SIEMENS

CARRIER-FREQUENCY LEVEL TEST SET K 2155

200 Hz to 620 kHz

Technical Manual

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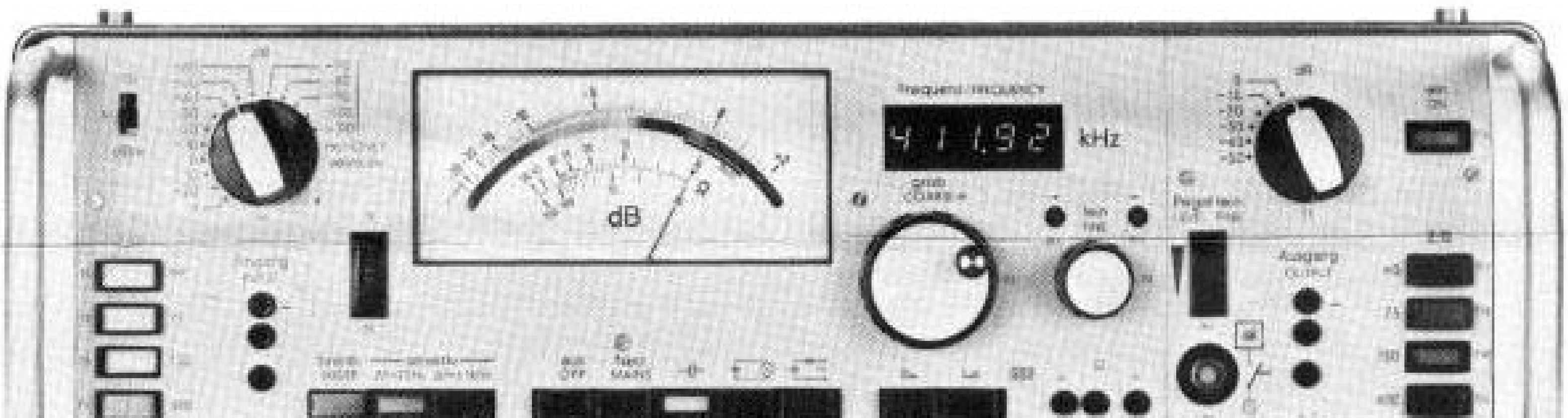

Figure 1 Carrier-frequency level test set K2155 consisting of level meter D2155 with oscillator section W3155

1 DESCRIPTION

1.1 Application

Level test set K2155 combines the level meter D2155 and oscillator W3155 in a single housing. Broadband and selective level, attenuation and gain measurements can be made over the entire frequency range from 200 Hz to 620 kHz. Measurements can also be made with reduced accuracy in the range 50 Hz to 200 Hz.

The level test set is designed for making in-service measurements on long-haul communications systems and equipment.

However, the accuracy, amplitude stability and frequency stability are also sufficient in many cases to meet laboratory requirements during development as well as for alignment, testing and quality control of communications system modules and equipment during production.

Level, gain, attenuation, cross-talk and harmonic distortion can be measured directly; return loss, longitudinal balance and impedance measurements can also be carried out using a measuring attachment.

The power supply for the measuring attachment is provided by jack Bu11 on the rear panel of the K2155 which delivers a stabilized output of 10 V for this purpose.

The 200 Hz to 620 kHz frequency range includes the VF telephony channel range (300 Hz to 3400 Hz) as well as the CCITT basic groups (12 kHz to 108 kHz) and basic supergroups (312 kHz to 552 kHz). The range of applications of the carrier frequency level test set covers all the carrier frequency systems and their components listed in Figure 2.

The wide measuring range of the level meter from -110 dB (dBm) to +20 dB(dBm) referred to a 0 dB meter reading, together with the selectable measuring bandwidth (20 Hz or 3.1 kHz depending on the application), allows all types of measurement to be made which occur in the application range mentioned above.

The filter with the 20 Hz measuring bandwidth is particularly suitable for frequency spectrum analysis, for measurements in speech and WT channels and for system pilot measurements. The 3.1 kHz wide filter simplifies tuning to a signal with an unknown frequency and allows phase jitter measurements to be made in the carrier frequency range with a phase jitter meter connected to the single-sideband output.

The selected center frequency or the output frequency can be read off on the five-digit digital frequency meter (resolution 10 Hz) built into the instrument. This enables frequency measurements to be made at the lowest levels and with superimposed interfering signals.

In Figure 2, a summary of the common carrier frequency systems is given and compared with the frequency range of level test set K2155.

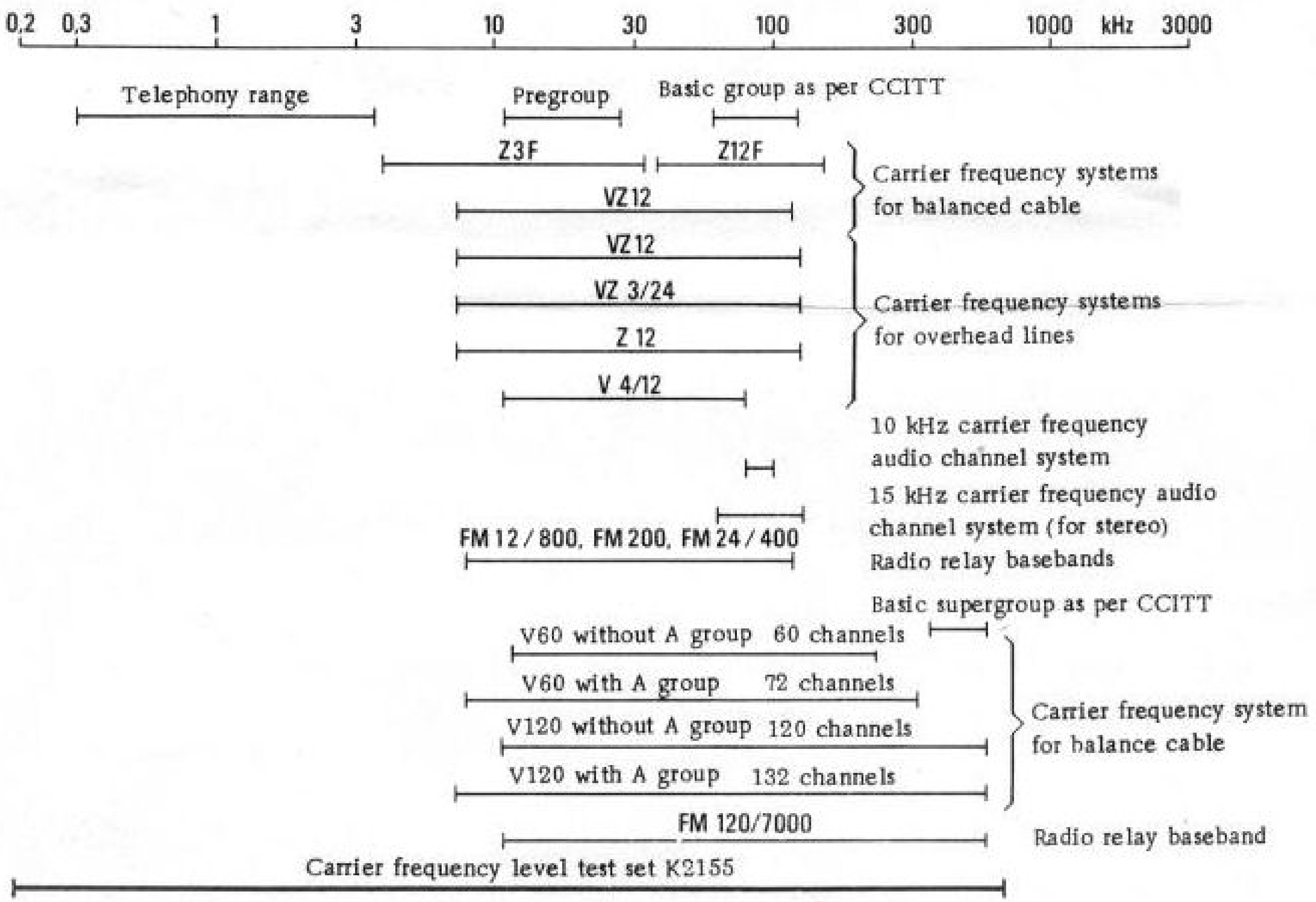

Figure 2 Frequency plan for the communications bands and for level test set K2155

1.2 Electrical Specifications

Specifications Level meter D 2155 with Tracking Oscillator W3155 (Option)

Wideband measurement

Test frequency

Measuring range: 200 Hz to 620 kHz
Measurements at level < 0 dB (dBm) are possible at frequencies of 50 Hz and above

Reference value: 10 kHz

Level measurement

Measuring range
for 0 dB meter reading
switchable in 10 dB steps: − 60 to + 20 dB/dBm

smallest measurable level: − 70 dB (dBm, 600 ohms)/
− 65 dBm (75; 150 ohms)
smallest readable level: − 80 dB (dBm, 600 ohms)/
− 75 dBm (75; 150 ohms)

Reference value:
for Z = 75 ohms: 0 dB (dBm)

Operating error limits [1])
in the range 1 to 200 kHz: ± 0.25 dB
200 Hz to 620 kHz: ± 0.35 dB

Contained in operating error:

Intrinsic error [2])
Receive level in the 0 dB (dBm) range
for 0 dB meter reading: ± 0.1 dB
Influence error affecting the measured level
Attenuator error referred to the 0 dB/dBm range: ± 0.1 dB
additionally in the range − 60 dBm (75; 150 ohms): ± 0.1 dB
Frequency response referred to the reference value of the frequency and 0 dB meter reading
in the range 1 to 200 kHz: ± 0.1 dB
200 Hz to 620 kHz: ± 0.25 dB

Selective measurement

Test frequency

Measuring range: 200 Hz to 620 kHz
Measurements in the range − 80 to 0 dB/dBm are possible at frequencies of 50 Hz and above

Reference value: 10 kHz

Frequency setting
manually, coarse and fine
continuously adjustable up to 620 kHz
Frequency display: 5 digits
Resolution: 10 Hz

Operating error limits [1])
$\pm 2 \cdot 10^{-5} \pm 1$ unit of the last place

Level measurement

Measuring range
for 0 dB meter reading, switchable in 10 dB steps:

in the frequency range 800 Hz to 620 kHz	200 Hz to 800 Hz
− 110 to + 20 dB (dBm)	− 90 to + 20 dB (dBm)

In the measuring ranges − 100; − 110 dB (dBm, 600 ohms) and − 90 to − 110 dBm (75; 150 ohms) the measuring bandwidth 20 Hz should be used
smallest measurable level: − 110 dB (dBm)
smallest readable level: − 120 dB (dBm)

Measuring bandwidth, switchable

Selectivity	narrow	wide for test frequency ≧ 10 kHz
Pass-band width, Δa ≦ 0.5 dB	± 3 Hz	± 800 Hz
Bandwidth, Δa = 3 dB	approx. 20 Hz	approx. 3.1 kHz
Stop-band attenuation, Δa > 70 dB	± 150 Hz	
Δa > 50 dB		± 10 kHz

Reference value
for Z = 75 ohms: 0 dB (dBm)

Operating error limits [1])
in the level measuring range − 90 to + 20 dB (dBm)
1 to 200 kHz: ± 0.25 dB
200 Hz to 620 kHz: ± 0.3 dB

Contained in operating error

Intrinsic error [2])
Receive level in the 0 dB (dBm) range
for 0 dB meter reading: ± 0.1 dB
Influence error affecting the measured level
Attenuator error referred to the 0 dB (dBm) range: ± 0.1 dB
additionally in the range − 90 dB (dBm): ± 0.1 dB
− 100 dB (dBm): ± 0.3 dB
− 110 dB (dBm): ± 0.9 dB
Frequency response referred to the frequency reference value and 0 dB meter reading
in the range 1 to 200 kHz: ± 0.1 dB
200 Hz to 620 kHz: ± 0.15 dB

Intermediate frequencies
f_{i1}: 1 MHz; f_{i2}: 100 kHz; f_{i3}: 10 kHz

Image-frequency rejection
for $f_m + 2 f_{i1} \geqq 70$ dB
$f_m + 2 f_{i2} \geqq 70$ dB
$f_m + 2 f_{i3} \geqq 70$ dB

Intrinsic harmonic distortion 2nd and 3rd order products with sensitivity increased by 50 dB: > 70 dB below fundamental

Signal output

Audio output (SSB output)
switchable to upper and lower sideband
Output level with 0 dB meter reading:
approx. 0 dB across load ≧ 600 ohms

Wideband and selective measurement

Signal input

Balanced input
Input impedance in the range 1 to 300 kHz: ≧ 10 kilohms
0.3 to 620 kHz: ≧ 5 kilohms
0.2 to 0.3 kHz: ≧ 3 kilohms
switchable to: 75; 150 ohms (± 1 %) and 600 ohms (± 2 %)

[1]) The operating error limits are applicable within the rated range of use of the influence quantities and the measurement ranges of the associated influence characteristics; they include the separately listed intrinsic error and influence error.

[2]) The intrinsic error per DIN 43 745 (IEC-Publ. 359) is applicable to the reference values or ranges of the influence quantities and associated influence characteristics.

Ground unbalance
for $Z \leqq 150$ ohms in the range 0.2 to 620 kHz: $\geqq 40$ dB
for $Z = 600$ ohms in the range 0.2 to 100 kHz: $\geqq 40$ dB

Input jack
three-contact jack, balanced

Transmit

Output frequency

The generator section frequency is tuned from the level meter

Measuring range
200 Hz to 620 kHz
Measurements at an output level < -20 dB/dBm are possible at frequencies of 50 Hz and above

The following items (Frequency setting, Reference value, Operating error limits) apply on level meter:

Frequency setting
manually, coarse and fine
continuously adjustable up to 620 kHz
Frequency display: 5 digits
Resolution: 10 Hz

Reference value: 10 kHz

Operating error limits [1]
$\pm 2 \cdot 10^{-5} \pm 1$ unit of the last place displayed

Output level

Measuring range
for 0 dB level meter reading
settable in 10-dB steps: -50 to 0 dB/dBm

continuously variable by: approx. 12 dB with reference to meter reading
smallest settable level: -61 dB (dBm)

Reference value for internal impedance = load = 75 ohms:
0 dB (dBm)

Operating error limits [1]
in the range 200 Hz to 620 kHz: ± 0.3 dB

Contained in operating error

Intrinsic error [2]
Output level in the 0 dB (dBm) range
for 0 dB level meter reading: ± 0.15 dB

Influence error affecting the output level
Attenuator error referred to the 0 dB (dBm) range: ± 0.1 dB
Frequency response referred to the frequency reference value and 0 dB meter reading
in the range 200 Hz to 620 kHz: ± 0.15 dB

Harmonic distortion
2nd and 3rd order products at internal resistance = load $\geqq 75$ ohms
in the range 1 to 100 kHz: > 50 dB below fundamental
200 Hz to 620 kHz: > 40 dB below fundamental

Spurious signals
at 0 dB (dBm), internal resistance = load $\geqq 75$ ohms:
> 60 dB below fundamental

Signal output

Balanced output
Source impedance (as per IEC-Publ. 403): approx. 0 ohm
Output impedance (as per IEC-Publ. 403): approx. 0 ohm
switchable to: 75 ohms (± 2 %) and 150; 600 ohms (± 1 %)

Output jacks
three-contact, balanced

Output balance:
for $Z \leqq 150$ ohms in the range 200 Hz to 620 kHz: $\geqq 40$ dB
for $Z = 600$ ohms in the range 200 Hz to 100 kHz: $\geqq 40$ dB

Power supply

Power connection
double-insulated (Protection class II)

Line voltage
Rated range of use: 99 to 143 V and 198 to 286 V
automatic changeover

Line frequency
Rated range of use I: 50 Hz ± 5 %, 60 Hz ± 5 %
Limit range of operation: 47 to 63 Hz

Power input: approx. 6 W

Battery operation (option)
2 Ni-Cd rechargeable batteries 6 V/6 Ah
Operating time without recharge
for wideband measurements: approx. 60 h
for transmit and selective measurement modes: approx. 35 h

Recharge time with internal charger
for an operating time of 8 h: approx. 14 h
for a full charge: approx. 34 h
In ac operation trickle charge is applied
The instrument is automatically switched off before the batteries are completely discharged

Safety specifications: as per DIN 57411, VDE 0411/1

Environmental conditions

Influence quantities

Ambient temperature
Reference value: 23 °C ± 1 °C
Rated range of use I: $+5$ to 40 °C
Limit range of operation: -10 to $+55$ °C
Limit range for storage and transport: -40 to $+70$ °C

Relative humidity
Reference range at 23 °C: 45 to 75 %
Rated range of use I: 20 to 80 % (excluding condensation)
(absolute humidity < 25 g/m³)
Limit range of operation:
10 to 90 % (absolute humidity < 30 g/m³)
(operable 15 min after switching on)

Barometric pressure, altitude
Reference value: 101.3 kN/m² (1013 mbar)
Rated range of use I: 70.0 to 106.0 kN/m² (up to 2200 m)
(700 to 1060 mbar)
Limit range of operation: 53.3 to 106.0 kN/m² (up to 4300 m)
(533 to 1060 mbar)

Radio interference suppression
corresponds to RFI class K as per VDE 0875
and allgemein. Genehmigung DBP No. 647/1961
and allgemein. Genehmigung DBP No. 345/1952

[1] The operating error limits are applicable within the rated range of use of the influence quantities and the measurement ranges of the associated influence characteristics. they include the separately listed intrinsic error and influence error.

[2] The intrinsic error per DIN 43 745 (IEC-Publ. 359) is applicable to the reference values or ranges of the influence quantities and associated influence characteristics.

1.3 Mode of operation

1.3.1 Overall function

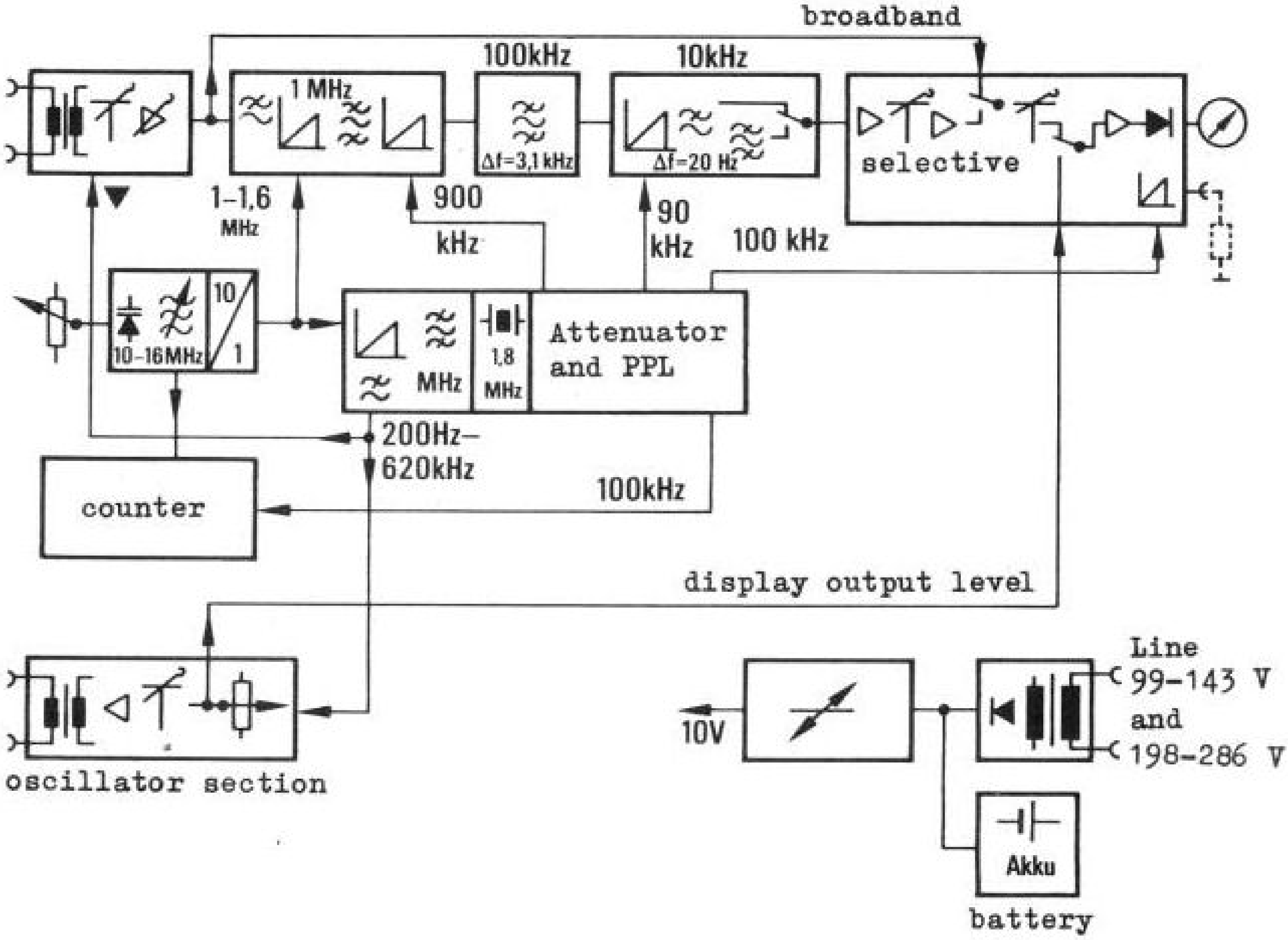

Figure 3

The carrier frequency level test set K2155 consists of level meter D2155 and oscillator W3155.

1.3.1.1 Level meter D2155

The receiver section has a floating, balanced input for the frequency range 200 Hz to 620 kHz. In the test panel, the input signal is first brought up to the optimum level for processing by the following stages. This is done as a function of the sensitivity control setting using the input attenuator and preamplifier.

The signal path splits after the test panel according to which operating mode is selected (broadband or selective).

In the broadband mode, the measurement signal is passed directly to the broadband output amplifier. The signal is first attenuated by the attenuators contained in the output amplifier to a degree set by the position of the sensitivity control and then amplified and rectified.

"Quasi-RMS" rectification with a very high linearity is used. As a result, even noise measurements can be carried out with a high degree of accuracy. A moving-coil meter with a mechanically robust taut-band suspension indicates the measured value on a voltage linear dB scale. The meter also has a scale for the charge condition of the internal battery as well as two resistance scales for impedance measurements with a measuring attachment (e.g. B2005).

In the selective measuring mode, the signal passes from the test panel through two conversions with 1 MHz and 100 kHz IF frequencies to the 100 kHz bandpass filter which determines the 3.1 kHz bandwidth. This bandpass filter is followed by a further conversion down to the 10 kHz IF range. The bandwidth can be switched down to 20 Hz in this frequency range. This is achieved by switching a mechanical filter with a steep cutoff in the signal path. The level is then matched to the broadband output amplifier and rectifier with the attenuators and amplifiers controlled by the sensitivity switch.

The output amplifier also contains the single-sideband converter which translates the input signal to 1 kHz when it is in the center of the filter passband. Either the lower or the upper sideband of the output signal can be selected using two illuminated switches.

All the fixed converter frequencies are derived from a 1.8 MHz temperature-stabilized crystal oscillator, as is the time base for the digital frequency meter.

The variable first converter frequency of 1.002 to 1.620 MHz is delivered by a varactor-tuned oscillator and a 10:1 frequency divider. The oscillator frequency can be coarse and fine tuned with two precision ten-turn potentiometers. The operating limits of the fine frequency control are signalled by two LEDs. The fine frequency control has a range of about 5 kHz which was selected to allow convenient tuning in the 3.1 kHz wide speech channel.

The receiver is fitted with a continuously tuned calibrator which permits calibration at the measurement frequency by turning the receiver sensitivity control to the "Calibrate" position.

The calibration signal is generated by mixing the 1 MHz signal (derived from the crystal oscillator) with the 1.002 to 1.620 MHz output of the variable frequency oscillator. The 200 Hz to 620 kHz lower sideband is then filtered out and passed to the test panel input. This signal is also required for the optional oscillator section.

A digital frequency meter displays the center frequency of the filter in the selective mode or the output frequency when using the built-in oscillator. This meter counts in the original 10 - 16 MHz range of the variable frequency oscillator and uses a pre-divider controlled by the gate interval in order to make the display as flicker-free as possible.

The power supply for the test set is drawn either from the 99 to 143 V or 198 to 286 V AC line or from the internal Nickel-Cadmium battery (optional). The changeover between the two AC voltage ranges is carried out completely automatically. When operating from the internal battery, the supply voltage cuts off automatically when perfect operation can no longer be guaranteed due to a discharged battery.

1.3.1.2 Oscillator W3155 (optional)

The input signal fed to the oscillator section is the same as is used for calibration. The signal is passed through a potentiometer which allows fine level adjustment over a range of about 12 dB to the 5 x 10 dB attenuator, amplified and then coupled out via an output transformer to a floating, balanced output.

1.3.2 f_1 oscillator - D5763 -

The f_1 oscillator module delivers the following signals:

a) The carrier signal for the first conversion in the selective measurement mode (1 to 1.62 MHz)

b) A second, decoupled carrier signal for generating the calibration and output signals (1 to 162 MHz)

c) The counter signal for the digital frequency meter (10 to 16.2 MHz)

In this module, the stabilized 10 V output of the power supply is initially converted to a highly constant, temperature-stabilized 9.5 V supply. For this purpose, the voltage of a temperature-compensated reference diode (pos. 121) is increased from 6.2 V to 9.5 V with an operational amplifier. This voltage is then fed to the varactor diodes in the oscillator via the frequency setting potentiometers. The oscillator itself consists of integrated circuit SO 42 E (pos. 142), coil pos. 70 and the varactors pos. 124-127. A transistor stage at the output of the oscillator provides adequate decoupling and a low internal impedance. The 10 to 16 MHz oscillator signal is fed to the digital frequency meter via the three TTL gate modules (pos. 143-145) which function as decoupling stages.

A 10/1 TTL frequency divider (pos. 146) is connected after the first decoupling stage (pos. 143). This leads to two outputs via two further gate modules (pos. 147, 148) which operate as buffer amplifiers. The output of gate pos. 148 delivers the carrier for the first conversion in the selective receiver section, and the output of gate pos. 147 feeds the carrier to the mixer used for generating the calibration signal and for supplying the oscillator section. Both outputs deliver a frequency in the 1.002 to 1.62 MHz range.

1.3.3 f_2 oscillator - D5764 -

This module contains the frequency generating circuits for all of the fixed converter frequencies and for the calibration and oscillator signals.

A 900 kHz symmetrical square-wave signal is first derived from the 1.8 MHz crystal oscillator signal by a 2/1 division in pos. 171. This is fed out via output A 16, 17 on the connector strip to provide the carrier signal for the second conversion stage which transposes the first IF of 1 MHz to the 100 kHz range.

The third converter frequency of 90 kHz is generated by a 10/1 division (pos. 173) of the 900 kHz signal. This is used to bring the second 100 kHz IF frequency down to the 10 kHz level.

The 900 kHz signal is also divided down to 100 kHz by a 9:1 divider consisting of pos. 174, 175. This is used to derive the time base for the counter and for extracting the single-sideband converter frequency in the output amplifier.

A phase-locked loop consisting of the two C-MOS modules pos. 176 and 177 are used to derive a frequency of 1 MHz from the 100 kHz signal. Pos. 176 contains a voltage-controlled oscillator and a phase comparator. Pos. 177 contains a 10/1 divider. The frequency and the phase of the voltage-controlled oscillator are regulated in such a way that the signal derived by a 10/1 division of the output frequency matches the frequency and phase of the 100 kHz reference signal. As a result, a crystal-accurate 1 MHz signal is then available at the voltage-controlled oscillator output.

A tuned circuit consisting of coil pos. 73 and capacitor pos. 104 extracts the fundamental frequency from this 1 MHz square-wave signal and maintains a constant amplitude as a function of temperature and other influence effects by regulating the controllable current source pos. 162. A temperature-compensated reference diode (pos. 150) serves as the reference for the control circuit. The filtered and levelled 1 MHz signal must be highly stable since it is used to derive the calibration signal for the level meter by mixing it with the 1 to 1.62 MHz output of oscillator f_1. After mixing in the precision active mixer pos. 180, the lower sideband (200 Hz to 620 kHz) is extracted by the subsequent filter and fed out at a low impedance via pin B 20, 21 on the connector strip to the oscillator section and to the test panel for calibration purposes.

1.3.4 Test panel - D5761 -

In the test panel, the input signal is fed via the input transformer to the initial attenuator (pos. 20,21) which attenuates it by either

The third converter frequency of 90 kHz is generated by a 10/1 division (pos. 173) of the 900 kHz signal. This is used to bring the second 100 kHz IF frequency down to the 10 kHz level.

The 900 kHz signal is also divided down to 100 kHz by a 9:1 divider consisting of pos. 174, 175. This is used to derive the time base for the counter and for extracting the single-sideband converter frequency in the output amplifier.

A phase-locked loop consisting of the two C-MOS modules pos. 176 and 177 are used to derive a frequency of 1 MHz from the 100 kHz signal. Pos. 176 contains a voltage-controlled oscillator and a phase comparator. Pos. 177 contains a 10/1 divider. The frequency and the phase of the voltage-controlled oscillator are regulated in such a way that the signal derived by a 10/1 division of the output frequency matches the frequency and phase of the 100 kHz reference signal. As a result, a crystal-accurate 1 MHz signal is then available at the voltage-controlled oscillator output.

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1.3.4 Test panel - D5761 -

In the test panel, the input signal is fed via the input transformer to the initial attenuator (pos. 20,21) which attenuates it by either

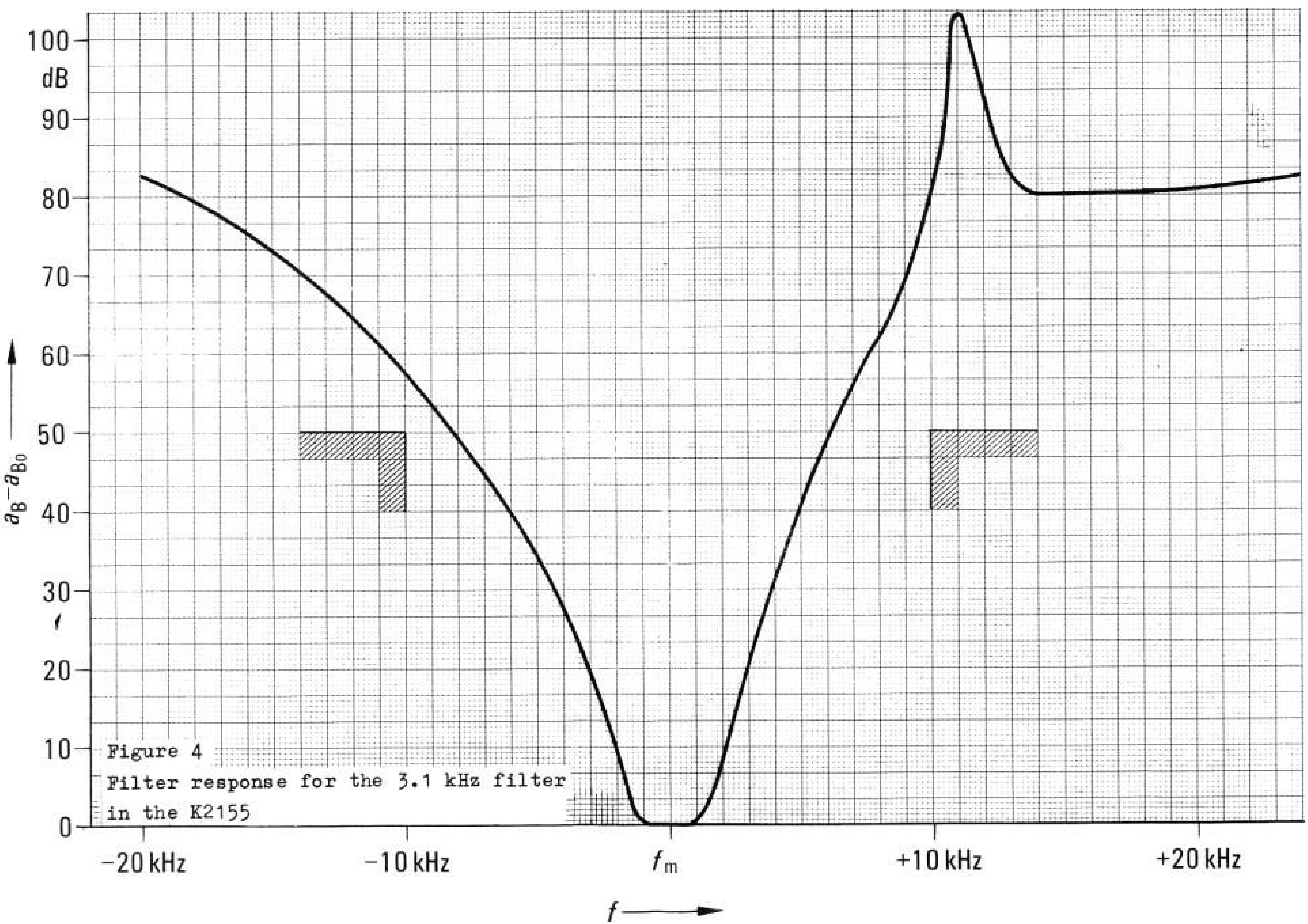


Figure 4
Filter response for the 3.1 kHz filter
in the K2155

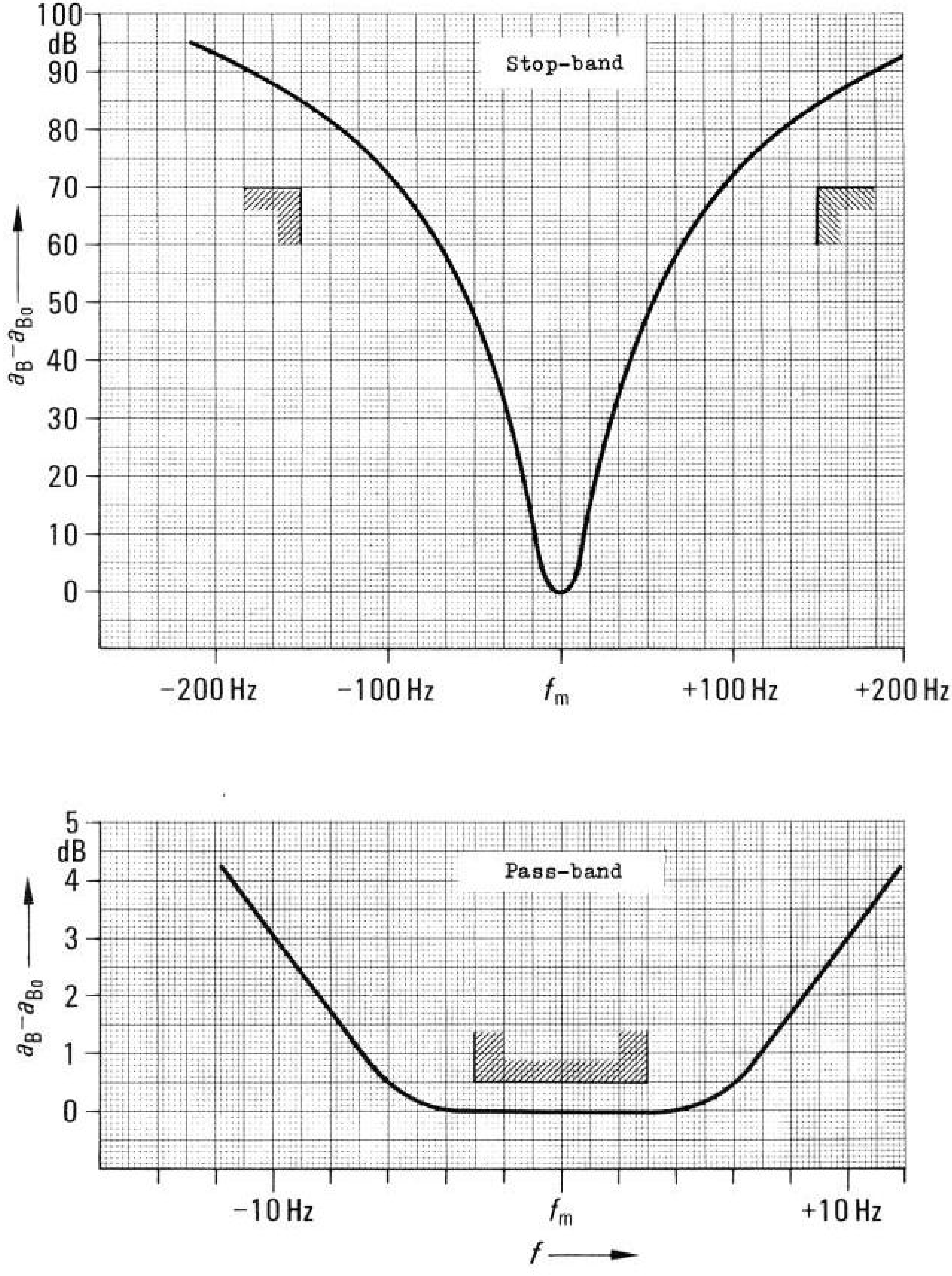


Figure 5

Filter curves for the 20 Hz filter in the K2155 with the 900 kHz carrier signal from the f_2 oscillator D5764. This signal is then passed to the bandpass filter D5768 via pin A1,2.

1.3.6 100 kHz bandpass filter - D5768 -

A five-section LC bandpass filter separates the 100 kHz mixer product from the remaining mixer products in the first modulator D5762. In addition, this filter determines the larger of the two measuring bandwidths of the receiver. It has a 3.1 kHz wide 3 dB bandwidth which is designed to match the channel width of normal carrier frequency speech channels. Transistor pos. 90 provides a low output impedance. The output B 20, 21 is connected to the input of the second modulator D5770. Figure 4 shows the pass-band and stop-band ranges of this filter.

1.3.7 Second modulator - D5770 -

The translation to the third intermediate frequency of 10 kHz is carried out in modulator pos. 90 using the 90 kHz carrier signal from the f_2 oscillator D5764. The 10 kHz is separated out from the other mixing products by a low-pass filter. The signal is switched to one of two paths with FET switch pos. 91 depending on the measuring bandwidth selected. With the 3.1 kHz measuring bandwidth, the signal is provided directly to the following output amplifier D5771 from the low-pass filter via an emitter-follower at pin A1, 2.

If the 20 Hz measuring bandwidth is selected, the signal is fed through two mechanical filters with a steep cutoff slope which are decoupled with a buffer stage. Figure 5 shows the pass-band and stop-band characteristics of these 20 Hz filters.

1.3.8 Output amplifier - D5771 -

In the selective measurement mode, the 10 kHz IF signal from the second modulator D5770 is first amplified by about 16 dB and then attenuated by 0/10/20/30 dB in the controllable inductive attenuator pos. 140. The level is increased by about 24 dB in the following amplifier. An active low-pass filter then limits the noise bandwidth to about 15 kHz. The changeover between broadband and selective measurement is carried out after this low-pass filter with FET switch pos. 233. With broadband measurements, the signal bypasses the converter section and is supplied directly to pin A1, 2 from the test panel D5761.

After the broadband/selective changeover switch, the signal path is identical for both types of measurement. It passes through an attenuator with steps of 0/10/20/30 dB to an emitter-follower and from there to a further attenuator with steps of 0 and 20 dB.

When the output level display is selected, a signal from the oscillator section W3155 is injected after this attenuator in place of the measurement signal. This results in the position of the fine level control potentiometer P4 being displayed.

There then follows an amplifier stage (pos. 210,211) which increases the level by about 22 dB. Two anti-parallel diodes (pos. 195) are connected in the feedback circuit of the following amplifier. These diodes and the rectifier diodes form a diode quartet which are tightly toleranced in order to achieve a highly linear scale law.

The single sideband modulator (pos. 241) is coupled in via a buffer stage (pos. 217) at the output of the amplifier stage pos. 211. This modulates the 10 kHz IF signal with a carrier frequency of 9 or 11 kHz thus generating a low-frequency 1 kHz signal which can be selected from the upper or lower sideband. The active low-pass filter at the modulator output suppresses the carrier residual and other mixing products from the modulator. In addition, an output stage (pos. 218, 219) ensures that the single sideband output has a low impedance in order to make the amplitude independent of the load.

The 9 or 11 kHz carrier signal is derived from the 100 kHz output of the f_2 oscillator D5764. For this purpose, a 10 kHz signal is first produced by a 10/1 division (pos. 244) and used as the reference signal for the PLL circuit pos. 242. The frequency of the internal voltage-controlled oscillator is divided by a factor of 9 or 11 with the programmable divider pos. 243 and then fed to the phase comparator in pos. 242. The output signal of the phase comparator is used to tune the voltage-controlled oscillator frequency in such a way that the frequency and phase of the two 10 kHz signals are identical. The oscillator thus operates at 90 or 110 kHz. This frequency is again divided by 10/1 (pos. 244) and then serves as the carrier for the SSB conversion.

1.3.9 Oscillator section - W3155 -

The oscillator section receives a signal in the 200 Hz to 620 kHz frequency range from the f_2 oscillator D5764. It can be continuously attenuated by about 15 dB with the fine level control potentiometer P4 via the buffer stages pos. 120, 121 which are used to provide a high input impedance. Transistors pos. 122, 123 amplify the signal by about 14 dB. At this point, a signal is tapped off and fed via pins 22, 23 to the output amplifier for the output level display. In the "dBm" mode, the attenuator consisting of resistors pos. 28, 29, 30 corrects the output level as a function of the selected oscillator section internal impedance. After decoupling stage pos. 124, 125, the 5 x 10 dB attenuator follows which is set by switch S3 to provide coarse output level control. This is connected to the push-pull class B power output stage which has a gain of about 10 dB. Transformer pos. 20 provides a balanced, floating output.

1.3.10 Digital frequency meter - F5050 -

The 100 ms gate interval is first generated from a 100 kHz square-wave signal from the f_2 oscillator D5764 by division in the CMOS counters pos. 136, 137, 138. In addition, the pulse signals for storing the counter reading in the display memory after expiry of the gate interval and for resetting the counter are taken from counter pos. 138.

These signals drive the counter module pos. 130. It contains the counter, a display memory and the multiplexer circuits for sequentially driving the LED displays (pos. 20...24). In addition, the blanking input at pin 9 of the counter module is used to flash the frequency disply if the reading falls below the value 000.00. This is the case when the frequency of the f_1 oscillator falls below 10 MHz. The Schmitt trigger pos. 135 then operates as an astable multivibrator and periodically blanks out the display.

The f_x signal to be counted in the frequency range 10...16.2 MHz is first amplified by the differential amplifier stage pos. 111,112 and then brought up to TTL levels with stage pos. 110. This is connected to gate pos. 134 which only allows the incoming timing pulses to pass through to the following TTL counter pos. 133 during the 100 ms gate interval when pin 9 is at logic "L". This counter divides the input frequency by a factor of 10 since the counter module pos. 130 can only handle frequencies of up to about 3 MHz.

The internal supply voltage for the complete counter module is 5 V. This is derived from the unregulated supply voltage of the K2155 (about 11...30 V) with a switching regulator (pos. 140). Due to the high efficiency of this regulating principle (ca. 80%), the operating time is considerably increased when using the instrument with the internal battery.

1.3.11 Power supply - D5772 -

With line operation, the supply voltage passes through the two RFI suppression chokes pos. 20, 21 to transformer pos. 38. Depending on the input voltage, relay pos. 40 either switches the two primary windings in series (U 198...286 V) or in parallel (U 99...143 V).

Zener diode pos. 57 is used to differentiate between the two ranges. This diode conducts once the input voltage exceeds about 170 V and switches transistor pos. 70 on. This in turn short-circuits the drive voltage at transistor pos. 71 thus causing the relay to open. The AC voltage at the transformer secondary is converted to DC with the bridge rectifier pos. 60 and smoothed with capacitor C40.

Transistors 70, 71 in the input regulator effectively suppress the residual "hum" voltage superimposed on the DC voltage across the smoothing capacitor.

The DC voltage is then fed from pin 11 on the connector strip through the function switches $T_8 ... T_{12}$ to the voltage regulator input at pin 12. Operational amplifier pos. 80 drives the power transistor pos. 72 in such a way that a stable 10 V supply is available at pins 5...8. The 6.2 V zener diode pos. 64 serves as the reference for the voltage regulator.

Switches $T_8 \ldots T_{12}$ also connect pin 14 on the connector strip to the smoothing capacitor when operating from the line. Transistors pos. 73...75 form a constant current source which trickle-charges the internal batteries with about 50 mA during line operation in order to prevent self-discharge. This current increases to about 250 mA when switch 12 is pressed ("Charge" mode).

With battery operation, the internal batteries are connected directly to the input of the voltage regulator (pin 12) with switch 10.

1.3.12 Master circuit board - D5773 -

This double-sided printed circuit board is used to interconnect the modules on the one hand and to connect them to the front panel controls on the other. With the exception of a few screened cables, printed conductors are used to make all the connections.

A number of pins identified with numbers (test points) are set into the board for making measurements during maintenance, fault-finding and repair work.

The master circuit board also includes the automatic battery cutout, the control circuit for the LEDs in the fine frequency adjuster, an attenuator for the calibration signal and a transistor switching stage which switches the counter on when the instrument is turned to the "Calibrate" position.

1.3.13 Designations, dimensions and weights

Item	Catalog No.	Dimensions w × h × d in mm	Approx. weight in kg
Carrier-frequency level test set K 2155			
with level meter and tracking oscillator			
200 Hz to 620 kHz, − 110 to + 20 dB/dBm	S44034-K2155-A302	455 × 150 × 457	12
Accessories			
1 power cable	C44195-Z9-C1	2500	0.2
Level meter D 2155			
200 Hz to 620 kHz, − 110 to + 20 dB/dBm	S44034-D2155-A302	455 × 150 × 457	11
Accessories			
1 power cable	C44195-Z9-C1	2500	0.2
Tracking oscillator W 3155 (plug-in)			
200 Hz to 620 kHz, − 60 to 0 dB/dBm	S44034-W3155-A302	–	1
Optional accessories			
Measuring attachment for Z, a_s, a, B 2005	see data sheet B 1002	127 × 163 × 114	1.2
2 Ni-Cd rechargeable batteries 6 V/6 Ah	C44153-Z2-C4	–	0.9
2 shielded connecting cables with 2 three-contact plugs	V42255-R15-A22	1600	0.2
2 shielded connecting cables with 1 three-contact and 3 banana plugs	V42255-R6-J22	1600	0.2

2. OPERATING INSTRUCTIONS

2.1 Putting the level meter into service

2.1.1 Line operation

The instrument is ready for operation once the line cable delivered with the instrument has been plugged into jack Bu 10 on the rear panel and switch 9 has been pressed ("Line").

The changeover between the two line voltage ranges of 99 to 143 V and 198 to 286 V is carried out completely automatically according to the input voltage.

If an internal battery is fitted, it is trickle-charged with 50 mA while the instrument is operated in the "Line" mode in order to prevent self-discharge.

It is not necessary to ground the instrument since the line input is fully double-isolated as per VDE specification 0411.

2.1.2 Battery operation

The instrument can be operated independently of the line supply if the battery option is fitted and switch 10 is pressed. The operating time is then at least 35 hours (assuming fully charged batteries). See 3.1 for battery insertion.

When switch 11 is pressed the on-load battery voltage can be checked using the bar on the meter. If the reading falls below the lower end of the bar the battery must be recharged.

2.1.3 Charging battery

In order to charge the battery, switch 12 must be pressed with the instrument connected to the line. The charging current is about 250 mA; i.e. a charging time of about 34 hours is required for a completely discharged battery to reach its full capacity.

2.1.4 Selection of the "Broadband" or "Selective" modes

Both broadband and selective measurements can be made with the test set K2155 in the frequency range 200 Hz to 620 kHz. One of the three switches 5, 6 or 7 must be pressed.

A filter bandwidth of 20 Hz or 3.1 kHz can be selected with switches 6 or 7 when making selective measurements.

The broadband filter is used to locate signals with an unknown frequency and for measurements in the carrier frequency speech channel. It is usable in the 10 kHz to 620 kHz frequency range.

The 20 Hz narrow-band filter has a very steep cutoff and is therefore suitable for all measurements in which closely spaced signals must be individually measured. This is the case, for example, when making measurements on system pilots or with measurements on AC telegraphy systems.

2.1.5 Frequency adjustment

In the selective mode, coarse and fine adjustment of the measurement frequency can be made with the two potentiometers P2 and P3. The selected frequency can be read off with a resolution of 10 Hz on the 5-digit digital frequency meter above the potentiometers.

The two LEDs SL1 and SL2 are intended to prevent a situation where the fine frequency control can no longer be turned in the desired direction because it is at or almost at its limit after the coarse frequency adjustment has been made. The diodes start to illuminate when the potentiometer is turned outside the center third of its range and become brighter as the limit is approached.

2.1.6 Calibration

The instrument is immediately ready for operation after switch-on. Before calibrating, the mechanical meter zero ($-\infty$) must be checked with the instrument switched off and, if necessary, reset using the screw under the meter.

Switch S2 must be turned to the calibration position (▼) at the left-hand limit in order to calibrate the test set.

Care must be taken with the K2155 to ensure that switch 15 (output level display) in the oscillator section is cancelled since this has priority over the calibration.

Calibration is carried out at the frequency indicated on the digital frequency meter using the internal tracking oscillator: this frequency must be in the range 200 Hz to 620 kHz. The highest accuracy is however obtained by calibrating at the 10 kHz reference frequency.

The meter needle must be set with P1 to the red calibration mark (▼) on the topmost scale.

The test set is only fitted with one calibration potentiometer "P1" for all three operating modes due to the small differences between the selective modes Δf=3.1 kHz, Δf=20 Hz and the broadband mode.
However, due to the small drift after switch-on and with temperature, it will generally be unnecessary to reset the calibration potentiometer.

2.1.7 Input impedance selection

The input impedance of the test set can be switched to 75 ohm, 150 ohm and 600 ohm. The Z value can be selected with switches 2 to 4.

A high input impedance can be selected independently with T1.

If necessary, the level meter can be converted to other Z values by exchanging a few resistors (e.g. to 130, 135 or 140 ohm instead of 150 ohm).

2.1.8 Selecting the sensitivity

The level meter sensitivity can be set with switch S2. The full range of +20 to -110 dB (dBm) is available with selective measurements. For broadband measurements, the sensitivity range is restricted to +20 to -60 dB (dBm).

Care must be taken with harmonic distortion measurements not to increase the sensitivity by more than 50 dB relative to the fundamental since this would overload the input and thus degrade the intrinsic harmonic distortion of the receiver.

2.1.9 dB/dBm changeover

The receiver calibration can be switched from dB to dBm for measuring power levels. The level reading at the meter is appropriately corrected as a function of the termination impedance selected.

In order to allow high impedance measurements to be made in parallel with a terminated system, switches $T_2 \ldots T_4$ remain depressed even when T_1 is down. The associated level correction for the dBm measurement is derived from the selected Z value.

2.1.10 Single sideband output

With selective measurements, a signal down-converted to the low frequency range is available at jack 2. This has a frequency of 1 kHz when the input signal lies in the center of the filter passband and a level of about 0 dB for a 0 dB meter reading. Either the upper or the lower sideband of the signal can be selected using T_{13} or T_{14}.

2.2 Putting the W3155 oscillator section into service

2.2.1 Switching on oscillator section

The power supply for the oscillator section can be switched on or off with switch 16. This facility is of particular interest with battery operation when the test set is only being used as a receiver since it can be used to increase the operating time.

2.2.2 Frequency adjustment

The two 10-turn potentiometers P2 and P3 are used for coarse and fine frequency adjustment.

Both the receiver and the oscillator have the same frequency setting. As a result, loop measurements can easily be carried out. It is not necessary to make any kind of adjustment to ensure that the signal remains in the center of the filter passband even with the narrowband 20 Hz filter.

The output frequency can be read off with a resolution of 10 Hz on the digital frequency meter.

Further information regarding frequency adjustment is contained in section 2.1.5 of the level meter description.

2.2.3 Output level adjustment

Fine and coarse setting of the output level is carried out with potentiometer P4 and switch S3 respectively.

Switch 15 is pressed for fine level adjustment. When in the depressed position, this switch causes the fine level setting of potentiometer P4 to be displayed on the D2155 meter. The fine control has a range of about 12 dB.

Coarse output level adjustment is carried out in steps of 10 dB with switch S3. The coarse level control range extends from 0 to -50 dB (dBm).

2.2.4 Selecting the internal impedance

Switches 17...20 can be used to select the internal impedance of the oscillator. Impedances of about 0 ohm, 75 ohm, 150 ohm and 600 ohm can be selected. Conversion to other values (e.g. 135 ohm or 140 ohm instead of 150 ohm) is also possible simply by changing a few resistors.

2.2.5 dB/dBm changeover

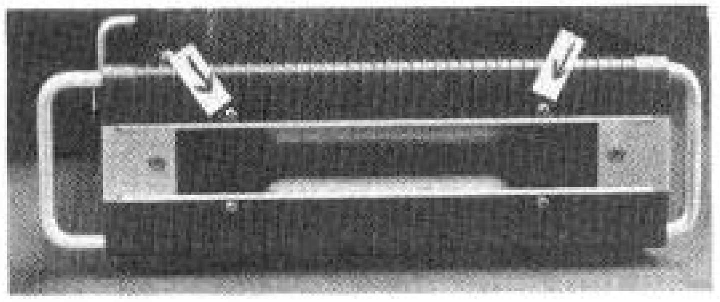
The dB/dBm changeover in the oscillator section is carried out synchronously with that of the level meter by S1. This changeover results in the output level being corrected as a function of the selected internal impedance to give a constant power at the load (with Ra = Ri) when switch S1 is in the "dBm" position.

This power level correction is disconnected when an internal impedance of ≈ 0 ohm is selected. In this case the output voltage level is independent of the setting of switch S1.

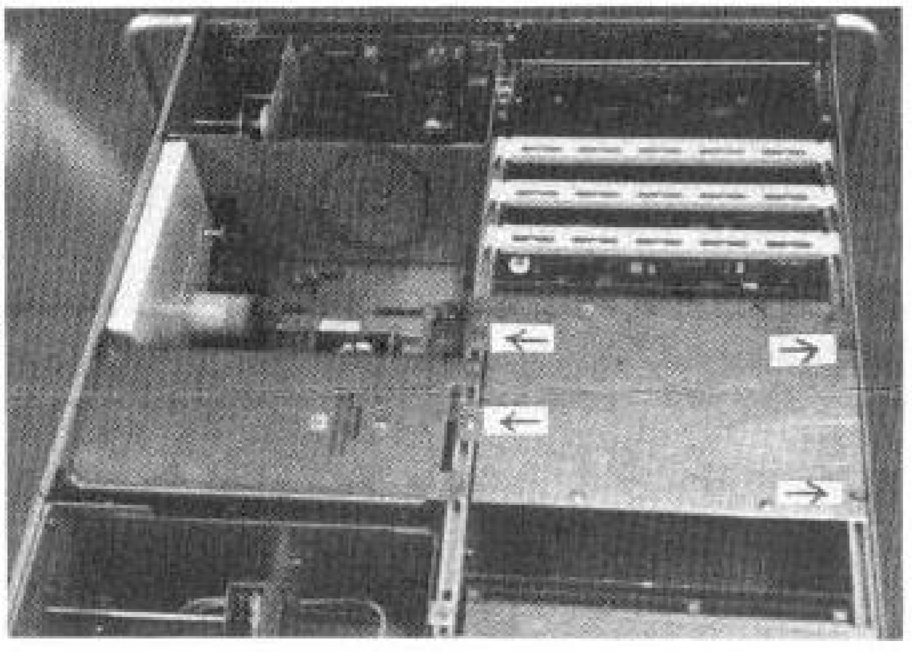
3. MAINTENANCE

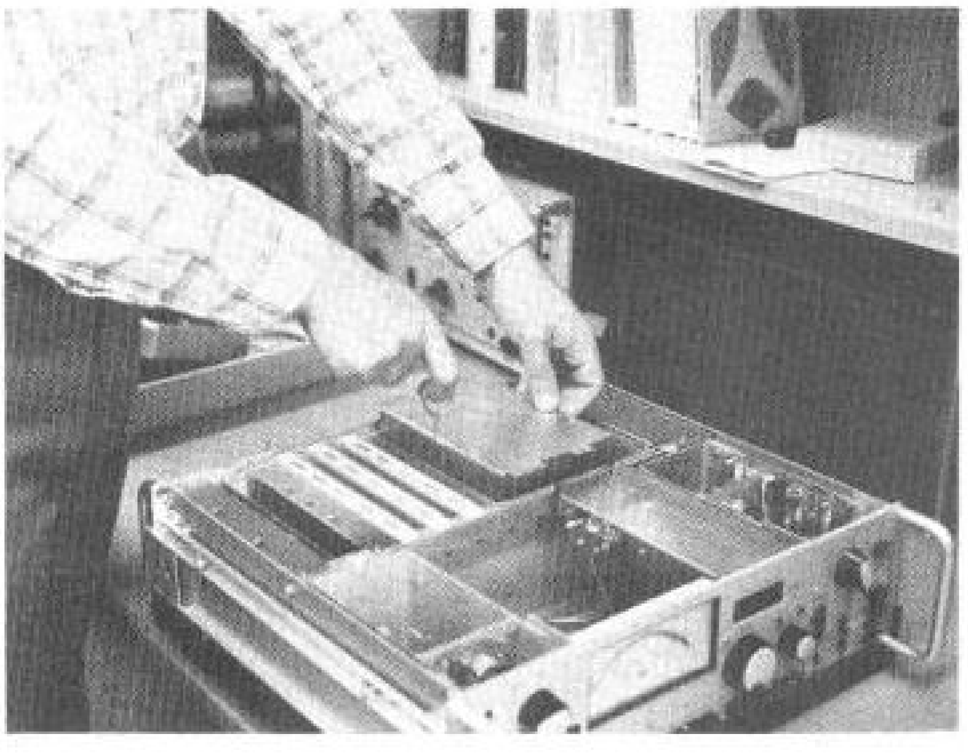
3.1 Inserting or replacing the batteries

If the optional battery operation is desired, 2 Varta type 5 M6 rechargeable Nickel-Cadmium batteries with terminals for push-on connectors must be fitted.

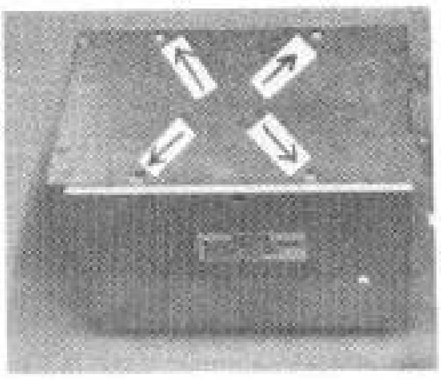


The two Phillips screws on each side of the instrument which fix the upper half of the cover must first be loosened (do not remove completely).

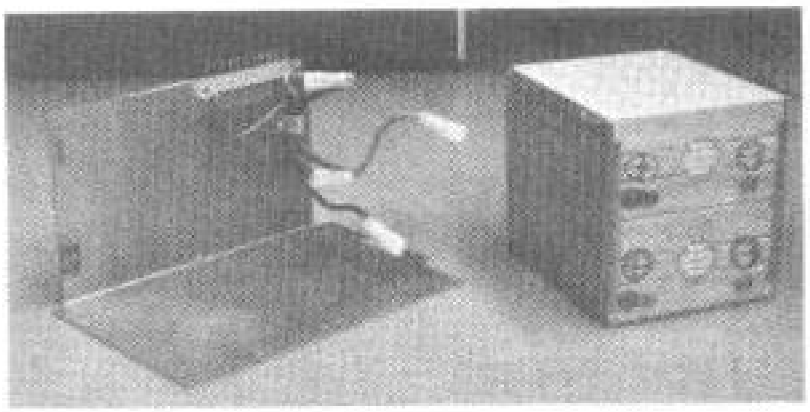




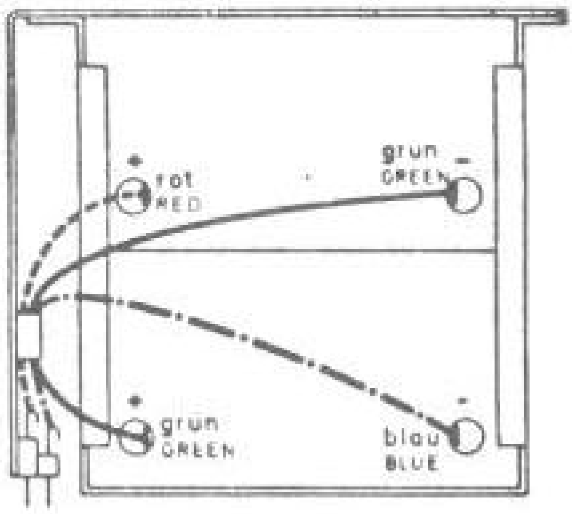
The four battery holder fixing screws are then removed and the whole unit is carefully drawn up and out using the plate extractor (marked with E in the figure) which is kept in the zipped bag in the instrument.



The lower part of the battery holder which accepts the two batteries can be removed after the four screws have been loosened.



The batteries are put in as shown in the photograph. The angle plate with the connector strip is then put on and fixed with the four screws. In order to avoid short-circuits, the wires with the push-on connectors should always be attached on an insulating surface.



The color-coded wires are connected up as shown in the sketch opposite.

The battery holder can now be lifted back into the module receptacle. Care should be taken not to damage the guides in the receptacle by twisting the holder.

After the battery holder has been slid back into the receptacle, it is fixed back in the instrument with the four screws and the upper cover half is replaced.

A longer charging time is required by brand-new batteries since this type of battery is usually stored discharged and hence a considerably longer charging time is required for the initial charge.

SIEMENS

P O MEASURING SET NO 55A

This instrument is a standard K2155-A302 with minor modifications which include among others:-

The provision of Post Office No. 1 plugs for input and output

The modification of the 150Ω impedances to 140Ω

The provision of a recorder output for a 400Ω or 1900Ω 500μA chart recorder and the modification of the fine level control of the tracking oscillator to give 22 dB continuous level variation.

As a result the following units and numbers have been modified or added:-

Description	Original No.	Modified No.	Change/New
Level Measuring Set	K2155-A302	K2155-A392	Changed
Tracking Oscillator	W3155-A302	W3155-A392	Changed
Amplifier	W5432-A301	W5432-A391	Changed
Measuring Field	D5761-A301	D5761-A391	Changed
Pre Amplifier	D5761-S1	D5761-S9	Changed
Final Amplifier	D5771-A101	D5771-A191	Changed
Mother Board	D5773-A701	D5773-A791	Changed
Recorder Amplifier		D5805-A701	New

The manual includes:-

Recorder Circuit operating instructions

Recorder Circuit diagram (where applicable) and

Details of differences from standard circuits (where applicable).

WARNING

If this set is to be powered from the mains, a mains cord with a fused plug must be used. The correct rating of the fuse is 3 AMP and a suitable cord is supplied with the instrument.

Note:
Where the state of charge of the batteries is unknown, they should be subjected to a full charge (press button T12) for a period of about 70 hours. Full capacity will be achieved after 3 full charge-discharge cycles.