6.3C DESIGN CONSIDERATIONS FOR HIGH-POWER VHF RADAR TRANSCEIVERS: PHASE MATCHING LONG COAXIAL CABLES USING A "CABLE RADAR"

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The Poker Flat 49.92-MHz MST radar uses 64 phase-controlled transmitters in individual shelters distributed throughout the antenna array. Phase control is accomplished by sampling the transmitted pulse at the directional coupler of each transmitter and sending the sample pulse back to a phase-control unit (described in paper 6.3B) located in the main building at the edge of the antenna array. This method requires phase matching 64 long (256 meter) coaxial cables (RG-213) to within several electrical degrees.

Preliminary measurements with a vector voltmeter showed that cables of this length changed electrical length by several tens of degrees due to mechanical flexing when being unspooled from cable reels. This result indicated that the cables would have to be installed in the cable troughs throughout the array before final cutting for phase match. Another set of preliminary measurements on two long RG-213 cables installed in cable troughs at Poker Flat showed that electrical length changed by about 60° for a temperature change of 20°C, but that the relative phase change between the two cables was essentially zero. Since only the relative phase is important in this system, a reference test cable was installed in the same cable trough system with the 64 phase sampling cables so that temperature effects would be same for all cables.

Tests with a time domain reflectometer showed that attenuation of high frequency components in the long RG-213 cable rounded the leading edge of the reflected pulse so that the cables could only be measured to within 50 cm (about 45° at 49.92 MHz). Another measurement technique using a vector voltmeter to compare forward and reflected phase required a directional coupler with unattainable directivity. Several other techniques were also found lacking, primarily because of loss in the long RG-213 cables. At this point we realized that what we needed was a simple version of the phase-coherent clear-air radar, i.e., a "cable radar". The only requirement was that the transmitted pulse be relatively short (∿ 1 μsec) since the round-trip transit time in the cable was less than 3 μsec.

A block diagram of the cable radar is shown in Figure 1. The pulse generator puts out 0.6 sec pulses with an interpulse period of 4 μsec. The phase paths through the manual-select coaxial SPDT switch are matched for both the reference and unknown cable ports. There are two ports available for the unknown cable; one is a specially made coaxial fitting that makes good electrical contact with the square-cut end of RG-213 cable, the other is a type "N" jack. The special fitting allows rapid cable length adjustment by incremental cutting to achieve the desired phase.

In operation the reference cable is selected and the adjustable line is set for a null on the oscilloscope. A coaxial fitting of known electrical length is then inserted in the adjustable line path and the oscilloscope gain is set so that 1° phase change gives a 1-cm deflection on the oscilloscope. The fitting of known length is then removed and the unknown cable is selected and cut until the phase matches the reference. All unknown 256 meter cables were precut to within about 50 cm using the time domain reflectometer and the cable radar was used to trim each unknown cable to a 1° or better phase match with the reference cable. Type "N" plug connectors were then installed on each cable and a final check of all 64 cables was carried out. Spot checks over a several year period at widely different outside temperatures show that the phases have remained the same to within a few degrees.

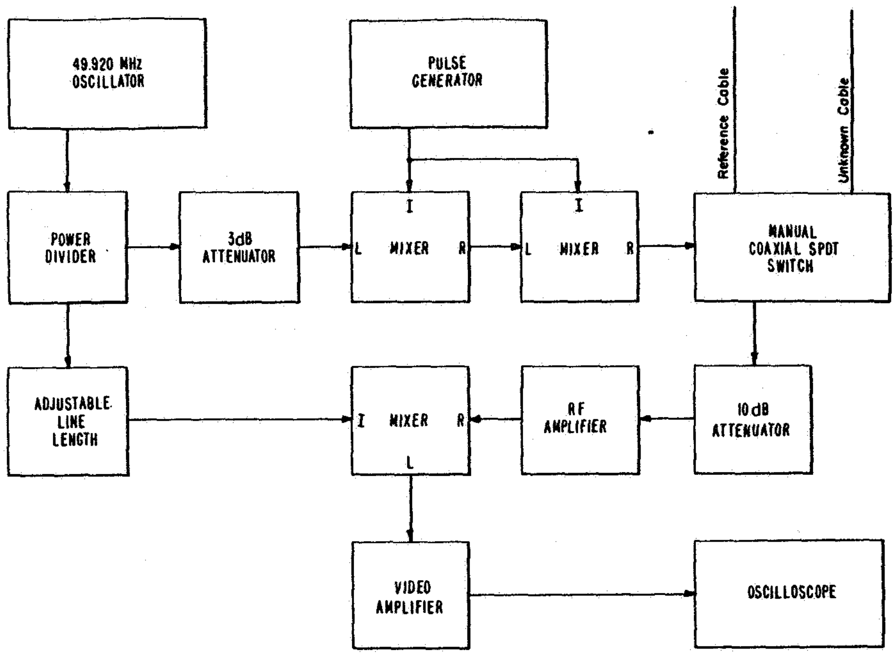

Figure 1.