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Measurements on TV transposers using TV Transcope MUF2

GENERAL TEST HINTS

Level adjustments

Input of test item
Level too high: risk of overdriving
too low: noise-infested test curve
Suitable level for TV transposers: RF input 5 mV,
IF input 10 mV
With the RF LEVEL control on the MUF 2 generator section set to 0 dB, the level of the sweep generator is 200 mV, that of the IF generator 500 mV (nominal level of vision carrier).
Input of selective demodulator. The maximum permissible level is 10 V_{rms} corresponding to 2 W. To adjust the desired position of the test curve on the display, increase the sensitivity using first the RF attenuator and then the two IF attenuators.
Input of broadband demodulator. The maximum permissible level is 5 V_{rms} corresponding to 0.5 W.

Selection of IF bandwidth

Normally the measurements are made at the IF bandwidth of 300 kHz. The bandwidth of 30 kHz is recommended in specific cases to increase the dynamic range or to perform measurements close to the carrier.

Sweep time in swept operation

Sweep time too short: distorted display of test curves
too long: flickering display
If the video filter for noise suppression is connected into circuit, the sweep time must be increased.

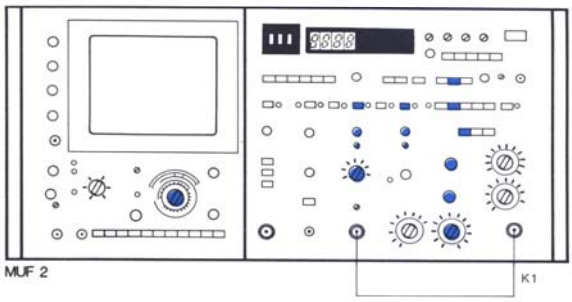
Level determination on display section

In the LIN. mode of the MUF 2, levels can be easily determined on the screen using the **graticule lines.** Values in percent can be found if the zero line is brought to coincidence with the lowest graticule line (Y position control turned fully clockwise). To ensure a better resolution, the measurements should be performed in the upper third of the screen if possible.

The **level line** and the **digital readout** of the MUF 2 afford even greater convenience. In the LOG. mode, the digital readout displays absolute levels in dBμV or dBm as well as level differences (△dB pushbutton) and, in the LIN. mode, voltages in V and power in W. After pressing the MHz pushbutton, the corresponding centre frequency appears in the readout. Prior to absolute level measurements, calibration is required (see righthand column). After selecting the display mode and the unit, set the level line to the desired point of the test curve; the result appears on the digital readout which displays rms values. The △dB pushbutton makes relative level measurements easy: set the level line to the reference value, press the △dB pushbutton (readout is set to zero) and shift the level line to the comparison point. The level difference between the two test points is now read out. The rating of any attenuators included in the setup can be entered with the dB EXT. decade switches and is taken into account for the readout.

Calibration for absolute level measurements

Calibration setup



Calibration

For absolute level measurements, calibration is required to compensate for the frequency response of the MUF 2 receiver section. The reference value is the level of the MUF 2 sweep generator which is accurate within ±0.3 dB. The gain of the set selective demodulator channel (LIN. or LOG.) is readjusted at the corresponding test frequency.

For this purpose use test cable K1 to connect the sweep generator output to the selective demodulator input (use K1 again in the test setup). After the settings described below have been made, a test trace and a calibration line are displayed. Use the CAL. control associated with the LOG. or LIN. mode to bring the two lines to coincidence.

Calibration settings

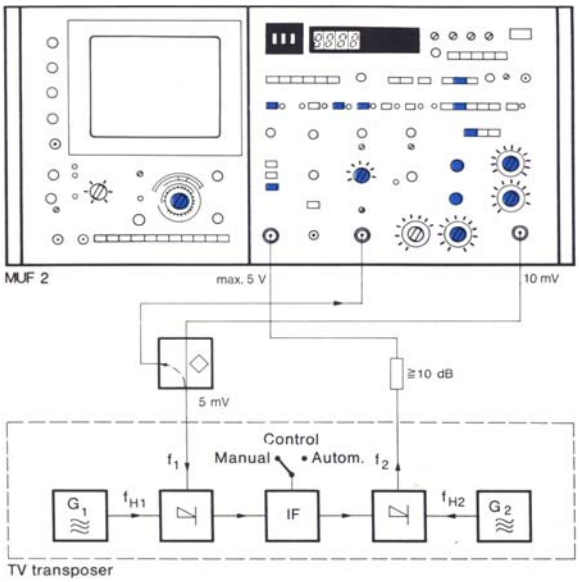
MUF 2
Sweep generator: Set the TUNING control (f_0) to the corresponding test frequency; $\Delta f = 0.1$ MHz/DIV.; → sweep.
Display section: 10 ms/DIV.
Selective demodulator: LIN. or LOG.; RF attenuator set to CAL. (undo the locking); use the CAL. control to bring the test trace and the calibration line to coincidence.

Test cable: Connect K1 between the output of the sweep generator and the input of the selective demodulator.

MATCHING – AMPLITUDE/FREQUENCY RESPONSE

Measurement on TV transposers

Measurement configuration



Test equipment/settings

MUF 2

Sweep generator: RF LEVEL –26 dB (10 mV); TUNING (f_o) set to receive frequency of TV transposer; $\Delta f = 1$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Broadband demodulator: 0.5 dB/DIV. for Yx2
Selective demodulator: LOG. (5 dB/DIV. for Yx2); reference = value for total reflection; RF ATTEN. –10 dB

VSWR bridge: (take into account 6 dB insertion loss!); connect directly to TV transposer input.

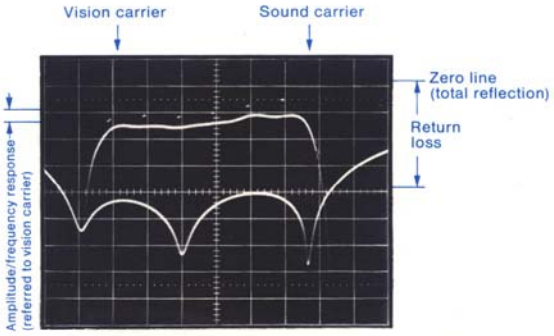
Power attenuator: ≧10 dB

TV transposer: Manual control mode

Measurement

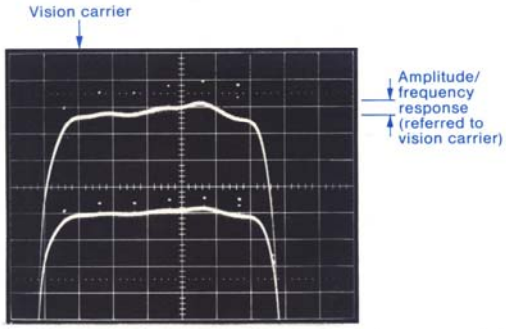
The matching (return loss) of the antenna input and the amplitude/frequency response of the TV transposer can be represented simultaneously on the MUF 2 display section.

The zero line for **measuring the return loss** can be determined with the test port of the VSWR bridge open (total reflection). Use the Y position control to bring this reference line to coincidence with a graticule line to facilitate evaluation of the screen display. With the VSWR bridge connected and the above settings made, the curves shown at the top of the righthand column are displayed. The reference line is the second graticule line from the top. Using the level line and the ΔdB pushbutton it is easy to determine the return loss (see page 5, level determination on display section). If the video filter (bandwidth 1 kHz) is connected into circuit, increase the sweep time until the test curve does not change any more.

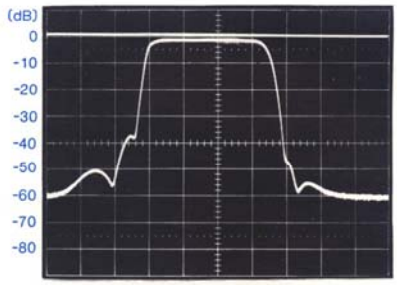


Return loss (lower curve) and amplitude/frequency response (vision carrier = reference value) of TV transposer
X: 10 ms/DIV. ($\Delta f = 1$ MHz/DIV.)
Y: 0.5 dB/DIV. (amplitude characteristic), 5 dB/DIV. (return loss)

When **measuring the amplitude/frequency response,** the input level of the TV transposer should be at least 5 dB lower than the value at which IF limiting starts. To make full use of the 60-dB dynamic range of the MUF 2 broadband demodulator, it is recommended that the voltage at the broadband demodulator be not higher than 5 V. To this effect, connect an attenuator of ≧10 dB to the transposer output. In the position 10 dB/DIV. and with the Y position control set fully clockwise, this yields a display height of about 9 divisions. The test result referred to the vision carrier can now easily be read off with the aid of the graticule. The two diagrams below show the amplitude characteristic of a TV transposer over the entire transmission range and extending into the adjacent channels.



Amplitude/frequency response over entire transmission range of TV transposer (double exposure, expanded and nonexpanded display)
X: 10 ms/DIV. ($\Delta f = 1$ MHz/DIV.)
Y: 0.5 dB/DIV. (top), 5 dB/DIV. (bottom)

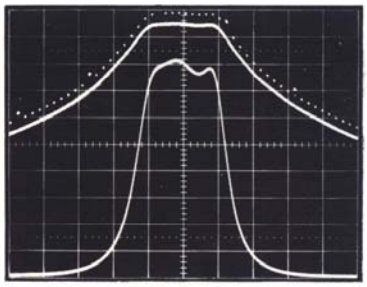


Amplitude characteristic of TV transposer extending into adjacent channels
X: 10 ms/DIV. ($\Delta f = 2$ MHz/DIV.)
Y: 10 dB/DIV.

MATCHING – AMPLITUDE/FREQUENCY RESPONSE

Measurement on individual stages or filters

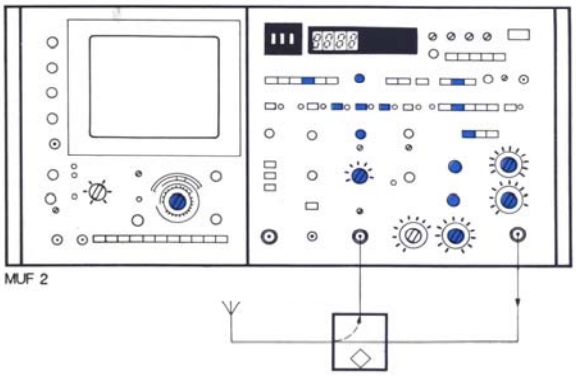
The measurement is made analogously as described before. To ensure satisfactory matching, the RF LEVEL control should be set to –6 dB (even better –10 dB). Connect the VSWR bridge directly to the input of the test item. A high-quality attenuator is required at the filter output (in particular if no buffer amplifier is provided). For stages without frequency conversion, the selective demodulator affords a considerably wider dynamic range.



RF amplifier with output filter of TV transposer: logarithmic (top) and linear representation of amplitude/frequency response
X: 10 ms/DIV. ($\Delta f = 5$ MHz/DIV.)
Y: for linear representation 10 divisions corresponding to 100% amplitude and 90% amplitude to approx. –1 dB

Measurement of antenna matching

Measurement configuration



Test equipment/settings

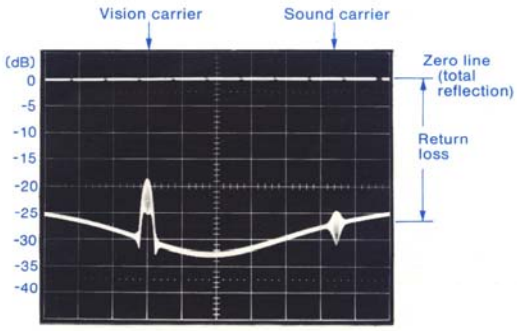
MUF 2

Sweep generator: RF LEVEL –10 dB (65 mV); TUNING (f_0) set to receive channel +2 MHz; $\Delta f = 1$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Selective demodulator: LOG. (5 dB/DIV. for Yx2); IF bandwidth 300 kHz; RF ATTEN. ≧0 dB

VSWR bridge

Measurement

The antenna connected via a VSWR bridge to the sweep generator output and selective demodulator input is swept in the LOG. mode over its frequency range and the return loss is displayed. The described measuring method is suitable both for transmitting and receiving antennas. Prior to the measurement, set the zero (reference) line to a graticule line with the test port of the VSWR bridge open (total reflection). The return loss can now be easily determined on the grated screen of the display section or with the aid of the level line and ΔdB pushbutton (see page 5, level determination on display section).



Return loss of antenna depending on frequency; vision and sound carriers of reference transmitter can be recognized.
X: 10 ms/DIV. ($\Delta f = 1$ MHz/DIV.)
Y: 5 dB/DIV.

STAGE GAIN

Stage gain (broadband measurement)

Calibration settings

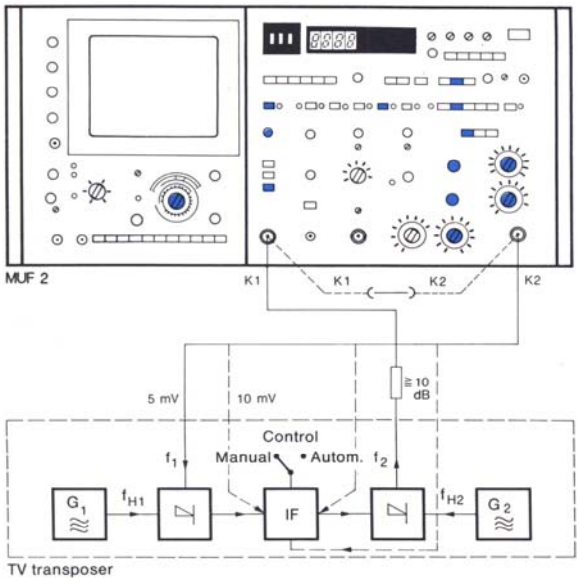
MUF 2

Sweep generator: RF LEVEL −6 dB (good matching); TUNING (f_o) to transmit frequency of TV transposer; $\Delta f = 2$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Broadband demodulator: 1 dB/DIV.; level line as reference for 0 dB gain; select suitable display height using the Y position control.

Test cables: K1 and K2 for connecting the sweep generator output and the broadband demodulator input

Note: Calibration is performed at the transmit frequency even if then the receive frequency or the IF is applied. Do not vary the position setting!

Calibration/measurement configuration



Test equipment/settings

MUF 2

Sweep generator: TUNING (f_o) in accordance with the frequency applied;
→ sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Broadband demodulator: 1 dB/DIV.; do not vary Y position setting.

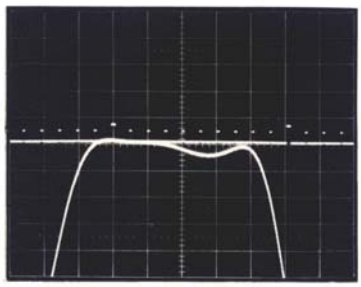
Power attenuator: ≧10 dB

TV transposer: Manual control mode

Measurement

Adjust the output attenuator of the sweep generator such that the test curve reaches the level (reference) line (see diagram below). The unknown stage gain corresponds to the difference between the two attenuator positions. Additional attenuators connected to the input or output of the test item must be taken into account. Make sure that the correct level is used with small-signal stages.

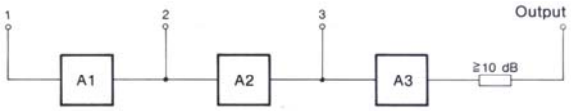
Note: If the MUF 2 broadband demodulator is connected ahead of the output filter of a broadband TV transposer, the second local oscillator may cause spuria.



Measurement of stage gain: After calibration, level line (top) is used as reference line for 0 dB gain.
X: $\Delta f = 2$ MHz/DIV.
Y: 0.5 dB/DIV. for Yx2

Stage gain (selective measurement)

In the case of test items without frequency conversion, the measurement of the stage gain should be made via the selective demodulator of the MUF 2 because of the wider dynamic range. The following method shows that a difference measurement with dB scaling is possible in spite of the LIN. mode which offers a higher resolution than the LOG. mode.



Test item with three amplifier stages

Measurement

Connect the test item between the sweep generator output and the selective demodulator input. Select the LIN. mode and set the dB EXT. decade switches to 0.00 dB. Use the RF and IF input attenuators to bring the level line to coincidence with the test curve in the upper third of the screen. Press the V pushbutton and read the voltage from the digital display.

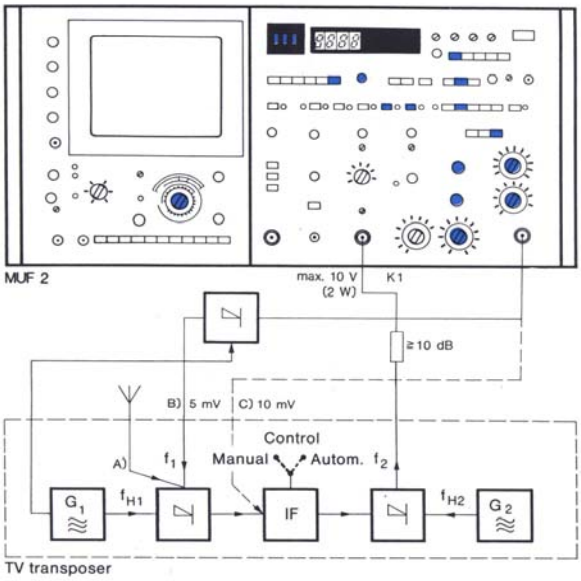
Then connect the sweep generator to input 2 of the test item (see diagram above) and repeat the above procedure. Adjust the dB EXT. decade switches until the voltage value obtained with the first measurement is displayed again. The gain adjusted in dB on the decade switches corresponds to the stage gain A1 of the first amplifier stage.

The gain of further stages can be determined analogously.

Calibration

See calibration for absolute level measurements, page 5.

Measurement configuration



Configuration for output power measurement on TV transposers with application of antenna signal (A), vision carrier at RF (B) and IF (C)

Note: Adjust the attenuation of the power attenuator such that, with the input attenuator set to 40 dB (2 W), the level at the test input of the selective demodulator does not exceed 10 V. The rating of the external power attenuator is automatically taken into account if the corresponding value is entered with the dB EXT. decade switches. Connect test cable K1 used for calibration between the power attenuator and the selective demodulator.

A) Power measurement when applying an antenna signal

Test equipment/settings

MUF 2

Display section: 2 ms/DIV.
Selective demodulator: Set TUNING control (f_o) to transmit frequency of TV transposer with a sweep width of 0.1 MHz/DIV. and then switch over to AFC; LIN.; W pushbutton; RF ATTEN. 2 W; IF bandwidth 300 kHz; → sweep.

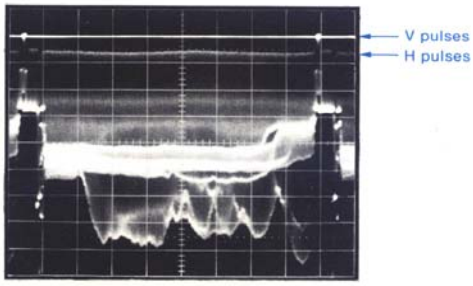
Test cable: K1 has been taken into account during calibration.

Power attenuator: ≧10 dB; enter the attenuation with the dB EXT. decade switches.

TV transposer: Automatic control mode

Measurement

Connect the antenna to the antenna input of the TV transposer. The MUF 2 performs as an analyzer. With a sweep time of 2 ms/DIV., the picture can be made stationary using the FINE adjustment control for X sweeping. The H and the equalizing pulses do not fully build up and are thus not suitable for power measurement. After the level line has been brought to the height of the V pulses, the digital readout indicates the power.



Output power measurement on TV transposers with antenna signal applied: Set level line to height of V pulses and read off result.
X: 2 ms/DIV.
Y: 10 divisions corresponding to 100%, 90% to approx. −1 dB

Power measurement when applying the vision carrier at B) RF or C) IF

Test equipment/settings

MUF 2

IF generator: RF LEVEL −20 dB (B), −34 dB (C); → sweep; FREQ. MARK. 10/1 MHz; PROGR. V.C. (vision carrier)
Display section: 10 ms/DIV.
Selective demodulator: TUNING (f_o) to transmit frequency of TV transposer; $\Delta f = 0.1$ MHz/DIV.; LIN.; W pushbutton; RF ATTEN. 2 W; IF bandwidth 300 kHz

Test cable: K1 has been taken into account during calibration.

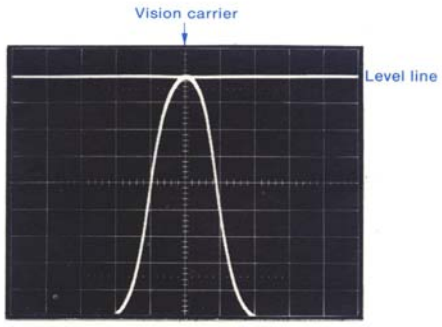
Power attenuator: ≧10 dB; enter the attenuation with the dB EXT. decade switches.

Mixer MUF 2-Z2: Required for B) only; converts the IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); with the RF LEVEL control set to −20 dB, the Mixer applies approx. 5 mV to the antenna input of the TV transposer.

TV transposer: Manual control mode

Measurement

Bring the level line to the highest point of the test curve and read the power off.



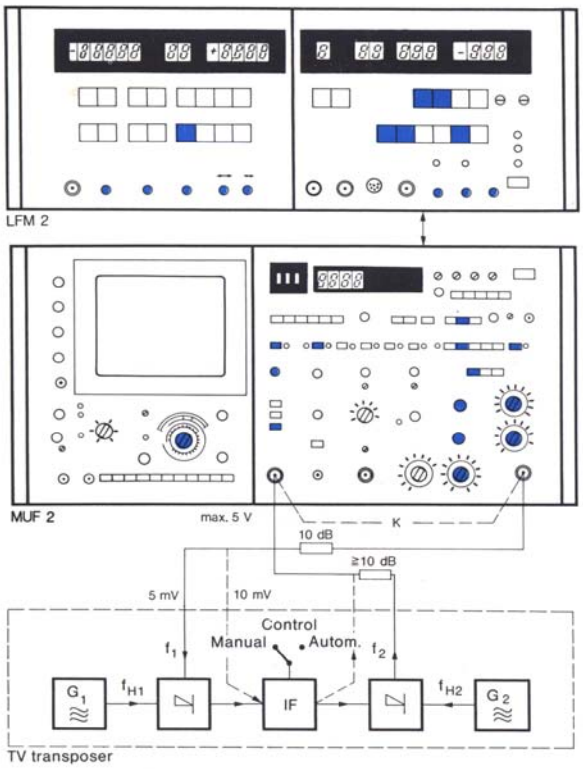
Output power measurement on TV transposers with vision carrier (RF or IF) applied: Shift level line to highest point of test curve and read power on digital readout.
X: 10 ms/DIV. ($\Delta f = 0.1$ MHz/DIV.)
Y: 10 divisions corresponding to 100%, 90% to approx. −1 dB

GROUP-DELAY/FREQUENCY RESPONSE

Calibration

Check the calibration with the CALIB. pushbutton pressed on the LFM 2. For this purpose, cable K is connected to the MUF 2 (see measurement configuration). The squarewave signal appearing on the screen is adjusted to a height of 10 divisions (the LFM 2 indicates 20 ns/DIV., i. e. 10 divisions corresponding to 200 ns). If a difference is found, correct using the adjustment facility on the MUF 2 rear panel.

Measurement configuration



Note: To avoid measurement errors, it is absolutely necessary that the equipment be interconnected with the correct characteristic impedance.

Measurement on TV transposers

Test equipment/settings

Group-delay Measuring Set LFM 2
Press the following pushbuttons: 20 kHz EXT.; REAR CONN.; (GEN. EXT.); MAN. and REC. TRIG.; ns/DIV. (desired scaling);

MUF 2
Sweep generator: RF LEVEL −22 dB (16 mV); TUNING (f_o) to receive frequency when measuring the complete transposer, to IF (38,9 MHz) when measuring the IF section; $\Delta f = 1$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz; LFM 2
Broadband demodulator: 1 dB/DIV.; LOG.; LFM 2
To make sure that the maximum input level is applied to the LFM 2, two sensitivity settings are possible in the MUF 2 broadband demodulator using a jumper: max. 1 V or max. 5 V (rms) RF input voltage. The 5-V setting is recommended for transposer measurements.
LF display channel (LFM 2): Press the two LFM 2 pushbuttons; probe frequency demodulation: DEMOD BR. (switch on MUF 2 rear panel).
Display section: 10 or 5 ms/DIV. or EXT./MAN.

Attenuator: 10 dB

Power attenuator: ≧10 dB

Connecting cable MUF 2-Z1: Establish the connection between the MUF 2 and the LFM 2 on the rear panel.

Shortcircuit cable: K used for calibrating the LFM 2

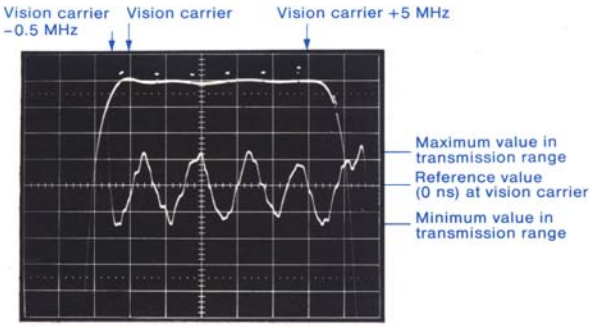
TV transposer: Manual control mode (adjust the same power value as for the automatic mode).

Measurement

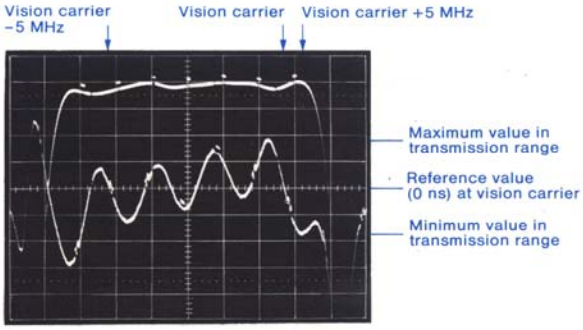
After pressing the above-mentioned pushbuttons, check whether the overdrive indicator $V_{20\ kHz}$ >max. has gone out on the LFM 2 (if required, reduce the MUF 2 output level). The reference signal for the group-delay measurement is automatically kept at the frequency which corresponds to the value at midscreen. If this centre frequency changes, the test curve is displaced from midscreen. This can be avoided by pressing the DELAY pushbutton on the LFM 2. For this purpose, the MUF 2 is set to EXT./MAN. The frequency corresponding to the luminous spot must be within the transmission range of the TV transposer. After pressing the MAN. and DELAY pushbutton on the LFM 2, the absolute delay is automatically compensated for. Use the position control on the MUF 2 to adjust the test curve to midscreen.

When measuring a test item without frequency conversion, the selective demodulator of the MUF 2 can also be used. With the video filter switched into circiut and the control turned fully clockwise, level adjustment is performed in the LIN. mode such that the upper screen edge is written at maximum modulation. Then logarithmic display of the test curve is also possible. The linear demodulator continues to demodulate the probe frequency. The IF bandwidth must be set to 300 kHz. Set the switch on the MUF 2 rear panel to DEMOD. SEL.

GROUP-DELAY/FREQUENCY RESPONSE



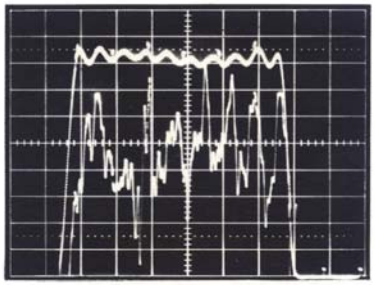
Amplitude/frequency response (top) and group-delay/frequency response of TV transposer
X: 10 ms/DIV. (Δf = 1 MHz/DIV.)
Y: Amplitude 10 dB/DIV., group delay 10 ns/DIV.



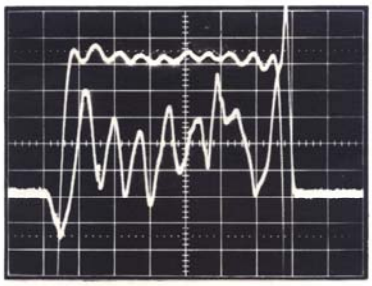
Amplitude/frequency response (top) and group-delay/frequency response of IF section of TV transposer
X: 10 ms/DIV. (Δf = 1 MHz/DIV.)
Y: Amplitude 1 dB/DIV., group delay 10 ns/DIV.

Measurement on surface acoustical wave (SAW) filters

SAW filters are increasingly used in TV transposers and CATV headends. They feature excellent selectivity and steep edges at the band limits. The partly large variations of the group-delay/frequency response of these filters can be determined only with group-delay measuring sets which ensure satisfactory resolution thanks to a suitable probe frequency. On the one hand, the probe frequency should be as high as possible to facilitate determination of the phase difference and on the other hand it should be as low as possible to ensure a high resolution for the measurement. The Group-delay Measuring Set LFM 2 from Rohde & Schwarz which uses a probe frequency of 20 kHz features excellent resolution and permits measurements down to the lower frequency limit of 100 kHz. The two diagrams below show the amplitude/frequency and group-delay/frequency response of a SAW filter: The LFM 2 with the probe frequency of 20 kHz was used for the upper diagram and a group-delay measuring set with a probe frequency of 132 kHz for the lower diagram. The evidently high resolution of the upper diagram proves that the probe frequency of 20 kHz is a suitable compromise and that, in particular at the band limits, erroneous measurements are avoided.



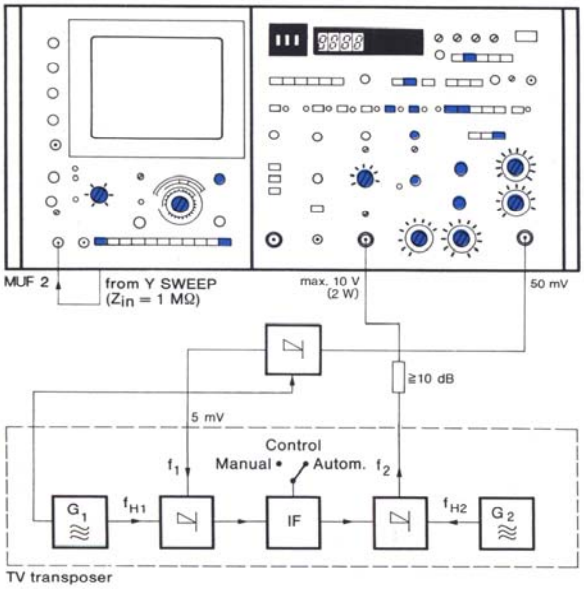
Amplitude/frequency response (top) and group-delay/frequency response of SAW filter, measured with Group-delay Measuring Set LFM 2 (20-kHz probe frequency) from Rohde & Schwarz
X: 10 ms/DIV. (Δf = 1 MHz/DIV.)
Y: Amplitude 1 dB/DIV., group delay 10 ns/DIV.



Amplitude/frequency response (top) and group-delay/frequency response of SAW filter, measured with group-delay measuring set using 132-kHz probe frequency
X: 1 MHz/DIV.
Y: Amplitude 1 dB/DIV., group delay 10 ns/DIV.

SIGNAL-TO-HUM RATIO

Measurement configuration



Test equipment/settings

MUF 2

IF generator: Program INTERMOD. "NW" (vision carrier 0 dB, sound carrier −10 dB); RF LEVEL −20 dB (50 mV); → sweep

Display section: 10 ms/DIV.; input 1 MΩ; DC coupling (=); NORM. triggering

Selective demodulator: LIN.; sweeping with 1 or 0.2 MHz/DIV. (analyzer mode) for f_o setting

Mixer MUF 2-Z2: Conversion of the IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); conversion loss 20 dB

Power attenuator: ≧10 dB

TV transposer: Automatic control mode; adjust nominal output power.

Measurement

Principle. The signal-to-hum ratio is the ratio of the black-to-white transition of the video voltage to an interfering hum voltage. The vision carrier delivered by the IF generator is converted in the mixer to the receive frequency of the TV transposer. The amplitude of the vision carrier is the reference value. It is adjusted such that the transposer performs with maximum level which corresponds to peak modulation at sync level. After setting the MUF 2 to the analyzer mode via the selective demodulator, a DC voltage proportional to the reference value is available at the rear Y-SWEEP output. In the SCOPE mode (red pushbutton), this DC voltage is used to determine the signal-to-hum ratio.

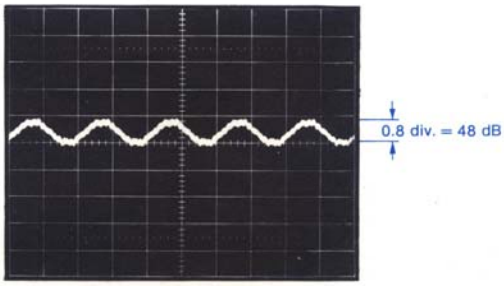
Setting MUF 2 to analyzer mode. Press the LOG. pushbutton on the selective demodulator and select a bandwidth of 300 kHz. Turn the LOG. position control fully clockwise and the level line control fully anti-clockwise. Adjust the RF ATTEN. such that the trace displayed on the screen does not go beyond the uppermost graticule line. Use the two IF attenuators (COARSE and FINE) to adjust the trace to full display height (= 10 divisions). Use the f_o control to move the vision carrier to screen mid, switch over to AFC and press the LIN. and LEVEL pushbuttons. Now the test trace is displayed on the uppermost and the level line on the lowest graticule line. Connect the Y-SWEEP output to the oscilloscope input.

Measuring in SCOPE mode. With the Y attenuator set to 0.2 V/DIV., the level line and the test trace are displayed as horizontal lines. Use the IF FINE control to adjust the two lines to a distance of 10 divisions (corresponding to 100%). These 10 divisions correspond to a signal-to-hum ratio of 0 dB, 1 division (=10%) thus covering 20 dB. Then switch off the level line (pressing the LIN. pushbutton again) and change over to ≈ input coupling and 50 Hz triggering. Limit the bandwidth to 1 kHz, i. e. press the VIDEO FILTER pushbutton. Set the Y attenuator to 10 mV/DIV. This corresponds to increasing the sensitivity by 26 dB so that 1 division now corresponds to a signal-to-hum ratio of 46 dB, smaller values to a higher ratio:

1.0 div. ≙ 46 dB
0.9 div. ≙ 47 dB
0.8 div. ≙ 48 dB
0.7 div. ≙ 49 dB
0.6 div. ≙ 50 dB
0.5 div. ≙ 52 dB, etc.

Measured values which exceed 50 dB considerably are not meaningful since they fall within the order of magnitude of the MUF 2 measurement error. Since the signal-to-hum ratio determined is referred to the snyc level, 4 dB must be subtracted to convert the result to the picture contents. The diagram below shows a signal height of 0.8 div. corresponding to 48 dB. After subtracting 4 dB, the signal-to-hum ratio is thus 44 dB.

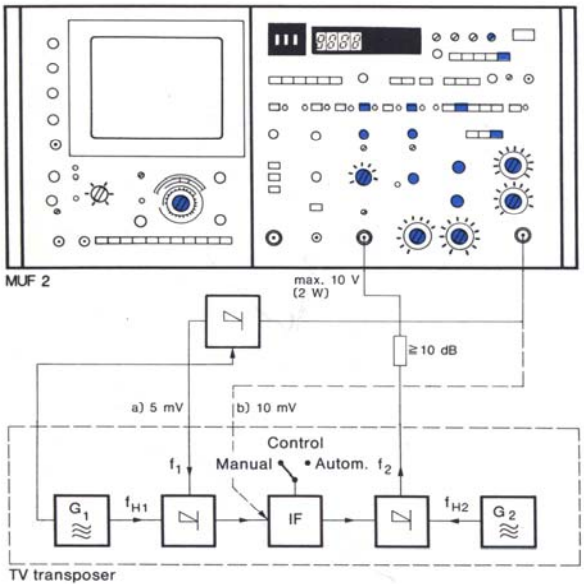
Note: For measuring the signal-to-hum ratio and for adjusting the hum compensation on higher-power systems (e. g. directly heated valve output stage) note that in most cases the CW output power is allowed only for a brief period. If necessary, measure 3 dB below nominal level (= black level) and specify this in the test report.



Measurement of signal-to-hum ratio of TV transposer

LINEARITY

Measurement configuration



Test equipment/settings

MUF 2

IF generator: RF LEVEL −34 dB when applying the signal to the IF section, −20 dB when applying the signal via the mixer to the antenna input (see measurement configurations a) and b)); PROGR. LIN. (VISION −3/−20/0 to 20 dB, SOUND −10 dB, SB −20 dB)

Display section: 2 ms/DIV.

Selective demodulator: LIN. (analyzer mode); TUNING (f_o) for instance at 0.1 MHz/DIV. to sideband or at 0.2 MHz/DIV. to carrier and sideband; then press LOG. (10 dB/DIV.) in addition; → sweep.

Mixer MUF 2-Z2: Conversion of the IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); conversion loss 20 dB

Power attenuator: ≧10 dB

TV transposer: Perform the adjustments with the vision carrier alone; adjust to nominal output power in the automatic control mode; switch over to the manual mode and adjust for the same value (= reference value).

Measurement

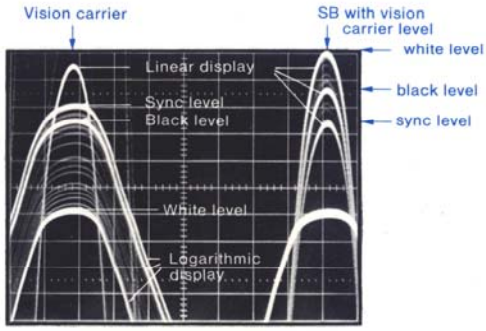
Principle. To determine the linearity, use a test carrier modulated with a constant-level auxiliary carrier. The level variation of the auxiliary carrier with differing carrier applied to the test item is a measure of the order of magnitude of the linearity error. In the example of the TV transposer, the vision carrier is used as the test carrier and the sideband carrier as the auxiliary carrier.

IF program LIN. of MUF 2. The IF program LIN. of the TV Transcope MUF 2 offers great measuring convenience. The vision carrier cyclically jumps to three different level values: −3 dB (black level), −20 dB (white level) and a value which can be set between 0 dB (sync level) and −20 dB using the front-panel control. The sideband carrier is used as the auxiliary carrier and has a level of −20 dB. The sound carrier has −10 dB.

Display. For ease of linearity evaluation, the SB carrier which is compressed differently at the different vision carrier levels is displayed with strong magnification. Simultaneous linear and logarithmic representation ensures easy association of the individual carriers and excellent resolution.

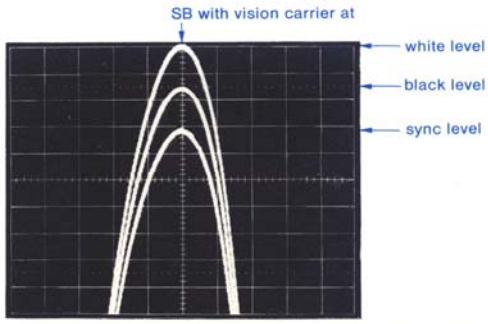
Method. First shift the zero line to the lowest graticule line (0 div.) and the maximum level value of the SB carrier to the uppermost graticule line (10 div.) Then switch to Yx2 and again shift the maximum level to the uppermost graticule line. Now 1 division corresponds to 5%.

Evaluation. In logarithmic representation the diagram below shows the vision carrier at three different levels and the associated compressed SB carriers (visible only as heavy lines in the LOG. mode). At the same time, the vision carrier (only one level value visible) and the three differently compressed SB carriers are displayed in the LIN. mode. The logarithmic mode is used only for visual evaluation of the vision carrier level within the range from 0 to −20 dB (complete characteristic). The SB compression between black and white level in per cent is called linearity figure. Use the linearity controls of the TV transposer to bring the three traces to coincidence if possible and then check the intermodulation rejection.



Vision carrier at different levels and SB carriers (compressed accordingly) in linear and logarithmic representation
X: 2 ms/DIV. (Δf = 0.2 MHz/DIV.)
Y: 5 dB/DIV. (Yx2!), corresponding to linearity error of 5%/DIV.

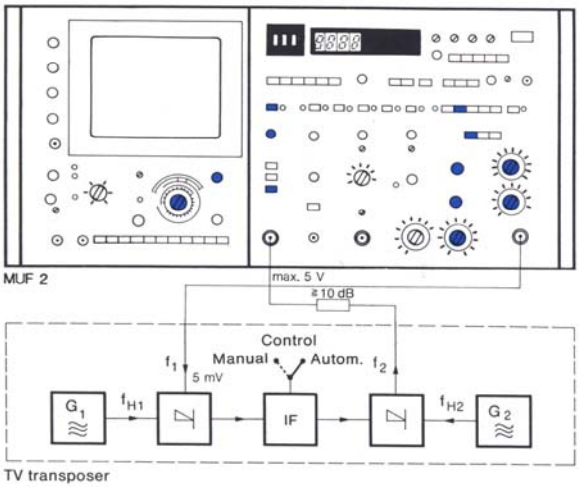
For accurate determination of the linearity error, it is recommended that the sweep time be increased.



Sideband carrier in linear representation (detail of diagram above)

LOWER CONTROL THRESHOLD

Measurement configuration



Test equipment/settings

MUF 2

Sweep generator: RF LEVEL −32 dB (5 mV), then reduce level (see measurement); TUNING (f_0) to receive frequency of TV transposer; sweep width 1 MHz/DIV., then 0.2 MHz/DIV.; sweep to →, then MAN.

Display section: 10 ms/DIV., then MAN.
Broadband demodulator: 1 dB/DIV.; LOG.

Power attenuator: ≥10 dB

TV transposer: Manual mode for tuning the sweep generator, automatic mode for determining the control threshold

Measurement

Setting MUF 2 to receive frequency. Set the TV transposer to the manual control mode and display the passband characteristic at a sweep width of 1 MHz/DIV. Then reduce the sweep width to 0.2 MHz/DIV. and shift the test curve with the f_0 control such that the vision carrier frequency is located in the centre of the screen. Then switch over to EXT./MAN. and bring the vision carrier (spot) again to screen mid using the MAN. control. Thus the frequency of the sweep generator corresponds to the vision carrier frequency of the TV transposer.

Determination of control threshold. Switch the TV transposer over to automatic control and adjust the output attenuator of the MUF 2 until the output voltage of the transposer decreases by 1 dB. The lower control threshold can now be calculated from the position of the attenuator (reference: 0 dB ≙ 200 mV).

INTERMODULATION

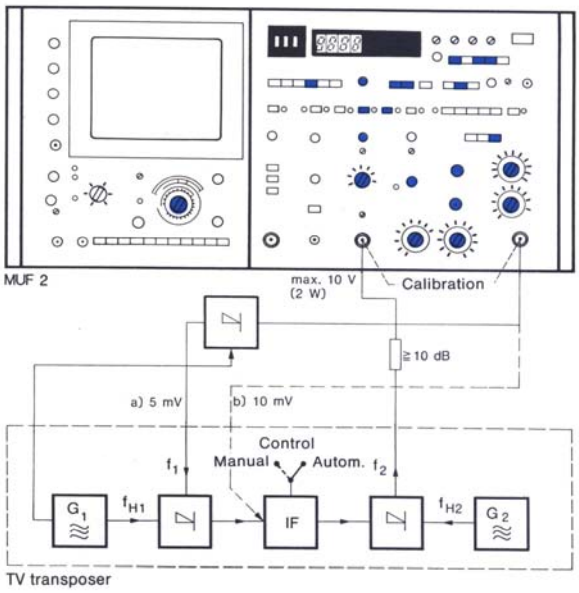
Calibration

Calibration of selective demodulator at f_0 = 35 MHz.
See calibration for absolute level measurements, page 5.

Calibration of IF generator. Switch the generator section over to IF GEN. Press the KM 2 and LIN. pushbuttons simultaneously (calibration setting) and adjust the three IF signals to the same amplitude in the linear display mode.

Output level adjustment of TV transposer. The vision carrier alone is used for level adjustment (PROGR. V.C. pressed). Use the RF level control of the TV transposer to adjust the transposer to nominal output power in the automatic control mode (for measuring the output power see page 9). When applying the signal to the IF section of the TV transposer, make sure that the precorrection network is driven with the specified level. Switch over to the manual control mode and adjust for the same output power as before.

Measurement configuration



INTERMODULATION
(continued)

Test equipment/settings

MUF 2
IF generator: RF LEVEL −20 dB (50 mV); when applying the signal to the IF section adjust the level required for the precorrection network; PROGR. INTERMOD. "KM 2" (normal levels, VISION/SOUND/SB = −8/−10/−16 dB) or "KM 1" (increased levels, VISION/SOUND/SB = −3/−10/−20 dB).
Display section: 10 ms/DIV.
Selective demodulator: LOG. (analyzer mode, 10 dB/DIV.); use the f_o control to adjust to the transmit frequency of the TV transposer; $\Delta f = 1$ MHz/DIV., then 0.1 MHz/DIV.; IF bandwidth 300 kHz or 30 kHz and video filter connected into circuit if required (see examples).

Mixer MUF 2-Z2: Conversion of the IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); conversion loss 20 dB

Power attenuator: ≧10 dB

TV transposer: Automatic control mode, then switch over to manual mode (adjustment of nominal output power).

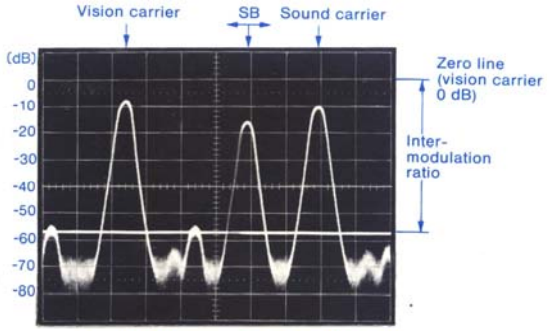
Measurement

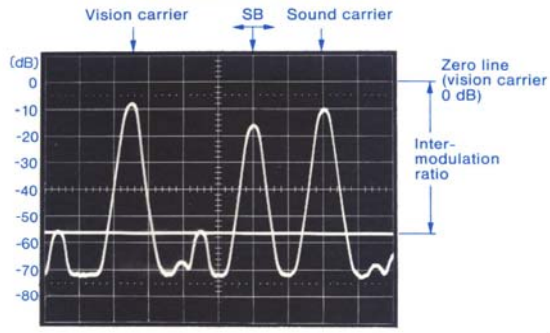
Principle. With the IF program INTERMOD. "KM 2" selected, the TV transposer is driven by the vision/sound/sideband carriers at −8/−10/−16 dB corresponding to the normal level range (from black to white level) of the TV picture. The "KM 1" program of the MUF 2 (VISION/SOUND/SB = −3/−10/−20 dB) simulates the transmission of colour signals (colour picture at red level).
Intermodulation is the interference which is produced by modulating the vision carrier with the difference frequency between sound carrier and colour subcarrier. Accordingly, the ratio of the modulation product to the vision carrier is called intermodulation ratio.

Since intermodulation products occur mainly in the output stage, either the RF or the IF input can be used for signal application.

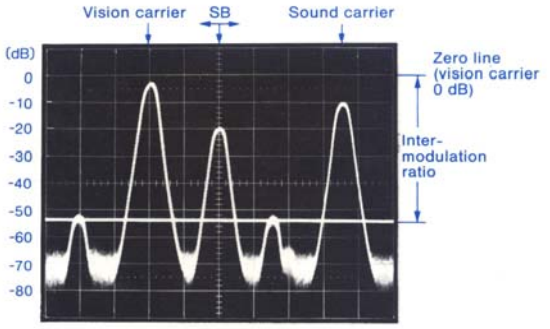
Method. With the IF program V.C. selected, use the position control to shift the vision carrier for instance to the last but one graticule line (= 9 divisions; reference value). To facilitate evaluation of the test result, adjust the level line to the same height as the vision carrier. Then select the desired IF program, INTERMOD. "KM 2", press the ΔdB pushbutton and tune the sideband frequency over the transmission range. The examples in the righthand column show that the intermodulation ratio can now easily be determined with the aid of the graticule or level line (see page 5, level determination on display section).

If the noise components are too high, connect the video filter and increase the sweep time until the curve does not exhibit any distortion.

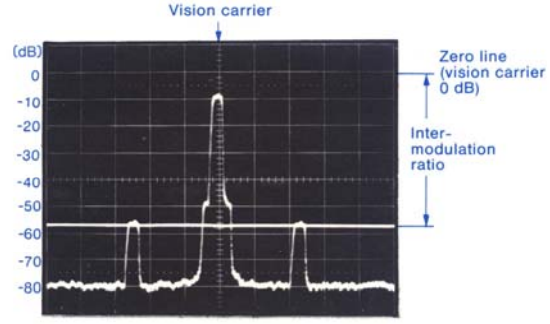




Intermodulation measurement on TV transposer with INTERMOD. "KM 2" program (normal levels, VISION/SOUND/SB = −8/−10/−16 dB), IF bandwidth 300 kHz; first diagram without, second diagram with video filter
X: 5 ms/DIV. ($\Delta f = 1$ MHz/DIV.)
Y: 10 dB/DIV.



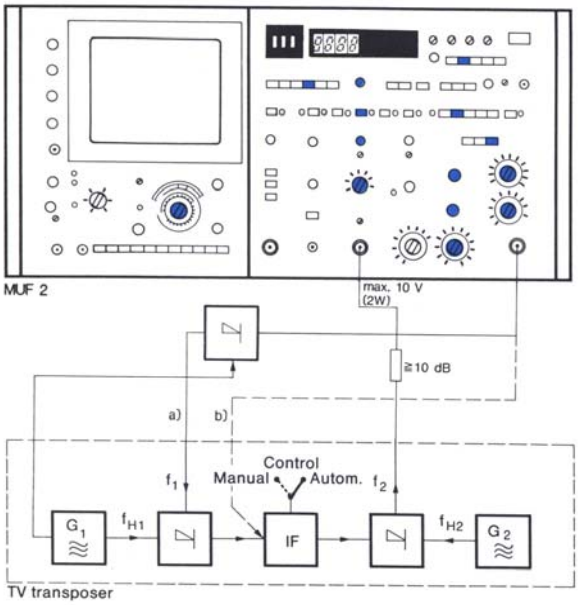
Intermodulation measurement on TV transposer with INTERMOD. "KM 1" program (increased levels, VISION/SOUND/SB = −3/−10/−20 dB), IF bandwidth 300 kHz
X: 5 ms/DIV. ($\Delta f = 1$ MHz/DIV.)
Y: 10 dB/DIV.



Intermodulation measurement on TV transposer close to the carrier using INTERMOD. "KM 2" program (normal levels, VISION/SOUND/SB = −8/−10/−16 dB), IF bandwidth 30 kHz, with video filter
X: 20 ms/DIV. ($\Delta f = 0.1$ MHz/DIV.)
Y: 10 dB/DIV.

SPURIOUS RESPONSE

Measurement configuration



Since spurious frequencies are mainly produced in the output stage, either the RF or the IF input can be used for signal application.

Test equipment/settings

MUF 2

IF generator: RF LEVEL −34 dB when applying the signal to the IF section; −20 dB when applying the signal via the mixer to the antenna input (see measurement configurations a) and b)); PROGR. INTERMOD. "NW" (VISION 0 dB, SOUND −10 dB)

Display section: 10 ms/DIV.

Selective demodulator: LOG. (analyzer mode, 10 dB/DIV.); TUNING (f_o) to transmit frequency of TV transposer; Δf = 2 MHz/DIV.; → sweep

Mixer MUF 2-Z2: Conversion of the IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); conversation loss 20 dB

Power attenuator: ≧10 dB

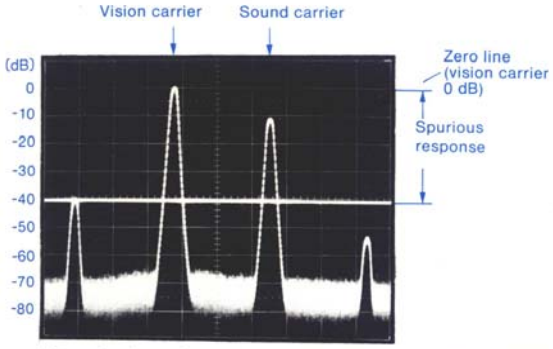
TV transposer: Automatic control mode; adjust for nominal output power.

Measurement

Principle. When transmitting two or several frequencies by way of a nonlinear characteristic, combination frequencies (intermodulation) are produced. Mixture products which, for instance as the difference frequency between the sound carrier and the colour subcarrier, modulate the vision carrier and are located in the transmission channel are called intermodulation products. If the intermodulation products are located in the adjacent channel, they are called spurious frequencies.

Evaluation. In the case of the present example, the IF generator INTERMOD. (PROGR. "NW") delivers the vision and the sound carriers with the level of 0 dB and −10 dB, respectively. The spurious frequencies produced in the TV transposer are determined.

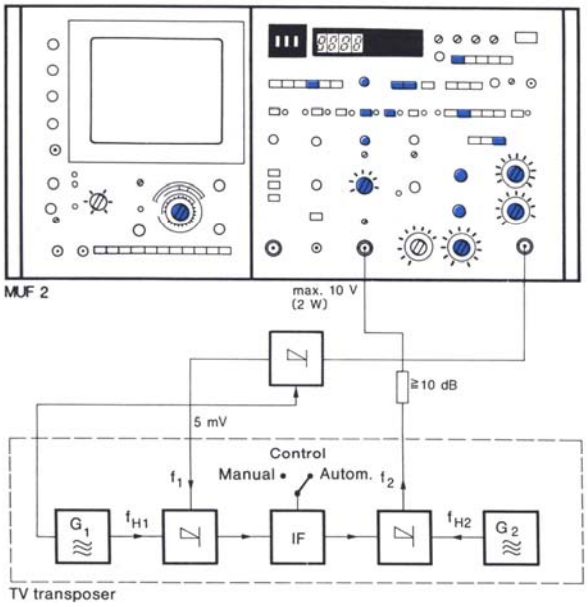
After the MUF 2 has been set up, the vision and the sound carrier as well as the mixture products are displayed (see diagram below). Press the Yx2 pushbutton for ease of evaluation. Using the level line, the spurious response can be easily determined. By varying the centre frequency, the mixture products at VISION −11 MHz and VISION +16.5 MHz can also be displayed.



Determination of spurious response: Shift level line from vision carrier (0 dB, reference) to spurious frequency and read result on digital display.
X: 10 ms/DIV. (Δf = 2 MHz/DIV.)
Y: 10 dB/DIV.

RF S/N RATIO

Measurement configuration



Test equipment/settings

MUF 2

IF generator: RF LEVEL –20 dB (50 mV); PROGR. V.C. (vision carrier)

Display section: 10 ms/DIV.

Selective demodulator: LOG. (analyzer mode 10 dB/DIV.); TUNING (f_o) to transmit frequency of TV transposer; sweep width 2 MHz/DIV.; → sweep; bandwidth 300 kHz, VIDEO FILTER connected into circuit

Mixer MUF 2-Z2: Conversion of IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); conversion loss 20 dB

Power attenuator: ≧10 dB

TV transposer: Automatic control mode

Measurement

Display. To measure the RF S/N ratio, the TV transposer is driven with a sinewave vision carrier. The automatic control mode ensures that the transposer is adjusted to nominal output power. After the required settings have been made, the vision carrier, the noise level of the transposer in the passband and the inherent noise of the MUF 2 are displayed (see diagram below). After having shifted the maximum value of the test curve to the last but one graticule line (reference 0 dB), the S/N ratio can be easily determined with the aid of the level line.

Conversion. Since the test bandwidth Δf is only 300 kHz, the test result has to be converted to the noise bandwidth ΔF of the TV transposer (8 MHz, in accordance with specifications ARD/DBP 5/2.6). In addition, a correction factor necessary because of the rectification in the TV Transcope must be taken into account.

Conversion to noise bandwidth

$$a = 10 \log \frac{\Delta F}{\Delta f} = \frac{8{,}000{,}000 \text{ Hz}}{300{,}000 \text{ Hz}} = +14.2 \text{ dB}$$

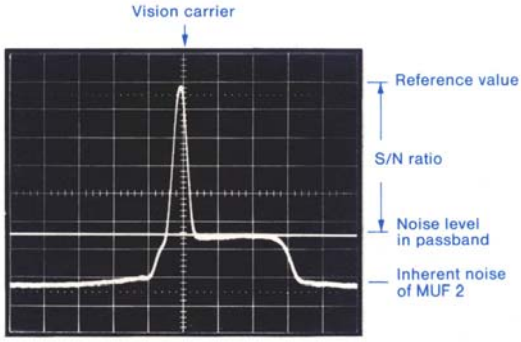
Correction of rectification +3 dB

Example. An S/N ratio of for instance 69 dB determined with the level line yields an RF S/N ratio of

69 dB – (14.2 + 3.0) dB = 51.8 dB

referred to the noise bandwidth of 8 MHz.

Video S/N ratio. The video S/N ratio is 4.1 dB below the RF S/N ratio.

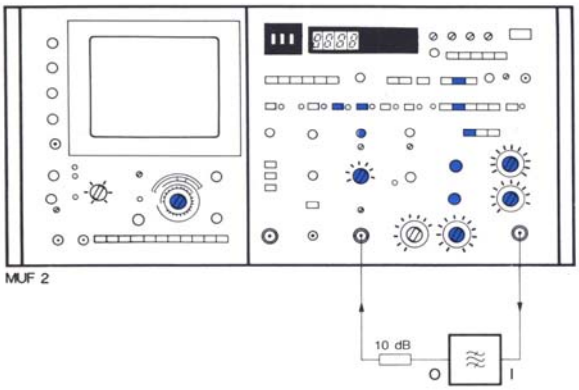


Measurement RF S/N ratio of TV transposer

SELECTIVITY

Input selectivity

Measurement configuration



The selectivity of the TV transposer input filter is determined between the antenna input (I) and the filter output (O).

Test equipment/settings

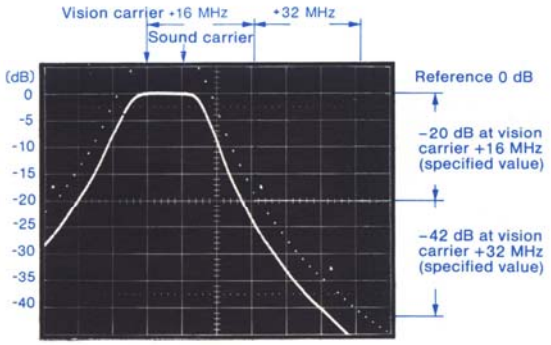
MUF 2
Sweep generator: RF LEVEL ≦−6 dB (e. g. −10 dB); TUNING (f_o) to receive frequency of TV transposer; $\Delta f = 5$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Selective demodulator: LOG. (analyzer mode, 10 dB/DIV.); Yx2

Attenuator: 10 dB

Input filter: Perform the measurement separately from the rest of the equipment.

Measurement

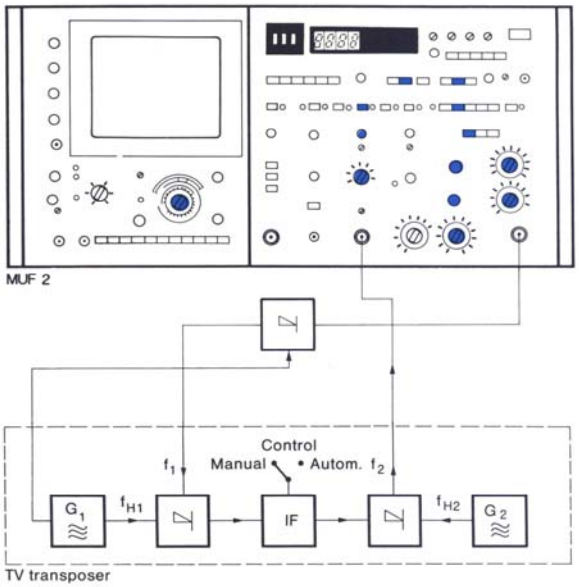
The passband characteristic of the input filter is displayed. The frequency markers facilitate checking of the values (−20 dB for vision carrier +16 MHz, −42 dB for vision carrier +32 MHz) stipulated in the specifications. To determine the selectivity below the vision carrier, shift the centre frequency f_o up.



Determination of selectivity of TV transposer input filter
X: 10 ms/DIV. ($\Delta f = 5$ MHz/DIV.)
Y: 5 dB/DIV.

Adjacent-channel selectivity
(measurement via RF and IF sections)

Measurement configuration



Test equipment/settings

MUF 2
Sweep generator: RF LEVEL −6 dB (100 mV); TUNING (f_o) to IF; $\Delta f = 2$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Selective demodulator: LOG. (analyzer mode, 10 dB/DIV.); VIDEO FILTER connected into circuit

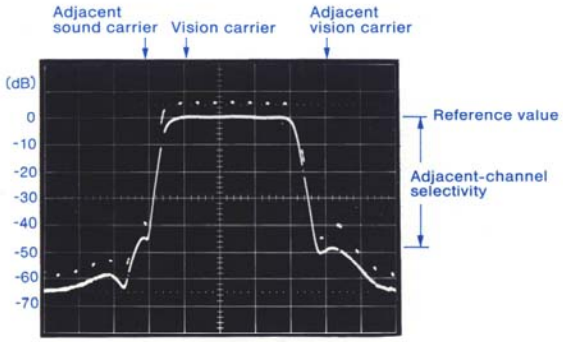
Mixer MUF 2-Z2: Conversion of the IF signal to the RF using the first local oscillator of the TV transposer (f_{H1}, 50 to 250 mV); conversion loss 20 dB

TV transposer: Manual control mode

Measurement

An important parameter of the TV transposer is the adjacent-channel selectivity, i. e. the increase of the attenuation of the selective networks at the frequency spacing of an adjacent channel above and below the band centre frequency.

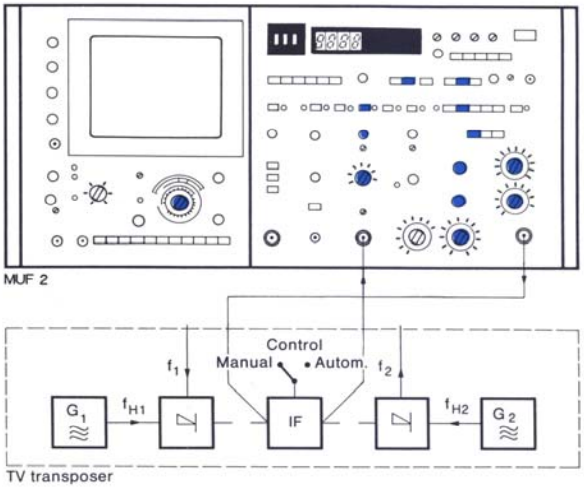
To facilitate pole determination, it is best to use a small sweep width which ensures a higher frequency resolution. The RF input voltage at the TV transposer is to be increased exceptionally to 10 mV to improve the S/N ratio. The frequency markers render the evaluation easy. For the required pole position, see the relevant specifications.



Determination of adjacent-channel selectivity of TV transposer (measurement via RF and IF sections)
X: 50 ms/DIV. (Δf = 2 MHz/DIV.)
Y: 10 dB/DIV. (video filter connected into circuit)

IF selectivity

Measurement configuration



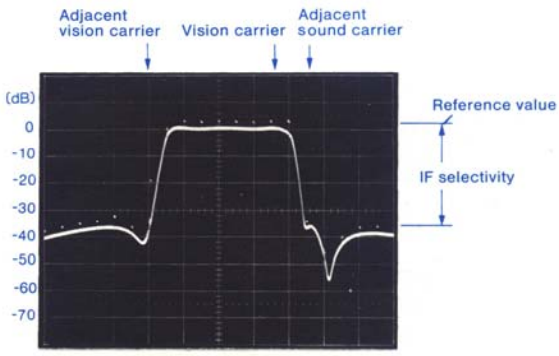
Test equipment/settings

MUF 2
Sweep generator: RF LEVEL −26 dB; TUNING (f_o) to IF; sweep 2 MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 10 ms/DIV.
Selective demodulator: LOG. (analyzer mode, 10 dB/Div.); VIDEO FILTER connected into circuit

TV transposer: Manual control mode

Measurement

Since the RF circuits of the TV transposer are only slightly involved with nearby selectivity, a simplified test setup (without mixer) can be used to measure at the IF with an accuracy which is sufficient in most cases. Set the poles in accordance with the manufacturer's specifications.



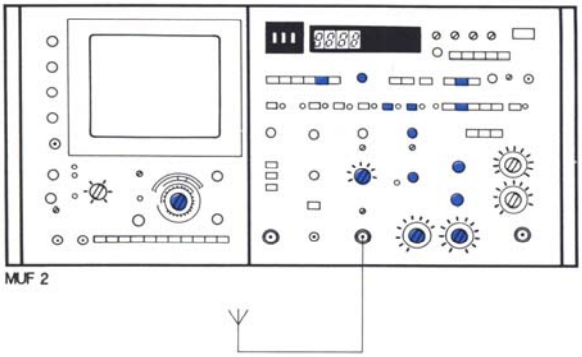
Determination of IF selectivity of TV transposer
X: 50 ms/DIV. (Δf = 2 MHz/DIV.)
Y: 10 dB/DIV., video filter connected into circuit

INPUT VOLTAGE – VISION/SOUND AND SOUND 1/SOUND 2 LEVEL RATIO

Calibration

See calibration for absolute level measurements, page 5.

Measurement configuration



Test equipment/settings

MUF 2

Selective demodulator: LIN. (analyzer mode); TUNING (f_o) to vision carrier frequency of received transmitter; $\Delta f = 0.1$ MHz/DIV. or AFC (see measurement); → sweep; FREQ. MARK. 10/1 MHz; IF bandwidth 300 kHz; use RF attenuator to adjust appropriate display height (if the display height is not sufficient, adjust also the IF attenuator).

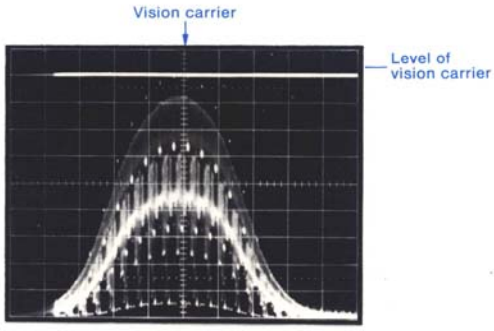
Display section: 10 ms/DIV.

Measurement

Standardized level ratios. To ensure interference-free operation, it is necessary to apply a sufficiently large signal (approx. 2 to 5 mV) to the transposer via the receiving antenna. Moreover, the level ratio between the vision and the sound carriers (13 dB) must be maintained along the transmission path. In the case of dual sound, the level of sound 1 is 13 dB and that of sound 2 is 20 dB below the vision carrier level.

Measurement of input voltage. Since the following measurements are absolute level measurements, calibration as described on page 5 is required.

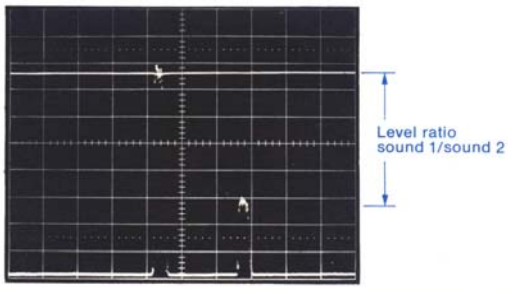
Adjust the selective demodulator to the vision carrier frequency of the received transmitter. With $\Delta f = 0.1$ MHz/DIV., the pattern shown above to the right is obtained. In the AFC mode (no sweeping) the modulation is displayed as a function of time (see output power measurement, page 9, top of righthand column). In both cases, shift the level line to the maximum of the corresponding test curve (V pulses). After the V pushbutton has been pressed, the voltage arriving from the antenna is read out. Note this voltage value since it is required for the subsequent measurements. Since synchronization is not established, the field blanking interval is moving over the screen. Use the X fine control to obtain a stationary pattern.



Vision carrier modulated with video signal; analyzer bandwidth 300 kHz; H pulses do not fully build up.
X: 10 ms/DIV. ($\Delta f = 0.1$ MHz/DIV.)
Y: Evaluation using level line (LIN.)

Measurement of vision and sound carrier ratio. The sound carrier level should be 10 dB lower than the vision carrier level. Tune the selective demodulator to the sound carrier using the f_o control. Increase the IF gain by 10 dB (IF ATTEN.) and shift the level line to the sound carrier maximum. Vary the attenuation at the dB EXT. decade switches until the same voltage value appears on the digital readout as for the vision carrier measurement. The value in dB on the decade switches equals the level ratio between the vision and the sound carrier.

Measurement of level ratio between sound carriers 1 and 2. With dual sound, the level ratio between the two sound carriers is also of interest. The measurement is performed in the same way as described for determining the level ratio between the vision and the sound carrier. Because of the 242-kHz spacing between the two sound carriers a test bandwidth of 30 kHz is required. The diagram below shows the two sound carriers.

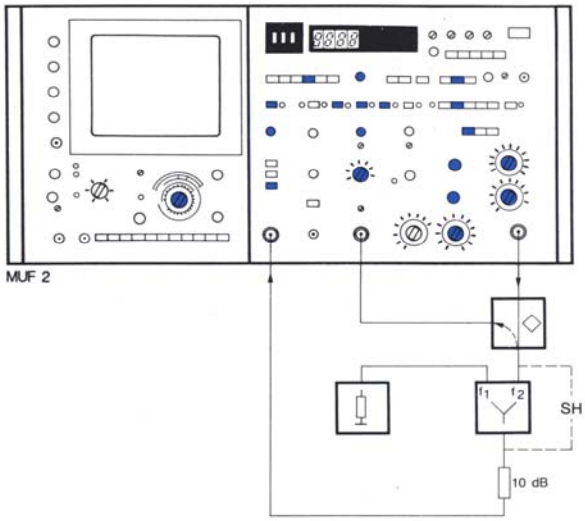


Measurement of level ratio between sound carrier 1 and sound carrier 2
X: 10 ms/DIV. ($\Delta f = 0.1$ MHz/DIV.)
Y: Evaluation using level line (LIN.)

MEASUREMENTS ON COMBINING FILTERS

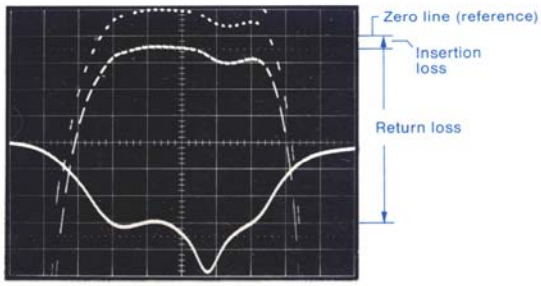
Matching, insertion loss

Calibration/measurement configuration



Measurement

The display section shows the passband characteristic and the matching of the combining filter as a function of frequency. Using the zero line (reference), the insertion and the return loss can be easily determined with the aid of the graticule or level line (see level determination on display section, page 5).



Passband characteristic and matching of combining filter as function of frequency
X: 5 ms/DIV. ($\Delta f = 5$ MHz/DIV.)
Y: 0.5 dB/DIV. (passband characteristic), 5 dB/DIV. (matching) } Yx2

Calibration

Calibration for measurement of matching. With the test port of the VSWR bridge open (total reflection), use the Y position control of the selective demodulator to adjust the test trace to the second graticule line from above (9 divisions). This line is the reference line.

Calibration for measurement of insertion loss. In the shortcircuit mode, SH (see above measurement configuration), use the Y position control of the broadband demodulator to adjust the test trace to the second graticule line from above (9 divisions).

Test equipment/settings

MUF 2
Sweep generator: RF LEVEL −6 dB (100 mV); TUNING (f_0) to channel frequency (f_2); $\Delta f = 5$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz
Display section: 5 ms/DIV.
Broadband demodulator: LOG.; 0.5 dB/DIV. with Yx2
Selective demodulator: LOG.; 5 dB/DIV. with Yx2

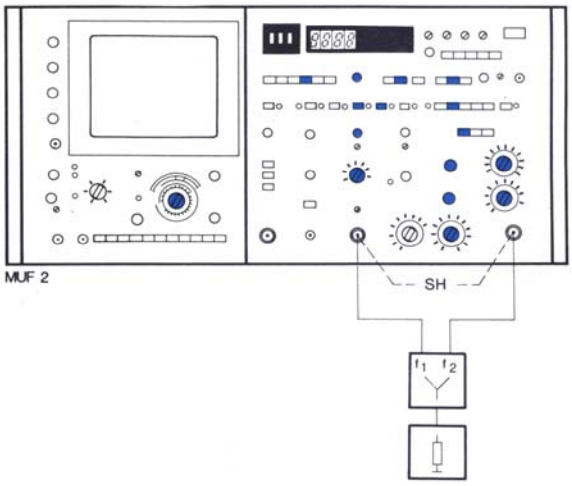
VSWR bridge

Combining filter: Terminate the free channel.

Attenuator: 10 dB

Isolation

Calibration/measurement configuration



Calibration

In the shortcircuit mode, SH (see above measurement configuration), use the Y position control of the selective demodulator to adjust the test trace to the second graticule line from above (9 divisions).

MEASUREMENTS ON COMBINING FILTERS
(continued)

Test equipment/settings

MUF 2

Sweep generator: RF LEVEL –6 dB (100 mV); TUNING (f_o) to channel frequency (f_2); $\Delta f = 2$ MHz/DIV.; → sweep; FREQ. MARK. 10/1 MHz

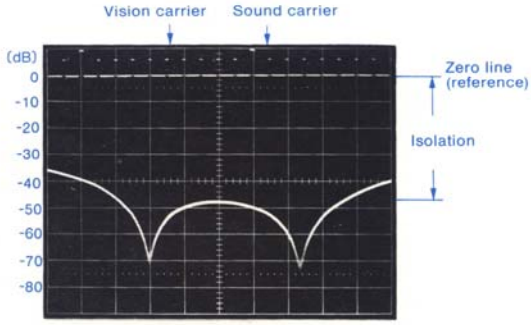
Display section: 5 ms/DIV.

Selective demodulator: LOG. (analyzer mode, 10 dB/DIV.); VIDEO FILTER connected into circuit

Combining filter: Terminate the output

Measurement

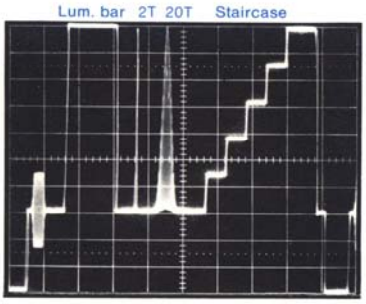
The isolation can be easily determined on the display section using the graticule or the level line (diagram to the right). It is recommended that the measurement be repeated with the inputs reversed. For this purpose, adjust the TUNING control (f_o) of the sweep generator to the channel frequency (f_1).



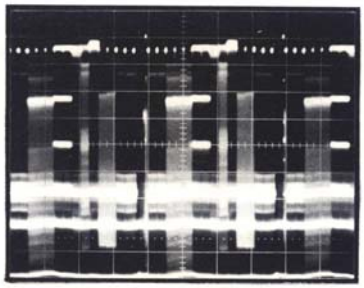
Isolation of combining filter as function of frequency
X: 5 ms/DIV. ($\Delta f = 2$ MHz/DIV.)
Y: 10 dB/DIV.

MUF 2 USED AS OSCILLOSCOPE

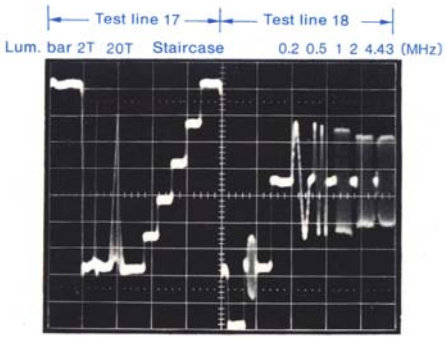
After pressing the SCOPE pushbutton, the MUF 2 performs as a general-purpose oscilloscope which can also be used for TV measurements. The measurements are performed via a high-quality receiver provided with a video output. V and H triggering is possible as well 20x expansion of the signal in the X direction to evaluate test lines. The following diagrams show some practical examples.



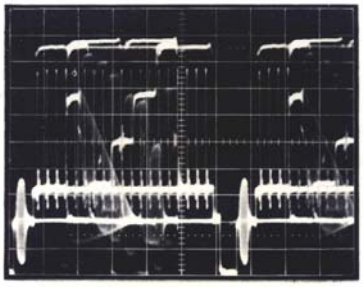
CCIR-17 test line for evaluation of pulse transmission of TV transposer; V_1 and +TRIGGER used, 75-Ω input
X: approx. 0.12 ms/DIV. and 20x expansion
Y: 0.1 V/DIV.



Hum at TV transposer output; V_2 and +TRIGGER used, 75-Ω input
X: 5 ms/DIV.
Y: 0.1 V/DIV.



CCIR-17 (as above) and CCIR-18 test lines for evaluation of amplitude/frequency response of TV transposer; V_1 and +TRIGGER used, 75-Ω input
X: approx. 0.2 ms/DIV. and 20x expansion
Y: 0.1 V/DIV.



Evaluation of interference and signal magnitude at TV transposer output; H and +TRIGGER used, 75-Ω input
X: 10 μs/DIV.
Y: 0.1 V/DIV.

Technische Daten

Wobbelsender

Frequenzbereich	3...1000 MHz
Wobbelhub	100, 50, 10, 5, 2, 1, 0,2, 0,1, 0 MHz/cm; AFC
Modell mit begrenztem Hub	10, 5, 1, 0,5, 0,2, 0,1, 0,02, 0,01 MHz/cm; AFC
Mittenfrequenz	beliebig einstellbar
Anzeige am Display	nach Tastendruck
Anzeigefehler	≦ ± 3 MHz
Hublinearitätsabweichung	≦ 1,5 %
Störhub (Δf ≦ 2 MHz/cm)	≦ 3 kHz
Oberwellenabstand	≧ 40 dB (typisch 46 dB)
Nebenwellenabstand	≧ 40 dB (typisch 50 dB)
Frequenzmarken (Impulsmarken)	100, 100/10, 10/1; extern
Markeneingang	0,1 V an 50 Ω; BNC-Buchse
HF-Austastung	während des Rücklaufs
Kontrollausgang (Rückseite)	25 mV an 50 Ω (konstant)
Externe Modulation (z. B. durch LFM 2)	f_{mod} = 20 kHz, U_{ss} = 1 V (25pol. Buchse, Rückseite)

Bild-Ton-Seitenband-Generator (BTS)

Frequenzen Bild/Ton/Seitenband	38,9/33,4/33...40 MHz (Standard B/G, andere auf Anfrage)
Trägerauswahl (Tasten)	Bildträger/Nebenwellen-/Kreuzmodulations-/Linearitätsmessung
Nebenwellenabstand	> 70 dB
Kontrollausgang (Rückseite)	25 mV an 50 Ω

Ausgang (umschaltbar)	Wobbel- oder BTS-Signal
Wobbelsignal (U_{eff})	100 mV (−7 dBm) ± 0,3 dB bei Ausgangsteiler: −6 dB (≙ Eingangsteiler: CAL.)
BTS-Träger (U_{eff})	je 500 mV (an 50 Ω); je um 3 dB veränderbar (Bildträger außerdem 0...−20 dB)
Frequenzgang Seitenband	≦ ± 0,2 dB
Pegel bei LIN, KM, NW	entsprechend Programmwahl (siehe Meßbeispiele)
Ausgangsteiler	1-dB-Stufen (bis −99 dB)
Teilerfehler	typisch ≦ ± 0,25 dB
Anschluß	N-Buchse (50 Ω)
Welligkeitsfaktor s	≦ 1,3 (Teiler 6 dB) ≦ 1,2 (Teiler ≧ 10 dB)

Selektivdemodulator (Empfänger)

Frequenzbereich	25...1000 MHz
Abstimmung	über YIG-Oszillator des Wobbelsenders; einschaltbare AFC
Maximale Eingangsspannung	U_{eff} ≦ 10 V (Eingangsteiler 40 dB)
Eingangsempfindlichkeit	< 2 µV ≙ −101 dBm (Teiler −10 dB, ZF-Bandbreite 30 kHz, Videobandbreite 1 kHz), ≙ −116 dBm/kHz
Leistungsmeßbereich	0...2 W; mit eingestellter externer Dämpfung (max. 60 dB) je nach ZF-Teiler bis 2 kW
Anschluß	N-Buchse (50 Ω)
Eingangsteiler	−10/.../+40 dB (10-dB-Stufen)
Welligkeitsfaktor s	≦ 1,3 bei Schalterstellung ≧ 0 dB
Teilerfehler	≦ ± 0,2 dB/10 dB; max ± 0,5 dB
ZF-Teiler (nur Lin-Darstellung)	0/.../−60 dB (10-dB-Stufen), dazwischen kontinuierlich
Teilerfehler	≦ ± 0,2 dB/10 dB bis −50 dB; max. ± 0,8 dB bis −60 dB
Dynamik der Log-Darstellung	> 80 dB
Abweichung	± 1 dB bis −70 dB
Dynamik der Lin-Darstellung	20 dB
Abweichung	≦ 3 % v. E.
Darstellbereich (U_{eff})	10 V...2 µV (≙ 134 dB), je nach Teilerstellungen
ZF-Bandbreite	30 oder 300 kHz
Demodulator	für AM-Signale
Videobandbreite	etwa 150 kHz oder ≦ 1 kHz
Aussteuerbereich der Anzeige	bis oberste Rasterlinie bei Bild-Lage Rechtsanschlag und Y×1
Frequenzgang der Anzeige	25...600 MHz: ≦ 2 dB, 600...1000 MHz: ≦ 3 dB, (max. 0,4 dB/10 MHz)
NF-Ausgang (Rückseite)	0,1 V/Div., f_{max} = 150 kHz

Analysierbetrieb (weitere Daten)

Intermodulationsabstand (Eingangsteiler 0 dB)	≧ 64/≧ 70 dB bei $U_{Bild\ eff}$ = 100/30 mV (für B-/T-Pegel 0/−10 dB)
Oberwellenabstand (Eingangsteiler 0 dB)	≧ 40/≧ 50 dB bei $U_{E\ eff}$ = 100/30 mV
Abstand beliebiger Nebenwellen (ohne Eingangssignal)	≧ 70 dB (Bezug: max. Anzeigepegel)

Breitbanddemodulator

Frequenzbereich	3...1000 MHz
Anzeigemaßstab	1/5/10 dB/Div.
Maximale Eingangsspannung	U_{eff} ≦ 5 V, $U_{=}$ ≦ 10 V
Anschluß	N-Buchse (50 Ω)
Welligkeitsfaktor s	≦ 1,2
Dynamik	60 dB (5 V...5 mV)
Anzeigefehler	≦ ± 1,5 dB (bis −50 dB)
Eingangsspannung bei Messung mit LFM 2	U_{eff} ≧ 200 mV

NF-Eingang

Anschluß	BNC-Buchse; $R_e \geqq 500\ k\Omega$
Frequenzbereich	0...10 kHz
Ablenkkoeffizient	0,5 mV/Div.

Sichtgerät

Leuchtschirm	80 mm x 100 mm; beleuchtetes Innenraster
Leuchtfarbe/Nachleuchtdauer	grün/mittelkurz (GP)

Y-Achse

Ablenkkoeffizient	10 mV/Div....0,5 V/Div.
Dehnung (bei Wobbelbetrieb)	x2
Frequenzbereich	0...12 MHz (DC-Kopplung) 0,3...12 MHz (AC-Kopplung)
3-dB-Bandbreite	12 MHz (bei 5 MHz: ≦ ±0,2 dB)
Dachschräge 50 Hz/15 kHz	≦ ±1 %
Schwarzwertmodulation	≦ ±1 %
Kompensierbare Gleichspannungsanteile	±250 mV bei 10 mV/Div. bis ±2,5 V bei ≧100 mV/Div.

Y-Eingang

Durchschleiffiltereingang	75 Ω (Abschluß einschaltbar); ohne Abschluß für Tastteiler geeignet (1 MΩ‖35 pF); BNC-Buchsen
Rückflußdämpfung	≧34 dB (bis 6 MHz)
Abschwächer stetig	≧1:2,5
stufig	1:1/2/5/10/20/50
Eichspannungsgeber (Oszilloskopbetrieb)	U_{ss} = 0,8 V (Rechteck)
Amplitudenfehler	≦ ±1 %
Tastverhältnis	2

Zeitachse

Zeitmaßstab Oszilloskopbetrieb	0,1 µs...0,2 s/cm; extern; Hand
Dehnung	x20 (nicht für <5 µs/cm)
X-Eingang (Rückseite)	0...+5 V; max. 50 Hz
Steuerung des Ablaufvorganges	automatisch
Single (bei Wobbelbetrieb)	durch Taste oder mit ext. 5-V-Impuls

Triggerung

Triggerniveau	normal/50 Hz: einstellbar, V_1/V_2/H: fest eingestellt
Triggerquellen	ext./int./Netz
Polaritätswahl	+/-
Ansprechschwelle, intern	3 Skalenteile
extern (rücks. BNC-Buchse)	U_{ss} = 1...4 oder 4...20 V

Hellsteuerung

Zeitablauf MAN./EXT.	Vor- und Rücklauf hell
Wobbel- und Analysierbetrieb	
Taste „→"	Vorlauf hell, Rücklauf dunkel
Taste „0⇄"	Vor- und Rücklauf hell; Null-Linie im Rücklauf
Oszilloskopbetrieb	Vorlauf hell, Rücklauf dunkel

Meßwertanzeige

Pegellinieneinstellung	von Hand
Meßwertanzeige	3½ Stellen (LED)
Dimension	V, mV, µV, W, mW, dBµV, dBm, ΔdB (Speicherung für Differenzbildung), MHz
Berücksichtigung externer Dämpfungswerte durch Rechner	bis 59,9 dB einstellbar (je nach Teilerstellung)

Eichung

Schalterstellung CAL bewirkt	10 dB im Eingangsteiler, Einschaltung Wobbelsender, Ausgangspegel 100 mV ±0,3 dB
Eichvorgang	Senderausgang mit Empfängereingang verbinden, Lin- oder Log-Anzeige auf Pegellinie einstellen

Gruppenlaufzeitmessung (zusammen mit LFM 2)

Selektivdemodulator (MUF 2) in Betriebsart LIN

Eingangsspannungsbereich (U_{eff})	min. 10 mV	max. 10 V
bei Eingangsteilerstellung	ZF: -20 dB	ZF: 0 dB
	HF: 0 dB	HF: 40 dB
Laufzeitfehler	≦20 ns/10 dB bei Pegeländerung ≦8 ns/10 MHz bei Frequenzänderung	

Breitbanddemodulator (MUF 2)

Eingangsspannungsbereich (U_{eff})	200 mV...1 V (5 V intern einstellbar)
Laufzeitfehler	wie Selektivdemodulator

Zusatzgeräte

Meßmischer MUF 2-Z2	25...1000 MHz; 50 Ω
Frequenzgang innerhalb 10 MHz	≦ ±0,1 dB
Mischdämpfung 25...800 MHz	20 dB ±2,5 dB
über 800 MHz	20 dB +3/-2 dB
ZF-Eingang (U_{eff})	≦50 mV ≦100 mV für Übersichtsmessung
Eingang Mischoszillator (U_{eff})	50...250 mV
Rückflußdämpfung	>10 dB (ZF-Eingang: >20 dB)
Anschlüsse	N-Buchsen (ZF-Eingang: N-Stecker)
Intermodulation (100...1000 MHz, $U_{E\,eff}$ = 50 mV)	
Nebenwellenabstand	>60 dB (B/T ≙ 0/-10 dB)
Kreuzmodulationsabstand	>70 dB (B/T/S ≙ -8/-10/-16 dB oder -3/-10/-20 dB)
Stromversorgung	+15 V (MUF 2) oder +12 V (LMF 2)

Verstärker MUF 2-Z3	10...1000 MHz; 50 Ω	
Verstärkung	27 dB ±1,5 dB	
HF-Eingang (U_{eff})	max. 25 mV	für Oberwellenabstand ≧40 dB
HF-Ausgang	0,5 V (an 50 Ω)	
Rückflußdämpfung	Eingang: ≧15 dB, Ausgang: ≧11 dB	
Anschlüsse Eingang/Ausgang	N-Buchse/N-Stecker	
Stromversorgung	wie Meßmischer	

XY-Schreiberadapter LFM 2-Z3

Ablenksägezahn (X) für XY-Schreiber	ca. 0...5 V
Ablaufzeit	ca. 1 Minute
Signal für Schreibstiftabhebung (Penlift)	TTL-Pegel (Polarität intern umschaltbar)
Meßsignal (Y)	über Verbindungskabel vom MUF 2 (Y-Ausgang)
Tasten CALIB	Eichung der XY-Auslenkung am Schreiber
RESET	stellt Schreibstift in Null-Position
START	bewirkt einmaligen Schreibablauf
Anschluß	RECORDER: BNC
Stromversorgung	wie Meßmischer

VSWR-Meßbrücken (50 Ω)	**SWOB 4-Z**	**ZRB**
Frequenzbereich	10...1000 MHz	5...2000 MHz
Anschluß Eingang und Ausgang	N-Buchsen	N-Buchsen
Meßobjekt	N-Stecker	N-Buchse
Richtdämpfung	≧40 dB	≧46 dB
Durchgangsdämpfung	6,5 dB	6,5 dB

Überspannungsschutz SWOB 5-Z5 (für HF-Ein- oder -Ausgang)

Ansprechschwelle	etwa 4 V (U_ oder U~)
Abschaltzeit	≦3 ms

Demodulator SWOB 3-Z (Tastkopf mit BNC-Stecker)

Frequenzbereich	0,5...400 MHz (informativ bis 1000 MHz)
Impedanz bei 50/200 MHz	≧30 kΩ‖2...3 pF/≧10 kΩ
Eingangsspannung	min. 50 mV (volle Bildhöhe), max. zulässig 5 V HF, überlagerte Gleichspannung bis 100 V

Allgemeine Daten

Nenntemperaturbereich	+5...+40 °C
Arbeitstemperaturbereich	0...+50 °C
Lagertemperaturbereich	-20...+70 °C
Stromversorgung	115/125/220/235 V +10/-15 %, 47...63 Hz (120 VA)
Abmessungen, Gewicht	492 mm x 250 mm x 530 mm, 24 kg

Bestellangaben

Bestellbezeichnung (50 Ω) ▶ Umsetzermeßeinrichtung MUF 2

MUF 2	337.0013.52
MUF 2 mit begrenztem Hub	337.0013.54

Mitgeliefertes Zubehör: HF-Verbindungskabel (100 cm, 50 Ω, N-Stecker) 155.0055.00, Netzkabel, Beschreibung

Empfohlene Ergänzungen

Verbindungskabel zum LFM 2 mit Fertigungsnummer 871.739/.. und 300.974/..	MUF 2-Z1	337.7824.00
für andere Modelle LFM 2	MUF 2-Z4	337.7830.00
Meßmischer	MUF 2-Z2	349.8820.50
Verstärker	MUF 2-Z3	353.5816.50
Gerätedeckel (und Halterung für Meßmischer, Verstärker und Meßbrücken)	MUF 2-Z5	337.7747.00
XY-Schreiberadapter	LFM 2-Z3	340.5906.02
VSWR-Meßbrücken	SWOB 4-Z	912.7003.00
	ZRB	335.2819.50
Überspannungsschutz	SWOB 5-Z5	333.9316.54
Demodulator (Tastkopf)	SWOB 3-Z	241.2116.00
10:1-Tastteiler (Kompensationsbereich 10...40 pF)	UTKS	241.0013.00
1:1-Taster	UTKS	241.1310.93
Transportkoffer (750 mm x 550 mm x 380 mm)		190.5695.00

Kameras: Steinheil (M20, M30, M32); Tektronix