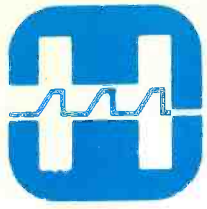

HARRIS

COMMUNICATIONS AND
INFORMATION HANDLING

HICOM CONTROL TERMINAL

INTERFACE SPECIFICATION

PM-1464

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7711-100-50050

HARRIS COMMUNICATIONS AND INFORMATION HANDLING

WARRANTY

Harris Corporation/RF Communications Div. warrants the equipment purchased hereunder to be free from defects in material and workmanship under normal use and service when used for the purpose for which the same is designed, for a period of one year from date of receipt, provided that notice of such defect is given to RF Communications or its authorized service depot, within 60 days after discovery thereof and provided that inspection by RF Communications or its authorized service depot, indicates the parts are defective to RF Communications' reasonable satisfaction. RF Communications' obligations under this warranty are limited to the repair or replacement of defective parts and the return of such repaired or replaced parts to the purchaser F.O.B. Factory. At RF Communications' option, any defective part shall be returned to RF Communications' factory for inspection, properly packed and all expenses prepaid. No parts shall be returned unless the purchaser first obtains a return authorization number, which will be furnished on request. No warranties other than those set forth in this section are given or are to be implied with respect to the equipment furnished hereunder and Harris Corporation/RF Communications Div. shall in no event be liable for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

NOTE

Certain fixed price repair charges may be established by Harris Corporation/RF Communications Div. with authorized service depots providing for labor coverage during the warranty period. The customer is advised to ascertain these charges from his dealer at the time of purchase.

CORRESPONDENCE AND PARTS ORDERING

Whenever writing about this unit or ordering parts, always refer to the model and serial numbers and the approximate date of purchase. Special parts should be ordered by the RF part number and the schematic designation number. Standard parts can be obtained from your local parts distributor.

RETURN OF EQUIPMENT

No equipment or part thereof shall be returned to Harris Corporation/RF Communications Div. unless the purchaser first obtains a return merchandise number from RF Communications. This number is to be marked on the shipping container. Equipment should be returned to Harris Corporation/RF Communications, 1680 University Avenue, Rochester, New York 14610 USA.

HARRIS COMMUNICATIONS AND INFORMATION HANDLING

HICOM CONTROL TERMINAL

INTERFACE SPECIFICATION

Revised November, 1976

This specification reflects characteristics of equipment described in the System Requirements and Description segment. It may not apply in all details to specific configurations as described in Section 1.0 of that segment, but applies where required for the equipment to be delivered.

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Interface Specification Contents

1.0 INTRODUCTION

This specification defines the functional and operational interfaces of the Harris/RF Communications HICOM Control Terminal and ancillary equipment. The Control Terminal performs the function of interconnecting IMTS mobile radio telephones with the public switched telephone network. All call processing, data recording, equipment switching, and remote system hardware are under control of a stored program processor in the Control Terminal.

The points of interface covered by this specification are: the mobile unit through its signaling sequence; the trunks to the Central Offices and Mobile Service Operator positions; the interconnecting facilities to the transmitters and receivers of the base stations; the size, weight, power and environmental requirements; man-machine; magnetic tape data formats; maintenance; and announcement recorder and reproducer. Unless specified, all impedance measurements and frequency response data are referenced to 1000 Hz.

2.0 MOBILE UNIT TONE SIGNALING INTERFACE

This section describes the tone parameters and sequences for the supervisory signaling over the radio channels between the Mobile Units and the system Base Station transmitter and receivers.

The signaling performed on the land-to-mobile and mobile-to-land RF links is defined in Figures 2.0-1 and 2.0-2. The detailed requirements of the signaling sequence are given in the following paragraphs.

2.1 Mobile-to-Land, Land-to-Mobile and Mobile to Mobile Signaling Tones

Five audio frequency tones are used for all supervisory signaling to and from the Mobile Units. Downlink tones (Control Terminal to Mobile) are idle, 2000 ± 5 Hz, and seize, 1800 ± 5 Hz. Uplink tones (mobiles to Control Terminal) are guard, 2150 ± 25 Hz, connect, 1633 ± 20 Hz and disconnect, 1336 ± 20 Hz.

2.1.1 Idle Tone

The Control Terminal generates a marked-idle signal designating an available call channel. The Base Station transmits idle tone on any single channel to designate its use as the system call processing channel.

2.1.2 Idle Tone Removal Time

The Control Terminal recognizes the Mobile Unit's (MU) guard-connect tone sequence and removes idle tone within 37 msec of the beginning of the MU's connect-tone transmission.

2.1.3 Mobile-to-Land Connect Acknowledgment

After reception of the connect signal from an MU, the idle tone is removed for 300 msec, and then the seize tone is applied. The seize tone is held for a minimum of 50 msec.

2.1.4 ANI Reception Characteristics

2.1.4.1 ANI Start Delay Time

The Control Terminal measures the time between the end of the seize tone burst and receipt of the first Automatic Number Identification (ANI) pulse. If this time exceeds 1 second (including computer scan time) a reorder tone is returned to the MU for 30 seconds and the call is disconnected.

2.1.4.2 ANI Digit Interval

The Control Terminal measures the time between reception of each ANI digit. If this time exceeds 1 second a reorder tone is returned to the MU for 30 seconds and the call is disconnected.

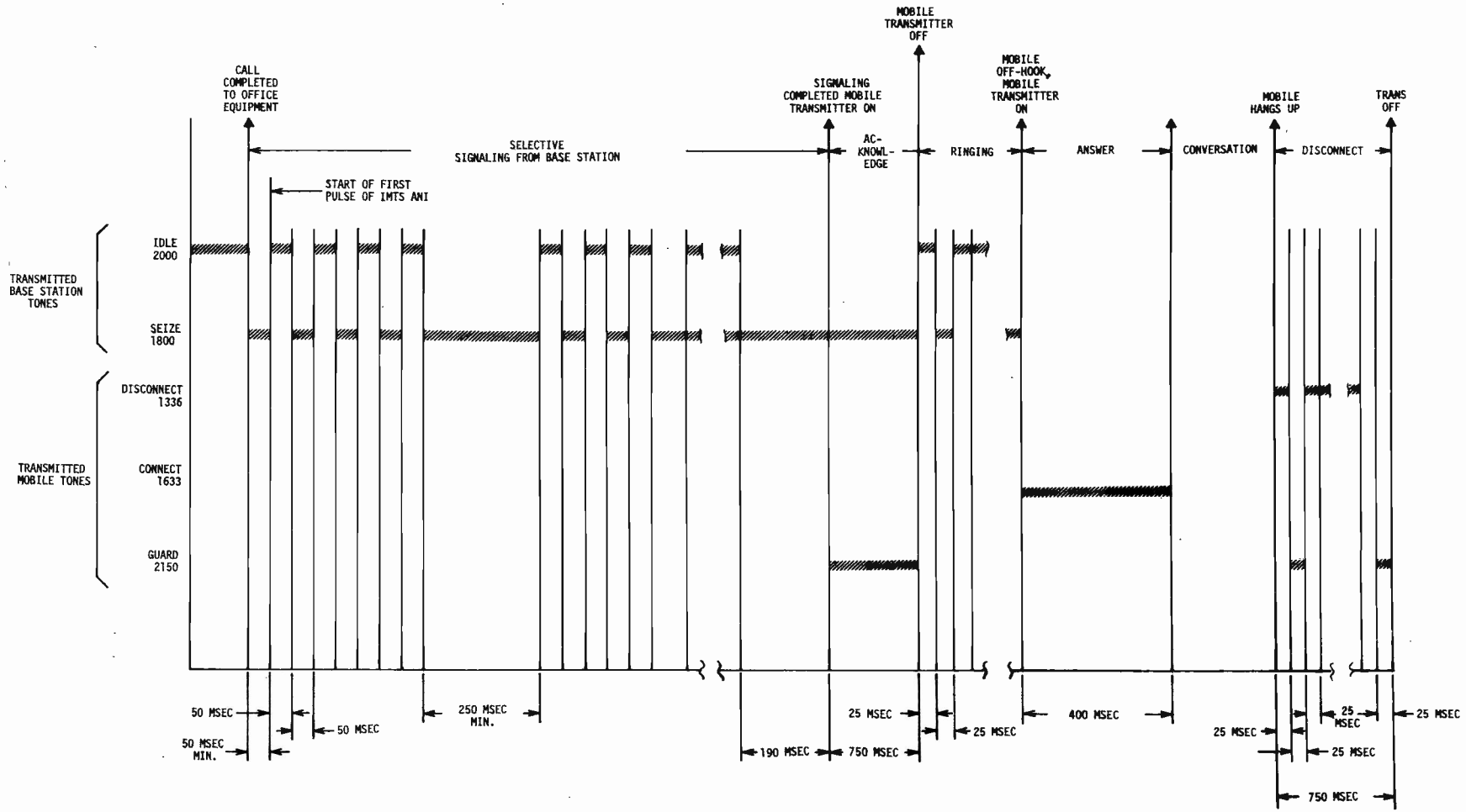


Fig. 2.0-1
LAND-TO-MOBILE CALL
SIGNALING TONES SEQUENCE CHART

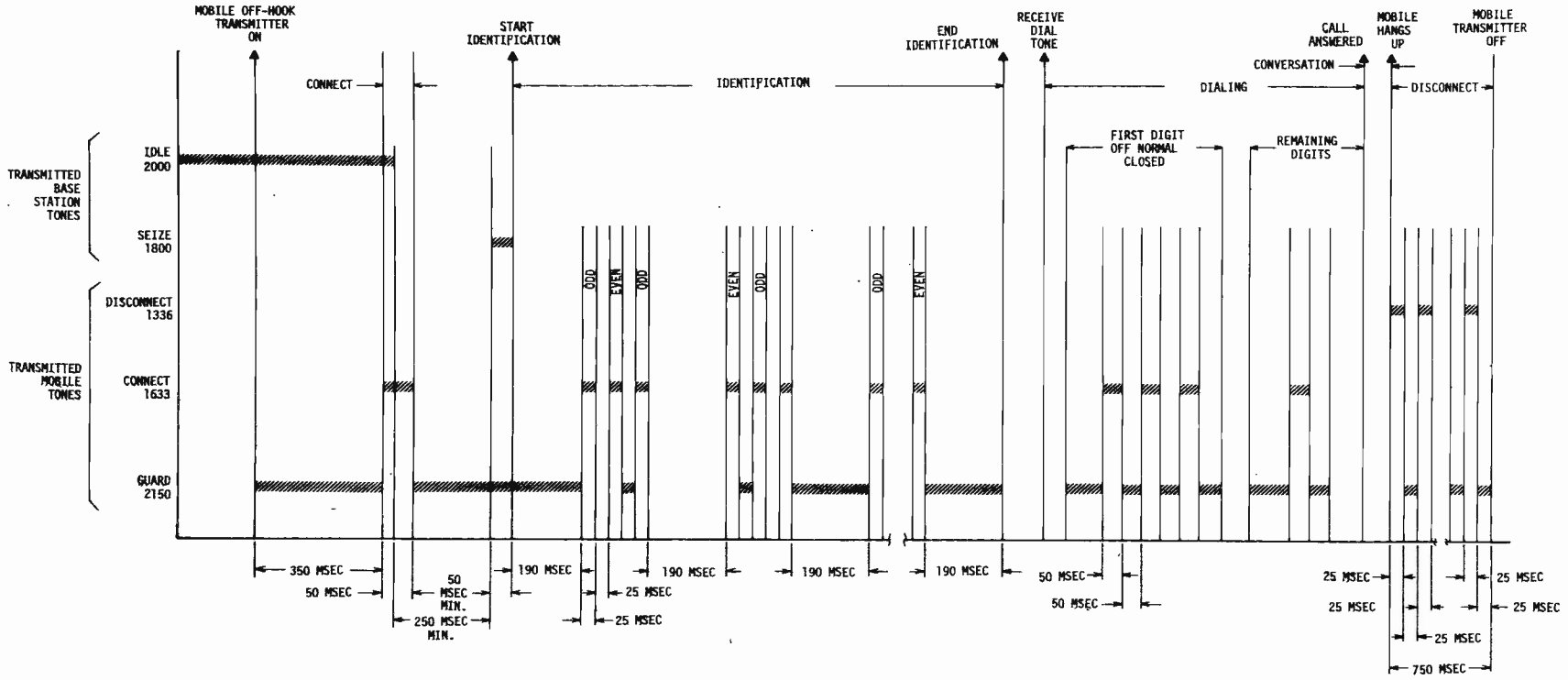


Fig. 2.0-2
MOBILE -TO-LAND CALL
SIGNALING TONES SEQUENCE CHART

2.1.4.3 ANI Parity Check

The Control Terminal checks parity of each ANI digit. On calls with bad parity a reorder tone is returned to the MU for 30 seconds and the call is disconnected.

2.1.4.4 ANI Address Verification

The Control Terminal checks the received ANI address to verify that it is a home address or an authorized roamer. If the address is acceptable the call is processed. If the address is not authorized for service, an announcement* is returned to the MU for 25 seconds and the call is disconnected.

2.1.5 Dial Tone Acquisition

After receipt of the MU's ANI, the Control Terminal generates dial tone and returns the dial tone to the MU.

2.1.6 Dial Pulse Acceptance

The Control Terminal accepts dial pulses at a nominal 10-pps rate and 50 percent break and repeats these pulses to the Central Office with proper pulse characteristics. The dial pulses from the MU will consist of a 50 $\pm$ 10 msec burst of connect tone with a 50 $\pm$ 10 msec interpulse time of guard tone. An interdigit time of 600 msec minimum is required. The first digit must be received within 10 sec of the dial tone. If the interdigit time exceeds 10 sec the call will be disconnected. After dialing is completed, the Central Office is accessed by the Control Terminal.

2.1.7 Land-to-Mobile Addressing

2.1.7.1 Seize Tone Prior to Addressing

The Control Terminal disconnects the idle tone and applies the seize tone for at least 300 msec prior to the first signaled digit pulse.

2.1.7.2 Addressing Pulse Characteristics

The Control Terminal provides dialing of mobile addresses at a nominal 10 $\pm$ 0.5 pps and 50 $\pm$ 10 percent break. The pulse rate does not vary beyond 10 $\pm$ 1.5 pps and 50 $\pm$ 3 percent break.

2.1.7.3 Address Interdigit Time

The addressing interdigit time is 300 msec $\pm$ 25 mesc.

*All announcements are contingent on the HICOM Control Terminal being equipped with the Voice Announcement Recorder option. If not, tones are supplied in lieu of announcements.

2.1.7.4 NPA Addressing

The Control Terminal provides means of coding the first three digits of the called MU address such that any Numering Plan Area (NPA) code may be pulsed on outgoing calls.

2.1.8 Called MU Acknowledgment

2.1.8.1 Acknowledgment Reception

After dialing is complete, the Control Terminal provides the seize tone until an acknowledge burst of guard tone is received from the MU. The Control Terminal is capable of recognizing an acknowledge burst of 500 msec minimum duration.

2.1.8.2 Acknowledgment Failure

Up to 3 seconds is permitted for an MU to respond to its called address with an acknowldege burst. If the acknowledge is not received, the Control Terminal will cease processing that call and return a "CANNOT BE REACHED" voice announcement* to the calling party.

2.1.9 Ring Signal

If the acknowledge signal is received from the called MU the Control Terminal generates a ring signal of idle and seize tones alternating at a 20-pps rate with a 1 second on and 3 seconds off duty cycle.

2.1.10 Called MU Answer Characteristics

2.1.10.1 Answer Signal Reception

The Control Terminal accepts an answer tone consisting of 287 msec (min.) of connect tone. Reception of the answer tone permits conversation between the calling party and the called MU.

2.1.10.2 Unanswered Call

If the Control Terminal fails to receive an answer pulse within 45 seconds, the call is disconnected and the ringback signal to the Central Office is inhibited and a "CANNOT BE REACHED" announcement* is sent to the calling party.

2.1.11 Call Disconnect Characteristics

2.1.11.1 Disconnect Signal

The Control Terminal accepts an MU originated disconnect signal composed of alternating 25-msec pulses of guard and disconnect tones. The Control Terminal recognizes a disconnect signal of 500 msec minimum duration.

*All announcements are contingent on the HICOM Control Terminal being equipped with the Voice Announcement Recorder option. If not, tones are supplied in lieu of announcements.

2.2 Subscriber Directories

Complete listings of all valid home subscribers in the system are maintained in a positive directory. Local NPA addresses which are to be denied system access are omitted from the positive file directory. Foreign NPA addresses to be denied access to the system are listed in the negative directory.

The positive file contains registry for up to 10,000 addresses in any one area code (NPA). Random number assignment is provided eliminating any requirement for block assignments. Where two or more NPA's are served, 10,000 addresses are provided in each NPA.

The negative file is maintained strictly to deny access to specified addresses, address groups, or foreign or home NPA's. The number of addresses that may be contained in this file is a variable which is a function of the system configuration.

2.3 Validation Checks

Prior to processing a call to or from a Mobile Unit, the Control Terminal performs a validation test on the MU's address as dialed by the calling party, or as received in the form of an ANI from the MU. The test involves two memory files designated positive directory and negative directory.

MU users with a home NPA (defined as any or all NPA's within any one terminal) are given service automatically if their number appears in the positive directory. Service is denied to home NPA numbers not in the positive directory with a "CANNOT BE SERVED" announcement* returned to the caller if the number is listed in the negative directory. A "DISCONNECTED" announcement* is given if the number is not listed in either directory.

MU users with a foreign NPA (defined as a valid NPA that is different from a home NPA) are also given service automatically if their number is not in the negative directory. If their number is in the negative directory, the caller is given a "CANNOT BE SERVED" announcement* on an attempted call.

If a call is placed via a roamer "trunk" (C.O. line) or by the Mobile Service Operator, the NPA is checked for the form 'XOX' or 'X1X'. When the NPA is not of the proper form, reorder tone is given to the calling party. When the NPA format is valid, a check is made of the negative directory, and service is denied if the ANI is in the directory.

2.4 Service to Roamers

Roamers are MU's operating out of their area of registry and may be called via the Touch Tone® (DTMF) roamer "trunk" or by accessing via the Mobile Service Operator. Roamers listed in the negative file are denied service.

*All announcements are contingent on the HICOM Control Terminal being equipped with the Voice Announcement Recorder option. If not, tones are supplied in lieu of announcements.

If a tone pair representing an asterisk (*) is received by the Control Terminal on a DTMF roamer "trunk," all previously dialed digits will be ignored and the caller may immediately re-dial.

2.5 Mobile Unit Busy Checks

After the validation of an MU's number, a check is made to determine if the addressed MU is busy. For a land-to-mobile call, a busy check is made only in the service area corresponding to the trunk being used. For mobile-to-land calls**, all channels are checked. (This is the "bandit" check.) On a land-to-mobile call, if the MU is busy, a busy tone is returned to the calling party. On a mobile-to-land call**, if the MU's number is busy on another channel, an entry is made to the billing record on the magnetic tape with the proper call class code, and the "CANNOT BE SERVED" announcement* is returned to the MU.

*All announcements are contingent on the HICOM Control Terminal being equipped with the Voice Announcement Recorder option. If not, tones are supplied in lieu of announcements.

**Includes mobile-to-mobile calls.

2.6 Numbering Plan

The HICOM dial numbering plan uses a standard IMTS format, 4 digits plus 3 digits for an area code (Numbering Plan Area). The full 7-digit plan permits service to be provided to roamers without ambiguity (within an NPA) and standardizes the address formats from system to system. Each subscriber within an NPA is identified by and responds to the unique address assigned to his MU. The address formats used in IMTS are as shown below:

1 MU Automatic Number Identification (ANI)

NPA-XXXX

2 Land Address dialed by the MU user

NXX-XXXX (Local Exchange or Any Exchange in Local NPA)

or 1 - NPA-NXX-XXXX (Any Exchange)

3 MU's Received Address

NPA-XXXX

4 Mobile Service Operator Address

Any single - or multiple - digit address beginning with zero (0).

On any mobile-to-land call, the Control Terminal checks the first and second digits to determine if 1, 3, 7, or 11 digits are to be dialed. Dialing to the output trunk is not initiated until all digits are received from the MU.

2.7 Direct Distance Dialing

Outgoing long distance calls from an MU can be dialed by the Mobile Service Operator or dialed direct by the calling user. Dual billing is required: time charges on the HICOM system and time and distance charges on the long distance network. Since the access to the DDD network normally is through a trunk circuit to a toll switch from the Control Terminal (and not a subscriber loop as with a normal telephone), a means of automatic number identification (ANI) for the calling number is provided by HICOM for accounting purposes in the connecting telephone system.

2.8 Billing and Traffic Measurements

Call data are maintained for a history of every call that enters the system including telephone numbers, equipment utilized, duration of call, etc. Class failure codes are assigned for all invalid and incomplete calls. The output is formatted for recording on IBM-compatible, 1600-cpi magnetic tape.

3.0 CONTROL TERMINAL TO CENTRAL OFFICE INTERFACE

The Control Terminal must be an integral part of the Mobile Telephone System in order to meet its operational performance requirements. This is achieved through proper interface of the Control Terminal with technical and service operators, and with such connecting equipment as Central Office* trunks, and Mobile Operator consoles. The following paragraphs specify the Control Terminal to trunk line interface requirements. These requirements are taken from the "Technical Interface Criteria Related to Direct Inter-connection of Privately Owned PBX Systems to the Public Telephone Network" document prepared by the FCC PBX Advisory Committee Technical Standards Subcommittee, dated July 1972.

3.1 Trunk Interface

3.1.1 General

The Control Terminal (CT) operates with interconnecting Central Offices (CO) over one-way incoming and one-way outgoing trunks. The trunk interface to the Mobile Operator console operates two-way, except no addressing is required from the CT to the operator position.

The trunks employ various methods of signaling and addressing, and operate in various modes as delineated in this section. Where possible, the trunk interface circuits are designed to operate in multiple methods and modes selectable by strapping or a similar technique. The input trunks of each area controlled by the terminal may be isolated as required. The number and type of trunks that must be interfaced for each area will vary as a function of the system configuration. Figure 3.1-1 shows the methods and modes of signaling in which the CT must operate.

For the purpose of the interface portion of this specification, the term "trunk" is defined as a metallic pair designated "TIP" and "RING" unless otherwise specified. The point of interface with the Telephone Company's network is normally a terminal block furnished and installed by the Telephone Company in a location near the Control Terminal. The trunk interface circuits of the CT present a barrier to hazardous voltages and signals that could otherwise be applied to the trunks, to the CO's, or to Mobile Operator consoles attributed to faults occurring within the CT. Figure 3.1-2 shows the trunk connections of the system.

3.1.2 Incoming Trunks

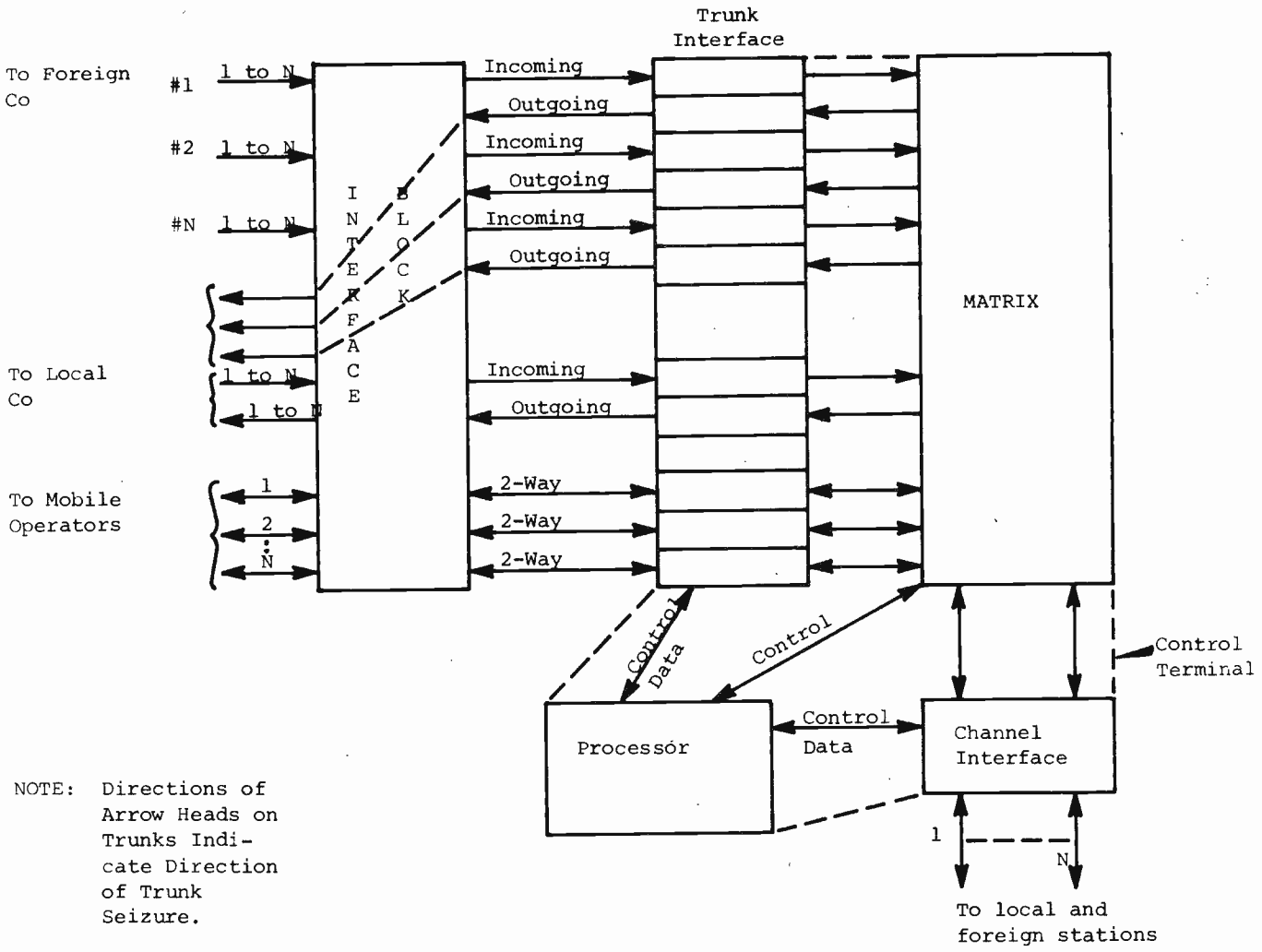
3.1.2.1 Direct Inward Dialing Trunks

An incoming trunk is defined as a trunk circuit that may only be seized by an off-hook signal initiated by the CO for the purpose of placing a call to a MU through the CT. The CT cannot transmit address pulses over an incoming trunk, and can only signal "off-hook" on the trunk

*"Central Office" as used in this specification may refer to any connecting office and therefore the meaning is not restricted to "end offices" or "Class 5 offices."

	Incoming Trunk Interface			Outgoing Trunk Interface		2-Way Operator Trunk Interface	
						From Operator	To Operator
Supervisory Signaling	E&M	Reverse Battery	Ground Start	E&M	Reverse Battery	MF E&M	E&M
Address Pulsing	DP MF	DP MF	DTMF	DP MF	DP MF	MF DP	None Required
Addressing Mode	Wink Delay Bylink	Wink Delay Bylink	Bylink	Wink Delay Bylink	Wink Delay Bylink	Delay Bylink	Not Applicable

Figure 3.1-1. Trunk Interface Signaling Criteria



NOTE: Directions of Arrow Heads on Trunks Indicate Direction of Trunk Seizure.

Figure 3.1-2. Trunk Interconnection Diagram, Control Terminal

in response to the CO off-hook signal. An incoming trunk, therefore, has two-way supervisory (on-hook, off-hook) signaling, but always initiated by the CO, and one-way address signaling generated by the CO.

Incoming trunks may employ either ground start, reverse battery or E&M supervisory signaling. The ground start trunks utilize DTMF address pulsing; the reverse battery trunks utilize open-close circuit address pulsing; while the E&M trunks use either open-close circuit or MF address pulsing. Open-close circuit pulsing is normally referred to as dial pulsing (DP) and consists of series of momentary on-hook, off-hook signals. The reverse battery trunks and E&M trunks operate in either of three modes: wink start, delay dialing or by-link. The ground start trunks operate in the by-link mode; however, a "go-ahead" signal is sent to the calling party to indicate readiness to accept the called number.

Addressing received on the reverse battery and E&M trunks may be either two or four "line assignment numbers" (digits) depending upon the type of CO to be interfaced. Ten digits (NPA-XXX-XXXX) must be received on the ground start trunks to be properly processed.

The interface circuit clears or marks invalid partial addresses when a subscriber fails to complete dialing in the alloted time.

Each incoming trunk interface circuit includes a green light to indicate "busy" from time of trunk seizure until the trunk is released by the Control Terminal. The lights are observable from the front of the terminal.

3.1.3 Outgoing Trunks

3.1.3.1 Output to DDD Network

An outgoing trunk is defined as a trunk circuit that is seized by an off-hook signal initiated by the CT for the purpose of placing a call through a connecting office (normally a toll switching facility such as a Class 4 office). An outgoing trunk therefore operates opposite to an incoming trunk, having two-way supervision initiated only by the CT and one-way address signaling generated by the CT.

Outgoing trunks may employ reverse battery or E&M supervisory signaling and DP or MF addressing. The outgoing trunks are capable of operating in any one of the three modes: wink start, delay dialing, or by-link.

Each outgoing trunk interface circuit contains lamps to indicate when the trunk is in use, and when it is out of service as the result of a fault. A green lamp is used to indicate busy, and a red lamp is used to indicate out of service.

3.1.4 Two-Way Trunks

3.1.4.1 Mobile Service Operator Trunks

A two-way trunk is defined as a trunk circuit that is seized by either the Control Terminal or the Mobile Service Operator (MSO). Thus the two-way trunks have two-way supervisory signaling that is initiated by either end. Address signaling on the operator trunk is only initiated from the Mobile Service Operator console.

The two-way trunks utilize E&M supervision with either DP or MF addressing, but not both on the same trunk. The two-way operator trunks use delay dialing.

Each two-way trunk interface circuit contains lamps to indicate when the trunk is in use, and when it is out of service as the result of a fault. A green light is used to indicate the busy status, with a red light to indicate the trunk taken out of service by the Control Terminal.

3.1.5 Trunk Circuit Characteristics

The interconnection of the Control Terminal and the telephone company switched telephone network is in accordance with the following paragraphs.

3.1.5.1 Hazardous Voltages and Currents

Voltages and currents in the telephone plant are considered hazardous if levels exist of sufficient magnitude to imperil the safety of telephone personnel, cause irreversible damage to telephone plant or equipment, or jeopardize reliable continuity of service. Of greatest concern are voltages and currents associated with or produced by power generating and distributing equipment, whether or not such equipment is a part of the HICOM Mobile Telephone System. As a consequence, compliance with appropriate national and local electrical codes with respect to protection of all exposed wiring and installation of AC power is required.

3.1.5.2 Maximum-Voltage Limits: Steady-State Signals

The maximum permissible values of steady-state voltages, measured at the point of connection to telephone facilities are given in the following paragraphs.

The barrier portion of the trunk interface circuitry is designed to insure that failures in the Control Terminal do not cause signals exceeding the limits of these paragraphs to be applied to the telephone company side of the trunks.

3.1.5.2.1 The maximum permissible peak AC voltage between tip and ring conductors may be 71 volts, except that 142 volts peak between the two conductors is permissible so long as the peak potential between either conductor and common ground does not exceed 71 volts.

3.1.5.2.2 The maximum permissible DC potential between tip and ring conductors may be 135 volts, except that 270 volts DC is permissible so long as the potential between either conductor and common ground does not exceed 135 volts.

3.1.5.2.3 The maximum permissible DC potential between either conductor and ground may be 135 volts.

3.1.5.2.4 For steady-state signals possessing both AC and DC components, the maximum permissible composite peak potential between either conductor and ground may be 71 volts.

3.1.5.2.5 For steady-state signals possessing both AC and DC components, the maximum permissible peak potential between conductors may be 142 volts, so long as the peak potential between either conductor and ground does not exceed 71 volts.

3.1.5.3 Maximum Current Limits

The maximum continuous current allowed to flow in either the tip or the ring conductor on the Telephone Company side, whether AC, DC or a composite of AC and DC, is 0.12 amperes rms. (The use of multiple conductors to reduce the current per conductor is not permissible.)

3.1.5.4 Transient Voltage Limits

3.1.5.4.1 Relay Transients

Voltage transients incident upon the Telephone Company side of the barrier interface (conductor to conductor, or conductor to ground) resulting from release of relays in the Control Terminal may not exceed 600 volts crest amplitude.

3.1.5.4.1.1 Relay release transients incident upon the interface will decay to half crest amplitude within 2 ms.

3.1.5.4.2 Lightning and Power Surges

Transients at the interface resulting from lightning strikes or power line crosses do not cause damage to the Control Terminal under the following conditions:

3.1.5.4.2.1 Conductor-to-Conductor Surges:

Max. crest amplitude: 1000 volts
Rise time to crest: 10 microseconds (test specification)
Max. decay time to half crest: 1000 microseconds.

3.1.5.4.2.2 Conductor to ground surges:

Max. crest amplitude: 5000 volts

Rise time to crest: 1.2 microseconds (test specification)
Max. decay time to half crest: 50 microseconds.

3.1.5.5 Signal Power

Excessive signal power injected into the switched telephone network can result in increased noise and crosstalk levels, produce faulty signaling and supervision, or interfere with normal testing and maintenance programs. In general, signals considerably lower in level than those considered "hazardous" will cause problems, with some frequency bands being more susceptible to harm than others. One consequence of this frequency dependency is the necessity for specifying distortion limits in the transmission path to control generation of harmonics of an acceptable signal that may fail in a far more sensitive frequency band.

3.1.5.5.1 Talking Path Characteristics

3.1.5.5.1.1 Gain

The gain in the talking path from the channel circuit input of the Control Terminal to the trunk circuit interface does not exceed 0 dB at any frequency.

3.1.5.5.1.2 Attenuation Distortion

In order to prevent interference to network control signaling, the signal level applied by the IMTS control terminal to the DDD network in the 2450-Hz to 2750-Hz band must not exceed that in the 800-Hz to 2450-Hz band.

3.1.5.5.1.3 Nonlinearity Distortion

Nonlinearities in the talking path do not produce harmonic components nor intermodulation products that are less than 30 dB below the composite signal level for any of the 12 DTMF frequency pairs, for any composite signal power level lower than +3 dBm.

3.1.5.5.2 In-Band and Out-of-Band Signal Power

The maximum power that any signal generator contained within the IMTS is capable of delivering to a 600-ohm resistive load at the trunk interface, except during tone-address signaling, does not exceed the limits shown in the following table:

Frequency Band	Maximum Permissible Power
300 Hz to 3995 Hz	-9 dBm (3 sec. average)
3995 Hz to 4005 Hz	-27 dBm (instantaneous)
4005 Hz to 10,000 Hz	-16 dBm (instantaneous)
10 kHz to 25 kHz	-24 dBm (instantaneous)
25 kHz to 40 kHz	-36 dBm (instantaneous)
Above 40 kHz	-50 dBm (instantaneous)

3.1.5.5.2.1 In addition to the above requirements an additional restriction is placed on signal levels at frequencies close to 2600 Hz (the frequency of inband signaling tone). The power of any signal generated within the IMTS Mobile Telephone System in the frequency band between 2450 Hz and 2750 Hz does not exceed the power level of signals present at the same time in the frequency range between 800 Hz and 2450 Hz.

3.1.5.6 Longitudinal Balance

To provide longitudinal isolation between the Control Terminal and the telephone company facilities, metallic isolation of the type afforded by a repeat coil or isolation transformer is provided.

3.1.5.6.1 Interface Longitudinal Balance

Each trunk circuit at the point of interconnection with the telephone company facilities, provides a minimum of 40-dB longitudinal balance at all frequencies between 300 Hz and 3400 Hz. This requirement is met with the Control Terminal in either a talking or hold state, and with any loop current from 23 ma to the upper limit of the Control Terminal operational loop current flowing in the trunk.

3.1.6 Addressing Supervisory Mode

The Control Terminal is capable of operating in any one of three modes of supervision to denote start of addressing for trunks. Conversion to any mode (bylink, wink start and delay dial) is easily accomplished after the Control Terminal is installed on site. On-hook and off-hook signals in the following specifications for these modes are any of the type described in Section 3.1.7.

3.1.6.1 Bylink

The Control Terminal is ready to receive address digits within 25 milliseconds after receipt of the trunk seizure signal from the Central Office. On outgoing trunks, the Control Terminal initiates addressing nominally 100 milliseconds, and as a minimum 70 milliseconds, after sending the trunk seizure signal to the Central Office.

3.1.6.2 Wink Start

In this mode, the calling and called exchanges (the Control Terminal may be either depending upon whether the trunk is an output or input trunk) both signal on-hook toward the opposite end in the idle condition. On

receipt of a trunk seizure signal (calling office goes off-hook), the called office delays returning an off-hook signal to the calling end until it is ready to receive the dialed pulses (when the Central Office is the called office, the delay is the time to assign a register - or sender - to the trunk). When the called end is ready to receive digits it signals by going off-hook for nominally 200 milliseconds (minimum of 140 milliseconds, maximum 290 milliseconds), then back on hook. The Control Terminal wink pulse is 150 ± 10 milliseconds. The time between recognition of the trunk seizure and the start of the wink pulse by the Control Terminal is a minimum of 70 milliseconds. The time between trunk seizure and the start of the wink pulse by a Central Office will vary, but is at least 70 milliseconds. The terminal is prepared to accept dialed digits 50 msec after the end of its wink pulse. The Control Terminal is capable of recognizing a wink start pulse of 100 to 350 milliseconds, and does not begin address outpulsing until at least 70 milliseconds after the Central Office returns to the on-hook state.

3.1.6.3 Delay Dial

The delay dial mode operates similarily to the wink start mode. Both ends signal on-hook in the idle condition. When the calling office seizes a trunk (goes off-hook) the receiving office returns an off-hook signal to the sending end within 300 milliseconds, but not prior to 70 milliseconds, if it is not ready to receive addressing digits. The called end signifies its readiness to accept digits by returning on-hook. Called offices must be ready to accept digits 50 milliseconds after returning to on-hook, while calling offices must delay sending the first digit 70 milliseconds after receiving the on-hook signal from the called office.

3.1.6.4 Stop

A stop signal is an off-hook condition transmitted toward the calling end which occurs after some, but not all, of the digits have been received at the called end, which indicates that the called end is not ready to receive the remaining digits. It is required on DP calls which are directed, after some digits have been outpulsed, to trunks terminating in line-link or common control offices.

3.1.6.5 Go

A go signal is an on-hook condition transmitted toward the calling end following a stop signal and indicates that the called end is ready to receive additional digits. It continues until the called party answers or reorder or no-circuit signals are returned. After receipt of a go signal, senders delay the first pulse a minimum of 70 milliseconds.

3.1.7 Supervision

3.1.7.1 Ground Start Trunks

The specifications given in this section and its sub-sections are for Control Terminal incoming ground start trunks only, for use with DTMF addressing.

3.1.7.1.1 Idle State

The minimum total resistance across the tip and ring terminations into the Control Terminal during the idle state shall be 20K ohms.

The terminal trunk circuit draws no more than 0.5 ma DC in the ring conductor during idle circuit conditions, measured with the tip conductor open.

No potential more positive than Control Terminal ground is applied to either the tip or the ring conductor.

3.1.7.1.2 Trunk Seizure

The Control Terminal recognizes a grounding of the tip lead of an idle trunk by the Central Office as a trunk seizure signal, (CO goes off-hook). After a minimum delay of 80 milliseconds the trunk input circuit causes a light on a front panel of the terminal to be illuminated.

The trunk seizure ground signal can be detected through various trunk resistances by the Control Terminal, including the 250-ohm resistance of the Central Office. The trunk interface circuit has selectable taps to detect the ground signal, within the current limits specified, through the following trunk (tip conductor) resistances:

1. Conventional loops, 850 ohms
2. Unigauge loops, 1450 ohms
3. Miniguage loops, 1600 ohms
4. Extended range loops, 2350 ohms

These resistances as mentioned above include the 250-ohm Central Office resistance.

The DC resistance of the Control Terminal circuit is such that the sum of the currents in the tip and ring conductors does not exceed 6 ma at the interface during seizure.

The ground detection circuitry operates properly with up to ±3 volts DC earth potential difference between the Control Terminal ground and the Central Office ground.

Provisions are made in the trunk interface circuitry of the terminal to reverse the functions of tip and ring, i.e., to operate as a ground start on the ring conductor rather than the tip conductor.

3.1.7.1.3 Answer Supervision

When the Control Terminal responds to an incoming seizure the trunk circuit places a DC path across the tip-ring conductors at the interface with a DC resistance not exceeding 300 ohms, except for trunk circuits providing line current limiting. Where a variable DC resistance is used to limit the loop current on short CO loops, the resistance is such that a minimum of 23 ma of loop current flows for all loops with less than the maximum permissible loop resistance for the serving Central Office.

The trunk interface circuitry provides a voice band transmission path from the interface to the DTMF tone detectors of the terminal, and returns an order tone in accordance with paragraph 3.1.9.4 within 160 milliseconds after application of the DC path.

3.1.7.1.4 Call Supervision

The Control Terminal maintains the DC loop continuity during momentary interruptions of Central Office battery and/or ground that do not exceed 300 milliseconds in duration.

The Control Terminal does not generate momentary breaks in the DC path through the trunk circuit exceeding 140 milliseconds in duration except for signal disconnect.

3.1.7.1.5 Disconnect

If the MU subscriber goes on-hook before the calling party goes on-hook the Control Terminal returns to the idle condition (open circuit, on-hook signal.)

If the Central Office goes on-hook (removes ground from the tip conductor) for a minimum of 300 milliseconds and the MU subscriber is still off-hook, the terminal returns the trunk to the idle condition and is ready to accept another trunk seizure signal from the Central Office within 850 milliseconds.

3.1.7.2 Reverse Battery Trunks

The specifications in this section and its subsections define requirements for Control Terminal Direct Inward Dialing (DID) trunks that employ

reverse battery supervision. The battery voltage supplied by the terminal is -48 ±5 volts DC. Either MF or dial pulse addressing is used in conjunction with these trunks.

3.1.7.2.1 Idle State

The Control Terminal maintains an idle condition when the DC resistance bridged between tip and ring conductor terminals of the trunk circuit is greater than 30,000 ohms.

The Control Terminal circuit provides a battery supply voltage on the ring conductor, with a battery feed resistance and minimum voltage consistent with Section 3.1.7.2.2. The Control Terminal circuit provides ground through a resistance consistent with Section 3.1.7.2.2 on the tip conductor toward the interface to the Central Office.

The impedance across the tip and ring conductors at the interface is equivalent to 900 ohms ±10% (600 ohms ±10% optional) in series with a 2 ± 10% microfarad capacitor.

3.1.7.2.2 Trunk Seizure - Incoming Calls

The Control Terminal trunk circuit detects the application of a path of DC continuity, having a resistance of 2410 ohms maximum between the tip and ring conductors at the interface, as a Central Office seizure signal. The minimum loop current at the Central Office required to operate its supervisory relay during seizure on DID trunks is 15 ma. Using battery and ground pulsing, the total loop resistance limit is 2000 ohms, plus 410 ohms Central Office relay resistance. Assuming a 43-volt terminal battery and 30K ohms loop leakage, the maximum Control Terminal battery supply resistance for limiting loop operation is 410 ohms total, or 205 ohms in each conductor. Control Terminal trunk circuits intended for DID service with more than 205-ohms, battery supply resistance in each conductor provides a minimum battery supply potential that insures a loop current flow of 16.2 ma through a load resistance consisting of 2410 ohms paralleled by a 30K-ohms leakage resistance.

3.1.7.2.2.2 The Control Terminal off-hook, on-hook responses to trunk seizure by the Central Office is in accordance with the address supervisory mode as defined in Section 3.1.6. To signal off-hook, the Control Terminal reverses the polarity on the idle state (on-hook) tip and ring conductors; placing the battery voltage on the tip conductor, and ground on the ring conductor. Upon completion of the address signaling the Control Terminal provides the generation and transmission of call progress signals in accordance with Section 3.1.9. The maximum delay between completion of address signaling and provision of a path for transmission of call progress information is 750 milliseconds.

3.1.7.2.3 Answer Supervision

When the called mobile subscriber answers a call, the Control Terminal changes the on-hook signal that is returned during addressing to an off-hook signal, by battery reversal on the trunk leads in accordance with section 3.1.7.2.2.2.

3.1.7.2.4 Call Supervision

The Control Terminal maintains the off-hook signal to the Central Office during momentary opens of the trunk continuity by the Central Office that do not exceed 140 milliseconds in duration.

3.1.7.2.5 Disconnect

3.1.7.2.5.1 When the mobile subscriber goes on hook before the Central Office disconnects at the conclusion of a call, the Control Terminal trunk circuit restores on-hook polarity toward the Central Office (battery on ring and ground on tip). The trunk remains busy until an on-hook signal is received from the Central Office.

3.1.7.2.5.2 When the land subscriber goes on hook prior to the mobile subscriber the Control Terminal trunk circuit detects a Central Office on-hook by an increase in external loop resistance to 30K ohms minimum for more than 300 milliseconds, and returns to idle condition. If the mobile subscriber remains off-hook after receipt of the Central Office disconnect signal, the Control Terminal returns the trunk circuit to on-hook.

3.1.7.2.5.3 The Control Terminal is able to properly process a new incoming trunk seizure within 850 ms of onset of the off-hook signal from the Central Office on that trunk.

3.1.7.3 E&M Trunks

The specifications in this section and its subsections define requirements for supervision on: the two-way trunks between the Control Terminal and the Mobile Operator console, the trunks for outgoing calls from mobile subscribers, and for Direct Inward Dialing trunks. E&M supervision provides for a two-way path for simultaneous signaling between a called office and a calling office, without interference, over a two-wire trunk. The trunk interface circuit is designed to interface a four-wire E&M trunk wherein the tip and ring pair carry audio signals and the E&M pair carry the supervisory and DP or MF address signaling.

E&M supervisory signaling may be used on trunks having a maximum resistance of 25 ohms. The input impedance of the E&M trunk interface circuit is 900 ohms $\pm$ 10%, or a strappable to 600 ohms $\pm$ 10%. The output impedance to the matrix of the terminal is 600 ohms $\pm$ 10%.

3.1.7.3.1 Idle State

In the idle state, each end signals on-hook to the other as a ground on its own M lead. This signal results in each end applying a bias voltage of approximately one half of its nominal -48 VDC battery voltage on the M conductor (the difference in potential being compensated for on the E lead). In this condition, the E lead of the Control Terminal circuit indicates an open circuit.

3.1.7.3.2 Trunk Seizure

Trunk seizure is an off-hook indication signaled by the calling end to the called end. The off-hook signal is initiated by changing the ground on the M lead to battery, which in turn changes the bias potential on the calling end tip conductor to the battery potential. Detection of the battery potential, after the idle condition, by the terminal indicates trunk seizure by the mobile operator console (or the Central Office) and causes the terminal E lead to indicate ground (trunk busy) to the Control Terminal's processor.

3.1.7.3.3 Answer Supervision

The called end signals off-hook when the called party answers. (Note: This off-hook and return to on-hook is also given as required to signal wink start, delay dial and stop-go dialing as required by the addressing supervisory mode of Section 3.1.6, except the Control Terminal does not signal stop-go dialing.) The off-hook answer signal is generated by the called office switching its M lead from ground to battery and applying the battery potential to the M conductor. When an answer signal is detected by the Control Terminal it changes the open circuit signal on its E lead to ground.

3.1.7.3.4 Call Supervision

On a call initiated by the Control Terminal the off-hook indication to the called end is not interrupted from time of trunk seizure to disconnect, except for the addressing sequence, for periods in excess of 140 milliseconds. On a call received by the Control Terminal, an interruption of the calling end off-hook signal in excess of 300 milliseconds, except during the addressing sequence, is interpreted as a disconnect signal.

3.1.7.3.5 Disconnect

If an on-hook signal is detected on the trunk by the Control Terminal in excess of 300 milliseconds, except during the addressing sequence, the Control Terminal returns to the on-hook condition. If the mobile subscriber hangs up (goes on-hook) before the far end of the trunk goes on-hook, the Control Terminal returns to the on-hook idle condition.

3.1.8 Address Signaling

Address signaling may take the form of dial pulsing (DP), multifrequency (MF) pulsing or dual tone multifrequency (DTMF) pulsing. The type of signaling to be used on the various trunks is specified in Sections 3.1.2 through 3.1.4. The requirements for these methods are as follows:

3.1.8.1 Dial Pulsing (Open-Closed Circuit Pulsing)

Address signaling pulses consist of a sequence of momentary openings of the loop in response to a Central Office sender operation. The numerical value of each dialed digit is represented by the number of on-hook (loop open or break) intervals in a train of pulses, except for the digit "0", which is 10 pulses. The on-hook intervals are separated by short off-hook (loop closed) intervals, with individual digits separated by 600 millisecond intervals.

3.1.8.1.1 Outgoing Dialing

The Control Terminal transmits dial pulses toward the interface at a pulse repetition rate of 10 $\pm$ 0.5 pulses per second.

3.1.8.1.1.1 Circuit Characteristics

The tip and ring conductors on the Control Terminal side of the trunk interface circuit are bridged by a non-inductive resistance so that the impedance between tip and ring conductors during make portions of dial pulses is 300 ohms maximum.

3.1.8.1.1.1.1 The series resistance in the dialing path may be increased to limit current on short Control Terminal to Central Office trunks so that a minimum of 23 ma flows for all loops consistent with the serving Central Office supervisory limits.

3.1.8.1.1.1.2 The resistive bridge is inserted during the first break of each dialed digit and remains until the last break in the pulse train has occurred.

3.1.8.1.1.1.3 The resistive bridge is removed within 350 ms of the end of the last break in a pulse sequence.

3.1.8.1.1.1.4 Removal of the resistive bridge after dialing does not decrease the loop current below 23 ma for longer than 1 ms.

3.1.8.1.1.1.5 Any circuitry bridged across the tip and ring conductors on the Central Office side of the trunk circuit pulsing relay during dial pulsing must present a minimum AC impedance as indicated in Figure 3.1-3.

3.1.8.1.1.1.6 The DC resistance bridged across tip and ring on the Central Office side of the pulsing contacts must be 150K ohms minimum.

3.1.8.1.1.2 Pulse Interval

With trunk terminating impedances as described in Section 3.1.8.1.2, the percent break of the dial pulses transmitted across the interface is 61 $\pm$ 2 percent. Percent break is defined as the sum of the break intervals divided by the sum of the break-plus-make intervals.

3.1.8.1.1.2.1 The total duration of pulsing relay contact bounce occurring at the start of a make interval (pulse chatter) does not exceed 3 ms. Momentary closures of the loop resulting from transient operation of the pulsing relay during break intervals do not exceed 100 microseconds.

3.1.8.1.1.3 Interdigit Interval

The interdigit time, from the end of the last on-hook pulse of one digit train to the beginning of the first on-hook pulse of the next digit train, is 600 milliseconds. If a stop signal is received from the Central Office (goes off-hook) at any time up to the last 65 milliseconds of the interdigit interval, the terminal delays a minimum 70 milliseconds after the Central Office returns to on-hook (go signal) prior to transmitting additional digits.

3.1.8.1.2 Incoming Dialing

The Control Terminal is capable of receiving and correctly registering dial pulses transmitted by the Central Office at pulse rates between 7.5 and 12 pulses per second received with a break percentage between 59.5 and 67.5 percent.

3.1.8.1.2.1 The Control Terminal recognizes loop dial pulses with loop resistance between 0 and 1500 ohms during make intervals and a minimum resistance of 30K ohms during break intervals.

3.1.8.1.2.2 The Control Terminal processes a digit train with an interdigit time as short as 500 milliseconds.

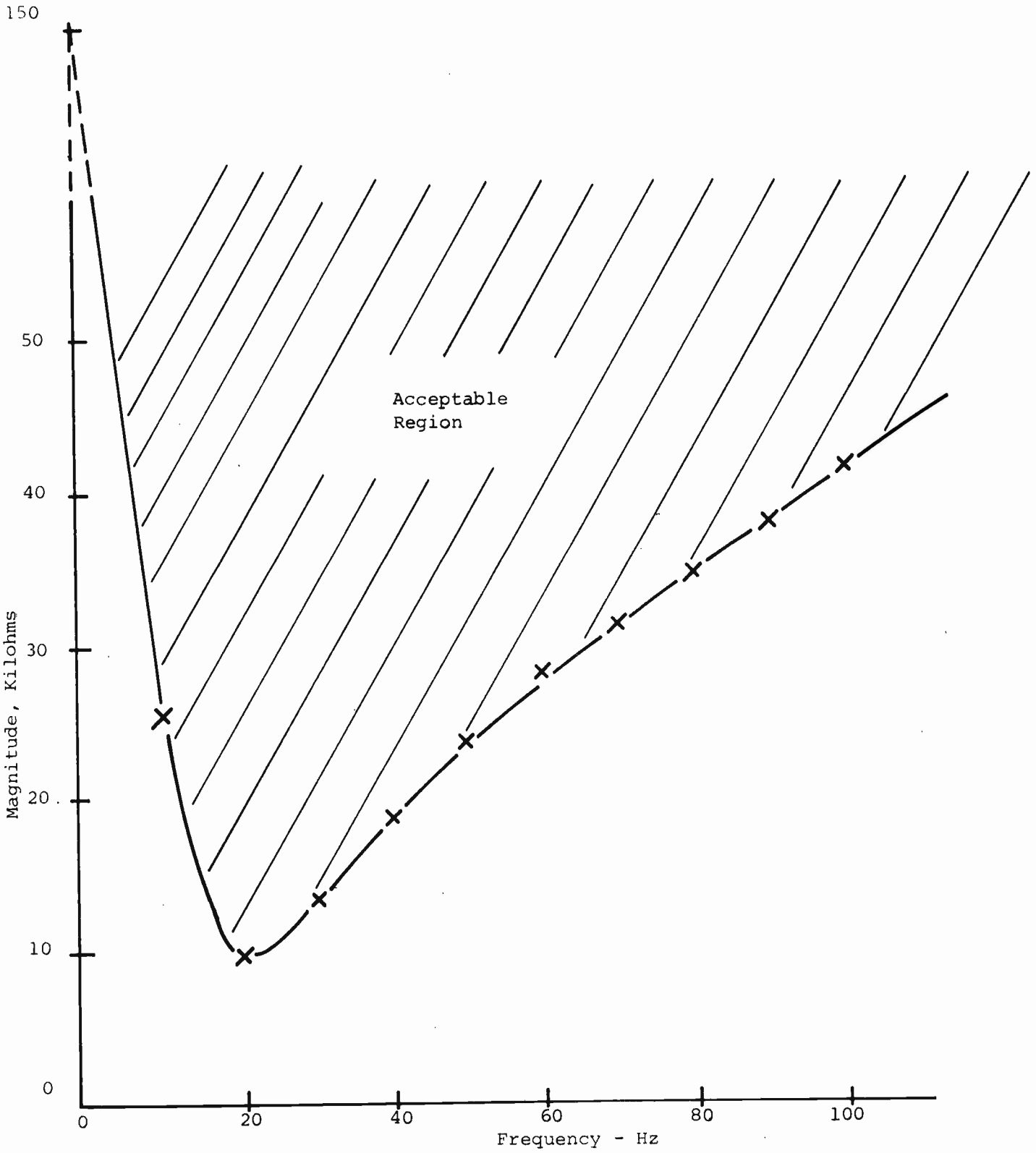


Figure 3.1-3.

Impedance Required On Central Office Side
Of Pulsing Contact During Dial
Pulsing (Section 3.1.8.1.1.1.5).

3.1.8.2 Dual Tone Multifrequency (DTMF) Addressing

The DTMF pulsing system consists of transmitting and receiving equipment for transferring valid addressing information over telephone trunks by various combinations of seven voice band frequencies. Each digit is composed of two frequencies, one from each of two mutually exclusive frequency groups of four frequencies in one group and three in the other. The signal frequencies are geometrically spaced and were selected on the basis that the two frequencies of any valid signal combination are not harmonically related.

3.1.8.2.1 Incoming Dialing

The Control Terminal when operating with Central Offices employing DTMF addressing for roamer trunks decodes the frequencies given in the following table into the digits shown in the table:

High Group Frequencies (Hz) / Low Group Frequencies (Hz)	1209	1336	1477	(1633)*
697	1	2	3	(A)
770	4	5	6	(B)
852	7	8	9	(C)
941	*	0	#	(D)

3.1.8.2.1.1 Pulse Rate

The pulse rate is a function of the dexterity of the calling subscriber, however, the DTMF receiver operates with pulse rates up to 12.5 digits per second.

3.1.8.2.1.2 Tone and Interdigital Intervals

The DTMF tone receivers operate with a minimum tone interval of 40 milliseconds (both frequencies), and a minimum interdigital interval of 40 milliseconds.

3.1.8.2.1.3 Tone Stability

The frequencies of the received DTMF tone are within ± 1.5% of the nominal values given in Section 3.1.8.2.1.

* Reserve states for 4 additional signals which may be utilized in future DTMF addressing but now are not but later can be accommodated by the Control Terminal.

3.1.8.2.1.4 Tone Receiver Sensitivity

The receiver is capable of receiving the frequencies over a voltage range of 0.95 to 0.075 volts rms per frequency and with a difference in amplitude from 0 to 5 dB between the frequencies. The receiver operates satisfactorily with a signal-to-noise ratio of 22 dB per frequency (thermal noise flat weighting) with the minimum allowable received levels and maximum allowable frequency error.

3.1.8.3 Multifrequency (MF) Addressing

The Multifrequency pulsing system consists of transmitting and receiving equipment for transferring valid addressing information over telephone trunks by various combinations of two, and only two of five frequencies in the voice band. Each combination of two frequencies represents a pulse, and each pulse represents a digit. MF receivers detect the pulses and transfer the digital information to control equipment which establishes connections through the switches. The MF system transmits only addressing information; hence another signaling system such as E&M or Reverse Battery must be provided for supervision.

Additional signals are provided by combinations using a sixth frequency. The six frequencies are spaced 200 Hz apart. These six frequencies provide fifteen possible two-frequency combinations. Ten combinations are used for the digits 0 to 9 inclusive, and one each for signals indicating the beginning (KP) and end (ST) of pulsing. The remaining three combinations are used for special signals not currently used in IMTS signaling.

3.1.8.3.1 Incoming and Outgoing Dialing

The Control Terminal when operating with Central Offices or Mobile Service Operator consoles employing MF addressing, decode and encode the frequencies given in the following table into the corresponding digits shown in the table:

FREQUENCIES FOR MF PULSING

DIGIT	FREQUENCIES (Hz)
1	700 & 900
2	700 & 1100
3	900 & 1100
4	700 & 1300
5	900 & 1300
6	1100 & 1300
7	700 & 1500
8	900 & 1500
9	1100 & 1500
0	1300 & 1500

The trunks also signal with a KP pulse (1100 Hz and 1700 Hz) signifying the start of an address, and a ST pulse (1500 Hz and 1700 Hz) signifying the end of an address. These signals are accepted by the Control Terminal, and are transmitted as a part of each address outputted.

3.1.8.3.1.1 Pulse Rate

The Control Terminal is capable of receiving digits at rates of two to ten per second. The nominal rate from Central Offices for a four-digit address is seven digits per second. The nominal rate from Mobile Service Operator consoles is two digits per second. The Control Terminal outpulses at a rate of 7 digits ± 1 digit per second.

3.1.8.3.1.2 Tone and Interdigital Intervals

The MF tone decoders operate with 260 millisecond tone intervals and 230-millisecond no-tone intervals at two digits per second; and 35 millisecond tone intervals and 65 millisecond no-tone intervals at the 10-digit-per-second rate. The decoders also operate with the tone and no-tone intervals associated with the signaling rates given in Section 3.1.8.3.1.1. Nominal interdigit intervals of 68 ± 7 milliseconds are associated with a nominal seven digits per second from the Central Office. The outgoing MF signals have interdigit intervals of 68 ± 7 milliseconds. The transmitted KP pulse is 100 ± 7 milliseconds.

3.1.8.3.1.3 Tone Stability

The frequencies of the received MF tones may be within ± 2.5% of the nominal values given in Section 3.1.8.3.1. The Control Terminal verifies that two and only two tones for each digit are received, and returns a reorder signal if an error is detected. The frequency of the oscillators of the transmitters are within ± 1.5% of the nominal frequencies of paragraph 3.1.8.3.1.

3.1.8.3.1.4 Tone Receiver Sensitivity

The limit for operating sensitivity of the MF receivers is -22 dBm per frequency (the normal power output of Central Office MF transmitters is -6 dBm per frequency at the zero transmission level point allowing operation with trunks having approximately 14 dB loss). High input signals to the receivers do not cause false operations due to intermodulation products. The Control Terminal MF receivers operate with 6.0 dB of slope in frequency of the input tones.

3.1.8.3.1.4 Transmitter Power Output

The output of the MF transmitters from the Control Terminal does not exceed -6 dBm per frequency at the zero transmission level point at the terminal block. The maximum allowable slope in frequency transmission is 6 dB.

3.1.9 Call Progress Signals

Call progress tones generated by the Control Terminal, as defined herein, and as transmitted to the trunk interface are of a tonal quality and rate of interruption easily recognized and understood by users of the public switched telephone network. The Call Progress signals are: busy tone, reorder (overflow) tone, order ("second dial") tone, and ringback (audible ring) tone. These signals consist of dual tones as specified for all but the order tone, a single-frequency tone.

3.1.9.1 Call Progress Tone Characteristics

The composite tone levels for any call progress signal are within the range of -13 dBm to -21 dBm when measured across a 600 ohm resistive termination at the interface terminal block. The frequency stability of the tones is ± 1% (due to all causes) of the nominal values. The signal tone levels are potentiometer adjustable, and remain constant within ± 1 dB over a Control Terminal battery range of -45 to -52 VDC, and over a temperature range of 32°F to 122°F (0°C to + 50°C).

For outgoing calls, the Control Terminal provides a transmission path through the terminal with an insertion loss not exceeding 0.5 dB, measured between a 600 ohm resistive termination at the input to the channel side of the switch matrix and a 600 ohm resistive termination on the output of the trunk interface circuit to the Central Office, in the 300 Hz to 3400 Hz frequency band for the transmission of call progress signals generated by the Central Office during call setup.

3.1.9.2 Busy Signal

The busy signal generated by the Control Terminal consists of 480 Hz and 620 Hz at a level of -21 dBm per frequency, interrupted at a rate of 60 ± 2 interrupts per minute.

3.1.9.3 Reorder Signal

The reorder (overflow) signal generated by the Control Terminal consists of 480 Hz and 620 Hz, each at a level of -16 dBm, interrupted at a rate of 120 ± 2 interrupts per minute.

3.1.9.4 Order Tone

The order ("second dial") tone returned on the direct dial roamer "trunks", signifying to the caller ready to receive DTMF digits, consists of two pulses of 480 Hz tone at a level of -17 dBm. The pulses are 125 ± 6 msec in duration separated by 125 ± 6 msec of no tone.

3.1.9.5 Ringback Signal

Ringback (audible ringing) consists of 440 Hz and 480 Hz at a level of -16 dBm per frequency. The signal indicates that the called MU has been reached and ringing has started.

3.1.10 Speech Chracteristics

The trunk interface circuits of the Control Terminal have a frequency response that is within ± 1.0 dB over the range of 300 to 2750 Hz. The average voice signal power at the output of the 900-ohm impedance Control Terminal interface circuits do not exceed -12 dBm averaged over any three second interval.

4.0 CONTROL TERMINAL TO BASE STATION INTERFACE

Two 2-wire circuits between the Control Terminal and the Base Station Control Unit provide a separate pair for each message channel to the transmitters, and a separate pair for each corresponding message channel from the receivers. Base Station transmitter control is performed via audio tones on each transmitter message channel. The tones are detected and filtered such that normal audio transmissions and signaling are unaffected.

Control Terminal supervision of Base Station transmitters includes the following functions:

1. OFF - Off the air, on standby (off control is also located on the local control panel at transmitter).

2. Fo - Unmodulated carrier radiated at 0.5 watt.

3. Marked Idle - 2 kHz tone at full power.

4. Full Power (Busy) - Call placement signaling and message at full power.

5. Test Convert - Checks entire station and communication loop in the full power mode.

Status signals returned to the Control Terminal via the receive line are:

1. RF - Indication of transmitter radiation during full power modes.

2. Received Carrier - Indicates mobile carrier loss or presence of a foreign carrier on the channel.

The audio level on the channel side of the 2-to-4 wire hybrid is controlled by VOGAD-SONAD units. Message audio or IMTS tone signaling and transmitter control tones, under control of the processor, are matched to the wireline or microwave facilities and sent to the BSCU. At the BSCU, the audio or call-up signaling tones are routed to the customer's transmitters while the amplified and detected low-level inband supervision tones are used to control the output of a loop current source or a set of relays to provide open-close contact signaling. The resulting signals to the transmitters control their power output status or provides for a check of the Base Station under full power as indicated in the preceding paragraph.

The Control Terminal channel interface provides terminal to base station connections over either wireline or microwave facilities using tone supervision.

Transmitter control circuits from any point are such that grounding or shorting any line in the control circuit does not cause the transmitter to radiate.

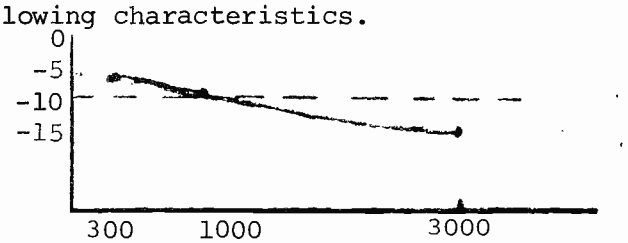
The base station receivers, or receiver voting units, interface the Control Terminal directly or through the Base Station Control Unit (BSCU) depending upon the relative locations of the system components. When the interconnection is directly to the Control Terminal, a four-wire line for each channel is still required between the terminal and the BSCU; two for the transmitter audio and control, and two for the transmitter RF power on signal or Received Carrier signal back to the terminal.

4.1 Line Characteristics

The input and output impedances of the line matching circuits of the Control Terminal, and the BSCU are strap selectable for 150, 600 or 1350 ohms ± 10% balanced to ground. The input and output impedances of the Receiver Voting Unit is 600 ohms. The lines from the BSCU to the Base Station transmitters and receivers or Receiver Voting Units must not exhibit a loss in signal level exceeding 10 dB or exhibit a resistance exceeding 3500 ohms. The line-matching circuits of the equipment contain lightning and power surge protection.

The line types that are required for transmitter/receiver interfaces are Voice Grade Type 2002 Conditioned RT circuits or the equivalent. The lines should be adjusted so that line loss at 1000 Hz is -10 dB. In addition, the line should have the following characteristics.

Frequency	Loss
300 Hz	-8 dB
1000 Hz	-10 dB
3000 Hz	-15 dB



The use of in-band tones for transmitter and receiver control requires roll-off at the higher frequencies. The lines should be equalized as close as possible to the above requirements.

4.2 Signal Characteristics

4.2.1 Audio

The audio output from the Control Terminal is adjustable from +2 dBm to -10 dBm and is normally set to -7 dBm ± 1 dBm over a frequency range of 300 Hz to 3000 Hz. Audio amplifiers in the BSCU, having a 20-dB range, are provided to adjust the audio output to the transmitters and the audio output to the Control Terminal from the Base Station receivers. Audio output includes the ringback, busy and reorder Call Progress tones which are generated when required by the connecting office.

4.2.2 Signaling Tones

The idle tone and seize tones are adjustable at the Control Terminal from no tone to +3 dBm, and are normally adjusted to -7 dBm

± 1 dBm output to the telephone line. The Control Terminal tone detectors are within 25 Hz when adjusted for the center frequencies for the guard, connect and disconnect IMTS tones, at 25°C and -48 VDC input power. The tones will be properly decoded over a dynamic range of 12 dB when the nominal input to the Control Terminal is -17 dBm with -3.3 kHz deviation carrier applied.

4.2.3 Call Progress Tones

In addition to the idle and seize tones, 350-, 440-, 480- and 620- Hz tones are used to generate Call Progress signals to the MU users. These signals are described in the following sections. (Ring-back and busy tones are excluded; these are generated by the connecting office. See Section 4.2.1. Reorder is generated either by the connecting office or the Control Terminal depending where the blockage occurs.) The tone generators in the Control Terminal have a frequency tolerance of ±0.5%, and an output amplitude tolerance of ±1 dB. The total distortion is less than 1%.

4.2.3.1 Dial Tone

The dial tone is composed of the 350 Hz tone and the 440 Hz tone. The output of this signal from the Control Terminal to the BSCU is adjustable from -3 dBm to no signal and is set at a level of -13 dBm ±1 dBm per frequency. The tone pair when transmitted is continuous.

4.2.3.2 Reorder Tone

The reorder (overflow) tone is composed of the 480 Hz tone and the 620 Hz tone. The output of this signal from the Control Terminal to the BSCU, that is interrupted at a 120 IPM rate, is adjustable from -11 dBm to no signal, and is set at a level of -21 dBm ± 1 dBm per frequency. The signal is on for 300 ± 50 msecs and off for 200 ± 50 msecs.

4.2.3.3 Receiver Off Hook (ROH) Tone

The ROH tone is the 480 Hz tone transmitted to the BSCU at a level of -8 dBm and interruption rate of 240 IPM. The output from the terminal of this signal is adjustable from +2 dBm to no tone.

4.2.4 Station Call Sign Signals

Station FCC call signs are generated each 30 minute (+0, -10 minutes) interval unless the channel is busy, in which case the call sign is sent at the end of the call. Call signs are sent in International Morse Code using the seize tone, at a rate of 20 to 25 words per minute. The level of the signal is as specified for the seize tone in Section 4.2.2.

4.2.5 Transmitter Control Tones

Combinations of three audio tones are used to select transmitter power settings. An absence of any tone is a command to standby power (no RF radiation). The 2000 Hz idle tone commands the transmitter to

full power. When the channel is seized and the idle marker removed, a 2962 Hz tone is sent to the BSCU to keep the transmitter at full power. When the call or call attempt is completed, the channel is commanded to ony one of three states: back to marked idle, to Fo power or to the standby mode. The tone signals and their characteristics are given in the following paragraphs.

4.2.5.1 Tone Frequencies

Tone Frequencies	Transmitter Condition	Remarks
2000 ± 10 Hz	Full Power	Idle Marker ON
2962 ± 10 Hz	Full Power	Channel Busy
2794 ± 10 Hz	Fo Power	0.5 W, unmodulated
2962 ± 10 Hz and 2794 ± 10 Hz	Test Convert	Full Power - Manual Only
No Tone	Standby Power	No RF Radiation

The 2962 Hz Channel Busy tone is applied when a channel is seized and the 2000 Hz marker tone is removed.

4.2.5.2 Tone Levels

The 2000 Hz idle tone is adjustable from +3 dBm to no tone, and is normally sent to the BSCU at -7 ± 1 dBm. The 2962 and 2794 Hz tones are adjustable from -50 to -30 dBm, and are normally sent at a level to be -35 ± 2 dBm at the BSCU.

4.2.6 Transmitter Control Signals

The transmitter control tone signals sent from the Control Terminal to the BSCU are converted by the BSCU into either loop-current signals or contact closure signals that interface the transmitters.

4.2.6.1 Loop-Current Signals

The loop-current signals are applied to a line pair between the BSCU and each transmitter as shown in the following table:

Signal	Current Range	Remarks
Full Power	+2.5 to +3.0 ma	Marker or Busy
Fo Power	-2.5 to -3.0 ma	--
Test Convert	+10.0 to +9.0 ma	--
Off (Standby)	0	Open Current

4.2.6.2 Contact Closure Signals

A separate relay contact is provided in the BSCU for each of the following signals: Full Power (marker or busy), Fo Power, and Test Converter mode. The signal is indicated when the contact is closed. When all three contacts are open, the transmitter is commanded to Off (Standby). The contacts are rated at 240 ma or 10 volt-amperes resistive.

4.2.7 Status Signals

4.2.7.1 Transmitter RF-On

The BSCU contains an interface to the transmitter to provide an RF carrier On indication to the Control Terminal. The RF-On signal is transferred to the BSCU from the transmitter by either loop-current or contact-closure signaling.

The BSCU converts the RF-On signal from the transmitter to a tone signal of 2962 Hz $\pm$ 10 Hz that is transmitted back to the Control Terminal over either the receive audio pair, or a special pair provided for this signal. The tone is adjustable from -50 to -30 dBm and is normally set to provide a -30 dBm $\pm$ 2 dBm signal at the Control Terminal.

An RF-On indicator is provided for each transmitter at the BSCU. The indicators are lighted when the Power On signals are received from the transmitters.

4.2.7.1.1 Loop-Current Signaling

The RF-On signal is generated as a result of a return current of from +4 ma to +6 ma on the audio pair from the transmitter (indicating transmitter RF relay closure).

4.2.7.1.2 Contact Closure Signaling

The BSCU detects the closure of a contact over a special line pair from the transmitter as an indication of RF power on. The BSCU will generate a maximum of 5 ma through the contact at a maximum line and contact resistance of 1000 ohms.

4.2.7.2 Received Carrier

The Control Terminal has provisions for monitoring all channels (receivers) for the presence of an RF carrier. Tone or DC current signals from the receivers or Receiver Voting Units are converted by the BSCU into 3100 Hz audio tone signals that are transmitted to the Control Terminal. The signals from the receivers and voting units are transmitted on the audio pair of the talk channel between these units and the BSCU. For those configurations where the receivers or voting units are co-located or near the Control Terminal their outputs are connected directly to the terminal, bypassing the BSCU.

4.2.7.2.1 Tone Signaling

The BSCU can detect and process a 1950 ± 10 Hz audio tone from a receiver as an indication of no carrier being received at the input to the receiver. A level of at least -30 dBm is required at the input to the BSCU.

NOTE: If the IMTS system operates without receiver voting, the 1950 Hz tone will be heard by a land party until the called mobile subscriber answers.

4.2.7.2.2 DC Current Signals

Receivers with carrier-operated relays (COR) providing a closed contact across the audio pair between the receiver and the BSCU when a carrier is being received, are interfaced by feeding a 4 to 10 ma current through the loop from the BSCU, or from the Control Terminal if the received audio is not routed through the BSCU. The current is detected through the closed loop by the BSCU or terminal, and generates the received carrier signal. Receivers that provide a COR to switch in a current source generator, must provide a current of 4 to 10 ma to the input of the BSCU, or Control Terminal.

The BSCU and Control Terminal can also operate with receivers that supply either a ground or battery (-48 VDC) on one of the lines of the audio pair, when a carrier is being received. Either method requires 4 to 10 ma of current. This technique provides only two states of operation:

1) Carrier present (high current)

2) No carrier or line bad or receiver bad (low or no current).

5.0 CONTROL TERMINAL PHYSICAL INTERFACE

The Control Terminal exhibits the hardware characteristics identified in the following paragraphs.

5.1 Packaging Configuration

5.1.1 Control Terminal Rack Assemblies

The Control Terminal is packaged in standard racks similar to the configuration shown in Figure 2.2-1 of the Proposal Section. Each rack is designated by serial number and type by means of permanent markings on the rack frame in a visible, but unobtrusive, location.

Standard frames for 23-inch chassis, that can be bolted to the floor of the facility, house the various chassis. The base of each frame in contact with the floor has a surface area of 291 square inches. The overall frame widths are each 25 inches. Chassis mounted in the frames are self-contained modular units. The height dimension of each chassis is a multiple of standard, 1.75-inch-panel increments. The chassis are configured not to exceed 7-1/2 feet in height. The rack mounted equipment does not extend more than 12 inches from the center of the rack, with an overall dimension of 16.5 inches, to allow proper aisle clearance for maintenance and test equipment.

Except for the blower chassis in the Interface and Control Rack, individual chassis can be added or removed from a rack without disturbing the other units in the frame. In addition, the Control Terminal confirguration is easily modified by adding or removing an entire rack without major equipment modification.

Frames, chassis, and internal modules are labeled to allow identification during operation and maintenance without equipment disassembly.

All equipment is finished with a paint (Fed STD-595 Gray) that is uniform in color and lustre and resists scratching. Rack-mounted equipment is protected by metal enclosures with front and rear panels.

5.1.2 Base Station Control Unit

The BSCU is a chassis having a standard 19-inch wide panel, 12-1/4 inches high and a chassis depth of 16-1/2 inches, and is capable of controlling from one to six transmitters.

5.1.3 Receiver Voting Unit

A Receiver Voting Unit is contained in a chassis having a standard 19-inch wide panel, 7 inches high and 9-1/2 inches deep, and a jack field having a 19-inch wide panel 1-3/4 inches high and 6 inches deep. The unit can vote the outputs of from two to six receiver sites on a frequency channel. An extender unit of the same size increases the vote capability to as many as 12 sites.

5.1.4 Teletypewriter and Stand

The teletypewriter set is 22 inches wide by 8-3/8 inches high by 18-1/2 inches deep. The stand for the set is 17-3/4 inches wide by 24-1/2 inches high and 6-1/2 inches deep. The rail-type feet of the stand are 17-3/4 inches long.

5.2 Weights and Floor Loading

5.2.1 Control Terminal Rack Assemblies

The maximum loading exerted on the floor by the Control Terminal racks is 2.25 pounds per square inch.

5.2.2 Teletypewriter and Stand

The TTY set weighs 44 pounds, and the stand weighs 12 pounds.

5.2.3 Base Station Control Unit

The BSCU with six transmitter control modules weighs less than 50 pounds.

5.2.4 Receiver Voting Unit

The Receiver Voting Unit with six receiver modules weighs less than 30 pounds.

5.2.5 Base Station Interface Rack

A standard frame for 19-inch chassis contains BSCU's and Receiver Voting Units* The base of each frame in contact with the floor has a surface area of 247 square inches.

5.3 Environment

5.3.1 Control Terminal Rack Assemblies

The Control Terminal racks operate within the specified tolerances of this document over a temperature range of 50°F to 113°F (10°C to 45°C), and a relative humidity range of from 20% to 95%, non-condensing.

5.3.2 Base Station Control Unit

The BSCU operates within the specified tolerances of this document over a temperature range of 32°F to 131°F (0°C to 50°C), and a relative humidity range of from 5% to 95%, non-condensing.

*If Receiver Voting Units are located at Base Station site.

5.3.3 Receiver Voting Unit

The Receiver Voting Unit operates within the specified tolerances of this document over a temperature range of 32°F to 140°F (0°C to 60°C), and a relative humidity range of 5% to 95% noncondensing.

5.3.4 Teletypewriter

The TTY set operates within the specified tolerances of this document range of 41°F to 110°F (5°C to 43°C), and a relative humidity range of 5% to 95% noncondensing.

5.4 Power Requirements

The various components of the system utilize -48 VDC and/or 115 VAC input power. The equipment meets the requirements specified in this document over the following input power ranges:

-45 VDC to -52 VDC

115V ± 10%, 1ø, 60 Hz ± 3 Hz

5.4.1 Control Terminal Rack Assemblies

Processor Rack: A single processor configuration requires 25 Amperes at -48 VDC. In addition, the rack may be operated from a backup AC power source (automatic switchover provided in case of DC power failure) of 8.5 Amperes at a 0.9 power factor. For the dual processor configuration, 50 Amperes of DC power is required with a back-up source of 17 Amperes AC.

Interface and Controls Rack: A full complement of chassis and cards requires 27 Amperes of -48 VDC power. An additional 3.84 Amperes of "clean" -48 VDC is required for supervisory signals.

Magnetic Tape Rack: The dual tape unit configuration requires 13 Amperes from -48 VDC power source. This rack also has provisions for automatic switchover to a back-up AC power source of 6 Amperes at a power factor of 0.83.

Auxiliary Rack: The single magnetic tape configuration in an Auxiliary Rack also containing a full complement of equipment (casette/cartridge tape recorder, with a magnetic tape unit installed, voice announcement unit*, unibus switch, and test equipment) requires 21 Amperes at -48 VDC with an AC back-up source of 9 Amperes. The full-complement Auxiliary Rack without the magnetic tape unit requires 25 Amperes at -48 VDC with an AC back-up source of 8.5 Amperes at -48 VDC with an AC back-up source of 8.5 Amperes at a 0.9 power factor.

5.4.2 Base Station Control Unit

A Base Station Control Unit with six transmitter control modules requires 2.0 Amperes of AC power.

*Voice announcement unit operates on DC only.

5.4.3 Receiver Voting Unit

A Receiver Voting Unit with six receiver modules requires 1.0 Ampere of AC power.

5.4.4 Teletypewriter

The teletypewriter requires 10 Amperes at -48 VDC or 15 Amperes of AC current for starting, and 4.0 Amperes of AC power during normal operation.

5.5 Safety Features

To assure safe Control Terminal operation, the following safety features are employed.

1 All high voltage lines in a rack are marked with a visible WARNING sign. All high voltage terminal blocks are suitably covered or otherwise protected from accidental contact by craftsmen performing routine maintenance.

2 Suitable latches or locks are incorporated to prevent chassis from being removed from the rack in one singular push or pull motion.

3 Lights are employed to give a positive indication when rack power is "ON".

4 Operating instructions are supplied with each Control Terminal and contain any information relative to safe operation.

6.0 MAN-MACHINE INTERFACE

System control and monitoring functions are performed by a system technical operator's interface with the Control Terminal processor. The system technical operator utilizes processor peripheral equipment, namely the teletypewriter and magnetic tape facilities, in order to exercise his control. To further assist the technical operator, test jacks, switches, keys, indicators, fuses and alarms are located on the front of appropriate equipment.

6.1 System/Operator Interface

The comprehensive man/machine software package provides the means for an operator to communicate with the system via a teletypewriter. Table 6.1-I lists the standard technical operator control commands. All of the commands can be executed from the teletypewriter. Control via the teletypewriter allows the operator to perform the following functions:

1. Control system operation.
2. Enter date and print date and time of day.
3. Add and remove subscribers to and from the directories.
4. Print or punch the current directories on the teletypewriter, or record on the cassette tape.
5. Determine specific subscriber status.
6. Place specific equipment in and out of service.
7. Determine specific equipment and call status.
8. Override system control of transmitter modes.
9. Perform diagnostic testing of specific equipment.
10. Switch standby equipment into operation.
11. Provide backup capability for recording of billing data.
12. Provide entry of security and ID information.
13. Print statistics.
14. Provide for exercise of optional functions.

All comamnds as listed in Table 6.1-I are identified by two alphabetic characters. Numeric information that may follow as parameter input must be decimal. Requests and data that are entered are checked by the system for format validity, then processed to execute the requested function. Operator and system responses are listed below.

OPERATOR/SYSTEM RESPONSES

READY	The system is ready for operator input. READY is printed on the teletypewriter followed by date and time after initialization and immediately after a transaction has been processed and the system can accept another request. READY is always followed by the Gregorian date (month, day, year), the time in hours, minutes and seconds and the Julian date (3 digits).
ERROR	The incorrect teletypewriter entry is printed along with the word ERROR. The system is returned to the ready state.
(CR) or (,)	All standard operator function fields must be followed by a carriage return or comma. A field is determined by all the characters typed between any two delimiters.
/	Abort entry. A slash character entered at any time aborts the current operator request and returns the system to the ready state.
E	Function end. This terminates data entry for the requested function and returns the system to the ready state. End is not valid.
RUBOUT/ DELETE	Delete the last input character. Characters may be deleted back to the beginning of the current field. A backward slash \ is printed for each RUBOUT.

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS

1. CONTROL SYSTEM OPERATION

ON (CR)	Turn system on; start call processing. From Control Terminal power on and program start time, the only function performed is the servicing of the operator interface software. This allows the technical operator to update directories, enter time, and to perform other operator functions before call processing is initiated.
OF (CR)	Turn system off; do not accept any new calls. If any calls are in process, a message (BUSY) is printed. After all calls currently in progress are terminated, a message (SYSTEM OFF READY) is printed on the teletypewriter and the system returns to the pre-system on condition.

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS (Cont'd)

2. ENTER DATE AND PRINT TIME OF DAY

AY (CR) M, D, YY(CR)	Date is entered as month, day, year. Leading zeros are not necessary for the month and day. Year must be two digits. Date and time are printed after entry is made. Conversion is also made to Julian date.
PT (CR)	Print date and time. Date and time are printed on the teletypewriter in the following format: Month-day-year hours minutes seconds Julian date. Example: 11-16-73 12 25 42 320

3. ADD AND REMOVE SUBSCRIBERS TO AND FROM DIRECTORIES

AD (CR) NPA (CR) S1:Z, S2:Z SN, E (CR)	Add subscriber to the home directory. Up to 10,000 mobile numbers for each valid area code can be entered. NPA must be a valid three-digit home area code. S1, S2, . . SN are four-digit subscriber mobile numbers. Leading zeros do not have to be entered. These 4 digits are followed by a colon (:) and the zone identification, either a 1 or 2 digit number between 1 and 15.* Example: 1234:4. E is the terminating character. Entry of a number already in the directory will cause an ERROR printout.
RD (CR) NPA (CR) SN, E (CR)	Remove subscriber from home directory. NPA must be a valid three digit home area code. S1, S2, S3 . . SN are four digit subscriber mobile numbers. Leading zeros do not have to be entered. E is the terminating character. Entry of a number not in the directory will cause an ERROR printout. Service for these subscribers is deleted from the specified directory.
AR (CR) S1, S2, S3.. SN, E (CR)	Add numbers to the negative directory. By selective formatting of S1, S2, S3 . . SN this command will perform the following functions: If S = 3 digit valid NPA, the entire NPA is placed in the negative directory. If S = 7 digit number, that single subscriber is added. If S = 7 digit followed by a "1", this indicates that start of a block of consecutive ascending numbers to be added. If S = 7 digit number followed by a "2", this indicates the end of a block. Example: 30510001, 30519992. These subscribers are denied service by the system.
RR (CR) S1, S2, S3.. SN, E (CR)	Remove numbers from the negative directory. S is formatted the same as in the AR command. Removal of blocks must correspond to identical blocks currently in the directory. These subscribers are now to be allowed service.

*Option. Used only if area of registry identification/zone ID option is selected.

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS (Cont'd)

4. PRINT OR PUNCH THE CURRENT DIRECTORIES ON THE TELETYPEWRITER OR RECORD ON THE CASSETTE TAPE

PD (CR) NPA (CR) (CR) OR T (CR)	Punch and/or print all subscriber numbers in the directory with area code NPA. A message is printed for the operator to allow him the option to punch a tape. Subscriber information is punched in the format as described under adding subscribers to the directory. If a tape is produced, it may be read back into the system. Entering an NPA code of ØØØ designates the negative directory.
CD (CR)	Dump directory (both Negative and Positive Directories) information to cassette recorder. The home directories and negative directory are written on the cassette recorder. All information is written in binary. This command can only be executed in the pre-system on or OFF state.
CL (CR)	Load directory information from the cassette recorder. Home directories and negative directory are read from the cassette. The command can only be executed in the system states as explained above.

5. DETERMINE SPECIFIC SUBSCRIBER STATUS

RS (CR) NPA (CR)	Negative status. Prints the negative directory for the NPA entered.
RS (CR) S (CR)	Negative status. S is a seven digit number. Prints ACTIVE if S is not in the negative directory. Prints INACTIVE if S is in negative directory.
HS (CR) NPA (CR) S (CR)	Home status. NPA is a three digit valid home area code. S is a one to four digit number. Prints ACTIVE if S is in home directory. Prints INACTIVE if S is not in home directory.

6. ADD OR REMOVE SPECIFIC EQUIPMENT IN AND OUT OF SERVICE

RT (CR) TT (CR)	Remove trunk from system use. The trunk number TT is removed from service.
AT (CR) TT (CR)	Add trunk for system use. The trunk number TT is added back into service for system use.
RC (CR) CC (CR)	Remove channel from system use. The channel number CC is removed from service.
AC (CR) CC (CR)	Add channel for system use. The channel number CC is added back into service for system use.

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS (Cont'd)

7. DETERMINE SPECIFIC EQUIPMENT AND CALL STATUS

KC (CR) CC (CR)	Print status of channel. The current status of channel CC (ACTIVE, INACTIVE, BUSY, or TEST REQUIRED) is printed on the teletypewriter.
KT (CR) TT (CR)	Print status of trunk. The current status of trunk TT (ACTIVE, INACTIVE, BUSY, or TEST REQUIRED) is printed on the teletypewriter.
PA (CR) CC (CR)	Print activity status for channel CC. The following information is printed: Channel number, mobile number, land line number, and channel seize time.

8. OVERRIDE SYSTEM CONTROL OF TRANSMITTER MODES

XS (CR) T (CR)	Place transmitter T in standby mode.
XF (CR) T (CR)	Place transmitter T in F zero mode.
XM (CR) T (CR)	Place transmitter T in marker mode.
XV (CR) T (CR)	Place transmitter T in voice mode.
XR (CR) T (CR)	Reset transmitter T to automatic mode.

9. PERFORM DIAGNOSTIC TESTING

SD (CR)	Start diagnostic testing. The automatic diagnostic test procedure is started.
ED (CR)	End diagnostic testing. The automatic diagnostic test procedure is stopped.
DC (CR)	Return system diagnostics to active service.

10. SWITCH STANDBY EQUIPMENT INTO OPERATION

ST (CR)	Switch to standby central timer card. Switch all basic system timing functions to be performed to the standby central timer card.
NT (CR)	Return to primary central timer card. Switch all basic system timing functions to be performed to the primary central timer card.

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS (Cont'd)

SC (CR)	Switch to standby time of day clock. TOD information is read from the secondary clock for billing and traffic timing.
NC (CR)	Return to primary time of day clock. TOD information is read from the primary clock for billing and traffic timing.
NB (CR)	Activate both diagnostic bus cards. If either bus diagnostic card was removed from service, this command will return it to service.
SM (CR) N (CR)	Switch to standby matrix controller. N = AMX chassis number. (One digit)
NM (CR) N (CR)	Return to primary matrix controller. N = AMX chassis number. (One digit)

11. PROVIDE BACKUP CAPABILITY FOR RECORDING FOR BILLING DATA

MC (CR) C (CR)	Magnetic tape control. Operator control of the nine track magnetic recording tape is controlled as follows: C = 1 Initialize Tape Drive 1 C = 2 Initialize Tape Drive 2 C = 3 Switch or terminate current tape drive C = 4* Write current data block to magnetic tape C = 5* Magnetic tape degauss override

12. PROVIDE ENTRY OF SECURITY AND ID INFORMATION

SI (CR) CCCC (CR) ID (CR)	Sign in. This command must be entered before any other command will be accepted. CCCC is printing or nonprinting. ID is the operator identification.
SO (CR)	Sign out. This command disables the man/machine interface and allows entry of no other command except sign in (SI).

13. PRINT STATISTICS

PS (CR)	Print statistics. The channel statistics collected during the previous hour are printed on the teletypewriter. Data printed includes date and hour, channel number, minutes of channel usage, number of calls attempted and completed for mobile to land and land to mobile sequences.

*Optional

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS (Cont'd)

14. PROVIDE FOR THE EXERCISE OF OPTIONAL FUNCTIONS

AA (CR)	Add mobile test number.
S, E (CR)	S = number of mobile unit. (7 digits) E = terminating character Mobiles undergoing maintenance calls are specially flagged so automatically they will not be billed for the test calls.
RA (CR)	Remove mobile test number.
S, E (CR)	S = number of mobile unit to be removed. (7 digits) S = Ø All mobile test numbers are removed E = terminating character
PN (CR)	Print all mobile test numbers. All mobiles whose numbers have been entered while undergoing maintenance test calls are listed on the teletypewriter.
SS (CR)	Print status of all channels and trunks. Each trunk or channel's status (ACTIVE, INACTIVE, BUSY, or TEST REQUIRED) is printed on the teletypewriter.
SX (CR) CC (CR)	Switch standby channel card into service. The channel number CC is switched into service.
RX (CR) CC (CR)	Return standby channel card to standby service. The channel number CC is removed from service.
EA (CR)	Enable alarms. The system major and minor alarms can be returned to service after being disabled.
DA (CR)	Disable alarms. The system major and minor alarms can be removed from service for the convenience of the system technical operator.
AB (CR) NPA (CR) U (CR) 11X, DD (CR) E (CR)	AB = add abbreviated dialed number NPA = mobile unit's area code U = mobile unit's number (4 digits) X = Ø to 9, the abbreviated number DD = the digits to be dialed E = terminating character
RB (CR) NPA (CR) U (CR) E (CR)	RB = remove abbreviated dial user NPA = mobile unit's area code U = mobile unit's number (4 digits) E = terminating character

TABLE 6.1-I. STANDARD OPERATOR CONTROL COMMANDS (Cont'd)

PB (CR) (CR)	Print abbreviated dial users. All mobile subscribers in all the terminals's home NPA's are printed on the typewriter.
PB (CR) NPA (CR) (CR)	Print abbreviated dial users. All mobile subscribers in this NPA are printed on the teletypewriter.
PB (CR) NPA (CR) U (CR)	Print abbreviated dialed numbers. All abbreviated dialed numbers for mobile subscriber U are printed on the teletypewriter. NPA is the subscriber's area code.
VS (CR) L (CR)	Variable statistics. L = 1 to 24. Statistics are gathered for the number of hours indicated, then automatically printed on the teletypewriter. L = Ø. Statistics are gathered hourly. Printout must be manually requested using the PS (CR) command.
MC (CR) N (CR) NNNNNN (CR)	Magnetic tape identification. N = 1 or 2, depending upon which magnetic tape unit is selected. NNNNNN is up to a 6 digit ID number for the tape.
BA (CR) C1, C2 ... E (CR)	Activate all channels busy. C1, C2 ... are the channel numbers. E is the terminating character. All specified channels are put in a busy condition.
BR (CR) C1, C2 E (CR)	Deactivate all channels busy. Format is the same as for BA command. All specified channels are returned to active service.

7.0 MAGNETIC TAPE OUTPUT

All channel usage statistics, call records, time records, plant statistics, call billing data and tape transfer records are collected in computer format on magnetic tape.

When computer tapes are changed, tape records are used to preface and end a tape. If the tape change is made manually, where the operator commands the CPU to switch the tapes, the ending format will appear. If the CPU switches automatically due to a fault in one magnetic tape recorder, the trailer will not appear, but the header will appear on the backup tape recorder. These headers and trailers include:

1. Time and date
2. Tape identification
3. Record counts
4. Tape transport record

See Table 7.0-I for standard Transfer In Label tape format.

See Table 7.0-II for standard Transfer Out Label tape format.

Hourly channel usage statistics include:

1. Time data
2. Attempted calls
3. Completed calls
4. Usage time

See Table 7.0-III for standard Channel Usage Statistics tape format.

Call record statistics include:

1. Mobile number
2. Land number (ON MOBILE-TO-LAND CALLS)
3. Time data
4. Radio channel used
5. Call class indicator

See Table 7.0-IV for standard Call Record tape format.

See Table 7.0-V for standard Call Class Indicators.

Time change and control records are used when there is a change in computer processor clock. The statistics include:

1 Old date and time

2 New date and time

3 Current date and time

4 Processor used

See Table 7.0-VI for standard Time Change Record tape format.

See Table 7.0-VII for standard Time Control tape format.

Plant **Statistics** or TTY Communications are a record of all commands entered through the TTY. The record includes:

1 Current time

2 Alpha/numeric inputs

See Table 7.0-VIII for standard Plant Statistics or TTY **Communications** tape format.

TABLE 7.0-I. TRANSFER IN (HEADER) LABEL FORMAT

Field Name	Position From	Position To	No. of Pos.	Contents and/or Remarks
Start of Entry	1	2	2	Constant - Hex 'CC' -1100 1100
Single Entry ID	3	3	1	Constant - Hex '1' - 0001
Format Modifier	4	5	2	
Filler	6	6	1	Constant - Hex 'B' - 1011
Start Month	7	8	2	Month Tens and Units Digits
Start Day	9	10	2	Day Tens and Units Digits
Office Recording Type	11	12	2	Tens and Units Digits
Tape Identification No.	13	18	6	6 Numerics
Start Hour	19	20	2	Hour Tens and Units Digits
Start Minute	21	22	2	Minute Tens and Units Digits
In Record Count	23	30	8	8 Numerics
In Block Count	31	35	5	5 Numerics
Tape Transport Number	36	36	1	Numeric 1 or 2
CPU Program Issue	37	40	4	4 Numerics

TABLE 7.0-II. TRANSFER OUT (TRAILER) LABEL FORMAT

Field Name	Position From	Position To	No. of Pos.	Contents and/or Remarks
Start of Entry	1	2	2	Constant - Hex 'CD'-1100 1101
Single Entry ID	3	3	1	Constant - Hex '1' - 0001
Format Modifier	4	5	2	Constant 2 Digit BCD
Filler	6	6	1	Constant - Hex 'B' - 1011
End Month	7	8	2	Month Tens and Units Digits
End Day	9	10	2	Day Tens and Units Digits
Office Recording Type	11	12	2	Tens and Units Digits
Tape Identification No.	13	18	6	6 Numerics
End Hour	19	20	2	Hours Tens and Units Digits
End Minute	21	22	2	Minute Tens and Units Digits
Out Record Count	23	30	8	8 Numerics
Out Block Count	31	35	5	5 Numerics
Tape Transport Number	36	36	1	Numeric 1 or 2
CPU Program Issue	37	40	4	4 Numerics

TABLE 7.0-III. CHANNEL USAGE STATISTICS FORMAT

Field Name	Position From	Position To	No. of Pos.	Contents and/or Remarks
Start of Entry	1	2	2	Constant - Hex 'CA'-1100 1010
Current Month	3	4	2	Month Tens and Units Digits
Current Day	5	6	2	Day Tens and Units Digits
Current Hour	7	8	2	Hour Tens and Units Digits - See Note 1
Usage - Minutes	9	12	4	Minutes Tens and Units Digits
Call Attempts (L-M)	13	16	4	Four digits (current hour only)
Calls Completed (L-M)	17	20	4	Four digits (current hour only)
Call Attempts (M-L)	21	24	4	Four digits (current hour only)
Calls Completed (M-L)	25	28	4	Four digits (current hour only)
Operator Handled Calls See Note 2	29	32	4	Four digits per channel group (current hour only)
Circuit Attempts, All channels busy Note 2	33	36	4	Four digits per channel group (current hour only)
Radio Channel Trunk No.	37	38	2	Two Digit BCD
Filler	39	56	18	Constant HEX 'B's

NOTE 1: If the usage involved is from 0800 through 0859, the current hour to be shown is 08.

2: These items are calculated on a per channel group (area) basis.

TABLE 7.0-IV. CALL RECORD FORMAT

Field Name	Position From	Position To	No. of Pos.	Contents and/or Remarks
Start of Entry	1	1	1	Constant - Hex 'C' - 1100
Mobile Number	2	8	7	NPA and Line Number
Land Number	9	18	10	NPA, NNX, Line Number
Month-Land/Radio Answered	19	20	2	Month Tens and Units Digits
Day-Land/Radio Answered	21	22	2	Day Tens and Units Digits
Radio Channel Seizure Time	23	28	6	Hour, Minutes and Seconds
Radio Channel Disconnect Time	29	34	6	Hour, Minutes and Seconds
Land or Radio Party Answer Time	35	40	6	Hour, Minutes and Seconds
Land Party Disconnect Time	41	46	6	Hour, Minutes and Seconds
Call Class Indicator	47	48	2	See Table 7.0-V
Radio Channel Trunk Number	49	50	2	Two Digit BCD
CO, Mobile Service Operator or DDD Trunk Number	51	52	2	Two Digit BCD
Filler	53	56	4	Hex 'BBBB'

TABLE 7.0-V. CALL CLASS INDICATORS

01	Home mobile number is in the positive file. Roam mobile number is not in the negative file. Called Party Answer Time is recorded.	Billable Message
02	Home mobile number is not in the positive or the negative files.	Disconnect or wrong number announcement
03	Home mobile number is not in the positive file and is in the negative file. Foreign mobile number is in the negative file.	Cannot be served announcement
04	No DDD or Mobile Service Operator Trunk available.	Reorder Tone
05	No Radio Party Disconnect Signal.	Permanent Signal Billable Message
06	Call attempted by mobile number same as one busy on another channel.	Cannot be served announcement
07	Mobile number does not acknowledge.	Cannot be reached announcement
08	Mobile number acknowledges but does not answer.	Cannot be reached announcement
09	Mobile number busy.	Busy Tone
10	All channels busy. Broadcast queue full.	Reorder Tone
11	Mobile carrier lost for more than 15 seconds or any abnormal failures.	Billable message
12	Operator handled by Mobile Service Operator.	Route to Mobile Service Operator
13	Central Office start dial not received in 15 seconds.	Reorder
14	Digits dialed by mobile unit timed out	Reorder Tone
15	Digits from the CO or Mobile Service Operator trunk timed out or were not in the proper form.	Reorder Tone
16	Invalid or incomplete ANI or invalid dialed digits received from the mobile unit.	Reorder Tone
17	Called party does not answer (busy, complete to announcement, does not answer).	Disconnect when mobile unit goes on hook.
18	Audio from mobile lost for 2.25 min.	Billable message

TABLE 7.0-VI. TIME CHANGE RECORD FORMAT

Field Name	Position From	Position To	No. of Pos.	Contents and/or Remarks
Start of Entry	1	2	2	Constant - Hex 'CF'-1100 1111
OITD	3	8	6	Office Tape Identity
Changed to Month	9	10	2	Month - Tens and Units Digits
Changed to Day	11	12	2	Day - Tens and Units Digits
Changed to Year	13	14	2	Year - Last 2 Digits
Changed to Hour	15	16	2	Hour - Tens and Units Digits
Changed to Minutes	17	18	2	Minutes - Tens and Units Digits
Changed to Seconds	19	20	2	Seconds - Tens and Units Digits
Changed from Month	21	22	2	Month - Tens and Units Digits
Changed from Day	23	24	2	Day - Tens and Units Digits
Changed from Year	25	26	2	Year - Last 2 Digits
Changed from Hour	27	28	2	Hour - Tens and Units Digits
Changed from Minutes	29	30	2	Minute - Tens and Units Digits
Changed from Seconds	31	32	2	Seconds - Tens and Units Digits
Time Change Indicator	33	33	1	0 = Time Change Only 1 = Date Change Only 2 = Time and Date Change
Central Processing Unit	34	34	1	1 = Processor Unit #1 2 = Processor Unit #2
Filler	35	56	22	Filler Hex 'B's

TABLE 7.0-VII. TIME CONTROL FORMAT

Field Name	Position		No. of Pos.	Contents and/or Remarks
	From	To		
Start of Entry	1	2	2	Constant - Hex 'DA'-1101 1010
OTID	3	8	6	Office Tape Identity
Current Month	9	10	2	Month Tens and Units Digits
Current Day	11	12	2	Day Tens and Units Digits
Current Hour	13	14	2	Hour Tens and Units Digits
Current Minutes	15	16	2	Minute Tens and Units Digits
Current Seconds	17	18	2	Second Tens and Units Digits
Central Processing Unit	19	19	1	1 = Processor 1 2 = Processor 2
Current Record Count	20	27	8	8 Digit Numeric
Current Block Count	28	32	5	5 Digit Numeric
Filler	33	56	24	Filler - Hex "B"s

TABLE 7.0-VIII. PLANT STATISTICS OR TTY COMMUNICATIONS FORMAT

Field Name	Position From	Position To	No. of Pos.	Contents and/or Remarks
Start of Entry	1	2	2	Constant Hex 'DF' 1101 1111
Current Month	3	4	2	Month Tens and Units Digits
Current Day	5	6	2	Day Tens and Units Digits
Current Hour	7	8	2	Hour Tens and Units Digits
Current Minute	9	10	2	Minutes Tens and Units Digits
Continuation Character	11	12	2	00 = Not last record of a command 01 = Last record of a command
Message Text	13	NN	NN	Alpha or numeric characters
Last Position		56		

8.0 MAINTENANCE INTERFACE

Diagnostic tests are performed automatically by the processor of the Control Terminal. The tests are run periodically at time intervals depending upon the criticality of the circuits under test. Table 8.0-I provides a typical list of the tests showing the device tested, the alarm level and the test intervals.

In addition to lamps indicating faults, and a printout of the occurrence on the TTY (by fault class number), three sets of relay transfer contacts having a current-carrying capability of 5 amperes at 115 VAC are provided for each major and minor alarm to operate remote indicators in the Central Office.

9.0 VOICE ANNOUNCEMENT RECORDER UNIT AUDIO INPUT INTERFACE

Recording of messages is accomplished either through the use of a standard telephone handset or a cassette playback unit. The latter may be useful when the ambient noise level at the Voice Announcement Recorder Unit is too high to permit a good recording with a handset.

The sensitivity level for the input to the record amplifier from a 900-ohm telephone handset is -26 dBm. The average volume when speaking into a telephone handset provides the proper recording level. The proper level is preset by adjusting a gain control for a VU meter reading of about 0 VU. Output signal leads from the handset are at the tip and ring contacts of the phone plug.

The output from the earphone jack of a battery-operated cassette playback unit can provide for a full-level recording using an adapter cable matching a cassette mini-jack on one end and a standard 2-conductor phone jack (Switchcraft part number 40DK05) at the other end. The record level is preset by adjusting the gain level as described for the telephone handset above.

Additional specifications for the Voice Announcement Recorder Unit are as follows: Frequency response: ± 3 dB, 300 to 3200 Hz; message length: 12 seconds; capacity: 3 message channels; SNR: 40 dB; output impedance: 8 ohms; output power: 0.5 W usable power capable of driving 150 600-ohm or 225, 900-ohm trunk lines with appropriate transient protection resistors in each line; primary power requirement: -44 to -56 VDC, 55 W maximum; temperature: 0°F to 140°F (-17.8°C to 60°C); humidity: 10 percent to 95 percent relative humidity (noncondensing); size: 12-1/4 x 19 x 9 inches (311 x 483 x 229 mm).

TABLE 8.0-I. PROCESSOR CONTROLLED DIAGNOSTIC SUMMARY

DIAGNOSTIC MESSAGE PRINTOUT FORMAT

FXXX 06-21-74 083845 172
M D Y H M S

MESSAGE	DESCRIPTION	CARD OR CHASSIS	MAJOR ALARM OR MINOR ALARM	HOW OFTEN TEST CONDUCTED
Failure Class Date Time Date				
F 000 F 010, to F 070	Audio Matrix Module failure	AMM	Minor	Once per hour
F 001 F 011, to F 071	Audio Matrix controller failure	ASX	Minor	Once per hour
F 063	Even Bus Diagnostic failure	ADC	Minor	Once per hour
F 065	Even Central Timer failure	ACS/ACT	Minor	Once per second
N 065	Even Central Timer	ACT/ACS	Minor	Real time
F 067	Even Real Time Clock failure	ACK	Minor	Once every 30 seconds
F 071	System Diagnostic failure	ASD	Minor	Once per hour
F 073	Odd Bus Diagnostic failure	ADC	Minor	Once per hour
F 075	Odd Central Timer failure	ACS/ACT	Minor	Once per second
N 075	Odd Central Timer	ACT/ACS	Minor	Real time
F 077	Odd Real Time Clock failure	ACK	Minor	Real time
F 100 to F 277	Trunk Interface failure	ATI, ATO	Minor	Once per day
F 300 to F 377	Radio Channel Interface failure	AIC, AIK	Minor	Once per hour
B 300 to B 377	Bandit Call Attempt on Channel		Minor	Real time
N 300 to N 377	No Station ID on Channel in last 20 minutes		Minor	Once each 20 minutes
D 300 to D 377	Foreign Carrier detected		Minor	Real time
R 300 to R 377	Foreign Carrier removed		Minor	Real time
F 401	CP1 Processor failure		Minor (if both)	Once per hour
F 402	CP2 Processor failure		Minor (Major)	Once per hour
F 405	System Diagnostic failure	ASD	Minor	Real time
F 410 to F 417	Core Memory failure On-Line Processor		Minor	Once per hour
F 420 to F 427	Core Memory failure Off-Line Proc.		Minor	Once per hour
F 450	Auxiliary Rack Power Supply failure	ADU	Minor	Once per second
F 451	CPU1 Rack Power Supply failure	ADU	Minor	Once per second
F 452	CPU2 Rack Power Supply failure	ADU	Minor	Once per second
F 453	Control and Interface Power Supply failure	APS	Minor	Once per second

TABLE 8.0-I. PROCESSOR CONTROLLED DIAGNOSTIC SUMMARY

MESSAGE	DESCRIPTION	CARD OR CHASSIS	MAJOR ALARM OR MINOR ALARM	HOW OFTEN TEST CONDUCTED
F 454	Magnetic Tape Power	ADU	Minor	Once per second
F 455	Odd Time-of-Day Clock Battery failure	ASD	Minor	Once per second
F 456	Even Time-of-Day Clock Battery failure	ASD	Minor	Once per second
F 461	Zone ID failure, CPU1		Minor	Real time
F 462	Zone ID failure, CPU2		Minor	Real time
F 470	Drum Announcer - no motion		Minor	Once every 20 minutes
F 471	System turned off		Minor	Real time
F 472	Software Program Counter		Minor	Real time
F 474	Processor Hardware failure		Minor	Real time
F 475	CPU Addressing and time out error		Minor	Real time
F 476	CPU Reserved Instruction Trap		Minor	Real time
F 477	CPU Switchover		Minor	Real time
F 501	Tape #1 Off-Line		Minor	Real time
F 502	Tape #2 Off-Line		Minor	Real time
F 511	Tape #1 missing Write Enable Ring		Minor	Real time
F 512	Tape #2 missing Write Enable Ring		Minor	Real time
F 521	Tape #1 not at BOT		Minor	Real time
F 522	Tape #2 not at BOT		Minor	Real time
F 531	Tape #1 Block Count Warning		Minor	Real time
F 532	Tape #2 Block Count Warning		Minor	Real time
F 541	Tape #1 End of Tape		Minor	Real time
F 542	Tape #2 End of Tape		Minor	Real time
F 551	Tape #1 Tape Drive failure		Minor	Real time
F 552	Tape #2 Tape Drive failure		Minor	Real time
F 560	Man/machine command to tape, cannot be executed or already done		Minor	Real time
F 571	Magnetic Tape Controller #1 not acceptable		Minor	Real time
F 572	Magnetic Tape Controller #2 not acceptable		Minor	Real time
F 577	Degauss Check failure (optional)		Minor	Real time
F 600	Interprocessor Check Sum Error		Minor	Real time
F 601	Interprocessor Channel failure		Minor	Real time
F 602	Cartridge Error		Minor	Real time

TABLE 8.0-I. PROCESSOR CONTROLLED DIAGNOSTIC SUMMARY

MESSAGE	DESCRIPTION	CARD OR CHASSIS	MAJOR ALRAM OR MINOR ALARM	HOW OFTEN TEST CONDUCTED
F 603	Interprocessor Channel Timer expired		Minor	Real time
F 604	Channel Transfer reinitiated		Minor	Real time
S XXX	Card Address		Minor	Once per hou

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