NATIONAL RADIO ASTRONOMY OBSERVATORY
SOCORRO, NEW MEXICO
VERY LARGE ARRAY PROJECT

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Use of the Waveguide Test Set to Monitor Waveguide Installation Quality

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This report discusses optimum ways to use the NRAO Waveguide Test Set to monitor the quality of installation work on the buried TE_{01} communications waveguide at the VLA site. Ideally, it would be desireable to accurately monitor, from a central point near the control building, the additional attenuation from newly installed sections of waveguide (with lengths in the order of 100 meters) that have been attached to existing trunk lines that are already kilometers in length. This is difficult with the test setup that is currently employed owing to the weakness of the signal echo returned from the far end of the waveguide with respect to the reference echo returned from the nearby shutter.

The reader is referred to the manual furnished with the Test Set for a description of the equipment and for definitions of terminology used in this report.

Since the accuracy of measurements made with the test set on long waveguides is limited by the small ratio of the signal to the reference echo rather than by limited transmitter power, two courses of action are available: 1) modification of the shutter or its location in order to weaken the reference echo to about equal the signal echo, or 2) modification of the test set electronics to better accomodate the weak signal echo.

For the purpose of monitoring waveguide installation quality as set out above, the course of action that will require the least development work and yield the best results is one that falls in the first class. It is to equip the shutter with fittings

of the length that will allow it to be put in place of a coupler in any manhole, and then to install it in the farthest out finished manhole on the waveguide run being installed. Such a setup will give a measurement of the transmission characteristics of the next increment of waveguide being installed that is at least as good as the laboratory measurements of sample lengths of waveguide that were made with that equipment. Newly installed increments of waveguide that are "out of spec." by a few hundredths of a decibel can be easily discovered by this technique. The setup is shown in the figure.

If the equipment is set up in the manner described above, a calibration procedure that insures that the shutter is properly adjusted when the measurement is made will be required. This procedure must determine that the hole in the shutter blade is perfectly aligned with the waveguide bore when the shutter is in the "open" position. The apparent waveguide attenuation as measured with the test set is at a minimum when the above condition obtains; thus, the easiset way to align the shutter is to adjust it while watching the waveguide attenuation. This can be done if a remote indicator of the attenuation as displayed on the test set is provided at the shutter location. An expanded scale meter circuit as shown in the figure will suffice to do the adjustment.

If it is necessary to operate the shutter from a small generator set, a check should be made to see that the voltage regulation

of the generator is adequate. The primary power consumption of the shutter is high only when the shutter is switching; this transient load may affect the generator governor. If so, the effect will be obvious by listening to the machine. A "waster" load on the generator would reduce the proportion of the transient load and improve the regulation, if necessary.

If the test set must be used to directly measure long waveguides, the following modifications in the set and the measurement setup may help to obtain more accurate results:

1) Place the shutter as far from the set as practicable. This change will allow the use of longer pulses, which will increase the echo energy and thus improve the signal-to-noise ratio.

2) When the waveguide attenuation is large (e.g. 10 dB) a quantization step on the digital panel meter becomes signifigant with respect to the value displayed, thus limiting the measurement accuracy. This problem can be countered by making the signal integration period an integer number of times as long as the reference integration period. Ideally, such a change will increase the displayed ratio by a factor equal to the increase in the signal integration period. Tests will be required to see if the integrator linearity is sufficient for this to be true to the required accuracy. The echo detector power law will also have to be measured over the desired operating range.

The change can be accomplished by removing the wire running from pin 9 on the digital board blue ribbon connector to pin 7 from pin 7, connecting it instead to pin 14 for a factor of two increase in the signal integration period. It may be connected to pins 9, 2, or 12 of the 8281 chip at position X (see figures 7 and 15 of the manual) for increases of a factor four, eight, or sixteen, respectively. The wire from pin 9 of the connector should be wired to a SPDT switch so that either the original or the longer integration period can be selected. Calibration would be done with the switch set at "1", measurement with it at "n".

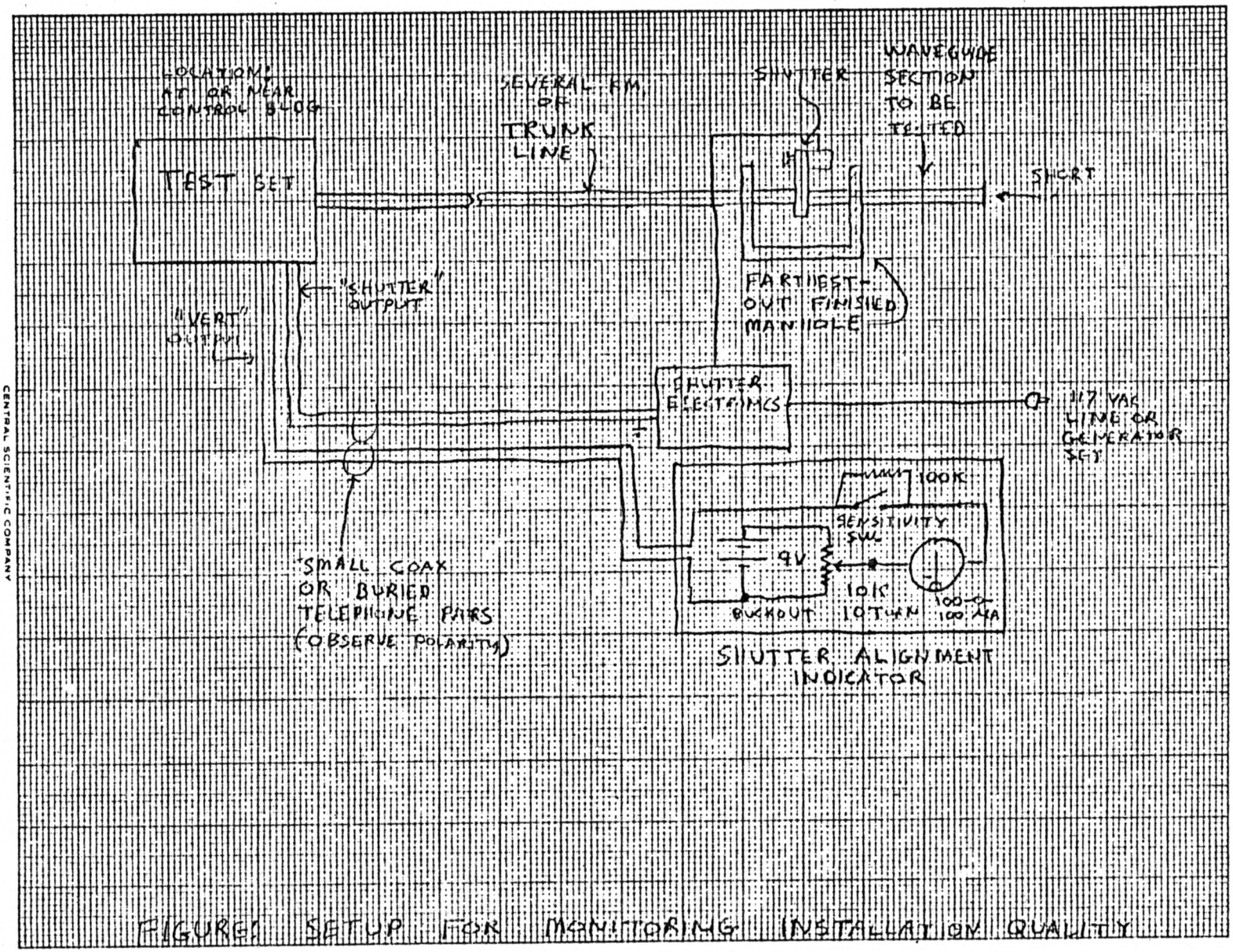

FIGURE 1 SETUP FOR MONITORING INSTALLATION QUALITY

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