INSTRUCTION MANUAL

B+K PRECISION 1050

TELEPHONE ANALYZER

B+K PRECISION DYNASCAN CORPORATION

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltage poses an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly in the equipment under test. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits.

2. Voltages of 325 Vdc and 120 Vac are present inside the Model 1050 Telephone Analyzer; servicing this or any other electrical instrument should be performed only by qualified electronics technicians trained to work in the presence of high voltage.

3. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.

4. Use an insulated floor material or a large, insulated floor mat to stand on, an insulated surface on which to place equipment; make certain such surfaces are not damp or wet.

5. Do not insert fingers or metal objects into either **TELEPHONE TEST JACK.** Whenever the analyzer is on and the **DIAL MODE/CONT.** button is engaged, 48 Vdc is present at these jacks. Also, ringing voltages between 35 Vrms and 100 Vrms are present at **TELEPHONE TEST JACK #1**, the telephone cord, and the telephone during the ring test. If telephone insulation is cracked, nicked, split, or bare wire is exposed, the cord should be replaced immediately to prevent electrical shock.

6. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.

7. When using a probe, touch only the insulated portion. Never touch the exposed tip portion.

8. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformers, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.

9. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

INSTRUCTION MANUAL ADDENDUM

for

MODEL 1050 TELEPHONE ANALYZER

Additional Information On Troubleshooting Cordless And Corded Telephones.

Some of the early users of the Model 1050 Telephone Analyzer have passed along some additional suggestions on troubleshooting corded and cordless telephones that you may find helpful.

Although the manual suggests a ring threshold of 40 volts rms, this somewhat overstates the worst case condition. FCC regulations require the telephone companies to provide a minimum of 45 volts ring signal. Thus, 45 volts is a preferred ring voltage threshold for servicing application. 40 volts would be a good threshold value for a manufacturer's test of new telephones, allowing a cushion for possible performance degradation over a long period of usage.

It was also pointed out that the manual does not give a recommended frequency tolerance for guardtone. The guardtone generator in the portable unit and the guardtone detector in the base unit should be within ±50 Hz of each other for satisfactory operation.

Another fact to consider is that many of the newer cordless telephones use a PLL (Phase Locked Loop) rather than a filter for guardtone detection. For telephones that use a PLL for guardtone detection it is actually just as easy to adjust the guardtone detector (the PLL has a frequency adjusting potentiometer) as it is to adjust the guardtone generator. Because a PLL is used, range would not be effected by offset guardtone. With a PLL system, the cordless telephone would not function at all if the frequency is off by enough to prevent the PLL from locking on to the signal.

ADDENDUM

to

INSTRUCTION MANUAL

for

MODEL 1050

TELEPHONE ANALYZER

It has been discovered that step number 9 on page 40 of the Model 1050 Instruction Manual is incorrect. Step number 9 should read as follows (underscored represents added information):

9. Plug another telephone into the **AUDIO IN** modular telephone jack, <u>select the **EXT & INT** mode of **RF OUTPUT**, and turn on the **EXT MOD LEVEL** control</u> (keeping all other controls and connections undisturbed). Turn off the **1 kHz MOD LEVEL** (turn the control fully counterclockwise). While speaking into one telephone's mouthpiece (the one plugged into the **AUDIO IN** jack) you should be able to clearly hear what is said at the earpiece of the other telephone (the one plugged into **PHONE TEST JACK #2**).

Instruction Manual
for
B+K PRECISION
Model 1050
TELEPHONE ANALYZER

B+K PRECISION DYNASCAN CORPORATION

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INTRODUCTION

The B & K-Precision Model 1050 Telephone Analyzer is a full featured test instrument for testing, troubleshooting, and adjusting corded telephones, cordless telephones, telephone answering machines, automatic dialers and most other telephone products. The instrument generates virtually all signals needed for telephone product servicing. These signals include dc telephone line voltage, 20 Hz ring signal, dial tone, ringback, fixed 1 kHz audio, variable 100 Hz to 10 kHz audio, and rf on all frequencies assigned for cordless telephone operation. The instrument also analyzes virtually all signals generated by telephone products. These include DTMF and pulse dial verification, dc levels, audio levels, relative rf level, rf frequency error, and FM deviation. Other important features include testing of telephone cords for short or open circuit paths, a variable 1.5-10 V dc power source, and jacks to accomodate an oscilloscope or frequency counter for external measurements.

CORDED TELEPHONE FUNCTIONS

This instrument simulates a telephone exchange in that it generates a dial tone, rings an on-hook telephone, stops ringing when the telephone is taken off-hook, links two telephones together for voice quality testing, and operates answering machines, automatic dialers, and other telephone products. When the analyzer is used in the dial mode of operation, the telephone test jacks simulate the voltage and resistance of a telephone line. A dial tone identical to that provided by the telephone company's is supplied at the test jacks as well as ringing signals (jack #1 only), ringback tones (jack #2 only), and voice communication between the test jacks. A switch reverses the polarity of the dc voltage applied to the first telephone test jack to allow testing of the automatic polarity circuits in the telephone.

When a telephone is plugged into the first telephone test jack, dialed numbers (from either a pulse or tone dial telephone) are decoded and displayed by the analyzer. For use with high speed dialers, the numbers are slowly released in the same order as dialed.

During the ring test, ring voltage can be adjusted from 35 to 100 Vrms. This not only tests the ability of a telephone to ring but also finds the threshold voltage of the telephone's ringer circuit. For intermittent ringing problems and signal tracing, the analyzer's ring generator can be switched to a continuous ring cycle (as opposed to the normal 2 to 2-1/2 seconds on and 3-1/2 to 4 seconds off).

When the analyzer is switched to the continuity mode of operation, the telephone test jacks and handset continuity jacks are connected so that handset and telephone line cords can be tested for shorts and breaks. The polarity switch is used to verify that the cord is wired correctly.

CORDLESS TELEPHONE FUNCTIONS

The analyzer also includes many features for cordless telephone servicing. When used in the receive mode, the instrument serves as a calibrated test receiver for servicing the companion base or portable transmitter. The tester will show whether or not a signal is being generated by the transmitter under test. Step attenuators at the input of the tester permit relative rf power output measurement. A meter measures carrier frequency error and can be switched to measure transmitter modulation. An audio output is available at an output terminal for connection to an oscilloscope, frequency counter, or other instrument. This permits convenient measurement of the guardtone frequency, for example. The audio output is also applied to a speaker, permitting voice quality and other listening tests.

When used in the transmit mode of operation, the instrument serves as an rf signal generator, simulating the base or portable transmitter for servicing the companion receiver. A properly modulated rf output from the tester should result in an audible signal from the receiver under test (go-no go test). Such a signal also permits signal tracing throughout the receiver under test. The rf output level is variable, permitting relative receiver sensitivity measurement. The rf output frequency is calibrated, thus a measurement in the receiver under test determines any carrier frequency error. A built-in 1 kHz oscillator provides convenient internal modulation and a built-in variable frequency oscillator can be used to span the audio frequency and generate guardtones. Two external modulation jacks permit modulation by an audio generator or a telephone (voice test). Internal and external modulation are independently selectable and adjustable, and both may be used simultaneously if desired. The built-in frequency error/modulation meter measures modulation or error and the level meter measures a variety of ac or dc levels from input and output connectors on the front panel. The oscilloscope output jack permits measurement of the modulating signal. A frequency counter could be connected for accurately setting the internal audio generator to the desired guardtone or ring signal frequency.

The tester operates on all radio frequencies allocated for cordless telephone usage by the FCC, including the 1.7 MHz, 46 MHz, and 49 MHz bands. Digital channel selection is fast and easy. A phase locked loop and crystal control provide stable frequency precision, serving as a standard for checking and readjusting cordless telephone frequency generation circuits.

The frequency error/modulation meter has two ranges, 0 - 3 kHz and 0 - 10 kHz. The low range provides good resolution for carrier frequency error measurement and low modulation and the high range permits measurement of fully modulated signals. Also, when the 0 - 3 kHz range and rf error mode are selected, a filter is enabled that removes the effect of guardtone modulation. This allows frequency error measurements to be made without disabling the guardtone signal in the unit under test. The built-in 1 kHz oscillator output is also available at an output jack for external use. It is convenient for modulating the rf carrier of a cordless telephone transmitter under test.

The guardtone filter can be switched in or out, permitting measurement of guardtone modulation when desired, and rejecting guardtone and high frequency noise (above 3 kHz) from the speaker for voice listening tests.

LEVEL METER FUNCTIONS

The level meter measures a variety of ac and dc signal levels. When the audio output mode is selected, three metering ranges are available. When any of the other modes are selected two metering ranges are available. All ac measurements can be made in either volts or dBm.

When the meter is used to measure telephone line audio, it shows the actual signal level that is present when operating the telephone on a telephone line. The meter may be used to measure both incoming and outgoing audio as well as dailing tone signal level.

The meter may also be used to measure the level of signals fed to the audio input jacks. This is a convenient way to set externally generated signal levels for use as a modulation source when transmitting. When the external modulation level control is turned off, the audio input telephone jack is disabled and the input impedance of the BNC jack is switched from 600 Ω to 1 MΩ. This allows the audio input BNC to be used as a probe input and the meter to be used as a general purpose ac voltmeter.

When one of the audio output pushbuttons is selected, the meter shows the output voltage of the internal signal generator. This allows you to set the level of the internally generated modulation signal without the use of an oscilloscope or ac voltmeter.

The meter also may be used to measure the level of a signal applied to the demodulator probe jack. This permits the use of a demodulator probe touched to an antenna of any cordless telephone to measure relative transmitter power.

When one of the dc volts out pushbuttons is selected, the meter shows the dc voltage that is available at the dc voltage output jacks. This allows you to set the dc voltage without the use of an external voltmeter.

The load function of the meter allows you to measure relative signal strength of 1.7 MHz band rf transmitted from the base unit. This eliminates the need for special circuits to connect the rf signal to a signal level meter.

FEATURES

TELEPHONE POWER SOURCE:
Simulates standard telephone line. When a telephone is plugged into the analyzer, a dc voltage is applied to the line through a resistance that simulates line resistance. Off-hook detection circuit in analyzer simulates conditions on standard telephone line; e.g., ring signal is automatically cancelled when telephone goes off hook.

CORD TEST:
Checks for shorts, open conductors, and bad connectors. Simply plug in a telephone cord and the indicator(s) lights if the cord is good.

RING TEST:
20 Hz ringing signal simulates a telephone exchange. Ringing voltage is variable from 35 to 100 Vrms. Switchable to continuous ringing for signal tracing and intermittent problems.

DIAL TEST:
Decodes dialing signals for both pulse and tone dial telephones and indicates number dialed. Holds up to 16 digits in memory for slow release. Slow sequence releases two numbers/second so that even rapidly dialed numbers can be easily read. Can also test Redial and Memory dial functions of a telephone. For tone dial telephones, an indicator lights when level is sufficient.

VOICE LEVEL TEST:
Indicator lights when voice level meets or exceeds minimum acceptable level.

SECOND TELEPHONE CAPABILITY:
Permits voice quality of telephone to be checked when a second telephone is available. Also permits testing of answering machines.

POLARITY TEST:
Tests automatic polarity circuit in telephone. Assures that telephone will operate if polarity of telephone line is reversed.

TELEPHONE LIGHTING:
Power is provided at the phone jack to check the light in a "Princess" type telephone (or any other telephone with a light in it).

LINE SCOPE JACK:
An output jack on the front panel allows an oscilloscope to be used to monitor dialing pulses and voice audio applied to telephone test jacks.

PRECISION DIAL TONE AND RINGBACK SIGNAL:
Simulates standard telephone company dial tone and ringback signals.

FREQUENCY RESPONSE TEST:
Using the built-in frequency generator and audio metering circuits, it is easy to test frequency response on corded or cordless telephones.

PRE-PROGRAMMED FREQUENCIES:
All frequencies that are allocated for cordless telephone usage are programmed into the tester. Using the chart at the back of this manual, you can select any frequency used for cordless telephone operation.

CHANNEL NUMBER DISPLAYED:
Channel display indicates the channel that is presently selected (0 through 99). Each cordless telephone frequency is assigned to a specific channel or channels.

RELATIVE TRANSMITTER POWER MEASUREMENTS:
Three step attenuator allows measurement of relative rf power of cordless telephone transmitters.

1.7 MHz RF LEVEL METERING:
Relative rf power of a 1.7 MHz band cordless telephone base unit transmitter can be measured. Analyzer simulates standard power line load and couples rf signal to internal meter.

RELATIVE RECEIVER SENSITIVITY MEASUREMENTS:
Three step and variable attenuators allow

"Princess" is a registered trademark of AT&T

measurement of relative rf sensitivity of cordless telephone receivers. Attenuation is variable from 0 to approximately 110 dB.

INTERNALLY GENERATED VARIABLE FREQUENCY SIGNAL:
Built-in generator provides 100 Hz to 10 kHz signal for use in modulating rf signal or for external use in signal tracing. When using the Analyzer as a transmitter, the generator may be set to ring or guardtone frequency.

INTERNALLY GENERATED 1 kHz SIGNAL:
Built-in 1 kHz generator provides audio signal for use in modulation of rf signal.

MODULATION LEVEL CONTROLS:
Front panel controls allow you to adjust the level of the external, 1 kHz, and variable frequency modulating signals independently, can be used simultaneously if desired.

THREE CHOICES OF MODULATING SIGNALS:
RF Output controls allow you to choose external modulating signal, internal modulating signal, or both internal and external modulating signals.

TWO TYPES OF MODULATING SIGNAL INPUT JACKS:
BNC or modular telephone jack allows use of signal generator or telephone as modulating signal source.

CHOICE OF RF INPUT MODE OF OPERATION:
Frequency error mode allows you to check cordless telephone transmitter carrier frequency error in kHz. Modulation deviation mode allows you to check deviation of cordless telephone carrier signal caused by modulating signal.

SCOPE OUT JACK:
An output jack on the front panel provides the demodulated signal for use with an oscilloscope or frequency counter.

DUAL SCALE DEVIATION METER:
Dual scale meter allows you to read frequency error or deviation from 0 to 3 kHz or from 0 to 10 kHz.

BUILT-IN SPEAKER AND AUDIO AMPLIFIER:
Built-in speaker allows you to listen to demodulated signal. Volume level is adjustable using the Speaker Volume control.

SELECTABLE GUARDTONE REJECT:
Reject mode connects a low pass filter which eliminates any signals above 3.5 kHz from the demodulated audio. Pass mode disconnects the low pass filter.

DEMODULATOR PROBE MEASUREMENTS:
When the demodulator probe function of the meter is selected and a demodulator probe is connected to the demodulator probe jack, the probe may be touched to the antenna of any cordless telephone for a relative measurement of the output power of the cordless telephone's transmitter. Input for demodulator probe may also be used for signal tracing of a cordless telephone rf signal.

BUILT-IN DC POWER SUPPLY:
Jacks provide variable 1.5 to 10 Volt dc voltage for powering a cordless telephone in lieu of batteries or defective power supply. May also be used to test effect of varying battery voltage. Built-in metering with two ranges allows setting of output voltage without the use of an external voltmeter.

LINE AUDIO MEASUREMENTS:
Using the level meter, it is possible to measure the level of the audio signal at telephone test jack #2.

AUDIO INPUT MEASUREMENTS:
The level meter may also be used to measure the level of audio applied to the audio input jacks. This allows the level of the externally generated signal to be set without the use of an external meter.

AUDIO OUTPUT MEASUREMENTS:
Using the level meter, it is also possible to measure the level of the internally generated variable frequency signal. This allows you to set the level of the signal without the use of an external meter.

SPECIFICATIONS

CORDLESS TELEPHONE TESTER

TRANSMIT AND RECEIVE FREQUENCIES

All assigned cordless telephone frequencies in ranges of 1.6 to 1.8 MHz, 46 to 47 MHz, and 49 to 50 MHz (see inside rear cover).

TRANSMITTER

RF Generating Systems:
Crystal-controlled phase-locked loops.

Frequency Selection:
2-Digit dedicated channel selection.

Frequency Display:
2-Digit channel number indication.

RF Temperature Stability:
± 0.001% (10 ppm).

RF Output Level:
0 dB into 50 Ω, ±3 dB; continuously variable attenuation of 0 to 20 dB, uncalibrated.

Attenuation Steps:
Low Band: 20 dB, 30 dB, and 40 dB, ±1 dB.
High Band: 20 dB, 30 dB ±1dB,
40 dB +0 dB/-5 dB.

Modulation:
F.M.

Modulation Bandwidth:
600 Hz to 7 kHz ±3 dB, 1 kHz ref.
400 Hz to 10 kHz ± 4.5 dB, 1 kHz ref.

Modulation Source:
Three sources (for use separately or simultaneously):
- internal 1 kHz generator;
- internal variable audio generator;
- external source (AUDIO IN jacks).

Modulation Voltage:
0.5 Vrms (1.4 V p-p) into AUDIO IN jack (10 Vrms absolute max).

Deviation:
0 to ±10 kHz, adjustable.

Deviation Display:
Analog meter accuracy; 0 to 3 kHz range, ±10% of full scale, 0 to 10 kHz range, ±5% of full scale.

Deviation Monitoring:
Connection for external oscilloscope.

1 kHz GENERATOR

Use:
Generates frequency modulation of internal transmitter, if selected.

Frequency:
1 kHz ±1%.

Distortion:
0.8% max.

RECEIVER

Frequency Selection:
Same method as for transmitter.

Frequency of Received RF:
Frequency error (compared to selected channel frequency) displayed on analog meter, 0 to 3 kHz and 0 to 10 kHz ranges, 8 kHz max.
0 to 3 kHz Range:
±5% of full scale, ±0.25 kHz.
0 to 10 kHz Range:
±5% of full scale.

Modulation Bandwidth:
High Band: 400 Hz to 3 kHz ±1 dB; 3 kHz to 7 kHz +1 dB/-4 dB, 1 kHz ref.
Low Band: 400 Hz to 3 kHz +1 dB/-4 dB, 1 kHz ref.

Modulation of Received RF:
Displayed on deviation meter, 0 to 3 kHz and 0 to 10 kHz ranges, 7 kHz max.
±0.3 kHz for 0 to 3 kHz deviation (high and low band).

±0.3 kHz ±10% for 3 kHz to 7 kHz deviation (high band only).

Guardtone Rejection:
Filter and switch allow observation or rejection of guardtone modulation.
3 kHz low pass filter, nominal 20 dB/octave.

Deviation Monitoring:
Connection for external oscilloscope.

Audio Monitoring:
Connection for external oscilloscope.
Built-in speaker with volume control and ON/OFF switch.

CORDED TELEPHONE TESTER

GENERAL

Telephone Line Simulation:
Single or two telephone operation.

DC Line Voltage:
52 V ±15%, 1.5 kΩ source impedance.

Current:
28 mA nominal (off hook).

Polarity Test Switch:
Dial Mode: reverses telephone line polarity.
Continuity Mode: Checks for inverted wire order in telephone and handset cords.

Voice/Dial Level Indicator:
Illuminates for levels greater than 0.1 V.

Cord Tests:
Tests both 2-wire and 4-wire telephone line and handset modular cords for shorts or continuity. Tests for both normal and inverted wire order.

Reset:
When pressed; shuts off ring, clears display, and removes dial tone.

RING SOURCE

Frequency:
20 Hz.

Voltage:
Adjustable from 35 to 100 Vrms ±10% with 1 ringer equivalent load.

Off-Hook Detection:
DC line voltage less than 25 volts inhibits ring.

Ring Cycle:
2 seconds on, 4 seconds off, or continuous ring with RING LEVEL control pulled out.

AUTOMATIC NUMBER IDENTIFICATION

DTMF (Dual Tone Multiple Frequency):

Tolerance:
Accepts tone within ±1.5% of nominal.

Tone Duration For Identification:
50 msec minimum.

Interdigit Time:
50 msec minimum.

Amplitude Response (Composite Tone):
0.25 V (-10 dBm).

PULSE DETECTION:

Rate:
8 to 20 pulses/sec.

Break Time:
30 msec minimum.

Make Time:
15 msec minimum.

Interdigit Time:
315 msec minimum.

Recognition Time (end of digit):
100 msec minimum.

Manual Dialing (pulse type and DTMF):
Detects and decodes number dialed by telephone under test.

AUTOMATIC DIALER AND REDIAL

Pulse Type:
Verifies numbers dialed.

DTMF:
Uses a delay circuit to verify numbers dialed with rates up to 10 digits/second. Digits are displayed at a rate of 2/second for easy verification.

DIALED NUMBER DISPLAY:
Single 0.43" 7 segment LED. Delay feature for high speed dialer. Digit flashes to mark display update.

TONE CHARACTERISTICS

Dial Tone:
352 Hz and 440 Hz nominal.

Dial Tone Accuracy:
±2%.

Dial Tone Amplitude(s):
0.05 V nominal.

Ringback Tone:
440 Hz and 20 Hz.

Ringback Tone Amplitude:
0.026 V nominal.

AUXILIARY CIRCUIT SPECIFICATIONS

AUDIO GENERATOR

Frequency Range:
100 Hz to 10 kHz, continuously variable.

Frequency Accuracy:
Depends on accuracy of external frequency counter.

Frequency Stability:
±0.1% ±1 Hz per 15 minute interval (after 15 min. warm-up).

Amplitude Flatness
Within ±0.5 dB, 100 Hz to 10 kHz.

Internal Use:
Generates frequency modulation for deviation level adjustments, for either voice information or guard tones. Level continuously variable. Can be monitored by external counter or oscilloscope as well as by Level Meter.

External Use:
Generates 0 to 1 Vrms (into 600Ω), variable. Amplitude can be monitored by Level Meter.

Output Impedance:
600 ohms ± 10%.

Distortion:
1% max. at 1 kHz, 3% max. for 1 kHz to 10 kHz, 6% max. for 100 to 1000 Hz.

LEVEL METER

Function Selection:
Push-button switches (interlocked).

Function Measured:
Audio Output: 0-30mV, 0-100 mV, and 0-1 V (rms).

Audio Input: 0-1 V and 0-10 V (rms).

Telephone Line Audio: 0-1 and 0-10 V (rms).

DCV Supply Output: 1.5-5 V and 1.5-10 V.

RF Demodulator Probe Input: 0-1 and 0-10 V.

Internal Dummy Load: 0-1 and 0-10 V (rms).

Accuracy:
±5% of full scale.

Input Impedance:
1 MΩ ±10% (with EXT MOD LEVEL-OFF).

Audio Frequency Response:
45 Hz to 20 kHz ±3 dB, 1 kHz ref.

dBm Scales:
Provided for use in AC functions (0 dBm = 1mW across 600 Ω).

DC VOLTS OUTPUT

Voltage Range:
1.5 to 10 V, continuously variable. Can be monitored by Level Meter.

Output Current:
0 to 150 mA, overload current limited.

Load Regulation:
0.25% or 25 mV max. change of voltage with current variation within rated limits.

Line Regulation:
0.5% or 50 mV max. change of voltage with ±10% change of line voltage within rated limits

Isolation:
Both terminals isolated from earth ground, 200 V max. allowed float voltage.

120 VAC JACK

Use:
Supplies power for a cordless telephone base station and is path for its rf output. Measures both A & B rf modes.

Output Current:
1/4 A max. (fused).

Isolation:
None.

GENERAL

Connectors
Telephone: modular RJ-11 style (4 contact).
DCV out: banana (5-way binding posts).
RF and AF: BNC.

Digital Display:
2+1 7-segment LED digits, 0.43" high.

Operating Temperature:
0^{o} to 40^{o}C (32^{o} to 104^{o}F).

Power Required:
105 to 132 V, 60 Hz, 80 VA.

Dimensions:
(H x W x D)19 x 45 x 29 cm (7.3 x 17.8 x 11.6")

Weight:
9.5 kg. (21 lbs.)

OPTIONAL ACCESSORIES
B & K-Precision Model PR-32 demodulator probe.
Cobra Model TA-302 wired to modular plug telephone adapter.
Cobra Model TA-305 4-pin to modular plug telephone adapter.
Cobra Model WP-142 standard telephone.

SUPPLIED ACCESSORIES
Model CC-53 Coupling Coil.
Instruction Manual.
Schematic Diagram and Parts List.

DEFINITIONS OF TERMS

1.7 MHz Band. Any of several specific carrier frequencies of approximately 1.7 MHz. The base-to-portable link of all earlier cordless telephones operates in the 1.7 MHz band.

46 MHz Band. Any of several specific carrier frequencies of approximately 46 MHz. The base-to-portable link of all later cordless telephones operates in the 46 MHz band.

49 MHz Band. Any of several specific carrier frequencies of approximately 49 MHz. The portable-to-base link of all cordless telephones operates in the 49 MHz band.

Carrier Frequency. The center frequency of a radio signal that can be modulated in frequency, amplitude, or other ways to transmit audio, images, or other electronic signals.

Δ(Delta) F. The amount of offset (measured in kHz) from a specified carrier frequency.

Demodulation. Separating the modulating signal from the carrier frequency. The circuit used for demodulation in cordless telephone receivers is usually called a "discriminator".

Deviation. The amount of frequency swing from the carrier frequency in FM modulation. A carrier frequency of 49.700 MHz with ±10 kHz deviation swings from 49.690 MHz to 49.710 MHz. The amount of deviation is determined by the amplitude of the modulating signal. FCC regulations specify the maximum deviation permissible for cordless telephone service.

Dial Tone. Tone generated by the telephone company to indicate that your telephone is off hook and ready to dial.

DTMF (dual tone multiple frequency). Pairs of tones generated by telephone. Each digit is a different pair of tones. Sometimes referred to as "Touch Tone".

Discriminator. An FM demodulation circuit.

EPROM (Erasable Programmable Read Only Memory). A digital logic device that stores bits of digital information (either a logic high or logic low). This particular memory device retains information even when power is removed from the chip. It is possible to erase and re-program this device using hardware that is outside of the device in which the memory is used.

FCC (Federal Communications Commision). Governs radio licensing and assigns radio frequencies for private, commercial, and governmental usage. Also enforces existing radio and communication laws. Cordless telephone carrier frequency assignment, maximum transmitter power, maximum deviation, etc. are controlled by FCC regulations.

FM (Frequency Modulation). The encoding (modulation) of a carrier signal by causing frequency changes. The amount of frequency change depends on the amplitude of the modulating signal.

Guardtone. In cordless telephone operation, a 5 to 7 kHz audio signal that modulates the portable transmitter carrier signal when in the talk mode. The guardtone is detected in the base receiver to initiate "off hook" circuit conditions. A guardtone filter prevents the 5 to 7 kHz tone from being applied to the telephone line along with the 300 - 3000 Hz voice audio. Several guardtone frequencies are used to help prevent unauthorized capture of a telephone line by nearby cordless telephones operating on the same carrier frequency.

I-F (Intermediate Frequency). A frequency within a receiver that is lower than the carrier, typically 10.7 MHz (1st i-f) and 455 kHz (2nd i-f). An i-f signal is produced by a mixer.

Mixer. A circuit with two rf input signals (typically, the received rf carrier and a local oscillator signal), whose output signal frequency equals the difference between the two input frequencies.

"Touch Tone" is a registered trademark of AT&T.

Modulation. A change in the carrier signal caused by voice, audio tones, or other electronic signals. For cordless telephones, FM modulation is used.

Off-Hook. Condition when telephone is taken out of the cradle as if engaged in a telephone call or dialing.

On-Hook. Condition of telephone when in the hung up position. Telephone is idle when on-hook.

Phase Locked Loop. A frequency generator comprised of a reference frequency oscillator, a VCO, and a feedback loop including a programmable digital divider and an error detector. By selecting different divider ratios in the programmable digital divider, a phase locked loop can operate on many different frequencies with stability and accuracy that approaches that of its single crystal-controlled reference oscillator.

Ring Signal. On a telephone line, a 20 Hz, 80 to 130 Vrms signal generated by telephone company to ring telephone. Standard signal is on for 2 to 2-1/2 seconds, off for 3-1/2 to 4 seconds. On the base-to-portable link of a cordless telephone, a specific audio tone (typically in the 700 Hz to 1500 Hz range) used to modulate the rf carrier, concurrent with the 20 Hz ring signal on the telephone line.

Ringback Signal. Signal generated by telephone company to indicate that the telephone being called is ringing. Standard signal is a 440 Hz signal chopped at 20 Hz and on for 2 to 2-1/2 seconds, off for 3-1/2 to 4 seconds.

VCO (Voltage Controlled Oscillator). Oscillator whose frequency is dependent upon the applied voltage.

CONTROLS AND INDICATORS
(Refer To Fig. 1.)

1. **POWER Switch.** Turns tester ON and OFF.

2. **LEVEL Meter.** Used in conjunction with meter range/function switch (item 39). Shows level of **LINE AUDIO, AUDIO INPUT, AUDIO OUTPUT, DEMOD. PROBE, DCV OUT,** and **LOAD.** Seven scales are provided; 0 to 10 Volts, 0 to 5 Volts, 0 to 30 mV, -infinity to -28 dBm, -infinity to 22 dBm, -infinity to 2 dBm, and -40 to -18 dBm. The 0 to 10 scale is used when range selected is **100 mV, 1 V,** or **10 V;** 0 to 5 scale when the **5 V DCV OUT** range and function are selected; 0 to 30 mV scale when the **30 mV AUDIO OUTPUT** range and function are selected; -infinty to 22 dBm scale when the range selected is **22 dBm**; -infinity to 2 dBm scale when the **2 dBm AUDIO OUTPUT** range and function are selected; and the -40 to -18 dBm scale when the **-18 dBm AUDIO OUTPUT** range and function are selected.

3. **AUDIO OUTPUT FREQUENCY Control.** Controls frequency of internally generated audio signal. Frequency is variable from 100 Hz to 10 kHz. This audio is available at the **AUDIO OUT** jack as long as the **AUDIO OUT LEVEL** control is turned on.

4. **AUX LINE Indicator.** During cord test, indicates condition of two auxiliary wires in detachable cord. When lighted, continuity is indicated.

5. **SINGLE LINE Indicator.** During cord test, indicates condition of two telephone wires in detachable cord. When lighted, continuity is indicated. For most telephones only these two telephone wires are used. The two auxiliary wires are used to carry power to a night light in a telephone.

6. **VOICE/SIGNAL LEVEL Indicator.** Lights when dialing tones are above minimum level. Lights on voice peaks when above minimum required level.

7. **DIALED NUMBER DISPLAY.** Single digit display. Indicates telephone number actually dialed. Digit is blanked momentarily between digits.

8. **CHANNEL Indicator.** Two digit display. Indicates channel in use. See inside rear cover for frequency listing of each channel.

9. **RING Button.** Starts ringing telephone at voltage set by **RINGER LEVEL** control. Ringing continues until telephone is picked up or **RESET** button is pressed.

10. **RESET Button.** Resets DIALED NUMBER DISPLAY circuitry and causes a "0" to be displayed. Also turns off dial tone and cancels ring signal.

11. **↑UP Controls.** Controls channel selection. Right button causes ones digit to count up when pressed. Left button causes tens digit to count up when pressed. Momentarily pressing button will cause one count up, holding button will cause continuous counting up. Channel is locked in when the button is released. When the ones digit counts up past 9, it does not cause the tens digit to count up (i.e. when counting up from channel 19, if only the right **↑UP** button is pressed, the next channel will be 10, not 20).

12. **CHAN. RESET Control.** Resets channel to "00" when pressed.

13. **METER RANGE Switch.** Selects **ΔF/MOD** meter range. When **3 kHz** is selected, lower **ΔF/MOD** meter scale is used and maximum reading is 3 kHz. When **10 kHz** is selected, upper scale is used and maximum reading is 10 kHz.

14. **INPUT GUARDTONE Switch.** In **RF INPUT** mode, when switch is in the **PASS**

position, guardtone and other signals above 3 kHz are passed to the **ΔF/MOD** meter, speaker, and **SCOPE OUT** jack. In **RF INPUT** mode, when switch is in the **REJ** position, guardtone and other signals above 3 kHz are filtered out and are not fed to the **ΔF/MOD** meter, speaker, and **SCOPE OUT** jack.

15. **ΔF/MOD Meter.** Shows amount of carrier frequency error or carrier deviation in kHz. Two scales are provided, 0 to 3 kHz and 0 to 10 kHz.

16. **1 kHz MOD LEVEL Control.** Controls level of 1 kHz internally generated modulating signal when **INT** or **EXT & INT** mode of **RF OUTPUT** are selected. When this control is turned fully counterclockwise, the 1 kHz signal is turned off.

17. **EXT MOD LEVEL Control.** Controls level of externally applied modulating signal when **EXT** or **EXT & INT** mode of **RF OUTPUT** is selected. Full counterclockwise rotation disables **AUDIO IN** telephone jack and terminates **AUDIO IN** BNC jack into 1 MΩ. On position enables **AUDIO IN** telephone jack and terminates BNC and telephone jack into 600 Ω.

18. **RF OUTPUT MOD Controls.** Selects output mode. The instrument acts as a cordless telephone transmitter when one of the three output modes is selected.

    EXT: When this button is engaged, carrier is modulated by external signal applied to the **AUDIO IN** jacks.

    INT: When this button is engaged, carrier is modulated by internally generated 1 kHz and/or variable frequency sine waves.

    EXT & INT: When this button is engaged, carrier is modulated by both an external signal (applied to the **AUDIO IN** jacks) and the internally generated signal(s).

19. **RF INPUT Controls.** Selects input mode. The tester acts as a cordless telephone receiver when one of the two input modes is selected.

    RFΔF: When this button is pushed in, **ΔF/MOD** meter reads amount of carrier frequency error (ΔF).

    MOD (DEV): When this button is pushed in, **ΔF/MOD** meter reads amount of carrier signal deviation caused by modulating signal.

20. **RF IN/OUT Jack.** Connector for input and output RF.

21. **INPUT/OUTPUT ATTENuation (dB).** Three switches select attenuation for both input and output rf signals. Provide 20 dB, 30 dB, or 40 dB steps of attenuation. Can be used together to give attenuation steps from 0 to 90 dB. The **OUTPUT LEVEL** control can be used in conjuction with these switches to provide up to 110 dB total output attenuation.

22. **RF OUTPUT LEVEL Control.** Controls output level of RF signal. Range of attenuation is approximately 0 to 20 dB.

23. **SCOPE OUT Jack.** Supplies demodulated output for viewing on oscilloscope when in receive mode (when one of the **RF INPUT** modes has been selected). In transmit mode (when one of the **RF OUTPUT** modes has been selected) signal that is being used to modulate carrier is supplied. Also permits measurement of signal using a frequency counter.

24. **SPEAKER VOLUME Control.** Controls volume of audio output at speaker. Complete counterclockwise rotation to **OFF** position disconnects speaker.

25. **DIAL MODE/CONT. (Continuity) Button.** Controls mode of **PHONE TEST JACKS.** When this button is engaged, the jacks are connected for cord continuity testing. When this button is disengaged, the jacks are connected for telephone testing.

26. **POLARITY NORMAL/REVERSE Button.** When the analyzer is in **DIAL MODE** of operation, button reverses po-

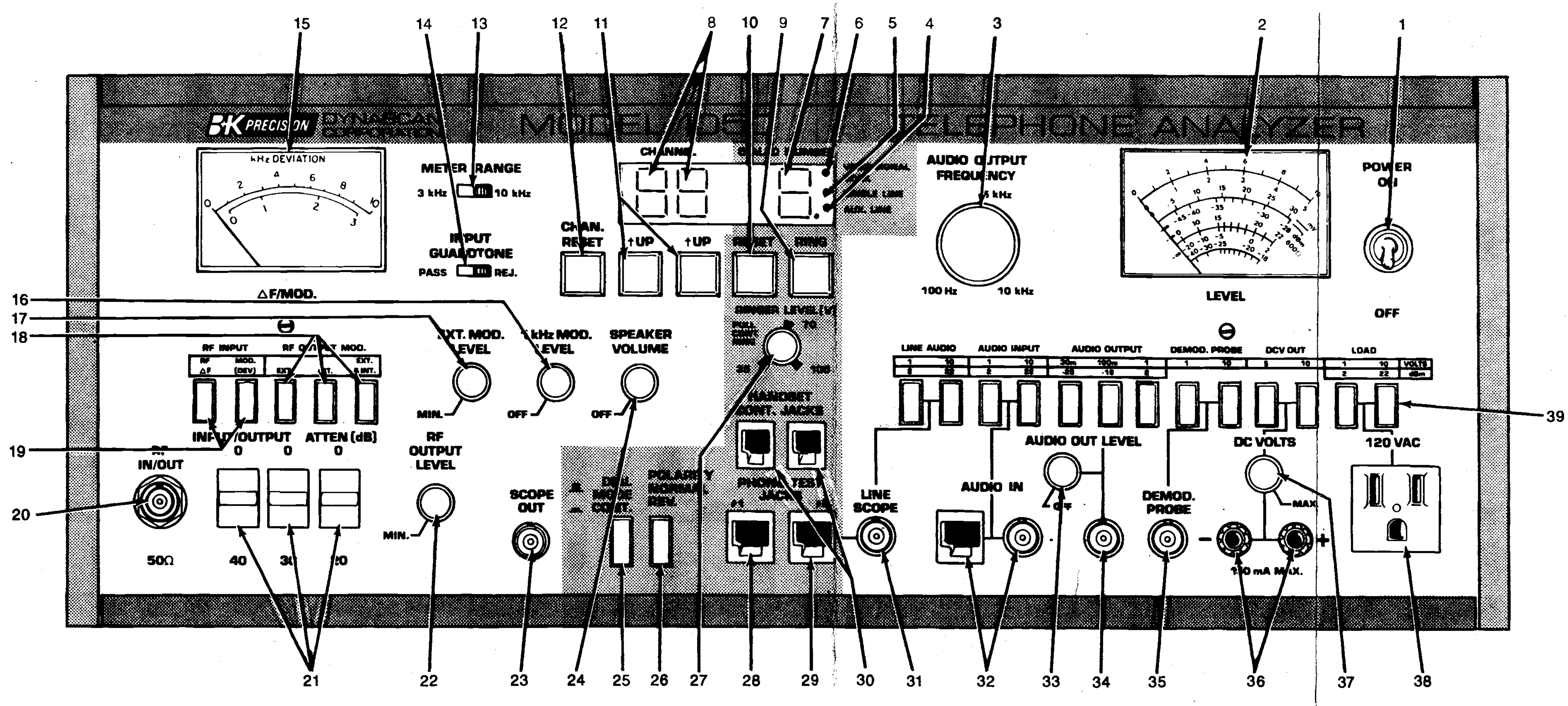


Fig. 1. Controls And Indicators.

larity to test telephone's steering diodes. When the analyzer is in the **CONT.** mode of operation, this button reverses polarity to test a cord for improper wiring (reversed leads). When this button is engaged, polarity is reversed at **PHONE TEST JACK #1.** When this button is disengaged, polarity at **PHONE TEST JACK #1** is normal.

27. **RINGER LEVEL (V)/PULL CONT. (continuous) RING control.** Adjusts level of ring signal from 35 to 100 Vrms. When this control is pulled out, ring signal is continuous from the time the **RING** button is pressed until the telephone is taken off hook or the **RESET** button is pressed (when control is pushed in, ring signal is 2 to 2-1/2 seconds on, 3 to 3-1/2 seconds off).

28. **PHONE TEST JACK #1.** Input for telephone to be tested. Also for testing telephone cords.

29. **PHONE TEST JACK #2.** Input for second telephone for testing answering machines and voice quality. Also for testing telephone cords.

30. **HANDSET CORD TEST Jacks.** Inputs for testing detachable handset cord.

31. **LINE SCOPE Jack.** Output for viewing the input and output signals that are present at the **PHONE TEST JACKS.**

32. **AUDIO IN Jacks.** Input for external modulating signals. Two types of jacks are provided, a modular telephone jack and a BNC jack. Power is provided to light the dial light in telephones that are equipped with one. **EXT MOD LEVEL** control must be on 'not fully counterclockwise) to enable telephone jack and permit external modulation. Input is terminted into 600 Ω. When **EXT MOD LEVEL** control is off (fully counterclockwise), telephone jack is disabled and BNC jack is terminated into 1 MΩ. A probe connected to the BNC jack can be used for audio signal tracing with the level of the signal measured on the **LEVEL** meter.

33. **AUDIO OUT LEVEL Control.** Controls level of variable frequency internal audio generator. Signal is available for internal rf modulation and at **AUDIO OUTPUT** jack. When control is rotated fully counterclockwise, **AUDIO OUTPUT** is turned off.

34. **AUDIO OUT Jack.** Internally generated variable frequency audio is supplied at this jack. Level is adjusted by **AUDIO OUT LEVEL** control and **AUDIO OUTPUT** buttons. Frequency is adjustable from 100 Hz to 10 kHz using the **AUDIO OUTPUT FREQUENCY** control. Jack has 600 Ω output impedance.

35. **DEMOD. PROBE Jack.** Input for a demodulator probe. Can be used to trace a signal through an rf section of a cordless telephone. Also, when connected to the antenna of the cordless telephone under test, can measure relative rf output power of telephone.

36. **DC VOLTS Output Jacks.** DC Output voltage for powering a cordless telephone portable or base unit. Variable from 1.5 to 10 Volts.

37. **DC VOLTS Control.** Controls level of DC voltage at **DC VOLTS** output jacks. Level is variable from 1.5 to 10 Volts.

38. **120 VAC Outlet.** AC outlet for a cordless telephone base unit. Outlet is only to be used for a cordless telephone because maximum current output is 1/4 A. If this current is exceeded, the fuse on the rear panel will blow. This outlet is wired to serve as an antenna dummy load for 1.7 MHz band cordless telephone base units. Relative rf power can be measured on **LEVEL** meter.

39. **LEVEL Meter Range Buttons.** Select range and function of **LEVEL** meter. All buttons are mechanically interlocked so that only one button can be engaged at a time. Each new selection disengages the previous selection.

    LINE AUDIO Buttons: When either one of these two buttons is engaged, the **LEVEL** meter displays the level of the audio applied to the

PHONE TEST JACKS. When the **1 V/2 dBm** button is engaged, the full scale voltage is 1 V and the full scale reading in dBm is 2 dBm. When the **10 V/22 dBm** switch is engaged, the full scale voltage is 10 V and the full scale reading in dBm is 22 dBm.

AUDIO INPUT Buttons. When one of these buttons is engaged, the **LEVEL** meter displays the level of the signal applied to the **AUDIO IN** jacks. When the **1 V/2 dBm** button is engaged, the full scale voltage is 1 V and the full scale reading in dBm is 2 dBm. When the **10 V/22 dBm** button is engaged, the full scale voltage reading is 10 V and the full scale dBm reading is 22 dBm.

AUDIO OUTPUT Buttons. When either one of these buttons is engaged, the **LEVEL** meter displays the level of the **AUDIO OUTPUT.** When the **30 mV/-28 dBm** button is engaged, the full scale voltage is 30 mV and the full scale reading in dBm is -28 dBm. When **100 mV/ -18 dBm** button is engaged, the full scale voltage reading is 100 mV and the full scale dBm reading is -18 dBm. These buttons also affect the maximum output at the **AUDIO OUT** jack. To allow full output at the jack, either the **1 V/2dBm** button must be engaged, or all the **AUDIO OUTPUT** buttons must be disengaged.

DEMOD. PROBE Buttons. When either one of these two buttons is engaged, the **LEVEL** meter displays the level of the rf signal applied to the **DEMOD. PROBE.** When the **1 V** button is engaged, the full scale reading is 1 Volt. When the **10** button is engaged, the full scale reading is 10 Volts.

DCV OUT Buttons. When either one of these buttons is engaged, the **LEVEL** meter displays the level of the DC voltage at the **DC VOLTS** jack. When the **5 V** button is engaged, the full scale voltage is 5 V. When the **10 V** button is engaged, the full scale voltage reading is 10 V.

LOAD Buttons. When either one of these buttons is engaged, **LEVEL** meter displays relative level of rf signal applied to **120 VAC** receptacle (earlier cordless telephones use the line cord as an antenna). When the **1 V/2 dBm** button is engaged, the full scale voltage is 1 and full scale reading in dBm is 2. When the **10 V/22 dBm** button is engaged, full scale voltage reading is 10 and the full scale dBm reading is 22.

40. **SPEAKER** (not shown). Allows user to listen to audio signal in **RF INPUT** and **RF OUTPUT** modes of operation.

41. **AC Receptacle Fuse.** (On rear panel, not shown). Fuse for front panel **120 VAC** receptacle.

42. **Line Fuse.** (On rear panel, not shown). Fuse for instrument.

INITIAL SETUP

Familiarity With Controls

It is recommended that before using this instrument to test telephone products you become familiar with the controls and functions of this analyzer. To do this, read the CONTROLS AND INDICATORS section and then, using a cordless telephone that you know is operating properly, use the analyzer to test first the non-rf functions then the rf functions (the operating instructions are set up in this order). This will give you an idea of what the analyzer is capable of and what results telephone products under test should produce.

Initial Control Settings (Refer to Fig. 2.)

It is best to begin operation with the controls set as follows:

METER RANGE switch:	**10 kHz** position
INPUT GUARDTONE switch:	**REJ** position
INPUT/OUTPUT ATTENuators:	all at 0 (up)
RF INPUT:	**RFΔF** engaged
RF OUTPUT LEVEL:	fully clockwise
SPEAKER VOLUME:	low or **OFF**
1 kHz MOD LEVEL:	mid-range
EXT MOD LEVEL:	mid-range
AUDIO OUT LEVEL:	mid-range
RINGER LEVEL (V):	35
DC VOLTS:	fully counter-clockwise

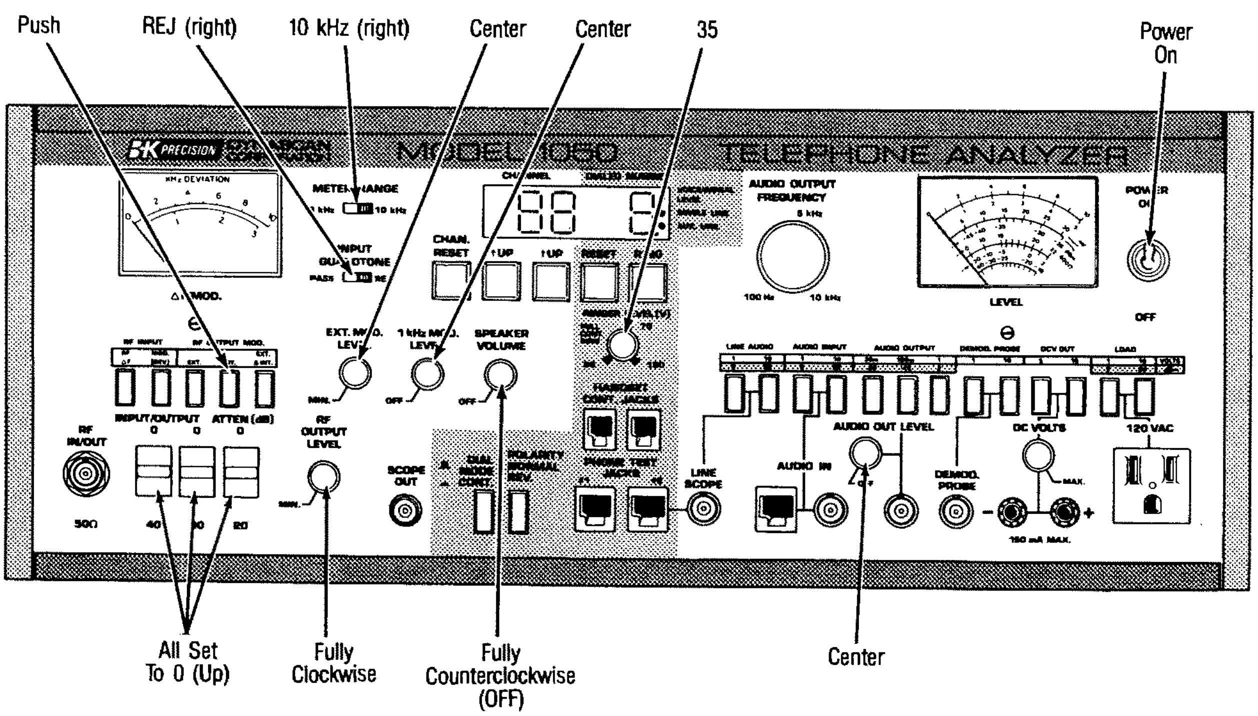


Fig. 2. Initial Control Settings.

NON-RF TESTS

CORD TEST (Refer to Figs. 3. and 4.)

This test is used to check a *DETACHABLE* handset (handset to desk unit) cord or telephone (telephone to wall) cord. *IF THE CORD IS NOT DETACHABLE AT BOTH ENDS IT CAN NOT BE TESTED; GO ON TO THE OTHER TESTS.* If the telephone cord is found to be in proper working order, any problem can be isolated to the telephone or the telephone company's equipment. If the cord is defective, other tests should still be carried out (after replacing the cord or cords) to insure that there is no problem with the telephone itself.

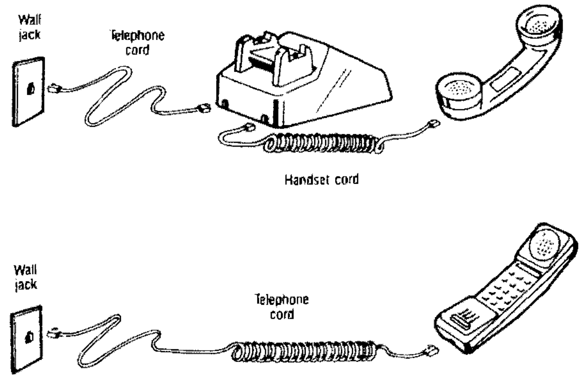


Fig. 3. Telephone Cord and Handset Cord.

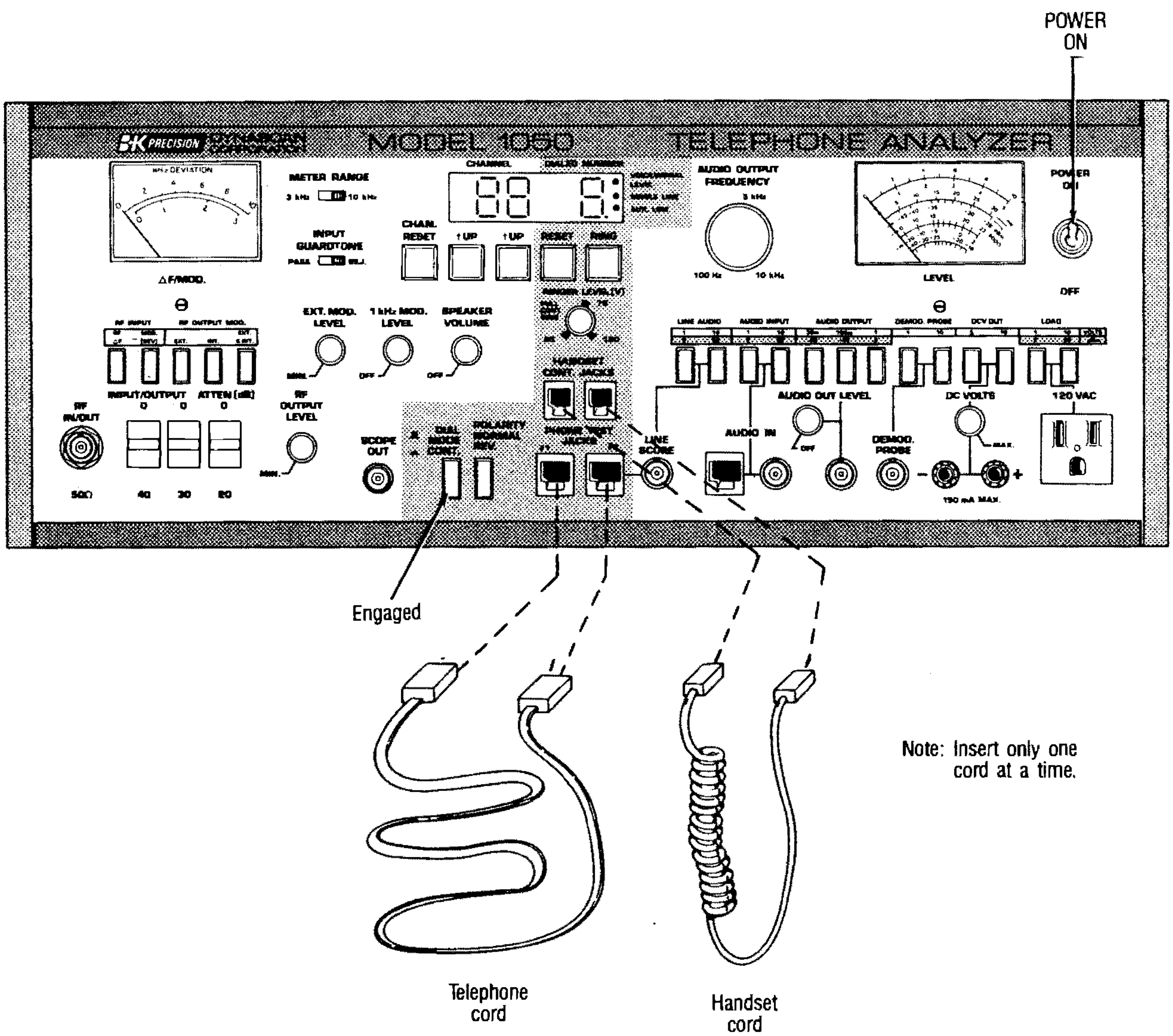


Fig. 4. Cord Test Set-up.

Only one cord can be tested at a time, *do not plug in both cords at the same time. Handset and telephone cords are not interchangeable and should not be plugged into the wrong jacks.*

1. To test the telephone cord (see Fig. 3. for example of cord type) for continuity or shorts, plug both ends of the cord into the **PHONE TEST JACKS** and make sure that the **DIAL MODE/CONT.** button is engaged. If the **SINGLE LINE** indicator lights, the cord is good for normal telephone operation. If the **AUX LINE** indicator **also** lights, the cord is good for lighted telephone operation. The **SINGLE LINE** indicator shows the condition of the two wires in the cord used for dialing, ringing, and conversation. The **AUX LINE** indicator shows the condition of the two wires in the cord that bring power to the night light in a telephone. If the indicators fail to light, the cord is defective. Gently bend and squeeze the cord to check for intermittent continuity or shorts. If the indicator(s) go out or flicker, the cord should be replaced.

2. Next, using the **HANDSET CONT. JACKS**, test the handset cord in the same manner as the telephone cord.

NOTE

The **POLARITY NORMAL/REV.** button should be disengaged for this test. If the indicator(s) fails to light, engage the **POLARITY NORMAL/REV.** button and check the indicators again. If the indicator(s) lights with the polarity reversed, the cord has reversed leads. If the telephone is not polarity sensitive, it should operate properly with this type of cord.

DIAL TEST (Refer to Fig. 5.)

This test applies to both tone dial and pulse dial (non tone dial) telephones. If tones are heard at the earpiece when digits are pressed, the telephone is a tone dial model, if a series of clicks are heard, it is a pulse dial model. When numbers are dialed faster than 2 digits/second, the tester stores up to 16 digits in its memory and releases them at 2 digits/second. If you wish to clear the **DIALED NUMBER** display, press the **RESET** button. This will clear the memory and place a "0" on the display (unless telephone is still dialing).

1. Make sure that the **DIAL MODE/CONT.** button is disengaged and plug the telephone that you wish to test into **PHONE TEST JACK #1.** *If a telephone is plugged into PHONE TEST JACK #2, make sure that the telephone is hung up (on hook) throughout this test.*

2. Hang up the telephone under test (place it on hook).

3. Pick up the telephone under test (take it off hook) and listen for the dial tone. If no dial tone is present this indicates that the telephone will not operate properly and should be repaired or replaced.

4. Press or dial each digit (be sure to use all 10 digits). With tone dial telephones it is also possible to test the "*" and "#" keys. The "*" key displays a decimal point (.) and the "#" displays a bar (-) on the **DIALED NUMBER** display. Each digit should appear on the **DIALED NUMBER** display in the same order as dialed. The display blanks momentarily each time a new digit is displayed so that if the same digit is dialed two or more times in a row (example: 177-2266), each individual digit can be distinguished. Also, each time a number is pressed on a tone dial telephone, the **VOICE/SIGNAL LEVEL** indicator should light. If the numbers do not appear on the **DIALED NUMBER** display in the correct order (or the **VOICE/SIGNAL LEVEL** indicator does not light each time a digit is pressed on a tone dial telephone), the telephone's dialing system is not operating properly and the telephone should be repaired or replaced. If you wish to view the dialing pulses (from a pulse dial telephone), an oscilloscope can be connected to the **LINE SCOPE** jack on the front panel.

5. It is also possible to test the redial feature of a telephone. To do so, perform steps 1 through 4 of the DIAL TEST

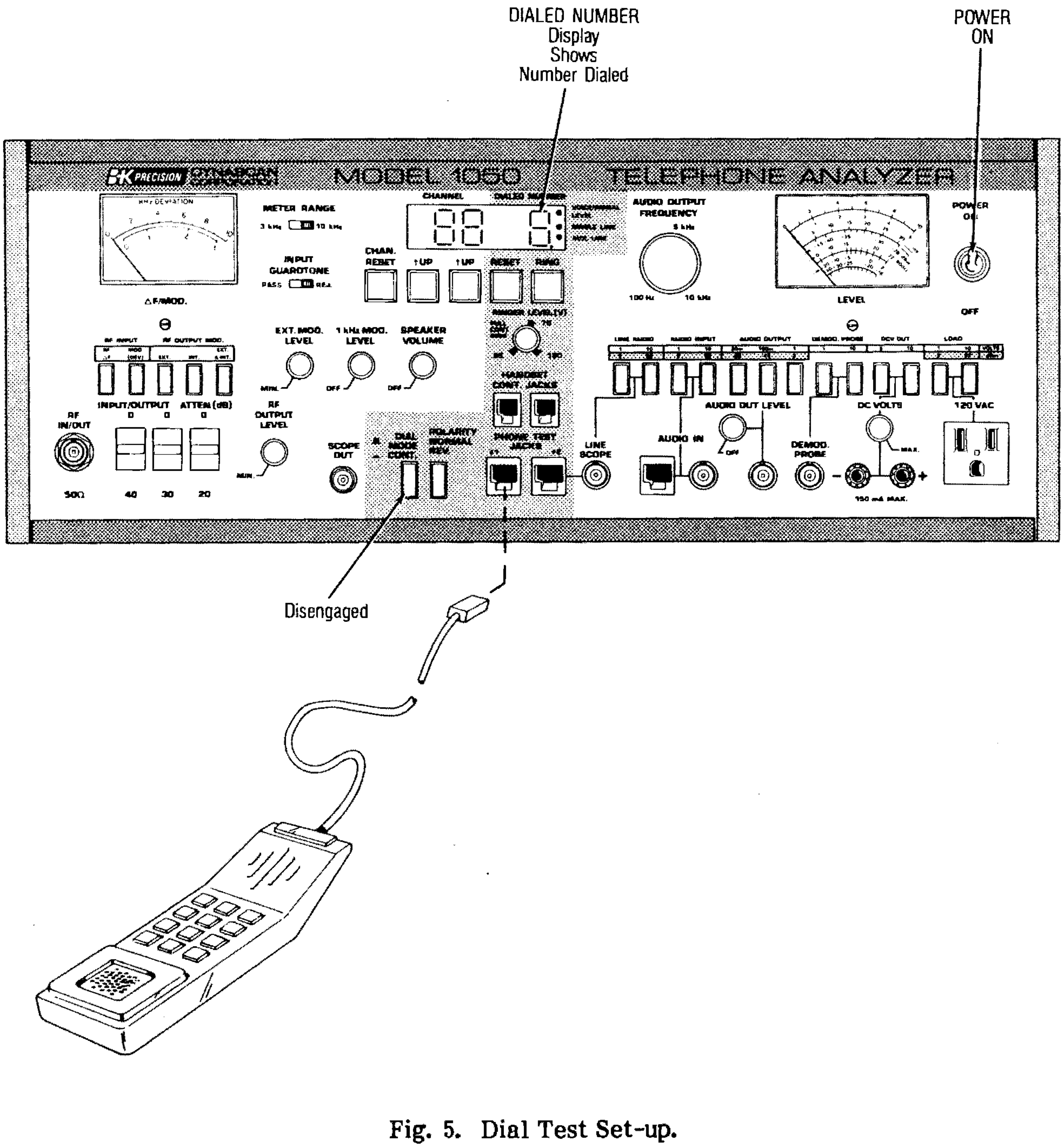


Fig. 5. Dial Test Set-up.

and then perform the redial feature for the telephone under test. Each digit should again appear on the **DIALED NUMBER** display in the same order as dialed. If all the digits do not appear in the same order as they were dialed, the telephone's redial function is not operating properly and the telephone should be repaired or replaced.

RING TEST (Refer to Fig. 6.)

DO NOT HOLD THE TELEPHONE NEAR YOUR EAR DURING THIS TEST, ringing might be loud enough to cause hearing damage if the telephone is rung next to your ear.

1. Plug the telephone that you wish to test into **PHONE TEST JACK #1** and hang it up (place it on hook).

2. Adjust the **RINGER LEVEL (V)** control to 35 and press the **RING** button. Slowly increase the **RINGER LEVEL (V)** control until the telephone begins to ring. The telephone should ring until it is picked up (taken off hook). When the telephone starts ringing you have reached the threshold voltage of the telephone's ringer circuit. If the telephone will not ring at all (even with the **RINGER LEVEL (V)** control turned all the way up), it should be repaired or replaced. If the telephone will not ring with less than 100 V (most telephones should ring with as low as 40 V), it indicates that the telephone will not work in a long line situation (when the telephone is to be used many miles from a switching station). In this case the telephone should be repaired or replaced. If you wish to listen to the ringback tone while the telephone is ringing, a second telephone can be plugged into **PHONE TEST JACK #2** and held up to your ear.

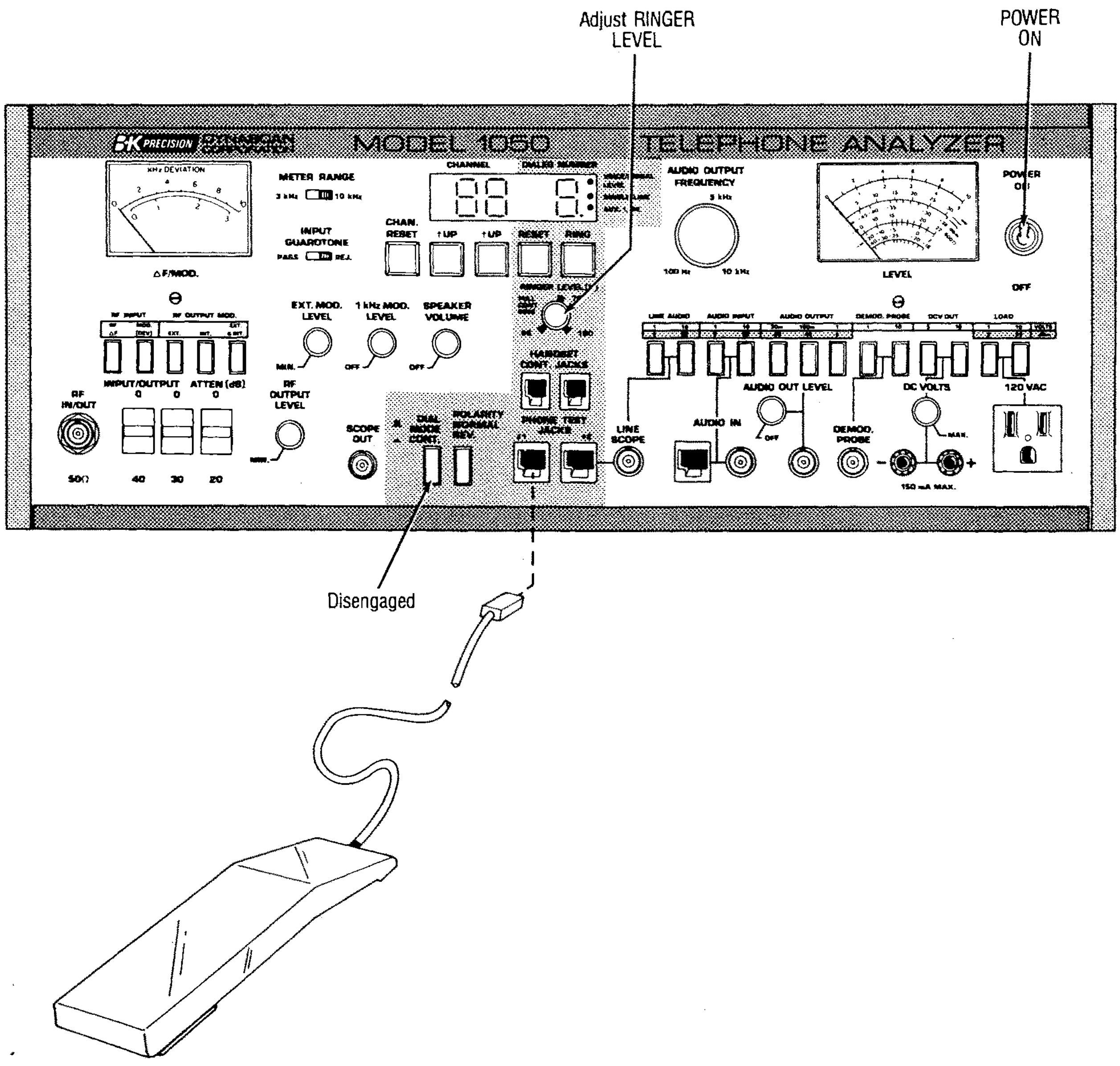


Fig. 6. Ring Test Set-up.

3. To cause the telephone to ring continuously (rather than the 2 to 2-1/2 seconds on and 3-1/2 to 4 seconds off), pull the **RINGER LEVEL (V)** control out. This will cause continuous ring generation for tracing or measuring the signal.

NOTE

If a large number of telephone-type devices are connected to a telephone line it could prevent a good telephone from ringing. If the telephone being tested fails to ring when actually hooked up to a telephone line but rings under this test, exceeding the ringer equivalent could be the cause of the problem. The ringer equivalent number is on the telephone. If the total ringer equivalents exceed 5, this could be the cause of the problem.

VOICE LEVEL TEST (Refer to Fig. 7.)

1. Plug the telephone that you wish to test into **PHONE TEST JACK #1** and pick up the telephone (take it off hook).

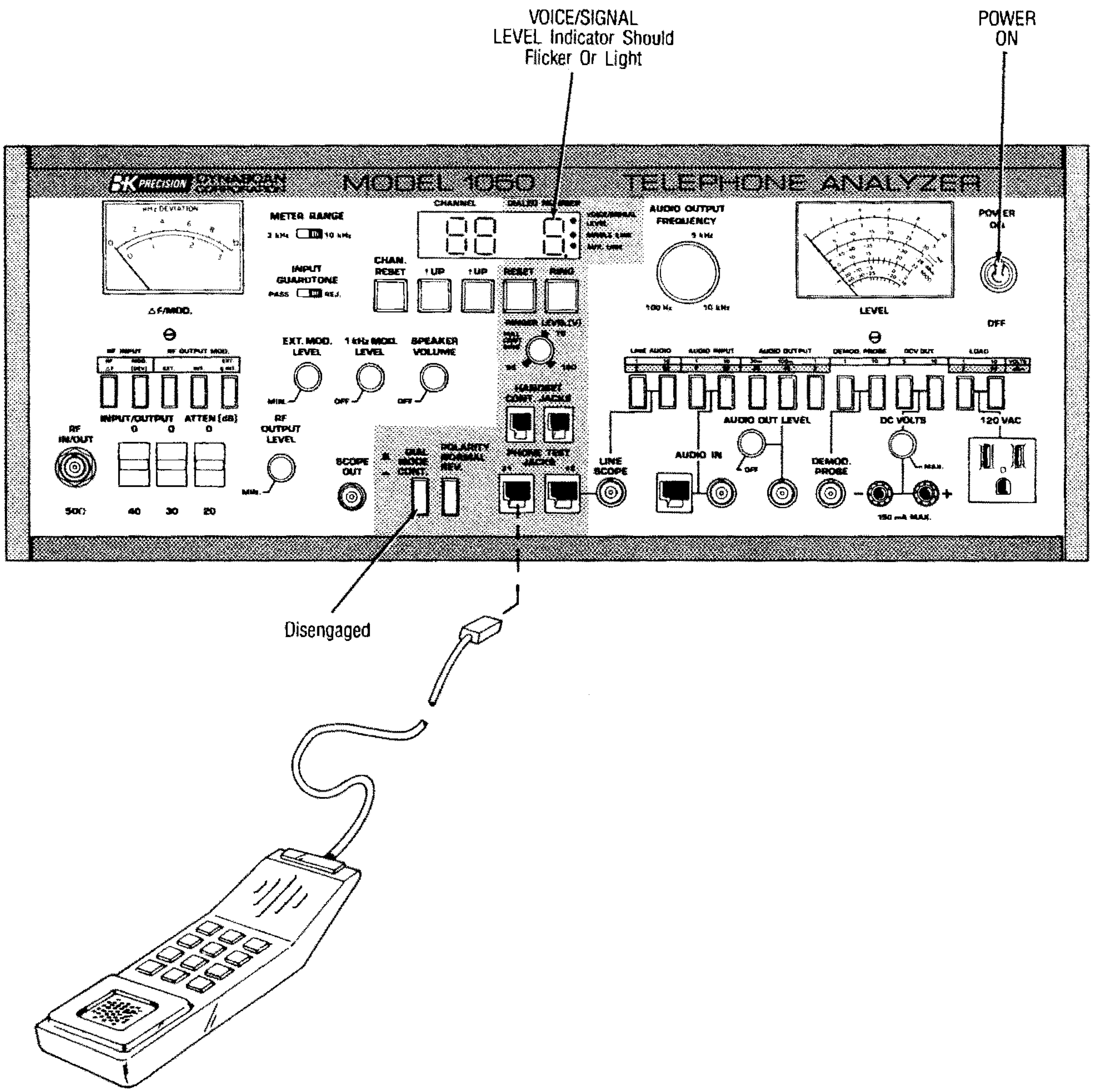


Fig. 7. Voice Level Test Set-up.

2. Press the **RESET** button to stop the dial tone. It is important to turn off the dial tone while checking the **VOICE/SIGNAL LEVEL** indicator because the dial tone will cause the tester to read the voice level inaccurately. The **VOICE/SIGNAL LEVEL** indicator should light or flicker when you talk into the telephone. If the indicator fails to light occasionally while you are talking into the telephone, the telephone should be repaired or replaced.

3. Set the **POLARITY NORMAL/REV.** button to the **REV.** position (engaged) and repeat steps 1 and 2 of the VOICE LEVEL TEST. This reverses the polarity of the power supplied to the telephone and should not affect operation of most telephones. Some telephones are not polarity guarded (usually telephones that are at least several years old). Check the schematic diagram of the telephone under test to see if it is polarity guarded or not. If the telephone is not polarity guarded there is no need to repair it if it does not operate properly when the polarity is reversed. However, the polarity of the telephone line must be correct to assure that the telephone will operate properly. If the telephone is polarity guarded and the test results are not the same with the polarity reversed, the telephone should be repaired or replaced.

4. It is also possible to check the level of the audio signal by switching to the **LINE AUDIO** mode of metering. The signal strength will be read on the **LEVEL** meter.

VOICE QUALITY TEST (Refer to Fig. 8.)

To test the voice quality, two telephones are required.

1. Plug the telephone that you wish to test into **PHONE TEST JACK #1** and a telephone that is known to be in working order into **PHONE TEST JACK #2.**

2. Pick up both telephones (take them off hook). You should now be able to talk and listen as if a telephone call has been completed between the two telephones.

   a. From telephone 1 you should be able to clearly hear the person talking into telephone 2 (the telephone that is known to be in working order). This checks the quality of the audio reception of telephone 1.

   b. The person at telephone 2 should be able to clearly hear you talking into telephone 1. This checks the quality of the audio transmission from telephone 1.

CORDLESS TELEPHONE TEST

To test the non-rf functions of a cordless telephone simply perform the following steps:

1. Plug the cordless telephone's base unit ac power cord into the **120 VAC** outlet on the front panel.

2. Plug the base unit's telephone cord into **PHONE TEST JACK #1.**

3. Test procedures for cordless telephones are identical to test procedures for regular telephones. Be sure however, to follow the instruction manual for the cordless telephone under test. Perform each telephone test in this manual to assure that all functions of the telephone are operating properly. If the cordless telephone does not ring, dial, or perform as expected, there are many additional tests that can be performed by the Telephone Analyzer to isolate the problem. Additional tests can also be performed to determine relative power, relative sensitivity, etc.

ANSWERING MACHINE TEST

This analyzer can also be used to check telephone answering machines. To test an answering machine perform the following steps:

1. Plug the answering machine's ac power cord into an ac outlet (other than the front panel outlet on the anlalyzer).

2. Plug the answering machine's telephone cord into **PHONE TEST JACK #1.** Plug a

telephone known to be in working order into **PHONE TEST JACK #2.**

3. Set the **RINGER LEVEL (V)** control to 100 (make sure that this control is not pulled out during this test).

4. To cause the answering machine to answer a call, switch the answering machine to the answering mode and pick up telephone 2 (take it off hook). Press the **RING** button and after enough rings have been generated the answering machine should answer the call (for example; if the answering machine is set to answer a call after five rings, after the fifth ring the answering machine should answer the call). If the answering machine fails to answer the call, it should be repaired or replaced.

5. After the answering machine answers the call, you should clearly hear the prerecorded message from the earpiece of the telephone plugged into **PHONE TEST JACK #2.** When the answering machine

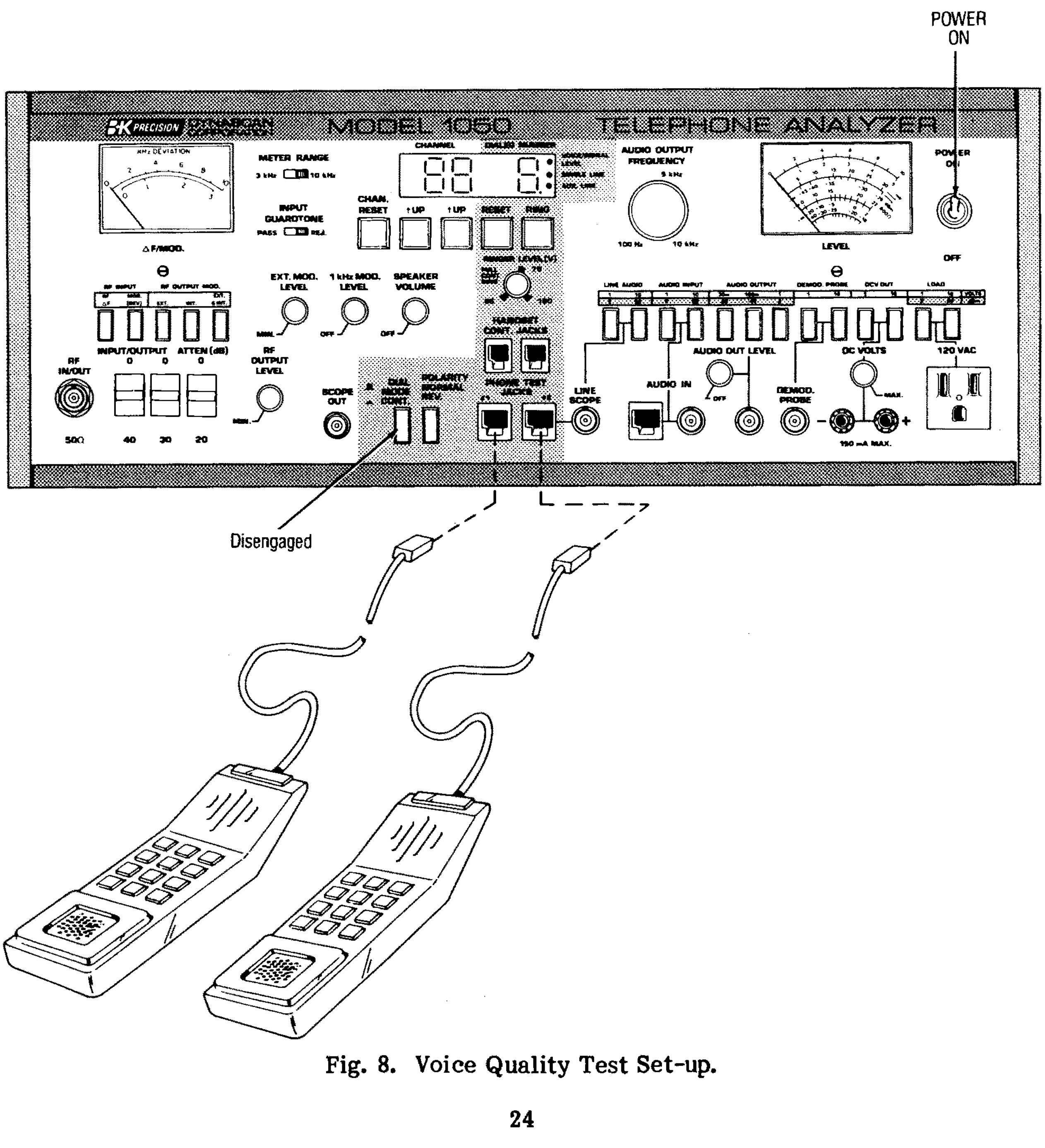


Fig. 8. Voice Quality Test Set-up.

gives the tone to leave a message, speak into the telephone to leave a message. Hang up the telephone (put it back on hook) and play back the message.

6. If the answering machine has a remote message playback feature you can test this also. Repeat steps 4 and 5 and after the call has been answered, signal the answering machine to playback the messages. You should be able to hear the messages on the telephone plugged into **PHONE TEST JACK #2.**

7. After you have verified that the answering machine is operating properly, set the **RINGER LEVEL (V)** control to approximately 50 (about midway between 35 and 70). With the answering machine still in the answer mode, press the **RING** button. The answering machine should again answer the call after enough rings have been generated. If the answering machine fails to answer the call, it indicates that it will not operate properly in a long line situation (when the telephone is to be used many miles from a switching station) and the answering machine should be repaired or replaced.

AUTOMATIC TELEPHONE DIALER TEST

1. Plug the automatic telephone dialer's ac power cord into an ac outlet (other than the front panel outlet on the anlyzer).

2. Program each memory in the automatic dialer to dial any number (it is best to use each digit at least once).

3. Using **PHONE TEST JACK #1,** hook up the telephone dialer according to its manual.

4. Perform steps 1 through 4 of the DIAL TEST using the automatic dialer in place of the telephone to be tested. Test each memory in the same manner.

THE TELEPHONE ANALYZER AS A DEMONSTRATOR

The Telephone Analyzer makes a good device for telephone demonstrations.

1. The analyzer can be used to show a person how to operate special features of a telephone. For example; to demonstrate the use of a redial feature, perform the DIAL TEST and the redial function of the telephone.

2. The tester can also be used to show a person how to operate a cordless telephone. Simply hook up the telephone as described in the CORDLESS TELEPHONE TEST and then go to the desired operation you wish to demonstrate. For example; to demonstrate the dialing procedure, you would perform the DIAL TEST.

RF TESTS

Attaching An "Antenna"

In order to transmit or receive signals it is necessary to attach some kind of an antenna. For convenience, a BNC receptacle (**RF IN/OUT**) and an antenna coupling coil have been provided. The coupling coil may be used in all tests when checking 46/49 MHz band cordless telephones and all tests except "Checking Base Unit Carrier Frequency Error" and "Checking Base Unit Modulation and Audio Quality" when checking 1.7/49 MHz band cordless telephones. Simply connect the coil's BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer and place the coil as instructed in the individual test procedures that follow. For the tests that the coupling coil may not be used for, a BNC to clips cable is recommended. Connect the BNC end of the cable to the **RF IN/OUT** jack and place the clips as instructed in the test procedures that follow.

Cordless telephones with a base-to-portable frequency in the 1.7 MHz band use the power cord as the base unit transmitting antenna and a ferrite bar as the portable unit receiving antenna. If the base-to-portable frequency is in the 46 MHz band, the telescoping antennae on the base and portable units are used. Most cordless telephones use telescoping antennae for portable-to-base communication; however, some of the compact cordless telephones use a ferrite bar in the portable unit and the line cord in the base unit. More information is given on how to connect the "antenna" later in this section of the manual.

CHANNEL SELECTION

The analyzer provides every frequency allocated for cordless telephones within the 99 channels programmed into its memory. For a listing of these frequencies and the corresponding channels please refer to the chart on the inside rear cover of this manual. To determine the operating frequency of a specific cordless telephone, consult its service manual. Usually, a channel number will be indicated on the cordless telephone itself. For example, if a Cobra cordless telephone is being tested and the channel indicated on the telephone is CH 1A, after checking the manual you will find that the portable-to-base unit frequency is 49.830 MHz and the base-to-portable frequency is 1.690 MHz. A guardtone, or pilot signal frequency is also indicated on the telephone (e.g., G1) but identification of guardtone frequency is not necessary for channel selection. For further information on guardtone frequencies refer to the section titled "RECEIVING SIGNALS" later in this manual.

The selected channel is indicated by the two digit **CHANNEL** display on the front panel. Three controls are provided to select the desired channel, a **CHAN. RESET** and two ↑**UP** buttons. When the **CHAN. RESET** button is pressed, the channel is reset to channel 00. When one of the ↑ **UP** buttons is pressed, the corresponding digit will count up once each time the button is momentarily pressed. If the button is held in, the channel will continue to count up until the button is released. The new channel is locked in when the button is released. The right ↑ **UP** button controls the ones digit and the left ↑**UP** button controls the tens digit. Scrolling the ones digit up has no effect on the tens digit (i.e., if channel 19 is selected and the right ↑**UP** button is pressed, the next channel will be 10, not 20).

1. Turn the **POWER** switch on. The **CHANNEL** indicator will display 00, the **DIALED NUMBER** display will light, and the panel meter light will come on when the power is on.
2. Obtain the channel number from the telephone (for this example the channel number on the Cobra cordless telephone will be CH 1A).
3. Check the telephone service manual for the cordless telephone frequency that corresponds to that channel number (for Cobra cordless telephones, CH 1A corresponds to a portable-to-base frequency of 49.830 MHz and a base-to-portable frequency of 1.690 MHz).
4. Check the frequency chart on the inside rear cover of this manual for the ana-

lyzer channels that correspond with the 49.830 MHz and 1.690 MHz frequencies. The 49.830 MHz frequency is used on channel 22 and channels 30, 32, 34, 36, and 38. The 1.690 MHz frequency is used on channel 2 and channels 31, 33, 35, 37, and 39. Some frequencies are used on more than one channel for convenience. By using channels 30, 32, 34, 36, and 38 in conjunction with channels 31, 33, 35, 37, and 39 the frequency can be switched between "portable-to-base" and "base-to-portable" by momentarily pressing the ↑**UP** button on the right a single time. When channel 39 is reached, pressing the ↑**UP** button on the right once more will bring the analyzer back to channel 30 again.

5. If you wish to test the portable unit transmitter (operating on Cobra channel 1A), you should select channel 30. This will cause the analyzer to receive the signal from the portable transmitter as if the analyzer was the base receiver. Press the left ↑**UP** button and hold it until channel 30 is indicated. Upon releasing the button, channel 30 (49.830 MHz) is selected.

6. If after testing the portable unit transmitter you wish to test the portable unit receiver, you will have to change to channel 31 (1.690 MHz). Pressing the right ↑**UP** button once will change the channel to 31.

RECEIVING SIGNALS

This instrument can receive signals on any of the frequencies allocated for cordless telephones. This means the analyzer can receive signals transmitted by either the base unit or the portable unit. Signals transmitted by a portable unit use a 49 MHz carrier (49.670 to 49.990 MHz) and signals transmitted by a base unit use either a 1.7 MHz carrier (1.665 to 1.770 MHz) or a 46 MHz carrier (46.610 to 46.970 MHz).

Checking Portable Unit Carrier Frequency Error (Refer to Fig. 9.)

1. Set the analyzer to the channel that corresponds to the portable-to-base frequency of the cordless telephone. This frequency should be around 49 MHz, as this is the frequency band allocated by the FCC for portable-to-base transmission.

2. With the arrow (printed on the coupling coil label) pointing toward the base of the antenna, place the coupling coil over the fully extended antenna stalk. It is best to hold the portable unit as you would during normal operation throughout testing. If no external antenna is present on the portable unit, use the BNC to clips cable by holding the clips near the cordless telephone's ferrite antenna.

3. Set the **METER RANGE** switch to the **10 kHz** position, the **INPUT GUARD-TONE** switch to **REJ**, and press the **RFΔF** button located with the **RF INPUT** controls of the analyzer. The **ΔF/MOD** meter will now show the amount of offset (error) from the carrier frequency (indicated in kHz on the upper scale). If the reading is above 3 kHz, adjust the carrier frequency of the telephone for as low an error reading as possible. If the reading is below 3 kHz (initially or after adjusting), set the **METER RANGE** switch to the **3 kHz** position. Now the deviation is read on the lower scale (still in kHz). If the reading is above 2 kHz, the carrier frequency is off by a considerable amount and the telephone should be adjusted accordingly. The meter does not indicate whether the frequency is off in a positive or negative direction. Watch the meter closely as you adjust the carrier frequency. If the reading increases as you adjust the frequency you are adjusting in the wrong direction - adjust the telephone to get as low a reading as possible. Typically, no adjustment is attempted if the initial reading is less than 2 kHz.

NOTE

It is important to begin testing carrier frequency error with the **METER RANGE** switch in the **10 kHz** position. When the switch is in the **3 kHz** position a low pass filter is engaged to remove the effects of guardtone modula-

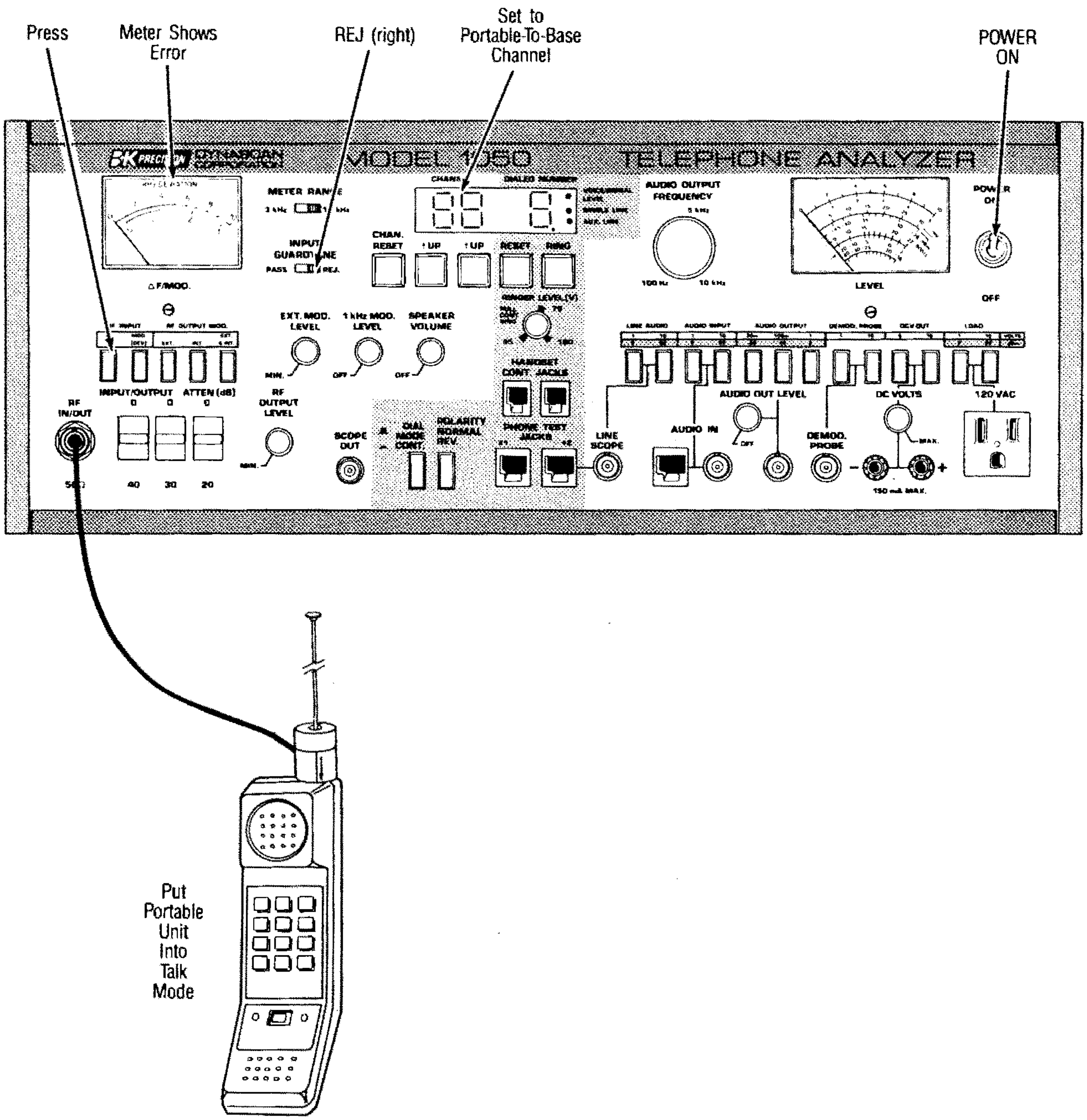


Fig. 9. Checking Portable Unit Carrier Frequency Error.

tion. This filter not only removes modulation above 3 kHz, but also frequency error greater than 3 kHz. Thus, there may be very low meter readings on the 3 kHz range when the error is much greater than 3 kHz.

Checking Guardtone (Pilot Signal)
(Refer to Fig. 10.)

1. Set the analyzer to the channel that corresponds to the portable-to-base frequency of the cordless telephone. The frequency should be around 49 MHz, as this is the frequency band allocated by the FCC for portable-to-base transmission.

2. With the arrow (printed on the coupling coil label) pointing toward the base of the antenna, place the coupling coil over the fully extended antenna stalk. It is best to hold the portable unit as you

would during normal operation throughout testing. If no external antenna is present on the portable unit, use the BNC to clips cable by holding the clips near the cordless telephone's ferrite antenna.

3. After it has been determined that the carrier frequency is within specifications (no more than 2 kHz of error), set the **METER RANGE** switch back to the **10 kHz** position and press the **MOD (DEV)** button (located with the **RF INPUT** controls of the analyzer). The **ΔF/MOD** meter will now show the deviation (measured in kHz on the upper scale) caused by the modulating signal.

4. Set the **INPUT GUARDTONE** switch to the **PASS** position. This passes the guardtone (pilot signal) and other signals above 3 kHz. The guardtone (pilot signal) is an audio signal that is used to cause the base unit to lock on to the sig-

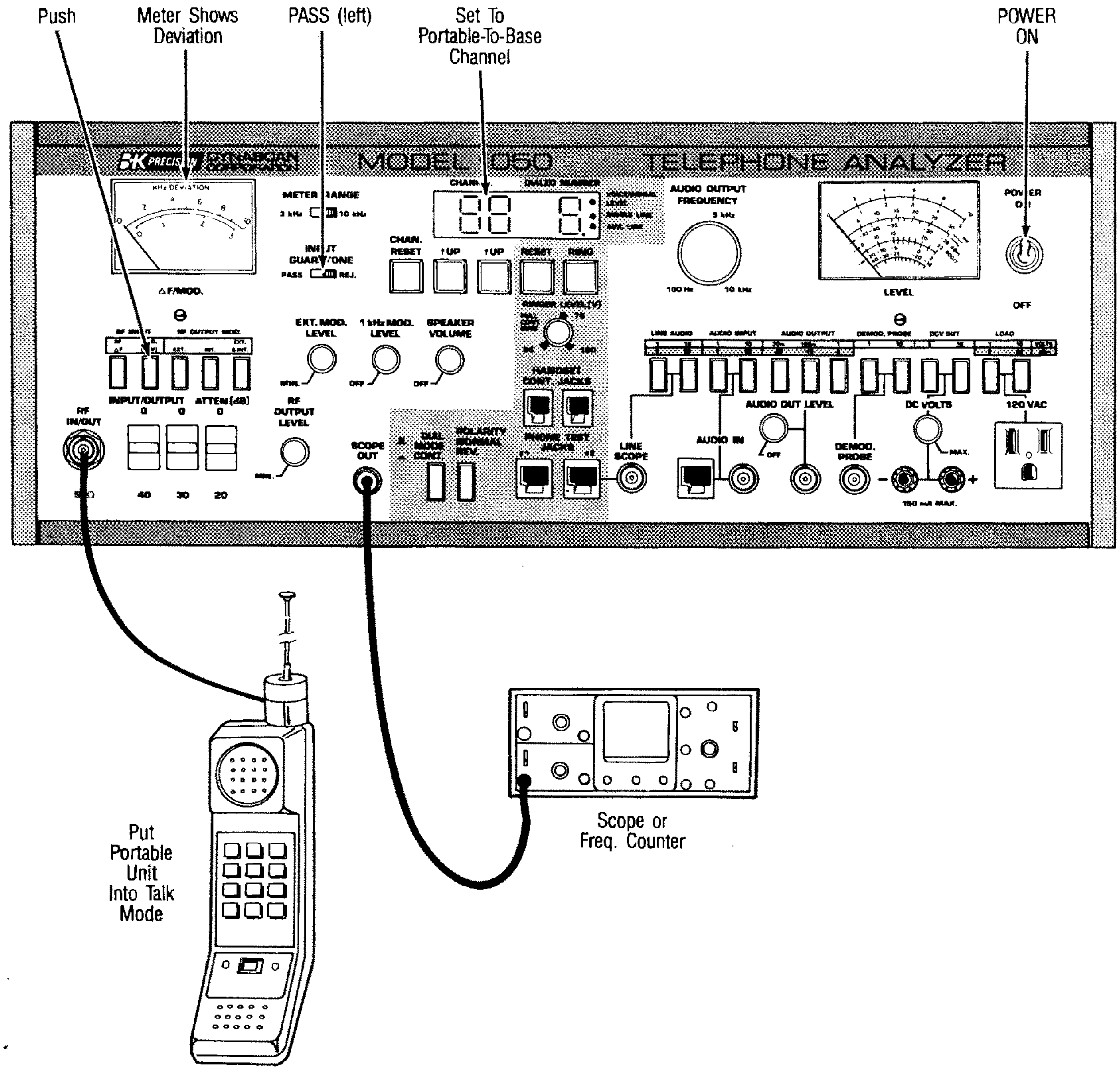


Fig. 10. Checking Guardtone.

nal being sent by the portable unit. To identify the guardtone frequency, check the cordless telephone's service manual.

5. Connect an oscilloscope or frequency counter to the **SCOPE OUT** jack. To view the signal on an oscilloscope, a vertical setting of 0.5 V/Div and a horizontal setting of 0.2 ms/Div are recommended. Check that the frequency of the output matches the guardtone (pilot signal) frequency specified in the telephone's service manual. If the frequency is not within specifications, adjust it accordingly.

6. To test the relative transmitter power of the portable unit, transmit a signal to the analyzer from a known good cordless telephone portable unit and note how much attenuation you can select and still receive the signal clearly. The unit under test should be able to clearly transmit a signal to the Analyzer with approximately the same amount of attenuation selected.

NOTE

If the cordless telephone's portable unit has a mute switch, it is preferable to keep it depressed while checking the guardtone. If it does not have a mute switch, cover the mouthpiece and be careful not to allow any sound to reach the mouthpiece. If any audio (other than the guardtone) is transmitted by the portable unit, it will cause the guardtone frequency reading to be inaccurate.

Checking Portable Unit Modulation And Audio Quality (Refer to Fig. 11.)

1. Set the analyzer to the channel that corresponds to the portable-to-base frequency of the cordless telephone. The frequency should be around 49 MHz, as this is the frequency band allocated by the FCC for portable-to-base transmission.

2. With the arrow (printed on the coupling coil label) pointing toward the base of the antenna, place the coupling coil over the fully extended antenna stalk. It is best to hold the portable unit as you would during normal operation throughout testing. If no external antenna is present on the portable unit, use the BNC to clips cable by holding the clips near the cordless telephone's ferrite antenna.

3. Set the **INPUT GUARDTONE** switch to the **REJ** position. This will eliminate the guardtone (pilot signal) and all high frequency (above 3 kHz) "noise".

4. Set the **METER RANGE** switch to the **10 kHz** position. While speaking into the portable unit's mouthpiece, watch the **ΔF/MOD** meter. The meter's needle should deflect away from zero (typical readings are approximately 1 to 2 kHz). This indicates the carrier deviation caused by the modulating signal. As you speak into the mouthpiece more loudly, the deflection will increase. If the reading remains at or below 3 kHz, you may switch the **METER RANGE** switch to the **3 kHz** position. This will make more accurate readings possible.

5. Still speaking into the portable unit's mouthpiece, adjust the **SPEAKER VOLUME** control until the audio output at the speaker reaches a suitable level. You should be able to clearly hear (from the analyzer's speaker) what is being said into the telephone's mouthpiece. It is also possible to connect an oscilloscope to the **SCOPE OUT** jack on the analyzer and view the voice waveform. Recommended oscilloscope settings are 0.5 V/Div for vertical and 0.2 ms/Div for horizontal.

6. If you wish to listen to the guardtone (pilot signal) or any other high frequency audio, you can set the **INPUT GUARDTONE** switch to the **PASS** position. While some signals above 3 kHz may be transmitted by the cordless telephone, the frequency range of standard telephone company equipment is only 300 to 3000 Hz. This means that even though you can hear the high frequency audio through the analyzer's speaker, it will not be heard by a party at the other end of a telephone call.

Checking Base Unit Carrier Frequency Error (Refer to Fig. 12.)

1. Make sure that the **DIAL MODE/CONT.** button is disengaged for this test. Plug

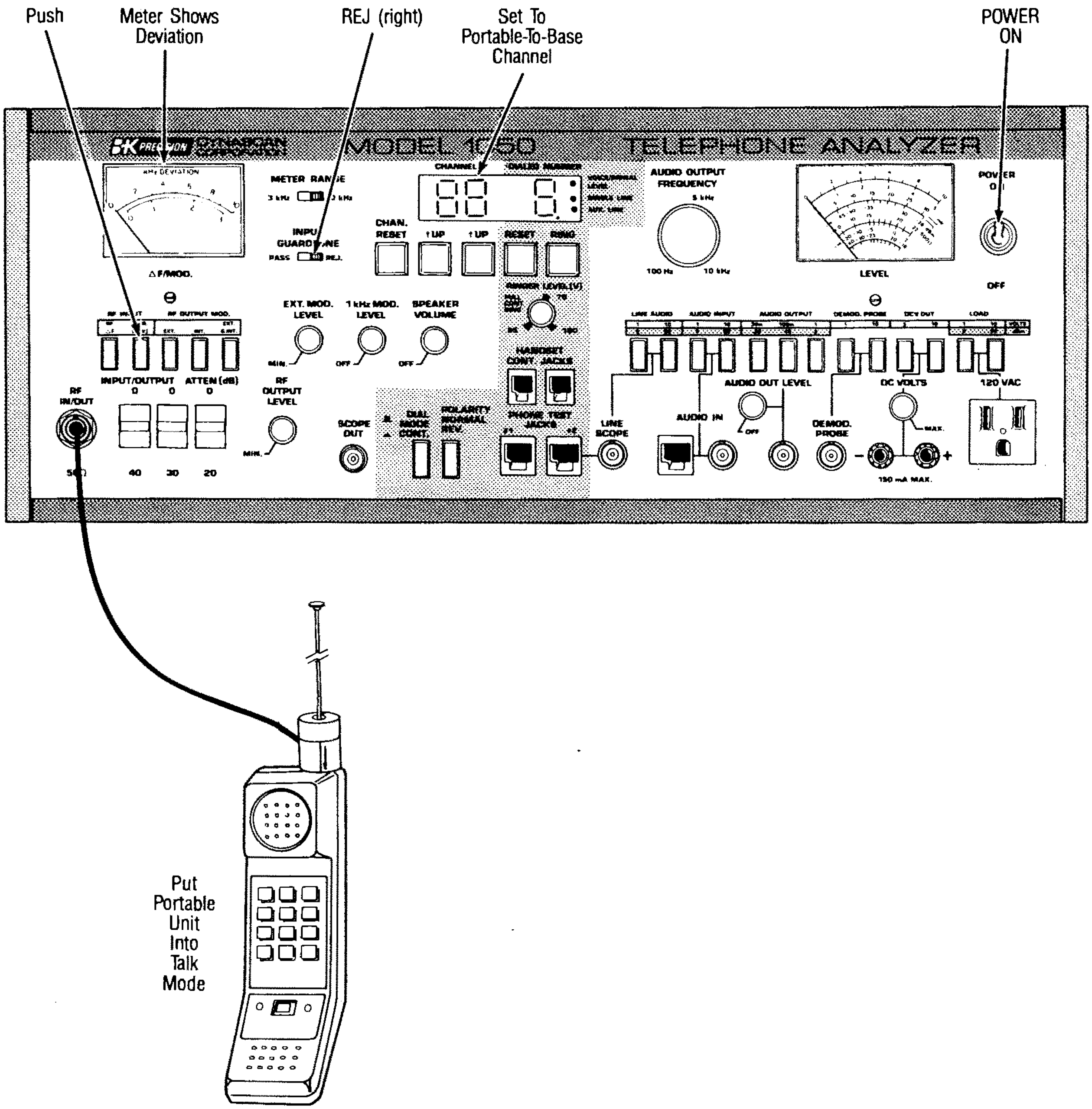


Fig. 11. Checking Portable Unit Modulation And Audio Quality.

the base unit's power cord into the **120 VAC** outlet on the analyzer and plug the base unit's telephone cord into **PHONE TEST JACK #1.**

2. Set the analyzer to the channel that corresponds to the base-to-portable frequency of the cordless telephone. This should be around 1.7 or 46 MHz, as these are the frequency bands allocated by the FCC for base-to-portable transmission.

3. If the base-to-portable frequency is in the 46 MHz band, slide the coupling coil (with the arrow printed on the label pointing toward the base of the antenna) over the fully extended antenna and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer. If the base-to-portable frequency is in the 1.7 MHz band you must use a BNC to clips cable. To use the cable, place the clips over the base unit ac

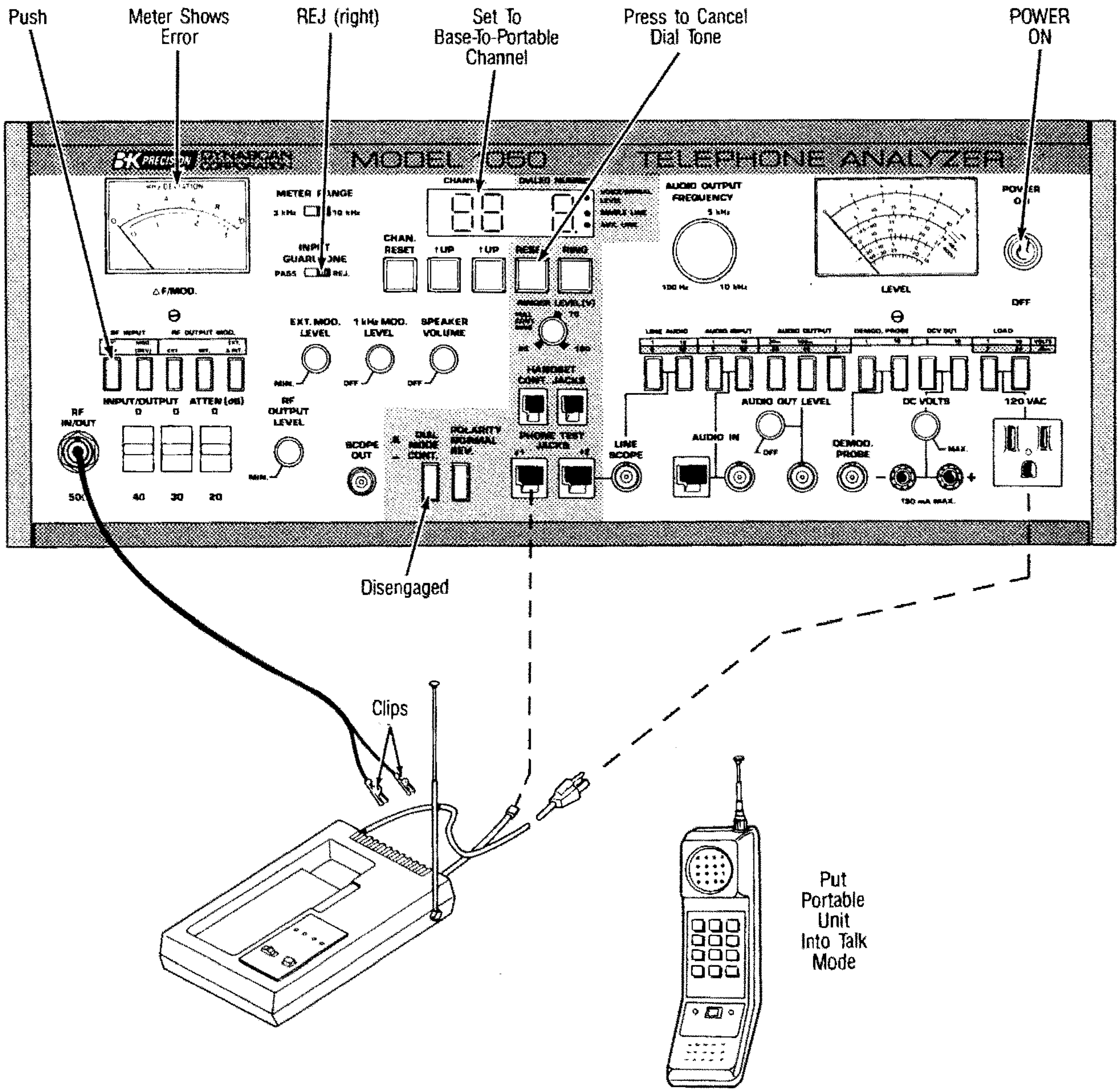


Fig. 12. Checking Base Unit Carrier Frequency Error.

power cord and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer.

NOTE

To measure **ΔF** (frequency error) transmit an unmodulated carrier signal from the base unit. Modulation (ring signal, dial tone, or audio tone) will cause an error in the reading.

4. Put the portable unit into the talk mode and press the **RESET** button on the analyzer to cancel the dial tone. This will cause the base unit to generate an unmodulated carrier signal. If the portable unit is not functioning properly, there are several other ways to get the base unit to transmit an unmodulated rf signal.

   a. Pressing the CALL button on the base unit will cause the base unit to transmit a modulated carrier signal. However, immediately after the CALL button is released, the base unit will continue to transmit an unmodulated carrier signal before the transmitter turns off.

Measure ΔF during this delay period.

b. If the base unit has no call button, plug the base unit into **PHONE TEST JACK #1** and the press the **RING** button. The rf level may be measured at any time after the **RING** button has been pressed but the carrier frequency error should only be measured between ring cycles. This allows measurement of an unmodulated carrier frequency.

c. Another method relies on the fact that immediately after a base unit is plug into the **120 VAC** jack, it generates an rf signal for a brief period. Both rf level and carrier frequency error can be measured immediately after the base unit is plugged in.

d. The delay period during which unmodulated rf carrier is generated varies from one cordless telephone to another. If the delay period is too short for the meter to settle and obtain an accurate reading, you must open up the base unit and trip the relay.

5. Set the **METER RANGE** switch to the **10 kHz** position and press the **RFΔF** button located with the **RF INPUT** controls of the analyzer. The **ΔF/MOD** meter will now show the amount of offset (error) from the carrier frequency (indicated in kHz on the upper scale). If the reading is above 3 kHz, adjust the telephone's carrier frequency error for as low a reading as possible, then continue on with the test. If the reading is below 3 kHz (on the upper scale), set the **METER RANGE** switch to the **3 kHz** position. Now the deviation is read on the lower scale (still in kHz). If the reading is above 2 kHz, the carrier frequency is off by a considerable amount and the telephone should be adjusted accordingly. The meter does not indicate whether the frequency is off in a positive or negative direction. Watch the meter closely as you adjust the carrier frequency. If the reading increases as you adjust the frequency you are adjusting in the wrong direction - adjust the telephone to get as low a reading as possible. Typically, no adjustment is attempted if the initial reading is less than 2 kHz.

NOTE

It is important to begin testing carrier frequency error with the **METER RANGE** switch in the **10 kHz** position. When the switch is in the **3 kHz** position a low pass filter is engaged to remove the effects of modulation. This filter not only removes modulation above 3 kHz, but also frequency error greater than 3 kHz. Thus, there may be very low meter readings on the 3 kHz range when the error is much greater than 3 kHz.

Checking Ring Signal (Refer to Fig. 13.)

1. Set the analyzer to the channel that corresponds to the base-to-portable frequency of the cordless telephone and press the **MOD (DEV)** button located with the **RF INPUT** controls of the analyzer. The frequency should be around 1.7 or 46 MHz, as these are the frequency bands allocated by the FCC for base-to-portable transmission.

2. Make sure that the **DIAL MODE/CONT.** button is disengaged. Plug the base unit's ac power cord into the **120 VAC** outlet on the analyzer and plug the base unit's telephone cord into **PHONE TEST JACK #1.** Set up the base unit (and portable unit) as if you are waiting for a telephone call (so that the base unit is on hook).

3. If the base-to-portable frequency is in the 46 MHz band, slide the coupling coil (with the arrow printed on the label pointing toward the base of the antenna) over the fully extended antenna and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer. If the base-to-portable frequency is in the 1.7 MHz band you must use a BNC to clips cable. To use the cable, place the clips over the base unit ac

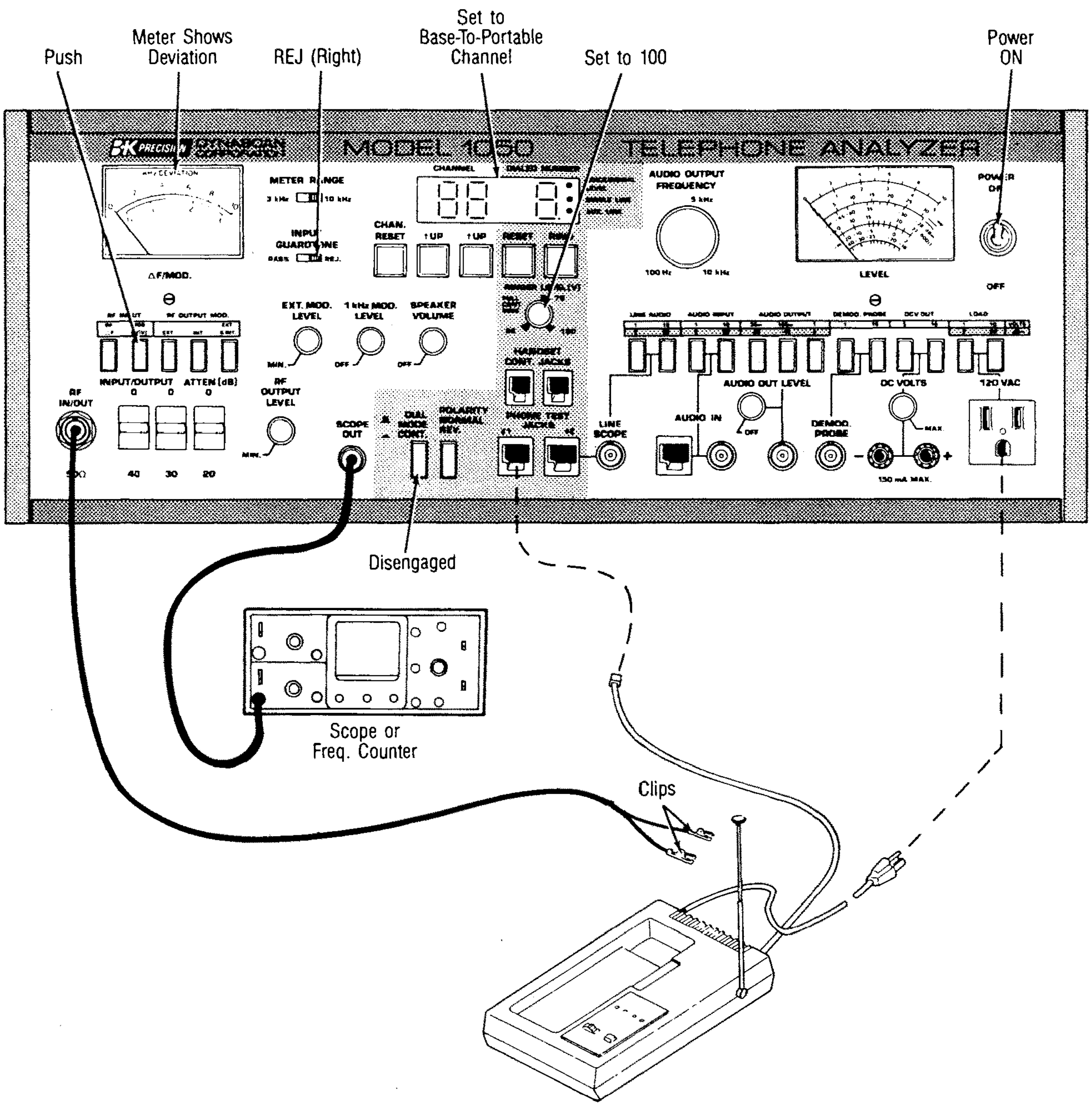


Fig. 13. Checking Ring Signal.

power cord and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer.

4. Set the **INPUT GUARDTONE** switch to the **REJ** position. This will eliminate all high frequency (above 3 kHz) "noise". No guardtone (pilot signal) is generated by the base unit, however, there might still be high frequency noise that you wish to eliminate.

5. Set the **RINGER LEVEL (V)** control to **100** and press the **RING** button on the front panel of the analyzer. Pull out the **RINGER LEVEL (V)** control to cause continuous ringing. Connect an oscilloscope to the **SCOPE OUT** jack. To view the signal on the oscilloscope, a vertical setting of 0.5 V/Div and a horizontal setting of 0.2 ms/Div are recommended. Check that the frequency and amplitude of the base - to - portable ring

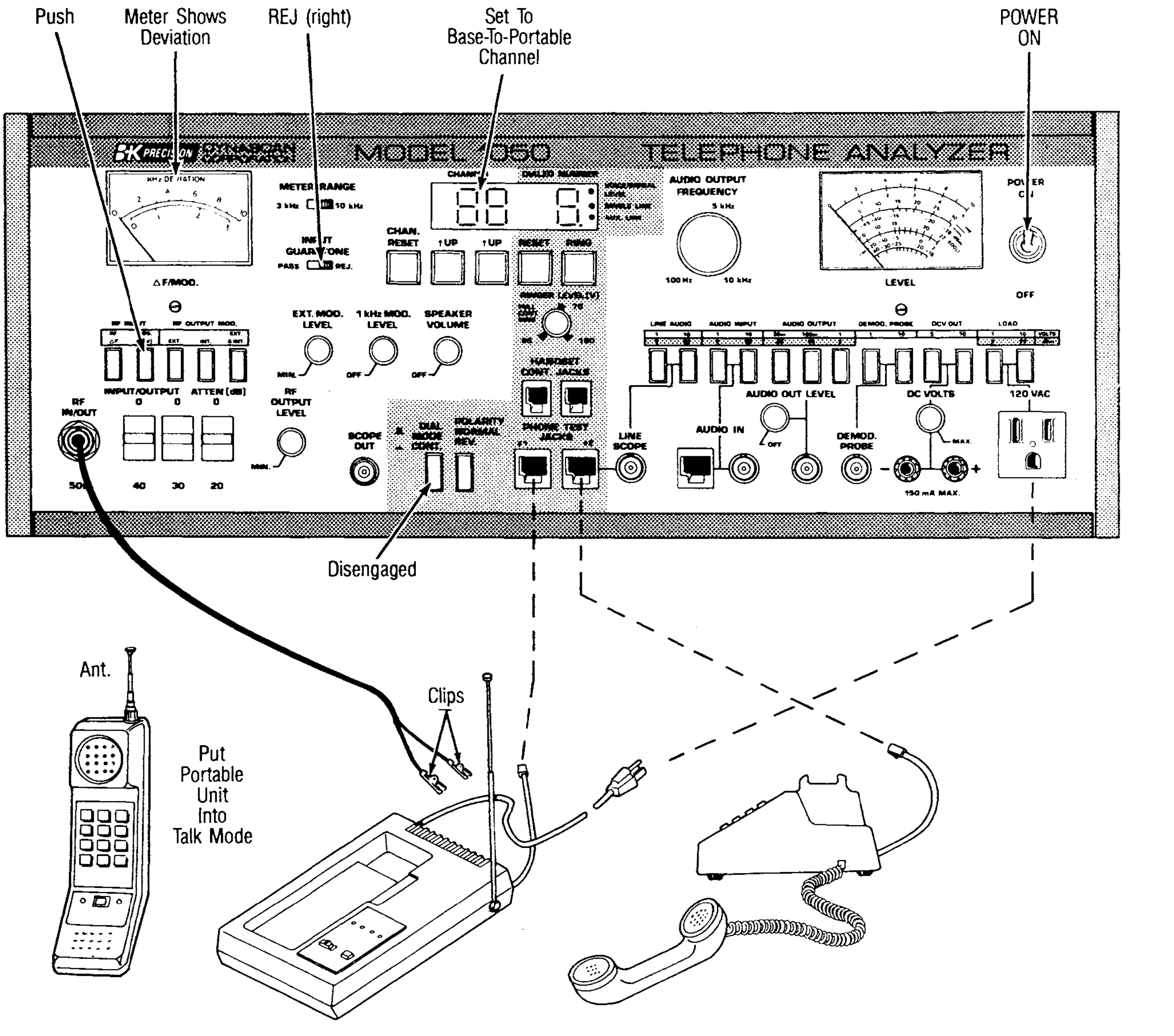


Fig. 14. Checking Base Unit Modulation And Audio Quality.

signal match the specifications in the telephone's service manual. If the frequency is not within specifications, adjust it accordingly.

Checking Base Unit Modulation And Audio Quality (Refer to Fig. 14.)

1. Set the analyzer to the channel that corresponds to the base-to-portable frequency of the cordless telephone. The frequency should be around 1.7 or 46 MHz, as these are the frequency bands allocated by the FCC for base-to-portable transmission.

2. Make sure that the **DIAL MODE/CONT.** button is disengaged. Plug the base unit's ac power cord into the **120 VAC** outlet on the analyzer and plug the base unit's telephone cord into **PHONE TEST JACK #1.** Plug a corded telephone into **PHONE TEST JACK #2** and take the telephone off hook. This will cancel the dial tone when the base unit goes off hook.

3. If the base-to-portable frequency is in the 46 MHz band, slide the coupling coil (with the arrow printed on the label pointing toward the base of the antenna) over the fully extended antenna and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer. If the base-to-portable frequency is in the 1.7 MHz band you must use a BNC to clips cable. To use the cable, place the clips over the base unit ac power cord and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer.

4. Set the **INPUT GUARDTONE** switch to the **REJ** position. This will eliminate all high frequency (above 3 kHz) "noise". No guardtone (pilot signal) is generated by the base unit, however, there might still be high frequency noise that you wish to eliminate.

5. Set the **METER RANGE** switch to the **10 kHz** position. While speaking into the corded telephone's mouthpiece, watch the **ΔF/MOD** meter. The meter's needle should deflect away from zero. This indicates the deviation caused by the modulating signal (typical deflection is 1 to 2 kHz). As you speak into the mouthpiece more loudly, the deflection will increase. If the reading remains at or below 3 kHz, you may switch the **METER RANGE** switch to the **3 kHz** position. This will allow more accurate readings as the maximum deflection is now 3 kHz.

6. Still speaking into the telephone's mouthpiece, adjust the **SPEAKER VOLUME** control until the audio output at the speaker reaches a suitable level. You should be able to clearly hear (from the analyzer's speaker) what is being said into the telephone's mouth piece. It is also possible to connect an oscilloscope to the **SCOPE OUT** jack on the analyzer and view the voice waveform.

7. If the base-to-portable frequency is in the 46 MHz band, use the coupling coil and step attenuators to measure the relative power of the transmitter. Transmit a modulated signal to the Analyzer from a known good unit and note how much attenuation you can select while still receiving the signal. When checking the relative transmitter power of the unit under test, you should be able to receive the signal (from the unit being tested) with approximately the same amount of attenuation selected. If the cordless telephone's base-to-portable frequency is in the 1.7 MHz band, the **LOAD** pushbuttons and the **LEVEL** meter can be used to measure the signal output level of the base unit's transmitter. Most cordless telephones should cause a reading of approximately 3.5 to 4 volts when the 10 V range is selected.

NOTE

Due to the inherent characteristics of demodulator circuits, as signal levels go below about 0.7 volts rms the voltage used to power the diodes becomes a significant part of the input voltage. This causes the output reading (on the **LEVEL** meter) to become inaccurate as input voltages drop below 0.7 volts.

TRANSMITTING SIGNALS

The analyzer can transmit signals on any of the frequencies allocated for cordless telephones. This means the analyzer can transmit signals to be received by either the base unit or the portable unit. Signals received by a base unit use the 49 MHz band (49.670 to 49.990 MHz) and signals received by a portable unit use either the 1.7 MHz band (1.665 to 1.770 MHz) or the 46 MHz band (46.610 to 46.970 MHz). The analyzer provides a modular telephone jack and a BNC connector for externally generated modulating signals. Also provided are an internally generated 1 kHz sine wave and an internally generated variable frequency (100 Hz to 10 kHz) sine wave. External, internal, or both (external and internal) modulating signals are selectable using the **RF OUTPUT** controls. Both the external and internal signal levels are adjustable using the **EXT MOD LEVEL, 1 kHz MOD LEVEL,** and **AUDIO OUT LEVEL** controls. When using the analyzer as a transmitter, it is best to keep the **SPEAKER VOLUME** turned **OFF** unless you wish to listen to the signal that you are using to modulate the carrier signal.

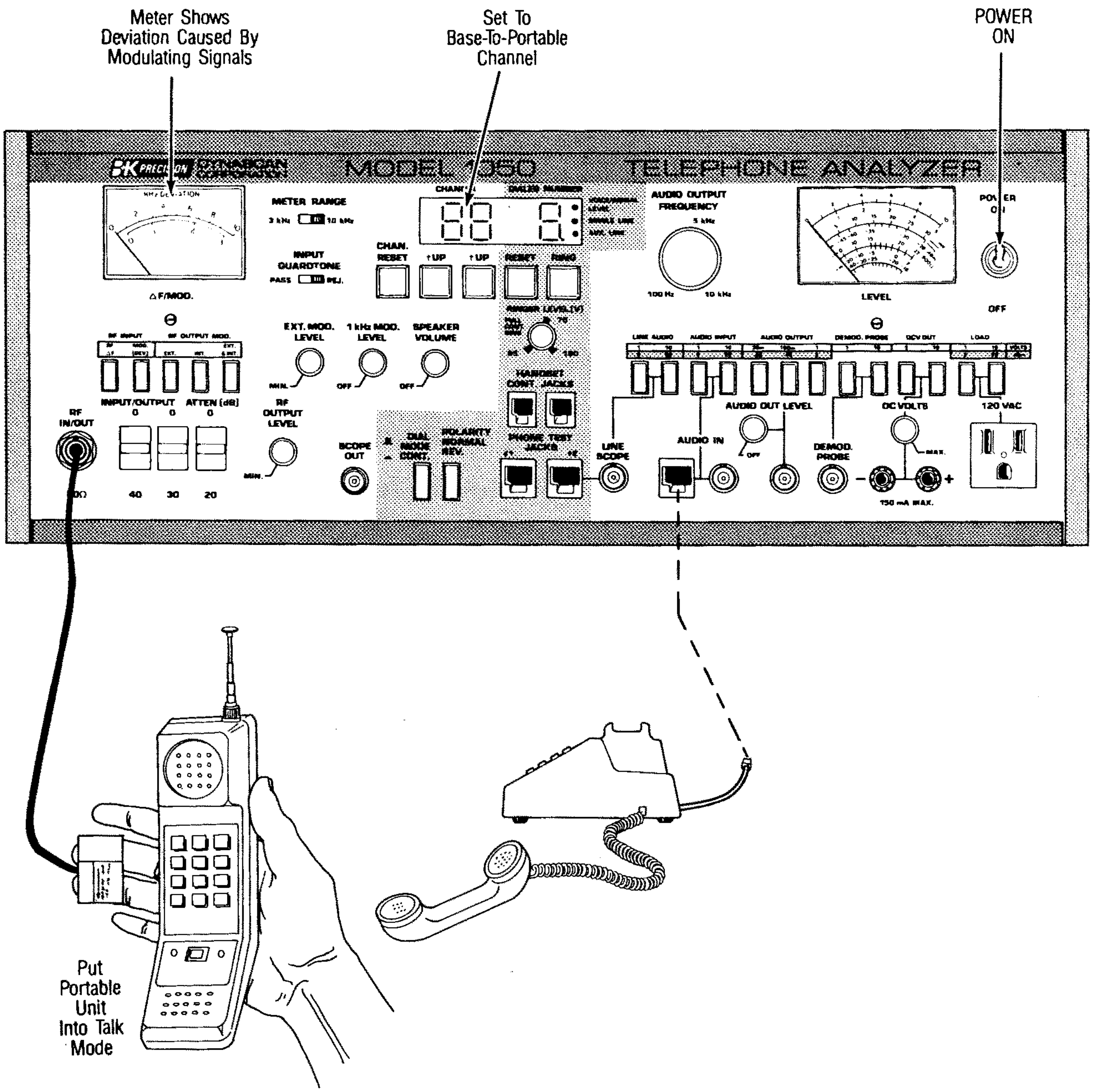


Fig. 15. Checking Portable Unit Reception.

Checking Portable Unit Reception (Refer to Fig. 15.)

1. Set the analyzer to the channel that corresponds to the base-to-portable frequency of the cordless telephone. This frequency should be in the 1.7 or 46 MHz area as these are the frequency bands allocated by the FCC for base-to-portable transmission.

2. If the base-to-portable frequency is in the 46 MHz band, slide the coupling coil (with the arrow printed on the label pointing toward the base of the antenna) over the fully extended antenna and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer. If the base-to-portable frequency is in the 1.7 MHz band hold the coupling coil parallel and about two inches from the ferrite bar antenna.

3. Set the **RF OUTPUT LEVEL** and **EXT MOD LEVEL** controls to the **MIN** position (fully counterclockwise). Turn on all the attenuators (slide them down).

4. Select the **INT** mode of **RF OUTPUT** on the analyzer and put the cordless telephone's portable unit in the "talk" mode. Turn the **AUDIO OUT LEVEL** control to the **OFF** position and adjust the **1 kHz MOD LEVEL, RF OUTPUT LEVEL,** and the **INPUT/OUTPUT ATTEN (dB)** controls until you are able to hear the 1 kHz tone at the speaker of the portable unit. If you still cannot hear the tone with the **1 kHz MOD LEVEL** and **RF OUTPUT LEVEL** controls turned all the way up (fully clockwise), and all **INPUT/OUTPUT ATTEN (dB)** controls set to 0, the portable unit is not receiving the signal properly and must be repaired. The more attenuation you can select and still receive the signal the more sensitive the portable unit is. Most cordless telephone portable units should be able to receive the signal with approximately 80 dB of attenuation selected (70 dB on the step attenuators and the **RF OUTPUT** control set to mid-range).

5. After it has been determined that the portable unit is receiving properly, turn the **1 kHz MOD LEVEL** control to **OFF** and turn the **AUDIO OUT LEVEL** control on. Connect an oscilloscope or frequency counter to the **AUDIO OUT** jack. Set the analyzer's internal signal generator to produce a 0.5 Vrms (1.4 V peak to peak) 300 Hz sine wave using the **AUDIO OUTPUT FREQUENCY** and **AUDIO OUT LEVEL** controls (the signal voltage can be read using the **LEVEL** meter). It should not be necessary to adjust the **RF OUTPUT** or **INPUT/OUTPUT ATTEN (dB)** controls to get sufficient volume at the portable unit. If sufficient volume cannot be obtained, it indicates that the audio bandwidth of the cordless telephone is not up to specifications.

6. Repeat step 5 using a 0.5 Vrms 3000 Hz signal in place of the 300 Hz signal. Because the frequency response has been tested at 300, 1000, and 3000 Hz, it is not necessary to test at other frequencies (in most situations). If you do wish to test the frequency response across the full range, make sure that the output voltage of the internal signal generator is at 0.5 V rms for each test frequency.

7. Plug a corded telephone into the **AUDIO IN** modular telephone jack and set the analyzer to the **EXT RF OUTPUT** mode. Adjust the **EXT MOD LEVEL** control while speaking into the corded telephone. From the portable unit, you should be able to hear what is being said into the corded telephone clearly and at sufficient volume. Once again, the **RF OUTPUT** and **INPUT/OUTPUT ATTEN (dB)** controls should not need adjusting.

Checking Base Unit Reception
(Refer to Fig. 16.)

1. Set the analyzer to the channel that corresponds to the portable-to-base frequency of the cordless telephone. This frequency should be around 49 MHz (49.670 to 49.990 MHz) as this is the frequency band allocated by the FCC for portable-to-base transmission.

2. Set the **RF OUTPUT LEVEL** and **EXT MOD LEVEL** controls to minimum positions (fully counterclockwise). Turn on all the attenuators (slide them down).

3. With the arrow (printed on the coupling coil label) pointing toward the base of the antenna, slide the coupling coil over the fully extended antenna and connect the BNC connector to the **RF IN/OUT** jack on the front panel of the Analyzer.

4. Plug the cordless telephone base unit's ac power cord into the **120 VAC** receptacle on the analyzer and plug the base unit's telephone cord into **PHONE TEST JACK #1.** Plug a telephone into **PHONE TEST JACK #2** and pick it up (take it off hook). Make sure that the **DIAL MODE/CONT.** button is disengaged throughout this test. Select the **INT** mode of **RF OUTPUT** and turn the **1 kHz MOD LEVEL** control off.

5. Obtain the guardtone (pilot signal) frequency of the cordless telephone under test by checking the telephone's service manual.

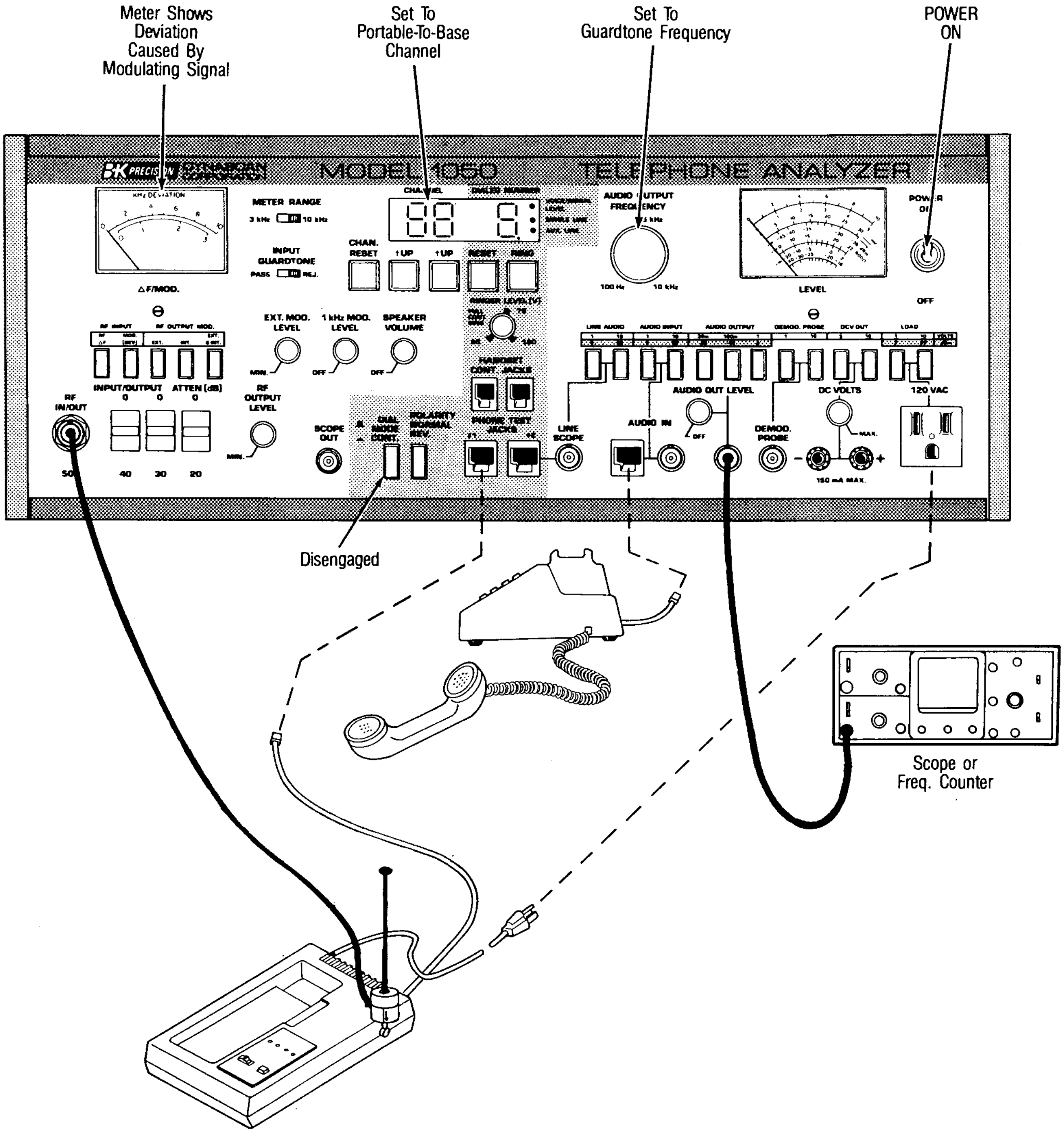


Fig. 16. Checking Base Unit Reception.

6. Set the analyzer's internal signal generator to the guardtone (pilot signal) frequency (check the analyzer's frequency using a frequency counter connected to the **AUDIO OUT** jack). The typical guardtone signals for the Cobra cordless telephones are 5.3, 6.0, or 6.7 kHz. Set the output level of the guardtone frequency to 0.5 Vrms (1.4 V peak to peak) using the **AUDIO OUT LEVEL** control, **AUDIO OUTPUT** pushbuttons, and **LEVEL** meter.

7. Adjust the **RF OUTPUT LEVEL** and **INPUT/OUTPUT ATTEN (dB)** controls until the relay in the cordless telephone base unit energizes (many base units have an "IN USE" light that comes on when the relay is energized). The base unit should now be in the talk (off hook) mode.

8. Adjust the **1 kHz MOD LEVEL** control until you hear the 1 kHz signal at the earpiece of the telephone plugged into **PHONE TEST JACK #2.** Most cordless telephone base units should be able to receive the signal when about 80 dB of attenuation is selected (the step attenuators set to 70 and the **RF OUTPUT LEVEL** control set mid-range). For relative receiver sensitivity measurements, check a known good unit to see how much attenuation can be selected while still receiving the signal and use those settings as a reference.

9. Plug another telephone into the **AUDIO IN** modular telephone jack (keeping all other controls and connections undisturbed). Turn off the **1 kHz MOD LEVEL** (turn the control fully counterclockwise). While speaking into one telephone's mouthpiece (the one plugged into the **AUDIO IN** jack) you should be able to clearly hear what is said at the earpiece of the other telephone (the one plugged into **PHONE TEST JACK #2**).

ADDITIONAL INFORMATION

Using The LEVEL Meter

The **LEVEL** meter and metering control pushbuttons on the front panel of the analyzer make a wide variety of measurements possible. When one of the two **LINE AUDIO** pushbuttons is selected, the meter shows the level of the signal at **PHONE TEST JACK #2.** The two **PHONE TEST JACKS** are interconnected, but not directly. This means that readings from **PHONE TEST JACK #2** will be more accurate than readings from **PHONE TEST JACK #1.**

Selecting one of the two **AUDIO INPUT** pushbuttons, causes the meter to show the level of the signal applied to the **AUDIO IN** jacks. When the **EXT. MOD LEVEL** control is turned off (fully counterclockwise), the telephone jack is disabled and the input impedance of the BNC receptacle is 1 MΩ. In this mode the **LEVEL** meter may be used as a general purpose ac voltmeter. When the **EXT. MOD LEVEL** control is turned on (not fully counterclockwise), both the telephone jack and the BNC receptacle are enabled and the input impedance of the jacks is 600 Ω. In this mode the jacks are used as inputs for an external modulating signal and the meter may be used to measure the level of the input signal.

If one of the three **AUDIO OUTPUT** pushbuttons is selected, the level of the signal at the output of the internal signal generator is read on the meter. This allows for the level of the internally generated signal to be adjusted without the use of an oscilloscope or external meter. Also, maximum level of the signal is affected if either the **30 mV/-28 dBm** or **100 mV/-18 dBm** pushbutton is selected. When the 30 mV or 100 mV pushbuttons are engaged the output range of the audio generator is 30 mV or 100 mV respectively. If another meter function (or the 1 V pushbutton is engaged), the **AUDIO OUTPUT** jack has a maximum output of 1 V (when the **AUDIO OUT LEVEL** control is fully clockwise).

When one of the two **DEMOD PROBE** pushbuttons is selected, the meter shows the level of the signal applied to the **DEMOD PROBE** jack. A demodulator probe may be used to check the relative signal strength at points in the circuit where rf is present. The recommended probe for this jack is a B & K-Precision Model PR-32 or equivalent.

NOTE

Due to the inherent charateristics of demodulator circuits, as signal levels go below about 0.7 V rms the voltage used to power the diodes becomes a significant part of the input voltage. This causes the output reading (on the **LEVEL** meter) to become inaccurate as input voltages drop below 0.7 volts. Refer to the demodulator probe's instructions for input to output voltage characteristics.

Selecting one of the two **DCV OUT** pushbuttons causes the meter to show the level of dc voltage at the **DC VOLT OUT** jacks. This dc supply can be used to power a portable or base unit that has a defective power supply. Once set, the meter may be switched to other functions. The preset voltage will continue to be available at the **DC VOLTS OUT** jacks.

If one of the two **LOAD** pushbuttons is selected, the meter shows the relative signal strength of a 1.7 MHz band base unit transmitter. This is possible because base units that operate in the 1.7 MHz band transmit the rf signal over the ac power line. Fig. 17 shows the equivalent load that terminates the cordless telephone base unit transmitter. Note that the readings are taken across a 50 Ω resistance. Although this does not represent the total rf signal (the total load including the capacitive reactance may be about 150 Ω at 1.7 MHz), it gives a reading relative to the total rf signal. A known good unit may be used to establish a reference load if desired. Meter readings for a properly operating cordless telephone base unit transmitter are typically 3.5 to 4 V.

NOTE

Due to the inherent charateristics of demodulator circuits, as signal levels go below about 0.7 V volts the voltage used to power the diodes becomes a significant part of the input voltage. This causes the output reading (on the **LEVEL** meter) to become inaccurate as input voltages drop below 0.7 volts.

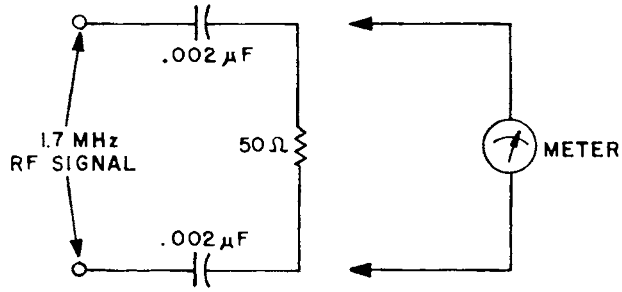


Fig. 17. Equivalent Load Circuit for 1.7 MHz Signal Level Measurements.

Recommended Test Equipment

When troubleshooting telephone equipment, additional general purpose electronic test equipment is necessary. The following equipment is recommended:

B & K-Precision Model 1803 100 MHz Frequency Counter or equivalent.

B & K-Precision Model 1560 60 MHz Oscilloscope or equivalent. An oscilloscope with at least 50 MHz bandwidth permits direct examination of the rf carrier. The oscilloscope should also offer a channel 1 output. This output provides sufficient gain to drive a frequency counter with low signal levels and avoids special "T" connectors.

It has been discovered that step number 9 on page 40 of the Model 1050 Instruction Manual is incorrect. Step number 9 should read as follows (underscored represents added information):

9. Plug another telephone into the **AUDIO IN** modular telephone jack, select the **EXT & INT** mode of **RF OUTPUT**, and turn on the **EXT MOD LEVEL** control (keeping all other controls and connections undisturbed). Turn off the **1 kHz MOD LEVEL** (turn the control fully counterclockwise). While speaking into one telephone's mouthpiece (the one plugged into the **AUDIO IN** jack) you should be able to clearly hear what is said at the earpiece of the other telephone (the one plugged into **PHONE TEST JACK #2**).

WHAT'S INSIDE YOUR TELEPHONE?

By Christopher Kite

This article by Christopher Kite, B & K-Precision Engineering Department, appeared in the February, 1984 issue of Electronic Servicing Technology.

Most of us use a telephone several times a day, but until recently, we have had little reason to wonder what goes on inside the telephone. Obviously, there is a microphone in the mouthpiece and a speaker in the earpiece, and perhaps some kind of audio amplifier for each. Beyond that, most of us have given little thought as to what else may be involved. In the past, the local telephone company supplied the telephone along with telephone service. If repair or replacement was ever needed, the telephone company handled it.

The recent changes in FCC regulations regarding telephone service have drastically changed this situation. There is an explosive growth in the private ownership of telephones. Repairing and replacing telephones became the telephone owner's responsibility starting January 1, 1984. In turn, he or she has to look to electronic service shops with telephone expertise for testing and repair service. You will need to understand how telephones operate if you are to participate in this new segment of the electronics service industry, or even to effectively evaluate the pros and cons of getting into telephone servicing.

An old-timer in the telephone business gave me this helpful tip, which I have found very helpful. "Remember that a telephone has five functions to perform. These are just as true today as when Molly the switchboard operator performed them 50 years ago. Almost every advance in the telephone industry involved an electronic method of performing these functions. Think about these five functions when testing telephones, and don't forget that one function may have an effect on another.

Those five functions are:

Supervision - Scanning the circuits to determine when someone wishes to place a call. Molly has become an electronic switching exchange; lifting your telephone off the hook now signals "Molly", and she acknowledges by returning a dial tone.

Addressing - Indicating who you wish to call. This is now the dialing function.

Alerting - Ringing of the telephone to announce your incoming call. This is the ringing function, little changed from Molly's day.

Transmitting - Sending your voice out over the wire. Carbon microphones are no longer used but little else has changed.

Receiving - Listening to someone's voice coming in over the wire. Not much about this function has changed.

STANDARD TELEPHONE CHARACTERISTICS (Refer to Fig. 18.)

All telephones have a few standard characteristics making them compatible with the telephone exchange. This means that virtually all telephones are interchangeable with each other, even though there are major internal circuit differences. Fortunately, it makes the telephone a little easier to understand because a few basic characteristics are unchanged from one telephone to another.

Before examining the telephone and its circuits, a review of the most important of these standard telephone characteristics is in order. This necessarily overlaps and includes some characteristics of the telephone line and the telephone exchange. The minimum specification for some of the telephone line characteristics is established by FCC regulations. The most important characteristics are summarized in Figure 18.

2-Wire Circuit

The telephone is basically a 2-wire device. Voice audio in both directions, dc power for

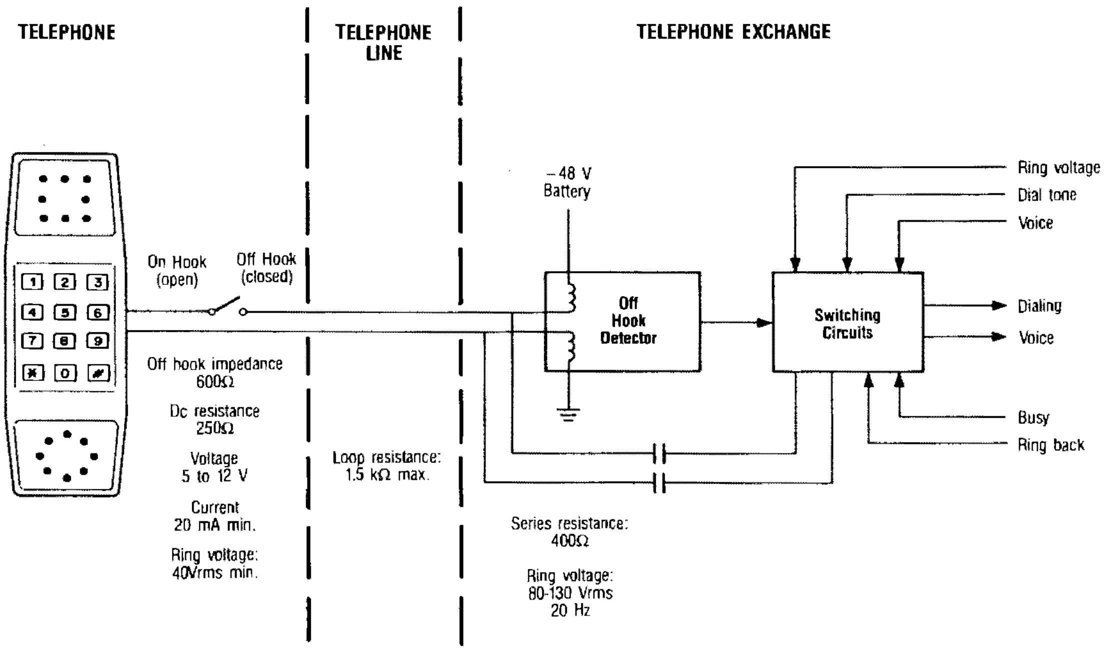


Fig. 18. Standard Telephone Characteristics.

operating the telephone circuits, dial tone, dialing, and ringing are all carried on a single pair of wires. There are normally four wires in the telephone line, but only one pair is used in standard telephones. The extra pair of wires may carry power to the night light in a "Princess"-type telephone, for example. Do not confuse a line having four wires with the more common definition of 4-wire circuits. In 4-wire circuits, transmit-voice is carried by one pair and receive-voice by the other pair. Externally, telephones use 2-wire circuits where transmit- and receive-voice are carried on the same pair.

Bandwidth

Your conversation over a telephone has a distinct "telephone" sound that is considerably different than talking to the same person face to face. This is caused by the acceptable but somewhat limited frequency response of 300 to 3000 Hz within 6 dB of the 1 kHz response.

Impedance

The typical off-hook telephone impedance is approximately 600 Ω at audio frequency (300 to 3000 Hz). The dc resistance of the telephone may be considerably lower, and is often approximately 250 Ω.

Battery Voltage

Because there is obviously no ac power cord on your telephone and no battery to replace, power for operating the electronic circuits must be supplied by the telephone line. The telephone exchange continuously applies a dc voltage to the telephone line through a series impedance, usually -48 V. The term "battery" is used because the telephone company normally supplies this power from a huge bank of parallel batteries that will continue to provide telephone operation in case of power failure.

When the telephone is on hook, it is a dc open circuit and no line current flows. When the telephone is off hook, line current flows and powers the telephone. The telephone company is required to supply at least 20 mA (a value originally required for satisfactory operation of carbon microphones). The loop resistance of a long telephone line may be up to 1.5 kΩ, in which case line current will prob-

"Princess" is a registered trademark of AT&T

ably be no more than 20 mA. For shorter telephone lines, available line current may be as high as 120 mA, but most telephones include compensation to automatically shunt excess line current. The voltage across an off-hook telephone is usually 5 V to 12 V.

When voice is present, current variations are superimposed on the dc. Typically, a voltage-regulator circuit within the telephone provides constant voltage to the electronic circuits even though the line current varies.

Polarity

The standard dc polarity for telephone lines is negative to "ring" and return to "tip". "Tip" and "ring" terminology is common in telephone circuits and refers to the tip and ring portions of a telephone jack or equivalent. In this context, "ring" has nothing to do with the ringing of the telephone, but refers to the concentric ring on the jack which provides one connection.

Ringing

The telephone company applies a highly accurate 20 Hz sine wave ringing voltage of 80 Vrms to 130 Vrms. The most typical value is 100 Vrms (280 V peak-to-peak). All telephones should be capable of ringing with ringing voltage that could drop as low as 40 Vrms over a long telephone line with 1.5 kΩ impedance. In some party line applications, additional frequencies are used; telephone ringers with corresponding resonant frequencies assure that only one telephone rings. The ringing signal is applied to the telephone line only when the telephone company's equipment detects a high impedance (present when the telephone is on hook). The ringing is usually 2 to 2-1/2 seconds on and 3-1/2 to 4 seconds off, for a 6-second repetition cycle.

Dialing (Refer to table 1.)

Dialing is accomplished through either pulses (for rotary or non-tone dial telephones) or tone pairs (for tone dial telephones). Pulses are produced simply by opening and closing a

Digit (Symbol)	Frequencies (Hz)
1	697 1209
2	697 1336
3	697 1477
4	770 1209
5	770 1336
6	770 1477
7	852 1209
8	852 1336
9	852 1477
0	941 1336
*	941 1209
#	941 1477

Table 1. Standard DTMF Dialing Tone Frequencies.

set of contacts (rotary dial telephones) or turning a switching circuit on and off (push-button pulse dial). Touch Tone and other compatible dialing tones are produced by oscillators that generate tones which are mixed in pairs to form each digit. The 3 x 4 matrix layout of the dialing keypad selects one "row"

"Touch Tone" is a registered trademark of AT&T

oscillator and one "column" oscillator for each digit. These are commonly known as the DTMF (Dual-Tone Multi Frequency) frequencies.

BLOCK DIAGRAM ANALYSIS (Refer to Fig. 19.)

The block diagram of a basic telephone with electronic ringer (the circuits of the Cobra clock radio/telephone) is depicted in Figure 19. The ringing signal is applied directly to the electronic ringer, an oscillator and buzzer circuit, which operates at a rate of approximately 2.8 kHz, interrupted at a rate of 20 Hz. This causes the "chirping" sound that is heard when the telephone rings. These signals are only applied to the buzzer while the ringing signal is present. Thus, if the ringing signal is on for two seconds and off for four seconds, the chirping is heard for two seconds at four second intervals.

For standard desk telephones (those with a bell rather than an electronic ringer), the ringing signal is capacitively coupled to an electromechanical bell, causing it to jingle at its mechanical resonant frequency of 20 Hz. Capacitive coupling is important; the ringer must not offer a dc path for line current when the telephone is on hook.

Power, incoming and outgoing audio signals, and dialing signals for the telephone are fed through a diode bridge, an on-hook/off-hook switch, and a switching circuit. The diode bridge serves as an automatic polarity corrector for the electronic circuits in the telephone, providing the proper polarity even if the dc polarity of the telephone line connection becomes reversed. When the telephone is off hook, the switching circuit applies power to the audio amplifier. The dialing chip gets power directly from the diode bridge, bypassing the on-hook/off-hook switch. This is necessary with redial and memory telephones because the dialing chip must always have power to store the redial information in the memory.

When you dial the telephone, an oscillator feeds into the dialing chip, which generates a certain number of pulses for each digit. These pulses cause the dial pulse switching circuit to emit the proper pulse train for each digit. The pulse train is fed through the on-hook/off-hook switch and the diode bridge and onto the telephone line. The dialing pulses are fed through the telephone line to the telephone company's equipment where they are decoded to cause the proper connection to be made.

When you talk, the outgoing audio is fed into an audio amplifier from the microphone. This amplified signal is fed to the primary of the hybrid transformer, which feeds the signal through the switching cicuits and to the telephone line. The signal is also fed to the secondary of the hybrid transformer, which feeds

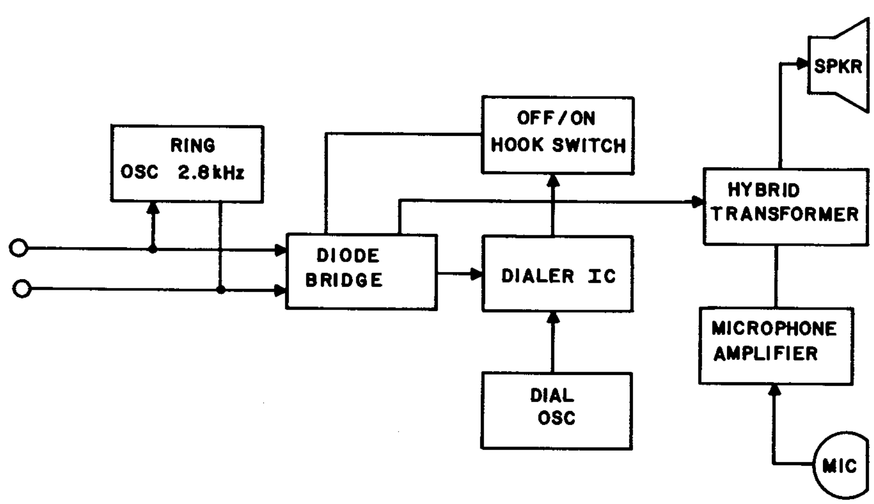


Fig. 19. Block Diagram of Electronic Telephone.

the signal at a low level to the speaker so that you hear your own voice in the ear piece as you speak. This is known as sidetone. Without this, your conversation would sound unnatural. If the level of sidetone is too high, it will cause the person speaking into the telephone to speak too softly, and if the level is too low, it will cause the person speaking into the telephone to speak to loudly. The outgoing signal that is fed through the switching circuit passes through the circuit, the on-hook/off-hook switch, and the diode bridge. The signal is then fed to the telephone line where it is connected to the telephone on the other end of the line by the telephone company. Incoming audio is fed by the telephone company through the line and into the telephone. This signal passes through the diode bridge, the on-hook/off-hook switch, and the switching circuit. The signal is then fed through the hybrid transformer and into the speaker. As can be seen from this example, an audio amplifier for the incoming signal is not always required.

SCHEMATIC DIAGRAM ANALYSIS (Refer To Fig. 20.)

Ringer Circuit

The ring buzzer (BZ1) and oscillator (Q101) are capacitively coupled to the telephone line. This is done to prevent the dc voltage from turning on the oscillator. A 27 V zener diode (ZD101) is also connected between the oscillator and the telephone line to prevent small signals, such as dial tones or audio, from triggering the oscillator. The high-voltage ringing signal (at least 40 Vrms at 20 Hz) exceeds the zener voltage turn-on point and provides power to the 2.8 kHz oscillator. Power derived from the 20 Hz ring signal is essen-

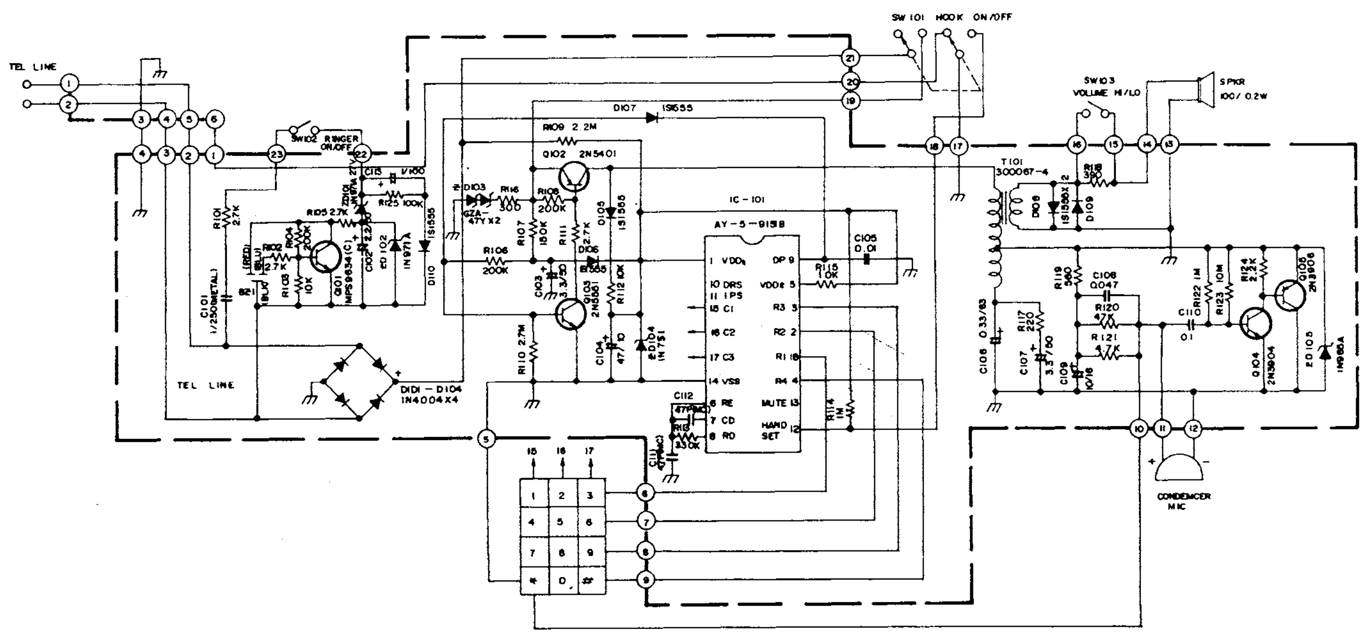


Fig. 20. Schematic Diagram Of An Electronic Telephone.

tially a 20 Hz square wave that interrupts the 2.8 kHz oscillator at a 20 Hz rate. This signal is generated when the ringing signal is active.

Diode Bridge

The diode bridge (D101 to D104) is in the circuit so that the polarity of the voltage applied to the dialing IC and transistors will remain the same even if the polarity of the 48 Vdc provided by the telephone company is reversed.

Dialing Circuit

The dialing keypad is connected to the IC where each digit that has been dialed is read. Because this is a pulse-dial telephone rather than a tone-dial telephone, the dialing IC releases a corresponding number of pulses for each digit. A storage device in the dialing IC allows the digits to be dialed faster than they are clocked out. C112 and R113 are a timing circuit to control the dialing IC so that the dialing pulses are clocked at a steady rate. These pulses are fed to a switching circuit (Q102 and Q103) that turns on and off to simulate an on-hook/off-hook condition. When the telephone is hung up, the last number dialed is latched into the memory so that it can be released when the redial button is pressed.

Hybrid Transformer And Microphone Amplifier

When you speak into the microphone, the signal is amplified by the microphone amplifier so that it can be transmitted over the telephone line. The primary winding of the hybrid transformer acts as the audio load for the microphone amplifier. The microphone amplifier varies the current through the primary of the hybrid transformer at the microphone audio rate, and thus through all series circuits including the telephone line and the voice transformer at the telephone exchange. Some of the microphone audio is also coupled into the secondary winding of the hybrid transformer. This signal, known as sidetone, is applied to the speaker at a low level.

Incoming audio is also in the form of current variation on the telephone line. This current variation is fed through the diode bridge, the on-hook/off-hook switch, the switching circuit and the hybrid transformer. The audio variations are coupled to the secondary of the hybrid transformer and to a pair of diodes. These diodes protect the speaker from spikes that might be present by clipping off any signal above the forward voltage drop of the diodes. The signal from the diodes is then fed to a 100 Ω, 0.2 mW speaker.

WHAT MAKES YOUR CORDLESS TELEPHONE OPERATE?

By Christopher Kite

Elsewhere in this manual, you will find an article entitled "What's Inside Your Telephone?" by Christopher Kite. "What Makes Your Cordless Telephone Operate?", by the same author, supplements that introduction to telephone functional operation by extending the explanation to include cordless telephones.

INTRODUCTION

Starting with the most basic premise, a cordless telephone embodies all the circuits and functions of a conventional (corded) telephone, plus a two-way radio communication link. The two-way radio link covers not only voice communications, but must include some method of dialing, ringing, and controlling the hook switch.

Cordless telephones are composed of two separate units, a base unit and a portable unit. The two units are linked together using full duplex FM radio, a base-to-portable link and a portable-to-base link which can operate simultaneously. Both the base and portable units have a transmitter and a receiver. The base unit is connected directly to the telephone line and serves as a link between the portable unit and the telephone line. Fig. 21 shows typical operation of cordless telephone operation. The diagram shown depicts both 1.7 MHz band and 46 MHz band operation. Fig. 22 shows a block diagram for typical cordless telephones. This diagram also depicts both 1.7 MHz and 46 MHz band cordless telephones. Please refer to these two figures throughout the following circuit description.

Cordless telephone base-to-portable links use a carrier signal in either the 1.7 MHz or 46 MHz frequency band. Earlier cordless telephone base-to-portable links use the 1.7 MHz band and use the ac power line as an antenna. This is necessary because a very long antenna is needed for optimum transmission of a signal at this low of a frequency. Newer cordless telephone base-to-portable links use the 46 MHz band, using a telescoping antenna. The base unit contains a power supply (operating from the ac line voltage) which is used to power the transmitter and receiver and also to charge the batteries of the portable unit.

Cordless telephone portable-to-base links use a carrier signal in the 49 MHz frequency band. This signal is transmitted using a telescoping antenna. In addition to the transmitter and receiver, portable units contain a speaker, microphone, dialing keypad, and rechargeable batteries.

Because of the limited number of cordless telephone rf channels, the same channels are repeated over and over again. With the relatively short range of cordless telephones and the use of the following techniques, a minimum of interference, false ringing and security problems (unauthorized capturing of a telephone line) are present.

False ringing is reduced by using several specific ring frequencies for the base-to-portable link. In this way, two cordless telephones with overlapping range and operating on the same rf channel, but with different ring frequencies, will not cause ringing of the neighboring unit.

Similarly, use of several specific guardtones (pilot signals) for the portable-to-base link reduces unauthorized use of a telephone line. The base unit will not respond to a portable unit unless the proper guardtone is sent. This prevents capture of a base unit by a nearby portable unit on the same rf channel, but with a different guardtone.

Earlier cordless telephones use only guardtones and ring frequencies to help prevent unauthorized capturing of telephone lines and false ringing. Newer cordless telephones use digital coding which precedes ringing and base unit capture. With digital coding, it is no longer necessary to use individual guardtones and ring frequencies. Usually a single guardtone and ring frequency are used for all cordless telephones that utilize digital coding. Digital coding methods vary from one cordless telephone manufacturer to another. For details, consult the service manual for the cordless telephone under test.

INCOMING CALLS

Between calls, the cordless telephone is in a "standby" mode; that is, both the base and portable transmitters are turned off and both receivers are awaiting incoming rf carrier signals.

When a 20 Hz ringing signal is received by the base unit from the telephone line, a 20 Hz ring detector turns on the base unit transmitter and a ring signal generator circuit which feeds a special frequency ringing signal to the transmitter. This is typically a specified audio frequency in the 700 Hz to 1500 Hz range. Different frequencies are used for ring signals in different cordless telephones to help prevent false ringing (i.e., the ringing of portable units that use the same channel, when the ringing signal does not originate from the portable unit's corresponding base unit). At the transmitter the ringing signal is used to modulate a carrier signal (either in the 1.7 or 46 MHz band). This modulated carrier is then transmitted to the portable unit.

The receiver section of the portable unit has power if the portable unit is in either the talk or standby mode as long as the power is turned on and the batteries are charged. The incoming signal is demodulated by the receiver and fed to the ring signal detector. The ring signal detector is a filter that only passes a certain frequency ring signal. If the ring frequency transmitted by the base unit is correct (i.e., compared to the ring signal filter frequency), the ring signal is passed to an audio amplifier. Here the signal is amplified and fed to the speaker.

When someone answers the call, the portable unit is switched from the standby mode to the talk mode. This disconnects the ring signal from the amplifier and turns on the rf transmitter and pilot signal generator and both of the audio amplifiers and gates. The pilot signal (guardtone) and audio (from the microphone) are fed to the transmitter where they modulate a 49 MHz band carrier. This modulated signal is then transmitted over the telescoping antenna to the base unit.

The base unit receives the signal, demodulates it and feeds it to the pilot signal detector and a low pass filter. When the pilot signal (guardtone) is at the correct frequency, the pilot signal detector energizes the relay into an off-hook condition through the relay driver. The off-hook relay turns on the base unit transmitter. The low pass filter blocks the guardtone and feeds voice audio (300 Hz to 3 kHz) to the hybrid transformer. The hybrid transformer feeds the audio signal to the relay where it is sent out over the telephone line when the relay is in the off-hook condition. The hybrid transformer also feeds a low level audio signal to the transmitter for sidetone in the portable unit.

Incoming audio (from the telephone line) is fed through the relay to the hybrid transformer when the relay is in the off-hook condition. This audio signal is fed to the transmitter where it is used to modulate a carrier signal in either the 1.7 or 46 MHz band. This modulated signal is transmitted over the antenna to the portable unit.

The portable unit receiver demodulates the signal and feeds it to the audio amp and gate. When the portable unit's switch is in the talk mode, the demodulated audio signal is amplified and fed to the speaker (earpiece).

OUTGOING CALLS

When a telephone call is initiated from a cordless telephone, the portable unit is switched from the standby mode to the talk mode. This turns on the transmitter and pilot signal (guardtone) generator. The guardtone or pilot signal is typically a specified frequency tone in the 4 kHz to 7 kHz range. The pilot signal modulates a 49 MHz band carrier, and is transmitted to the base unit over the telescoping antenna.

This signal is demodulated by the base unit's receiver and fed to the pilot signal detector and the low pass filter. The pilot signal detector energizes the relay to an off-hook state (through the relay driver) if the pilot signal is at the correct frequency. The cordless telephone is now off-hook and a telephone number can be dialed. The low pass filter only allows signals at or below 3 kHz to pass, so the guardtone signal is rejected by the low pass filter, while dialing and voice signals are allowed to pass.

When a digit is pressed at the portable unit of a pulse dial cordless telephone, the pilot signal is interrupted a certain number of times for each digit. The relay interrupts the off-hook condition each time the pilot signal is interrupted. This on-hook/off-hook change at the relay causes dialing pulses to go out over the telephone line. These pulses are decoded by the telephone exchange just like with an ordinary pulse dial telephone and the telephone call is routed to the telephone number dialed.

When a digit is pressed at the portable unit of a tone dial cordless telephone, the dialing tones and guardtone are used to modulate the carrier signal. Dialing tones are in the 300 - 3000 Hz band and guardtones are above 3000 Hz. The modulated signal is received by the base unit, demodulated, and then (if the guardtone frequency is correct) the tones are sent out over the telephone line, decoded, and used to route the telephone call just as with a corded telephone.

As previously stated, in the off-hook state, both transmitters are on in a full duplex configuration to permit talking and listening simulataneously. Incoming and outgoing audio are handled as described in the previous section. When the call is completed, the cordless telephone portable unit is set back to the standby mode and the pilot signal is discontinued. This causes the base unit relay to go back to an on-hook condition and incoming calls can now be accepted.

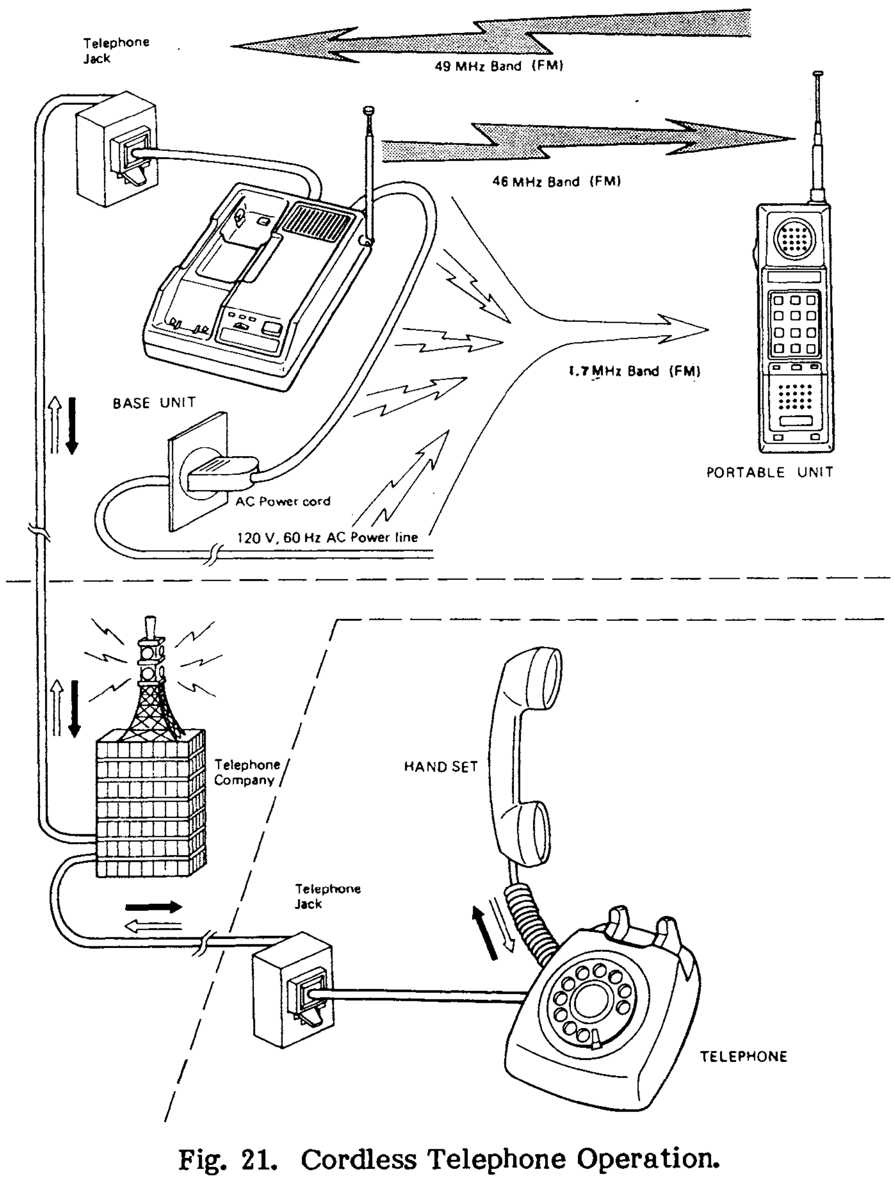


Fig. 21. Cordless Telephone Operation.

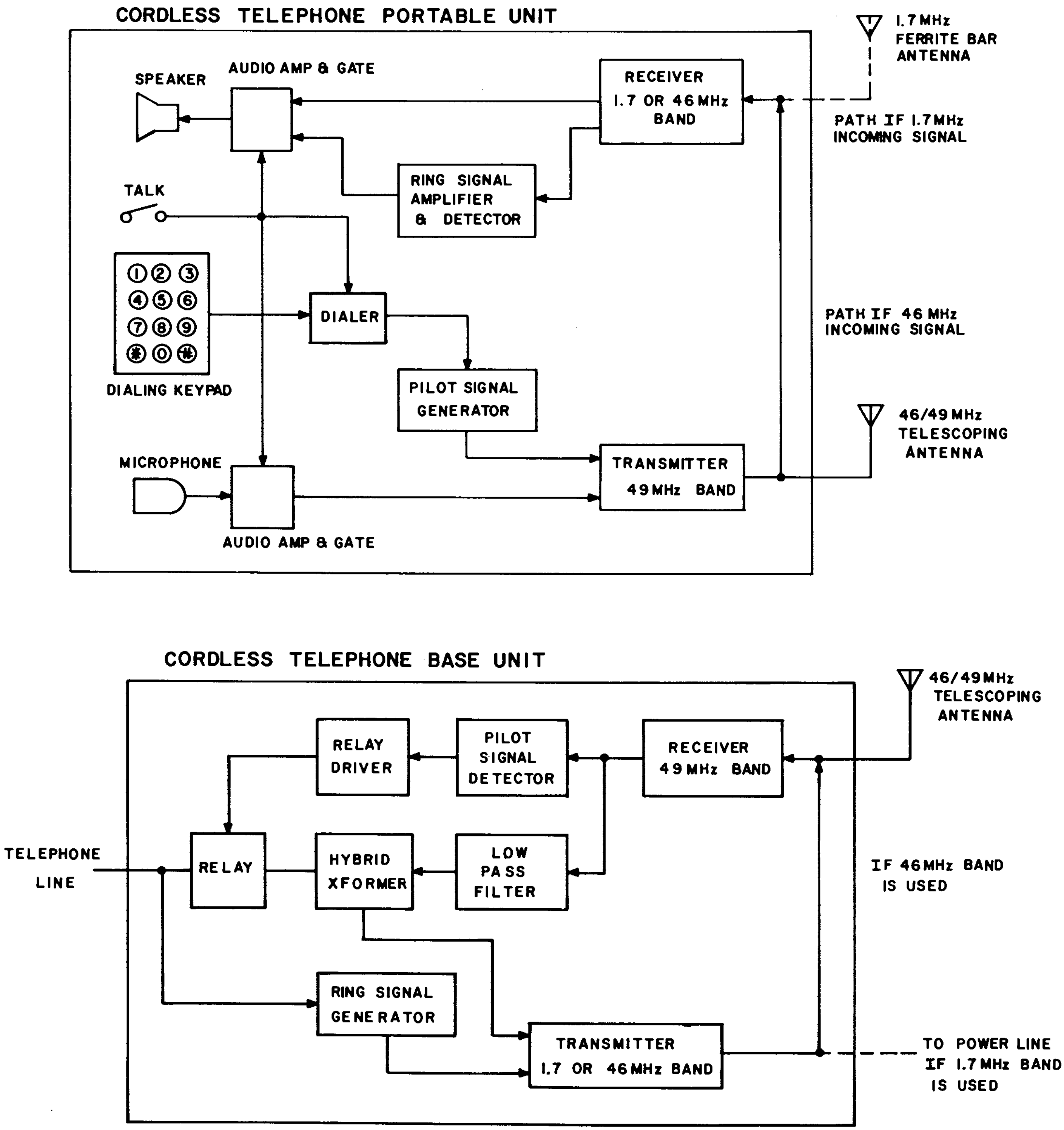
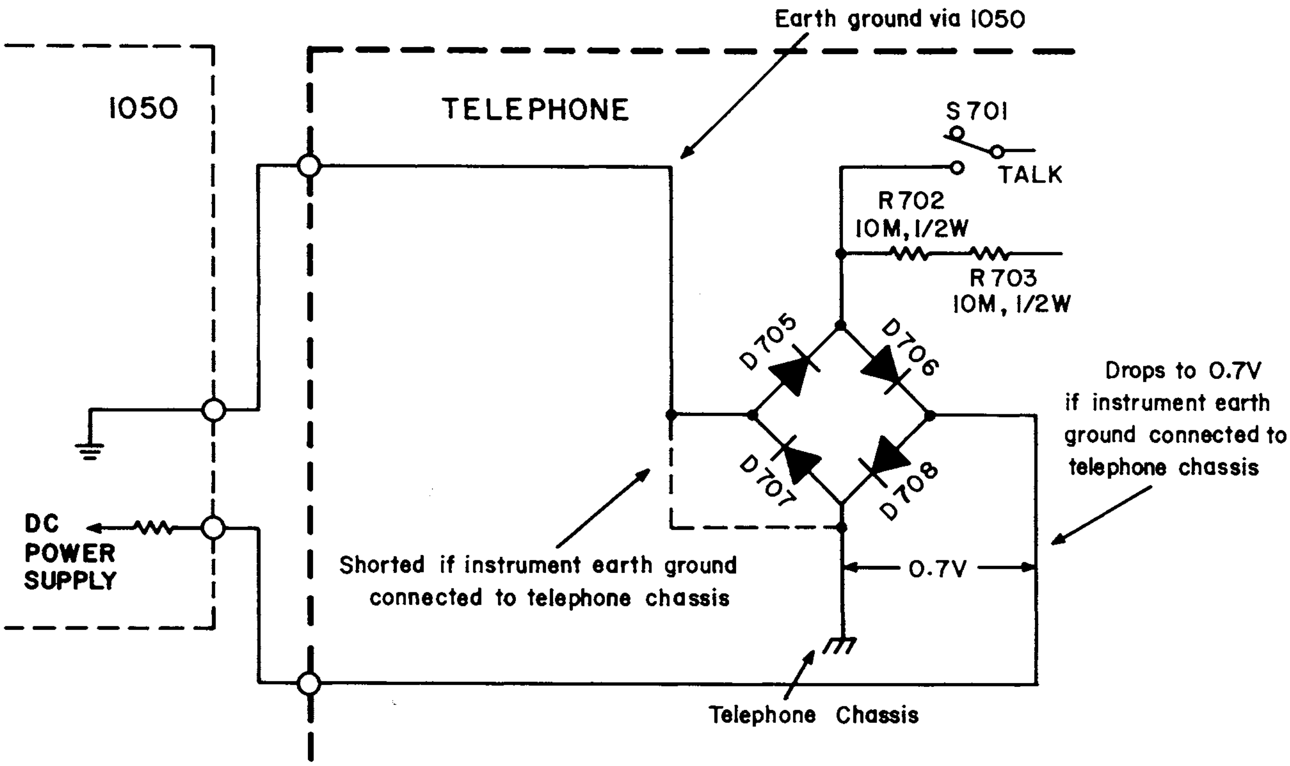


Fig. 22. Cordless Telephone Base And Portable Unit Block Diagrams.

TELEPHONE TROUBLESHOOTING CONSIDERATION



When a telephone product is plugged into the Model 1050 Telephone Analyzer, the ground lead of an oscilloscope or other earth grounded test instruments should not be connected. Connect only the probe tip and leave the ground lead disconnected. An explanation follows:

When a telephone is plugged into the Model 1050 Telephone Analyzer, one side of the telephone line is returned to earth ground through the analyzer (see illustration above). Because of the diode bridge in most telephones, the telephone chassis (signal common) becomes a dc potential with respect to this earth ground point. There is no particular disadvantage to this configuration. In fact, the Telephone Analyzer provides exactly the same condition as a telephone plugged into a telephone company jack.

The ground lead of many test instruments such as oscilloscopes, frequency counters, signal generators, etc. is also returned to earth ground through the ac power cord. Since the Telephone Analyzer already provides one earth ground point in the telephone, an earth grounded test lead of another test instrument should not be connected to the telephone chassis (signal common). To do so shorts one of the diodes of the bridge, as shown in the illustration. Because of the high impedance in series with the power supply from the tester, no damage occurs. However, the voltage supplied by the bridge drops to approximately 0.7 V and the telephone circuits cease operation.

The recommended procedure for oscilloscope use is to leave the ground lead disconnected and use only the probe tip. AC coupled measurements are not affected. For dc coupled measurements, the probe tip may be initially touched to the signal common point and the vertical position control set to center the trace as reference. Subsequent measurements then represent the waveform or voltage with respect to the signal common point. If noise becomes a problem with the ground lead disconnected, it may be connected to the earth ground point in the telephone. Both leads of most voltmeters are isolated from earth ground, and thus the signal common may be used for reference.

TROUBLESHOOTING CORDED TELEPHONES

By Christopher Kite

Telephone troubleshooting requires the same basic methods of troubleshooting as other electronic equipment. A logical pattern of checks and measurements will most effectively isolate the defective part. This introductory article outlines one logical pattern of checks and measurements with enough detail to help develop some insight for adapting the technique to all telephones.

One of the most valuable tools for troubleshooting corded telephones is at least a fundamental knowledge of normal circuit operation. We recommend reading the article "What's Inside Your Telephone?", found elsewhere in this manual, as a pre-requisite for telephone troubleshooting. The other requirement for telephone troubleshooting is the correct test equipment. The B & K-Precision Model 1050 Telephone Analyzer meets all the special test equipment requirements for telephone troubleshooting. General purpose test equipment such as a multimeter and oscilloscope are needed, of course, and a second telephone in known good working condition is very handy for some tests. As you gain experience, you may wish to alter the pattern of checks and measurements and develop your own set of short-cuts.

A schematic diagram of an electronic telephone is included (Fig. 23.). This schematic diagram is used for reference in several of the troubleshooting examples to demonstrate at least one specific example in detail. Although circuits may vary from one telephone to another, most technicians should be able to adapt the troubleshooting techniques to other similar circuit configurations.

CHECKING THE TELEPHONE'S WEAK LINK; THE CORDS

Possibly the most common cause of telephone problems is the failure of handset and teléphone cords. When a telephone does not operate properly, the cords should be the first thing checked. The cords are subjected to quite a bit of hard use. They are often stretched, twisted, and nicked up through normal everyday use. If an intermittent problem develops, it is a very good bet that one of the cords is at fault.

The Analyzer will test a detachable cord for both shorts and opens. Both handset and telephone line cords should be tested and replaced if not good. When testing the cords, it is important to bunch up and then stretch the cord to simulate the conditions the cord goes through when a telephone conversation is being held.

Unfortunately, older telephones (and some one piece models) do not have detachable telephone cords. If a cord is not detachable it should be carefully inspected for signs of excessive wear, knicks, cuts, and frayed wires and should be replaced if any problems are spotted. It is also possible to test a non-detachable cord using an ohmmeter or continuity tester. Simply disconnect both ends of the cord and put one lead of the ohm meter or continuity tester at each end of one of the cord's conductors. Resistance should be very low (almost zero or right at zero). High resistance readings indicate that an open is present in the cord and the cord should be replaced. With one of the leads still touching one end of the cord, the lead at the other end should be touched to each of the other conductors one at a time. Resistance should be infinite or very close to infinite. Readings of low resistance indicate that a short is present in the cord and it should be replaced. Test each conductor of the cord in the same way.

CHECKING RINGING

After verifying that the cords are in good shape, or after replacing the cords if necessary, the telephone should be tested for ringing. At the same time you should also check the ring threshold voltage. This is the minimum voltage at which the telephone will ring. The Analyzer generates a variable voltage ring signal that simulates the signal that the telephone company applies to the line. If

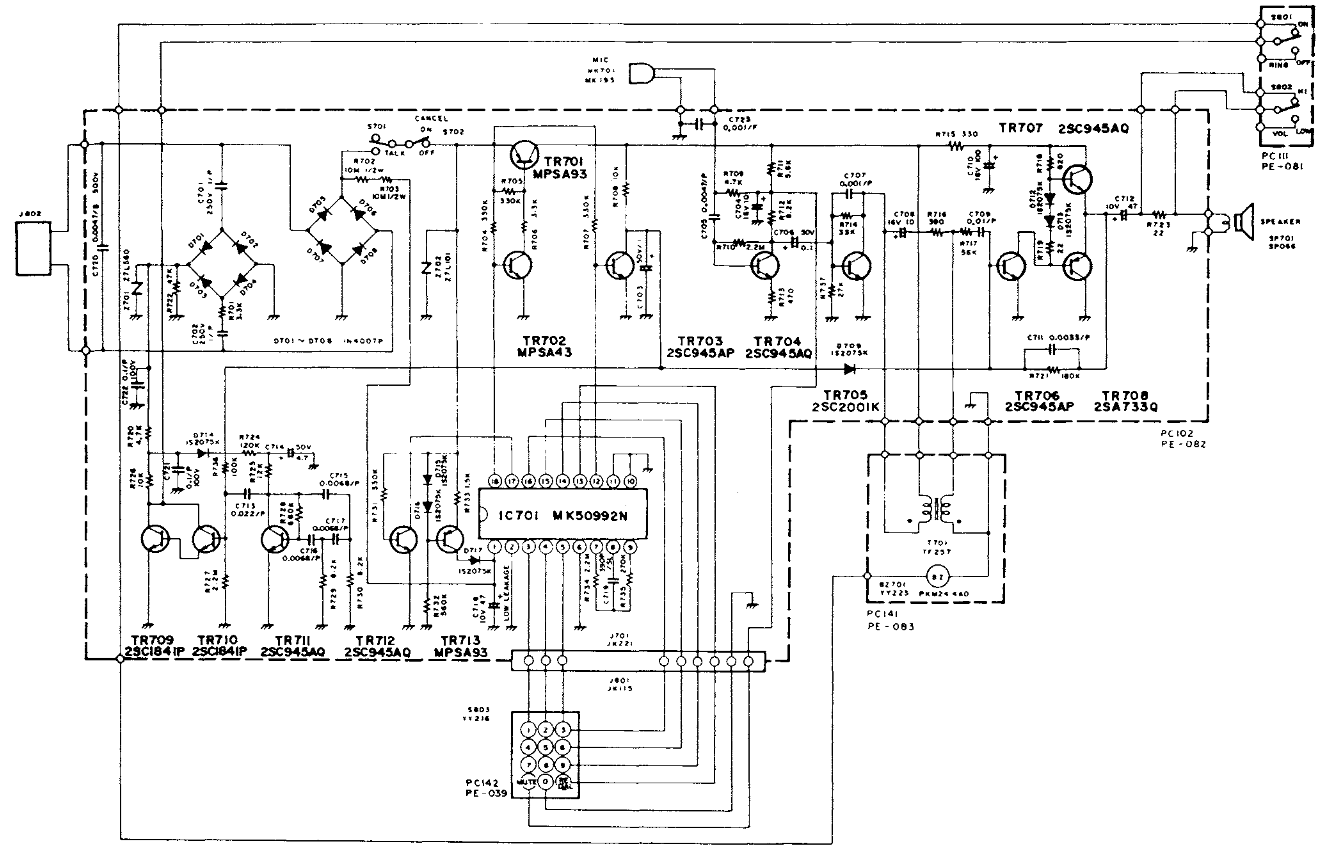


Fig. 23. Schematic Diagram of an Electronic Telephone.

the telephone will not ring with a ring voltage of 40 Vrms or lower, the ringer circuit is probably defective. While the telephone company generally supplies 80 to 130 Vrms to the telephone line, telephone line resistance and loading from other telephone devices on the same line can cause the voltage to drop as low as 40 Vrms. When you lift the telephone off-hook, ringing should stop immediately. If the telephone continues to ring, the telephone is not coming off-hook properly and this problem should be investigated. Before checking the switch or other electrical parts inside the telephone, make sure that nothing is preventing the hook switch from moving.

If the telephone fails to ring during this test, several things can be checked to isolate the problem. Watch the **VOICE/SIGNAL LEVEL** indicator during the ring test. If the indicator does not flicker after the **RING** button has been pressed, the Analyzer is not generating a ring signal. Most likely, this is because the Analyzer detects an off-hook condition at the telephone and disables the ring generator. A probable cause of this would be shorted or leaky ringer coupling capacitors (C701 and C702), or a shorted or leaky transient suppressor capacitor (C722).

If the Analyzer is generating a ring signal, trace the signal through the ringer circuit of the telephone to find the point where the signal path is disrupted or severely attenuated. It is usually more convenient to switch to continuous ring for these signal tracing measurements. The specific ring circuit for each telephone may differ and the measurements should be adapted to the specific telephone being tested. However, to demonstrate the technique, let us examine the points of measurement for the telephone depicted in Fig. 23. This is the schematic diagram of a telephone with an electronic ringer circuit. Setting the Analyzer to apply a continuous 20 Hz ring signal at approximately 100 volts rms, our first point of measurement may be from the junction of D701 and D703 to ground using an oscilloscope. Because D701-D704 form a full wave bridge rectifier, the 20 Hz ring signal should be converted to a 40 Hz ripple signal. If the signal is absent we should check for an open C701, C702, or R701, or a shorted C722, or Z701. An abnormal signal may be caused by bridge diodes D701-D704, or shorted C721. If the signal is normal at the first point of measurement, we might jump to buzzer BZ701 for our next measurement. Since the 40 Hz ripple acts as a power source for oscillator TR711, the signal should be interrupted at a 40 Hz rate. Presence of the signal means that the buzzer itself is defective. If the signal is absent, check the contacts of switch S801, then check TR709, TR710, TR711, and associated components.

CHECKING DIALING

Checking the ability of the telephone to dial correctly should be the next step performed. The Analyzer decodes both tone and pulse dial signals and displays the actual number dialed on the **DIALED NUMBER** display. Each digit should be tested for both tone and pulse dial telephones. For tone dial telephones, the level of the dialing signal should also be checked.

Standard rotary dial telephones use a set of contacts that are mechanically opened and closed to dial numbers. When the dial is released, contacts open and close accordingly. For example, for the digit "7", the contacts open and close 7 times. A mechanical governor controls the speed of rotation, and thus the period and repetition rate of dial pulses. The dial pulses may be observed on an oscilloscope at the **LINE SCOPE** jack of the Analyzer, which is connected across the telephone line. Usually if a rotary dial telephone will not dial it is because the contacts are bent, oxidized, or corroded away. Oxidized contacts may be carefully cleaned but if the contacts are bent or corroded they should be replaced.

If a push-button type pulse dial telephone fails to dial numbers, the first step is to check the dialing IC. Observe the output of the dialing IC (pin 18 on IC701) while dialing a number. The output should pulse a certain number of times for each digit pressed (1 pulse for the "1" digit, 5 pulses for the "5" digit, 10 pulses for the "0" digit, etc...).

If the dialing IC checks out alright, the problem is probably with the switching transistors (TR701, 702). These transistors take the place of the mechanical contacts on rotary dial telephones, "opening" and "closing" the line in response to the period and repetition rate established by the dialing IC (IC701). One of the more common faults I have noted in troubleshooting electronic telephones is the failure of these switching transistors to completely turn off during dial pulses. If these transistors allow as little as 1 mA of leakage, some or all of the dial pulses may not be recognized by the telephone exchange. The Analyzer, similarly, will not responde properly to dialed numbers if leakage exceeds 1 mA. This may be additionally confirmed by examining dial pulses at the **LINE SCOPE** jack. Using dc coupling on the oscilloscope, note the dc reference level with the telephone on-hook. Next, note whether the line switches all the way to the reference level during dialing pulses.

I have also noted that telephones with this problem appear to break down gradually, with the problem first occuring when the telephone line voltage is high. That is, they may dial normally when the telephone line voltage is 48 volts or less, but may not work when stressed with a higher telephone line voltage such as 52 volts. Thus, B & K-Precision has designed the Model 1050 Telephone Analyzer with a nominal 52 volt telephone line voltage rather than 48 volts. This significantly improves the ability to reject telephones with marginal switching transistors and those with impending failure.

"Touch Tone" and equivalent DTMF dialers produce a pair of tones for each digit. Improper level or improper frequency can cause dialing failure. The **VOICE/SIGNAL LEVEL** indicator should light for each digit. The DTMF dialing module is typically replaced rather than repaired in the field.

"Touch Tone" is a registered trademark of AT&T

CHECKING AUDIO

Level and quality of audio should be checked in both directions. The voice at the earpiece should be loud enough and clear enough so that it can be easily understood. Outgoing voice should also be loud enough and clear enough to be easily understood at the other earpiece. In addition, the sidetone volume should be at a level where the person speaking into the telephone does not feel that they have to shout or whisper.

If the level of outgoing audio from the telephone is not high enough to light the **VOICE/ SIGNAL LEVEL** indicator, the outgoing audio circuitry must be checked (TR704,705). Use the Analyzer to inject a signal into the telephone at the microphone and trace the signal through the telephone. This should result in tracking down the problem, most likely a lack of amplification or a presence of unwanted attenuation.

Insufficient input audio volume requires the troubleshooting of the audio input circuits and amplifier (TR706-708). Once again, use the Analyzer as a signal source (inject the signal at the telephone line) and trace the signal throughout the telephone. As in the previous case, the probable cause will be lack of amplification or presence of unwanted attenuation.

If both the incoming audio volume and the sidetone are low, the problem is most likely in the audio amplifier (TR706-708). Check that the gain of this amplifier stage is up to specifications. Another possibility for the cause of low incoming audio volume and sidetone is the failure of the hybrid transformer (T701); however, the failure of the transformer will usually result in low audio output level as well.

If there is a total lack of incoming and outgoing audio, yet dialing and ringing functions are operating properly, there is probably a break in the circuitry between the switching transistors (TR701-703) and the microphone amplifier (TR704,705). Use the Analyzer to supply power to the telephone and check voltages.

TROUBLESHOOTING CORDLESS TELEPHONES

by Christopher Kite

This introductory article provides a logical sequence of checks and measurements that may be used to isolate a defective circuit in cordless telephones. It can serve as a valuable guide to technicians inexperienced in cordless telephones. Of course, an article like this can not cover all the variations found among the numerous brands and models of cordless telephones available. However, the basic operation of all cordless telephones is the same. The examples cited in this article can be readily adapted to help you track down specific problems in most cordless telephones.

INTRODUCTION

Cordless telephones are fairly complex pieces of electronic equipment, embodying all the circuits of a corded telephone plus two FM transmitters and receivers. Technicians who have troubleshooting experience with CB radios or similar equipment should have little trouble adapting their experience to cordless telephones.

The proper test equipment is essential for cordless telephone troubleshooting. The B & K-Precision Model 1050 Telephone Analyzer, a general purpose oscilloscope, a general purpose frequency counter, a demodulator probe, and a multimeter should meet all those requirements.

Another valuable troubleshooting tool is a good knowledge of the cordless telephones. In addition to this article, I recommend the articles "What's Inside Your Telephone?", "How Does Your Cordless Telephone Operate?", and "Troubleshooting Corded Telephones" as good background information. These articles are found elsewhere in this manual. A service manual for the specific cordless telephone being serviced is also desirable, and sometimes indispensable.

GETTING STARTED

I like to start with a "Ring Test", "Dial Tone Test", "Dial Test", "Voice Test" sequence of operational checks. Even if I have a description of the symptoms, I like to verify the symptoms myself. This operational check will usually do it, and it takes so little time. The entire sequence can be done in 10 or 15 seconds. If the cordless telephone can not successfully complete these tests, the results have already isolated the problem to a specific portion of the system, and a few additional tests will narrow it down to a specific circuit or component. If the cordless telephone passes these tests, we know that it will operate at short range. We can then proceed to check more subtle symptoms such as short range, interference, etc. A different set of tests is needed to narrow down this type of problem.

THE 15-SECOND OPERATIONAL CHECK

Ring Test

Apply ac power to the base unit and connect it to a telephone jack. Leave the portable unit in STBY (on hook). Apply a 100 V, 20 Hz ring signal to the telephone line and see if the portable unit rings. If the telephone does not ring, "Ring Test" troubleshooting is needed. If the telephone rings, check further that the ringing threshold is below 40 volts. If not, troubleshoot that problem. If so, proceed to the "Dial Tone Test".

Dial Tone Test

Remove 20 Hz ring signal before starting this check. Then simply set the portable unit to TALK and listen for the dial tone. If the dial tone is heard, proceed to the "Dial Test". If not, "Dial Tone Test" troubleshooting is needed.

Dial Test

Dial each digit 0 thru 9 and observe whether the correct digits are shown on the DIALED NUMBER display. If so, proceed to the "Voice Test". If not, "Dial Test" troubleshooting is needed.

Voice Test

Speak into the mouthpiece and note whether the VOICE LEVEL indicator lights on voice peaks. Listen to the earpiece for correct sidetone level and overall voice quality. If satisfactory, the cordless telephone is operational. If not, "Voice Test" troubleshooting is needed.

ANALYSIS OF OPERATIONAL TESTS

Let us further examine the value of each of the operational tests just described. Some additional information is also provided to help isolate faults to a narrower group of circuits.

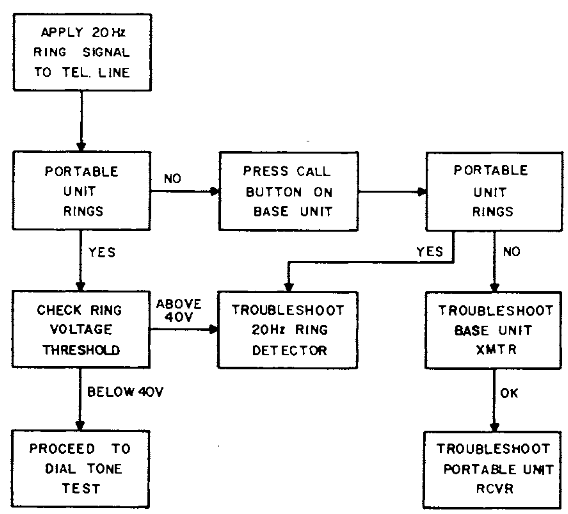
Ring Test Analysis

The first test of this sequence is the "Ring Test". The "Ring Test" is performed by first inserting the telephone line and ac power plugs of the cordless telephone base unit into the Telephone Analyzer. Leave the portable unit in standby (on hook). Next, set the ring generator voltage to maximum and for continuous ring operation and press the RING button on the Analyzer. The ringer (buzzer or speaker) on the portable unit of the cordless telephone should sound.

Let's analyze what this test shows us while looking at the block diagram shown in Fig. 24. All the shaded circuits of Fig. 24 are used during ringing. The Analyzer applies a 20 Hz ring signal to the telephone line. The 20 Hz ring detector recognizes it and turns on the base unit rf transmitter and modulates the rf carrier with a ring signal (typically, a specific audio frequency in the 700 to 1500 Hz range). The portable unit receiver detects the rf signal. A narrow band filter detects the correct ring frequency and feeds an audio tone to the speaker. Most cordless telephones use the same speaker used in voice communication. However, some cordless telephones actually use a separate buzzer. If the telephone rings, all of these circuits are operating. If the telephone does not ring, one of the circuits in the shaded area is defective.

If the "Ring Test" is successful, gradually reduce the ringer voltage and note the approximate voltage at which ringing stops. Some cordless telephones may ring with ringer voltage set all the way to minimum, which is excellent. Most cordless telephones will stop ringing below about 40 volts, and should be considered normal. If the ringing threshold is higher than 40 volts, some additional troubleshooting checks should be made in the 20 Hz ring detector circuit of the base unit.

Most base units have a CALL button which can be pressed to ring the portable unit without 20 Hz ring signal applied to the telephone line (I have a friend who uses it to find his misplaced portable unit). If the "Ring Test" was not successful, press the CALL button on the base unit and note whether the ringer in the portable unit now sounds. The CALL button normally activates the base unit rf transmitter and applies ring signal modulation, causing the portable unit ringer to sound. In this case, there is no 20 Hz ring signal applied to the telephone line and the 20 Hz ring detector circuit is not used. This check half splits the circuits in the shaded area. If the ringer now sounds, we have isolated the problem to the telephone cord or the 20 Hz ring detector. If the ringer does not sound, we know that the base unit rf transmitter or portable unit receiver are probably the cause. A few additional measurements will isolate the specific circuit.



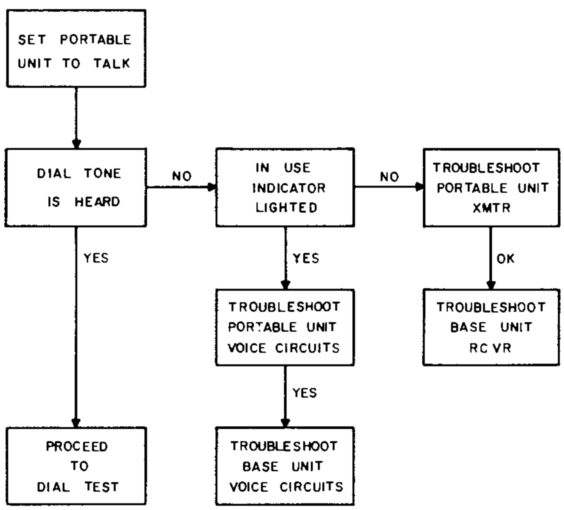
Ring Test Summary

Dial Tone Test Analysis

The second test in this sequence is the "Dial Tone Test". At the conclusion of the "Ring

Test", simply pick up the portable unit, set it to the TALK mode, and listen for dial tone. Also note whether the IN USE indicator on the base unit is lighted; most cordless telephones have an IN USE indicator to show the "off hook" condition.

Let us again examine the block diagram of Fig. 24 and analyze what this test can show us. For the IN USE indicator to light, most of the circuits in the unshaded area are used. When the portable unit is placed in the TALK mode, its rf transmitter and pilot signal (guardtone) generator are turned on. The base unit receiver detects the rf signal and recognizes the guardtone. Guardtone detection operates the "off hook" relay, which completes the connection to the telephone line and turns on the IN USE indicator.



Dial Tone Test Summary

For the dial tone to be heard in the portable unit, most of the circuits in both the shaded and unshaded areas are used. First, an "off-hook" condition must be established, which is checked by operation of the IN USE indicator, as just described. These are the unshaded circuits of the block diagram. An off-hook condition causes the Analyzer to generate dial tone and apply it to the telephone line. For the dial tone to be returned and heard in the portable unit, many of the shaded circuits, previously used in the "Ring Test", are again used. The "off hook" relay turns on the base unit rf transmitter (this time without ring signal modulation). Dial tone audio from the telephone line modulates the rf carrier, which is detected by the portable unit receiver and fed through the audio circuits to the earpiece.

If you can hear dial tone, both paths are operating. If the IN USE indicator lights, the portable-to-base path (unshaded circuits) is operating. If the IN USE indicator does not light, the problem lies in the unshaded circuits.

Analyzing the Combination of "Ring Test" and "Dial Tone Test" Results

If the "Ring Test" is unsuccessful, the "Dial Tone Test" should be performed anyway, because the combination of the two tests can further isolate the location of the problem. Refer to the block diagram to analyze why the following combinations of symptoms narrow down the number of circuits to be suspected.

If neither the CALL button nor 20 Hz ring generator will ring the portable unit, and neither the IN USE indicator lights nor is dial tone heard, the problem may be in the base unit power supply. A defective power supply may cause both the rf transmitter and receiver of the base unit to be inoperative. Dead batteries in the portable unit could also cause this symptom, as both the rf transmitter and receiver of the portable unit would be inoperative.

If the CALL button rings the portable 20 Hz unit and the IN USE indicator works, but the ring generator will not ring the portable unit and dial tone is not heard, the telephone cord is probably defective.

If neither the CALL button nor the 20 Hz ring generator will cause the portable unit to ring, but the IN USE indicator lights, listen to the portable unit for static. If static is heard, it is more likely that the base unit transmitter is not providing an rf carrier signal. If nothing is heard, the portable unit receiver is more likely defective.

Dial Test Analysis

If the "Ring Test" and "Dial Tone Test" are successful, the "Dial Test" should be performed. If either of the first two tests is unsuccessful, troubleshooting and repair of those problems must be attended to first.

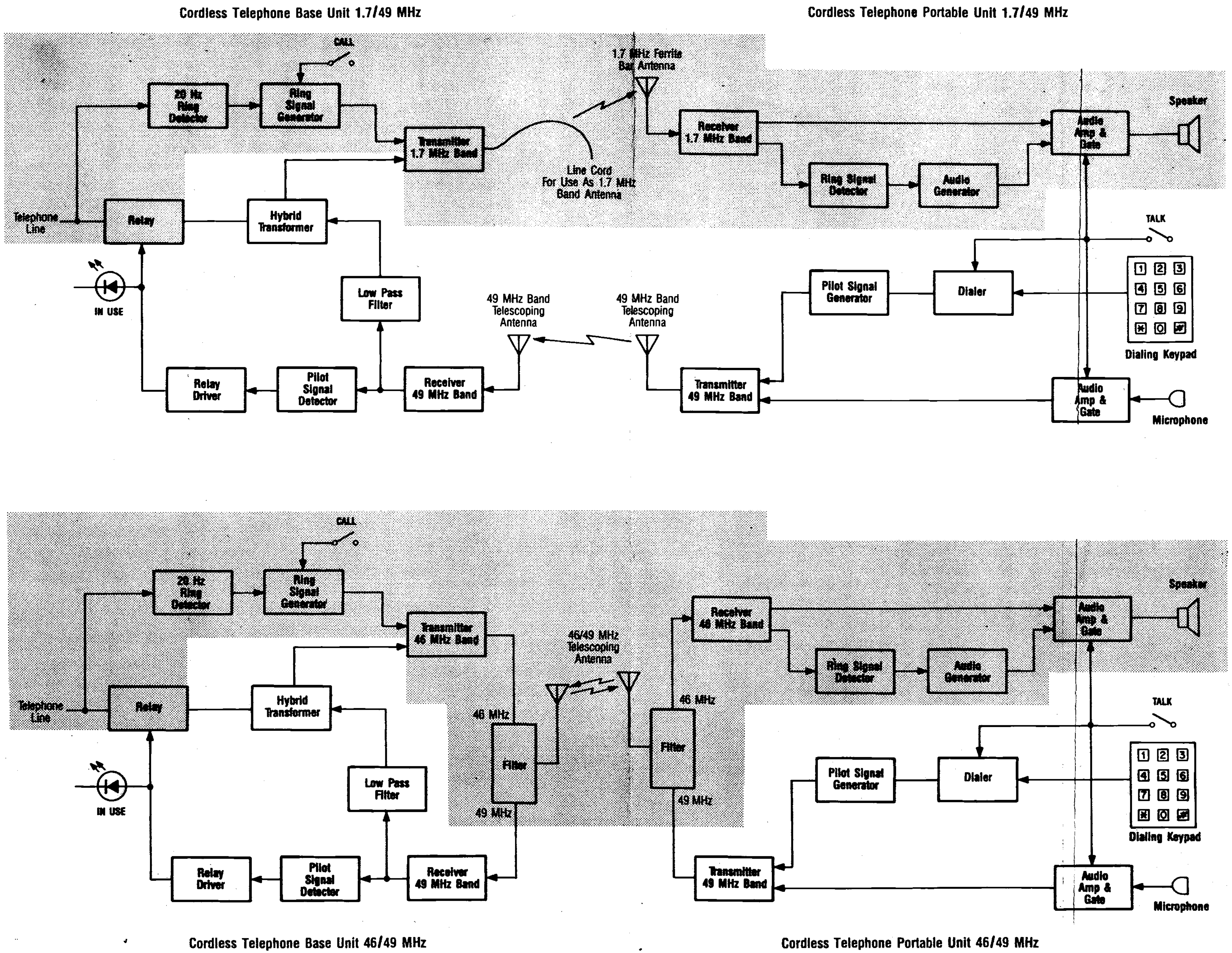
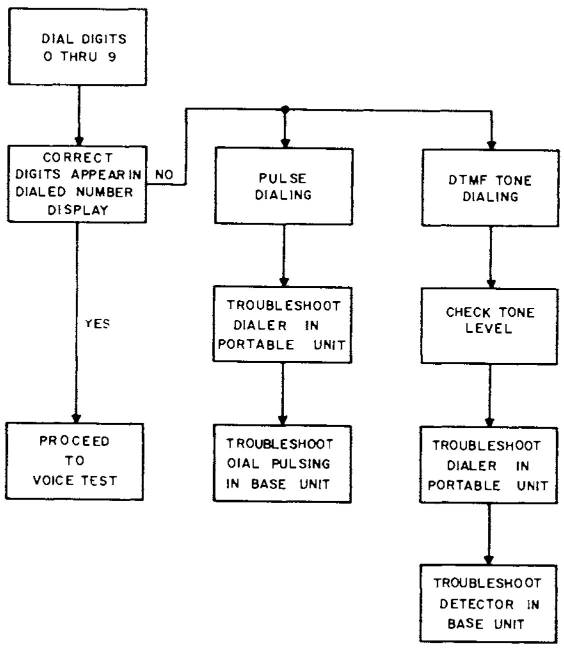


Fig. 24. Fault Analysis Block Diagram.

The "Dial Test" consists of dialing all digits 0 thru 9 and observing that those same digits are displayed on the DIALED NUMBER display of the Analyzer. If so, we will proceed to the "Voice Test". If not, we have a dialing problem to troubleshoot. A paragraph is devoted to that testing technique later in this article.

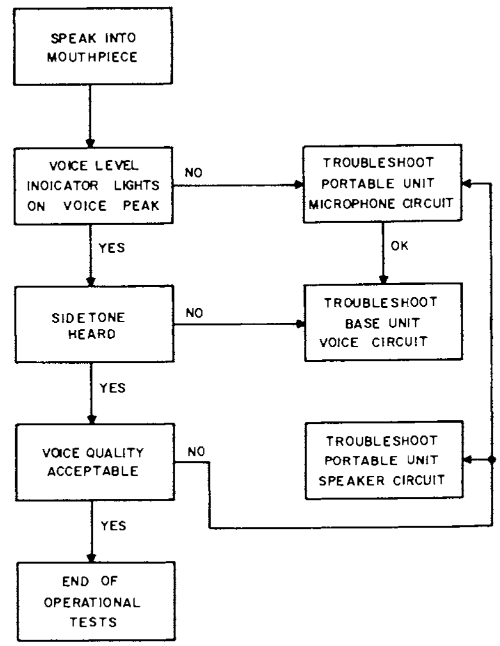


Dial Test Summary

Voice Test Analysis

If we have successfully completed the first three tests, we should now perform a "Voice Test". This tests consists merely of speaking into the portable unit mouthpiece, observing that the VOICE LEVEL indicator on the Analyzer lights during voice peaks, and listening to the sidetone in the earpiece. Listen for adequate voice sidetone level and for good voice quality.

The earlier tests have already checked out the rf path in both directions and confirmed that the telephone cord is good. The "Dial Tone Test" has even confirmed the audio path from telephone line to the portable unit. This last test will additionally confirm the audio path from portable unit to the telephone line, recheck the return audio path, check for voice level, and check for distortion.



Voice Test Summary

If the VOICE LEVEL indicator does not light at all, the voice circuits in the portable unit transmitter or base unit receiver are suspected. Low voice sidetone level may be caused in either direction; microphone audio is fed through the portable-to-base rf link, coupled by a hybrid transformer to the telephone line and into the base-to-portable rf link at the base unit and fed back to the earpiece. Measuring the voice level at the telephone line half splits this path to help isolate the cause of attenuation.

FAULT ISOLATION

Once the operational checks have shown a problem and narrowed it down to a broad group of circuits, further checks and measurements will be required to narrow it down to a specific circuit. The following methods should be helpful in developing techniques of fault isolation for each non-satisfactory operational test. Due to the fact that repair might uncover or create new operational problems, it is always a good idea to go back and repeat the tests after the cordless telephone has been repaired.

No Ring From CALL Button

If the portable unit will not ring from the CALL button on the base unit, we need to determine whether the problem is in the base unit transmitter or the portable unit receiver. First, let's check out the base unit transmitter. The first measurement is rf output level.

For 1.7 MHz band units, simply press the LOAD pushbutton and read the LEVEL meter on the Analyzer while holding the CALL button on the base unit. The base unit transmitter rf output is fed into the ac power cord. The analyzer includes an rf detector circuit which measures the rf level fed into the ac outlet on the front panel.

For 46 MHz band units, connect an rf demodulator probe to the Analyzer and select the DEMOD PROBE mode. Touch the probe to the antenna of the base unit and read the LEVEL meter on the Analyzer while holding the CALL button on the base unit.

For either 1.7 MHz band or 46 MHz band units, most good cordless telephones should measure about 4 volts, but a reading of even 1/2 volt should permit ringing at close range. The base unit transmitter is completely dead if there is no reading. Make dc voltage and resistance measurements in the rf oscillator and output stages to determine the cause of the problem.

If an rf output is indicated, we should measure frequency error and ring signal modulation. Connect a cable to the RF IN/OUT jack and clip the leads over the ac power cord. Turn on the base unit transmitter without ring voltage modulation and measure rf frequency error (ΔF). If frequency error is more than 2 kHz, the base unit transmitter frequency should be adjusted.

If the base unit transmitter is working, we should check that the transmitter is being modulated by the proper "ring signal" (in the 700 to 1500 Hz frequency range). The "ring signal" is generated either when the CALL button has been pressed or when a 20 Hz ring signal is detected from the telephone line. It is important that this signal be of correct frequency and amplitude because the filter in the portable unit will not recognize a signal that is of the wrong frequency or too weak. The ring signal should produce about 3 to 4 kHz of deviation. We can measure the ring signal frequency by connecting a frequency counter to the SCOPE OUT jack.

If all of the previous tests work, we know that the fault is in the portable unit. The first step is checking that the portable unit is receiving the signal.

Set up the Analyzer to transmit an rf signal to the portable unit. Set the Analyzer's audio generator to the proper ring frequency and set the level control for 4 kHz of deviation. Connect a probe to the output of the discriminator and measuring the ac signal level on the Level meter of the Analyzer. This permits the Analyzer to function as an audio voltmeter for signal tracing. It may be wise to actually view the signal on an oscilloscope to make sure that it has not been distorted in the demodulation process.

If no signal is present, the problem is in the rf or i-f section of the portable unit receiver. Check that each of the oscillators is operating, and check each i-f signal to make sure that the mixers are operating properly. Most receivers are dual conversion, using two local oscillators and two i-f frequencies.

If the undistorted signal is present at the discriminator, the problem is in either the ring signal detector, audio generator, or the speaker (some units may use a separate buzzer rather than the same speaker that is used for voice reproduction). Moving the probe over to the output of the ring signal detector you should once again get a deflection on the Level meter. If no signal is present, try varying the frequency of the audio generator. If this causes a signal at the output of the ring signal detector, check the frequency where ringing occurs and re-adjust the base unit's ring signal generator to that frequency. If varying the audio frequency does not produce an output from the ring signal detector, it is defective.

If a signal is present at the output of the ring signal detector move the probe to the output of the audio generator to make sure that an audio tone is being generated. If no audio signal is being generated, the audio generator is defective. If an audio signal is being generated, the speaker is probably defective.

No Ring From Ring Generator

If the portable unit rings normally from the CALL button on the base unit, but does not ring from the 20 Hz signal applied to the telephone cord by the Analyzer, we should make sure that the Analyzer is actually generating a ring signal. If the VOICE/SIGNAL LEVEL indicator fails to flicker after the RING button has been pressed, we know that the Analyzer is not generating a ring signal. This is probably because the Analyzer detects an off-hook condition in the base unit. When the Analyzer detects an off-hook condition, it will not generate a ring signal (just like telephone company equipment). A possible cause for the base unit being off-hook might be another portable unit operating on the same carrier and guardtone (pilot signal) frequencies "capturing" the base unit, or a fault in the base unit placing a low impedance across the telephone line.

If the Analyzer is generating a ring signal, the 20 Hz ring detector circuit in the base unit should be checked. Apply a continuous ring signal and trace the ring signal through the suspected circuit with an ac voltmeter. If the telephone cord is open, there will be no ring signal present at the input to the 20 Hz ring detector. The ring detector circuit often uses an opto-isolator to switch on the rf transmitter and 700-1500 Hz ring signal generator. Check whether the output of the opto-isolator is switching. A non-continuous ring signal may be more suitable for this check.

No Dial Tone With IN USE Indicator On

If the dial tone can not be heard at the speaker of the portable unit when the IN USE indicator is on, the problem must lie in the base-to-portable link. Because we have already checked most of the circuits invloved in the base-to-portable link during the ring test, we can narrow down the defective circuits to either the audio amplifier & gate (in the portable unit) or the voice audio circuits in the base unit. In units where a separate buzzer is used for ringing, the problem could also possibly be the speaker in the portable unit.

No Dial Tone And IN USE Indicator Fails To Light

If no dial tone signal is heard and the IN USE indicator fails to light, we must troubleshoot the circuits in the portable-to-base link. Because the portable unit is subjected to harder use (i.e., possibly being bumped or dropped), we should start by checking the portable unit transmitter.

First check the rf level using a demodulation probe and the LEVEL meter. As stated previously, most good cordless telephones should measure about 4 volts, but a reading of even 1/2 volt should permit close range operation. The portable unit is completely dead if there is no reading. Make dc voltage and resistance measurements in the rf oscillator and output stages to pinpoint the problem.

If an rf output is indicated, we should measure the frequency error and guardtone modulation. Use the analyzer to measure the frequency error. If the error is more than 2 kHz, the portable unit transmitter frequency should be adjusted.

If the portable unit transmitter is working, we should check that the transmitter is being modulated by the proper pilot signal (guardtone). It is important that this signal be of correct frequency and amplitude because the pilot signal detector will not recognize a signal that is of the wrong frequency or too weak. The pilot signal should produce about 3 to 4 kHz of deviation. The pilot signal frequency can be measured on a frequency counter connected to the SCOPE OUT jack. If the guardtone frequency is not within specifications, adjust it accordingly and proceed to testing the base unit.

If the portable unit proves to be in proper operating condition, we must check the base unit. The first step is to check that the base unit is actually receiving and demodulating the rf signal. Use the Analyzer to transmit an rf signal to the base unit. Adjust the AUDIO OUTPUT FREQUENCY and AUDIO OUT LEVEL controls for 3 kHz of deviation at the proper pilot signal (guardtone) frequency. Adjust the 1 kHz MOD LEVEL control for an additional 3 kHz of modulation (6 kHz of total deviation). Connect an oscilloscope to the discriminator output of the 49 MHz band receiver and check that the guardtone is present. If it is, make sure that the signal is of the proper frequency. If the signal isn't present or has been distorted or altered, the receiver is defective.

Usually the base unit receiver consists of several stages; an rf amplifier, 1st i-f (1st mixer, local oscillator, and i-f filter), and 2nd i-f stage (2nd mixer, local oscillator, i-f filter, and detector). First, check the local oscillators for activity, if they fail to oscillate they are defective and are probably the cause of the problem. After the local oscillators have been verified as operational, check the output of each stage (i.e., begin with the rf amplifier, 1st mixer, 1st i-f filter, etc...). An rf demodulator probe connected to the DEMOD PROBE jack of the Analyzer and read on the LEVEL meter is a convenient method of making these measurements.

The next step is to check that the pilot signal detector is detecting the signal and causing the telephone to go off hook. If the pilot signal (guardtone) is being detected, a signal should be sent to the relay driver to cause the telephone to go off hook. If the pilot signal is not being detected, vary the frequency of the Analyzer's audio generator to make sure that the pilot signal detector is not set up to receive a different frequency guardtone. If the pilot signal detector detects a different frequency (from the one that was originally selected), it would be easier to change the pilot signal frequency in the portable unit (to match that frequency of the pilot signal detector) than to change the filter component values in the pilot signal detector.

If the pilot signal detector is operating, the problem is either in the relay driver or the relay. Check that the output of the relay driver is sending a signal to the relay to cause it to switch to an off hook position. If it is, the relay is defective. If it isn't, the relay driver is defective.

Pulse Dial Failure

If a pulse dial cordless telephone fails to produce any digits at the Analyzer's display, the dialing IC is probably defective. Most pulse dial cordless telephones have a dialing IC that turns the pilot signal generator on and off. This causes the base unit to switch on and off hook and pulses the telephone line. Because all the other circuits were operational in the previous tests, the dialing IC is essentially the only component that would be defective. This can be verified by checking dial pulsing in the portble unit with an oscilloscope.

If the incorrect digits appear at the Analyzer's display, the base unit relay is probably defective. Even though the relay operates properly for the ring test and dial tone test, it is possible that it is causing the cordless telephone to dial the wrong digits. If the relay spring loses some of its tension or the relay becomes "sticky", the duty cycle of the pulses is changed and telephone company equipment (as well as the Analyzer) sees the wrong digits. Replacing the relay will solve this dialing problem.

Tone Dial Failure

As with pulse dial cordless telephones, the components that could possibly cause dialing failure are very limited. The first step is to check the output of the crystal used with DTMF chip. Using an oscilloscope you should be able to see some kind of an oscillating trace. If the the crystal is oscillating, you should check the output of dialing IC. If the cystal is not operating, it should be replaced.

The dialing IC should output the proper tone pairs for each digit. If it doesn't, it should be replaced. If both the dialing IC and crystal are operating, then there must be attenuation somewhere in the signal path that is causing the tone level to be so low that it can not be recognized.

If the portable unit proves to be operating properly, the problem is in the base unit. The two most common problems are, distortion caused by the detector circuit, or improper tone level adjustment. If the VOICE/SIGNAL LEVEL indicator failed to light, the problem is probably caused by an improper level adjustment. Check the service manual for the cordless telephone and find the level adjustment potentiometer. Adjust it for correct tone level. If the level is correct, the problem is most likely distortion caused by the detector circuit. Connect an oscilloscope to the LINE SCOPE jack and check the signal for distortion. If distortion is present, the detector circuits are defective.

VOICE LEVEL Indicator Fails To Light

The first step in troubleshooting why the VOICE LEVEL indicator fails to light, is to check the portable unit. Use the AUDIO OUTPUT to inject an audio tone into the microphone circuit fo the portable unit. Signal trace the audio signal with an ac voltmeter, or using the AUDIO IN and LEVEL meter function of the Analyzer as an ac voltmeter. Check that there is a signal being fed to the audio amp gate. The audio amp & gate should feed the amplified voice signal to the transmitter were it is used to modulate the carrier signal. If the voice signal is being fed to the transmitter but the demodulated rf signal has no audio present, there is probably a broken connection between the audio amp & gate and the transmitter.

If the portable unit is operating properly, the next step is to check the base unit. At the base unit, the receiver demodulates the rf carrier and outputs the guardtone and voice audio signals. The low pass filter should output the voice audio and feed it to the hybrid transformer. The hybrid transformer should feed the signal out to the telephone line and back to the transmitter (the level of the signal fed to the telephone line should be much higher than the level of the signal fed to the transmitter) where it is sent to the portable unit as sidetone. Any problem must lie in the low pass filter, the hybrid transformer, or the connection between the two because all other components involved have previously been tested.

Sidetone Level Too Low

Because the sidetone is fed to the portable unit from the base unit, the only likely cause of very low or nonexistent sidetone would be the failure of the hybrid transformer in the base unit. Because all other circuits involved have been tested previously, this is the only problem with sidetone that we are likely to see. Check the modulation level of the base transmitter with voice or audio tones applied. Less than 3 kHz deviation at normal voice peak level indicates a problem in the hybrid transformer.

Voice Quality Unacceptable

If the voice quality of the cordless telephone proved to be unacceptable, the problem could lie in either the portable or base unit. Connect an oscilloscope to the LINE SCOPE jack. The AUDIO OUT jack provides a low distortion sine wave, which may be injected at the portable unit microphone. If distortion is evident on the scope, make additional waveform measurements in the audio circuits of the portable unit microphone circuit and then in the base unit receiver discriminator and audio circuit (using the scope). If no distortion is present at the LINE SCOPE jack, check the hybrid transformer in the base unit transmitter, then the discriminator and speaker audio circuits of the portable unit receiver.

TROUBLESHOOTING POOR PERFORMANCE

When we talk about a cordless telephone performing poorly, we are usually referring to very short range. There are several things to consider when trying to diagnose short range problems. Many of us think only of rf power when we try to correct a short range problem. There are in fact, several reasons that the range of a cordless telephone might not be up to specifications. Just as low rf power might affect range, receiver sensitivity could also be the cause. Additional causes might be an offset pilot signal or ring signal frequency, or PLL drift. Range is also affected by the amount of shielding in the building and the effectiveness of the ac wiring as a 1.7 MHz antenna. Also to be considered is the fact that short range could be caused by the base unit transmitter, portable unit transmitter, base unit receiver, or portable unit receiver (or any combination).

The most common problems causing reduced range are low rf power and low receiver sensitivity. Fortunately, these are also the easiest parameters to check.

When we tested the cordless telephone for ringing and dial tone, we measured the relative rf power. As stated in those paragraphs in this article, level readings for transmitters should be around 4 volts for most cordless telephones (some of the short range telephones have much lower output voltages, check the service manual for the telephone you are servicing). If the output voltage is not up to specifications, adjust the output of the weak transmitter.

Using the Analyzer and coupling coil, it is fairly easy for us to check the sensitivity of a receiver. Simply use the Analyzer to transmit a modulated rf signal to the receiver and check to see how much attenaution you can select and still clearly receive the signal. Most cordless telephones should be able to receive the signal with approximately 80 dB of attenuation selected (some short range telephones might need lower amounts of attenuation, check the service manual for the telephone you are repairing) when the coupling coil goes over the antenna. This figure may be as low as 40 dB for internal antennae (ferrite bar) when coupling efficiency is low. Experience with similar type cordless telephone units will quickly establish normal reference levels for each type. If the receiver does not operate acceptably we must go through the receiver section and check for weak transistors or unwanted attenuation. Usually the problem will be a weak first transistor. If this is the case, replacing the transistor should cure the short range problem.

Another possible cause of short range is the drifting of the pilot signal (guardtone) frequency. It is important that the pilot signal frequency match the frequency that the pilot signal detector is tuned for. Use a frequency counter to measure the pilot signal frequency error of the cordless telephone transmitter. If the frequency is off just a slight amount, it could cause the range of the telephone to become dramatically shorter. Pilot signal frequency error can also cause other operational difficulties and the pilot signal generator should be adjusted whenever error is noticed.

Just as pilot signal can drift, ring signal can also become offset and affect the range of the cordless telephone. Using the same technique as when testing the pilot signal, check that the ring signal is within specifications. If not, it should be adjusted accordingly. Once again, it is important that the ring signal frequency matches the frequency of the ring signal detector.

Phase locked loop (PLL) drift is another common cause of short range. The PLL controls the rf carrier frequency and is particularly susceptible to drift when the batteries are low. Check that the output of the PLL (rf output) is up to specifications using the ΔF function of the Analyzer. If it is not, it should be adjusted. Even a slight frequency error can cause operational problems (i.e., short range).

TESTING DIGITALLY CODED CORDLESS TELEPHONES

When testing digitally coded telephones it is imperative that you use the service manual for the telephone under test. Digital coding techniques vary greatly from one manufacturer to another and even from one model to another. Some methods for testing digitally coded cordless telephones follow.

Digitally coded telephones establish a "handshake" before voice communication is possible. With one popular scheme, the portable unit sends out a digital code. The "1"s and "0"s of the digital code are achieved by shifting the rf carrier between two frequencies. The digital code is decoded by the base unit receiver, which turns on the base unit transmitter and encoder and sends a code back to the portable unit. Lastly, the portable unit receiver decodes the returned digital message and completes the "handshake" by shutting off the encoder and enabling the voice circuits. The problem with troubleshooting this "closed loop" system is that almost any problem, either rf or digital, will prevent the "handshake" from being completed. When the "handshake" is not completed after a few tries, the system shuts down, preventing rf testing.

I prefer to bypass the digital code (using jumper connections that are listed in the cordless telephone service manual) and test the base unit without the use of the coding. This permits testing of the rf and audio functions. Generally, if the unit works when the code is bypassed, the coding or decoding circuitry is faulty. Several things must be kept in mind when testing with this method however. Some digitally coded phones use no guardtone or ring signal, they send a digital code for ringing and a digital code to signal the base unit to go off hook. This means that causing the portable unit to ring without using the base unit is very difficult. The rest of the circuitry can be tested however, narrowing the problem down to strictly the ringer circuits.

Fortunately, most portable unit transmitters can be activated and checked just by setting the portable unit to TALK. Usually it will be possible to view the digital code on an oscilloscope using the SCOPE OUT jack. Most manufacturers seem to use a scheme that involves generating the digital code at the beginning of transmission. When using the SCOPE OUT jack you probably won't be able to decipher the code. However, you can verify that the digital code is actually modulating the carrier. Chances are, if a code is being transmitted, the encoding circuits are functioning properly. This means that the fault is probably in the decoding portion. The transmitter may shut off after sending the digital code a few times if no acknowledgement is returned. Thus, it may be necessary to turn the TALK switch off, then back on to resume testing.

It is also possible with some units to use the portable unit to capture the base unit (if the portable unit is functioning) then turn off the power on the portable unit and maintain the link to the base unit with the Analyzer. Use the power off switch rather than returning "on hook" so that the disconnect code is not sent.

Some cordless telephones have built in systems for testing the phone. One such method involves setting all the digital code selection switches to the on position. This disables certain signals or tones that are generated for calling the user's attention to a problem. As mentioned previously, a service manual is of extreme importance when servicing digitally coded telephones.

Another method of testing the base unit transmitter (if jumper connections are not listed in the service manual) is to activate the base unit transmitter by applying ring voltage to the telephone line. If the base unit transmitter is operating and generating a ring code, the portable unit receiver can be checked by monitoring the discriminator output or the "Code In" input to the digital encoder/decoder chip.

Another thing to remember is that with some digital coding schemes, pulse dialing or tone dialing is acheived digitally between the portable unit and the base unit. The base unit decoder then generates the actual pulsing or DTMF tones and applies them to the telephone line.

OTHER CORDLESS TELEPHONE SCHEMES

Some manufacturers are using a dual guard-tone design, which improves security without the complexity of digital coding. With one scheme that I have seen, a 700 Hz tone is sent initially, then a 6 kHz tone. Both tones must be of correct frequency and must occur within a certain time window to capture the telephone line. The anlyzer could be used to simulate this scheme for testing purposes by using both an external audio generator and the internal variable generator. Switching from external to internal modulation modes at the proper time would achieve this simulation.

As pointed out at the beginning of this section, I did not intend to cover every circuit variation that might be encountered while servicing cordless telephones. To begin with, there are probably some designs in use of which I am not yet aware. Furthermore, there will probably be some new designs introduced the day this manual gets sent to the printer. However, I am confident that the basic troubleshooting techniques described in this section will apply to almost all cordless telephones. I am further confident that the very versatility built into the Model 1050 Telephone Analyzer will also meet the testing requirements for nearly all cordless telephones. Some models merely require more ingenuity and insight on your part to develop the proper testing technique.

NON-RF TESTING (Refer to Fig. 25.)

CORD TEST

For the Cord Test, both ends of a detachable telephone cord are plugged into the appropriate jacks. Two sets of jacks are provided, the **PHONE TEST JACKS** for checking detachable telephone cords (telephone to wall) and the **HANDSET CONT. JACKS** for detachable handset cords. The two sets of jacks are wired in parallel and either type cord is tested in the same manner, but only one may be tested at a given time. When the **DIAL MODE/CONT.** button is engaged a current is fed through each pair of wires (the two wires for voice, dialing, ringing, and power and the two wires for power for a lighted telephone) in the telephone cord from the +5 V supply through a 270 Ω resistor. At the other end of the cord an LED is connected between one terminal of the cord jacks (one terminal and one LED for each pair of wires) and ground. One LED lights when a 2-wire cord has continuity with no shorts. Both will light for a good 4-wire cord. If the LED(s) fails to light, the cord is defective, either shorted or no continuity. When the **POLARITY NORMAL/REV.** switch is disengaged, the cord is tested as if properly wired. When the **POLARITY NORMAL/REV.** switch is engaged, the cord is tested as if the plugs on the cord are reversed.

DIAL TEST

For the Dial Test, the telephone to be tested is plugged into **PHONE TEST JACK #1.** The Off Hook Detector circuit connects the Line Simulator circuit and the Dial Tone & Ringback Signal Generator to the telephone through the Polarity Test Switch when the telephone is taken off hook. The Line Simulator circuit applies a negative dc voltage through a 1.5 kΩ resistance. The Polarity Test switch reverses the dc polarity to test the telephone's ability to operate with either polarity. The Dial Tone & Ringback Signal Generator circuit generates two tones (440 Hz and 352 Hz), mixes them together to produce a precision dial tone, and feeds this tone to the telephone. As soon as the first digit is dialed from the telephone, the dial tone is disconnected and the tones or pulses are fed to the Dialed Number Display Logic circuit. The Dialed Number Display Logic circuit decodes the pulses or tones into a four bit binary logic signal. The four bit binary code is then fed to the Dialed Number Display delay which stores up to sixteen dialed digits and releases them at approximately 2 digits/second so that they can be easily read from the **DIALED NUMBER** display. The Dialed Number Display delay feeds the code to a decoder/driver which drives a seven segment LED display. Each time a new digit is displayed, the **DIALED NUMBER** display is blanked momentarily.

VOICE/TONE DIAL LEVEL TEST

The telephone to be tested is plugged into **PHONE TEST JACK #1.** The Off Hook Detector circuit connects the telephone to the Line Simulator and the Voltage Level Detector through the Polarity Test Switch when the telephone is taken off hook. The Voltage Level Detector rectifies the tone dialing or voice signal into a full wave voltage which is fed to an op-amp. The op-amp feeds the voltage to an LED with a 5 V reference signal connected to the other end. If the voltage applied to the LED is at a level sufficiently above 5 V, the LED lights.

RING TEST

For the Ring Test, the telephone to be tested is plugged into **PHONE TEST JACK #1.** The Off-Hook Detector circuit connects the telephone to the Line Simulator, Ring Generator, and Ring Amplifier through the Polarity Test Switch when the telephone is on hook. The Ring Generator produces a 20 Hz square wave ring signal that is on for 2 to 2-1/2 seconds and off for 3 to 3-1/2 seconds. The square wave ring signal is then passed through a low pass filter which removes the

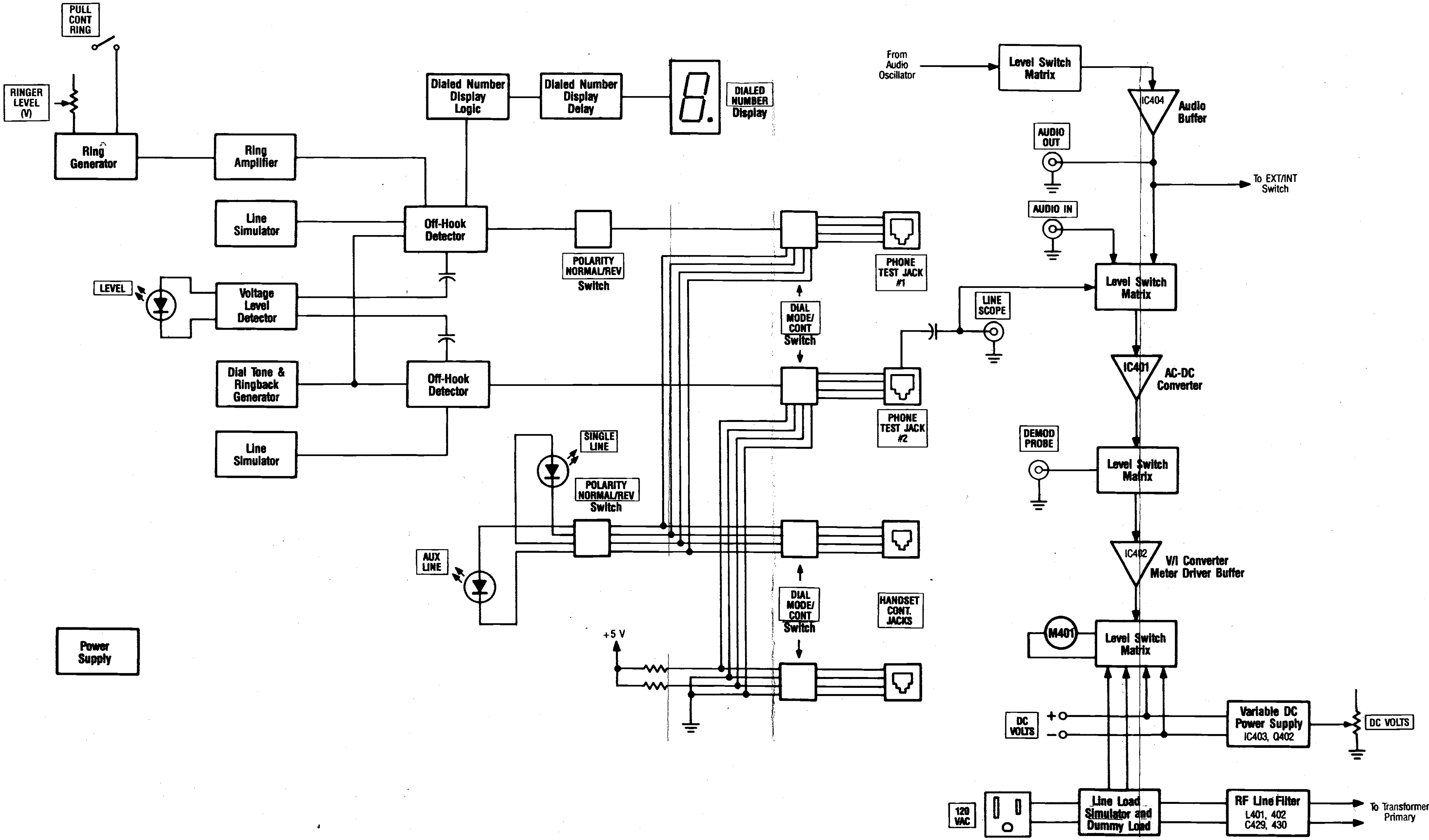


Fig. 25. Model 1050 Block Diagram For Non-RF Testing And Level Metering.

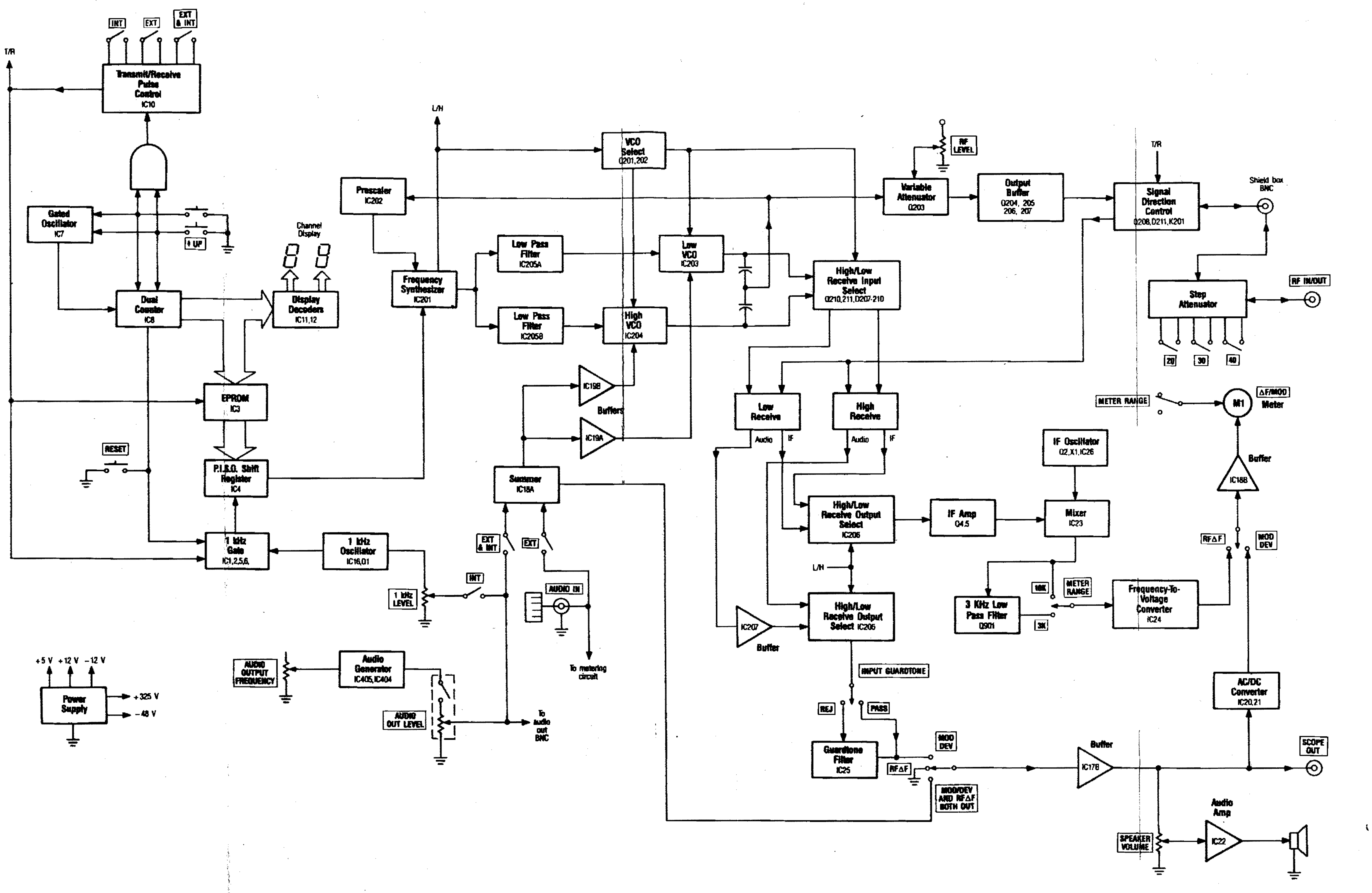


Fig. 26. Model 1050 Block Diagram For RF Testing.

harmonics and passes a 20 Hz sine wave. The signal is then fed through a potentiometer (**RINGER LEVEL (V)**) where the ring level is adjusted. The ring signal is then fed to the Ring Amplifier which amplifies it to a voltage between 35 V rms and 100 V rms (depending on the **RINGER LEVEL (V)** setting) and feeds it to the telephone. Pulling out the **RINGER LEVEL (V)** control causes the ring signal to be generated continuously rather than 2 to 2-1/2 seconds on and 3 to 3-1/2 seconds off. When the telephone is taken off hook, the Off-Hook Detector circuit inhibits the Ring Generator. If a telephone were connected to **PHONE TEST JACK #2** and taken off hook during the non-continuous ring test, a ringback signal of 440 Hz chopped by 20 Hz ringing at 2 to 2-1/2 seconds on 3 to 3-1/2 seconds off would be produced by the Dial Tone & Ringback Generator. If the telephone were connected during continuous ringing, a continuous ringback signal of 440 Hz chopped by 20 Hz would be produced and fed to the telephone (at **PHONE TEST JACK #2**).

RF TESTING (Refer to Fig. 26.)

CARRIER FREQUENCY GENERATION

Channel Selection

When power is first turned on, the dual counter (IC8) is automatically reset. This results in an output of low level logic signals at all eight (four lines for each digit) output lines. When one of the ↑**UP** buttons is pressed the corresponding counter starts counting up until the button is released. The right ↑**UP** button corresponds with the ones digit counter and the left ↑**UP** button corresponds with the tens digit counter. When the **CHAN. RESET** button is pressed, all eight output lines of the counter are reset.

The dual counter (IC8) outputs four BCD bits (on lines 3 - 6 and 11 - 14) of data to each of the display decoders (IC11 and IC12) and all eight bits to the EPROM (IC3). The display decoders latch the signals and display the proper channel on the LED displays. Upon the release of the ↑**UP** button, the EPROM (Erasable Programmable Read Only Memory) latches onto an 11 bit code (eight bits from the counter, one bit from the T/R line, and two from the 1 kHz gate circuit), and uses the 11 bits as an address. It then outputs the data stored in the corresponding memory location and feeds that data to the PISO (Parallel In Serial Out) shift register (IC4). After the data is loaded into the register (in parallel) it is clocked out (in serial) to the frequency synthesizer (IC201) by a gated 1 kHz signal (IC1, 2, 5, and 6).

Phase Locked Loop

This data is decoded and one bit is fed to the VCO (voltage controlled oscillator) select circuit (Q201, 202). These transistors enable either the low VCO (IC203) or high VCO (IC204). The low VCO is for the 1.7 MHz band and the high VCO is for the 46 and 49 MHz bands. When the low VCO is enabled, its output filters (L203, 204 and C226, 227) are also enabled. The data is also decoded to control the width of the pulses at the output of the frequency synthesizer. These pulses are fed to the low pass filters which feed a variable dc voltage to the varactors at the inputs of the VCOs. This changes the capacitance of the varactors and thus the VCO frequency.

Because only one of the VCOs is enabled at a time, only the VCO that is enabled will have an output. The output of the VCO is fed back to the frequency synthesizer through the prescaler (IC202). This path forms a PLL (phase locked loop) to maintain a precise frequency at the output of the VCO.

Modulation

If the tester is being used as a transmitter, the modulating signal is also mixed in at the inputs of the VCOs. This signal comes through the summer (IC18A) from either the **AUDIO IN** jacks, the internal signal generator (1 kHz and/or variable frequency), or both (depending on which mode of operation is selected). If the tester is being used as a receiver, no signal will be present at the outputs of the buffers (IC19A, B).

RECEIVING SIGNALS

RF Input And Routing

The RF signal is fed into the tester through the **RF IN/OUT** jack on the front panel. This signal is fed through the step attenuator where it can be attenuated from 0 to 90 dB. From the attenuator the signal is fed to the signal direction control (K201, Q208, and D211).

When none of the **RF OUTPUT** modes has been selected, the signal direction control relay (K201) is deenergized and the signal is fed to the low/high receive circuits. When any of the **RF OUTPUT** modes has been selected, a high level logic signal (5 V) is applied to Q208 which energizes the relay, making a path for the outgoing signal. When none of the **RF OUTPUT** modes has been selected, a low level logic signal (0 V) is applied to Q208 and the relay is deenergized, making a path for the incoming signal.

The VCO select circuit controls the high/low receive input select circuit (Q210, 211 and D207-210). When the low VCO is enabled, the low receive circuit is selected and when the high VCO is enabled, the high receive circuit is selected. The VCO output is mixed in with the incoming rf in the receive circuits. The VCO frequency is selected by the EPROM so as to produce the correct i-f on each channel.

The low receive and high receive circuits output the demodulated signal and an i-f signal of approximately 455 kHz. The high/low receive output select circuits connect these signals to the guardtone filter (IC25) and the i-f amp (Q4, 5) respectively. When the tester is in the **MOD (DEV)** mode of operation, the demodulated audio signal is connected to the guardtone filter. When the tester is in the **RFΔF** mode of operation, the i-f signal is connected to the i-f amp. The controlling logic signal is generated by the frequency synthesizer and fed directly to the high/low receive output select circuits (which are simply electrical bilateral switches).

Audio Signal

When the **INPUT GUARDTONE** switch is in the **REJ** position, the demodulated audio signal is fed through the guardtone filter. This filter is a low pass filter with a break frequency at 3 kHz and a roll off rate of approximately 20 dB/octave. From the guardtone filter, the signal is fed to a buffer (IC17B). When the **INPUT GUARDTONE** switch is in the **PASS** position, the filter is bypassed and the signal is fed directly to the buffer (IC17B). From the buffer, the signal is fed to an audio amp (IC22), the **SCOPE OUT** jack, and an ac/dc converter (IC20, 21). The audio amp is controlled by the **SPEAKER VOLUME** control and feeds the amplified audio signal to the speaker. The ac/dc converter changes the ac signal to a dc voltage and feeds this dc voltage to the **ΔF/MOD** meter (M1) through a buffer (IC18B).

I-F Signal Processing

The i-f signal is amplified by the i-f amp (Q4, 5) and fed to the mixer (IC23). There it is combined with the locally generated 455 kHz reference frequency which is produced by a 4.55 MHz oscillator (X1, Q2) and divide-by-ten circuit (IC26). The mixer output is the difference between the two signals. For a carrier frequency that is "right on", the resulting i-f is 455 kHz, and the mixer output (ref minus i-f) is zero or very close to zero.

When the 3 kHz range is selected, the output of the mixer is fed to the frequency-to-voltage converter (IC24) through a low-pass filter which reduces errors due to modulation. When the 10 kHz range is selected, the output of the mixer is fed directly to the frequency-to-voltage converter. The frequency-to-voltage converter produces a dc voltage proportional to carrier frequency error. This voltage is fed to the **ΔF/MOD** meter through a buffer and causes the meter to read the error.

TRANSMITTING SIGNALS

RF Path

From the VCO (whichever one is enabled), the modulated signal is fed to the variable attenuator (Q203) (the amount of attenuation is controlled by the **RF LEVEL** control on the front panel). From the variable attenuator, the signal is fed through the output buffer

(Q204, 205, 206, 207) to the signal direction control. From here the signal is routed through the step attenuator and out to the **RF IN/OUT** BNC jack on the front panel.

Modulation

There are three choices of modulating signals; an internally generated signal (1 kHz and/or variable frequency audio), an externally generated signal fed to either of the **AUDIO IN** jacks, or both external and internal signals (1 kHz and/or variable frequency audio) together. These choices are selected by the **RF OUTPUT** controls on the front panel.

The 1 kHz oscillator (IC16, Q1) feeds a 1 kHz signal to the **RF OUTPUT** switch unit through the **1 kHz MOD LEVEL** control (S9, VR3). The **1 kHz MOD LEVEL** control adjusts the level or disconnects (when the control is fully counterclockwise) the 1 kHz signal. A TTL signal is continually derived from the 1 kHz oscillator and fed to the 1 kHz gate (IC1, 2, 5, 8) in programming the frequency synthesizer (IC201).

The variable frequency audio oscillator (IC405) feeds an audio signal (adjustable from 100 to 10,000 Hz) through the **AUDIO LEVEL** control (S414, VR406) and S405 - 407 of the metering switch unit to an amplifier (IC404). The **AUDIO LEVEL** control adjusts the level or disconnects (when the control is fully counterclockwise) the variable frequency audio. The amplified audio signal is fed to the **AUDIO OUT** jack, the AC/DC converter, and the **RF OUTPUT** switch unit.

The externally generated signals are also fed to the **RF OUTPUT** switch unit. The **RF OUTPUT** switch unit feeds the internally generated signal(s) (when the **INT** mode is selected), the externally generated signals (when the **EXT** mode is selected), or both the internally and the externally generated signals (when the **EXT & INT** mode is selected) to a summer (IC18A). The summer is used to mix the internally generated signal with the externally generated signal when the **EXT & INT** mode of operation is selected. When either the **INT** or **EXT** mode of operation is selected, the summer simply acts as a buffer and outputs either the internally or the externally generated signal.

From the summer (IC18A) the signal is sent to three separate buffers. One buffer (IC19A) is used to feed the signal to the low VCO where the signal is used to modulate the low band carrier (if the low band has been selected). Another buffer (IC19B) is used to feed the signal to the high VCO where the signal is used to modulate the high band carrier (if the high band has been selected).

Monitoring The Signal

The third buffer (IC17B) is used to feed the signal to the audio amp (through the **SPEAKER VOLUME** control), the **SCOPE OUT** jack, and the ac/dc converter (IC20, 21). From the audio amp (IC22) the amplified audio signal is sent to the speaker where it can be monitored. The **SCOPE OUT** jack is used to drive an oscilloscope or frequency counter for analyzing the audio signal. The ac/dc converter changes the ac voltage to a dc voltage and feeds this voltage to the meter (M1) through a buffer.

LEVEL METERING (Refer to Fig. 25.)

The **LEVEL** Meter can be used to measure a variety of signals from the input and output jacks on the front panel. Seven scales are provided on the meter for measurement in either volts or dBm. The **LEVEL** Meter Switch Unit is used to select the function and range of the meter.

The **LINE AUDIO** signal is fed from the **PHONE TEST JACKS** through a capacitor and the Level Switch Matrix, to the **LINE SCOPE** jack and the AC-to-DC Converter (IC401). The **LINE SCOPE** jack is used to monitor the signal that is applied to the **PHONE TEST JACKS**. From the AC-to-DC Converter, the signal is fed to the Level Switch Matrix where it is connected to the **LEVEL** Meter (M401) through a Voltage-to-Current Converter (IC402) when either of the **LINE AUDIO** buttons are engaged.

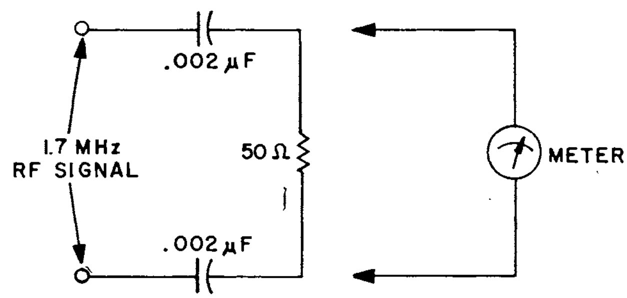
The **AUDIO IN** signal is fed to the Level Switch Matrix from the **AUDIO IN** jacks. From the Level Switch Matrix the signal is routed through the AC-to-DC converter, the Level Switch Matrix, and the Voltage-to-Current Converter to the **LEVEL** meter (M401) when either of the **AUDIO INPUT** buttons are engaged. When the **EXT MOD LEVEL** control is turned off (**MIN**), the **AUDIO IN** telephone jack is disabled and the input impedance at the BNC jack is 1 MΩ. When the **EXT MOD LEVEL** control is switched on, both the telephone jack and the BNC jack are enabled and the input impedance is 600 Ω.

The variable frequency audio (generated by IC405) is fed through the Level Switch Matrix and the Audio Buffer (IC404) to the **AUDIO OUT** BNC jack and to the Level Switch Matrix. From the Level Meter Switch Matrix, the signal is fed through the AC-to-DC Converter, the Level Switch Matrix, and the Voltage-to-Current Converter to the **LEVEL** Meter (M401) when any of the **AUDIO OUTPUT** buttons are engaged. The Level of the signal is controlled by the **AUDIO OUT LEVEL** control and the **AUDIO OUTPUT** switches in the first Level Switch Matrix stage. When the **30 m** or **100 m** buttons are engaged, the maximum signal level is 30 mV rms or 100 mV rms respectively. When the **1** button or any other of the **LEVEL** meter switches are engaged, the maximum level of the signal is 1 V rms.

A DC signal from the **DEMOD PROBE** jack is fed through the Level Switch Matrix to the Voltage-to-Current Converter (IC402). From the Voltage-to-Current Converter the signal is routed to the **LEVEL** meter (M401) when either of the **DEMOD. PROBE** buttons are engaged.

The internal Variable DC Power Supply (IC403, Q402) is adjusted using the front panel control. The supply feeds the voltage to the **DC VOLTS** jack on the front panel and to the Level Switch Matrix. From the Level Switch Matrix, the voltage is fed to the **LEVEL** meter when the either of the **DCV OUT** buttons are engaged.

The **120 VAC** receptacle on the front panel is used to power a cordless telephone base unit and simulate a power line load. Cordless telephone base units with 1.7 MHz band transmitters feed the rf signal into the power line. Power is supplied to the cordless telephone base unit through the RF Line Filter (L401, 402 and C429,430). This filter allows the 120 VAC to reach the cordless telephone base unit but prevents the 1.7 MHz rf signal from entering the Analyzer's line cord. The rf signal is fed to the rf detector circuits (peak-to-peak ac-to-dc converter that converts 1.7 MHz rf but blocks 120 VAC line voltage) where the rf component is removed and sent to the Level Switch Matrix. From the Switch Matrix the signal is fed to the **LEVEL** meter (M401) when either of the **LOAD** buttons are engaged. The equivalent load cicuit that is present at the **120 VAC** jack follows.



POWER SUPPLY

The power supply provides five separate voltages. A +5 V supply is used to power most of the logic devices and the signal direction control relay. A +12 V and -12 V supply are used to supply power to the operational amplifier chips, the remaining logic devices, and to bias transistors. A -52 V supply is used to power the telephone line simulator and a +325 V supply is used to power the ring signal amplifier.

PERIODIC METER ZERO ADJUSTMENT

Occasionally it may become necessary to "zero" the meters. To do so perform the following:

1. Make sure that the tester is turned off.
2. While viewing the meter from directly in front of it, adjust the screw (directly under the meter) until the meter's needle becomes centered over the "0" mark at the extreme left side of the scale. This adjustment may be performed on both the **LEVEL** and **ΔF/MOD** meter.

FUSE REPLACEMENT

If the line fuse blows, the channel indicator and meter lamp will no longer light and the analyzer will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine the cause of the blown fuse, then replace it only with a 3/8 A, 250 V slow blow fuse. This fuse is located on the rear panel in the lower fuse holder.

In addition to the line fuse, there is also a fuse to protect the **120 VAC** outlet on the front panel. The fuse should not normally open unless a device that draws more than 1/4 A of current is plugged into the **120 VAC** front panel receptacle or a problem has developed with the unit. Try to determine the cause of the blown fuse, then replace it only with a 1/4 A, 250 V slow blow fuse. This fuse is located on the rear panel in the upper fuse holder.

WARNING

1. *The following instructions are for use by qualified service personnel only. To avoid electrical shock, do not perform servicing other that contained in the OPERATOR MAINTENACE section unless you are qualified to do so.*

2. *A shock hazard is present whenever the cover is removed and the power cord is plugged into an ac outlet. Line voltage may be present on some circuits even when the* ***POWER*** *is off.*

REMOVAL OF TOP COVER (refer to Fig. 27.)

To remove the top cover from the Telephone Analyzer, remove the four screws at the top of the rear panel. Swing the back of the cover up and push it forward.

To replace the cover, line the protrusions of the top cover up with the four slots at the front of the unit. Swing the cover down and line up the holes in the top cover with the four holes in the rear panel and replace the four screws.

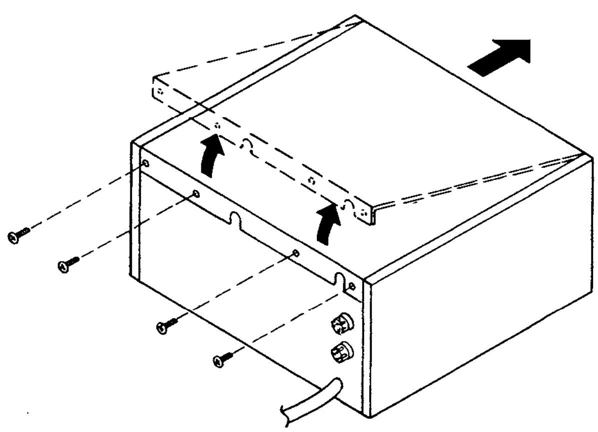


Fig. 27. Removal Of Top Cover.

CALIBRATION (Refer To Table 2)

This unit was carefully checked and calibrated at the factory prior to shipment. Readjustment is recommended only if repairs have been made in a circuit affecting calibration. Keep in mind that some recalibration procedures require high precision test instruments. Those adjustments should be attempted only if the proper test equipment is avilable and you are qualified in its use. Allow the Telephone Analyzer to warm-up for 1/2 hour before performing calibration.

Test Equipment Required:

Signal Generator with at least 2 MHz, 3 V (rms) output, B & K-Precision Model 3020 or equivalent.

RF generator with frequency accuracy of ±10ppm, Wavetek Model 3001 or equivalent.

FM deviation meter (1.6 to 50 MHz) with accuracy of ±4% at 1 kHz modulation (or better), Wavetek Model 4101 Modulation Meter or equivalent.

Distortion Analyzer with resolution of at least 0.1%, Hewlett-Packard Model 333A or equivalent (must have 600 Ω load across input terminals).

Frequency counter with time base accuracy of ±1ppm, B & K-Precision Model 1855, or 1851, or equivalent.

True rms reading multimeter with dc resolution of at least 0.01 V, B & K-Precision Model 2818 or equivalent.

Flat-blade alignment tool.

Procedure:

Initial Setup:

1. With the power off and the Telephone Analyzer unplugged, adjust the screws directly under the meters on the 1050 so that the meters read zero (always view meters from directly in front). Tap it gently and re-check adjustment.

ADJUSTMENT	FUNCTION OF ADJUSTMENT
VR2	1 kHz Level
VR4	10 kHz Deviation (Transmit, 1.6 MHz Band)
VR5	10 kHz Deviation (Transmit, 49 MHz Band)
VR7	1 kHz Clipping (Distortion of 0.40 %)
VR8	1 kHz Frequency
VR9	Offset For Frequency-To-Voltage Converter
VR10	Meter Calibration For ΔF
VR11	Meter Calibration For 10 kHz Range (Receive)
VR12	Meter Calibration For 3 kHz Range (Receive)
VR201	10 kHz Deviation (Transmit, 46 MHz Band)
VR202	2 kHz Deviation (Receive, 1.6 MHz Band)
VR401	Audio Level Metering (1 V Range)
VR402	**DEMOD PROBE** Level Metering
VR404	**LOAD** Level Metering (Lower Range)
VR405	**LOAD** Level Metering (Upper Range)
VR407	Audio Generator (Level)
VR408	Audio Generator (Distortion)
VR409	Audio Generator (Distortion)
VR410	Audio Generator Frequency (Low End)
VR412	Audio Level Metering (30 mV Range)
VR413	**DC VOLTS** Level Metering
VR601	Ringback Signal Frequency
VR602	Ring Voltage (High End)
VR604	Ring Voltage (Low End)
C215	Channel 29 RF Output Frequency (49.99000 MHz ±0.05 kHz)

Table 2. Functions Of Calibration Adjustments.

2. Set Telephone Analyzer controls as follows:

RFΔF:
Pushed in (the four buttons to its right all out).
METER RANGE:
10 kHz.
INPUT GUARDTONE:
REJ.
EXT MOD LEVEL:
Fully counterclockwise (**MIN**).
1 kHz MOD LEVEL:
Pointing 4 o'clock.
SPEAKER VOLUME:
OFF.
RF OUTPUT LEVEL:
Fully clockwise (max).
INPUT/OUTPUT ATTENuation:
All switches set to 0.

DIAL MODE/CONT:
Out (**DIAL MODE**).
POLARITY:
Out (**NORMAL**).
RINGER LEVEL:
Fully clockwise (**100 V**) and pulled out (**CONT RING**).
AUDIO OUTPUT FREQUENCY:
1 kHz (9 o'clock).
AUDIO OUT LEVEL:
3 o'clock (toward **DC VOLTS** control).
DC VOLTS:
Fully counterclockwise (**MIN**).
LOAD 1 V:
Pushed in.
POWER:
OFF.

3. Remove the top cover from the unit.

Adjusting LOAD Metering Cicuits

WARNING

*Make sure that the Telephone Analyzer is unplugged and turned off during the **LOAD** calibration procedure. The load circuitry is connected to the power line and should not have line voltage applied to it during **LOAD** calibration. Failure to unplug 1050 could result in severe electrical shock.*

1. Connect one lead of the signal generator to point A and the other lead to point B as defined in Fig. 28.
2. Adjust signal generator for an output of 1 Vrms at 1.730 MHz (make sure that instrument being used to measure signal level has an input impedance at least 1 MΩ).
3. Press **LOAD 1** V button.
4. Adjust VR404 for a reading of 10 on the top scale of the Telephone Analyzer **LEVEL** meter.
5. Press **LOAD 10 V** pushbutton on Telephone Analyzer.
6. Adjust signal generator output for an output of 3 to 5 Vrms at 1.730 MHz (leave generator connected at same circuit points).
7. Adjust VR405 to match voltage applied by signal generator (3 to 5 Vrms) on top scale of the Telephone Analyzer **LEVEL** meter.
8. Disconnect external signal generator from 1050.

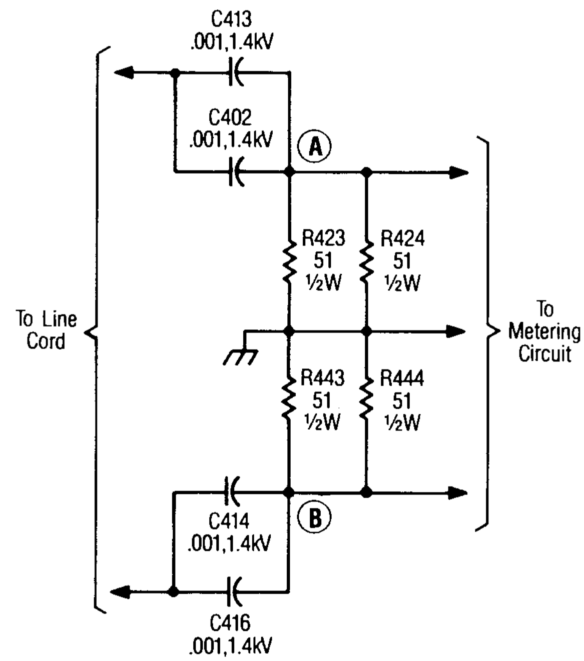


Fig. 28. Schematic for **LOAD** meter function calibration.

Adjusting DC VOLTS Metering Circuits

1. Plug the Telephone Analyzer's line cord into an ac outlet and turn power on. 1050 meter lamps should light and digital display should read "00 X" ("X" in a digital reading indicates any digit). If the **DIALED NUMBER** display does not light, press the **RESET** button on the Telephone Analyzer.

WARNING

Line Voltage is present on metering PC board. Use an insulated tool for adjustments.

2. Connect multimeter to **DC VOLTS** output jacks.
3. Press **DCV OUT 10** pushbutton on the Telephone Analyzer. Adjust **DC VOLTS** for an output of 10.0 Volts at **DC VOLTS** jacks.

4. Adjust VR413 for a reading of 10 on top scale of 1050 **LEVEL** meter.

Adjusting DEMOD PROBE Metering Circuits

1. Connect **DC VOLTS** output jacks to **DEMOD PROBE** input jacks.
2. Press **DEMOD PROBE 10** on the Telephone Analyzer and adjust **DC VOLTS** control for an output of 9.7 volts (on multimeter) (the demodulator probe delivers 9.7 volts dc with 10 volts rms signal applied).
3. Adjust VR402 for a reading of 10 on top scale of Telephone Analyzer **LEVEL** meter.
4. Remove connection between **DC VOLTS** jacks and **DEMOD PROBE** jacks.

Adjusting Audio Generator

1. Press **AUDIO OUTPUT 1** pushbutton on the Telephone Analyzer.
2. Set **AUDIO OUT LEVEL** control to 4 o'clock.
3. Set up distortion analyzer for distortion reading at 1 kHz.
4. Adjust **AUDIO OUTPUT FREQUENCY** control on Telephone Analyzer for minimum reading on distortion analyzer (this preliminary step accurately sets frequency to 1 kHz).
5. Adjust VR408 then then VR403 alternately for minimum meter indication on distortion analyzer (should be at or below specification for 1050 audio output distortion).
6. Set up distortion analyzer to read output voltage at **SCOPE OUT** jack.
7. Adjust VR407 for a reading of 1 volt on distortion analyzer.
8. Adjust VR401 for a reading of 10 on top scale of Telephone Analyzer **LEVEL** meter.
9. Press **AUDIO OUTPUT 30 m** pushbutton on Telephone Analyzer.
10. Adjust **AUDIO OUT LEVEL** for a reading of 30 mV on distortion analyzer.
11. Adjust VR412 for a reading of 30 mV (full scale) on 0-30 mV scale of **LEVEL** meter.
12. Press **AUDIO OUTPUT 1** pushbutton on Telephone Analyzer and connect the frequency counter to the **AUDIO OUT** jack.
13. Set **AUDIO OUTPUT FREQUENCY** control to minimum (fully counterclockwise)
14. Adjust VR410 for frequency counter reading of 60 to 70 Hz.
15. Turn **AUDIO OUT LEVEL** on the Telephone Analyzer to **OFF**.
16. Disconnect distortion analyzer from Telephone Analyzer.

Adjusting Ringback Signal

1. Take frequency reading at TP601 on the left edge of the lower left PC board using frequency counter.
2. Adjust VR601 for a reading of 440 ±2 Hz on frequency counter.

Adjusting Ringing Circuits

1. Plug one REN (Ringer Equivalent Number) load (0.47 μF in series with 8.2 kΩ) into **PHONE TEST JACK #1**. Connect the multimeter across the load.
2. Set for continuous ring.
3. Momentarily press the **RING** button on the Telephone Analyzer. Adjust VR602 for a reading of 99.0 to 101.0 volts on the true rms reading multimeter.
4. Rotate **RINGER LEVEL (V)** knob on 1050 fully counterclockwise. Adjust VR604 for a reading of 34.0 to 36.0 V on true rms reading multimeter.
5. Momentarily press **RESET** button to stop ring signal.
6. Disconnect multimeter and load from Telephone Analyzer.

Adjusting I-F Oscillator Circuits

1. Remove the four screws holding the shield box to the rails and gently lift the box (inside the Telephone Analyzer) off of the rails, tipping it towards the front far enough to permit access to the area of the circuit board around the crystal (left rear of board).

2. Prop up the shield box by placing a thin ruler across the rails under it. The shield box is to remain propped up from step 3 of i-f adjustments through step 4 of 1 kHz generator adjustments.

3. Use the frequency counter to measure the frequency at the right-hand side of R67 (below and to right of crystal) for correct reading. If necessary, adjust C34 (below and to left of crystal) for a frequency of 455,000 ±5 Hz.

4. Measure the dc voltage at the wiper contact of VR9 (next to C34).

5. Adjust VR9 for 0 V ± 0.04 V.

Adjusting 1 kHz Generator

1. Set **1 kHz MOD LEVEL** to 4 o'clock.

2. Press **INT** button on Telephone Analyzer.

3. Connect the frequency counter to measure the frequency at the **SCOPE OUT** jack.

4. Adjust VR8 (left rear of circuit board for a frequency of 1000 ± 2Hz.

5. Connect the distortion analyzer to measure the distortion at the **SCOPE OUT** jack. Adjust VR7 (next to VR8) for distortion of 0.40%.

NOTE

Do not set distortion for less than 0.40%; oscillator stability may be affected.

6. Return shield box to former position.

Adjusting 49 MHz Band Output Frequency

1. Select channel 29.

2. Press **EXT** button on Telephone Analyzer.

3. Adjust C215 (through most foward hole in top cover of shield box) for a frequency of 49.99000 ±.00005 MHz from the **RF IN/OUT** jack.

Adjusting ΔF/MOD Meter Circuits

1. Gently slide the shield box back along the rails, just enough to reach VR10 (left edge of PCB) without straining the wires.

2. Press **MOD (DEV)** button on 1050.

3. Select channel 20. Connect the rf generator and the deviation meter to the **RF IN/OUT** jack along with a 50 Ω termination.

NOTE

The deviation meter may already incorporate a 50 Ω termination, in which case an external one will not be necessary.

4. Set the rf generator for a frequency of 49.670 MHz at 30 mV rf output level. Set the generator for 1 kHz modulating signal. Adjust the modulation amplitude for a reading of 5 kHz on the deviation meter.

5. Adjust VR11 (middle pot of three in front center of 1050) for a reading of 5 kHz on the 10 kHz scale of the **ΔF/MOD** meter.

6. Adjust the modulation amplitude for a reading of 2 kHz on the deviation meter.

7. Set the **METER RANGE** switch on the Telephone Analyzer to the **3 kHz** position.

8. Adjust VR12 (right of VR11) for a reading of 2 kHz on the 3 kHz scale of the **ΔF/MOD** meter.

9. Set the rf generator frequency to 1.690 MHz.

10. Select channel 02 and check that the deviation meter still reads 2 kHz. If necessary, adjust VR202 (through the

hole nearest the left edge of the shield box) for a reading of 2 kHz on the 3 kHz scale of the **ΔF/MOD** meter. Turn off the rf generator's modulation.

11. Set the **METER RANGE** switch on the 1050 to the **10 kHz** position.

12. Press the **RFΔF** switch on the 1050.

13. Set the rf generator to a frequency of 1.695 MHz (5 kHz offset from correct frequency of 1.690 MHz).

14. Adjust VR10 (center left on circuit board) for a reading of 5 kHz on the 10 kHz scale of the **ΔF/MOD** meter.

15. Disconnect the rf generator; leave the deviation meter (and 50 Ω termination) connected to **RF IN/OUT** jack.

16. Press the **INT** button and select channel 05.

17. With the **1 kHz MOD LEVEL** control still set at 3 o'clock position, adjust VR2 (left of VR11) for a reading of 10 kHz on the 10 kHz scale of the **ΔF/MOD** meter.

18. Adjust VR4 (left front of circuit board) for a reading of 10 kHz on deviation meter.

19. Select channel 25.

20. Adjust VR5 (left front of circuit board) for a reading of 10 kHz on deviation meter.

21. Select channel 15.

22. If necessary, adjust VR201 (through hole that is closer to the middle of the top cover of shield box) for a reading of 10 kHz on deviation meter.

23. Re-attach the shield box and top cover.

INSTRUMENT REPAIR SERVICE

Because of the specialized skills and test equipment required for instrument repair and calibration, many customers prefer to rely upon B & K-Precision for this service. We maintain a network of B & K-Precision authorized service agents for this purpose. To use this service, even if the instrument is no longer under warranty, follow the instructions in the WARRANTY SERVICE INSTRUCTIONS. There is a nominal charge for instruments out of warranty.

ADDITIONAL SERVICING INFORMATION

A complete service manual will be available for the Model 1050 Telephone Analyzer. Requests should be sent to the B & K-Precision Service Department address listed in the WARRANTY SERVICE INSTRUCTIONS. Be sure to specify Model 1050.

WARRANTY SERVICE INSTRUCTIONS
(For U.S.A. and its Overseas Territories)

1. Refer to the MAINTENANCE section of your **B & K-Precision** instruction manual for adjustments that may be applicable.

2. If the above-mentioned does not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred in U.S.A.) to the nearest **B & K-Precision** authorized service agency (see list enclosed with unit).

If your list of authorized **B & K-Precision** service agencies has been misplaced, contact your distributor for the name of your nearest service agency, or write to:

B & K-Precision, Dynascan Corporation
Factory Service Operations
4050 North Ravenswood Avenue
Chicago, Illinois 60613
Tel (312) [redacted] 889-8870
Telex: 25-3475

Also use this address for technical inquiries and replacement parts orders.

LIMITED ONE-YEAR WARRANTY

DYNASCAN CORPORATION warrants to the original purchaser that its **B & K-Precision** product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

DYNASCAN will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized **B & K-Precision** service contractor or the factory service department, accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty registration card to DYNASCAN, **B & K-Precision,** 6460 West Cortland Street, Chicago, Illinois 60635 within fifteen (15) days from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

DYNASCAN shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your **B & K-Precision** distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to **B & K-Precision** Service Department, 4050 North Ravenswood Avenue, Chicago, Illinois 60613, properly packaged to avoid damage in shipment.

B & K-Precision Test Instruments warrants products sold only in the U.S.A. and its overseas territories. In other countries, each distributor warrants the **B & K-Precision** products which it sells.

NOTES

CHANNEL	FREQ (MHz)	COBRA CHANNEL	CHANNEL	FREQ (MHz)	COBRA CHANNEL
0	1.665		40, 42, 44, 46, 48	49.845	7A P→B
1	1.665		41, 43, 45, 47, 49	1.710	7A B→P
2	1.690	1A B→P	50, 52, 54, 56, 58	49.860	13A P→B
3	1.695		51, 53, 55, 57, 59	1.730	13A B→P
4	1.710	7A B→P	60, 62, 64, 66, 68	49.875	19A P→B
5	1.725		61, 63, 65, 67, 69	1.750	19A B→P
6	1.730	13A B→P	70, 72, 74, 76, 78	49.890	25A P→B
7	1.750	19A B→P	71, 73, 75, 77, 79	1.770	25A B→P
8	1.755		80	46.610	
9	1.770	25A B→P	81	49.670	
10	46.610		82	46.630	
11	46.630		83	49.845	
12	46.670		84	46.670	
13	46.710		85	49.860	
14	46.730		86	46.710	
15	46.770		87	49.770	
16	46.830		88	46.730	
17	46.870		89	49.875	
18	46.930		90	46.770	
19	46.970		91	49.830	
20	49.670		92	46.830	
21	49.770		93	49.890	
22	49.830	1A P→B	94	46.870	
23	49.845	7A P→B	95	49.930	
24	49.860	13A P→B	96	46.930	
25	49.875	19A P→B	97	49.990	
26	49.890	25A P→B	98	46.970	
27	49.930		99	49.970	
28	49.970				
29	49.990				
30, 32, 34, 36, 38	49.830	1A P→B			
31, 33, 35, 37, 39	1.690	1A B→P			

(B→P = BASE TO PORTABLE
P→B = PORTABLE TO BASE)

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480-460-9-001