TELEPHOTOGRAPHY

GENERAL DESCRIPTIVE INFORMATION

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1. GENERAL

1.01 This section describes facsimile (telephotography) transmission and gives a brief description of facsimile systems. Detailed information for the design of facsimile circuits is found in Section 880-410-100 and associated sections.

1.02 This section is reissued to update and expand the definitions of certain transmission parameters in Part 4, particularly phase jitter. Part 6, "Facility Selection," has been revised to include much more detail concerning the selection of the best available facilities for telephoto transmission. Since this is a general revision, change arrows are not used.

1.03 Section 314-728-502 describes the initial and periodic tests required on facsimile circuits (4002 channels and 4002 channels with special conditioning). These tests, in many cases, may be used to verify and locate troubles as described in this section.

1.04 Facsimile (voice-grade) service is the process or result of the process by which fixed graphic material such as charts, circuit diagrams, maps and handwritten or typewritten copy is converted to signals which are used either locally or remotely to produce in record form a likeness (facsimile) of the subject copy.

1.05 Telephoto is one form of facsimile transmission. Telephoto equipment supplies copy at the receiving end by exposing areas on light sensitive film or paper. A photographic process of developing and fixing is required before the copy can be used. "Facsimile" (or "direct recording") machines on the other hand provide direct-copy by using a chemically treated or a carbon-backed paper and a marking stylus which converts impulses of electric current to marks on the paper. In general, direct-copy machines can be used to best advantage with written or printed material where only black and white are to be transmitted; telephoto systems will more faithfully reproduce a gray scale and are capable of better definition.

1.06 Specially engineered channels are required to transmit telephoto signals. These channels are derived from existing voice-grade circuits. The characteristics of normal voice facilities will not necessarily give satisfactory results on telephoto transmission even though the frequency bandpass requirements are similar. Envelope delay distortion, noise, intermodulation and harmonic distortion, amplifier gain stability, crosstalk, and echo limitations are much more severe for telephoto transmission.

2. SCANNING AND RECORDING PROCESS

2.01 In telephoto reproduction, variations in density from black through shades of gray to white of very small picture elements (about 0.0001 square inch in area) are converted sequentially to variations in the amplitude of an electrical current by a scanning process. These variations of current are transmitted to the recording device. The reduction of the original picture to elemental areas and the conversion into electrical current variations is accomplished by machines designed for this purpose. Telephoto receiving machines reconstruct the picture from the electrical current variations. This is done by exposing a photographic film, element by element, to a light beam which is intensity modulated according to the information received from the transmitting machine.

2.02 Figure 1 is a simplified sketch showing one typical electro-mechanical scanning method. A photograph or other "copy" is wrapped around a cylinder, face up and with no overlap of picture edges. The cylinder is rotated by an electric motor. A rectangular spot of white light is focused on the face of the covered cylinder illuminating a small portion of the picture. This small area determines the size of the transmitted picture element. The light reflected from the picture element is picked up by a photocell which produces an electrical current proportional to the average light intensity received from the picture element. Within the picture element the photocell can not distinguish variations in light intensity but operates on the average illumination in the element. The light source and photocell are usually combined in one housing called a scanning head.

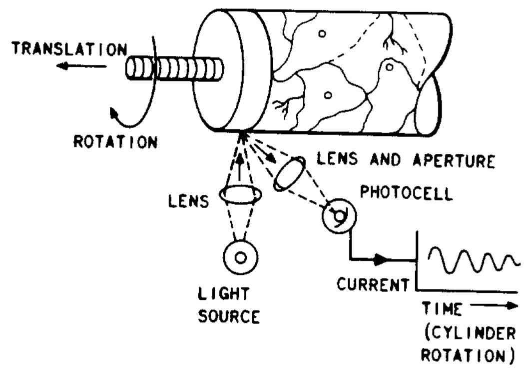

Fig. 1—Scanning

2.03 As the cylinder is rotated, the spot of light traces out a line about 0.01 inch wide around the cylinder. At the same time, the cylinder is translated along its axis continuously so that for each revolution it moves the width of one scanning line. In this manner the spot of light traces out a helix which, after a sufficient number of cylinder revolutions, covers the entire picture area. The output of the photocell is a current which varies with the average intensity of the light reflected from the succession of picture elements. This varying current contains all of the information developed by the scanning process.

2.04 At the receiving terminal the process is reversed. As shown in Fig. 2, a light source is focused on a cylinder covered with a light sensitive film or paper. Current from the transmitting end is made to vary the intensity of the spot of light. As the cylinder rotates and moves along its axis, the light-sensitive sheet on the cylinder is progressively exposed by the helix of light traced on its face. In this manner the picture information contained in the varying current is reproduced on the light-sensitive sheet at the receiving terminal. A photographic process of developing and fixing is required before the exposed film is ready for use in making photo prints.

2.05 Accurate reproduction at the receiving terminal is accomplished only when the recording cylinder exposes each line on the sensitized

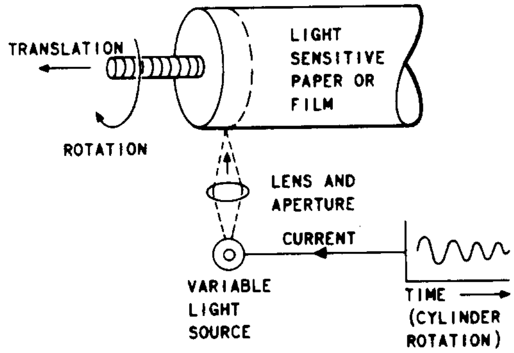

Fig. 2—Recording

sheet in exact correspondence with the position of the scanned line on the transmitted copy. This requires the speeds of both cylinders to be in synchronism and the cylinders to be so positioned that the copy is centered on the recording medium. This last consideration is referred to as proper phasing. Fig. 3A shows typical received copy with a properly operating recorder. Fig. 3B shows the effect of poor speed synchronization. This shows the successive line displacement or "skew," resulting from a small difference in speed between the transmitting and receiving cylinders. A large difference in speeds would cause separation of the pattern into an unrecognizable line structure. Fig. 3C shows the effect of incorrect phasing where the recording cylinder is one-half a revolution behind or ahead of the transmitter. The dark line in the center is produced when the copy holding mechanism or "clamp bar" is under the transmitter scanning head.

2.06 The precise speed control required is frequently accomplished through use of a fork or crystal oscillator and power supply at each terminal which controls the cylinder drive motor in the equipment. Proper phasing is accomplished in a variety of ways and is somewhat different for each make of machine. However, the signal on which the phasing control depends is similar in almost all current makes of machines.

2.07 In order to obtain correct phasing, the recording terminal must receive an indication from the transmitting terminal as to the position of the scanning cylinder. One way of providing such an indication is to send an electrical signal which corresponds to a particular location on the transmitting cylinder. For example, the part of the transmitting cylinder which contains the clamp bar for holding the picture tight against the surface contains no picture information and the time used to scan that area is available for generating a phasing signal. Such a signal might be generated by a switch which would be operated each time the cylinder rotates or by having the scanning head generate a voltage pulse as it scans a distinctive

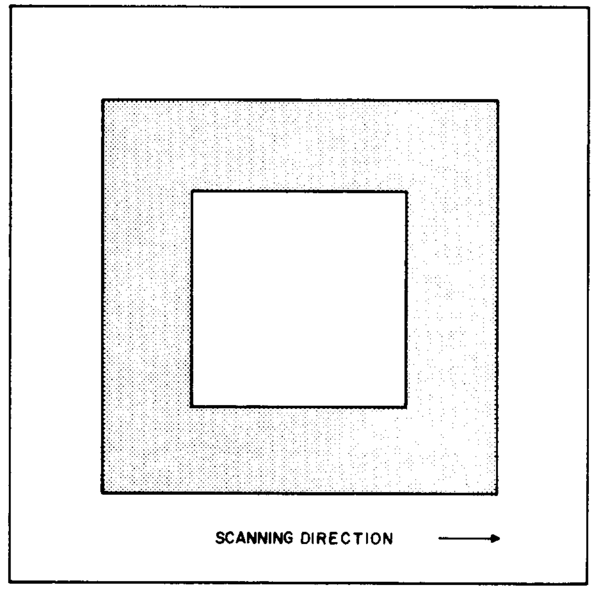

Fig. 3A—Properly Received Copy

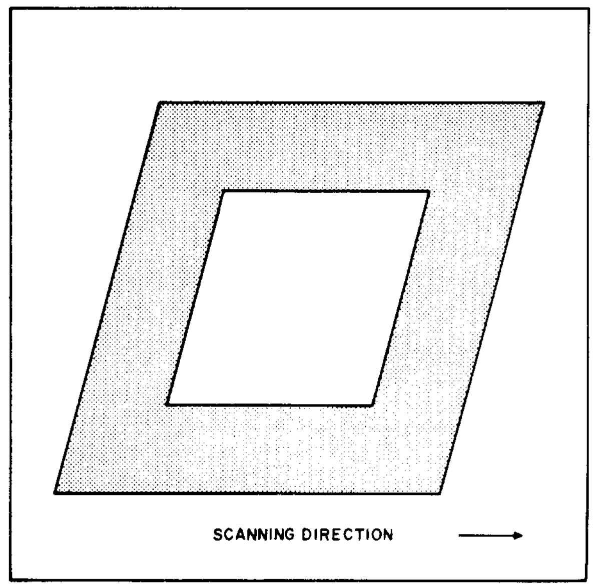

Fig. 3B—Effect of Skew

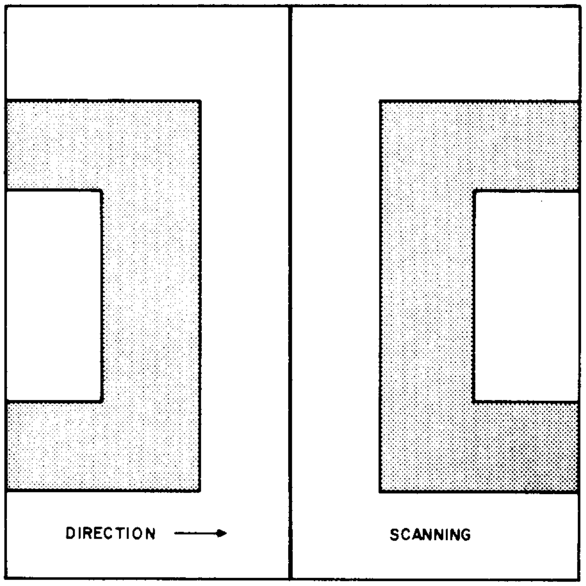

Fig. 3C—Effect of 180° Phasing Error

stripe painted on the transmitting cylinder (see Fig. 3C). The resulting electrical signal can be used at the receiving terminals to synchronize the receiving machines with the transmitter.

2.08 The currents generated in the scanning process possess all the information that is to be transmitted to the remote locations. As long as these currents maintain their relative magnitudes and time relationships, the information they carry may be detected and used. However, changes in the character of the current comprising the telephoto signal will impair the quality of the received picture.

2.09 The reproduction quality of a telephoto scanning system is limited by its ability to resolve closely spaced variations of picture density. This is usually expressed as horizontal and vertical resolution in lines per inch of scanned material. Horizontal resolution is usually defined parallel to the direction of scanning. Vertical resolution is taken perpendicular to the direction of scanning.

2.10 Figure 4A represents the current generated by a telephoto pickup head as it scans a set of closely spaced black and white lines running perpendicular to the scanning direction. For this special case it is assumed that the width of the scanning aperture is very small, much smaller than the width of any line. The resultant photocell current is shown having variations which correspond exactly with the changes between black and white. Shades of gray would provide current excursions lying between the black and white values shown.

2.11 As a practical matter the scanning aperture must have some width. Fig. 4B shows the current generated by a pickup head having an aperture width of the same order of magnitude as black line Number 2. It is necessary to recall that the photocell current at any time is proportional to the average illumination and that variations within the area of the scanning spot will not register. Note that there is no sharp change in current marking the transition between the black and white

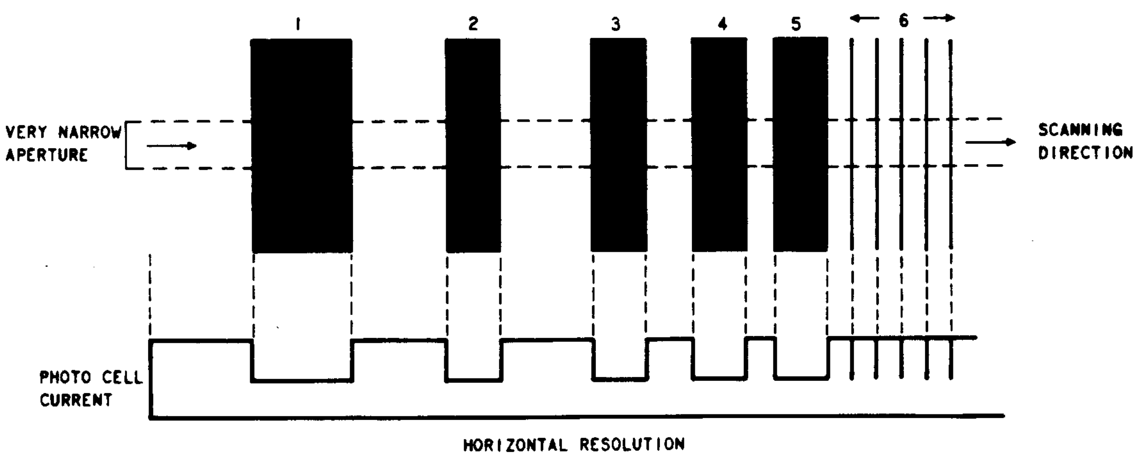

Fig. 4A—Very Narrow Aperture

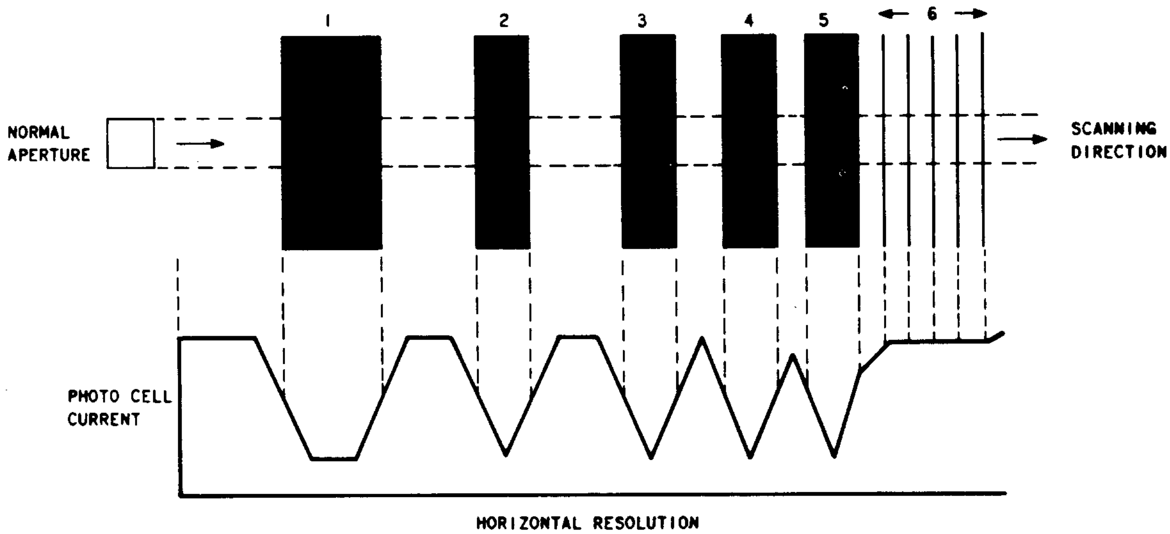

Fig. 4B—Normal Aperture

lines. Rather, there are gradual transitions indicated by the sloping sides of the current waveform. On the reproduced copy these will show up as gray edges on each side of the black lines. In effect this reduces the sharpness of the lines. When the line width approaches that shown for black lines 3 and 4, the line structure on the reproduced copy, as shown by the photocell current, is reduced to a variation in gray shading between black and white with almost no totally black or totally white areas. This particular situation, where the spot and line width are exactly equal, can be considered a limiting case. When the white lines are less than the slot width and the black lines are as shown by lines 4 and 5, the reproduced copy contains fuzzy black lines separated by gray areas. When the lines are as indicated by 6 in Fig. 4B, the scanning spot does not detect the individual lines and they are entirely lost. The conclusion is that horizontal resolution is limited by the width of the scanning aperture.

2.12 If the limiting case, where the aperture width is equal to the line width, is taken as a point of reference, the horizontal resolution in lines per inch equals $\frac{1}{\text{width of aperture, inches}}$

For an aperture width of 0.01 inches the horizontal resolution would be $\frac{1}{0.01}$ = 100 lines/in. (50 black and 50 white lines/in.).

2.13 In discussing vertical resolution a similar approach is followed. Fig. 5A shows a set of black and white lines running parallel to the direction of scanning. The thickness of the lines is made equal to the height of the scanning aperture, as a limiting case, for the first six scanning lines. If the aperture is so positioned that it lines up as shown in Fig. 5A, the reproduced copy would look just like the first six lines of the original. Scanning lines 7 and 8 would reproduce as gray areas with no line structure. If, however, the scanning lines were positioned as shown in Fig. 5B, the reproduced copy would have no line structure at all since the aperture would be scanning one-half a black line and one-half a white line. This would result in one gray shade for lines 1 through 5 and another lighter gray shade for lines 6 through 8. In order to be certain of having at least one completely white line it is necessary that the aperture height be only one-half the white line thickness. To be certain of having one all black line, it is also necessary that the aperture height be only one-half the black line thickness. This indicates that line separation in the vertical direction may be accomplished with an increasing degree of certainty as the aperture height is reduced from one to one-half of the minimum desired line thickness. Experimental evidence based upon judgment tests indicates that, for practical vertical resolution, this ratio should be approximately 0.7. This can be expressed as:

$$\text{vertical resolution, lines per inch} = \frac{0.7}{\text{aperture height, inches}}$$

For an aperture height of .01 inches the vertical resolution would be $\frac{0.7}{0.01}$ = 70 lines/inch.

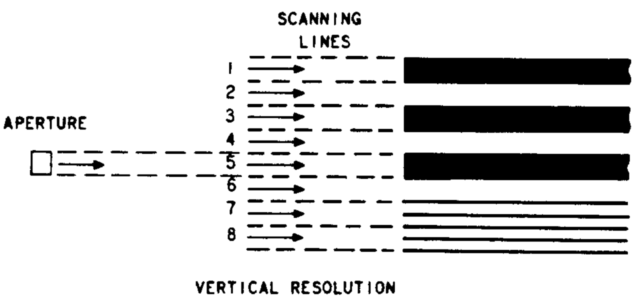

Fig. 5A—Aperture Lined Up With Limiting Scanning Lines

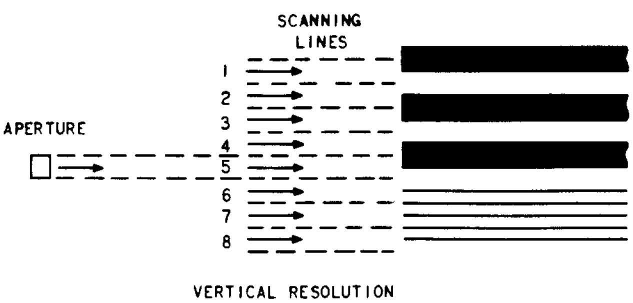

Fig. 5B—Aperture Not Lined Up With Limiting Scanning Lines

2.14 The reproduction at the receiving terminal should possess the same width to height relationship, or aspect ratio, as the transmitted picture. In order to accomplish this, the transmit and receive machines must have two like characteristics: the drum must rotate at the same rate and the index of cooperation should be the same. The index of cooperation may be expressed as:

index of cooperation = DN

where D = diameter of drum in inches

N = number of scanning lines per inch

With the advent of flat bed scanning machines and continuous feed recorders, the drum diameter has no real meaning since in these machines there is no drum. An index of cooperation may then be given by πDN where πD represents the effective drum circumference or total scanning line length.

Therefore, it can be concluded that the reproduced picture at the receiving terminal may be of a different over-all size than the transmitted picture and still retain the same aspect ratio provided that the drums rotate at the same rate and that the index of cooperation is the same.

3. TELEPHOTO SIGNAL TRANSMISSION

3.01 The output of the scanning photocell is a current which varies in magnitude with the average illumination. This current is equivalent to a nonvarying direct current plus a large number of alternating currents having a wide range of frequencies. Assuming a horizontal resolution of 100 picture elements per inch and a scanning speed over the circumference of the cylinder of 20 inches per second, the number of elements scanned in one second is 100 × 20 = 2000. This is equivalent to 2000 picture elements per second (the maximum number of variations of signal per second). A 2000 element-per-second signal of the telephoto type requires a minimum usable bandwidth of 2000/2 = 1000 Hz for satisfactory transmission. Thus, at the very least, this telephoto signal should pass all frequencies between zero and 1000 Hz. For any telephoto system the picture element or bit rate may be computed from the following formula:

$B = SN$

where B = bits per second
N = horizontal resolution lines per inch
S = scanning speed

$$\text{inches per second} = \frac{RC}{60}$$

R = speed of cylinder, rpm
C = circumference of cylinders inches

The actual bandwidth required for satisfactory transmission of a given bit rate depends in large measure upon the type of transmission system used, and the limits imposed on distortion. The bandwidth taken as one-half the bit rate is the minimum bandwidth for an ideal system. Actual bandwidth requirements are somewhat in excess of that computed in this manner.

3.02 The need to pass all frequencies from zero to somewhere around 1000 Hz, the telephoto "base band," would put impossible requirements on the use of regular telephone facilities. At the lower frequencies, up to about 200 Hz, the normal telephone circuit components provide too great a loss and too large a phase shift for satisfactory picture transmission. Baseband transmission could be accomplished over limited distances, but the resultant costs would be prohibitive. The alternative has been the use of a modulated carrier whereby the required passband is moved upward from the lower end of the voiceband to those frequencies between 1000 and 2800 Hz per second. This system has proved to be quite successful and the most economical in adapting the telephoto signal for transmission over telephone channels. Most commercial telephoto machines that use message telephone and/or private line facilities now provide an amplitude- modulated carrier signal for transmission.

3.03 The carrier frequency for the machines of any particular telephoto transmission system is based on the required bit rate or minimum bandwidth requirement. The carrier frequency should be twice the bandwidth required or greater. This could also be stated as follows: the carrier frequency should always be equal to or greater than the bit rate. An overlap of the lower sideband and the unmodulated signal will result if the carrier frequency is less than twice the required bandwidth. Fig. 6A shows a carrier frequency which is not twice the bandwidth and the resulting overlap of 500 to 1000 Hz. Fig. 6B shows a carrier frequency which is twice the bandwidth; no overlap occurs. An overlap such as that indicated in Fig. 6A would result in two different picture elements being transmitted in the 500- to 1000-Hz band and would register in a receive picture as "fuzzy" borders on all transitions of black to white, or white to black, commonly called "Kendall Effect." Most commercial telephoto machines that use message telephone and/or private line facilities utilize a carrier frequency which is in the neighborhood of 2000 Hz.

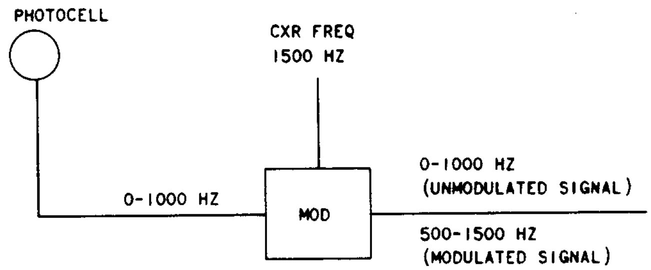

Fig. 6A—Improper Carrier Frequency

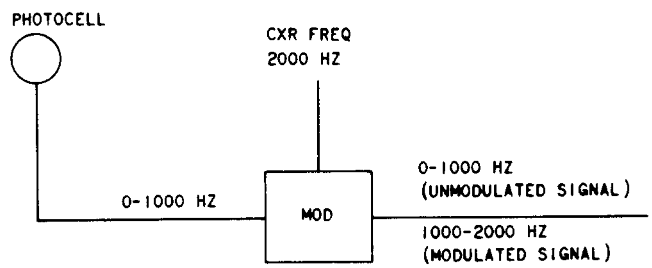

Fig. 6B—Proper Carrier Frequency

3.04 As stated in 3.02, the frequencies between 1000 and 2800 Hz per second are transmitted over the message telephone or private line facilities. The type of transmission, whether single sideband, single sideband plus vestigial sideband, or double sideband, is determined by the commercial telephoto machine manufacturer based on this bandwidth limitation.

3.05 Ideally, the transmission line or facility between a transmit machine and a receive machine should simulate a short length of wire connecting the machines as if placed "back-to-back" at the same location. When telephone facilities are used in a fully coordinated telephoto transmission system, characteristics such as loss-frequency, gain-frequency, level stability, delay, echo, and noise must be considered and corrective steps taken as required to enable satisfactory transmission. The following paragraphs discuss in a general way the above-mentioned characteristics and corrective steps taken in actual practice.

3.06 When a picture is scanned, the carrier amplitude is varied at the rate that the photocell current is varied. Fig. 7 shows a carrier frequency level which results in a system arranged for 30-dB contrast when material such as that shown is scanned. It can be seen that the shades from black to white are represented in the carrier frequency level as amplitude changes. In a system such as that shown in Fig. 7, maximum carrier level represents white scanned material, minimum carrier level represents black scanned material, and carrier levels between minimum and maximum represent the various shades of gray. The minimum and maximum conditions are reversed in some systems, ie, maximum carrier level represents black scanned material and minimum carrier level represents white scanned material. This is of no consequence if all machines in a particular system are arranged alike. The contrast range, or "wedge," varies from 8 dB to 32 dB in various systems, depending on the degree of shading required.

4. TRANSMISSION CONSIDERATIONS

A. Circuit Net Loss

4.01 The circuit net loss is generally defined as the net loss from any send point to any receive point. These levels are indicated on the circuit layout cards. Requirements and allowable deviations are specified in Section 880-410-100 and associated sections and Plant Section 314-728-502. Circuit design should be such that minimum signal level will be above noise level.

B. Net Loss Variations

4.02 The level of a transmission system used for telephoto signals must remain stable. Level changes cause the signals to reach the receiver at a level different from that transmitted and result in different shades of gray in the reproduced picture. In telephoto systems that use the photographic process, a level change in the order of 0.25 dB can be detected in a reproduced picture. Level changes that affect telephoto signals can be classified as ***short-term*** and ***long-term*** changes. Sections 880-410-101, 880-410-102 and 314-728-502 specify the maximum deviation limits permitted for both short-term and long-term net loss variations.

Short Term Variations

4.03 The short-term level changes are those changes which occur during the time required to scan and transmit a complete picture. Short-term net loss variations may be attributed to variations in the dynamic regulation of repeaters and carrier systems; to changes in net loss that occur as a result of switching or alternate routes; and in some cases, to changes resulting from maintenance routine.

4.04 Short-term level changes can be noticed in portions of a particular reproduced (received) picture sometimes as small as a part of one horizontal scanning line or they may be in groups of scanning lines. Some of the more common short-term level changes are known as hits, gain-hits, opens, loss-of-carrier, streaks, bars, and simply level changes. The facilities used in a fully coordinated telephoto transmission system are equipped with such devices as regulating repeater lockup circuits operated by tone-lockup (TONLOC) and tone-operated control circuit (TOCC). TONLOC is an acronym derived from the words tone and lockup and defines equipment used primarily to fix the gain of the regulators at a constant value during picture transmission.

4.05 Upon recognition of tone or telephoto signals the TOCC terminates the opposite direction of transmission. The result is a reduction in noise and echo that might otherwise cause impairment to the picture signal. The TOCC may also be used (in a different application) to lock the gain of cable regulators to a constant value upon recognition of tone or telephoto signals. In this application, the TOCC prevents gain changes (stepping) in the regulators that might otherwise occur during picture transmission. The TOCC may be used in this application to replace TONLOC equipment on existing circuits. It is recommended that all TONLOC equipment be replaced with TOCCs, where practical, and that all new circuits be designed using TOCCs. Section 314-715-104 covers TOCC equipment.

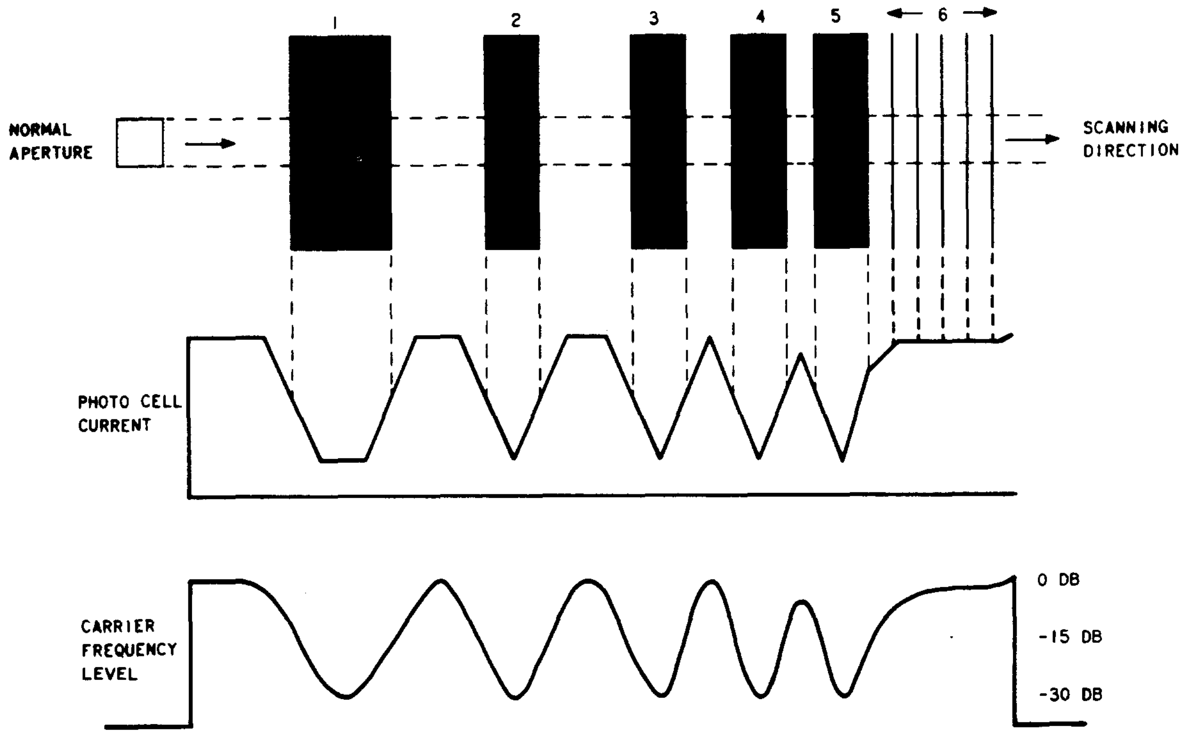

Fig. 7—Carrier Frequency Level

4.06 The 71A1 level compensator is used with A-type channel banks to reduce the line level variation that might otherwise impair the picture signal. The compensator functions on changes in level that occur during transmission of a line pilot signal inserted at the sending end. The compensator will maintain the output of the receiving terminal constant within ±0.2 dB for level changes of up to ±5.0 dB in the transmission path. Careful consideration must be given in the use of 71A1 level compensators. Some picture impairment may occur as a result of increased delay distortion caused by the filters in the circuit. The circuit is also vulnerable to beating of the compensator pilot frequencies caused by crosstalk coupling in the two directions of transmission. Section 880-410-103 covers the engineering considerations.

Long-Term Variations

4.07 Long-term net loss variations occur as a result of daily and seasonal temperature changes and as result of the accumulative changes in system alignment over long periods (misalignment).

C. Signal Level

4.08 The signal level is defined as maximum facsimile (telephoto) RMS signal power (dBm) measured at any test point in a facsimile system. For the system shown in Fig. 7, maximum power would be measured when transmitting an all-white picture segment. Requirements for circuit design and level requirements are specified in Section 880-410-100 and associated sections. Signal level with reference to a zero transmission level point (TLP) should be indicated on the circuit layout record (CLR). It has been determined that signals with powers in excess of −13 dBm at a 0 TLP, when combined on a random power basis, can cause overloading of broadband carrier facilities. Normally, signal levels are limited to this level in voiceband channels. Because it is not feasible to limit some operations to this level at the present time, type 4002 channels are temporarily exempt from this requirement. For press networks that are designed to operate at higher levels, pad switching for the two modes of transmission (facsimile or telephone) is accomplished at customer premises.

D. Frequency Response

4.09 Frequency response, sometimes referred to as slope, attenuation distortion, or attenuation/frequency distortion, is the departure from uniform response of a circuit referenced to 1000 Hz within a given frequency band.

4.10 The amplitude characteristics in the 1000- to 2800-Hz band is of primary importance if the received picture is to contain a faithful reproduction of gray scale contained in the transmitted picture. For instance, in Fig. 7, assume that the scanning from bar 4 to bar 5 causes a 2000-Hz-per-second carrier to be modulated at the rate of 800 Hz and bars 4 and 5 cause a 30-dB decrease in carrier level. A composite signal containing 1200 Hz (2000-Hz carrier minus 800 Hz) would appear on the transmission facilities and would be detected at the receiving terminal for reproduction. If the frequency response of the transmission facilities was not uniform and this signal was affected so that it was received 20 dB below maximum level instead of 30 dB below as it left the transmitting terminal, the reproduced bars would be a shade of gray instead of black. Therefore, it can be concluded that, if the message telephone and private line facilities are to allow the transmission of good quality telephoto signals, the frequency response characteristic in the 1000- to 2800-Hz band must be uniform. In practice, the private line facilities which are leased for telephoto transmission are equipped with adjustable frequency and gain equalizers and equalizing repeaters to provide a transmission system which has uniform loss-frequency characteristics. Frequency-response objectives are given in Section 314-728-502.

E. Envelope Delay Distortion (EDD)

4.11 For successful telephoto transmission, the various frequencies contained in a composite telephoto signal should reach the receive terminal in the same time relationship to one another as when they were transmitted. If changes in the time relationships of the various frequencies do occur in transmission, delay distortion will be present in the reproductions. For instance, assume that a picture is being scanned and transmitted, and it contains detail which, when scanned, results in 1200 Hz being followed 500 μs later by 2400 Hz on the line facilities. If the 2400 Hz reached the receiving terminal at a greater or lesser time than 500 μs behind the 1200 Hz, the detail contained by 2400 Hz would be in a different position on the received picture than in the picture transmitted.

4.12 In telephoto transmission, it has been established that the allowable delay distortion is about the length of one picture element (bit). In any telephoto system, the horizontal resolutions and speed of scanning determine the bits per second, and the time for one bit would be expressed in microseconds by dividing the bits per second into 1,000,000. For instance, in a system which produces 2000 bits per second, the length of one bit would be 500 microseconds. From this it can be seen that the telephone facilities used in a fully coordinated telephoto system must not cause excess delay distortion, or picture impairment will result. In practice, delay equalizers are provided in necessary circuit locations to meet the delay distortion requirements of a particular system.

4.13 A detailed discussion of envelope delay is given in Section 880-100-100. Envelope delay is measured by means of the 25-type voiceband gain and delay measuring set described in Section 103-115-100. The EDD requirements for telephoto and facsimile services are given in Sections 880-410-101, 880-410-102 and 314-728-502. General engineering information for EDD is covered in Section 880-410-100.

F. Noise

Message Circuit Noise

4.14 Telephoto transmissions are very susceptible to interference, especially interference which is in the region of 1000 Hz to 2800 Hz. The types of interference most commonly encountered are random noise, such as electron tube noise, static, and ordinary line noise. Interference will register in the received copy according to its magnitude and the wedge (gray scale) used in a particular system. In other words, the signal-to-noise ratio governs the amount of deterioration that interference will cause in a received picture. For instance, if a system uses a 30-dB wedge, the random noise will not cause interference if it is 45 dB or more below maximum picture tone. Noise generally appears as streaks or snow in a received picture.

Impulse Noise

4.15 The same standards applied for message circuits are considered adequate for facsimile circuits. Generally speaking, impulse noise is not as destructive of analogue facsimile signals as it is of digital data signals.

Single-Frequency Interference

4.16 Another form of noise is a foreign tone or single frequency (SF). This type noise may be due to singing repeaters, crosstalk or cross-modulation involving SF signaling tones. If sufficient in level, it will modulate with picture carrier and appear in the picture as a pattern overriding picture information. The more common type patterns are known as beat, bar, herringbone and wood-grain.

4.17 The single-frequency interference can be determined by analyzing the received copy and using the following formula:

$$f = N \times S$$

where f = frequency
N = number of bars occurring in one linear inch as measured along a scanning line
S = linear scanning speed in inches per second

4.18 Tone-operated control circuits are used at certain bridging and switching points to prevent noise buildup. Engineering instructions outline the application of the TOCC equipment.

G. Return Loss

4.19 Telephoto transmission systems which are arranged for 2-way operation (4-wire circuits) are subject to ***return loss*** or ***echo problems.*** Echo in reproduced copy appears as duplicate images of the picture components. Echo is a result of portions of the original signal being returned and combining with the original signal. The returned signal energy is displaced in time as compared with the original signal and, therefore, is registered in a displaced position on the reproduced copy. Echo resembles delay distortion in received copy.

4.20 A return loss less than 40 dB will register as an echo in received copy. Since one 4-wire bridge causes from 75 to 80 dB of return loss, additional bridges added to the circuit will reduce the figure to the vicinity of 50 dB. Any other fault can easily cause the return loss to be less than 40 dB. Improper or missing terminations, impedance mismatches, monitoring apparatus connected to a circuit improperly, and improper levels may cause poor return loss. In practice, the private line facilities, leased for telephoto multipoint operation, are equipped with TOCCs at necessary circuit locations to reduce return currents.

H. Frequency Shift

4.21 A frequency shift may exist on carrier systems operated in a single sideband suppressed carrier mode. This shift is the result of the difference in frequency between the injection of carrier at the modulator and injection of carrier at the demodulator. Frequency shift is not a serious problem for most facsimile (telephoto) applications.

I. Phase Jitter

4.22 Various sources cause the instantaneous phase, or zero crossings, of a signal to "jitter" at rates normally less than 300 Hz. This effect is primarily caused by a ripple in the dc power supply that appears in the master oscillator of long-haul carriers and that is often multiplexed through many stages. Some phase jitter also occurs in short-haul systems from incomplete filtering of carrier from one carrier repeater to another.

4.23 Distortion, quantizing noise, random noise, and single-tone interference can also cause an apparent increase in phase jitter. A detailed discussion of phase jitter can be found in Section 314-410-500.

J. Nonlinearity

Compression

4.24 Compression, in facsimile transmission, is the undesired decrease in the ratio of white to black amplitude of the picture signal resulting in a loss of contrast in the picture reception. Compression is generally noted in the white end of the white-to-black wedge. Loss of blacks is often mistakenly classed as a compression trouble when noise of sufficient level is present to deteriorate true black. It can be seen that compression will be more damaging to a system with a contrast range of 0 to 20 dB than to a system with a contrast range of 0 to 30 dB. A transmission test simulating the picture wedge can be made to ensure that the ratio of white to black is maintained.

Harmonic Distortion

4.25 Harmonic distortion is a form of nonlinear amplification creating a second and third harmonic of the fundamental. In telephoto transmission, it may not be troublesome since the present picture carriers are in the 2000-Hz region and their harmonics would be out of voice and picture bandwidth.

Intermodulation

4.26 Intermodulation, due to a nonlinear amplifier, may take the form of a frequency pattern in facsimile service. This pattern is generally due to a frequency out of the picture band modulating with the picture carrier. The interfering frequency may be determined by analyzing the received copy and using the following formula:

$$f = C \pm (N \times S)$$

where f = frequency
N = number of bars occurring in one linear inch as measured along a scanning line
S = linear scanning speed in inches per second
C = carrier frequency

4.27 The frequency of interference developed by this formula may be a product of modulation and not necessarily the frequency causing the basic trouble. For example, an interfering frequency of 120 Hz modulating with a 2000-Hz picture carrier may produce a pattern or modulating frequency of 1880 or 2120 Hz.

5. LAYOUT DEFINITIONS

5.01 Circuit layout definitions associated with design and operation of facsimile circuits and networks can be found in Part 12 of this section.

6. FACILITY SELECTION

6.01 Facilities for type 4002 basic and special-conditioned channels must be selected with care. The frequency response and noise characteristics of the facility are particularly important. Tables A through D below are guides for selecting facilities. The order in which a facility is listed does not indicate preference over another lower on the list.

TABLE A

ACCEPTABLE FACILITIES

Carrier

L, R (all types)	Note 1.
T, D1A bank	Notes 2, 3, 4, 5.
T, D1B bank	Notes 2, 3, 4.
T, D1D bank	Notes 2, 3.
T, D2 or D3 bank	Note 2.

Cable

Nonloaded	Premium facility for short lengths. Note 6.
B22, B44	Premium facility.
H44, B88	Remove SX or CX telegraph where present.
H88	Conditional. Note 7.

TABLE B

FACILITIES TO BE AVOIDED IF POSSIBLE

Carrier

N1	Note 8.
O, ON1, ON2	Notes 8, 9.
N2, N3	Note 10.

Cable

H88	Conditional. Note 7.

TABLE C

UNACCEPTABLE FACILITIES

Carrier

M, D, G

Cable

H-135 or heavier loading.

TABLE D

OLDER FACILITIES THAT MAY STILL BE IN USE

Carrier	
C2, 3, 4	Equip with 2B pilot channel. Notes 11, 12, 13.
C5	Notes 11, 12, 13.
H	Note 12. Use for one direction only.
J	Note 11.
K1	Avoid channels 1 and 12.
K1 line, K2 amps or terminals	Avoid channels 1 and 12. Notes 14, 15.
K2	Avoid channels 1 and 12. Notes 15, 16.
L, R on LMX-1 terminals w/o group regulation	Notes 1 and 15.
Wire	
Pilot-wire regulated cable units.	Note 17.
Open wire	Equip with 5-kHz carrier filters or none. Use noise filters.

Note 1: If the channel group in question is part of a direct supergroup or mastergroup, any channel is satisfactory. If not, and if group connectors may be present, avoid channels 1 and 12 on multilink services, and channels 1, 2, 11, and 12 on either (A) basic channels with more than three midlinks or (B) multilink special-conditioned channels.

Note 2: Acceptable for FM facsimile. Unacceptable for AM press telephoto—picture reception is degraded by a bar pattern.

Note 3: Close the "Y" and "Z" option screws on the carrier group alarm panel to keep short carrier hits from being converted into 20-second outages by the CGA timing. For more details, see 3.15 of Section 365-108-102.

Note 4: Use no more than two links in tandem. Verify that the transmitting gate network for the affected block of six channels is a 4019BD. Check that the compressor network for the affected block of 12 channels is a 4020AA.

Note 5: Close the "Y" option screw on the (E & M) channel unit if the signaling path is not being used.

Note 6: Nonloaded facilities are suitable when terminated in 150-ohm equalizers (359B or M). The following lengths will provide 1 dB of slope between 300 and 3200 Hz:

CABLE		LENGTH kf	LENGTH mi.
19DNB	(.066)	23	4.4
19CNB	(.084)	18	3.4
22BSA	(.082)	14	2.7
24DSM	(.084)	12	2.3
26BST	(.079)	10	1.9

Note 7: To avoid equalization problems, avoid short loops with only a single load. Smoothly-loaded cable will be satisfactory over distances of 20 miles or less for basic 4002 channels with not more than one midlink. For cases with more midlinks, special conditioning, or long end sections, it is necessary to use actual measurements, artificial line tests, or computer simulation to decide whether equalization is feasible.

Note 8: On AM press telephoto systems, the carrier system must be operated noncompandored to prevent distortion of levels. To do this, use special-service channel units. On N1, use enhanced-level lineup (BSPs 362-315-501 and -502). Noise limits cannot usually be met with noncompandored operation. On FM facsimile systems, compandored operation is satisfactory. However, on multimidlink or special-conditioned channels, do not use compandored-without-signaling channel units due to unpredictable delay distortion. Special-service channel units may be necessary to get better frequency response.

Note 9: If a message channel unit is used, check that it is equipped with a 529D or E filter for improved frequency response and reduced crosstalk into the twin channel.

Note 10: On AM press telephoto systems, the carrier system must be operated with VF amplifiers to prevent distortion of levels. Noise limits usually cannot be met in noncompandored operation. On FM facsimile, compandored operation is satisfactory.

Use the later-model channel modems for better frequency response. These are J99272BF or BY for N2 and J99300AY for N3.

Note 11: Equip line with drainage coils.

Note 12: Check for frequency shift.

Note 13: Equip other channels with volume limiters. Do not use for special-conditioned channels.

Note 14: Equip with dc on the V or T2 twist amplifiers and transmit group amplifier. Use J68784D receive group amplifier.

Note 15: For AM telephoto on a basic channel, use the 71A1 level compensator described in BSP 314-725-100.

Note 16: Where K2 carrier operates jointly with N1, N2, or ON2 carrier, 56-kHz pilot variations can occur due to crosstalk coupling. Where a basic channel for AM telephoto is assigned to a K2 channel, the 71A1 level compensator should be used. Otherwise the 56-kHz carrier of the N systems should be removed. On N1 or N2, this is done by replacing the Channel 11 modems with Channel 13. With ON2, the two channels sharing the 56-kHz carrier in Group 5 should be turned down and the carrier removed.

Note 17: Equip with TONLOC or TOCC regulator lockup equipment to prevent regular stepping (gain changes) during picture transmission. The TONLOC is described in BSP 314-715-101; the TOCC in 314-715-104.

7. SIGNALING

7.01 Circuit and network coordination for the Press Telephoto Networks are generally maintained on a loudspeaker monitor basis.

7.02 Single-frequency signaling should be avoided because false operation may occur when the scanning picture contains information at the SF frequency. Signaling is generally accomplished by inband methods using SF- or multifrequency-type signals. The type most commonly used for private line applications is single frequency, which employs a 2600 Hz tone. The SF units used have guard arrangements to prevent false operation due to spurious signals, but certain types of data or data patterns could cause false operation. Some general limitations to assure that the data signal will not adversely affect the SF unit are as follows:

(a) Energy must not be transmitted solely in the 2450- and 2750-Hz band.

(b) If energy exists in the 2450- and 2750-Hz band, it must be no greater than the simultaneous energy in the 800- to 2450-Hz band.

When signaling is required on an AM telephoto system operated at levels of 0 dBm0, it is necessary to use the latest-type SF units to protect against false operation. The E4B and F-type units have improved guard circuits. In troublesome cases on 0 dBm0 systems, the arrangements of Fig. 8 will give an extra 10 dB of protection against false rings.

7.03 A 1000-Hz interrupted signal is used in limited cases for audible visual indication. An additional use of the 1000-Hz interrupted signal is to reset and cycle certain customer facsimile receivers. To reset these type facsimile machines, a "shorting feature" is provided by operating a 20-Hz relay and obtaining a short from contacts of this relay. This short allows operation of a relay to reset and cycle the customer machine.

7.04 Customer network operations may necessitate splitting and switching operations at unattended offices. This operation is furnished with 2-tone or selective signaling (SS1) equipment.

8. CHANNEL TERMINATIONS

8.01 Standard 110A key terminating equipment, described in Section 314-732-100, is used to terminate the service at the customer premises in a 600-ohm impedance.

8.02 Normal functions, included as an integral part of the terminating equipment, are arrangements whereby the customer may:

(a) Receive picture transmission

(b) Originate picture transmission

(c) Monitor and record his own transmission when arranged for 4-wire operation

(d) Conduct telephone conversations with and signal any point on the network

(e) Conduct optional loudspeaker monitoring of network activities.

8.03 This equipment has 1C pads in the send, receive, and talk circuits to obtain proper operating levels.

8.04 Optional functions that can be obtained with standard 110A key terminating equipment are:

(a) Additional receive-only facsimile terminations at the same location

(b) Additional loudspeaker monitoring arrangements

(c) A split-switch arrangement to furnish a control channel to the central office for network splitting

(d) A test key to provide a loop back for maintenance purposes.

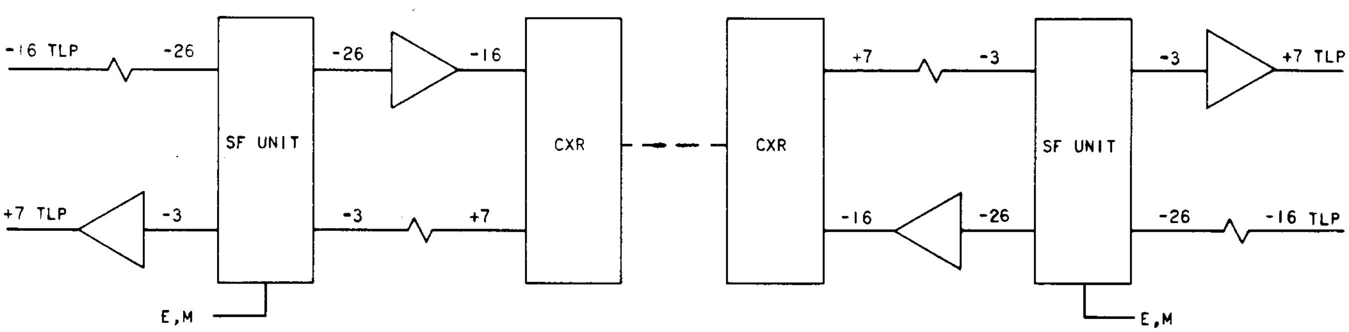

Fig. 8—Signaling Arrangement for Troublesome Cases On 0 dBm0 Systems

8.05 Portable-temporary 110A key equipment is available for quick-start service. This equipment contains the basic requirements of a send, receive, and talk station. It is also arranged for splitting and switching, as well as loud speaker monitoring. It has a test key to provide loop-back for maintenance purposes. It cannot be arranged for additional receive-only stations.

8.06 Testing procedures for local channels and station equipment may be found in BSP Sections 314-730-500 and 314-730-502.

9. CIRCUIT ARRANGEMENTS

9.01 In order to meet the requirements of various customers, several circuit arrangements have been developed. Circuits may be arranged as follows:

(a) Two-point one-way or 2-way (4-wire) service

(1) Simultaneous and nonsimultaneous

(2) Signaling if required

(b) Multipoint one-way or 2-way (4-wire) service

(1) Nonsimultaneous

(2) Receive-only or transmit-only legs on 2-way (4-wire) service if required

(3) Signaling if required

(4) Switching provisions for splitting the circuits in part or connecting two circuits, if required.

9.02 Two-way (4-wire) circuits may be arranged for talking. This enables the customer to use the circuit for talking when it is not in the facsimile mode.

9.03 Alternate telephone and/or telephoto and data channels may be required. Engineering practices must be followed to ensure that all 2-wire connections are removed during the telephoto mode of operation.

9.04 4002 channels may be provided as:

1. Two-point

2. Multipoint (no more than 4 midlinks).*

Network switching may result in exceeding the maximum permissible midlinks and hence the limits for the circuit. Care should be taken in network layout to prevent such an occurrence. Fig. 9 shows a typical multipoint layout.

*No more than 1 midlink is recommended for 4002 channels with special conditioning. See Section 880-410-102.

9.05 The switching together of circuits such as state networks to a backbone circuit may make meeting the midlink requirement impossible. If this condition exists, the customer should be advised that degraded transmission may result.

9.06 Specially conditioned 4002 facsimile channel requirements are available in the following circuit arrangements.

(a) Two-point: The controlling parameter is envelope delay distortion.

(b) Multipoint: Transmission via one midlink in tandem with two end-links will usually be feasible. Two and possibly three midlinks may be feasible in some cases but should not be attempted without specific transmission engineering review. More than three midlinks should not be considered. Fig. 10 is a typical multipoint configuration using the one midlink concept.

9.07 TOCC should be used on multipoint, nonsimultaneous circuits and networks as outlined in Section 880-410-100 and associated sections and Section 314-715-104. Application of TOCCs is necessary to limit noise and return loss during picture transmission.

10. CENTRAL OFFICE ARRANGEMENTS

10.01 Most central office equipment is suitable for use in telephoto and facsimile services, but care must be taken in the selection and arrangement of the equipment to ensure satisfactory performance. Some of the considerations applicable to the selection and use of central office equipment are given in the following paragraphs.

10.02 Except for small central offices requiring only jacks, the central office equipment should include a testboard that is designed specifically to permit testing and monitoring of telephoto and

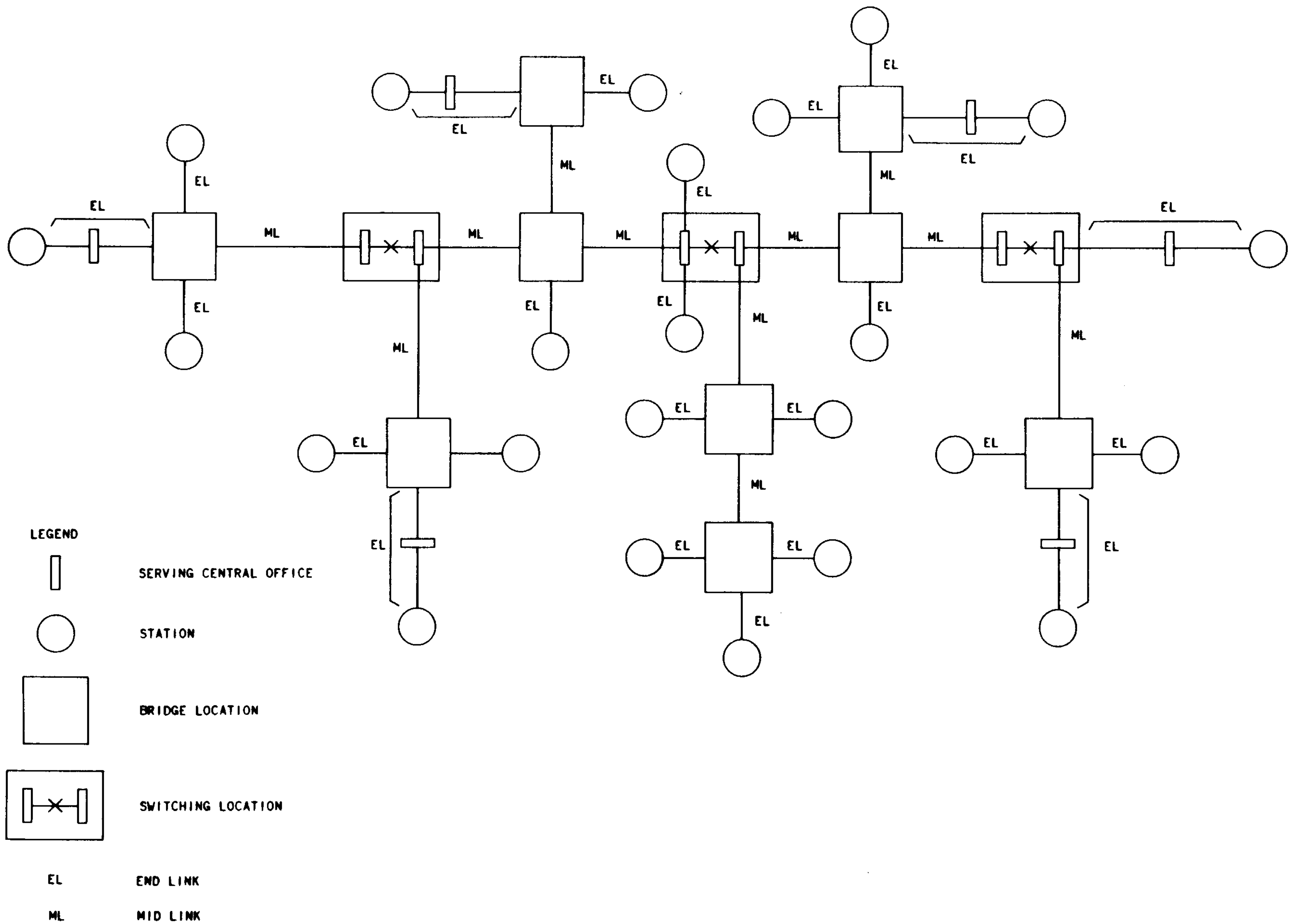

Fig. 9—Typical Half Duplex Multipoint Layout With Central Office Switching Illustrating Six Midlink Concept

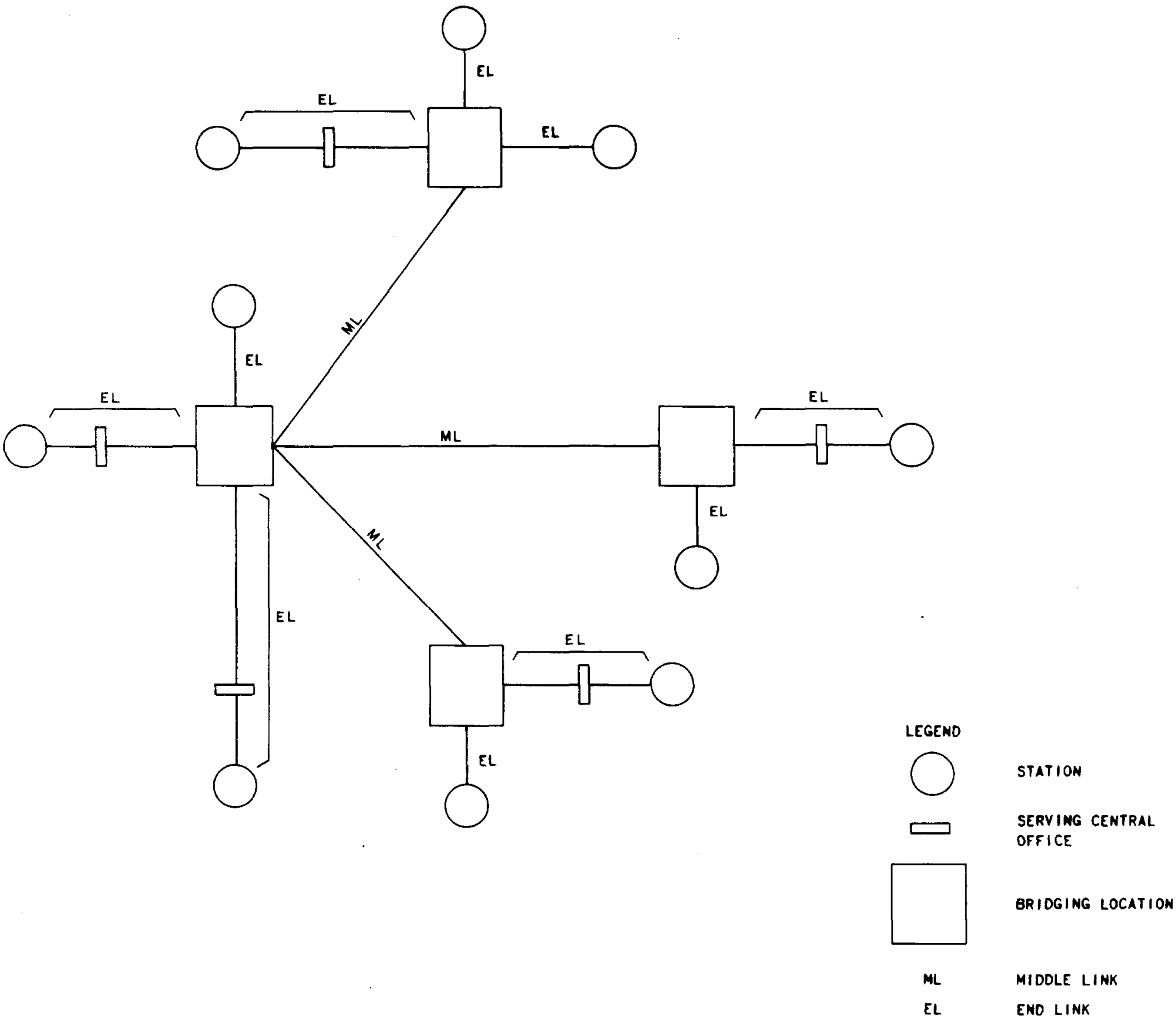

Fig. 10—Typical Half Duplex Multipoint Layout With One Midlink Connected Between Stations

facsimile service and that has a jack field arrangement which provides the necessary access. The testboard could be used with more than one telephoto or facsimile service.

10.03 The use of single- instead of double-conductor jacks on the telephoto testboard would lighten the circuit load to be handled by the testing facilities of each position and permit the use of automatic 600-ohm terminations in jack circuits assigned to picture transmission paths. Special monitoring jacks should be provided at each input and at one output of each bridge circuit to allow loudspeaker or volume indicator monitoring with the use of a high-impedance monitoring circuit. Similar jacks should be provided on a disassociated basis of cross-connection to local channels or as required. The special monitoring jacks should be wired to eliminate the possibility of hits on the telephoto services caused by momentary short circuiting as the monitoring circuit plug is being inserted. As an additional safeguard against operating errors, the special monitoring jacks should be designed to accept no plug except that of the high-impedance monitoring circuit.

10.04 Potentiometer monitor jacks (PMJ) should be used on bridge legs not already equipped with high-impedance monitoring jacks. Use of the PMJ will allow proper monitoring of a telephoto circuit during transmission without causing hits to the picture when the monitor cord is inserted.

10.05 Most 4-wire 4-way and 4-wire 6-way bridges presently in use are acceptable for telephoto with the exception of 4-wire 4-way bridges having three transpositions. If it is necessary to use a bridge having only three transpositions, the fourth leg of the bridge should be terminated in 600 ohms. The return loss of a bridge alone with all sides terminated in 600 ohms should be at least 85 dB. Circuits should be arranged so that direct transmissions to the greatest number of customer stations pass through the least number of bridges in tandem. If possible, no more than one bridge should be included in the main line of a network passing through an office.

10.06 Level adjusting keys should be available on all receive bridge legs except interbridge. If these keys are not part of the bridge, they should be provided as a separate piece of equipment. Telephoto circuits should be lined up with a 1-dB level key in the circuit. When level keys are available, bridge levels are as follows:

15-dB loss bridges: +6 dBm input, −9 dBm output

20-dB loss bridges: +6 dBm input, −14 dBm output

It is recommended that, for circuits employing 15-dB bridges, the minimum office level be −20 dBm. However, where this is not practical, an office level of −25 dBm is permitted, if no tie cable pairs between frames are employed. This rule applies to the 20-dB bridges also.

10.07 Listed below are some common 4-wire bridges and their transpositions. The drawings referenced are Long Lines Department drawings. The preferred arrangement, shown on SM-11605-SD, Fig. 2, was specifically designed for telephoto use.

SD-21616, Fig. 20, and SD-55647, Fig. 11

1 in—2 out
2 in—3 out
3 in—1 out

SD-21616, Fig. 43; SM-11605, Fig. 1; and SM-12001-SD, Fig. 1

1 in—2 out
2 in—1 out
2 in—3 out
4 in—1 out

SD-21616, Fig. 42; SM-11605, Fig. 2, and SM-12001-SD, Fig. 2

1 in—2 out
2 in—3 out
2 in—5 out
3 in—4 out
4 in—1 out
4 in—5 out
5 in—6 out
6 in—1 out
6 in—3 out

10.08 Talkback bridges are required on most customer loops; where full-duplex (2-way simultaneous) operation is required, however, a talkback arrangement must be provided at the customer location.

10.09 There are two acceptable methods for talkback arrangements on telephoto service. The first method uses two resistance bridges connected together through one-half of a repeater. Acceptable resistance bridges for this purpose are:

SD-21616, Fig. 5

SM-12001-SD, Fig. 18

SM-11605, Fig. 5.

10.10 The second method utilizes talkback bridges arranged for insertion into both directions of transmission of a 4-wire circuit. These bridges are primarily intended to be used adjacent to a 4-way or 6-way bridge but may be used otherwise. These types of bridges are equipped with 1C pad sockets and the pad value determines talkback loss. These bridges are:

SM-12001-SD, Fig. 20

SM-11650-SD, Fig. 27.

10.11 In addition to a regular telephone set, each testboard position should have an auxiliary telephone circuit for use when the regular set is not available.

10.12 Attenuation equalization should be applied where needed. Post-equalization instead of pre-equalization should be used where gain equalizers are employed. Pre-equalization is permitted using LE type equalizers on short, nonloaded local channels but the use of 24V4 or 44V4 gain devices equipped with 359-type equalizers may be required on long, nonloaded local channels.

10.13 Delay equalization should be provided where necessary. The 200-type equalizers may be used if already available. Where new equipment must be ordered, use types such as the 950A and/or 950B. Either post-delay or pre-delay equalization is acceptable.

10.14 The J99347 VF amplitude and delay equalizing equipment, utilizing the 950A (amplitude) and 950B (delay) type equalizers, was designed to replace the J99292C amplitude and delay equalizing unit and the associated 384- and 385-type delay equalizers. This equipment consists of the J99347AA VF amplitude and delay equalizing unit (J-board equalizer), the J99347B-L1 amplitude and delay equalizing equipment bay (J-board bay), and the J99347C-L1 VF amplitude and delay equalizing equipment shelf (J-board equipment shelf).

10.15 The J-board equalizer and associated equipment, including plug-in 950-type equalizers, allow a greater latitude for conditioning voiceband data transmission facilities than the equipment it replaces.

10.16 For specific information concerning 950A-type and 950B-type equalizers, refer to Sections 314-820-107 and 314-820-108. The J99347 VF amplitude and delay equalizer equipment is covered in Section 314-820-106.

10.17 Repeating coils for use on telephoto services must be selected so that the frequency-response characteristic of the coil will meet the requirement for the type of service involved. The coil impedance should also match that of the local channel as closely as possible.

10.18 Only repeaters modified for negative feedback or split operation are acceptable for use on telephoto circuits. The 4AF repeater is modified for negative feedback and should be operated on step 11 or 12 of its input transformer for maximum stability.

10.19 Tone-operated control circuits (TOCC) should be assigned to telephoto services as required. Refer to Section 314-715-104 for specific information concerning their use.

10.20 Switching on telephoto circuits is accomplished by means of the circuits of either Fig. 14 or Fig. 18 of SD-55647. The circuits of Fig. 1 and Fig. 7 of SD-55647 are used when necessary.

11. LOCAL CHANNELS

11.01 A local channel is defined as a facility between the centralized control key at the serving central office and the line jacks of the terminating equipment at the customer premises. The 1000-Hz insertion loss of the channel should not exceed 12 dB.

11.02 Requirements for loaded and nonloaded local channel facilities are given in Section 880-410-100.

12. GLOSSARY OF TERMS

A. Terms Common to Message Plant

Carrier Facility

A voice-grade channel derived from the modulation and demodulation process using open wire, cable, coaxial, or radio facilities as the transmission medium between terminals.

Circuit Unit

A circuit unit consists of line facilities and associated equipment (a regulator section of cable) between two designated points.

Nonregulated Section

A nonregulated section is a portion of a circuit not under the control of any pilot wire transmission regulator. The receiving side of the repeater at each end of the section is included.

Regulator Section

A regulator section is that portion of a circuit within the control of a pilot wire regulator. A regulator section includes, in each direction of transmission, a receiving side of a repeater at the output end of the section but no repeater at the input end.

Repeater Section

A repeater section consists of all the equipment and line existing between the output of one repeater and the output of the adjacent repeater.

B. Terms Associated Directly With Facsimile (Telephotograph) Network (Telephone)

Attenuation Equalizers (GE and LE)

See Section 314-820-105.

Basic Delay Equalizers

Delay equalizers are used to correct the delay-frequency characteristics of facilities. See Section 314-820-100.

Bridging Network

A bridging network is the resistance arrangement provided for interconnecting branch circuits on a 4-wire basis. There are three types of bridging networks: a 4-wire, 4-way (15.0 dB, 1-kHz loss), a 4-wire, 6-way (19.6 dB, 1-kHz loss), and a one-input, 10-output, one-way (13.5 dB, 1-kHz loss).

Channel Termination

The equipment necessary to provide send and receive, send only, receive only and send and receive with extension receive only (for example, equipment such as loud speakers, 110A key equipment jack circuits for local channel facilities, key equipment, relay equipment, signal lamps and terminating blocks). This equipment is owned and maintained by the Associated Company.

Control Section

A section of a telephotograph network for which a control office is responsible. (See "Subcontrol Office.")

Demarcation Point

A point of connection between channel termination and customer equipment. It can be a connecting block or jack terminating in Telco equipment bay.

End Link

The facility between a central office relay switching location or a central office bridging location and the transmission interface (demarcation point) at the customer premises. This definition holds whether the end link consists of a local channel or consists of an intercity facility and a local channel.

Facsimile or Telephotograph Transmission Channels

This channel offering consists of furnishing, on a private line service basis and for designated periods, facilities for transmitting pictures and similar material between designated locations. This offering may also include the use of the network as a talking channel for coordination purposes during intervals when telephotographs are not being transmitted.

Facsimile (Voice-Grade) System

The process, or result of a process, by which fixed graphic material, such as charts, circuit diagrams, maps, and handwritten or typewritten copy, is converted to signal waves which are used either locally or remotely to produce in record form a likeness of subject copy.

Level Adjusting Keys (LK)

These keys provide 1- and 2-dB pads controlled by twist key and are connected into the circuit between the output of the line circuit and the input to the bridge to permit rapid adjustment during service.

Level Compensator 71A1 (PCS, PCR)

Level compensators are designed to compensate for a level change (up to ±5 dB) originating on a broadband carrier facility. Level compensators reduce or eliminate interfering patterns created on carrier facilities such as K2 or L. Level compensators consist of two sets of equipment, one at the sending end (PCS) and one at the receiving end (PCR).

Level Jacks

This term defines the jacks which are bridged across a circuit.

Local Channel Facilities

This term, when referred to in connection with telephotograph transmission, means the local channel facilities between the centralized control bay at the central office and the line jacks which are located in the line terminating bay at the customer station. At other than a splitting point, a sending local channel and a receiving local channel are provided between the central office and the customer station. At a splitting point, a total of five local channels are provided, two sending local channels, two receiving local channels, and the local channel which is used to operate the splitting relay. In either case, if necessary, each sending and receiving local channel is simplexed in order to derive a direct current control circuit between the central office and customer station. A local channel may be used as a "send-only" station or "receive-only" station. A spare local channel may be ordered for either a splitting or for other than a splitting point.

Midlink—Middlelink

The transmission facilities between central office relay switching and/or bridging locations.

Noise Filter (NF)

Noise filters are used to suppress low-frequency noise. Noise filters are always used where a physical open-wire circuit is employed.

Potentiometer Level Jacks (PLJ)

This term defines the level jacks associated with a potentiometer arrangement which is bridged across a circuit. The measured level at these jacks is down about 25 dB from the circuit level. Potentiometer level jacks are used very little and should be replaced by potentiometer monitor jacks (PMJ), a new type of high-impedance monitoring circuit that is now available for use in new installations.

Potentiometer Monitoring Jacks (PMJ)

A type jack provided on the legs of the bridging network for a high-impedance monitoring circuit.

Regulating Network Lockup Circuit

This circuit is used at regulating repeater points in aerial cable sections or in buried regulated cable sections to prevent changes in regulating networks during intervals that pictures are being transmitted. For 4002 channels the circuit is actuated by "TONLOC" equipment or tone-operated control circuits (TOCC).

Splitting Arrangement

The customer may require, at one or more points, a circuit arrangement which enables the customer to split the network at the specified point and operate the resulting sections independently. This is defined as a splitting arrangement.

Subcontrol Office

Subcontrol office is a responsibility assigned to a testroom to test and maintain a portion of the control section. (See "Control Section.")

Talk-Back Bridge

Two types of talk-back bridges are employed. When a buffer amplifier is used, the loss through the circuit is 3.6 dB and the loss to the talk-back amplifier is 9.4 dB. When a talk-back amplifier is not employed, a differentially balanced circuit is used. When such a circuit is equipped with 3-dB pads, the loss to the circuit is 3.0 dB; the loss in the talk-back path is 21.7 dB.

Telephone Patching Layout (TPL)

The facilities (terminating in jacks at each terminal) that are suitable for the restoration and maintenance of private line telephone service. Telephotograph service where the line facility meets telephotograph transmission requirements is included.

Telephotograph Circuit Unit (TFCU)

The facilities and associated equipment provided between two adjacent bridging offices or between a terminal office and its adjacent bridging office. A TFCU includes the telephone repeater, where assigned, at each terminal.

Telephotograph Networks

A telephotograph network is comprised of the facilities and associated equipment which are required to furnish a specified telephotograph transmission channel. A network includes the regularly assigned telephotograph circuit units, the interconnecting bridges, the sending and receiving local channel facilities, and channel terminations.

Telephotograph Patching Layout (TFPL)

A telephotograph patching layout, abbreviated TFPL, includes facilities and associated equipment (delay equalizers, negative feedback amplifiers, split filament repeaters, etc) suitable for the restoration and maintenance of telephotograph service.

Telephotography System

Telephotography is a process or method of facsimile that is capable of distinguishing and recording gray scale or halftone subject matter. Generally, it employs the use of photographic material and processing.

Test Section

A telephotograph network is sectionalized into two or more sections for the purpose of making daily and monthly tests. Each of these sections is defined as a test section.

TONLOC Equipment

"TONLOC" is a functional name derived from the words "Tone" and "Lockup". As applied to a telephotograph network, this equipment causes relay contacts connected to other apparatus, most commonly the regulating network lockup circuit, to operate while picture carrier tone is applied to either side of the 4-wire circuit. An adjustable delay circuit prevents release of this control for a predetermined number of seconds following removal or other loss of the picture carrier tone.

Tone Operated Control Circuit (TOCC)

A device used at a bridging office which, when operated by picture carrier, terminates all receiving legs except the leg receiving transmission. In effect, it makes that office a one-way office. The tone-operated control circuit is used in the transmission circuit to reduce return currents and noise on a large network. It may find use in furnishing TONLOC service and switching compandors into N and ON channels during talking periods.

C. Terms Common to Industry Abstracted From IRE Standards on Facsimile, June 1956

**Baseband*

In a carrier (or subcarrier) wire or radio transmission system, the band of frequencies occupied by the signal before it modulates the carrier (or subcarrier) frequency to form the transmitted line or radio signal.

*This asterisk indicates more common terms—more frequently used.

> ***Note:*** The signal in the baseband is usually distinguished from the line or radio signal by ranging over distinctly lower frequencies, which at the lower end relatively approach or may include dc (zero frequency). In the case of a facsimile signal before modulation on a subcarrier, the baseband includes dc.

**Black Recording*

In an amplitude-modulation system, that form of recording in which the maximum received power corresponds to the maximum density of the record medium. In a frequency-modulation system, that form of recording in which the lowest received frequency corresponds to the maximum density of the record medium.

**Black Signal*

The signal at any point in a facsimile system produced by the scanning of a maximum density area of the subject copy.

**Black Transmission*

In an amplitude-modulation system, that form of transmission in which the highest transmitted power corresponds to the maximum density of the subject copy. In a frequency-modulation system, that form of transmission in which the lowest transmitted frequency corresponds to the maximum density of the subject copy.

**Carrier Beat*

The undesirable heterodyne of signals, each synchronous with a different stable reference oscillator, causing a pattern in received copy. Where one or more of the oscillators is fork controlled, this is called fork beat.

Converter, Facsimile

A device which changes the type of modulation.

****Definition***

Distinctness or clarity of detail or outline in a record sheet, or other reproduction.

****Density (in facsimile)***

A measure of the light-transmitting or light-reflecting properties of an area. It is expressed by the common logarithm of the ratio of incident to transmitted or reflected light flux.

> ***Note:*** There are many types of density which will usually have different numerical values for a given material: eg, diffuse density, double diffuse density, specular density. The relevant type of density depends upon the geometry of the optical system in which the material is used.

****Direct Recording***

That type of recording in which a visible record is produced without subsequent processing in response to the received signals.

****Drive Pattern***

Density variation caused by periodic errors in the position of the recording spot. When caused by gears this is called gear pattern.

****Drum Speed***

The angular speed of the transmitter or recorder drum.

> ***Note:*** This speed is measured in revolutions per minute.

****Echo***

A signal which has been reflected at one or more points with sufficient magnitude and time difference to be perceived in some manner as a signal distinct from that of the main transmission.

****Effective Band (in Facsimile)***

The frequency band of a facsimile signal wave equal in width to that between zero frequency and maximum keying frequency.

> ***Note:*** The frequency band occupied in the transmission medium will, in general, be greater than the effective band.

Electrochemical Recording

Recording by means of a chemical reaction brought about by the passage of signal-controlled current through the sensitized portion of the record sheet.

Electrolytic Recording

That type of electrochemical recording in which the chemical change is made possible by the presence of an electrolyte.

Electronic Line Scanning

That method of scanning which provides motion of the scanning spot along the scanning line by electronic means.

Electronic Raster Scanning

That method of scanning in which motion of the scanning spot in both dimensions is accomplished by electronic means.

Electrostatic Recording

Recording by means of a signal-controlled electrostatic field.

Electrothermal Recording

That type of recording which is produced principally by signal-controlled thermal action.

Elemental Area

Any segment of a scanning line of the subject copy the dimension of which along the line is exactly equal to the nominal line width.

> ***Note:*** Elemental area is not necessarily the same as the scanning spot.

End-of-Copy Signal

A signal indicating termination of the transmission of a complete subject copy.

Envelope Delay

The time of propagation, between two points, of the envelope of a wave.

> ***Note:*** The envelope delay is measured by the slope of the phase shift in Hertz plotted against the frequency in Hertz. If the system distorts the envelope, the envelope delay at a specified frequency is defined with reference to a modulated wave which occupies a frequency bandwidth approaching zero.

Envelope Delay Distortion

That form of distortion which occurs when the rate of change of phase shift with frequency of a circuit or system is not constant over the frequency range required for transmission.

> ***Note:*** Envelope delay distortion is usually expressed as the difference in microseconds between the maximum and minimum envelope delays existing between the two extremes of frequency defining the channel used.

Facsimile (in electrical communications).

The process, or the result of the process, by which fixed graphic material including pictures or images is scanned and the information converted into signal waves which are used either locally or remotely to produce in record form a likeness (facsimile) of the subject copy.

Facsimile Signal (Picture Signal)

A signal resulting from the scanning process.

Facsimile-Signal Level

The maximum facsimile signal power or voltage (rms or dc) measured at any point in a facsimile system.

> ***Note:*** It may be expressed in decibels with respect to some standard value such as 1 milliwatt.

Facsimile System

An integrated assembly of the elements used for facsimile.

Facsimile Transient

A damped oscillatory transient occurring in the output of the system as a result of a sudden change in input.

Facsimile Transmission

The transmission of signal waves produced by the scanning of fixed graphic material, including pictures, for reproduction in record form.

Frame (in facsimile)

A rectangular area the width of which is the available line and the length of which is determined by the service requirements.

Framing

The adjustment of the picture to a desired position in the direction of line progression.

Framing Signal

A signal used for adjustment of the picture to a desired position in the direction of line progression.

Grouping

Periodic error in the spacing of recorded lines.

Halftone Characteristic

A relation between the density of the recorded copy and the density of the subject copy.

> ***Note:*** The term may also be used to relate the amplitude of the facsimile signal to the

density of the subject copy or the record copy when only a portion of the system is under consideration. In a frequency-modulation system an appropriate parameter is to be used instead of the amplitude.

Index of Cooperation, Scanning, or Recording Line

In rectilinear scanning or recording, the product of the total length of a scanning or recording line by the number of scanning or recording lines per unit length.

Note 1: The International Index of Cooperation (diametrical index of cooperation) is based on drum diameter and is defined by the International Radio Consultative Committee (CCIR). It is 1/p times the scanning line index of cooperation.

Note 2: For a scanner and recorder to be compatible, the indices of cooperation must be the same.

Jitter (in facsimile)

Raggedness in the received copy caused by erroneous displacement of recorded spots in the direction of scanning.

Kendall Effect

A spurious pattern or other distortion in a facsimile record caused by unwanted modulation products. This pattern arises from the transmission of a carrier signal and appears in the form of a rectified baseband interfering with the lower sideband of the carrier.

Note: This occurs principally when the single sideband width is greater than half the facsimile carrier frequency.

Light Flux (Luminous Flux)

Radiant flux in the visible-wavelength range, usually expressed in lumens.

Maximum Keying Frequency (Fundamental Scanning Frequency)

The frequency, in Hertz, numerically equal to the spot speed divided by twice the scanning spot X dimension

Maximum Modulating Frequency

The highest picture frequency required for the facsimile transmission system.

Note: The maximum modulating frequency and the maximum keying frequency are not necessarily equal.

Multiple Spot Scanning

Scanning carried on simultaneously by two or more scanning spots, each one analyzing its fraction of the total scanned area of the subject copy.

Noise

Any extraneous electrical disturbance tending to interfere with the normal reception of a transmitted signal.

Nominal Line Width

The average separation between centers of adjacent scanning or recording lines.

Overlap X

The amount by which the recorded spot X dimension exceeds that necessary to form a most nearly constant density line.

Note: This effect arises in that type of equipment which responds to a constant density in the subject copy by a succession of discrete recorded spots.

Overlap Y

The amount by which the recorded spot Y dimension exceeds the nominal line width.

Phase Delay

In the transfer of a single-frequency wave from one point to another in a system, the time delay of a part of the wave identifying its phase.

Note: The phase delay is measured by the ratio of the total phase shift in Hertz to the frequency in Hertz.

Phase-Frequency Distortion

Distortion due to lack of direct proportionality of phase shift to frequency over the frequency range required for transmission.

Note 1: Delay distortion is a special case.

Note 2: This definition includes the case of a linear phase-frequency relation with the zero frequency intercept differing from an integral multiple of π.

****Phasing***

The adjustment of picture position along the scanning line.

Phasing Signal

A signal used for adjustment of the picture position along the scanning line.

Photosensitive Recording

Recording by the exposure of a photosensitive surface to a signal-controlled light beam or spot.

****Picture Frequencies***

The frequencies which result solely from scanning subject copy.

Note: This does not include frequencies which are part of a modulated carrier signal.

****Picture Inversion***

A process which causes reversal of the black and white shades of the recorded copy.

****Receiver, Facsimile***

The apparatus employed to translate the signal from the communications channel into a facsimile record of the subject copy.

****Record Medium***

The physical medium on which the facsimile recorder forms an image of the subject copy.

Record Sheet

The medium which is used to produce a visible image of the subject copy in record form. The record medium and the record sheet may be identical.

Recorded Spot

The image of the recording spot on the record sheet.

Recorded Spot X Dimension

The effective recorded spot dimension measured in the direction of the recorded line.

Note 1: By effective dimension is meant the largest center-to-center spacing between recorded spots which gives minimum peak-to-peak variation of density of the recorded line.

Note 2: This term applies to that type of equipment which responds to a constant density in the subject copy by a succession of discrete recorded spots.

Recorded Spot Y Dimension

The effective recorded spot dimension measured perpendicularly to the recorded line.

Note: By effective dimension is meant the largest center-to-center distance between recorded lines which gives minimum peak-to-peak variation of density across the recorded lines.

****Recorder, Facsimile***

That part of the facsimile receiver which performs the final conversion of electrical picture signal to an image of the subject copy on the record medium.

Recording (in facsimile)

The process of converting the electrical signal to an image on the record medium.

Note: See "Direct Recording," "Electrochemical Recording," "Electrolytic Recording," "Electrostatic Recording," "Electrothermal Recording," and "Photosensitive Recording."

Recording Spot (in facsimile)

The image area formed at the record medium by the facsimile recorder.

****Reproduction Speed***

The area of copy recorded per unit time.

Scanner

That part of the facsimile transmitter which systematically translates the densities of the subject copy into signal-wave form.

****Scanning (in facsimile)***

The process of analyzing successively the densities of the subject copy according to the elements of a predetermined pattern.

> ***Note:*** The normal scanning is from left to right and top to bottom of the subject copy as when reading a page of print. Reverse direction is from right to left and top to bottom of the subject copy.

Scanning Line Frequency

See "Stroke Speed."

Scanning Line Length

The total length of scanning line is equal to the spot speed divided by the scanning line frequency.

> ***Note:*** This is generally greater than the length of the available line.

Scanning Spot (in facsimile)

The area on the subject copy viewed instantaneously by the pickup system of the scanner.

Scanning Spot X Dimension

The effective scanning spot dimension measured in the direction of the scanning line on the subject copy.

> ***Note:*** The numerical value of this will depend upon the type of system used.

Scanning Spot Y Dimension

The effective scanning spot dimension measured perpendicularly to the scanning line on the subject copy.

> ***Note:*** The numerical value of this will depend upon the type of system used.

****Signal Contrast (in facsimile)***

The ratio expressed in decibels (dB) between white signal and black signal.

Signal Frequency Shift

In a frequency shift facsimile system, the numerical difference between the frequencies corresponding to white signal and black signal at any point in the system.

Simple Scanning

Scanning by only one scanning spot at a time during the scanning process.

****Skew (in facsimile)***

The deviation of the received frame from rectangularity due to asynchronism between scanner and recorder. Skew is expressed numerically as the tangent of the angle of this deviation.

Spot Projection

The optical method of scanning or recording in which the scanning or recording spot is defined in the path of the reflected or transmitted light.

Spot Speed

The speed of the scanning or recording spot within the available line.

> ***Note:*** This is generally measured on the subject copy or on the record sheet.

****Stagger***

Periodic error in the position of the recorded spot along the recorded line.

Start Record Signal

A signal used for starting the process of converting the electrical signal to an image on the record sheet.

Start Signal

A signal which initiates the transfer of a facsimile equipment condition from standby to active.

Stop Record Signal

A signal used for stopping the process of converting the electrical signal to an image on the record sheet.

Stop Signal

A signal which initiates the transfer of a facsimile equipment condition from active to standby.

Stroke Speed (Scanning or Recording Line Frequency)

The number of times per minute, unless otherwise stated, that a fixed line perpendicular to the direction of scanning is crossed in one direction by a scanning or recording spot.

> ***Note:*** In most conventional mechanical systems this is equivalent to drum speed. In systems in which the picture signal is used while scanning in both direction, the stroke speed is twice the above figure.

Subcarrier

A carrier which is applied as a modulating wave to modulate another carrier.

Subject Copy

The material in graphic form which is to be transmitted for facsimile reproduction.

Synchronizing (in facsimile)

The maintenance of predetermined speed relations between the scanning spot and the recording spot within each scanning line.

Synchronizing Signal (in facsimile)

A signal used for maintenance of predetermined speed relations between the scanning spot and recording spot within each scanning line.

Tailing (Hangover)

The excessive prolongation of the decay of the signal.

****Transmitter, Facsimile***

The apparatus employed to translate the subject copy into signals suitable for delivery to the communication system.

Underlap X

The amount by which the center-to-center spacing of the recorded spots exceeds the recorded spot X dimension.

> ***Note:*** This effect arises in that type of equipment which responds to a constant density in the subject copy by a succession of discrete recorded spots.

Underlap Y

The amount by which the nominal line width exceeds the recorded spot Y dimension.

****Vestigial Sideband***

The transmitted portion of the sideband which has been largely suppressed by a transducer having a gradual cut-off in the neighborhood of the carrier frequency, the other sideband being transmitted without much suppression.

Vestigial Sideband Transmission

That method of signal transmission in which one normal sideband and the corresponding vestigial sideband are utilized.

****White Recording***

In an amplitude-modulation system, that form of recording in which the maximum received power corresponds to the minimum density of the record medium. In a frequency-modulation system, that form of recording in which the lowest received frequency corresponds to the minimum density of the record medium.

***White Signal**

The signal at any point in a facsimile system produced by the scanning of a minimum density area of the subject copy.

***White Transmission**

In an amplitude-modulation system, that form of transmission in which the maximum transmitter power corresponds to the minimum density of the subject copy. In a frequency-modulation system, that form of transmission in which the lowest transmitted frequency corresponds to the minimum density of the subject copy.

13. REFERENCES

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