The Groove Tubes

Glory Compressor

Reference Manual
5/16/2006 REV 6

INTRODUCTION:

THANK YOU, for your purchase of the Groove Tubes Variable Transconductance Glory Compressor.

Please read over this manual carefully as it contains information essential to the proper operation and maximum enjoyment of this dynamics controller.

The Glory Compressor is designed to provide suitable downstream dynamics processing when paired with the GT VIPRE, or any other professional audio source, and furnish maximized sonic performance coupled with a generous ability to wrap itself around the dynamic content of any signal source you may wish to transform.

With the Glory Compressor's feature compliment, you no longer have to settle for what a given audio signal sounds like with a low-headroom solid-state dynamics controller, or be boxed-in by limited side-chain control options.

The Glory Compressor is designed to be flexible, and to adapt to accommodate your situation, rather then the other way 'round. To this end you will notice that it is the anticipation of your compressor applications, which has driven every detail of the Glory Compressor's planning, engineering, feature set, operating convenience and adaptability.

UNPACKING

Unpack the compressor carefully and make sure that all supplied accessories are present. Examine all items for any possibility of shipping damage. All seven tubes should be standing at attention in their sockets. If the compressor is damaged or fails to operate, notify the shipper and your dealer or us immediately. Or if the compressor was shipped to you directly, notify the shipping company without delay.

Your Glory Compressor was packed with the following accessories:

A. 1 each rack-mount bracing kit.
L/R pair of rack mounting braces, which can be attached to the sides of the Glory chassis, and rack mounted I RU above the Glory front panel. This brace provides both rear chassis

support as well as insuring good ventilation for the top of the Chassis.

B. 1 each 6 foot IEC 3-conductor power cable.

C. 1 each Owner's manual.

Note: It is prudent to retain the shipping materials for future use, as these materials are custom formed for the Glory Compressor and will greatly minimize the chance of shipping-related damage.

Important Safety Instructions

Safety symbols used in this product:

This symbol alerts the user that there are important operating and maintenance instructions in the literature accompanying this unit.

This symbol warns the user of un-insulated voltage within the unit that can cause dangerous electric shocks.

This symbol warns the user that output connectors contain voltages that can cause dangerous electrical shock.

Please follow these precautions when using this product:

1. Read these instructions.
2. Keep these instructions.
3.Heed all warnings.

4.Follow all instructions.

5.Do not use this apparatus near water.

6. Clean only with a damp cloth. Do not spray any liquid cleaner onto the faceplate, as this may damage the front panel controls or cause a dangerous condition.

7. Install in accordance with the manufacturer's instructions.

8.Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat.

9. Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding-type plug has two blades and a third grounding prong. The wide blade or the third

prong is provided for your safety. When the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.

10. Protect the power cord from being walked on or pinched, particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.

11.Use only attachments or accessories specified by the manufacturer.

12.Use only with a cart, stand, bracket, or table designed for

use with professional audio or music equipment. In any installation, make sure that injury or damage will not result from cables pulling on the apparatus and it's mounting. If a cart is used, use caution when moving the cart/apparatus combination to avoid injury from tip-over.

13. Unplug this apparatus during lightning storms or when unused for long periods of time.

14. Refer all servicing to qualified service personnel.

Servicing is required when the apparatus has been damaged in any way, such as when the power-supply cord or plug is damaged, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

15. This unit produces heat when operated normally. Operate in a well-ventilated area with at least six inches of clearance from peripheral equipment.

16. This product, in combination with an amplifier and headphones or speakers, may be capable of producing sound levels that could cause permanent hearing loss. Do not operate for a long period of time at a high volume level or at a level that is uncomfortable. If you experience any hearing loss or ringing in the ears, you should consult an audiologist.

17. Do not expose the apparatus to dripping or splashing. Do not place objects filled with liquids (flower vases, soft drink cans, coffee cups) on the apparatus.

18. WARNING: To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.

CE Declaration of Conformity

CE

Manufacturer's Name: Groove Tubes llc
Manufacturer's Address: 1543 Truman Street
San Fernando, CA
91340
USA

declares, that the product:

Product Name: Glory Comp
Model Type: Variable
Transconductance Tube Compressor

conforms to the Standards for Safety and EMC for this product listed on the Internet site:

www.groovetubes.com

Quick Start Guide

Step 1: Preliminary inspection.

Remove the Glory Compressor from the package and carefully inspect the unit for outward signs of damage or distress. All projecting controls and connectors should operate smoothly and uniformly, and the enclosure's surfaces should be free of irregularities. All seven tubes should be standing at attention in their sockets. Contact your dealer, the shipper or us without delay if there is evidence of damage to the unit.

Step 2: Park it.

Budget a suitable space to install the unit in an equipment rack. Make sure there is at least 1U of breathing space above and below the compressor, and that the airflow in the rack is not constricted, since there will be about 95 Watts of power dissipated by the unit. Keep cables and other objects away from the rear panel and heat-sink since this panel will get rather warm during operation.

Step 3: Hook it up, front panel control initial start-up positions.

A. Route the target signal to either the INPUT XLR or TRS jack. The TRS input jack will exhibit 6 dB more sensitivity then the XLR input. Apply a 0 VU (+4 dBu, 1.23 Vrms) signal to the XLR jack, **or** a -6 VU (-2 dBu, about 600 mVrms) signal to the TRS jack. ***Using the TRS input jack will interrupt any signal applied to the XLR input jack.*** Both jacks present bridging loads to the line input signal, of about 10k and 20k ohms respectively, and both are actively balanced.

B. Route the processed signal from the unit via the PROGRAM OUTPUT XLR plug or TRS jack to suitable line-level monitoring and/or recording gear. ***Be careful not to connect the compressor outputs to any microphone-level inputs not capable of handling large line-level signal levels. Damage to the mis-connected microphone preamp may result.***

C. Connect the compressor to the correct line voltage using the supplied IEC power cable.

D. Turn the power on. Power lamp blinks during 30 second warm-up period, and COMP relays hard-bypass the compressor

audio path by tying the like-format PROGRAM INPUT and OUTPUT connectors together. The green COMP LED remains unlit until the warm-up period is completed.

Notice that the relay-bypass circuit can only connect like style PROGRAM connectors together, i.e., XLR in to XLR out, and TRS in to TRS out. For example, if the XLR PGM input is being used and the bypass mode is asserted, no pass-through signal will be heard on the TRS PGM output jack. In this case, the pass-through signal **will** be heard at the XLR PGM output.

Step 4: front panel control initial start-up positions.

Position the front panel potentiometers and switches at the following starting points:

INPUT = 0 Db,
THRESHOLD = -15 dB,
ATTACK = 35 ms,
RELEASE = 150 ms,
RELEASE MODE = LOG
RATIO = 1:1 (compression disabled),
OUTPUT = 0 dB,
METER = IN,PGM position,
COMPressor (hard-wire bypass switch) = IN,
LINK = LOCAL,
SIDE CHAIN SOURCE = INT,
SIDE CHAIN EQ LF = 0 dB, HF = 0 dB, and
GLORY = EARTH.

After the 30-second warm-up period, the compressor's VU meter should show PGM IN activity derived from the signal hitting the PROGRAM INPUT jacks, and, if the COMP switch is in the "IN" position, the green COMP LED will illuminate. Adjust the INPUT control to get an average VU meter reading of 0 if need be. It is OK if the meter gently hits the positive end-stops on signal peaks; the compressor input circuitry has lots of headroom. The uncompressed signal should be audible at the PROGRAM OUTPUT jacks. Then:

A. Rotate the **METER** switch to the OUT, +8 position, or whichever position best suits your production plant's operating level. The soon-to-be processed (output) signal level should be visible on the VU meter and audible on any attached outboard monitoring gear.

Notice that the output meter indication reflects the actual signal present at the XLR PROGRAM OUTPUT plug, in actual 600-ohm dBm units, when a 600 ohm load is present. The reading will change somewhat depending on downstream load conditions. If the load is light (say 10 k-ohms), the meter will read at a somewhat higher level then if the load was precisely 600 ohms. If the load is short-circuited, the meter will read below -20 VU (no movement).

B. Rotate the **METER** switch to the GR, X1 position.

The meter should rest at the zero VU mark after 10 - 15 minutes of warm-up time (or you may adjust zero-trim at power-up if desired, but it may need to be touched up on the way to temp stabilization), and now indicates the amount of gain reduction, in dB, which should be zero since the **RATIO** switch is still at the 1:1 position. The 1:1 ratio is included in order to allow an audition of the signal path without dynamics processing.

Notice that the zero-trim interacts with the GR meter circuits only, *and not the on-line audio signals.*

The GR X2 position doubles the VU meter's indicated amount of GR, where a reading of -5 becomes -10 and so forth.

Rotate the **RATIO** switch slowly clockwise, stopping at 3:1.

The meter should deflect downward away from the zero mark, depending on the volume of signal exceeding the **THRESHOLD** setting of -15 dB. Notice that the **THRESHOLD** switch calibration marks are referred exclusively to the IN-PGM VU meter zero mark. In this case, compression will begin for signal levels that exceed -15 VU when the **METER** switch is in the IN-PGM level-reading position.

Notice that the VU meter, in typical fashion, may not show large amounts of downward deflection when responding to compression of fast or staccato signals, such as rim-shots and the like. Also, the total amount of GR displayed will be reduced by long ATTACK or short RELEASE time, since these types of settings reduce the magnitude of the control voltage produced by the side-chain circuitry.

At this point, the compressor should be actively reducing the amplitude of the target signal. The user may now begin to

explore the various control settings, and arrive at those which best suit the signal to be processed.

 Note: Gain Reduction meter stabilization (GR x1 and x2)

Glory needs about 30 minutes of warming before the GR meter will stabilize to read “0”. When turned on, the meter will typically read a dB or so more than “0” until it fully warms and stabilizes. Meanwhile, this temporary condition will not affect Glory’s audio performance in any way OR affect the operational mode of the meter when showing gain reduction. You may wait for the meter to net itself in as the unit warms up, or of course it is possible to continually trim the meter to “0” until fully warmed up. Unless time pressure prevents it, we suggest that you trim the GR “0” setting when the Glory is fully warmed up, and let the meter reach “0” during future sessions.

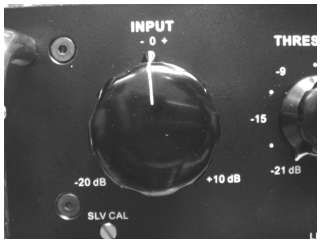
Front Panel Features and Controls

A brief description of the control functions follows. The fundamental ideas will be well-known to those who have spent time with dynamics controllers used for audio production, but there are a number of new twists and features that make an examination of this section profitable.

The usual suspects

The Glory Compressor incorporates many familiarly labeled controls, as may be found when comparing the control family with those appearing on recent models of solid-state dynamics processors. Indeed, the attractive and flexible dynamics-control array found on modern and certain vintage compressors did in part inspire the control complement for the Glory Comp. The feature twist here is the objective of providing user-selectable parametric time and level control flexibility in an all-tube compressor. Tough, but do-able.

INPUT potentiometer and **THRESHOLD** rotary switch.



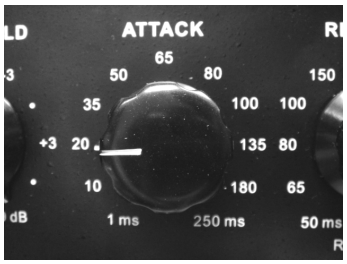
Do just what they say. The **INPUT** control provides program signal input level scaling, from –20 dB of attenuation, to +10 dB of gain. It is used to adjust the program input level, until the average level provides ample input **IN**put-**P**ro**G**ra**M** VU meter deflection with averages hovering about the 0 dB mark.

The **THRESHOLD** control may then be used to set the level of the compression knee, with compression effects commencing when input signals exceed the chosen knee voltage. The control's calibration is referenced to the ***PGM*** meter zero VU deflection mark. Unlike most modern fixed-knee compressor designs, the separate **THRESHOLD** compression knee control permits flexibility over the indicated range, independent of the Input control setting. Notice that the chosen compression ratio will be reached at a signal level at about 2 dB over that indicated by the **THRESHOLD** switch setting.

The independent **RATIO** and **THRESHOLD** controls permit interesting and subtle application of the compressor, by, for example, setting the knee at very low signal levels (-21 dB), and applying very shallow compression **RATIOs** of, say, 1.5:1. The user may then reach deeply under the peak dynamic events in the program signal, and give subtle added thickness to material starting at more than 20 dB BELOW the peak program operating level. Useful for raising foreground sound minutiae and elevating room ambience details.

ATTACK and **RELEASE** rotary switches

ATTACK rotary switch



Each of these two controls function conventionally, with separate time-constant circuit stages dedicated to each control. The **ATTACK** control sweeps through an approximately 250:1 adjustable time-constant range. The expanded 1 to 100 ms mid-values correspond to the range of average time intervals required for the human ear to respond to an impulsive signal.

Note however that a 1 **m**illi**s**econd transient will correspond to nearly 100 sound samples in a 96 kHz digital system. Which means it will still be possible to clip digital systems briefly, even with the **ATTACK** time set to minimum. Occasional slight clipping of a 1 **ms** interval of program material in a well designed digital system will be inaudible, and may be avoided by modest drive level reduction to the digital system.

The **ATTACK** and **RELEASE** controls are best set to values that fit the particular musical situation. By “fit” it is meant that, in general, faster A&R settings for percussive signals where there is little sustain or ambient sound, and slower for more ponderous acoustic events where there are long decay intervals from an instrument or room reverberation. Initial control-setting exploration will be necessary to fit the time constant controls to the musical events at hand.

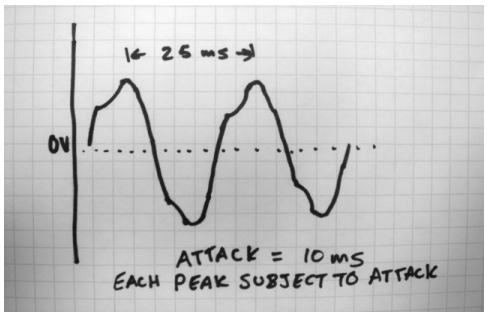
To minimize compression artifacts, it is best to keep the **ATTACK** control set to time periods equal to ½ or less of the **RELEASE** control setting, and both set to intervals longer then

the time period of whatever bass content might be present in the signal.

Be aware that the wide time-constant control range provided is very much a double-edged sword, where the most prominent elements in the program material may dominate the results. The user may choose to apply these controls conventionally for smooth results, or intentionally misapply them as an aid towards a particular artistic expression. For best results, it is strongly recommended that the user spend a little time and acquaint themselves, if necessary, with the advantages and limitations of the TC controls and their dynamic effects on the processed signal.

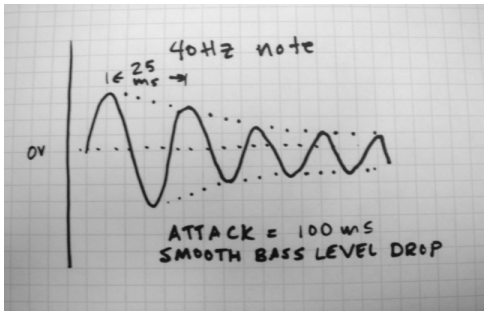
Here's an example of how short **ATTACK** control settings may cause a conflict when processing a signal: The open E string on a conventionally tuned string bass guitar will produce a note at about 41 Hz. This corresponds to about 25 milliseconds per cycle.

There will be a cycle-by-cycle distortion induced into the signal if the **ATTACK** and **RELEASE** controls are set aggressively, to, say, 1 ms and 25 ms (LIN mode) respectively.



(Note figure at right: Output waveform with ATTACK time period set longer then the bass note period, versus ATTACK set shorter then bass note period. Each half cycle of the bass will be individually modulated in the latter case.)

The resulting induced artifacts should be interpreted as normal and expected, since the compressor's time-constant controls have been set in such a way as to force the system *to react to each bass note cycle as if it were the bass signal's amplitude envelope*. In this case, each half-cycle will be subject to having a bite taken out of it, which will be audible. If these artifacts are deemed to be undesirable, simply increasing the time-constant control settings a bit will return the compressor to normal amplitude-envelope level control mode.

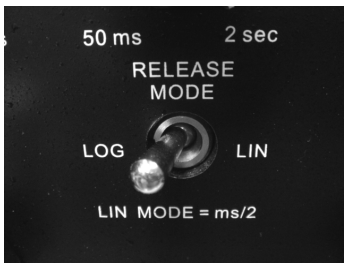


In short order, the informed enthusiast/professional will get the hang of it, and should have to endure no more than a brief teething period of compressor control exploration.

RELEASE rotary switch

The **RELEASE** control switch features a 40:1 adjustable time-constant range in two overlapping ranges. It is closely associated with the **RELEASE MODE** switch, which splits the release mode time constants into two largely overlapping ranges, yielding a maximum ratio of 80:1.

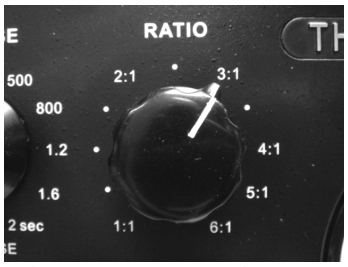
The first range, 50 – 2000 milliseconds, is covered by the **LOG** release mode. The **LOG** (exponential) mode places the gain-cell's gain-reduction release profile under the control of a time-constant circuit comprised of a conventional "resistor and capacitor control voltage network. The **RELEASE** control is simply the user-adjustable resistor in the R-C circuit. The term "log" is used here because the curve shape is related to the log family of curves, and it is easier to screen the term "LOG" on the front panel of the equipment.



This kind of logarithmic (exponential) release-control behavior, as derived from an R-C circuit, is available, if not mandatory, in the vast majority of level-dynamics controllers that have ever appeared on the market. In some designs, it cannot, for practical purposes, be avoided. For example, the photo-resistors in optically controlled compressors exhibit this logarithmic attack and release response since it is native to the photo-resistor's behavior. In the past, many designers choose to use photo-Rs that, in general, are somewhat quicker then 50 milliseconds, coupled to additional circuitry to stretch out the time-constant values.

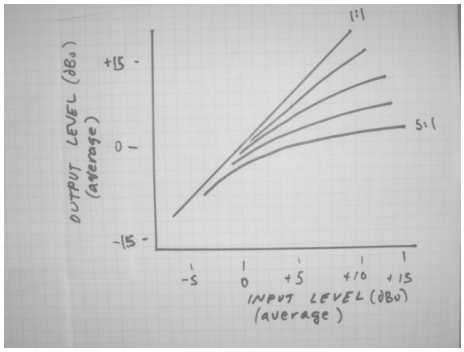
The second release mode range, 25-1000 milliseconds, is furnished by the LINear release mode. This release mode furnishes a crisp release profile, without the slow taper-to-zero GR release characteristic of the LOG mode. Useful for more aggressive dynamics control of dry signals, meaning sounds that do not have a long decay period associated with them such as vibrating strings, or strong room reverberation.

RATIO rotary switch



The eleven-step **RATIO** control spans compression ratios of 1:1 to 6:1, with the indicated ratio expressed in decibels. The 1:1 or "compression off" position lets users audition (or use) any signal as it flows through the all-tube audio path without applying any compression, and without forcing the user to engage the relay hard-bypass audio path. The 1:1 position may be used as a convenient starting point for setting PGM and **OUTPUT** levels if desired.

Notice that the **RATIO** control features an expanded selection of values over the "shallow" compression ratios of 1.25:1 through 3:1. The shallow ratios may be used in a subtle fashion by allowing the unit to reach well below the audio program's zero dB PGM mark, and begin lightly compressing material above about -25 dB IN-PGM level for better articulation of micro-dynamic program details while at the same time largely preserving macro-dynamic events. The user should keep in mind that the full value of the selected **RATIO** setting will be reached when the signal is about 2 dB above the **THRESHOLD** control setting, depending on the nature of the signal being processed.



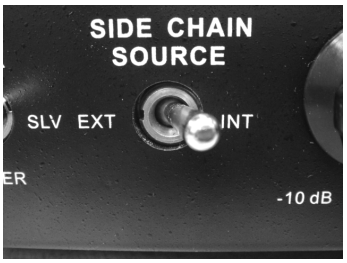
The shallow ratios are also useful when a track is to be passed through the compressor two or more times. For example, the first time during a live performance, and again during playback, as some situations may demand. A high quality (low artifact) recording medium is required for this kind of application.

The compressor tops out at a ratio of 6:1, meaning, in this situation, that the output level will rise by only 2 dB with an input rise of 12 dB over threshold. This is a fairly drastic rate of compression for a single-stage discreet component compressor, but may not be quite enough for those interested in creating digital files whose average level is riding within a half dB of digital full-scale. Multiple passes through the unit may be necessary, which effectively increases

the number of gain-varying stages the signal encounters. By using two or more passes through the compressor, the control settings may be optimized for peak events on the first pass, and average events on the second. This approach mimics the chain-of-compressors/limiters technique used in many classic recordings of the past. Of course, other additional analog or digital dynamics processors may be brought to bear on the signal, where the situation calls for it.

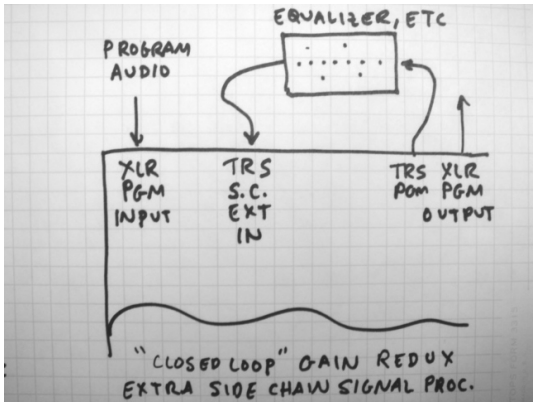
Side Chain Controls

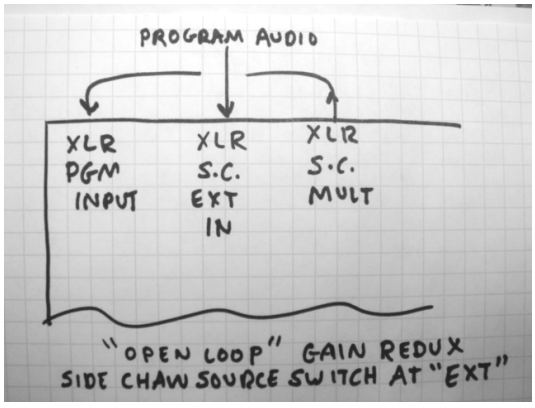
Side CHAIN SOURCE switch



The **SIDE CHAIN SOURCE** switch's INTernal position directs a sample of the post-compressed audio signal to the front end of the side-chain circuitry, closing the side chain control loop. Any external signals present at the rear panel SIDE CHAIN input jacks are ignored. In this state the compressor is running "closed-loop" with all side-chain rotary switch settings conforming to their stated values.

The EXTernal switch position routes any signal present at the rear panel SIDE CHAIN jack directly to the front end of the side chain circuitry. In this state the compressor is running





"open-loop" and, after passing through the side-chain Time Constant circuitry, the control voltage is sent to the tube variable gain cell. This approach provides a radically different gain-reduction control curve and shape, with a more spread-out knee and a somewhat higher ultimate compression ratio. Care must be taken to watch the amount of gain

reduction to prevent “bottoming out” as the GR approaches 20 dB. The amount of GR may be observed via the meter switch’s GR X1 or X2 position.

SIDE CHAIN EQ rotary switches

LF and HF controls furnish up to 10 dB of boost or cut to the internally sampled side-chain signal. The LF control shelves at 50 Hz, and the HF control at 10 kHz. The EQ contours are low-Q in nature, and are similar to those found on consumer hi-fi preamps, much like “Baxandall” style bass and treble curves. This helper EQ is not intended to be of surgical precision, and is furnished as a convenient aid in addressing musical signals overly rich in low or high band-edge content.

The EQ controls are labeled in such a way as to reflect the resulting signal character *exiting the compressor.* Pushing the LF EQ clockwise in the (+) direction will let more bass *out* of the compressor, meaning the unit becomes *less* sensitive and reduces its reaction to bass content in the program material. Conversely, rotating the HF control counterclockwise in the(-) direction will make the compressor react *more strongly* to HF content, such as cymbals, muted horns or vocal sibilance.

A typical application would be the application of the LF EQ control when compressing bass-heavy material. This sort of signal can provoke a form of overreaction in the side-chain circuitry, where gain reduction of the whole mix becomes dominated by the bass content. Rotating the LF control a few steps clockwise can help tame the problem while permitting more aggressive TC control settings then might otherwise be possible.

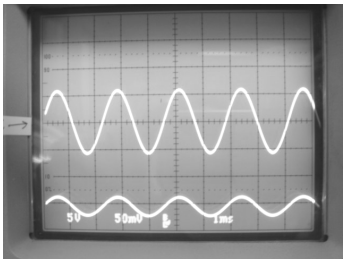
Alternatively, the HF EQ control may be *reduced,* making the compressor react more aggressively to the squeak of a muted horn, or to an overly sibilant vocal/microphone combination.

Notice that shorter **ATTACK** times may need to be selected to help emphasize the side-chain’s reaction to fast or high-frequency signals, and help shorten leading-edge chirp of such signals. Set the ATTACK switch to the 1 or 10 ms setting to aid in attaining fastest reaction to transient or other signals rich in higher treble content.

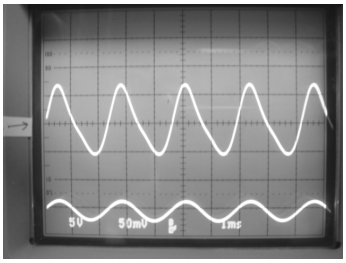
The **GLORY** Control

This unique control adjusts the intensity of the Glory Effect as mixed into the processed signal. Specifically, the Effect is summed with the post-compressed audio being fed to the compressor's driver and power output stage. But what exactly is the Glory Control, and what does it do?

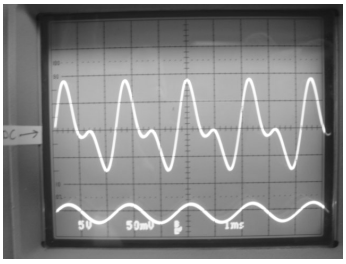
The Glory Effect essentially consists of special circuitry that samples the program input signal, from which low-order even harmonics are generated, over a limited band of frequencies, and intentionally added back to the compressed signal in amounts deemed by the user to be appropriate for the sonic events at hand. The harmonic bandwidth is confined to operate on signal fundamental frequencies from 40 to 700 Hz.



The program material is routed through two parallel routes. This 1st oscilloscope picture shows the signal flowing through the side-chain signal path is routed to the Glory effects circuit. The Effects circuit then manipulates the signal so as to produce even order harmonics ONLY, predominantly 2nd -order. These "close-in" signals, removed by only one octave from the fundamental, are then added to the post-compressed signal in amounts to suit the tastes of the engineer / producer.



The next picture shows Enhancement of 2nd order content as the GLORY control is advanced towards fully clockwise position. The last picture is somewhat exaggerated for clarity.



The low-order harmonic content has the potential to add thickness or palpability to a single-voiced musical signal being acted upon, provided it is used in tasteful proportions. On certain sources, such as upright bass or bass guitar, the apparent loudness and overall audibility may be enhanced without noticeably increasing the overall signal level. The effect on bass signal content is somewhat reminiscent of the "synthetic bass"

circuits offered over the last 60 years, in that the bass notes can be made more audible by putting harmonic energy above the low-frequency pass-band limits of the monitor loudspeakers or headphones. Used judiciously, the presence of small amounts of 2nd order harmonic content in certain program material is generally able to produce a pleasing consonant sonic sensation, versus the dissonant glary sensations generally produced by higher-order harmonics.

Alternately, producing trace amounts of consonant phantom, or "Tartini" notes, as may be found in certain electric or acoustical guitar playing styles for example, can bring forth the "chimey" qualities of the sound source. The phenomenon which produces the Tartini notes is called Intermodulation, which exists in all electrical circuits, in loudspeakers, in musical instruments, in the nonlinearities of the air itself, and also within the human hearing mechanism. It is capable of being produced in some quantity whenever one or more elements in a (sound) system chain do not exhibit perfect linearity.

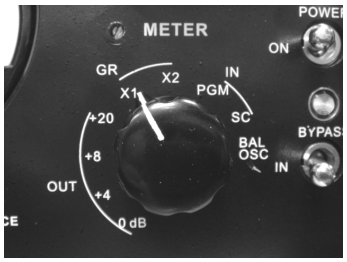
InterModulation products are comprised of the sum and difference of two (or more) signal frequencies present in the non-linear medium or signal path. In this case, the Glory effect emphasizes the sum, or higher frequency components, more then the difference frequencies. From an operational standpoint, the Glory effect level may need to be increased above those settings which produce tasteful amounts of 2nd harmonic enhancement in order to produce appreciable amounts of IM.

As you might imagine, intermod creates both consonant and dissonant signals, many of which will not be musically related to the fundamental. It can be a very aggressive sound spoiler, or a suave and charming addition to the musical event being processed. In general, as an effect, it is very much a wild card in a wideband production chain, where you may expect certain specific types of signals to be enhanced, while many others will be degraded. This is why the Glory effect is intended primarily for use with individual voices or instruments, rather then on finished mixes or other massed sound sources. As always, quick auditioning will reveal whether or not the Glory effect is appropriate for the situation.

The Glory Circuit produces its effect in a new way, without adding much in the way of DC-shift to the main signal, partially due to the effect itself being free from much

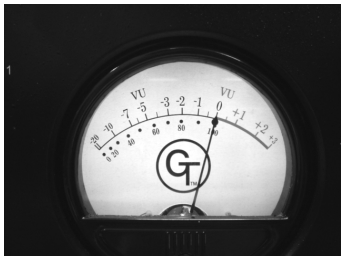
fundamental signal content. There is no directly comparable effect elsewhere on the market. Because of this, users are advised to set aside a convenient exploratory period where the careful application of harmonics to a variety of musical signals may be mapped out for best results for your particular applications.

METER switch and **GR ZERO** trim.



The **METER** switch serves to point the VU meter towards a variety of locations within the compressor. The switch positions are arranged in four groups. Three of the four, the **OUT**put, **IN**put and the **BAL OSC** , are direct audio level readings as measured at the PGM XLR output connector.

The **GR** switch positions change the meter display to the current level of compressor **G**ain **R**eduction, with the meter idle position of 0 VU rather then the mechanical rest position at the far left of the meter scale. As the compressor performs signal level reduction, the VU meter will deflect towards the left-hand side of the scale, indicating the amount of gain reduction action in play.



Vacuum tubes being what they are, an amount of GR-zero drift will occur during the initial few minutes after switching the unit on from a cold start. The meter's GR ZERO position may be trimmed to indicate zero during this time if desired. Adjusting the zero trim does not influence the amount of gain reduction the compressor is providing; the change is confined to the meter drive circuit only.

Notice that the meter's ballistic behavior will remain consistent with VU norms at all times and for all METER switch settings. This means that the meter's ability to respond to fast transient events is restricted, whether directly reading an audio signal or the Gain Reduction signal. Keep in mind that the amount of gain reduction may be much higher then indicated by the meter, especially when heavily compressing transient-rich signals with ATTACK and RELEASE time constants set to small values.

Other Recessed Controls

BALANCE potentiometers

The two **BALANCE** controls trim the counter-phase or "push-pull" balanced signal levels developed by the matched pair of variable-transconductance tubes within the compressor. They are used at the factory for initial set-up, and, as the control tubes age, for occasional slight touch-up as needed. They are also used when the sad time comes to replace the variable-gain tubes with new ones.

The gain-changing capability of the Glory Compressor rests upon the behavior of the selected pair of 5749 variable transconductance tubes in the push-pull program audio signal path. Because of this, every compressor is fitted with a closely matched pair of these tubes, and the **BALANCE** potentiometers are trimmed for best counter-phase balance level-matching before leaving the factory.

Each potentiometer influences different parts of the tube pair's variable gain curves, and by careful adjustment a very good mirror-image signal match may be obtained as the tubes sweep over their variable-gain operating range.

The CATHODE trim pot pushes the tube's variable-gain curves about over their entire operating range, and is a somewhat more critical control. The PLATE pot has influence over the high-gain part of the gain curves, where the compressor is at idle, at or near zero GR. Both potentiometers respectively control the balance of the cathode and plate loads seen by the pair of 5749s. A rough indication of the relative matching of the tubes can be made by observing how well electrically centered these controls are when the unit is in operation. By centered it is meant that the control is at or near mid-span in mechanical and electrical location. Each potentiometer's mechanical rotation range covers about 300 degrees.

Note that it is a good practice to leave these controls *undisturbed* except when a quick test indicates the need for slight adjustments. The need for adjustment may be ascertained by an increase in audible artifacts during heavy compression and release of sharp percussive sounds, or as indicated by a large increase in the relative level of the

residual signal heard when the internal BALance OSCillator is put into action.

BALANCE OSCILLATOR

As an aid in correctly setting the PLATE and CATHODE trim pots, the compressor is equipped with a built-in 330 Hz test-balance oscillator. The BAL OSC is asserted, and a balance-indicating signal becomes audible through the PROGRAM outputs, when the **METER** switch is rotated to the BAL OSC position at full clockwise rotation.

The balance test of the variable transconductance tubes is done by impressing upon them a common mode (not push-pull) signal. When the balance is ideal, there will be zero output of the test signal at the program output jack.

In practice, this is rarely the case, therefore the PLATE and CATHODE trim pots are slowly rocked back and forth to produce the deepest null of the test tone. There will be several test tone null pair settings of these controls, and the deepest null should be chosen as representing the best setting. This null should occur near the center of the trim pot rotation (+/- 20% of center). If not, the variable transconductance tubes may need replacement with better matched devices.

NOTE: Allow the unit to fully warm up before interpreting any test results. Otherwise the results will not be valid.

SLaVe CAL control

The **SLV CAL** control permits GR line-up with other linked Glory Compressors and is discussed below.

Rear Panel Features

LINK switch and STEREO LINK TRS jacks

Each Glory Compressor is equipped with a pair of three-circuit (TRS) **C**ontrol **V**oltage jacks on the rear panel. The two are electrically identical for easy daisy-chaining arrangements. The jack's tip contact is the **CV** send voltage, and the ring is the **CV** receiver circuit. The sleeve is circuit ground. A program-level and control-setting dependent control voltage is developed within each unit, and may be sent (by daisy-

chaining) to a maximum of 6 neighboring Glory Compressors via the rear panel jacks.

Be careful not to inadvertently connect an audio signal to these control jacks, or to wire these jacks to other audio inputs on other gear. Doing so may result in damage to the compressor or other equipment. Be careful not to use 2 circuit TS cables with the LINK jacks.

Using the **LINK** switch, each Glory Compressor within a local linked group may be set to one of three control modes.

The MASTER position asserts the chosen unit to be the master time constant control source for the remaining units. Essentially, the master unit's side-chain controls represent the "dashboard" for itself and the other units in the linked chain. In this mode, all control voltages, including the master's, are fed through the master side-chain through analog "diode-OR"ing of the control signal. This means that whichever compressor is being hit with the loudest signal (or producing the highest control voltage) will be the dominant device in the chain, with all others following the GR commands of that particular unit, including the master.

Note: Be careful not to set two or more linked units into the MASTER mode, since this jams control amplifier outputs together, and may overheat components inside the affected compressors.

*When starting out with a linked set of compressors, it is recommended that each unit's **THRESHOLD**, **ATTACK**, **RELEASE**, **RELEASE MODE** and **RATIO** controls be set alike as a starting point.

Any single unit in the chain may be designated as the MASTER, as convenience dictates.

The SLV position switches the unit into the control voltage listening mode, where the gain reduction is under the command of the master or external control voltage. If no external voltage is detected, the compressor will return to zero GR and the local side-chain controls will be offline.

As an aid in lining up the compressor with its neighbor(s), a **SLV CAL** control is furnished above the **LINK** switch. This

control will slew the GR control signal by about +/- 50%, with the mid-rotation position corresponding to a zero-trim state.

*Typical alignment procedure, for two (or more) linked units:

1. Send a 0 VU (+4 dB) signal to the MASTER compressor input jack.
2. Adjust the MASTER unit's **INPUT**, **THRESHOLD** and **RATIO** controls to produce a -6 dB (50%) reading on the X1 GR meter scale.
3. Observe the SLAVE unit's X1 GR meter reading; adjust trim to reach -6 dB reading as necessary.

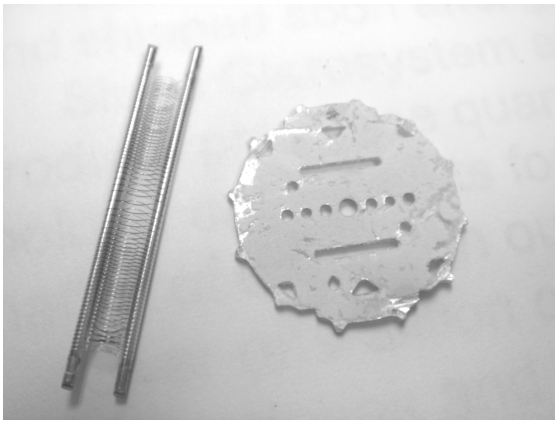
The **LINK** switch's LOCAL switch position removes the unit from the chained set without removing the LINK cabling on the rear panel. In this stand-alone mode, the selected unit will not send any control signal to the master, or respond to any outside control voltages. Useful for setup of an individual unit in a set of chained units, by getting the local compressor into the ballpark before restoring it to the linked group.

Special Refinements Under the Hood

The heart of the matter:
Variable transconductance tube gain stage.

The Groove Tubes Glory Compressor is, first and foremost, an all-tube compressor. Inside, the program audio is multiplied by nothing but tubes, as the Program signal propagates from the main input jacks to the main output plugs and jacks.

Each stage, and there are four distinct amplifier stages, consists of pairs of carefully balanced and self-balancing push-pull class-A vacuum-tube circuits. This includes the electronically controlled vacuum-tube-based variable gain stage.



Very much the exception in what are today generically referred to as “all-tube” compressors, the Glory Comp makes use of the spectacularly linear and specially selected remote-cut-off 5749 pentode operating in the triode mode. These variable-transconductance tubes handle the delicate task of modulating the program signal level. The most important of the desirable characteristics that this tube provides are a superbly wide dynamic control range approaching 20 dB (near a 10-to-1 voltage reduction), coupled with freedom from undesirable artifacts. Twenty dB of clean gain reduction represents the greatest practical limit for a factory-built audio production compressor based on a single balanced stage of variable-gain tube circuitry.

The sonic bonus of using this tube type is a delightfully smooth and suave gain-change characteristic as the variable gain stage sweeps through its control range. Being more linear and more “invisible” than alternative 6386-based designs, users will find that only the most extreme control settings produce audible compression phenomenon.

In the spirit of high-linearity, the Glory Compressor’s variable gain stage is carefully devised in order to secure optimum gain reduction behavior from the stage’s pair of

variable transconductance tubes. The stage design includes calibration trim controls mounted on the front panel for easy accessibility. The controls serve a dual purpose by helping the user touch up slight drift over time, if needed, and help swamp out the inevitable production tolerance differences that may be found between various specimens of the same GT-VMU-101 tube type.

Happily, each half of the variable gain stage circuit, and its pair of tubes, is individually accessible, with each tube fitted to its own socket. Through this arrangement, the chronic problem of matching each tube's gain characteristics to one another is effectively addressed! This is especially relevant when the 5749 is compared to some historically popular, but now scarce and very expensive alternatives that consist of two triode sections trapped within one bottle. Indeed, when examining the issue of scarcity, the 5749 is available in deep supply from Groove Tubes for about $20 USD each, as compared to the 6386 which is now in short supply and typically sell for over $100 each IF you can find anyone who is willing to part with them.

Glory owners will find that keeping spares around or buying any replacement tube types for the compressor is not now, nor will it soon become a bank-account-breaking frustration in the future. Low cost-of-ownership is intended by design.

Polyphase rectifier for smoooother control of bass dynamics.

Special attention was lavished on the traditionally under-served side-chain circuitry found in compressors, which is used to derive the gain-varying DC control voltage from the signal being processed.

One of the historically difficult areas of signal-dynamics control has been that of handling bass-rich signal content. Specifically, it was and is difficult to cleanly control, say, upright bass or bass guitar when the compressor's Attack and Release controls are set to very short time periods. Strong compression artifacts can arise when a compressor's dynamic-control time constants are increased to periods approaching, or equal to, the time period of the wave it is trying to dynamically control (which is generally a bad practice). The severity of these artifacts depends somewhat on the compressor's signal rectifier and control loop design, and the settings of the ATTACK and RELEASE controls.

Difficulties with conflicting “signal-vs-settings” time constants seldom arise with, say, electro-optical compressors. Primarily because the compression (attack and release) time constants reach a ceiling imposed by the relatively slow electro-optical resistive cells used for that kind of compressor, even though specific user “attack” and “release” controls are provided. The trade-off between the two variable-gain techniques becomes that of cost and complexity versus loss of dynamics-control range. In the end, due to the limited time-constant control range available, the optical compressor’s usefulness is ultimately restricted to a smaller number of possible compressor applications, and virtually no hard limiter applications since the optical elements tend to be a bit too slow for instantaneous level control.

The Glory Compressor’s dynamics-control circuitry has been specially designed to bridge the gap between electronic and optical gain-reduction characteristics. The Glory Comp features special low-frequency phase-splitting circuitry which is applied to the varying program signal voltage sample, before being presented to the compressor’s rectifier circuit. The LF signal content is then full-wave-rectified by two separate peak rectifier circuits. The result is up to four peak events per cycle of bass signal content (versus two), creating a far smoother DC control voltage for modulating the variable gain circuitry at low frequencies. This yields an electronic gain control with the smoothness of optical limiting, but without the ultimate speed and control restrictions of the optical approach! Plus, the Attack/Release controls may be positioned at faster, more aggressive settings for bass signals before noticeable sonic conflict sets in. Note, however that the compressor’s front panel time-constant controls have enough short time-period range for a user to overwhelm the advantages of the rectified 4-phase bass signals, which will produce audible artifacts.

Transformerless inter-stage coupling to the make-up-gain stage!

Designers of vintage variable-mu tube compressors had very few options when contemplating how to cleanly get the processed signal off the plates of the variable-gain tubes. In the past this was traditionally accomplished by using inter-stage transformers, with balanced primary windings connected to the variable-transconductance tubes, and isolated secondaries connected to downstream amplifier stages. The transformer served to work around two important problems.

First, it removed the wildly varying DC bias voltage component from the audio signal on the plates of the variable transconductance tubes, leaving only the audio voltage present on the secondary winding.

Second, the signal balance of the recovered audio signal voltage could be maintained in near-perfect push-pull complementary symmetry by virtue of constructing a pair of identical coils for the inter-stage transformer secondary. The signals on the secondary would then be fed to the make-up gain stage, or, as in the case of the good old Fairchild 660 /670, directly out to the line-matching output transformer.

But this approach was not and is not without compromise. Wide-band high-performance inter-stage transformers, then as now, are complex and expensive components, which, at best, impose rather severe bandwidth and phase limitations on the audio signals passing through them. This especially true when connecting a transformer with fixed characteristics to tubes whose output characteristics are intentionally changing on command. Basically, as the variable transconductance tubes are biased into heavy gain reduction, their ability to push the transformer is reduced. This can and does induce a certain amount of degradation in the audio path. One may expect, for starters, elevated levels of distortion at the band edges, and an overall drop in bandwidth (dulling of high frequencies, thinning of deep bass notes) during compression.

The Glory Compressor features a novel hybrid servo system, which cancels the fluctuating DC control voltage in the recovered audio from the variable transconductance tubes in an active all-electronic manner. This leaves only the balanced audio signal, without resorting to inter-stage transformers. The variable transconductance tubes are loaded only with forgiving, purely resistive loads. This provides the user with an all-tube variable gain cell whose high bandwidth remains constant during compression! Remarkable! Fun is waiting for the user, as the Glory Comp throws open new tonal territory in high-bandwidth vacuum-tube based dynamics processing.

The Output Stage (Too loud, man.)

The Glory Compressor follows in the footsteps of the venerable VIPRE microphone preamplifier in its internal all-balanced signal path architecture, and in its prodigious output signal level capabilities. In the spirit of professional production

gear from the past, and in light of current new 24-bit digital recording developments, the output stage has been designed to provide up to +36 dBm, or 4 Watts into 600 ohms, or 120 V peak-to-peak across 600 ohms! What this means is that the compressor will never be the weak link in so far as headroom or voltage drive capabilities are concerned.

Ironically, the latest developments in some of the newest "high-definition" digital audio production workstations have a direct bearing on why the high voltage / high power capability is part of the design. It seems that some of the new 24-bit digital systems demand rather high input voltage in order to reach full-scale modulation. Evidently, in order to make the signal-to-noise improvements inherent in the new 24 bit systems meaningful, some converter hardware suppliers have raised the A-to-D input drive voltage requirements to levels beyond the capabilities of what most popular op-amp based outboard gear can provide. This was foreseeable, since, at present and practically speaking, there will always be about ½ to 2 micro-volts of noise present across a 20 kHz audio bandwidth at the input of the new 24-bit high-bandwidth converters, unless exotic and expensive (and impractical) cryogenic methods are used to reduce it. The noise origins are a combination of the real-world effective signal source impedance being presented to the converter's analog inputs, and nearby spurious digital or analog noise sources, which may be leaking into the converter inputs due to circuit layout issues, or proximity to other noisy system elements, and so forth.

When 1 microvolt of input noise is multiplied by about 16.8 million, which is the approximate number of steps in a 24-bit system, the resulting number is 16.8 volts. This implies a minimum drive voltage requirement of 16.8 volts RMS (sine wave) or about 48 volts peak-to peak for meaningful 24-bit full-scale modulation under ideal circumstances, not counting dither. Many real world converter systems will generally need more drive than 16 Vrms. Surprise! You're out of drive headroom when hitting your 24-bit converter with a signal from outboard gear using monolithic op-amps running off of +/- 15 to 18 volt supply rails!

Here's some numbers from a field report received recently regarding the new HD workstation systems and their compatibility with a lot of existing gear:

When most solid-state gear is hooked up to the new 24 bit inputs, the signal can only get up to "-6 or -12" (dB BELOW full-scale) on a given track before wholesale clipping of the source gear sets in, depending on the design of the source. When faced with this awful situation brought on by limited voltage drive capabilities, the recording engineer must decide whether to use the *less sensitive* "+4" inputs on his new 24-bit digital equipment, and throw away the top 2 or 4 or 5 bits of resolution in order to keep from clipping his source gear. Or, equally unattractive, choose to use the *more sensitive* "-10" A/D converter inputs, and throw away the BOTTOM 2 or 4 or 5 bits to noise, ON TOP of whatever the dithering algorithm is doing to the low-level data. Either way, some of the extra resolution provided by the 24 bit systems, and much of the point and effort to provide new high-resolution digital mediums, is simply discarded by such compromise.

The Glory Compressor itself will never force the recording engineer into a no-win drive-level trade-off, since the compressor's audio path electronics are very far removed from the paltry +/-15 volt power-supply voltage-rail limitations found in nearly all of the popular op-amp-laden audio production gear. Here again the tried-and-true vacuum tube, and it's purpose-designed application in audio production, is more then up to the task of providing plenty of clean attractive audio for the latest and greatest digital gear. No stock (unmodified) audio production equipment pieces currently in production and on the American market can casually provide abundant headroom *for the 24-bit systems*, by furnishing 120Vpp across 600 ohms (more when lightly loaded!). Output capabilities like this are realizable in transistorized designs, but with much greater circuit complexity and expense, along with lower reliability, not to mention the sonic penalties.

Power Supply Highlights

The Glory Compressor uses all-triode circuitry throughout the signal path. This includes all of the pentode tubes, which are electronically configured as triodes. In this way the attractive characteristics of the triode are made available without the high cost and general unavailability of other generic triodes, which might otherwise be suitable for the job at hand.

In order to keep the chain of triodes confined to operating over the specific working range intended, the high-voltage

supply must be held at a constant value. Since the compressor is a dynamics or signal-level processor, it becomes mandatory to hold the high-voltage rail to within a few percent of the target voltage at all times. In this spirit, the Glory Compressor features a special high-voltage regulator that serves to keep the high-voltage at a stable value, and, through an unusual synthetic-inductor function, provides smoothing or ripple filtering as well. All of this regulator activity is located “upstream” of the high-tension supply’s large filter capacitor, zeroing out any small wide-band noise components which the regulator may generate.

The power supply features a warm-up high-voltage hold-off circuit, which keeps the B+ on hold until the tube filaments are sufficiently warmed up. In this case, the hard-wire signal bypass relays electrically link the program input and output connectors together until the warm-up cycle is complete. This prevents any large warm-up-related signal transients from appearing at the program output connectors.

Power supply energy storage is ample in the Glory Compressor. Over 50 joules of potential energy in the large high-voltage filter cap alone! This level of reserve energy helps give the signal path and output stage immunity from perturbation by loud or highly dynamic signals. Put another way, the program audio will have that completely un-strained quality that only abundant power reserves and signal headroom will provide.

Unpacking and Inspection

Your Groove Tubes Glory Compressor was carefully packed at the factory, and the shipping carton was designed to protect the unit during shipping. Please retain this container in the unlikely event that you need to return your Glory for servicing.

The shipping carton should contain the following items:

- Glory Variable Transconductance Compressor
- This instruction manual
- Power cable
- Groove Tubes Warranty card
- Rack mounting hardware (two pieces plus parts to attach them to the Glory when rack mounting).

NOTE: It is important to register your purchase; if you have not already filled out your warranty card and mailed it back to Groove Tubes, please take the time to do so now.

Installing in a Rack

The Glory may be simply set on a table, or installed in a standard 19" audio equipment rack. While the rack mounting holes are integral to the front panel, the Glory is unusually deep and heavy, so extra support must be provided for the rear of the unit. Before the Glory is installed in a rack, we recommend that you attach the reinforcing rack kit to handle the weight of the unit and provide ventilation room. The rail kit requires one free rack space above the Glory.

NOTE Since the vacuum tubes in the Glory generate a certain amount of heat, make sure adequate ventilation is provided in the rack.

To attach the rack kit:

The reinforcing rails should be attached to the sides of the unit. They are screwed to the sides of the preamp and extend to above the front panel. Standard rack screws are then used to fasten both the Front Panel and the Rack Kit to the Rack Rails panels.

Specifications

Size: 19”W x 18”D x 5.2” (3RU) H, including projecting controls and parts. Budget 5 RU for proper ventilation and heat dissipation, with 1 RU above and below the enclosure. Exceptions being other equipment housed in shallow enclosures that will not block the compressor’s ventilation slots.

Weight: 37 lbs, not including rack brace kit. Kit requires 1 RU of vertical clearance, which makes good use of the ventilation spacing required by the unit, and **must be installed** if the compressor is to be used in a mobile or transportable production application.

Mains requirements: 120 VAC, 60~, 130 Watts warm-up interval, 100 Watts during operation.

Warm-up delay: Approximately 30 seconds from cold start to COMP relay engagement (green comp lamp is lit). Note that about 5 minutes of additional warm-up time is recommended to permit the tubes to reach thermal equilibrium before use begins.

Fuse Complement (120 VAC): 5x20 mm 1.6 A, 250 V SLO-BLO for the mains, 5x20 mm 0.125 A, 250 VAC standard speed for B+. **220-240 VAC:** Use 5x20 mm 0.8A SLO-BLO for the mains fuse.

Maximum PROGRAM input signal level, PROGRAM XLR input: +32 dBu, or 30 Vrms, 87 Vp-p.

PROGRAM input impedance: XLR= 35 k-ohm bridging balanced, TRS = 18 k-ohm bridging balanced. Always ground the ¼ inch plug’s RING to SLEEVE when feeding UNbalanced signals into the PROGRAM input TRS jack.

Maximum PROGRAM output signal level, PROGRAM XLR output: +34 dBu, or 38 Vrms, 109 Vp-p across 600 ohms (2.5 watts), add about 5 dB for 10k-ohm loads (**Caution! High voltage**!). Subtract 6 dB (50%) for the PROGRAM TRS output jack.

PROGRAM output impedance: XLR = 600 ohm balanced floating transformer coil, TRS = 150 ohm balanced floating transformer coil. Always ground the ¼ inch plug’s RING to SLEEVE when converting BALanced signals from the TRS jack into UNbalanced signals.

System PROGRAM THD, IM at:

Input and Output Gain = 0 dB, operating level = 1.23 V rms @ 440 Hz (+4 dBm output), no gain reduction, Glory effect at minimum, Program XLR output, 600 ohm load, Bandwidth 22 – 22 kHz.

THD = 0.09 %, IMD = 0.06%.

System PROGRAM THD, IM at:

Input and Output Gain = 0 dB, operating level = 12.3 V rms (+24 dBm output), no gain reduction, Glory effect at minimum, Program XLR output, 600 ohm load, Bandwidth 22 – 22 kHz.

THD = 0.6%, IMD = 0.6% .

System PROGRAM THD, IM at:

Input and Output Gain = 0 dB, input level = 7.75 V rms (+20 dBu input, +20 dBm output), 10 dB of gain reduction, Glory effect at minimum,Program XLR output, 600 ohm load, Bandwidth 22 – 22 kHz.

THD = 1.1 %, IMD = 0.6% .

System PROGRAM hum+noise, IN/OUT controls @ unity, input jacks open, A weighted = –68 dBm.

System PROGRAM dynamic range = 103 dB, ref +35 dBm out or 3% THD.

Maximum PROGRAM path gain = 20 dB.

Maximum PROGRAM gain reduction = 18 dB, single-stage balanced variable transconductance vacuum tubes.

Maximum SIDE CHAIN input signal level, SIDE CHAIN XLR input: +24 dBu, or 12.3 Vrms, 35 Vp-p.

Note that the XLR and SIDE CHAIN TRS input jack sets are furnished hard-wired in parallel, as a convenience to the operator. Be careful not to drive both XLR and TRS jacks with separate line input signals, use one input at a time.

Maximum SIDE CHAIN output signal level, SIDE CHAIN XLR output: +24 dBu, or 12.3 Vrms, 35 Vp-p. Subtract 6 dB (50%) for the SIDE CHAIN TRS output jack.

Note that the SC output level is between 10 and 15 dB lower then the program input signal, due to dynamic range limitations of the op-amp based side-chain circuitry. The side chain signals are not intended to be used as a source of on-line production quality audio.

SIDE CHAIN EQualisation: Shelving, +/- 10 dB @ 50 Hz, and +/- 10 dB @10 kHz. Operates on INTernal SIDE CHAIN SOURCE mode only.

GLORY EFFECT: 0 - 50% THD, mostly 2nd order, injection ratio depending on instantaneous Gain Reduction, input signal and output signal drive levels. Effect limited to 60 - 800 Hz window; intended primarily for operation on fundamental signal content of single or small groups of instruments or voices.

Operating temperature: 10 - 40 degrees C, 50 - 104 degrees F.

Operating humidity: 0 - 90 percent relative humidity, non-condensing.

Obtaining Repair Service

Before contacting Groove Tubes, check over all your connections, and make sure you've read the manual.

Customers in the USA and Canada: If the problem persists, call Groove Tubes 818-361-4500 and request the Customer Service department. Make sure you have the unit's serial number with you. Talk the problem over with one of our technicians; if necessary, you will be given a return order (RO) number and instructions on how to return the unit. All units must be shipped prepaid and COD shipments will not be accepted.

For prompt service, indicate the RO number on the shipping label. **Units without an RO will not be accepted.** If you do not have the original packing, ship the unit in a sturdy carton, with shock-absorbing materials such as Styrofoam pellets (the kind without CFCs, please) or "bubble-pack" surrounding the unit. Shipping damage caused by inadequate packing is not covered by the Groove Tubes warranty.

Tape a note to the top of the unit describing the problem, include your name and a phone number where Groove Tubes can contact you if necessary, as well as instructions on where you want the product returned. Groove Tubes will pay for standard one-way shipping back to you on any repair covered under the terms of this warranty. Next day service is available for a surcharge. Field repairs are not authorized during the warranty period, and repair attempts by unqualified personnel may invalidate the warranty.

Service address for customers in the USA:

Groove Tubes Service Department
1543 Truman Street
San Fernando, CA 91340

Customers outside the USA and Canada:
Contact your local Groove Tubes distributor for any warranty assistance. The Groove Tubes Limited Warranty applies only to products sold to users in the USA and Canada. Customers outside of the USA and Canada are not covered by this Limited Warranty and may or may not be covered by an independent distributor warranty in the country of sale. Do not return products to the factory unless you have been given specific instructions to do so.

Internet Address: Important information and advice is available on our web site:

WEB SITE: http://www.groovetubes.com

Email may be addressed to:

SALES: sales@groovetubes.com
TECHNICAL: lab@groovetubes.com

Groove Tubes Limited Warranty

GROOVE TUBES llc ("GROOVE TUBES") warrants this product to be free of defects in material and workmanship for a period of one (1) year for parts and for a period of one (1) year for labor from the date of original retail purchase. This warranty is enforceable only by the original retail purchaser and cannot be transferred or assigned.

The purchaser should complete and return the enclosed warranty card within 14 days of purchase.

During the warranty period GROOVE TUBES shall, at its sole and absolute option, either repair or replace free of charge any product that proves to be defective on inspection by GROOVE TUBES or its authorized service representative. In all cases disputes concerning this warranty shall be resolved as prescribed by law.

To obtain warranty service, the purchaser must first call or write GROOVE TUBES at the address and telephone number printed below to obtain a Return Authorization Number and instructions concerning where to return the unit for service. All inquiries must be accompanied by a description of the problem. All authorized returns must be sent to GROOVE TUBES or an authorized GROOVE TUBES repair facility postage prepaid, insured and properly packaged. Proof of purchase must be presented in the form of a bill of sale, canceled check or some other positive proof that the product is within the warranty period. GROOVE TUBES reserves the right to update any unit returned for repair. GROOVE TUBES reserves the right to change or improve design of the product at any time without prior notice.

This warranty does not cover claims for damage due to abuse, neglect, alteration or attempted repair by unauthorized

personnel, and is limited to failures arising during normal use that are due to defects in material or workmanship in the product.

THE ABOVE WARRANTIES ARE IN LIEU OF ANY OTHER WARRANTIES OR REPRESENTATIONS WHETHER EXPRESS OR IMPLIED OR OTHERWISE, WITH RESPECT TO THE PRODUCT, AND SPECIFICALLY EXCLUDE ANY IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY OR OTHER IMPLIED WARRANTIES.
Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

IN NO EVENT WILL GROOVE TUBES BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, INDIRECT OR OTHER DAMAGES RESULTING FROM THE BREACH OF ANY EXPRESS OR IMPLIED WARRANTY, INCLUDING, AMONG OTHER THINGS, DAMAGE TO PROPERTY, DAMAGE BASED ON INCONVENIENCE OR ON LOSS OF USE OF THE PRODUCT, AND, TO THE EXTENT PERMITTED BY LAW, DAMAGES FOR PERSONAL INJURY. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

THE INTERNAL LAWS OF THE STATE OF CALIFORNIA SHALL GOVERN THIS CONTRACT WITHOUT REFERENCE TO CONFLICTS OF LAWS. This warranty gives you specific legal rights, and you may also have other rights required by law, which vary from state to state.

This warranty only applies to products sold to purchasers in the United States of America or Canada. The terms of this warranty and any obligations of Groove Tubes under this warranty shall apply only within the country of sale. Without limiting the foregoing, repairs under this warranty shall be made only by a duly authorized Groove Tubes service representative in the country of sale. For warranty information in all other countries please refer to your local distributor.

PLEASE SEND IN YOUR WARRANTY CARD for more effective service and product update notices

GROOVE TUBES llc

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