VSWR:

The reflective property of each port of a ferrite circulator or isolator is usually specified in terms of VSWR For critical applications a Smith Chart, with an impedance plot recorded at a specified reference plane, can be provided. A typical specification for VSWR is 1.25. However, a value of 1.10 can be provided for narrow band applications.

INSERTION LOSS:

This parameter is used to specify the forward loss characteristics of a circulator or isolator. Most catalog models have an insertion loss specification of 0.4dB to 0.5dB. Many low noise systems require an isolator with as low an insertion loss as possible. For these applications the insertion loss can be minimized by using low loss ferrite and dielectric materials. Losses as low as 0.1dB have been provided in large production quantities.

ISOLATION:

This parameter is used to specify the reverse loss characteristics of an isolator. The parameters isolation, VSWR, and insertion loss are required to specify an isolator whereas a circulator is completely defined by only the VSWR of the three ports and insertion loss. Although a circulator can be made into an isolator by terminating one port, it does not have an intrinsic isolation value. The isolation measured would be dependent on the VSWR of both the termination and the circulator port. Most isolators are specified at 20dB but value of 26dB can be obtained for narrow band applications.

Example: A circulator has a measured VSWR of 1.22 for all three ports. If a perfect test termination with a VSWR equal to 1.00 were available to place on Port 3, the resulting isolation from Port 2 to Port 1 would be 20dB. If a test termination with a VSWR equal to 1.05 were placed on Port 3, the resulting isolation from Port 2 to Port 1 would vary between 18.2 and 22.5dB depending on the phasing between the two VSWR's. The resulting isolation value is a function of the VSWR of the test termination and how it may phase with the VSWR of the circulator port.

TEMPERATURE RANGE:

The operating temperature range of a circulator or isolator is limited by the ferrite materials available. In general the lower the operating frequency the greater the temperature sensitivity an isolator will have. Temperature compensation can be used at some operating frequencies. Catalog units make use of temperature compensation where possible. Operating temperatures from -20°C to +85°C are common although some models are limited to 0 to 50°C. The storage temperature is generally the military range of -20°C to +85°C. Although temperatures of -40°C to +85°C; can also be provided.

INSERTION PHASE:

Many applications require circulators and isolators to be supplied as phase matched sets. Although the catalog circulator and isolators are not phase matched, this feature can be provided on a specified basis.

The tolerance in phase matching will depend on the particular circulator and isolator model and size of the lot to be matched. Phase matched pairs can usually be provided to within ±5 degrees.

MAGNETIC SHIELDING:

Catalog circulator and isolators all have sufficient magnetic shielding for general handling and mounting. These units can usually be mounted to within ½ inch of one another or from other magnetic materials without degrading electrical performance. For more stringent applications (mounting in direct contact with a magnetic plate) additional shielding may be required and necessitate a larger package size.

RFI SHIELDING: Standard circulators and isolators have an RFI leakage measured at proximity of 30 to 40dB. Special packaging and sealing methods can improve the RFI shielding. Leakage values in excess of 60dB can be provided but require additional shielding to be incorporated during the initial design.

TERMINATION RATING:

The termination rating on isolators must be sufficient to safely dissipate the reverse power that is expected to occur under normal or anticipated fault conditions. The reverse power will be determined by the power applied to the input port of the isolator and the mismatch on the output port. This reverse power will be dissipated by the internal termination.

All units, except the drop-in and surface mount isolators have terminations rates at 100 watts peak and 2 watts average power. If frequency, bandwidth and size permit, higher peak and average power values can be specified. Average power ratings of less than 50 watts for the lower frequency standard isolators usually do not require cooling other than mounting to a heat sink. Higher power levels may require the termination be mounted directly to a heat sink or the use of other forms of cooling. Allowances must be made for some degradation in isolation for the higher power rated terminations.

POWER RATING:

The input power to a circulator or isolator can be supplied from a CW or a pulsed source. In the case of a pulsed source both the peak and average power components of the pulse train should be specified in order to determine an adequate safety margin for a particular circulator or isolator.

The peak power can be at a high enough level to cause breakdown or arcing. This generally results in permanent degradation of electrical performance. A proper connector selection and an optimized internal geometry are required to maximize the peak power capability of a particular circulator or isolator. Contingent on the peak power level and other parameters, circulators or isolators can be provided that will operate to altitudes in excess of 100,000 feet.

The peak power level can also cause an increase in the insertion loss in a below resonance design, due to non-linearity effects of the ferrite material. This increase can occur at peak power levels considerably lower than that required for breakdown or arcing. The increased insertion loss will cause more power to

be dissipated in the ferrite region of the device which will result in overheating. Higher peak power levels can be obtained by using a special ferrite material.

Non-Linearity effects of the insertion loss do not occur in the above resonance circulators or isolators. All standard circulators and isolators that are above resonance will have the letter “A” as part of the assigned model number. Most circulators and isolators below 2 GHz center frequency are also above resonance.

The average power rating of a circulator or isolator is determined by the insertion loss, the internal geometry of the ferrite region, and the type of cooling available. The insertion loss of a circulator or isolator will cause some of the average power to be absorbed and dissipated in the ferrite region as heat. Adequate cooling is necessary to ensure the ferrite material does not reach an excessive temperature. Mounting to a heat sink for cooling is sufficient in many cases if the average power is moderate.

In high power applications, a component with a high VSWR connected to the output port of an isolator will reflect a substantial amount of power. The temperature of the ferrite region as well as the internal voltage will increase causing the performance to deteriorate or arcing to occur before full rated input power can be realized.

Circulators and isolators that must meet stringent peak and average power levels require design considerations of many parameters. The normal and worst case load VSWR conditions and the available cooling must be specified when ordering high power isolators or circulators.

CONNECTORS:

The connectors used on the standard SMA Coaxial Isolators and Circulators and N Type Coaxial Isolators and Circulators are female. Other connectors can be provided based on operating frequency and package size. However, certain types may cause electrical degradation. Most versions of SMA, Type N connectors can be supplied for special applications.