# TEKTRONIX®

# 7K11

## CATV PREAMPLIFIER

## INSTRUCTION MANUAL

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Serial Number B020276

070-1664-00

## WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

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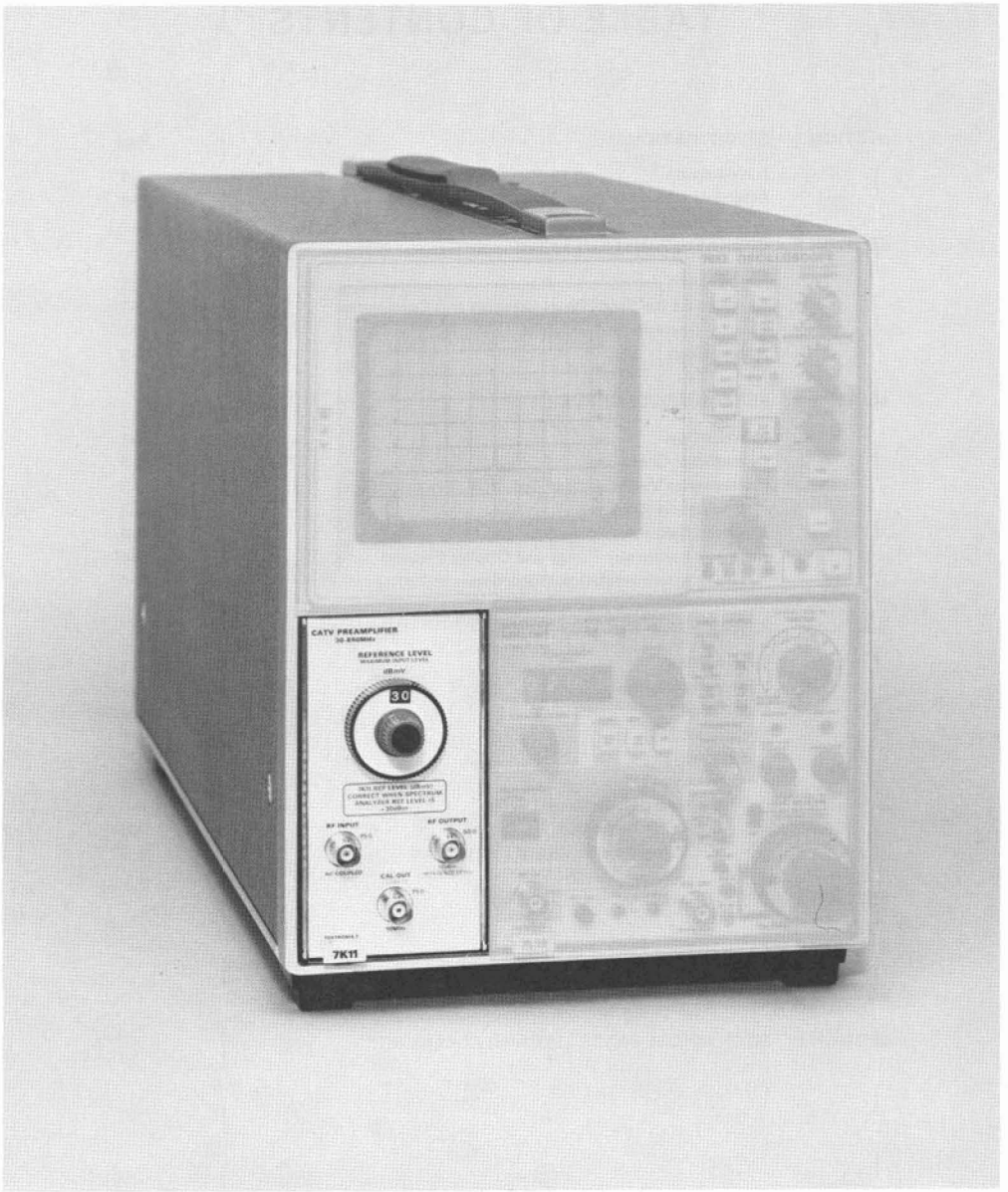



Fig. 1-1. 7K11 CATV Preamplifier.

# SPECIFICATIONS

## Introduction

This manual contains information relative to the operation and service of the 7K11 CATV preamplifier. The manual is divided into sections with appropriate titles. The Table of Contents that precedes this section gives a breakdown of each section.

The 7K11 Preamplifier is a 7000-Series Plug-In Unit that is designed to operate as an accessory for the 7L12 or 7L13 Spectrum Analyzers. This unit, in combination with a spectrum analyzer, will measure CATV system performance as required by the FCC and compare system performance to industry standards.

## ELECTRICAL CHARACTERISTICS

(Includes the 7L12 or 7L13)

**Frequency Range**

30 MHz to 890 MHz.

**Display Flatness (7K11/7L12 or 7K11/7L13)**

±1.0 dB, with respect to 50 MHz level, over the frequency range of 50 MHz to 300 MHz, increasing to ±2 dB with respect to 50 MHz, over the full frequency range.

**Sensitivity (Signal + noise = 2X noise, LIN mode)**

The following characteristics apply at 50 MHz in combination with the 7L12 or 7L13 Spectrum Analyzer.

| Signal Level | Resolution Bandwidth |
|---|---|
| −90 dBmV | 30 Hz |
| −80 dBmV | 300 Hz |
| −73 dBmV | 3 kHz |
| −65 dBmV | 30 kHz |
| −55 dBmV | 300 kHz |
| −45 dBmV | 3 MHz |

Noise figure for the 7K11 is 5 dB or less.

**Intermodulation Distortion**

IM products from two 0 dBmV input signals within any frequency span are down 80 dB or more. The 7K11 will not degrade the IM distortion characteristics of the Spectrum Analyzer.

**Reference Level**

Calibrated levels in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV Calibrator at 50 MHz. Maximum deviation from this reference is; 0.2 dBmV + 0.01 dBmV per dB deviation from the +30 dBmV, 7K11 reference level. This is equivalent to:
± [0.2 dBmV + 0.01 | 7K11 REF LVL − 30 dBmV| ].

**Calibrator**

50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.5 dB, from 75 Ω, at 25°C.

The input impedance of the 7K11 is approximately 75 Ω, with a VSWR of 2:1 or better with 10 dB or more attenuation (from 50 MHz to 300 MHz).

# OPERATION

## Introduction

This section describes the function of the front panel controls and connectors, a general operating procedure and some applications[1] for the instrument. Performing the operating procedure should help acquaint you with the 7K11 as an accessory for the Spectrum Analyzers in CATV applications.

## FUNCTION OF THE FRONT PANEL CONTROLS AND CONNECTORS

### REFERENCE LEVEL and MAXIMUM INPUT LEVEL

Concentric controls that select a calibrated reference level for the top of the graticule on the CRT display. This level can be selected in 1 dBmV or 10 dBmV steps to +79 dBmV. The reference level is indicated via a readout window on the selectors and in the upper left section of the CRT display when the 7K11 is used with a 7000-Series oscilloscope that has the readout feature. This REFERENCE LEVEL is also the MAXIMUM INPUT signal level for linear operation. Accuracy is referenced to the +30 dBmV Calibrator at 50 MHz.

### RF INPUT Connector

A 75 Ω BNC input connector for the input signal application.

### RF OUTPUT Connector

A 50 Ω signal source of the signal that is applied to the RF INPUT. This signal level depends on the setting of the REFERENCE LEVEL selector and applied signal level. The output is −30 dBm when the input signal level equals that indicated by the REFERENCE LEVEL readout. NOTE: The 7L12 or 7L13 Reference Level can be set to a setting such as −40 dBm, to increase sensitivity, provided the additional level (in this case 10 dB) is summed with the 7K11 REFERENCE LEVEL indication.

### CAL OUT Connector

Provides access to an accurate +30 dBmV, 50 MHz signal, from a 75 Ω source. This signal is used as an absolute reference for the display and is used to calibrate the 7K11/Spectrum Analyzer ensemble. Harmonics of the 50 MHz pilot signal provide a picket fence of markers across the frequency span, which are used for accurate frequency and span calibration. The pilot or fundamental 50 MHz provides the amplitude REFERENCE LEVEL. NOTE: Always use the 75 Ω, 5 1/2 inch cable, which is supplied with the accessories, to connect the CAL OUT to the RF INPUT.

## GENERAL OPERATING INFORMATION[1]

This portion of the section describes the front panel adjustment procedure necessary to calibrate the 7K11, Spectrum Analyzer, and 7000-Series mainframe as a system.

*NOTE*

*External graticules are designed so they compensate for parallax of the camera. Graticule markings will therefore be correct on photographed displays.*

**1. Preliminary Setup and Calibration Procedure**

a. Plug the 7K11 and Spectrum Analyzer into a 7000-Series mainframe. An oscilloscope with variable persistence or bi-stable storage is recommended.

b. Connect the 7K11 and Spectrum Analyzer as shown in Fig. 2-1 and turn the power on.

c. Set the controls and selectors as shown in the illustration. Connect the CAL OUT signal of the 7K11 to the RF INPUT and the RF OUTPUT to the Spectrum Analyzer RF Input. Ensure that the Spectrum Analyzer Reference Level is set to −30 dBm and the 7K11 REFERENCE LEVEL is +30 dBmV.

d. Allow approximately 30 to 40 minutes for the instruments to stabilize.

[1] **Tektronix brochure, "no loose ends", No. A-2698 (supplied with the 7K11 accessories); Tektronix brochure, "Spectrum Analysis and CATV Systems", No. A-2515; and Tektronix measurement concept booklet, "Spectrum Analyzer Measurement Theory and Practice", Part No. 062-1334-00; are recommended treatise on applications and measurement evaluation.**

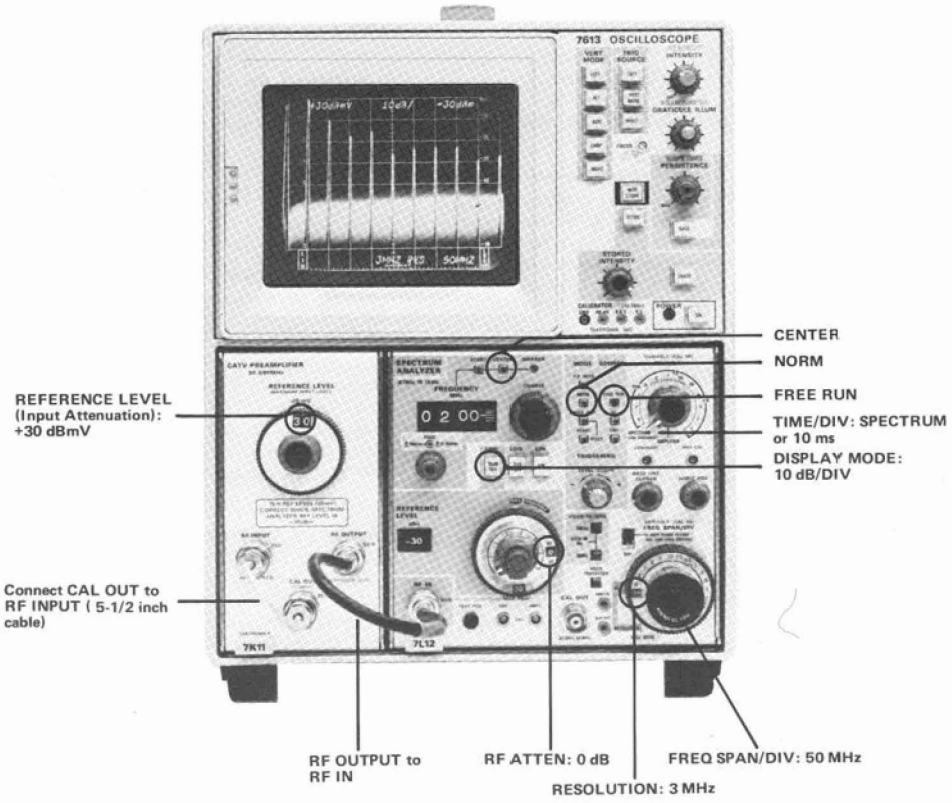



Fig. 2-1. Initial setup, showing control and selector positions.

e. Adjust the oscilloscope Intensity, Focus and Astigmatism controls for optimum display definition with normal intensity.

f. Depress the 2 dB/Div display mode button on the analyzer and position the baseline of the display to the bottom graticule line with the Vert Position control. Center the display with the Horizontal Position control.

g. Now depress the 10 dB/Div (LOG) display pushbutton on the analyzer. Display should now resemble that shown in Fig. 2-1.

*NOTE*

*When the oscilloscope has a CRT with P7 phosphor, a viewing hood will help shield ambient light and enhance the display information.*

**2. Calibrate the sweep span and reference level, using the 7K11 Calibrator signal and the procedure described in the Spectrum Analyzer manual.**

## APPLICATIONS

The gain and 75 Ω to 50 Ω conversion of the 7K11 provide the increased sensitivity that is necessary for the Spectrum Analyzer (7L12) to make all CATV performance tests. Tektronix "Proof of Performance" brochure provides procedures for making these measurements. The following describes a typical application for the 7K11/7L12.

### Sensitive Intermodulation Measurements:

a. Connect the test point of the CATV system to the 7K11 RF INPUT connector.

b. Select a Frequency Span/Div so the spectrum of one channel is displayed (0.5 MHz). Tune the Spectrum Analyzer Center Frequency to the center of the channel.

c. Adjust the Resolution and sweep speed for a flicker-free display with distinct video and sound carrier. Adjust the sweep speed so the video information moves across the display and does not obscure any IM (beat) products. Switch in filters, adjust Resolution, persistence, and Intensity, until the carrier to noise amplitude ratio is optimized

d. Use the 10 dB/Div display mode and check for a peak carrier to noise ratio that is 50 dB or more.

e. Check the display for IM products above and below the picture carrier by tuning slowly either side of the carrier signal or switch the center frequency from Center to Start position. Once a beat is located, compare the peak video carrier level to the peak intermodulation (beat) signal level. See Fig. 2-2.

f. Check to ensure that the beat signal is not a product of the 7K11 amplifier by changing the input attenuation (REFERENCE LEVEL) a few dB (e.g., 3 dB). If the change of the beat signal amplitude level is more than the input attenuation change, the 7K11 amplifier is producing the signal.

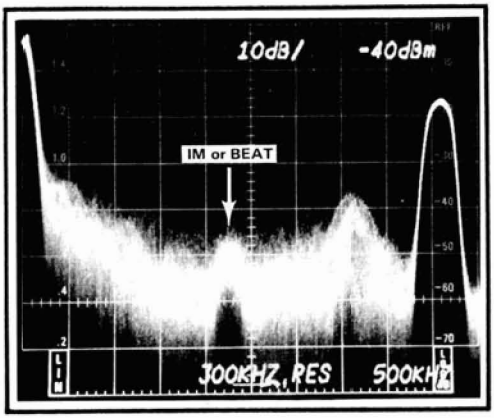



**Fig. 2-2. Display showing intermodulation above the picture carrier.**

# PERFORMANCE CHECK

## Introduction

This section verifies the operational performance of the 7K11 to the characteristics specified in the Specifications section. Verification of the electrical characteristics requires sophisticated test equipment; however, an incoming acceptance check procedure is provided in the first portion of this section to check the instrument operation. This procedure will not measure specified parameters. The second portion of this section provides a list of test equipment and procedures for measuring the specified parameters and characteristics.

## OPERATIONAL CHECK AND INSTRUMENT FAMILIARIZATION

This portion contains a sequence of procedures that checks the instrument operation and will help familiarize you with the instrument operation. Because the 7K11 Calibrator and attenuator are very accurate, they are used as the reference for this operational checkout.

### Preliminary Preparation

Perform the Preliminary Front Panel Setup Procedure that is described in the Operating Instructions so the system display (amplitude and frequency span) is calibrated.

### 1. Check Frequency Range (30 MHz to 890 MHz)

a. Apply the CAL OUT signal through the 75 Ω, 5 1/2 inch cable, to the RF INPUT and connect the RF OUTPUT to the Spectrum Analyzer RF Input through a 50 Ω coaxial cable.

b. Set the 7K11 and Spectrum Analyzer selectors as follows:

**7K11**

| | |
|---|---|
| REFERENCE LEVEL | +10 dBmV (This is 20 dB above the calibrator +30 dBmV reference level so harmonics of the fundamental will spread across the 900 MHz spectrum.) |

**Spectrum Analyzer**

| | |
|---|---|
| Center Frequency | 500 MHz |
| Reference Level (RF Attenuator at 0 dB) | –30 dBm |
| Display Mode | 10 dB/Div |
| Freq. Span/Div | 100 MHz |
| Resolution | 3 MHz |
| Time/Div | Spectrum or 10 ms |

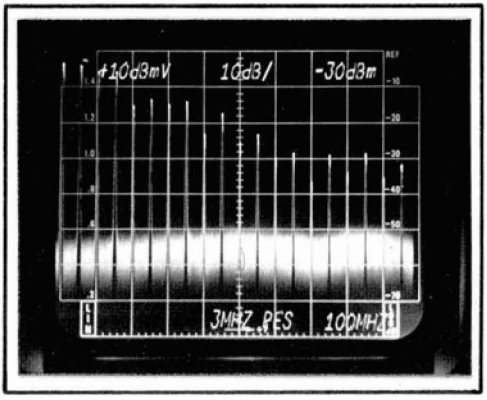



**Fig. 3-1. 50 MHz markers across a 1000 MHz display.**

c. Check the 1000 MHz span for 50 MHz markers out to 900 MHz. Marker amplitude will decrease towards the upper end of the spectrum. See Fig. 3-1.

### 2. Check the Calibrator Reference Level

a. Change the Spectrum Analyzer Display Mode to 2 dB/Div. Tune the Center Frequency to the 50 MHz fundamental. Uncouple the Freq Span/Div from the Resolution and open the display to 10 MHz/Div. Resolution should remain at 3 MHz. Change the 7K11 REFERENCE LEVEL to +30 dBmV.

b. Disconnect the cable between the 7K11 RF OUTPUT and the Spectrum Analyzer RF Input and apply the Spectrum Analyzer Calibrator signal to its RF Input. Note the amplitude of the 50 MHz, −30 dBm signal.

c. Now apply the 7K11 RF OUTPUT to the Spectrum Analyzer RF Input and the CAL OUT (+30 dBmV) to its RF INPUT. The amplitude difference between the two calibrator signals should be slight.

*NOTE*

*Because of the additive tolerances of the 7K11 and Spectrum Analyzer Calibrators, plus the 7K11 attenuator and amplifier, it is impractical to establish limits. This comparison is only an operational check.*

## 3. Check the Attenuator

*NOTE*

*The attenuator accuracy is checked at the factory. This check will detect component failure but it will not check the tolerance characteristics. If the tolerance characteristics are to be checked, a reference attenuator calibrated by the user or manufacturer to specifications more rigid than the 7K11 attenuator must be used.*

a. Apply the 50 MHz, +30 dBmV signal to the RF INPUT and connect the RF OUTPUT to the RF Input of the Spectrum Analyzer.

b. Set the front panel controls as follows:

| 7K11 | |
|---|---|
| REFERENCE LEVEL | +30 dBmV |
| **Spectrum Analyzer** | |
| RF Attenuator | 30 dB |
| Reference Level | −20 dBm |
| Display Mode | 10 dB/Div |
| Freq. Span/Div | 5 MHz |
| Resolution | .3 MHz |
| Time/Div | Spectrum or 10 ms/Div |

c. Tune the 50 MHz signal to the center of the graticule, then open the display by decreasing the Freq Span/Div to 2 MHz.

d. Adjust the signal amplitude with the Spectrum Analyzer Variable Gain control to a graticule reference line (e.g., one division below the top line).

e. Check the 7K11 attenuator by increasing the settings in 10 dB steps above +30 dBmV while decreasing the Spectrum Analyzer RF attenuator setting in 10 dB increments and noting the difference in signal amplitude. Now decrease the 7K11 attenuator settings below +30 dBmV and increase the analyzer RF attenuator settings and note the difference. Difference between the two should not exceed 1.5 dB.

f. Return the attenuators to +30 dBmV and 30 dB. Switch to the 2 dB/Div display mode and re-establish a signal reference level with the Variable Gain control.

g. Check the 1 dB steps of the 7K11 attenuator by noting the decrease of signal amplitude on the display as the attenuation is increased.

## 4. Check Sensitivity (−45 dBmV at 3 MHz Resolution)

a. Switch the Spectrum Analyzer Display Mode to Lin and add 30 kHz of Video Filter.

b. Increase the 7K11 attenuator setting 45 dB (REFERENCE LEVEL to 75 dBmV). Now increase the Spectrum Analyzer IF gain (selector and Variable) setting until the average noise floor on the display rises one division.

c. Check that the amplitude of the signal is at least twice the noise level ( $\geqslant$ 2 div). See Fig. 3-2.

This completes the operational check of the instrument's performance. If you desire to validate the specified parameters (which requires sophisticated test equipment), continue to the next part of this section.

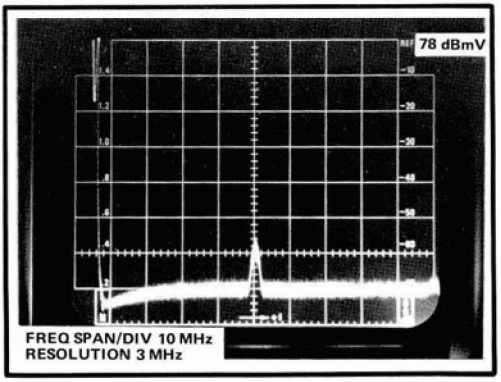



**Fig. 3-2. Measuring sensitivity. Signal level = 2X noise.**

## PERFORMANCE VERIFICATION OF SPECIFIED CHARACTERISTICS

The following procedures describe how to measure the 7K11 characteristics as specified. It does not include internal adjustments or checks. If the instrument fails to meet specified performance requirements, the adjustment procedure will be found in the Service section under Calibration.

### History Information

The instrument and manual are continually evaluated and updated. Circuits and manual procedures may be modified. Information applicable to earlier instruments are included either as deviations within these steps or as a subpart of the steps. These modifications are added at the back of the manual as inserts or indicated in the procedure.

### Equipment Required and Recommended

The following test equipment and fixtures are recommended to perform this portion of the performance check. Test equipment specifications are the minimum requirements for accurate checks. Substitute equipment must equal or exceed these specifications.

The fixtures (attenuators, etc.) are used where necessary to facilitate the procedure. These fixtures are available from Tektronix, Inc., and can be ordered through your local Tektronix Field Office or representative.

### EQUIPMENT LIST

NOTE: This equipment is also required to recalibrate the instrument.

1. Spectrum Analyzer ensemble (Oscilloscope and 7L12 or 7L13 Spectrum Analyzer). NOTE: Storage or variable persistence oscilloscopes are desirable for spectrum analysis. Tektronix 7000-Series storage or variable persistence oscilloscopes (7613, 7623, 7313) accept three plug-in widths. The 7L13 Spectrum Analyzer requires three plug-in widths; therefore, the 7K11/7L13 ensemble must be used with non-storage mainframes such as 7704A and 7904.

2. Leveled sweeper or signal generators that cover the frequency range of 30 MHz to 890 MHz. (Use a power meter to verify that the generator output remains constant over this frequency range.)

   a) Hewlett Packard Model 8660A with 86602A RF Section; or

   b) Hewlett Packard Model 608E (10 MHz to 480 MHz) plus Model 612A.

The Model 612A does not have a leveled output; therefore, it must be adjusted manually as the frequency is changed.

3. Vector Voltmeter with a frequency range of 50 MHz, to measure the Calibrator +30 dBmV output level tolerance: Hewlett Packard Model 8405A.

4. Digital Counter to check 50 MHz accuracy of the calibrator: Tektronix 7D14 Digital Counter with a readout 7000-Series oscilloscope, or a DC-502 with the TM-500-Series.

5. Type BNC 50 Ω to 75 Ω Minimum Loss Attenuator: Tektronix Part No. 011-0057-00.

6. Two 5:1, 50 Ω Attenuators: Tektronix Part No. 011-0060-01.

7. Two 18 inch, 50 Ω low loss coaxial cables with BNC to BNC connectors: Tektronix Part No. 012-0076-00.

8. BNC "T" Connector: Tektronix Part No. 103-0030-00.

9. 75 Ω Feedthrough Termination: Tektronix Part No. 011-0055-00.

## PERFORMANCE CHECK

### 1. Check the Calibrator Frequency (Accuracy 50 MHz ±0.01%)

The frequency of the calibrator may be checked by an accurate frequency counter, such as Tektronix 7D14 Digital Counter Plug-In Unit with a readout 7000-Series Oscilloscope or a DC-502 with TM-500-Series. No procedure for this check is provided, because the CAL OUT signal can be connected through the CATV Preamplifier unit to the input of the counter and the frequency readout noted.

### 2. Check Calibrator Output (+30 dBmV ±0.3 dB)

The output of the calibrator contains harmonics; therefore, direct measurement is not possible.

**Vector Voltmeter Method (Hewlett Packard Model 8405A Vector Voltmeter)**

a. Terminate the "A" probe with a BNC 75 Ω feedthrough termination and connect the probe, through the termination, to the CAL OUT connector on the 7K11.

b. Switch the Vector Voltmeter frequency to 50 MHz.

c. Check for an RMS reading between 31.2 mV to 32.1 mV (+30 dBmV is 31.6 mV RMS into 75 Ω). If output is out of specification, refer to Calibrator Output adjustment in the Calibration Procedure.

### 3. Check RF Attenuator Accuracy (Within ±0.2 dB + 1% of the dB readout)

*NOTE*

*The RF attenuator accuracy is checked at the factory to ensure that it is within specifications. Step #3 in the first portion of this section will detect any component failure within the attenuator but it will not check the tolerance characteristics. If the exact attenuation error of the selector is required, a reference attenuator, calibrated by the user or manufacturer to more rigid specifications than the 7K11 RF attenuator, must be used.*

### 4. Check the Frequency Range and Display Flatness (±2 dB, 30 MHz to 890 MHz, ±1 dB, 50 MHz to 300 MHz).

a. Set the 7K11 and Spectrum Analyzer controls as follows:

| | |
|---|---|
| | **7K11** |
| REFERENCE LEVEL | 10 dBmV |
| | **Spectrum Analyzer** |
| Center Frequency | 50 MHz |
| Reference Level (RF at 0 dB) | –30 dBm |
| Display Mode | 2 dB/Div |
| Freq. Span/Div | 100 MHz |
| Resolution | 3 MHz |
| Time/Div | Spectrum or 10 ms |

b. Apply the output of a leveled sweeper or signal generator through a 50 Ω to 75 Ω Minimum Loss Attenuator, to the RF INPUT of the 7K11. Connect the RF OUTPUT to the RF Input of the Spectrum Analyzer.

c. Tune the sweeper or signal generator to 50 MHz and adjust the output for a signal reference level of approximately 5 divisions on the display.

d. Check the frequency range and flatness of the 7K11/Spectrum Analyzer ensemble, by sweeping or tuning the signal generator(s) from 30 MHz to 890 MHz. Display flatness must be within 1 dB from 50 MHz to 300 MHz with reference to 50 MHz, and within 2 dB from 30 MHz to 890 MHz. Frequency range must equal or exceed 30 MHz to 890 MHz.

### 5. Check Intermodulation Distortion

The 7K11 will not degrade the IM performance specifications of the Spectrum Analyzer. Intermodulation distortion from two 0 dBmV signals is down 80 dB or more.

One method of checking this specification is to check the 7K11/Spectrum Analyzer ensemble to ensure that the IM distortion characteristics of the Spectrum Analyzer have not been degraded. Check by performing the procedure described in the Spectrum Analyzer manual. NOTE: Use a 50 Ω to 75 Ω Minimum Loss Attenuator between the 50 Ω signal source and the RF INPUT of the 7K11.

Over the linear operating range of the 7K11 amplifier, the gain remains relatively constant or on a 1:1 ratio. The ratio of intermodulation products (3rd order) from two or more input signals is about 3:1. This analogy is used to extrapolate the IM distortion figure of the 7K11 by the following procedure.

a. Apply two signals within the frequency range of the 7K11 and separated approximately 2 MHz to 10 MHz, through two 5X attenuators (for isolation), a BNC "T" connector, then through a 50 Ω to 75 Ω Minimum Loss Attenuator, to the 7K11 RF INPUT. Fig. 3-3 illustrates this setup.

b. Set the front panel controls and selectors as follows:

| 7K11 | |
|---|---|
| REFERENCE LEVEL | +30 dBmV |
| **Spectrum Analyzer** | |
| Display Mode | 10 dB/Div |
| RF Attenuator | 0 dB |
| Reference Level | −30 dBm |
| Video Filter | 30 kHz |
| Center Frequency | Tuned midway between the two applied signals |
| Freq Span/Div and Resolution | Span should be wide enough to observe the two input signals and their IM products. Resolution set for optimum sensitivity. |

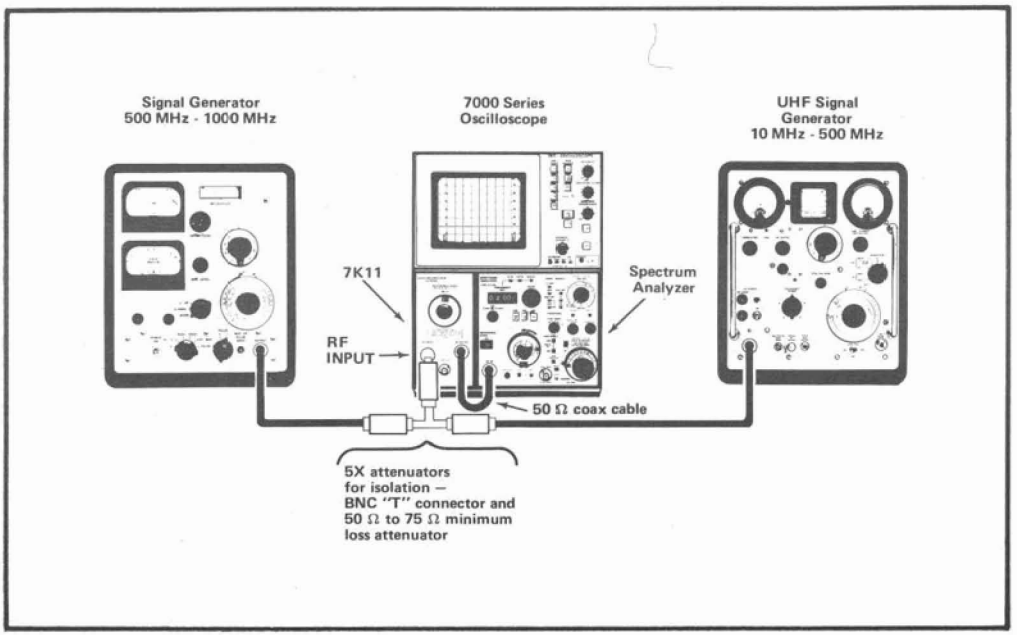



Fig. 3-3. Equipment setup and connections necessary to measure intermodulation distortion.

c. Adjust the output of the two signal sources until both signals are full screen or at the reference level.

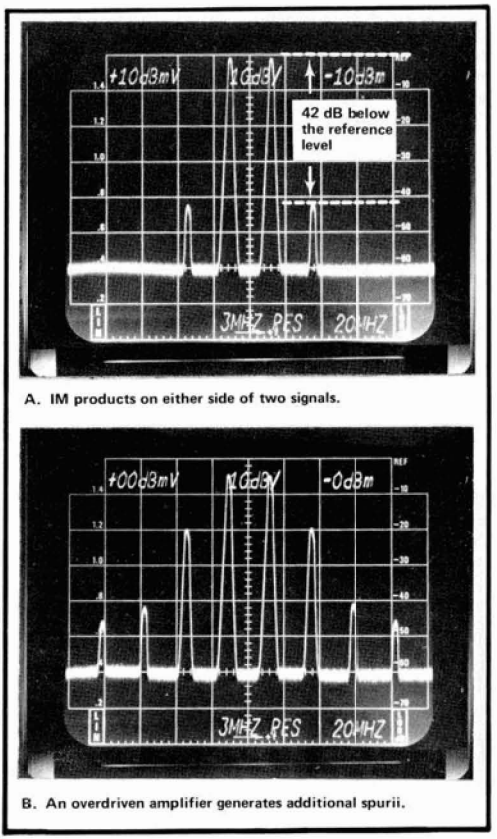
*NOTE*

*When the 7K11 REFERENCE LEVEL is +30 dBmV, the input to the amplifier stage is 0 dBmV, because the attenuator is between the amplifier and the RF INPUT connector.*

d. Decrease the 7K11 REFERENCE LEVEL (attenuator) setting in 10 dB steps and increase the Spectrum Analyzer RF Attenuator setting in 10 dB steps until the intermodulation signals appear on the display. See Fig. 3-4. NOTE: Verify the 2:1 ratio of the IM products by noting the amplitude increase for a 10 dB change in the 7K11 input level. If the amplifier is not overdriven, the amplitude level of the IM products will increase 20 dB with a change of 10 dB attenuation. When the amplifier is overdriven, additional spurs will be generated either side of the IM signals. If this occurs, increase the 7K11 RF ATTENUATOR setting and decrease the Spectrum Analyzer RF Attenuator setting.

3. Note the level of the IM signals; then determine by extrapolating, the level of the IM signals below 0 dBmV. For example: A change of 20 dB in attenuation would add 40 dB to the noted level of the IM signals below the reference level. If the level of the IM signals is 45 dB below the top of the graticule, with the signal input to the 7K11 20 dB above the reference level, the interpolated IM distortion would equal (45 dB + 40 dB) 85 dB.

This completes the performance check for the 7K11. It will now perform within the specifications described in Section 1.




A. IM products on either side of two signals.

B. An overdriven amplifier generates additional spurii.

Fig. 3-4. Display of IM distortion and an overdriven amplifier.



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