WR-28 Waveguide Switch Controller

Al Ward W5LUA and Jim McMasters KM5PO

Introduction

My original 47 GHz transverter is now dedicated to EME so I decided to build up a second 47 GHz transverter which will be dedicated to terrestrial work. I was fortunate enough to be able to find a motorized WR-22 waveguide switch for EME. The search for a WR-22 or WR-19 waveguide switch for the second transverter was non-productive. In searching Ebay, I did find a Flann Microwave WR-28 waveguide switch model number 22333-2E. This particular WR-28 waveguide switch does not use any chokes making it possible to provide reasonable performance on 47 GHz. The WR-28 chokes are a source of undesired resonances at 47 GHz [1], [2]. This relay is a servo operated unit which required a special test box to "drive" it. I needed to find a way to motorize the WR-28 switch.

Solution

My original thought was to remove the servo motor and drive the waveguide switch with a small reversible dc motor as I had done in my 76 GHz transverter [3]. The solution seemed bulky for the room I had to install it in. I was chatting with Jim KM5PO and Jim said that he had a servo motor solution driven by an Arduino Nano that should work for my application. Jim built a prototype and I adapted his solution to my waveguide switch.

Figure 1 Prototype built by Jim KM5PO

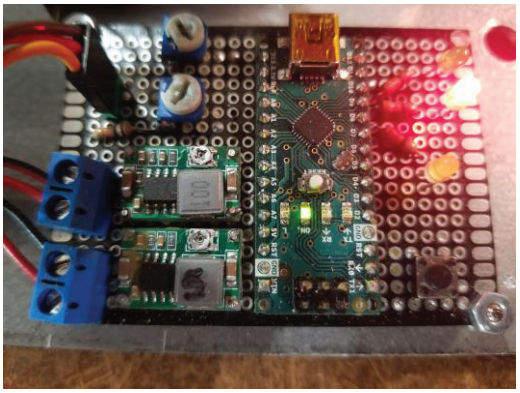


Figure 2 KM5PO Servo controller utilizing an Arduino Nano.

Overview of Arduino operation as explained by Jim KM5PO.

A schematic of the servo driver circuit is shown in the references at the end of the article. An Arduino based driver seemed a good solution. Arduinos have two basic processes implemented through a program or "sketch". First a setup step and then a never-ending loop. During the loop we simply look for a change in the PTT sensor, (pulling SW1 to ground initiates the PTT sensor) and then react to the change by directing the servo into a transmit or receive position and limit the movement to stored limit values. After a command to move the servo, we detach the servo with a software command since we do not need to continuously send position information while the never-ending loop process is running (this also eliminates jitter). The gearing of the servo is adequate to hold a position for the waveguide relay while waiting for a new command. A separate calibration function is implemented so that the transmit and receive endpoints may be set using two pots RV0 and RV1 which preserve the settings when power is turned off to the 47 GHz system. The calibration process is initiated by pushing the "Cal" button once and the amber LED D1 will light. Use RV0 to set the end limit in receive and RV1 to set the end limit in transmit. Once calibration is completed pushing the "Cal" button again will exit the Cal mode. In the original prototype, variable resistors RV0 and RV1 were single turn potentiometers. It is suggested that multi-turn potentiometers be used to set the end points with finer resolution. The servo circuit pulls approximately 40 mA when idle and 250 mA when positioning the servo. The circuit is designed to operate from 12V but will work on any voltage between 9V and 14V.

The Arduino sketch and KiCad schematic are available and listed in the references.

I took Jim's solution and adapted it to my new 47 GHz transverter as shown in Figure 3.

Figure 3. Using Servo to actuate waveguide switch. Switch in receive position.

The mechanical items are typical RC car components. The servo motor is a DS3218mg and a couple of 1.5” servo arms and a small turnbuckle. The ideal solution might have been to directly mount the servo motor to the shaft of the waveguide switch but this arrangement provides more flexibility in packaging and setup. Most waveguide switches have a detent that actually allows the switch to slide into position when it gets close so having a turnbuckle with the two arms actually provides some “looseness” in the mechanical arrangement which helps the switch establish where it wants to be at rest.

I mounted the new servo motor directly to the side of the waveguide switch with a couple of brackets and using original mounting holes. As I did in my original article, I used a microswitch as the last set of contacts to supply voltage to the DB6NT PA [3]. The microswitch location was made slightly variable so it would only close once the servo motor has stopped moving. This switch could also be used as feedback to the IF rig indicating it is OK to supply IF power to the transverter. I chose the option of turning on the PA since there is significant amount of LO coming out of the DB6NT transverter and subsequently being amplified by the PA. Figure 4 shows the waveguide switch in the transmit position.

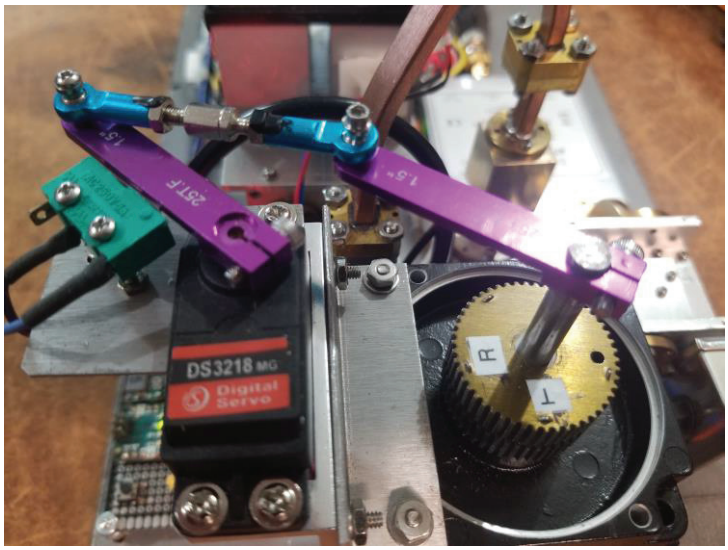


Figure 4. Waveguide switch in transmit position. Note the microswitch is closed by the arm.

It is extremely important to allow the waveguide switch to slide into its correct position for both receive and transmit. You can generally use a flashlight and look into the antenna port of the relay to check alignment. Having some looseness in the mechanics can also allow this to happen. The turnbuckle provides a course alignment. Jim has incorporated potentiometers for fine tuning the actual receive and transmit position.

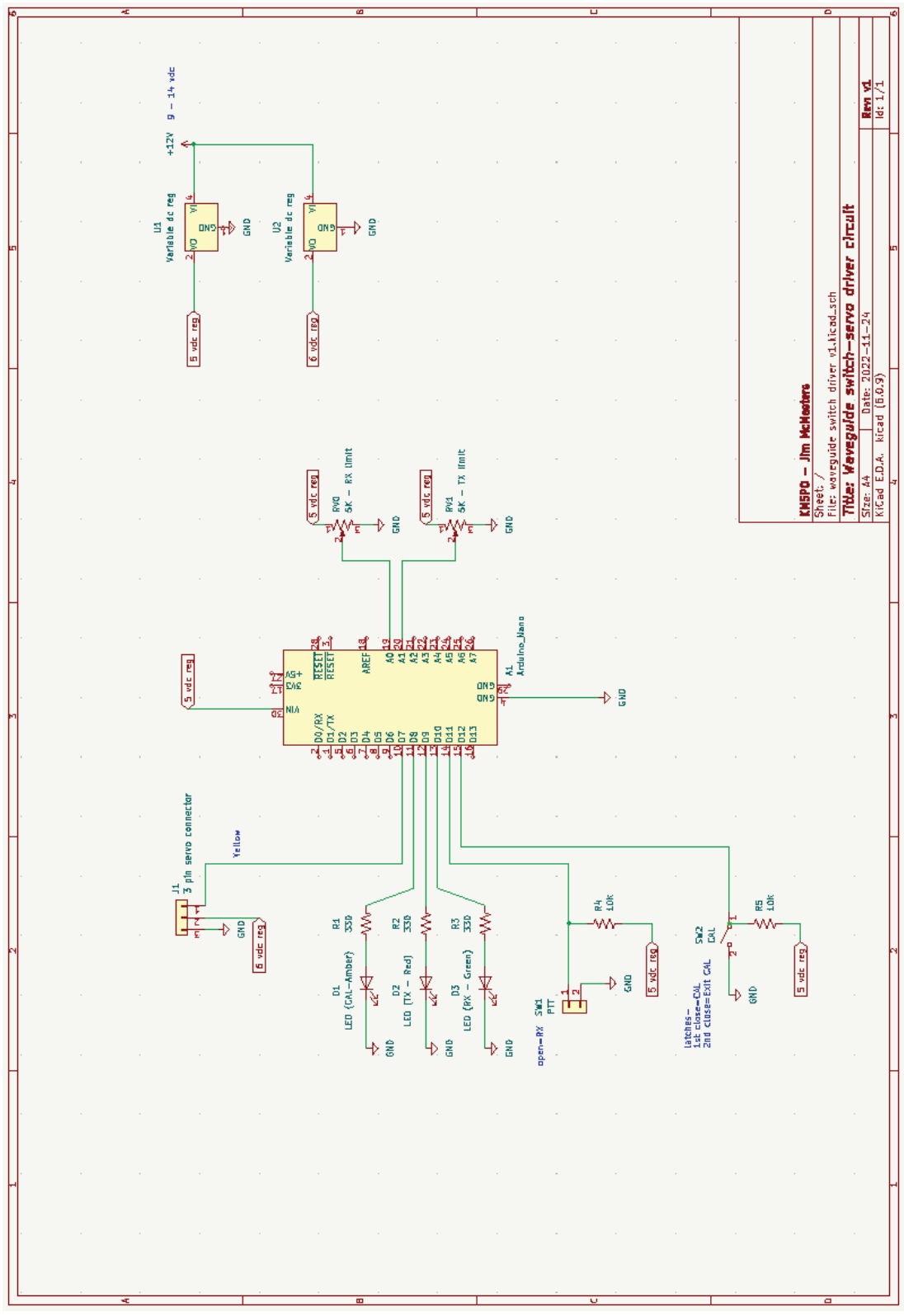
It is hoped that this waveguide switch controller will provide an easy solution to motorizing that manual waveguide switch.

I thank Jim KM5PO for his help with this project.

Al Ward W5LUA & Jim McMasters KM5PO March 2, 2023

References

1. Barry Malowanchuk VE4MA" Use of WR-28 Waveguide on 47 GHz", Proceedings of Microwave Update 2019, ARRL, pp 58-72
2. Al Ward W5LUA, "RelCom WR-28 Waveguide Switch at 47 GHz", Proceedings of Microwave Update 2019, ARRL, pp 318-319
3. Al Ward W5LUA, "Motorizing WR-10 & WR-15 Waveguide Switches", Proceedings of Microwave Update 2019, ARRL, pp 315-317
4. **Arduino code - KiCad files available at www.ntms.org**
5. W5LUA_microwave_switch_v1.2 Arduino sketch (text file for easy reading) Jim McMasters KM5PO - Al Ward W5LUA 4k
6. W5LUA_microwave_switch_v1.2 Arduino sketch (.ino file for Arduino IDE) Jim McMasters KM5PO - Al Ward W5LUA 4k
7. Waveguide_switch_servo_driver_circuit_W5LUA schematic image (jpeg image) Jim McMasters KM5PO 92k
8. KiCad schematic project file for Waveguide_switch_servo_driver_circuit_W5LUA (project file for KiCad IDE) Jim McMasters KM5PO 9k
9. KiCad schematic detail file for Waveguide_switch_servo_driver_circuit_W5LUA (detail file for KiCad IDE) Jim McMasters KM5PO 64k
10. Waveguide switch-servo driver circuit on next page


KM5PO – Jim McHeekins
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Title: Waveguide switch-servo driver circuit
Size: A4
Date: 2022-11-24
KiCad E.D.A. kicad (6.0.9)
Rev v1
Id: 1/1
U1
Variable dc reg
+12V
9 – 14 vdc
GND
5 vdc reg
U2
Variable dc reg
6 vdc reg
RV0
5K – RX limit
RV1
5K – TX limit
A1
Arduino_Nano
J1
3 pin servo connector
Yellow
R1
330
D1
LED (CAL-Amber)
R2
330
D2
LED (TX – Red)
R3
330
D3
LED (RX – Green)
R4
10K
SW1
PTT
open=RX
SW2
CAL
R5
10K
Latches–
1st close=CAL
2nd close=Exit CAL