015-0408-00 P-P Detector Amplifier

SECTION I

INTRODUCTION and SPECIFICATION

Product Description

The Tektronix 015-0408-00 Peak-To-Peak Detector Amplifier and an 015-0413-00 Detector Head comprise an NBS-traceable Peak-To-Peak Detector System (Fig. 1-1) intended primarily for baseband video frequency response testing.

The small Detector Head contains the detecting diodes and provides a 75-ohm termination. It is designed to be used directly at the signal source, and is connected to the Detector Amplifier using a 012-0159-00 low-loss coaxial cable. The Detector Amplifier provides a high impedance load and bias for the Detector Head and corrects offset and dynamic gain errors of the head. (Other commonly available detectors do not correct for errors introduced by offset and dynamic impedance of the detector diodes.) Envelope flatness is viewed on an oscilloscope using the unterminated OUTPUT on the front panel of the Amplifier. The Amplifier also has both inverting and non-inverting inputs for differential frequency response measurements. The Amplifier is a single-wide plug-in and requires a TM500 or TM5000 Series Power Module as a host.

Product Purpose

The Peak-To-Peak Detector System allows precise comparison of sinewave amplitudes at frequencies throughout the video spectrum. The frequency response of an analog generator, such as the combination of the Tektronix 067-1011-00 Digital Sweep Generator and the Tektronix 1900 Test Signal Generator (used as a DAC), may be calibrated using the Peak-To-Peak Detector System as a transfer standard. The 1900 Generator may then be used as a frequency response transfer standard to calibrate frequency response and chrominance-luminance gain of test equipment such as waveform monitors and vectorscopes.

The Detector Amplifier's inverting and non-inverting inputs facilitate differential frequency response measurements from the input to the output of a system, thereby cancelling the frequency response errors of the test generator.

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Performance Conditions

The following electrical characteristics are valid only if the 015-0413-00 Peak-To-Peak Detector Head has been tested and verified by a Tektronix standards laboratory. Additionally, the 015-0408-00 Peak-To-Peak Detector Amplifier must be adjusted and tested at an ambient temperature of 25 degrees C, plus or minus 5 degrees, and operated at a normal ambient temperature between 0 and 15 degrees C. Allow a 20-minute warm-up period before performing verification tests.

Table 1-1

SYSTEM ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
+ INPUT - INPUT		Non-inverting. Inverting.
Level Control Range	0.25 to 1.0V, within 10%	P-P ac input.
Envelope Gain	Unity, within 0.1%	For 1.0% signal change
Envelope Offset	0V, within 0.1V	Envelope Peak
Amplifier Output Impedance		Nominal 75 ohms, source-terminated. Do not terminate receiver.
Detector Input Impedance	75 ohms	
Return Loss	At least 46 dB	To 5 MHz
Maximum Input Voltage	1.0V peak-peak ac.	

Table 1-1 (Cont.)

SYSTEM ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information		
		Typical Response	Transfer Uncertainties	
			TEK	NBS
Frequency Response				
25 kHz	+0.1, -0.7%	+0, -0.25%	+/-0.05%	+/-0.01%
50 kHz	+0.1, -0.3%	+0, -0.1%	+/-0.05%	+/-0.02%
100 kHz	+/-0.1%	+/-0.05%	+/-0.05%	+/-0.02%
200 kHz	+/-0.1%	+/-0.02%	+/-0.05%	+/-0.05%
500 kHz	+/-0.1%	+/-0.02%	+/-0.05%	+/-0.05%
1 MHz	0.0% (Reference)	+/-0.02%	+/-0.05%	+/-0.05%
2 MHz	+/-0.1%	+/-0.02%	+/-0.05%	+/-0.1%
5 MHz	+/-0.1%	+/-0.02%	+/-0.05%	+/-0.1%
10 MHz	+/-0.15%	+/-0.05%	+/-0.05%	+/-0.1%
20 MHz	+/-0.2%	+/-0.1%	+/-0.05%	+/-0.2%
30 MHz	+/-0.5%	+/-0.2%	+/-0.1%	+/-0.2%
50 MHz	+/-2.0%	+/-1.0%	+/-0.2%	+/-0.5%
Mainframe Interface		TM500. Uses any single-wide location. Keyed at 6-7 and 23-24 as Signal Source family.		

Table 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Supplemental Information
Temperature	
Operating	0 to +50 degrees C.
Storage	-40 to +65 degrees C.
Altitude	
Operating	To 4,572 m (15,000 feet).
Storage	To 15,240 m (50,000 feet).

Table 1-3

PHYSICAL CHARACTERISTICS

Characteristics	Information
Finish	Anodized aluminum side-panel and chassis.
Length	29.2 cm (11.5 in.).
Width	6.6 cm (2.6 in.).
Height	12.7 cm (5.0 in.).
Net Weight Net Shipping Weight	0.59 kg (1.3 lbs.). 1.3 kg (2.8 lbs.).

SECTION 2

OPERATING INSTRUCTIONS

This section describes installation, operating controls, connectors and indicators. Following these discussions are example applications.

Installation and Removal Instructions

The Peak-To-Peak Detector Amplifier is calibrated with NBS traceability and ready to use when received. It operates in any of the Tektronix TM500 or TM5000 Series Power Modules, referred to hereafter as "TM500". Refer to the power module instruction manual for line-voltage requirements and power module operation.

CAUTION

Turn the power module off before inserting or removing the Detector Amplifier, otherwise arcing may occur at the rear interface connectors. Arcing reduces the useful life of the connectors and damage may be done to the plug-in circuitry.

Check for plastic barriers on the interconnecting jacks of the power module in the selected compartments. If the barriers do not match the cutouts in the Detector Amplifier circuit board edge connector, they may indicate special rear interface connections for another type of instrument. Do not insert the plug-in until this has been verified by qualified service personnel. The TM500 power module MUST have a barrier installed between pins 6 and 7 at the standard barrier location to ensure proper connector alignment. The TM500 Power Module may also have an optional barrier between pins 23 and 24. A barrier in any other location will preclude insertion of the Detector Amplifier because that barrier would indicate that the compartment has been reserved for other plug-ins.

When the connectors are properly matched, align the Detector Amplifier with the upper and lower guides of the selected compartments. Insert the Detector Amplifier into the compartment and press firmly to seat the circuit board in the interconnecting jack.

To remove the Detector Amplifier, turn off the TM500 Power Module and pull the release latch, located on the lower left corner of the Detector Amplifier until the connector disconnects from the power module. The Detector Amplifier will now slide out of the power module.

Functions of Controls, Connectors, and Indicators

+ INPUT	signal fed to this input channel produces a non-inverted envelope at the OUTPUT connector.
- INPUT	A signal fed to this input channel produces an inverted envelope at the OUTPUT connect. Differential measurements are possible using both inputs.
+ INPUT LEVEL - INPUT LEVEL	These variable controls set dynamic gain offset correction in the Detector Amplifier as a function of signal level. Three LED indicators for each INPUT show high, low, and correct settings of the LEVEL controls.
+ INPUT ENABLE - INPUT ENABLE	These button switches turn on or off the corresponding INPUT channel.
OUTPUT	This BNC connector provides the detected envelope output after gain and offset corrections through the INPUT channels. DO NOT TERMINATE THIS OUTPUT.

OPERATING CONSIDERATIONS

Terminating

The 015-0413-00 Detector Head has a built-in 75-ohm termination resistor in its input circuit. Connect the head directly to the output of the generator or device-under-test (D.U.T.). Connect the high impedance output of the Detector Head directly to the 015-0408-00 Detector Amplifier via a 012-0159-01 low-loss 75-ohm coaxial cable. The OUTPUT of the Detector Amplifier is source-terminated in 75 ohms and to avoid reflections should not be terminated at the receiving end.

Low-Loss Coaxial Cables

Use the 72" 75-ohm, low-loss coaxial cable (012-0159-01) supplied as a standard accessory to connect the Detector Head to the Detector Amplifier. For differential measurement applications, a second cable should be ordered along with a second Detector Head. Test cables of this length and type were used to generate the frequency response curve accompanying each Detector Head.

Using 75-ohm coaxial cable longer than 72", or using cable other than 75-ohm coaxial, will degrade the envelope rise and fall times and affect the high frequency response slight =

APPLICATIONS

1900 Frequency Response

The hook-up illustration in Fig. 2-2 shows how the 015-0413-00 Detector Head and the 015-0408-00 Peak-To-Peak Detector Amplifier are used, along with the 067-1011-00 Digital Sweep Generator as a signal source, to calibrate the digital-to-analog converter frequency response in the Tektronix 1900 Digital Test Signal Generator. The Detector Head should be directly attached to the Full Field Out connector on the 1900. The standard accessory 72" coaxial cable should be used between the Head and the Detector

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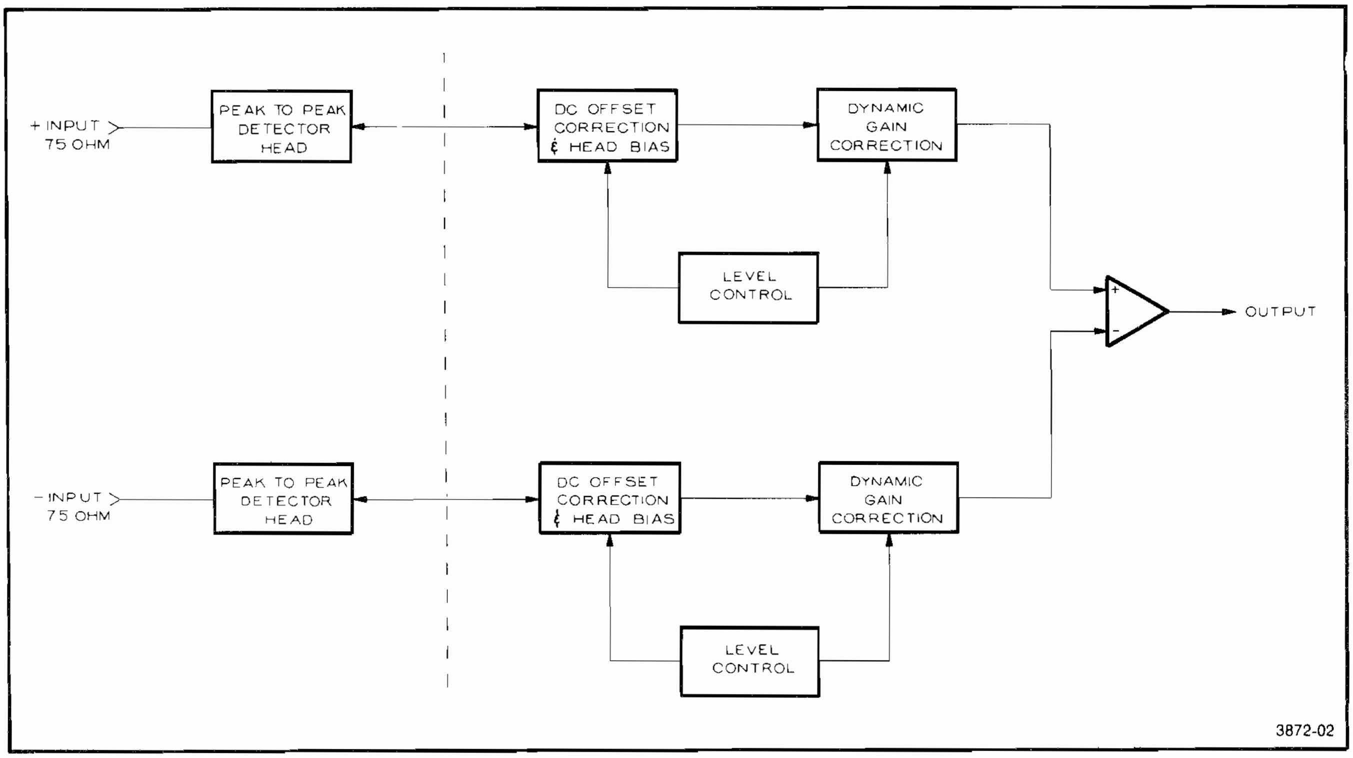

Fig.2-1. Peak-to-Peak Detector System Block Diagram.

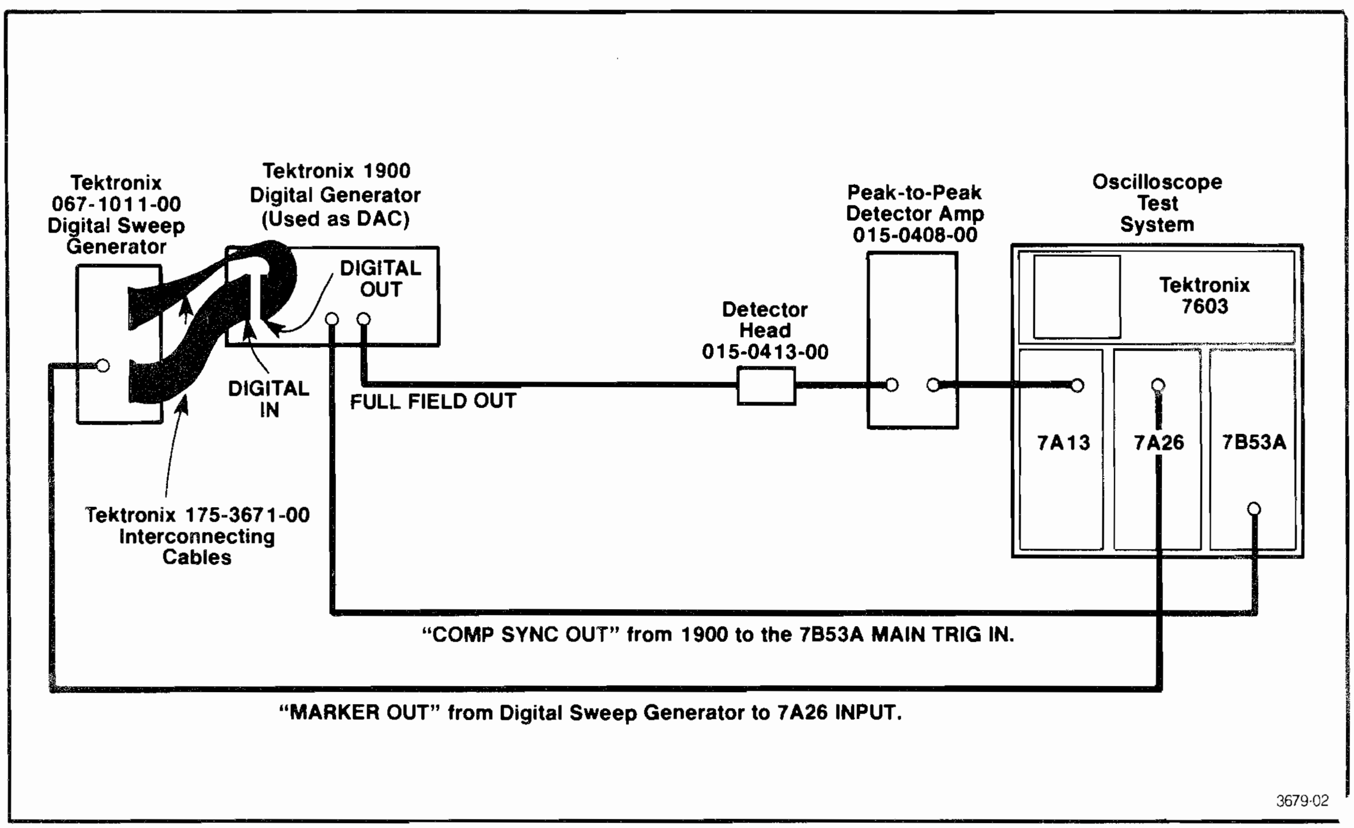

Fig. 2-2. Calibrating the 1900 Frequency Response.

Amplifier. View the unterminated output of the Detector Amplifier using the offset function of a differential comparator vertical amplifier (Tektronix 7A13 or equivalent) in a dual-channel oscilloscope. Adjust the LEVEL control of the INPUT channel being used on the Detector Amplifier until the green LED lights and the two red LED's extinguish.

Establish a reference amplitude level at a low frequency (left side of the display). Compare amplitude deviations throughout the frequency sweep relative to this reference point. Evaluate the amplitudes as percent deviations of the peak-to-peak input signal. Fig. 2-3 shows a typical resultant detector envelope output display, with frequency markers from the 067-1011-00 Digital Sweep Generator displayed through the other vertical channel of the oscilloscope. The frequency response shown is +/- 2 mV for a 714 mV signal, that is, +/- 0.3%.

NOTE

> It is very important to understand that, in either the single-ended or differential detection mode, the absolute amplitude of the detected envelope is not displayed on the oscilloscope. The display is the detected change in the peak-to-peak amplitude of the envelope as the input signal sweeps through a frequency range. Once an amplitude is established at a chosen frequency for a reference point, other frequency amplitudes in the sweep may be accurately measured relative to that point.

Waveform Monitor Calibration

Calibration of the frequency response of a waveform monitor or other display device requires having a test signal generator with well-characterized frequency response. If the waveform monitor has a loop-through input, the test signal generator may be fed to one side of the loop-through and its output continuously monitored by terminating the other side of the loop-through with a detector head. (This application is illustrated in Fig. 2-8c under the discussion "Zero Impedance Response vs 75-ohm Response.")

Scan by Zenith

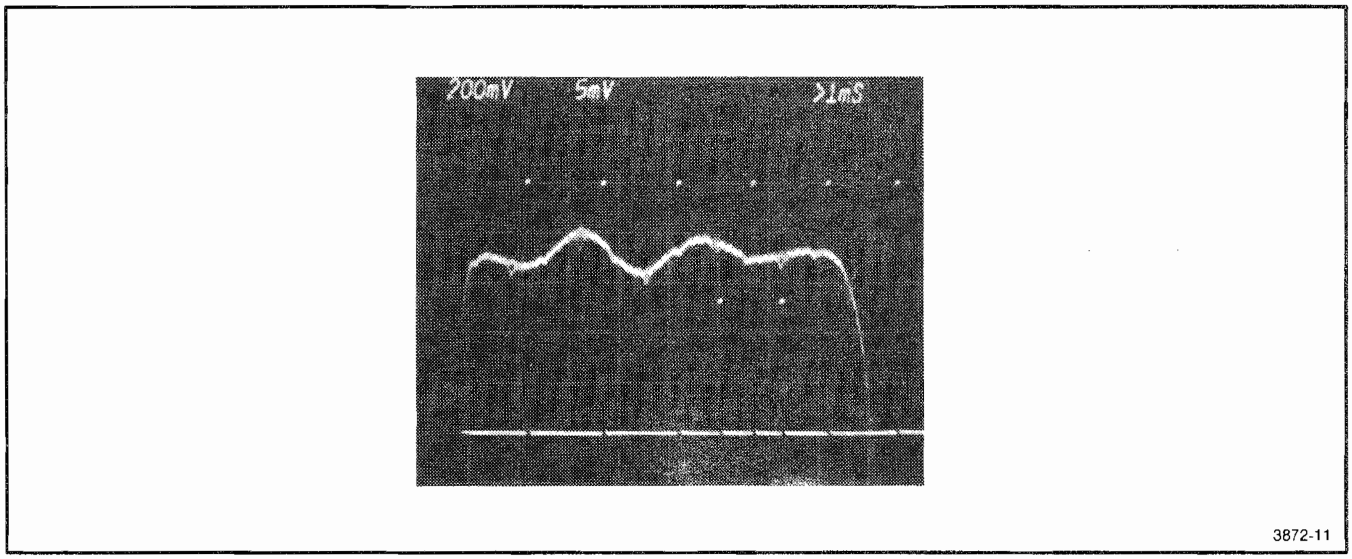

Fig. 2-3. Typical Detector Output when set up as in Fig. 2-2. Note that glitches and markers are from the signal source, not the Detector.

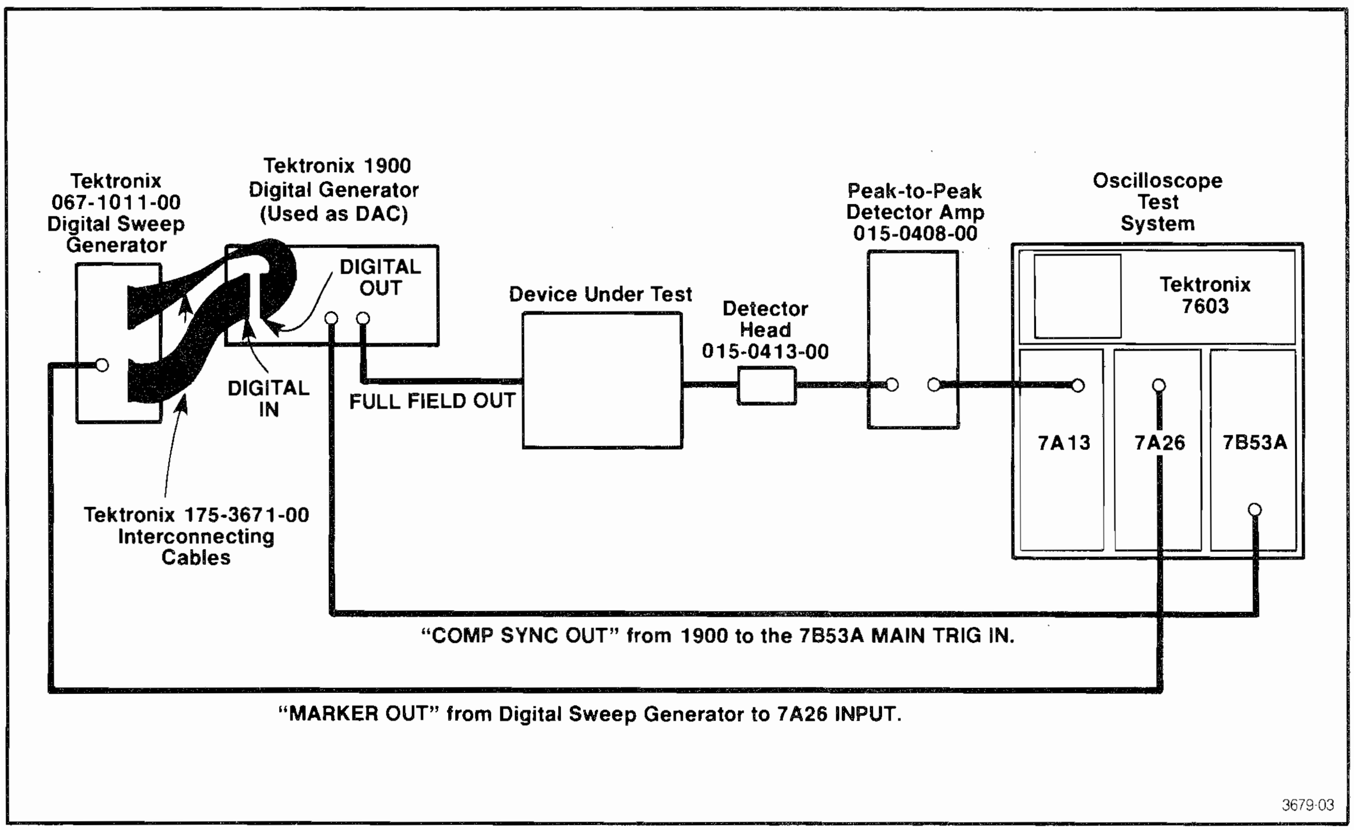

Fig.2-4. Checking Frequency Response of Device Under Test.

If a CW generator such as a Tektronix SG 503 is being used, the Detector Amplifier output may be fed to a DVM. With this test setup, the test generator output level may be set to exactly the same amplitude by checking for the same DVM reading each time the frequency is changed.

Device-Under-Test (D.U.T.) Frequency Response

The hook-up illustration in Fig. 2-4 shows how the calibrated DAC function of a 1900 can be used with the Digital Sweep Generator and the Peak-To-Peak Detector System to evaluate the video spectrum frequency response of a device-under-test (D.U.T.). The resultant detector envelope represents the frequency response errors of the 1900 DAC and the device-under-test.

Differential Mode

When the frequency response errors of the test signal source are significant compared to the expected errors of the D.U.T., use the differential mode (See Fig. 2-5). Referring to Fig. 2-6, when the gain of the D.U.T. is exactly one, the errors in the frequency response of the test signal generator get cancelled by the common-mode rejection of the differential detector. Since the frequency response, and therefore the gain (Av), of the D.U.T. is going to vary with frequency, the equation describing the configuration in Fig. 2-6 at any one frequency is :

$$(\text{Vsource}) \times (\text{Av of D.U.T.}) - \text{Vsource} = \text{V out.}$$

The "X" (times) symbol is because cascaded voltage gains multiply, and the "-" (minus) symbol is because of the function of the differential amplifier.

So, if the Vsource has a 0.5% frequency response error and the D.U.T. has a 2.0% error, the detected difference (ideally 2.0%) will actually be:

$$(0.995) \times (0.98) - (0.995) = -0.0199 = -1.99\%.$$

In this example, the 0.5% test signal generator error resulted in a measurement error of 2.0% - 1.99%, or only 0.01%.

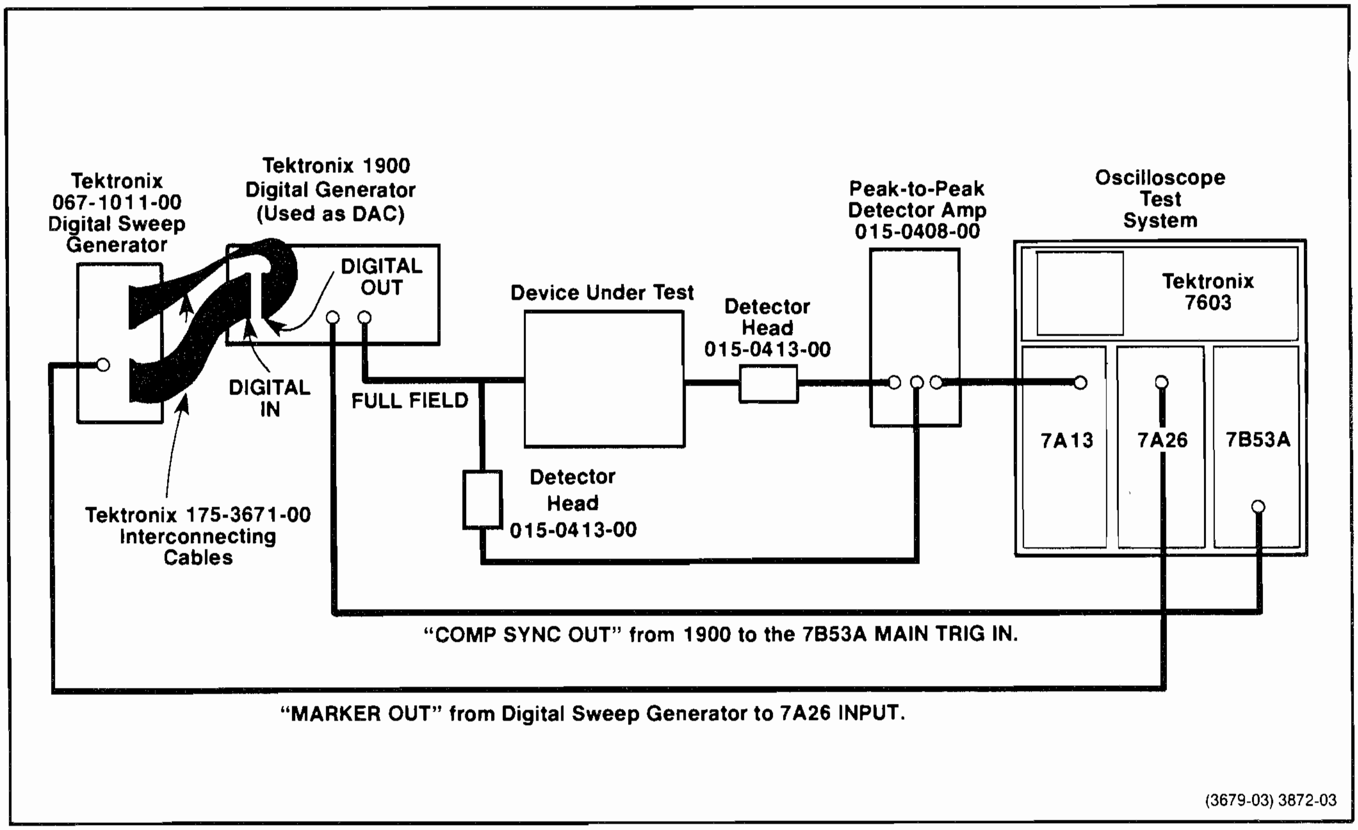

Fig.2-5. Checking Frequency Response of Device Under Test in the Differential Mode.

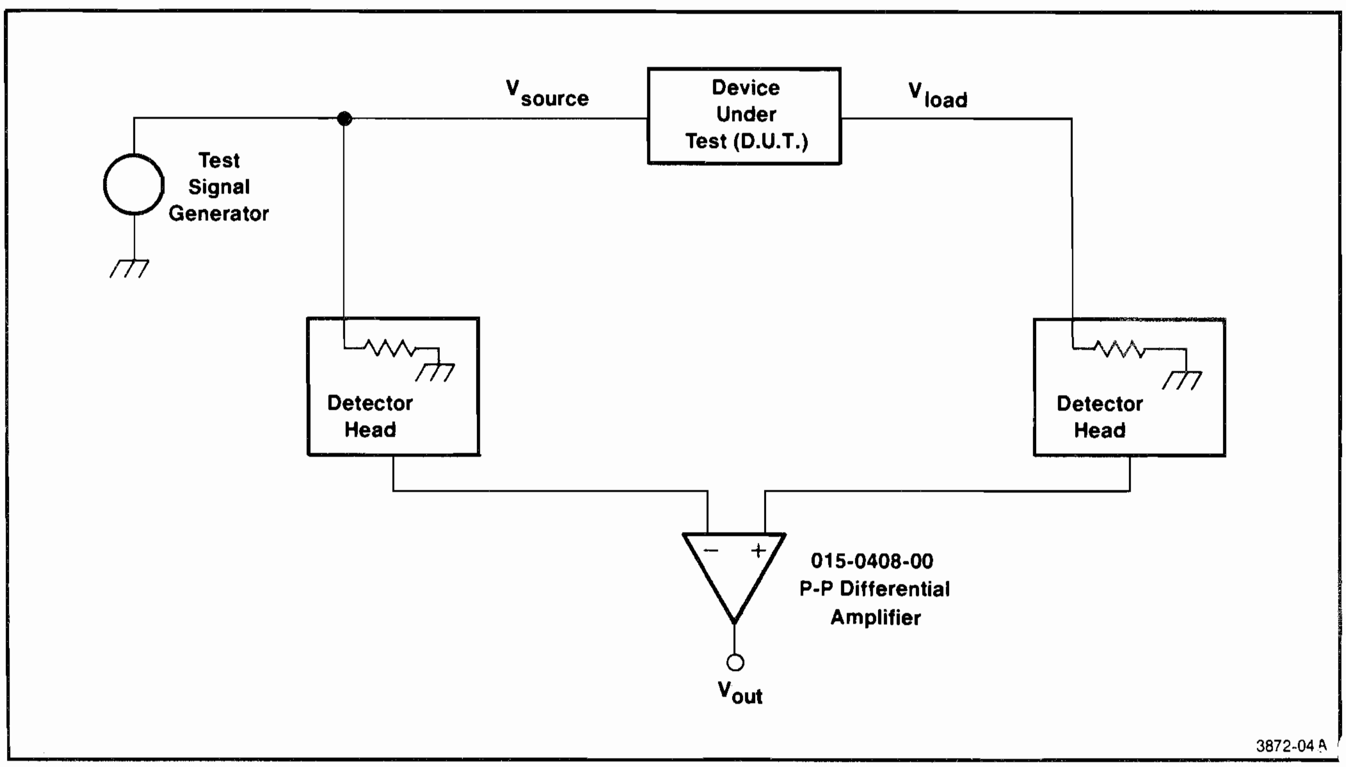

Fig.2-6. Differential Detection Configuration.

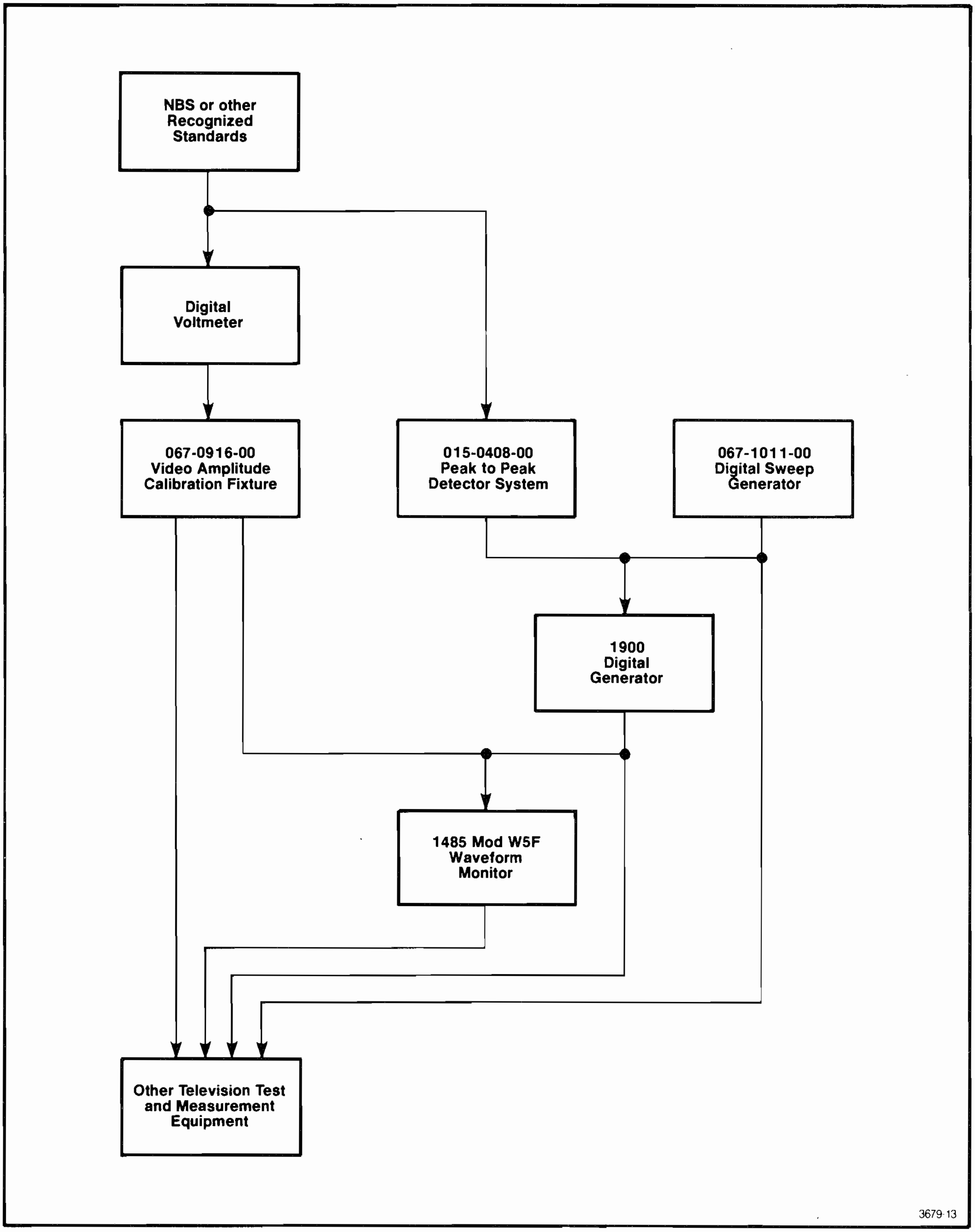

Fig. 2-7. NBS Traceability Explanation.

NBS Traceability

The Tektronix 067-1011-00 Digital Sweep Generator is part of a set of calibration fixtures which can be used to provide NBS-traceable for television signal measurements. The path for attaining NBS traceability is illustrated in Fig. 2-7. A digital voltmeter and the 067-0916-00 Video amplitude Calibration Fixture are transfer standards to allow accurate and traceable low frequency amplitude measurements with a Tektronix 1485 MOD W5F Waveform Monitor. The digital sweep generator in conjunction with the 015-0408-00 Peak-To-Peak Detector System allows accurate and traceable measurement of the Tektronix 1900 Test Signal Generator response. Combining the low frequency measurements with the high frequency measurements yields a complete systematic approach to establishing accurate video amplitude measurements.

FREQUENCY RESPONSE CHARACTERIZATION

The 015-0413-00 Detector Head

One Detector Head is included as a standard accessory with the 015-0408-00 Peak-To-Peak Detector Amplifier. A second head can be ordered separately for differential measurement applications. Additional heads can be ordered as spares. Each 015-0413-00 Detector Head is separately packaged with a verification graph of its particular frequency response. (An example graph is illustrated in the Performance Check Section.) The information in this graph can be used to optimize the flatness response of a signal source at a frequency point between 25 kHz and 50 MHz. Typical response of the Peak-To-Peak Detector System is of such accuracy that only small improvements will be gained by compensating for the small amount of error in the Detector Head.

Zero Impedance Response vs 75 ohm Response

The 015-0413-00 Peak-to-Peak Detector Head provides very close to a 75 ohm load to the AC input source. This is evidenced by the return loss being greater than 46 dB. There is, however, a small capacitance in parallel with the detector head input. This capacitance has no effect on detector frequency response when the

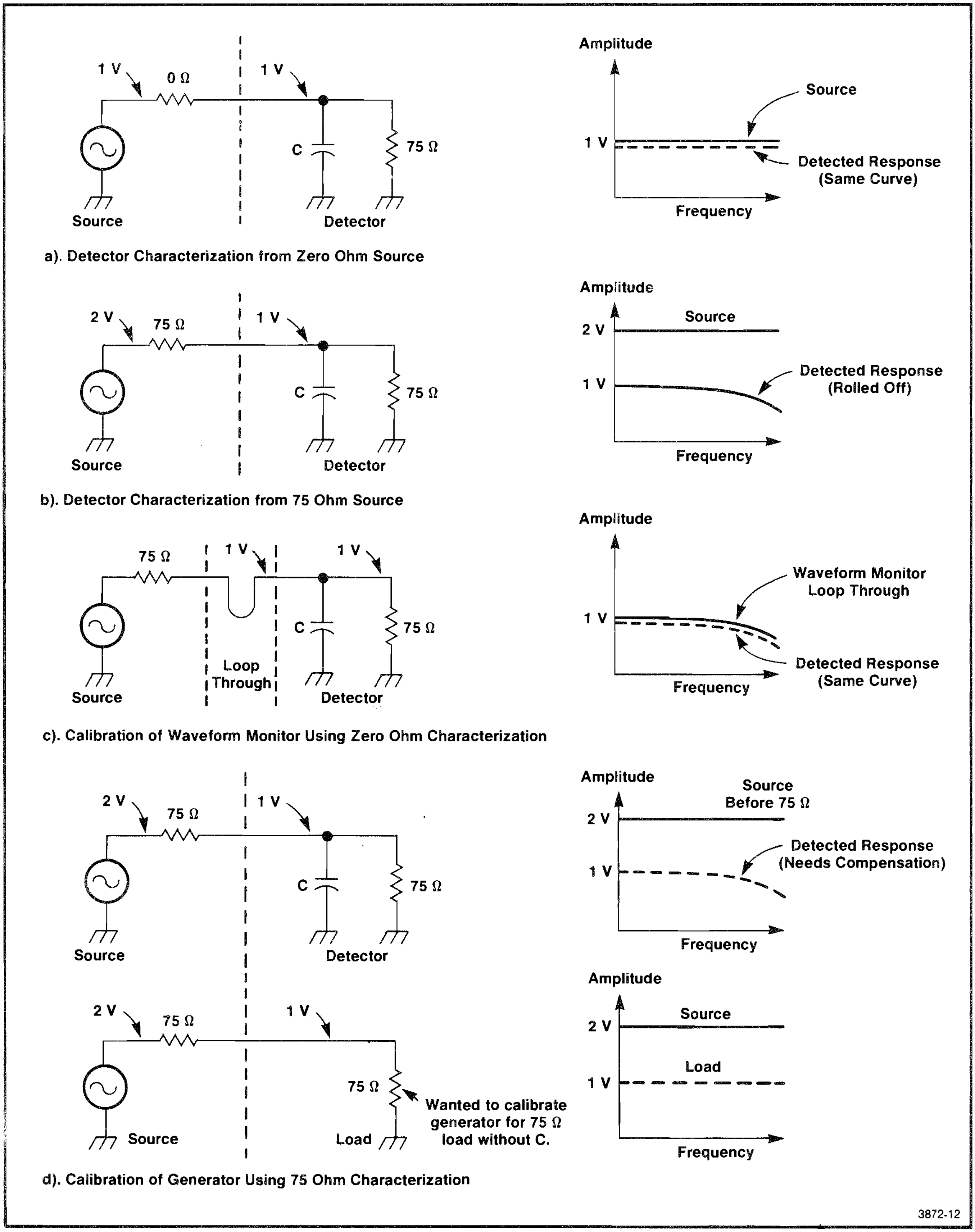

Fig. 2-8. Zero Ohms vs 75 Ohms Characterization.

detector is driven from a zero ohm source (pure voltage source), as shown in Fig. 2-8a, but will cause a slight roll off when the detector is driven from a 75 ohm source, as shown in Fig. 2-8b. By characterizing the detector at zero ohms, this capacitance is effectively cancelled. When used in a 75 ohm circuit, the detector will display the same output as if the detector capacitance were just part of the circuit being tested. Depending on the application, it may be desirable to have the detector head charaterized for zero impedance response as shown in Fig. 2-8c, or characterized for 75 ohm response as shown in Fig. 2-8d. The frequency response curve supplied with each detector head is for a zero impedance source. The differences in zero impedance and 75 ohm characterizations are very small, typically 0.03% at 30 MHz, 0.05% at 50 MHz, and imperceptible below 5 MHz. These errors are less than the tranfer uncertainies in deriving the detector characterization and normally need not be taken into account. For very demanding applications and for sake of completeness, it may be desirable to understand the differences in the two detector characterizations and their applications.

When using the detector to calibrate a waveform monitor with a loop-through input, as shown in Fig. 2-8c, the objective is to have a flat frequency response test signal at the input to the waveform monitor, which is the same as flat frequency response at the input to the detector. The detector indicates errors in the source generator plus errors due to detector loading. If a variable amplitude discrete frequency output sinewave generator is used, the amplitude of the generator may be manually adjusted to correct both errors. The zero impedance characterization should be used for this application, because it shows the response directly at the detector input rather than the response before a 75 ohm source resistor.

When using the detector to calibrate a video generator or other device under test and the objective is to have a flat response when operating into a pure 75 ohm load, the 75 ohm characterization of the detector should be used. In this application, shown in Fig. 2-8d, the detected output should not be set to have flat response with the detector's capacitive loading in circuit. Rather, the detected output should be set to roll off to match the 75 ohm characterization curve. In this manner, the generator will have a flat response when the detector's capacitive loading is removed and the generator is operated into a pure 75 ohm load.