K9HZ 64 dB I2C 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

7. 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.
8. Connect the RF input to SMA connector J4 and the RF output to J3.
9. Connect 12-15VDC to pins J1. Take special care to ensure the polarity of the power connection is maintained.
10. 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

Part Number	Description	Quantity	Designator	Mouser
12065D106KAT2A	10uf 50V 1206 SMD Capacitor	1	C1	581-12065D106KAT2A
C1206C104M5UAC	0.1 uf 50V 1206 SMD Capacitor	4	C2, C4, C9, C10	80-C1206C104M5UAC
T490A107M6ATE800	100uf 6V 1206 SMD Capacitor	1	C3	80-T490A107M6ATE800
C1206C474K3R	470nf, 50V SMD Capacitor	2	C5, C6	80-C1206C474K3R
C1206C102K5R7210	1nf, 50V SMD Capacittor	2	C7, C8	80-C1206C102K5R7210
	1x2 IDC Male Header Pins	1	J1	
	2x5 IDC Male Header Pins	1	J2	
	SMA PCB Mount Female	2	J3, J4	
CR1206-J/-000ELF	0 Ohms, 1206 SMD Resistor	3	R1, R2, R3	652-CR1206-J/-000ELF
CR1206FX-1002ELF	10K, 1/4W 1206 SMD Resistor	4	R4, R5, R6, R7	652-CR1206FX-1002ELF
MCP23017-E/SO	MCP23017-E/SO	1	U1	579-MCP23017-E/SO
LM1117MPX-3.3/NOPB	LM1117MPX-3.3	1	U2	926-LM1117MPX-33/ NOPB
81-PE4312C-Z	PE4302 or PE4312	2	U3, U4	81-PE4312C-Z
From K9HZ	PCB	1		

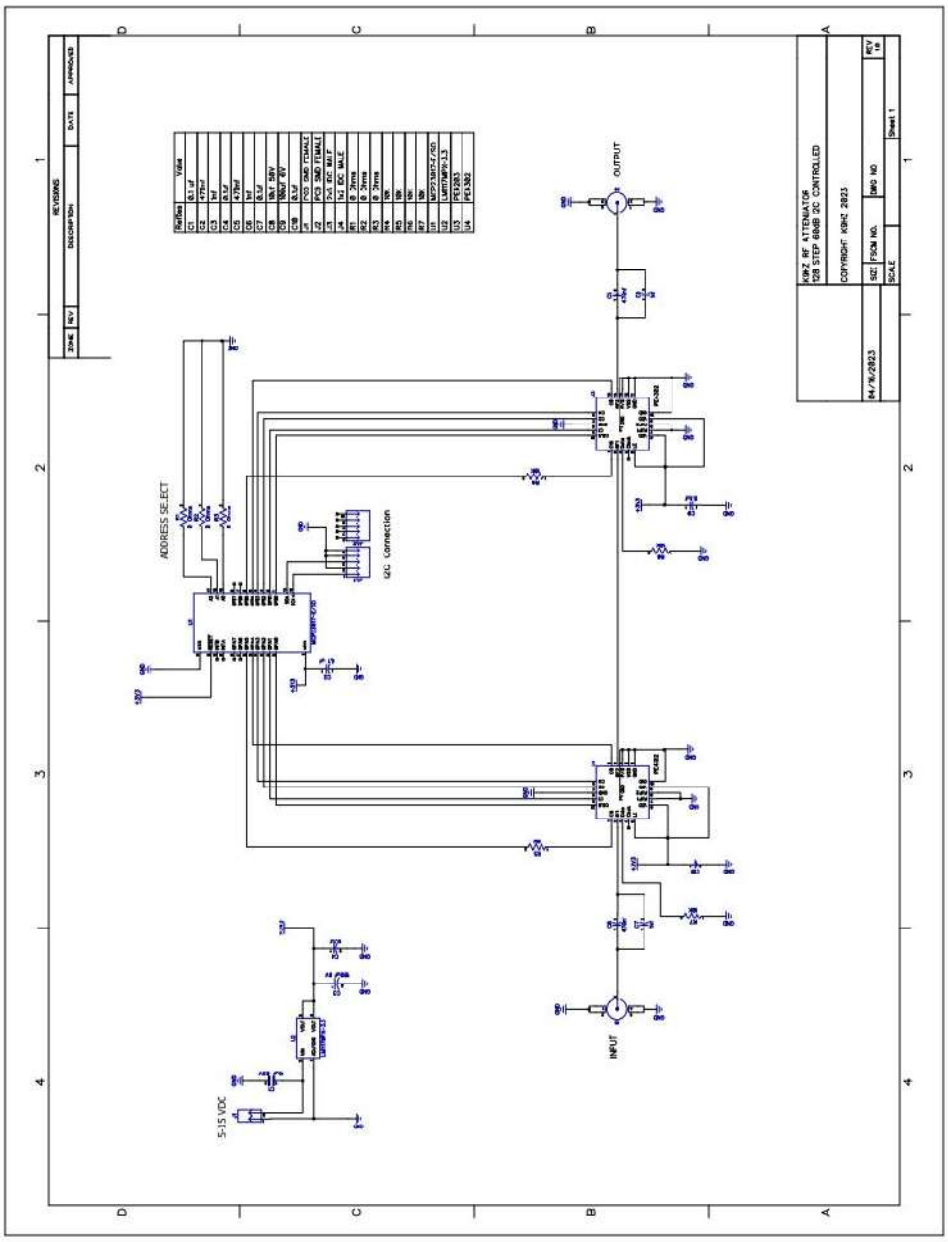

Figure 1. K9HZ I2C Digital RF Attenuator Schematic

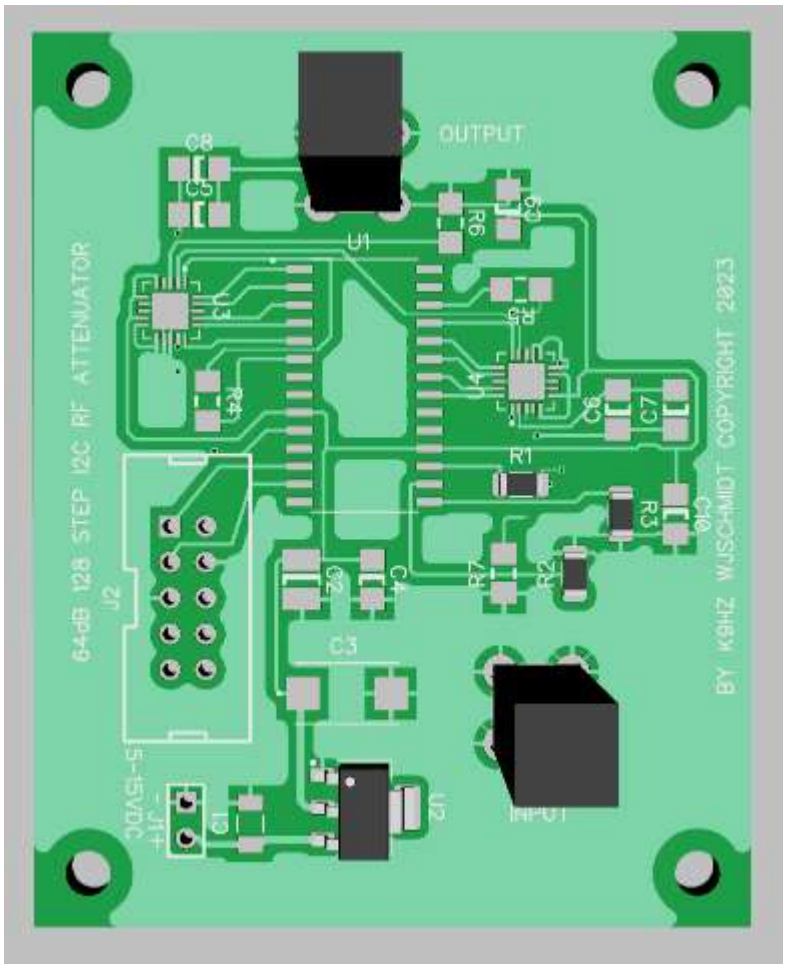

Figure 2. K9HZ I2C Digital RF Attenuator PCB