107-TYPE TEST LINE FOR DATA TRANSMISSION MAINTENANCE

DESCRIPTION

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1. GENERAL

1.01 This section describes the 107-type test line and its application. Due to present and future demands for data transmission on voice-frequency (VF) circuits, the 107-type test line was developed to obtain an accurate, standard, widely available dial accessed test line for testing VF circuit parameters that affect voiceband data signals. Upon seizure, the 107-type test line transmits a programmed sequence of signals one-way on a far-to-near basis. These test signals permit testing by one person using appropriate test receivers on the near end for measurement of all parameters affecting data transmission. The 107-type test line equipment is shown in Fig. 1. See Table A for the 107-type test line signal specifications.

1.02 This section is reissued to include compatibility with No. 1 ESS and No. 2 ESS switching equipment and addition of a STOP SEQUENCE switch.

1.03 The 107-type test line can be installed in any electromechanical, No. 1 ESS, or No. 2 ESS telephone office and can be used with appropriate receiving equipment to measure the characteristics of a single trunk link, customer loop, etc, on a one-way basis. Measurements may involve a multiplicity of telephone links including several offices, VF paths, and carrier systems. The transmission measurements may be made at access points within the central office or on trunk, loop, and station equipment outside central offices where appropriate test equipment and access are provided.

1.04 The programmed sequence of 107-type test line signals shown in Fig. 2 consists of a peak-to-average ratio (P/AR) signal, 1004-Hz tone, 404-Hz tone, 2804-Hz tone, quiet termination, intermodulation distortion signal, and a long-term 1004-Hz tone. Voice-frequency parameters that can be measured using the 107-type test signal include envelope delay distortion (P/AR), gain slope, noise without tone, return loss, intermodulation distortion, noise (C-notched), impulse noise with tone, phase jitter, gain hits, phase hits, dropouts, and frequency shift. Cross reference of individual

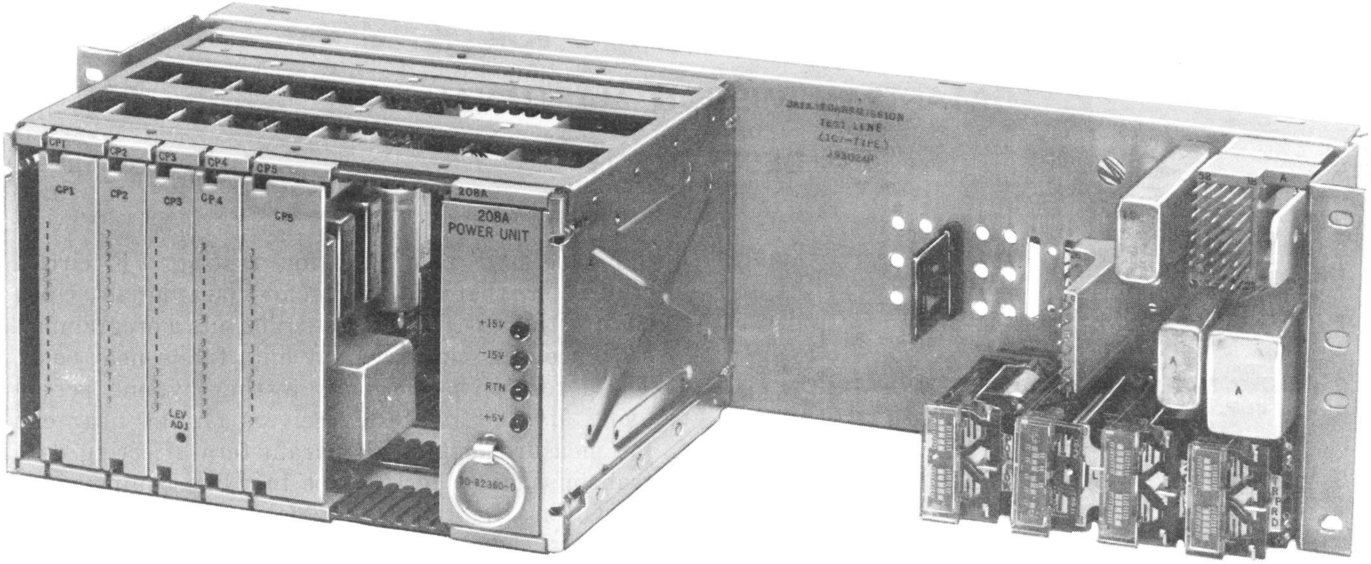


Fig. 1—Typical 107-Type Test Line Equipment

test signals to VF parameters measured is shown in Table B.

1.05 While the primary purpose of the 107-type test line is to test a VF channel for its data handling capability, the test line can also be useful in indicating the general transmission quality of a voiceband channel whether it is to be used for speech or for data.

2. 107-TYPE TEST SIGNAL ACCESS INFORMATION

2.01 In class 5 offices, the 107-type test line is accessed on a Direct Distance Dialing (DDD) basis by dialing an "office" code and station number comprising a total of seven digits or, if the 107 line is to be accessed from another area code, by dialing an "area" code, an "office" code, and a station number comprising a total of ten digits. In class 4 or higher offices, the 107-type test line is accessed by dialing 107 over the trunk to be tested. After a 107-type test line connection has been seized at the far end, the test line will transmit the sequence of test signals shown in Fig. 2 to the near-end office. Test signal transmission may be terminated at any time by the originator returning to the on-hook condition.

2.02 In a typical office (far end) containing a 107-type test line, DDD access from the near-end office is through the test board or test frame as shown in Fig. 3. Appropriate transmission measuring equipment is required on the near end of the 107 test connection for test measurements. In the event transmission measurements are to be made from the near end to the far end and a 107-type test line is available at the near end with none at the far end, a separate line of communication must be established with a person at the far end. The person at the far end makes the appropriate transmission measurements, using the 107 line at the near-end, and relays the results to the near end.

3. 107-TYPE TEST SIGNAL DESCRIPTION

A. P/AR Signal

3.01 On VF transmission paths, the P/AR line signal, composed of a complex series of transmitted pulses, is used to measure the simultaneous effects of envelope delay distortion, bandwidth reduction, and poor return loss (evidenced by gain and phase ripples). These transmission impairments cause intersymbol interference of data signals during transmission. The P/AR test signal is insensitive to steady interferences or impairments on a channel such as harmonic distortion, noise (unless it exceeds current standards), or phase jitter, and is completely unaffected by frequency shift and impulse noise.

TABLE A

107-TYPE TEST LINE CHARACTERISTICS

ACCURACY OF TIME INTERVALS	±1%
LENGTH OF ON-HOOK FLASH	3 sec.
CURRENT DRAIN	0.4 amp from —48 Vdc office battery
OUTPUT LEVELS	—16 dBm (TP0) true rms
	—18 dBm (TP2)
OUTPUT IMPEDANCE	600 or 900 ohms, return loss >40 dB

	P/AR (Hz)	SINUSOIDAL TONES (Hz)	INTERMODULATION DISTORTION TONES (Hz)
Output Frequencies	fn* = (2n — 1) 125 Hz + 15.625 Hz	1004.0, 404.0, 2804.0	856.75, 862.77, 1372.0, 1388.0
Signal Purity. All Harmonics	—	56 dB below fundamental	35 dB below fundamental
Frequency Accuracy	±0.005% of nominal	±0.005% of nominal	±0.005% of nominal
Output Level Adjustment	—	±0.4 dB	—
Output Level Stability	±0.1 dB	±0.03 dB	±0.25 dB
Level Difference Between Tones	—	±0.1 dB	±0.25 dB

* n = 1, 2, ... 16 — (See Section 103-110-110.)

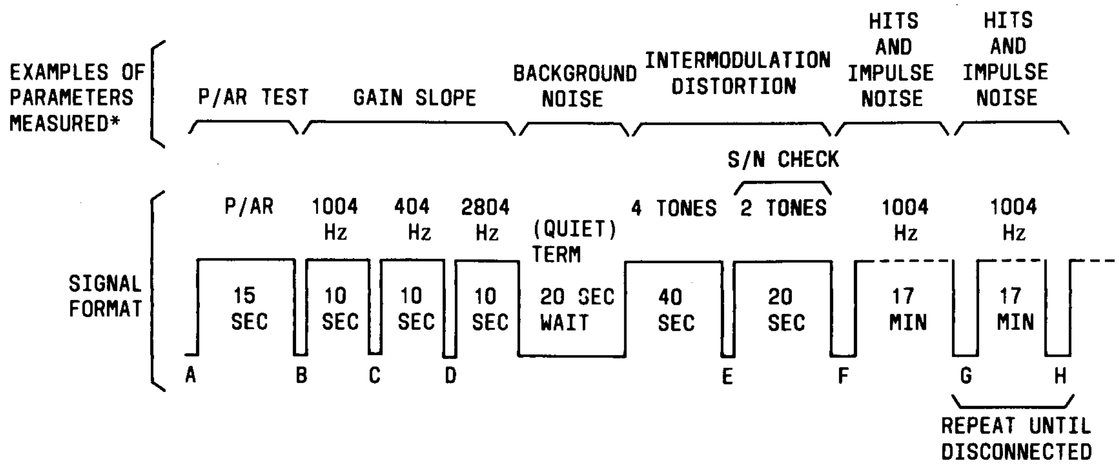
3.02 The P/AR test signal has a known peak-to-full wave average ratio with a value of 10 dB. If the P/AR line signal encounters distortions in the VF path during transmission, the pulses are altered resulting in a different P/AR test signal received. Using the appropriate test receivers for measuring, the known P/AR signal is compared to the received P/AR signal resulting in a percentage ratio relative to the undistorted P/AR test signal. This ratio serves as the basis for the P/AR weighted measurement or rating for channel adaptability to data transmission.

3.03 The envelope delay distortion for a hardwired, looped private line facility tends to remain invariant or change slowly with time. The parameters for envelope delay distortion which the P/AR test signal measures may be used as a benchmark type of measurement when recorded during circuit-order testing for a new circuit. Subsequent P/AR measurements could determine if there were changes in the facilities provided on the circuit.

Note: For further information concerning P/AR signals, see Section 103-110-110.

B. 1004-Hz, 404-Hz, and 2804-Hz Tones

3.04 The sinusoidal test tones of 1004 Hz, 404 Hz, and 2804 Hz permit measurements of harmonic distortion, frequency shift, noise with



* SEE TABLE B FOR COMPLETE BREAKDOWN.

NOTES:

A - 300 MSEC OFF-HOOK WAIT (QUIET) TO ALLOW SINGLE FREQUENCY SIGNALING SYSTEM TO STABILIZE.

B, C, D, E - 1 SEC OFF-HOOK WAIT (QUIET) TO INDICATE WHEN THE TEST SIGNAL HAS CHANGED.

F, G, H - 3 SEC ON-HOOK FOLLOWED BY 300 MSEC OFF-HOOK WAIT FOR SUPERVISION.

ALL TEST SIGNALS ARE TRANSMITTED AT -16 DBM (TP0) LEVEL OR -18 DBM (TP2) LEVEL.

Fig. 2—107-Type Test Line Signal Format

TABLE B

107-TYPE TEST LINE INTERVAL OF TRANSMISSION AND VF MEASUREMENT CAPABILITIES (USING APPROPRIATE RECEIVING EQUIPMENT FOR MEASURING) FOR EACH TEST SIGNAL

TRANSMITTED SIGNAL	INTERVAL OF TRANSMISSION	VF PARAMETER MEASURED
P/AR	15 sec.	Envelope Delay Distortion
1004 Hz	10 sec.	Signal-to-C-Notched Noise, Harmonic Distortion, Frequency Shift, Noise-with-Tone, and Gain Slope
404 Hz	10 sec.	Gain Slope
2804 Hz	10 sec.	Gain Slope
Quiet Termination	20 sec.	Background Noise and Return Loss
4-Tone	40 sec.	Intermodulation Distortion
2-Tone	20 sec.	Signal-to-Noise Check on the Intermodulation Distortion Measurement
On-Hook	3 sec.	Supervisory Test
1004 Hz (Long-Term)	17 min.	Impulse Noise with Tone, Gain Hits, Phase Hits, Dropouts, Phase Jitter, and Harmonic Distortion

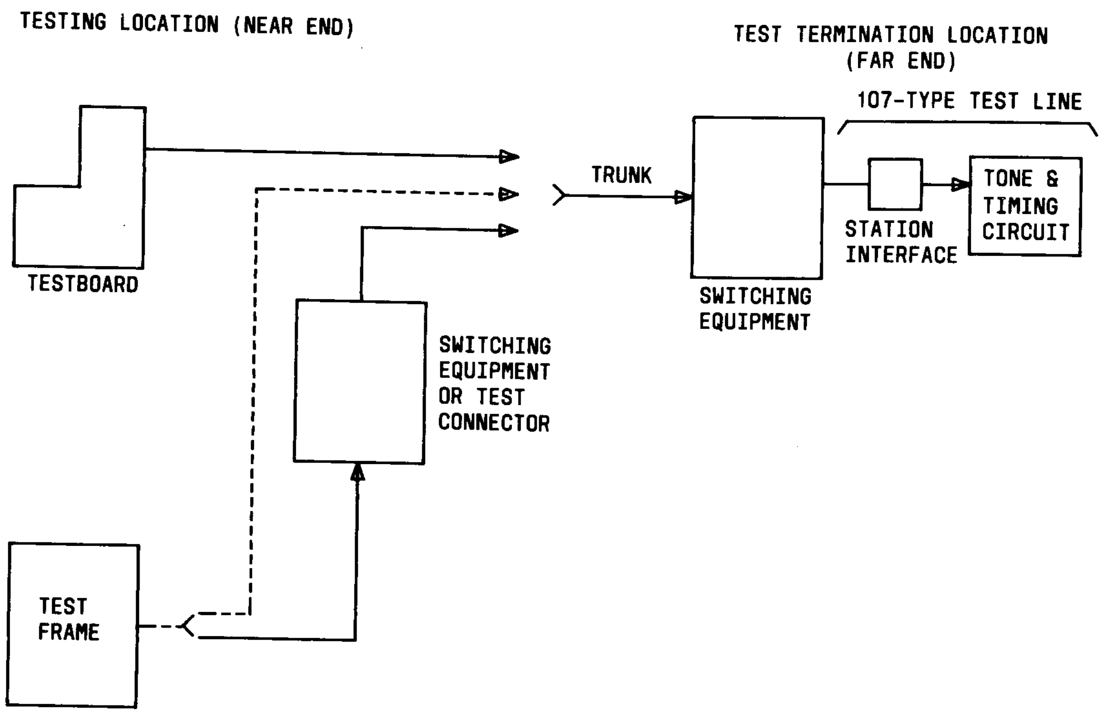


Fig. 3—Arrangement for 107-Type Test Line

tone, gain slope, and signal-to-C-notched noise in excess of 50 dB. All frequencies are offset by 4 Hz to permit accurate level measurements on T1 carrier which uses a sampling rate of 8 kHz. A test tone at any integral submultiple of the 8-kHz sampling rate can cause a relatively small number of harmonically related tones to fall back in the voiceband causing variations, or "beats," in the measured parameters. For example, at 1000 Hz, the level varies or "beats" by ±0.25 dB and the C-notch noise "beats" by ±5 dB.

3.05 Although the 107-type test line basic unit signal level output has been adjusted by the manufacturer at -16 dBm or -18 dBm (depending on the type of office), the output level may be readjusted to compensate for office wiring loss by adjusting the LEV ADJ accessible through the faceplate of CP3.

C. 20-Second Quiet Termination

3.06 The 20-second quiet termination permits measurement of background noise or return loss. During the 20-second quiet interval, the test line output impedance of 600 or 900 ohms is modified by reducing the series capacitance to 2.16 μF which gives the standard compromise network termination for return loss measurements.

D. 4-Tone Intermodulation Distortion Test Signal

3.07 The 4-tone intermodulation distortion test signal permits measurement of intermodulation distortion, sometimes referred to as harmonic distortion, or nonlinear distortion. The intermodulation distortion of concern is distortion within an individual voice channel. It should not be confused with the intermodulation noise which crosstalks into the channel as a result of nonlinearities in multiplex equipment and line amplifiers of a frequency division multiplex system. Although these nonlinearities can contribute to nonlinear distortion, at voice frequencies their contribution is usually negligible.

3.08 The 4-tone method uses two sets of tones, all of which have the same amplitude. One set of tones consists of frequencies at 857 and 863 Hz (a 6-Hz spacing). The second set of tones consists of frequencies of 1372 and 1388 Hz (a 16-Hz spacing). The power level of the combined tones is a nominal -16 dBm0. Intermodulation products of these tones will be created within a nonlinear voice channel. The resulting intermodulation distortion is determined by measuring the second- and third-order intermodulation products using narrow-band filters in a receiver.

E. 2-Tone Signal-to-Noise (S/N) Check

3.09 The 40-second transmission of the 4-tone test signal is followed by a 20-second transmission of 1372-Hz and 1388-Hz test tones to check the contribution of noise to the 4-tone intermodulation distortion measurement. These two test tones are the same high-frequency tones used in the 4-tone transmission test. In order to keep compandors or quantizers in the facilities at the same operating point, the two test tones are transmitted at a 3-dB higher level. As a result, the only power in the narrow-band second- and third-order intermodulation distortion slots will be due to background noise.

F. Long-Term 1004-Hz Tone Interval

3.10 The long-term 1004-Hz tone interval of 17 minutes allows enough time to perform the standard 15-minute impulse noise measurement. The 17-minute interval also permits a reasonable setup time in order to perform simultaneous measurements of gain and phase hits and impulse noise. Impulse noise, gain hit, or phase hit measurement consists of counting the number of hits exceeding predetermined thresholds during a predetermined time interval. Because of the sporadic nature of these phenomena, relatively long time periods are required for measurement.

4. CONTINUOUS OUTPUT OF INDIVIDUAL 107-TYPE TEST SIGNAL MODE

4.01 The 107-type test line has incorporated into CP1 a manually operated internal switch with positions STOP and GO. The function of the switch in the STOP position is to halt the 107 test signal sequence in any mode, supplying a continuous output of any one of the test signals for troubleshooting purposes or for a concentrated study of the mode selected.

4.02 In addition to the STOP switch, a STOP SEQUENCE switch also has been provided. The STOP SEQUENCE switch locks the 107 test signal in any mode of operation in its automatic sequence. This is an improved means of stopping the tone generator. Previously, to lock the test signal in one of the modes of operation, a short had to be placed between terminals 53 (SEQ 1) and 54 (SEQ 2). This shorting procedure is now rated MD and replaced by the STOP SEQUENCE switch.

CAUTION: The 107 test signal should not be left locked in a continuous mode of operation when the preceding tests are completed. It is important to remember to return the STOP switch to the GO position or to return the STOP SEQUENCE switch to normal operation. This is because the 107-type test line cannot be accessed properly if left in the continuous mode of operation after the original seizure has been terminated.

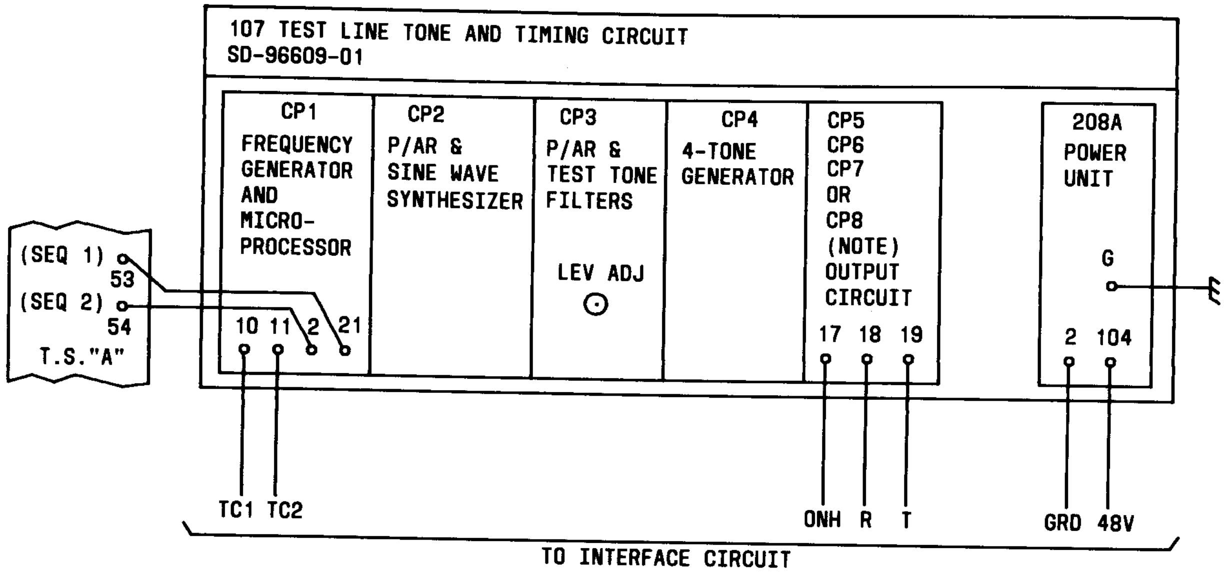
5. EQUIPMENT DESCRIPTION

5.01 The equipment for a 107-type data transmission test line basic unit consists of plug-in circuit packs of which five constitute the tone-generating and tone-sequencing circuitry and one, a dc-to-dc power converter. (See Fig. 1.) The basic unit is 10 inches wide and 6 inches high. It is arranged to be mounted on a 23-inch miscellaneous relay rack. Space is available on the 23-inch rack to accommodate additional interface circuitry. The basic unit and additional interface circuitry make up the functional circuitry required to place the 107 test signal "on-line." Signal level adjustment of sinusoidal tones may be made through holes in the faceplate of CP3 which allow screwdriver access.

6. GENERAL DESCRIPTION OF OPERATION

6.01 The tone and timing circuit is made up of the six circuit packs shown in Fig. 4, including the power supply. Start of the 107-type test line signal is through leads TC1 and TC2 (CP1) of the tone and timing circuit as shown in Fig. 5. The heart of the tone and timing circuit is a 4-bit microprocessor system located in CP1. The microprocessor, together with crystal oscillator clocks, performs all the timing and tone control functions.

6.02 The train of clock pulses from CP1 is applied to the P/AR and sine-wave synthesizers on CP2. The P/AR line signal and sinusoidal tones are synthesized digitally from encoded quantized amplitude samples of the desired signals in read-only memory (ROM) devices. The analog signal is



NOTE:

CP NO. & REF	OUTPUT LEVEL	OUTPUT IMPEDANCE
CP5-REF. J93024H, LIST 18	-16 dBm0	600
CP6-REF. J93024H, LIST 17	-18 dBm0	600
CP7-REF. J93024H, LIST 16	-16 dBm0	900
CP8-REF. J93024H, LIST 15	-18 dBm0	900

Fig. 4—107-Type Test Line Basic Unit

recovered from the digital information by sequentially scanning the ROM with a signal from the crystal-controlled memory address counters and then converting these digital samples to analog voltages in the digital-to-analog (D/A) converter.

6.03 The output of the D/A converter is a quantized representation of the desired signal. This analog signal is fed to the P/AR and test tone filters (CP3). These filters are low-pass reconstruction filters which reduce the level of unwanted sidebands produced by the harmonics of the memory scanning frequency. The filtered P/AR signal is applied directly to the output circuit pack (CP5, CP6, CP7, or CP8). The filtered sine wave is applied to the output circuit pack through a switching relay in the 4-tone generator (CP4).

6.04 Circuit pack CP4 provides a test signal for making intermodulation (nonlinear) distortion measurements. The test signal consisting of four tones is generated from crystal oscillators in pairs (high- and low-frequency pairs). The two pairs of tones are added together in the output circuit. For a signal-to-noise (S/N) check (2-tone transmission), an inverter disables the low-frequency pair of tones and operates a transistor switch which causes the output amplifier to increase the level of the high-frequency pair by 3 dB. The output is fed to the output circuit pack (CP5, CP6, CP7, or CP8). When the 2-tone or high-frequency pair is transmitted, it has the same power as the 4-tone signal.

6.05 The four output circuit packs (CP5, CP6, CP7, and CP8) shown in Fig. 4 have identical characteristics except for the output impedance (600 or 900 ohms) and output level (-16 dBm or -18 dBm). The output impedance and output level are selected depending on the type of central office in which the 107-type test line is to be located. Supervisory on-hook information and a tip (T) and ring (R) balanced signal output are also provided by the output circuit.

6.06 The 208A power unit converts the -48 Vdc office battery to ±15 Vdc and +5 Vdc to supply power to the circuit packs.

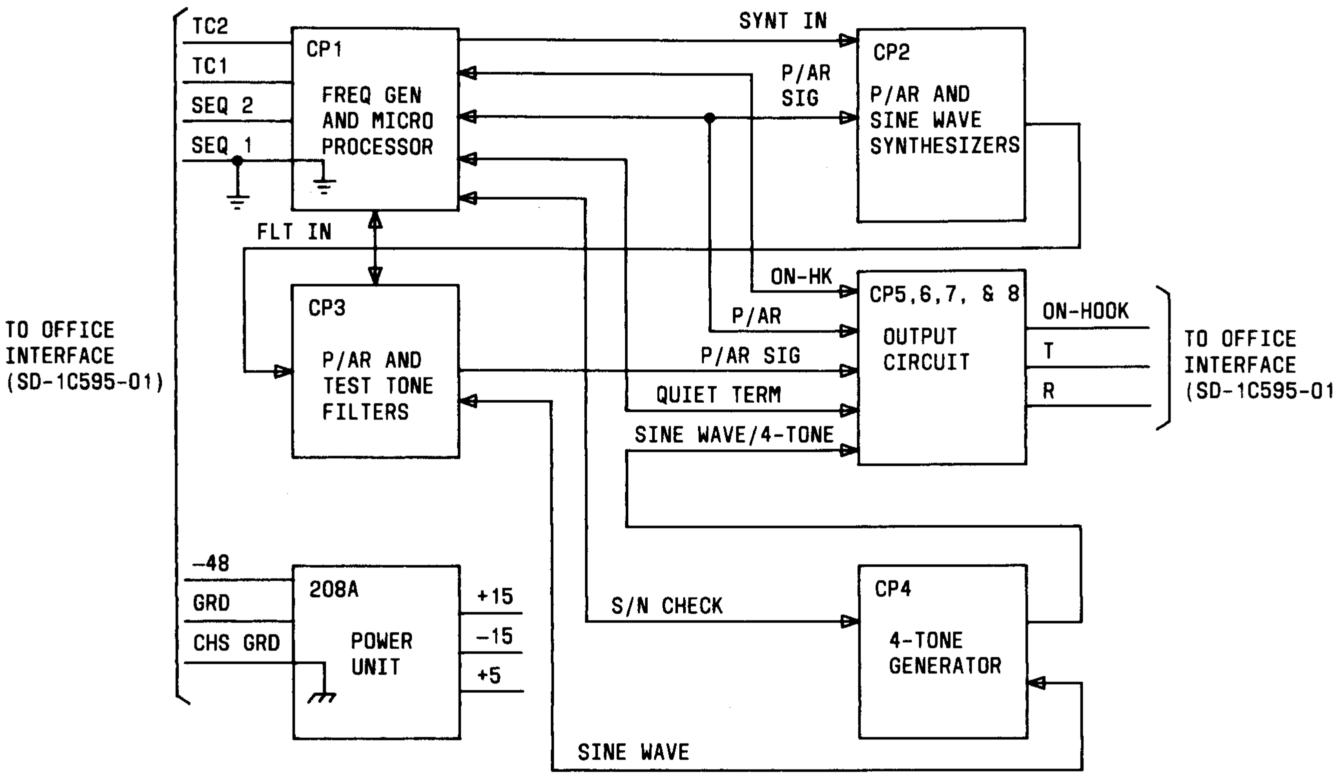


Fig. 5—107-Type Test Line Tone and Timing Circuit Block Diagram

6.07 The tone and timing circuit is compatible with all electromechanical switching equipment and with some electronic switching systems. The test line tone and timing circuit can be used with the following terminations.

- Step-by-Step Tandem Completion, 900 ohms, TP0 or TP2
- Crossbar Tandem Completion, 900 ohms, TP0 or TP2
- Step-by-Step Toll Completion, 600 ohms, TP0 or TP2
- Crossbar No. 5 (2-Wire) Tandem Completion, 900 ohms, TP0 or TP2
- Crossbar No. 5 (2-Wire) Toll Completion, 600 ohms, TP0 or TP2
- Crossbar No. 5 (4-Wire) Toll Completion, 600 ohms, TP0 or TP2
- Crossbar No. 4A or 4M (4-Wire) Toll Completion, 600 ohms, TP0 or TP2
- Crossbar No. 5 (4-Wire) Local Completion, 600 ohms, TP0 or TP2

- Panel Local Completion Battery Cutoff (BOC) Intermediate or First Line, 900 ohms, TP0 or TP2
- Panel Local Completion (BCO) Single or Last Line, 900 ohms, TP0 or TP2
- Panel Local Completion Ground Cutoff (GCO) Intermediate or First Line, 900 ohms, TP0 or TP2
- Panel Local Completion (GCO) Single or Last Line, 900 ohms, TP0 or TP2
- Non-PBX Step-by-Step Local Completion, 900 ohms, TP0 or TP2
- Crossbar No. 5 (2-Wire) Local Completion, 900 ohms, TP0 or TP2
- Crossbar No. 1 Local Completion, 900 ohms, TP0 or TP2
- ESS No. 1 (2-Wire), 900 ohms, TP0 or TP2
- ESS No. 2 (2-Wire), 900 ohms, TP0 or TP2
- ESS No. 1 (4-Wire), HILO (4-Wire), 600 ohms, TP0 or TP2.

7. INTERFACE CIRCUITRY

7.01 Interface circuits providing switch access to the 107-type test line are available for all classes and types of electromechanical offices (see SD-1C595-01).

7.02 Information concerning interface circuits may be found in Section 801-250-168. This section contains, in addition to ordering information, data regarding office impedance, transmission levels, etc, for various types and classes of central offices.

8. REFERENCES

8.01 The following references contain additional information.

NUMBER	TITLE
103-110-110	J94027A, C, and E P/AR Meter Generators and J94027B P/AR Meter Receiver Description, Operation, and Maintenance
801-250-168	Equipment Design Requirements
SD-1C595-01	Common Systems—107-Type Test Line Circuit
SD-96609-01	Common Systems—Transmission Measuring Data Transmission Test Line (107-Type) Tone and Timing Circuit
314-410-500	Voice Bandwidth Private Line Data Circuits Tests and Requirements
314-205-500	Data Systems—DATAPHONE® Service and Data Access Arrangements on Direct Distance Dialing Network—Overall Data Transmission Test Requirements