POLARIZATION DIVERSITY CAPABILITY
THROUGH SAMPLING AT THE RF LEVEL

Harvey Endler, William Turner
Electra Magnetic Processes, Inc.
9616 Owensmouth Ave.
Chatsworth, CA 91311

ABSTRACT

Novel RF circuitry for selecting the stronger of two telemetry signals (RHCP or LHCP) is presented. Polarization diversity capability with uninterrupted data flow can be achieved without using two expensive single channel data receivers and a diversity combiner. In certain dedicated systems only a single AM/FM receiver is required. This paper describes the RF signal processing and logic circuitry of a developed system and describes how it is applied in a lightweight polarization diversity single channel monopulse tracking system.

INTRODUCTION

Missile wrap around antennas are designed to have non-overlapping nulls in their right hand circular and left hand circular polarized patterns. Certain types of ground clutter favor multipath phenomena of RHCP signals. Consequently, dual polarization diversity receiving systems are frequently required for telemetry application. In polarization diversity telemetry receiving systems, it is necessary to select a stronger of two signals. Usually this is accomplished using two data receivers with a diversity combiner. However, in parasitic* and portable telemetry trackers the additional volume, cost, weight, and attendant reliability of all this equipment cannot be tolerated.

A system composed of a single FM data receiver together with an ancillary lightweight AM receiver or a single dedicated FM/AM receiver will meet the above criteria.

This paper describes circuitry which allows received RHCP and LHCP signals to be sampled and compared and when the LHCP signal amplitude exceeds the RHCP signal by

* A compact polarization diversity telemetry receiving system developed by NSWSES to mount on the pedestal of a missile directing antenna. In this application the director is always pointed towards the instrumented missile.
a preset amount, then and only then will the data channel be switched from RHCP to LHCP. Otherwise, data flow is uninterrupted via the RHCP channel.

In certain applications the scheme allows the use of only a single AM/FM receiver. These applications include systems where the flow of data can be interrupted for short intervals (dedicated sampling frame), or in TV video systems where RF sampling can be accomplished during the vertical flyback interval.

**RF CIRCUITRY**

A block diagram of the RF portion of a typical single channel monopulse polarization diversity system is given as Figure 1. RF circuitry which is peculiar to this diversity selection is shown within the dashed lines. All eight blocks within the diversity system have been realized on a single stripline board, including the PIN drivers. This stripline board is 4.5 x 4.5 x 1/8 inch, exclusive of SMA connectors and PIN driver IC’s. Drivers are mounted on the stripline board to improve switching speed by reduction of cable capacitance and current limiting resistors. Both the RHCP and LHCP channels are equally divided, half of each being used for uninterrupted data, and the other half for polarization amplitude comparison.

The RF portion is designed to operate from 1435 to 2300 MHz. Specifications for this assembly are 1.3:1 VSWR at all ports under all switching conditions, less than 1.0 dB insertion loss above power split, 20 dB isolation between LHCP and RHCP, and 10 ns switching speed. Both RF switches, the data switch, and the tracking switch, are fail-safe in the RHCP position, should the driver or logic circuitry fail.

A schematic of the RF circuit pattern is given as Figure 2. The basic circuit element is a 3 dB quadrature hybrid coupler, composed of two tandem 8.34 dB crossover couplers, printed on both sides of a 0.011 inch teflon-glass stripline board. With no PIN diodes conducting, then one-half of the RHCP input emerges at the data receiver, and the other half at the tracking receiver, and LHCP is terminated in internal loads. When the PIN diodes in the tracking switch are conducting, then one-half of the LHCP input emerges at the tracking receiver, whereas the RHCP input is transmitted to the internal load. Similarly, when the diodes in the data channel switch are conducting, then the LHCP input emerges at the data receiver. The four PIN diodes are hermetic HP 5082-3140’s.

The PIN diode drivers Z1 and Z2 are National DH 0035 IC’s which provide the current and voltage peaking necessary for 10 ns switching. These drivers are mounted on the stripline ground plane and are connected to the PIN diodes through a network consisting of an RF feedthrough and a 2-section quarter wavelength choke. Each PIN switch driver is controlled by complementary signal commands generated by the timing and logic circuitry.
TIMING AND LOGIC

Timing signals are accepted from the logic circuitry. Typically, signal sampling occurs at one kilohertz rate. The LHCP signal is sampled, stored, then amplitude compared with the sampled RHCP signal. If two or more comparisons indicate that the LHCP signal is 3 dB greater than the RHCP signal, the LHCP signal is then applied to the data receiver.

SINGLE CHANNEL TRACKER APPLICATION

When employed in a dual diversity single axis telemetry tracking system, signal sampling occurs at twice the antenna lobing rate. Thus, an amplitude comparison of the RHCP and LHCP signals is made each time the tracking antenna is scanned to the right and to the left of the tracking axis. The AM output from the sampling receiver is also applied to the tracking loop’s angle error demodulator.

Note that when a difference in power level exists between the LHCP and RHCP channels, the AM output of the sampling receiver is amplitude modulated. Consequently, when the received level of one polarization channel is more than 10 dB below the remaining channel, the AM output is 100 percent modulated and the tracking loop gain is reduced by 50 percent causing the rotator’s response to slow. This undesirable but tolerable feature affects tracking only during a crossing missile exercise. However, for such tracker-to-missile aspect angles, the received signal is predominantly linearly polarized and the output levels of the RHCP and LHCP channels are within 1 dB of each other. Thus, the tracking loop gain and servo response are maximized in situations where full response is required.

CONCLUSIONS

Simple circuitry has been presented for selecting the stronger of two orthogonally polarized RF telemetry channels. Polarization diversity can be obtained with the use of an inexpensive, lightweight track-only receiver, instead of two complex telemetry receivers. In some cases, operation with only one receiver is possible. This subsystem has been installed on an EMP 12-element portable array tracker and is in field test. A second generation stripline assembly is in test, and incorporates one stage of low noise GaAs FET preamplification in front of the RF power splitter. This will allow use of simplified polarization selection in low noise systems without the need for separate low noise preamplifiers.
FIGURE 1
BLOCK DIAGRAM OF RF FRONT END
FIGURE 2
SCHEMATIC
RF DIVIDER/SWITCH