S1075

SPECTRUM ANALYZER

OPERATION & APPLICATION MANUAL

REV A

P/N 001-115-00

TRILITHIC
9202 E. 33rd STREET
INDIANAPOLIS, IN 46236

317/895-3600

REV 9/87

CAUTION

UNITS SHIPPED FROM THE FACTORY ARE INTENDED FOR 115 VAC OPERATION, UNLESS SPECIFICALLY MARKED FOR 230 VOLT OPERATION.

DAMAGE DUE TO CONNECTING A 115 VOLT UNIT TO 230 VOLT POWER SOURCE CONSTITUTES "MISUSE" AND IS NOT COVERED BY THE TRILITHIC WARRANTY.

IMPORTANT NOTICE

HANDLE WITH CARE

THIS ELECTRONIC INSTRUMENT WAS DESIGNED FOR NORMAL OPERATING AND STORAGE CONDITIONS ENCOUNTERED IN FIELD USE. HANDLE AND TRANSPORT IT WITH CARE TO AVOID DAMAGE TO DELICATE COMPONENTS AND CIRCUITS.

INSTRUCT PERSONNEL WHO ARE UNFAMILIAR WITH ELECTRONIC INSTRUMENTS TO AVOID DROPPING, THROWING, BOUNCING, STRIKING, OR OTHERWISE MISHANDLING THE UNIT. WHEN TRANSPORTING THE UNIT IN A VEHICLE, TAKE CARE TO CUSHION IT AGAINST SEVERE SHOCKS.

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INTRODUCTION

The S1075 Spectrum Analyzer is a general purpose, high reliability instrument designed for making rapid signal strength measurements in the 4 to 1000 MHz frequency range. The unit is completely portable, weighing less than 30 pounds, and can operate off its own internal rechargeable batteries or from an external 12 to 15 volt source, including vehicle 12v battery with a negative ground. A protective bag with a carrying handle for simple field operation in adverse environments is also available.

The S1075 displays a 70 dB dynamic range for signal levels as low as +20 dBmV. Relative amplitude measurements can be made in seconds. A manual sweep mode is included for amplitude measurements where integration of modulation is necessary for more accurate readings of signal strength. Measurements within ± 2 dB can be made simply, swiftly and reliably. The internal battery is capable of three hours of continuous operation. With care 12 hours intermittent operation between recharges can be easily achieved.

Frequency can be easily identified within ±100kHz using the center frequency digital readout combined with the frequency markers. Amplitude measurements can be made over a 126 dB range utilizing the input attenuation and 70 dB on-screen amplitude calibration.

SPECIFICATIONS

Frequency Range:	
Band B	4 to 1000 MHz
Band C	4 to 1000 MHz, front panel adjustable down to 5 MHz
Band D	sweep width minimum
Calibrated Dispersion:	2, 20 and 200 kHz/div and 1, 10 and 100 MHz/div ±20% continuously variable, and CW.
Frequency Accuracy:	Dial accuracy is ±10% of dispersion setting or ±2 MHz whichever is greater.
Stability (Drift):	Typical drift of unit is 30 kHz/min. if not phaselocked. After 1 hour warmup and with unit phaselocked, drift is 10 kHz/min.
Residual FM:	Less than 20 kHz peak-to-peak, unlocked. Less than 500 Hz peak-to-peak phaselocked.

NOTE

Sensitivity, frequency response, and amplitude display measurements must be made at resolutions and rate time dispersion products that do not degrade the response time displayed on the CRT.

Therefore, when making such measurements, the operator should set the RATE, RESOLUTION, and DISPERSION controls such that the signal level displayed has been maximized.

Noise Sidebands:	More than 50 dB below CW signal level 15 kHz or more away from signal in a 1 kHz bandwidth.
Input Impedance:	75 ohms, return loss greater than 18 dB for input attenuator settings of 10 dB or more.

Frequency Markers:	1 and 10 MHz.
Marker Accuracy:	±0.05%
Resolution-IF Bandwidths:	200 kHz, 30 kHz & 1 kHz @ 3 dB points, 60 dB/3 dB ratio. (200 kHz = 10:1, 30 kHz = 3:1, 1 kHz = 5:1)

AMPLITUDE SPECIFICATIONS

Measurement Range:	-50 dBmV to +76 dBmV @ 200 kHz resolution.
Average Noise Level:	-52 dBmV @ 200 kHz bandwidth, with video filtering.
Frequency Response:	With the input attenuator set at 10 dB, the frequency response, including the input attenuator, is ±2.0 dB from 4 to 1000 MHz.
Amplitude Display:	Relative amplitude accuracy for 70 dB range ±2.0 dB (not including frequency response error).
Graticule Marking:	70 dB log scale calibrated in dBmV (-50 dBmV to +20 dBmV). 12 dB scale calibrated in dBmV (-30 dBmV to -42 dBmV). Linear scale 100%, 75%, 50%, 25%.
Residual Responses:	Less than -50 dBmV with no signal input. (10-1000 MHz).
Attenuation:	RF attenuation is 80 dB max in 1 dB steps.
Hum Measurements:	Calibrated at 2% per major division (60 Hz). Input level for HUM measurement must be between -10 to +10 dBmV.
Video Filter:	Post detection filter used to average the noise. Switch selected 1 kHz and 10 Hz bandwidth.
Cal Out:	54 MHz @ +10 dBmV. 54 MHz output level accuracy ±.5 dB 0 to 50 °C.

DISPLAY SECTION

Cathode Ray Tube:	4000 volt potential, P40 phosphor.
Graticule:	8 x 10 division (approx. 2" x 4" or 5 x 10 cm),5 sub-divisions per major division on horizontal vertical axis.
Bezel:	Accepts Tektronix camera mount.

GENERAL CHARACTERISTICS

Intermodulation Distortion:	1 signal @ +10 dBmV - 2nd order - 55 dBc. 2 signals @ +10 dBmV - 2nd order - 50 dBc and 3rd order - 60 dBc for seperations > 1.5 MHz and - 50 dBc < 1.5 MHz.
Sweep Rate:	Rate is continously variable from .03 to 30 Hz, manual and single sweep.
Temperature Range:	Operating +32°F to +122°F (0°C to +50°C). Storage -30°F to +140°F (-34°C to +60°C).
Power:	Internal battery, external +12 to +15 DC @ 2.0 amps. Approx. 3 hours of continuous operation on internal battery.
Dimensions:	9" x 13.5" x 15"
Weight:	Approx. 29 lbs, including bag and battery. (battery weight is 6 lbs) (2.3 kg) Shipping weight is approx. 40 lbs (18 kg).
Audio Recovery:	AM/NBFM audio recovery system.

Accessories Supplied:

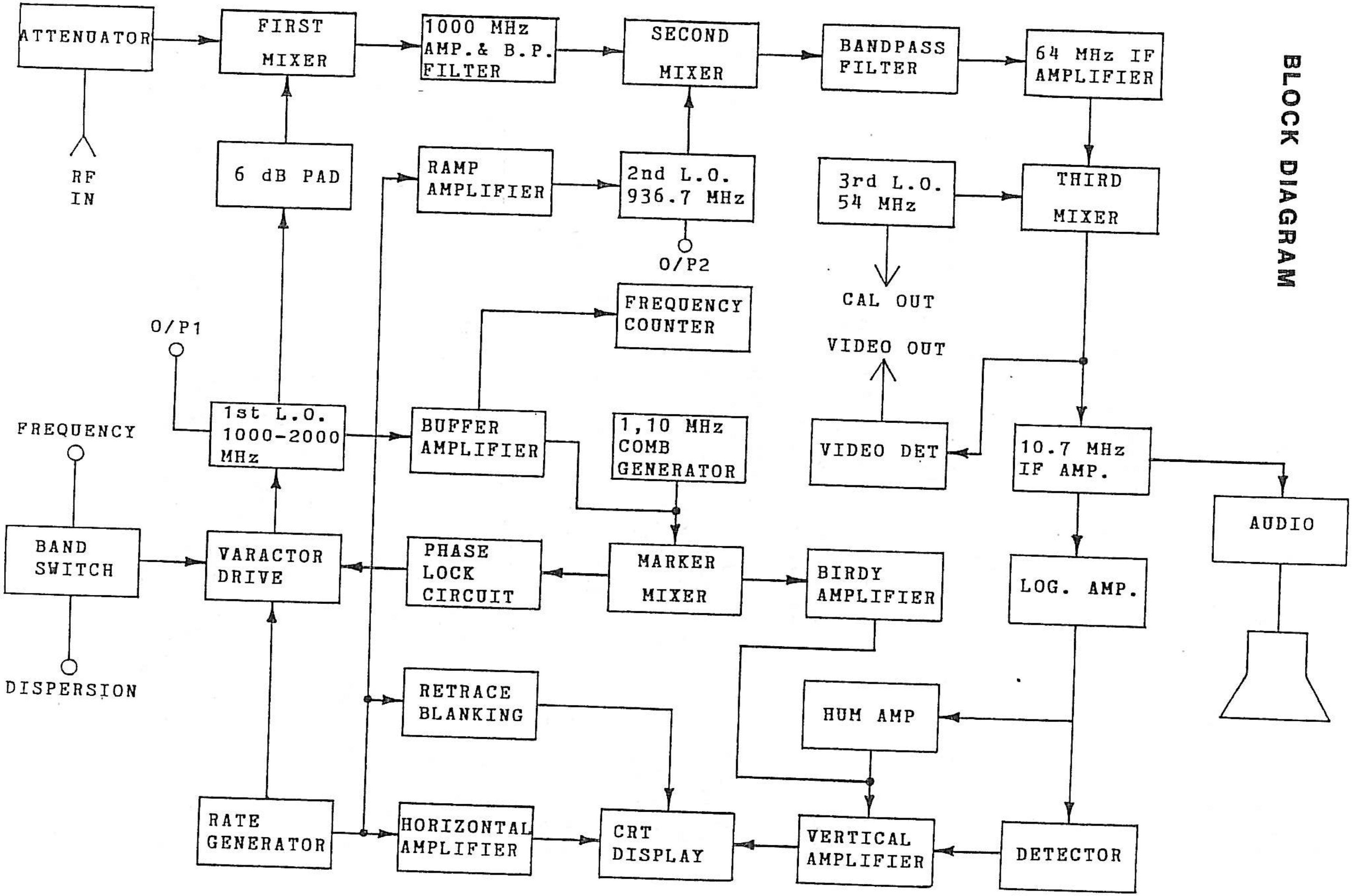
Operation and Application Manual

Options Available:

DS-9 Digital Storage	1024 horizontal x 256 vertical matrix with store and freeze modes.
Auto Power Cord	
Protective Carrying Bag	
Initial Battery Pack	

CIRCUIT DESCRIPTION

BLOCK DIAGRAM



CIRCUIT DESCRIPTION

The following paragraphs describe circuit functions depicted in the Block Diagram.

ATTENUATOR

The RF attenuator attenuates input signals in 1 dB and 10 dB steps.

CAUTION

The input to the attenuator must not exceed .5w average and the output of the attenuator must not exceed .2w average.

FIRST LOCAL OSCILLATOR

The voltage tuned oscillator can be set for either a swept or CW output in the 1000 to 2000 MHz range. A -10 dBm sample is provided at the TG-1 front panel SMA connector.

FIRST MIXER

The first mixer is of the double balanced type, using four matched Schottky-barrier diodes configured as a ring modulator. The input and output circuits are connected through special wideband transformers designed for this purpose. The output of the first mixer is 1000 MHz.

1000 MHz BANDPASS FILTER

The bandpass filter selects the 1000 MHz frequency component of the first mixer output.

SECOND LOCAL OSCILLATOR

The 2nd L.O. is a stable tuned line oscillator operating at a center frequency of 936.7 MHz. The output of the 2nd L.O. is coupled to the 2nd mixer. In narrow dispersion modes the 2nd L.O. is swept by an amplified ramp derived from the rate generator. This ramp signal varies the capacitance of the 2nd L.O. transistor. A -10 dBm sample is provided at the TG-2 front panel SMA connector.

SECOND MIXER

The output of the 2nd L.O. and the buffered output of the first mixer are heterodyned in the 2nd mixer to produce an output of 64.7 MHz. The output of the 2nd mixer is buffered then filtered to remove unwanted responses, and the 64.7 MHz output is coupled to the 64 to 10 MHz converter. The 64.7 MHz bandpass filter has a high insertion loss because of its selectivity and therefore follows the amplifier.

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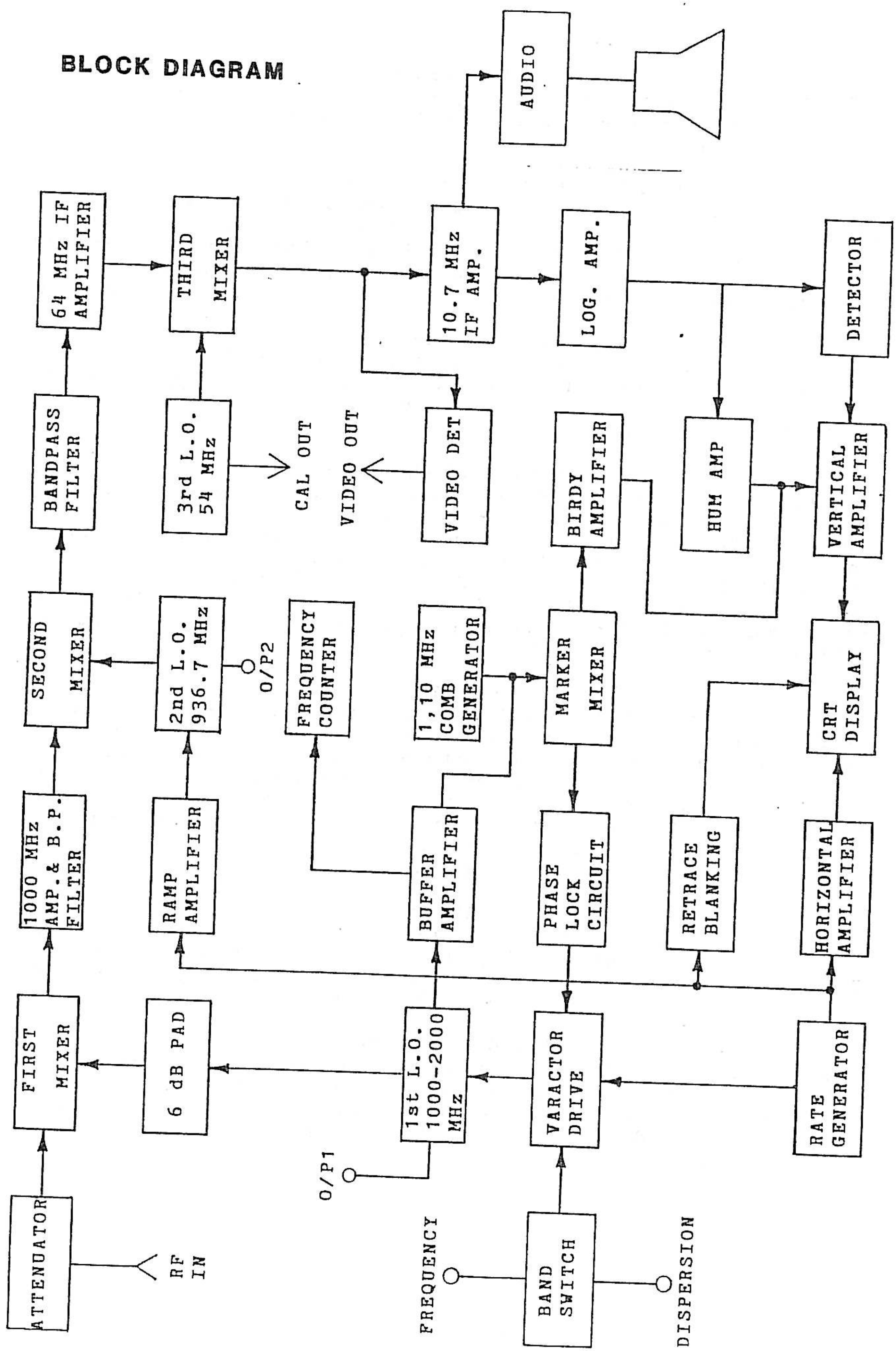

64.7 MHz AMPLIFIER

This IF stage is a single integrated circuit amplifier. The gain of the amplifier is adjusted over a 6 dB range from the front panel AMPL CAL control.

THIRD LOCAL OSCILLATOR AND CAL OUT

The 3rd L.O. is a crystal controlled oscillator operating at 54 MHz. The output of the 3rd L.O. is coupled to one input of the third mixer. The output of the 54 MHz oscillator is also coupled to the CAL OUT connector on the front panel. It provides a calibrated +10 dBmV signal level for amplitude calibration.

THIRD MIXER AND IF AMPLIFIER

The 3rd mixer is a balanced mixer combining the 64.7 MHz output of the second IF and the output of the 3rd L.O. The result is then amplified by a two stage tuned amplifier with a 200 kHz bandwidth.

LOGARITHMIC AMPLIFIER

The logarithmic amplifier is a monolithic integrated circuit consisting of two parallel 35 dB log amplifier stages that are summed in two differential outputs. The output is proportional to the sum of the logs of the input voltages to the two stages. The input signal from the 10.7 MHz IF amplifier is split between two limiting integrated circuit amplifier stages that drive the logarithmic amplifier. The output of the logarithmic amplifier drives the detector amplifiers.

DETECTOR

The detector input consists of two differential-input, differential-output integrated circuit amplifiers. Each IC drives a pair of hot-carrier diodes used as linear detectors. The detector outputs are added, and the combined output drives the vertical amplifier. The front panel LOG range switch selects either the 2 dB or 10 dB detector output range, each of which is obtained from a calibrated internal voltage divider. In addition, a linear detector mode is provided.

AUDIO

A sample of the 10.7 MHz IF signal is fed to a dual detector circuit consisting of a quadrature narrowband FM detector and an AM detector. Audio squelch is derived from the AM detectors AGC voltage. Type of detection and volume are front panel selectable.

VERTICAL AMPLIFIER

The vertical amplifier utilizes two operational amplifiers to drive a complementary pair of output transistors which drive the vertical deflection coil. A portion of the vertical output is sampled and fed back to the IC drive circuitry for gain stabilization.

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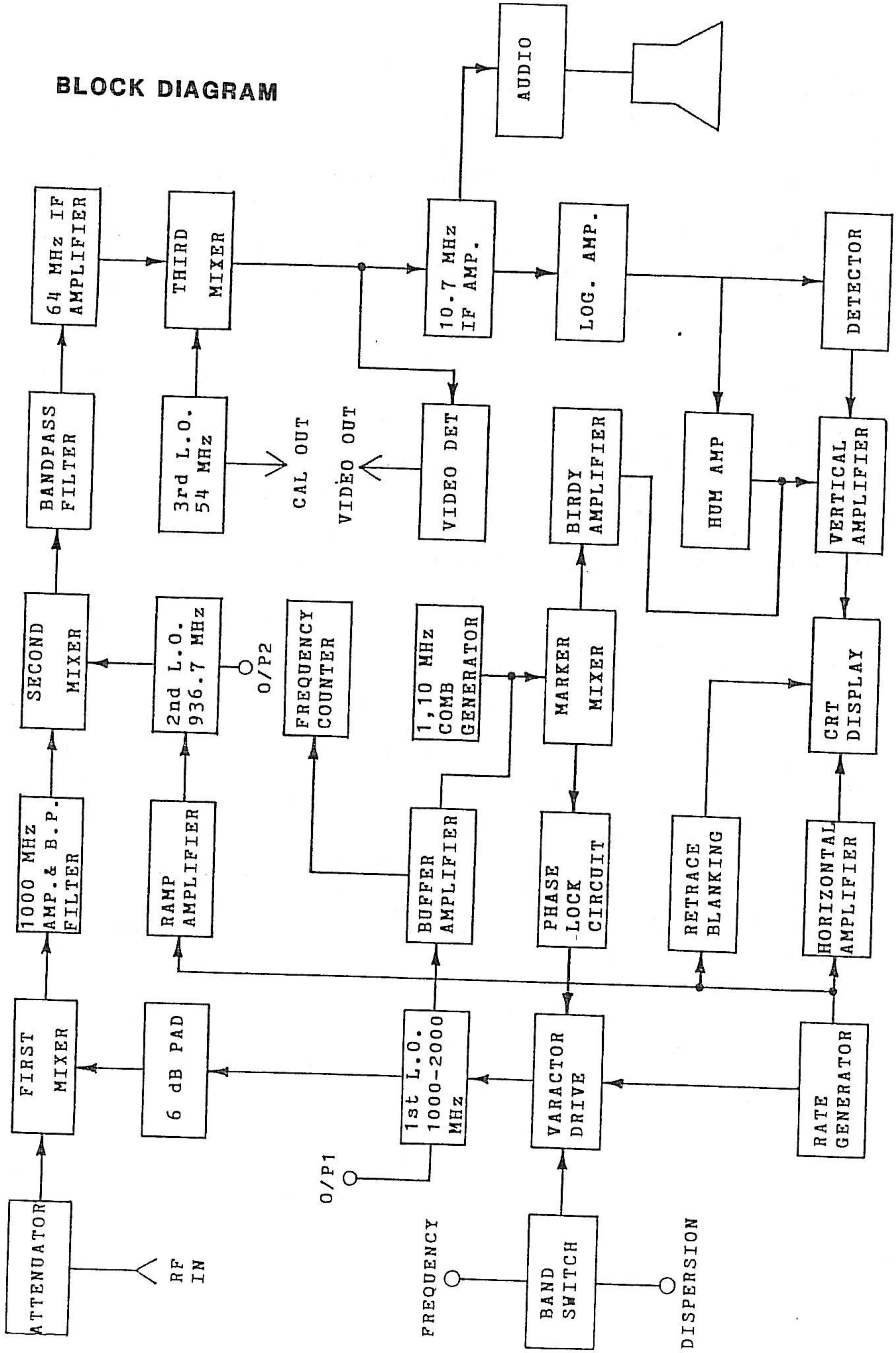

RATE GENERATOR

The rate generator utilizes a pair of integrated operational amplifiers to generate the timed waveforms driving the horizontal amplifier and varactor drive circuits. Three modes of sweep operation may be selected by operation of the front panel AUTO/MAN/SS (single sweep) switch. When the AUTO/MAN/SS switch is in AUTO, the horizontal sweep rate is continuously variable from .3 to 30 Hz, or .03 to 3 Hz by using the ÷10 switch. When the switch is in MAN position the horizontal position of the trace is varied by rotation of the RATE/MAN control. Single sweep may be used in conjunction with the AUTO mode by selecting SS and depressing the TRIG switch.

VARACTOR DRIVE

The varactor drive circuit controls the voltage to the varactor diodes in the 1st local oscillator. It consists of two integrated circuit amplifiers. The amplifiers input consists of two additive voltage components, a DC component determined by the setting of the front panel FREQUENCY control and a triangular wave component determined by the setting of the front panel DISPERSION switch. The triangular wave is derived from the rate circuit. In phaselock operation the output of the phaselock circuit is coupled to the 2nd amplifier stage.

The varactor drive output voltage determines varactor diode capacitance which in turn determines the frequency of the 1st L.O. The varactor drive is adjusted to provide a linear oscillator frequency characterstic on the CRT display.

HORIZONTAL AMPLIFIER

The horizontal amplifier consists of an operational amplifier driving a complementary pair of output transistors which drive the horizontal deflection coil. A sample of the horizontal deflection signal is fed back to the input of the operational amplifier for gain stabilization.

1, 10 MHz COMB GENERATOR

Two crystal controlled harmonic markers with frequencies of 1 and 10 MHz are included in the Spectrum 1075. The birdies derived when the markers are mixed with the 1st local oscillator sample provide a precision method for monitoring frequency. A marker accuracy of 0.05% ±2 MHz is obtained. The ±2 MHz portion of the error can be minimized by centering the fine tune control. Maximum precision is achieved when the birdy at 0 frequency is centered in the zero response bell with the FINE TUNE control in 1 kHz resolution. The 1 MHz marker clock is divided by five to provide a 200 kHz reference for the phaselock loop.

MARKER MIXER

The output of the comb generator and the 1st local oscillator sample are heterodyned in the marker mixer. When the frequency of the 1st L.O. is near a comb frequency multiple, a zero beat or birdy is produced.

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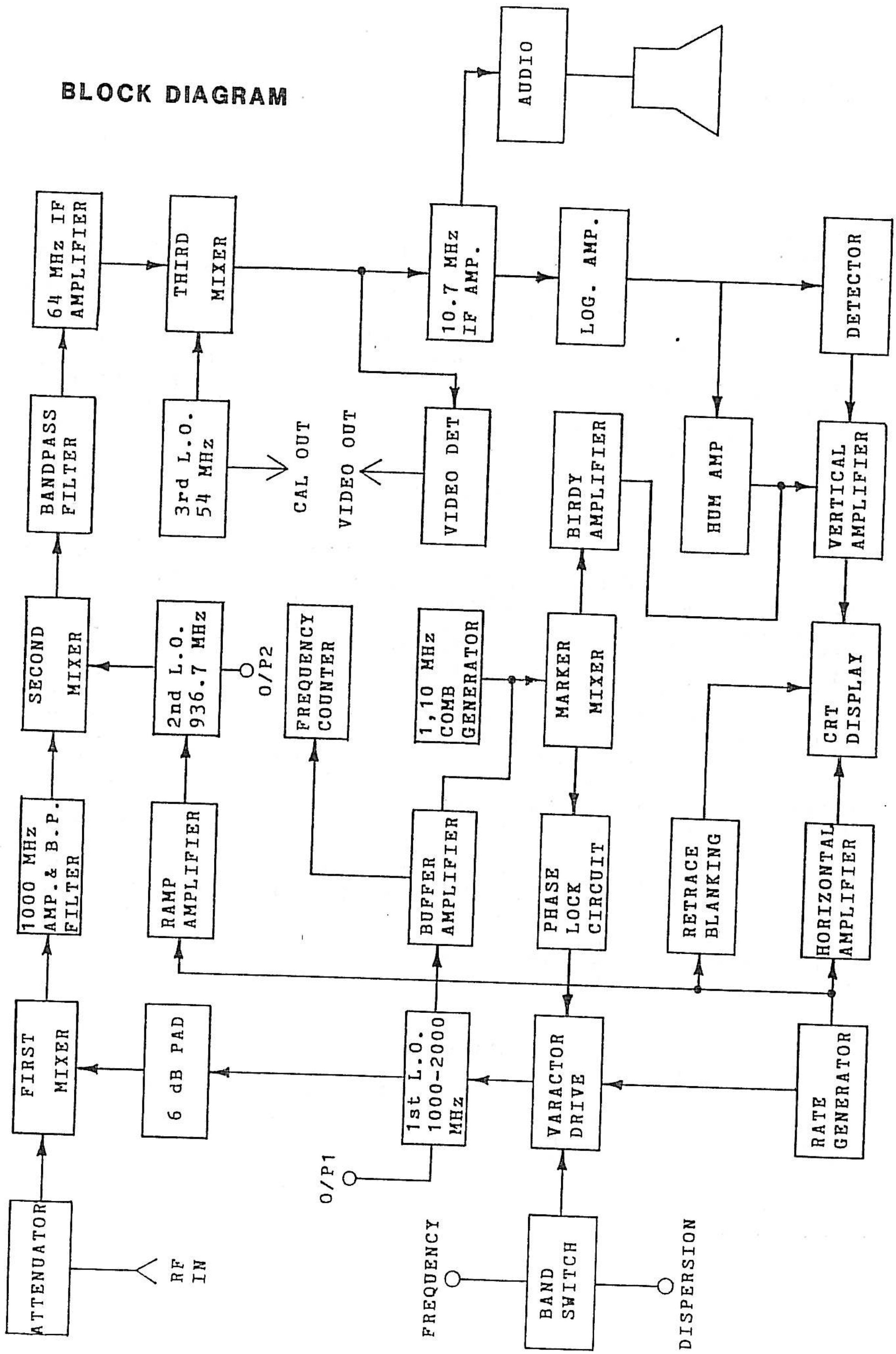

BIRDY AMPLIFIER

The birdy information developed in the marker mixer is amplified and shaped in the birdy amplifier. The output of the birdy amplifier is added to the log amp detector output in the vertical amplifier.

PHASELOCK CIRCUITRY

The phaselock technique compares the frequency and phase of the 1st L.O. to a 200 kHz reference oscillator. If the two signals differ in frequency and/or phase, an error voltage is generated and applied to the 1st L.O., causing it to correct in the direction required for decreasing the difference. The correction procedure continues until lock is achieved, after which the 1st L.O. will continue to track the refernce. Because of the high frequency of the 1st L.O. (1 to 2 GHz), the phase sample is developed by heterodyning the 1 MHz comb generator and the 1st L.O. The 200 kHz reference is obtained by dividing the 1 MHz comb reference by five.

The phaselock circuitry operates for dispersions of 200 kHz/div and less.

LOW VOLTAGE POWER SUPPLY & BATTERY SAVER CIRCUIT

The primary power for the analyzer is from the built-in AC supply or internal 12v battery. The low voltage power supply provides 4 regulated voltages, +11.3, +9.1 and two 5.7v supplies. The regulators drop the battery voltage to these required levels and maintain the regulated level against load fluctuation and input voltage variation. The regulator circuits utilize operational amplifiers to drive series pass regulator transistors. Unregulated +20 and -3.7 volt supplies are provided by a low current DC to DC converter. A built-in switching regulator supply is available to allow recharging of the internal battery and/or operation of the analyzer from AC power. The front panel source switch is provided to select the internal battery or AC power source. The battery saver circuit automatically disconnects the battery when it's voltage drops below 10v. This prevents complete discharge of the battery insuring longer battery life. An audible battery warning is also given at five minute intervals as a reminder that the analyzer is being powered from the internal battery.

HIGH VOLTAGE POWER SUPPLY

The high voltage power supply provides a regulated 4000v DC to the CRT anode and control voltages to the various CRT elements. Operational amplifier circuitry and one transistor provide drive for the flyback transformer. A sample of the high voltage is fed back to a series regulator circuit which controls the duty cycle of the flyback drive transistor. The variation of the driver transistor duty cycle regulates the high voltage supply.

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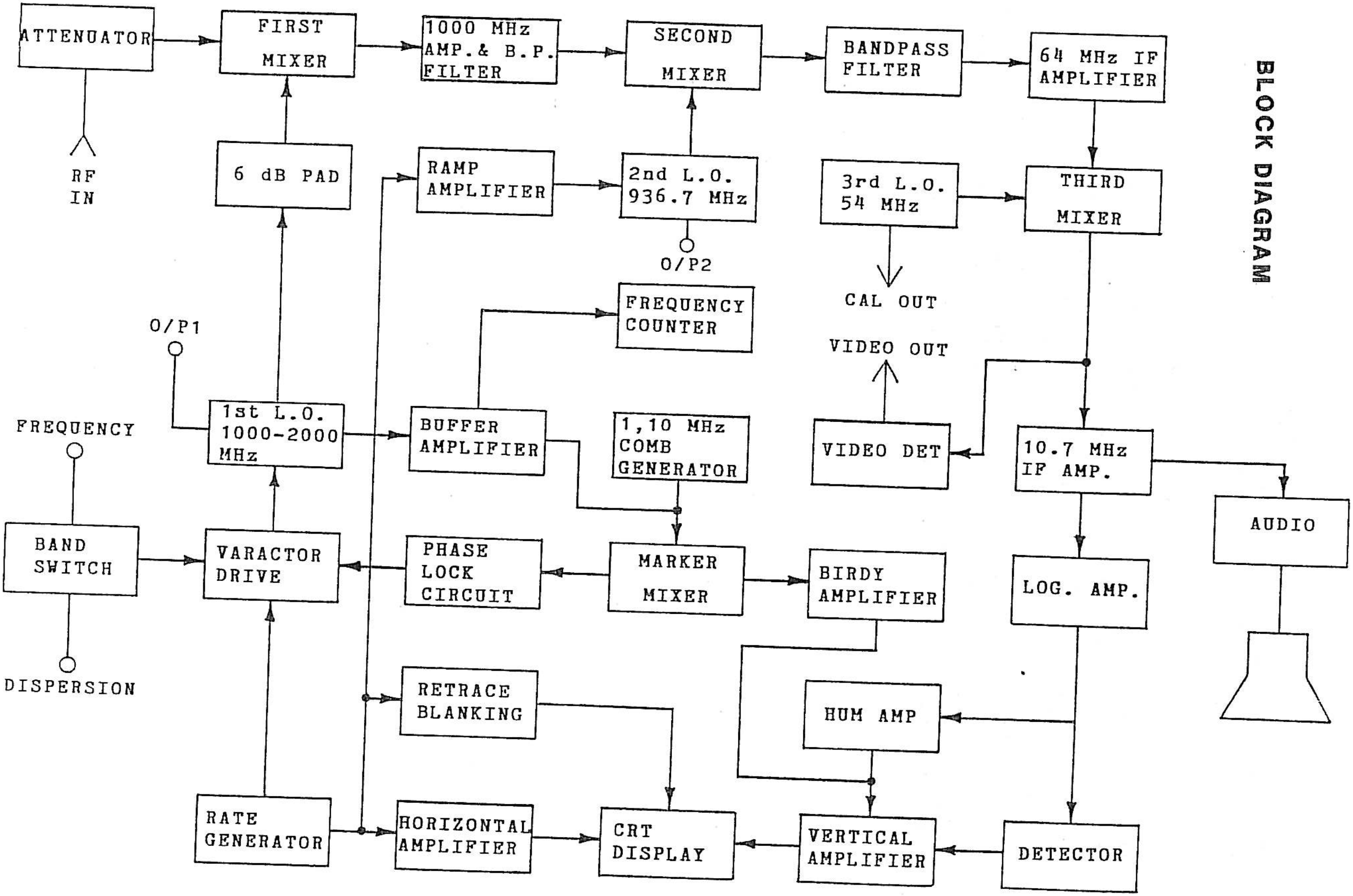


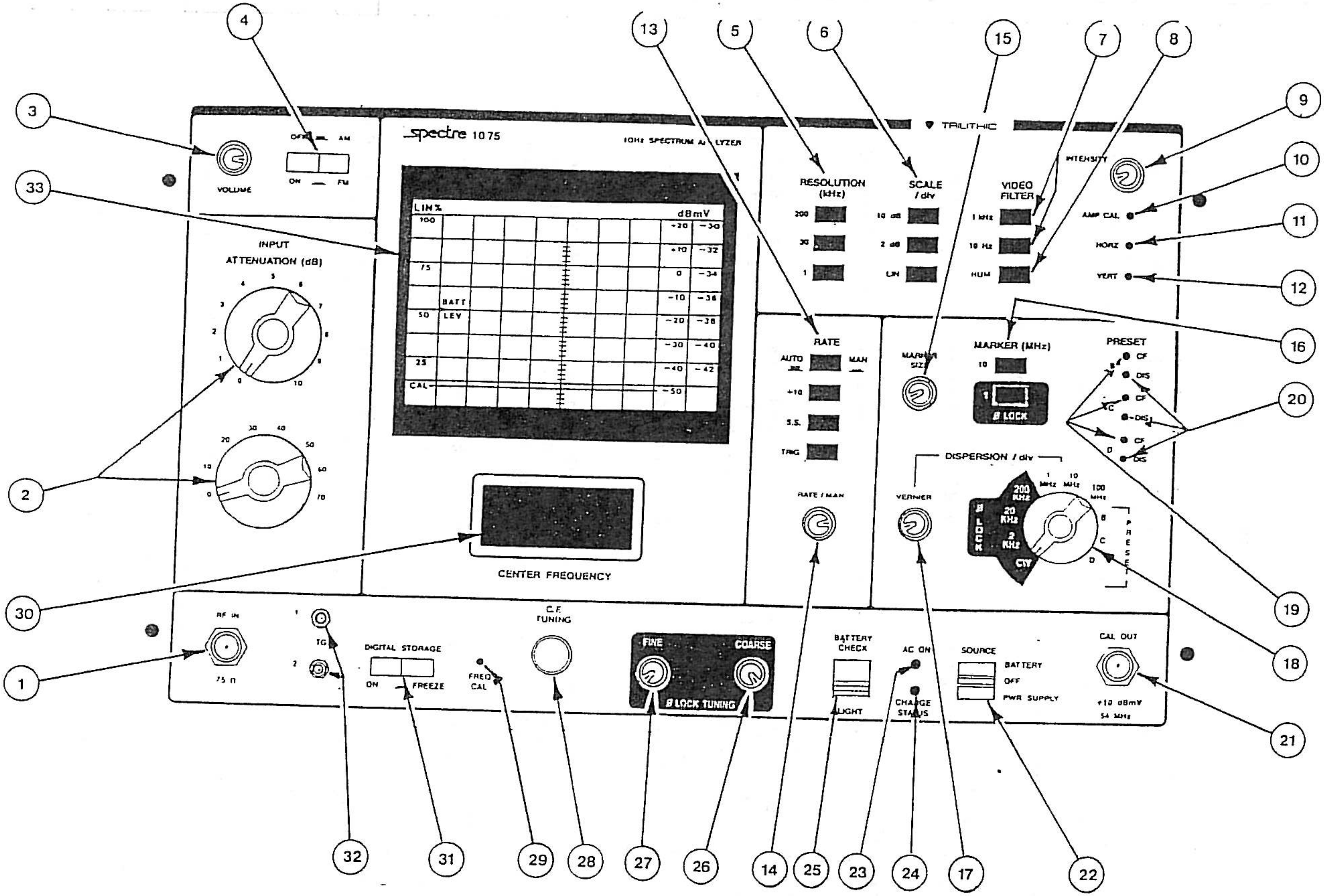
HUM AMPLIFIER

This amplifier provides sufficient voltage to drive the vertical amplifier when making hum measurement.

FREQUENCY COUNTER

The frequency counter samples the first local oscillator frequency when the horizontal sweep crosses center screen. The exact position at which the sample is taken is adjustable with the front panel FREQ CAL control. When the sample period begins a time circuit provides a 128 usec gate signal to a 7224 single chip counter which counts the 1st L.O. frequency prescaled by 128. At the end of the gate time the LCD readout is updated and latched until the next sweep. In MANUAL mode the counter is allowed to free run and the FREQUENCY READOUT indicates the frequency at the position of the dot on the CRT display.

OPERATING INSTRUCTIONS



S1075 - FRONT PANEL CONTROLS

OPERATING INSTRUCTIONS

Introduction

The following paragraphs describe the location and function of the front panel controls and connections and covers preliminary operating procedures. See the front panel diagram for the location of the controls. The numbers following the control name corresponds to the numbers on the diagram.

RF IN CONNECTOR --1

This F connector accepts the input signal to the analyzer.

INPUT ATTENUATION (dB) -- 2

The attenuators provide up to 80 dB of attenuation to the input signal.

VOLUME --3

The volume control adjusts the speaker output level when either the AM or FM detector is used.

AM/FM-ON/OFF --4

The ON/OFF Audio Recovery switch activates the built in detector/audio amp circuitry. The AM/FM switch selects either the AM or narrow band FM detector circuits.

RESOLUTION -- 5

Individual switches select the IF bandwidths (200kHz, 30 kHz, or 1 kHz).

SCALE/div -- 6

The 10 dB/div switch provides a 70 dB range, calibrated from +20 to -50 dBmV. The 2 dB/div position provides a 12 dB range, calibrated from -30 to -42 dBmV. Linear mode is calibrated in %.

FILTER Switch --7

This switch selects reduced video filter bandwidths of 1 kHz or 10 Hz.

HUM -- 8

This control allows the measurement of hum on the signal carrier. See the application section for details on Hum measurement.

INTENSITY -- 9

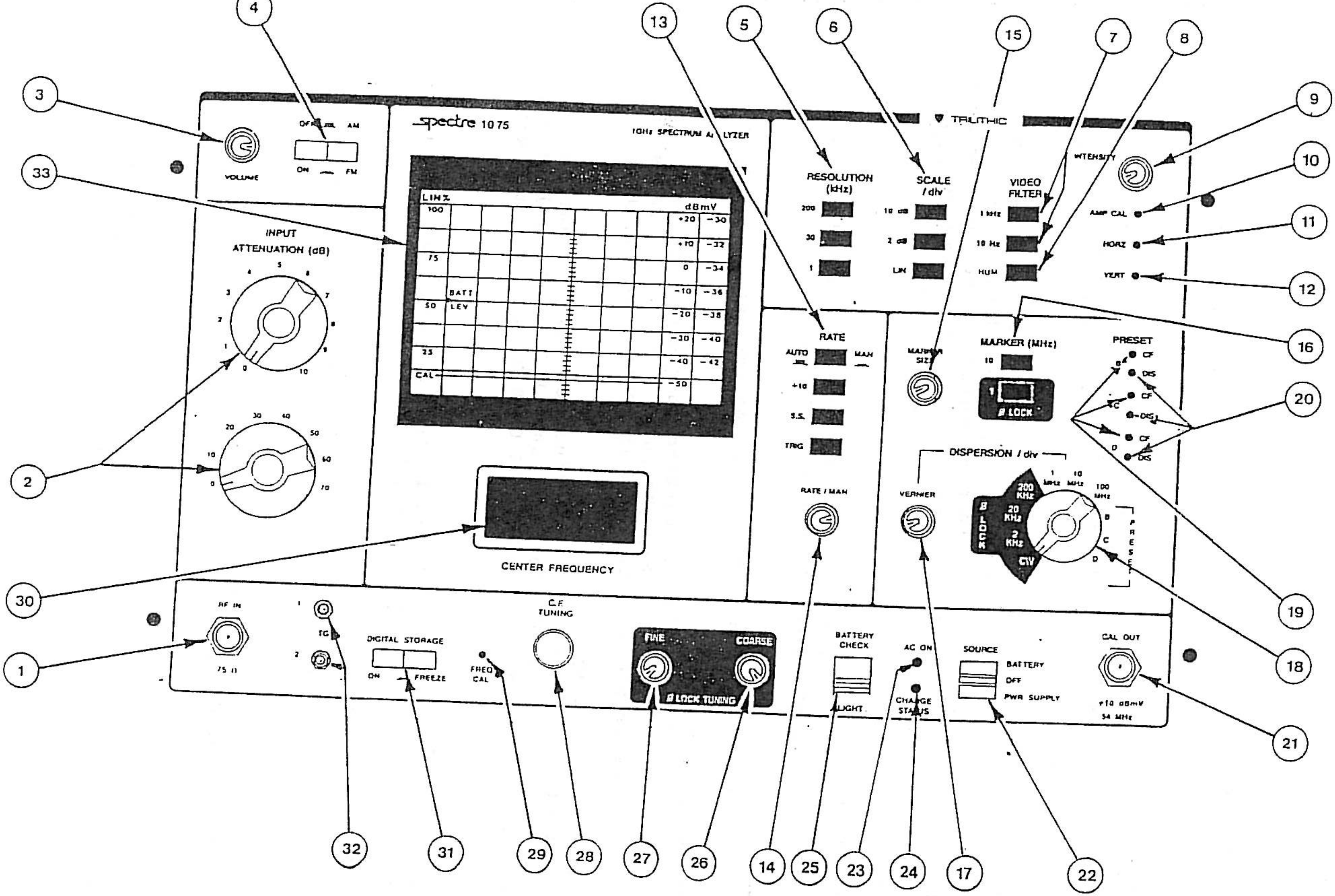
This control adjusts the screen display's brightness.

AMPL CAL -- 10

With the CAL OUT (21) signal injected at the RF IN connector (1), this control is used to calibrate the graticule scale at +10 dBmV at 54 MHz.

HORZ -- 11

This control adjusts the horizontal (sideways) placement of the trace.



S1075 - FRONT PANEL CONTROLS

VERT -- 12
This control adjusts the vertical (up and down) position of the trace.

RATE -- 13
The RATE switch controls the sweep circuit of the analyzer. In the AUTO mode the RATE/MAN control adjusts the scanning rate of the display. Selecting the ÷10 function will reduce the scanning rate by 10.

The SS (single sweep) and TRIG functions are used in the AUTO mode to provide a single scan which may be used in conjunction with the rear panel AUX OUTPUT in performing X-Y recordings of the analyzer display. In the MAN mode the RATE/MAN control allows manual scanning of the display by rotating the control back and forth.

RATE/MAN -- 14
The RATE/MAN control adjusts the sweep time or positions the display dot depending on the RATE mode selected.

SIZE --15
This control varies the amplitude of the markers on the screen.

MARKERS/PHASE LOCK --16
Pushbuttons select 1 and 10 MHz markers on the CRT display. For 200 kHz/DIV dispersions or less, the phase lock switch locks the first L.O. Markers are not displayed in phase lock dispersions.

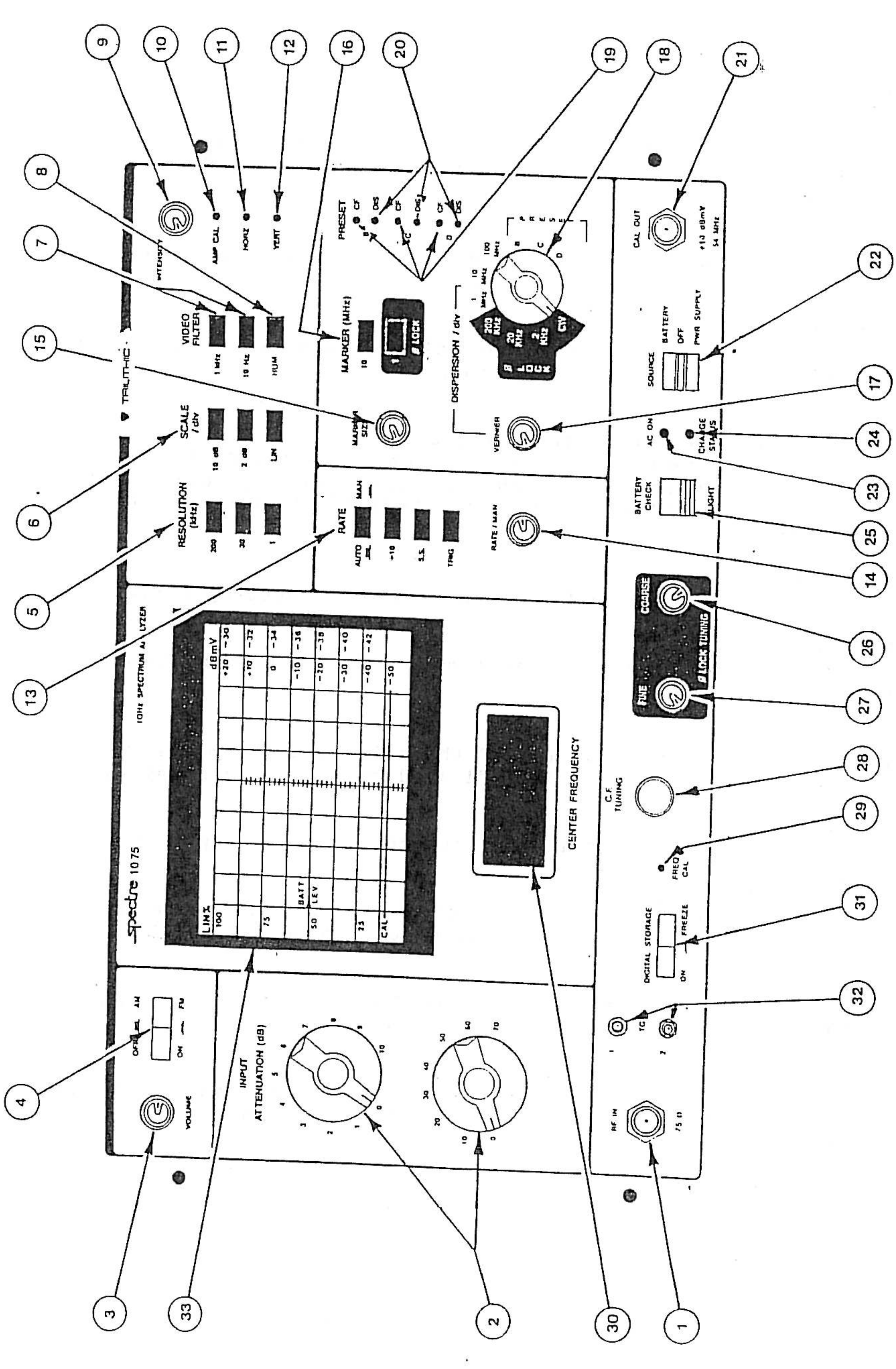
DISPERSION VERNIER --17
This control allows continuous adjustment of the analyzer's spectrum width from 100 MHz to zero, when DISPERSION (18) is not set to the preset bands. The DISPERSION/DIV is calibrated with the VERNIER in its fully CW position.

DISPERSION -- 18
This switch selects one of the analyzer's six dispersion widths, or the CW mode, or one of the preset bands (B,C, or D).

CF (B, C, & D) -- 19
Three controls permit adjustment of the center frequency for the three presets (B, C, & D).

DIS (B, C, & D) -- 20
Three controls permit adjustment of the dispersion width for the three presets (B, C, or D).

CAL OUT -- 21
This connector provides a 54 MHz signal with a reference level of +10 dBmV. It is used in conjunction with the AMPL CAL control (10) to set and check the accuracy of the unit's calibration.



S1075 - FRONT PANEL CONTROLS

SOURCE -- 22
The source switch selects the power source used by the analyzer. Battery mode is only available when the rear panel AC switch is tuned off or the unit is unpluged.

AC ON -- 23
The AC ON indicator glows red when the unit is pluged in and the rear panel AC power switch is turned on.

CHARGE STATUS -- 24
This indicator glows red when the battery is charging and green when the battery has been fully charged.

BATTERY CHECK/LIGHT -- 25
In Battery Check position the vertical deflection of the display indicates the battery level. Deflection above the BATT LEV line on the screen indicates that the battery level is adequate for operation. In the LIGHT position the CENTER FREQUENCY display is illuminated.

COARSE TUNE --26
This control tunes the analyzer over a 5 MHz frequency range.

FINE TUNE --27
This control tunes the analyzer over a small (200 kHz) frequency range.

C.F. TUNING --28
This permits continuous tuning of the anlyzer between 0 and 1000 MHz. The center frequency is indicated on the LCD display (30).

FREQ CAL -- 29
This control is used to calibrate the center frequency display.

CENTER FREQUENCY --30
The center frequency readout indicates the frequency at center screen in AUTO mode or at the position of the dot in MANUAL mode.

DIGITAL STORAGE --31
If you have the optional Digital Display Storage, this control will be preset to control that operation.

TG 1 & 2 --32
When the analyzer is used with a Tracking Generator, these connectors provide the output from the 1st L.O. and 2nd L.O. to the Tracking Generator.

INITIAL SETUP AND CALIBRATION CHECK

It is advisable that the operator become familiar with the initial setup and calibration procedure. The procedure should become a standard routine to insure accurate and reliable measurements made with this unit.

Set the front panel controls to the positions indicated below.

SOURCE	OFF
INPUT ATTENUATOR	0 dB
INTENSITY	Mid-range
SCALE/div	10 dB
VIDEO FILTER	Out
CENTER FREQUENCY	Fully CCW
DISPERSION	1 MHz/div
DISPERSION VERN	Cal (fully CW)
RATE/MANUAL	30 Hz fully CW
AUTO/MANUAL	AUTO
RESOLUTION	200 kHz

Set the source switch to the BATTERY position and allow approximately 15 seconds for the unit to warm up.

NOTE

The rear panel INT/EXT battery switch MUST be set to INT for battery operation.

Adjust the INTENSITY control to the required brightness. Activate the 1 kHz video filter and using the VERT control position the baseline trace on the CAL line of the graticule. Release the 1 kHz video filter and center the trace horizontally on the screen using the HORIZ control.

Press the battery check. The base line should rise to some point above the BATT LEVEL indicated on the graticule. This is an indication of the state of charge contained in the battery. The battery level is preset at the factory for a 11.6 volt charge level. If the battery check indicates a level below the BATT LEVEL the battery should be recharged.

Adjust the C.F. TUNING control until the ZERO response is displayed at center screen. Activate the 10 MHz marker. Center the FINE TUNE control. Adjust COARSE TUNE so that the ZERO response peak is centered around the 10 MHz marker.

NOTE

This procedure calibrates the marker frequency for general use. For frequency identification to within ±100 kHz see FREQUENCY IDENTIFICATION section of this manual. It should be noted here that when making frequency measurements with the analyzer the accuracy of the measurement will depend upon how accurately the ZERO response is centered around the 10 MHz marker. Any adjustment of the FINE TUNE and/or COARSE TUNE controls after the ZERO centering procedure will negate the calibration.

Connect a short 75 ohm coaxial cable (RG-59) between the CAL OUT connector and the RF IN connector.

Adjust the C.F. TUNING control for the response at 54 MHz. Adjust the AMP CAL control for a +10 dBmV signal level at 54 MHz. Check for the vertical trace to be on the CAL line. If not, use the VERT control to recenter on the CAL line. Repeat procedure as these controls interact. This calibrates the signal level circuitry for the analyzer.

Set the C.F. tuning control to 500 MHz and the Dispersion control to 100 MHz/div.

Remove the 75 ohm cable between the CAL OUT connector and the RF IN connector. The analyzer is now displaying the spectrum from 4 to 1000 MHz.

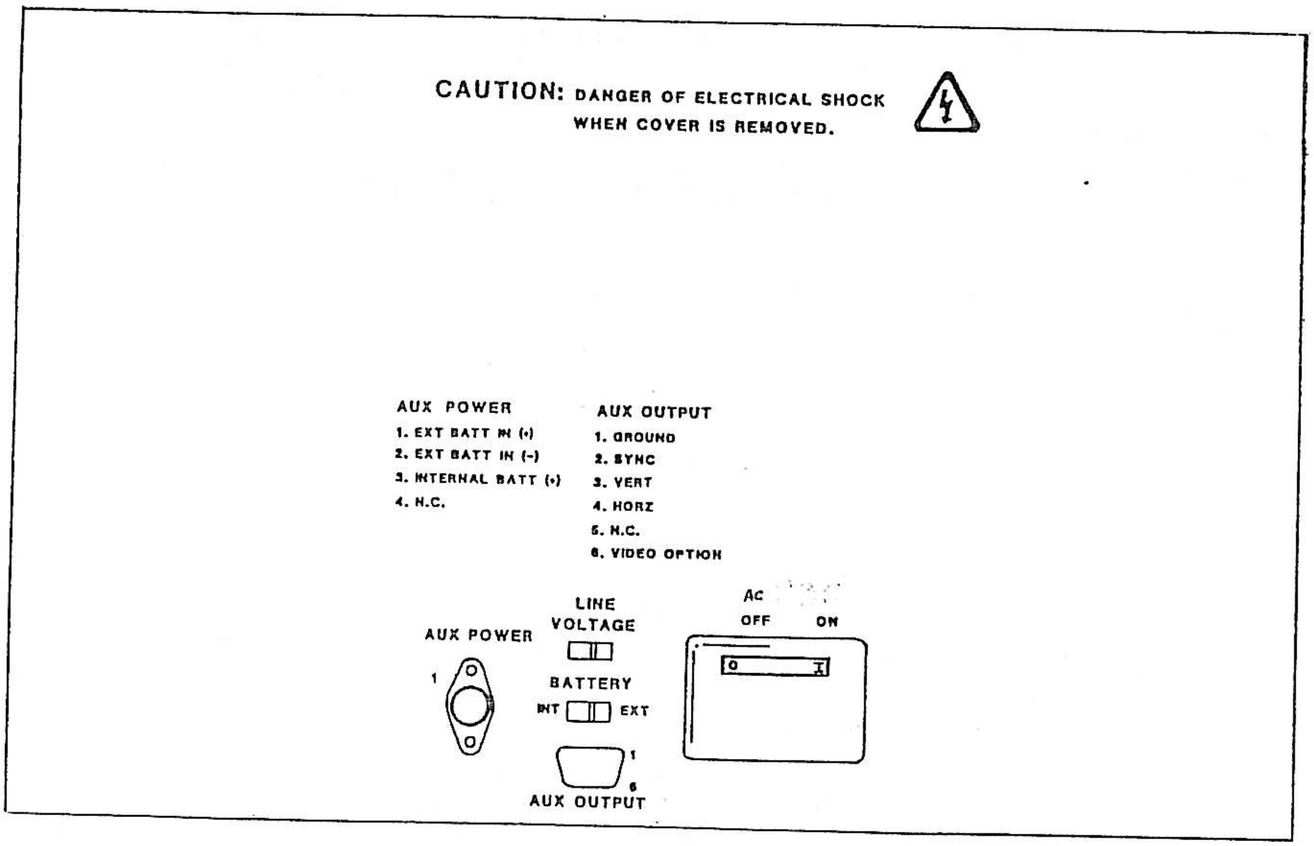
B, C, AND D BAND SETUP PROCEDURE

Along with the normal dispersion settings on the analyzer, bands B, C, and D were allocated for use where the operator may require test readings at certain frequency and bandwidth ranges throughout the test period. Bands B, C, and D can be preset for a specific frequency and bandwidth which saves the operator time in setup.

The phase lock circuitry is disabled in the B, C, and D band settings.

Set the front panel controls to the positions indicated in INITIAL SETUP AND CALIBRATION CHECK section.

Set the INPUT ATTENUATOR (dB) to 40 dB.



REAR PANEL

FIGURE 2

CAUTION

Input must never exceed .5 watt average. The output of the attenuator should not exceed +20 dBmV. Always insert 40 dB or more attenuation before connecting an input. After the signal is connected, attenuation may be reduced to produce an adequate display.

Set the DISPERSION/div control to BAND B and connect the signal desired. Adjust the C.F. for Band B until the signal is centered on the display. Adjust the DIS for Band B in conjunction with the 1 and 10 MHz markers for the bandwidth desired. For wide bandwidths use the MAN mode and position the dot on, first the right and then the left, side of the display while noting the difference in the CENTER FREQUENCY readout. With no further adjustment of the C.F. and DISPERSION controls set for Band B, the pre-selected center frequency and band width may be acquired at any time by switching the DISPERSION control to the Band B setting.

For preset Bands C and D use the same procedure described bor Band B.

OPERATION FROM AN EXTERNAL BATTERY

WARNING

At no time should a 115 VAC power source be connected to the analyzer's AUX POWER input connector located on the rear panel. See Figure 2.

The analyzer will accept a power source of 12 to 15 volts DC. The power source must have at least a 2 amp capability at full load. Connect the power source selected to the AUX POWER connector. Set the INT/EXT power switch to the EXT position and the SOURCE switch to BATTERY.

BATTERY CHARGING

Battery charging is accomplished through the internal AC power supply contained in the analyzer. Connect the analyzer to a suitable AC source and turn the rear panel power switch to ON.

The battery will charge from a low voltage of 11.6 volts to a full charge voltage of 12.5 volts in approximately 14 hours. The analyzer may be used for test purposes during the battery charge operation.

The CHARGE STATUS is a green/red LED battery charge indicator. The indicator normally glows green; if the battery is discharged, the indicator will glow red until a full charge is attained, then it will change to green.

PHASE LOCK SYSTEM

Various tests and measurements require extreme stability of the test instrument involved. Obviously, oscillator stability could not be measured if the stability of the oscillator was greater than that of the test instrument. Therefore, the analyzer is equipped with a phase lock system to insure maximum stability (500 Hz). The following procedure should be used to provide proper operation of the phase lock system. The phase (Ø) lock system is functional only in the 200, 20 and 2 kHz positions.

After performing the Initial Setup and Calibration Checks center the COARSE and FINE TUNE controls. Adjust the center frequency to approximately the frequency of interest. Set the DISPERSION/div control to the 200 kHz position and re-adjust the center frequency until the display is centered on the screen.

Activate the Ø LOCK switch and re-center the display using the COARSE and FINE TUNE controls. Adjust the RATE, DISPERSION and RESOLUTION controls to proper settings for the band width of interest. Refer to the Introduction of the Operation and Applications section for guidelines to proper settings.

NOTE

The following conditions should be noted when using the phase lock system:

a. C.F. TUNING should not be adjusted in the Ø LOCK position. If the CENTER FREQUENCY control is moved while in Ø lock the unit will jump lock. To avoid using the CENTER FREQUENCY control when in the Ø lock position, use the COARSE and FINE TUNE controls to adjust the frequency.

b. When the Ø LOCK switch is activated the display frequency may offset slightly to the left or right. This is normal operation. Use the COARSE and FINE TUNE controls to re-adjust the display to center graticule.

AUDIO RECOVERY OPERATION

This section describes operating procedures for proper audio reception. The analyzer may be used as a tunable FM or AM receiver with a 2 MHz window by performing the following steps.

1. Set the DISPERSION/div. control to 1 MHz/div and the DISPERSION Vernier to CW position.
2. Tune the C.F. TUNING control to the desired frequency with the aid of the center frequency readout and markers. Refer to Frequency Identification in the Operations and Applications section for assistance in performing this step.
3. Set the DISPERSION control to 200 kHz/div.
4. Activate the Ø LOCK switch.
5. Set the RESOLUTION control to the 30 kHz position.
6. Activate the MAN position of the AUTO/MAN control.
7. Tune the RATE/MAN control for a coverage of 2 MHz.
8. Select either FM or AM and adjust the volume control. The audio has a squelch function with a threshold of about -40 dBmV.

CENTER FREQUENCY DISPLAY

To calibrate the CENTER FREQUENCY display activate the 10 MHz marker and center the FINE TUNE control. Adjust the COARSE TUNE control so the ZERO response peak is centered around the 10 MHz marker.

Connect a short 75 ohm coaxial cable (RG-59) between the CAL OUT connector and the RF IN Connector.

Set the DISPERSION control to 100 MHz/div and the VERNIER to fully CW.

Set the 54 MHz CAL signal to the center graticule with the C.F. TUNING control. DO NOT ADJUST WITH THE COARSE AND FINE TUNE CONTROLS.

Adjust the FREQ CAL for a CENTER FREQUENCY reading of 54 MHz.

APPLICATIONS

INTRODUCTION

The S1075 Spectrum Analyzer is a swept heterodyne receiver that displays signals in the frequency domain. Signal frequency is measured in the horizontal direction, and signal voltage is measured in the vertical direction on the calibrated CRT display. Because the S1075 is capable of resolving a broad spectrum of RF signals, it is especially applicable to CATV system measurements. The CATV system performs in accordance with FCC technical standards. Most of the procedures are straight-forward, and satisfactory results should be easily attained. Some of the procedures may require a brief period of familiarization. The following paragraphs illustrate some of the applications of the S1075 Spectrum Analyzer.

One of the most common errors in conjunction with spectrum analyzer use is in the area of amplitude measurement. The accuracy of the amplitude measurement is dependent upon the RATE, DISPERSION and RESOLUTION controls settings. The interaction of these components can contribute to "scan loss",, which can give the operator erroneous readings. Proper care must be taken to insure against "scan loss" to achieve the highest level of accruacy in amplitude measurement.

The S1075 was designed to provide spectrum analysis of the 4 to 1000 MHz range. This is a rather large bandwidth to cover in one thirty hertz per second sweep rate. With a RESOLUTION setting of 200 kHz the response time allowed for the vertical circuitry to display the signal at full sweep width is approximately five milliseconds. Due to the response of the vertical amplifier, signal amplitude is lost, therefore "scan loss".

We overcome "scan loss" in the S1075 by incorporating a variable RATE control and a variable DISPERSION control. By slowing the RATE speed and/or narrowing the DISPERSION the time allowed to display the vertical signal increases reducing "scan loss".

The general rule to follow is to reduce the sweep RATE and DISPERSION width until the vertical signal level displayed NO longer increases in amplitude. Decreasing the RESOLUTION will require further reduction of RATE speed and DISPERSION width due to the reduction of bandwidth. Use of the VIDEO FILTER will require reduction of RATE speed and DISPERSION width as the VIDEO FILTER limits the bandwidth of the VERTICAL amplifier. When the operator becomes familiar with the interrraction of the RATE, DISPERSION, RESOLUTION and VIDEO FILTER controls in regard to "scan loss" the opportunity for error in amplitude measurements will decrease.

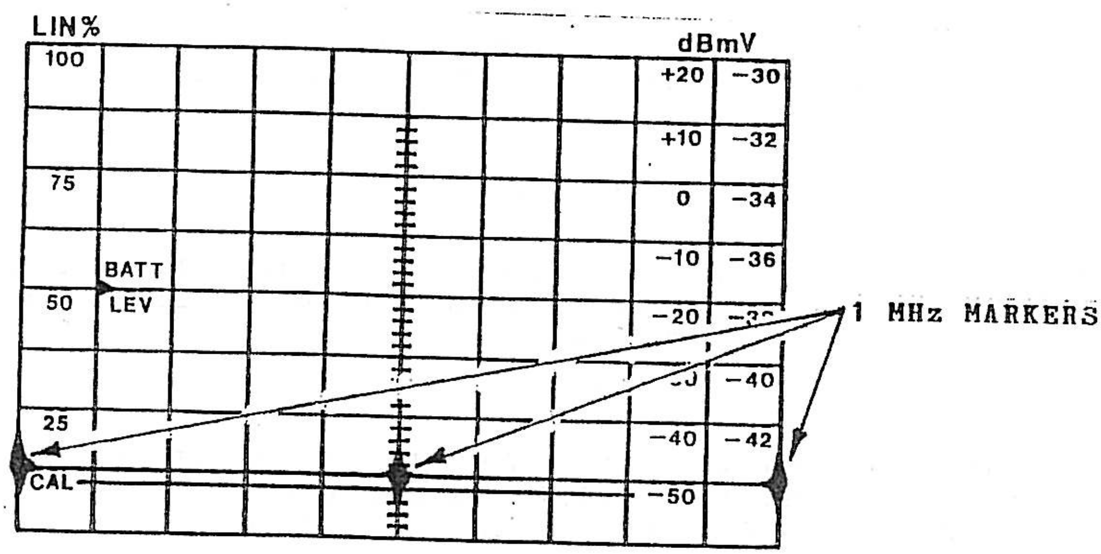

LIN%
100
75
50
25
BATT
LEV
CAL
dBmV
+20
-30
+10
-32
0
-34
-10
-36
-20
-40
-40
-42
-50
1 MHz MARKERS

FIGURE 5

FREQUENCY IDENTIFICATION

The S1075 may be used along with the following procedure to identify signal frequencies to within ±100 kHz of their actual frequency.

Set the front panel controls to the initial setup positions. Turn the unit on and allow at least a 10 minute warm up period.

Activate the 10 MHz MARKER and center the peak of the ZERO response about the 10 MHz marker using the COARSE TUNE control. Set the RESOLUTION control to 30 kHz and recenter the response over the marker.

NOTE

It may be necessary to narrow the sweep width by adjusting the DISPERSION VERNIER to get an accurate alignment.

C A U T I O N

Marker frequency has now been calibrated for ±100 kHz accuracy. **DO NOT** re-adjust FINE or COARSE TUNE controls as this will destroy calibration accuracy.

SET the RESOLUTION control to 200 kHz and the DISPERSION control to 100 MHz. Turn the DISPERSION VERNIER fully clockwise and adjust the CENTER FREQUENCY to the desired signal.

Set the DISPERSION control to 1 MHz and recenter the signal response with the C.F. TUNING control. Activate the 10 MHz marker and identify the frequency using the center frequency readout. Note whether the frequency of interest lies to the left or right of the 10 MHz marker.

Activate the 1 MHz marker and count the 1 MHz markers between the 10 MHz markers and the frequency of interest. If the frequency of interest is LEFT of center subtract the number of 1 MHz markers from the 10 MHz marker frequency; if it is RIGHT of center add the number to the 10 MHz marker frequency. You should now have the frequency identified to within 1 MHz.

Set the RESOLUTION control to 30 kHz and the RATE/MAN control to a slow rate and adjust the DISPERSION VERNIER so that the 1 MHz markers are 5 divisions apart while keeping the frequency of interest displayed on the screen. The frequency of the unknown signal can now be identified from the graticules each of which represent 200 kHz. See Figure 5.

AMPLITUDE MEASUREMENT

Measurement of signal levels is one of the basic functions of the spectrum analyzer. Please refer to the introduction of the Operations section to review amplitude measurement and "scan loss".

Perform the initial setup procedure and apply the signal under test to the RF IN connector.

Set the DISPERSION control to 1MHz/div and adjust the C.F. TUNING control to place the signal under test in the center of the graticule.

Adjust the RATE/MAN control for a sweep rate setting as described in the introduction of the Operations section. Set the SCALE/div control for 10 dB/div.

Adjust the INPUT ATTENUATOR (dB) to produce an on-screen trace with a maximum amplitude of +10 dBmV as read on the graticule scale to the right of the screen.

The input voltage is the sum of the amplitude indicated on the graticule and the attenuation of the RF attenuator in dBmV. Read the scale on the right side of the graticule.

NOTE

The S1075 allows for operator calibration of the vertical signal. The accuracy of the internal calibration signal is preset at the factory to be with in $\pm.25$ dB at 70^{o}F. The scale is calibrated at +10 dBmV. Therefore, for greatest accuracy in amplitude measurement adjust the display signal as close as possible to the +10 dBmV graticule with the input attenuators.

The S1075 is also provided with a 12 dB LOG RANGE. This scale should be used for higher resolution of signal levels. Adjust the INPUT ATTENUATOR (dB) to provide an on-screen trace with a maximum amplitude of less the -30 dBmV as indicated on the right most graticule scale. The input voltage in dBmV is the sum of the amplitude indicated on the graticule and the attenuation of the RF attenuator.

SPECTRAL PURITY

Perform the initial setup procedures and apply the signal under test to the RF IN connector.

Adjust the INPUT ATTENUATOR (dB) and C.F. TUNING controls to provide an on-screen trace. Set the DISPERSION control to give the desired sweep width.

Exmination of the desired signal and spurious responses is now possible. To determine the frequency and amplitude of these responses perform the procedures for FREQUENCY INDENTIFCATION and AMPLITUDE MEASUREMENT.

RESIDUAL FM

Perform the initial setup procedure and tune the signal of interest to the center graticule.

Reduce the DISPERSION control to 200 kHz and position the signal at center screen with the C.F. TUNING control. Activate the Ø lock switch.

NOTE

Tuning is now accomplished via the COARSE and FINE TUNING controls. DO NOT use the C.F. TUNING control.

Set the RESOLUTION control to 1 kHz and the DISPERSION control to 20 kHz/div. Set the vernier fully CW and re-center the signal if necessary. Reduce the sweep rate to a minimum by depressing the ÷10 switch and rotating it CCW.

The residual FM can now be determined by observing the width of the peak of signal in graticule divisions and multiplying by the DISPERSION/div setting.

ORIENTING ANTENNAS

The S1075 can be used to orient antenna systems for best reception.

Perform the initial setup procedures and attach the antenna downlead to the RF IN connector.

NOTE

If the antenna downlead system is other than 75 ohm, an impedance matching transformer is required if accurate level readings are necessary.

Adjust the DISPERSION control and the CENTER FREQUENCY control to provide a display of the signals to be received.
Adjust the INPUT ATTENUATION (dB) controls to provide an amplitude display of less then +10 dBmV. Set the RATE/MAN control to a fast sweep rate and the RESOLUTION control to 200 kHz.

Rotate the antenna system and observe the position which produces the maximum signal level.

CALIBRATION OF FIELD STRENGTH METERS

The CAL OUT connector on the S1075 supplies a +10 dBmV ±.25 dB at 70°, calibrated source at 54 MHz that may be used to calibrate Field Strength Meters.

Connect the Field Strength Meter to the CAL OUT connector on the S1075 with a 75 ohm coaxial cable of known attenuation.

Adjust the Field Strength Meter to 54 MHz and calibrate to +10 dBmV.

NOTE

Lower levels of calibration may be obtained by inserting a 75 ohm pad (Texscan FP-75) in series with the CAL OUT connector. The accuracy of the pad must be taken into consideration when using this method.

AMPLITUDE MODULATION

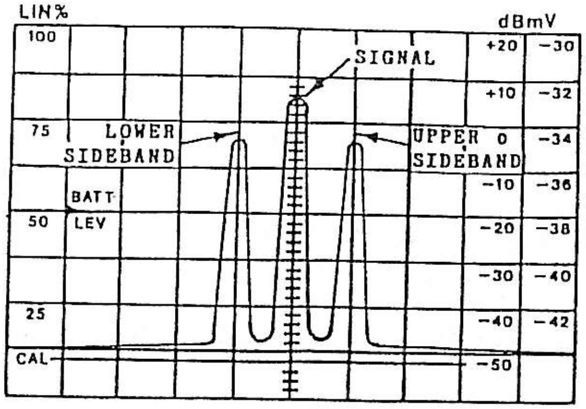
Amplitude modulation is defined as modulation in which the amplitude of a wave is the characteristic that is subject to variation. Sidebands are produced about the carrier and their amplitude is directly related to the level of the modulation. In the log mode, this is expressed by the formula:

$$M = 200 \times \left[\text{antilog}\left(\frac{V_{sb} - V_c}{20}\right)\right]$$

Where: M = modulation in %
V_{sb} = voltage in dBmV of the sideband
V_c = voltage in dBmV of the carrier

NOTE

V_{sb} will always be less than V_c, giving a negative value for the number whose antilog is being found. This procedure is for pure sine wave only.



DISPERSION set for 20 kHz/div.

RESOLUTION set for 1 kHz.

FIGURE 6

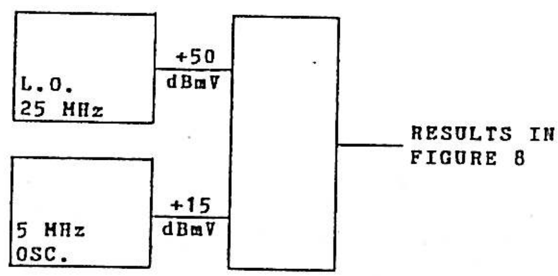


FIGURE 7

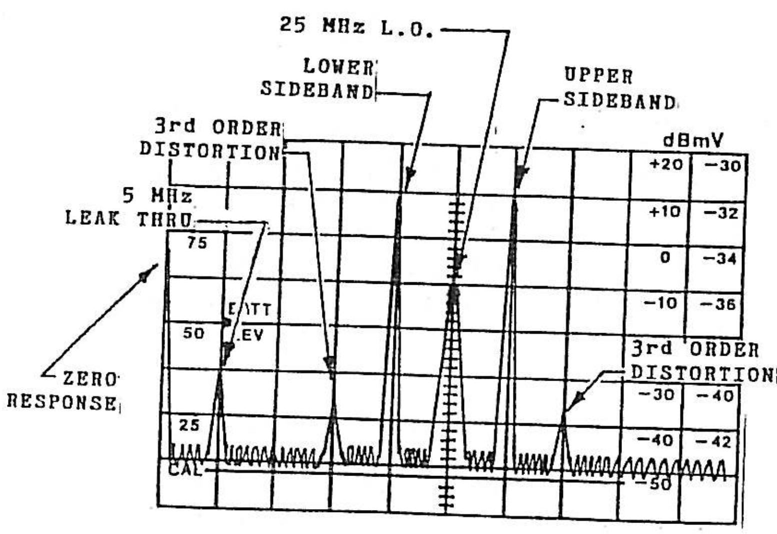


FIGURE 8

EXAMPLE: 50 MHz signal at -14 dBmV, amplitude modulated by 20 kHz signal. See Figure 6.

Since the carrier and side bands differ in amplitude by approximately 12 dB, this results in a modulation level of 50%.

Perform the initial setup procedure and apply the signal under test to the RF IN connector.

Adjust the C.F. TUNING control to display the fundamental test signal at center graticule. Adjust the DISPERSION control for a sweep width relating to the modulating signal. A general rule to follow would be to set the DISPERSION control for a setting equal to the moduating signal frequency divided by a factor of five.

EXAMPLE 1: 10 kHz modulating signal should be set for 2 kHz dispersion.

EXAMPLE 2: 1 MHz modulating signal should be set for 200 kHz dispersion.

Determine the vertical amplitude of the fundamental signal vs. the upper and lower sidebands. Use the formula above to determine the percentage of modulation.

TEST AND ALIGNMENT OF FREQUENCY CONVERTERS

A frequency converter is defined as a device that changes an alternating current from one frequency to another. Basic types of converters are mixers, multipliers, detectors, etc. The S1075 is capable of analyzing many of the basic parameters of those types of devices.

Perform the initial setup procedures and use the C.F. TUNING and DISPERSION controls to adjust for the proper frequency range of the device under test.

EXAMPLE: See Figure 7. A double balanced mixer with a L.O. at 25 MHz at +50 dBmV and mixed with a 5 MHz at +15 dBmV results in output as shown in Figure 8. The two sidebands created at 20 and 30 MHz show a conversion loss of approximately 6 dB. The local oscillator (25 MHz) has -60 dB isolation. The 5 MHz signal has approximately -45 dB isolation. Third order distortion products at 15-35 MHz are 46 dB down.

OSCILLATOR TEST AND ALIGNMENT

Since two of the basic parameters associated with oscillators are frequency and amplitude, the S1075 Spectrum Analyzer is well suited for oscillator test and alignment in the 4-1000 MHz range.

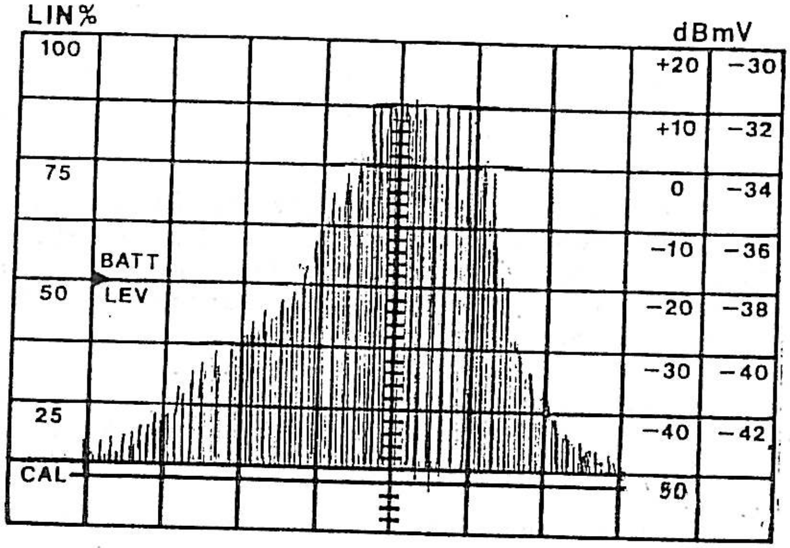


FIGURE 9

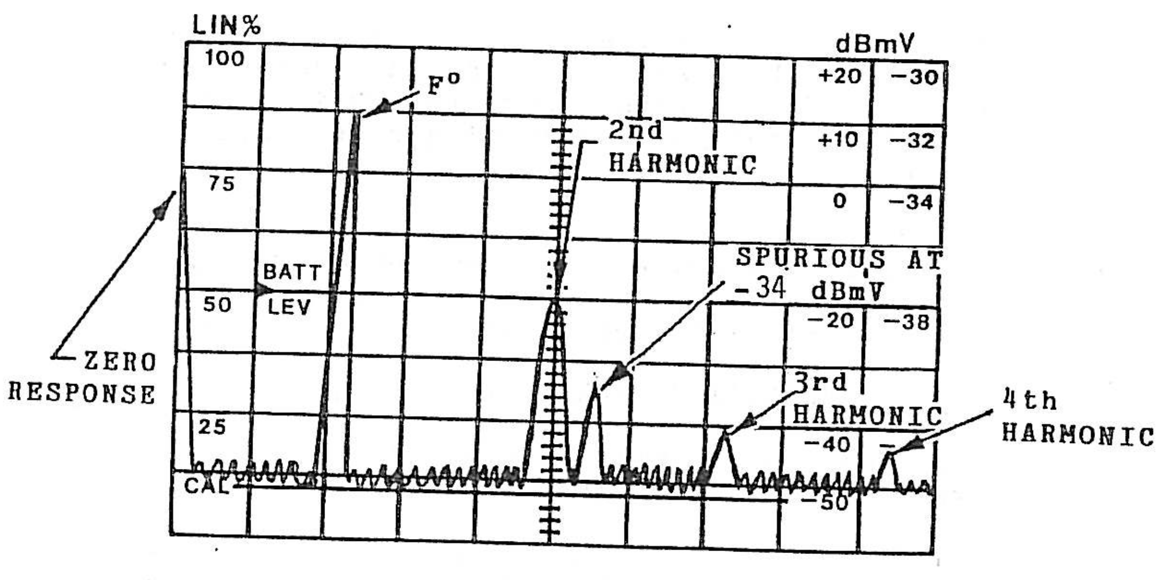


FIGURE 10

Perform the initial setup procedures and reduce the INPUT ATTENUATOR (dB) until the signal level is equal to or below +10 dBmV.

Adjust the C.F. TUNING control until the oscillators fundamental frequency is on the center graticule. The center frequency readout will indicate the approximate frequency. More accurate frequency identification can be made by performing the FREQUENCY IDENTIFICATION procedure.

The oscillator amplitude can be determined by attenuating the oscillator output level to a known reference level on the CRT.

EXAMPLE: See figure 9.

On-screen amplitude level	=	+10 dBmV
RF ATTN setting	=	30 dB
Actual amplitude level	=	+40 dBmV

The residual FM can be measured by dispersing the fundamental signal as follows:

1. Set the DISPERSION control to the 200 kHz position.

2. Center the oscillators fundamental signal using the C.F. TUNING control.

3. Activate the Ø LOCK control.

NOTE

When measuring residual FM of less than 10 kHz care should be taken not to confuse the FMing with the IF bandwidth. When the FM is small observe the apparent broadening of one side of the IF response.

4. Set the DISPERSION control to the 20 kHz/div calibrated position and recenter the frequency of interest if necessary with the COARSE and FINE TUNE controls.

5. Set the RESOLUTION control to 1 kHZ.

6. Slow the sweep rate until there is no further degradation of the signal amplitude.

7. Read the residual from the graticule as the apparent width of the peak of the signal.

EXAMPLE: With a signal amplitude of +9 dBmV in the 2 kHZ/div DISPERSION mode the residual FM appears to be approximately 20 kHz. See Figure 9.

Spurious and harmonic content of the oscillator can be measured easily and accurately. See Figure 10.

Perform the initial setup procedure.

EXAMPLE: For the fundamental frequency of the oscillator at approximately 50 MHz, +10 dBmV output level.

2nd harmonic at 100 MHz, output level -20 dBmV therefore, 2nd harmonic is 30 dB below the fundamental frequency.

3rd harmonic at 150 MHz, output level -45 dBmV, -55 dB below fundamental frequency.

4th harmonic at 200 MHz, output level -45 dBmV, -55 dB below fundamental.

PRELIMINARY FOR CATV TESTING

Connect the AC power cord or switch to the battery and energize the power switch. After about 10 seconds, the baseline should appear on the CRT. Permit the unit to warmup at least 2-3 minutes.

Set the INPUT ATTENUATOR (dB) to 40 dB and set the DISPERSION/div control to 100 MHz. Set the VERNIER fully CW.

Adjust the C.F. TUNING control until the readout indicates approximately 50 MHz. Set the INTENSITY control for a pleasing display.

Set the RATE/MAN control to the 30 Hz position (fully CW) and the RESOLUTION control to 200 kHz. Set the VIDEO FILTER control to 1 kHZ.

The baseline should be on the CAL graticule line and it should be sharp. If not, adjust the VERT, HORIZ, and INTENSITY control until a sharp, bright line appears on the CAL graticule.

Set the VIDEO FILTER control to the OFF position and connect the signal under investigation to the RF IN connector.

CAUTION

THIS INPUT MUST NOT EXCEED .5 WATT AVERAGE INPUT TO THE INPUT ATTENUATOR OR +20 dBmV OUTPUT FROM THE ATTENUATOR. THE S1075 HAS A BUILT IN DC BLOCK TO PROTECT ITS INPUT FROM AC OR DC UP TO 100v.

The unit is now ready to perform spectrum analysis in the 4 to 1000 MHz range.

IMPORTANT: Signal amplitude distortion occurs if the SWEEP RATE settings are too fast, or if the DISPERSION settings are too wide for the RESOLUTION setting, or for the VIDEO FILTER setting. Avoid signal amplitude reduction by decreasing the SWEEP RATE and DISPERSION settings until the displayed signal amplitude is constant and undistorted. Use the following table of control settings as a guide.

DISPERSION/ DIV	SWEEP RATE		
	30 Hz	3 Hz	.03 Hz
	IF FILTER	IF FILTER	IF FILTER
2 KHz	30 KHz	1 KHz	1 KHz
20 KHz	30 KHz	1 KHz	1 KHz
200 KHz	200 KHz	30 KHz	1 KHz
1 MHz	200 KHz	30 KHz	30 KHz
10 MHz	200 KHz	200 KHz	30 KHz
100 MHz	---	200 KHz	200 KHz

CAUTION

The input to the first mixer must not exceed +10 dBmV, or spurious signals could be generated. Use the attenuator to keep the on-screen signal amplitude from exceeding +10 dBmV.

VISUAL CARRIER LEVEL MEASUREMENTS

Perform the initial setup procedures but adjust the DISPERSION and C.F. TUNING controls for a convenient display.

Connect the RF IN connector to the desired system test point.

While observing the display, reduce the INPUT ATTENUATOR (dB) in 10 dB steps until the maximum on-screen visual (pix) carriers are at least 0 dBmV, but less than +10 dBmV as indicated in the right hand graticule scale. See Figure 11.

Use the small attenuator steps for aligning the vertical sync-peak of the maximum visual carrier to +10 dBmV or 0 dBmV horizontal graticule line. Dispersion must be reduced to see the vertical sync pulses.

NOTE

When measuring visual carrier levels, slow down the sweep rate until the maximum visual carrier level is observed. This maximum level is the visual carrier plus the vertical sync pulses which ride the crest of the carrier. When the dispersion, resolution and sweep rate are reduced sufficiently, the vertical-sync roll-through can be observed on the visual carrier.

The actual visual carrier level in dBmV equals the on-screen visual carrier in dBmV plus the input attenuation setting in dB.

EXAMPLE:	On-screen visual carrier level	= 10 dBmV
	Input attenuation setting	= <u>20 dB</u>
	Actual visual carrier level	= +30 dBmV

Repeat the steps for other channel visual carrier levels.

AURAL CARRIER LEVEL MEASUREMENTS (CATV)

Perform the initial setup procedure and connect the RF IN connector to the system test point.

Set the C.F. TUNING control to the desired channel center frequency. Adjust the DISPERSION control to 1 MHz and the VERNIER to maximum CW.

While observing the display, reduce the input attenuation in 1 dB steps until the maximum on-screen visual carrier is at least 0 dBmV, but less tha +10 dBmV. Observe the aural (sound) carrier at 4.5 MHz to the right of the visual carrier.

The difference between the on-screen visual and aural carrier levels should be 13 to 17 dB. Read the difference on screen, or add input attenuation until the visual carrier level equals theoriginal aural carrier level. This is true in CATV systems. MATV or off air signals may be different, therefore the aural level may be equal or larger.

NOTE

Avoid overload to the first mixer by limiting the on-screen signal level to +10 dBmV.

EXAMPLE 1: See Figure 12.
Using the right hand graticule scale.

On-screen visual carrier level	=	+10 dBmV
On-screen aural carrier levels	=	-10 dB
Difference in carrier levels	=	20 dB

EXAMPLE 2: Using the attenuation control settings.
Video = Audio

Attenuation setting	=	26 dB
Original attenuation setting	=	6 dB
Difference in settings equals difference in aural and visual carrier levels.	=	20 dB

SIGNAL-TO-NOISE MEASUREMENTS

Two methods of signal-to-noise measurements are described in this section. In Method I, the visual carrier-to-noise (C/N) measurements are made on individual channels. In Method II, the visual carrier-to-noise measurement is made over the full system frequency range.

Operate the analyzer so that the visual carrier levels are at least -10 dBmV. Use the INPUT ATTENUATOR control to limit on-screen visual carrier levels to +10 dBmV for carrier levels exceeding +10 dBmV.

METHOD I: Channel-by-Channel C/N Measurements

Set the controls as described in PRELIMINARY FOR CATV TESTING with the following exceptions.

Connect the RF IN connector to a system test point and adjust the C.F. TUNING control to the desired channel's center frequency.

EXAMPLE: Channel 7 (174-180 MHz),the center frequency is 177 MHz

Set the DISPERSION control to 1 MHz/div and the VERNIER for a 6 MHz display width. Use the front panel 1 MHz MARKER control to set sweep width and then turn off the marker.

NOTE

1 MHz markers will be easier to read by activating the VIDEO FILTER at 1 kHz.

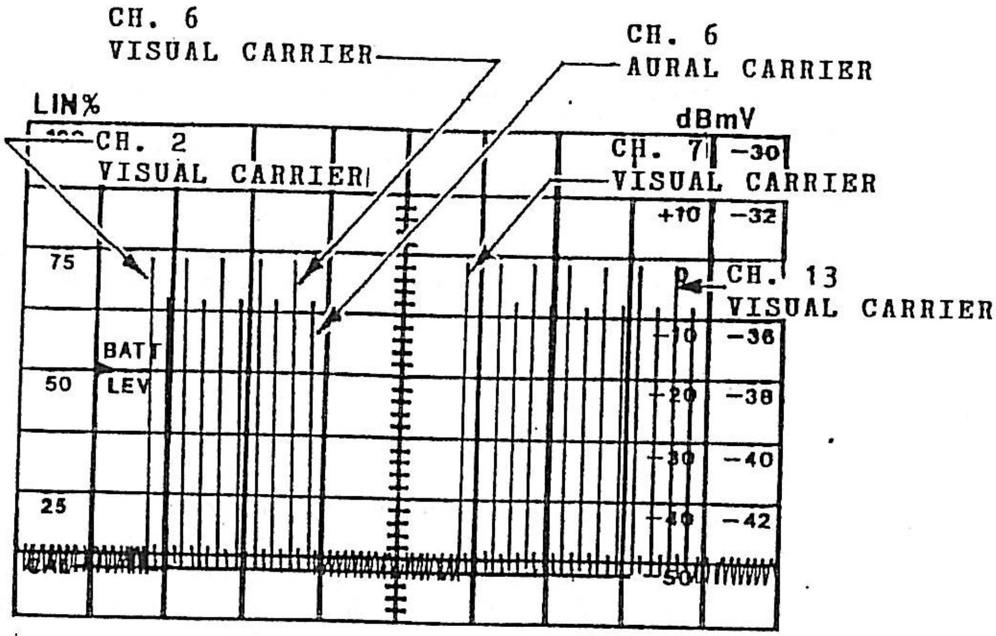


FIGURE 11

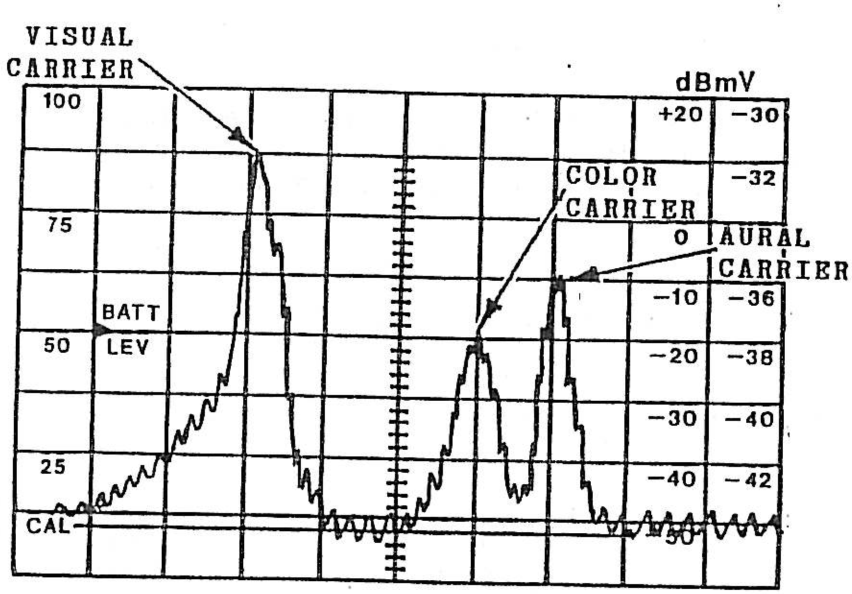


FIGURE 12

Set the VIDEO FILTER control to OFF and the RESOLUTION control to 200 Khz. Set the INPUT ATTENUATOR control to provide an on-screen visual carrier level of from 0 to 10 dBmV, but do not exceed +10 dBmV. Record the displayed visual carrier level.

Shut down the headend channel processor for the channel under observation and measure the noise indicated by the rising baseline as input attenuation is reduced.

NOTE

If the noise level is too low to cause a noticable rise in the baseline as the input attenuation is reduced, insert a channel filter and a Trilithic VSX-92 amplifier between the RF IN connector an the system test points. This filter prevents adjacent channel signals from over-loading the analyzer. The amplifier is to boost gain so that a noticeable baseline rise will occur at lower levels. Repeat tests as necessary after inserting the filter and amp.

The actual noise level (dBmV) is equal to the on-screen noise level (dBmV) and input attenuation (dB) and 17 dB correction factor.

NOTE

The correction factor accounts for the difference between the channel video noise bandwidth (4MHz), the analyzer's IF noise bandwidth (200kHz) and the log circuit response factor.

$$\text{IF correction factor} = 10 \log \frac{10\ 4}{0.2} = 13 \text{ dB}$$

Log circuit response factor	= -4 dB
Total correction factor	= 17 dB

The log circuit response factor is due to the supression of noise spikes in the log circuitry. Thus the overall average noise response in the log circuit is less. The log circuit correction factor is 4 dB.

The carrier-to-noise level (dB) = the actual visual carrier level in dBmV - the corrected noise level in dBmV.

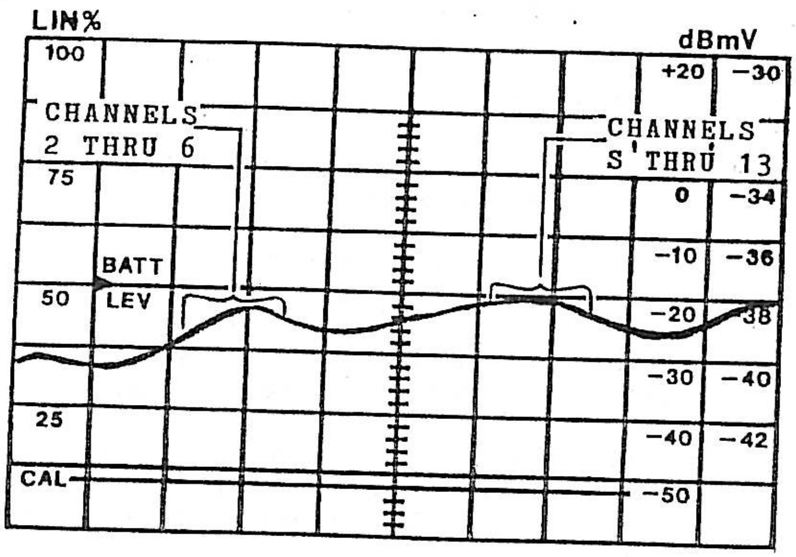

LIN%
100
75
50
25
CAL
CHANNELS
2 THRU 6
CHANNELS
S THRU 13
BATT
LEV
dBmV
+20
-30
0
-34
-10
-36
-20
-38
-30
-40
-40
-42
-50

FIGURE 13

EXAMPLE:

On-screen visual carrier level	=	5 dBmV
Input attenuation	=	20 dB
Actual visual carrier level	=	+25 dBmV
On-screen noise level	=	-30 dBmV
Input attenuation	=	+ 0 dB
Correction factor	=	+17 dB
Actual noise level	=	-13 dBmV
Actual visual carrier level	=	+25 dBmV
Actual noise level	=	-(-13 dBmV)
Carrier-to-noise (C/N)	=	+38 dBmV

FCC technical standard: Signal-to-noise ratio = 36 dB minimum.

METHOD II: Wide Range C/N Measurements

Set the front panel control as in PRELIMINARY FOR CATV TESTING section with the following exceptions.

Connect the RF IN connector to a system test point.

Set the INPUT ATTENUATOR control to provide an on-screen display of the visual carrier levels of up to +10 dBmV, but do not exceed +10 dBmV. Log the displayed visual carrier levels.

Shut down all headend processors except for the pilots and decrease the input attenuation settings until the baseline rises in the display. If the baseline does not rise follow the procedure for inserting a channel filter and VSX-92 amplifier.

Observe the shape of the noise trace. It may not be a straight line. Look at the point where the noise rises the most within the normal channels, but ignore the noise outside these normal channels. See Figure 13.

Calculate the noise as in Method I beginning with the highest noise level, and the lowest visual carrier level.

NOTE

Noise levels are temperature dependent. Highest system noise levels are obtained on hot summer days in the mid or late afternoon.

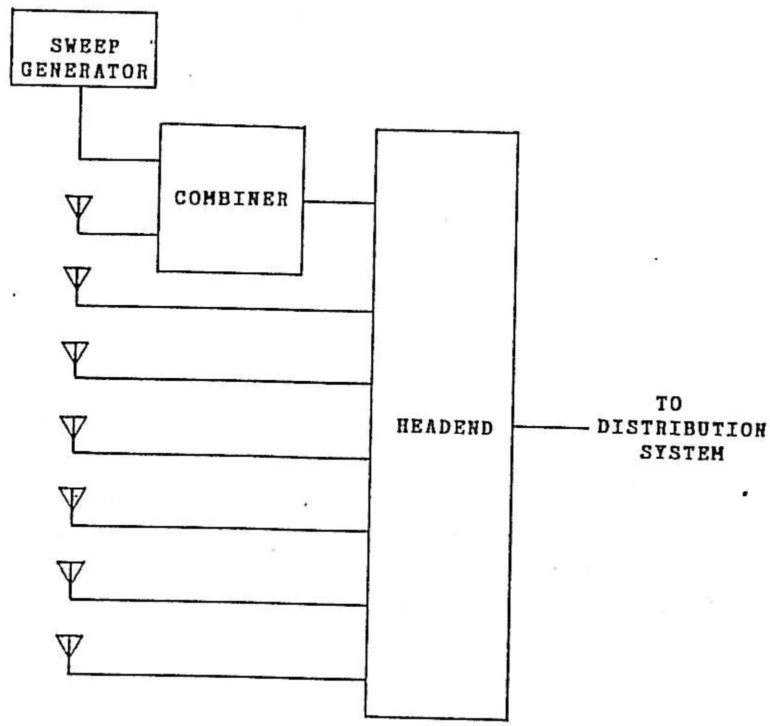


FIGURE 14: METHOD I SETUP

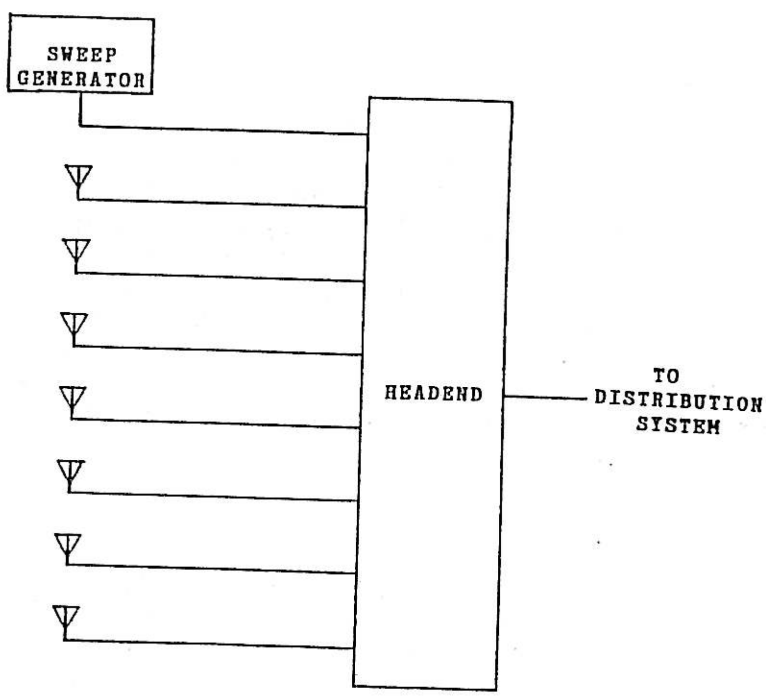


FIGURE 15: METHOD II SETUP

CHANNEL REQUENCY RESPONSE

There are several methods for measuring channel frequency response. In each method described here, a VHF sweep generator, such as the Trilithic VS-60C/Z with slow sweep options, and the S1075 spectrum analyzer are required.

METHOD I

Refer to Figure 14 for setup diagram. The sweep generator signal is injected at the input to individual headend processors and combined with the antenna signal. The sweep generator sweeps slowly through the system in a channel-to-channel basis at an RF level approximately 30 dB below the visual carrier level. The operator observes the slow sweep signal as it moves across the S1075 screen and determines the channel flatness is within ±2 dB. Use the 2 dB/div log mode or linear mode with the 1kHz video filter.

METHOD II

Refer to Figure 15 for setup diagram. The sweep generator is injected directly into the individual headend processors on a channel-by-channel basis, but the antenna of the channel being swept is not connected. The sweep generator signal level is set at a level that does not exceed that of the visual carrier. The S1075 is set up as in Method I. Method II eliminates the measurement problem caused by the carrier frequencies, but it does shut down the channel program during measurement. During this test the standby carrier for the channel under test must be disabled, usually by pulling the crystal. Use the 2 dB/div log mode or linear mode.

HEADEND RESPONSE

Use the setup in Figure 16 and set the sweep generator for a slow sweep rate, the center frequency for channel center frequency, and the sweep width for 6 MHz channel width. Use markers to identify system frequency. Set the RF output to provide a signal level equal to the channel visual carrier level. Obtain a graph or photograph of the oscilloscope display of the channel frequency response in which the X-axis is calibrated in frequency and the Y-axis is calibrated in dB. Carry out this procedure for each system channel to obtain the flatness of the entire headend. Perform these measurements when program material is not being transmitted.

DISTRIBUTION SYSTEM RESPONSE

Use the setup in Figure 17. In this case, the flatness of the entire distribution system on a channel-by-channel basis is obtained. The sweep generator is set for the same channels as in Method I, but at a very slow sweep rate, several seconds per channel. The RF output is set to provide a level of 20 dB below the visual carrier level for each channel.

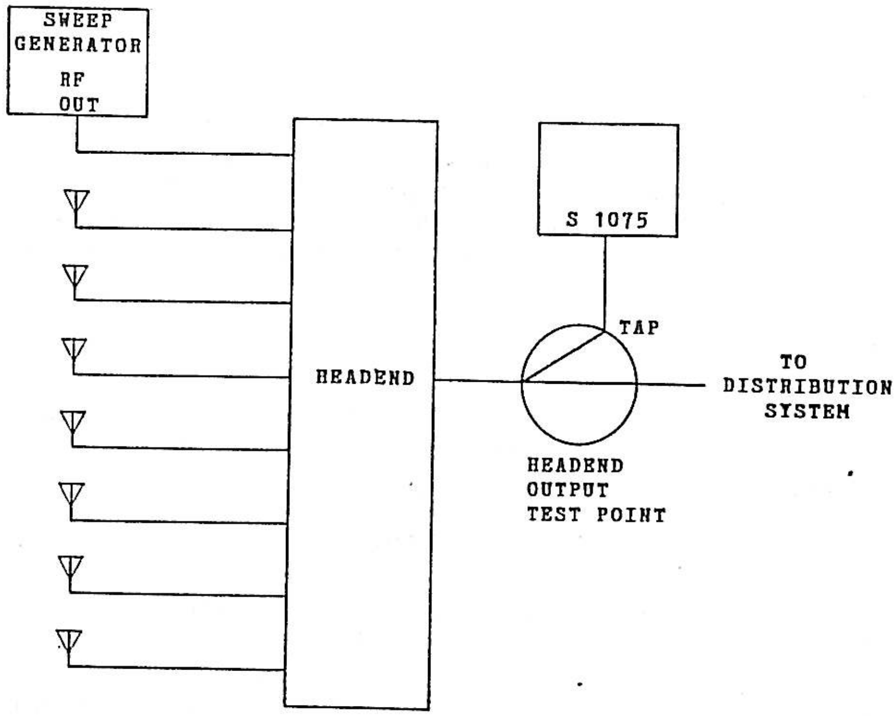


FIGURE 16: SETUP FOR HEADEND FLATNESS

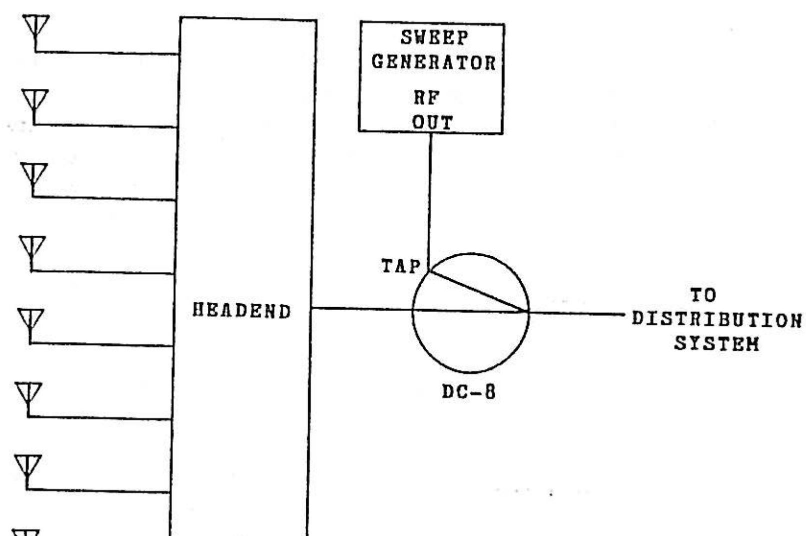


FIGURE 17: SETUP FOR DISTRIBUTION FLATNESS

The S1075 is connected to a system test point in the field. The controls are set to obtain a graph or photograph of the frequency responses on a channel-by-channel basis as the slow sweep signal moves across the S1075 display. The measurements are made during regular program transmissions.

TOTAL SYSTEM FREQUENCY RESPONSE

The graphs obtained from corresponding channels in Method I and Method II are added to obtain the overall system response. See the example in Figure 18.

INTERMODULATION

Two procedures are required to measure the intermodulation beats. Beats that are well away from the visual carrier are more easily resolved than those interspersed with the horizontal sync sidebands that are near the visual carrier. All intermod beats should be measured at a point in the system where visual carriers are at least +10 dBmV. A sufficient input attenuation setting will prevent S1075 overload which results in additional display beats. Look for any stray apparent carriers in the passband of active channels only. Insert a bandpass filter for the signal of interest between the system test point and the S1075 RF INPUT.

CAUTION

Overloading the S1075's first mixer will produce intermod. When observing a beat signal verify that it is really on the system by observing that a 3 or 6 dB increase in the S1075 input attenuation causes a 3 or 6 dB change in the intermod. If the intermod reduces by more than the amount of attenuation change, the S1075 is being overloaded and a bandpass filter for the desired channel is required.

METHOD I: Intermod Beats Far from Visual Carrier

Perform initial setup and set the center frequency to the desired channel`s center frequency.

Set the DISPERSION control to 1 MHz/div and the DISPERSION VERNIER to produce a sweep width of at least 6 MHz.

While observing the S1075 display, reduce the input attenuation in 10 dB steps until the on-screen visual carrier level is slightly less than +10 dBmV.

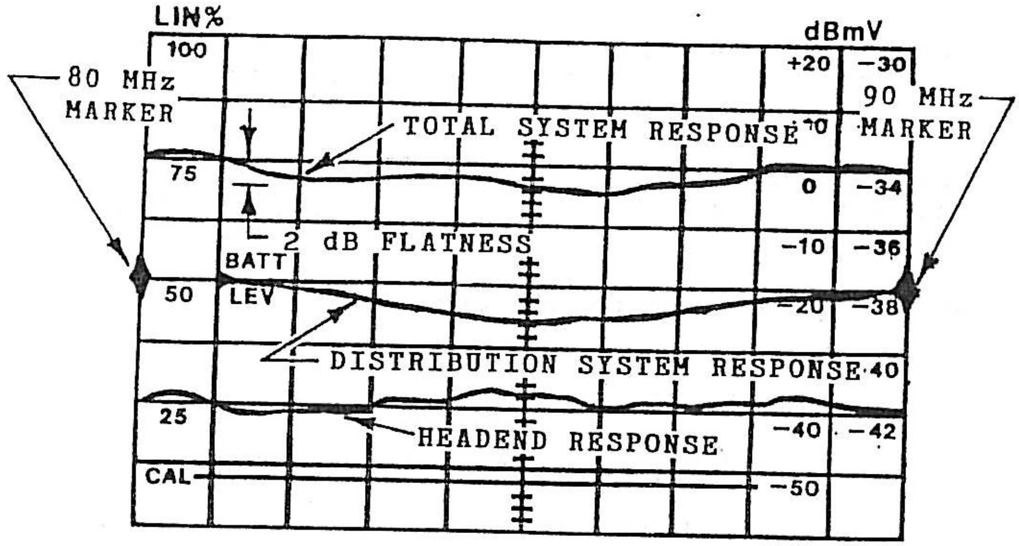


FIGURE 18

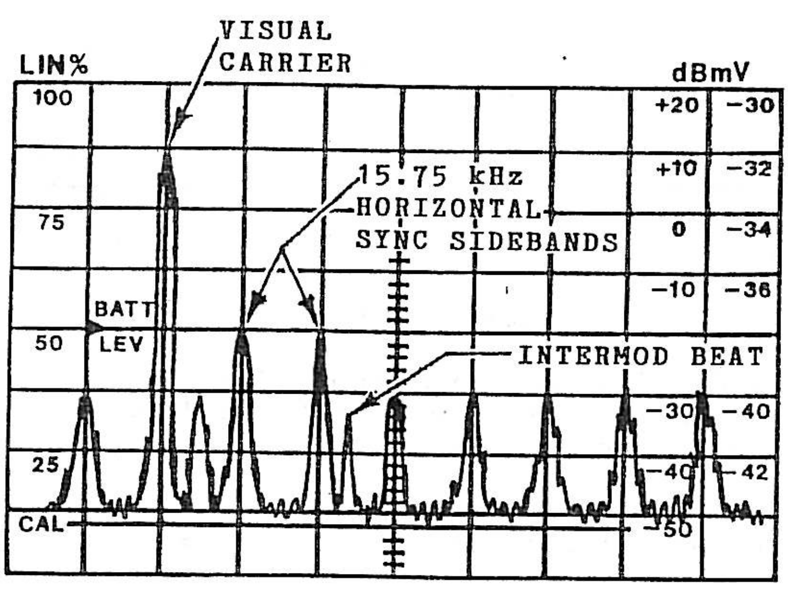


FIGURE 19

Measure the difference in amplitude between the vertical sync-tip level of the visual carrier and the intermod beat level within the channel.

EXAMPLE:	Visual carrier sync-tip level	=	+ 8 dBmV
	Intermod beat level	=	-(-41) dBmv
	Difference	=	49 dB

This difference should be 46 db minimum to fulfill FCC technical standards.

METHOD II: Intermod Beats Close to Visual Carrier

This method is also used for co-channel interference.

Measurement of intermod beats close to the visual carrier is a tedious process. It is advisable to narrow the search to a particular channel by connecting a TV receiver to the system test point. Beats of sufficient level to cause a grainy picture at a given channel setting should be investigated using the S1075.

Set the SWEEP RATE to .3 Hz and the RESOLUTION control to 1 kHz.

With the video carrier centered on the display, set the DISPERSION control to 200 kHz and activate Ø LOCK. Adjust the DISPERSION VERNIER in a CCW direction and observe a progression of 15.75 kHz sidebands produced by the horizontal sync pulses. Continue to adjust the VERNIER and the FINE TUNE control until the sidebands are aligned on the vertical graticule lines.

Look for an intermod beat or carrier between the equally spaced 15.75 kHz sidebands. See Figure 19.

EXAMPLE:	Visual carrier level	=	+10 dBmV
	Intermod beat level	=	-(-34) dBmV
	Difference	=	44 dB

CO-CHANNEL

Use the procedure described in Method II for the intermod beat measurement. The co-channel carrier will be located 10 kHz above or below the visual carrier. See Figure 20.

EXAMPLE:	Visual carrier level	=	+10 dBmV
	Co-channel carrier level	=	-(-40) dBmV
	Difference	=	50 dB

This difference should be 46 dB minimum fo fulfill FCC technical standards.

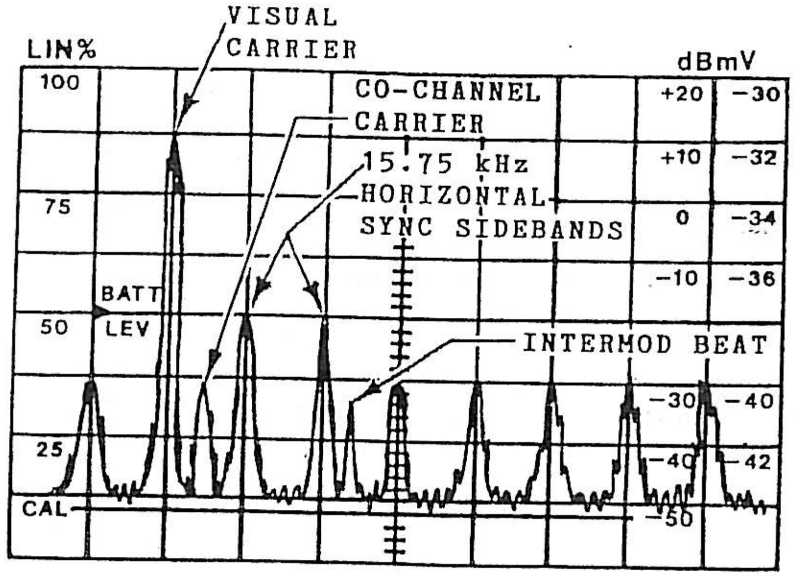
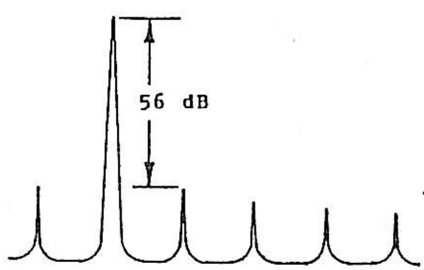


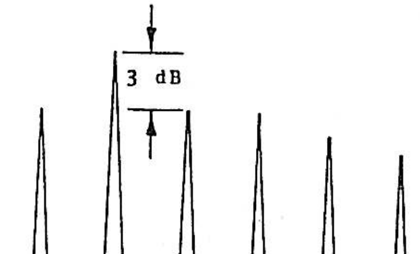
FIGURE 20

FIGURE 21

CROSS MODULATION MEASUREMENT



CROSS MODULATION



EFFECTIVE MODULATION

CROSS-MODULATION

The cross-modulation of a given system channel is derived from a two step measurement procedure. The cross-modulation expressed in dB is the difference between the two measurements.

Step 1: Measure the cross-modulation level with respect to the visual carrier level.

All system visual carriers, except that of the channel of intrest, are 100% amplitude modulated by a 15.75 kHz square wave, 50% duty cycle.

1. Insert a channel filter, Trilithic LSE or VF series, for the channel of interest between the S1075 and the system test point.
2. Set the SWEEP RATE control to .3 Hz.
3. Set the RESOLUTION control to 1 kHz.
4. Set the DISPERSION control to 200 kHz and center the video carrier on the display. Activate the Ø LOCK control and re-adjust the video carrier to center screen with the COARSE and FINE TUNE controls.
5. Obtain a display of the channel visual carrier and the progression of 15.75 kHz sidebands.
6. Observe and record the difference in dB between the first (maximum) 15.75 kHz sideband and the channel visual carrier level.

STEP 2: Measure the effective modulation level with respect to visual carrier level.

All system visual carrier levels including the channel of interest are 100% amplitude modulated as in Step 1.

1. With the S1075 controls set as in Step 1, obtain a display of the channel visual carrier and the progression of the 15.75 kHz sidebands.
2. Observe and record the difference in dB between the first (maximum) 15.75 kHz sideband and the channel visual carrier level.

STEP 3: The difference between the recorded readings in Step 1 and Step 2 is the cross-modulation expressed in dB. See Figure 21.

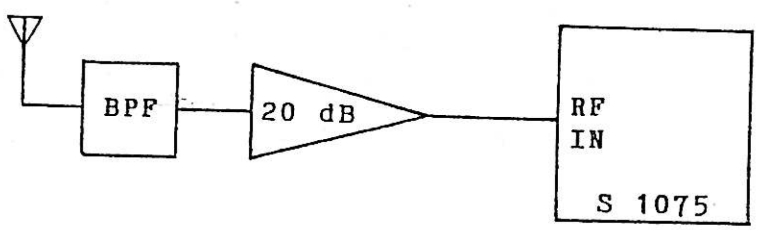


FIGURE 22: LEAKAGE MEASUREMENTS

Cross-modulation level with respect to visual carrier level	=	-56 dB
Effective modulation level with respect to visual carrier level	=	-(+3)dB
Cross-modulation	=	-53 dB

LEAKAGE MEASUREMENT

Leakage measurement with the S1075 is similar to the setup procedure used with a signal level meter such as the Spectrum 700. The S1075 has the advantage over the 700 because the operator can observe the signal being measured.

Because of the low signal levels to be measured, a high quality amplifier is required such as a Trilithic VSX-92. The return loss match should be at least 16 dB, and the gain should be at least 20 dB. Preamplifiers with headend type specifications, or integrated-circuit type line extender amplifiers are desirable. The antennas used must be half wave dipoles cut, or adjusted, to the channel center frequency, or a broadband antenna such as the Trilithic AFS-1, adjusted to the center frequency. A 50 to 75 ohm balun is used and a calibration chart is provided which converts signal voltage level to field strength in microvolts per meter for frequencies in the range of 20 to 200 MHz. 75 ohm half wave dipoles do not require impedance conversion networks. A bandpass filter encomposing the frequency required must be used such as a Texscan LSE or VF filter. See Figure 22.

Use the initial setup for CATV testing and make the necessary control adjustments to resolve the leakage of visual carriers from the CATV system.

Orient the antenna for maximum display amplitude.

NOTE

Separating the CATV system leakage signal from the direct transmitted signals is not practical. Perform the measurements on those channels where external signal levels are low enough to permit measurement of the CATV leakage.

Field strength intensity is determined by the following equation.

$$E = \frac{0.0121\ fv}{G} = \frac{CV}{G}$$

Where
- E = Field strength microvolts per meter
- f = Channel center frequency
- V = Input voltage to amplifier in microvolts
- G = Antenna gain factor = 1 for dipole (See Figure 24)
- C = A constant depending on channel center frequency (See Table 2)

EXAMPLE:

On screen leakage signal level		
Input attenuation setting	=	-33 dBmV
Actual S1075 input leakage signal level	=	0 dB
Amplifier gain	=	-33 dBmV
Amplifier input signal level	=	-20 dB
Filter loss	=	-53 dBmV
	=	+ 3 dB
Amplifier input voltage from Table 3	=	-50 dBmV
Channel 2 multiplying factor from Table 5	=	3.16 uV
Antenna gain (for 75 ohm dipole)	=	1.2
Field strength (E) = 1.2 x 3.16 uV	=	1.0
	=	3.79 uV/m

FCC technical standards for signal leakage:

Up to 50 MHz:	15 uV/m maximum at 100 feet
54 to 216 MHz:	20 uV/m maximum at 10 feet
Above 216:	15 uV/m maximum at 100 feet

HUM MODULATION

To measure hum or low frequency variations, transmit a pure CW signal into the system, such as an unmodulated pilot generator. Make sure PCG has no hum of its own, as this would add to the measurement and give a false indication of system hum.

Perform the initial setup procedure and set the center frequency to observe the pure CW carrier.

Set the RESOLUTION control to 200 kHz and activate the Ø LOCK. Set the DISPERSION control to the CCW position and peak the signal with the Ø LOCK tuning controls then set the display amplitude between +10 and -10 dBmV, by using the input attenuator.

Slow the sweep rate and activate the HUM control. If there is any amplitude modulation by hum in the system, the horizontal line will not be flat. Determine the peak-to-peak amplitude in division corresponds to 2% hum modulation.

dBmV	uV
-60	1.00
-59	1.12
-58	1.26
-57	1.41
-56	1.59
-55	1.78
-54	2.00
-53	2.24
-52	2.51
-51	2.82
-50	3.16
-49	3.55
-48	3.98
-47	4.47
-46	5.01
-45	5.62
-44	6.31
-43	7.08
-42	7.94
-41	8.91
-40	10.00

dBmV	uV
-40	10.0
-39	11.2
-38	12.6
-37	14.1
-36	15.9
-35	17.8
-34	20.0
-33	22.4
-32	25.1
-31	28.2
-30	31.6
-29	35.5
-28	39.8
-27	44.7
-26	50.1
-25	56.2
-24	63.1
-23	70.8
-22	79.4
-21	89.1
-20	100.0

dBmV	uV
-20	100
-19	112
-18	126
-17	141
-16	159
-15	178
-14	200
-13	224
-12	251
-11	282
-10	316
-9	355
-8	398
-7	447
-6	501
-5	562
-4	631
-3	708
-2	794
-1	891
0	1000

TABLE 3

CHANNEL	f = MHz CENTER FREQUENCY	C= 0.021 f
2	57	1.20
3	63	1.32
4	69	1.45
5	79	1.66
6	85	1.79
7	177	3.72
8	183	3.84
9	189	3.97
10	195	4.10
11	201	4.22
12	207	4.35
13	213	4.47

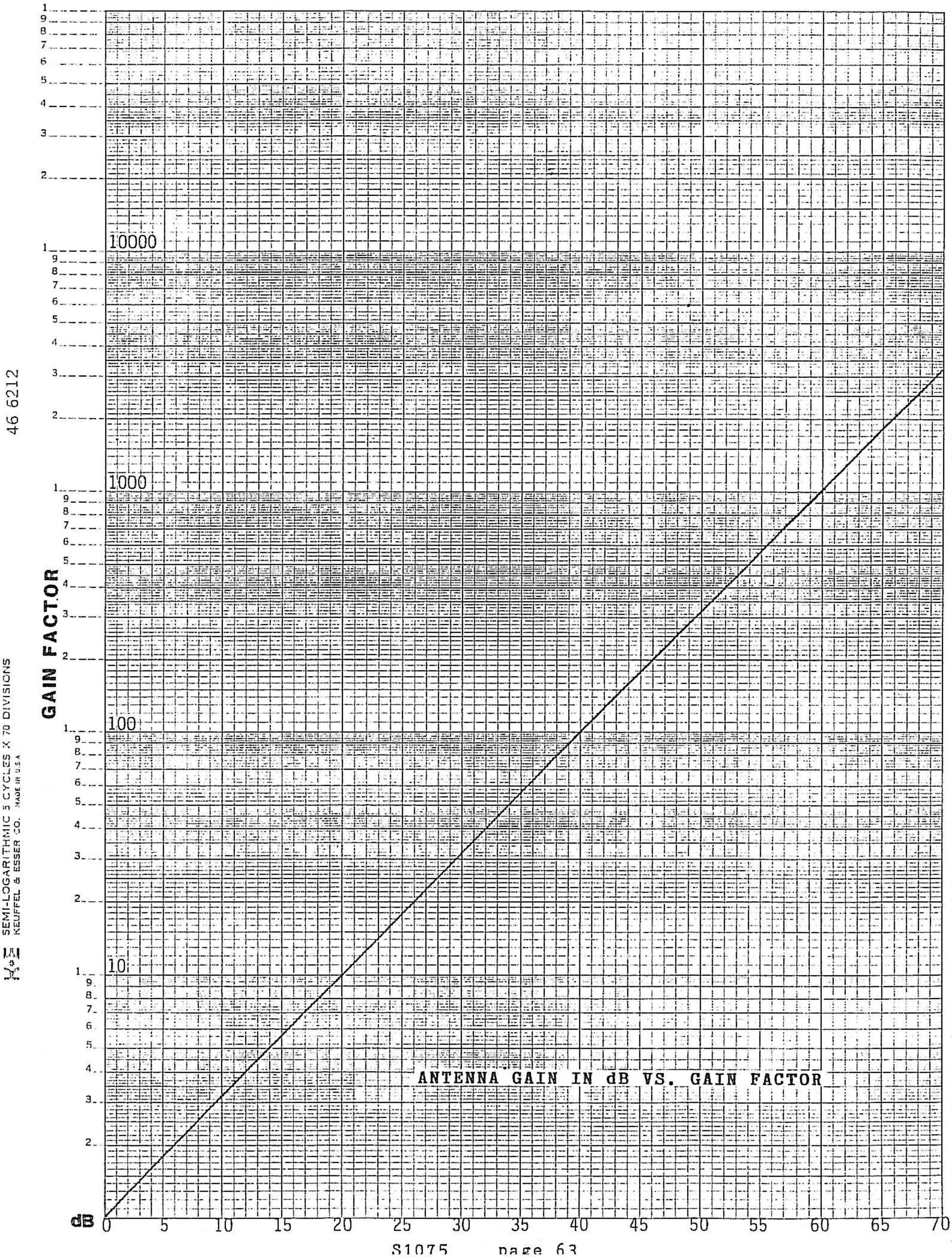
TABLE 2

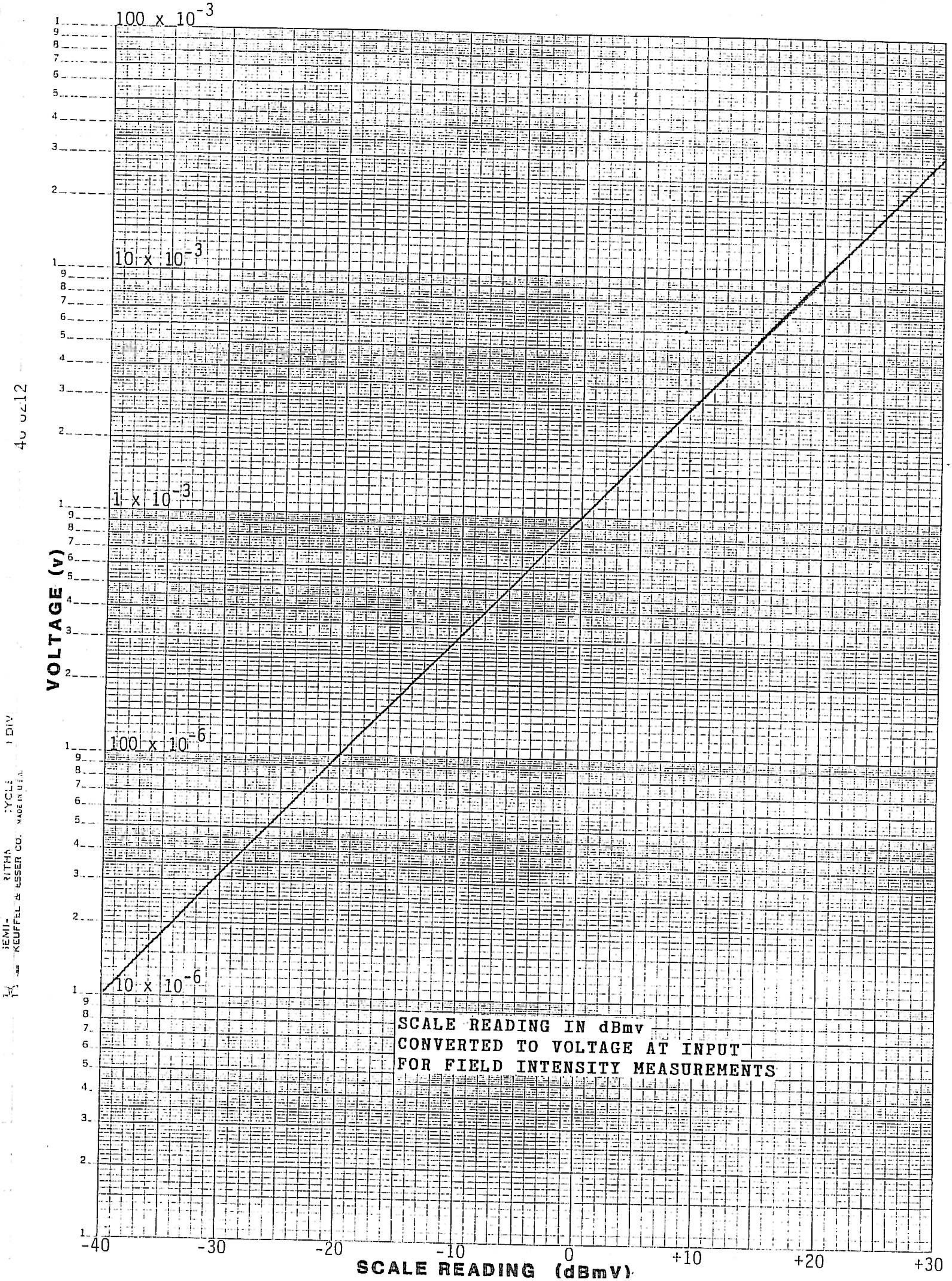
SCALE READING dBmV	INPUT VOLTAGE
-40	10 uV
-30	31.6 uV
-20	100 uV
-10	316 uV
0	1 mV
+10	3.16mV
+20	10 mV
+30	31.6 mV
+40	100 mV

TABLE 4

CONVERSION FACTORS FOR FIELD INTENSITY SURVEYS			
CHANNEL	FACTOR (C)	CHANNEL	FACTOR (C)
2	1.20	8	3.84
3	1.32	9	3.97
4	1.45	10	4.10
5	1.66	11	4.22
6	1.79	12	4.35
7	3.72	13	4.47

TABLE 5


GAIN FACTOR
10000
1000
100
10
ANTENNA GAIN IN dB VS. GAIN FACTOR
dB
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
46 6212
SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.



100 x 10^-3
10 x 10^-3
1 x 10^-3
100 x 10^-6
10 x 10^-6
VOLTAGE (v)
SCALE READING IN dBmv
CONVERTED TO VOLTAGE AT INPUT
FOR FIELD INTENSITY MEASUREMENTS
-40
-30
-20
-10
0
+10
+20
+30
SCALE READING (dBmV)
KEUFFEL & ESSER CO. MADE IN U.S.A.