A HIGH SPEED MICROWAVE MEASUREMENT RECEIVER

William L. Tuttle

ABSTRACT

In order to justify the expenditure for capital equipment such as a microwave receiver, it must be shown that the instrument provides the best value to the user. The best value for a microwave receiver for measuring today's complex microwave antennas dictates that the receiver be versatile enough to adapt and operate over a diverse set of applications and performance specifications. Some important characteristics to consider when evaluating a microwave receiver's value is measurement speed, frequency agility, number of measurement channels, remotability, dynamic range, ease of operation, and system integration.

This paper addresses the development and important characteristics of a high speed microwave receiver that was designed to provide users with maximum productivity, and therefore, the best value for a microwave antenna measurement receiver. Receiver characteristics such as acquisition speed, frequency agility, number of measurement channels, controls, interfacing, and versatility are discussed.

Keywords: Receiver, Productivity, Speed, Agility, Multiplexer, Remotability

1. INTRODUCTION

Scientific-Atlanta has developed the new Model 1795 Microwave Receiver to meet the stringent test requirements of today's antenna measurement industry. There have been several key improvements in the design of the Model 1795 over previous Scientific-Atlanta Receivers. These improvements focus on improving antenna range productivity. The receiver's measurement speed has been increased by a factor of 50. It has also been designed to take advantage of Scientific-Atlanta's FAST-TRAK tuning interface which provides phase locked tuning while making multifrequency measurements. Provisions have also been made for remotely controlling the transmit source and receive channels over long distances. The 1795 can easily be operated manually from the front panel or be integrated into an automatic system for operation over the bus. The large color CRT and menu driven operation has made the receiver easy to use and provides all the necessary measurement status and information for operation and data monitoring.

2. MEASUREMENT SPEED

The basic measurement cycle time for the Model 1795 is 200 microseconds which equates to 5,000 measurements per second. This speed can be realized for single frequency - single channel measurements with one sample. Since additional channels or samples require multiplexing of the basic measurement cycle, the speed of the total measurement changes proportionally. For example, for a four channel, single frequency measurement with 2 samples per channel, the total measurement cycle time for the four channels of averaged data is 1.6 milliseconds or eight times the basic measurement cycle.

3. FREQUENCY AGILITY

When multifrequency measurements are required, the 1795 Microwave Receiver operates with the Model 2180 Signal Source in the FAST-TRAK tuning mode to provide phase locked frequency slewing of the signal source/receiver combination. For this type of measurement, additional time is required for the measurement cycle due to the frequency transition or slew time and the associated instrument settling times. The Model 1795 has a specified maximum slew rate of 40 GHz per second.

The 2180 Signal Source has programmable slew rates up to the specified limit of 100 GHz per second. This allows the 1795 to track the 2180 and remain phase locked for rates as high as 40 GHz per second. FAST-TRAK tuning with the 1795/2180 Receiver/Signal Source combination eliminates the system timing inefficiency resulting from having to reacquire the signal and allow for the subsequent data settling to occur.

The Model 1796 High Speed Local Oscillator was designed to operate with the Model 1795 Receiver to provide multifrequency measurements within the frequency transition time of the source. Multifrequency measurement rates of 4,750 measurements per second, with each measurement at a different frequency, can be realized with this configuration.

4. NUMBER OF MEASUREMENT CHANNELS

The Model 1795 Microwave Receiver has two different multiplexers for applications that require more than one measurement channel. There is a two and four channel version. Depending on which multiplexer is in use, they can provide the capability to switch two, three, or four channels. Switching occurs during the basic measurement cycle period. The maximum multiplexed number of channels is four. As an example, a two channel multiplexer could be used at the transmit end of a range and two channels from a four channel multiplexer could be switched at the receive end providing four channels of data at one record increment.

5. REMOTABILITY

Most antenna measurement ranges require some way of remoting the instrumentation from the control console or operator's station. The 1795 Local Oscillator can be remotely located up to 2,000 feet from the receiver's I.F. Processor and Control Unit. This insures that the receiver will have the best possible sensitivity for the measurement.

The receive channel multiplexers interface to the Remote Local Oscillator, and therefore, can be placed as close to the receiving antenna ports as possible. The multiplexer unit can be remoted from the Remote Local Oscillator another 100 feet.

The transmit multiplexer interfaces to the 1795 Control Unit and can be remotely located up to 2,000 feet from the receiver. This configuration could be used to switch the source polarization or transmit channels.

The capability to remote the multiplexers and the local oscillator allow the receiver to be easily reconfigured for reverse range operations. The Model 1795 controls the switch timing of the multiplexers for the selected channel configuration. The multiplexers operate within a 20 microsecond period during the 200 microsecond measurement cycle. This time includes the time required for control signal propagation delays and data settling.

6. FRONT PANEL DISPLAY AND OPERATION

The Model 1795 has been designed to operate with a minimal amount of operator interaction. The receiver's operating functions have been divided into four major menu selections. The menu selections are Measurement, Control, Display, and Configuration. All of these functions can be selected from the front panel or over the bus. When selecting one of the four main menus, the corresponding menu field is displayed on the color CRT. The softkeys adjacent to the menu field allow the operator to select the desired parameter associated with the selected function. For specific numerical entries, a keypad and manual adjust knob can be used.

The Measurement Mode allows the operator to store and recall any front panel associated with any of the four menu categories. It is also used to normalize the display bins to a specific value for the desired data representation. A display bin contains the data of any measured channel. The 1795 has five bins that can be configured to display the selected data. The measurement mode is used to direct the data from any of the measurement bins to either one or both of the recorder outputs.

The Control Mode allows manual tuning of the receiver as well as LO lock on/off control. The receiver search width can also be selected in this mode. Selection of the number of measurement samples, and receiver calibration are other functions supported in this mode.

The Display Mode allows the measurement bins to be setup for the desired data format and presentation. Operations such as product or ratio operations are selected as well as normalization can be selected in this mode.

The configuration mode provides the selection for data output format, frequency display control, mixer parameters, and other diagnostic and special functions.

7. OPERATION AND CONFIGURATION

The large color CRT and menu driven format make the Model 1795 easy to use. It is designed to either operate manually from the front panel or automatically over the IEEE-488 Bus.

Figure 1. illustrates a possible configuration for interfacing and interconnection. The IEEE-488 and RS232C interfaces are used for instrument control and data transfer with compatible controllers and data storage devices. The receiver has two digital interfaces for real time simultaneous recording of receiver data in a single scan such as amplitude and phase. The receiver Control Unit also has a dedicated digital interface for high speed data transfer. This interface was specifically designed for automatic system applications that can take advantage of the receiver's high measurement rate. Receiver data can be transferred to controllers with parallel ports via this control unit interface independently of the IEEE-488 interface. This provides system operations concurrent with the receiver data transfer operations.

Another feature that the 1795 has for automatic system applications is the Measurement Control Buffer (MCB). The buffer is used to store specific receiver measurement parameters. The purpose of the buffer is to allow rapid recall of the parameters for high speed multiple measurement modes. The data is entered over the bus and is stored in the MCB. Upon each receiver trigger, a pointer indexes to next buffered entry. Parameters include: mixer currents, bin normalization results, common normalization results, tuning frequency, search width, recorder output enable, and display on/off. The buffer has the capacity for 512 entries.

8. SUMMARY

There are many characteristics to consider when evaluating a receiver for antenna measurements. The important characteristics discussed in this paper have a direct impact on a measurement range's productivity. These same characteristics have had a direct influence on the design of the Model 1795 Microwave Receiver. The Model 1795's measurement speed, number of measurement channels, frequency agility, remotability, and ease of integration and operation, have been optimized to provide the most efficient and productive microwave receiver available today.

FIGURE 1. MODEL 1795 MICROWAVE RECEIVER APPLICATION EXAMPLE