TEK INSTALLATION/PERFORMANCE VERIFICATION MANUAL

PART NO.: 070-8067-00
Product Group 2E

TEKTRONIX

2782
SPECTRUM ANALYZER

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Tektronix
COMMITTED TO EXCELLENCE

Preface

This manual contains installation and performance verification information for the TEKTRONIX 2782 Spectrum Analyzer. A thorough knowledge of frequency domain analysis is assumed.

Manuals that describe other aspects of the product are:

- Operators Manual
- Programmers Manual
- Service Manual

Documentation Standards

Most terminology and graphics follow ANSI standards. Refer to the following standards:

- ANSI Y1.1 — Abbreviations
- ANSI Y32.2 — Graphic Symbols
- IEEE 91 — Logic Symbols

Table of Contents

SAFETY SUMMARY

(Refer all servicing to qualified servicing personnel)

The safety information in this summary is for boty operating and service personnel. Specific warnings and captions will be found throught the manual where they apply, but may not appear in this summary.

CONFORMANCE TO INDUSTRY STANDARDS

The 2782 complies with the following Industry Safety Standards and Regulatory Requirements.

Safety

CSA: *Standard C22.2 No. 231 — Electrical and Electronic Measurement and Testing Equipment*

FM: *Electrical Utilization Standard Class 3810*

ANSI/ISA/S82 — *Safety Requirements for Electrical and Electronic Meassuring and Controling Instrumentation.*

IEC 348 (2nd edition) — *Safety Requirements for Electronic Measuring Apparatus.*

UL 1244 (2nd edition) —*Electrical and Electronic Measuring and Testing Equipment.*

Regulatory Requirements

VDE 0871 Class B —*Requlations for RFI Suppression of High Frequency Apparatus and Installations.*

FCC Part 15 Subpart J Class A — EMI Compatability

(Germany) — RöV X-ray Decree, Section 5, March1973

Military

Mil-Std 461B, Part 4

TERMS

In This Manual

CAUTION statements identify conditions or practices that could result in damage to the 2782 or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property, including the 2782 itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

In This Manual

This symbol indicates where applicable cautionary or other infor mation is to be found.

As Marked on Equipment

DANGER — High voltage.

Protective ground (earth) terminal.

ATTENTION — Refer to manual.

POWER

Power Source

The instrument is intended to operate from a power source that will not apply more than 250 V rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

The instrument is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptable before connecting it to the power terminal. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for the instrument.

Use only a power cord that is in good condition.

International power cords (Tektronix Options A1, A2, A3, and A5) are approved for the country of use, and are not included in the CSA certification.

For detailed information on power cords and connectors, see the Options appendix in the Operators Manual.

Use the Proper Fuse

To avoid fire hazard or equipment damage, use only the fuse of correct type, voltage rating, and current rating as marked on the instrument (as specified in the Replaceable Electrical Parts list of the Service Manual).

OPERATIONAL PRECAUTIONS

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate the instrument in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the instrument covers or panels unless you are qualified to do so. *REFER ALL SERVICING TO QUALIFIED SERVICE PERSONNEL.*

Introduction

General Information

The Tektronix 2782 Spectrum Analyzer is a high-performance instrument with a frequency range of 100 Hz to 1200 GHz. The minimum resolution bandwidth is 3 Hz, with a minimum span of 10 Hz, and provides measurement resolution proportional to the frequency accuracy or span. In addition to conventional digital storage features, non-volatile memory (NVRAM) stores up to 20 separate waveforms with their readouts and markers, for later recall for additional analysis and comparison. Also, store up to 20 different front-panel control setups for future recall. The instrument can selectively count one particular signal out of several that may be present at its input.

The single and delta markers provide direct readout of frequency and amplitude information of any point along any displayed trace. Or, get the relative (delta) frequency and amplitude information between any two points along any displayed trace or between traces.

The additional major performance features of your instrument include

- low phase noise
- synthesizer frequency accuracy
- precision signal counting
- precise amplitude measurement
- 3 Hz to 10 MHz resolution bandwidth
- multiband sweep
- three-color display
- strong front end
- menu-driven user interface
- dedicated function keys for commonly-performed tasks
- two user-assignable knobs
- remote operation over GPIB
- single and delta marker modes
- digital storage and real time display
- user-defined key sequences and macros
- front-panel keypad for data entry
- on-screen text entry
- full screen plot
- instrument settings and waveforms stored in non-volatile memory (NVRAM)

Information Changes

If a change is made to information in this manual, the change date and a brief description are included on the Manual Revision Status Page at the front of this manual. The location on the manual page where the change was made is noted by a vertical black change bar (|) on the left margin of the page. The change bar will appear only in the manual issue where the change first appears. Following manual issues will not show the change bar, but the date and description will remain on the Manual Revision Status Page.

User Survey

At the front of this Manual is a one-page user Manual Rating Form. We will appreciate it if you will take a few minutes to fill in the form; especially if you find something in the manual that is especially useful or slightly confusing.

Fold the form in half so the Tektronix, Inc. address is on the outside, staple, and put in the mail. No postage is necessary if mailed in the continental United States.

Standards and Conventions Used

This manual agrees with Institute of Electrical and Electronics Engineers, Inc. (IEEE) and International Electrotechnical Commission (IEC) standards. Abbreviations agree with American National Standards Institute (ANSI) Y1.1-1972. GPIB functions agree with the IEEE 488-1978 standard and the Tektronix Interface Standard for GPIB Codes, Formats, Conventions, and Features.

Copies of IEEE and ANSI standards can be ordered from IEEE. Contact your local Tektronix Sales Office or representative if you have questions about the Tektronix reference document.

Accessories

The following list includes the part numbers and descriptions for all standard accessories currently shipped with each instrument and for the optional accessories available.

Standard Accessories	Tektronix Part Number
• Adapter; N male to BNC female	103-0045-00
• Adapter; type N Crown	131-4329-00
• 4A fast-blow line fuses; 2 each	159-0320-00
• Power cord	161-0104-00
• Cable; 50 Ω, type SMA	012-0649-00
• 2782 Operators Manual	070-6794-00
• 2782 Programmers Manual	070-6796-00
• 2782 Operators Handbook	070-6795-00
• 2782 Programmers Reference Guide	070-6798-00
• 2782 Installation/Performance Verification Manual	070-8067-00
• Performance Verification Software	063-0227-00
• Flatness/Spurious Search Software	063-0228-02

Optional Accessories

• Service Kit	006-7334-00
includes 1 - Interconnecting cable	
1 - Cable Assembly	
1 - Adapter; 9-pin to 25-pin female	
6 - Cable; 50 Ω,	
1 - Coupler	
3 - Circuit Board Assembly	
• Cable, Waveguide Mixer	012-1346-00
• Rack Adapter Kit	016-1019-00
• Adapter Assembly; N male to N female	015-0509-00
• 2782 Module Level Service Manual	070-6799-00

Although not required for instrument operation, Tektronix offers additional accessory products for use with spectrum analyzers, such as Waveguide Mixers. Tektronix also prepares software packages that add to the instrument use. The packages contain many applications and utility routines covering swept-frequency measurements, waveform storage and recall, signal analysis, and remote site monitoring. The routines can be performed by non-technical operators as well as technical and experienced spectrum analyzer users. For additional information and ordering, contact your local Tektronix Sales Office or representative.

Options

The following list includes all options currently available for the 2782. Additional information concerning options can be found in the Operators Manaul.

Options A1, A2, A3, A4, and A5

Power Cord Options

Option B1

Module Level Service Manual

Option B2

1 Complete Set of Manuals
- 1 Installation/Performance Verification Manual
- 1 Operators Manual
- 1 Programmers Manual
- 1 Operators Handbook
- 1 Programmers Reference Guide
- 1 Module Level Service Manual

Options M1, M2, M3, M7, M8, and M9

Extended Service and Warranty Options

Option 18

WM782 Bands Q, U, V, E, and W
(frequency coverage from 33-110 GHz)

Option 19

All WM782 Bands A, U, E, F, G, and J
(frequency coverage from 26.5-325 GHz)

Option 20

Utility Software

Option 21

Compaq Portable II Computer with utility software

Option 30

Cradlemount For 19-inch Rackmounting

Service Information

Service Manual

The instrument Module Level Service Manual is a separate, optional publications (Options B1 or B2). The Service Manual includes block diagram descriptions, troubleshooting information, module adjustment procedures, maintenance procedures, the electrical and mechanical replaceable parts lists, standard and optional accessories, and block diagrams. Service Manuals are intended for use by *QUALIFIED SERVICE PERSONNEL ONLY*. To avoid electric shock, *DO NOT* perform any servicing unless qualified to do so. Service personnel should read the Safety information at the beginning of the Service Manual before performing any servicing.

Contact your local Tektronix Field Office or representative for manual ordering information.

Product Service

To assure adequate product service and maintenance for our instruments, Tektronix, Inc. has established Field Offices and Service Centers throughout the United States. Contact your local Service Center, representative, or sales engineer for details on Warranty, Calibration, Emergency Repair, Repair Parts, Scheduled Maintenance, Maintenance Agreements, Pickup and Delivery, On-Site Service for fixed installations, and other services available through these centers.

Maintenance Agreements

Several types of maintenance and repair agreements are available that range from calibration only or repair only to combined services of calibration and repair. Custom packages can be tailored to meet specific customer requirements.

The lowest cost/greatest value agreements are Warranty-Plus M-Options (described in Appendix C). Options M1, M2, M3, M8, and M9 are available at the time of product purchase and offer up to five years of coverage.

All agreements provide quality service that maximizes product performance and increases productivity without any unplanned costs. For more information, contact your local Tektronix Service Center.

Instrument Familiarization

This section includes the basic instrument operating instructions. An operational check is included for the front panel keys and controls and some of the operating functions. The instrument cabinet does not need to be removed to perform these check-out procedures. Refer any additional instrument check-out to qualified service personnel.

Incoming Inspection

The instrument was inspected both mechanically and electrically before shipment, and it should be free of mechanical damage and meet or exceed all electrical specifications. If the instrument does not meet specification requirements, contact your local Tektronix Field Office or representative.

Section 3 lists the instrument performance requirements. Section 4 is a detailed electrical performance verification procedure to check all specified performance requirements.

Storage and Repackaging

Long-Term and Short-Term Storage

Short Term (less than 90 days) — For short term storage, store the instrument in an environment that meets the non-operating Environmental Specifications in Section 3 of this Manual.

Long Term — For instrument storage of more than 90 days, use the original shipping container to repackage the instrument. Package the instrument in a vapor bag with a drying material and store in a location that meets the non-operating Environmental Specifications in Section 3 of this Manual.

If you have any questions about storing procedures, contact the Tektronix Factory Service Center in Beaverton, Oregon. (Your local Tektronix Service Center or representative can help you with this contact.)

Repackaging for Shipment

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag to the instrument that shows

- **the owner and address,**
- **the name of the individual at your location who can be contacted,**
- **the complete instrument serial number (stamped on a metal tag attached to the instrument rear panel), and**
- **a description of the service required.**

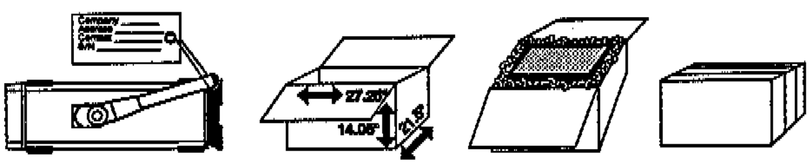
If the original shipping container is unfit for use or not available, use the following repackaging procedure or contact your local Tektronix Service Center or representative for assistance.

1. Use a container of corrugated cardboard with a test strength of 375 pounds (140 kilograms) and inside dimensions that are at least six inches more than the equipment dimensions (listed in the Physical Characteristics in Section 3), to allow for cushioning.

2. Install the instrument front cover, and surround the instrument with plastic sheeting to protect the finish.

3. Cushion the instrument on all sides with packing material or plastic foam.

4. Seal the container with shipping tape or an industrial, heavy-duty stapler.



Repacking for shipment.

Transit Case

We recommend using a high-impact, ruggedized transit case if your instrument is to be frequently shipped between sites. A hard transit case that meets these requirements and has space to hold most of the instrument standard accessories is available as an optional accessory from Tektronix. Contact your local Tektronix Field Office or representative for ordering information.

Instrument Installation

Air Flow Requirements

Operate the instrument in any position that allows air flow in the bottom and out the rear of the instrument. Feet on the four corners allow enough clearance even if the instrument is stacked with other instruments. The air is drawn in by a fan through the bottom and is released out the back. Avoid locating the instrument where paper, plastic, or any other material might block the air flow.

CAUTION

RACKMOUNT CAUTION

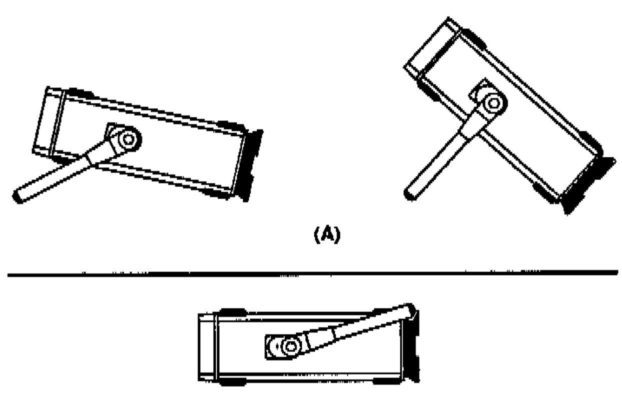
Special air-flow considerations are required if the instrument is part of a rackmount configuration.

Do not allow the temperature at the air intake on the bottom of the instrument to exceed the maximum instrument operating temperature of 55°C.

Overheating can cause long-term reliability and safety problems. Excessive overheating will result in the thermal fuse opening. If the thermal fuse opens, the instrument will cease to operate, and the instrument will require servicing. Refer any heating or cooling questions to qualified service personnel.

Handle

You can position the instrument handle at several angles to serve as a tilt stand. To stack instruments, position the handle at the top rear of the instrument; refer to Figure 2-1. To change the handle position, press in at both pivot points and rotate the handle to the desired position.



(A)

(B)

Figure 2-1. Handle Positioning

Cabinet

WARNING

It can be hazardous to remove or replace the cabinet on the instrument. Serious electrical shock can result from improper handling. Only qualified service personnel should attempt to remove or replace the instrument cabinet.

Front Cover and Accessories Pouch

The front cover provides a dust and water resistant seal and a convenient place to store accessories and external waveguide mixers. Use the cover to protect the instrument front panel during storage or transportation. To remove the cover, stand the instrument on the two back feet so the name on the handle is facing up and towards you, and pull slightly out and up on the sides of the cover. The accessories pouch is attached to the inside of the cover. To open the accessories pouch, pull up evenly on the flap.

Rear Cover

The rear cover provides a water and dust resistant seal. For access to the rear panel connectors, unsnap either the top or bottom of the cover. Never attempt to operate the instrument with this cover in place.

FRONT PANEL FAMILIARIZATION

Screen

The instrument screen displays the main instrument operating parameters, up to four waveforms in two colors, the current menu (if selected) and the status of the assignable knobs and KEYPAD; see Figure 2-2. Also displayed are the active function parameter readouts. There are three different menu-selectable instrument graticule patterns.

Busy . . .

Whenever the instrument performs a function that does not show instant results on the screen, the Busy . . . message is displayed. This is to let you know that internal activity is taking place, and there is no instrument malfunction even though no visible changes have occurred in response to your selections.

As soon as the activity is complete, the Busy . . . message goes away.

Keys

The instrument front panel contains 23 dedicated function keys, 20 KEYPAD keys for data entry, and 29 keys that control menu activity. The menu keys are distinguishable by their gray color.

The white dedicated function keys cause a single function to be performed each time they are pressed, and they remain dedicated to that function, regardless of menu state. For example, the SPAN step keys will control span steps even if the ResBW menu is displayed.

Use the KEYPAD to enter and change instrument parameters when a menu key is pressed. The active KEYPAD parameter is displayed in the bottom line of readout.

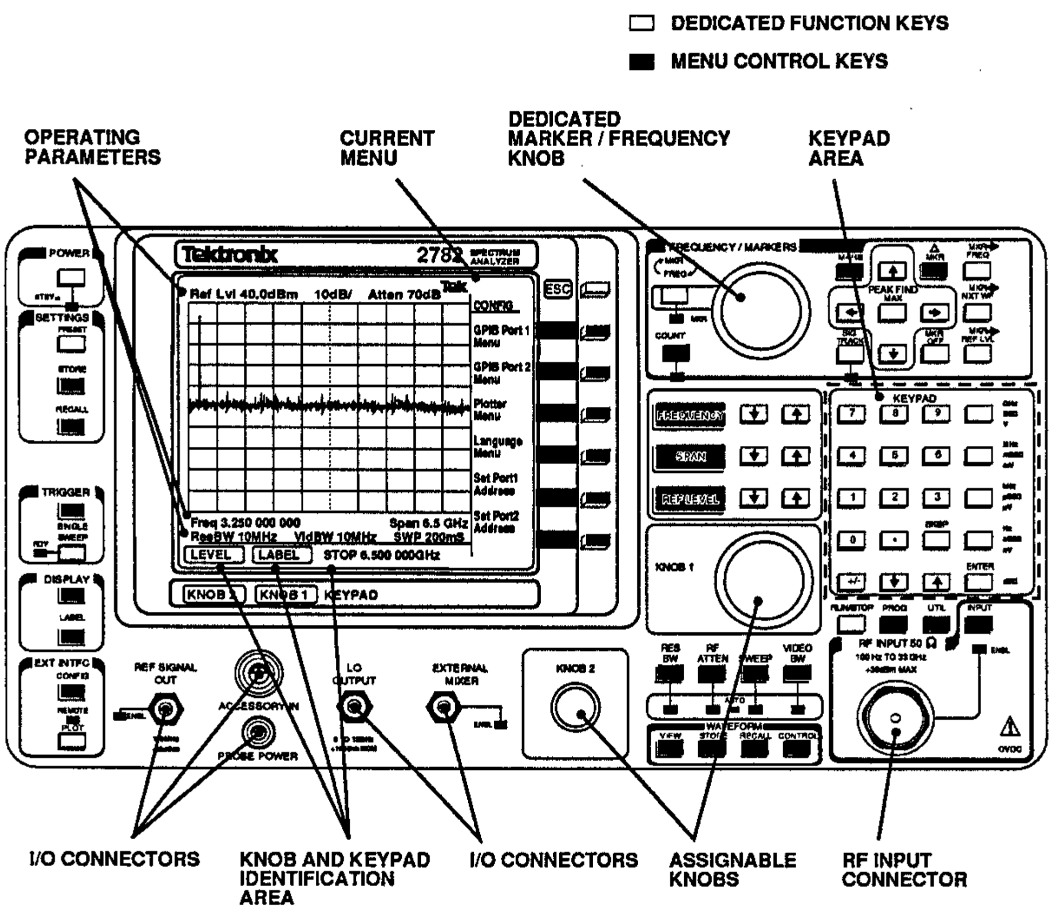


Figure 2-2. Front panel familiarization.

The gray front-panel keys are the menu keys that select top level menus. The menus list function choices and additional menus related to the key function. The keys to the right of the screen area on the CRT bezel are soft keys to choose a function or to bring up additional low-level menus. Pressing another menu key will bring up its function menu, replacing any menu that might have been displayed; however, when a lower-level menu is selected the title from the top-level menu is kept so that the return path is still present. Press ESC to move up out of low-level menus or to remove menus.

The functions of all instrument keys are discussed in detail in Section 4 of the operators manual.

Knobs

The instrument has three front-panel knobs.

• The FREQUENCY/MARKERS knob is dedicated to frequency and marker control.

• KNOB 1 and KNOB 2 are assignable to various instrument functions (like sweep or attenuation). The current knob assignment is shown in a box on the bottom of the screen. Temporary knob assignments are shown in the yellow, high-light mode (the knob will return to its previous assignment when the temporary activity is complete).

The functions of all instrument knobs are discussed in Section 4 of the operators manual.

REAR PANEL FAMILIARIZATION

The instrument rear-panel uses both the upper and lower panels to provide external access to the instrument; see Figure 2-3. The two panels are separated by a label containing identification and cautionary information and the air flow outlet area.

Upper Panel (Figure 2-3A)

PORT 1 and PORT 2 —These two auxiliary ports are 24-pin GPIB interface ports.

! **INSTRUMENT BUS** — This 9-pin connector accesses the internal serial bus. This connector is intended primarily for service applications.

! **ACCESSORY** — This 15-pin connector provides access to other instrument signals (access to video in, display in, and YTO voltage). This connector is described in Section 4 of the Operators manual under the Rear Panel portion of the Input/Output Connectors.

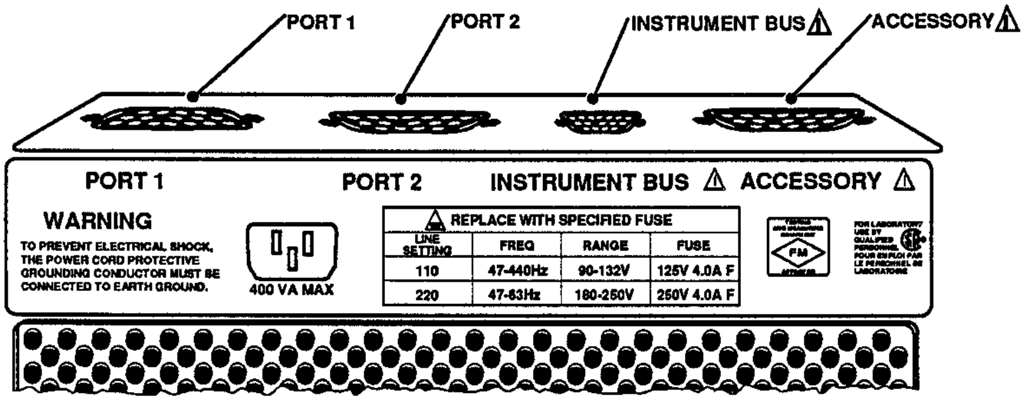


Figure 2-3A. Rear panel familiarization - upper face.

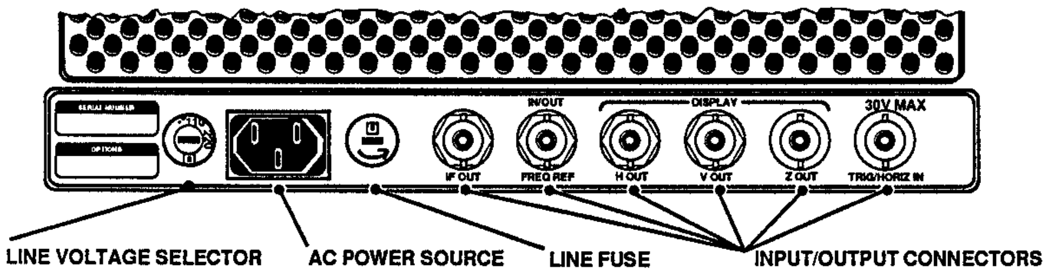


Figure 2-3B. Rear panel familiarization - lower face.

Lower Panel (Figure 2-3B)

Line Voltage Selector — Input power requirements are changed with the line voltage selector. Be sure the line voltage selector is set for the appropriate voltage range (either 110 V or 220 V).

AC Power Source — Use only the power cord and connector recommended for your instrument to connect to the input power source. See Power information in the Safety Summary earlier in this manual for more information.

Line Fuse — There is convenient rear-panel fuse access in case of replacement needs. The instrument uses a 4A fast blow fuse for either 110 VAC operation or 220 VAC operation. Remove the fuse holder and replace the line fuse with the appropriate fuse for the voltage range selected.

Input/Output Connectors — There are six BNC connectors that provide access to instrument input and output signals. These connectors are described in Section 4 of the Operators manual under the Rear Panel portion of the Input/Output Connectors.

Power Source

The instrument is intended to operate from a power source that will not apply more than 250 V rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

RF Input Connector

The front-panel RF Input connector is a planar crown interface that adds versatile ease of connector-type exchange. The interface is compatible with K or type N connectors. If frequent switching of connector types is required, use a cable with an N crown and one with a K crown, and conveniently swap back and forth between them.

CAUTION

K-Compatible Connector
K-compatible connectors can be easily damaged by over-tightening.

Carefully align the threads of the K-compatible connector with the crown adapter threads. Firmly install the connector finger tight. Use a torque wrench to tighten the connector to 8 in-lb of pressure to complete the installation.

Never use a tightening device such as pliers on a K-compatible connector.

Planar Crown Adapter
The planar crown adapter can be easily damaged by over-tightening.

Firmly, but carefully, install the adapter finger tight only. Do not use a wrench or other tightening device on the planar crown adapter.

If the planar crown interface becomes damaged, simply unscrew it and screw another one on. The connector is completely accessible from the instrument front panel, so no instrument disassembly or special tools are required.

Initial Turn On

Connect the instrument power cord to an appropriate power source as previously indicated. (The instrument fan will spin for a few seconds when the power is initially connected.) Power is now supplied to the instrument. The standby indicator is lit (red), and the instrument is in the standby mode and not yet operational. Push the front-panel POWER key. The standby indicator is off, and the instrument is now fully operational.

When the POWER key is pressed, the main control processor within the instrument performs a power-up routine. As part of this routine, the processor firmware version will be displayed on the screen for approximately five seconds, and the processor runs a memory and I/O test. When the power-up routine is finished, the instrument is ready to operate. Any power-up diagnostic failures are displayed on the screen.

The instrument operating functions and modes are initialized to the following factory (default) power-up states shown in Figure 2-4, unless the power-up state has been re-defined. The AUTO indicators for RES BW, RF ATTEN, SWEEP, and VIDEO BW and the ENBL indicator for RF INPUT are lit (red).

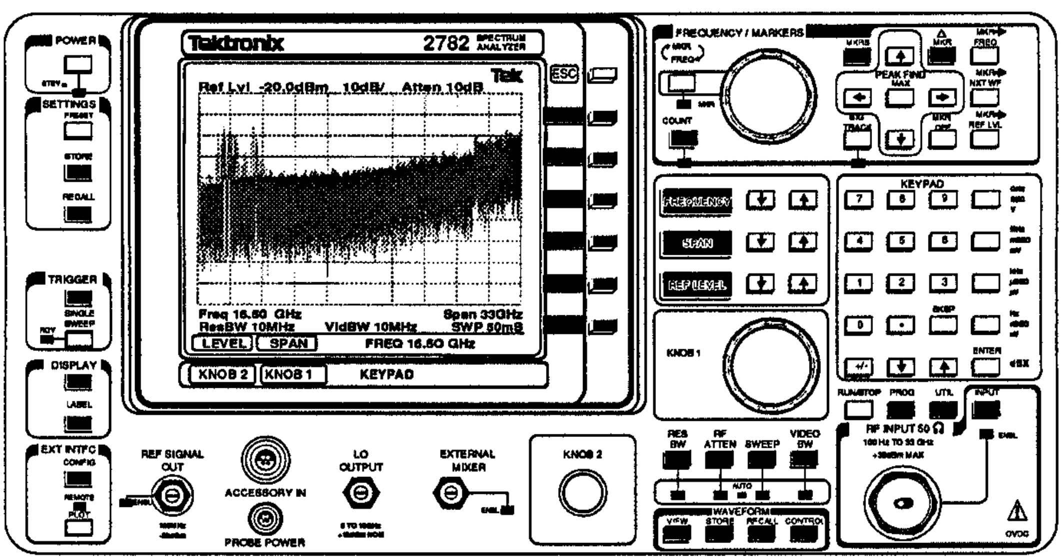


Figure 2-4. Instrument display and readout at initial turn on.

REF LEVEL	–20.0 dBm
FREQUENCY	16.50 GHz
SPAN	33 GHz
ATTEN	10 dB
RES BW	10 MHz
VID BW	10 MHz
SWP	500 mS
Vertical Scale	10 dB
KNOB 2	LEVEL
KNOB 1	SPAN
KEYPAD	Frequency

OPERATIONAL CHECK

The instrument is electrically and mechanically adjusted and tested at the factory for optimum performance. This procedure checks that the instrument is still operating properly. The internal reference signal is used as the source to check most of the operational characteristics. Since this internal signal is very accurate, this check procedure should satisfy most incoming inspection or pre-operational checkout requirements. This check will also familiarize you with instrument operation. (A detailed Performance Check that verifies all performance requirements found in Section 4 of this manual.)

This procedure checks the operation of front-panel keys and controls and ensures that the LEDs light when the appropriate function is active. Temporary KEYPAD assignments, assigning functions to KNOB 1 and KNOB 2, and the uses of the escape (ESC) key are discussed throughout the procedure where appropriate. For expected results, perform this check in the order given.

This procedure gives an overview of all instrument keys, control, and menus; however, all of the available menu selections are not included here. Refer to the Operators Manual for a complete description of the menu structure.

Preliminary Preparation

Perform the Initial Turn On earlier in this section, then allow the instrument to warm up for at least 30 minutes before proceeding with this check.

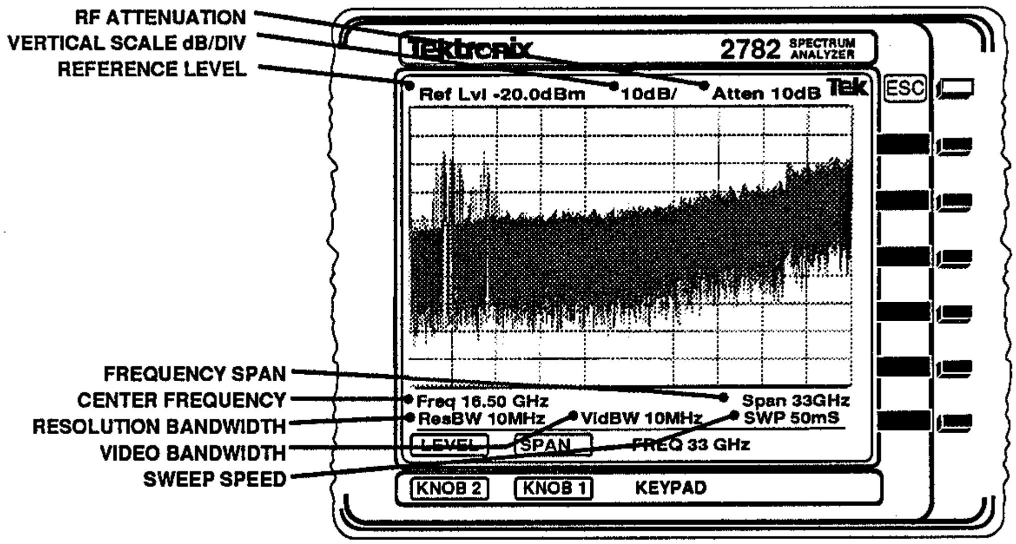


Figure 2-5. Instrument parameter readouts.

1. Initial Set Up

a. Connect REF SIGNAL OUT to RF INPUT 50 Ω with a 50 Ω coaxial cable.

b. Press PRESET to set the instrument to the factory-default conditions. The instrument center frequency is set to 16.5 GHz and the frequency span is 33 GHz, as indicated in the Freq and Span readout line just below the graticule area. All of the main instrument operating parameter settings are displayed on the screen. The characteristics of RES BW, RF ATTEN, SWEEP, and VIDEO BW are automatically coupled (the red indicator lights are lit) to maintain absolute amplitude and frequency calibration while the frequency, span, and reference level are changed.

c. The current center frequency is shown in the Freq parameter readout line; see Figure 2-5.

d. Enter a frequency of 33 GHz with the KEYPAD. As the value is being entered, it is displayed on the screen directly above the KEYPAD identification on the bezel. As soon as the terminator key (GHz) is pressed, the action is taken, and the Freq readout line shows the new setting. The new frequency setting is also shown in the KEYPAD buffer readout.

e. Press the SPAN key. The FREQ SPAN menu comes up on the right-hand side of the screen, and the graticule area shrinks horizontally to accommodate it.

f. Enter a span of 1 GHz with the KEYPAD. Again, the value being entered is displayed on the screen above the KEYPAD identification on the bezel.

g Instead of using the KEYPAD, change the reference level with the dedicated step keys to the right of the REF LEVEL key. Press the decrement step key (↓) once so the REF LEVEL readout on the screen shows –30 dBm (the steps are in 10 dB increments; the factory default step size).

h. During the adjustment of center frequency, reference level, and span, the functions of resolution bandwidth, video bandwidth, sweep time, and RF attenuation are automatically adjusted to maintain a fully-calibrated display.

2. Check Marker Activities

a. Press the MKRS key (gray key to the right of the FREQUENCY/ MARKERS knob) and the MARKERS menu comes up. The single (frequency) marker is automatically turned on (yellow and v-shaped) at center screen.

b. Many mode selections are made through a temporary KEYPAD assignment. One such mode is peak height. Select the Peak Find Menu by pressing the menu soft key on the bezel beside the selection. From the PEAK FIND menu, select Set Peak Height, again using the soft key on the bezel beside the selection. This selection temporarily assigns the KEYPAD to the selection. Select a peak height of 20 (dB) from the KEYPAD, and the selection will immediately appear in the highlight mode in the KEYPAD buffer area. Press ENTER. The signal peak height required for marker signal searches is now 20 dB, and the KEYPAD buffer area is returned to its previous assignment.

c. Press the MKR ↔ FREQ key to select MKR and rotate the FREQUENCY/MARKER knob to move the yellow, frequency marker across the waveform. Slowly rotate the knob to position the marker at the top of the signal nearest center screen. The Mkr readout display at the top of the screen should read approximately 3 GHz and approximately –40 dBm. Rotate the FREQUENCY/MARKER knob clockwise to position the marker on the next signal peak. The MKR readout display should read approximately 3100 MHz and approximately –40 dBm.

d. Press the front-panel PEAK FIND MAX key, and the frequency marker moves to the maximum signal peak on the screen.

e. Press the front-panel PEAK FIND → key, and the frequency marker moves to the next on-screen signal peak to the right.

f. Press the front-panel PEAK FIND ← key, and the frequency marker moves to the next on-screen signal peak to the left.

g. Press the front-panel PEAK FIND ↓ key, and the frequency marker moves to the next on-screen signal peak lower in amplitude.

h. Press the front-panel PEAK FIND ↑ key, and the frequency marker moves to the next on-screen signal peak higher in amplitude.

i. Press the front-panel MKR → FREQ key, and the signal at the marker moves to center frequency.

j. Press the front-panel MKR → REF LVL key, and the signal at the marker moves to reference level.

k. Set the Frequency to 100 MHz, Reference Level to –20 dBm and then the Frequency Span to 100 kHz.

l. Press MKRS to initiate the marker menu then press the PEAK FIND MAX key to place the marker at the top of the display.

m. Select BW Mkr Menu, and a horizontal cursor line with two bright dots appears on the screen. The dots show where the cursor line crosses the waveform on either side of the reference marker, and the measurement shown in the Mkr readout line is the frequency difference between the two dots; see Figure 2-6.

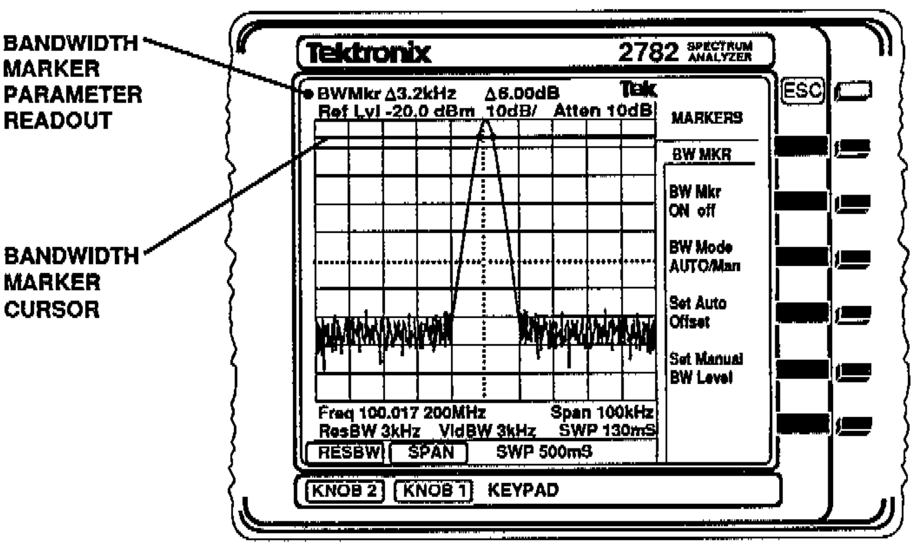


Figure 2-6. Bandwidth markers.

n. Select BW Mode MAN and then Set Manual BW Level. Move the bandwidth horizontal cursor line with KNOB 2, and note the action of the two dots and the readout. If the cursor line is placed where one or the other dot does not fall on a waveform crossing, that dot appears at the screen edge and the readout is the frequency of the reference marker.

o. Select BW Mkr OFF.

p. Press the ΔMKR key to bring up the DELTA MKRS menu, and a red v marker appears on the screen at the same location as the yellow reference marker.

q. Rotate the FREQUENCY/MARKERS knob to move the yellow, reference marker, and note the ΔMkr readout displays the frequency and amplitude difference between the two markers; see Figure 2-7.

r. Select Swap Ref Mkr and note that the delta and reference markers are exchanged (the colors and sizes are swapped). Since only the yellow, reference marker is movable, this will allow you to now move what was previously the delta marker.

DELTA MARKER PARAMETER READOUT

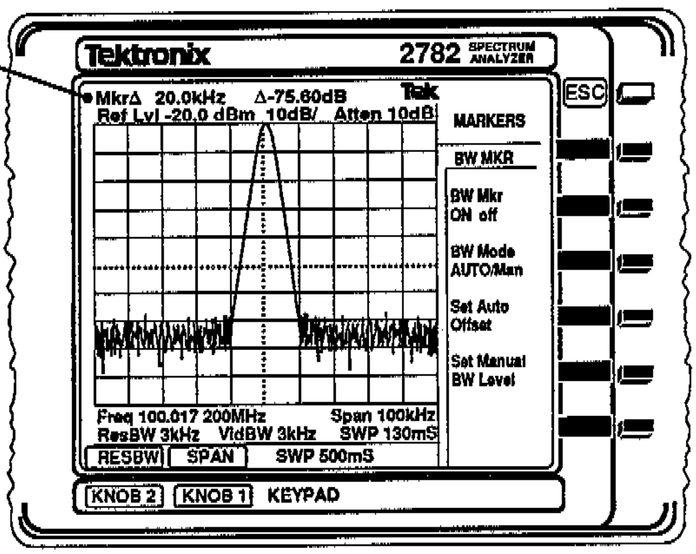


Figure 2-7. Delta markers.

3. Display Set-Ups and Adjustments

a. Press the DISPLAY key to bring up the DISPLAY menu.

b. Select the CRT Adjust Menu.

(1) Select Set Trace Rot. Turn KNOB 2 to rotate the trace as desired, and press ENTER to store a new trace rotation or press ESC to keep the adjustment the same.

(2) Select Set Brightness. Turn KNOB 2 to adjust screen brightness as desired, and press ENTER to store a new brightness setting or press ESC to keep the brightness the same.

(3) Select Set Focus. Turn KNOB 2 to adjust focus as desired, and press ENTER to store a new focus setting or ESC to keep the focus the same.

c. When all desired CRT adjustments have been made, press ESC to go back to the DISPLAY menu.

d. Select Clock Menu. The on-screen clock is set at the factory to display the current hour, minute, second, day, month, and year. The clock display is OFF at factory power-up.

(1) Select Clock ON.

(2) Select Set Date Menu. Set the year, month, and day, and press ENTER or ESC after each setting.

(3) Press ESC to return to the CLOCK menu.

(4) Select Set Time Menu. Set the hour, minute, and seconds, and press ENTER or ESC after each setting.

e. When the date and time are set as desired, press ESC twice to go back to the DISPLAY menu.

f. Select Graticule Menu. There are three graticule configurations available.

(1) Select TEN BY TEN for the standard graticule configuration (factory default).

(2) Select TWO BY TWO when some screen registration is necessary, but the full 10x10 is not required.

(3) Select NONE for a screen clear of all graticule markings.

(4) Select TEN BY TEN to go back to the standard graticule configuration.

4. Label Displays

a. Press the LABEL key to bring up the LABEL menu.

b. Select Sets Label ON and WF Label ON. The factory-default labels are displayed on the screen in their respective locations.

c. Select Enter New Sets Label to create your own settings label. Sets Label is turned OFF, the default label is replaced with New Label:, and the label character selections are available.

d. Rotate KNOB 1 to move the arrow-head cursor (located under A when initiated) to the desired character; see Figure 2-8. Press ENTER to select the character, and continue until the label is complete or the maximum of 30 characters is reached.

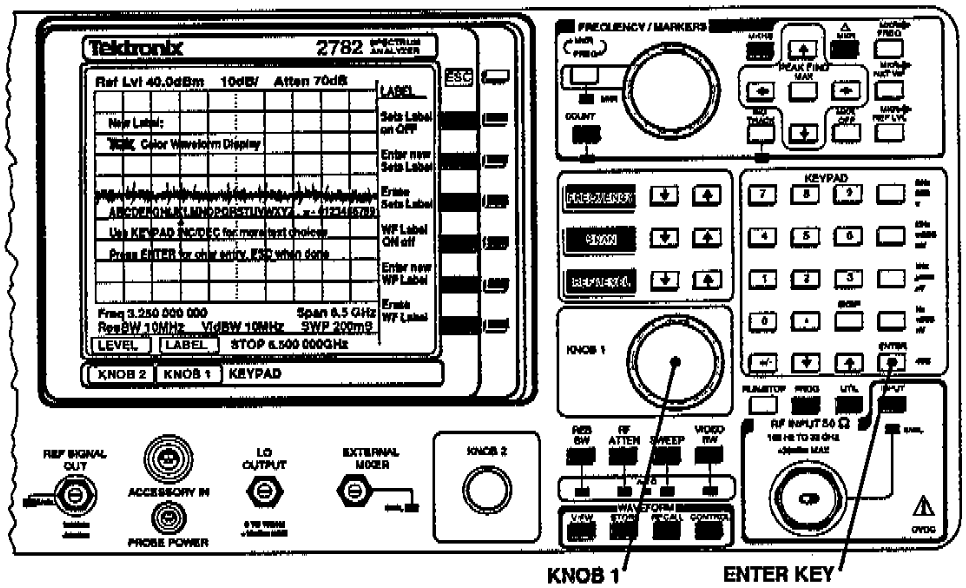


Figure 2-8. Enter a label on the screen.

Press the KEYPAD increment or decrement arrow keys to bring up the extended character set, if desired (any character mix from the two sets is available — within the maximum label length).

e. Press ESC when done to set the label, remove the prompt and character set, and turn Sets Label back to ON.

If any menu key is pressed while a label is being entered, the label menu will be replaced and the label created up to that time will be placed on the screen. If any menu key or ESC is pressed before any label characters have been selected, a blank label is created. This blank will replace any existing label in the label display area.

f. This label can now be stored with instrument settings, as long as Sets Label ON is selected. Sets Label OFF will not erase the label, but it will not be displayed or stored.

If Sets Label ON is selected, and the label is blank, nothing will appear in the LABEL column of the settings storage register when the settings are stored. If Sets Label OFF is selected, the date stamp will be stored in the LABEL column of the settings storage register.

g. Select Enter New WF Label to create your own waveform label, and follow the settings label instructions; or, go on to the next step. Waveform labels are stored with the WF STORE menu.

h. Turn either or both labels off, or they will remain displayed even when the settings and waveform display is changed. (The label will be stored with each changing display until the label is turned off or replaced.)

5. External Interface Configuration.

a. Press the EXT INTFC CONFIG key to bring up the CONFIG menu.

b. Select Set Port1 Address. Set the GPIB Port Address with the KEYPAD to any selection from 0 to 30, and press ENTER.

c. Select Plotter Menu. Select the plotter type that you will be using. Then, select Set Plot Address, enter the desired address with the KEYPAD, and press ENTER. The plotter address must match the address set at the plotter.

d. Press ESC to go back to the CONFIG menu, select GPIB Port1 Menu, then select Management Bus Menu. Select the end of message transfer applicable to your plotter; either EOI or LF/EOI. While LF/EOI is probably a safe choice, refer to your plotter documentation if you are unsure.

6. Plot

a. Connect your GPIB plotter to Port 2 according to the directions supplied with the plotter.

b. Press the PLOT key to send all screen information to the plotter over GPIB. The screen data is stored into a plotter buffer so that the instrument may continue to be used while the plotter is plotting.

7. Store and Recall Settings

a. Press the SETTINGS STORE key to bring up the SET STORE menu and the settings register; see Figure 2-9.

b. When the settings register is first called up, the first register open for storage and the STORE SETTINGS selection are highlighted. The settings register shows the center frequency of the stored settings in the FREQUENCY column and any displayed label in the LABEL column.

c. Store the current settings in register 4.

(1) Scroll to register 4 with KNOB 1.

(2) Register 4 is now highlighted.

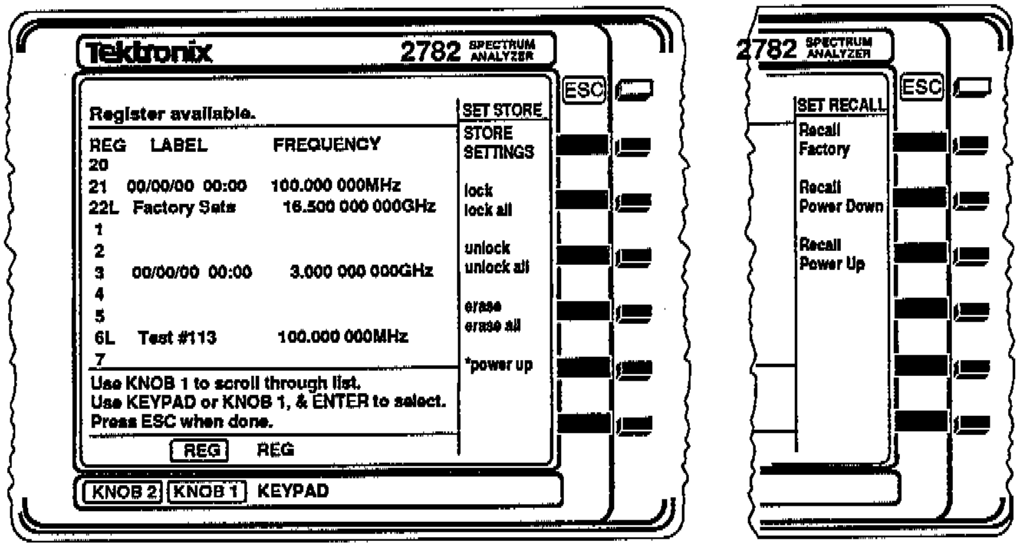


Figure 2-9. Settings Store and Recall Register Lists.

(3) Select SETTINGS STORE, and the current settings and label are stored in register 4.

If LABEL ON is selected at the LABEL menu, and the label is blank, nothing will appear in the LABEL column of the storage register when the settings are stored. If LABEL OFF is selected, the date stamp will be stored in the LABEL column of the storage register.

d. Press SETTINGS RECALL to bring up the SET RECALL menu and the settings register.

(1) Select RECALL POWER DOWN.

(2) The instrument returns to the state when power was last removed.

These settings (as well as any menu that was displayed at power down) were automatically stored in Set Store register 21.

e. Recall the instrument settings you saved in register 4 with RECALL POWER UP.

(1) Change the center frequency setting.

(2) Press SETTINGS RECALL again

(3) Select Recall Power Down, and note that the instrument settings are as they were before you changed center frequency.

f. Store the current settings, and define them to be the settings to be used at power up.

(1) Scroll to register 7 with KNOB 1. Select the register by scrolling to it or selecting it by number from the KEYPAD.

(2) Select STORE SETTINGS, and press ENTER.

(3) While the register is still highlighted, select *POWER UP, and press ENTER.

(4) The * preceding the register number indicates the user-selected power up settings are stored here.

These user-defined power-up settings will be used instead of the factory-default power-up settings; however, if these settings are ever erased, the factory-default power-up settings are again in effect.

(5) Press the POWER key once to turn off, then again to cycle the instrument power on.

(6) Note that the instrument settings are as you saved them in register 7.

(7) Change the center frequency to 100 MHz.

(8) Cycle the instrument power off and then back on again.

(9) Note that the instrument settings are again as they were saved in register 7.

(10) Scroll up to register 21 and note that the last change (frequency to 100 MHz) is held there as the power down setting.

8. RF Attenuation

a. Press the RF ATTEN key to bring up the RF ATTEN menu and assign the KEYPAD.

b. Note the differences between fixed and automatic RF attenuation.

(1) Note that the Auto selection is ON.

(2) Select 10 (dB) RF attenuation from the KEYPAD, press ENTER, and note that Auto goes OFF and the reference level remains the same, only the noise changes.

(3) Select Auto to turn it back ON. Auto ON will overdrive the first mixer by the amount selected by Set Mixer Overdrive.

(4) Using the dedicated keys, change the center frequency to 100 MHz, span to 100 MHz, and reference level to –20 dB; note the RF attenuation is 10 dB.

(5) Select Set Mixer Overdrive to temporarily assign the KEYPAD, select 10 (dB), and press ENTER. Note the drop in the noise level. The instrument is being driven 10 dB above the normal level, which allows a larger signal to noise ratio at the expense of higher distortion products. Auto ON will now pick 10 dB less attenuation than picked for optimum distortion performance in all but the 3 Hz resolution bandwidth, which has 10 dB available.

NOTE

There is up to 30 dB of mixer overdrive available.

9. Sweep

a. Press the SWEEP key to bring up the SWEEP menu.

b. Sweep will come up with the Auto mode ON unless the factory-default settings have been changed. Note the auto sweep operation.

c. Select Man Sweep Menu, then select Knob 1 to assign manual sweep to KNOB 1.

d. Select Man Sweep ON, and the SWP parameter reading is SWP MNL.

e. Rotate KNOB 1, and note manual sweep operation in the COARSE mode.

f. Select Knob1 Step FINE, rotate KNOB 1, and note manual sweep operation in the FINE mode.

g. Select Man Sweep OFF, and sweep is now back in the Auto mode.

10. Video Bandwidth

a. Press the VIDEO BW key to bring up the VIDEO BW menu.

b. Note differences in instrument operation when the resolution bandwidth to vertical bandwidth ratio is changed.

(1) The Auto selection must be ON.

(2) Note the rate at which the instrument is sweeping.

(3) Select Set Ratio ResBW/VBW to temporarily assign the KEYPAD.

(4) Increase the ratio by using the KEYPAD up-arrow increment key.

(5) Note how the sweep is slowed down with each key press.

(6) Decrease the ratio back to 1.00 with the KEYPAD decrement key.

11. Waveform View, Store, Recall, and Control

a. Press the WAVEFORM VIEW key to bring up the WF VIEW menu.

(1) If the factory-default settings have not been changed, the Normal waveform will be on in green and the Max Hold, Average, Math, view A, and view B waveforms will be OFF.

(2) Select A = Normal RD to turn the A waveform to red which copies the Normal waveform into the view A waveform. The Normal waveform has been stored into view A. This provides a "freeze" function.

View A and view B can display either a non-volatile register (red) or a Normal (normal) waveform; the control for this is in the WF RECALL menu.

(3) Select Max Hold GRN, and rotate the MARKER/FREQUENCY knob (the light to the left of the knob must be off for frequency control). Note that the red A waveform remains frozen, while the green Max Hold waveform and the green Normal waveform move.

(4) Select Normal RD, and rotate the MARKER/FREQUENCY knob.

(5) Select A = Normal OFF.

(6) Select Max Hold RD.

b. Press the WAVEFORM STORE key to bring up the WF STORE menu and the waveform register list, and the first empty register available is highlighted.

(1) Select MAX HOLD.

(2) Select an empty register with KNOB 1, and press ENTER. The Max Hold waveform is now stored in the selected register.

(3) While the selected register is still highlighted in the list (not the KEYPAD buffer area), select LOCK and press ENTER.

A confirmation message is displayed at the top of the screen, and an L is displayed to the right of the register number indicating that it is locked. The contents of this register cannot be changed unless the register is unlocked.

c. Press the WAVEFORM RECALL key to bring up the WF RECALL menu and the waveform register list.

(1) Select RECALL INTO B if the factory-default settings have been changed.

(2) With the KEYPAD, select a register with a stored waveform.

(3) Press ENTER, and the selected waveform has been recalled into view B.

d. Press the WAVEFORM VIEW key to bring up the WF VIEW menu again, and the waveform just recalled into view B is automatically displayed in red.

Select Max Hold OFF.

e. Press the WAVEFORM CONTROL key to bring up the WF CONTROL menu.

(1) Select Real Time Menu, then Real Time ON.

(a) The analog waveform is directly written to the CRT.

(b) Use the real time mode with wide video bandwidths like pulsed, demodulated signals.

(c) All color selection goes away, and the entire screen is displayed in green.

(d) Note that the active menu selections that were highlighted and fully capitalized are still capitalized and are displayed slightly brighter than the non-active selections.

(2) Select Real Time OFF and press ESC to back up to the WF CONTROL menu.

(3) Select Acq Mode Menu to display the waveform acquisition modes.

Select the MIN/MAX, MIN, MAX, and SAMPLE modes in turn and note how they differ from each other and the affect each has on the displayed noise.

(4) Press ESC to back up to the WF CONTROL menu.

(5) Select Average Menu, then Set Sweep Count.

Select 20 from the KEYPAD and press ENTER. This increases the number of sweeps to be averaged from the default of 10.

f. Press the WAVEFORM VIEW key to bring up the WF VIEW menu.

(1) Select Average RD and note that 20 waveforms are counted and averaged.

(2) Select Average OFF.

(3) Select Math RD.

g. Press the WAVEFORM CONTROL key, then select Math Menu.

(1) Select Operator1 Menu.

(2) The default math formula is displayed as shown here

(NORM)–	(A)	nop	(0)

(3) Select ADD +. Note that the formula reflects the change as it happens, and now is shown as

(NORM) +	(A)	nop	(0)

(4) Press ESC to go back to the MATH menu.

(5) Select Waveform2 Menu.

(6) Select CONSTANT then SET CONSTANT, and the KEYPAD is assigned to CONSTANT for waveform 2. Select 200 and press ENTER.

(7) Press the "Waveform View" key then push Math to RD.

(8) The display now shows the waveforms with a 2 division (200 display points) separation, and the formula again reflects the change.

12. INPUT

a. Change the center frequency to 3 GHz and the span to 6 GHz, and note the comb display.

The 100 MHz signal is still there at the left of the screen, but the comb display is also there.

b. Press the INPUT key to bring up the INPUT menu.

c. Select RefSig Out OFF, then back to ON, and note the display change.

When RefSig Out is OFF, the 100 MHz signal is gone, as is the comb.

d. Select RefSig Out SINGLE, then back to COMB, and note the display change.

e. Select Band Menu.

(1) Select Band to Knob 1 to assign band selection to KNOB 1.

(2) Select the external band range of 40-65.

Turn KNOB 1 clockwise until the external band range of 40-65 is reached. The current band range is displayed at the upper right of the screen, along with the harmonic (X5) of the YTO being used.

f. Press ESC to get back to the INPUT menu.

g. Select the Ext Mixer Menu, then Bias Menu.

Select BIAS RANGE to adjust the bias as desired (negative, center, or positive). Select negative bias for Tektronix WM 490 and WM 780 Waveguide Mixers. For the WM 782 Waveguide Mixer select the centered range.

h. Press the PRESET key to recall the factory power-up settings and return from external mixer operation to the coaxial band.

13. PROGRAM

You can prepare customized programs executed by front panel keys. Programs run independent of a controller and consist of up to 64 front-panel keystrokes or macros downloaded over GPIB. Any key can be used (referred to as code keys) except RUN/STOP or POWER.

Even with a key sequence or macro assigned to a key, the key still retains its original front-panel function. Press RUN/STOP and then a key with an assigned program, and the program is performed. In other words, the RUN/STOP key temporarily releases the key from its original assignment and invokes the program bound there. Only one key sequence or macro can be assigned to each key.

Each key sequence or macro is saved in NVRAM and is entered into a register at the next available register location. A screen message will flash when a code key is selected for assignment and the maximum number of key sequences is reached or the 36 Kbytes of memory dedicated to macros has been reached. Before any additional programs can be saved, existing programs (key sequences or macros, as applicable) must be erased.

Key Sequences

a. Display all key sequences.

(1) Press the PROG key, then select Sequence Menu to display the key sequence register. The register number, key, and identity of the first four keystrokes of the key sequence are displayed.

(2) You can change the key a key sequence is assigned to.

(a) Scroll through the register with KNOB 1 until the key sequence to be moved is selected.

(b) Select ASSIGN TO KEY then press ENTER.

(c) Press the new key, and the change shows up immediately in the KEY column. If a sequence was previously assigned to the selected key, that message will be displayed at the top of the screen, and no action will be taken.

b. Here are two examples of useful key sequences. The first example turns on all of the automatic functions (resolution bandwidth, sweep, video bandwidth, and RF attenuation) with only two keystrokes. The second example allows you to use only two keystrokes to escape from any level of menu activity. The third example explains how to include an existing key sequence within another key sequence.

Example 1 — Turn On All Automatic Functions

(1) Press the PRESET key to return to the factory-default conditions.

(2) Press the PROG key, then select Enter Key Sequence.

(3) Since the Auto selections will toggle off and on each time the corresponding soft key is pressed, and you are not sure what state Auto will be in when you run this key sequence, you must force the Auto conditions into the OFF state.

(a) Press the RES BW key. The KEYPAD is temporarily assigned to ResBW and Auto is ON. Press the KEYPAD decrement step key once to turn Auto OFF.

(b) Press the RF ATTEN, then SWEEP, then VIDEO BW keys and follow the procedure in (a).

(4) Turn all of the Auto selections on.

(a) Press the RES BW key, then select Auto ON.

(b) Press the RF ATTEN, then SWEEP, then VIDEO BW keys and follow the procedure in (a).

(5) Press the RUN/STOP key to terminate the key sequence. Then, press the RES BW key to assign the sequence to that key. This key sequence is now saved in NVRAM.

(6) Test the key sequence just assigned.

(a) Press the RUN/STOP key, then press the RES BW key to run the key sequence. Note that the RES BW, RF ATTEN, SWEEP, and VIDEO BW keys flash off and then back on.

Example 2 — Escape From Any Level of Menu

(1) Press the PROG key, then select Enter Key Sequence.

(2) Press the ESC key four times, then press RUN/STOP.

(3) Press ESC again and the multiple-ESC key sequence is now assigned to the ESC key. This key sequence is saved in NVRAM.

(4) Test the key sequence just assigned.

(a) Press the FREQUENCY key, select the Step Size Menu, select the Freq Keys Menu, and select Set Step in Hz.

(b) Press RUN/STOP ESC, and the menus are removed.

(c) This same multiple-ESC sequence can be a quick exit from only one or two levels of a menu as well.

Specification

DESCRIPTION

The following 2782 specifications and features apply after a 30-minute warm up, except as noted.

The Performance Requirement column defines some characteristics in quantitative terms and in limit form. Statements in this column are considered to be guaranteed performance that can be verified. Procedures to verify performance requirements are provided in the Performance Check portion of this manual.

The Supplemental Information column explains performance requirements or provides performance information. Statements in this column are not considered to be guaranteed performance, and are not ordinarily supported by a performance check procedure.

Verification of Tolerance Values

When performing compliance tests of specified limits listed in the Performance Requirement column, use measurement instruments that do not affect the values measured. Measurement tolerance of test equipment should be negligible when compared to the specified tolerance. If the tolerance is not negligible, add the error of the measuring device to the specified tolerances.

Table 3-1

FREQUENCY RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information		
External Mixer Input Bands		The 2782 input range is capable of extending from 8 GHz to 1200 GHz. Tektronix offers external wave-guide mixers that cover the 18 GHz to 325 GHz range.		
Odd LO Harmonic Bands		**Input Range (GHz)**	**LO Harmonic (N)**	**IF (GHz)**
Designation		8 to 12.5	1	–3.525
		12.4 to 18	1	+3.525
WM780K/WM490K		18 to 21.525	1	+3.525
(dual band)		21.225 to 26.5	3	–3.525
WM780A/WM490A		26.5 to 40	3	–3.525
WM780Q/WM490Q		33 to 50	3	–3.525
WM780U/WM490U		40 to 60	5	–3.525
WM780V/WM490V		50 to 75	5	–3.525
WM780E/WM490E		60 to 90	5	+3.525
WM780W/WM490W		75 to 110	7	–3.525
WM780F/WM490F		90 to 140	9	–3.525
WM780D/WM490D		110 to 170	11	–3.525
WM780G/WM490G		140 to 220	13	–3.525
WM780Y/WM490Y		170 to 260	15	–3.525
WM780J/WM490J		220 to 325	19	–3.525
		260 to 400	23	–3.525
		325 to 500	29	–3.525
		400 to 600	35	–3.525
		500 to 750	43	–3.525
		600 to 900	51	–3.525
		750 to 1100	63	–3.525
		600 to 1200	69	–3.525
Even LO Harmonic Bands				
WM 782A		26.5 to 36.125	2	–3.525
(dual band)		35.925 to 40	4	–3.525
WM 782Q		33 to 50	4	–3.525
WM 782U		40 to 65	4	–3.525
WM 782V		50 to 75	6	–3.525
WM 782E		60 to 95	6	+3.525
WM 782W		75 to 110	8	–3.525
WM 782F		90 to 140	8	–3.525
WM 782D		110 to 170	10	–3.525
WM 782G		140 to 220	14	–3.525
WM 782Y		170 to 260	16	–3.525
WM 782J		220 to 325	20	–3.525
		260 to 400	24	–3.525
		325 to 500	28	–3.525
		400 to 600	34	–3.525
		500 to 750	42	–3.525
		600 to 900	52	–3.525
		750 to 1100	62	–3.525
		600 to 1200	68	–3.525

Table 3-1 (Continued)

FREQUENCY RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Center Frequency Range Coaxial Input		100 Hz to 33 GHz
External Mixer Input		8 GHz to 1200 GHz
Resolution		0.1% of Span
Accuracy	± [Freq (RE + 10^{-10})] + S + M	Where: Freq = Center or Marker Frequency RE = Reference Oscillator Error S = 2% of Span or 20% of Resolution Bandwidth (whichever is greater) M = 10*N Hz for 10 Hz to ≤2 MHz Span or 100*N kHz >2 MHz Span
Marker Frequency Counter Range		100 Hz to 1200 GHz
Resolution		Selectable from 1 GHz to 1 Hz
Accuracy All Frequency Spans except 1MHz and 2 MHz 1 MHz and 2 MHz Frequency Spans	 ± [Freq (RE + 10^{-10})] + 8*N Hz + 1 LSD ± [Freq (RE + 10^{-10})] + 15*N Hz + 1 LSD	Where: Freq = Marker Frequency RE = Reference Oscillator Error N = LO Harmonic LSD = Least Significant Digit
Sensitivity	20 dB above noise and no more than 80 dB below Ref Level	Smallest signal that can be counted
Frequency Span Range Internal Coaxial Bands		10 Hz to 33 GHz, plus Max Span of 33 GHz
External Mixer Bands		10 Hz to 600 Hz
Resolution Frequency Spans ≥100 Hz Frequency Spans <100 Hz		 Selectable within ±1% Selectable within ±10%
Accuracy Frequency Spans >2 MHz >1 kHz and ≤2 MHz >100 Hz and ≤1 kHz	 ±2% ±1% ±7%	Frequency Spans ≥10 Hz and ≤100 Hz - ±7%

Table 3-1 (Continued)

FREQUENCY RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Resolution Bandwidth Range		6 dB bandwidths from 3 Hz to 10 MHz
Resolution		1-3-10 sequence
Bandwidth Accuracy 10 MHz and 3 MHz 1 MHz to 100 Hz 30 Hz and 10 Hz 3 Hz	 ±20% ±15% ±20% 	 +50% to −10%
Shape Factor	<10:1	60 dB/6 dB
Stability Residual FM ≤2 MHz >2 MHz	 1*N Hz p to p over 1 S, four out of five sweeps with 2782 reference locked to source to remove drift from measurement. 25*N kHz p to p over 500 mS	 Where N = LO Harmonic
Center Frequency Drift (Maximum) After 30 Minutes Warm Up ≤2 MHz >2 MHz		 <30*N Hz/minute of sweep time <25*N kHz/minute of sweep time Where N = LO Harmonic
After 1 Hour Warm Up ≤2 kHz >2 kHz	 <5*N Hz/minute of sweep time <5*N Hz/minute of sweep time	 Where N = LO Harmonic
Frequency Reference Accuracy Aging Rate		Reference Oscillator Error (RE) in accuracy specifications Applies after 7 days of continuous operation. <7 X 10^{-9} /day <1 X 10^{-6} /year (applies after 14 days of continuous oven operation. The Reference Oscillator and oven receive standby power whenever the instrument is plugged in.)

Table 3-1 (Continued)

FREQUENCY RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Frequency Reference Accuracy (continued) Warm Up		Standby Power: No warm-up time required. Without Power: After 24 hours turned off at room temperature; within 1 X 10^{-8} of frequency turnoff within 30 minutes. Long Term aging rate reached in 3 hours.
Temperature Drift with respect to 25°C		Serial Numbers BO19999 and below <±5 X 10^{-7} over the instrument temperature range of −10°C to +40° C, and <±1 X 10^{-6} over the range of +40°C to 55° C. Serial Numbers B020000 and above <±5 X 10^{-7} over the range of −10°C to +55°C

Table 3-2

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
RF Input		100 Hz to 33 GHz, dc coupled, Planar crown system connector with K compatible and N type adapters standard accessories
Impedance		50 Ω
VSWR With 10 dB RF Attenuation 100 Hz to 6.5 GHz 6.5 GHz to 28 GHz 28 GHz to 33 GHz		 <2.0:1 <2.5:1 <3.0:1

Table 3-2 (Continued)

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
RF Input (continued)		
Maximum Input Amplitude Without Damage AC		+30 dBm continuous, +47 dBm (50 W) peak with a pulse width of 1 µS or less with a maximum duty factor of <0.005, with a minimum of 50 dB RF attenuation +20 dBm continuous with 0 dB RF attenuation
DC		<100 mA continuous with 0.5 W (5 V)
1 dB Gain Compression Amplitude 100 Hz to 21 GHz 21 GHz to 28 GHz 28 GHz to 33 GHz	 0 dBm –3 dBm –6 dBm	
External Mixer Input Impedance		50 Ω with a VSWR of <1.9:1 at 525 MHz, and <2.2:1 at 3.525 GHz
Bias Voltage Range		–2 V to +2 V
Amplitude		Approximately –40 dBm for full screen signal, with –20 dBm Reference Level and 20 dB mixer conversion loss
1 dB Compression Point		–15 dBm at 3.525 GHz
Equivalent Input Noise 10 Hz Resolution Bandwidth and 0 dB Mixer Conversion Loss		–152 dBm, typical
LO Output Power 8.105 GHz to 17.9 GHz		+15 dB minimum
Marker Amplitude Measurement Range		–140 dBm to +30 dBm
Resolution		0.1 dB at 10 dB/div to 0.01 dB at 1 dB/div

Table 3-2 (Continued)

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Amplitude Measurement Display Flatness and Frequency Response (0-50 dB RF Attenuation, 20°C to 30°C		Flatness is specified over the temperature range of 20°C to 30°C. This is an overall instrument specification, including the RF Attenuation. (60 dB RF Attenuation, 20°C - 30°C)
100 to 6.50 GHz	±1 dB	± 1.0 dB
6.30 GHz to 12.775 GHz	±4.0 dB	± 4.0 dB
12.40 GHz to 21.25 GHz	±4.0 dB	± 4.0 dB
21.05 GHz to 28.025 GHz	±4.0 dB	± 4.0 dB
26.30 GHz to 33.00 GHz	±4.5 dB	± 4.5 dB
Reference Level Range		−140 dBm to +30 dBm; range extends to +60 dBm in overdrive mode
Resolution		0.1 dB
Temperature Drift		±0.15 dB/°C A self-correction cycle can be initiated that will correct reference level errors. Temperature drift then occurs relative to the temperature at the time of the self correction.
Vertical Display Law Range Log		1 dB/div to 15 dB/div
Linear		5 nV to 710 mV/div to two significant digits, nominal 5 nV to 22 V/div with 30 dB mixer overdrive
Square Law		10^{-18} W to 100 mW/div to two significant digits, nominal 10^{-18} W to 100 W/div with 30 dB mixer overdrive
Accuracy		The accuracy specifications apply for amplitude measurements done with the marker only, since marker measurements are corrected for logging errors.
Typical Temperature Drift 10 dB/div 1 dB/div		 2%/10°C 1.2%/10°C

Table 3-2 (Continued)

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information.
Amplitude Measurement (cont)		
Vertical Display Law Accuracy (continued)		
Log	±0.2 dB/1 dB incremental	
	≤ ±1.5 dB cumulative over the 0 to 90 dB range at self-correction temperature	≤ ±1.5 dB cumulative over the 0 to 90 dB range within ±5°C of self-correction temperature
	≤ +2/–3.5 dB cumulative over the 0 to 100 dB range at self-correction temperature	≤ +2/-3.5 dB cumulative over the 0 to 100 dB range within ±5°C of self-correction temperature
	±1.67 dB cumulative over 60 dB in 25 MHz path	
	±0.8 dB cumulative over 27 dB at 3 dB/div	
Linear	±5% of full scale	
Square Law	±8% of full scale	
RF Attenuator Range		0 dB to 70 dB
Resolution		10 dB
Accuracy at 100 MHz Center Frequency	±0.5 dB	
IF Gain		IF gain can be reduced to allow the RF input to be overdriven by 30 dB (that is, 0 dBm reference level with 0 dB RF attenuation). Note that only 10 dB of mixer overdrive is available with the 3 Hz resolution bandwidth.
Range		0 dB to 140 dB
Resolution		0.1 dB
Accuracy	≤ ±1.0 dB over the range of 0 to 50 dB and ≤ ±1.5 dB over the range 0 to 100 dB at self-correction temperature	Typically: ≤ ±1.0 dB over the range of 0 to 50 dB and ≤ ±1.5 dB over the range 0 to 100 dB within ±5°C of self correction temperature

Table 3-2 (Continued)

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Amplitude Measurement (cont)		
Gain Variation Between Resolution Filters At Self-Correction Temperature 10 MHz to 30 Hz 10 MHz to 10 Hz 10 MHz to 3 Hz	 0.5 dB peak to peak 0.75 dB peak to peak 2 dB peak to peak	Measured at –20 dBm reference level, 10 dB RF attenuation, and after two hour warm up.
Typically ±5°C of Self-Correction Temperature 10 MHz to 30 Hz (except 10 kHz) 10 MHz to 10 Hz 10 MHz to 100 Hz		 0.75 dB peak to peak 1.5 dB peak to peak 0.35 dB peak to peak
Error in Setting –20 dBm Reference Level	–20 dBm ±0.25 dB at self-correction temperature	Typically –20 dBm, ±1.2 dB within ±5°C of self-correction temperature At –20 dBm reference level, 10 dB RF attenuation, 3 MHz resolution filter, 100 MHz center frequency, sample acquisition mode using the REF SIGNAL OUT as a source. This error is added to the REF SIGNAL OUT Amplitude accuracy specification (Table 3-5) to arrive at the absolute amplitude accuracy at these instrument settings.
Band Switching Uncertainty	±1.5 dB	Gain changes when changing internal bands
Pulse Digitization Error		typically 4 dB Displayed pulse amplitude degradation versus actual pulse amplitude measured with a 200 nS wide pulse with 10 MHz resolution bandwidth, 10 MHz video bandwidth, and max or min/max acquisition mode
Amplitude Measurement Dynamic Range Equivalent Input Noise		With 0 dB RF attenuation and 10 Hz resolution bandwidth
100 Hz to 50 kHz	–78 dBm	
50 kHz to 5 MHz	–105 dBm	
5 MHz to 2.5 GHz	–135 dBm	
2.5 GHz to 6.5 GHz	–132 dBm	
6.5 GHz to 21.25 GHz	–125 dBm	
21.25 GHz to 28 GHz	–120 dBm	
28 GHz to 33 GHz	–107 dBm	

Table 3-2 (Continued)

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Amplitude Measurement (cont)		
Phase Noise Sideband (dBc/Hz)		Measured at frequency spans ≤2 MHz
Offset Center Frequency	100 Hz / 1 kHz / 10 kHz / 100 kHz / 1 MHz	100 Hz / 1 kHz / 10 kHz / 100 kHz / 1 MHz
6.5 GHz	–85 / –97 / –105 / –105 / –112	
12 GHz	–80 / –95 / –105 / –105 / –112	
21 GHz		–75 / –90 / –105 / –105 / –112
33 GHz		–70 / –86 / –97 / –97 / –102
Spurious Responses		Measured relative to (–30 dBm + RF Atten) signal amplitudes at the RF Input. All responses are less than (–80 dBc+20 log N) or (average noise level + 3 dB) whichever is greater, except as noted in the following specification. N = Harmonic Number.
Residual Signals		Signals displayed by the 2782 independent of input signals
100 Hz to 10 MHz	<–77 dBm	
(except at 2 MHz with 30 kHz and wider resolution bandwidth)	<–70 dBm	
10 GHz to 6.5 GHz	<–100 dBm	
6.5 GHz to 21.25 GHz	<–92 dBm	
21.25 GHz to 28.025 GHz	<–82 dBm	
28.025 GHz to 33 GHz	<–80 dBm	
Line Related Sidebands at Center Frequency		
<28 GHz	<–75 dBc	
28 GHz to 33 GHz	<–65 dBc	
Zero Spur	Equivalent to ≤0 dBm input signal	
Intermodulation Rejection Second Order Intercept (Center Frequency)		
1 MHz to 6.5 GHz	>+28 dBm	
6.5 GHz to 33 GHz		>+70 dBm
Third Order Intercept Signal Separation <150 MHz & >20 kHz (Center Frequency)		
1 MHz to 6.5 GHz	>+15 dBm	
6.5 GHz to 28 GHz	>+10 dBm	
28 GHz to 33 GHz		>+15 dBm

Table 3-2 (continued)

AMPLITUDE RELATED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Spurious Responses (cont)		
Signal Separation >150 MHz (Center Frequency)		
1 MHz to 6.5 GHz		>+15 dBm
6.5 GHz to 28 GHz		>+20 dBm
28 GHz to 33 GHz		>+20 dBm
Second Order Harmonic Distortion (Center Frequency)		Measured with −30 dBm input level
1 MHz to 6.5 GHz	<−60 dBc	
6.5 GHz to 33 GHz	<−100 dBc	
LO Emission (Center Frequency)		At 0 dB RF attenuation
100 Hz to 6.5 GHz		≤−75 dBm
6.5 GHz to 33 GHz		≤−65 dBm
IF/N Response		<−90 dBc Due to an input signal at 10.025 GHz/N, 3.525 GHz/N, or 525 MHz/N <−70 dBc Due to an input signal at 5.0125 GHz and center frequency in band 1 (0 to 6.5 GHz) Where N = LO Harmonic
Out of Band Responses Image Responses	<−65 dBc from 100 Hz to 33 GHz	Due to 100 Hz to 33 GHz RF input which lie outside the preselector bandwidth, or due to 3.525 GHz input to de-selected External Mixer input.
Harmonic Conversions		<−65 dBc from 100 Hz to 28 Hz <− 55 dBc from 28 Hz to 33 GHz
Signals at External Input with Coax. Input Selected		<−90 dBc from 100 Hz to 33 GHz

Table 3-3

DISPLAY CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Video Filter Range		0.03 Hz to 300 kHz 3 dB bandwidth, in a 1-3-10 sequence, each step nominally within ±25% Specific bandwidths in this sequence can be selected.
Digital Storage Maximum Sweep Rate With 10-bit Resolution With Reduced Horizontal Resolution		 10 ms 2 ms
Vertical Digitizer Uncertainty		±0.4%

Table 3-4

REAR PANEL INPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
FREQ REF (IN/OUT) Impedance		Nominally 50 Ω
Input Signal Frequency Allowed	10 MHz ±5 Hz	
Input Signal Amplitude Range	0 dBm to +15 dBm maximum	
Output Signal (when selected)		Nominally 0 dBm at 10 MHz (TTL-compatible)
Phase Noise Allowable		≤–100 dBc/Hz at 1 Hz offset, without degradation of instrument phase noise performance

Table 3-4 (Continued)

REAR PANEL INPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
TRIG/HORIZ IN Impedance/Coupling		Nominally 1 kΩ (trigger mode), or 8.25 kΩ (sweep mode) in parallel with 33 pF, dc coupled
Input Voltage Change Required for Triggering	0.5 V peak to peak	With selectable input frequency of 0 Hz to 5 MHz, or 0 Hz to 1.5 kHz (HF rejection)
Triggering Level		Adjustable between –5 V and +5 V with + or – slope selectable.
Input Voltage Required for Sweep		Selectable to between • 0 V left side of screen to +10 V right side of screen • –5 V left side of screen to +5 V right side of screen Do not exceed ±30 V (DC +peak AC) at the input. This selection is common with, but opposite of, the SWPOUT selection (that is, if SWPOUT is set for 0 to +10 V, TRIG/HORIZ IN is ±5 V).
Accessory Connector		A 15-pin connector for external inputs and outputs.
EXTBLANK (Pin 15) (Ext In Display Blanking)		External access to blanking of the CRT beam. TTL compatible — logic one blanks the screen.
EXTH+ (Pin 3), EXTH– (Pin 4) (Ext In Display Horiz) and EXTV+ (Pin 5), EXTV– (Pin 6) (Ext In Display Vert)		External access to the real time horizontal and vertical channels of the instrument.
Impedance/Coupling		>1.5 kΩ in parallel with 200 pF, DC coupled
Input Voltage Rating		Do not exceed ±5 V (DC + peak AC) at the inputs. Common mode offset not to exceed ±400 mV
EXTH+,– Expanded Graticule		Differential voltage of –0.9 V, ±10% at left edge of graticule, to +0.9 V, ±10% at right edge of graticule.

Table 3-4 (Continued)

REAR PANEL INPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Accessory Connector (cont) EXTH+,– (cont) Compressed Graticule		Differential voltage of –0.9 V, ±10% at left edge of graticule, to +0.55 V, ±10% at right edge of graticule.
EXTV+,–		Differential voltage of –0.6 V, ±10% at bottom edge of graticule, to +0.7 V, ±10% at top edge of graticule.
Bandwidth (3 dB)		Approximately 10 MHz
SWPOUT (Pin 7) (Sweep Output)		The sweep voltage used to drive the frequency control and display systems.
Impedance		1 kΩ
Output Voltage		Selectable to between • 0 V left side of screen to +10 V right side of screen • –5 V left side of screen to +5 V right side of screen Do not exceed ±30 V (DC +peak AC) at the input. This selection is common with, but opposite of, the TRIG/HORIZ IN selection (that is, if SWPOUT is set for 0 to +10 V, TRIG/HORIZ IN is ±5 V).
EXTVI+ (Pin 1), EXTVI– (Pin 2) (Ext In Video)		External access to the input of the 2782 video processing system This system includes video filters, digital storage acquisition, and the storage bypass mode.
Impedance/Coupling		75 Ω
Input Voltage Range		Differential or single-ended voltage of –0.875 V bottom of screen to +0.875 V top of screen. When using single-ended, ground one input. Do not exceed ±5 V (DC + peak AC) at the inputs. Common offset not to exceed ±400 mV.
Bandwidth		Approximately 7.5 MHz

Table 3-4(Continued)

REAR PANEL INPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Accessory Connector (cont) Penlift (Pin 8)		Unused
External YIG Coil Tune Voltage (Pin 9) and Return (Pin 10)		An external output of the YTO coil tuning voltage and a return path
Pins 11 and 12		Unused
Instrument Bus		Serial communications bus that the processors use to communicate with each other and the rest of the instrument modules Pin 1 Ground Pin 2 Status Line 0 (TTL output) Pin 3 Clock (TTL output) Pin 4 Data (TTL bi-directional) Pin 5 Service Request Line (TTL input) Pin 6 Status Line 1 (TTL output) Pin 7 Reset Line (TTL output) Pin 8 Data Direction Indicator (TTL input) Pin 9 Port Enable (TTL input)

Table 3-5

FRONT PANEL OUTPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
LO OUTPUT		Provides access to the output of the 1st local oscillator at >+4 dBm *This port must be terminated in 50 Ω at all times.*
PROBE POWER		Provides operating voltages for active probes

Table 3-5 (Continued)

FRONT PANEL OUTPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
PROBE POWER (cont)		Output voltages are • Pin 1 +5 V, ±5%, at 100 mA max • Pin 2 Ground • Pin 3 −15 V, ±5%, at 100 mA max • Pin 4 +15 V, ±5%, at 100 mA max
REF SIGNAL OUT Amplitude		−20 dBm
Amplitude Accuracy	±0.3 dB	
Frequency		100 MHz Phase locked to reference oscillator
ACCESSORY IN		General purpose serial data port for future accessory use
EXTERNAL MIXER LO Output 10 GHz to 16.5 GHz	≥+15 dBm	

Table 3-6

REAR PANEL OUTPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
V OUT (External Display Vertical Signal Output)		Jumper selectable between full deflection amplifier signal or the real time signal only. Factory set for real time only.
Amplitude		−1.25 V to +1.25 V for full screen deflection from bottom to top
Impedance		50 Ω
Accuracy		±10%

Table 3-6 (Continued)

REAR PANEL OUTPUT CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
H OUT (External Display Horizontal Signal Output)		Jumper selectable between full deflection amplifier signal or the real time signal only. Factory set for real time only.
Amplitude		–1.25 V to +1.25 V for full screen deflection from left to right
Impedance		50 Ω
Accuracy		±10%
Z OUT (External Display Blanking Signal Output)		Use the Penlift output (Pin 8 of Accessory Connector) for Z-axis control of a real time display using V OUT and H OUT is desired.
Amplitude		0 V fully blanked to +1 V full intensity
IF OUT Amplitude		+9 dBm, ±2 dB for full screen signal with –30 dBm reference level, 100 MHz center frequency and 1 kHz resolution bandwidth. The output level may be different with different reference levels, center frequencies, or resolution bandwidths.
Impedance		50 Ω (VSWR ≤1.5:1)
Frequency 3 MHz or 10 MHz Res BW		25 MHz
≤1 MHz Res BW		4 MHz
External Interface Connectors		Two GPIB connectors are standard.

Table 3-7

UNCATEGORIZED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
IEEE STD 488-1978 Port (GPIB) Interface Functions Port 1		SH1, AH1, T5, L3, SR1, RL0, PP0, DC1, DT1, C0 (Option 16 is RL1)

Table 3-7 Continued)

UNCATEGORIZED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
IEEE STD 488-1978 Port (cont) Interface Functions (cont) Port 2		SH1, AH1, T5, L3, SR0, RL0, PP0, DC0, DT0, C1, C2, C3, C27 (C0 is selectable)
Sweep Generator Sweep Speed Range		200 S to 2 µS in a 1-2-5 sequence
Accuracy ≤50 µS ≥20 µS	 ±5% ±10%	
Triggering		Adjustable trigger level and slope; HF Reject with 1.5 kHz cutoff frequency
Internal		AC coupled, frequency range from 10 Hz to 1 MHz; no more than two divisions of signal height required to trigger
External		DC coupled, frequency range from 0 Hz to 5 MHz and 0.5 V_{p-p} required to trigger
Line		Copy of AC line
Non-Volatile Memory CMOS Battery Backup NVRAM		Stores waveforms, settings, macros, and key sequences
Battery Type		Lithium cells **WARNING** To avoid personal injury, observe proper handling and disposal procedures for lithium batteries. **Lithium Battery Handling** Improper handling of lithium batteries may cause fire, explosion, or severe burns. • Do not recharge batteries • Do not crush or disassemble batteries • Do not heat batteries above 302°F (150°C) • Do not incinerate batteries • Do not expose battery contents to water **Warning Continued**

Table 3-7 (Continued)

UNCATEGORIZED CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
		WARNING (Cont) **Lithium Battery Disposal** Dispose of batteries in accordance with local, state, and national regulations. • Typically, small quantities (less than 20) can be safely disposed of with ordinary garbage in a sanitary landfill. • Larger quantities must be sent by surface transport to a hazardous waste disposal facility. Package the batteries individually, to prevent shorting, in a sturdy container that is clearly labeled as follows. *— Lithium Batteries —* *DO NOT OPEN*
Memory Retention		Guaranteed to −10°C ambient temperature
Battery Life		1.8 years at 20°C ambient temperature, continuous off time 1 year at 50°C ambient temperature, continuous off time Batteries are not used when the instrument is connected to a power source.
EEPROM		Stores instrument correction data.

Table3-8

POWER REQUIREMENTS

Characteristic	Description
Input Voltage	90 to 132 V_{ac}, 47 to 440 Hz 180 to 250 V_{ac}, 47 to 63 Hz
Power	250 W maximum, 2.8 A at 115 V_{ac}, 60 Hz
Leakage Current	3.5 mA maximum

Table 3-9

ENVIRONMENTAL CHARACTERISTICS

Meets the following MIL-T-28800C Type III, Class 3, Style C specification

Characteristic	Description
Temperature Operating	–10°C to +55°C (tested to –15°C)
Non-Operating	–62°C to +85°C
Humidity	5 cycles per MIL STD 810D Procedure III (modified)
Altitude Operating	15,000 feet (tested to 25,000 feet)
Non-Operating	40,000 feet (tested to 50,000 feet)
Vibration Operating	MIL STD 810D Procedure I (modified). Resonant searches in all three axes from 5 Hz to 15 Hz at 0.060-inch displacement for 7 minutes, 15 Hz to 25 Hz at 0.040-inch displacement for 3 minutes, and 25 Hz to 55 Hz at 0.020-inch displacement for 5 minutes (tested to 0.025 inch). Dwell for an additional 10 minutes in each axis at the frequency of the major resonance or at 55 Hz if none was found. Resonance is defined as twice the input displacement. Total vibration time is 75 minutes.
Shock Operating and Non-Operating	Three shocks of 30 g, one-half sine, 11 mS duration each direction along each major axis. Guillotine-type shocks. Tested to 50 g.
Transit Drop	8 inches, one per each of six faces and eight corners. Tested to 12 inches.

Table 3-9 (Continued)

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Description
Electromagnetic Interference (EMI) MIL STD	Meets MIL STD 461C Part 4 as follows
Conducted Emissions	CE01 — 60 Hz to 15 kHz, 15 dB relaxation below 2 kHz CE03 — 15 kHz to 50 MHz power leads
Conducted Susceptibility	CS01 — 30 Hz to 50 kHz power leads, full limits CS02 — 50 kHz to 400 MHz power leads, full limits CS06 — spike power leads, full limits
Radiated Emissions	RE01 — 30 Hz to 50 kHz magnetic field, 5 dB relaxation below 1 kHz and a 20 dB relaxation from 10 kHz to 35 kHz RE02 — 14 kHz to 1 GHz, meets MIL STD 461C Part 7 to full limits
Radiated Susceptibility	RS01 — 30 Hz to 50 kHz magnetic field, full limits RS02 — Magnetic Induction; 30 dB relaxation at 60 Hz, 20 dB relaxation at 440 Hz RS03 — 14 kHz to 1 GHz Front-End Responses, full limits at 1 V/meter, relaxed 10 dB at 10 V/meter. IF frequencies, relaxed 10 dB at 1 V/meter and relaxed 30 dB at 10 V/meter. 1 GHz to 10 GHz Front End Responses, full limits at 1 V/meter, relaxed 20 dB at 10 V/meter. IF Frequencies, relaxed 25 dB at 1 V/meter and relaxed 45 dB at 10 V/meter.

Table 3-10

PHYSICAL CHARACTERISTICS

Characteristic	Description
Weight With standard accessories and cover, except manuals	44 pounds (20 kg)
Dimensions Without front cover, handle, or feet	See Figure 3-1 8.050 X 12.90 X 18.59 inches (204.47 X 327.66 X 472.186 mm)
With front cover, handle folded back, and feet	8.050 X 15.750 X 21.638 inches (204.47 X 400.05 X 549.605 mm)
With front cover, handle fully extended	8.050 X 15.55 X 24.578 inches (204.47 X 394.97 X 624.281 mm)

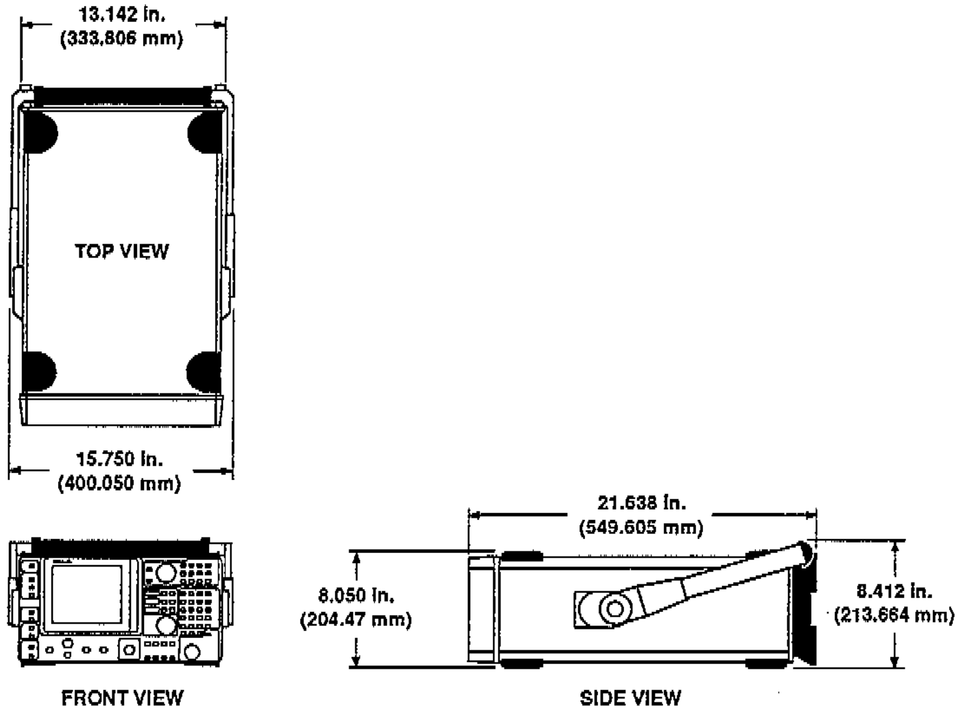


Figure 3-1. Dimensions.

Performance Tests

Introduction

This procedure checks the instrument performance against the specifications. The performance checks are divided into two parts; The first part checks the instrument amplitude flatness and residual spurious signal response. The second part checks general instrument parameters.

Both parts of this procedure are designed to be used with a personal computer and performance-check software, which automates some of the setup of the instrument and the recording of test data. The flatness-check software is a stand-alone program called CATS. The software used for the remainder of the checks is a spreadsheet that runs using Lotus 1-2-3 and Lotus Measure.

Performance Check Environment

The ambient temperature for the instrument should be within ±5° C of the temperature where self-correction of the instrument was performed. The ambient temperature during factory calibration is 25° C.

Before making any of these checks, allow the instrument to warm up for at least one hour.

Cautions Concerning the Software

The software used for these tests provide GPIB commands to control the instrument. Use of these commands provides automated setup and, in some cases, measurement of instrument specifications.

When the commands are sent to the instrument, the sequence may result in instrument status messages being displayed for a brief time. Once the instrument has received the commands, only messages relating to the test will be displayed.

We recommend that the steps be done in the given sequence since the controlling computer has no way of knowing the status of toggle functions done out of sequence. This can result in incorrect instrument settings. If it is necessary to perform a step out of sequence, first enter P(revious) then N(ext) to initialize the toggle functions.

When making a measurement, press the M key only once. If the key is pressed several times, the software may require several minutes to respond.

CAUTION

Do not attempt to use the Calibration selection of the Flatness Software without first consulting the Service Manual. Running the calibration portion of the program without the proper procedure and equipment could result in loss of flatness data.

Equipment List

The following equipment is required to perform the performance verification tests in this section.

Table 2-1. Equipment Required for Performance Verification

Item	Characteristic	Recommendation
Personal Computer	80286-based PC (IBM PC AT or equivalent), EGA graphics card and monitor, MS-DOS 3.1 or later, and two GPIB interface boards. The GPIB interface boards for the Flatness check must be National PC2A compatible. NOTE: If only the Performance Check is to be done, you may substitute a PC with 8088 CPU or better, MS-DOS 2.0 or better, dual floppy-disk drives or one floppy-disk drive and one hard-disk drive; 640 KBytes of RAM; graphics monitor; and one National PC2 or PC2A GPIB interface board.	Tektronix PEP301 with Tektronix S3FG120 GPIB Interface board. (Two GPIB Interface boards required for Flatness checks) or IBM PC XT or equivalent (IBM PC AT or equivalent for Flatness checks)
GPIB Interface Cable(s)	GPIB Interconnecting cable, 2 meters long. NOTE: 4 or 5 cables are required (depending on generators used) to perform the Flatness check. One cable is required for the Performance Checks.	Tektronix Part No. 012-0630-01
Performance Check Software		Tektronix 2782 Performance Verification Software, Tektronix Part Number 063-0227-00, version 5.0 or higher and Flatness, Calibration and Performance Verification Software, Tektronix Part Number 063-0228-01, version 2.0 or higher Lotus 1-2-3 Version 2.0 or later, Lotus Measure, Version 1.0 or later Two blank, formatted, 5.25-inch floppy disks

Table 2-1. Equipment Required for Performance Verification (Continued)

Item	Characteristic	Recommendation
Test Oscilloscope	100 MHz frequency range	Tektronix 2235 Oscilloscope
Power Meter	0 to 33 GHz frequency range	Hewlett-Packard HP 438A with HP 8484A and HP 8481A Power Sensors, and HP11708A 50 MHz 30 dB Reference Attenuator Flatness check - two additional power sensors are required. An HP 8487A replaces the HP 8481A, and an HP 8482A is also needed
Frequency Standard	10 MHz output, 0.01 Hz accuracy	WWV standards receiver or equivalent high-accuracy standard
Signal Generator	10 MHz to 112 MHz frequency range, with less than –50 dBc harmonic distortion. and lockable to 10 MHz external reference signal	Hewlett-Packard HP 8642A Synthesized Signal Generator or equivalent
500 MHz Comb Generator	500 MHz and harmonics, with connector head and 6 dB attenuator	Microwave Comb Generator. Tektronix Part No. 067-0885-00
Time Mark Generator	1 ns to 0.1 s marker output	Tektronix TG501
Function Generator	3 Hz to 10 MHz frequency range	Tektronix FG5010
Power Module	Required for TM500/TM5000-series test modules	TM5000-series Power Module (Option 02 required for external reference input)
Step Attenuators	1 dB steps, accurate within 0.1 dB at 100 MHz 10 dB steps, accurate within 0.5 dB at 100 MHz	Hewlett-Packard HP 355C Hewlett-Packard HP 355D
Fixed Attenuators	6 dB 50 Ω SMA (2 each) 10 dB 50 Ω, 2 W, dc to 12.4 GHz, N Connector	Tektronix Part No. 015-1001-00 Tektronix Part No. 011-0085-00
Terminators	50 Ω BNC feedthrough termination 50 Ω SMA-male end termination	Tektronix Part No. 011-0049-01 Tektronix Part No. 015-1022-00
Coaxial Cables	BNC, 50 Ω ±1% precision, 36 in. BNC, 50 Ω, 42 in. (2 each) SMA, 50 Ω, 28.5 in.(2782 standard accessory)	Tektronix Part No. 012-0482-00 Tektronix Part No. 012-0057-01 Tektronix Part No. 012-0649-00

Table 2-1. Equipment Required for Performance Verification (Continued)

Item	Characteristic	Recommendation
Connector Adapters	BNC male to BNC male (2 each) BNC female to BNC female BNC female to SMA female BNC T (2 each) N female to SMA male SMA female to SMA male	Tektronix Part No. 103-0029-00 Tektronix Part No. 103-0028-00 Hewlett-Packard 1250-2015 Tektronix Part No. 103-0030-00 Hewlett-Packard 1250-1562 Hewlett-Packard 1250-1462
BNC-to-Dual Pin Out Cable	Provide two pins for connecting to 2782 Accessories Interface	Connector (DF-15 style connector) Tektronix Part No. 175-1178-00
Synthesizer/Level Generator	Used for second and third order intercept checks.	Hewlett-Packard HP 3335A, HP 3336C, HP 8656A/B, Fluke 6061
Swept Frequency Generators (2 each)	dc to 40 GHz NOTE: Second generator is required only for second- and third-order intercept checks.	Wiltron 6769B, HP 83640A
Combiners (3 required)	Combiners are only needed for the second- and third-order intercept checks.	Mini-Circuits ZFSC-2-5 Mini-Circuits ZFSC-2-6 Narda 4324-2 (2 to 8 GHz) (All three are required for these checks)
Low-Pass Filters (4 required)	Low-pass filters are only required for second-harmonic distortion check.	K&L 4L51-15-B/B K&L 5L51-551-B/B K&L 5L120-850-O/O K&L 3L120-3500-O/O (All four are required for these checks)
Test Spectrum Analyzer	LO Out Phase Noise equal to 2782 (required only for Phase Noise Check) 10.525 GHz Center Frequency (required only for LO Emissions check)	Another Tektronix 2782 or Tektronix 492BP if Phase Noise check is not performed.

Table 2-1. Equipment Required for Performance Checks (Continued)

Item	Characteristic	Recommendation
Connectors, Pads, and Splitters	Power Divider (dc to 40 GHz)	Wiltron K240C
	40 GHz flexible 50 Ω cable with K connectors	WL Gore PD501501048.0
	3 dB attenuator (2 each)	Wiltron 43KC-3
	K-male-to-male connector	Wiltron K220
	N-female-to-SMA-male connector	Tektronix 015-1009-00
	2.4-mm-female-to-K-male connector	Hewlett-Packard 11904D
	K male-to-female connector (2 each) (optional)	Wiltron K224
	50 Ω termination	

Part I. Performance Check — Amplitude Flatness and Residual Spurious Signals Response

This section of the instrument performance verification procedure describes how to measure the frequency response (or amplitude flatness) and residual spurious signal response of the instrument. This part of the verification procedure is done with a Tektronix designed software package that performs flatness calibration and verification and a test of the residual spurious response. This software runs on an IBM-PC AT or compatible computer using DOS Version 3.1 or later.

Overview of the Flatness and Residual Signals Test Procedure

To verify the flatness performance and residual signal response of an instrument, you must perform the following steps:

A. Install the GPIB cards (two are required) in the personal computer.

B. Install the Flatness and Residual Signals test software on the personal computer.

C. Run the system configuration program (CONFIG.EXE).

D. Connect the test equipment to the GPIB port labeled GPIB0 on the computer.

E. Run the test equipment characterization program (UTIL.EXE).

NOTE

After the initial installation, this step is only necessary if the power divider or 3 dB pad are replaced.

Steps A through E are required for initial installation only.

F. Connect the Instrument Under Test to the GPIB port labeled GPIB1 on the computer. Setup the test configuration for flatness or residual spurious signals.

G. Run the program CATS.EXE. When prompted for the sequence to run, choose the CAL sequence to perform flatness calibration or the PV sequence to perform flatness verification and the residual signals test.

H. If a summary of the test data is desired, run the report generator (RPT.EXE).

I. If a graphics plot of the flatness test results is desired, run the program PLOTF.EXE.

The following sections describe these steps in detail.

A. Install the GPIB Card in the Personal Computer

The test equipment required for the flatness verification is given in the equipment list. Use the following procedure to install the GPIB cards.

1. Set the base addresses for the two PC2A GPIB boards and install them in the personal computer. (Instructions for setting the base addresses for these boards and installing them in the PC are contained in the instruction manual that comes with the board.)

   Each GPIB board must be given a base address that the software uses to identify the board. The PC2A boards should come with their base address set to 02E1 (hex). Leave one board set at that address, and set the address of the other board to 22E1 (hex). Leave the DMA channel and interrupt line settings at their defaults. To coincide with this procedure, it is helpful to label the GPIB boards with numbers: label the board with base address 02E1 as #0, and label the other board (base address 22E1) #1. Refer to Switch Setting illustration for setting the switches.

2. If conflicts occur with DMA or interrupts refer to the manual provided with the National Instruments GPIB-PC2A boards.

Key
Black = side you must press down
= used to set the interrupt line

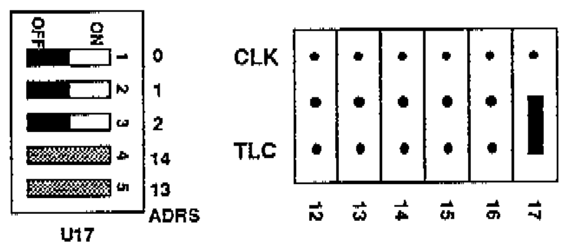
GPIB 0

Switches Set to Base I/O Address hex 02E1

GPIB 1

Switches Set to Base I/O Address hex 22E1

Key
Black = side you must press down
= used to set the base I/O address



Interrupt Jumper Setting for IRQ7 (Default Setting)

Default Switch Settings for the GPIB controller Cards.

B. Install the Flatness and Residual Signals Test Software

The software is contained on a set of 5 1/4-inch floppy disks, which come with this manual.

Use the following procedure to install the software on the personal computer :

1. Install disk 1 in drive A of the personal computer.
2. Set the default drive for A (A:<ENTER>).
3. Enter the following command to install the flatness software on your hard disk:

   A> install <ENTER>

   A prompt will instruct you to switch disks.

NOTE

INSTALL.BAT is a batch file that creates a directory on your hard disk (called TEKCATS) and several subdirectories. It then copies the flatness software into these directories.

C. Running the System Configuration Program (CONFIG.EXE)

The CONFIG.EXE program generates a table that describes the test equipment being used and their respective GPIB addresses. It also creates a data file for each power sensor, containing the calibration factors to be used at each frequency. The calibration factor information comes from the table printed on each sensor.

The CONFIG program is run automatically when the software package is first installed on your PC. You may run it manually any time you need to change a piece of test equipment, by entering the following at the prompt:

> CONFIG<ENTER>

CONFIG.EXE will prompt you for what test equipment is used and information concerning it. After all information is entered, you will be asked to verify that it is correct. If it is not, you will be asked to re-enter the information.

The information requested consists of the device's GPIB address (except for power sensors), an identification number for the device, and the date it will be due for re-calibration. For the power sensors, you will be asked to enter the table of calibration factors printed on the sensor. When entering calibration factor information be sure to include the 50 MHz reference value.

D. Connect the Personal Computer to Control the Test Instruments

1. Connect instrument to be tested, signal generators, and power meter to the computer through GPIB cables, as shown in Figure 4-1.

2. Apply power to the instrument and test equipment then allow a warm up of at least one hour.

3. Set the GPIB address of the instrument to 1 as follows. On the instrument front panel, press EXT INTFC CONFIG, then press the Set Port1 Address menu button. Enter 1 from the KEYPAD, and press ENTER. A message is then displayed on the CRT indicating that the GPIB port address has been reset.

4. If necessary, set the clock speed of the personal computer to 6 MHz.

   Instruments with firmware revisions before V2.1, are sensitive to the rate at which data is received through the GPIB interface. When an instrument is receiving a long or repetitive series of commands over the GPIB bus, it may stop responding to commands or queries. If this happens, the program will display a warning message;

   "DUT I/O ERROR —> WRITE FAILED".

To restore GPIB control, cycle the instrument POWER switch off and on; then, restart the test.

This problem occurs only when the instrument is connected to a high-speed controller with a very high GPIB data transfer rate (for example, a clock rate of 16 MHz). To prevent lock up of the instrument, set the clock rate of the PC to 6 MHz. This is commonly done by setting a switch on the PC mother board or by issuing a DOS command.

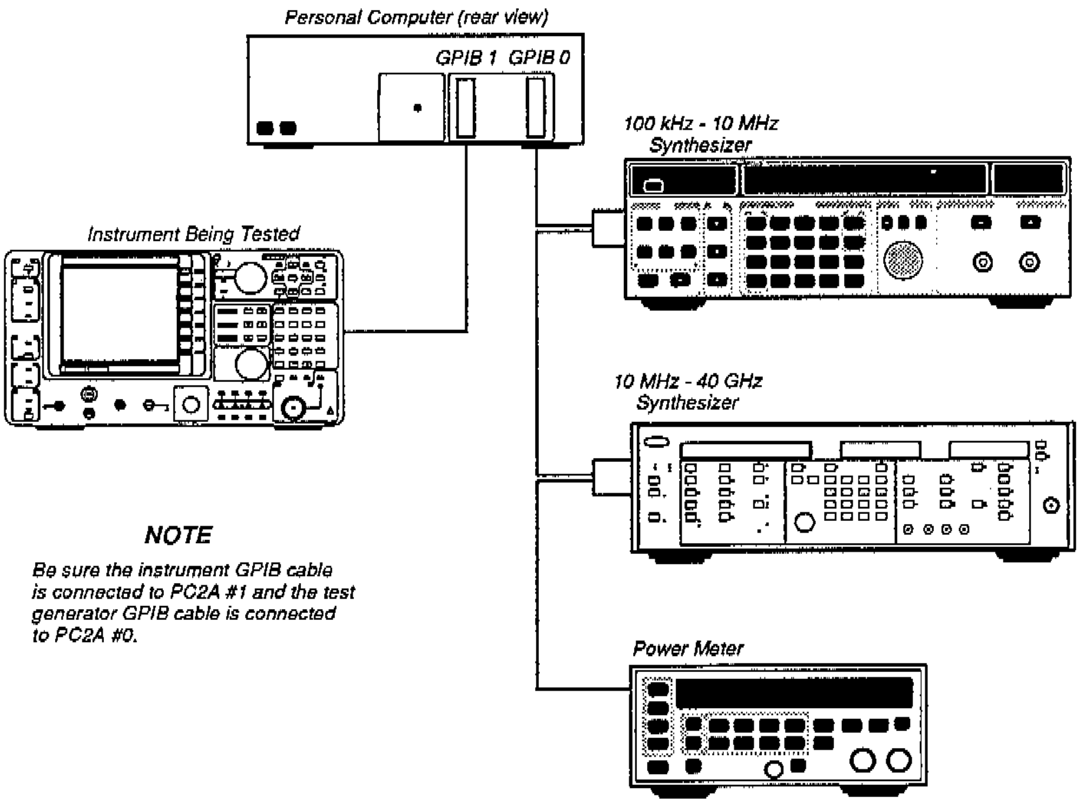


Figure 4-1. GPIB Connections for Flatness Check.

On the Tektronix PEP 30x controllers, use the SYSENV command that is supplied with the PC to slow the clock rate. The syntax for this command is SYSENV 6m.

NOTE

Slowing the clock rate of the personal computer will not significantly increase the time required to complete the test. This is because the personal computer spends most of its time waiting for the instrument and the test equipment to execute commands.

E. Running the Test Equipment Characterization Program (UTIL.EXE)

The flatness calibration and verification system uses a power divider and a power meter to compensate for flatness variations in the generators and for losses in the test system cabling. The flatness test program (CATS.EXE) performs this correction by measuring the signal amplitude at the second power divider output port (refer to Figure 4-2 and 4-3), then calculating the amplitude present at the instrument's RF Input. The error in displayed flatness is then corrected according to the actual power available at the RF Input.

For this method to work properly, the difference in amplitude between the second divider port and the instrument's RF Input (output of the 3 dB attenuator) must be characterized. This is the function of the UTIL.EXE program. To characterize the test setup, enter the following at the prompt on the PC:

> UTIL<ENTER>

UTIL.EXE and the flatness test program itself (CATS.EXE) both use the same display style and menu structure, so most of the following information also applies to CATS.EXE. The top part of the display contains information about what mode the program is running in (CAL or PV - Performance Verification), and so on. The bottom part of the display shows what function keys are enabled and what they do. The middle of the display is used for menus, instructions, and error messages.

Characterizing the power divider involves terminating output #1 with 50 Ω and measuring the power level at output #2 across the frequency range with a power meter, then swapping the power meter and the termination and measuring output #1. The power difference between the two ports is then stored in a data file for later use by the flatness test program (CATS.EXE). The test setups for measuring the first and second divider output ports are shown in Figures 4-2 and 4-3.

The power divider characterization takes about an hour and a half to run. For traceability reasons, the characterization must be run whenever the divider or the 3 dB attenuator are replaced (or even taken apart and put back together). We recommended that you purchase this pair of components specifically for this application, and dedicate them to it.

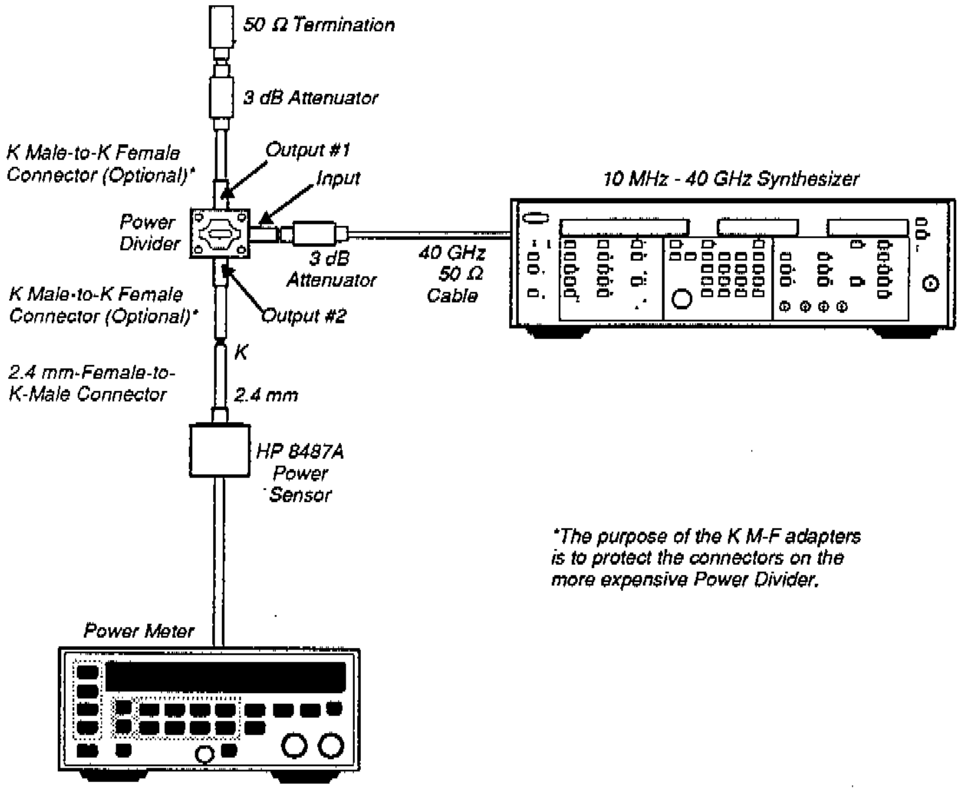


Figure 4-2. Test Equipment Characterization, Output Port #2

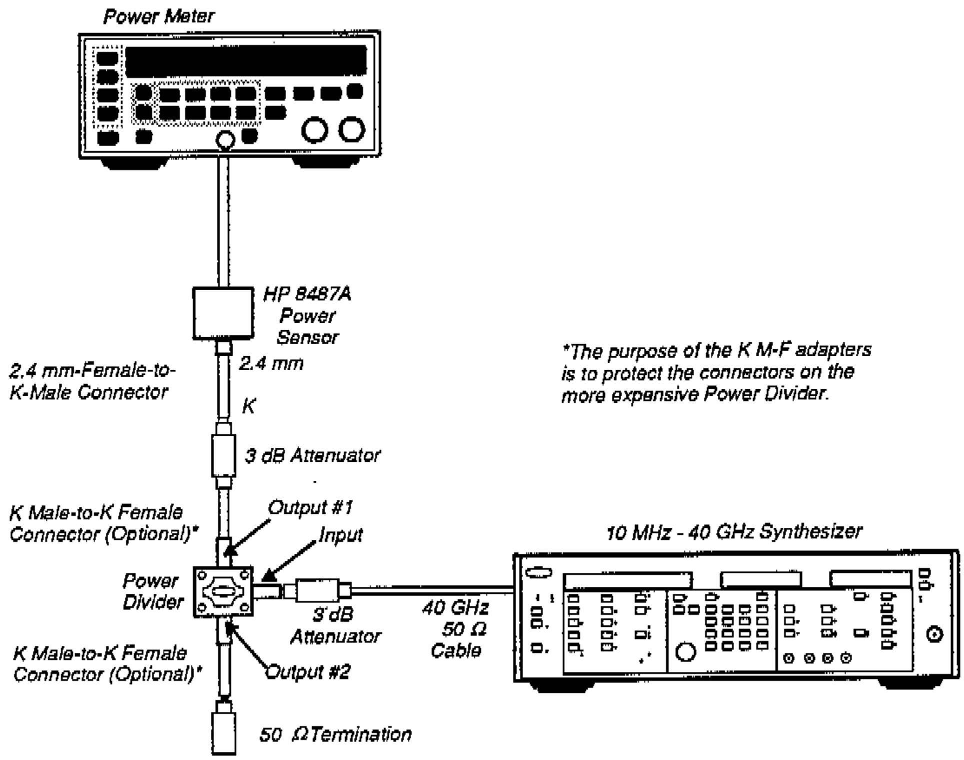
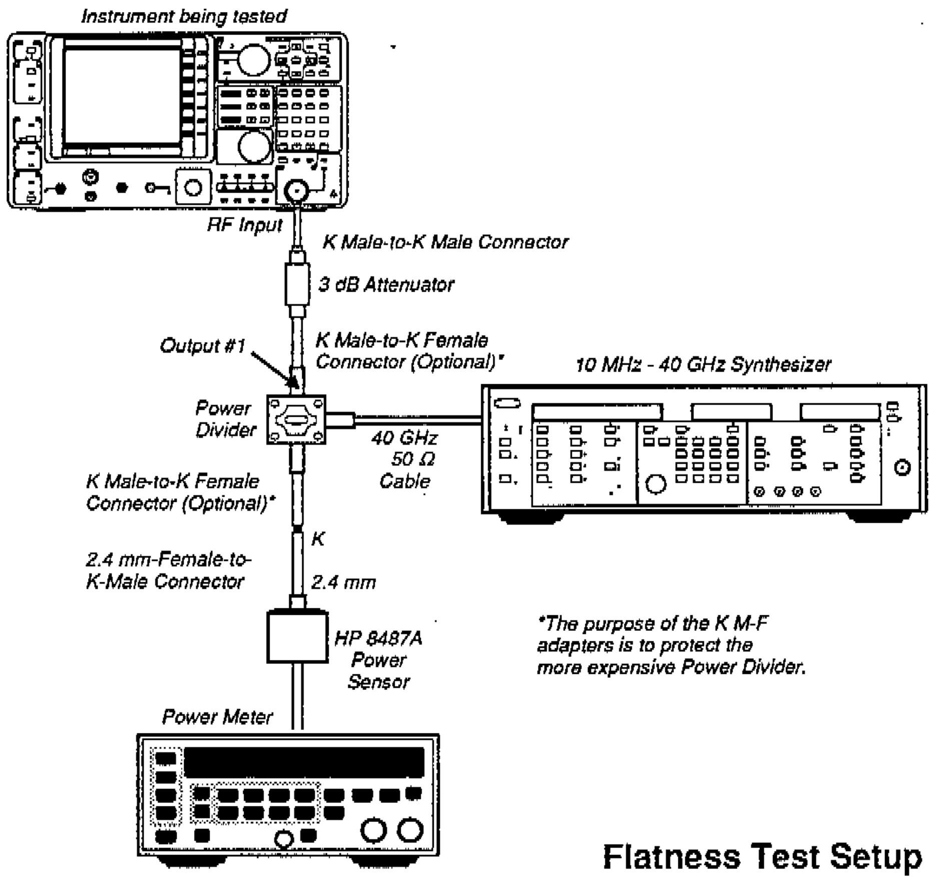


Figure 4-3. Test Equipment Characterization, Output Port #1

F. Connect the Test Setup as Illustrated



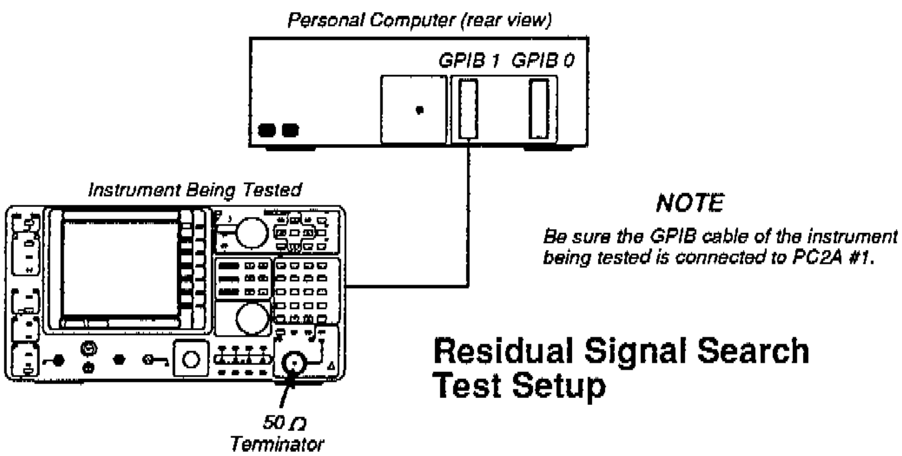


Figure 4-4. Test Equipment Setup.

G. Run the Verification Program (CATS.EXE)

The CATS.EXE program is used to calibrate the flatness of the instrument, to verify flatness, and to check for the existence of residual spurious signals. Only the flatness verification and residual signals procedures are discussed here.

Enter the following on the personal computer to run CATS.EXE:

>CATS <ENTER>

NOTE

As described earlier, the user interfaces for CATS.EXE and UTIL.EXE are similar, so much of the following information also applies to UTIL.EXE.

The CATS program is a menu driven program. After you have verified the date and time (pressed <ENTER>) and entered temperature and humidity information, a menu is displayed that allows you to choose the flatness calibration sequence (CAL) or the flatness verification and residual signals tests (PV). Select the PV sequence and press <ENTER>.

You are then prompted to connect the DUT (Device Under Test — the instrument being tested) to the test system and power it up. If the instrument is already powered up, it is a good idea to re-cycle the power at this time.

Next, you are prompted to enter the instrument's serial number. You will be asked to enter this a second time to verify correct entry of the serial number. The next menu to be displayed allows you to choose which tests are to be performed in the sequence.

The menu will allow you to select which tests are to be performed. This menu provides three selections:

1) RUN FULL SEQUENCE — Every test in the sequence is run, in order.

2) RUN PARTIAL — Selects a second menu that allows you to select a starting point in the testing sequence. The program then runs every test from that point to the end of the sequence.

3) SELECT TEST(S) — Causes a list of tests to be displayed. You can then select specific tests to be run. Multiple tests can be selected by entering a series of numbers separated by commas.

Select 1 and press <ENTER>.

If Flatness Verification is selected

Select the range of RF Attenuation settings to be tested. The default is to test all six settings (0 through 50 dB). To test the full range requires approximately two hours and forty five minutes.

Select the instrument frequency bands to be tested. The default is to test the entire range of the instrument.

NOTE

If the test equipment you selected (from CONFIG.EXE) does not cover the full frequency range of the instrument, the test will only run to the upper frequency limit of the generators.

From this point, CATS.EXE will execute automatically. All that is required is to change equipment (as shown in Figure 4-5). CATS.EXE will prompt you when this is necessary.

If Residual Signals is selected

Next, you will be asked to choose the range of frequencies to be tested. The choices are full or partial with the default being full. If you choose the partial test, you will be prompted for start and stop frequencies.

From this point on, the program will execute automatically.

Pressing the F1 key on the computer allows you to interrupt a test at any time. When this key is pressed, a menu with a list of choices is displayed.

NOTE

Do not press the help or interrupt keys in the middle of a test unless you really need to. Once a test is interrupted, it cannot be resumed at the point of interruption; instead, it must be restarted.

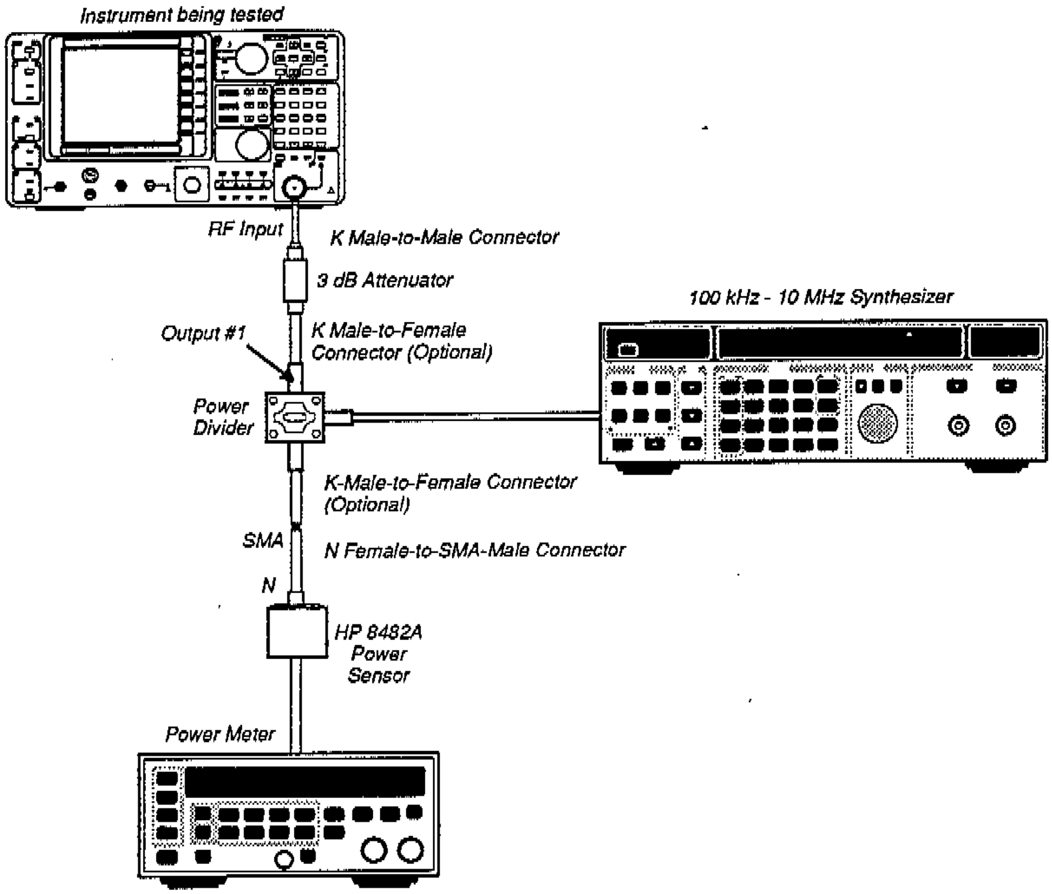


Figure 4-5. Low Frequency Test Equipment Setup.

H. Using the Report Generator (RPT.EXE)

The RPT.EXE program generates a summary of the text results from the data obtained with the residual spurious test. To run RPT.EXE enter at the DOS prompt:

>C:\TEKCATS\BIN\RPT(instrument serial number)<ENTER>

The (instrument serial number) is the serial number assigned to the instrument being tested.

If the directory C:\TEKCATS\BIN is included in a DOS path command, enter:

>RPT(instrument serial number)<ENTER>

RPT.EXE will then print the data acquired to the default printer.

I. Plotting the Flatness Test Results (PLOTF.EXE).

The utility program PLOTF.EXE reads the corrected flatness error files and plots the data on the personal computer monitor.

NOTE

This program requires an EGA monitor.

To run this program enter the following command on the personal computer:

>PLOTF <serial-number>[–h] <ENTER>

Enter the serial number of the instrument you want flatness data from. Use the same serial number you entered when you ran the flatness tests.

This program then draws a series of graphs on the monitor, each one representing the flatness error data for one RF attenuation setting. The horizontal axis of the graphs represents frequency, with the lowest band on the left and the highest band on the right. (The 0 to 6.5 GHz band is made up of the first two sections on the left side of the graph.) The vertical axis shows the flatness response in dB. The vertical scale of the graphs is set automatically so that all of the data will fit in the window.

After each graph is drawn, PLOTF.EXE pauses for you to examine the graph. Press <ENTER> to continue to the next graph. If your version of DOS will support EGA-mode screen dumps, you can use the Print Screen key to make a hard copy of the graphs. Just press <PRT SCR> before pressing <ENTER>. If your version of DOS does not support EGA-mode screen dumps, run the program PRTSCR.EXE found in the directory C:\TEKCATS\BIN. This is a Terminate-and-Stay Resident program that replaces the Print Screen function in DOS. You will then be able to do EGA-mode screen dumps.

The PLOTF.EXE program will automatically execute the Print Screen function if you type the -h option after the instrument serial number on the command line.

J. Enter the test results into the performance check software (Part II)

If the spurious response test was performed, during part II of this procedure, you will be prompted to enter data concerning any spurious responses found.

Part II. Performance Check — Version 5

This portion tests performance other than flatness. The instrument is controlled by a PC using Lotus Measure and Lotus 1-2-3 running software included with this manual.

Using the Performance Verification Software

The instrument performance verification software is contained on a 5.25-inch floppy disk, titled Performance Verification Software. The following sections describe how to install the software on your system, how to run the software, and how the programs operate.

Installing the Software

1. Make a back-up copy of the Performance Verification Software disk, and store the back-up copy in a secure place.

2. If Lotus 1-2-3 and Lotus Measure are not installed, do so at this time. Check that Lotus 1-2-3 is set as follows:

   • Default directory for Lotus set to drive where data from tests is stored (worksheet files)

   Hard disk system - Enter the following 1-2-3 commands
   / File Directory a:\
   Floppy system - Enter the following 1-2-3 commands
   / File Directory b:\

   • Undo function disabled - Enter the following 1-2-3 commands
   / Worksheet Global Default Other Undo Disable

   • Printer and graphic drivers properly selected

   • Options properly selected

3. Select from the following configurations and install your Performance Verification Software.

Installation using two floppy drives. For a personal computer that has two floppy disk drives (and no hard disk drive).

1. Install the Performance Verification Software disk in drive B and the 1-2-3 working disk in drive A.

2. Set the default drive for B (type b:<ENTER>).

3. Enter the following command to copy the file 2782qc.flp from the Performance Verification Software disk to your 1-2-3 working disk, under the file name 2782qc.bat.

   B> copy 2782qc.flp a:2782qc.bat <ENTER>

4. When Lotus Measure was installed, a file named nat488.set was created on the 1-2-3 working disk. If National Measure was installed, this file is not present, and a file named gpib.set will be present. Change the name to nat488.set with the following command.

   b>ren a:gpib.set a:nat488.set<ENTER>

5. Enter the following command to copy this file to the Performance Verification Software disk.

   B> copy a:nat488.set b: <ENTER>

6. Remove the 1-2-3 working disk from drive A and install a blank, formatted floppy disk in drive A.

7. Enter the following commands to create a new data disk. These commands will copy files clear.wk1 and 2782.bcf from the Performance Verification Software to the blank disk in drive A.

   B> copy clear.wk1 a: <ENTER>
   B> copy 2782.bcf a: <ENTER>

8. If the National PC2 GPIB card is being used instead of a PC2A, copy the file 2782pc2.bcf from the Performance Verification Software disk to replace file 2782.bcf on the new data disk, using the following command:

   B> copy 2782pc2.bcf a:2782.bcf <ENTER>

Installation using a single floppy drive or 2 floppy drives and a hard drive.

1. Install the Performance Verification Software disk in drive A.

2. Set the default drive for A (type a:<ENTER>).

3. Enter the following command to copy the file 2782qc.hrd from the Performance Verification Software disk to the root directory on the hard disk. The new file will be named 2782qc.bat.

   A> copy 2782qc.hrd c:\2782qc.bat<ENTER>

4. Modify your Autoexec.bat file to add the path where your 1-2-3 software resides (e.g. Path=c:\123).

5. Check the name of the driver set created when Measure was installed. If the driver is named gpib.set, as it is with National Measure, use the following command to change the name to nat488.set. Change the drive to C with >C:<RETURN> and change directory to the 1-2-3 subdirectory.

   C>ren gpib.set nat488.set<ENTER>

Then, return to drive A with the command >A:<RETURN>.

NOTE

This step is necessary because of changes in newer versions of Measure.

6. Enter the following commands to create a data disk on a blank formatted disk in drive B:

   A> copy clear.wk1 b:<ENTER>
   A> copy 2782.bcf b:<ENTER>

   These commands copy the files clear.wk1 and 2782.bcf from the distribution disk to the new data disk. If you only have one floppy disk drive, DOS will prompt you to change disks.

   If the National PC2 GPIB card is being used instead of the PC2A, copy the file 2782pc2.bcf to the file 2782.bcf, using the following command:

   A> copy 2782pc2.bcf b:2782.bcf <ENTER>

   This replaces the PC2A configuration file with the PC2 version.

Running the Performance Verification Software

Use the following procedure to run the instrument Performance Verification Software on a two-floppy-disk system.

1. Place the 1-2-3 working disk in drive A and the Performance Verification Distribution disk in drive B.
2. Set the default drive for A (type a:<ENTER>).
3. Enter the following command:

   A> 2782qc <ENTER>

4. When the spreadsheet is loaded, remove the Performance Verification Software disk from drive B and replace it with the data disk.

Use the following procedure to run the instrument Performance Verification Software on a single floppy disk and hard-disk system.

1. Place the Performance Verification Distribution disk in drive A.
2. Set the default drive for C (type c:<ENTER>).
3. Enter the following command:

   C> 2782qc <ENTER>

4. When the spreadsheet has been loaded, remove the Performance Verification Software disk from drive A and replace it with the data disk.

Using the Performance Verification Software

Once the Performance Verification Software is running, open either a new or existing data file. Existing data files contain information on previously tested instruments.

Opening a new data file.

1. Select OtherMenu R(etrieve). A prompt asks you if you remembered to save the measurement results. This is a safeguard against retrieving new data before the data currently in the spreadsheet is saved. If this is a new data file type y<ENTER>. (Type n<ENTER> if you have current data you wish to save.)

2. Select the clear.wk1 file with the cursor keys, and press the ENTER key.

3. Select OtherMenu S(ave) and enter a new file name for the data you wish to save and press ENTER. We recommend that you use the serial number located on a tag on the rear of the instrument (for example, B010075).

Opening an existing data file.

1. Select OtherMenu R(etrieve). A prompt asks you if you remembered to save the measurement results. Type y<ENTER>.

2. Using the cursor keys, select the data file you wish to open (the file should have a .wk1 extension) and press ENTER . (Press ENTER a second time if the menu does not re-appear.)

Making a Measurement.

Use the following procedure to make measurements, save measurement results, print results, and get out of trouble.

1. Select S(tep) to select a measurement step. A prompt will ask for a step number. Enter the step number and press ENTER. You can also select the next step or previous step with the N(ext) or P(revious) commands, respectively.

   When 1-2-3 goes to the selected step, the Measure program sets the instrument Frequency, Span, Ref Level, Res BW, Video BW, Sweep, Mixer Overdrive, and dB/div controls according to the settings included in the performance verification spreadsheet.

2. Set up the external equipment as described later in this procedure. The specific step number is shown in the prompt line at the top of the spreadsheet.

3. Set the instrument markers for the measurement as instructed. Turn on markers as necessary. They are not used for all measurements.

4. To place values in the spreadsheet, select M(easure). If this is not a marker value, you are prompted to enter a value from external equipment or the results of a pass/fail test (1/0).

5. Select C(alculate) to verify that the specification has been met. If the specification is not met, FAIL will be displayed.

6. Select the next S(tep) and repeat the general measurement procedure described in steps 2 through 5.

7. When you have completed measurement of a particular instrument, select OtherMenu S(ave) to save the data. A prompt will request a file name. If a data file exists for this instrument, select the file name with the cursor keys and ENTER. If no data file exists, enter a new file name and ENTER. We recommend that you use the instrument serial number for the file name. (Press ENTER a second time if the menu does not re-appear.)

8. To print the measurement results, select OtherMenu P(rint). (The compressed printing mode must be active to print measurement results).

9. To quit a measurement session, select Q(uit). You are asked if you remembered to save your current data. If you enter n, you are prompted to save it. If you enter y, the Measure program terminates. You can then use the 1-2-3 Q(uit) command (/ Q) to go back to DOS.

Getting Out of Trouble.

If the menu does not return after an operation, try pressing the ENTER key. If this does not work and you find yourself hung up, press the following sequence of keys: Ctrl-Break, Esc, Alt-M. This key sequence restarts the measurement macro program from the top. Your data will not be lost.

NOTE

Occasionally, the GPIB message buffer will overflow causing the instrument to hang up and not respond to messages from the computer. This can happen if you enter a series of spreadsheet commands in rapid succession. If this occurs, wait a moment to see if the instrument is able to clear the buffer. If it does not and entering Ctrl-Break, Esc, Alt-M does not restore the spreadsheet menu, cycle the instrument power by pressing the POWER key twice. When the instrument initializes, it clears its GPIB buffer. The spreadsheet menu should return and respond to commands. Spreadsheet data should not be lost, but it may be necessary to repeat a step.

Preparation for the Performance Check

1. Apply power and allow the instrument to warm up for at least one hour.

2. Connect the GPIB cable from the GPIB-interface board on the personal computer to the PORT 1 connector on the instrument rear panel.

3. Power up the personal computer.

4. Load the performance verification spreadsheet as previously described under *Using the Performance Verification Software*.

Steps 4-7. Third Order Intercept Check

This checks the instrument's third order distortion response to two input signals. Two signals cause distortion products large enough to display on screen. The resulting measurements are entered into the spreadsheet, and the intercept is calculated.

Performing this check at 20 MHz and 6 GHz will check both ends of the low band path, and 8 GHz checks the high band path.

This measurement is optional because of the expense of a second generator.

1. Select step 4 from the spreadsheet.

2. Connect the two synthesizer/level generators or the swept frequency generators through the Mini-Circuits ZFSC-2-6 Combiner (as shown in Figure 4-6). (Do not use the 6 dB pads with the Mini-Circuits Combiner).

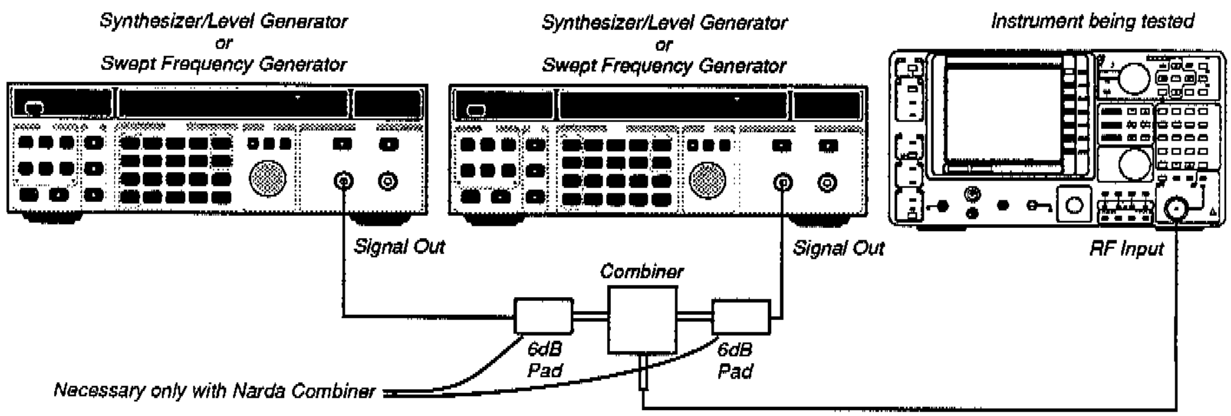


Figure 4-6. Test equipment setup for the Third Order and Second Order Intercept Checks.

3. Set one synthesizer for a frequency of 20.005424 MHz and the other for
20.011424 MHz.

4. Using the power meter, verify that the output from the combiner is –30 dBm from each synthesizer separately, and then connect the output of the combiner to the instrument RF INPUT.

5. Select sample mode by pressing WAVEFORM CONTROL, Acquisition Mode, and Sample. Position the yellow marker on the peak of the signal with the PEAK FIND MAX key.

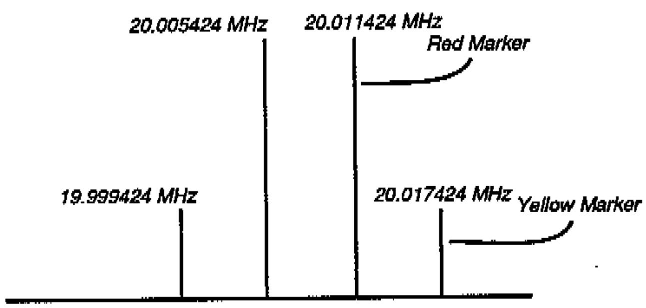


Figure 4-7. Third Order Intercept Distortion Frequencies Involved With Test.

6. Select Delta Marker then Swap Delta Markers function, then enter the frequency 20.017424 MHz. Turn on Average Waveform and allow 10 sweeps to average the display; then, select MKR NXT WF.

7. Position the marker away from center screen to measure the average noise; then, press the computer M key.

NOTE

Be sure to position the marker at the average value of the noise waveform.

8. Select step 5 from the spreadsheet.

9. Position the yellow marker on the average of the peak of the signal at center screen. This signal will be 3-4 dB larger than the noise (at most).

10. Press the computer M key to enter the intercept measurement in the spreadsheet; then, turn off the average waveform.

11. Select step 6 from the spreadsheet.

12. Disconnect the two synthesizer/level generators and combiner from the instrument. Connect a 6 dB pad to each input arm of the Narda 2-8 GHz combiner. Connect the two swept-frequency synthesizers to the 6 dB pads.

13. Set one synthesizer for a frequency of 6 GHz and the other for 6.00005 GHz.

14. Using the power meter, verify that the output from the combiner is –10 dBm from each synthesizer separately, and then connect the output of the combiners to the instrument RF INPUT.

15. Using the Δ MKR and Swap Ref function, position the red marker on the peak of the 6.000050 GHz signal and the yellow marker on the distortion product at 6.000100 GHz, and press the computer M key.

16. Disconnect the combiner from the instrument RF INPUT.

17. Select step 7 from the spreadsheet.

18. Set one synthesizer for a frequency of 8 GHz and the other for 8.00005 GHz.

19. Using the power meter, verify that the output from the combiner is –10 dBm from each synthesizer separately, and then connect the output of the combiners to the instrument RF INPUT.

20. Connect the combiner to the instrument RF INPUT.

21. Using the Δ MKR and Swap Ref function, position the red marker on the peak of the 8.000050 GHz signal and the yellow marker on the distortion product at 8.000100 GHz, and press the computer M key.

22. When the measurement has been completed in step 16, press the computer C key to check that the third-order intercepts are within specification.

23. Disconnect the synthesizers from the instrument.

Steps 8-14. Second Order Intercept Check

This check is similar to the Third Order Intercept check, except that the instrument second order responses are measured at the sum and difference frequencies. The input is overdriven to display the responses on the screen. The check is performed at 1 GHz, 100 MHz, and 3 GHz.

1. Select step 8 from the spreadsheet.

2. Connect the two swept-frequency generators to the Mini-Circuits ZFSC-2-5 combiner as shown in Figure 4-6. (Do not use the 6 dB pads with the Mini-Circuits Combiner.)

3. Set one synthesizer for a frequency of 1 GHz and the other for 10 MHz, then, using a power meter, separately set each synthesizer amplitude levels to –30 dBm at the output of the combiner, and connect the combiner to the instrument RF INPUT.

4. Place the single marker on the peak of the 1 GHz signal, and press the computer M key.

5. Select step 9 from the spreadsheet.

6. Using the single marker, measure the distortion product at 1.010 GHz, and press the computer M key.

7. Select step 10 from the spreadsheet.

8. Disconnect the coupler from the instrument RF INPUT.

9. Set one synthesizer for a frequency of 100 MHz and the other for 10 MHz, then, using a power meter, separately set each synthesizer amplitude level to –30 dBm at the output of the combiner, and connect the combiner to the instrument RF INPUT.

10. Using a single marker, measure the amplitude of the 100 MHz signal, and press the computer M key.

11. Select step 11 from the spreadsheet.

12. Using the single marker, measure the distortion product at 110 MHz, and press the computer M key.

13. Select step 12 from the spreadsheet.

14. Disconnect the two synthesizer/level generators from the instrument. Connect a 6 dB pad to each input arm of the Narda 2-8 GHz combiner. Connect the two swept-frequency synthesizers to the 6 dB pads, and connect the output of the combiner to the instrument RF INPUT connector.

15. Set one synthesizer for a frequency of 3 GHz and the other for 3.010 GHz. Then, using a power meter, separately set each synthesizer amplitude level to –30 dBm at the input of the coupler, and connect the coupler to the instrument RF INPUT.

16. Using the single marker, measure the amplitude of the 3.010 GHz signal, and press the computer M key.

17. Select step 13 from the spreadsheet.

18. Using a single marker, measure the distortion product at 6.010 GHz, and press the M key on the computer.

19. Select step 14 from the spreadsheet.

20. Using the single marker, measure the distortion product at 10 MHz, and press the computer M key.

21. Press the computer C key to check that the second-order intercept checks are within specification, then; disconnect the synthesizers from the instrument.

Steps 15-22. Second Harmonic Distortion Check

These steps check instrument distortion at the second harmonic of the input signal. Low-pass filters are used to reduce the second harmonic of the input signal. This assures that the displayed distortion is that of the instrument. Since the allowable distortion is high enough to be seen on screen, it is not necessary to overdrive the instrument input.

The test is performed at fundamental frequencies of 10 MHz, 49 MHz, 500 MHz, and 3 GHz.

Only the low band is tested; high band harmonics are widely separated and are eliminated by the preselector.

1. Select step 15 from the spreadsheet.
2. Connect a 50 Ω cable from one of the swept frequency synthesizers through the K&L 4L51-15-B/B low-pass filter to the instrument RF INPUT connector (as shown in Figure 4-8).
3. Set the synthesizer for a frequency of 10 MHz, and using a power meter, adjust the signal amplitude for –30 dBm at the output of the Low Pass Filter.
4. Select step 16 from the performance verification spreadsheet.
5. Using the single marker, measure the distortion product at 20 MHz, and press the computer M key.

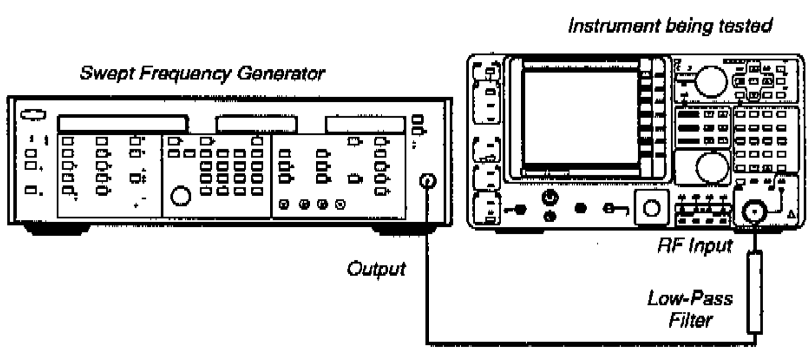


Figure 4-8. Test Equipment Setup for the Second Harmonic Distortion Check.

6. Select step 17 from the spreadsheet.
7. Replace the low-pass filter currently connected to the instrument RF INPUT connector with the K&L 5L51-551-B/B low-pass filter.
8. Set the synthesizer for a frequency of 49 MHz, and using a power meter, adjust the signal amplitude for –30 dBm at the output of the Low Pass Filter.

9. Using the single marker, measure the peak at 49 MHz, and press the computer M key.

10. Select step 18 from the spreadsheet.

11. Using the single marker, measure the distortion product at 98 MHz, and press the computer M key.

12. Select step 19 from the spreadsheet.

13. Replace the low-pass filter currently connected to the instrument RF INPUT connector with the K&L 5L120-850-O/O low-pass filter.

14. Set the synthesizer for a frequency of 500 MHz, and using a power meter, adjust the signal amplitude for –30 dBm at the output of the Low Pass Filter.

15. Using the single marker, measure the peak of the 500 MHz signal, and press the computer M key.

16. Select step 20 from the spreadsheet.

17. Using the single marker, measure the 1 GHz distortion component, and press the computer M key.

18. Select step 21 from the spreadsheet.

19. Replace the low-pass filter currently connected to the instrument RF INPUT connector with the K&L 3L120-3500-O/O low-pass filter.

20. Set the synthesizer for a frequency of 3 GHz, and using a power meter, adjust the signal amplitude for –30 dBm at the output of the Low Pass Filter.

21. Using the single marker, measure the peak of the 3 GHz signal, and press the computer M key.

22. Select step 22 from the spreadsheet.

23. Using the single marker, measure the 6 GHz distortion product, and press the computer M key.

24. When the step 22 measurement has been completed, press the computer C key to check that the second harmonic distortion checks are within specification.

25. Disconnect the synthesizer from the instrument.

Steps 23-24. Out-of-Band Response Checks

This step measures how well the instrument rejects out-of-band signals. Two measurements are made; one for the low-band path and one for the high-band path. The low-band test measures the response at 5.95 GHz for a signal input at the image frequency of 26 GHz. The high-band test checks the preselector rejection by measuring the response at 6.95 GHz of a signal input at the image frequency of 14 GHz.

1. Select step 23 from the spreadsheet.

2. Connect the swept frequency synthesizer through a 50 Ω cable to the instrument (as shown in Figure 4-9).

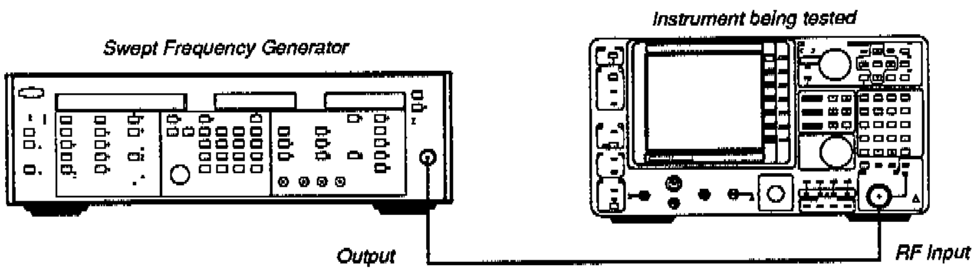


Figure 4-9. Test Equipment Setup for Out-of-Band Response and 1 dB Gain Compression Checks

3. Select a synthesizer signal-output frequency of 26 GHz and an amplitude of –10 dBm.

4. Using the single marker, measure the out-of-band response at 5.95 GHz, and press the computer M key.

5. Set the synthesizer signal output frequency to 14 GHz and the amplitude to –10 dBm.

6. Select step 24 from the spreadsheet.

7. Using the single marker, measure the out-of-band response at 6.95 GHz, and press the computer M key.

8. When the step 24 measurement has been completed, press the computer C key to check that the out-of-band response checks are within specification.

Steps 25-30. 1 dB Gain Compression Checks

This check sets the instrument to the 30 dB overdrive mode for the lowest IF gain. This allows displaying the low-band specification of 0 dBm at the top of the screen. The error should not accumulate to more than 1 dB at the 0 dBm level. To avoid error, measure the synthesizer power level with a power meter.

1. The swept-frequency synthesizer should still be connected to the instrument.

2. Select step 25 from the spreadsheet.

3. Set the synthesizer signal-output frequency for 1 GHz, and using a power meter, adjust the signal amplitude for –5 dBm. Connect the synthesizer to the instrument RF INPUT connector through a 50 Ω cable (as shown in Figure 4-9).

4. Using the marker, measure the amplitude of the signal at 1 GHz then press the computer M key.

5. Select step 26 from the spreadsheet. Then, increase generater power by
   5 dB to 0 dBm at the RF Input.

6. Using the marker, measure the amplitude of the signal at 1 GHz then press the computer M key.

7. Select step 27 from the spreadsheet

8. Set the synthesizer signal-output frequency for 21 GHz, and using a power meter, adjust the signal amplitude for –8 dBm.

9. Using the marker, measure the amplitude of the signal at 21 GHz then press the computer M key.

10. Select step 28 from the spreadsheet. Then, increase generater power by
    5 dB to –3 dBm at the RF Input.

11. Using the marker, measure the amplitude of the signal at 21 GHz then press the computer M key.

12. Select step 29 from the spreadsheet.

13. Set the synthesizer signal-output frequency for 28 GHz, and using a power meter, adjust the signal amplitude for –11 dBm.

14. Using the marker, measure the amplitude of the signal at 28GHz then press the computer M key.

15. Select step 30 from the spreadsheet. Then, increase generater power by
    5 dBm to –6 dBm at the RF Input.

16. Using the marker, measure the amplitude of the signal at 28 GHz then press the computer M key.

17. When the measurement has been completed in step 29, press the computer C key to check that the 1 dB compression checks are within specification.

18. Disconnect the synthesizer from the instrument.

Steps 31-45. Equivalent Input Noise Check

This measures the sensitivity of the instrument by measuring the internally generated noise referenced to the input.

The first part of this step measures noise in band one. Do the test at the frequency breaks and at 6.5 GHz.

In the other bands, the procedure searches for the highest noise level and stores this frequency in the spreadsheet. Then the analyzer is tuned to these points in each band, and the measurement is made.

1. Select step 31 from the spreadsheet.
2. Connect a 50 Ω terminator to the instrument RF INPUT (as shown in Figure 4-10).
3. Using the FREQUENCY/MARKERS knob, place the single marker at the 9th graticule line of the instrument screen.
4. Allow the instrument to sweep 9 times to obtain an average noise level. (The number of sweeps in the average is read out on the CRT screen.) When the average has been obtained, press the computer M key to enter the measurement in the spreadsheet.

NOTE

Do not use the dB/HZ Noise measurement function for this check.

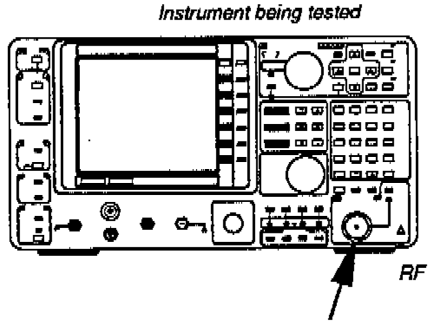


Figure 4-10. Test Setup for Equivalent Input Noise Check

5. Select steps 32 through 35 from the spreadsheet. For each step, measure the average noise at the 9th graticule line on the instrument screen, as described in steps 3 and 4.
6. Select step 36 from the spreadsheet.

7. Push the instrument MAX PEAK FIND key to place the marker on the highest average noise level, then press the computer M key.

8. Select steps 37 through 39 from the spreadsheet, and repeat step 7 for each step.

9. When the measurement has been entered in step 39, press the computer C key to calculate the frequency location for the highest noise for step 36 through 39.

10. Select steps 40 through 43 from the spreadsheet. For each of these steps, measure the average noise at the 9th graticule line as described in steps 3 and 4.

11. Select step 44 from the spreadsheet.

12. Allow the instrument to complete one sweep to obtain a stable baseline rise display. Then press the M key on the computer.

13. Select step 45 from the spreadsheet, place the marker at the 9th graticule line, then repeat step 4.

14. When the measurement has been entered in step 45, press the computer C key to perform the overall equivalent noise calculation.

15. Disconnect the 50 Ω termination from the RF INPUT.

Steps 46-55. Phase Noise Check

Phase noise sidebands are low-level random noise in the oscillator and synthesizer circuits. Phase noise sidebands extend over a wide frequency range, diminishing with frequency offset from the carrier. This check measures noise for two different carrier input frequencies. The measuring technique uses the dB/Hz measurement to average the marker and calculate 1 Hz noise bandwidth.

For the first part of this check, the REF SIGNAL OUT is used as the 100 MHz signal source. The inherent noise of this oscillator is very low, allowing the measurable noise from the synthesizers to be displayed. This check measures noise at all of the specified offset frequencies.

The second part of this check is made at 12 GHz and is optional because of the expense of the signal source (a second 2782). The signal source must have as little phase noise as possible for accurate measurements. Most synthesizers in this range have too much phase noise to be used as a signal source, but using the LO OUTPUT from a second 2782 as a signal source gives a signal with phase noise approximately equal to that of the instrument under test. An ideal signal source would have no phase noise sidebands, and the measurement would only reflect the noise of the instrument under test. Assuming the two sources are equal, the measurement number will be 3 dB above the noise of either instrument. The spreadsheet assumes that the sources are equal and subtracts 3 dB from the measurement. This means that the possible measurement error can be up to 3 dB if the sources are widely different.

1. Select step 46 from the spreadsheet.

2. Connect a 50 Ω cable from the REF SIGNAL OUT connector to the RF INPUT connector.

3. Wait for a complete sweep, then position the yellow marker on the peak of the calibrator signal.

4. Push the Δ MKR key, then select SWAP REF MKR.

5. Position the yellow marker for the frequency offset as directed by the spreadsheet prompt. Position the offset of the yellow marker from the peak (either to the left or to the right of the peak). The readout in the top left corner of the CRT screen indicates the amount of frequency offset. (The Swap Ref Marker menu key allows you to conveniently adjust both the red and yellow markers).

6. Allow two sweeps to complete for the dBc/Hz averaging. When the sweep passes the yellow marker twice, press the computer M key to measure the phase noise.

7. Select steps 47 through 50 from the spreadsheet. For each of these steps, repeat steps 3 through 6, placing the yellow marker to the offset indicated by the spreadsheet.

NOTE

When step 50 is reached, position the yellow marker to the right of the signal peak.

8. When the measurement has been completed in step 50, press the computer C key to check that the phase noise measured in steps 46 through 50 is within the specified range.

NOTE

Steps 51 through 55 require the use of a second 2782. These steps are an optional check of phase noise at 12 GHz.

9. Select step 51 from the spreadsheet.

10. Disconnect the cable from the REF SIGNAL OUT and RF INPUT connectors. Then, connect a 50 Ω cable from LO OUTPUT of the test spectrum analyzer to the instrument RF INPUT connector (as shown in Figure 4-11).

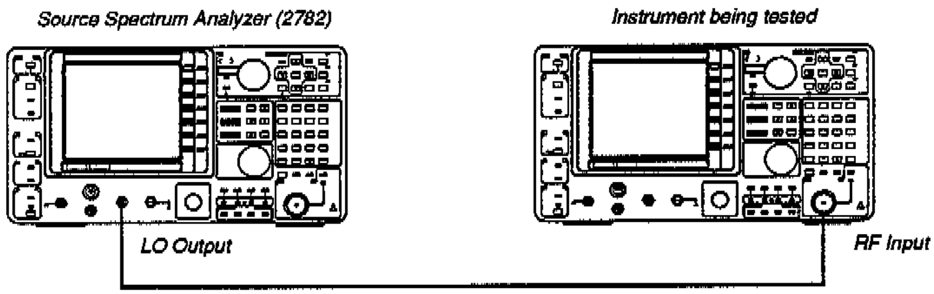


Figure 4-11. Test Equipment Setup for Steps 46-55 of Phase Noise Check.

11. Set the source spectrum analyzer for 15.525 GHz center frequency, zero span, and single sweep. This results in a 12 GHz signal of approximately 6 dBm being generated at the LO OUTPUT connector.

NOTE

In this test, a spectrum analyzer is used as a signal source.

12. Tune the yellow marker to the peak of the signal.

13. Push the instrument MKR→REF LVL key to position the signal to the top of screen.

14. Push the Δ MKRS key, then select SWAP REF MKR.

15. Place the yellow marker at the designated offset from the right side of the 12 GHz carrier as indicated by the spreadsheet. Then, after two sweep updates at the yellow marker, press the computer M key to record the phase noise measurement.

NOTE

If you cannot locate the signal, press the SPAN ⇑ key until the signal is visible. Tune the signal to center screen by placing the yellow marker on the peak of the signal and pressing the MKR ⇒FREQ key. When the signal is centered, press the SPAN ⇓ key to reduce the span to the value set by the spreadsheet (2 MHz for step 51). At this point, you may need to select the delta marker.

16. Select steps 52 through 55 from the spreadsheet, and repeat steps 12 through 15 for the offset frequencies given in the spreadsheet for these steps.

NOTE

The performance verification spreadsheet assumes that the phase noise of the source spectrum analyzer LO OUTPUT signal is equal to the phase noise of the instrument being tested and subtracts 3 dB from the measured values.

17. After step 55, press the computer C key to check that the phase noise measurements are within the specified range. Then, disconnect the test spectrum analyzer from the instrument being tested.

Steps 56-60. Residual Spurious Response Recording

The following procedure records the residual spurious response date that was taken from the residual spurious search program that was used in part 1 of this procedure.

1. Select step 56 from the spreadsheet.
2. From the residual spurious response data collected in Part 1 of this procedure for the 100 Hz to 10 MHz frequency range, enter the amplitude of the largest response found to be greater than –77 dBm (except 2 MHz where the specification is –70 dBm) into the spreadsheet. If no residual responses out of specification were found, enter –999 in the spreadsheet.
3. Select step 57 from the spreadsheet.
4. From the residual spurious response data for the 10 MHz to 6.5 GHz frequency range, enter the amplitude of the largest response found to be greater than –100 dBm into the spreadsheet. If no residual responses out of specification were found, enter –999 in the spreadsheet.
5. Select step 58 from the spreadsheet.
6. From the residual spurious response data for the 6.5 GHz to 21.3 GHz frequency range, enter the amplitude of the largest response found to be greater than –92 dBm into the spreadsheet. If no residual responses out of specification were found, enter –999 in the spreadsheet.
7. Select step 59 from the spreadsheet.
8. From the residual spurious response data for the 21.3 GHz to 28 GHz frequency range, enter the amplitude of the largest response found to be greater than –82 dBm into the spreadsheet. If no residual responses out of specification were found, enter –999 in the spreadsheet.
9. Select step 60 from the spreadsheet.
10. From the residual spurious response data for the 28 GHz to 33 GHz frequency range, enter the amplitude of the largest response found to be greater than –80 dBm into the spreadsheet. If no residual responses out of specification were found, enter –999 in the spreadsheet.

Step 61. Zero Hz Response Amplitude Check

This check measures the amplitude of the response at zero frequency. The instrument must be in full gain reduction mode to display the top of the response on screen.

1. Select step 61 from the spreadsheet.
2. Connect a 50 Ω termination to the instrument RF INPUT.
3. Press the PEAK FIND MAX key to place a single marker at the peak of the zero Hz response.
4. Press the computer M key to enter the amplitude of the zero Hz response.
5. Remove the 50 Ω termination from the instrument RF INPUT.

Steps 62-63. External Mixer Input LO Out

This instrument uses an external two-port mixer in which the external input port acts as both an IF input and LO output. A diplexer inside the instrument separates these signals by frequency. This check verifies that the instrument supplies the necessary minimum drive level to the mixer.

1. Select step 62 from the spreadsheet.
2. Remove the 50 Ω terminator from the instrument EXTERNAL MIXER connector, and connect the power meter to the connector (as shown in Figure 4-12). Use the Hewlett-Packard HP 8481A meter sensor head with the power meter. The sensor head requires a N-to-SMA connector.
3. Connect a 50 Ω cable from the power meter rear panel RCDR Output connector to pin 1 (signal) and pin 2 (ground) on the instrument ACCESSORY connector via a BNC to dual pin adapter cable.

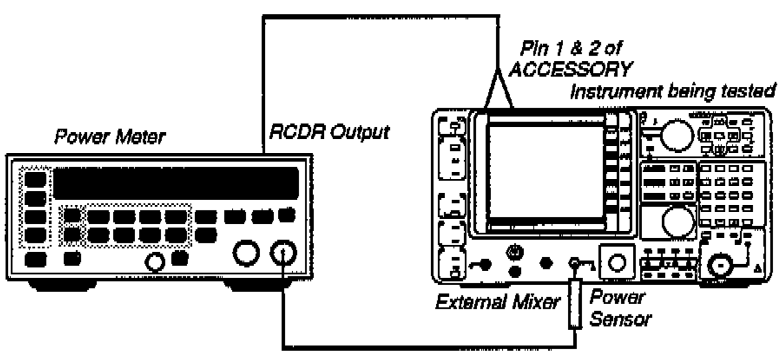


Figure 4-12. Test Equipment Connections for External Mixer Input LO Output Check.

4. Tune the marker to the lowest point on the red display on the instrument screen.

5. Push the computer M key to record the frequency at which the lowest power was seen.

6. Press the computer C key.

7. Select step 63 from the spreadsheet.

8. Record the power level indicated by the power meter into the spreadsheet.

9. Remove the power meter sensor from the EXTERNAL MIXER connector and connect the 50 Ω terminator to the EXTERNAL MIXER.

10. Disconnect the BNC to dual pin adapter cable from the instrument ACCESSORY connector and power meter RCDR Output.

Steps 64. 100 MHz Calibrator-Amplitude Check

This check uses a power meter to directly measure the accuracy of the REF SIGNAL OUT.

1. Select step 64 from the spreadsheet.

2. Turn off the Hewlett-Packard HP 432A Power Meter, connect the power sensor cable and HP 8484A Power Sensor head (item 5 of the equipment list) to channel A of the power meter, and re-apply power. (The power meter must be off when connecting the power sensor to prevent damage.)

3. Connect the Hewlett-Packard HP 11708A 30 dB attenuator to the Power Ref connector on the power meter.

4. Press the power meter Channel A button then press the Zero button. (Wait a few seconds for the zeroing routine to complete.)

5. Press the power meter Cal Factor button and use the power meter keypad to enter the Ref CF% value that is recorded on the HP 8484A power sensor head (for example, 97.0 ENTER).

6. Connect the HP 8484A power sensor head to the HP 11708A 30 dB attenuator that is connected to the power meter Power Ref connector (as shown in Figure 4-13A).

7. Press the power meter Osc button, then press the Cal Adj button. Enter the Ref CF% value that was entered from the power meter keypad in step 5. The power meter should read –30 dBm.

8. Disconnect the power sensor head from the 30 dB attenuator, and connect the power sensor head to the REF SIGNAL OUT connector of the instrument (as shown in Figure 4-13B).

9. Enter the power meter reading (in dB's) in the spreadsheet.

10. Press the computer C key to check that the 100 MHz calibrator amplitude is within specification.

11. Disconnect the power meter sensor head from the instrument.

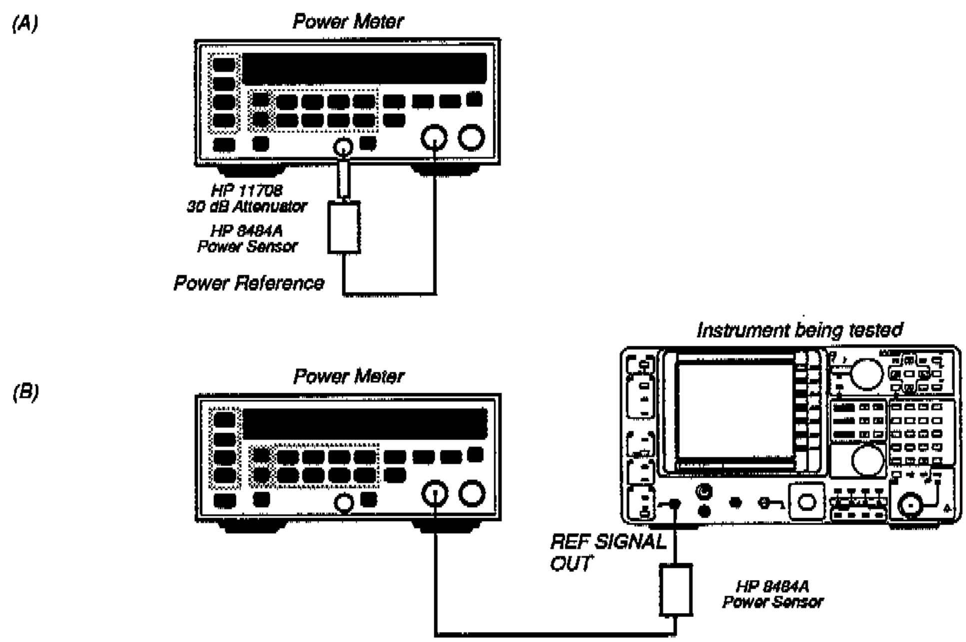


Figure 4-13. Test Equipment Connections for 100 MHz Calibrator Amplitude Check.

Steps 65-72. Center Frequency Accuracy Check

This test checks how close the 1st LO can be set, relative to the reference oscillator. The check is made at several different frequencies.

The reference oscillator error is eliminated by using the REF SIGNAL OUT .

1. Select step 65 from the spreadsheet.

2. Connect the 012-0649-00 50 Ω cable from the REF SIGNAL OUT connector of the instrument to the RF INPUT connector (as shown in Figure 4-14).

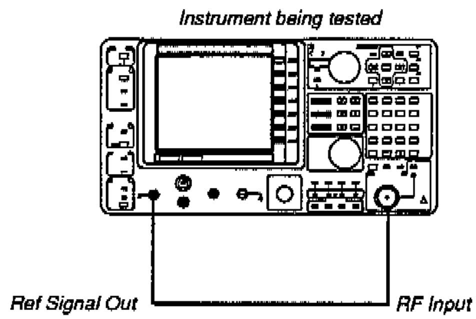


Figure 4-14. Test Setup for Center Frequency Accuracy Check.

3. Press the SINGLE SWEEP key twice. When the sweep has reached the right edge of the screen, press the PEAK FIND MAX key to place the single marker on the signal peak, then press the computer M key to record the center frequency measurement.

4. Select steps 66 through 68 from the spreadsheet, and repeat step 3 for each step.

5. Press the TRIGGER key. Select steps 69 through 72, pushing the PEAK FIND MAX key and the computer M key after each step selection.

6. When step 72 has been completed, press the computer C key to check that the center frequency measurements are within specification.

Steps 73-78. Marker/Counter Sensitivity Check

This check makes two measurements; marker counter accuracy at two frequencies and spans, and counter sensitivity.

Two counter sensitivity checks are made. The first checks that the counter accurately counts a signal with 20 dB signal-to-noise ratio, and the second checks that the counter accurately counts a signal 80 dB below the reference level.

The reference oscillator error is eliminated from the measurement by using the REF SIGNAL OUT as the signal source.

1. Select step 73 from the spreadsheet.

2. The instrument calibrator signal should still be connected to the RF INPUT connector from the last check. If it is not, connect the 012-0649-00 50 Ω cable from the REF SIGNAL OUT connector to the RF INPUT connector (as shown in Figure 4-14).

3. Press the instrument PEAK FIND MAX key to place the marker on the waveform peak that appears on or near the ninth vertical graticule line (assuming the left-most vertical graticule line is line zero). Then, press the computer M key to record the measurement. (Wait until the sweep has reached the far right side of the screen and the new frequency value has been displayed on the CRT readout before you press the computer M key.)

4. Select step 74 from the spreadsheet.

5. Press the instrument PEAK FIND MAX key to place the marker on the peak of the signal near the first graticule line. Wait for the frequency value to stabilize; then, press the computer M key.

6. Select step 75 from the spreadsheet.

7. Press the instrument PEAK FIND MAX key to place the marker on the peak of the signal near the first graticule line. Wait for the frequency value to stabilize; then, press the computer M key.

8. Select step 76 from the spreadsheet.

9. Using the FREQUENCY/MARKER knob, place the marker on the waveform peak on or near the ninth graticule line. Wait for the frequency value to stabilize; then, press the computer M key.

10. When step 76 measurement has been completed, press the computer C key to check that the marker counter accuracy is within specification.

11. Select step 77 from the spreadsheet.

12. Disconnect the 50 Ω cable from the instrument and connect the signal generator to the RF INPUT connector through a set of step attenuators and two 6 dB fixed attenuators (as shown in Figure 4-15). Set the signal generator for a signal output frequency of 100 MHz and an amplitude level of 12 dBm.

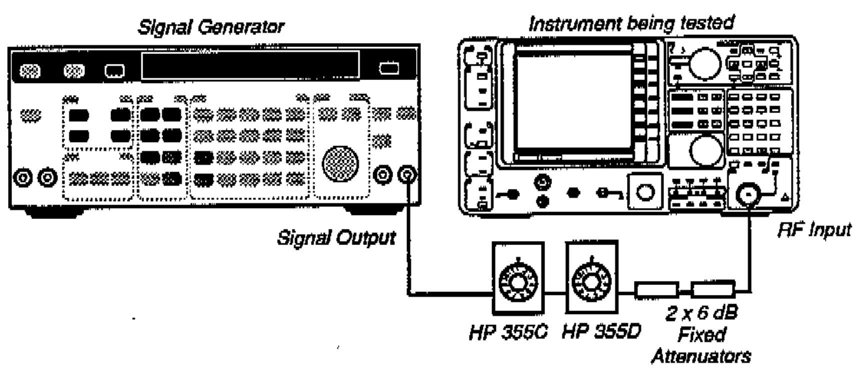


Figure 4-15. Test Equipment Setup for Steps 77 and 78 of the Marker Counter Check.

13. Set the step attenuators to 60 dB and push the MAX PEAK FIND key.

14. Push the Δ MKR key then select SWAP REF MKR and position the yellow marker on the noise floor displayed on screen.

15. Increase the attenuation with the step attenuators in 1 dB steps until the Δ dB marker readout on the top right side of the instrument screen reads 20 dB.

16. Select Δ Mkr OFF, then push the MAX PEAK FIND key.

17. After two sweeps, observe the instrument frequency counter at the top of the screen for 5 or 6 sweep counts, and check that the count does not vary more than ±6 Hz from sweep to sweep.

18. In the spreadsheet, enter a one if the count varies less than ±6 Hz and a zero if it does not.

19. Select step 78 from the spreadsheet.

20. Press the PEAK FIND MAX key.

21. Set the external attenuators for 80 dB of attenuation.

22. Observe the instrument counter at the top of the screen for 5 or 6 sweep counts, and check that it varies no more than ±6 Hz from sweep to sweep.

23. In the spreadsheet, enter a one if the count varies less than ±6 Hz and enter a zero if it varies more than ±6 Hz.

24. Disconnect the signal generator and step attenuator from the instrument RF INPUT.

Steps 79-96. Frequency Span Accuracy Check

This check uses delta markers to check frequency span accuracy and verify the 1-2-5 span sequence. Different sources are required to supply adequate signal level at all spans. A time mark generator is used for most measurements.

1. Select step 79 from the spreadsheet.

2. Connect the 500 MHz comb generator (item 8 in the equipment list) to the instrument RF INPUT connector (as shown in Figure 4-16A). The 3 dB attenuator and connector head provided with the comb generator are required for this test.

3. With the FREQUENCY/MARKERS knob, position the yellow marker on the time mark at the first vertical graticule line (assuming the left most vertical graticule line is line zero).

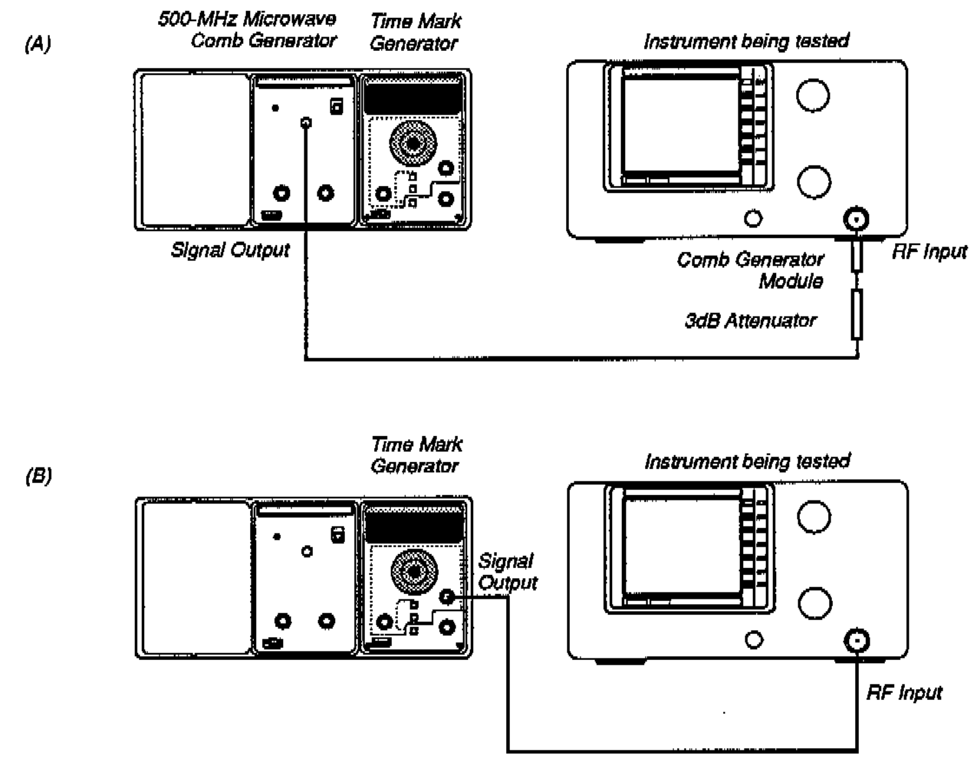


Figure 4-16. Test Equipment Setups for Frequency Span Accuracy Check

4. Push the Δ MKR key, then select SWAP REF MKR.

5. Position the yellow marker on the time mark at the ninth vertical graticule line. You can also use the PEAK FIND ⇐ and the PEAK FIND ⇒ keys to place the marker on the correct time marks.

6. Press the computer M button to enter the span accuracy measurement in the spreadsheet.

7. Disconnect the 500 MHz comb generator (including the 3 dB attenuator and the connector head) from the instrument. Then, connect a 50 Ω cable from the output connector of the time mark generator (item 9 in the equipment list) to the instrument RF INPUT connector (as shown in Figure 4-16B).

8. Select steps 80 through 96 from the spreadsheet. For each step, set the time mark generator to the setting given in the spreadsheet for the each step, and repeat steps 3, 4, and 5. For example, the prompt for step 80 says "Time Mark Gen - 10 ns" indicating that the time mark generator should be set for 10 ns marks.

NOTE

In slow sweep speeds, use the single-sweep mode and make the marker measurements on the stable display.

If you are not able to view the peak of the fifth time mark during step 96, press the MKR/FREQ key, adjust the FREQUENCY/ MARKERS knob to bring the fifth time-mark peak on screen, and press the MKR/FREQ key again.

9. When the span accuracy measurement has been entered for step 96, press the computer C key to check that the span accuracy is within specification.
10. Disconnect the time mark generator from the instrument.

Steps 97-110. Resolution Bandwidth Accuracy Check

This check measures all resolution bandwidth settings. The external calibrator is used as a signal source to measure bandwidth at all settings. These measurements are used in the Resolution Bandwidth Shape Factor check that follows.

1. Select step 97 from the spreadsheet.
2. Connect a 50 Ω cable from the instrument REF SIGNAL OUT connector to the RF INPUT connector.
3. Press the instrument PEAK FIND MAX key, then press the computer M key to enter the resolution bandwidth measurement. Be sure to allow the waveform display to stabilize and the sweep to complete before you press the computer M key.

NOTE

This test set up measures the bandwidth of the waveform at 6 dB down relative to the marker. Neither the marker nor the 6 dB down points need to coincide with a graticule line.

4. Select steps 98 through 110 from the spreadsheet, and repeat step 3 for each step.
5. When the step 110 measurement has been completed, press the computer C key to check that the resolution bandwidth accuracy is within specification.
6. Disconnect the cable from the instrument REF SIGNAL OUT and RF INPUT connectors.

Steps 111-114. Resolution Bandwidth Shape Factor Check

This check measures bandwidth using the 60 dB down BW MKR offset. An external source supplies the necessary power for wider bandwidths measurements. In narrower bandwidths, the internal calibrator supplies adequate power and eliminates source errors such as drift and FM.

The spreadsheet calculates the shape factor by the ratio of the 6 dB bandwidths to the 60 dB bandwidths. The 6 dB bandwidths were measured in the previous step.

1. Select step 111 from the spreadsheet.

2. Connect the signal generator to the instrument RF INPUT connector with a 50 Ω cable (as shown in Figure 4-17). Set the generator for an output-signal frequency of 100 MHz and an amplitude level of 0 dBm.

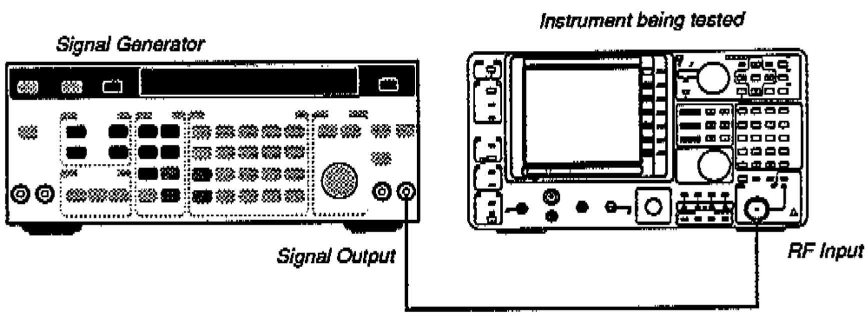


Figure 4-17. Test Equipment Setup for Steps 111-112 of Resolution Bandwidth Shape Factor Check.

3. Press the PEAK FIND MAX key, then press the computer M key to enter the measurement.

4. Select step 112 from the spreadsheet, and repeat step 3.

5. Disconnect the signal generator from the instrument, and connect the 012-0649-00 50 Ω cable from the REF SIGNAL OUT connector to the RF INPUT connector.

6. Select steps 113 and 114 from the spreadsheet, and repeat step 3 for each step.

7. When the step 114 measurement has been completed, press the computer C key to check that the resolution bandwidth shape factors are within specification.

Steps 115-116. Residual FM Check

This check measures the fast, relatively small, frequency excursions in the instrument. Residual FM is measured under locked and unlocked conditions using the calibrator as the signal source.

In the locked condition, the instrument is set to zero span and tuned so that the center of the screen is approximately 5 dB down on the 10 Hz filter slope. Any deviation in the analyzer frequency shows up as an amplitude change on screen. Measure the amplitude change on screen and enter that number into the spreadsheet. The spreadsheet calculates the slope of the 10 Hz filter by using the data previously measured for the resolution bandwidth and shape factor checks, and then converts the measured amplitude change into frequency change.

To measure residual FM in the unlocked condition, the instrument is set to the open loop mode. This allows the instrument to go to zero span without trying to lock. The measurement technique is the same as in the locked spans.

1. Select step 115 from the spreadsheet.
2. Connect the 012-0649-00 50 Ω cable from the REF SIGNAL OUT connector to the RF INPUT connector.
3. The baseline rise of the 100 MHz reference signal at zero span is a horizontal line that should be displayed on the screen. Use the instrument FREQUENCY ⇑ and FREQUENCY ⇓ keys to center the baseline rise to approximately the middle of the screen (as shown in Figure 4-18).
4. Push the SINGLE SWEEP key and allow the sweep to finish.
5. By using the Delta Markers function, determine the area of the baseline rise that has the greatest vertical deviation over the entire 10 horizontal divisions, then press the computer M key.
6. Press the TRIGGER key to restart the sweep.
7. Select step 116 from the spreadsheet.
8. Using the FREQUENCY/MARKERS knob, move the peak of the 100 MHz calibrator signal at center screen. Then, press the SPAN key and enter
   0 Hz from the KEYPAD.
9. Press MKR/FREQ to allow the FREQUENCY/MARKER knob to control marker movement.
10. The baseline rise of the calibrator signal is displayed as a horizontal line. Using the instrument FREQUENCY ⇑ and FREQUENCY ⇓ keys, adjust the baseline rise two divisions from the top graticule line.

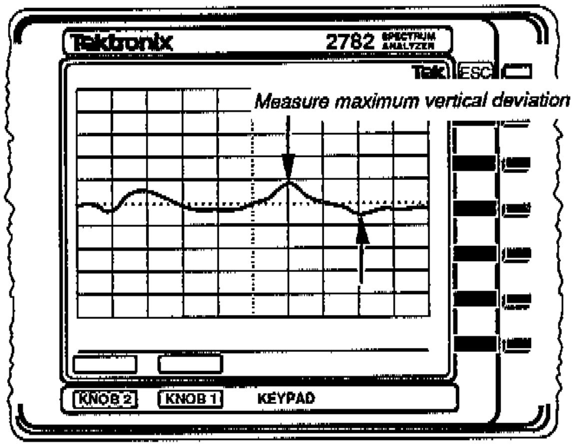


Figure 4-18. Residual FM check display.

11. Push the SINGLE SWEEP key and allow the sweep to finish.

12. Using Delta Markers, determine the area of the baseline rise that has the greatest vertical deviation over the total 10 horizontal divisions (as shown in Figure 4-18). Then press the computer M key to enter the measurement into the spreadsheet.

13. Push the TRIGGER key to restart the sweep.

Step 117. Center Frequency Drift Check

Center frequency drift is the slow, long-term frequency drift of the instrument.

This check is done at a sweep speed of 60 seconds over 10 divisions at zero span on the slope of the 10 Hz resolution bandwidth filter. The vertical drift of the baseline is then computed in Hz/minute.

1. Select step 117 from the spreadsheet.

2. Connect the 012-0649-00 50 Ω cable from the REF SIGNAL OUT connector to the RF INPUT.

3. The baseline rise of the calibrator signal at present settings is a horizontal line and should be displayed on the screen.

4. Using the instrument FREQUENCY ⇑ and FREQUENCY ⇓ keys, center the baseline rise to approximately center screen.

5. Set the sweep speed to 60 seconds by pushing the SWEEP key then entering 60 seconds via the KEYPAD.

6. Push the SINGLE SWEEP key twice to start the sweep.

7. After the sweep is completed, adjust the delta markers to the min and max deviation over the display so that one marker is on the display at the left edge of the graticule and the other marker is at the right edge of the graticule (as shown in Figure 4-19).

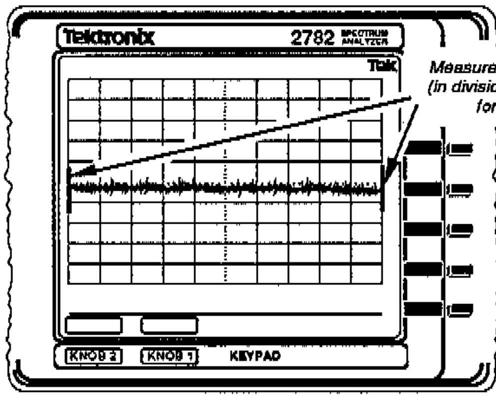


Figure 4-19. Baseline rise of 100 MHz reference signal.

8. Press the computer M key to record the frequency drift.

9. Press the computer C key to check that the center frequency drift is within specification.

10. Press the TRIGGER key to restart the sweep and disconnect the 50 Ω cable from the instrument RF INPUT.

Step 118. Factory Error In Setting –20 dBm Reference Level

This check measures the error in setting the –20 dBm reference level in 3 MHz Resolution Bandwidth. We first check this using the factory cal factors which were done at 23-24°C at the factory. We check against the typical spec within ±5°C of self-correction temperature. So, this measurement must be done with the temperature range at 18-29°C. A later check will calibrate –20 dBm absolute amplitude and, therefore, check this at self-correction temperature to verify proper operation of the self-correction function.

1. Select step 118 from the spreadsheet.

2. Connect the instrument REF SIGNAL OUT to the RF INPUT connector with the 012-0649-00 50 Ω cable.

3. Press the instrument PEAK FIND MAX key, then press the computer M key.

4. Disconnect the 50 Ω cable from the REF SIGNAL OUT connector and connect a SMA 6 dB attenuator between the 50 Ω cable and the REF SIGNAL OUT connector.

Steps 119-135. Factory Resolution Bandwidth Amplitude Accuracy Check

This check measures the difference in amplitude between the resolution bandwidth filters using the 3 MHz filter as a reference. We first check this using the factory calibration factors, which were done at 23-24°C at the factory. We check against the typical specification within ±5°C of self-correction temperature. So, this measurement must be done with the temperature range of 18-29°C. A later check will calculate relative amplitudes and, therefore, check this at self-correction temperature to verify proper operation of the self-correction function.

1. Run the VR Resonator Correction Routine by pushing the following key sequence.

   - ESC
   - UTIL
   - Vert Corr Menu
   - VR Reson Menu
   - Run Corr Cycle

NOTE

Step 1 is the VR Resonator Tracking vertical cal routine. The routine takes approximately 40 seconds to complete.

2. Select steps 119 through 132 from the spreadsheet, and repeat step 3 (of step 118 above) for each step.

NOTE

Steps 133 through 135 of the spreadsheet perform computations only. No measurements are entered in these steps.

3. Press the computer C key to check that the resolution bandwidth amplitude accuracy is within specifications.

4. Disconnect the 50 Ω cable and 6 dB attenuator from the instrument.

Step 136. Recalibration Error In Setting –20 dBm Reference Level

This check will calibrate –20 dBm absolute amplitude at 3 MHz resolution bandwidth and check to verify proper operation of the self correction function.

1. Connect the 012-0649-00 50 Ω cable from the REF SIGNAL OUT connector to the RF INPUT.

2. Run the VR Resonator Correction Routine and Resolution Bandwidth Correction Routine by pushing the following key sequence.

   - ESC
   - UTIL
   - Vert Corr
Menu
   - VR Reson
Menu
   - Run
Corr Cycle
   - Res BW
Menu
   - Run
Corr Cycle

   NOTE

   Step 2 is the VR Resonator and Resolution Bandwidth vertical cal routine. The routine takes approximately 16 minutes to complete.

3. After completion of step 2, select step 136 from the spreadsheet.

4. Press the PEAK FIND MAX key, then press the computer M key.

Steps 137-152. Recalibrated Resolution Bandwidth Amplitude Accuracy Check

This check measures the amplitude through each filter relative to 3 MHz, immediately after re-calibration.

The check will use the vertical re-calibration settings run at step 136. The result of this check is related to the self-correction temperature calibration.

1. Disconnect the 50 Ω cable from the REF SIGNAL OUT connector and connect a SMA 6 dB attenuator between the 50 Ω cable and the REF SIGNAL OUT connector.

2. Select steps 137 through 150 from the spreadsheet, and repeat step 4 (of step 136 above) for each step.

   NOTE

   Steps 151 through 152 of the spreadsheet perform computations only. No measurements are entered in these steps.

3. Press the computer C key to check that the resolution bandwidth amplitude accuracy is within specifications.

4. Disconnect the 50 Ω cable and 6 dB attenuator from the instrument.

Steps 153-184. Logging, Lin, and Square Law Accuracy Check

This check measures the incremental and cumulative logging error. The cumulative logging in 10 dB/division is checked over the entire 100 dB range. Incremental logging at each 1 dB is checked in 1 dB/division. Lin and Square Law accuracy is checked at 3 points on screen.

The test setup uses accurately characterized step attenuators. Two 6 dB attenuators between the step attenuators and the instrument's RF INPUT provide a stable 50 Ω load for both the step attenuators and RF input.

The measurement technique is to start at 10 dB/division and set the signal level near the top of the screen. Then, change the step attenuators in 10 dB steps, and measure the position on the screen with the marker. The spreadsheet calculates the cumulative error for each 10 dB step.

Similarly, 1 dB/division incremental logging is checked in 1 dB/division steps.

Next, similar measurements are made in the lin mode. With the signal at the top of the screen, attenuate the input by 6 dB and check for half screen. Then, add 6 dB more attenuation and check for quarter screen. The spreadsheet calculates the percentage of full screen for the lin mode.

Similar measurements are made in the power mode by using Watts/division and 3 dB steps.

1. Select step 153 from the spreadsheet.

2. Connect the signal generator to the instrument RF INPUT connector through a set of variable step attenuators and two 6 dB fixed attenuators.

3. Set the signal generator output frequency for 112 MHz and the amplitude level for 12 dBm. Set the step attenuators for 0 dB attenuation.

4. Press the MAX PEAK FIND key, then adjust the signal generator amplitude level to place the top of the signal at the top of the screen (0 dBm as measured by the marker).

5. Adjust the signal generator frequency control to move the 100 MHz signal to center screen, if needed.

6. Press the MAX PEAK FIND key to place a marker on the peak of the signal, then press the computer M key to enter the level of the signal in the spreadsheet.

7. Select steps 154 through 163 from the spreadsheet. For each step, set the step attenuator as shown in the spreadsheet, then repeat step 6. (Be sure to wait for a complete sweep before you press the computer M key).

NOTE

During steps 162 and 163 the averaging is activated. Allow five sweep averages before pushing the computer M key.

It is important that the step attenuators are set immediately after the step is exercised for steps 162 and 163. If the attenuator is set later, push the following key sequence.

•WAVEFORM VIEW
•AVERAGE
OFF
RD

8. Push the computer C key.

NOTE

Steps 164 and 165 of the spreadsheet are left blank.

9. Select step 166 from the spreadsheet, and set the step attenuators for 0 dB. Then, adjust the signal generator amplitude level to place the peak of the signal at the top of the screen (approximately –48 dBm).

10. Press the PEAK FIND MAX key to place a single marker on the peak of the signal, and press the computer M key.

11. Select steps 167 through 176 from the spreadsheet. For each step, set the step attenuators for the attenuation shown in the spreadsheet, then repeat step 10.

12. Select step 177 from the spreadsheet.

13. Set the step attenuators to 10 dB, and adjust the signal generator amplitude level to place the top of the signal at the top of the screen (approximately 12 dBm).

14. Place a single marker on the peak of the signal, and press the computer M key.

15. Select steps 178 through 180 from the spreadsheet. For each step, set the step attenuators as shown in the spreadsheet, then repeat step 14.

16. Select step 181 from the spreadsheet.

17. Set the step attenuators for 10 dB, and adjust the signal generator amplitude level to place the top of the signal at the top of the screen (approximately 12 dBm).

18. Place a marker on the peak of the signal, and press the computer M key.

19. Select steps 182 through 184 from the spreadsheet. For each step, set the step attenuators as shown in the spreadsheet, then repeat step 18.

20. When the measurement has been completed in step 184, press the computer C key to check that the logging, lin, and square law checks are within specification.

Steps 185-187. Not Used.

These steps are intentionally blank. Go to step 188.

Steps 188-288. IF Gain Accuracy Check

This check measures the accuracy of IF Gain over a 100 dB range in 1 dB steps. This is a lengthy process, requiring about 15 minutes.

At 100 dB external attenuation, the leakage around the step attenuators can be significant. Use double-shielded cable between the generator and attenuators, 6 dB pads after the attenuator, and the specified connectors.

The measurement technique is much like the RF Attenuator check, matching the internal IF gain change with external attenuation. Start with a signal at the center of the screen in 1 dB/division and narrow bandwidth so that the residual noise of the instrument is low enough for the full gain positions. The test frequency is 112 MHz to avoid a potential spurious response at 100 MHz.

To measure the IF Gain accuracy, increase IF Gain by 1 dB, add 1 dB of external attenuation, then make the measurement. Repeat this for the full 100 dB range.

After the data is entered, the spreadsheet calculates the cumulative error for each step and compares it to the specification.

NOTE

For accuracy, use the test equipment specified in the equipment list and be sure the sweep is complete before entering the value in the spreadsheet (M key).

1. Select step 188 from the spreadsheet.

2. Connect the signal generator to the instrument RF INPUT connector through a set of variable step attenuators and two 6 dB fixed attenuators (as shown in Figure 4-15).

3. Set the signal generator output for a frequency of 112 MHz and an amplitude level of 7 dBm. Set the variable step attenuators for 0 dB attenuation. Then, adjust the signal generator output so that the peak of the waveform is centered vertically on the instrument screen.

4. Press the PEAK FIND MAX key to place the marker on the peak of the waveform. Then, press the computer M key.

5. Select step 189 from the spreadsheet, and increase the attenuation 1 dB with the step attenuators.

6. Press the PEAK FIND MAX key to place the marker on the peak of the waveform, and press the computer M key to enter the measurement.

7. Select steps 190 through 288 from the spreadsheet and repeat step 6 for each. (When you reach an even decade of attenuation, reset the 1 dB step attenuator to 0 dB and increase the 10 dB step attenuator by 10 dB.)

NOTE

From step 271 to 288 the averaging is activated. Allow 3 sweep averages before pushing the computer M key.

It is important that the step attenuators are set immediately after the step is exercised for steps 271 through 288. If the attenuator is set later, push the following key sequence.

•WAVEFORM VIEW
•AVERAGE
OFF
RD

8. When the measurement has been entered for step 288, press the computer C key to check that the IF gain measured in steps 188 through 288 is within the specified range.

9. Disconnect the signal generator and step attenuators from the instrument.

Steps 289-291. Not Used.

These steps are intentionally blank. Go to step 292.

Steps 292-299. RF Attenuator Accuracy Check

This checks the RF attenuator accuracy as corrected by IF Gain. The RF attenuator is characterized at the factory during initial calibration. The calibration data is stored in EEPROM and is used to offset the IF Gain to compensate for attenuator errors.

The measurement technique is to compare the internal attenuation with calibrated external attenuators. Set an external step attenuator for full attenuation, and set the internal attenuation to minimum. Then, change each attenuator to offset the other. Variations in the display amplitude indicate an error in the attenuator. Measure each step, and the spreadsheet calculates the difference. This is an absolute measurement, not incremental. That is, 30 dB attenuation should be 30 dB ± tolerance when measured.

Be sure to use the equipment recommended in the equipment list at the beginning of this section.

1. Select step 292 from the spreadsheet.
2. Connect the signal generator to the instrument RF INPUT connector through a set of variable step attenuators and two 6 dB fixed attenuators.
3. Set the step attenuators for 70 dB. Then, set the signal generator frequency to 100 MHz and adjust the amplitude of the output signal so that the peak of the waveform is half screen (approximately 12 dBm).

NOTE

For the above step, it may be necessary to adjust the signal generator frequency control to display the signal on screen.

4. Press the instrument PEAK FIND MAX button, then press the computer M key.
5. Select steps 293 through 299 from the spreadsheet. Then, for each step, set the external attenuators for the settings shown in the spreadsheet, and repeat step 4.
6. Press the computer C key to check that the RF attenuator accuracy is within specification.

Steps 300-303. External Frequency Reference Lock Range Check

This checks that the external FREQ REF (IN/OUT), when set for an input, will accept and lock to a signal over the specified frequency and amplitude range. The external source needs to be locked to a WWV frequency standard receiver or some other high-accuracy source. At times, the test may involve a wait of 40 seconds for the reference to stabilize.

1. Select step 300 from the spreadsheet.
2. Connect a 50 Ω cable from the FREQ REF (IN/OUT) connector on the rear panel of the instrument to the output of the signal generator (as shown in Figure 4-20).

NOTE

A message concerning the Frequency Reference will be displayed on screen.

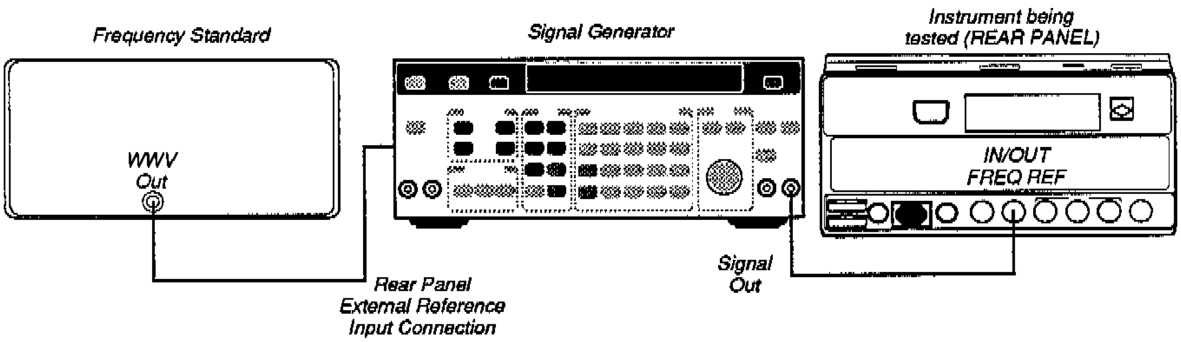


Figure 4-20. Test Equipment Connection for External Frequency Reference Check.

3. Connect a 50 Ω cable from the output of the 10 MHz frequency standard to the external reference input of the signal generator.

4. Set the signal generator output for 10.000 MHz at +5 dBm, with the signal frequency locked to the frequency standard signal.

NOTE

After approximately 40 seconds the Reference Frequency message will no longer be displayed. This is an indication that the instrument is locked to the external 10 MHz source.

5. Set the frequency of the signal generator to 9.999995 MHz, and check that the phase-lock loop for the reference frequency remains locked. If the phase-lock loop becomes unlocked, the instrument display will indicate Reference Loop Will Not Lock.

NOTE

Wait approximately 40 seconds after setting the signal generator frequency to give the phase-lock loop time to respond.

6. Press the computer M key then 1 to enter that the phase-lock loop remained locked, and enter a 0 if it did not.

7. Reset the signal generator signal output frequency to 10 MHz, and if the phase-lock loop became unlocked in step 6, wait until the loop locks again and the message is removed from the screen.

8. Select step 301 from the spreadsheet.

9. Set the frequency of the signal generator to 10.000005 MHz, and check that the phase-lock loop for the reference frequency remains locked (the message Reference Loop Will Not Lock. is not displayed).

10. Press the computer M key then 1 to enter that the phase-lock loop remained locked, and enter a 0 if it did not.

11. Select step 302 from the spreadsheet.

12. Set the signal generator output for 10 MHz and 0 dBm.
13. Check that the phase-lock loop for the reference frequency remains locked (the message Reference Loop Will Not Lock. is not displayed).
14. Press the computer M key then 1 if the phase-lock loop remains locked, if it does not, enter 0.
15. Select step 303 from the spreadsheet.
16. Set the signal generator output amplitude for +15 dBm, and check that the phase-lock loop for the reference frequency remains locked (the message Reference Loop Will Not Lock. is not displayed).
17. Press the computer M key then 1 if the phase-lock loop remains locked, if it does not, enter 0.
18. Disconnect the signal generator and 10 MHz frequency standard from the instrument.

Steps 304-306. Internal Trigger Level and Frequency Check

These steps check that the instrument will trigger properly on a signal that is displayed on the screen within the specified level and frequency range.

The signal that is used to develop the trigger is applied to the external video input. This provides a display to check trigger slope, level, and HF rejection.

1. Select step 304 from the spreadsheet.
2. Connect the test setup as per Figure 4-21.

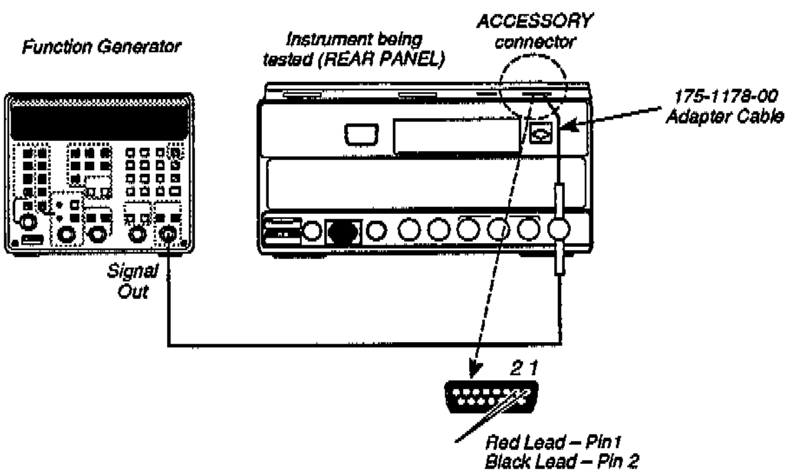


Figure 4-21. Test Equipment Connections for Internal Trigger Check.

3. Set the Signal Generator Output for a sine wave with a frequency of 10 Hz and an amplitude of 550 mV p-p.

4. Vary KNOB 1 until a stable waveform is displayed.

5. Press TRIGGER then SLOPE POS/neg menu key to select NEG, and check that the sweep is triggered on the falling (negative) edge of the waveform.

6. Again, press the SLOPE pos/NEG menu key to select POS, and observe that the display is triggered on the leading (positive) edge of the waveform.

7. Press the computer M key then 1 if the triggering requirements have been met. If the requirements are not met, enter 0.

8. Select step 305 from the spreadsheet.

9. Set the signal generator output to a frequency of 1 MHz.

10. Repeat step 4 then step 7 for the 1 MHz signal input.

11. Select step 306 from the spreadsheet.

12. Set the Signal Generator for an output frequency of 1 kHz, then adjust the signal amplitude (approximately 3V p-p) for a full screen display.

13. Vary KNOB 1 and check that the positive slope of the signal can be triggered at any point over the top 5 left vertical divisions of the display.

14. Press the computer M key then 1 to enter that the triggering requirements have been met. If the requirements are not met, enter 0.

Steps 307-309. External Trigger Level and Frequency Check

This check is similar to the Internal Trigger check. In this check, the test signal is applied to the rear panel EXT TRIG/HORIZ input. To display the signal, an input to pins 1 and 2 of the ACCESSORY connector is necessary.

1. Connect the test setup as per Figure 4-21.

2. Select step 307 from the spreadsheet.

3. Set the Signal Generator output for a frequency of 5 MHz and an amplitude of 865 mV p-p.

4. Adjust KNOB 1 for a stable display.

5. Press the computer M key then 1 to enter that the triggering requirements have been met. If the requirements are not met, enter 0.

6. Select step 308 from the spreadsheet.

7. Set the Signal Generator output for a frequency of 1.5 kHz.

8. Repeat steps 4 and 5 to verify performance.

9. Select step 309 from the spreadsheet.

10. Increase the Signal Generator output amplitude to 3.5 V p-p.

11. Vary KNOB 1 and check that the positive slope of the signal can be triggered at any point over the top 5 left vertical divisions of the display.

12. Press the computer M key then 1 to enter that the triggering requirements have been met. If the requirements are not met, enter 0.

13. Disconnect the test equipment.

Steps 310-311. External Sweep Input Check

This checks that the specified voltages will move the sweep horizontally over the total screen area.

1. Select step 310 from the spreadsheet.

2. Connect a 50 Ω cable to the function generator signal output (as shown in Figure 4-22), and connect a BNC-Tee (center) to the other end of the cable.

3. Connect a 50 Ω cable from one side of the Tee to the instrument TRIG/HORIZ IN connector on the rear panel. Connect a 50 Ω cable from the other side of the Tee to one of the test oscilloscope's vertical inputs.

4. Set the function generator for a sine wave output at a frequency of 100 Hz and amplitude of 9 volts p-p, as measured with the test oscilloscope. Then, adjust the function generator dc offset for 4.5 volts.

5. While viewing the signal on the screen, adjust the function generator amplitude and offset controls for a full 10 divisions of deflection.

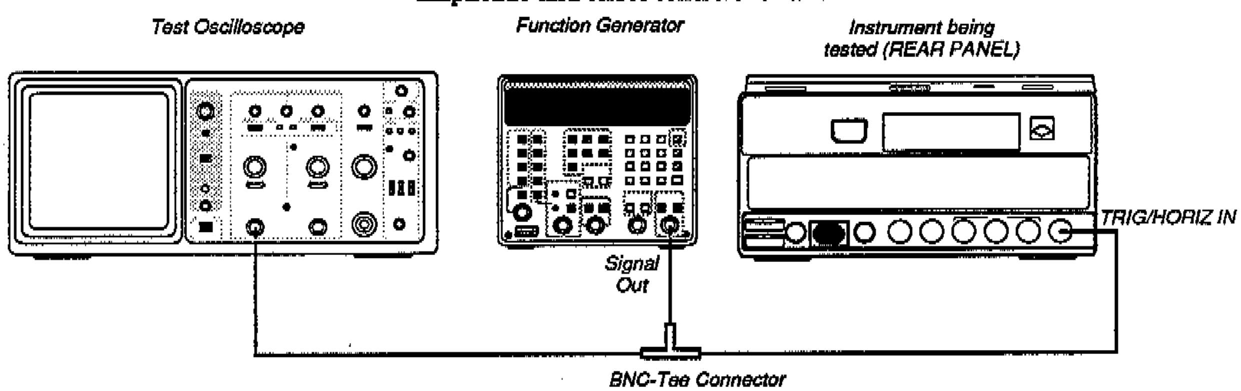


Figure 4-22. Test Equipment Connections for External Sweep Input Check.

6. Determine the voltage level (relative to 0 volts) of the negative peaks of the signal displayed on the test oscilloscope. Then, press the computer M key and enter the voltage in the spreadsheet.

7. Select step 311 from the spreadsheet.

8. Determine the voltage level (relative to 0 volts) of the positive peaks of the signal displayed on the test oscilloscope. Then, press the computer M key and enter the voltage in the spreadsheet.

9. Disconnect the function generator and 50 Ω cable from the instrument.

Steps 312-317. Sweep Speed Timing Accuracy Check

This check measures the time for the sweep to travel across the screen. A time-mark signal is applied to the external video input, and the instrument is internally triggered. Then, the sweep speed is checked over decade steps.

This check is similar to the Frequency Span check. Time marks are positioned to the first and ninth graticule lines then measured with the ΔMKR function. To measure the 100 µs/division sweep interval, it is necessary to observe the real-time signal (not digitized as in other checks). To use the markers in conjunction with the real time display, carefully follow the procedure.

1. Select step 312 from the spreadsheet.

2. Connect the time mark generator (through a X5 50 Ω attenuator) to the video input of the ACCESSORY connector on the instrument rear-panel with a 50 Ω cable and a BNC-to-dual-pin-out cable (as shown in Figure
4-23). The red lead connects to pin 1 (signal) and the black lead to pin 2 (ground).

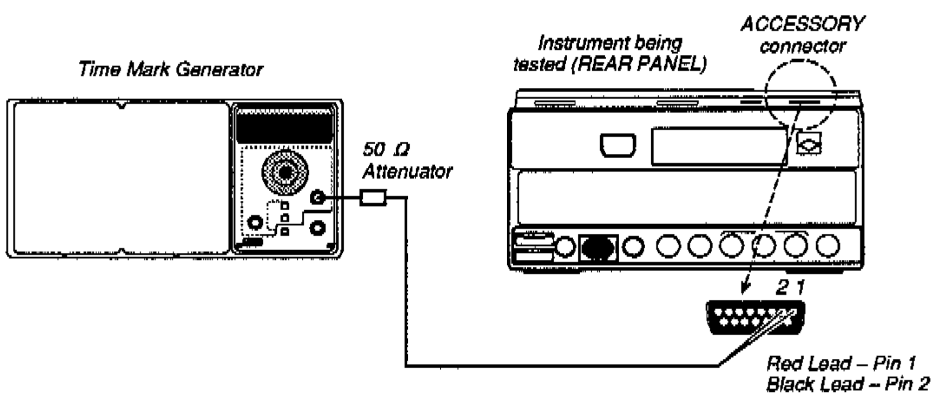


Figure 4-23. Test Equipment Connections for Sweep Speed Timing Accuracy Check.

3. Set the time-mark generator to 1 second.

4. Press the Δ MKR key, and adjust KNOB 1 for a stable trigger display as needed.

5. Position the markers to the first and ninth time marks on the screen using the SWAP REF MKR menu function.

6. Press the computer M key to measure the time between the first and ninth markers and enter it into the spreadsheet.

7. Select step 313 from the spreadsheet.

8. Set the time-mark generator for 0.1 second and repeat steps 4, 5, and 6.

NOTE

If you have difficulty triggering the display, press the SINGLE SWEEP key to make the measurement, then press the TRIGGER key before going to the next measurement.

9. Select step 314 from the spreadsheet.

10. Set the time-mark generator for 10 milliseconds. Then repeat steps 4, 5, and 6.

11. Select step 315 from the spreadsheet.

12. Set the time-mark generator for 1 millisecond. Then repeat steps 4, 5, and 6.

13. Select step 316 from the spreadsheet.

14. Set the time-mark generator for 100 microseconds. Then repeat steps 4, 5, and 6.

15. Push the TRIGGER key.

16. Disconnect the cable from the time-mark generator, and press the SINGLE SWEEP key.

17. If necessary, vary KNOB 1 to obtain a flat trace display.

18. Select step 317 from the spreadsheet.

19. Set the time-mark generator for 10 microseconds.

20. Reconnect the cable to the time-mark generator. Then, press the TRIGGER key, and adjust the triggering so that stable time marks are displayed.

21. While observing the real-time time marks, position the markers at the base of the first and ninth real-time time marks using the Swap Ref Marker function.

17. Press the computer M key to measure the time between the first and ninth markers.

18. Press the computer C key to check that the sweep-timing accuracy is within the specification.

19. Disconnect the time-mark generator from the instrument.

Steps 318-322. Flatness and Frequency Response Recording

These steps enter flatness check data for use in the spreadsheet.

1. Select step 318 from the spreadsheet.

2. From the flatness check data collected in Part I of this procedure, determine the maximum p-p corrected flatness (in dB's) for all the attenuator settings in the 100 Hz to 6.5 GHz frequency range (see the example in Figure 4-24). Then, enter one half of this value at this step in the spreadsheet.

NOTE

Use the PLOT.EXE program, either to make a hard copy of the plots of the flatness data or to examine the flatness data on the computer monitor. The PLOT.EXE program is described earlier in this procedure under Plotting the Flatness Test Results (PLOT.EXE).

The data in these plots is relative to the gain measured at 100 MHz. Therefore, the 0 dB line represents the gain at 100 MHz.

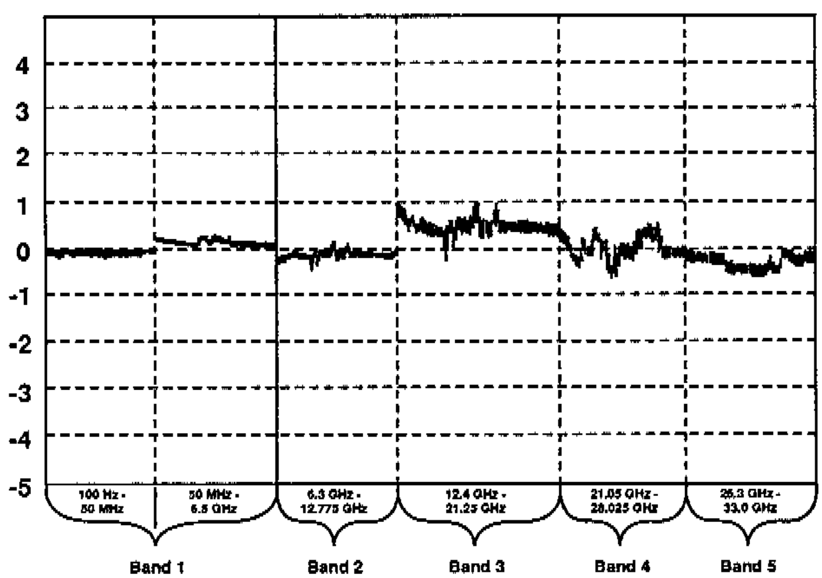


Figure 4-24. Example Plot for Flatness and Band Switching Uncertainty Measurements.

3. Select step 319 from the spreadsheet, and enter one half of the maximum p-p corrected flatness for the 6.3 GHz to 12.775 GHz frequency range.

4. Select step 320 from the spreadsheet, and enter one half of the maximum p-p corrected flatness for the 12.4 GHz to 21.25 GHz frequency range.

5. Select step 321 from the spreadsheet, and enter one half of the maximum p-p corrected flatness for the 21.05 GHz to 28.025 GHz frequency range.

6. Select step 322 from the spreadsheet, and enter one half of the maximum p-p corrected flatness for the 26.30 GHz to 33.0 GHz frequency range.

Step 323. Band Switching Uncertainty Check

This step uses the average corrected flatness data for each band to determine the error due to gain change. Gain is changed to compensate for insertion loss error in each band.

1. Select step 323 from the spreadsheet.

2. Using the corrected flatness data plots obtained from the Part I flatness checks (see the example in Figure 4-24), determine the average gain for each band at all RF attenuation settings, relative to the 0 dB line.

3. Enter in the spreadsheet the value (in dB's) of the largest gain measured in step 2.

Step 324. 2 MHz Spurious Response Check

This step checks the 2 MHz spurious response at 2 MHz center frequency.

1. Connect a 50 Ω termination to the instrument RF INPUT.

2. Select step 324 from the spreadsheet.

3. Press the MAX PEAK FIND key; then, press the computer M key.

4. Remove the 50 Ω termination from the instrument RF INPUT.

5. Push the PRESET key to return the instrument to the factory-default conditions.