

6386 Vacuum Tube Limiter

Features

- Classic feedback compression using the same gain control tube as the Fairchild 660 and 670
- Modern class A, solid-state gain make-up stage for wide bandwidth and low distortion
- Soft-knee design with smooth transition from compression to limiting
- Fast attack (0.5ms) and release times ideal for tight program compression or tracking
- Low noise and superior transient response
- Three sidechain operating modes: Fast, Presets and Manual
- Two completely independent channels with stereo linking
- Tubes calibrated for precise stereo balance
- Hard bypass switches for each channel
- Sidechain inserts for frequency-dependent compression and de-essing
- Transformerless balanced output stage capable of delivering +27dBu
- Soft-start warm-up with outputs bypassed until all voltages are stabilized
- Gold-plated relay contacts, I/O connectors and tube sockets
- Fully regulated high voltage (250V), filament and bipolar power supplies
- Custom toroidal power transformer with shield for minimum hum
- Polypropylene capacitors and metal film resistors

Introduction

Thank you for purchasing the Pendulum 6386, a modern two channel tube limiter designed to have the compression characteristics of a vintage unit, but with a higher level of sonic accuracy. Rather than trying to recreate the past, we decided to taken an entirely different approach. The 6386 uses the gain control tube found in the vintage Fairchild limiters to provide the classic feedback response unique to the characteristics of this tube. Subsequent amplification is accomplished with a Class A, balanced, transformerless solid-state line amp, rather than the push-pull transformer output stage used on vintage variable-mu units. The result is a limiter that possesses the 'dynamic signature' of a classic tube compressor, but with a more accurate, less colored signal path.

The soft-knee design used in the 6386 offers effortless dynamic control with a smooth transition from compression to limiting. In addition, both channels can be operated independently, or linked with the flip of a switch. When linked, the threshold and attack/release parameters are controlled entirely by channel 1, assuring precise stereo balance over the entire range of gain reduction.

For maximum versatility, the 6386 incorporates a solid-state sidechain to provide a wide range of control with three modes of processing: In the FAST mode, the limiter works extremely fast (0.5ms attack time), and is remarkably free of the 'pumping' artifacts normally encountered with slow variable-mu compressors. It's the ideal choice for invisible dynamics processing, either for tracking or tight program compression.

The PRESET mode consists of six classic attack/release time settings (identical to the Fairchild 670) that are optimized for program compression, including two settings with program-dependent release times.

The MANUAL mode offers total control over the attack and release times, which is particularly useful for creative compression effects or for processing bass guitar.

Most important, the hard bypass switches on the front panel conveniently allow a quick determination of exactly what the 6386 is, or in most cases, isn't doing to your signal.

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 6386 Vacuum Tube Limiter, a 3 prong IEC power cord, and this operating manual.

Mounting

The 6386 uses two EIA-standard rack spaces, and can be mounted in any standard 19 inch (483mm) equipment rack. If the 6386 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. Excessive shock and vibration can cause damage or premature failure of the vacuum tubes, or cause them to shaken loose from their sockets. Please avoid rough handling.

Ventilation

For proper operation, it is *very* important that adequate ventilation is provided. Vacuum tubes produce a significant amount of heat that must be removed from inside the chassis. The side panel vent holes and top panel slit vents should never be blocked in any way. Never mount the 6386 below a rack unit with a depth greater than 7 inches (178mm). Do not mount the 6386 near other heat-producing equipment such as power amplifiers or other vacuum tube products. If possible, leave open at least one rack space above the unit, and use a rack spacer with a ventilation grille. Never operate the 6386 inside a road case where the side panels are cushioned in foam.

Preventing Ground Loop Hum

One of the reasons the 6386 sounds so good is that it uses an active-balanced output stage rather than an output transformer. However, it does not benefit from the galvanic isolation provided by an output transformer. For this reason, a few precautions are necessary to insure hum-free operation:

- Isolate the front panel from the rack rails. Use plastic shoulder washers to prevent electrical contact between the rack ears of the 6386 and the metal rails of the equipment rack.
- Isolate the 6386 from units mounted above or below it in the rack. Make sure the front panels are not in electrical contact and that the top or bottom cover screws of the 6386 are not touching those of any other units.
- Connect the 3 prong IEC power cord to the single-point star grounded electrical source for your facility.

The idea here is to make sure the 6386 seeks ground at only one point. For safety reasons, do not lift the ground at the IEC power cord. Keep in mind that in a properly grounded hookup, the 6386 does not hum. Please, take the time to do this right, and you will be rewarded with hum-free operation. Call us if you have any questions. Please note that *pin 2 is hot*.

Power Requirements

The 6386 is equipped with a 3-prong IEC power connector and detachable cord. Never operate the 6386 with the ground on the power cord defeated. Unless otherwise stated, this unit operates from 120V/60 Hz at 30W. The ac fuse is accessible from the rear panel and is rated at 1A/250V (3AG) SLO-BLO. To check or replace the fuse, make sure the unit is unplugged. Operation at 240V/50Hz is available as an option. Please contact us for more information.

Servicing

Other than changing the tubes, the user should not attempt to service the 6386 beyond that described in this manual. Never remove the covers or attempt to replace the tubes until the unit has been disconnected from the ac power source, and all circuits inside have been allowed to discharge for a period of at least 30 minutes. The vacuum tubes become very hot once the unit has been turned on, and they should not be touched until they have cooled to room temperature. 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.

Operation

While the operation of the 6386 may appear to be rather straightforward, there are a few features which may differ from what you're accustomed to seeing on other vacuum tube compressors. You may find it useful to refer to the Condensed Operating Instructions at the beginning of this manual to quickly identify the operation of the front panel controls. However, we suggest you read through this section to take advantage of all its features, and to make sure you are operating the 6386 in the way most appropriate for the type of dynamics processing you're doing.

Hookup

Please refer to the rear panel layout (see the Condensed Operating Instructions) for the location of the inputs, outputs, and ac power. *Make all connections to the 6386 before applying power.*

Inputs

On the right hand side of the rear panel are the transformer-balanced inputs for channels 1 and 2. The female XLR connectors on top are 3 pin balanced inputs with Pin 1 = ground, Pin 2 = positive phase input (+), and Pin 3 = negative phase input (-). Use them for connecting the 6386 to +4dBu transformer-balanced or active-balanced sources. If you encounter ground loop hum when connecting to balanced sources, lift the shield from Pin 1 on the input end of the cable.

The two 1/4" jacks below the XLR connectors are TRS Balanced connectors, wired in parallel to the XLR inputs, with Tip = Pin 2, Ring = Pin 3, and Sleeve = Pin 1. Use them for connecting the 6386 to unbalanced sources. Do not attempt to use the XLR and 1/4" inputs simultaneously.

Outputs

To the left of the input jacks are the active-balanced output jacks for channels 1 and 2. The male XLR connectors on top are 3 pin balanced outputs, with Pin 1 = ground, Pin 2 = positive phase output (+), and Pin 3 = negative phase output (-). Connect these outputs to XLR- or TRS-balanced line-level inputs. If you encounter ground loop hum when connecting to balanced inputs, lift the shield from Pin 1 on the input end of the cable.

The two 1/4" jacks below the XLR connectors are TRS balanced output connectors, wired in parallel to the XLR outputs, with Tip = Pin 2, Sleeve = Pin 1. Use them for connecting the 6386 to unbalanced inputs or mixer inserts.

AC Power

On the left side of the rear panel is the IEC input socket. Connect to a 120V/60Hz receptacle with the 3 prong IEC power cable supplied with the 6386. *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 above the power inlet socket. Although it might seem a bit awkward to put the ac power switch on the rear panel of the 6386, there is a very good reason for it. By keeping the ac away from the front panel, hum induced by the ac line into the front panel circuitry can be virtually eliminated.

If necessary, replace the 1A/250v 3AG SLO-BLO fuse only with the same type and rating.

Power-up Sequence

To prolong tube life, the 6386 goes through a soft-start sequence for gently applying power to the tubes and stabilizing the circuit before engaging the outputs. When the power switch is turned on, the outputs remain in BYPASS and the dc voltage on the tube filaments is ramped up to 12.6Vdc. Next, the high voltage supply is slowly increased to 250V and the circuit is allowed to stabilize for about 2 minutes. Finally, the IN/BYPASS switches are activated and the blue 'on' led on the front panel is illuminated. For best results, please allow the 6386 to warm up for 10 minutes or longer before use. *FOR LONGER TUBE LIFE, TURN OFF THE 6386 WHEN NOT IN USE.*

6386 Front Panel Controls

Please refer to the front panel layout (see the Condensed Operating Instructions) for the location of all switches and controls discussed below. The operation of both channels is identical, unless the two channels are linked. All toggle and rotary switch contacts are gold-plated for high reliability. All panel rotary controls are long-life conductive plastic potentiometers.

Input: Off to Max

The INPUT control is actually a passive balanced attenuator positioned between the input connector and the input transformer. It controls the input level to the input transformer, and consequently, the input level to the 6386 gain control tube. *In normal operation the INPUT control should be set fully clockwise to MAX, since the 6386 is designed to operate with +4dBu input levels.* On occasion, it will be necessary to reduce the input level to the 6386 to prevent overload of the input transformer or the tube gain stage. Monitor the input level with the VU meter to determine if input attenuation is required. Unlike most other tube compressors, the input control is located in the primary circuit of the input transformer, and does not affect the balance of the gain control stage.

Threshold: Off to Max

The THRESHOLD control determines how much gain reduction is applied to the source material. Since the 6386 is a 'soft-knee' feedback compressor, it does not have a strictly-defined 'threshold', like VCA-based units that uses feedforward detection. A maximum of 12dB of gain reduction is available from the 6386 gain control tube. The range of the THRESHOLD control is off to -20dB, which permits a steady-state input level as low as -8dBu to achieve the full 12 dB of gain reduction.

Output: Off to Max

Use the OUTPUT control to increase the signal level after compression. Up to 15dB above the level of the input signal is possible. The unity-gain setting (0dB) is 12:00. The OUTPUT controls on the 6386 are audio taper potentiometers. Linear taper potentiometers, which permit finer adjustment of output level in the critical 0-12dB range, are available as an option.

Meter: Input/Gain Reduction/Output

The illuminated ANSI VU meters are electronically isolated from the signal path, and can be switched to measure input, output or gain reduction. Keep in mind that a VU meter is a mechanical device, designed in accordance with a well-accepted ballistic standard, to indicate an average loudness level. On the other hand, the led meters on your mixer or digital recorder are reading a peak program level, and faithfully register all those short transient spikes that add little to the perceived loudness of the program material. The ratio of the peak to average levels can be 20dB or greater depending on the source (e.g. drums). So, if you're wondering why the led meters on your recorder are flashing near zero, but the input and output levels on the VU meters of the 6386 are hovering at or below -10, you're simply seeing the difference between the peak and average program level.

Input

When the METER switch is in the INPUT position, the VU meter indicates the signal level at the XLR and 1/4" input connectors. The meter is calibrated to 0dB = +4dBu (1.23vrms). Use this setting to monitor the average program level into the input transformer and compression tube of the 6386. To minimize control voltage artifacts in the signal path (especially when using the FAST mode), the input level should be in the range of -5 to 0VU.

Gain Reduction

When the METER switch is in the GAIN REDUCTION position, the VU meter indicates the amount of gain reduction applied to the input source. Keep in mind that the meter is indicating an *average* gain reduction, and does not reflect how the 6386 is responding to peaks faster than the meter's response time. When the peak to average ratio is high (e.g. drums), trust your ears to be the ultimate judge.

Zero

A screwdriver - adjustable trim control, located below the METER switch, is used for zeroing the meter when it is set to read GAIN REDUCTION. Use a small, flat-bladed screwdriver, and adjust the meter to indicate 0VU with the THRESHOLD control set to OFF. Gain Reduction is measured directly from sidechain control voltage, so very little drift of the meter should occur. Let the unit warm up for at least 20 minutes before making any adjustment.

Output

When the METER switch is in the OUTPUT position, the VU meter indicates the signal level at the XLR balanced output connectors. The meter is calibrated to 0dB = +4dBu (1.23vrms). Use this setting to monitor the average program level sent to a tape machine, mixer input or channel insert.

Mode: Fast/Presets/Manual

The 6386 incorporates a solid-state sidechain circuit to provide a wide range of dynamic control. For maximum versatility, there are three distinctly different modes of operation.

Fast

In the FAST mode, the gain control tube operates with very fast attack and release times (0.5ms and 50ms respectively). This mode is remarkably free of pumping artifacts even at high compression levels. It's the ideal choice for tracking or tight program compression. Use it whenever you don't want to hear the 6386 working, particularly on vocal tracks.

Presets

The PRESETS mode consists of six attack/release settings which are ideal for program compression. These presets are identical to those found on the classic Fairchild 670 Limiter. The first four presets offer a selection of fixed attack and release times, with the release times indicated on the dial markings. Presets 5 and 6 are program-dependent release times, where there is initially a quick release, followed by a longer decay time to zero gain reduction. Think of these settings as a 'gated' release time, where the compressor operates more rapidly at the average program level, but takes much longer to return back to zero gain reduction. In other words, the compressor does not immediately 'suck back to zero' when there is a brief pause in the program (e.g. between words in a vocal track).

Manual

The MANUAL mode offers total control over the attack and release times. The range of the attack and release controls is 1ms to 40ms and 0.1s to 2s respectively. Manual control is particularly useful for creative compression effects or for processing bass guitar. Quite often, a greater level of compression can be applied to program material if a very long attack time and a short release time are used. In this instance, the compressor is responding to the average program level, does not 'over-compress' on short peaks, and recovers quickly. In other words, it doesn't 'pump' as much!

Sidechain Inserts

On the rear panel are two TRS 1/4" jacks (one for each channel) for inserting an outboard EQ into the sidechain detector circuit. This is useful for frequency-dependent compression or de-essing. The Tip is Send, and Ring is Return.

Link/Split

When this switch is set to SPLIT, the two channels of the 6386 operate independently. In LINK, the sidechain circuits for the two channels are coupled for stereo operation. The THRESHOLD, dynamics processing (fast, preset and manual modes) and IN/BYPASS functions are controlled entirely by Channel 1. The INPUT and OUTPUT controls for the two channels should be set to the same values.

Although linking the two channels will keep the stereo image centered, it may tend to collapse the stereo spread a bit too much on some program material. In this case, run the two channels of the 6386 SPLIT, and set all the controls for both channels to the same values. Listen carefully to verify that the degree of image shift that occurs is acceptable.

In/Bypass

These are 'hard' bypass switches for comparing the processed sound directly with the original source. IN connects the output of the 6386 line stage directly to the output connectors. BYPASS connects the input source directly to the output. When linked, and channel 2 is set to IN, the IN/BYPASS switch for channel 1 conveniently controls both channels at once.

Other Issues

Internal Adjustments

There are three adjustments to the 6386 that are only accessible by removing the top cover:

- Calibration of the meter when measuring gain reduction
- Stereo balance of the gain control tubes in LINK mode.
- Ac and dc balance of each gain control tube for control voltage rejection.

These adjustments are required only if one of the tubes are replaced, or if they drift out of calibration with age. Since these adjustments must be made with the ac power on, and potentially lethal voltages are present inside the chassis, we recommend that they be made only by qualified service personnel who are familiar with working around high voltage tube circuitry.

For your safety, we strongly recommend that you contact us for servicing. On request, detailed instructions for performing these procedures will be provided to qualified service personnel.

Options

There 6386 is available with transformer-balanced outputs using high-quality Jensen transformers. However, we do not recommend this unless absolutely necessary, since the transformers will color the sound. If at all possible, try to make it work without them. See the section entitled 'Preventing Ground Loop Hum' for more information.

Replacing the Tubes

TO PROLONG TUBE LIFE, TURN THE 6386 LIMITER OFF WHEN NOT IN USE!

All vacuum tubes have a limited life due to reduced electron emission from the oxide coating on the cathode and/or a buildup of impurity gases in the bulb. The gain control tubes in the 6386 are expected to give many years of service. If you notice the sound quality deteriorating - higher distortion, muddiness, or microphonic behavior - it's time to change the tubes. We recommend changing only the tube that is defective. If you are uncomfortable with replacing the tubes yourself, please have it done by qualified service personnel. Replacement tubes are available directly from us. They are rather expensive, but still available in limited quantities.

1. Unplug the 6386 and wait at least 30 minutes for the high voltage in the unit to discharge and for the tubes to cool to room temperature.
2. Remove the top cover by removing the nine #6-32 Phillips-head screws.
DO NOT remove the bottom cover.
3. Note the position of the two tubes (V1 and V2) in the porcelain sockets.

The gain control tubes are 6386 GE (Five Star) miniature tubes

**NOTE: THERE ARE NO SUBSTITUTES FOR THIS TUBE!
ONLY THE EXACT REPLACEMENT WILL WORK!
WATCH OUT FOR COUNTERFEITS!**

4. Remove the tube and replace it with the same type.
5. Reinstall the top cover and screws.

There is only one variety of the 6386 tube available. It is a GE five star military tube, with the tube number '6386' etched into the glass envelope. If '6386' is screen-printed on the glass but the number is not etched into the glass, it is probably a counterfeit. The most common counterfeit is a 5670, which is also a military tube that has the same pin configuration. However, is not an exact replacement and will not work properly. It is easy to tell the difference by holding the original tube and the replacement side-by-side and comparing the internal structure.

6386 Specifications

Circuit Type:	remote cutoff gain control tube with balanced class A solid-state line stage and transformerless output
Input Sensitivity:	+4dBu
Input Impedance:	10k Ω (nominal) with 1:1 input transformer
Freq. Response:	-1.0dB 15Hz and 75kHz with 600 Ω output load
Noise:	less than -85dB below +4dBu output level with Output control at unity gain (12:00)
Distortion:	less than 0.08% THD+N, 20Hz to 10kHz
Output:	+27dBu balanced into 600 Ω load
Max. Gain Reduction:	12dB
Threshold:	up to 12dB of gain reduction at -8dBu input level
Ratio:	1:1 to limiting, program-dependent
Output:	off to +15dB
Modes:	fast, preset or manual operation
Fast:	0.5ms attack, 50ms release
Presets:	1ms/0.1s, 1ms/0.3s, 2ms/1.0s, 4ms/2s, 2ms/1 to 4s and 1ms/0.5 to 20s (program dependent)
Manual:	attack time variable from 1.0ms to 40ms release time variable from 0.1s to 2s
Meter:	selection of input level, gain reduction, or output level input and output levels are referenced to +4dBu = 0VU
In/Bypass:	hard bypass of input signal to output connector
Link/Split:	links channel 1 and channel 2 for stereo operation
Polarity:	input and output XLR connectors are pin 2 hot
Vacuum Tubes:	(2) 6386, GE five star
Power:	120Vac, 30W (240Vac optional)
Power Supplies:	+250Vdc, +12.6Vdc and \pm 18Vdc, fully regulated with soft-start warm-up and output bypass
Dimensions:	2U enclosure, 19" x 3.5" x 12.5" (48.2 x 8.8 x 31.8 cm)
Weight:	14lbs (6.4kg)

Limited Warranty

Pendulum Audio, Inc. warrants to the first purchaser of a new Pendulum 6386 Vacuum Tube 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. There is no warranty on vacuum tubes.

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), 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 which vary from state to state.