

DATA SET 105C
USED ON PRIVATE SERVICE SYSTEMS
SWITCHING SYSTEM NO. 307
DESCRIPTION AND OPERATION

1. GENERAL

1.01 This section contains a general description and operating principles of the data set 105C and associated equipment. It does not include information concerning the teletypewriter (TTY) equipment or line circuit.

1.02 Illustrations used in this section are development models and may differ from production models. These differences will be corrected in later issues of this section.

1.03 The purpose of this equipment is to provide a means for connecting two teletypewriter-voice stations through the

4-wire switching system and to provide means for conversion between the dc teletypewriter signals and the voice frequency carrier signals transmitted over the lines.

2. DESCRIPTION

2.01 In addition to the data set 105C, the station equipment consists of a modified 100 speed, 8-level M35 ASR teletypewriter (TTY), a telephone handset, an attendant circuit, and a line circuit. The data set 105C, telephone, attendant circuit, and line circuit are all built into the TTY cabinet. (See Fig. 1.) Calls between two 105C stations are made by connecting directly the two stations via the 4-wire switching network.

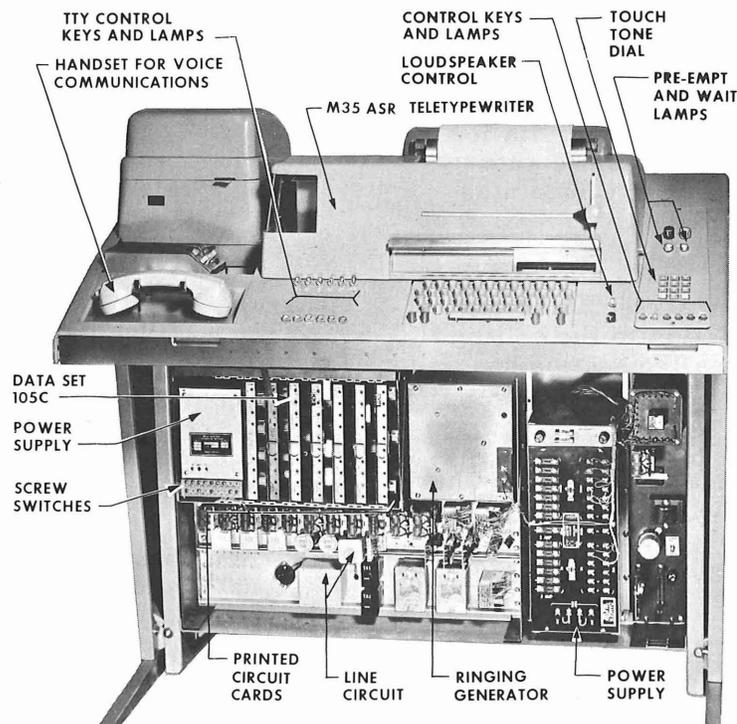


Fig. 1 - M35ASR Teletypewriter with Data Set 105C and Associated Equipment

2.02 The station equipment has a dual function:

(a) The teletypewriters produce and utilize signals on a dc basis. A translation to ac is necessary before the signals are put on a telephone line and at the distant terminal a shift back to dc is required for the operation of the receiving teletypewriter. The station equipment performs these dc to ac and ac to dc translations.

(b) The station equipment in addition to its data translation functions must also provide the standard telephone functions accomplished by HCV telephone sets on the switched network.

2.03 Additional functions of the station equipment provide a means for:

- The interconnection of two teletypewriter stations through the 4-wire network in conjunction with a TTY attendant circuit.
- Monitoring of information tones during the connecting sequence by means of a loudspeaker.
- Conversion between the dc signals of the teletypewriter and the ac signals required by the telephone plant.
- Enabling the teletypewriter station to answer incoming TTY calls automatically and to receive incoming messages without the intervention of an attendant.
- An automatic multi-character answer-back as an indication to the calling station that the called station has been reached and is ready to receive a message.
- Avoiding the printing of random characters due to teletypewriter turn-on and shut-down procedures or due to line noise during the connecting or disconnecting sequence.
- Optional half duplex or full duplex transmission, as required.

- Either station to break transmission from the other station and to provide a lamp indication that a break signal has been received, in addition to the usual blocking of transmission.
- When sending to a low-speed station, to provide a lamp indication when the storage capacity of the central office data converter is nearly filled; and if sending is not slowed at this time, to provide means for blocking transmission.
- Rapidly disconnecting either station from the other stations without causing the printing of "hit" characters.
- Preventing a station from being permanently held busy after the calling station has disconnected.
- The automatic disconnection of both stations in the event of a circuit failure.
- Putting the set into a "don't answer" mode by external switches, such as the teletypewriter "paper low" switch.
- Making or holding the set busy by external switches.
- Proper outputs for activating the mode switching circuit of the teletypewriter.
- Under key control, a local mode to enable the attendant to practice on the teletypewriter.
- Under key control, for maintenance purposes, a test mode in which carrier signals received from a test center are demodulated to dc signals, looped to the modulator input, remodulated, and then transmitted back to the test center.
- In addition to the TTY mode, an alternate voice mode of operation.
- The attendant to switch between the TTY and VOICE modes at any time.

- When the data set is in the VOICE mode, adequate side-tone between the handset transmitter and receiver.
- An audible and visual indication that the station has been pre-empted by a call of higher precedence.

Regenerating received data.

KEYS AND LAMPS

2.04 The attendant circuit includes the following keys and associated lamps which will appear on the dial faceplate. An arrangement for these keys and lamps is shown in Fig. 1.

2.05 VOICE (nonlocking): Operated by an attendant

- (a) To originate a call in the VOICE mode
- (b) To switch to the VOICE mode when reaching an intercept operator
- (c) To switch to the VOICE mode if the called station answers in the VOICE mode.

Operation of the VOICE key at an originating station should place the telephone handset on line; the data set should be placed off line in the originating mode. After the data portion of a call has begun, the VOICE key will be disabled since an accidental operation of the VOICE key would result in a disconnect due to loss of carrier. The VOICE lamp should light the key enclosure during the time when the station is in the VOICE mode.

2.06 DATA (nonlocking): Operated by an attendant

- (a) To originate a call in the DATA mode
- (b) To switch from the VOICE mode to the DATA mode.

Operation of the DATA key at an originating station should place the data set on line in the originating mode. Operation of the key at an answering station (done only on transferring from the VOICE mode to the DATA mode) should place the data set on line in the answering mode. The DATA lamp should

light the key enclosure during the time when the station is in the DATA mode.

2.07 OFF (nonlocking): Operated by the attendant to release all other locking keys and to put the station on-hook. The OFF lamp should light the key enclosure during the disconnect sequence, whether the station is disconnected manually or automatically. When loss of carrier has been detected, the lamp should light the key enclosure until the station goes on-hook automatically. When a pre-empt signal has been indicated, the OFF lamp should light the key enclosure until the station is manually put on-hook.

2.08 ANS (nonlocking): Operated by the attendant to answer manually incoming calls when the station is in the local condition or in a low-paper condition. Operation of the ANS key should put the data set online in the answering mode. The ANS key should be disabled after the connection has been established. When the ANS key is depressed, or on a call which is answered automatically, both the DATA and ANS lamps should light. The ANS lamp should remain lit during the entire call.

2.09 LOCAL (locking): If this key is operated by the attendant while the station is on-hook, the local condition should prevail. This condition permits the teletypewriter select magnet driver to be driven from the keyboard for practice or maintenance. The lamp should light the key enclosure while the key is depressed. The key may be released and the lamp extinguished either by

- (a) Depressing the ANS key when ringing indicates an incoming call, or
- (b) Depressing the OFF key which will return the station to normal idle condition.

When the LOCAL key is operated by the attendant while the station is off-hook, the dc output of the demodulator should be connected to the modulator input for test purposes. The lamp should light the key enclosure and remain lit until the OFF key is operated, which should return the station to normal.

2.10 OUT OF SERVICE (locking): Operated by the attendant to present a don't answer (DA) condition to the terminal switch. Operation of the key should disable the ringer and turn the motor off. While the station is in the out-of-service condition, a lamp should light the key enclosure. The key should remain depressed and the lamp should remain lit until the condition is released by operation of the OFF key.

2.11 TRANSMISSION INTERRUPT AND RESTORE key (nonlocking): Operated by the attendant to unblind the data set signal input previously blinded by the receipt of a break signal. A lamp associated with the key should light when a break signal is received and remain lit until the restore key is depressed.

2.12 In addition at full-duplex stations, the TRANSMISSION INTERRUPT AND RESTORE key will essentially make the station half-duplex while it is depressed. This provision is necessary so that the ALT MODE-V transfer sequence generated at the keyboard may reach the stuntbox of the station initiating the transfer.

2.13 LOOP-BACK KEY AND LAMP (nonlocking): By operating the Loop-Back key, the incoming line is looped back into the outgoing line within the line circuit. This is needed for line testing from the central office.

2.14 BUZ-RLS (nonlocking): Operated to release the buzzer on paper-low and paper-out alarms. A lamp associated with the alarm should light the key at all times when the buzzer is activated.

2.15 WAIT (lamp): A high intensity WAIT lamp should light to indicate that data should not be sent from the teletypewriter. The lamp should be lit under the following conditions:

- (a) When a restraint signal is received from a 4-to-3 row converter used in transmission to 3-row TWX stations on the DDD switching plan or from an ADTL during testing.
- (b) During intervals when the data set is in the DATA mode, but is completing handshaking sequences. This is espe-

cially needed on the transfer from the VOICE mode to the DATA mode since answer-back is not sent.

- (c) At all times when the station is in the VOICE mode.

2.16 PRE-EMPT (lamp): The PRE-EMPT lamp should light when an indication is received from the line circuit that a pre-empt signal has been detected. Depressing the OFF key should extinguish the lamp and put the station on-hook.

AUDIBLE ALARMS

2.17 There should be two audible alarms in the attendant circuit. The buzzer should be activated to call the attendant's attention to a condition of the station itself; the ringer should sound to indicate certain signals received on the line.

2.18 The buzzer should sound when the teletypewriter

- (a) Indicates a low-paper condition, or
- (b) Indicates paper-out.

2.19 The BUZ-RLS key should release the buzzer in both conditions.

2.20 The ringer should be activated under the following conditions:

- (a) Normal interrupted ringing should be activated when the answering station times out on an incoming voice call and automatically transfers to the VOICE mode. The ringer should be released when the handset is lifted.
- (b) Normal interrupted ringing should be activated when a station detects an ALT MODE-V control sequence and transfers to the VOICE mode. The ringer should be released when the handset is lifted.
- (c) Normal interrupted ringing should be activated when an incoming call is received. The ringer should be released when the station goes off-hook.
- (d) Continuous ringing should be activated when a pre-empt signal is

detected. The ringer should be released by depressing the OFF key.

2.21 The first two ringing conditions above are under data set control. Interrupted ringing current will be supplied by the line circuit. The last two ringing conditions are under control of the line circuit and ringing is supplied on the regular ringing pair.

DIALING

2.22 The attendant set at all 100-wpm stations includes a TOUCH-TONE dial including 12 keys; 10 keys to be used for the digits 0 through 9 (no letters required), an asterisk key to be used for repertory dialing, and a special grade key to be used if communication with other networks is desirable. An optional arrangement includes four precedence keys in addition to the 12 keys specified above. The precedence keys, in addition to generating TOUCH-TONE frequencies provide dc contact closures to the line circuit.

3. OPERATION

3.01 The following description applies to the operation of a Data Set 105C in conjunction with its associated TTY, telephone, attendant, and line circuits.

ORIGINATING (DATA MODE)

3.02 To initiate a DATA call, the attendant operates a pushbutton labeled DATA on the attendant circuit. Operation of this pushbutton turns on the TTY motor and presents an off-hook signal to the line circuit which in turn presents an off-hook signal to the central office to which the station is connected. The switching equipment will return dial tone just as in the case of a normal telephone call. The attendant circuit has a loudspeaker so that dial tone can be heard. Upon reception of the dial tone, the attendant dials the number of the station to be reached (called the answering station). Dialing these digits causes the switching network to perform in the same manner as if this were an ordinary telephone call. The central office equipment is arranged to recognize whether or not the called station is another 4-row station. If this is the case, the connection

will be established directly. If, on the other hand, the called number is a 3-row station, the call is routed via a data converter. The originating attendant is able to monitor the progress of the call by listening to audible tones from the loudspeaker.

3.03 Most successful attempts to reach the answering station will be answered automatically at the first ring so that the ringback tone may not be heard by the originator. If there is a delay in answering, ringback tone will be heard. If all trunks are busy or the called station is busy, tones that signify such conditions will be heard. The call is then reoriginated at some suitable time as in regular telephone practice.

ORIGINATING (VOICE MODE)

3.04 To initiate a voice call, the attendant lifts the telephone receiver and then operates the pushbutton on the attendant circuit labeled VOICE. Operation of this pushbutton turns on the TTY motor and presents an off-hook signal to the line circuit which in turn presents an off-hook signal to the central office to which the station is connected. The switching equipment will return dial tone which will be heard by the attendant in the telephone receiver. Upon reception of the dial tone, the attendant dials the number of the station to be reached. The network then completes the call in the normal manner.

ANSWERING

3.05 When a station which is ready to accept a call is rung, it will automatically answer by turning on its TTY motor and by going off-hook. This will cause the answering station to send an off-hook signal to the line circuit and in turn to the serving central office and trip ringing as in a regular telephone call. This off-hook signal is sent back to the originating office for charge record purposes, precisely as if it were a regular telephone call.

3.06 If the TTY of the called station is not ready to accept a call or if the LOCAL key in the attendant circuit is depressed, the automatic answering device is disabled but the ringer of the attendant circuit will

sound. This "don't answer" condition is controlled by contacts in the 105C circuit.

3.07 It is possible to override the "don't answer" condition at a station by depressing the ANS (answer) key of its attendant circuit. It is also possible to put the station in an out-of-service condition, by depressing the OUT OF SERVICE key. When the station is in this condition, it will not answer and the ringer will not ring.

CONNECTING (GENERAL)

3.08 Each station has a frequency shift transmitter and a frequency shift receiver which will be used to transmit and receive the teletypewriter information. Each transmitter and each receiver is able to switch to either of two frequency bands. The particular band selected depends on whether the station is originating or answering a call. Thus, two frequency shift channels are available. The lower frequency band will be denoted as the f_1 band. In this band the frequencies corresponding to mark and space signals are: f_{1m} mark (f_{1m}), 1270 cps; f_{1s} space (f_{1s}), 1070 cps. The upper frequency band will be denoted as the f_2 band. In this band the frequencies corresponding to mark and space signals are: f_{2m} mark (f_{2m}), 2225 cps; f_{2s} space (f_{2s}), 2025 cps. During data transmission one of these frequency channels is used on one pair of the 4-wire telephone lines and the other frequency channel is used on the other pair. The marks and spaces from the TTY are transmitted by means of these frequency shift tones. During the setup of the call neither transmitter is sending signal energy. Tones corresponding to the f_1 and f_2 data channels are turned on at appropriate times following the off-hook signal of the terminating station.

3.09 When the answering station goes off-hook, a timing interval of approximately 1.4 seconds is generated. During this interval no tone is transmitted from the answering station. This interval is called the single frequency (SF) guard interval. It is required to guarantee the propagation of the off-hook signal from the answering to the originating office. Certain

single frequency signaling circuits in the toll line connection require this no-tone condition for proper operation. Following this single frequency guard interval, the answering station transmits f_{2m} , (2225 cps), causing any echo suppressors in the toll path to disable. Echo suppressors which are encountered when the station is switched to a 2-wire network, are arranged so that they are disabled upon receipt of a steady tone in the band from 200 to 2300 cps. This allows transmission in both directions simultaneously over the toll circuits.

CONNECTING (ORIGINATING STATION IN TTY MODE)

3.10 Frequency f_{2m} from the answering station is received by the demodulator at the originating station, which is tuned to receive on the f_2 band. It recognizes f_{2m} , but takes no action until f_{2m} persists for about one-half second. This mark timing interval is provided to allow sufficient time for the echo suppressors to be disabled and also to guard against signal imitation by noise. After this mark timing interval, the originating station connects the demodulator output through to the TTY receiver. The originating station then sends f_{1m} , which proceeds to the answering station, where the demodulator is tuned to the f_1 channel. Frequency f_{1m} is received and timed at the answering station. At the expiration of about one-quarter second, the demodulator is connected through to the TTY receiver. The data set at the answering station then triggers a device in the TTY which sends an answer-back by generating one or more selected characters. Operation of either the TTY keyboard or the tape transmitter will cause the sending contacts to modulate one of the data transmission channels. The answering station attendant will respond by means of characters typed on the TTY keyboard or by tape transmission.

3.11 Note that there has been an interchange between the originating and answering stations using f_{2m} and f_{1m} . It is important that neither teletypewriter should be connected to the receiving end output of the data channel prior to solid application of

the correct data transmission frequency from the transmitter at the opposite end. If the TTY selector magnet driver were connected to the output of the demodulator during the setup of the call, the TTY would print random characters due to line noise, or would run open. This would be unsatisfactory from a service standpoint.

3.12 Thus, when the teletypewriters are in communication, data transmission from the originating station to the answering station uses the f_1 channel, and transmission from the answering station to the originating station is over the f_2 channel.

These are frequency shift channels with a ± 100 cps swing, which is sufficient to support data transmission at a speed of 200 bits per second. Speeds considerably lower than this are presently used; however, capacity has been built into the data set to allow higher speeds of transmission to meet future requirements. The teletypewriters are connected together by means of two separate one-way channels on the transmission lines, either or both of which can be modulated at any given time. Thus, it is possible to obtain full duplex operation, although half duplex operation is normally used, and the data set will usually be provided with this option. With half duplex operation only one of the frequency shift channels can be used at a given time, and the channel in the opposite direction will normally be continuously marking.

3.13 After the two teletypewriters are connected through the data sets to the line, conversation proceeds by TTY keyboard or tape transmitter.

CONNECTING (ORIGINATING STATION IN VOICE MODE)

3.14 Frequency f_{2m} from the answering station is received by the demodulator at the originating station. The originating station being in the voice mode does not send f_{1m} but remains off-hook. The answering station continues to send f_{2m} for a period of 5 seconds while monitoring for f_{1m} . At the end of the 5-second period, the answering station, not having received

f_{1m} , switches into the voice mode. The answering station then begins interrupted ringing until the attendant lifts the telephone set. The voice communication between the two stations proceeds in the normal manner.

3.15 The connection of a 105C station originating in the voice mode and a standard telephone subscriber proceeds in the same manner as the connection of two standard telephone subscribers. There is no exchange of marking or spacing frequencies involved in such a connection.

TRANSFER BETWEEN THE DATA AND VOICE MODES

3.16 Before connection with another station, the attendant at an originating station may switch between the data and voice modes by pressing the appropriate pushbutton on the attendant set. After connection, the attendants at their respective stations may transfer from the voice mode to the data mode by pressing the DATA pushbutton on their attendant sets. The transfer from the data to the voice mode is initiated at either station by pressing the alternate mode key and then the V key on the TTY. This simultaneously energizes a stunt box in the TTYs at both the originating and answering stations. The stunt box closes a contact which initiates the transfer to voice sequence in the data set. The stunt box method of switching the stations into the voice mode is necessary to assure simultaneous transfer by both stations. Because no carrier is sent in the voice mode, both stations must be transferred simultaneously to prevent disconnection by one of the stations due to an apparent carrier fail.

TRANSMISSION INTERRUPT

3.17 Either station can interrupt the transmission from the connected station by depressing the TRANSMISSION INTERRUPT key on the TTY. This causes the transmission of a spacing signal of a fixed duration, regardless of the length of time the key is depressed. This interval, about 200 milliseconds, is chosen to be long enough to enable the other end to identify the signal as a transmission

interrupt and not a TTY character, and is chosen to be sufficiently short not to cause a disconnection.

3.18 At the receiving station, the transmission interrupt signal is electronically detected, which results in lighting the TRANSMISSION INTERRUPT lamp in the attendant circuit, the short circuiting of the transmitting contacts, and the opening of the clutch magnet circuit. In addition, the mode switching circuit (if provided) in the TTY will be activated.

3.19 To restore to normal, the TRANSMISSION RESTORE key in the attendant circuit is depressed momentarily.

RESTRAINING

3.20 The restrainer is provided to enable the station to communicate with the slower TWX stations via data converters. The restrainer is activated by the data converter in the central office to stop transmission from the station whenever the character storage device at the converter is nearly filled. The restrainer, when activated, stops any transmitter distributor at the station (if equipped) and lights the WAIT lamp as an indication for the typist to stop typing or to slow down. The transmitter distributor is restarted and the lamp extinguished upon cessation of the restrainer activating signal from the data converter. If transmission from the station does not stop, resulting in an overflow of the storage device, the data converter sends a transmission interrupt signal, followed by a restraint signal. In this case, both the WAIT and TRANSMISSION INTERRUPT lamps will remain lit and transmission from the station will be stopped. In this way, this transmission interrupt signal is distinguished from a transmission interrupt sent by the connected station, which lights the TRANSMISSION INTERRUPT lamp only.

DISCONNECTING

3.21 Either of the two connected stations can initiate a disconnect sequence. The normal method consists of transmission of the EOT (end of transmission) TTY character. This causes a contact in each stunt box of the sending and receiving TTY to close. Each station then times an inter-

val of about 40 milliseconds during which it sends its marking frequency, after which the station restores to its normal on-hook condition. The timed marking interval prevents a hit character from being printed at the other end due to the possible stagger in operating times of the circuits.

3.22 An alternate way to disconnect consists of the depression of the OFF key at either station. The station will then transmit a 3/4-second burst of spacing carrier to the distant station. (Frequency f_{1s} will be sent from an originating station; f_{2s} will be sent from an answering station.)

After sending this spacing signal, the station having its OFF key operated will disconnect from the line and revert to its normal on-hook condition. This 3/4-second clearing signal is recognized at the distant station as a request to disconnect at that end also. If a spacing signal is received for more than 500 milliseconds, the station will assume that this is a request to disconnect and will proceed to initiate its own clearing sequence just as if an attendant had operated the OFF key locally. This automatic disconnect on a spacing signal and the transmission of space as a clearing signal allows a station to be disconnected from either end or from both ends of the connection.

3.23 The station is normally arranged to disconnect when meeting a variety of abnormal line conditions. If the transmission line goes open, thereby removing the carrier, a carrier fail detector circuit will initiate the clearing sequence and both stations will disconnect.

PRE-EMPT

3.24 The station is provided with circuitry which will allow it to recognize its being pre-empted. If the station is using a given line and that line is seized by the central office for a call or higher precedence, the station will indicate the condition by continuous ringing and lighting the OFF and PRE-EMPT lamps. The attendant then returns the station to the idle condition by momentarily pressing the OFF key.

3.25 In the event that the higher precedence call is for the station which was just pre-empted, the station will answer the call in the normal manner, once it has been released from the pre-empt condition by the attendant.