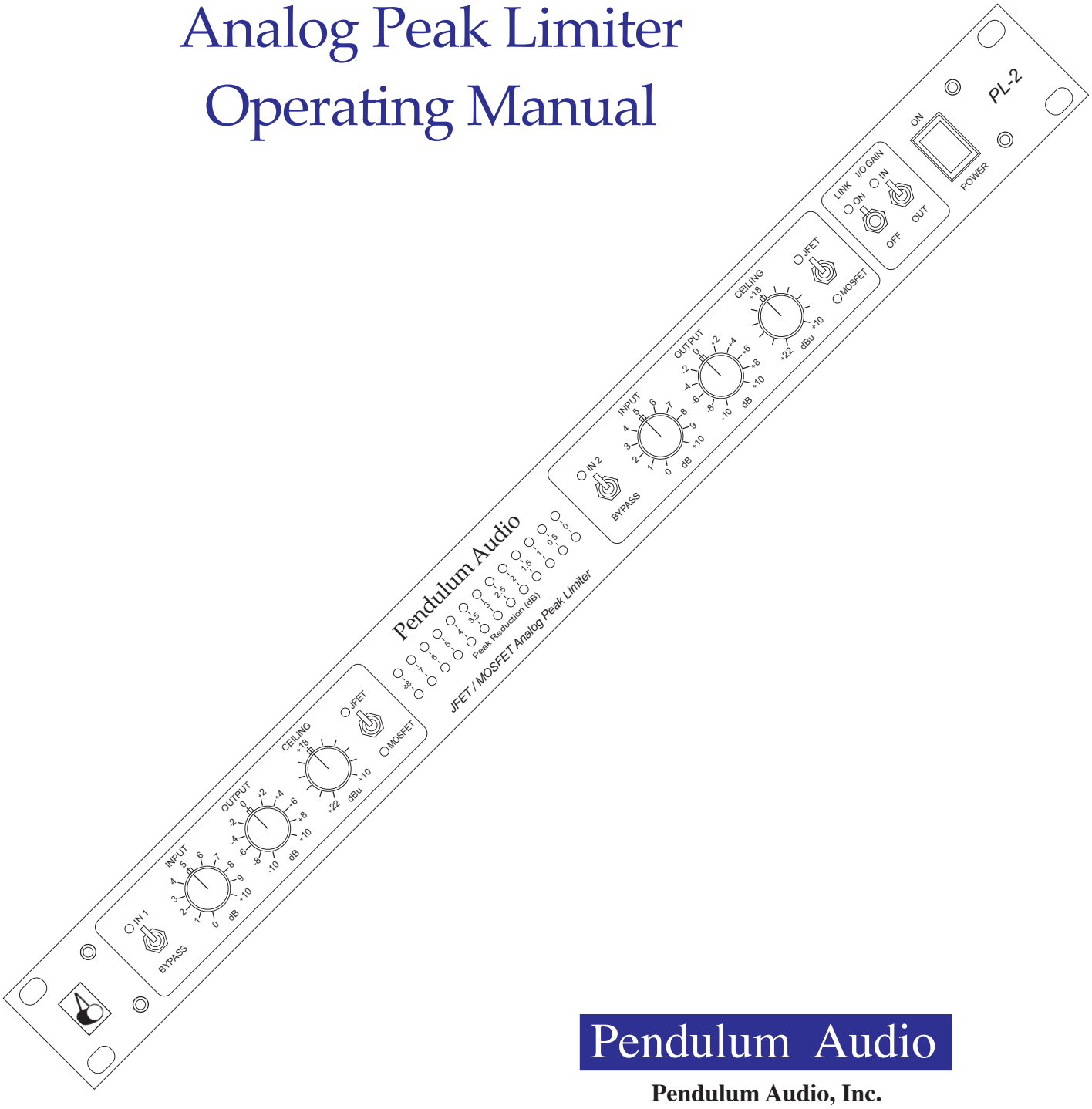
PL-2 Brickwall
Analog Peak Limiter
Operating Manual



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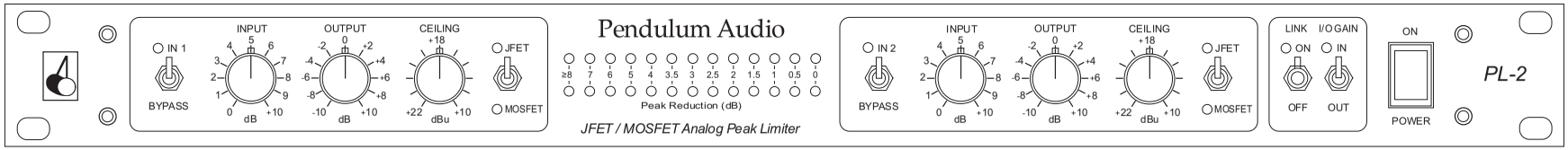
PL-2 Condensed Operating Instructions



IN/BYPASS

With the switch in the 'IN' position, the peak limiter activated, and the LED near the switch is illuminated. When in 'BYPASS', the PL-2 is entirely out of the signal path.

INPUT

The INPUT control is an 11 position stepped switch that increases the gain of the input stage in 1dB increments from 0 (unity) to +10dB.

OUTPUT

The OUTPUT control is an 11 position stepped switch that increases the gain from 0 (unity) to +10dB, or decreases the gain from 0 (unity) to -10dB in 2 dB increments.

CEILING

The CEILING control determines the signal level at which the peak limiter is activated. It can be set from +22dBu to +10dBu. This encompasses the range of 'digital zero' most often encountered with typical A/D converters, as well as having additional margin for using the peak limiter creatively at lower levels. When the OUPTUT is set at unity gain, the CEILING control sets the maximum output level.

JFET/MOSFET

The JFET/MOSFET switch determines which type of device is doing the peak limiting. The JFET gives a stiffer form of limiting, while the MOSFET is more forgiving.

LINK

This switch links the two channels for stereo operation. The IN/BYPASS, CEILING and JFET/MOSFET controls are linked and controlled by Channel 1. The INPUT and OUTPUT controls are not linked and must be set individually.

I/O GAIN

This switch is a global bypass of the INPUT and OUTPUT gain stages. It shortens the signal path of each channel, and calibrates the maximum output level to the threshold established by the CEILING control. This mode is useful for mastering applications.

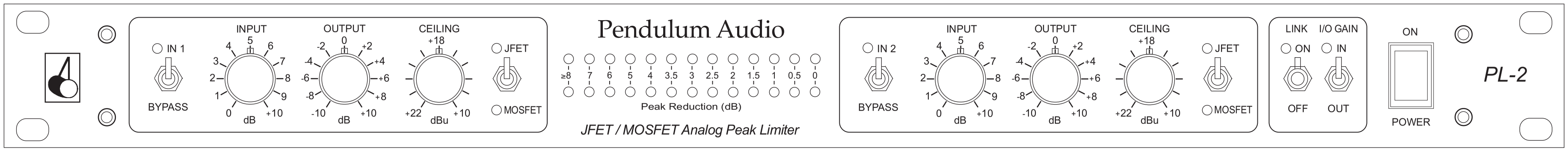
LED Display

The 13-segment LED display gives a true indication of the amount of peak limiting applied to the signal. It displays the amount of peak reduction in 0.5 dB increments from 0 to -4dB, and 1 dB increments from 4 to greater than -8 dB. The LED ladder uses a 3-color scheme to indicate how audible the peak limiting might be on transient source material.

Multi-Unit Link

The MASTER OUT and SLAVE IN jacks permit the linking of several units for multi-channel applications. Connect the MASTER OUT from one unit to the SLAVE IN of all linked units. When all units switched to 'Link', the CEILING control of Channel 1 of the master unit sets the ceiling of all slave units. The INPUT and OUTPUT controls are not linked and must be set individually.

PL-2 Front Panel Templates



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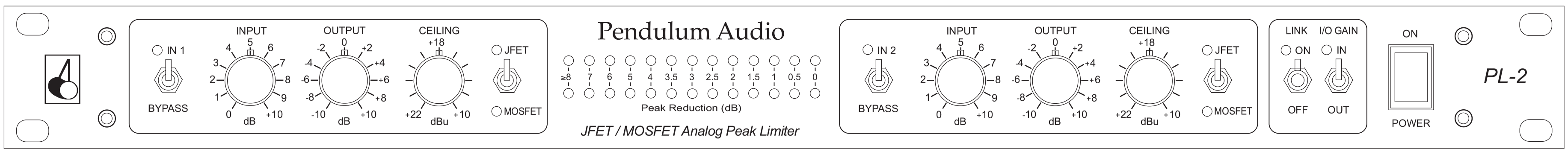

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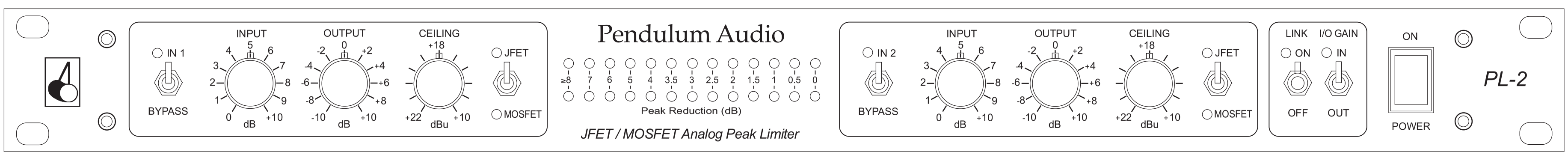

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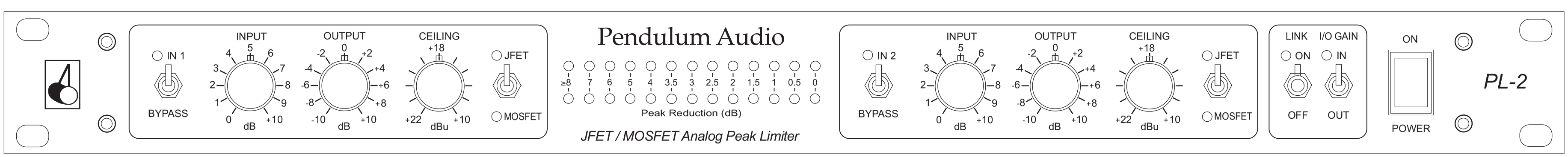

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PL-2 Brickwall Analog Peak Limiter

Features

- Two independent channels with stereo link
- JFET (hard) and MOSFET (soft) peak limiting modes
- Limiter circuit ‘switched out’ of the signal path when below threshold
- Precise readout of peak reduction
- Stepped input and output gain controls ideal for mastering or session recall
- I/O gain stages can be bypassed to shorten signal path
- Multiple units can be linked for multi-channel applications
- Active-balanced inputs and outputs
- Gold-plated switch contacts and I/O connectors
- Audiophile-grade passive components
- 120V or 240V ac voltage switch on the rear panel.

Introduction

Thank you for purchasing the Pendulum PL-2, a stand-alone two channel version of the very popular peak limiter in our Quartet II Tube Recording Channel. It uses a novel approach to brickwall limiting in the analog domain, one that is fast enough to prevent digital overs without using time delay or phase-shift delay techniques. This allows us to keep the analog signal path short, and keep the limiting circuit 'switched out' of the signal path below the peak limiting threshold. Distortion for all levels below the limiting threshold is low, and does not rise as the threshold for limiting is approached. Unlike analog peak clippers, which chop off the top and bottom of the waveform, our limiter retains dynamic information at the top of the peak. And unlike digital limiters, there is no latency, so it can be used as an insert on an analog mix!

The PL-2 has two modes of peak limiting, using either junction field-effect transistors (JFET) or metal-oxide semiconductor field effect transistors (MOSFET) as the control elements. While both are equally capable of brickwall limiting, each type has its own characteristic sound. The JFET tends to be a stiffer, harder mode of limiting, while the MOSFET has a softer, more compliant response. The resulting waveforms look different, and each device has its own characteristic sound.

The two channels for the PL-2 can be linked for stereo or used independently. Multiple units can be linked via the Master/Slave jacks on the rear panel, making it ideal for multi-channel processing.

In addition, Input and Output gain controls allow the user to scale the gain structure for a wide range of applications, from driving the front end of an A/D converter at +20 dBu, to inserting it as an effect into a +4 dBu patch bay. The I/O gain stages can be bypassed globally to shorten the signal path for mastering applications. Each channel also has an expanded 13 segment LED display that accurately indicates peak reduction.

Unpacking

The unit was carefully packed at the factory to protect against damage in transit. Nevertheless, be sure to inspect the unit and shipping carton for any signs of damage that may have occurred during shipment. If there is any damage, notify us immediately for further instructions. It’s also a good idea to save the carton and packing materials should you ever need to return the unit for repair. The shipping carton should contain the following items: the PL-2 Analog Peak Limiter, an IEC 3 prong power cord, and this operating manual.

Mounting

The PL-2 uses one EIA-standard rack space, and can be mounted in any standard 19 inch (483mm) equipment rack. If the PL-2 is mounted in a mobile rack or road case, it is important that the rear of the chassis is supported to prevent possible damage from mechanical shock and vibration. Please avoid rough handling.

Ventilation

For proper operation, it is important that adequate ventilation is provided. Heat generated inside the unit is radiated out through the ventilation holes in the side panels. Do not block these vents. Never operate the PL-2 inside a road case where the side panels are blocked.

Power Requirements

The PL-2 is equipped with a 3-prong IEC power connector and detachable cord. Never operate the PL-2 with the ground on the power cord defeated. Unless otherwise stated, this unit operates from either 115-120V/60 Hz or 230-240V/50 Hz at 16W. Before the unit is plugged in, select the correct ac voltage using the switch adjacent to the IEC inlet on the rear panel. The ac fuse is accessible within the rear panel IEC input jack and is rated at 1.5A/250V (5x20mm) SLO-BLO. To check or replace the fuse, unplug the power cable from the IEC input jack.

Servicing

The user should not attempt to service the PL-2 beyond replacing the fuse. To reduce the risk of fire or electrical shock, do not expose to rain or moisture, or operate it where it is exposed to water. Since potentially lethal voltages are present inside the unit, it should only be opened by qualified service personnel. Refer all servicing, or any questions about servicing, to Pendulum Audio, Inc.

Hookup

Please refer to the rear panel layout (see the Condensed Operating Instructions) for the location of the inputs, outputs, ac power inlet and power switch. Make all connections to the PL-2 and select the proper ac voltage before applying power.

Inputs and Outputs

On the right hand side of the rear panel are the XLR input and output jacks for channels 1 and 2. Connect line-level sources to the PL-2 using standard balanced XLR cables. Pin 1 = ground. Pin 2 = + (positive phase), pin 3 = - (negative phase). Note: Do not connect the outputs of the PL-2 to an input that has +48V phantom power applied to it.

Multi-Unit Link

The two 1/4" jacks on the rear panel located to the left of the XLR I/O connectors are used to link several PL-2 units for multi-channel applications.

Master Out: Use this jack to connect the PL-2 designated as the 'master' unit to the Slave IN inputs of the PL-2 slave units. Multiple slave units may be fed from this Master output by using 'Y'-cables. This jack is half-normalled to the Slave Input.

Slave In: Use this jack to connect slave units to the Master Output of the PL-2 master unit. This jack is half-normalled to the Master Out.

AC Power

- On the left side of the rear panel is the IEC input socket. Connect to a 120V/60Hz or 230V/50Hz receptacle with the 3-prong IEC power cable supplied with the PL-2. Set the ac voltage switch for the correct line voltage before connecting the PL-2 to the ac line. For safety reasons, do not lift the ground on the power plug by using a 3-to-2 ground lift adapter.
- Turn on the power to the unit using the ac power switch located on the right-had side of the front panel. When the unit is off, the inputs and outputs are hard-bypassed .
- If necessary, replace the 1.5A/250V (5x20mm) SLO-BLO fuse (inside the IEC input socket) only with the same type and rating.

How it Works

What is a Peak Limiter?

It's probably easier to first state what a peak limiter is not – it's *not* a compressor. In its simplest form, a compressor is a device makes signals that are too loud softer, and signals that are too soft, louder. Actually, it does this by reducing the overall level and then 'making up' the difference at the end of the chain by adding level, the so-called makeup gain. The net result is an increase in the average program level, which depends on the amount of gain reduction that is applied and the parameters chosen (attack an release times, ratio, etc). Since the ear is sensitive to the average program level, the overall effect is an increase in apparent level.

Brickwall peak limiting is a special case of compression, where the attack and release times are (nearly) zero, and the ratio is infinite. Infinite ratio means the signal level cannot exceed at predetermined level, called the limiting threshold or the 'ceiling'. Unlike a compressor, a peak limiter does not continuously change the overall program, but acts on any signal above this ceiling. If the peaks are short in duration, meaning they do not contribute much to the average program level, the average program level can increased by boosting the output level by an amount equal to the peak reduction. The result is an increase in loudness, without constantly adjusting the overall program level.

It sounds simple, in theory, but the real trick is being able to reshape the peak in such a way that it is largely inaudible. Certainly, clipping the peaks accomplishes the same thing, but in most cases sounds rather nasty.

Our JFET/MOSFET Peak Limiter

Our goal with the PL-2 was to devise a way to reshape the peaks to make them nearly inaudible for reasonable amounts of peak limiting. The JFET/MOSFET Peak Limiter in the PL-2 uses a novel approach to brickwall analog limiting, with both JFET and MOSFET modes for two different characters of peak limiting, and accurate led metering. Unlike other designs, distortion remains low until the limiting threshold is reached. When not triggered, the Peak Limiter circuit is out of the signal path entirely. When not linked, the two channels of the PL-2 are entirely independent.

A Few General Comments about Peak Limiting and the PL-2

- Peak limiters work best on short transients. Any peak limiter will be audible when trying to act on steady-state program material (e.g. bass guitar). The LED display can serve as a guide to how audible the peak limiting might be. If the LEDs are lit continuously, you can be certain that significant distortion is occurring. Listen carefully to see if you're hearing artifacts.
- All peak limiters add distortion when limiting. By their very nature, they change the shape of the waveform, which is, by definition, distortion. However, some peak limiters begin distorting well below threshold. The active devices doing the peak limiting in the PL-2 are entirely out of the circuit until the threshold for limiting is achieved, and switched out again after limiting. This keeps distortion low when no limiting is occurring.
- The amount of distortion depends on how the peak limiting is implemented. To make the peak limiting in the PL-2 less audible, a certain amount of 'compliance' is built-in to the limiting action. This means that instead of chopping off the peaks and losing all dynamic information, some 'wiggle' is left at the top. The JFET and MOSFET devices have differing amounts of compliance, which results in differences in the character of limiting. The JFET tends to produce 'harder' limiting, with less compliance, while the MOSFET produces 'softer' limiting, or more compliance.
- Peak limiting should be used to avoid a worse-sounding alternative. For example, clipping distortion from digital 'overs' will always sound worse than a good peak limiter.

- Ignore all of the above when using the peak limiter as an effect. Heavy limiting of an acoustic guitar might sound nasty, but heavy limiting of distorted tracks, like electric guitar, can be a beautiful thing. The same goes for snare and drum overheads. In fact, we structured the input and output gain controls so that the PL-2 can be used 'creatively' on signals well below digital zero. Since the PL-2 is analog, it can be used in situations the latency associated with digital limiters make them problematic, like on a bus in an analog mixer.

Operation

Please refer to the front panel layout (see the Condensed Operating Instructions) for the location of all switches and controls discussed below.

IN/BYPASS

With the switch in the 'IN' position, the Peak Limiter activated, and the yellow LED near the switch is illuminated. When in 'BYPASS', the Peak Limiter is entirely out of the signal path. Channel 2 is controlled by Channel 1 when the unit is in 'LINK' mode.

INPUT

The INPUT control is an 11 position stepped switch that increases the gain of the input stage in 1dB increments from 0 (unity) to +10dB. Use it to increase the level to the input of the peak limiter when the input level is below that required for peak limiting.

CEILING

The CEILING control determines the reference output level at which the peak limiter is activated. It can be set from +22dBu to + 10dBu. This encompasses the range of 'digital zero' most often encountered with typical A/D converters, as well as having additional 'margin' for using the peak limiter creatively. Channel 2 is controlled by Channel 1 when the unit is in 'LINK' mode.

OUTPUT

The OUTPUT control is an 11 position stepped switch that decreases the gain of the input stage in 2dB increments from 0 (unity) to -10dB, or increases the gain of the input stage in 2dB increments from 0 (unity) to -10dB. Use it to match the output level of the PL-2 to the device is driving. For example, it can boost the level after limiting to match the input requirements of an A/D converter (+20dBu), or cut the level to match the input of a +4dbu insert. The input and output controls are scaled to span the range of I/O for either digital or analog devices. When the OUTPUT control is set at 0, the CEILING control sets the maximum output level.

JFET/MOSFET

The JFET/MOSFET switch determines which type of device is doing the peak limiting. As discussed above, the JFET (red LED illuminated) gives a stiffer form of limiting, while the MOSFET (blue LED illuminated) is more forgiving. Due to the differing nature of the JFET and MOSFET devices, slight re-adjustment of the CEILING control may be necessary when switching between the two modes. Channel 2 is controlled by Channel 1 when the unit is in 'LINK' mode.

Link

With the switch in the 'IN' position, Channel 1 and Channel 2 are linked for stereo operation, and the yellow LED near the switch is illuminated. In LINK mode, the INPUT/BYPASS, JFET/MOSFET and CEILING are all controlled by Channel 1. The INPUT and OUTPUT controls are not linked and must be set individually.

I/O GAIN

With the switch in the 'IN' position, the INPUT and OUTPUT gain stages are switched into the signal path and the yellow LED near the switch is illuminated. In the 'OUT' position, these two stages are bypassed, and the output level of the PL-2 is determined solely by the level of signal at the input of the PL-2, and the CEILING control. With no peak limiting, the unit operates at unity gain. This mode is useful for mastering applications.

Multi-Unit Link

The MASTER OUT and SLAVE IN jacks permit the linking of several units for multi-channel applications. Connect the MASTER OUT from one unit to the SLAVE IN(s) of all linked units. When all units switched to 'Link', the CEILING control of Channel 1 of the master unit sets the ceiling of all slave units. All other controls are not linked and must be set individually.

LED Display

The 13-segment LED display gives a true indication of the amount of peak limiting applied to the signal. It is obtained by continuously comparing the input and output levels, and scaling this difference in dB relative to the CEILING reference level. It displays the amount of peak reduction in 0.5 dB increments form 0 to –4 dB, and 1 dB increments from -4 to greater than -8 dB. The LED ladder uses a 3-color scheme to indicate how audible the peak limiting might be on transient source material. Blue (0 to -4) is the 'safe' region of operation, with yellow (-5) and red (-6 to >-8) indicating caution is required.

PL-2 Specifications

Circuit Type:	Class A solid-state peak limiter with transformerless balanced inputs and outputs and dual mono or stereo operation
Input Sensitivity:	+4dBu
Input Impedance:	20kΩ
Input Gain:	0 to +10dB in 1dB steps
Freq. Response:	-1.0dB 5Hz and 80kHz
Noise:	>90dB below +4dBu
Distortion:	less than 0.03% THD+N, 20Hz to 20kHz, at all signal levels below limiter threshold
Output Impedance:	300Ω
Output Gain:	-10 to +10dB in 2dB steps
Max. Output Level:	+27dBu
Polarity:	input and output XLR connectors are pin 2 hot
Display:	13 segment LED ladder from 0 to -8dB

General

Power:	120V or 240Vac, 16W
Power Supplies:	+± 18Vdc, +15Vdc, +12Vdc, fully regulated
Dimensions:	1U enclosure, 19" x 1.75" x 8.0" (48.2 x 4.4 x 20.32 cm)
Weight:	6.7 lb. (3.1kg)

Note: Operating level is +4dBu = 0VU = 1.228v
Unless otherwise stated, all measurements are referenced to +4dBu, 0-80 kHz bandwidth.
All specifications are subject to change without notice.

Limited Warranty

Pendulum Audio, Inc. warrants to the first purchaser of a new Pendulum PL-2 Peak Limiter that the unit is free of manufacturing defects in materials and workmanship for a period of one (1) year from the date of purchase. Pendulum Audio, Inc.'s sole obligation under this warranty shall be to provide, without charge, parts and labor necessary to remedy defects, if any, which appear within one (1) year from the date of purchase. All warranties expressed or implied made by Pendulum Audio, Inc., including warranties of merchantability and fitness, are limited to the period of this warranty. Pendulum Audio, Inc. is not responsible for indirect, incidental or consequential damages arising from the use or failure of this product, including injury to persons or property.

This warranty does not cover damage due to: misuse, abuse, modification, accident or negligence. The warranty does not apply if the unit is repaired or altered by persons unauthorized by Pendulum Audio, Inc. in such a manner as to injure, in Pendulum's sole judgment, the performance, stability or reliability of the unit. The warranty does not apply if the unit is connected, installed or used otherwise than in accordance with the instructions furnished by Pendulum Audio, Inc.

If the equipment requires warranty repair, return authorization must be obtained from Pendulum Audio, Inc. prior to shipment. Equipment should not be shipped to Pendulum Audio, Inc. until return authorization and the proper shipping address is obtained from us. The equipment (with all its components parts and connecting cables) must be suitably packaged, including a note with the owner's name, address, telephone number and a description of the reason for return. The owner pays two-way shipping (we recommend UPS or Fed Ex, not US postal service), and we suggest that the shipment be insured for its full value.

This limited warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for us any liability in connection with the sale of our products than set forth herein. This limited warranty gives you specific legal rights, and you may also have other rights that vary from state to state.