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Multi-Taper © "Foot Pedal" Audio Control System

Patent pending

Typical FP-100 Configuration

Multi-Taper © "Foot Pedal" Audio Control System

General Description:

This "pedal" is the first in a series of advanced technology volume and/or audio effects control systems based upon a series of revolutionary technologies developed by Telonics, Inc. This particular system takes the mechanical form of a conventional foot pedal in either the "high" or "low" profile configuration. It can be used as a foot pedal of the simplest form; however it contains technical capabilities which far exceed those of any currently available audio dynamics control device. The basic model includes accurate emulations of virtually all audio tapers of mechanical potentiometers ("pots") used in the past, as well as the audio control "taper" of all popular electronic foot pedals. (Additional replica tapers or custom tapers can be factory added in a very short time via its USB port). Tapers are selectable by means of a digital switch on the side of the unit near the input and output jacks. This patent-pending control system does not utilize potentiometers, encoders or light devices of any type. There are no components to wear out.

It incorporates the latest technology in low-noise, high headroom amplification - in a class with the latest exceptional dynamic response studio-grade amplifiers, while preserving the warmth of vintage tone. It is fully buffered, preventing noise from externally connected tuners and other devices from entering the signal chain as well as providing safety from system malfunction due to shorted or intermittent cables. A full-time tuner output allows tuning with the pedal in any position, including the "off"/minimum position. It is factory programmed via a miniature USB port. Subsequent software updates may be uploaded via this USB port. It is solidly built such that it will not skate around the floor with foot movement. A blue LED pedal-board light indicates both proper power and that it is operating within acceptable parameters.

An optional ***micro-miniature remote sensor is available which assumes full control of the pedal*** when plugged in. This remote control system opens limitless possibilities, from mechanical control by instruments, to usage by musicians who have a physical impairment and have been prevented from playing until now. (A remote sensor will be supplied *at no charge* to individuals who suffer a physical impairment which can be aided by this remote control device).

Its internal circuitry is well-behaved in terms of power supply connection, interruption or disconnection, thereby minimizing noise which might annoy listeners or possibly damage speaker systems. This is no garage-shop hobbyist toy. It is the culmination of years of research, designed and hand-built in the U.S.A. by leading and internationally recognized aerospace engineers, technicians, assemblers and musicians in a state-of-the-art facility in Mesa, Arizona by Telonics, Inc., an established leader in scientific instrumentation and communications since the 1970's. Dependability, long-term reliability, performance and value are paramount in this pedal.

Telonics, Inc. is well known by scientists world-wide for the manner in which we stand firmly behind our products on a personal basis. Please contact Dave Beaty with any questions you might have, we invite design comments and are open to any and all suggestions:

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Mechanical

Pedal:

Material: CNC milled 6061-T6 Aluminum with hardened bearing surfaces
Axles are oil-hardened (O1) tool steel, 55-60 C-scale Rockwell

Finish: Heavy hard anodized (Mil-A-8625 Type II, Class 2, 0.002")

Lettering: Laser-engraved (all markings are burned through the hard anodize coating. No paints or inks are used on the product, markings will not smear or wear off.)

Outline Dimensions: 10.6L x 3.7W x 2.4H in. (27L x 9W x 6.1H cm)

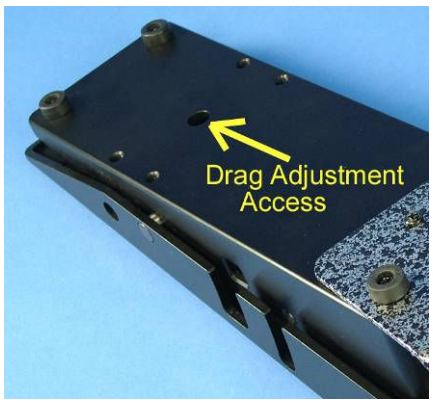
Weight: 2.35 lb (1.06 kg)

Optional External Sensor:

Size: 0.8L x 0.9W x 0.125H in. maximum
(20.3L x 22.9W x 3.2H mm) maximum

Connector: ¼" TRS male "Stereo Plug" (Tip-Ring-Shield/Sleeve)

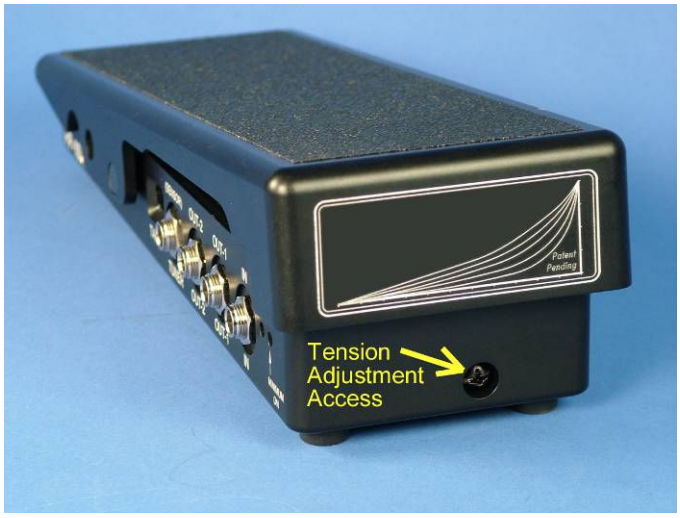
Mechanical Adjustments:



Both **DRAG** (Ease of Pedal Movement) and **TENSION** (Pedal Return Tension) are independently adjustable to suit the user. Please refer to the photos and drawings provided in this document:

Drag: A 3/16 (0.187) inch "Allen"-type HEX head cap screw located on the bottom of the pedal provides a means of customizing the **Drag** experienced during pedal movement. A 3/16 inch HEX wrench is supplied from the factory for this adjustment. Note that this adjustment is very sensitive. Turning this screw only a slight amount will greatly change the ease of pedal movement. A fraction of a turn Clockwise (CW) will increase drag (make the pedal more difficult to move). Conversely, a small amount of adjustment in the Counterclockwise (CCW) direction will decrease the drag, making the pedal easier to move.

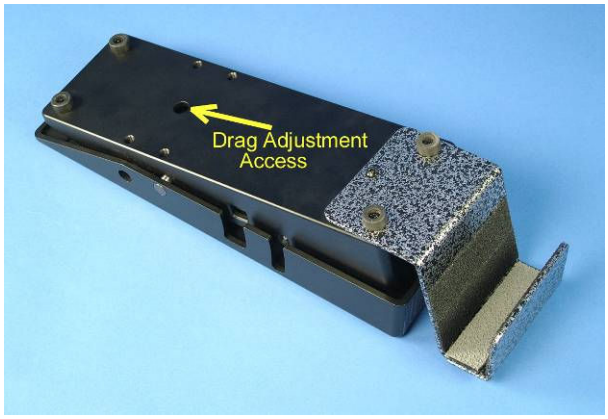
Tension: A Phillips-head screw on the front face of the base adjusts **pedal return Tension (lift).** It can only be properly adjusted if the Drag adjustment is fully relieved (set to minimum drag). It exhibits a very wide adjustment range, requiring several turns in either direction to make an appreciable difference. It has been factory adjusted with the *drag* adjustment set to minimum. If you should decide to adjust it, first be sure the Drag screw is turned CCW to minimum drag, make any desired tension adjustment, then re-set the Drag to complete the process.



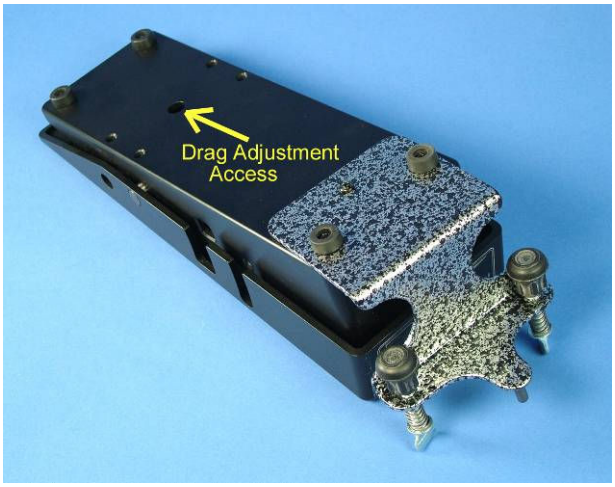
Bracket Interface: The pedal is designed to interface with most popular pedal bar brackets which utilize either two screws, or a triangular three hole pattern. The screws which attach the two front feet are slightly longer in order to allow for the thickness of a bracket.

To mount a two-hole bracket, remove the two front feet and mount it using the two screws with the rubber feet still attached (under the bracket).

To attach three-hole brackets, remove both front feet AND the single screw just behind them (slightly toward the center of the pedal). Attach the bracket using all three screws.



Note that some brackets are not produced with consistent hole pattern location and spacing. In some cases it may be necessary to enlarge a hole or holes, or even re-drill the odd hole in a bracket. (Refer to the pictures showing various types of pedal bar mounting brackets, no modifications to these brackets were necessary.)



Pedal shown with Emmons-style mounting bracket

Electrical:

Power Supply: UL and CE approved transformerless power supply*

PS-1: 100-120 VAC, 60 Hz (US power)
2.5L x 1.1W x 1.7H in. (63L x 26.6W x 43.3H mm) (typical)
<3.5 oz (<100 g)

PS-2: 90-264 VAC, 47-63 Hz (Worldwide usage)
2.9L x 1.7W x 1.3H in. (74L x 43.5W x 34H mm)
<6 oz (<170 g)

* Note: Two (2) power supply options are available:

1. PS-1"S" or "L" - supplied with conventional coaxial DC mini-plug end (S) which allows the user to plug and unplug the pedal easily, or may be supplied with a locking plug (L) which firmly attaches to the pedal's power jack (J5) and cannot be pulled out accidentally.

   (The PS-1 units plug in 90 degrees to an AC "mains" power strip and occupy only one outlet slot. They are very small, lightweight {<3.5 oz., <100 g}and do not emit the 50-60 Hz AC hum-producing electrical fields normally associated with the older transformer-type "wall-wart" power supplies.)

2. PS-2 International model, slightly larger, with interchangeable prongs which snap into place for international use. Supplied with conventional coaxial DC mini-plug end which allows the user to plug and unplug the pedal easily.

   (Like the PS-1 units described above, the PS-2 International units do not exhibit the 50-60 Hz AC hum-producing electrical fields normally associated with the older transformer-type "wall-wart" power supplies.) Still relatively lightweight, the PS-2 power supplies are slightly larger than the PS-1 power supplies.

Jacks and Controls:

NOTE: *All inputs and outputs are buffered and isolated such that shorted or Intermittent Cables will not damage the pedal, interfere with other cable functions or adversely effect signal levels.*

Inputs:

Monaural models are supplied with a *dual-function input jack (J1, refer to Outline Drawing on page 14) and associated circuitry which will accept a conventional ¼" **TS** plug for conventional unbalanced pickups.
*It will ALSO accept standard **TRS** plugs for BALANCED line inputs (for future very low-noise balance-wound pickups.
In **Stereo** models, input jack J1 accepts a conventional ¼" **TRS** stereo plug.

Monaural (MONO) Models:

IN-Unbalanced: Input jack (J1) accepts standard ¼" **TS**-type audio plug for all conventional unbalanced, high impedance pickups.

The input jack (J1) *ALSO* accepts ***BALANCED*** inputs as follows:

IN-Balanced: In anticipation of forthcoming advances in pickup design, Input jack (J1) also accepts standard ¼" **TRS**-type plugs for both high and low impedance balanced pickups. Its associated circuitry automatically detects the type of input (balanced or unbalanced) and requires no switching or other user intervention.

Stereo Models:

IN-Stereo, unbalanced: Input jack (J1) accepts standard ¼" **TRS**-type INPUT jack for two independent input signal sources using unbalanced, high impedance pickups. Wiring connections are:

Tip = Left Channel
Ring = Right Channel
Shield = Common signal ground

24VDC (power): J5 is the DC power input jack. It may ONLY be used with a factory supplied power supply. It will accept either the standard smooth-barrel DC power plug, or the optional ¼-turn locking type DC power plug. The non-locking plug makes it easy to remove the power supply for transport, while the locking tabs prevent the plug from being accidentally being pulled loose.

The unit is specifically designed such that unpleasant loud pops which might damage speaker systems are NOT generated when (or if) the power plug is suddenly pulled out while the amplifier systems are on/live.

OUTPUTS

OUT-1: in monaural models, J2 (refer to Outline Drawing on page14) is a conventional ¼ inch **TS** jack with its audio output level buffered, and controlled by pedal movement. Audio taper selection is controlled by the taper program preset switch as well as by a user-selected "minimum OFF" setting which the user may adjust for each individual taper.

OUT-2: in monaural models, J3 (refer to Outline Drawing on page 14)) is also a conventional ¼ inch **TS** jack. This jack provides an output which is identical to that of OUT-1, and is normally used to provide a second identical, phase-coherent signal source for players who wish to feed their signal to a second preamp, combo amp or special effects system.

In stereo models, J2 and J3 provide individual buffered, analog signal chain outputs for Left and Right Channels respectively.

TUNER/sensor: J4 (refer to Outline Drawing on page 14) is a dual-function ¼" jack, providing a full-time TUNER OUTPUT signal, *regardless of pedal position* (¼" **TS**-type). This allows the user to continuously monitor tuning with the pedal in any position, including the full/minimum off position. *This output is buffered and isolated. It will not allow the noise from digital tuners to get back into the system.*

This jack (J4) is *also* used for the optional **Telonics Miniature Remote Sensor** (TMRS). It accepts the ¼" **TRS**-type plug on the TMRS cable and automatically communicates with the sensor when the user chooses to use the TMRS instead of the foot pedal to control volume.
When the remote sensor is plugged into J4 *it automatically assumes full control of the pedal, replacing the control function of the foot platform.*

CONTROLS:

INPUT IMPEDANCE: A miniature screwdriver adjustment is provided on the right side of the pedal (near the front, immediately forward of the INput jack J1) which controls the input impedance of the low-noise, high headroom input amplifier. **Please utilize the miniature screwdriver adjustment tool provided and *take care to avoid excessive force.*** This control is set to maximum as supplied from the factory. In the past, players have unknowingly (and in a few cases knowingly), employed impedance controls as a "poor man's tone control", lowering the input impedance to load the pickup and reduce its high frequency response. If desired, that can still be done with these pedals, however the practice "swamps" or reduces the output of the pickup, reduces its resonant characteristics, diminishes its dynamic characteristics and reduces its frequency response. Some players are accustomed to the resultant sound "muted" or "nasal" quality when their pick-ups are impedance-loaded, and they use this adjustment to subtly color their sound.

Musicians tend to get together and compare hardware by substitution and often (if not generally) come to false or unrepeatable and/or confusing conclusions. The equipment being compared (various instruments with different pickups, different amplifiers with varying input impedances, different pedals being using with preamplifiers having impedance controls, etc), will produce differing/inconclusive results with various models and types of pickups, as they will exhibit different characteristics when loaded with the same impedance. This is why a given device may yield wonderful results with one persons' instrument, but have little effect, no effect, or even an adverse effect when used with another instrument.

Its not rocket science, it's just that there may be a large number of complex variables. In such cases, very simple tests can be very misleading.

If you are using a studio-quality preamplifier with proper tonal shelving characteristics such as the LeMay-series preamps, it is suggested that the user leave this control at the factory setting (maximum clock-wise, very high impedance/little or no pickup loading) and allow his/her preamplifier to provide control of tonal characteristics without inhibiting the performance of their pickup..

If conventional amplifiers are used, we suggest that this control be used very sparingly, and only after all other tonal possibilities on the amplifier are exhausted. Nonetheless, this control is provided for those players who have played that way for many years and feel that they cannot achieve their individual sound any other way.
Note that this control is both small and delicate. Please utilize the miniature screwdriver adjustment tool provided and *take care to avoid excessive force*. The entire range of adjustment occurs over approximately a 240 degree range. If it were a clock-face, maximum pickup loading would occur at about 8:00 o'clock (fully CCW) and minimum loading at 4:00 o'clock (maximum CW). We suggest that you check and make sure that it is <u>fully clockwise (CW) when not being used</u>. You can watch the pocket clip on the adjustment tool provided with the pedal while turning it to get an idea of where it is set.

MINIMUM ON: An adjustment access hole is provided immediately forward of the Input Impedance access hole on the right front corner of the pedal. This adjustment ***controls the minimum level of audio signal which is allowed to pass through the pedal when the control platform is fully back***, or in the MINIMUM sound level position. Units are factory adjusted such that the output level appears OFF to the ear when the pedal is fully back (the most popular adjustment setting for the majority of musicians). The adjustment range of this control is determined by software. (It is normally correct for applications encountered thus far, however it can be factory-altered with very little effort.)

HOW TO CHANGE the Minimum ON setting for a given taper:

If you first understand a bit about how the system operates when you change the *minimum on* adjustment, the operation will go much more smoothly.
When the pedal is first powered up, the "brain" inside the pedal "sees" the last setting that someone made with this control. When you select a given taper with the selector switch, it checks its memory for the last setting used with that taper, and implements it. Then it begins to "look at", or check the *minimum on* control to see if you are moving it (It checks for any movement about 60 times each second). If the control is not moved, the brain is happy and nothing happens.

Now you want to change the setting.
The brain has been given a rule, that it is to record your new setting 10 seconds after you stop moving the control.

The *instant* you move the adjustment, the brain starts a 10 second countdown – which is reset to10 *each time you move the control*. When you finally stop moving the control for a 10 second period, the brain writes (what it now "thinks" is) your "final" setting to a memory location associated with the taper you are using. It will then recall this setting each time you select this same taper.

Now that you know the rules for how it works, ***you may not be so surprised when you move the control for the first time and the volume suddenly changes*** initially.
Let's think about why this might happen; initially the volume is set according to the position of your pedal, as defined by the taper you have chosen, and modified further by the last memorized setting of the *minimum on* control which the brain pulled from memory. Now you move the control a bit one way or the other. The system immediately adjusts to the new setting!
If you moved the control up, the sound level jumps to the new increased level. Conversely, if you happened to move it down, the sound level abruptly drops to the new level.
Of course after that point, you can select any desired level with great precision. Then if you don't change the control for 10 seconds, the new setting is written to memory and that setting will now be the **new *minimum on*** setting until you decide to change it.

Note that this control is both small and delicate. Please utilize the adjustment tool provided and take care to avoid excessive force. The entire range of adjustment occurs over approximately a 240 degree range. If it were a clock-face, the adjustment range would occur from about 8:00 o'clock (fully CCW) to about 4:00 o'clock (maximum CW). You can listen to the audio volume while turning it with the pedal FULLY BACK, (MINIMUM SOUND position) to determine where it is set.

The pedal will "remember" this setting and store it in FLASH memory along with the particular taper you have it set to - 10 seconds after you stop moving the control. That way, when you recall any taper using the TAPER switch (described below), your desired minimum-off setting will be preserved for that taper.

TAPER: A means to select the desired audio taper is provided in the form of a **taper program preset switch** which selects the desired taper by means of two small buttons on either side of the display window. One button advances the number, the other reduces the number.
The factory-supplied tapers are as follows:

1 Hilton* LED light pedal ("new type" with small detachable power supply)

2 Goodrich* LED light pedal (green LED model)

3 Goodrich* pot pedal (using Clarostat type EJA1N116P504A)

4 Emmons* factory pot pedal (using classic Allen-Bradley pot, Type J, JAIN200P504AA)

5 Hilton* LED light pedal ("old type" with large permanently attached Motorola power supply)

6 thru **9** -other tapers may be added in these positions.

0 is reserved as a programming position and will not respond to pedal movement.

If a given switch position is unused (currently like 6 thru 9), the output will be held to a fixed low volume and will not respond to pedal action.

* Note: Hilton, Emmons and Goodrich are fine companies who produce a good product and stand behind their products in a commendable manner. Their names are included solely for comparison of an electronic characteristic exhibited by one or more of their pedal models; in this case, that characteristic is measured audio taper.

Blue Pedal board Light:

The blue light (LED) on the left side of the pedal serves to illuminate the pedal board, but it also serves as a visible error status reporting interface between the user and the microprocessors in the pedal. The most important functions are listed below:

Pedal attitude invalid : The pedal is designed to be used on a fairly flat floor surface (unless inclined upward and/or cocked slightly sideways when attached to pedal boards or when using an Emmons pedal-board mount). Its attitude control system allows for such usage, but if the pedal is placed in an attitude which exceeds those normal limits, two things happen; first the volume is reduced to a fixed, low volume and secondly, the blue LED will blink rapidly. The unit will revert to normal operation as soon as it is returned to a valid orientation and attitude.

Error or Fault: If the internal self-test routines encounter an internal circuitry fault, bad power supply condition or other failure condition, the LED will blink rapidly.

NOTE: The user may choose to have the <u>blue LED either ON or OFF</u> (other than when it reports a problem by blinking).
The desired condition may be set using the following procedure:

1. With the power plug removed, set the pedal on a flat surface and advance or retard the TAPER switch to position "0" (zero).

2. If you wish the LED to be **normally ON**, tilt the top of the pedal fully forward (maximum ON) and insert the power plug. The blue LED will come ON, and it will normally stay ON from that point forward.

If you wish the LED to be **normally OFF**, unplug the power cord, tilt the top of the pedal fully back (minimum ON) and insert the power plug. The blue LED will not come on, and it will normally stay OFF from that point forward (unless an error is encountered).

You may then advance or retard the TAPER switch to the taper you prefer and use the pedal normally.

Signal Path:

Some of the most important aspects of your sound are directly influenced by the signal path from the pickup in your instrument to the initial preamplifier in your system.
Be very careful what you insert in your signal path. Unless you have a high grade preamplifier (such as the LeMay preamp series), a high-quality cable (low capacitance), as short as possible, should be connected from the output of your instrument to the input jack (J1) of this pedal. The output of the pedal (J2 or/and J3) should likewise be connected to your amplifier using a short length of high quality, low capacitance cable. You then have a clean, low-noise, purely analog signal path with great signal handling characteristics.

If you insert an effects pedal or other device between the pickup of your instrument and the pedal, you have just prevented yourself from taking advantage of many of the important capabilities of this pedal.

Such devices will not offer the necessary head-room (instantaneous high signal level handling characteristics), nor will they offer low-noise preamplifiers and provide the desired wide-band, airy frequency response. Additionally, and even worse, many such devices are digital in design. (While very good digital front ends 'are' available, they cost thousands of dollars and are only found in the highest grade studio recording equipment.) This means that the lower cost effects units must take the signal from your pickup and run it through a lower performance A/D, or analog-to-digital converter. They then process and/or "model" the digital signal to achieve some desired characteristic (delay, reverb, rotary, chorus, etc). After effect(s) processing they must convert the processed (and degraded) digital signal back to analog form in order to feed it to your amplifier using a D/A, or Digital-to-Analog converter. The A/D and D/A converters do not have the premium signal handling capabilities of the high-end preamplifier designed into this pedal. Although set for unity throughout gain, this pedal sets the stage for everything in your signal chain.

So where "should" you put effect units in your amplifier set-up?
The place for effect hardware devices is in the effects (EFX) loop(s) of your amplifier, NOT in the direct signal path, and most certainly NOT between your pickup and the pedal - not even between the pedal and your amplifier.

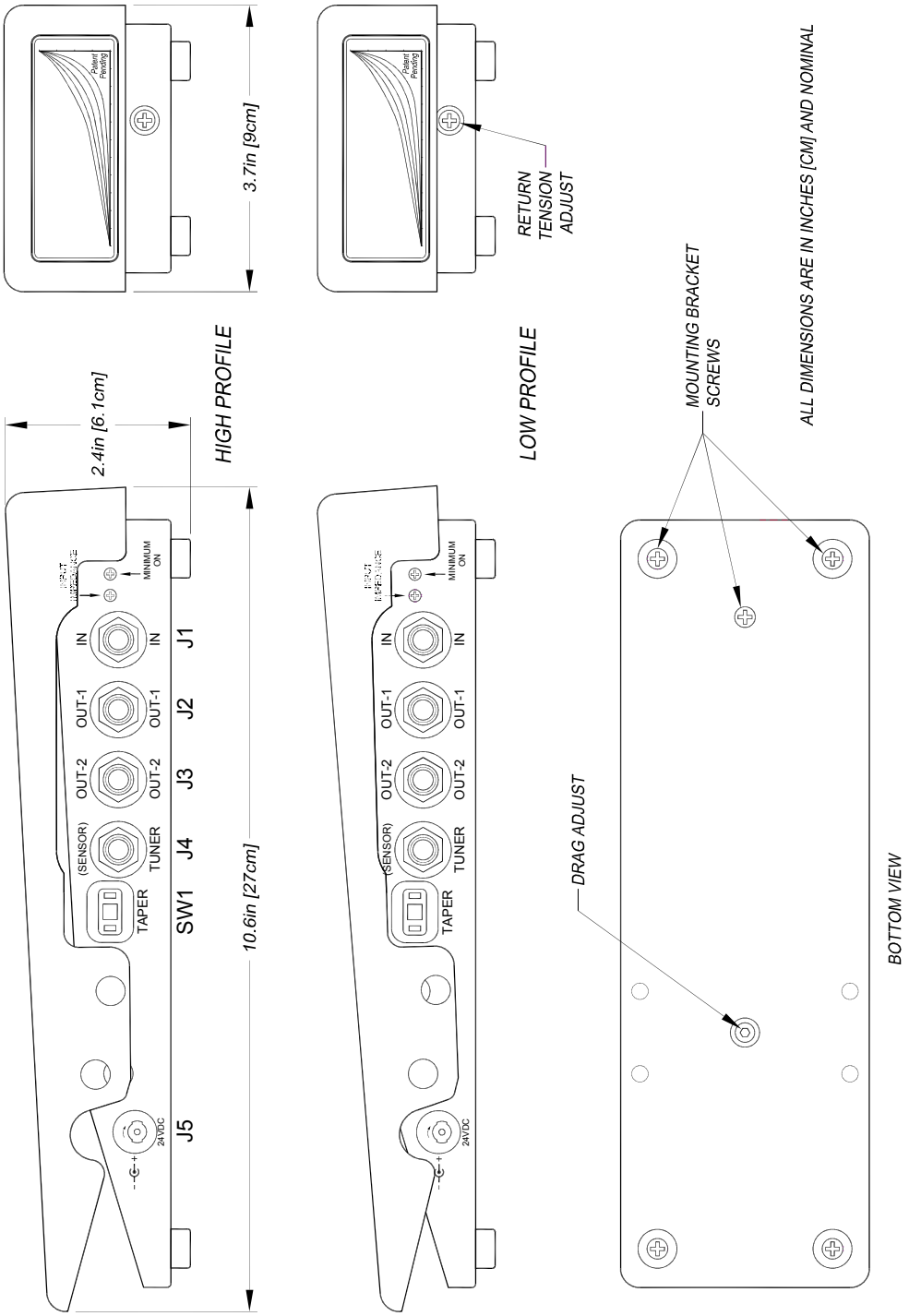
Additionally, good, high quality effects units are designed to work in PARALLEL with the analog signal path, this **parallel configuration is also called "FULL WET".** Some of the better effects units (even effects pedals), are now being designed with a "SERIES/PARALLEL" switch inside the unit in order to service the old in-line guitar stomp-box/pedal board applications, while allowing them to work properly in high-end applications such as recording-grade preamplifiers and studio boards. The reverb unit called "Mr. Springgy" (which emulates the old spring reverb units) is a typical example. The better effects rack units (such as the Lexicon MX-200), are designed with two (2) sets (or "banks") of effects, both a serial bank and a parallel bank. Setting such EFX units to <u>parallel mode</u> and using them in conjunction with a high quality preamplifier offering parallel EFX loops provides the highest level of audio performance.

Signal Path Discussion Summary:

In summary, if you have a conventional amplifier, connect your pedal directly between your instrument and the input of your amplifier. Do not insert effects units, impedance matching boxes or any type of preamplifier device between the instrument and the pedal.

If you have a high (studio) quality preamplifier which provides input circuitry equal to that of this pedal, connect your instrument directly to the input of the preamplifier, then insert the pedal (using two cables, one IN and one OUT) in the INSERT/Pre-EQ EFX loop of your preamplifier (this point inserts the pedal in the signal chain immediately after the first stage of amplification and prior to the EQ/tone shaping circuitry. The LeMay preamplifier series provides a pair of IN and OUT jacks specifically for this purpose as well as providing a separate EFX loop (mono or stereo) for parallel-mode effects units).

Outline Drawings



Quick Connection Diagram