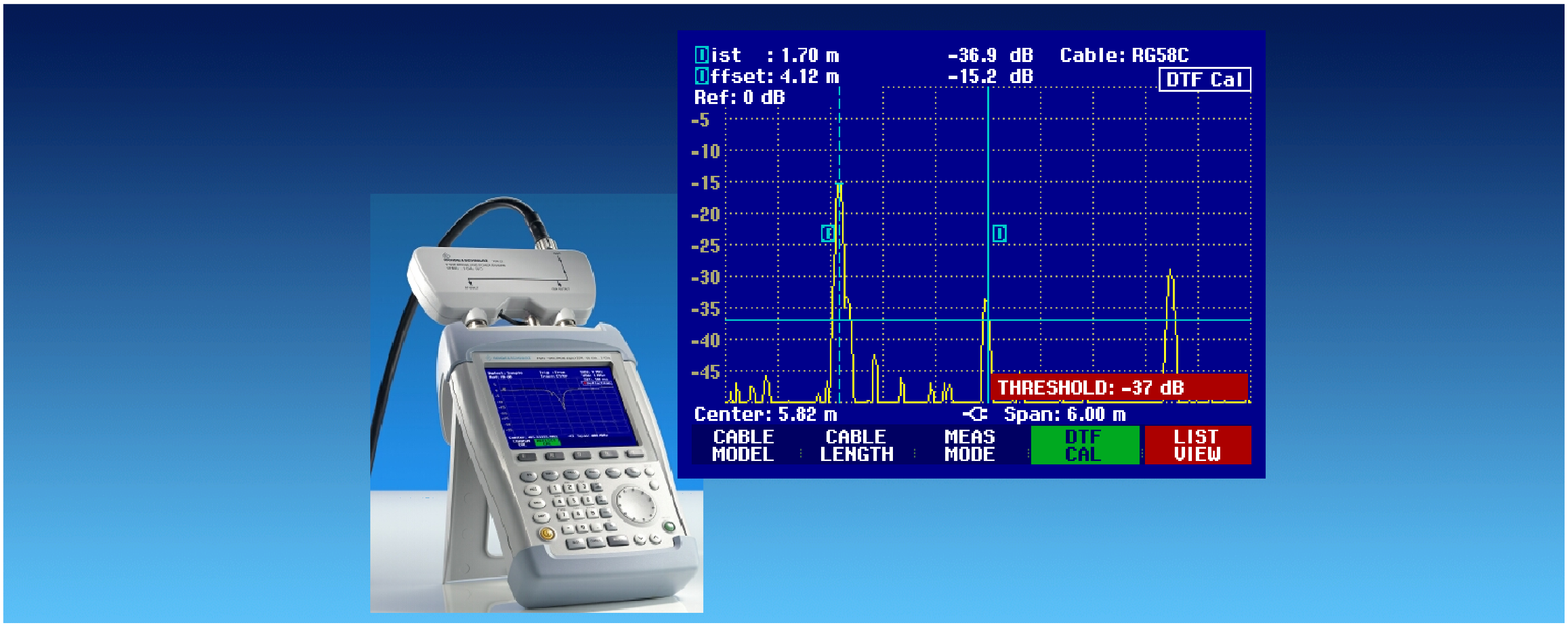

Products: R&S®FSH3-TV

Distance-To-Fault (DTF) Measurement in 75 Ohm Systems with the R&S®FSH3-TV

Application Note

Measuring cable characteristics is important when it comes to installing and servicing cable TV systems. Cable pinches or poor connections considerably influence the characteristics of cable TV systems.

This document shows how the measurement is carried out in a 75 Ohm system. The basics of distance-to-fault measurements, the test setup, calibration and measurement are discussed.

ROHDE & SCHWARZ

Subject to change – H. Gsoedl 06.2006 – 7BM60_0E

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1 Overview

Measuring cable characteristics is important when it comes to installing and servicing cable TV systems. Cable pinches or poor connections considerably influence the characteristics of cable TV systems.

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2 Requirements

The VSWR Bridge and Power Divider R&S®FSH-Z2, the R&S®FSH-B1 distance-to-fault measurement option, a 75/50 Ohm matching pad (R&S®FSH-Z38, R&S®RAM, or R&S®RAZ) and a short circuit in BNC or 75 Ohm N configuration are required for measurements in 75 Ohm systems.

3 Basics

The R&S®FSH3-TV allows the determination of cable faults. The TV analyzer measures the sum of the applied tracking generator signal and the signal reflected by the cable being measured in the frequency domain. Depending on the phase of the signal reflected from a fault to the transmitted signal, both signals are added to, or subtracted from, each other. This results in ripple on the overall received signal in the frequency domain. The R&S®FSH3-TV converts the received signal by means of a fast Fourier transform (FFT) in the time domain. Using the characteristics of the measured cable, the R&S®FSH3-TV calculates and displays the magnitude of the reflection.

4 Test Setup

In order to carry out a DTF measurement, the VSWR bridge (R&S®FSH-Z2) must be installed in accordance with the following instructions:

- Attach the connecting cable of the R&S®FSH-Z2 VSWR bridge to the CONTROL INTERFACE input of the R&S®FSH3-TV.
- Connect the VSWR bridge with the generator output and the RF input of the R&S®FSH3-TV.
- Connect the measuring cable supplied with the R&S®FSH-B1 option with the test port of the VSWR bridge.

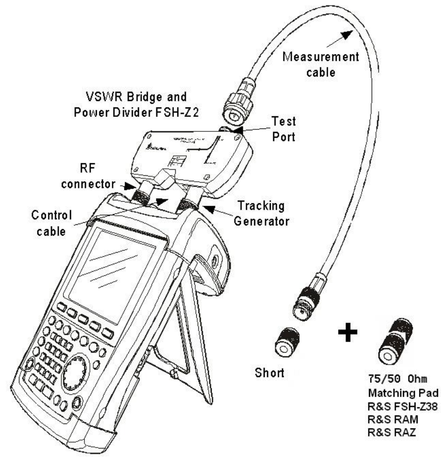


Fig. 1: Calibration/test setup for DTF measurements in a 75 Ohm system

The 50 Ohm output of the measurement cable must also be adapted for measurements on 75 Ohm cables.

5 Distance-to-Fault Measurement

1. Selecting the DTF Measurement Screen

Carry out the following steps in order to select the distance-to-fault function:

- Press the MEAS key.
- Press the MEASURE softkey.
- Select DISTANCE TO FAULT from the menu with the cursor keys or the rotary knob and confirm with the ENTER key or the MEAS softkey.

The following measurement screen appears:

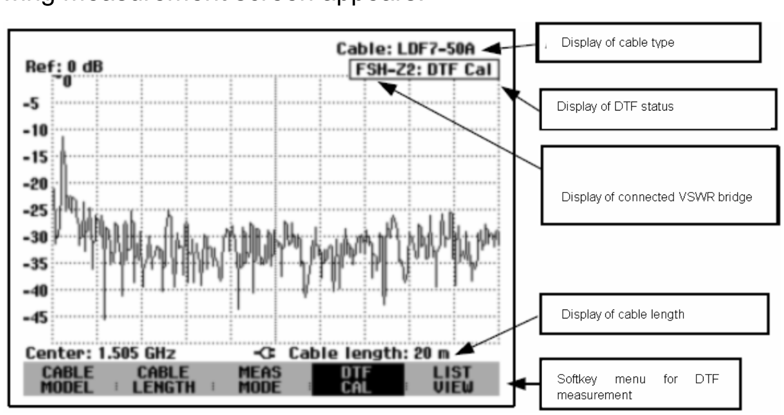


Fig. 2: DTF screen

2. Determining the Type of Cable

Frequency-dependent cable models can be produced with the R&S®FSH View Windows software (supplied with the R&S®FSH3-TV) and loaded into the R&S®FSH3-TV. The procedure is described in the R&S®FSH View online help.

Cable parameters (velocity factor, attenuation) can also be entered manually:

- Press the CABLE MODEL softkey.
- Press the SELECT USER MOD softkey.
- Press the DEFINE USER MOD softkey.
- Select **FREQUENCY…**, confirm with ENTER, and enter the specific frequency.
- Press the DEFINE USER MOD softkey .
- Select **VELOCITY FACTOR…**, confirm with ENTER, and enter the value.

  (velocity factor = $\frac{1}{\sqrt{\varepsilon_r}}$)

- Press the DEFINE USER MOD softkey.
- Select **ATTENUATION…**, confirm with ENTER, and enter the cable attenuation value.

3. Entering the Estimated Cable Length

In order to achieve optimal results, an estimated cable length must be entered that is approximately 20 % to 50 % higher than the actual length of the cable that is to be measured. (Reason: measurement accuracy)

- Press the CABLE LENGTH softkey.
- Enter the desired value via the keypad or the rotary knob.

4. Calibration

The test setup must be calibrated before the measurement starts. A short circuit (SHORT) on the 75 Ohm port of the matching pad is necessary; see Fig. 1.

- Press the DTF CAL softkey.
- Screw the short circuit (SHORT) firmly onto the 75 Ohm port of the matching pad.

Start the SHORT calibration with the CONTINUE softkeys.

5. Measurement

After successful calibration, connect the R&S®FSH3-TV via the measurement cable and the 50/75 Ohm matching pad to the system interface.

When performing DTF measurements of a cable system, make sure that there are no decoupled components or circuits in the section that is being examined. Also make sure that no useful signal is present in the system section that is to be examined. In both cases, it would be impossible to obtain useful results.

6 Examples of Distance-to-Fault Measurements

Buildings/indoor signal feed: The following example illustrates a typical problem in the distribution of cable TV signals:

Typical signal distribution as occurs in buildings or factories (test signal source) can frequently be described by connecting signal access points (1 to 5) in series.

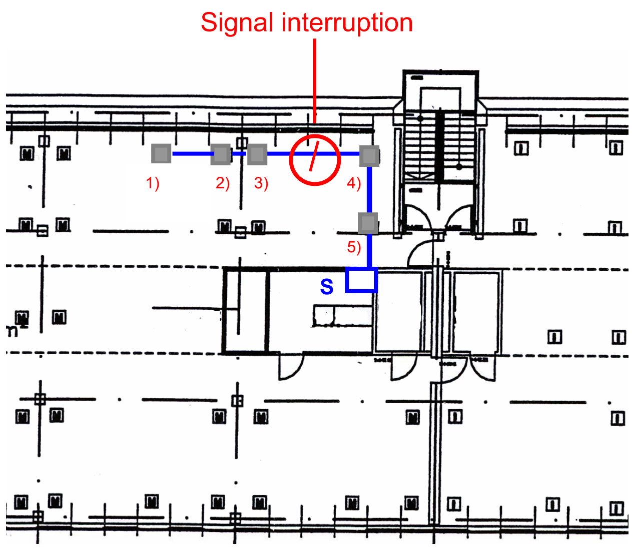


Fig. 3: Indoor cable installation

To operate the above network, a signal that is fed from the cable shaft (S) must be available with sufficient level at each signal access point.

If the signal is interrupted along the feed path, unrestricted distribution can no longer be ensured.

Use the following procedure to locate possible faults in the distribution network.

- Sequentially check the level and/or signal quality at the signal access points (1 to 5). The goal is to determine the specific connections where faultless signal reception is still possible or no longer possible, i.e. in the above graphic between points 3 and 4. For this purpose, the spectrum analyzer function of the R&S®FSH3-TV or the TV receiver mode can be used.

  → The goal is to localize the section of the line where the fault occurs.

- After the correct functioning of the cable connections has been verified, it can be concluded that there must be a fault in the actual connecting cable.

The distance-to-fault measurement is now performed. Attach the R&S®FSH3-TV via the measurement cable and the 50/75 Ohm matching pad to the system interface after successful calibration. Possible faults can be determined with an accuracy of the cable length / (1023 points).

Checking the Outdoor Cable Network

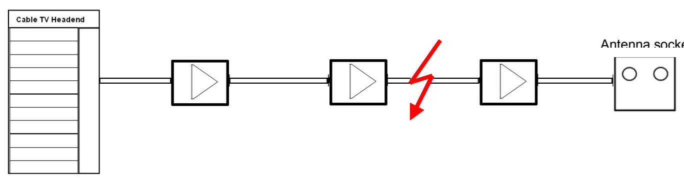


Fig. 4: Diagram of an outdoor cable network (headend – house connection)

As shown in the above graphic, the distribution of the cable TV signal goes from the cable headend to the various households via cable feeds that are equipped with intermediate amplifiers about every 300 m to 400 m. This ensures that the signal level meets the quality requirements of the subscriber.

If interruptions of the signal occur on the transmission path from the cable headend to the subscriber, comprehensive examination and troubleshooting measures must be carried out. Especially because of the great amount of time and effort involved in repair, often including considerable excavation work, dependable and precise procedures are necessary to detect faults

Faults are detected as follows:

- Sequentially check the level and/or signal quality at the intermediate amplifiers. The goal is to determine the specific cable sections where faultless signal reception is still possible or no longer possible.

- After verifying that both the amplifiers and connections in the observed section function correctly, the cable is separated from the amplifier, the R&S®FSH3-TV connected via the measurment cable and the matching pad, and the DTF measurement is carried out. The result helps to determine the distance of the cable defect from the measurement plane.

7 Examples of Measuring Cable Faults

Multiple cable faults can be the cause of missing or insufficient signal feed. Two possible faults are described below. You will also see how distance-to-fault measurements provide optimal user benefit.

Note:

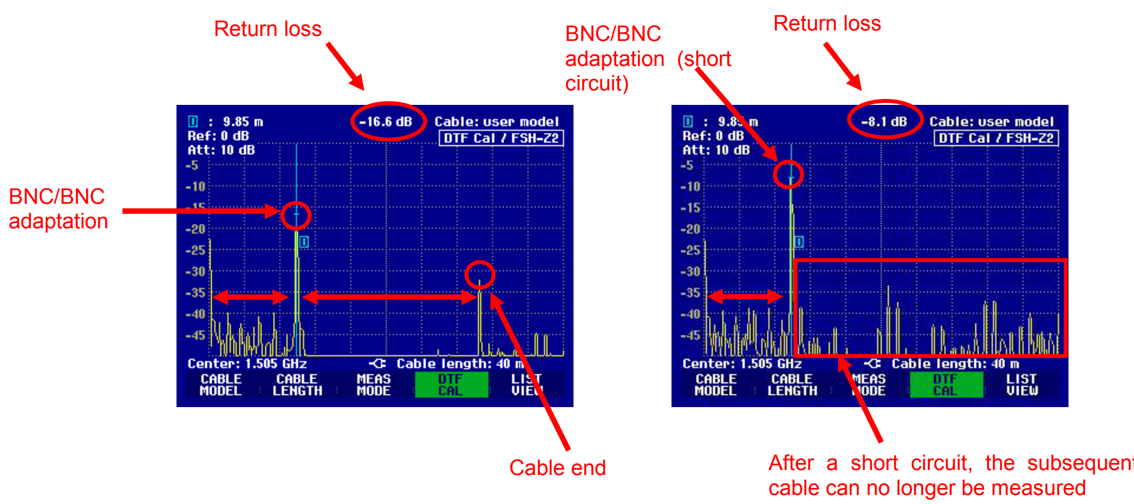
The measurement examples in this section were carried out with 75 Ohm cables meeting the following specifications:

- *Velocity factor: 0.659*
- *Attenuation at 100 MHz: 0.110 dB/m*

Adaptation and Connection Faults

A frequent cause of cable faults are faulty connections or frequently used matching pads. Faults such as short circuits or faulty contact can be the result.

A possible scenario can be described as follows:



The left graphic shows an adapted cable section of approx. 10 and 20 meters. The cable end and the adaptation that has taken place can be easily and unambiguously identified.

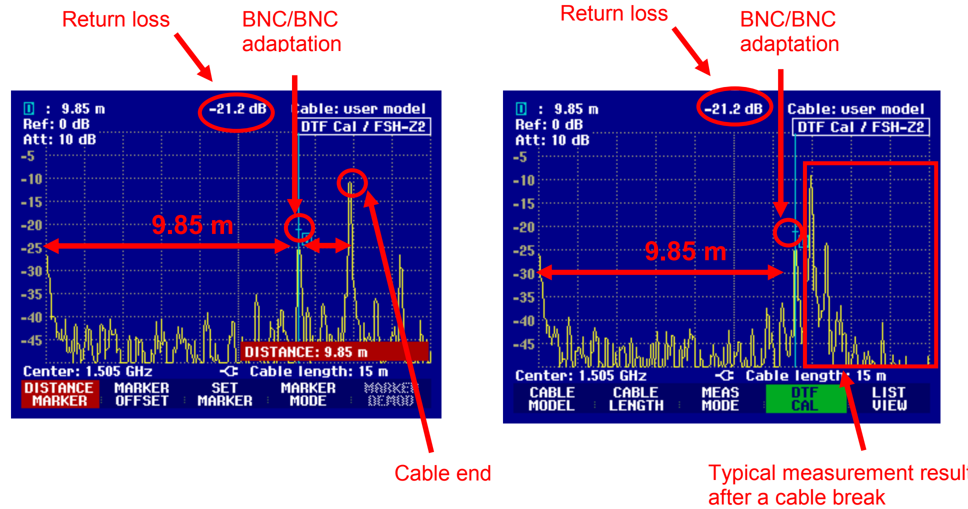
A different case is shown in the right-hand graphic. The adaptation used here almost seems to have caused a short circuit or open circuit. This is indicated by the very high return loss of –8.1 dB. After adaptation the subsequent cable can no longer be measured.

Cable Discontinuities

Mechanical stress, i.e. bending and kinking, can cause signal reflection and subsequently cable breaks. Cable gnawing by rodents can be another reason for signal impairment in a cable.

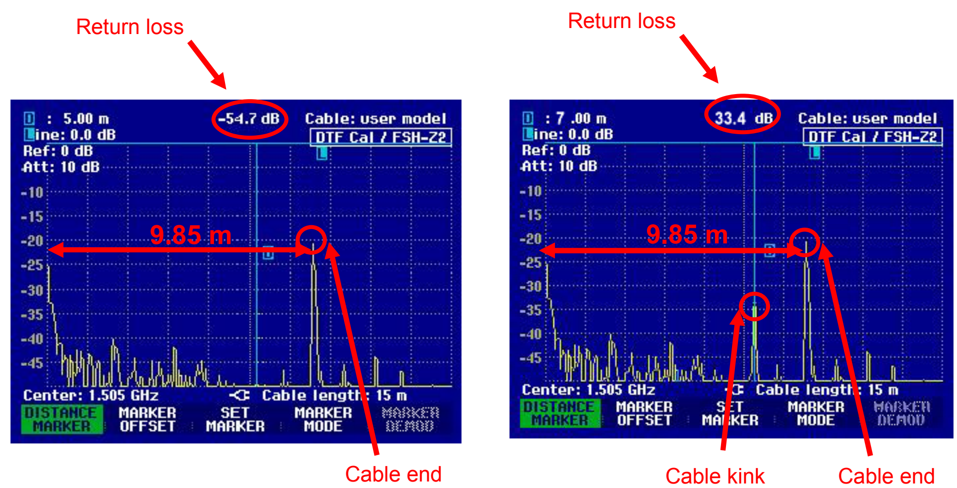
Cable Breaks

The following diagrams show how a cable interruption can be detected by means of a DTF measurement. The left-hand figure shows an uninterrupted test setup up until the open connection of a cable. A complete break in a cable a few dozen centimeters following an adaptation is shown in the right-hand setup by way of comparison.



Cable Pinches

When laying cables it is important to ensure that any continuous stress such as kinks and pinches in the cable are avoided. Otherwise, fatigue is likely to occur. The distance-to-fault measurement is thus highly beneficial when laying cables.



A DTF measurement of a cable without faults is shown in the left-hand figure. The right-hand graphic shows detection of an elevated value of return loss about 7 m after the measurement plane. Such an elevation indicates pinching of the cable.

8 Additional Information

Our Application Notes are continuously revised and updated. Please check for any changes at http://www.rohde-schwarz.com. Please send comments or suggestions in connection with this application to **Broadcasting-TM-Applications@rsd.rohde-schwarz.com**

9 Ordering Information

TV Analyzer	R&S®FSH3-TV	2111.7005.63
Options		
Remote Control for R&S®FSH3-TV	R&S®FSHTV-K1	2111.7140.02
DVB-C/J.83/A/B/C (QAM) Firmware for R&S®FSH3-TV	R&S®FSHTV-K21	2111.7211.02
ATSC/8VSB Firmware for R&S®FSH3-TV	R&S®FSHTV-K22	2111.7228.02
Distance-to-fault Measurement (includes 1 m cable, R&S®FSH-Z2 required)	R&S®FSH-B1	1145.5750.02
Vector Transmission and Reflection Measurements	R&S®FSHTV-K21	1157.3387.02
Receiver Mode	R&S®FSH-K3	1157.3429.02
Recommended extras		
Preselector for R&S®FSH3-TV	R&S®FSHTV-Z60	2111.7105.02
Spare F Adapter, 75 Ohm, female/female for Preselector R&S®FSHTV-Z60	R&S®FSHTV-Z61	2111.7111.02
Power Sensor 10 MHz to 8 GHz	R&S®FSHTV-Z61	1155.4505.02
VSWR Bridge and Power Divider, 10 MHz to 3 GHz (contains short, open and 50 Ohm load for calibration)	R&S®FSH-Z2	1145.5767.02
Directional Power Sensor 25 MHz to 1 GHz	R&S®FSHTV-Z61	1120.6001.02
Power Sensor 10 MHz to 18 GHz	R&S®FSHTV-Z61	1165.1909.02
Directional Power Sensor 200 MHz to 4 GHz	R&S®FSH-Z44	
Matching Pad 50/75 Ohm, 0 Hz to 2700 MHz	R&S®RAZ	0358.5714.02
Spare RF Cable, 1 m, N male/N female for R&S®FSH-B1	R&S®FSH-Z2	1145.5867.02
12 V Car Adapter	R&S®FSH-Z2	1145.5873.02
Serial/Parallel Converter	R&S®FSH-Z2	1145.5880.02
Carrying Bag	R&S®FSH-Z2	1145.5896.02
Transit Case	R&S®FSH-Z2	1300.7627.02
Combined Short/Open and 50 Ohm Load for VSWR and DTF calibration	R&S®FSH-Z2	1300.7504.02
Spare Short/Open Calibration for R&S®FSH-Z2	R&S®FSH-Z30	1145.5773.02
Spare 50 Ohm Load for R&S®FSH-Z2 for VSWR and DTF calibration	R&S®FSH-Z31	1145.5780.02
Spare Battery Pack	R&S®FSH-Z32	1145.5796.02
Spare AC Power Supply	R&S®FSH-Z33	1145.5809.02
Spare RS-232-C Optical Cable	R&S®FSH-Z34	1145.5815.02
Spare Headphones	R&S®FSH-Z36	1145.5838.02
Spare USB Optical Cable	R&S®FSH-Z37	1300.7733.02
Matching Pad 50/75 Ohm, DC to 1000 MHz	R&S®FSH-Z38	1300.7740.02
Matching Pad 50/75 Ohm	R&S ®RAM	0358.5414.02
Spare CD-ROM with Control Software R&S®FSH View and Documentation for R&S®FSH3-TV	R&S®FSHTV-Z65	2111.7340.02

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