# The Tellun Corporation

# TLN-132 Dual Voltage Controlled Amplifier

## User Guide, Rev. 1.1

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## *Introduction*

The TLN-132 is a two channel VCA based on a Solid State Micro Technology For Music SSM 2022 chip. Both channels are identical and feature: separate linear and exponential control voltage inputs with reversing attenuators, a gain control for adding a constant value to the linear control input, and a bias control for adding a constant value to the exponential control input. Both linear and exponential inputs can be used at the same time. DC coupling is used throughout for passing DC signals. One signal input and one signal output are provided.

## *Circuit Description*

Since both channels of the TLN-132 are identical, only channel 1 will be discussed.

Refer to page 3 of the schematic for the following discussion on the VCA design.

The SSM 2022 (U10) is a dual VCA chip with both linear and exponential control voltage inputs. The circuitry on the left side of the schematic is specific to channel one. C21 and C22 are bypass caps for the power supply. R47 sets the reference current for U10. C25, C27, and R50 provide feed forward compensation for the on chip control amps of U10. TP5 and R48 are for DC offset and control voltage feed through trimming (see the Calibration section). The input signal at the IN jack is fed to an inverting amplifier (one half of U8) before reaching U10 so that the output signal will be in phase with the input signal. The output signal is converted from a current to a voltage using the other half of U8 and appears at the OUT jack.

Refer to page 1 of the schematic for the following discussion on the control signal inputs for channel one.

The linear control signal appearing at the LIN input is fed to a reversing attenuator built around VR4 and U2. VR3 supplies a DC bias to the linear control signal. R11 provides a negative offset for the bias DC bias control. This permits burying the signal appearing at the LIN input below the threshold where the VCA will open[1]. Using the resistor values shown, the VCA will begin to open when the GAIN control reaches the 2 position. The linear control signal is then fed to a precision diode circuit built around U3. This circuit is necessary to prevent negative voltages from being fed into the linear control input of the SSM 2022. TP2 trims the VCA response so that five volts appearing at the LIN input will provide unity gain (see the Calibration section).

The exponential control signal appearing at the EXP input is fed to a reversing attenuator built around VR2 and U1. VR1 supplies a DC bias to the exponential control signal. TP1

[1] This idea was borrowed from the MOTM-110 Ring Mod and VCA.

trims the VCA's "dB per volt" response (see the Calibration and In Use sections for details on using the exponential control inputs).

The signal output (from page 3 of the schematic) is fed to a clipping detector built around U4. R20 and R21 set the trip point for the detector. Should the output signal exceed +6V, a comparator fires to charge C23 through D2. This signal is then fed to a voltage follower for driving an LED. R22 prevents C23 from discharging too quickly so that the LED will stay lit long enough to capture any short clip.

Page 2 of the schematic shows the control signal inputs for channel two. The operation is identical to that described above for channel one.

## *Construction Tips*

Use a socket for the SSM 2022; this is a rare and expensive chip. Sockets are not necessary for the other chips.

Coax cable should be used for the two input signals (J5, J7) and the two output signals (J6, J8).

The PCB uses 0.4" spacing for the resistor pads, 0.3" for the diode pads, and 0.2" spacing for the capacitor pads.

Save some scrap resistor leads and use them to connect the switching lug of the phone jacks to ground for the control voltage and audio inputs (J1, J2, J3, J4, J5, J7).

**Panel Wiring Guide**

| *Panel Designation* | *PCB Designation* | *Wire Length (inches)* | *Wire Type* |
|---|---|---|---|
| BIAS 1 pot | VR1 | 4 | twisted |
| EXP 1 pot | VR2 | 4 | twisted |
| GAIN 1 pot | VR3 | 8 | twisted |
| LIN 1 pot | VR4 | 6 | twisted |
| BIAS 2 pot | VR5 | 7 | twisted |
| EXP 2 pot | VR6 | 6 | twisted |
| GAIN 2 pot | VR7 | 5 | twisted |
| LIN 2 pot | VR8 | 5 | twisted |
| EXP 1 jack | J1 | 4 | twisted |
| LIN 1 jack | J2 | 5 | twisted |
| EXP 2 jack | J3 | 8 | twisted |
| LIN 2 jack | J4 | 8 | twisted |
| IN 1 jack | J5 | 4 | coax |
| OUT 1 jack | J6 | 4 | coax |
| IN 2 jack | J7 | 8 | coax |
| OUT 2 jack | J8 | 8 | coax |
| LED 1 | LED1 | 4 | twisted |
| LED 2 | LED2 | 4 | twisted |

For VR1-VR8, the square pad on the PCB indicates pin 1, the middle pad is pin 2, and the remaining pad is pin 3. The pin out for most pots is (left to right): 3, 2, 1 when viewing the back of the pot with the leads facing down.

For J1-J8, the square pad on the PCB indicates the ground connection.

For the LEDs, the square pad on the PCB indicates the cathode. The cathode is normally the shorter lead on an LED.

## *Calibration*

Let the VCA warm up for a few minutes before attempting calibration.

### *Channel 1*

TP2 sets the linear control voltage response so that +5V appearing at the LIN1 input will provide unity gain. Disconnect any signals from the EXP1 and LIN1 inputs. Set the BIAS1 control to the 0 position. Adjust GAIN1 so that pin 7 of U2 reads exactly 0.000 volts. Apply a 10 Vpp audio signal to IN1. Apply +5.000 volts to the LIN1 input and set the LIN1 control to the +5 position. Adjust TP2 until the signal at the OUT1 output is reading10 Vpp (unity gain).

TP1 adjusts the VCA response to the signal appearing at the EXP1 input. This effectively sets the “dB change per volt” and can be set to whatever response the user prefers. Set the GAIN1 and EXP1 knobs to maximum. Disconnect any signals from the LIN1 input. Apply a 10 Vpp audio signal to IN1. Apply +5.000 volts to the EXP1 input and adjust the BIAS1 control until the signal at the OUT1 output is reading 10 Vpp (unity gain). Change the voltage at the EXP1 input from +5.000 volts down to +4.000 volts. Choose a response (dB per volt) from the table below and adjust TP1 until the output level equals the value in the Vout column.

The gain equation is: dB change per volt = $20 \, Log_{10} ( \, Vout / 10 \, )$.

| *dB per volt* | *Vout (measured at OUT1)* |
|---|---|
| 14 | 2.0 Vpp |
| 16 | 1.6 Vpp |
| 18 | 1.25 Vpp |
| 20 | 1.0 Vpp |

TP5 adjusts both DC offset and control voltage feed through. Disconnect any signals from the IN1 and EXP1 inputs. Set the BIAS1 knob to the 0 position. Set the GAIN1 and LIN1 knobs to the maximum position. Apply a 10 Vpp audio signal to the LIN1 input. Adjust TP5 for the minimum signal present at OUT1.

***Channel 2***

TP4 sets the linear control voltage response so that +5V appearing at the LIN2 input will provide unity gain. Disconnect any signals from the EXP2 and LIN2 inputs. Set the BIAS2 control to the 0 position. Adjust GAIN2 so that pin 1 of U6 reads exactly 0.000 volts. Apply a 10 Vpp audio signal to IN2. Apply +5.000 volts to the LIN2 input and set the LIN2 control to the +5 position. Adjust TP4 until the signal at the OUT2 output is reading10 Vpp (unity gain).

TP3 adjusts the VCA response to the signal appearing at the EXP2 input. This effectively sets the "dB change per volt" and can be set to whatever response the user prefers. Set the GAIN2 and EXP2 knobs to maximum. Disconnect any signals from the LIN2 input. Apply a 10 Vpp audio signal to IN2. Apply +5.000 volts to the EXP2 input and adjust the BIAS2 control until the signal at the OUT2 output is reading 10 Vpp (unity gain). Change the voltage at the EXP2 input from +5.000 volts down to +4.000 volts. Choose a response (dB per volt) from the table below and adjust TP3 until the output level equals the value in the Vout column.

The gain equation is: dB change per volt = $20 \text{ Log}_{10}$ ( Vout / 10 ).

| *dB per volt* | *Vout (measured at OUT2)* |
|---|---|
| 14 | 2.0 Vpp |
| 16 | 1.6 Vpp |
| 18 | 1.25 Vpp |
| 20 | 1.0 Vpp |

TP6 adjusts both DC offset and control voltage feed through. Disconnect any signals from the IN2 and EXP2 inputs. Set the BIAS2 knob to the 0 position. Set the GAIN2 and LIN2 knobs to the maximum position. Apply a 10 Vpp audio signal to the LIN2 input. Adjust TP6 for the minimum signal present at OUT2.

## *Modifications*

TL072 op amps can be used instead of the MXL1013 and OP275GP op amps.

The clip detector circuitry is optional.

The trip point for channel one's clip detector can be modified by changing either R20 or R21; it's simply a voltage divider. The same applies to channel two. The current limiting resistor for the LED (R23 for channel one, R46 for channel two) may need to be changed if a different type of LED is used for the clip detector.

The feature for burying the linear control voltage signal can be disabled by leaving out R11 for channel one and R34 for channel two. R12 and R35 will have to change from 180K to 220K if R11 and R34 are left out.

## *In Use*

The linear control voltage input on the SSM 2022 works in the expected manner: 0 volts gives zero gain, and gain increases as a positive voltage is applied. The TLN-132 is designed so that 0 volts gives zero gain and +5V gives unity gain. The GAIN knob can be used to supply a constant voltage so that the 0 volts gives unity gain and –5V gives zero gain.

The exponential control voltage is a peculiar beast on the SSM 2022. Gain is specified as the product of the linear control current and the negative exponent of the voltage at the exponential control input. Thus, 0 volts gives unity gain, positive voltages reduce gain, and negative voltages increase gain. However, in order for this to work at all, there must be a voltage applied to the linear control input. To make sense of this, the reversing attenuator for the exponential control voltage signal is wired backwards so that an increasing positive voltage will be converted to an increasing negative voltage. This will produce the correct "sense" as the EXP control is adjusted between –5 and +5. Unfortunately, just reversing the sense of the control voltage is not enough to make the exponential input behave completely normal; there is still the issue that 0 volts produces unity gain, and gain increases as the voltage goes negative. In order to reduce the gain below unity, a positive voltage must be added. The BIAS control adds a positive voltage so that gain can be controlled between unity and –N dB.

Use of the EXP input requires careful balancing between the GAIN, LIN, EXP, and BIAS controls. There is no single correct way to set these. The clipping indicator is a valuable tool when setting these controls. The clipping indicator will trigger whenever the output signal exceeds +6V. The output signal will not clip at +6V, this is simply an indicator that the output is too hot and that the controls need to be adjusted. The GAIN, LIN, EXP, BIAS controls should be adjusted so that the clip indicator never triggers under normal use.

Here is one example that illustrates how to set the controls for an exponential response to an envelope generator signal that is applied to the EXP input. The envelope generator signal begins at 0 volts, rises to +5V, and then drops back to 0 volts (standard AD response).

| | |
|---|---|
| LIN | set to minimum (0), best to leave the LIN input disconnected |
| GAIN | set somewhere between 5 and 10 |
| EXP | set to somewhere between 0 and +5, this sets the envelope range (dB change) |
| BIAS | set so that +5V from the envelope generator produces unity gain, use the clipping indicator to ensure that the output doesn't get too hot as the EXP control is increased |

Note in this example that the BIAS control effectively sets the maximum output level, while the EXP control sets the minimum output level.

# *TLN-132 Parts List*

### Resistors

| *Quantity* | *Description* | *Part No.* | *Notes* |
|---|---|---|---|
| 4 | 1 M | R17, R19, R40, R42 | 5% or better, Mouser #291-1M |
| 2 | 10 K | R18, R41 | 5% or better, Mouser #291-10K |
| 8 | 100 K | R21, R44, R52, R53, R56, R58, R59, R60 | 5% or better, Mouser #291-100K |
| 2 | 150 K | R20, R43 | 5% or better, Mouser #291-150K |
| 2 | 1.8 M | R22, R45 | 5% or better, Mouser #291-1.8M |
| 2 | 3.3 K | R23, R46 | 5% or better, Mouser #291-3.3K |
| 2 | 100 ohm | R50, R51 | 5% or better, Mouser #291-100 |
| 2 | 1 K | R55, R61 | 5% or better, Mouser #291-1K |
| 1 | 36 K | R47 | 1%, Mouser #271-36K |
| 10 | 49.9 K | R6, R7, R15, R16, R29, R30, R38, R39, R54, R57 | 1%, Mouser #271-49.9K |
| 4 | 1 M | R11, R34, R48, R49 | 1%, Mouser #271-1.0M |
| 12 | 100 K | R1, R3, R4, R9, R13, R14, R24, R26, R27, R32, R36, R37 | 1%, Mouser #271-100K |
| 2 | 56 K | R10, R33 | 1%, Mouser #271-56K |
| 2 | 10 K | R2, R25 | 1%, Mouser #271-10K |
| 2 | 1 K | R8, R31 | 1%, Mouser #271-1K |
| 2 | 220 K | R5, R28 | 1%, Mouser #271-220K |
| 2 | 180 K | R12, R35 | 1%, Mouser #271-180K |

### Capacitors

| *Quantity* | *Description* | *Part No.* | *Notes* |
|---|---|---|---|
| 2 | 33 pF ceramic | C29, C30 | can substitute 22 pF, Mouser #140-50N5-330J |
| 2 | 100 pF ceramic | C25, C26 | Mouser #140-50N5-101J |
| 2 | 4.7 nF ceramic | C27, C28 | Mouser #140-50P5-472K |
| 2 | 0.01 uF ceramic | C23, C24 | Mouser #147-71-103 |
| 21 | 0.1 uF ceramic | C3 – C22, C31 | Mouser #147-72-104 |
| 2 | 22 uF 25V electrolytic | C1, C2 | can use 35V, Mouser #140-XRL25V22 |

### Semiconductors

| *Quantity* | *Description* | *Part No.* | *Notes* |
|---|---|---|---|
| 6 | MXL1013 (or LT1013) dual op amp | U1, U2, U3, U5, U6, U7 | can substitute TL072, Allied #735-3671 |
| 1 | TL074CN quad op amp | U4 | can substitute TL084, Allied #735-2729 |
| 2 | OP275GP dual op amp | U8, U9 | can substitute TL072, Allied #630-9295 |
| 1 | SSM 2022 VCA | U10 | |
| 4 | 1N4148 diode | D1 – D4 | can substitute 1N914, Allied #950-1550 |
| 2 | Lumex red LED, #SSI-LXH387ID | LED1, LED2 | Digikey #67-1155-ND |

### Potentiometers & Trimmers

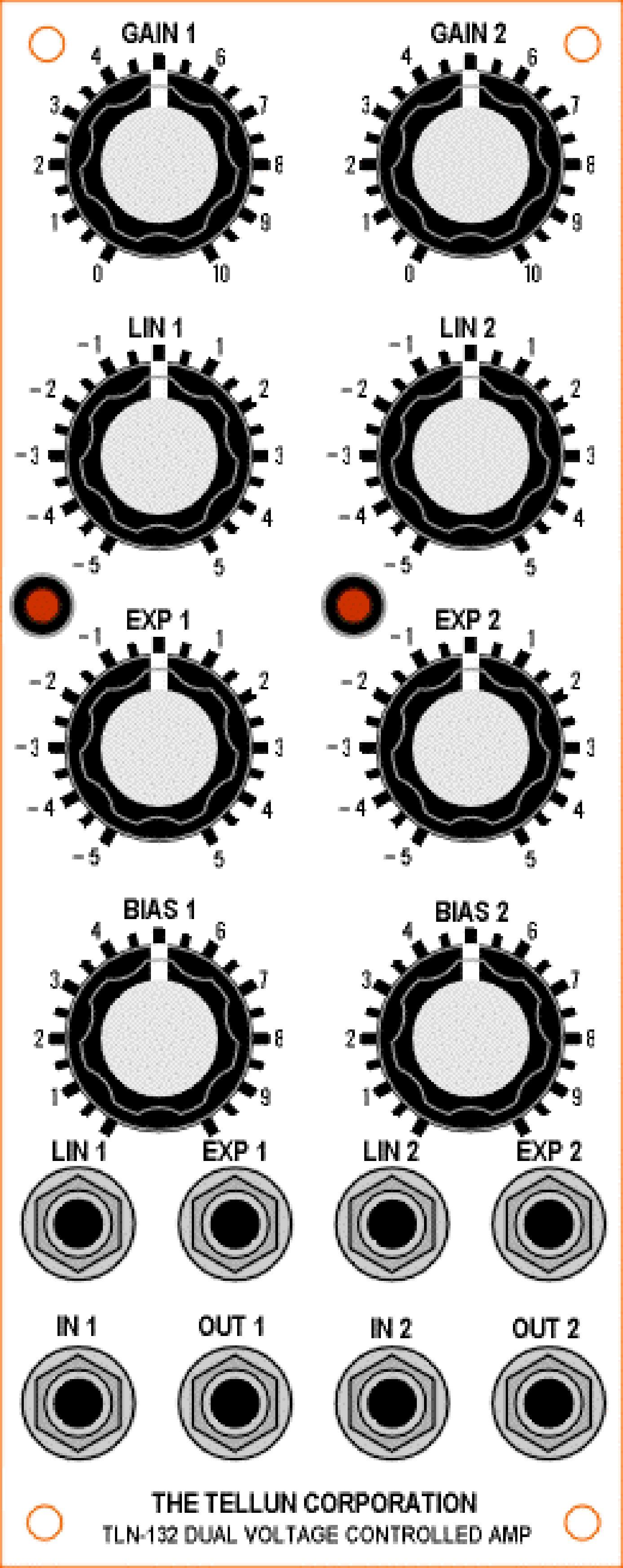
| *Quantity* | *Description* | *Part No.* | *Notes* |
|---|---|---|---|
| 8 | 100 K linear pot | VR1 – VR8 | Spectrol 149 series, Allied #970-1791, or Bournes 91 series, Allied #754-9420 |
| 4 | 25 K trimmer (multi-turn) | TP1 – TP4 | Mouser #72-T93YA-25K |
| 2 | 100 K trimmer (multi-turn) | TP5, TP6 | Mouser #72-T93YA-100K |

### Miscellaneous

| *Quantity* | *Description* | *Part No.* | *Notes* |
|---|---|---|---|
| 8 | phone jack | J1 – J8 | Switchcraft 112A, Allied #932-9391 |
| 1 | 16 pin DIP socket | | for U10 |
| 1 | 14 pin DIP socket | | for U4 (optional) |
| 8 | 8 pin DIP socket | | for U1, U2, U3, U5, U6, U7, U8, U9 (optional) |
| 2 | axial ferrite beads | L1, L2 | Active #MURJP2141, or Mouser #623-2743002112 |
| 1 | MTA-156 power connector | JP1 | Mouser #571-6404454 |

### Hardware

| *Quantity* | *Description* | *Notes* |
|---|---|---|
| 8 | knobs | ALCO PKES90B1/4 |
| 1 | TLN-132 panel | front panel |
| 1 | TLN-132 pcb | printed circuit board |
| 1 | 4 pot short Stooge bracket | Stooge bracket |
| 4 | #6-32 screw, spacer, and nut | for mounting circuit board to Stooge bracket |
| 4 | pot nut | for mounting Stooge bracket to front panel |
| 4 | #8-32 black screw | for mounting module to cabinet |
| 1 | power cable | with MTA-156 connectors |
| | heat shrink cable | |
| | wire ties | |
| | coax cable | |
| | hookup wire | |
| | solder | both organic and no clean |


GAIN 1
GAIN 2
LIN 1
LIN 2
EXP 1
EXP 2
BIAS 1
BIAS 2
LIN 1
EXP 1
LIN 2
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IN 1
OUT 1
IN 2
OUT 2
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