"How does True Bypass Really Measure Up?"

Definitive Test Results Demonstrating
The Difference Between True Bypass and Buffered Bypass

Prepared by:

Bruce Ritz - Chief Designer, *gig-fx*

Contributors:
Jeff Purchon – CEO, *gig-fx*
Eric Corpus & Steve Blucher – R & D, Dimarzio

Published: January 2009

gig-fx, inc.
1050 Winter Street, Suite 1000, Waltham, MA 02451 USA
Tel: ++ USA 978 263-6432 Fax: ++ USA 978 662-2025
www.gig-fx.com

"How does True Bypass Really Measure Up?"

This document sets out to reveal the exact difference between True Bypass and Buffered bypass, by means of audio tests and specific technical measurements comparing both bypass methods.

BACKGROUND

In the early days, True Bypass was considered to be a simple way of switching effects in and out. No thought had been given to signal integrity or frequency response; only later did people come to believe that True Bypass would help preserve signal fidelity. A True Bypass switch completely disconnects a guitar's signal from an effect's input and output, thereby eliminating signal loading by the effect. This was necessary because the input impedance of many vintage effects was much lower than that of most amplifiers, thereby affecting signal level and frequency response.

It became apparent, however, that True Bypass has some disadvantages. First, the only hardware available to implement True Bypass is a clunky mechanical switch that often creates loud, potentially speaker- damaging POPs and can also be less than reliable. A high-quality audio mechanical footswitch is also relatively expensive – especially for a stereo effect. The major drawback of True Bypass, however, is that it changes the total cable length between the guitar and the amp when switched in and out. An inductive signal source like a guitar pick up is not good at driving long lengths of cable. Even expensive high quality cables can affect the pickup's load and ultimately, the guitar's tone.

Consequently, many manufacturers adopted the buffered bypass design to overcome the disadvantages of mechanically switched True Bypass. It is cheaper, more reliable, presents constant high impedance to the pickup, and is much better at driving long cables due to its low resistive output impedance. A well designed buffered bypass can also prevent loud pops when switched in and out. Ideally, the buffer's input should look as much like a guitar amp input as possible, and if the buffer is placed properly the impedance seen by the guitar will never change when the effect is switched in and out.

One would therefore think that buffered bypass is a better solution, so why do so many musicians still insist on True Bypass? We had to find out for ourselves. Our initial audio tests surprised us; the gig-fx buffered bypass provided a noticeably brighter sound than a True Bypass. We continued with audio tests, and discovered that other buffered bypass pedals provided a similar, brighter sound. After some initial concern that the gig-fx bypass had an unwanted treble boost, we quickly realized that the True Bypass was actually rolling off the highs and that the buffered response was more accurate. After getting similar results with other pedals, we searched the internet and found that many bloggers and pundits have already concluded what we have: True Bypass often degrades, rather than preserves, a guitar signal. Nevertheless, no one has presented any hard data to confirm this assertion – until now.

Consider the situation in Fig. 1. There are two lengths of cable: between the guitar and the effect (Input Cable) and between the effect and the amplifier (Output Cable). When the effect is engaged, the guitar sees the input cable plus the effect. Engaging True Bypass removes the effect and combines the lengths of the two cables, effectively doubling - or even tripling - the cable length that the guitar pickup has to drive. With a buffered bypass (Fig. 2), both the length of cable and the load that the guitar has to drive remain constant when the effect is either engaged or bypassed. Consequently, there is little or no change in the frequency response of the signal reaching the amplifier. Note that the switches shown can be either mechanical or electronic.

Fig. 1 - UNBUFFERED TRUE BYPASS

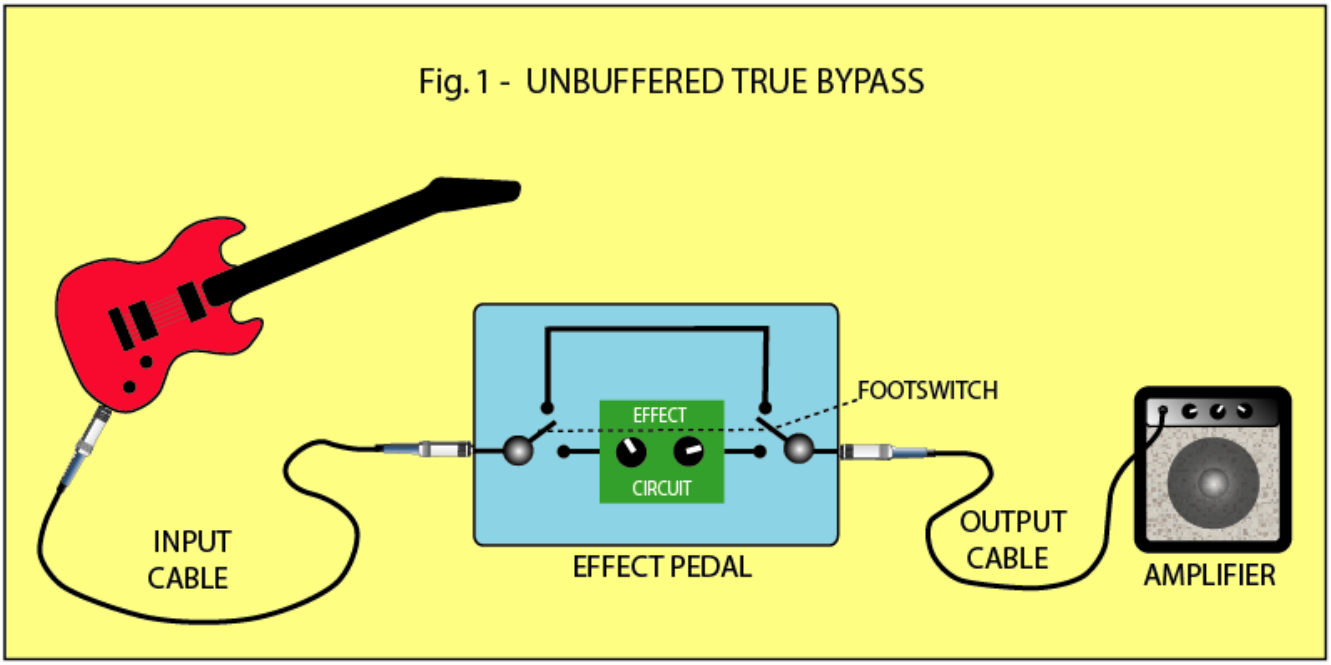
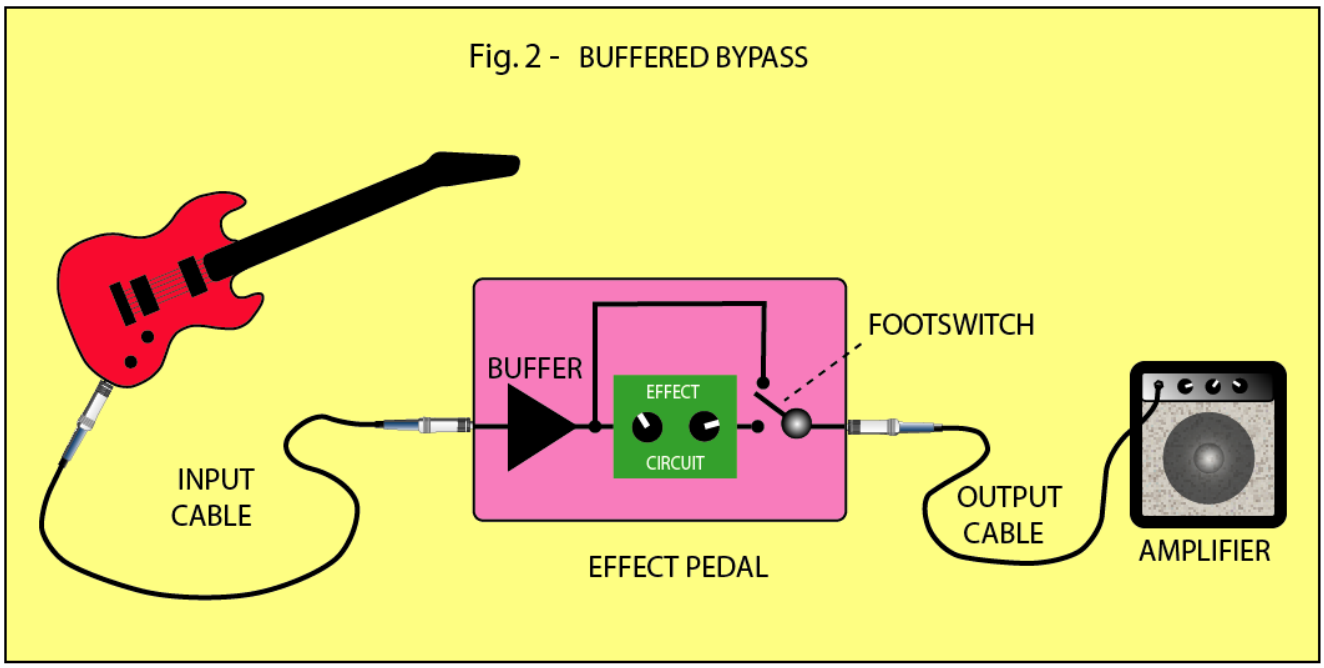
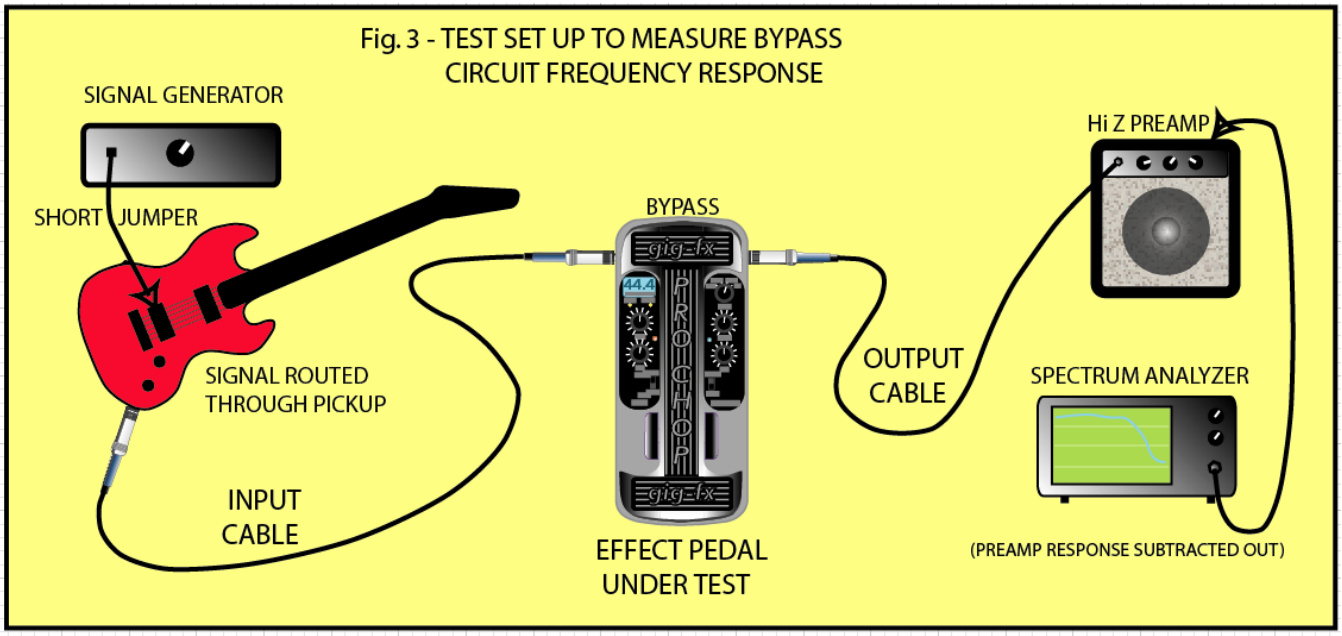


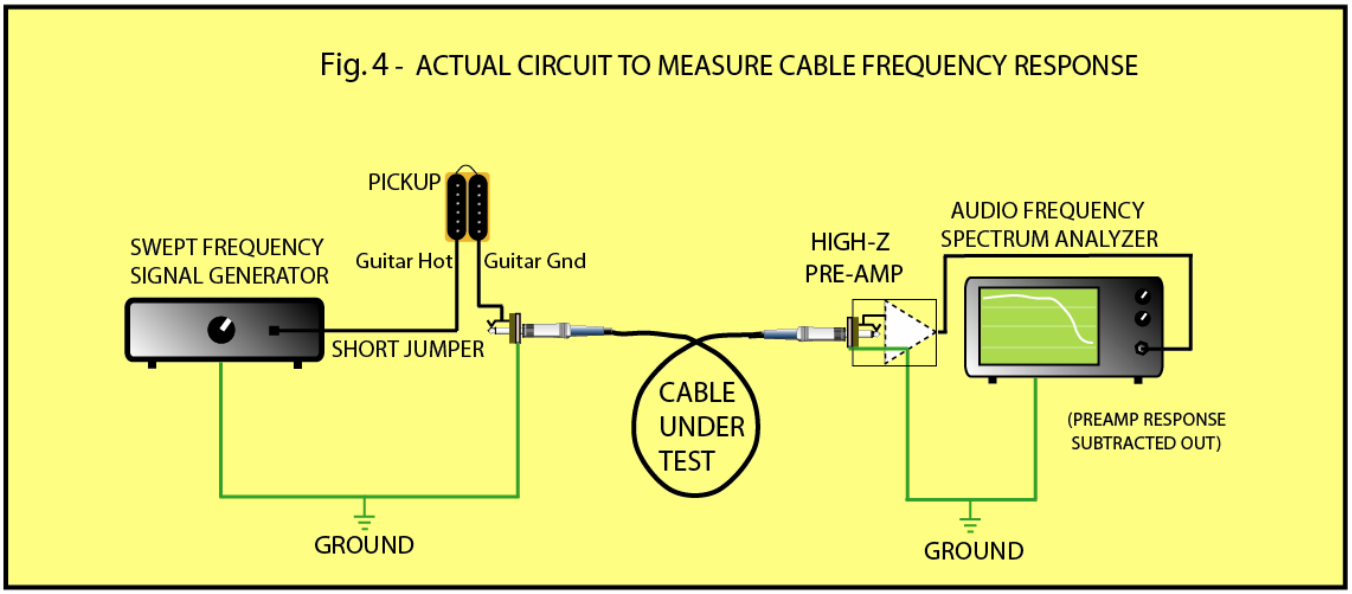
Fig. 2 - BUFFERED BYPASS

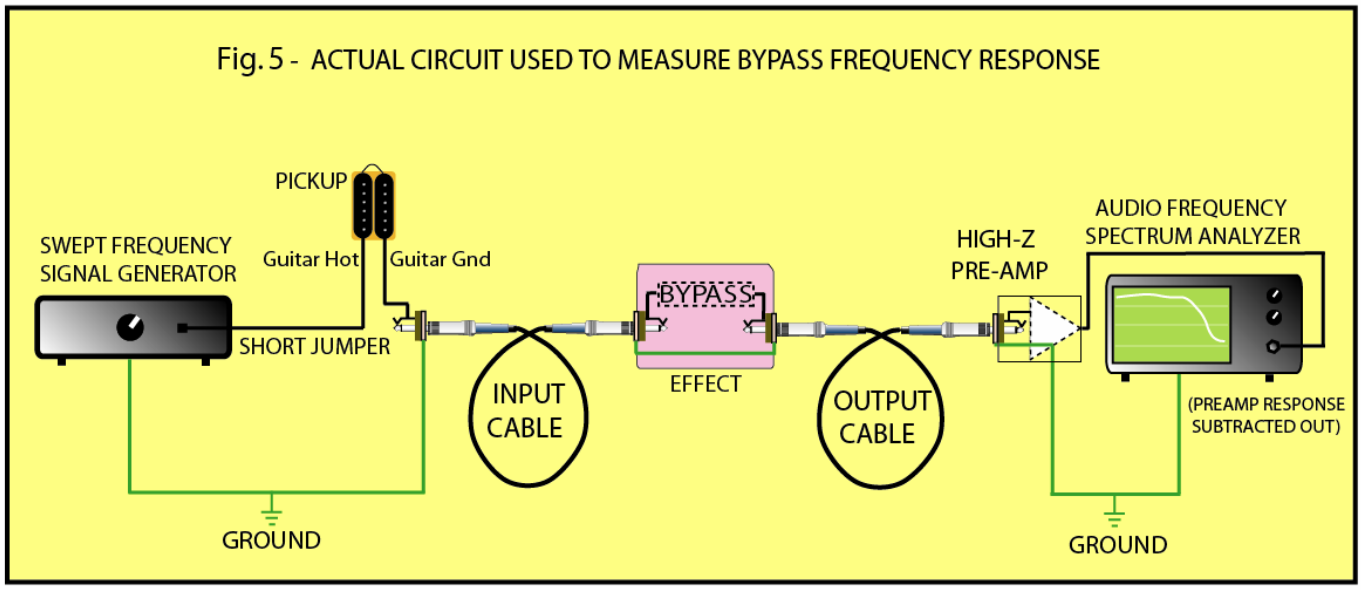


ACTUAL MEASUREMENTS

In order to get some guidance about pickups and to confirm that our intended test method would be accurate, we consulted our good friends at DiMarzio. They agreed that using the setup of Fig. 3 would yield definitive results and recommended one of their high-output pickups for the test. The swept frequency source (signal generator) drives its pure sine wave signal directly through the guitar pickup, effectively converting its very low source impedance to that of the guitar pickup. In this way, the test signal actually comes out of the guitar pickup, thus emulating a guitar signal. To make the test even more realistic, the high impedance (Hi Z) preamp is the first stage of a Fender tube amp. The spectrum analyzer then measures the frequency content of the signal coming out of the guitar preamp. Note that the analyzer is set to compensate for the preamp response. The short jumper between the Signal generator and guitar is as short as possible (a few inches). Cable 1 and Cable 2 are typical lengths but are adjusted for various tests as needed. Fig. 4 shows the actual electrical connections to individually test the cables and Fig. 5 describes connections for the bypass test.







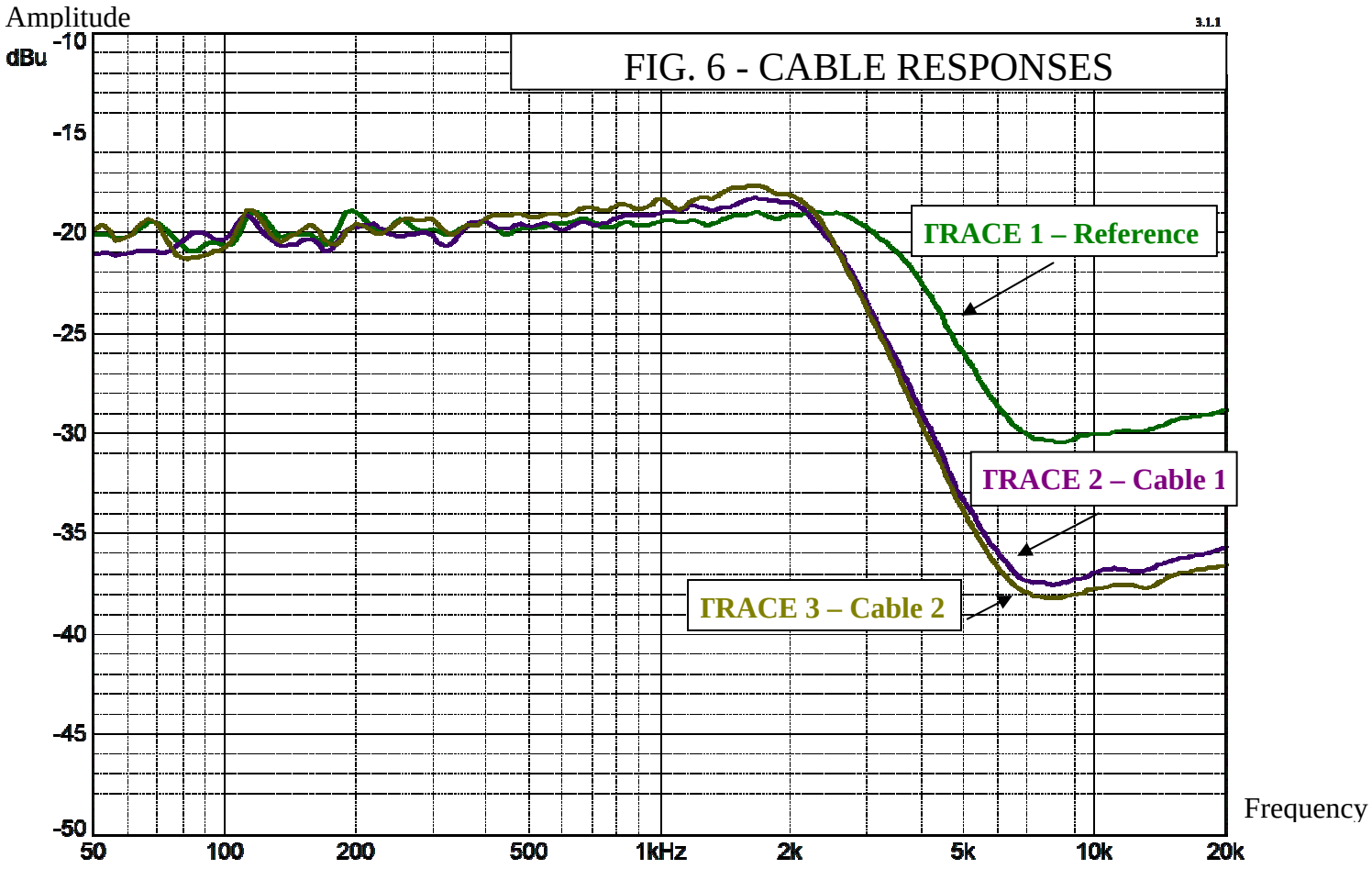
TEST NOTES:

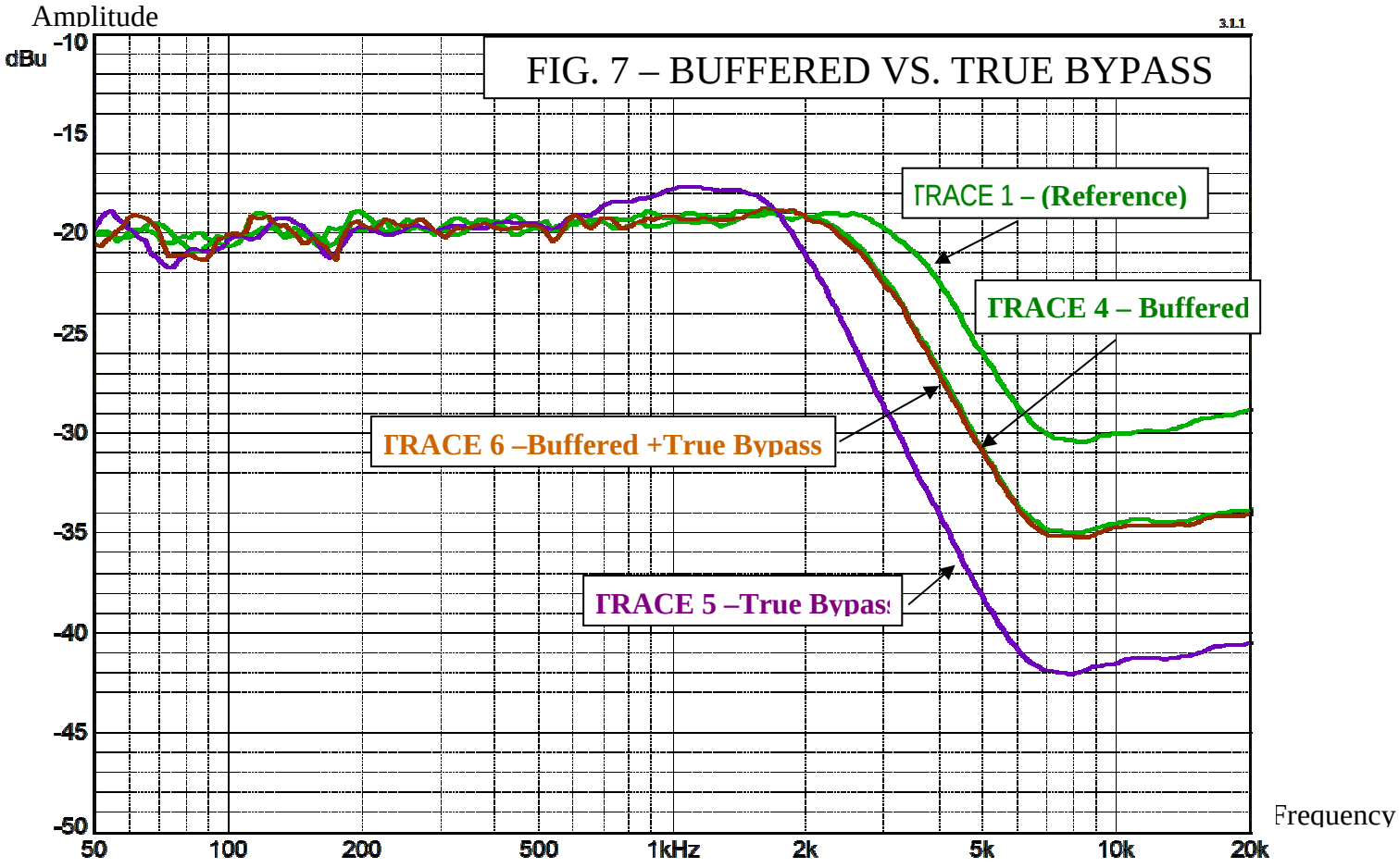
- A guitar's tone and volume control components could affect the results in this test configuration, as they are effectively in parallel with the pickup. Consequently, we used a guitar whose owner had already removed the tone control, and we set the volume control to maximum resistance to minimize its effect.
- Reference measurements were made for all cables in the test: short jumper, 10ft. Monster Cable, and 18ft. Planet Waves.
- The Guitar was a Kramer American (RED) fitted with a DiMarzio Super Distortion DP100 pickup.
- The True Bypass Effect was a Dunlop 535Q Cry Baby, but it could have been any DPDT footswitch.
- The Buffered Effect was a *gig-fx* ProChop.

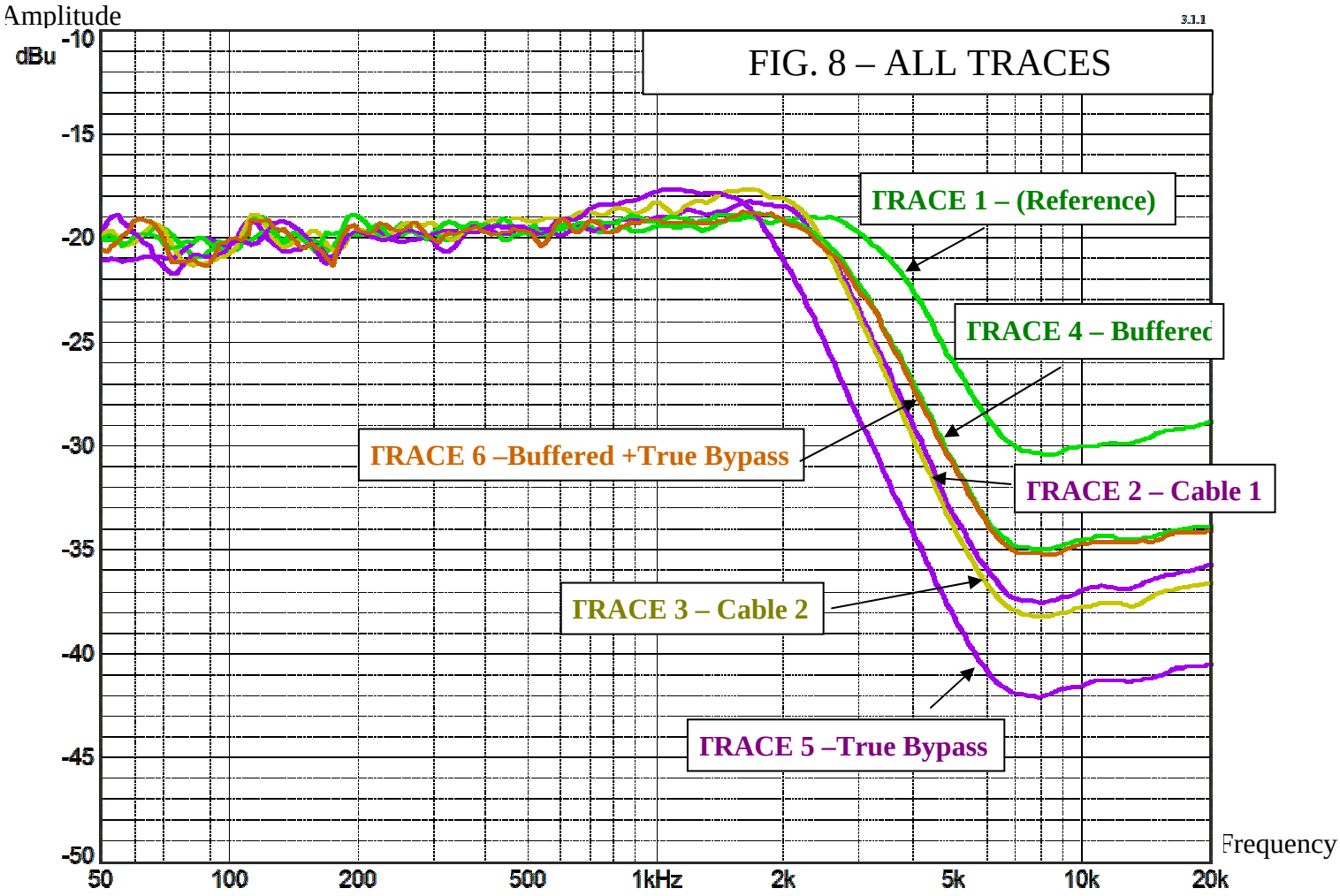
RESULTS

TRACE	TEST	COMMENT
1	CABLE 1 = Short Jumper	Reference Trace – Best possible response
2	CABLE 1 = 12ft. Monster	Response of Effect Input Cable
3	CABLE 2 = 18ft. Planet Waves	Response of Effect Output Cable
4	BUFFERED EFFECT	Cable 1 = 12ft. Monster - ProChop - Cable 2 = 18ft. Planet Waves
5	TRUE BYPASS	Cable 1 = 12ft. Monster - Cry Baby - Cable 2 = 18ft. Planet Waves
6	BUFFERED EFFECT PLACED BEFORE TRUE BYPASS EFFECT	Same cables as used for Traces 4 & 5 Cable 1 - ProChop – Short Jumper - Cry Baby – Cable 2

Fig. 6 shows the responses of just the cables.
Fig. 7 compares True Bypass vs. Buffered and Buffered followed by True Bypass.
Fig. 8 combines all the traces for comparison.


Amplitude
dBu
-10
-15
-20
-25
-30
-35
-40
-45
-50
50
100
200
500
1kHz
2k
5k
10k
20k
Frequency
FIG. 6 - CABLE RESPONSES
TRACE 1 – Reference
TRACE 2 – Cable 1
TRACE 3 – Cable 2


Amplitude
dBu
-10
-15
-20
-25
-30
-35
-40
-45
-50
50
100
200
500
1kHz
2k
5k
10k
20k
Frequency
FIG. 7 – BUFFERED VS. TRUE BYPASS
TRACE 1 – (Reference)
TRACE 4 – Buffered
TRACE 6 –Buffered +True Bypass
TRACE 5 –True Bypass



Results—

The above test confirms what many people have already figured out—that True Bypass typically degrades, rather than preserves, the tone of a guitar signal. Furthermore, a buffered effect at the beginning of the chain will actually improve the overall response.

The reference trace (using short jumpers instead of cables) shows the frequency characteristics of the guitar going directly into a guitar amp. As seen here, a guitar pickup's high frequency roll-off typically starts between 2KHz and 3KHz. Inserting a typical good quality cable (Fig. 6) is seen to reduce the guitar's bandwidth by almost 1/3, and combining two cables using a True Bypass (Fig.7) reduces it by almost 1/2! This will kill many of the harmonics and could make a guitar sound dull. Generally, one can correct for the first cable (effect input) by adjusting tone controls or EQ, but switching the second cable in and out with True Bypass makes compensation impossible - or at least highly impractical.

A buffered bypass placed between the two long cables (Trace 6/Fig.7) completely negates the effect of the second cable. Moreover, Fig.8 shows that a well designed buffer can actually improve the response of the effect input cable; one sees (Trace 4) that the high frequency harmonics are better preserved. Also note that if the buffer is placed first in the effects chain (Trace 6), any True Bypass effects that follow will not significantly degrade the bypass signal.

True, purists will say that electronic buffers can degrade S/N ratio, add distortion, and introduce loss, especially with several effects in series. Nevertheless, these problems are minimized by well designed, high quality buffer circuits. Of course, some will be better than others.

Those who still want to use True-Bypassed effects should consider a buffered effect or low gain preamp at the beginning of the effects chain. In this way, the guitar pickup will always see the same load impedance, and the long cable between the pedal board and the amp will have little effect on the signal. Otherwise, plan to spend a fortune on premium quality cables and limit cable length wherever you can.

It has to be said that in the early days, 'Vintage' players without buffered bypass still sounded great with noisy setups and lossy cables. Good, pleasing tone is created by a combination of several factors, rarely from a perfectly flat frequency response curve. It is the peaks, valleys, and roll off of the curve that produce a distinctive sound. Buffered bypass alone is not the answer, but it will preserve the original harmonics and frequency response of your guitar pickups better than a True Bypass will.

The conclusion? Choose your effects for the sounds they provide and enjoy, with a clear conscience, the fact that a good buffered bypass will actually help your tone. In the end, common sense must prevail. Try not to put a dozen buffered effects in a row, but do not limit yourself to only true bypass effects either. For the best results, put a good buffered effect at the beginning of the chain, and mix it up after that to suit your taste.

Bruce Ritz is chief designer at *gig-fx*
Contributors:
Jeff Purchon - *gig-fx*
Eric Corpus and Steve Blucher – Research & Development, Dimarzio

(Point of interest: If you do not know what type of bypass your effect has, True Bypass will work with no power applied to the effect.)