KT4QW 6M Repeater

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RF Management

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RF Management Objectives It is beyond the scope of this paper to explain the detail assembly instructions of the duplexer system. Rather, the electrical and mechanical details of the system are described. For overall system reference, refer to Figure 2. which appears earlier in this paper. It is important to note that the transmitter is dumping approximately 100 watts (70,700,000 micro-volts) onto the common coaxial transmission line. At the same time the received signal in the 1 micro-volt range, 1 MHZ lower than the transmit frequency, is traveling from the antenna to the receiver. This creates a very demanding job for the duplexer. The objectives of the duplexer are:

a. Routing the transmitter r.f. energy (53.250 MHZ) to the common antenna with minimum loss while greatly attenuating the noise and harmonics generated by the transmitter. It is unavoidable that a transmitter generates "white" or "shot" noise. While this noise is usually at a much lower level than the carrier, it is spread over a wide frequency range and when allowed to reach the receiver, can easily be at a higher level than the desired received signal and thereby causing desensing of the receiver. Obviously, it must be drastically reduced at all frequencies... especially within the bandpass of the receiver. This is the reason more filtering in required on the transmit side than on the receive side. This why the bandpass filter is used on the transmit side.

b. Routing the received r.f. energy (52.250 MHZ) from the antenna to the receiver with a minimum loss, while greatly attenuating the transmitter r.f. A band-pass filter could be used to good benefit on the receive side but it inserts more attenuation than the "notch" type filter. Attenuation on the transmit side can be off-set by using more power, but on the receive side receiver sensitivity is lost and can not be regained.

Transmit 2nd Harmonic Reject Filter (F0)- This filter consists of a shorted quarter wave RG-8 coaxial stub at the transmit frequency. This has negligible effect at the transmit frequency but it forms a half wave shorted stub at the transmit second harmonic. This causes a very low shunt impedance across the transmission line at the second harmonic. This filter element reduces the second harmonic ___db at antenna and at the input of the repeater's receiver. This filter is constructed of RG-8 coaxial cable shorted on one end and a PL-259 installed on the other. The length of this stub is determined as follows. L= 2950.68/MHZ X VF L is length in inches, VF is the velocity factor of the coaxial cable expressed in decimal form (.66 in this case). This formula yields an answer of 36.57 inches for the 53.250 MHZ frequency being used. This coaxial stub presents a very high Z at the transmitter frequency but a very low shunt Z at the second and higher even-order harmonics.

Transmit Band Reject (Notch) Filters (F1, F2, F3, & F5) (To be included later)

Transmit Band Pass Filter (F4) (To be included later)

Receiver Band Reject (Notch) Filter (F6, F7, F8 & F9) **(To be included later)**



RF Interconnections The interconnecting jumper cable between elements of the duplexer filter system is made of quarter wave lengths of coaxial cable. The length should be calculated based on whether it is on the transmit or receive side. Keep in mind that you are dealing with the receive frequency on the transmit side and visa versa. This creates a condition whereby the attenuated notch of each filter is additive . This filter is constructed of RG-8X coaxial cable with a PL-259 connector installed on each end. The length of this jumper is determined as follows. L= 2950.68/MHZ X VF L is length in inches, VF is the velocity factor of the coaxial cable expressed in decimal form (.75 in this case). This formula yields an answer of 41.56 inches for 53.250 MHZ and 41.56 inches for 52.250 MHz. Measurements are made from the tip of the connector to the tip of the connector on the other end. RG-8X coax is used because it is very flexible and is therefore easy to form a compact coil for neat packaging.

Power/SWR Metering Metering The metering of transmit r.f. is accomplished by a Model 43, RF Directional Thruline Wattmeter by BIRD Electronic Corporation. The Model 43 THRULINE Wattmeter is an insertion type RF wattmeter, designed to measure power flow and load match in 50 ohm coaxial transmission lines. It is intended for use on CW, AM, FM and TV modulation envelopes, but not pulsed modes. The Model 43, when used in 50 ohm applications, has an insertion VSWR of less than 1.05 to 1 up to a frequency of 1000MHz. The meter is direct reading in watts, expanded down scale for easy reading and is graduated 25, 50 and 100 watts full scale. The power ranges used are determined by the Plug-In Elements, which fall in ten frequency band groups covering from 2-2300MHz plus additional special elements in various power and frequency ranges. The plug in element used for the KT4QW 6M Repeater is the 100A which has frequency range of 25 to 60 MHz and a full scale of 100 watts. By reversing the position of the plug-in element, both incident and reflected power can be observed. The manufacturer specification of accuracy is +-5% of full scale. Measurements may be made without interruption of the RF line. Antenna/transmission line SWR is important in terms of performance...especially duplexer performance.

Transmission Line The transmission line is a 100 ft. Length of RG-8 coaxial cable equipped with PL-259 connectors on each end. It is planned to replace this coax with a lower loss double shielded cable, to reduce transmission loss and to improve isolation between the receiver and transmitter.

Antenna System The antenna used on the KT4QW repeater system is an end fed half wave vertical, carefully tuned for a very low swr. The site is 35 feet above sea level and the antenna's topmost point is 80 feet above ground level. At this limited antenna height, the coverage area is somewhat limited. It was dicovered that swr levels that are acceptable to normal operation, cause serious interaction with the duplexer filter system. The swr on this antenna as measured with the in-line Byrd Wattmeter varies very slightly around 1.1: 1 depending upon the temperature and air moisture conditions. This antenna is of the "Hanging Vertical" variety which is more thoroughly explained in Appendix B of this paper.

Grounding System The system is grounded with an 8ft. copper clad steel ground rod installed approximately 6 in. outside the wall penetration for the antenna feed. The coax outer braid is grounded directly to the main ground rod at the point of entrance to the building. All elements of the system are grounded directly to a #6 copper wire connected directly to the ground rod. All connections are secured mechanically. Solder connections and bi-metallic connection are avoided. Heavy braid is used to interconnect the ground to the various duplexer elements. The battery charger is grounded through the power line.