<table>
<thead>
<tr>
<th>Instrument</th>
<th>Output Level</th>
<th>Treble Boost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gibson L6-S</td>
<td>120 mV</td>
<td>2500 mV</td>
</tr>
<tr>
<td>PAF</td>
<td>110 mV</td>
<td>ETC-S, E90, ETC-D, With Full Treble Boost</td>
</tr>
<tr>
<td></td>
<td>100 mV</td>
<td>ETC-S, ETC-D, Without Treble Boost</td>
</tr>
<tr>
<td></td>
<td>90 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 mV</td>
<td></td>
</tr>
</tbody>
</table>

**PICKUP OUTPUT LEVEL COMPARISON**
PICKUPS

Bartolini pickups are made to satisfy the musician's demand for superlative sound quality. Each type of pickup has been designed to fill a specific need and to provide unmatched tonal response and performance. Each of the following types of pickups is available in a wide variety of shapes to fit many different stock and custom instruments.

In the diagrams the aperture (A) is the length of string sensed by the pickup. Single coil pickups have narrow aperture and brighter, more defined sound. Dual coil pickups have wide aperture and fuller, mellower sound. The string sensing coils are shown with a solid line and the hum cancelling coils with a dashed line. The DC resistance and peak impedance values shown are for the large humbucker size pickups. For comparison:

<table>
<thead>
<tr>
<th></th>
<th>DC resistance</th>
<th>Peak impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gibson Patented Humbucker</td>
<td>7.4 K-ohms</td>
<td>250 K-ohms</td>
</tr>
<tr>
<td>Fender Stratocaster</td>
<td>5.5 K-ohms</td>
<td>530 K-ohms</td>
</tr>
</tbody>
</table>

SINGLE COIL

SINGLE COIL (S) — Narrow aperture, medium output pickups with warm, full range sound. Increased high and low frequency response yields more clarity and dynamic range than conventional designs. Very low noise and hum, due to lower peak impedance.

DC resistance: 6.7 K-ohms
Peak impedance: 200 K-ohms

SPLIT HUMBUCKER (T) — Same aperture, output level and excellent tone as the single coil pickups plus the same low noise and hum of dual coil designs. Coils can be wired in series or parallel for added high frequency response or separately for stereo output.

DC resistance: 7.5 K-ohms
Peak impedance: 220 K-ohms

HUM CANCELLERS (HC) — Narrow aperture, slightly lower output level than S or T designs with extended high frequency response. Highest clarity and definition coupled with maximum rejection of hum and noise. The 1HC, 2HC and SBHC models can be capacitance tuned to deliver the same resonance and midrange emphasis (without hum) as the best P90 single coil pickups.

DC resistance: 7.5 K-ohms
Peak impedance: 160 K-ohms

VERTICAL HUM CANCELLERS (V) — In narrow pickups (Jazz Bass*, Strat* and our acoustic model 3AV) the hum cancelling coil is stacked under the string sensing coil. Interaction between the stacked coils results in improved attack characteristics and lower output levels. The response of these pickups is unsurpassed for punch, clarity and lack of noise.

DC resistance: Jazz Bass* 9.0 K-ohms
Peak impedance: (9V) 120 K-ohms

Strat* 8.2 K-ohms
Peak impedance: (3XV) 105 K-ohms

Acoustic 1.5 K-ohms
Peak impedance: (3AV) 48 K-ohms

PICKUP RESPONSE

For an explanation of pickup response, impedance, tone quality and testing, see pages 12-15 of this catalog.

The output level of the pickups is measured with a 12" length of .017" plain string tuned to A440 picked medium strong by a mechanical picker with the pickup face held 3/16" away from the string. The output level is measured with an AC voltmeter with VU response. The average output level for chords is approximately 3 times higher. For very hard picking, peak output levels from chords can be 8 to 10 times higher.

DUAL COIL (C) — Widest possible aperture dual coil design. The large humbucker size (1C) pickup has a 40% wider aperture than conventional humbuckers. The sound is very warm with excellent treble response. Lower peak impedance yields very low hum and noise levels. The coils can be easily connected in series, parallel, out-of-phase and single coil configurations.

DC resistance: 8.0 K-ohms  Peak impedance: 190 K-ohms

LAMINATED CORE HUMBUCKERS (LC) — Designed for the guitar player who demands maximum midrange punch and resonance. Best silicon steel laminated cores enhance midrange, distortion and sustain beyond the range of conventional humbuckers. Available in 4 different output levels, all with 4-conductor output cable for series, parallel or single coil wiring.

DC resistance: LC40 5.5 K-ohms  LC50 7.5 K-ohms  LC60 13.0 K-ohms  LC70 15.8 K-ohms

TAPPED COIL (B) — This pickup design features two regions of emphasis in its sound spectrum. Special winding and construction techniques yield impedance peaks at 1.5-2.5 KHz and at 4-6 KHz for midrange emphasis and extended response at high output levels. The aperture of this design is slightly smaller than that of the Dual Coil design. Two separate windings on each coil form yield many possible tonal qualities. The windings can be wired to a 5 position switch to select output levels and tone qualities ranging from all windings in series to both coils out of phase.

TRIPLE COIL (E) — This pickup is a combination of the Dual Coil and Hum Canceller designs. Both sensing coils can be selected to form a wide aperture dual coil pickup, or each sensing coil can be selected separately with full hum cancellation. Switching between several of these options in series or parallel can be done easily with DPDT switches. All coil configurations can be capacitively tuned just like the Hum Cancellers. Available in standard humbucker size and larger pickups.

5 and 6 STRING BASSES

Our dual coil, triple coil and hum-canceller designs can be built to span the string widths of 5 and 6 string basses. The split coil design can be built to fit 6 string basses. The P-Bass* and single coil or vertical hum canceller J-Bass* pickups can also be built to fit 5 or 6 string PJ* basses.

ELECTRONICS

Bartolini electronic on-board preamplifiers, tone control modules and distortion effects complement and extend the tonal range and performance of any instrument. The on-board modules are easy to install, require only one battery and have very long battery life. They are fully shielded and feature extremely low hum and noise levels.

ELECTRONIC PICKUPS

Our electronic pickups are available in hum canceller and dual coil designs. The built-in preamplifiers have the same response and boost options as our on-board preamplifiers. They are available in large humbucker size and in Precision bass size.

DISTORTION

Our distortion effect, the Tube-it, is capable of distortion-sound qualities fully equal to that of the best stock or modified Marshall amplifiers. See back cover.
LARGE HUMBUCKER SIZE PICKUPS

All of our pickups, with the exception of the Laminated Core humbuckers, are electrostatically shielded and cast in special epoxy resins. They have very low hum, noise and microphonic levels. Their smooth, full range frequency response makes them an excellent choice for both guitars and basses. These pickups fit the large humbucker mounting rings and will sense total string width of approx. 2¼" (54mm). For pickup output level, refer to the front cover of this catalog.

1S  Warm, smooth, full range single coil sound and very low hum and noise. This pickup has more low and high frequency response than conventional humbuckers. The coil is below the logo, except for matched pairs in which the rhythm pickup coil is above the logo. Matched pairs have opposite polarity magnets for humbucking combination.

1T  Split humbucker design retains the smooth single coil sound of the 1S. Each coil senses half of the strings. Both coils in series or parallel combination eliminate hum. This pickup can also be used as a pair of stereo single coils (3&3). Treble coil is below the logo.

1HC Hum canceller design for bright, smooth, clear single coil sound without hum and noise. Can be capacitor tuned to give the midrange enhancement of the best P90 single coils. Matched pairs with sensing coils above and below the logo are available.

1C  (the Beastie II) Dual coil humbucker with very warm tone, excellent treble response and very low noise and hum. Aperture is 40% wider than conventional humbuckers for warm, full lows. Unequal coil design has more clarity in dual coil modes, more tonal differences in single coil modes. Can be wired in series, parallel, single coils, out-of-phase.

1B  (the Beast II) Tapped dual coil design has multiple resonances for added midrange punch and treble clarity. Two separate windings on each coil can be selected with toggle or rotary switch to obtain a wide variety of tonal qualities ranging from all windings in series to both coils fully out-of-phase.

1E  Triple coil pickup, outer coils sense string motion, center coil cancels hum. Coils can be wired for wide aperture humbucker sound (like the 1C) or hum cancelled single coil sound (like the 1HC) with toggle or rotary switches.

ACTIVE ELECTRONIC PICKUPS

Our active electronic pickups add the features of our on-board preamplifiers (TC1, TC3) to those of our dual coil (1C) and hum canceller (1HC) pickups. Both the coils and the preamp are fully accessible for maximum versatility. The tonal range of these pickups extends from nearly acoustic clarity to strong midrange boost specifically shaped to obtain the best power guitar distortion (see page 12). Many sound variations are achievable with these pickups, alone or in combination with other passive or active pickups. Battery drain is very low—4 months continuous use from a single 9V battery.

ETC-S  Hum cancelled single coil sound (1HC) with high gain, low noise preamp similar to the TC1.
ACTIVE ELECTRONIC PICKUPS (continued)

E90  Hum cancelled single coil sound (1HC) with high gain, low noise preamp (TC3) for outstanding clarity and
definition. This pickup has more midrange boost than the ETC-S and is strongly recommended for best power
guitar distortion sound.

ETC-D Dual coil sound (1C) with high gain, low noise preamp (TC3). Coils can be wired in series or parallel.

POLYPHONIC PICKUPS — Separate outputs for each string.

Low separation polyphonic pickups switch output smoothly between adjacent channels during deep “bends” (L). High
separation pickups are designed for use with synthesizer drivers (H). Narrow aperture, medium output. String
 spacings other than those shown are available on special order.

16L or H  Hexaphonic guitar pickup. 13/32” string spacing (10.3mm).

16L or H  Humbucking or Hum Cancelling Hexaphonic pickups - 2 coils per channel in either humbucking or hum
(HB or HC) cancelling configuration.

14L or H  Quadraphonic bass pickup. 21/32” string spacing (16.7mm).

LAMINATED CORE EPOXY HUMBUCKERS

Specially designed for maximum midrange and resonance from a passive pickup. Silicon steel laminations, high power ceramic magnets and special winding techniques allow these pickups to exceed traditional design in resonance, midrange emphasis and output levels. The four models offer a wide range of output level, sustain and midrange enhancement. All LCE pickups have 4 conductor shielded cable for series, parallel and single coil mode selection. Internally constructed as shown at left, these pickups are now shielded and cast in curved top epoxy blocks, for low noise and freedom from microphonic effects. For output levels, refer to “LC’s” on front cover.

<table>
<thead>
<tr>
<th>Model</th>
<th>DC Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCE40 (LC40)</td>
<td>5.5 K-ohms</td>
</tr>
<tr>
<td>LCE50 (LC50)</td>
<td>7.5 K-ohms</td>
</tr>
<tr>
<td>LCE60 (LC60)</td>
<td>13.0 K-ohms</td>
</tr>
<tr>
<td>LCE70 (LC70)</td>
<td>15.8 K-ohms</td>
</tr>
</tbody>
</table>

SMALL HUMBUCKER SIZE PICKUPS

These pickups fit the Les Paul Deluxe*, Epiphone*, Firebird* and similar mounting rings. They will sense total string widths of approximately 2-1/16” (52mm).

2S  Single coil design, same as 1S
2T  Split humbucker design, same as 1T
2HC  Hum canceller design, like 1C with narrower aperture
2B  Tapped dual coil design, like 1B with narrower aperture and slightly lower output level

Using the 2HC or 2C pickups with the TC1 or TC3 preamps will yield the same performance as the ETC-S, E90 or ETC-D pickups in instruments with these smaller pickup sizes.

POLYPHONIC PICKUPS - Separate outputs for each string

26L or H  Hexaphonic guitar pickup, same as 16 L or H
24L or H  Quadraphonic bass pickup, same as 14L or H
"SOAP BAR" PICKUPS

SBHC Hum canceler design with the same output as our model 1HC. Can be capacitance tuned to yield the same resonance and midrange emphasis as the best P90 single coils without hum. Just as with 1S, 2S, 1HC and 2HC, these pickups can be ordered in matched pairs, rhythm pickup coil above logo, lead pickup coil below logo for maximum separation between coil positions.

SBC  Dual coil design similar in aperture and output to our model 2C.

SBB  Tapped dual coil design similar in aperture to our model 1B, slightly lower output level.

STRATOCASTER* PICKUPS

3X Single coil design with full range sound and 50% more output than the stock Strat* pickup. This exact replacement with extended low and high frequency response yields a warm, brilliant tone with less upper midrange emphasis than the stock pickup.

3S  Tapped single coil design with full range sound and twice the output of the stock Strat* pickup. The coil is tapped at a point that yields the same output level as the stock Strat* with full range sound quality. This pickup is now exact replacement size.

3XV Vertical hum canceller design of the same size as the 3S. The sound quality is very smooth and bright, with more high frequency response than the 3X and complete hum and noise cancellation. The output level is 1 db less than the Telecaster* rhythm pickup. These pickups work very well in combination with our TC3 preamplifier or TCT tone control. With the TC3 unboosted, the output level will exceed that of PAF*'s.

LCE3X Single coil Laminated Core Epoxy pickup, same size and shape as 3XV. Resonance and midrange emphasis like LCE humbuckers (p.5). Output level 1 dB lower than 3X. DC resistance 6.0 K-ohm.

POLYPHONIC PICKUPS - Separate outputs for each string

36L or H  Hexaphonic guitar pickup of the same size as the 3S. 13/32” (10.2mm) string spacing.

JAZZ GUITAR PICKUP

5J Dual coil design has full range response and outstanding tone quality. Mini humbucker size and only ¼” thick including cable and bracket that attaches the pickup to the end of the fingerboard. Bracket fits Johnny Smith and other similar fingerboards.
The clear, acoustic tone of these pickups is due to their unequalled precision in sensing string vibrations. Their narrow aperture and low peak impedance yield extended high frequency response, superior transient response and unmatched clarity. Effectively free from feedback under the most demanding performance conditions they also compensate accurately for the extra loudness of the B string in acoustic string sets. These pickups are easily attached to the sound-hole of the acoustic guitar with the plastic brackets provided. The brackets hold the pickup firmly in place and provide full height and tilt adjustment, without marring the finish of the instrument. The 3A and 3AV pickups are available with 9 foot cable and shielded phone plug. The 3AJ and 3AVJ pickups are available with a top quality strap pin jack at no extra cost.

**3A, 3AJ** Outstandingly quiet single coil pickup for acoustic guitar.
Aperture: 1/8”  Peak impedance: 55 K-ohms at 16.5 KHz  DC resistance: 1.8 K-ohms

**3AV, 3AVJ** Vertical hum canceller version of the 3A.
Aperture: 1/8”  Peak impedance: 90 K-ohms at 13.8 KHz  DC resistance: 4.4 K-ohms

---

**INSTALLATION SUGGESTIONS FOR GUITARS**

**Single Pickup Power Guitar**
- LC60  or  E90 in midrange boosted mode

**Stratocaster** Guitar
1. 3X at neck, mid or all 3 positions.
2. 3S with or without tap switch at treble position.
3. 3 - 3XV’s and a TC3 using the 2nd tone knob for boost control.

**Dual Pickup Guitar**

<table>
<thead>
<tr>
<th>TREBLE PICKUP</th>
<th>BASS PICKUP</th>
<th>EXTRAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S matched pair (or 2 1T’s)</td>
<td>1HC</td>
<td>series/parallel switch for 1C</td>
</tr>
<tr>
<td>1C</td>
<td>1HC</td>
<td>series/parallel or series/1/3 out-of-phase switch for 1B</td>
</tr>
<tr>
<td>1B</td>
<td>1C</td>
<td>series/treble coil switch for each pickup</td>
</tr>
<tr>
<td>LC50</td>
<td>1C</td>
<td>series/parallel switch for 1C</td>
</tr>
<tr>
<td>LC60</td>
<td>LC50</td>
<td>series/parallel switch for ETC-D</td>
</tr>
<tr>
<td>LC70</td>
<td>LC60</td>
<td>parallel/treble coil switch for 1E’s</td>
</tr>
<tr>
<td>1C</td>
<td>E90</td>
<td>plus TC3 preamp and boost switch for TC3</td>
</tr>
</tbody>
</table>

Options 7 and 8 are equivalent to option 2 with a TC3 preamp. A boost switch for the TC3 is recommended.
BASS PICKUPS

Our bass pickups are renowned for their full range response, outstanding clarity and very low levels of hum, noise and microphonics. Their extended low and high frequency response enhances every nuance throughout the entire range of the instrument. In passive instruments or in active instruments, using our on-board electronics, these pickups provide the ultimate in bass tone quality and response.

PRECISION BASS* PICKUPS

8S  Exact replacement for Fender Precision Bass*. Excellent clarity, punch and balance with least noise. The 8S is a pair of single coil units.

84L  Precision Bass* quadraphonic pickup with separate coils for each string.

8E active Precision Bass* pickup. Built in special TC3 preamp extends frequency response and has low midrange control feature. This pickup can be wired to a 3 position switch (DPDT on-off-on) to give full range, upper midrange or treble boosted sounds all at the same output level. In addition the low midrange can be contoured in the same way as with our TCT module (see page 12). The 8E pair requires a single 9V battery which will power it for 4 months of continuous use.

JAZZ BASS* PICKUPS

9S  Exact replacement for Fender Jazz Bass*. Excellent clarity, punch and balance. Each unit is a single coil with very low noise characteristics. The pair is fully humbucking when both volume knobs are at maximum.

9V  Vertical hum canceller pickups for Jazz Bass* with improved attack and definition. Each unit offers full hum cancellation. Output level is 5 dB lower than that of stock pickups.

94J  Humbucking quadraphonic pickups for Jazz Bass* with outstanding clarity and definition. Each pickup has separate outputs for each string. The output from each pair of strings in each unit is humbucking. The output of the bass pickup is equal to that of the stock pickup. The output of the treble pickup is 20% higher for better balance between pickups.

PRECISION JAZZ BASSES

The following pickup combinations are suggested for PJ basses for improved balance and tone quality.

8S and 9S treble pickup. High output, low noise. Treble pickup not entirely hum free.

8S (rewired in parallel) and 9V treble pickup. Lower output level, hum free.

8S and 94J treble pickup. High output, hum free.

JAZZ BASS* TREBLE PICKUPS

9S, 9V and 94J treble pickups are available separately.

"Johnny Smith" is a registered trademark of Norlin Musical Industries. "Strat," and "Fender" are registered trademarks of CBS Inc. "Ibanez" is a registered trademark of Hoshino Gakki Ten. "Music Man" is a registered trademark of Music Man, Inc. "Guild" is a registered trademark of Avnet, Inc. Bartolini Guitars is not in any way affiliated with Norlin Musical Industries, CBS Inc., Hoshino Gakki Ten, Music Man, Inc. or Avnet, Inc.
RICKENBACKER* 4000, 4001 and 4080 BASSES

6RS Single coil pickup replaces bass pickup in these instruments without modifications. Replaces treble pickup with slight modifications.

6RT Split humbucker pickup for single coil sound without hum. Replaces stock pickups as above.

6RC Dual coil pickup for higher output, fuller sound. Replaces stock pickups as above.

6RHC Hum cancelling pickup replaces stock pickups as above. Recommended in matched pairs (see 1HC) with our active tone controls.

6S Single coil pickup replaces rubber pad in mute compartment to add a 3rd pickup to these instruments for maximum treble sound.

64H - Quadraphonic version of 6S.

MUSIC MAN*, IBANEZ*, GUILD*, and LONG SCALE BASS PICKUPS

These Music Man*, Ibanez* and Guild* bass pickups replace the stock pickups without modifications. The I4 series pickups replace the old MC924 pickup which measures 1⅝" x 3¾" (41mm x 99mm). The Guild* pickup replaces the large bass humbucker which measures 1¾" x 3" (48mm x 76mm). The Long Scale bass pickup measures 1⅝" x 3" (38mm x 76mm) and has a flat brass bracket tapped for 2 4-40 screws spaced 3¾" apart. Reversed split humbuckers (T) with treble coil above the logo are available on request.

MM .... Replaces the Music Man* Stingray bass pickup.
I4 .... Replaces the Ibanez* MC924 pickup.
GB .... Replaces the large Guild* bass humbucker (1⅝" x 3").

MMT .... I4T .... GBT .... 4T Split humbucker.
MMC .... I4C .... GBC .... 4C Dual coil humbucker.
MMHC .... I4HC .... GBHC .... 4HC Hum canceller.
MME .... I4E .... GBE .... 4E Triple coil.
MMB .... I4B .... GBB .... 4B Tapped dual coil.
MM4L .... I44L .... GB4L .... 44L Quadraphonic pickup.

5 and 6 STRING BASSES

Dual coil, split humbucker, triple coil and hum canceller designs can be built to span the string widths of 5 and 6 string basses. Total string widths greater than 2¼" must be specified together with fretboard curvature so that the output level of each string can be balanced. There is an additional charge for total string widths greater than 2¼". We recommend that placement of the outside strings should be at least ¼" from the edge of the pickup.
ELECTRIC MANDOLIN PICKUP

8HC Narrow aperture, medium output, hum cancelling coil pair for maximum definition and clarity with least hum and noise. Coils can be wired in series or parallel. For total string widths up to 1½". Pickup is built into one unit of our model 8S (Precision Bass*) pair.

ON-BOARD ELECTRONICS

TC1, TC2, TC3 and TC4 preamps - The Chip

These preamplifiers improve the performance and tonal quality of electric guitars and basses by increasing the output level, boosting midrange and treble (optional) and decreasing the output impedance of the instrument. Increasing the output level is most useful for lead guitar where higher output from the instrument improves the overdriven tone of the amplifier. On guitars these preamps are capable of gain ratios exceeding 100. On basses they can increase the output level while reducing treble losses in the cable. They can also enhance broad regions of midrange and treble to change the tonal balance of the instrument.

Some of the amplification characteristics of the TC3 are shown on the graph at right. If the boost lead is not used the gain is 12 db (4 times the input signal). With boost components added the preamplifier can enhance all frequencies (10 mfd), midrange frequencies (1 mfd) or upper midrange and treble frequencies (.33 mfd). These characteristics and capacitor tuning of the pickup coils can produce a tonal response that is best suited for overdriving amplifiers for best power guitar tone (see page 12). On basses the midrange and treble boosted sounds can be attenuated to the same level as the unboosted signal so that a simple 3 position toggle switch can select full range, midrange or treble boost all at the same output level. The TC1 or TC2 preamps should be used for pickups with output level lower than 25 mV on the pickup output level comparison (front cover), or when extra unboosted gain is needed. The TC2 preamp is the stereo version of the TC1 and the TC4 is the stereo version of the TC3.

These preamps are hand built from discrete components for best distortion and noise characteristics and fully shielded for least hum. They are rugged, reliable, easy to install and very easy on batteries (4 months of continuous use from a single 9V battery). They are half the size of a 9V battery.

These preamps are built into our active electronic pickups (ETC-S, E90, ETC-D and 8E).

ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>TC1</th>
<th>TC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>input impedance/output impedance</td>
<td>300 K-ohms/60 K-ohms</td>
<td>500 K-ohms/60 K-ohms</td>
</tr>
<tr>
<td>minimum gain (500 K-ohm load)</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>maximum gain</td>
<td>more than 100</td>
<td>more than 100</td>
</tr>
<tr>
<td>maximum undistorted output</td>
<td>2.5 V</td>
<td>2.5 V</td>
</tr>
<tr>
<td>maximum input for undistorted output</td>
<td>250 mV</td>
<td>500 mV</td>
</tr>
</tbody>
</table>
ACTIVE TONE CONTROL — TOT module

This active tone control has the tonal characteristics of the early Fender* amplifiers with Bass-Mid-Treble controls. The Bass and Treble controls give 13 dB boost or cut at 40 Hz and 4 kHz respectively. The Midrange control can cut up to 14 dB at 400 Hz. Input impedance, maximum input, maximum output and treble boost options are the same as shown for the TC3 preamp.

Rugged, reliable and easily installed, this unit is fully shielded and slightly smaller than a 9V battery. Battery life is more than 2 months of continuous use for a single 9V alkaline battery. The Bass and Treble controls require 500 K-ohm audio pots. The Midrange control requires a 25 K-ohm pot, audio or linear. Potentiometers not included.

PARAMETRIC FILTER — EZQ module

This module is specifically intended as a low pass filter with variable (compensated) Q, but it can also be used as a bandpass or highpass filter. Using the EZQ with our bass hum-cancellers provides the utmost definition for percussive (string slap) bass techniques, as well as a wide range of tonalities not achievable with standard (shelving) tone controls. The EZQ is a low noise filter that will accept input from any pickup or combination of pickups without instability or oscillation. This unit is smaller than the TCT and also uses a single 9V battery. Battery life is 2 months of continuous use. The frequency range extends from 600 Hz to 5000 Hz and the boost at maximum Q exceeds 20 dB. Decreasing the Q value increases the overall gain to maintain nearly constant loudness. The EZQ requires 2 dual 50 K-ohm pots (not included) for frequency and Q control.

ACTIVE TONE CONTROL — TBT module

This active tone control features independent Bass and Treble controls which are user adjustable with external capacitors. Each control boosts or cuts up to 15 dB. With both controls at 5 the response is flat and the noise level is 3 dB lower than that of the TCT. The TBT offers more control over the center frequency and the width of the midrange minimum and is useful when only two tone control knobs can be used on the face of the instrument. The TBT is slightly smaller than a 9V battery and will operate for 2 months continuously on a single 9V battery. Both controls are 50 K-ohm linear potentiometers (not included). Several tuning capacitors are included with this unit.
During the last 3 years we have experimented extensively with the sound requirements of several guitar players who demanded the ultimate in power guitar tone. Several interesting features of the interaction between guitar and amplifier in the distortion mode showed up during these experiments. Too much high frequency response in the guitar signal confuses the amplifier and the resulting distortion is "blatty". Beyond a certain level, increasing the guitar output level degraded the tone quality. Dual coil pickups or too much low frequency content also diminished the midrange bite. To avoid these problems we modified the response of our ETC-S pickup and later switched preamps to arrive at the E90 design. To achieve the best power guitar tone the coils of the E90 are retuned to midrange frequencies with a small capacitor to ground, then the boost option is used to further enhance the midrange and finally the output is attenuated and adjusted to match the amplifier input requirements. These three modifications can be switched out with a 3PDT switch to obtain a smooth, full range sound of unmatched clarity at the same level as the boosted mode. The only passive pickups that approached the performance of the E90 in the boosted mode were the LC60 and LC70 installed with a tilt such that the bass blade was twice as far from the strings as the treble blade. Tilting the pickup yields the tone quality of a single coil with the low noise of a humbucker.

Most bass players enhance both the low and the high frequency sounds of their instruments, either at the amplifier controls or with on-board electronics. The preferred spectrum shape seems to be a wide valley 5 to 8 dB deep with its center between 400 and 800 Hz. This frequency contour produces a tone quality similar to the brilliance of a good steel string acoustic guitar except one octave lower. This and many other tonal responses are easily obtained with our TCT and TBT tone control modules.

**HIGH IMPEDANCE VS. LOW IMPEDANCE** — The impedance of most of our passive pickups is lower than traditional designs, sometimes 4 to 5 times lower. The shape of the impedance curve is the important factor in the tone quality of a magnetic pickup. Most pickup coils have resonant peaks in their response. In low impedance designs the resonant peak occurs at higher frequencies than in high impedance designs. In some cases the resonant peak occurs at frequencies beyond the range of human hearing and the pickup response is "flat" within the audible range. The lowered impedance is always the result of fewer turns of wire and the output level of these pickup coils is lower than that of high impedance designs. The response of the pickup coils is shaped by the preamplifier or preamp and filter combinations used to compensate for the reduced output.

The sound quality that is usually described as "low impedance" or "piano wire" tone comes from strong narrow-band enhancement in the 3-5 KHz region. This tone quality can easily be achieved with any of our bass pickups and our EZQ parametric filter module. The EZQ is also recommended for adding a new dimension to the sound of fretless basses.
STRINGS AND COILS

When the pick releases the string it causes two ripples to shuttle between the bridge and the nut or fret. Figure shows typical string ripples at several intermediate stages during the first half cycle of vibration. The ripples are reflected from the nearest fixed end of the string then travel along the string to the opposite fixed end where they are reflected again. Viewed along the string the motion is an elliptical path that changes in orientation as its amplitude decays. Figure 2 shows the string orbits during the first few cycles of oscillation. The complex motion shown in Figures 1 and 2 is equivalent to a sum of harmonics that varies during the attack and decay of a note.

Figure 3 shows the fundamental and the first 4 harmonics and also the relationship between a note and the fifth and the octave above it. The fundamental of the note is at 100 Hz; its harmonics occur at multiples of that frequency. The fundamental of the octave is at 200 Hz, twice the frequency of the lower note. Every harmonic of the octave agrees with every other harmonic of the lower note. The fundamental of the fifth is at 150 Hz, 3/2 the frequency of the lower note. Every other harmonic of the fifth agrees with every third harmonic of the lower note. The small circles show the harmonics in agreement.

In acoustic instruments the string motion is coupled to the soundboard by the bridge. Since the bridge cannot move sideways (Figure 2) only those components of the string motion that can move the bridge up and down will be amplified. This lack of symmetry in the coupling of string vibration to the soundboard contributes strongly to the complex tone quality of plucked acoustic instruments. Our Hi-A label was derived from "high asymmetry" and the ability of our polyphonic designs to sense string motion in the same way as the bridge of an acoustic guitar. The resonances of the acoustic body also contribute to the tone quality of the instrument by enhancing some of the harmonics of each note.
In most electric instruments the string ripple is sensed by magnetic pickups. The magnetic field of the pickup links its elements (magnets, coil cores, polepieces, etc.) and the string. Changes in the string position cause small changes in the total magnetic flux linking the pickup elements and the string. The pickup coils produce electrical pulses that correspond to changes in the magnetic flux that passes through the coils. Pickup resonances can also enhance some of the harmonics and change the tonality of a plucked note.

The length of string sensed by the pickup contributes strongly to its tonal quality. This "window" (Figure 4) through which the pickup "looks" at the string ripples is called the "aperture" of the pickup. Narrow aperture pickups (single coil) sense the shuttling string ripples most accurately and yield more clearly defined sound. Wide aperture pickups ("humbuckers") sense the ripples at a different time at each poletip. The combination of both signals can diminish or even cancel some of the upper harmonics while enhancing the lower harmonics of a note. This effect produces the mellower tonality of humbuckers. When the separation between sensing coils is wide enough (like in a Strat in the intermediate switch positions) the cancellations between pulses from the same ripple can be clearly heard as "out-of-phase" sounds.

Pickup coils are real inductors with resonant peaks usually in the audio range. Their impedance rises from the DC resistance value to a maximum of several hundred thousand ohms at several kilohertz and drops again at higher frequencies. The inductance of the coil can be measured at frequencies well below resonance. The value of the winding capacitance labeled C in Figure 5 and the high frequency losses to magnets, core materials, shielding and other things near the coil (AC resistance) cannot be measured directly but can be implied from the impedance curve.

The frequency and Q of the resonant peak are the major features of the pickup response curve. The Q value of the pickup is the width of its response curve 3dB below the maximum divided into its resonant frequency. The higher the Q value the narrower and taller the resonant peak. Figure 6 compares a high Q design (Strat) with a low Q design (1C). The Strat features a treble peak at the coil resonance. In the 1C that peak has been damped out and the response covers a wider frequency range.

The square wave magnetic pulse test shown of Figure 7 is a slalom course for pickups. The test pulse at left switches quickly from one magnetic polarity to the other 2000 times per second. The actual switching was too fast for the film and did not leave a trace. The dotted lines are hand drawn. The outputs of the pickup coils in the magnetic field are displayed on the oscilloscope. The pickups are loaded with a 500K-ohm resistor. The 3A follows the test pulse most accurately, showing a small, well-damped oscillation after each "gate". Its frequency response is smooth and free of resonances in the audio range. The 5J and 8S pickups also show well-damped recovery as they follow the test pulse. Both have a smooth frequency response very similar to the 1C. The Strat or LC40 curves show oscillation that damps out slowly. This is equivalent to a peak in the frequency response curve at the resonant frequency. GH is a patented Gibson humbucker with an intermediate frequency response curve.
After 11 years of part-time research in the acoustics of nylon string instruments, speaker cabinets, power amplifiers, and polyphonic pickups, we started manufacturing magnetic pickups as a full-time job in 1974. Our first professional year was spent making only quadraphonic and hexaphonic (Hi-A) pickups. In 1975 we brought out our first monophonic designs under the Hi-A label. Since then we have greatly expanded the number of monophonic and polyphonic pickups (both Bartolini and Hi-A label) and added preamplifiers, preamplified (electronic) pickups and tone control modules.

In 1975 we introduced square-wave magnetic pulse testing for magnetic pickups, expanding upon our description of the impedance curve of these pickups. Shortly afterwards we introduced the mechanical string picker to the field of pickup testing. In 1977 we introduced the first electronic (preamplified) pickup with parametric bandpass enhancement (the EVQ). These pickups were also some of our earliest hum canceller designs in large humbucker size. These side-by-side hum cancellers were improved in the following years until it was possible to obtain the sound quality of the best traditional single coils without the hum and noise. Toward the end of 1980 we started manufacturing vertical hum canceller designs as our 3AV acoustic and as replacements for Fender Strat* and J-Bass* pickups. In addition, we introduced the 94J, our quadraphonic for J-Basses*.

In 1981 we brought out our Laminated Core humbuckers, adding the choice of upper midrange enhancement to the smoother response of our previous designs. After extensive experimentation with the sound requirements of several New Wave and Heavy Metal guitarists, we developed a pickup specifically tailored for power guitar tone and a distortion effect that sounds exactly like the best heavy metal amplifiers.

In 1982 we presented the results of our experiments with Classic and Flamenco guitars at a meeting of the Catgut Acoustical Society in DeKalb, Illinois. These results and many other scientific inquiries into the acoustics of guitars and violins were published in the Journal of Guitar Acoustics**. We have continued the work on nylon string instruments with an electronic device capable of controlling the attack, decay and tonal characteristics of a solid body instrument to duplicate the sound quality of the best acoustic instruments.

As we celebrate our 10th year of manufacturing, we'd like to thank the thousands of musicians, luthiers and repairmen whose requests and suggestions have helped to develop and improve our products.

**The Journal of Guitar Acoustics is published by Tim White at P.O. Box 128, Grass Lake, Michigan USA 49240.
Keep it warm

Compare to the response of a MARSHALL JCM800 50 watt amplifier with controls set Presence: 8 Bass: 8 Midrange: 5 Treble: 5 Master: 2½ Pre-amp: 6½. The input test signal is a 400 Hz sine wave.

The TUBE-IT can give you these and many other fine tube sounds and operates continuously for one month on one 9V battery.

"Marshall" is a trademark of Marshall Amplification Ltd. Bartolini Guitars is not in any way affiliated with Marshall Amplification Ltd.
## PICKUPS AND ELECTRONICS

### LARGE HUMBUCKER Size Pickups
- 1S: $94.
- 1T or 1HC: 103.
- 1C: 107.
- 1B: 125.
- 1E: 127.
- VBB-C: 110.

### Laminated Core Pickups
- LCE40: 87.
- LCE50: 92.
- LCE60: 97.
- LCE70: 102.

### Active Electronic Pickups
- E90: 115.
- E90-D: 120.
- EBB-D: 117.

### Hexaphonic Pickups
- 16L or H: 135.
- 16LHB or HHB: 160.

### SMALL HUMBUCKER Size Pickups
- 2S: 94.
- 2T or 2HC: 103.
- 2C: 107.
- 2B: 125.

### Hexaphonic Pickups
- 26L or H: 135.

### "SOAP BAR" Pickups
- SBHC: 103.
- SBB: 125.

### STRATOCASTER Size Pickups
- 3X: 80.
- 3S: 85.
- VBB-S: 80.
- 3XV: 90.

### Laminated Core Pickups
- LCE3X: 77.

### Hexaphonic Pickups
- 36L or H: 135.

### JAZZ GUITAR Pickups
- 5J: 132.

### ACOUSTIC PICKUPS
- 3A: $95.
- 3AV: 106.

### PRECISION BASS Size Pickups
- 8S: 114.
- 8ST: 114.
- 8T: 114.

### Active Electronic Pickups
- 8E: 135.

### Quadruphonic Pickups
- 84P: 145.

### JAZZ BASS Size Pickups
- 9S: 123.
- 9S Treble: 67.
- 9V: 143.
- 9V Treble: 77.

### RICKENBACKER Size Pickups
- 6RS: 94.
- 6RT or 6RHC: 103.
- 6RC: 107.
- 6S: 93.

### Quadruphonic Pickups
- 64H: 120.

### OTHER 4 STRING BASS PICKUPS
- ****T... 4T, I4T, W4T, MMT, B_T, GBT
- ****HC... 4HC, I4HC, W4HC, MMHC, B_HC, GBHC
- ****C... 4C, I4C, W4C, MMC, B_C, GBC
- ****B... 4B, I4B, W4B, MMB, B_B, GBB
- ****E... 4E, I4E, W4E, MME, B_E, GBEB

B can be BA, BB, BC, BD. These are soap bar shapes listed in our Bass Shapes sheet.

### Mandolin Pickup
- 8HC: 97.

---

Our Stratocaster replacement pickups are now available in white at no extra charge. Our Jazz Bass replacement pickups are available only in black. All other pickups are available in white or in creme (ivory) color with a $6.00 surcharge to the regular price.
ON-BOARD ELECTRONICS

TC1, TC3, TC5 $30.
TC2, TC4, TC5 50.
TCT 65.
TBT 70.
TBIBT 90.
EZQ 83.

ACCESSORIES

MINI-TOGGLE SWITCHES - 1/4" stem - C&K or ALCO brand
SPDT (on-off-on) Coil cut or Boost selector for active electronic pickups. Flat lever...$5.25
DPDT (on-on) Series/parallel or phase reversal Flat lever... 5.75
DPTT (on-on-on) Pickup selector, series/parallel/s.coil or Q selector for EZQ. Flat lever... 7.50
3PDT (on-on) Boost switch for E90, E90-D and E88-D Round lever... 8.00
4PDT (on-on-on) Triple coil selector switch Round Lever.. 13.50

ROTARY SWITCHES
4 Pole - 5 Position Shorting(make before break)
Centralab PSA-210....... 23.00

POTENTIOMETERS
50 K-ohm Linear, Center detent 3/8"d. x 3/8"1. stem, 5/8"d. body, 1/4"d. x 5/16"1. solid shaft
Bass and Treble controls for TBT or TBIBT. Alpha brand....$4.00
Dual 50 K-ohm Linear, Center detent 3/8"d. x 3/8"1. stem, 5/8"d. body, 1/4"d. x 5/16"1. solid shaft
Active blend control for TBIBT Alpha brand....$8.80
Dual 250 K-ohm Special Center detent 3/8"d. x 3/8"1. stem, 5/8"d. body, 1/4"d. x 5/16"1. solid shaft
Blend control - both pickups full on at center Alpha brand....$10.40
25 K-ohm Linear 5/16"d. x 3/8"1. stem 15/16"d. body, 1/4"d. x 5/16" knurled shaft
Midrange control for TCT $4.60
25 K-ohm Linear 5/16"d. x 1/4"1. stem 15/16"d. body, 1/4"d. x 3/8"1. solid shaft
Midrange control for TCT Alpha brand....$1.70
Dual 50 K-ohm Linear 5/16"d. x 1/4"1. stem 15/16"d. body, 1/4"d. x 3/8"1. solid shaft
Frequency control for EZQ Alpha brand....$2.70

SHIELDED MULTI-CONDUCTOR CABLE
Alpha 3304 - 4 conductor/braided shield 1/8" diameter......$2.10/ft
Alpha 3308 - 8 conductor/braided shield 3/16" diameter...... 2.40/ft
Belden - 4 conductor/foil shield 5/32" diameter...... .50/ft