Phase 3
by Videoquip Research

RLA-2
Stereo Remote Level Amplifier

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Phase 3 RLA-2 User Manual

The RLA-2 is a stereo remote level amplifier allowing remote gain control of a stereo analog audio signal. The RLA-2 incorporates analog voltage controlled amplifiers (VCA) as the gain controlling device.The gain control mechanism includes both conventional D.C. voltage control via an attached potentiometer or voltage source, as well as RS-422 serial control.

This allows a host PC or controller with an RS-422 serial port to operate the RLA-2. Note that either D.C. voltage or RS-422 serial control is available, although not simultaneously. The internal ribbon cable connector must be placed in the appropriate IDC header to facilitate the desired operation. Note that the RLA-2 is shipped from the factory with the cable header in the D.C. voltage control position. A DB-9F rear panel connector is used to interface the control scheme to the internal circuitry of the RLA-2.

When D.C. voltage control is desired, it is possible to provide a control voltage range between 0 and +12V D.C., where 0V D.C. represents maximum gain and +12V represents maximum attenuation.

The DB-9F connector provides +12V and 0V (ground) from the internal power supply for connecting an external potentiometer as the voltage control element. The D.C. inputs to the voltage control buffer circuitry are taken from the wiper of the potentiometer(s). Note that either a single or dual potentiometer may be used. If a single potentiometer is used, only a single +12V and ground pair from the DB-9F connector should be taken to the potentiometer and the wiper should be connected to both voltage control inputs on the DB-9F connector.

The range of allowed input voltages for maximum attenuation ranges from as low as approximately +3 Volts at the low end, to +12 Volts at the upper end. Voltages higher than +12 Volts will be clamped by a diode to prevent over-driving the input.

Note that control voltages down to +3 Volts are more unlikely to be found in most equipment. It is expected that +5 Volts is a more likely candidate when driven from a computer interfaced DAC or similar equipment.

In addition, both channels feature a mute input, which mutes the selected output with a sustained connection to ground from either mute input. When the grounded mute input is released, the gain is restored to the previous level as determined by the potentiometer position.

Calibration of Voltage Control Inputs

The RLA-2 features a unique “auto-calibration” mode of operation, which simplifies the process of providing maximum attenuation for a given set of conditions.

The VCA device itself provides either gain or attenuation depending upon the polarity of the applied D.C. control voltage. With 0 Volts applied to the control pin of the VCA, the input/output gain is unity or 0 dB. Positive control voltages attenuate the output signal from the VCA, while negative control voltages actually introduce real signal gain.

Since most control signals, including computer output digital to analog converters (DACS) usually provide unipolar control signals, frequently from 0 to +5V, which allows the computer to control the RLA-2 with this given control range. Since 0V at the control pin represents unity gain at the output of the VCA, this sets the maximum gain. At the other end, +5V represents the maximum voltage available to lend to signal attenuation.

In “auto-calibration” mode, the maximum positive voltage available for attenuation is input to the control pin for each channel. The internal microcontroller then takes that D.C. control voltage and adjusts the absolute value either up or down by comparing it with a local “ideal” control voltage in an attempt to scale it to the reference. If the voltage is high enough to provide the maximum attenuation, the calibration procedure completes normally, and the microcontroller illuminates the green “calibration” LED’s on the front panel.

If the applied voltage is not sufficient to allow an ideal maximum attenuation, the LED for each channel is flashed to indicate that calibration could not be performed with the applied voltage.

If a potentiometer is connected to the RLA-2 as a gain control element, calibration is guaranteed if the available +12V voltage source provided by the rear panel DB-9F connector is used.

The “auto-calibration” procedure also helps to resolve and compensate for long cable lengths between the RLA-2 and the attached potentiometer or other control device. The effect of any voltage drops from the RLA-2 to the potentiometer and back again from the wiper is automatically included in the voltage calibration.

The gain of the RLA-2 typically is set to unity with a control voltage of 0V D.C., and an on-board trim potentiometer is used to trim the gain. If desired, this potentiometer can be adjusted in such a way that greater than unity gain can be achieved with a control voltage of 0V input as required by a given installation. Trim pots R35 and R72 can be used to trim the output gain by approximately +/- 6 dB.

RLA-2 SYSTEM CALIBRATION

To calibrate the RLA-2 with a given input voltage, the following procedure should be observed.

1) Apply the maximum positive voltage (between approximately +3V and +12V) to the correct D.C. control input pins of the DB-9F connector.

2) Turn off the power to the RLA-2, if it was not turned off previously.

3) Using a small flat-blade screwdriver or similar tool, depress the recessed front panel switch labelled CALIBRATION and hold it down.

4) Turn on the power switch to the RLA-2 while holding the CALIBRATION switch down for approximately one or two seconds, before releasing the

5) The front panel calibration LED's will be extinguished initially, but if the calibration for Channel 1 is successful, the LED corresponding to Channel 1 will quickly illuminate, followed by Channel 2. The calibration value required for each channel will be stored in EEPROM.

6) The firmware of the RLA-2 will make three attempts to calibrate the control voltage before flashing the LED of the Channel that was unsuccessfully calibrated. An on-board EEPROM device stores the calibration value required for that particular Channel which is restored upon power-up. If the calibration was successful, that "status" is stored in EEPROM as well. If upon power-up either LED is flashing, that is an indication that a previous calibration attempt was unsuccessful and that it should be re-calibrated before use again.

RS-422 Control Scheme

As described previously, it is possible to use a host PC or controller to control the gain of the RLA-2. Note however, that multi-drop RS-422 operation of multiple RLA-2 devices is not possible, and a dedicated serial port is required for multiple unit applications. In this case, multi-drop operation is said to mean multiple devices on the same line each with a unique address. In order to use RS-422 as the controlling mechanism, it is necessary to change the internal IDC 10 pin ribbon cable header from the voltage control header to the serial control header.

To convert the unit to RS-422 control, remove the top cover, and place the ribbon cable header from the rear DB-9F connector in the correct on-board male header.

J5 is used for D.C. control voltage applications
J6 is used for RS-422 serial control applications

DB-9F Control Connector – RS - 422 Pin Configuration (J6)

Pin Number	Function
1	N.C.
2	TXD-
3	RXD+
4	GND
5	N.C.
6	GND
7	TXD+
8	RXD-
9	N.C.

DB-9F Control Connector – D.C. Voltage Configuration (J5)

Pin Number	Function
1	+12V
2	Channel 1 VCA Input Voltage
3	Channel 1 Mute Input **
4	Ground
5	Ground
6	+12V
7	Channel 2 VCA Input Voltage
8	Channel 2 Mute Input **
9	Ground

** Active low (closure to ground) mute input. The mute condition is sustained for the duration that the mute input (pin 3 & 8) is grounded, and is released when the mute input is removed from ground. The RLA-2 incorporates both hardware and software low pass filters to provide a controlled “soft mute”, in addition to smooth response to D.C. input level step changes.

Refer to the page 5 of the attached schematics for sample potentiometer wiring implementations, including the recommended scheme for wiring the potentiometer and mute switches. Both single and dual pot versions are shown. Typical potentiometer values are in the range of about 10 K Ohms. Audio taper potentiometers may be used, depending upon the required transfer characteristic of rotation versus perceived audio level change.

NOTE: With no attached potentiometer or voltage source, the gain of the VCA is 0 dB or unity gain, assuming the on-board gain trim pots have been set for unity gain.

RLA-2 Serial (RS-422) Control Scheme

The serial remote control protocol for computer communications with the RLA-2 is described in this document. The RLA-2 Remote Gain Amplifier can be used with either:

1) Local Voltage Control of both audio channels, including mute inputs for each input.

2) The RS-422 serial remote control input.

Each control type shares a single DB-9 rear panel connector, and only one control scheme can be used at a time. The main printed circuit board has two 10 pin male IDC header blocks, that accept the 9 pin ribbon cable from the rear panel single DB-9F connector.

When local voltage control is desired, the ribbon cable assembly is connected to the appropriate IDC connector (J5), and this mode is available.

When RS-422 remote control is desired, the ribbon cable assembly is connected to IDC connector (J6), and this mode is available.

The serial remote control protocol is designed to allow point to point RS-422 control of one RLA-2, note that it is not a multi-drop protocol and no daisy chaining capability is provided. If more than one RLA-2 is used in a system with serial control, each RLA-2 must be controlled from a separate serial port.

RLA-2 Serial Remote Protocol - Description

The RLA-2 does not include any provision for a logical address as would be found in a daisy chained multi-drop environment, as discussed above. The protocol consists of a header byte, a message byte, a data byte, and an optional checksum byte.

The RLA-2 provides host communications at 9600 Baud, no parity, 8 data bits, and 1 stop bit. The protocol is a constant length (4 bytes), with all bytes required, although don't care data (the value can be from anything from 00h to 0ffh) can be sent for each message type.

All message types will echo the four bytes sent to it, as confirmation that it is connected to the host and that communications has been established. A special message type can be used as an “Alive Inquiry” <03H>, which simply returns or echoes the received bytes with no internal processing.

Protocol Format

Header	Message Type	Data Byte	Checksum
<AAH>	0,1,2 or 3	<gain value>	Optional

Defined Message types

0x00H - Disable checksum processing. This message type forces the RLA-2 to ignore checksum data as received, although the dummy checksum must be sent as a don't care value, since the protocol is constant length.

0x01H - Enable checksum processing. This message type forces the RLA-2 to receive a correct checksum of the received data, before updating the gain setting. This should serve to minimize the effect of communication line errors that would affect the gain setting. The received checksum must match the checksum calculated by the RLA-2 before the new gain setting is updated. If the received and calculated checksum values do not agree, then that transmission is ignored as far as a gain update is concerned, however the command is echoed to the host.

0x02H - Data Mode (set gain value). This message type allows the gain of the RLA-2 to be set (both channels) with a data byte and an optional **valid** checksum byte (depending on the status as described in messages 00 and 01.

The range of gain settings is from 0x00H to 0x0FFH, where 0x00H is maximum attenuation, and 0x0FFH is maximum level. Each step of 0x01H, is *approximately* 0.5 dB change in output level.

0x03H - Alive Inquiry. This message type will simply return (echo) the message with no internal action on the part of the RLA-2, as confirmation of status.

Checksum Byte

If message type 01H has been sent to the RLA-2 in a previous session, it is necessary for a correct checksum byte to be sent as the last byte in a transmission, **only when using message type 02H**. The RLA-2 has an internal EEPROM device to store calibration settings as well as the checksum required status. This makes it possible to retain the need for checksum processing, even after a new power-up cycle. The status is updated in EEPROM after receipt of message types either 00H or 01H.

The checksum is calculated as the two's complement XOR sum of the first 3 bytes of the transmission, excluding byte 4, the actual checksum byte.

Example1

If checksum processing has been enabled using message type 01H, then the following would describe the gain update method, using message 02H.

Byte 1	**Byte 2**	**Byte 3**	**Byte 4**
<0xAAH>	<0x02H>	<gain data, 00H to 0FFH >	<checksum>

Example2

To disable checksum processing, send the following command

<0xAAH> <00H> <00H> <00H>

To enable checksum processing, send the following command

<0xAAH> <01H> <00H> <00H>

The alive inquiry is selected as follows

<0xAAH> <03H> <00H> <00H>

The RLA-2 will echo the command string sent to it for the message types defined above. Reception of any other message types will cause the RLA-2 to ignore the transmission and return nothing.

Appendix A- Interfacing an external potentiometer to the RLA-2

This appendix will discuss some implementation issues that will affect the operation of the RLA-2 when using a potentiometer as the voltage control method.

It is common to use a potentiometer with an audio (log) taper when it is being used as an inter-stage volume control device, (i.e., between a pre-amp and a power amplifier stage).

The RLA-2 uses a VCA as a control element, as is common for voltage controlled amplifiers. The VCA has a control port voltage sensitivity measured in mV per dB of change. This produces a nice, predictable response but unfortunately, it doesn't necessarily result in a comfortable change of loudness curve with respect to the rotation of the potentiometer, as far as the human ear is concerned.

The VCA used in the RLA-2 has a control voltage sensitivity of 28 mV/dB. This means that for every 28 mV of D.C. control voltage applied, the output will change by 1 dB. The implication is that a relatively low control voltage range will support a fairly wide dynamic range. It also implies that in a real world environment, the output may seem a bit too sensitive to the rotation of the potentiometer. This situation arises because a VCA will appear to "magnify" changes in control voltage in a manner that seems awkward because small changes in pot rotation will seem to cause large amplitude changes. What we want to do is to slow or customize the change in resistance versus the rotation of the potentiometer.

This effect is most disturbing in the top half of the rotation of the pot where we expect small changes in the output amplitude, but instead we are experiencing fairly large changes. When the signal has been attenuated sufficiently (counter-clockwise rotation), it doesn't really matter as much, because you can't hear the output anyway.

As you rotate the potentiometer clockwise, you want to increase the amplitude of the output. Suppose you were using a 10K Ohm Linear and you wanted a log or audio type taper. Connecting a resistor of about 2.5K Ohms would approximate that taper. The resistor value should be about 0.25 x RPOT. If you are already using a pot with an audio taper, the resistor value will have to be determined by experimentation. It may be easier to just use another pot in place of a fixed resistor and just adjust it until you get the result you want. Then just measure the value and replace it with a fixed resistor of the same value.

Another way to understand it is that you are trying to almost "program" the voltage that you want at various angles of potentiometer rotation. That would be ideal, but a resistor doesn't really provide as much control over the exact response that is needed, it can only approximate the response.

RLA-2 Specifications

Power Requirements	115 VAC, 60 Hz or 230 VAC, 50Hz, 6W

Analog Audio Inputs

Input Impedance	40 Kohms balanced, 20 Kohms unbalanced
Maximum Input Level	+24 dBu
Input Connectors	XLR-3F, x 2
Common Mode Rejection	-70 dB @ 60Hz

Analog Audio Outputs

Output Impedance	100 Ohms balanced
Output Signal Level	0 dBu nominal, +24 dBu max
Output Connectors	XLR-3M, x 2
Frequency Response	20 Hz to 20 KHz +/- 0.25 dB
THD + Noise	0.07% or less
Hum and Noise	-70 dBu, with 22 KHz LPF in measured path

Remote Control

Connector Type	DB-9F x 1 (Used for D.C. or RS – 422 Control)
D.C. Remote	Provides two +12VD.C. voltage sources For connection to a remote potentiometer External Mute Inputs (pull down to ground)
RS-422 Serial Remote	9600 Baud, No Parity, 8 Data, 1 Stop Checksum Enabled or Disabled

Warranty

Videoquip Research Limited (VRL) warrants the RLA-2 for a period of 2 (two) years from the date of shipment from the factory, to be free of defects in workmanship and material under normal use and service. This warranty is void if failure is due to abnormal use or modification, or if serial numbers have been tampered with. VRL's liability is limited to the repair or replacement of this unit, or to a sales credit, and the warranty action taken is at the sole discretion of VRL. Any warranty claims must be received in writing by VRL before the expiration of the two year period. Warranty coverage does not include shipping costs. This warranty is in lieu of all other warranties, expressed or implied, and all other obligations or liabilities of Videoquip Research Limited.