.

The ILA's dual potentiometer appears on the I$^2$C bus as a slave device with a hard-wired 7-bit I$^2$C slave address of 0101111 (0x2F). This occupies bits 7 to 1 in the first byte transmitted in an I$^2$C transfer i.e. 0101111x (0x5E or 0x5F). The least significant bit, bit 0 is the R/W bit ('1' for Read commands, 0x5F and '0' for Write commands, 0x5E).

Read and write operations follow the standard 2-wire serial bus protocol involving start, stop, repeated start, R/W and ACK and NACK states. For more information refer to the analog Device's AD5142 datasheet.

### Write Commands:

Write command transfers involve 3 bytes:
Byte 1: Hard-wired Slave Address + R/W bit (0x5F for read, 0x5E for write)
Byte 2: Command byte comprising control bits (D7-D4) + address bits (D3-D0)
Byte 3: Data byte

The following tables shows the slave address + R/W byte, control + address byte and the data byte values for the available commands in hexadecimal format (0x--):

| Write Commands | Byte 1<br>Slave Address + R/W | Byte 2<br>Control + Address | Byte 3<br>Data |
|---|---|---|---|
| Write Offset Pot Value | 0x5E | 0x10 | Offset Pot value to be written |
| Write Gain Pot Value | 0x5E | 0x11 | Gain Pot value to be written |
| Control commands: | | | |
| Save Offset Pot to EEPROM | 0x5E | 0x70 | 0x01 |
| Save Gain Pot to EEPROM | 0x5E | 0x71 | 0x01 |

| Write Commands | Byte 1<br>Slave Address + R/W | Byte 2<br>Control + Address | Byte 3<br>Data |
|---|---|---|---|
| Increment Offset Pot | 0x5E | 0x40 | 0x01 |
| Increment Gain Pot | 0x5E | 0x41 | 0x01 |
| Decrement Offset Pot | 0x5E | 0x40 | 0x00 |
| Decrement Gain Pot | 0x5E | 0x41 | 0x00 |
| Disable writing to EEPROM | 0x5E | 0xD0 | 0x01 |
| Enable writing to EEPROM | 0x5E | 0xD0 | 0x02 |

Example 1: to write the Offset potentiometer value and store it in EEPROM send the following bytes:-

| Byte 1 | Byte 2 | byte 3 |
|---|---|---|
| 0x5E | 0x10 | Value |

| Byte 1 | Byte 2 | byte 3 |
|---|---|---|
| 0x5E | 0x70 | 0x01 |

Example 2: to write the Gain potentiometer to mid-scale (128) send the following bytes:-

| Byte 1 | Byte 2 | byte 3 |
|---|---|---|
| 0x5E | 0x11 | 0x80 |

## Read Commands:

Read commands involve three separate I$^2$C transactions:
1. The first three-byte operation (Byte 1 LSB = 0) writes the register address within the potentiometer which contains the required data
2. Re-write the Slave Address (Byte 4) with LSB = 1 i.e. a 'read' operation
3. Read back one byte – byte 5 contains the requested data

| Read Commands | Byte 1 | Byte 2 | Byte 3 | Byte 4 | Byte 5 |
|---|---|---|---|---|---|
| Read/Write bit (LSB)  -> | 0 (Wr) | n/a | n/a | 1 (Rd) | n/a |
| Read Control Register | 0x5E | 0x30 | 0x02 | 0x5F | Control Register value |
| Read Offset from EEPROM | 0x5E | 0x30 | 0x01 | 0x5F | Offset Pot value from EEPROM |
| Read Gain from EEPROM | 0x5E | 0x32 | 0x01 | 0x5F | Gain Pot value from EEPROM |
| Read Offset Pot Value | 0x5E | 0x30 | 0x03 | 0x5F | Offset Pot value |
| Read Gain Pot Value | 0x5E | 0x31 | 0x03 | 0x5F | Gain Pot value |

The above sequence is continually transmitted at 1-second intervals in order to detect if an ILA is connected.

Example 3: to read the Gain potentiometer wiper position, send and receive the following bytes:-

| Write 1 | Write 2 | Write 3 |
|---|---|---|
| 0x5E | 0x31 | 0x03 |

| Write 4 | Read byte 5 |
|---|---|
| 0x5F | Gain Pot value |

For further understanding of the I$^2$C Bus protocol consider this datasheet from Ti:
http://www.ti.com/lit/an/slva704/slva704.pdf

## Appendix C – Production Programming Dot Net Drivers

For further details and help files please contact Mantracourt Electronics.

The ILA exposes the following methods:

| Method | Description |
|---|---|
| AutoConnect | Automatically connects to the serial port with the ILA Programmer attached. If there are two programmers connected, the first one is selected. |
| Connect | Connect to the serial port. |
| DecrementGain | Decrease Gain Pot value by one |
| DecrementOffset | Decrease Offset Pot value by one |
| DisableEEPROMWrite | Disable writing to EEPROM |
| Disconnect | Close serial port |
| EnableEEPROMWrite | Enable writing to EEPROM |
| ExecuteCommand | Send command to programmer. |
| GetControlRegister | Read ILA control register |
| GetGain | Read Gain Pot value |
| GetGainEEPROM | Read Gain value from EEPROM |
| GetDigitalInput | Read programmer input port state |
| GetOffset | Read Offset Pot value |
| GetOffsetEEPROM | Read Offset value from EEPROM |
| GetSerialNumber | Read programmer serial number |
| GetStatus | Read programmer status register |
| GetVersion | Read programmer firmware version |
| IncrementGain | Increase Gain Pot value by one |
| IncrementOffset | Increase Offset Pot value by one |
| Reset | Reset programmer only. The ILA device status is not changed. |
| SaveGainEEPROM | Write Gain Pot value to EEPROM |
| SaveOffsetEEPROM | Write Offset Pot value to EEPROM |
| SetDigitalOutput | Set the output port state |
| SetGain | Write Gain Pot Value |
| SetOffset | Write Offset Pot Value |

### Calibration

Use the formulas in Appendix A to determine the Gain and Offset Pot values from the *Actual mA measured* and *Desired mA* calibration end-points.

In conjunction with the ILA programmer and I$^2$C lead, use the 'AutoConnect' or 'Connect' Method to connect to the USB serial port which the programmer is plugged into.

Execute the 'SetGain' and 'SetOffset' methods to set the potentiometers to the required values.

Using 'SaveGainEEPROM' and 'SaveOffsetEEPROM' commits the values to the EEPROM to ensure that the potentiometers are set correctly at subsequent power-ups.

The ILA programmer also provides the user with two digital inputs with 10k pull-up resistors to +5V and two digital outputs with 470 ohm series current limiting resistors. Use the 'GetDigitalInput' and 'SetDigitalOutput' methods to access them. These digital I/O lines can be conveniently integrated into an automatic calibration system.

## Appendix D – Production Programming Virtual COM Port

All communications between the ILA programmer and a virtual USB COM port take place via Mantracourt's 'ASCII' protocol.

Only printable characters and carriage-return ('<CR>' ASCII code 13) commands are used which allows a "dumb" terminal device or a PC programme such as Hyper-Terminal or Termite to interrogate the device.

This simple protocol allows the user to:
- Read a parameter
- Write a value to a parameter
- Execute a command

For example, a typical ASCII packet contains the following components:

| Framing Character | Station Address | Separator | Command Identifier | Access Code | <CR> if Access Code is '?' Value if Access Code is '=' | End of frame |
|---|---|---|---|---|---|---|
| ! | 001 | : | e.g. GAIN | '?' or '=' or '<CR>' | <CR> or Value | <CR> |

**Framing Character:** For framing purposes the '!' character is used to signal the start of a new message.

This character is only ever transmitted by the host.

**Station Address:** This is three-digit ASCII decimal number (0-999), determining which slave device(s) the command is intended for. All three digits must be sent. In the case of the ILA Programmer this will always be 001.

**Separator:** Always present. Because no checksum or message verification techniques are used, slave devices can use this as an extra check on message validity.

**Command Identifier:** Up to four case-insensitive, alpha-numeric characters containing the ASCII name of the relevant command.

**Access Code:** Defines what type of response is expected:
- '=' signifies a *write* operation with the data value to follow
  e.g. !001:OFFS=128<CR>  - sets the Offset potentiometer wiper value to 128

- '?' represents a *read* operation where the host is expecting to receive the value of a particular parameter
  e.g. !001:GAIN?<CR>  - reads back the current wiper position of the Gain potentiometer

- <CR> means the command is an action type (execute)
  e.g. IGNP - increment the offset potentiometer.
  This <CR> acts as the end of frame character and terminates the message. There is no requirement for a further End of frame <CR>.

**End of frame:** A <CR> is always sent to indicate the end of the message.

N.B. this <CR> may be present in the Access Code placeholder (see above and the Command Table below).

### Response Message Formats

There are three possible types of response: acknowledge (ACK), acknowledge with data (for a read), and not-acknowledge (NAK)

- ACK the command was understood and executed successfully.

- ACK-with-data is a decimal number (sign + five digits) followed by <CR>. This confirms a read and returns the data value. A typical successful response example would be: '+00134<CR>' when requesting the Offset potentiometer's wiper position.

- NAK is a '?<CR>' sequence. The device rejected the command.
  There are several possible reasons for a NAK response

- Command identifier not recognised.
- Badly formatted command e.g. missing command identifier, unrecognised access-code character, or unexpected character somewhere else.
- Access attempted but not supported by this command.

N.B. From receipt of the host's terminating <CR> the slave device should respond within 50ms. After this period it can be assumed there will be no response to follow.

### *Command Table:*
N.B. all commands must be preceded with **!001**

| Command Identifier | Description | Access Code | Terminator | Terminator |
|---|---|---|---|---|
| RST | Programmer reset | <CR> (exec) | None | None |
| IOFP | Increment Offset Potentiometer | <CR> (exec) | None | None |
| IGNP | Increment Gain Potentiometer | <CR> (exec) | None | None |
| DOFP | Decrement Offset Potentiometer | <CR> (exec) | None | None |
| DGNP | Decrement Gain Potentiometer | <CR> (exec) | None | None |
| SOFP | Save Offset Potentiometer in EEPROM | <CR> (exec) | None | None |
| SGNP | Save Gain Potentiometer in EEPROM | <CR> (exec) | None | None |
| INHP | Disable writing to EEPROM | <CR> (exec) | None | None |
| ENDP | Enable writing to EEPROM | <CR> (exec) | None | None |
| OFFS | Write Offset Potentiometer with Value | = | Value | <CR> |
| GAIN | Write Gain Potentiometer with Value | = | Value | <CR> |
| OFFS | Read Offset Potentiometer | ? | <CR> | None |
| GAIN | Read Gain Potentiometer | ? | <CR> | None |
| OP1N | Turn output 1 ON | <CR> | None | None |
| OP1F | Turn output 1 OFF | <CR> | None | None |
| OP2N | Turn output 2 ON | <CR> | None | None |
| OP2F | Turn output 2 OFF | <CR> | None | None |
| VER | Programmer version | ? | <CR> | None |
| SERL | Programmer serial number low byte | ? | <CR> | None |
| SERH | Programmer serial number high byte | ? | <CR> | None |
| OFSE | Read Offset Potentiometer value from EEPROM | ? | <CR> | None |
| GAIE | Read Gain Potentiometer value from EEPROM | ? | <CR> | None |
| CTLR | Read Potentiometer Status register | ? | <CR> | None |
| STAT | Digital I/O status byte (sum of binary weighted bits $D_3$-$D_0$): 1 = OUTPUT1 ON/OFF 2 = OUTPUT2 ON/OFF 4 = INPUT1 ON/OFF 8 = INPUT2 ON/OFF | ? | <CR> | None |

# EU DECLARATION OF CONFORMITY

We, the undersigned:

Name of Manufacturer: **Mantracourt Electronics Ltd**

Address: **The Drive, Farringdon, Exeter, Devon, EX5 2JB**

Country: **United Kingdom**

Declare under our sole responsibility that the following products:

**ICA Series**

Is in conformity with the following relevant Union harmonisation legislation:

**LVD directive 2014/35/EU**
**EMC directive 2014/30/EU**
**RoHS directive 2011/65/EU**

Based on the following harmonised standards:

| | | |
|---|---|---|
| **EN 61326-1:2013** | **/** | **IEC 61326-1:2012** |
| **EN 61326-2-3:2013** | **/** | **IEC 61326-2-3:2012** |
| **EN 61010-1:2010** | **/** | **IEC 61010-1:2010** |

Name and position of person binding the manufacturer or authorised representative:

Signed

$C \in$

Name: **Robert Willmington-Badcock**
Function: **Managing Director**
Location: **Mantracourt Electronics Ltd**
Date of issue: **20th July 2017**

# Warranty

All ILA products from Mantracourt Electronics Ltd., ('Mantracourt') are warranted against defective material and workmanship for a period of one (1) year from the date of dispatch.

If the 'Mantracourt' product you purchase appears to have a defect in material or workmanship or fails during normal use within the period, please contact your Distributor, who will assist you in resolving the problem. If it is necessary to return the product to 'Mantracourt' please include a note stating name, company, address, phone number and a detailed description of the problem. Also, please indicate if it is a warranty repair.

The sender is responsible for shipping charges, freight insurance and proper packaging to prevent breakage in transit.
'Mantracourt' warranty does not apply to defects resulting from action of the buyer such as mishandling, improper interfacing, operation outside of design limits, improper repair or unauthorised modification.

No other warranties are expressed or implied. 'Mantracourt' specifically disclaims any implied warranties of merchantability or fitness for a specific purpose.
The remedies outlined above are the buyer's only remedies. 'Mantracourt' will not be liable for direct, indirect, special, incidental or consequential damages whether based on the contract, tort or other legal theory.

Any corrective maintenance required after the warranty period should be performed by 'Mantracourt' approved personnel only.

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| Applies To: | **ILA Product Range** |
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*In the interests of continued product development, Mantracourt Electronics Limited reserves the right to alter product specifications without prior notice.*

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