

## **MICROWAVE AND INTERCONNECTIONS OVERVIEW**

The High Level Transmitter Microwave (HPM) and Interconnection circuits comprise that portion of the radar which routes and controls RF energy from the output of the Final Power Amplifier (FPA) to the selected antenna face. The RF energy is from the FPA klystrons operating in parallel. The parallel RF signals are combined and applied to successive stages of waveguide switching. The switching circuits are operated in response to signals originating at the Digital Control Group which is external to the Transmitter Group. The selected RF path routes the summed RF energy to the transmitter feed horn which is directed (space fed) at the antenna face. The high energy levels handled by the HPM circuits require support equipment to provide coolant and a high dielectric gas (SF6) for waveguide pressurization.

### **FUNCTIONAL DESCRIPTION**

#### **Microwave and Interconnections**

The Microwave and Interconnections (High Power Microwave-HPM) equipment contains all the microwave components and associated monitoring, control, and cooling components found between the klystrons and RF circulator and the first high power face switch. Most of these components are contained in Klystron Microwave Device Assembly. The output RF path from the klystrons is through flexible waveguide sections to Waveguide Shutters. The shutters are manually closed to conserve the SF6 pressurizing gas during replacement of klystrons or other microwave components. The shutters are locked in position by Kirk Key locks. Beyond the shutter, each line contains two directional couplers with associated filters and attenuators for monitoring the output of the klystron. The next component in each waveguide run is an RF Circulator-Isolator. The RF passes from the input to the output port. One other port is terminated in a medium power dummy load. The fourth port is connected through waveguide containing a directional coupler to a high power dummy load. The directional coupler, with its filter and attenuator, is used for arc monitoring. Beyond the circulator-isolator, waveguide sections complete the path to the Klystron Microwave Devices Assembly.

#### **High Power Face Switch**

High Power Face Switch No. 1 (HPFS 1) receives the waveguide output of the Klystron Microwave Devices Assembly. HPFS 1 is a differential phase shift RF circulator with two output ports. Switching to either output port is accomplished by reversing the polarity of the magnetic fields to parallel, ferrite-loaded, ceramic waveguide sections (Waveguide Switch Assemblies). The RF input is applied to a RF Power Combiner, which acts as a power splitter. The two outputs are from this power splitter are then sent through two more power splitters. Thus, the RF input is split into four equal parts, which are then applied to the four Waveguide Switch Assemblies. After switching in the Waveguide Switch Assemblies, the RF is recombined into a single output. The output

of HPFS 1 may be switched to HPFS 2 or EPFS 3 depending upon which of four antenna faces are selected for radiation. The purpose of splitting the RF input into four equal parts before switching is to reduce the power applied to each switch and, therefore, the size of the switches required. A water cooled ceramic waveguide is used to maximize power handling capabilities.

### **Driver Power Supplies**

The Driver-Power Supplies furnish a polarized current to the coils of the magnets surrounding the ferrite-loaded waveguide of the RF Circulator.

### **Waveguide Shutter Assemblies**

The Waveguide Shutter Assemblies each receive two waveguide outputs from HPFS 1, HPFS 2, and HPFS 3 respectively. The two outputs of shutter assembly from HPFS 2 go to Antenna Faces 1 and 2 while the two outputs from HPFS 3 go to Antenna Faces 3 and 4. In each waveguide run beyond the shutter assembly for HPFS 2 and HPFS 3, there are three directional couplers for RF and arc monitoring.

### **Power Distribution Units**

The Power Distribution Units control power distribution to the Driver-Power Supplies and to indicate the operational status of the equipment. Fault indicators show waveguide arc and hydraulic failure locations for the RF Circulators, and Driver-Power Supply summary fault locations.

### **High Power Microwave Control-Monitor**

The High Power Microwave Control-Monitor receives fault, status, control, and interlock signals from areas within and without Microwave and Interconnections (High Power Microwave) equipment areas, displays fault and status indicating, and sends information and control to HLT Control and Monitoring.

### **Digital Data Processor**

The Digital Data Processor monitors the high power microwave for waveguide arcing and generates waveguide switching commands for the HPFS.

## **PHYSICAL DESCRIPTION**

### **Klystron Circulator-Isolator**

The circulator-isolator is wall-mounted, weighs approximately 600 pounds, and is 1'6" x 1'6" x 9'0" high. It is a four port device, water cooled. Two ports connect to the input and output waveguide, the third port connects to a medium power (water cooled) load and the fourth port connects to a high power dummy load.

### **Klystron Microwave Devices Assembly**

This unit is an open steel frame, weighing 7000 pounds, 15'8" wide x 3'6" deep x 10'0"

high, housing 5 waveguide switches, 5 switch drivers, a low power RF Power Combiner, three high power RF Power Combiners and a high power Waveguide Shutter at the output. One medium and two high power dummy loads are connected to the ports of two of the high power RF Power Combiners.

The Microwave Devices Assembly also has four directional couplers, filters, and attenuators for RF and arc monitoring. All components including the associated waveguide in this assembly are water cooled.

### **RF Circulators:**

There are three RF Circulators (commonly referred to as High Power Face Switch (HPFS) used, each contained in an open steel frame weighing 6000 pounds apiece and approximately 9'0" x 5'9" x 6'8" high. The open steel frame supports two waveguide switches on its top shelf and two waveguide switches on its lower shelf. These waveguide switches are ferrite devices generally referred to as HPFS modules. The center of the frame, contains the hydraulic input and output plumbing. The ends of the frame support the input and output waveguide power splitters. The frame support also holds electrical terminals for distribution of wiring harness to the arc detection and interlock circuits. Water cooled dummy loads or shorting plates are attached to unused ports of hybrids and waveguide switches as terminations.

### **Waveguide Shutter Assemblies:**

There are three waveguide shutter assemblies. One each is contained in each of the three RF Circulators referenced above. Each waveguide shutter assembly supports two waveguide shutters. Also, each assembly contains a directional coupler, RF filters, and an arc detector on each input waveguide for arc monitoring.

### **Driver Power Supplies:**

There are 24 Driver Power Supplies associated with the three HPFS's. They are housed in 12 standard double-bay transmitter racks. Each power supply is made up of six subassemblies mounted to a pair of full height pull-out drawers. Large components, such as the power supply variac and the output inductor, are located at the cabinet bottom. Cabinet cooling is supplied by a water heat exchanger, with components such as resistors and rectifiers mounted directly to the water manifold.

### **Power Distribution Units:**

There are three power distribution units, each of which is associated with one HPFS and 8 Driver Power Supplies. Each power distribution is identical and consists of a two-bay cabinet. One bay houses a Control Monitor Panel, two Power Supplies, and an Amplifier Detector. The second bay houses a Power Distribution Panel, and three Power Supplies.

**High Power Microwave Control-Monitor:**

This unit is a standard two bay cabinet. No cooling is required.

**Digital Data Processor**

This unit is a single-bay cabinet which contains the printed circuit boards comprising the arc logic, command logic, relay logic, fault logic, and a digital data display circuit. There are no operating control panels in this cabinet.

**Transmit Feedhorn Window**

The output of the HPFS'S are connected to the respective feed horn window by long runs of high power waveguide. The feedhorn windows (total of 4) are physically located on the Comparator Assemblies in the Anechoic Chambers. This window is cooled with SF6 gas.