# Reference Distribution Amplifier for the Block IV Subcarrier Demodulator Assembly

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*A Reference Distribution Amplifier designed for the Block IV Subcarrier Demodulator Assembly is described in this article. From one 10-MHz input, the unit generates three 10-MHz reference outputs. The references are variable in phase, and their level is fixed at 0 dBm. The control of phase and monitoring of output levels facilitate computer operation.*

## I. Design Approach

The Reference Distribution Amplifier (Ref DA) is an RF module in the Block IV Subcarrier Demodulator Assembly (SDA) used to furnish test and calibration signals, coherent 10-MHz reference signals whose phase is controlled remotely, interplex phase control, and monitor and confirmation circuits. A block diagram of the Ref DA is presented in Fig. 1, and its functional characteristics are presented in Table 1. The 10-MHz input (J1) is first passed through a quadrature hybrid, and either the 0 deg port or the 90 deg port is selected (allowing the SDA to be configured in either the "normal" or the "interplex" mode). The reference is then applied to a 0- to 180-deg phase shifter (made up of a switchable 0- or 90-deg section and a variable 0- to 90-deg section), so that the SDA can be phased to one of two receivers. The test signal (J2) output power is critical, since it is used as a standard to set the SDA RF gain and is therefore automatic-gain-controlled. The output of the automatic-gain-control amplifier is the input to a three-way power splitter. A second quadrature hybrid is used to allow the test output (J2) phase to be controlled for use in the internal calibration of the SDA.

The variable phase shifters are voltage-controlled by an analog signal generated in the SDA Control Unit. No attempt was made to linearize the phase vs control voltage since the SDA internal calibration automatically sets the phase correctly and does not require linearity. This approach allows a simpler, more stable design. Outputs J3 and J4 furnish the coherent reference signal to the SDA

and have their phase adjusted during the internal calibration procedure of the SDA.

Each output is monitored by rectifying the RF level and comparing this signal to a standard dc reference. All three confirmation output signals are logically ANDed together. The input reference signals are treated similarly, and the input/output confirmation signals are exclusively ORed so that the monitor signal is true when the input and output are the same (i.e., no input/no output or input/output) and false when the input and output are not the same (i.e., a module failure). A monitor signal is also generated to determine if the SDA has proper reference input signals.

## II. Test Results

A prototype Ref DA has been built, and documentation is nearing completion. The phase shifters and automatic-gain-control amplifier are on one printed wiring board, and the control buffers and monitor logic are on another.

Test data taken on the prototype module indicate that output level stability over 0 to 50°C is within $\pm 0.25$ dB for all outputs. Phase stability over the temperature range is within $\pm 1.5$ deg for the J2 output and within $\pm 2.5$ deg for the J3 and J4 outputs. Phase shift vs control is approximately exponential and has a maximum slope of $<20$ deg/V (typically 16 deg/V). Maximum harmonic distortion is typically 3% over the phase shift range.

**Table 1. Functional characteristics of Ref DA**

| Characteristic | Parameter |
|---|---|
| Phase stability (0–50°C) | ±3 deg |
| Phase shift capability | J2: ≧180 deg<br>J3 and J4: ≧90 deg with respect to J2 |
| Output power | J2: 0 ± 0.5 dBm<br>J3 and J4: 0 ± 2.0 dBm |
| Harmonic distortion | < 5% |
| Spurious levels | > 60 dB below 10-MHz output level |
| Monitor | |
| Reference: | Confirms, for both 5- and 10-MHz reference inputs (J5 and J1), ≧0 dBm |
| Module: | Confirms, for levels at J3 and J4, ≧−5 dBm |
| Input impedances | Voltage standing-wave ratio < 1.1 |
| Operating temperature | 0–50°C |

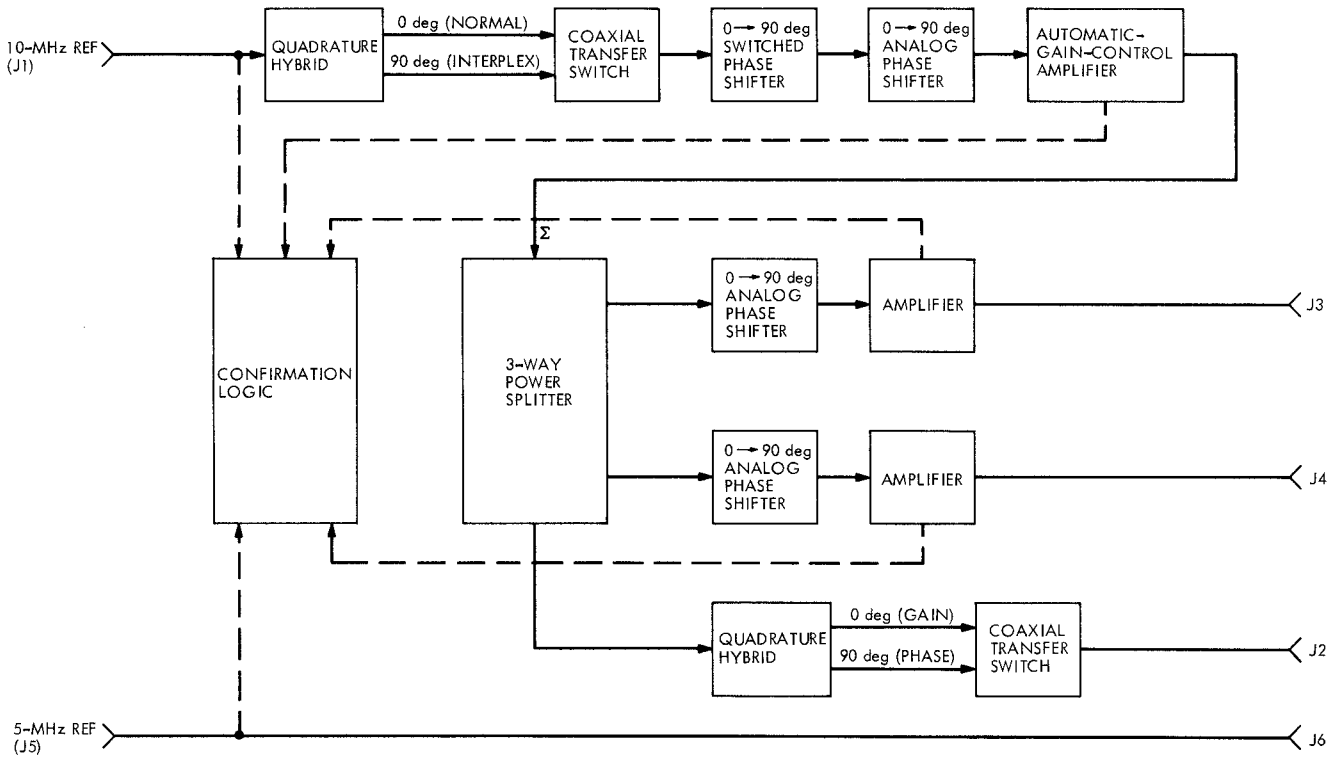


**Fig. 1. Block diagram of Ref DA**