**K9HZ 64 dB I2C Digital RF Attenuator**

**BUILD INSTRUCTIONS for PCB V1.0**

**May 8, 2023**

**Operating Data:**

Power Requirements: 12-15 VDC at 10ma.

Frequency Range: 1MHz – 4GHz.

Input: up to 30 dBm max (or 1w) at 50 ohms.

Output: Input (dBm) - ndB , where n=0.5 to 63 in 128 - 0.5 dB steps

I2C Address Range: 20 to 27 hex.

Attenuation Device: Two PE4302 or PE4312.

Uses: RF power control (transmit), RF gain (receive), ALC.

**Theory of Operation**

The attenuator consists of two PE4302 or PE4312 50 Ohm 6 bit, digital RF attenuators in series that are controlled by a MCP23017 16-bit I/O expander with a I2C serial interface. The expander has two 8-bit word (eight line) outputs, one used with each attenuator. Therefore, by using the Adafruit MCP23xxx library, any application can control the attenuator by writing a value of 0-63 to GPIOA (for the #1 attenuator) and 0-63 to GPIOB (for the #2 attenuator). This corresponds to 128 half dB steps from 0 to 63 dB. The MCP23017 has three address lines, so that up to eight different RF attenuators or devices that use the MCP23017 on the same I2C buss.

**Inventory and Prework**

Before you begin, inventory your parts against the latest BOM to make sure you have everything you need to complete the attenuator build. The complete BOM is given in Table 1.

**Building the Attenuator**

With a medium heat soldering iron (30-40W), begin the assembly of the attenuator board in this order:

1. Place the PE4302s (or PE4312s), U2 and U3 in position on the PCB noting the correct orientation. There is a dot on the chip corner to signify the pin one position. There are multiple ways to solder these chips into position depending upon the equipment you have available. Using a hot-plate and gel solder is probably the easiest.
2. Solder the MCP23017 on the PCB. The designator U1 is at the top of the device with the pin 1 dimple in the top left corner.
3. Place the chip resistors on the PCB except for R1-R3.
4. Select the I2C address for the MCP23017 by placing 0 ohm resistors in at the R1-R3 positions. Note that R3 in place is for A0 = 0, R2 for A1 = 0, R1 for A3 = 0.
5. Place the chip capacitors on the PCB. Note that the C3 position is large enough for an electrolytic or tantalum leaded capacitor. However, a chip capacitor can be used too but you may have to extend the capacitor slightly with a lead cut from a ¼ watt resistor.
6. Mount the remaining parts on the PCB. Take care to mark the positive side of J1 on the PCB with a marker.

**Final Steps**

1. Connect the I2C buss from a processor (test or otherwise) to J2. Note that pin 1 is SCK, pin 3 is SDA, and pins 2, 4, and 5 are ground.
2. Connect the RF input to SMA connector J4 and the RF output to J3.
3. Connect 12-15VDC to pins J1. Take special care to ensure the polarity of the power connection is maintained.
4. At this point, the attenuator is active. Use your processor to write values of 0-63 into GPIOA and GPIOB as 0.5 dB attenuation increments

**Tables and Figures**

**Table 1. The Latest BOM for the K9HZ I2C RF Attenuator V1.0**



![A picture containing text, diagram, plan, technical drawing

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**Figure 1. K9HZ I2C Digital RF Attenuator Schematic**

A picture containing circuit, electronic engineering, electronic component, passive circuit component

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**Figure 2. K9HZ I2C Digital RF Attenuator PCB**