

# APPLICATION NOTE



## INDEX

- 1 MEASURING FREQUENCY MODULATED SIGNALS  
Discussion of a system for measuring fm on rf carriers from 10 mc to 12.4 kmc unaffected by incidental am and small carrier frequency drift. Carrier shift and deviation measurements may also be made. 7 pages.
- 2 MEASURING FREQUENCY FROM VHF UP TO AND ABOVE 18 GC WITH TRANSFER OSCILLATOR/COUNTER TECHNIQUES  
  
Illustrates how frequencies up to 18 gc (kmc) may be measured with a harmonic generator and a Dymec 5796 Transfer Oscillator. Also, a discussion of system components and measurement resolution above 18 gc (kmc). 5 pages.
- 3 MEASUREMENT OF RF PULSE CARRIER FREQUENCY  
  
The problems of accurately determining carrier frequency during short rf pulses is discussed. Several methods are presented, with typical data, for making such measurements from UHF to X-band. 7 pages.
- 4 OUT OF PRINT
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- 6 HOMODYNE GENERATOR AND DETECTION SYSTEM  
  
The measurement of attenuation, rf leakage signals, antenna patterns, etc. with a homodyne generator and detector system is reviewed. Shows advantages of this system over other types of detectors. Also, a discussion of errors and various experiments are included. 11 pages.
- 7 POWER METER ACCURACY  
  
Briefly describes the factory test procedure and a method of field verification of better than  $\pm 5\%$  accuracy of the  $\text{\textcircled{hp}}$  Model 430C Microwave Power Meter. Consideration of bolometer mount efficiency and an estimate of overall power measuring system accuracy is presented. 5 pages.
- 8 FACTORY TEST AND ALIGNMENT PROCEDURE MODEL 382A  
  
Reprinted as Service Note 382A-1.
- 9 DOPPLER FREQUENCY SHIFT SIMULATION AT MICROWAVE FREQUENCIES  
  
The simulation of doppler frequency shift has been used as a means of checking radar, navigational, and other instrumentation systems. This memorandum discusses adaption of the  $\text{\textcircled{hp}}$  Model 490A TWT Amplifier to such an application. Some qualitative data on the use of TWT amplifiers in doppler frequency shift simulation is presented. 7 pages.
- 10 MICROWAVE SPECTRUM SYNTHESIS  
  
The use of the traveling wave tube offers a relatively easy method to produce microwave modulation for spectrum synthesis. The versatility provided by the broad bandwidth and flexibility of modulation of the TWT is also presented with a comparison of other microwave modulators. 6 pages.
- 11 DOMESTICATING THE TRAVELING WAVE TUBE  
  
A discussion of such general characteristics of the traveling wave tube as broad and narrow band amplification, modulation characteristics, and linear detection in microwave measurements. Some general applications of the TWT are included. 9 pages.
- 12 APPENDIX I, HOW A HELIX BACKWARD-WAVE TUBE WORKS  
  
The backward-wave oscillator provides a flexible source of microwave energy that can be voltage tuned over bandwidths from 1.5 to 1 to as high as 5 to 1. This note discusses the basic concepts of the helical backward-wave tube. 4 pages.
- 13 OUT OF PRINT
- 14 TRAVELING-WAVE TUBE AMPLIFIERS  
  
Discussion of the characteristics of traveling-wave tube amplifiers and several applications. An appendix offers a technical explanation of how the TWT operates. A second appendix notes a constant amplitude, linear sawtooth generator which may be used to shift the phase of frequency of the rf output from a TWT amplifier. 17 pages.

Because of the specialized nature of Application Notes, they are available only by individual request, general mailings not being maintained.



- 15 DISTORTION AND INTERMODULATION  
A brief discussion of measurements of system nonlinearity with particular emphasis placed on distortion and intermodulation measurements. Harmonic distortion by means of the fundamental rejection method is introduced as well as intermodulation measurements using both the CCIF and SMPTE methods. 7 pages.
- 16 WAVES ON TRANSMISSION LINES  
The wave equations are developed for the lossless transmission line. The effects of termination, reflection losses, and standing waves are discussed. An explanation of the Smith Chart as used for both lossless and lossy line calculations is included with a numerical example. 14 pages.
- 17 SQUARE WAVE AND PULSE TESTING  
A discussion of square wave and pulse testing of linear systems. The transformation from the time-to-frequency-to-time domain is explained, and a table of selected Fourier and LaPlace Transforms is included. The response of linear systems to both impulse and square wave excitation is discussed with particular emphasis placed on the physical significance of such responses. 15 pages.
- 18 INTRODUCTION TO SOLID STATE DEVICES  
An introduction to the atomic structure of conductors, semi-conductors, and insulators with emphasis on energy levels and gaps. Such topics as the motion of holes and electrons, photo conduction, and the doping of crystalline materials are discussed. 27 pages.
- 19 A TECHNIQUE FOR CALIBRATION PHASE SHIFTERS  
Reprinted as Service Note 885A-1.
- 20 HEWLETT-PACKARD SIGNAL GENERATOR OUTPUT ATTENUATORS  
A short discussion of the waveguide beyond cutoff type of attenuator. Since the geometry of this type of attenuator and probe frequency response determine its operation, the control of these two variables assures specified attenuator accuracy. 2 pages.
- 21 MICROWAVE STANDARDS PROSPECTUS  
A tabular list of equipment (with costs) to make standard measurements of frequency attenuation, impedance, and power over various frequency ranges in coax or waveguide systems. Instrumentation shown is a good compromise between accuracy and cost. 47 pages.
- 22 OUT OF PRINT
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- 24 PULSE MODULATION OF AUDIO OSCILLATORS  
The use of a diode and a pulse source will permit pulse modulation of  $\text{\textcircled{hp}}$  audio oscillators. 1 page.
- 25 CATHODE RAY TUBE PHOSPHORS AND THE INTERNAL GRATICULE CATHODE RAY TUBE.  
A definitive analysis of different phosphors commonly used in CRT's: their advantages and application. Design features of  $\text{\textcircled{hp}}$ 's Internal Graticule are covered, and the aluminizing process used for  $\text{\textcircled{hp}}$  CRT's is discussed. Approximately 5 pages.
- 26 OUT OF PRINT
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- 28 OUT OF PRINT
- 29 A CONVENIENT METHOD FOR MEASURING PHASE SHIFT  
A method for reading phase shift directly with an oscilloscope is presented. Method uses the Hewlett-Packard Webb Mask available from  $\text{\textcircled{hp}}$  Representatives. 2 pages.
- 30 MEASUREMENT OF CABLE CHARACTERISTICS  
Discussion of measurements of characteristic impedance, and attenuation of coaxial cables and swr of cable connectors. 5 pages.
- 31 EXTERNALLY DRIVING THE 202A LOW FREQUENCY FUNCTION GENERATOR  
Transient response of networks and systems often can be better observed by applying single cycles or pulses rather than by continuous driving. Circuit changes are shown for converting the 202A to externally controlled single cycle operation. 4 pages.

32 COUNTING AND RECORDING INSTRUMENTATION

Tabular and descriptive presentation, in several parts, of compatible Hewlett-Packard digitizing, counting, and recording instruments: their functions, limitations, and uses. Permits correlating measurement variables and needs with existing capabilities of Hewlett-Packard instrumentation in the measurement area just described. 16 pages

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36 SAMPLING OSCILLOGRAPHY

A comprehensive discussion of sampling oscillography including history of the technique, general sampling considerations (plotting points, sampling time limits, bandwidth and a block diagram with related circuit explanation). 7 pages.

37 MONITORING A RADIO TRANSMITTER SIGNAL WITH AN  $\Phi$  120A or 130B OSCILLOSCOPE

A simple external circuit is shown which when added to an  $\Phi$  120A, 122A, or 130B Low Frequency Oscilloscope allows rf transmitter output and modulation to be monitored on the oscilloscope. 3 pages.

38 MICROWAVE MEASUREMENTS FOR CALIBRATION LABORATORIES

An explanation of theory, accuracy, and special techniques employed for microwave standards measurements. Step by step procedures for some of the common measurements. 118 pages.

39 STANDARDS CALIBRATION PROCEDURES

Calibration procedures for some of the  $\Phi$  instruments commonly found in standards laboratories. 62 pages.

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41A A HOLD-OFF CIRCUIT FOR THE MODEL 405AR DIGITAL VOLTMETER

Provides circuit details and description of a simple hold-off arrangement which can be added to the  $\Phi$  Model 405AR Digital Voltmeter so that its reading will be held to meet requirements of scanning and similar applications. 1 page.

41B OUT OF PRINT

41C OUT OF PRINT

41D DECREASING THE RESPONSE TIME OF THE MODEL 405 INPUT FILTER

Describes how the response time of the Model 405 can be reduced to make it compatible with the maximum sampling rate of  $\Phi$  printers. (5 prints per second). 1 page.

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43 CONTINUOUS MONITORING OF RADAR NOISE FIGURES

Noise measuring theory is reviewed, radar system requirements for integral noise figure meters are discussed, and the  $\Phi$  Model 344A Noise Figure Meter is described. Specifications and operating ranges of the  $\Phi$  Model 344A are included. 11 pages.

44A SYNCHRONIZING THE MODEL 185A OSCILLOSCOPE

Briefly describes various synchronizing methods and shows how accessories add to the 185A's versatility. It also discusses the effects of fm and jitter on measurement accuracy. 5 pages.

44B MORE INFORMATION AND EASIER PULSE ANALYSIS WITH THE MODEL 185A 1000 MC OSCILLOSCOPE

Dramatic photographs plus supporting text illustrate the 185's unusual performance in measuring and displaying fast rise time phenomena. 4 pages.

44C A METHOD OF AUTOMATICALLY MEASURING COMPONENT SWITCHING SPEED CHARACTERISTIC WITH THE 185A

The system described in this application note represents a basic measuring technique that can be extended to more complete and specialized automatic testing systems. The Model 185A is used with a Model 523C or 523D Electronic Counter to make automatic waveform measurements with direct readout in micro, nano or picoseconds. 3 pages.

44D SAMPLING OSCILLOSCOPE ACCESSORIES AND HOW TO USE THEM

Indicates the correct sampling oscilloscope accessories for different circuit applications. The effect of excessive probe inductance and capacitance at higher frequencies is discussed, as are the related compensating techniques. Charts, graphs, tables, and circuit problems show how the sampling oscilloscope probes can best be utilized for optimum accuracy and performance. 7 pages.

- 45 DIRECT READING TEST METER SIMPLIFIES MAGNETIC INK PRINTING QUALITY CONTROL  
Description and application of the  $\Phi$  Model H06 428A Magnetic Printing Tester. Printing parameters and measurements are discussed, such as density of ink, paper porosity, dimensional inaccuracies, compensation techniques, etc. Explains advantages in keeping uniform magnetic ink conditions for computer and automatic sorting applications. 3 pages.
- 46 OUT OF PRINT
- 47 PROVIDING 100-, 1000-, 10,000-SECOND GATE TIMES FOR THE MODEL 524C/D COUNTER  
Describes a method of easily adapting the Model 524C/D to provide extended gate times when used with the 526C Period Multiplier. 1 page.
- 48 APPLICATIONS OF THE  $\Phi$  MODEL 218A, A VERSATILE GENERAL-PURPOSE PULSE AND DELAY GENERATOR  
Describes the uses of Model 218A as a general-purpose laboratory pulse generator. A 218A can often take the place of several special-purpose pulse generators when the appropriate plug-in unit is used. 12 pages.
- 49 MEASURING THE FREQUENCY OF SMALL 10-100 MC SIGNALS  
Transfer oscillator techniques are employed to measure signals in the 10-100 MC range with good sensitivity, stability and ease of operation and adjustment. 3 pages.
- 50 OUT OF PRINT
- 51 MODIFIED 485B PROVIDES CONVENIENT AND ECONOMICAL MIXER FOR X AND H-BAND LABORATORY RECEIVERS  
Explains and illustrates method and technique for modifying the  $\Phi$  Model 485B Detector Mount as a mixer to obtain a 30 mc output -- providing greater sensitivity and dynamic range in laboratory X and H-band measurements. 2 pages.
- 52 FREQUENCY AND TIME STANDARDS  
Delves into the general theory and principles of frequency and time determination, measurement, and system operation. Describes the various procedures for operation of  $\Phi$  instruments as basic system standards. Approx. 38 pages.
- 53 TRANSMISSION LINE TESTING USING THE SAMPLING OSCILLOSCOPE  
Reviews characteristics and related measurement problems of transmission lines. Shows how sampling oscilloscope techniques simplify transmission line measurements by using visual presentation to locate discontinuities, measure characteristic impedance, and check line uniformity. Describes and illustrates method used to obtain the nature and value of the reflected discontinuity. Relates reflection coefficient or vswr to reflection magnitude. 6 pages.
- 54 IMPROVEMENTS IN MICROWAVE SWEPT-FREQUENCY TECHNIQUES  
A comprehensive discussion of improved microwave swept-frequency techniques for obtaining accurate test results quickly. Typical block-diagrams with corresponding test graphs illustrate the techniques applied to measurements of SWR, directivity, attenuation, crystal matching, noise figure, error analysis, and fast visual presentation. Reduction of test time and error in usual reflectometer setups is stressed. 6 pages.
- 55 CONVERTING THE MODEL 302A WAVE ANALYZER FOR USE WITH GROUNDED-INPUT RECORDERS.  
Illustrates a simple method for modifying the 302A Wave Analyzer, without degrading the signal, so that the recorder output is completely isolated from system ground. The modification makes the Wave Analyzer completely compatible with not only grounded-input recorders, but all recorders. 1 page.
- 56 MICROWAVE MISMATCH ERROR ANALYSIS  
Discusses the possible error in microwave power and attenuation measurements due to mismatch loss. Presents a method of determining the limits of these errors through the use of mismatch-loss charts. Approximately 7 pages.
- 57 NOISE FIGURE PRIMER  
Detection system sensitivity depends upon noise present with a signal, and noise contributed by the system. This Note defines Noise Figure, and illustrates its use in minimizing system contributed noise. Approximately 7 pages.

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