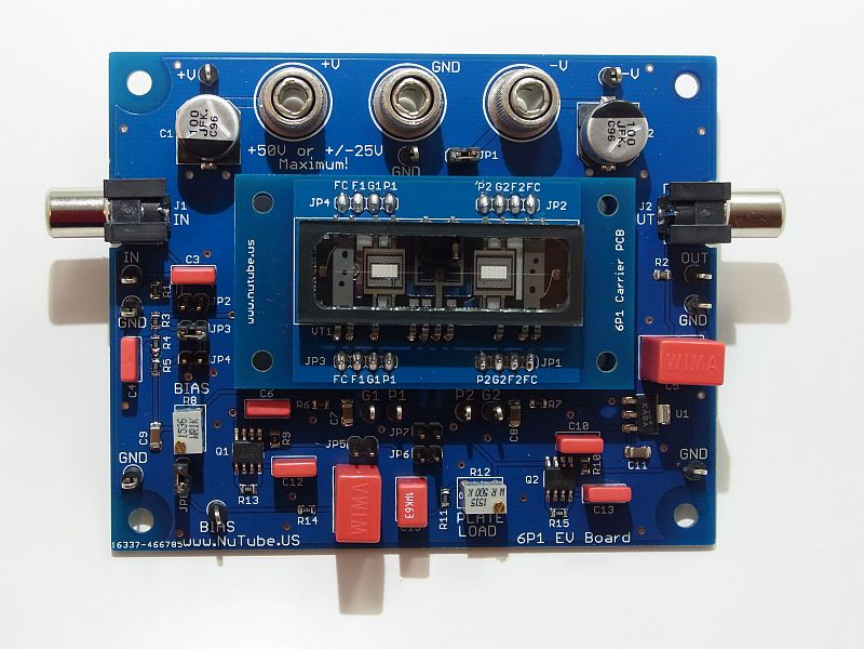
Nutube.US

6P1 Evaluation Board

User Manual

Introduction

The 6P1 Evaluation Board (EVB) is a vehicle for testing and evaluating the Korg Nutube 6P1 dual triode in audio circuits.



This product is designed and manufactured by Nutube.US.

Nutube.US is an independent, authorized distributor of the Korg Nutube device. Nutube.US is not affiliated with Korg or Korg USA.

The EVB is intended for laboratory use by qualified personnel.

For more information, please visit www.nutube.us and www.korgnutube.com.

Architecture & Theory of Operation

The 6P1 EVB is composed of four major blocks:

- Power supply and bias
- Input buffer
- 6P1 stage
- Output buffer

Refer to the schematic diagram for details.

Power supply and bias:

Power for the 6P1 EVB is supplied from an external power supply. The board can be configured for single supply (a positive voltage and ground), or dual supplies (+/- voltages). A single supply between 5V and 50V, or dual supplies from +/-5V up to +/-25V, are supported.

A 3.3V LDO regulator on the board is used to supply bias and filament power for the 6P1. The filaments, which operate at 700mV, are driven through voltage dropping resistors. Bias is adjustable from 0 to +3.3V with a potentiometer, or may also be applied by an external power supply.

Input buffer:

Since the 6P1 is typically operated with zero or a positive grid bias, the grid of the tube draws a small amount of bias current. To present a high impedance to the driving source, a discrete JFET buffer circuit is used to drive the grid of the 6P1. Depending on configuration, this buffer may be AC or DC coupled.

The buffer is implemented with a dual matched JFET device, configured as a current-sourced source follower. The use of matched JFETs results in a buffer with near zero offset voltage.

6P1 stage:

The 6P1 is connected as a conventional grounded-cathode amplifier, with a resistive plate load. Since it is a directly heated triode, the cathode is the filament, and one end of the filament is grounded. The grid is driven by the input buffer. The plate load resistor, connected to the positive power supply, is composed of a 10kΩ fixed resistor in series

with a 500kΩ potentiometer, so it can be adjusted for different operating points. The plate is DC coupled to an output buffer.

The 6P1 contains two triode units. Jumpers on the PCB allow using only one of the triodes, or connecting both of the triodes in parallel. Parallel connection effectively doubles the transconductance of the tube.

The 6P1 tube is mounted on a daughterboard. This allows it to be easily replaced or exchanged, so that characteristic variation from tube to tube can be measured, or the tube replaced in the event of inadvertent damage. Extra carrier PCBs are available from www.nutube.us.

Be very careful when removing a carrier from the main PCB. The pins are fragile, and it is easy to bend or break the pins.

The carrier can be installed in either orientation – it is symmetrical. Rotating it by 180 degrees will exchange the connections for the two triode units.

Output buffer:

Since the plate resistance of the 6P1 is quite high, a second discrete JFET buffer (identical to the input buffer) is used to drive the output connector. The buffer input is directly connected (DC coupled) to the plate of the 6P1, so it is biased to the DC voltage on the plate. The buffer output is AC coupled to the output jack.

Configuration

Before use, the EVB must be configured using jumpers for the desired mode of operation. There are three different configurations:

Single-supply operation (default configuration):

In single-supply operation, the input signal is AC-coupled to the input buffer, which is biased to ½ the input supply voltage. The output of the buffer (also at ½ supply) is also AC-coupled to the 6P1 grid. Bias is fed directly to the grid.

JP6 and JP7 may be installed to operate both triodes in parallel.

For single-supply operation, the jumpers are configured as follows:

JP1	Installed	Connects V- and Ground
JP2	Not installed	
JP3	Installed	Provides V+/2 to bias input buffer
JP4	Not installed	
JP5	Not installed	
JP6	Either	Install to parallel triode sections
JP7	Either	Install to parallel triode sections
JP8	Installed	Provides adjustable bias to 6P1 grid

The EVB is shipped with jumpers installed for single-supply operation.

Dual-supply operation:

In dual-supply operation, the input signal is AC-coupled to the input buffer. Bias voltage is supplied to the input of the buffer, which is adjustable between 0 and +3.3V by the bias adjustment potentiometer. The output of the buffer is DC-coupled to the 6P1 grid. This configuration removes the large coupling capacitor needed to feed the 6P1 grid by providing bias current directly from the buffer.

JP6 and JP7 may be installed to operate both triodes in parallel.

For dual-supply operation, the jumpers are configured as follows:

JP1	Not installed	
JP2	Not installed	
JP3	Not installed	
JP4	Installed	Provides adjustable bias to input buffer
JP5	Installed	Bypasses 6P1 grid coupling capacitor
JP6	Either	Install to parallel triode sections
JP7	Either	Install to parallel triode sections
JP8	Not installed	

Dual-supply zero-bias operation:

Dual-supply zero-bias operation removes all coupling capacitors from the input section of the EVB. The input is DC-coupled to the input buffer, which is DC-coupled to the 6P1 grid. Therefore, any DC voltage present on the input connector is also applied to the 6P1 grid.

Under some conditions the 6P1 can be successfully used with zero bias. Using this configuration, it is also possible to impose a DC bias on the input using an external power supply. Note that the setting of the bias potentiometer has no effect in this configuration.

JP6 and JP7 may be installed to operate both triodes in parallel.

For dual-supply zero-bias operation, the jumpers are configured as follows:

JP1	Not installed	
JP2	Installed	Bypasses input coupling capacitor
JP3	Not installed	
JP4	Not installed	
JP5	Installed	Bypasses 6P1 grid coupling capacitor
JP6	Either	Install to parallel triode sections
JP7	Either	Install to parallel triode sections
JP8	Not installed	

Connection both triode units in parallel:

For all configurations, installing JP6 and JP7 will connect both triode units in parallel. The EVB is shipped with these jumpers installed. To evaluate using only one of the two triode units, remove JP6 and JP7.

Plate load resistance adjustment:

The plate load resistance can be adjusted using the “PLATE LOAD” potentiometer, R12. When shipped, the plate load resistance is set at 330kΩ, which is a good starting point for many applications.

If a specific resistance setting is desired, the potentiometer should be set before applying power. It can also be adjusted during operation, but resistance measurements must be made with power off.

To adjust the plate load resistance, connect an ohmmeter between the “P1” and “V+” test points and adjust the potentiometer. The ideal resistance depends on supply voltage and desired distortion characteristics.

Bias voltage adjustment:

The bias for the 6P1 can be adjusted using the “BIAS” potentiometer, R8. R8 forms a voltage divider between the +3.3V LDO output and ground. The bias is pre-set to 2.5V when shipped.

It is easiest to adjust the bias after the board is powered on (with no audio signal applied), by measuring the voltage between the “G1” and “GND” test points.

Connections

Once jumpers have been configured as described above, power can be connected to the EVB.

Power:

If using a single supply, connect a voltage between +5V and +50V to the "+V" binding post, and ground to the "GND" binding post. JP1 must be installed. A voltage of +12V is suggested as a starting point.

If using a dual supply, apply the positive voltage to the "+V" binding post, negative voltage to the "-V" binding post, and the common ground to the "GND" binding post. ***Ensure that the JP1 jumper is removed!*** The total applied voltage should not exceed 50V – for symmetrical supplies, this would be +/-25V. It is not mandatory that the supplies are symmetrical; for example, you could apply +40V and -10V to the inputs. This might be desirable for some applications. The positive supply should be at least 5V to guarantee that the 3.3V regulator functions correctly.

Alternatively, power can be connected to the test points near the binding posts.

Audio in and out:

The audio signal input is connected to the RCA jack labeled "IN" or to the "IN" test point. The maximum signal level resented to the input depends on the power supply voltage, bias setting, and plate load resistance used.

The audio signal output is connected to the RCA jack labeled "OUT" or the "OUT" test point.

External bias:

When using single-supply or dual-supply modes (but **NOT** dual-supply zero-bias mode), it is possible to bypass the internal bias supply and provide a bias voltage externally. To do this, JP8 is removed, and an external power supply is connected to the "BIAS" test point. Limit the applied voltage to between -10V and +5V.

In zero-bias dual-supply mode, a DC bias can be imposed on the input signal if desired.

Operation

With configuration and connections complete, apply power to the EVB.

There are a number of test points on the EVB that can be used to make measurements, or connect external circuitry or components. The test points are described below:

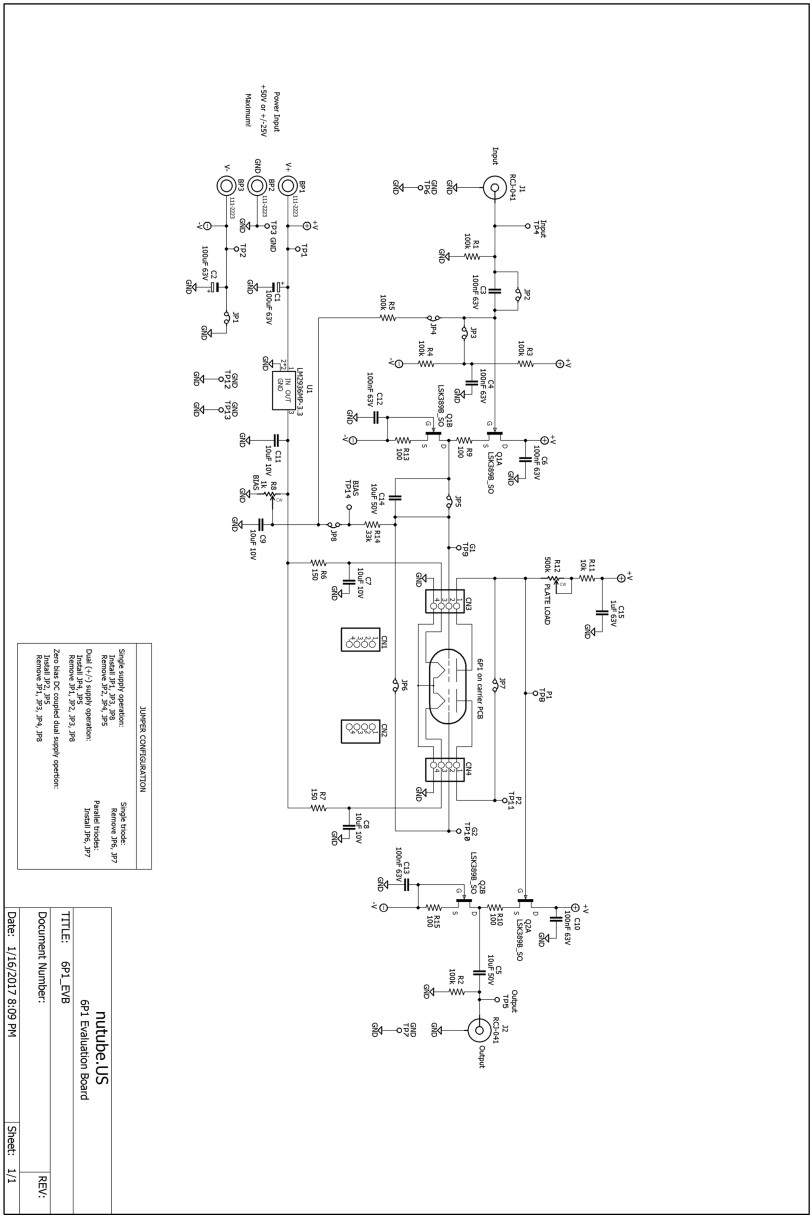
+V	Connected to the positive power supply input
-V	Connected to the negative power supply input
GND	Connected to ground (5 test points)
IN	Connected to the input signal at RCA jack
OUT	Connected to output signal at RCA jack
P1	Connected to 6P1 1st unit plate
G1	Connected to 6P1 1st unit grid
G2	Connected to 6P1 2nd unit grid
P2	Connected to 6P1 2nd unit plate
BIAS	Insertion point for external grid bias (JP5 & JP8 must be removed)

Note that if JP6 and JP7 are removed, the 2nd triode unit of the 6P1 grid and plate are accessible using the “G2” and “P2” test points. This can be used to implement external circuitry.

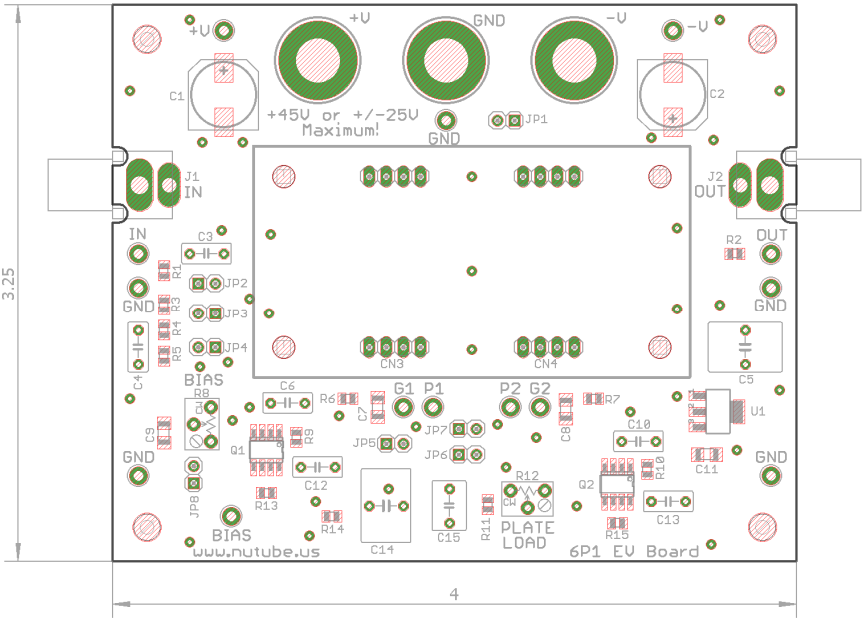
With no audio signal applied, you can measure the DC grid voltage at the “G1” test point, and the plate voltage at the “P1” test point. By making DC measurements, you can adjust the bias using the “BIAS” potentiometer (R8) and/or the plate load using the “PLATE LOAD” potentiometer (R12) to set the desired DC operating point.

With a sine wave test signal applied to the input, you can monitor the output signal using an audio analyzer or PC sound card and audio analysis software. Adjusting bias and plate load while observing an FFT of the output signal is useful to understand the harmonic distortion products that are generated by the 6P1. It can also be used to achieve a target “sound” by tailoring the distortion products to a desired profile.

Schematic Diagram

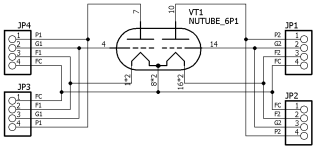


PCB Layout



CAD files (in Eagle CAD) for this EVB design can be downloaded from www.nutube.us.

Carrier PCB



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