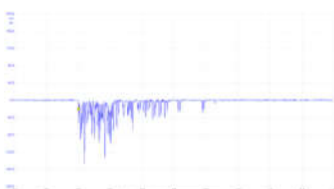
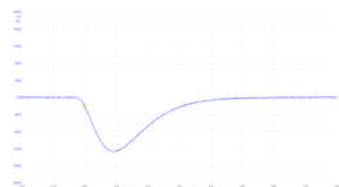
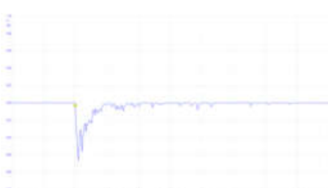
# CP15AF & CP15AL

## Pulse pre-amplifiers

## User Manual



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# 1 Contents

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# 3 Safety Information

CP15 preamplifiers are designed for compliance with harmonized electrical safety standard EN61010-1:2000. It must be used in accordance with its specifications and operating instructions. Operators of the unit are expected to be qualified personnel who are aware of electrical safety issues. The customer's Responsible Body, as defined in the standard, must ensure that operators are provided with the appropriate equipment and training.

The unit is designed to make measurements in **Measurement Category I** as defined in the standard.

Although the CP15 does not generate dangerous voltages, nor are they designed to measure directly such voltages, they may be in applications where such voltages are present. Appropriate precautions must be taken.

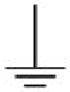
The unit should not be operated unless correctly assembled in its case. Only Service Personnel, as defined in EN61010-1, should attempt to work on the disassembled unit, and then only under specific instruction from Pyramid Technical Consultants, Inc. or their authorized distributors.

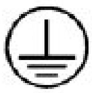
The unit is designed to operate from +/- 12 VDC power rails, with a maximum current requirement of 70 mV on each rail for the CP15. Up to four CP pre-amplifiers can be powered by one C400 pulse counting detector controller. CP pre-amplifiers can also be used in a mixture with the CP15 charge sensitive pre-amplifier / shaping amplifier.

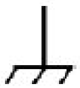
The CP pre-amplifier should be grounded by secure connection to a grounded conducting surface. If the unit is mounted on an insulating surface, then one of the four mounting screw locations must be re-assigned as a grounding connection.

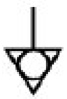
Some of the following symbols may be displayed on the unit and have the indicated meanings.


Direct current

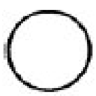

Earth (ground) terminal


Protective conductor terminal


Frame or chassis terminal


Equipotentiality


Supply ON


Supply OFF


CAUTION – RISK OF ELECTRIC SHOCK


CAUTION – RISK OF DANGER – REFER TO MANUAL

# 4 Models

| | |
|---|---|
| CP15AF | Variable gain pulse pre-amplifier optimized for use with sodium iodide scintillation detectors.<br>(FMB-Oxford part CP-15N) |
| CP15AL | Variable gain pulse pre-amplifier optimized for use with lanthanum bromide or lanthanum chloride scintillation detectors.<br>(FMB-Oxford part CP-15L) |

The following options for the CP15AL and CP15AF can be requested at time of order. Jumper settings can be set in the field by trained service personnel.

| | |
|---|---|
| -I/NI | Overall inverting or non-inverting (default is inverting so that photomultiplier pulses give positive-going pulses) |

# 5 Scope of Supply

CP15 model as specified in your order.

USB memory stick containing:

- Data sheet
- User manual
- Test results

Optional items as specified in your order, such as power supplies, cables and adaptors.

# 6 Optional Items

## 6.1 Power supplies and adaptors

PSU1212-L. +24 VDC to +/-12 VDC power supply, input for 2.1mm threaded jack, output 4 pin Lemo 0B.304.


PSU1212-C. +24 VDC to +/-12 VDC power supply, input for 2.1mm threaded jack, output 9 pin DSub female with pinout matching C400 connectors.

PSU1212-N. +24 VDC to +/-12 VDC power supply, input for 2.1mm threaded jack, output 9 pin DSub female with pinout matching NIM standard pre-amp power connectors,

PSU24-25-1. Universal 24 VDC PSU, 25 W, 100-240 VAC 50-60 Hz input via IEC C8 connector, S671K threaded jack output.

Note: If the CP15 is used with a C400, +/-12V power is provided by the C400.

## 6.2 Cables and adaptors

CAB-L00-10-L00 Lemo 00 coax cable assembly, 10’ (3 m). For signal output.

CAB-L00-30-L00 Lemo 00 coax cable assembly, 30’ (9 m). For signal output.

CAB-L304M-10-D9M Power cable assembly, 10’ (3 m). To power CP1x from PSU1212 or C400.

CAB-L304M-30-D9M Power cable assembly, 30’ (9 m). To power CP1x from PSU-B12 or C400.

ADAP-LEMO-BNC Adaptor, Lemo 00 coax plug to BNC jack. For signal output if using BNC-terminated cables.

Other lengths available on request.

# 7 Intended Use and Key Features

## 7.1 Intended Use

The CP15 models are intended to amplify and condition charge pulses generated by scintillation detectors based on photomultipliers. Other detectors that produce similar charge pulses can also use the CP15. The output is suitable for delivery to discriminator circuits and counters, or to multichannel analysers for pulse height spectral analysis. The C400 fast discriminator/counter is able to connect up to four detectors and CP15 pre-amplifiers and provides all necessary low voltage power and high voltage bias.

The CP15AF (also known as the CP-15N in FMB-Oxford Ltd installations) has gain and filtering suited to sodium iodide (NaI(Tl)) scintillation detectors. The burst of fast charge pulses from a single detection event is converted to a single smooth output pulse, well-suited to discrimination or pulse height analysis.

The CP15AL (also known as the CP-15L in FMB-Oxford Ltd installations) as gain and filtering suited to lanthanum bromide ($LaBr_3$) and lanthanum chloride ($LaCl_3$) scintillation detectors. These detectors are considerably faster than sodium iodide detectors (and more expensive) and are preferred for higher count rates. The CP15AL has a corresponding faster response, using filtering that provides a single output pulse per detection event but without compromising pulse pair resolution.

## 7.2 Key Features

Very compact and cost-effective unit with three DC-coupled amplification stages.

Gain and offset control trimpots

Fully bipolar; output can be inverted if required so that output pulses are always positive polarity.

Filtering suited to sodium iodide (CP15AF) or lanthanum halide (CP15AL) scintillation detectors.

Tolerant of long signal input cables.

Output able to drive a 50 ohm load.

Compatible with Pyramid C400 pulse counting detector controller.

# 8 Specification

| ***CP15AF*** | |
|---|---|
| Conversion gain | 1.1 +/-0.05 V per pC at maximum gain setting into 50 ohm load (output pulse height for charge in input pulse)<br>2.4 +/-0.1 V per pC at maximum gain setting into high impedance load (output pulse height to charge in input pulse) |
| Voltage gain | 7000 nominal (+77 dB) into 50 ohm load at maximum gain |
| Gain adjustment range | Zero to maximum, linear 21 turn potentiometer |
| Pulse output rise time | 660 nsec (10% to 90%) |
| Typical output pulse width (59 keV X-ray, NaI scintillation detector) | FWTM 3.6 µsec<br>FWHM 1.9 µsec |
| Unloaded noise | 6 mV into 50 ohm load (@ maximum gain) |
| Output compliance | Up to 3.0 V into 50 ohms, 9.0 V into high impedance |
| Maximum line length | Able to drive at least 10 m of RG-58, RG-174 or RG-318 coaxial cable. |

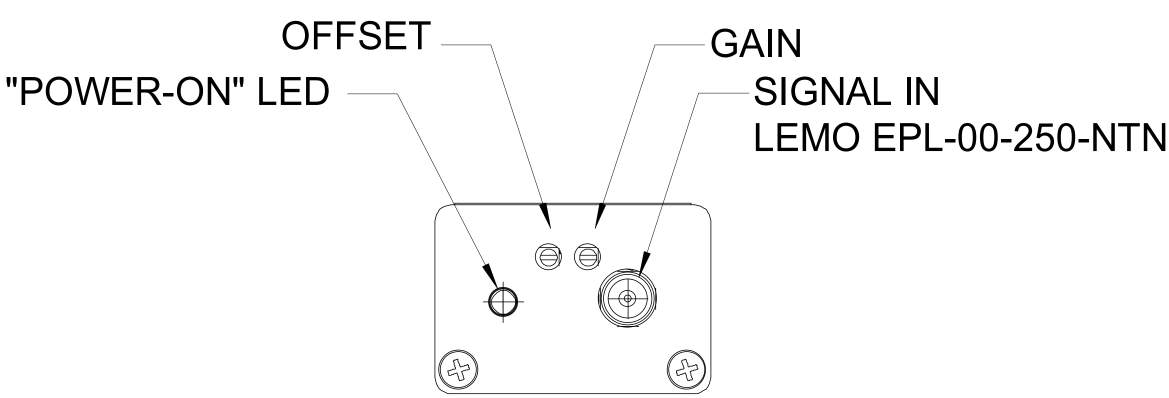
| ***CP15AL*** | |
|---|---|
| Conversion gain | 0.29 +/-0.02 V per pC at maximum gain setting into 50 ohm load (output pulse height for charge in input pulse)<br>0.57 +/-0.02 V per pC at maximum gain setting into high impedance load (output pulse height to charge in input pulse) |
| Voltage gain | 75 nominal (+37.5 dB) into 50 ohm load at maximum gain |
| Gain adjustment range | Zero to maximum, linear 21 turn potentiometer |
| Pulse output rise time | 80 nsec (10% to 90%) |
| Typical output pulse width (59 keV X-ray, $LaCl_3$ scintillation detector) | FWTM 110 nsec<br>FWHM 50 nsec |
| Unloaded noise | 1 mV into 50 ohm load (@ maximum gain) |
| Output compliance | Up to 1.7 V into 50 ohms, 3.6 V into high impedance |
| Maximum line length | Able to drive at least 10 m of RG-58, RG-174 or RG-318 coaxial cable. |

| ***Controls and displays (CP15AF and CP15AL)*** | |
|---|---|
| Controls | 21-turn trimpot (DC offset)<br>21-turn trimpot (gain control) |

| | |
|---|---|
| | Internal jumper for output polarity |
| Displays | Green LED (power on). |

| ***Power (CP15AF and CP15AL)*** | |
|---|---|
| Power input | +12 (+2/-4) VDC, -12 (+4/-2) VDC 70 mA typical, each rail. |

| ***Physical (CP15AF and CP15AL)*** | |
|---|---|
| Case | Al alloy nickel coated with mounting flange. |
| Case protection rating | The case is designed to rating IP43 (protected against solid objects greater than 1 mm in size, protected against spraying water). |
| Weight | 0.085 kg (3.0 oz). |
| Operating environment | 5 to 35 C (15 to 25 C recommended to reduce drift and offset)<br>< 80% humidity, non-condensing<br>vibration < 0.2 g all axes (1 to 100 Hz) |
| Shipping and storage environment | -10 to 50C<br>< 80% humidity, non-condensing<br>vibration < 2 g all axes, 1 to 100 Hz |
| Dimensions | (see figures 1 - 3). |



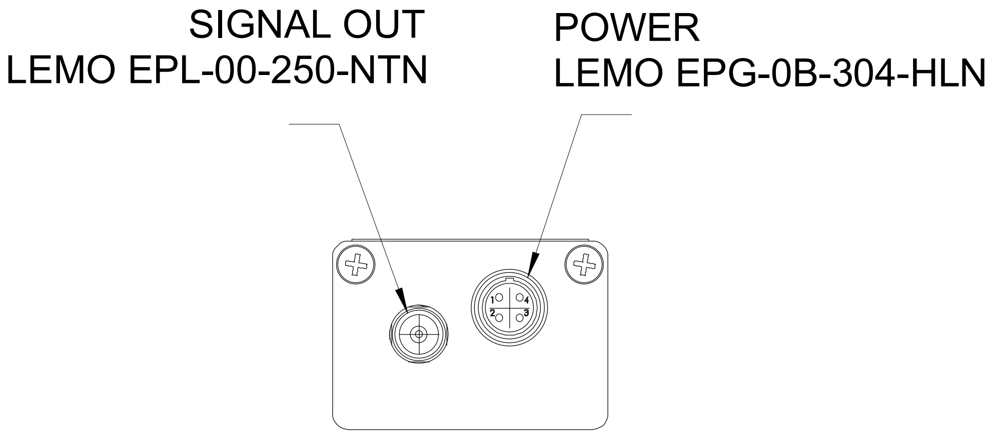



*Figure 1. CP15 case end panels. Dimensions mm.*

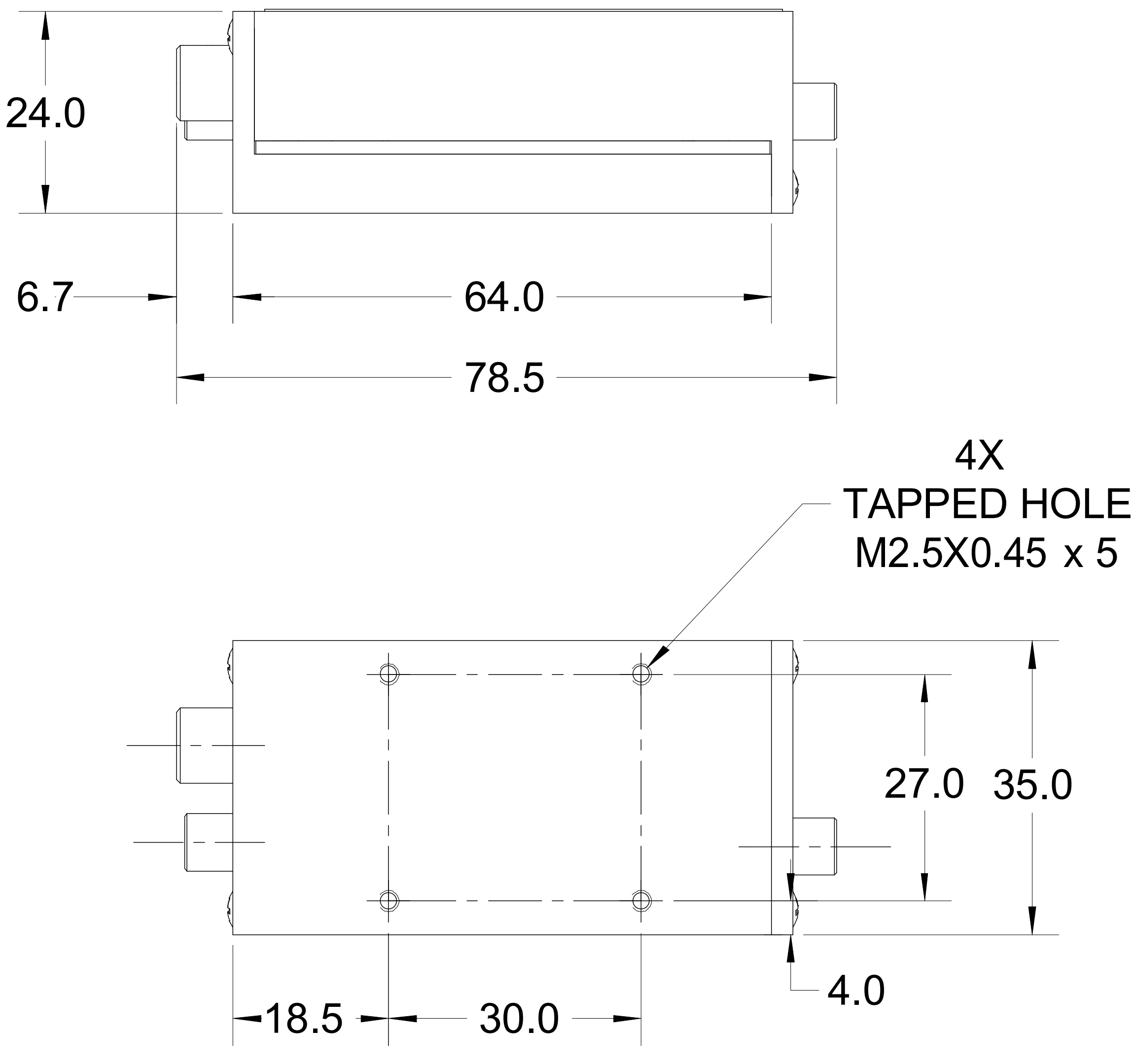



*Figure 2. CP15 underside (showing mounting holes) and side views. Dimensions mm.*

# 9 Installation

## 9.1 Mounting

The CP15 should be located close to the radiation detector to minimize the effect of cable capacitance on noise levels. It may be mounted in any orientation or may be simply placed on a level surface. A fixed mounting to a secure frame is recommended in a permanent installation for best low signal performance, as this can be degraded by movement and vibration. Four M2.5 tapped holes are provided in the base on a 27 mm by 30 mm rectangular pattern.

The mounting position should allow sufficient access to connectors and cable bend radii. Leave 60mm clearance at either end for mating connectors and cable radii.

Best performance will be achieved if the CP15 is in a temperature-controlled environment. No forced-air cooling is required, but free convection should be allowed around the case.

## 9.2 Grounding and power supply

A secure connection should be made via the mounting screws to local ground potential. If the unit is mounted on an insulating surface, then one of the four mounting screws can be re-assigned as a grounding connection.

+12 VDC and -12 VDC power should be provided from a suitably rated power supply with the following minimum performance:

| | |
|---|---|
| Output voltage | +12 (+1/-2) VDC<br>-12 (-1/+2) VDC |
| Output current | <= 100 mA each rail |
| Ripple and noise | < 100 mV pk-pk, 1 Hz to 1 MHz |
| Line regulation | Better than 240 mV |

## 9.3 Connection to equipment

### 9.3.1 Typical setup

The figure below shows a typical installation to read out a scintillation counter. The connection between the detector and the CP15 should be kept relatively short if possible. The connection from the CP15 to the readout device can be long provided that the cable is 50 ohm impedance and terminated in 50 ohms at the readout device.

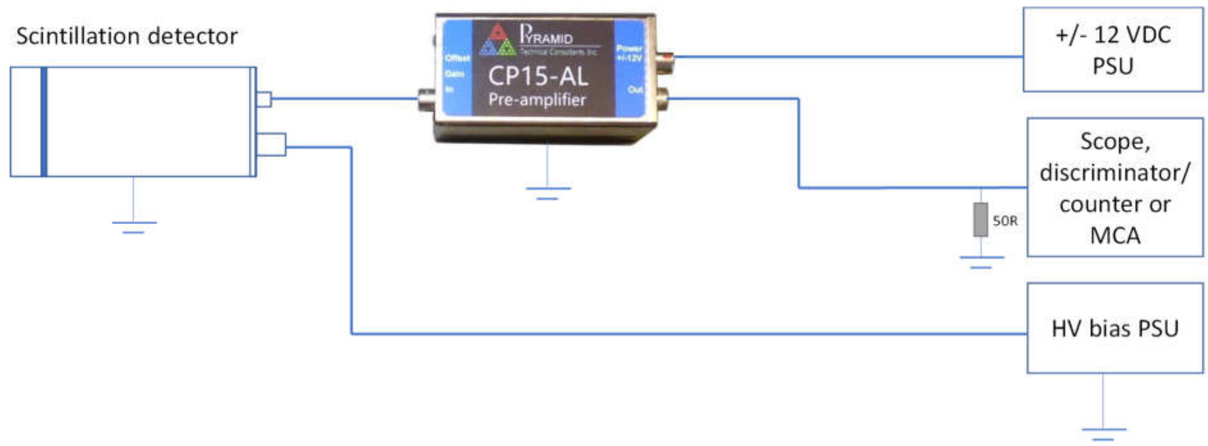



*Figure 3. Schematic CP15 installation for readout of a scintillation detector*

The charge pulse from a scintillation detector is electrons, thus negative polarity. The CP15 can handle positive or negative input pulses, but some readout devices might require a positive going pulse. To set the CP15 to be overall inverting so that negative input charge gives a positive voltage, the internal polarity jumper should be set to the default INV position.

### 9.3.2 Setup with the C400

The C400 is a partner product to the CP15. It provides pulse discrimination and counting electronics for four independent channels, each of which provides the bias, pre-amp power and signal processing for a detector system. Detector types can be mixed. The CP15 is well-suited as a preamplifier for the C400 but can of course be used with other pulse handling electronics also.

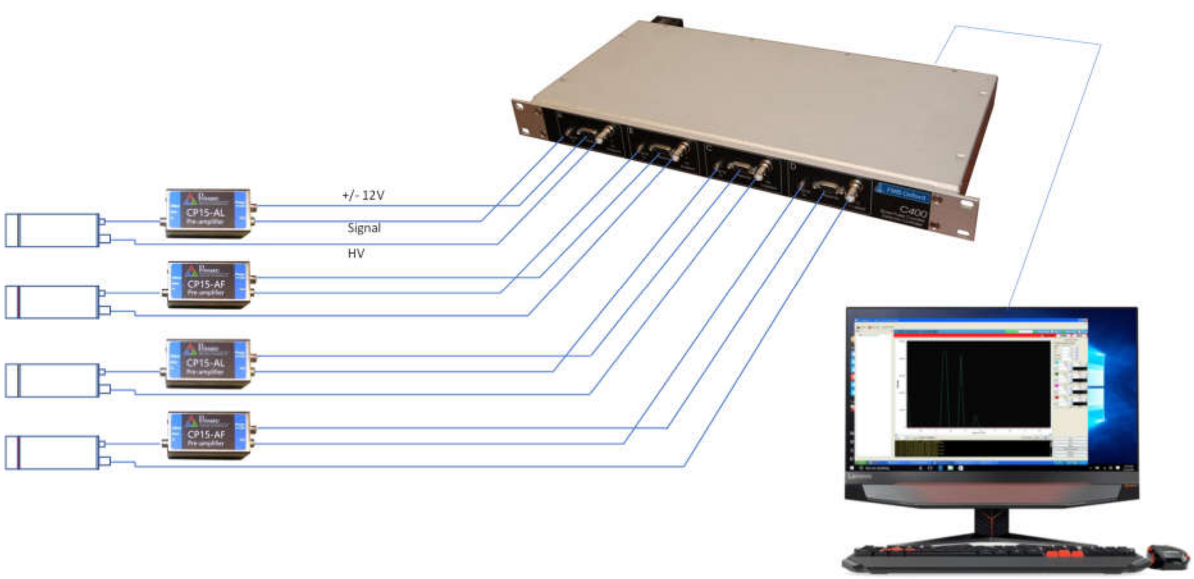



*Figure 4. Using the CP15 with the C400*

### 9.3.3 Effect of cable length

It is generally good practice to minimise signal cable lengths as far as practicable, in order to mitigate noise and signal distortion.

The cable from the CP15 output to the receiving electronics can be long, provided it has the correct 50 ohm impedance and is terminated in 50 ohms at the receiver.

The cable from the detector to the CP15 should be short if possible, although the CP15 is relatively tolerant of longer input cables when used with photomultiplier scintillation detectors. Longer cable can alter the pulse amplitude and the signal level. The following plots shows the measured amplitude and the rms noise level changed relative to a short cable as a function of coaxial length between the scintillation detector and the CP15.

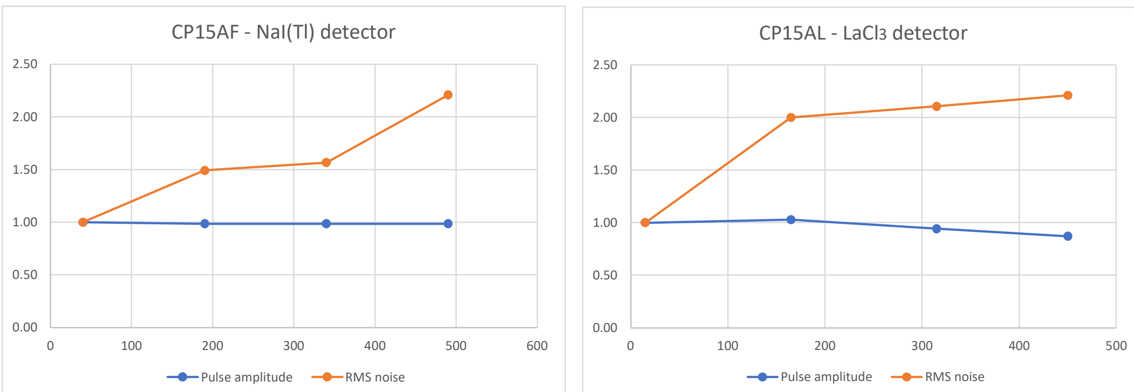



*Figure 5. Effect of input cable length on output pulse amplitude and rms noise level*

# 10 Comparison of CP15AF and CP15AL

An ideal scintillation detector would generate a single short pulse of charge for each ionizing photon or particle that interacts in the scintillating material. In fact the interaction is more complicated. If the detector signal is examined with a very high bandwidth measurement system, it appears as a burst of charge pulses. This is particularly evident for sodium iodide detectors but is also present for lanthanum halide detectors.

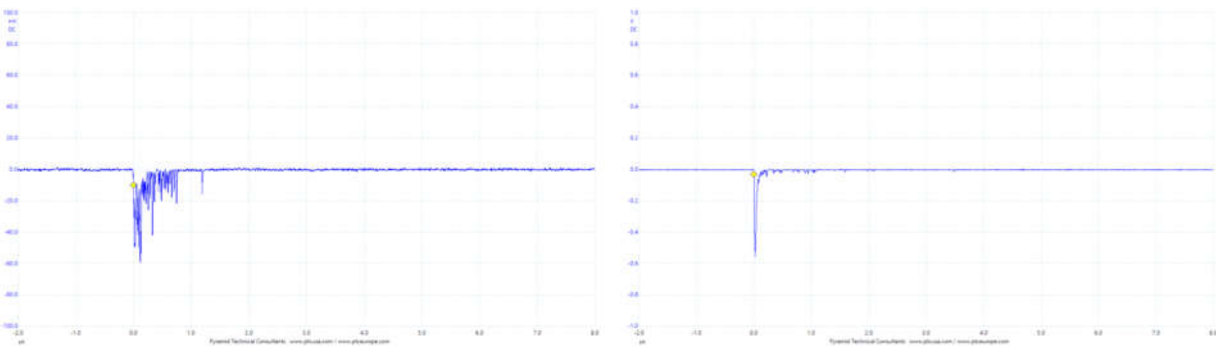


*Figure 6 Output for a single 59.6 keV X-ray event from a NaI detector (left) and a $LaCl_3$ detector (right) measured with a high bandwidth CP10B preamp; 1 µsec per division.*

The role of the CP15 preamplifier is to collect this burst of pulses into a single clean pulse that is suitable for counting and pulse height analysis. The CP15AF has a time constant large enough to collect all the output charge from a sodium iodide detector into a single output pulse. It will perform the same task for a lanthanum halide detector, but the speed advantage of the lanthanum halide will be lost.

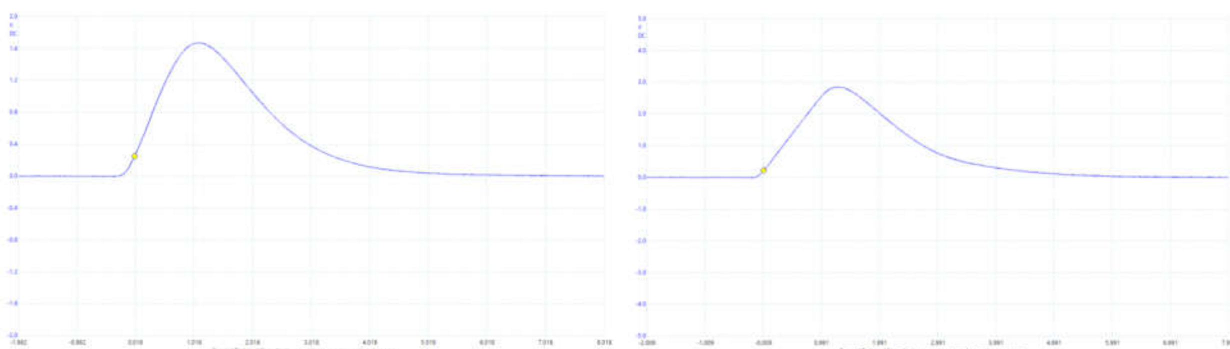


*Figure 7 Single output for a 59.6 keV X-ray event from a NaI detector (left) and a $LaCl_3$ (right) measured with CP15AF preamp; 1 µsec per division.*

The CP15AL is a faster circuit. It maintains the speed of the lanthanum halide detector while providing gain and a small amount of filtering to smooth the pulse for pulse height discrimination. If used with sodium iodide, too much of the underlying pulse structure is still evident, so this is not a recommended combination.

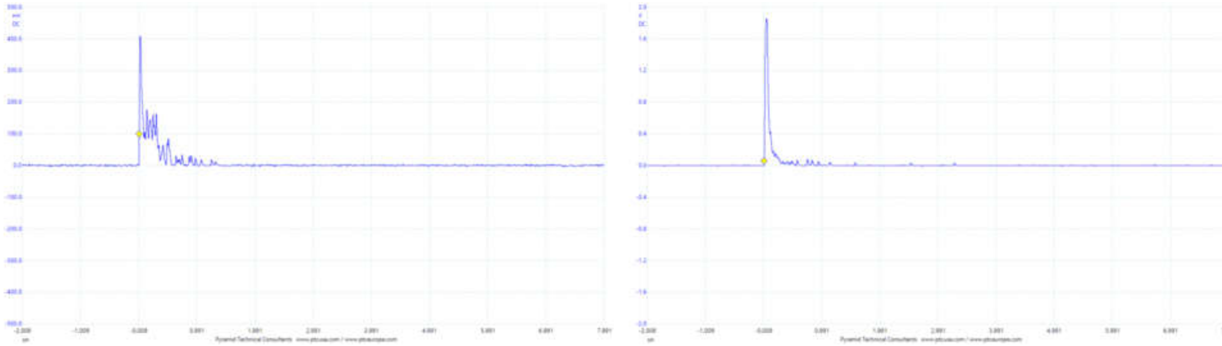


*Figure 8  Single output for a 59.6 keV X-ray event from a NaI detector (left) and a $LaCl_3$ (right) measured with CP15AL preamp; 1 µsec per division.*

# 11 Circuit overview

The simplified schematics below shows the functional blocks of the two CP15 models.

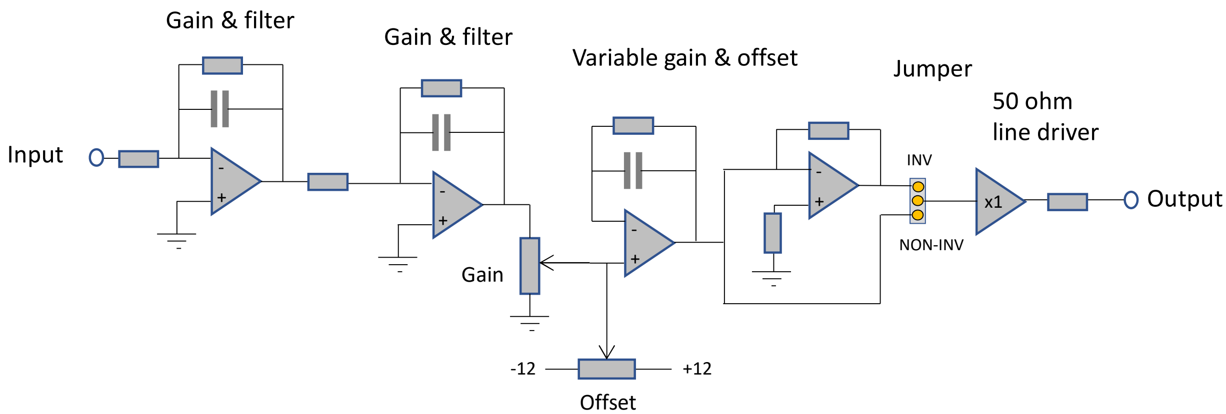



*Figure 9. CP15AF simplified block schematic.*

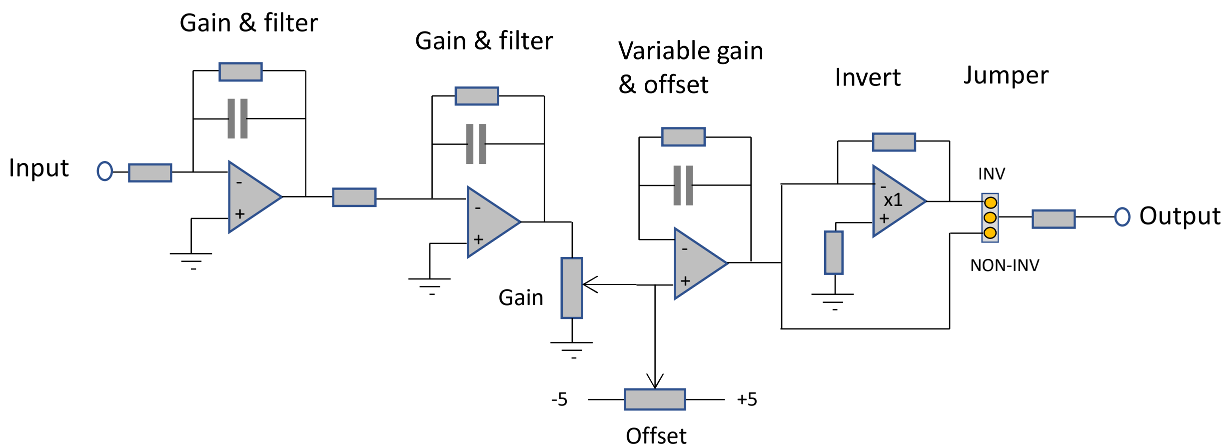



*Figure 10. CP15AL simplified block schematic*

The voltage developed by the signal charge pulse is amplified in three DC-coupled stages. The gains of the stages are larger in the CP15AF, but the capacitance values in the feedback provide more low pass filtering to provide a smooth output pulse. The CP15AL has lower total gain and less feedback capacitance on each stage and uses fast amplifiers throughout so that the much shorter pulses of lanthanum halide detectors are not broadened significantly, permitting higher count rates.

A resistive divider gain control between the second and third gain stages allows the overall gain to be adjusted. The offset potentiometer provides an adjustable voltage to compensate any DC offset. A fourth inverting amplifier stage has unity gain and the signal going to the output can be taken before or after it thus providing a choice of overall inverting or non-inverting response.

The CP15AF has a unity gain line driver matched to 50 ohms that allows large output pulses to be driven down long 50 ohm coaxial lines.

Incoming +/-12 V power is filtered and linear regulators produce the additional +/- 5 V rails required.  A LED confirms that the -5 V supply is present.

# 12 Setup and Calibration

## 12.1 Gain setting

The photomultiplier tube in a scintillation detector provides the large gain that converts the faint light from a single detection event into a readily measurable pulse of electrons. The amount of gain is determined by the high voltage applied to the photomultiplier in a non-linear fashion. Although it is possible to see low energy detection events by applying sufficient voltage, there are limitations:

- the tube will have a maximum allowed voltage

- as the voltage is increased, random “dark current” pulses released spontaneously become more frequent and larger, leading to unwanted background.

The adjustable gain of the CP15 allows the photomultiplier voltage to be set at a safe level with acceptable background signal. The pulse height of the signals of interest can then be set into a convenient range by adjusting the gain trimpot. A clockwise rotation of the trimpot increases the gain between zero and the maximum.

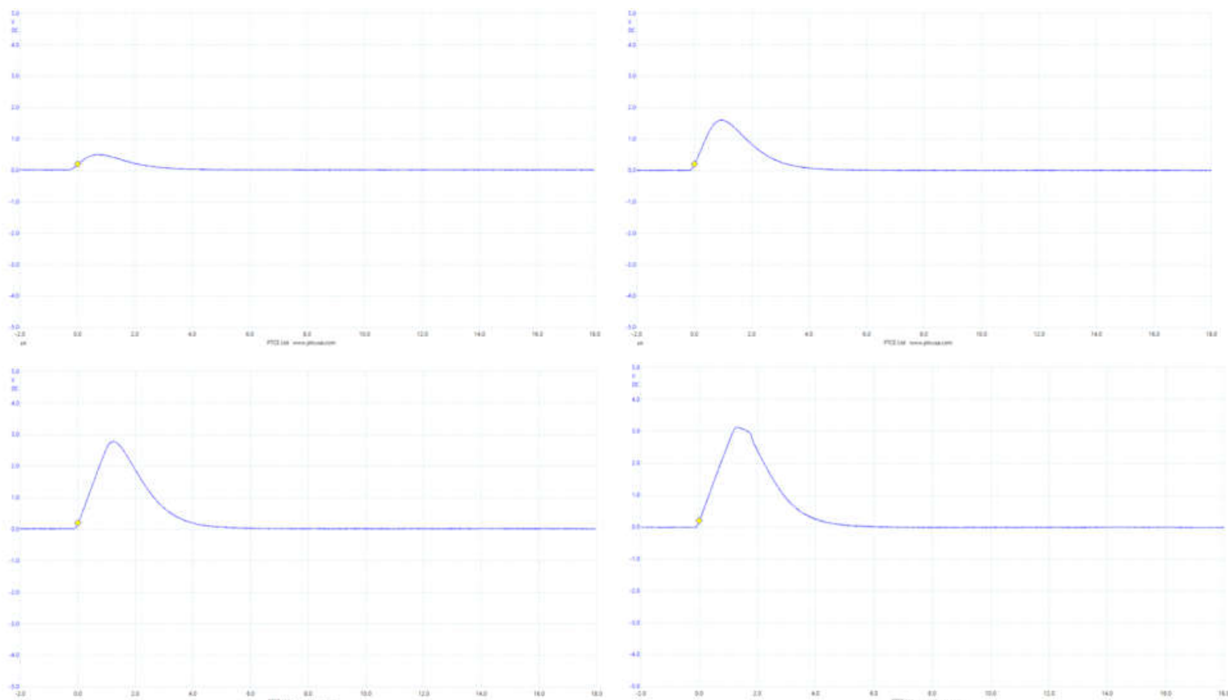


*Figure 11 CP15AF increasing gain setting, showing saturation onset in the final view*

## 12.2 Offset correction

The offset trimpot should be adjusted as necessary to remove any residual DC offset on the output. This can be observed by looking at the output signal on an oscilloscope. The offset is slightly coupled to the gain setting, more noticeably for the CP15AF. After setting the desired gain, adjust the offset to return the baseline to zero volts.

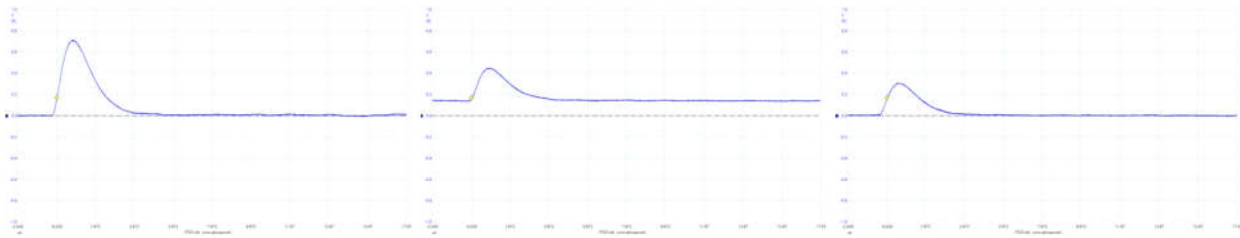


*Figure 12 Adjusting offset after adjusting gain for CP15AF*

## 12.3 Conversion gain

The conversion gain from coulombs of input charge to output pulse height can be determined if required using a test capacitor. Mount a 1.0 pF +/- 0.05 pF capacitor in a screened metal box, taking care to minimise parasitic capacitance.


*Figure 13 Setup for conversion gain calibration*

A 1.0 volt peak-peak square wave with fast risetime delivered to this test box will deliver a charge of 1.0 +/- 0.05 pC to the CP15 at each transition of the square wave, producing a series of positive and negative charges which in turn give a series of positive and negative going pulses.

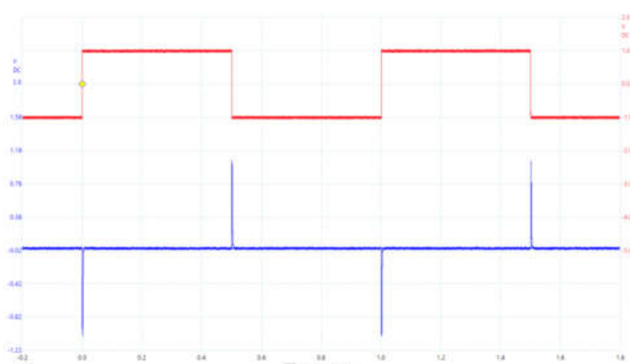


*Figure 14 Square wave into test capacitor and resulting charge pulses measured by the CP15.*

The conversion gain at the particular trimpot gain setting of the CP15 is the measured amplitude of the output pulses divided by the known input charge from the test capacitor. If the conversion gain is measured at the maximum trimpot setting, then it will reduce linearly as the trimpot is rotated anticlockwise.

## 12.4 Energy calibration

The amplitude of the output shaped signal will be linear with the charge in the input pulse up until the CP15 output saturates. If the amount of charge from the detector is also linear with the energy of the radiation, then the system can be calibrated as an energy analyser. You will need to know at least one point to establish the calibration.

As an example, you can calibrate a system comprising scintillation detector and the CP15AF using a suitable radiation source. A convenient source is the Am-241 isotope which generates a 59.6 keV gamma ray which will create a peak at the high energy end of a pulse height spectrum. If the application uses lower energy radiation, then the 5.9 keV X-rays from an Fe-55 source can be used as the reference.

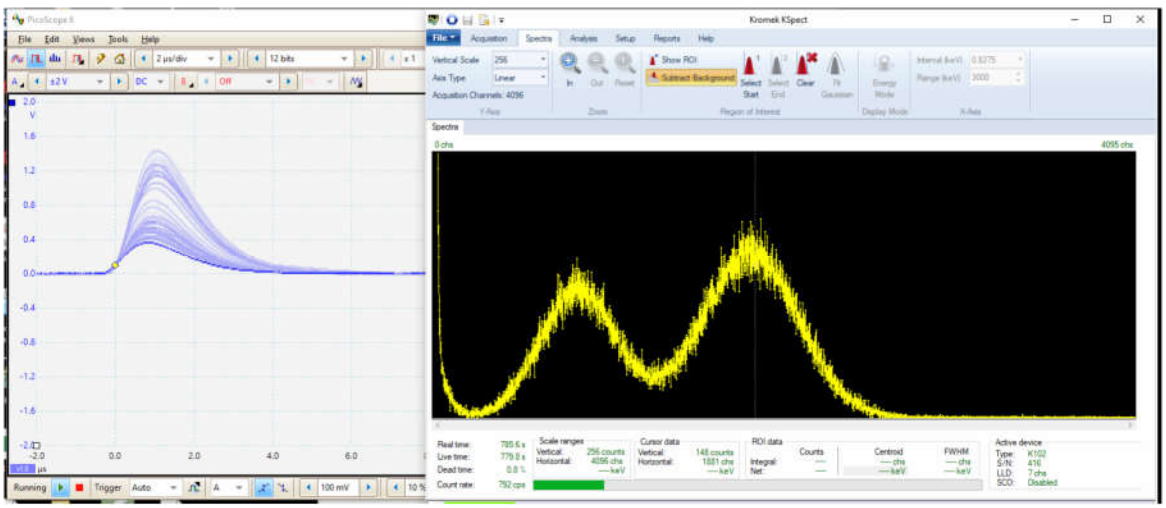


*Figure 15. Measured pulse height spectrum for Am-241 gammas, NaI scintillation detector and CP15AF*

Unknown X-ray peaks can then be assigned their energy by simple linear scaling relative to the known peak.

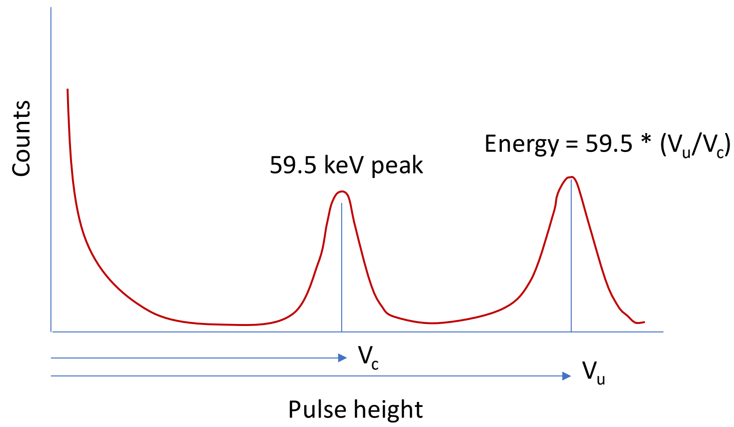
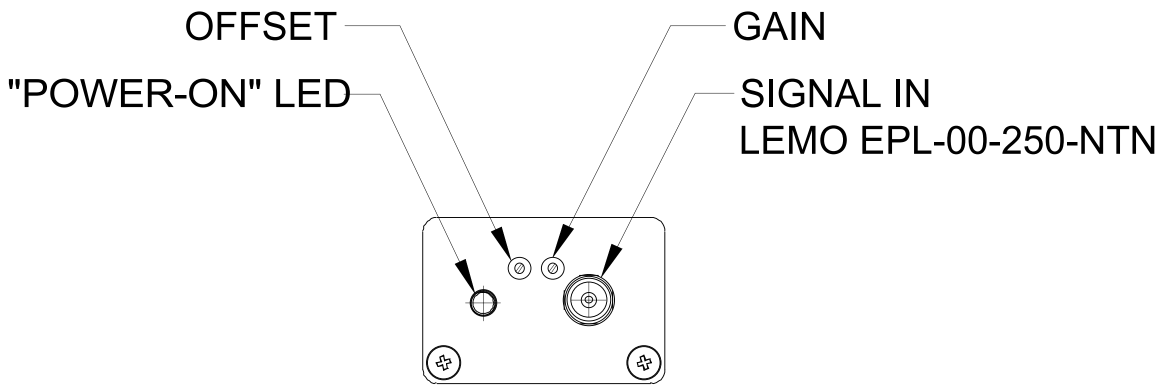



*Figure 16. Determination of energy by linear scaling*

# 13 Connectors, controls and indicators

## 13.1 Input end connectors, controls and indicators



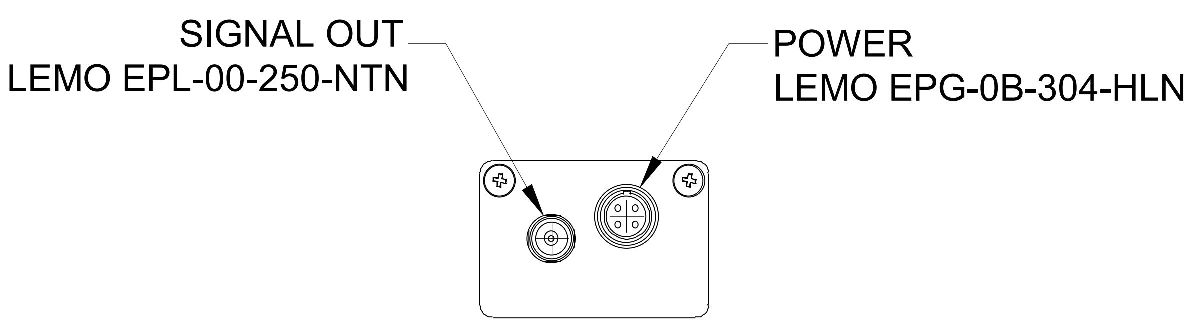

Lemo 00 coaxial connector (NIM-CAMAC CD/N 549) for detector signal input.

Green LED illuminated when CP15 is powered.

21-turn linear trimpot adjusting DC offset of output signal.

21-turn linear trimpot adjusting gain from zero to maximum.

## 13.2 Output end connectors

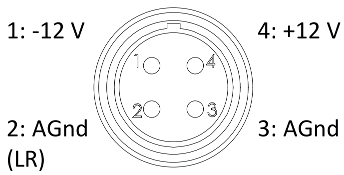



### 13.2.1 Out

Lemo 00 coaxial connector for signal output. Typical mating free connector Lemo FFA.00.250.

### 13.2.2 Power +/- 12 V

Lemo 0B four pin female, typical mating free connector FGG.0B.304.




View external looking on connector

Connector body and pin 3 connects directly to CP15 analog ground. Pin 2 connects to analog ground via ferrite bead.

## 13.3 Internal settings

We do not recommend that you open the CP15 case unless specifically instructed to do so by your supplier or Pyramid Technical Consultants, Inc. It is possible to damage the circuits or degrade noise performance if correct handling precautions are not employed.

The following information is provided for reference. To open the case, remove two M2.5 hex cross head screws from each end of the case. The top of the case can then be removed to reveal the circuit. A 2 mm jumper near the output sets the relationship between the input signal polarity and the output signal polarity.

| | |
|---|---|
| INV | Output voltage is the opposite polarity to the input charge (default configuration) |
| NONINV | Output voltage is the same polarity as the input charge |

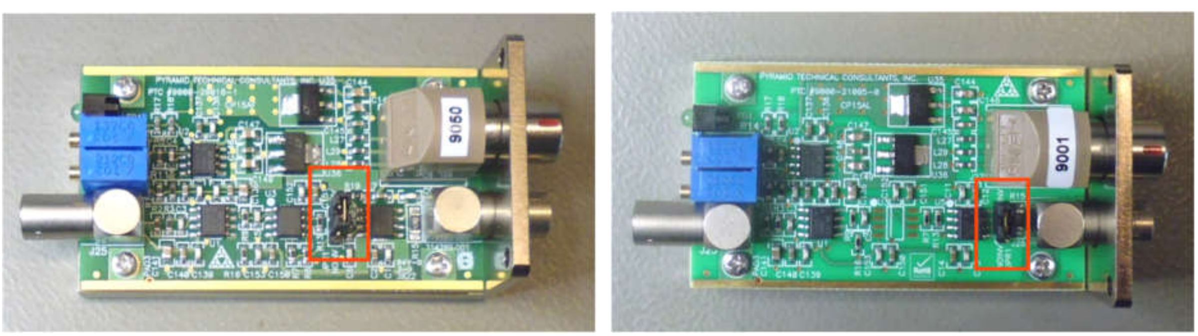



*Figure 17. Location of internal jumpers; left CP15AF, right CP15AL.*

# 14 Fault-finding

| Symptom | Possible Cause | Confirmation | Solution |
|---|---|---|---|
| No output pulses seen | No signal from detector. | Connect known good signal source. | Correct any detector or radiation source issue |
| | Very low pulse rate | Set up oscilloscope to capture individual events. | Increase radiation flux if possible. |
| | Insufficient gain | Look for pulses with oscilloscope. | Increase gain setting.<br>Increase detector gain if possible (photomultiplier voltage).<br>Reduce threshold of pulse counting discriminator circuits if possible. |
| | Wrong output pulse polarity – scalers and MCAs generally require positive polarity shaped pulses. | Check output pulse polarity with oscilloscope | Change CP15 internal polarity jumper setting. |
| | No power to CP15. | Check power LED, check voltages | Correct power supply. |
| | Polarity jumper not in place | Check that jumper is fitted to INV or NONINV position | Fit jumper as required. |
| | Missing HV bias voltage to detector | Check voltage. | Supply correct bias voltage for the radiation detector. |
| | CP15 input damaged. | Use test input to inject a signal. | Arrange for repair. |
| Output pulses distorted | Output saturating. | Check output pulse shape with | Use appropriate gain setting. |

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|---|---|---|---|
| | | oscilloscope. Reduce gain or reduce input signal size. | |
| | Reflections in long output cable. | Check cable termination. | Use 50 ohm termination at receiving device if cable is long. |
| Pulse heights differ by a factor of two from expected values. | Incorrect terminating resistance on readout device for CP15 pulse output. | Check impedance at readout device. | Use correct impedance. 50 ohms is recommended for long transmission lines. |
| Output has DC offset | Offset trim is incorrect. | Adjust trimpot to remove offset. | Adjust trimpot to remove offset. |
| Unexpected pulses | Cosmic rays or other background seen by detector. | Turn off detector bias to see that pulses stop.<br>Move away from radiation background. | Move detector or add shielding if possible.<br>If cosmic ray rate is significant for the measurement, add a coincidence detector system to reject cosmic ray events. |
| | Multiple pulses from detector for a single event appearing at CP15 output. | Look at individual events on CP15 output. | Use the appropriate CP15 model: CP15AF for slow detectors like NaI, CP15AL for fast detectors like $LaBr_3$, $LaCl_3$. |

# 15 Maintenance

The CP15 does not require routine maintenance or calibration. There is risk of contamination which may degrade performance if the case is opened in an uncontrolled environment. If you need to access the unit to change jumper settings, check first with your supplier or direct with Pyramid for guidance.

# 16 Returns procedure

Damaged or faulty units cannot be returned unless a Returns Material Authorization (RMA) number has been issued by your supplier or Pyramid Technical Consultants, Inc. If you need to return a unit, contact your supplier or Pyramid Technical Consultants at support@ptcusa.com, stating

- model
- serial number
- nature of fault

An RMA will be issued, including details of which service center to return the unit to.

# 17 Support

Documentation updates are available for download from the Pyramid Technical Consultants website at **www.ptcusa.com**. Technical support is available by email from support@ptcusa.com. Please provide the model number and serial number of your unit, plus relevant details of your application.

# 18 Disposal

We hope that the CP15 gives you long and reliable service. The CP15 is manufactured to be compliance with the European Union RoHS Directive 2002/95/EC, and as such should not present any health hazard. Nevertheless, when your device has reached the end of its working life, you must dispose of it in accordance with local regulations in force. If you are disposing of the product in the European Union, this includes compliance with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC. Please contact Pyramid Technical Consultants, Inc. for instructions when you wish to dispose of the device.

# 19 Declaration of Conformity

## Declaration of Conformity

Issued by: Pyramid Technical Consultants, Inc.
135 Beaver Street, Suite 102, Waltham MA 02452, USA

The undersigned hereby declares, on behalf of Pyramid Technical Consultants, Inc. that the referenced product conforms to the provisions as listed. Refer to the document: *Extension of testing and analysis to the PTC product line, December 10, 2007,* and its continuations, and the *I400 Technical Construction File* for detailed testing information.

| | |
|---|---|
| Product: | CP15AF and CP15AL pulse preamplifiers |
| Year of initial manufacture: | 2021 |
| Applicable Directives: | 73/23/EEC Low Voltage Directive:<br>Laws for electrical equipment within certain voltage limits<br><br>89/336/EEC – EMC Directive:<br>Laws relating to electromagnetic compatibility |
| Applicable Standards: | IEC 610101:2002 (2nd Edition)<br>UL 61010-1:2004<br>EN 61326: 1997+A1:1998+A2:2001<br>EN 55011:1998, A2:2002<br>EN 61000-6-2:2001 – Electromagnetic Compatibility<br>Generic Standard, Immunity for Industrial Applications |
| Issuing Agencies: | Safety: TUV Rheinland North America.<br>12 Commerce Rd, Newtown, CT 06470 USA<br><br>EMC: TUV Rheinland North America.<br>12 Commerce Rd, Newtown, CT 06470 USA |
| Applicable Markings: | TUV, FCC, CE |
| Authorized by: | President, Pyramid Technical Consultants, Inc. |
| Date: | September 27, 2022 |

The Technical Construction File required by theses Directives are maintained at the offices of Pyramid Technical Consultants, Inc, 135 Beaver Street, Suite 102, Waltham MA 02452, USA

# 20 Revision History

The release date of a Pyramid Technical Consultants, Inc. user manual can be determined from the document file name, where it is encoded yymmdd. For example, M10_UM_080105 would be a M10 manual released on 5 January 2008.

| ***Version*** | ***Changes*** |
|---|---|
| CP15_UM_220929 | First general release |
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