# NEW ANTENNA PATTERN RECORDER WHICH REDUCES TEST TIME AND PROVIDES ADVANCED DATA MANAGEMENT CAPABILITIES

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## ABSTRACT

As antennas have become more sophisticated, the testing requirements have grown tremendously. Testing often adds significantly to the cost of the system. A need has developed for test equipment more advanced than the completely manual systems of the past and less expensive than the completely automated systems of today. An antenna pattern recorder which helps to minimize test time is presented. The instrument utilizes a user friendly touch screen which facilitates user interaction with the unit. The pattern recorder is capable of measuring up to five channels of data simultaneously as a function of angle, linear position, or time. The data is stored on electronic media and may be saved, retrieved, zoomed, plotted, analyzed by internal programs or exported for analysis by external programs. The user may customize the plot format for test reports, proposal information, and other data requirements.

**Keywords:** antenna measurements, measurement instruments

## 1. INTRODUCTION

Phased array antennas and other complex antennas often require hundreds of antenna pattern measurements to completely characterize their performance. Attributes measured include beam pointing angle, beamwidth, sidelobe level, sidelobe envelope, axial ratio, null depth, and gain. Making these measurements using a "paper and pen" pattern recorder is very labor intensive. While several completely automatic measurement systems are available, these are too expensive for many users. A need was identified for a new, economical instrument which would allow the user to make measurements more efficiently and cost-effectively while storing all of the data on electronic media. The Scientific-Atlanta Model 1590 Pattern Recorder was developed to meet this need.

## 2. DATA INTERFACES

The Model 1590 Pattern Recorder accepts 1, 2, or 3 position data inputs in either BCD (binary coded decimal) or synchro format. The user may select which position data input to use for plots with a few simple touches of the screen and no movement of cables. Thus the measurement of a radiation pattern versus elevation angle followed by a radiation pattern versus azimuth angle is a simple sequence. Amplitude or phase may also be measured as a function of time using the instrument's internal clock.

The pattern recorder accepts up to 5 receiver data inputs in either BCD, analog, HSPI (high speed parallel input) or IEEE-488 format. It will collect and display one input channel of amplitude and phase data simultaneously or up to 5 channels of amplitude or phase data.

The Model 1590 supports a real time data collection rate in excess of 200 triggers per second. Triggering may be configured to be either free running, time based, or based on an external trigger. In all cases both position and amplitude or phase inputs are triggered simultaneously. This is an important feature not available on all antenna measurement systems, many of which take data asynchronously. This feature ensures the highest quality of measurement with proper correlation of position and amplitude data.

## 3. USER INTERFACE

The user interacts with the pattern recorder through a user-friendly touch screen. A touch screen interface was chosen because it reduces training time and operator error. The interface is menu-driven and graphically oriented, with push buttons, entry fields, radio buttons, and list boxes replacing complex keyboard commands. Read and response rates are extremely fast because users keep their eyes focused on the screen.

The data is displayed in real time on a 19-inch 256-color display. The instrument includes rack mount hardware for mounting in a standard 19" EIA rack. The unit requires only 21" of vertical rack space making it easy to integrate with existing test equipment.

## 4. TIME SAVING FEATURES

The pattern recorder offers a number of time saving features. These include the following:

Automatic labeling and customization of plots. Axes are automatically labeled and patterns are automatically reformatted using the information provided on a PAGE SETUP screen as shown in Figure 1. The user may specify rectangular or polar plots, amplitude scale, position scale, axes labels, and more. No paper change is required to change scales or otherwise change the plot format. The user may enter information which is applicable to all plots such as date, job number, and antenna description via the REMARKS screen one time and have the information included automatically on each plot. The engineer then need only enter the information unique to each measurement, such as frequency, as the measurements are made.

Neat, readable plots. All plots are made on either a laser printer or plotter on standard plain paper of user selected size. Testing costs are reduced by the elimination of special paper requirements. Further time and money are saved by the elimination of the labor required to reduce the large plots to standard 8

1/2 x 11" size so they will fit in the data notebook. Since labels and notes are printed by a laser printer, patterns are completely and neatly annotated. Figure 2 shows a sample plot.

Data analysis. The operator may use the built in marker functions to read beamwidth, sidelobe levels, boresight position, null depth, and axial ratio. A special gain function calculates antenna gain using the antenna substitution technique. The user may enter correction factors for amplitude taper, cable losses, etc. to ensure accurate gain measurements. Plots may be made on a relative dB scale or calibrated as a function of absolute gain in dBi.

Pattern Comparison. On a manual recorder system, if the operator wants to compare several measurements (for example at different frequencies) he must take each measurement on the same piece of chart paper. If a mistake is made on one measurement, the process must be restarted from the beginning. This type of measurement is greatly simplified using the 1590 Pattern Recorder. Once a measurement is made it can be stored in local memory and is frozen until the operator chooses to overwrite it. Since up to 10 patterns may be stored at any given time in local memory (and an infinite number in user defined files) and turned on and off individually, any combination of patterns can easily be overlaid and plotted.

Zoom patterns. Any data plot can be zoomed to a larger or smaller scale. The zoom can be defined either by a "rubber band box" picking points on the screen or by preset zoom limits. Figure 3 shows the ZOOM SETUP screen used to preset zoom limits. If testing requirements call for a $\pm 180°$ pattern to be taken on an 80 dB scale and a $\pm 10°$ pattern to be taken on a 40 dB scale, the first measurement can be made and plotted, and then the data can be zoomed and plotted for the second measurement with no additional testing required.

## 5. DATA MANAGEMENT

Data may be preserved in one of 3 ways:

1. Printing and plotting.
2. Saving in the 1590 format.
3. Exporting as a comma separated variable (CSV) file.

Printing and plotting. This function allows the user to make a hard copy of the graphics display on the screen. The instrument supports several different printers and plotters. Should no hard copy device be available, the user may choose the print to file option which will generate a file containing all of the necessary plot commands to produce the graphics output at a later time.

Saving in the 1590 format. This function saves all data in local memory to a user specified file. The information saved includes trace data, offsets, page setup, card configuration, and remarks. The data is easily recalled from the file using the LOAD option.

Export data for analysis. In the past if the engineer wanted to perform an analysis (such as calculating gain by pattern integration technique) the plotted pattern had to be digitized and the points entered into the analysis program. The Model 1590 allows the user to create a comma separated variable (CSV) file of position and amplitude (or phase) values for use in external programs.

Data which is saved or exported may be stored in the instrument's long term memory or transferred to standard 3 1/2 inch diskettes for portability and archival purposes. The instrument has 40 MBytes of internal memory available for storage and can store approximately 1,000 typical patterns ($\pm 180°$, $0.1°$ resolution). After data is transferred to diskettes, it may be erased from the instrument's memory to increase memory available for use in future measurements.

Use of file structures similar to those of 80X86-based personal computers simplifies data management functions and makes the instrument's operation easier to learn. The user may create directories to organize files and choose directory names to describe the data contained within them. For example a user may create a directory named "JOB123" in which to store the data measured on a particular antenna. As with computers, directories may be nested and may be removed when they are no longer needed.

File storage is simplified by the use of sequence numbers, similar to the serial numbers pre-printed on antenna pattern paper used in the Scientific-Atlant Model 1580. The user specifies a file prefix of up to five alpha-numerics. This prefix plus a three digit sequence number is then used as the suggested file name for all file operations. Extensions identify the type of file. For example COMET001.DAT is the 1590 data file, COMET001.CSV is the comma separated variable file, and COMET001.PLT is the plot file for antenna identified as COMET, pattern sequence number 001. The sequence number is incremented after save, plot, or both, depending on the user-defined setup. The sequence number is included on the hard copy output so that a plot may connected with the corresponding data files. The user always has the option of overwriting the suggested file name with a file name of his or her own choosing.

## 6. CONCLUSION

The Scientific-Atlanta 1590 Pattern Recorder allows a user to perform many tasks associated with antenna pattern measurement more quickly and more accurately resulting in reduced test time (and thus reduced system cost) and better characterization of the antenna's performance.

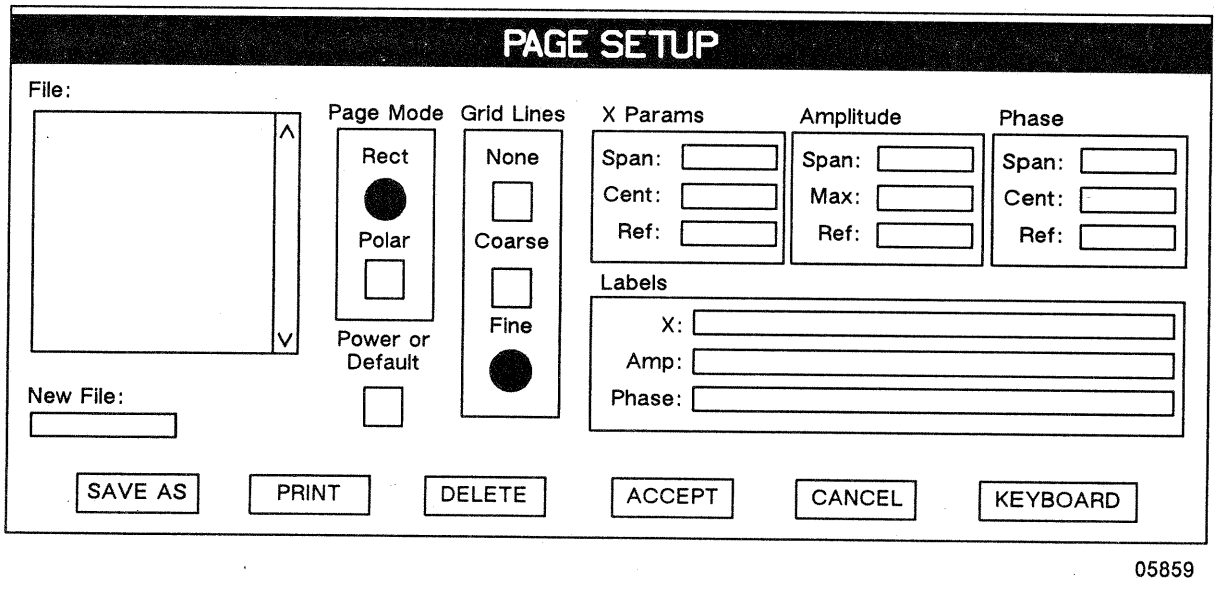


Figure 1. Page Set-Up Screen

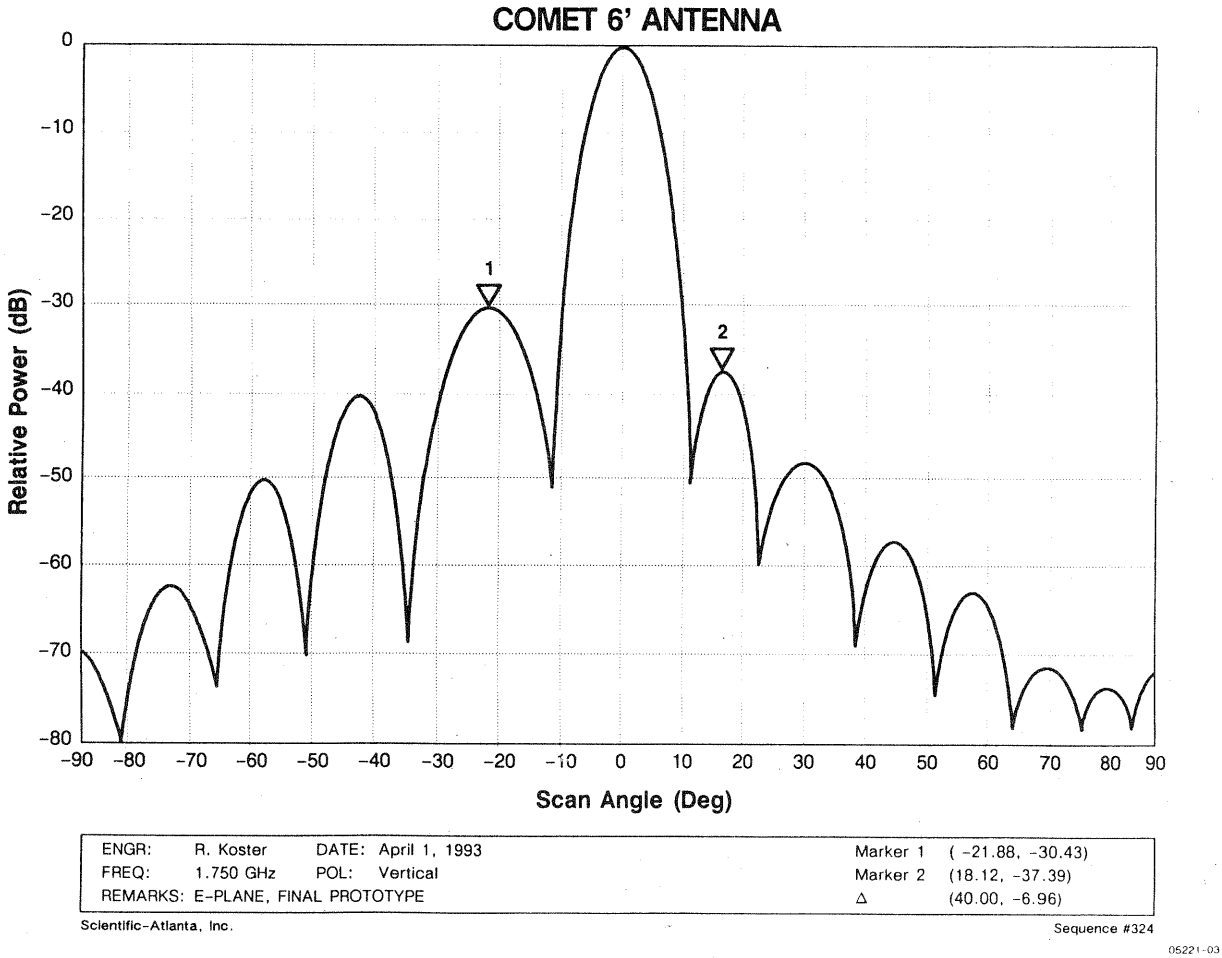


Figure 2. Sample Plot

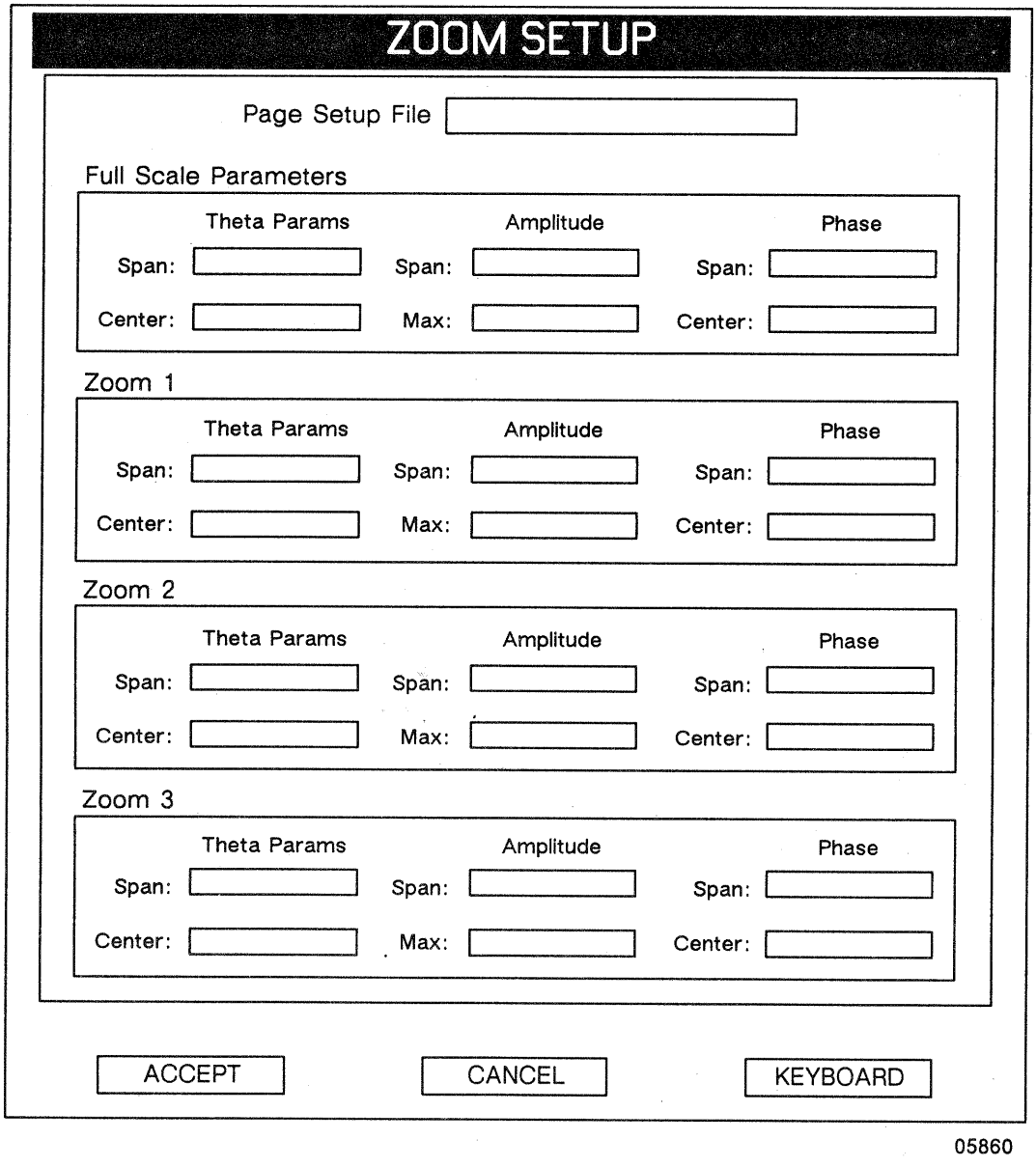


Figure 3. Zoom Setup Screen