CIRCUIT VOLTAGE LIMITS
GENERAL EQUIPMENT REQUIREMENTS

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1. GENERAL

SCOPE

1.01 This specification, together with the supplementary information listed herein, covers the

requirements for battery, 60-Hz ac, ringing, signal, and tone voltage limits.

1.02 The information contained herein has been compiled from design parameters of the equipment listed in Parts 4 through 21 of this specification. Changes and additions shall be transmitted by the Divisional Coordinator involved to the Bell Laboratories Standards and Materials Engineering Department (8251) for revision. ←
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1.03 This specification includes information formerly specified in Section 802-004-150 (J86718), together with information pertinent to recently introduced new systems.

1.04 This specification is reissued to add information pertinent to newly introduced systems and to clarify and update previous information.

1.05 The dc voltage limits listed herein, together with current drains, provide information for planning and engineering suitable power plant arrangements with required battery end voltage and reserve time for central office installations as follows:

(a) Summary of voltage supplies used by various systems. In this regard only "primary" voltages are listed and generally not the outputs of power conversion or regulating units which are always a required component of equipment. The power unit code may be listed under supplementary information.

(b) Working voltage range requirements which are the same as specified by the system drawings.

(c) Supplementary information covering special power supply requirements and distribution feeder design.

(d) Unless otherwise specified, the voltage limits given herein are at the supply side of the frame fuse panel, frame power converter, or individual circuit fuse.

It is not the intention of this specification to provide complete and comprehensive power requirements for the various systems. For example, specific directives concerning equipment which must share the same power plant or which have special requirements for distribution feeder design are not included. This type of information is usually provided in the general specification covering the particular system, such as J69202 for the 4A Toll Switching System, or in information drawings such as SD-81228-01 for broadband carrier equipment, or SD-1A148-01 for the No. 1 ESS System.

1.06 The information for ringing and tone sources listed herein represents the performance characteristics of these sources for central office equipment. It is arranged into four sections as follows:

(a) Continuous ringing supplies.

(b) Machine ringing and associated ground codes.

(c) Nonprecise call progress tones.

(d) Precise call progress tones.

Typical applications and associated switching systems are listed for each supply. However, it should be noted that all systems which use a given ringing and tone supply may not be listed and that certain supplies are used for miscellaneous purposes not listed herein. For these reasons, the information in this section should ***not*** be used to determine the ringing and tone requirements for any given office.

DEFINITION OF TERMS

1.07 ***Nominal voltage*** represents a voltage value understood to be approximate and commonly used for easy reference.

1.08 ***Normal voltage range*** represents overall range of normal day-to-day voltage operating values, resulting primarily from variations in feeder voltage drops due to load changes and from small variations in voltage regulators.

1.09 ***Emergency voltage limits*** represent the variations in voltage which may occur under unusual conditions such as interruption of commercial power service. These generally wide voltage excursions may be expected to occur infrequently and for only a small portion of the time. The lower voltage point of the emergency limits provides satisfactory operation for even worst-circuit conditions. Special power arrangements will generally be required for those cases where satisfactory circuit operation demands that emergency voltage limits must be the same as the normal range.

1.10 ***Maximum transient voltage*** represents the limit that shall be allowed to occur due to any cause whatsoever. This limit is typically imposed by the characteristics of electronic devices that could be damaged if the limit were exceeded.

→ 1.11 Voltage requirements for specific circuits may be listed within certain paragraphs. The systems served by these specific circuits do not necessarily have the same voltage requirements.

2. SUPPLEMENTARY INFORMATION

Power Data Book

X-64644— Commercial Power Service in USA
800-600-000—Checking List—General Equipment Requirements
802-000-000—Numerical Index—Power Systems
802-001-150—J86600—Reserve Engine—Generator Power Plants
802-001-151—J86500—List of Power Plants
802-001-152—J86200—Power Supply Units—Rectifiers and Voltage Regulators

3. DRAWINGS

SD-80700-01—Power Keysheet
SD-90250-01—Master Keysheet

4. SWITCHING SYSTEMS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
STEP-BY-STEP (SXS) SYSTEMS				
No. 1	−24	24 to 26	22 to 26	
No. 1	−48	48 to 50 or 50 to 52*	45 to 52	
→ No. 1 — Call Data Accumulators (CDA)	−50	48 to 50	46 to 52	
No. 1 — Message Register Service	+60 to +75 +130	— 125 to 135	60 to 75 125 to 135	
No. 1 — Coin Service Improvement and Dial Long Line (DLL) Circuits	+48	48 to 50	44 to 52	
→ 350A	−24	22 to 26	22 to 26 or 20 to 28	
350A	−48	48 to 50 or 50 to 52*	45 to 52	

→* Normal 50- to 52-, emergency 45- to 52-volt operation is permissible providing CEMF cells are available to give 48- to 50-volt operation during maintenance testing and that neither ANI, SXS CAMA, AIOD station identification equipment, SXS common control, SXS LAMA, SXS noncommon control, TOUCH-TONE calling circuits, nor Call Data Accumulator (CDA) circuits are supplied from the same 48-volt power plant.

4. SWITCHING SYSTEMS (Cont)

			NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
350A	—	Call Data Accumulators (CDA)	−50	48 to 50	46 to 52	←
350A	—	Message Register Supply	+60 to +75 +130	— 125 to 135	60 to 75 125 to 135	
350A	—	Coin Service Improvement and DLL Circuits	+48	48 to 50	44 to 52	
355A			−24	22 to 26	22 to 26 or 20 to 28	
355A			−48	48 to 50 or 50 to 52†	44 to 52* or 44 to 52‡	
355A	—	Call Data Accumulators (CDA)	−50	48 to 50	46 to 52	←
355A	—	Coin Service Improvement and DLL Circuits	+48	48 to 50	44 to 52	
356A			−48	50 to 52	44 to 52‡	

* A 105C plant using 23-cell battery without CEMF cells giving an overall range of 44 to 52 volts was acceptable on the basis that voltage below 45 volts would occur only at the end of a long power failure.

† Normal 50- to 52-, emergency 45- to 52-volt operation is permissible providing CEMF cells are available to give 48- to 50-volt operation during maintenance testing and that neither ANI, SXS CAMA, AIOD station identification equipment, SXS common control, SXS LAMA, SXS noncommon control, TOUCH-TONE calling circuits, nor CDA circuits are supplied from the same 48-volt power plant. ←

‡ A 105D plant using 24 cells and no CEMF cells except for overcharge or test with overall range of 44 to 52 volts is acceptable, since voltages up to 52 volts are satisfactory and voltage below 45 will occur only at the end of a long power failure. ←

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
360A	−24	22 to 26	22 to 26 or 20 to 28	
360A	−48	48 to 50 or 50 to 52*	45 to 52	
→ 360A — Call Data Accumulators (CDA)	−50	48 to 50	46 to 52	
360A — Coin Service Improvement and DLL Circuits	+48	48 to 50	44 to 52	
370A 370B	−48	(48 to 50) or (50 to 52)	44 to 52	
→ 35E97 — Call Data Accumulators (CDA)	−50	48 to 50	46 to 52	
35E97 — Coin Service Improvement and DLL Circuits	+48	48 to 50	44 to 52	
Intertoll Dialing	−24	23 to 25 24 to 26	22 to 26	
	−48	48 to 50 or 50 to 52*	45 to 52	
	+130	125 to 135	120 to 140	

† Normal 50- to 52-, emergency 45- to 52-volt operation is permissible providing CEMF cells are available to give 48- to 50-volt operation during maintenance testing and that neither ANI, SXS CAMA, AIOD station identification equipment, SXS common control, SXS LAMA, SXS noncommon control, TOUCH-TONE calling circuits, nor CDA circuits are supplied from the same 48-volt power plant.

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
PANEL SYSTEM				
	−24	24 to 26	22 to 26	
	−48	48 to 50	45 to 50	
CROSSBAR SYSTEMS (CSBR)—LOCAL				
No. 1	−24	24 to 26	22 to 26	
	−48	48 to 50	45 to 50	
No. 1 — With AMA	+130	125 to 135	120 to 140	
	115, 60 Hz	—	103.5 to 131.5, 58 to 60 Hz	
No. 5	−24	24 to 26	22 to 26	
	−48	48 to 50	45 to 50	
	+50	42 to 52	40 to 52	
	−72	71 to 74	66 to 75	
	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	
	115, 60 Hz	—	103.5 to 131.5, 58 to 60 Hz	
No. 5 — With AMA	115, 60 Hz	—	103.5 to 131.5, 58 to 60 Hz	
CROSSBAR SYSTEMS—TANDEM				
Tandem	−48	48 to 50*	45 to 50	
	+135	130 to 135*	127 to 140	
	+170	165 to 170	160 to 180	
Tandem — With AMA	115, 60 Hz	—	103.5 to 131.5, 58 to 60 Hz	
CROSSBAR SYSTEMS—TOLL				
No. 4, 4A,4M Toll Switching Systems	−24	24 to 26	22 to 26	
	−48	48 to 50	45 to 50	
	+130	125 to 135	125 to 135	

* Limits with ac power on rectifiers.

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
ELECTRONIC TRANSLATOR SYSTEM (ETS)				
	+24	25 to 26.25* 24 to 26.25†	21.75 to 26.25* 20.75 to 26.25†	+30
	−48	50.75 to 52.50* 49.75 to 52.50†	43.75 to 52.50* 42.75 to 52.50†	−55
	+48	50.75 to 52.50* 49.25 to 52.50†	43.75 to 52.50* 42.25 to 52.50†	
	−130 +130	125 to 135 125 to 135	125 to 135 125 to 135	
	208, 3ϕ, 60 Hz (Protected)	188 to 216‡, 60 Hz	180 to 224‡, 58 to 60 Hz	
	208, 3ϕ, 60 Hz (Essential)	188 to 216‡, 60 Hz	180 to 224‡, 58 to 62 Hz	
	117, 1ϕ, 60 Hz (Protected)	109 to 125§, to 60 Hz	104 to 129§, 58 to 60 Hz	
	117, 1ϕ, 60 Hz (Essential)	109 to 125§, to 60 Hz	109 to 129§, 58 to 62 Hz	

* Measured at power distributing frame.

† Measured at frame filter outputs.

‡ Measured line to line.

§ Measured line to neutral.

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
NO. 1 ELECTRONIC SWITCHING SYSTEM (ESS)				
	+24	25 to 26.25* 24 to 26.25†	21.75 to 26.25* 20.75 to 26.25†	+30
	−48	50.75 to 52.50* 49.75 to 52.50†	43.75 to 52.50* 42.75§ to 52.50†	−55
	+48	50.75 to 52.50* 49.25 to 52.50†	43.75 to 52.50* 42.25 to 52.50†	
	−130 +130	125 to 135 125 to 135	125 to 135 125 to 135	
	208, 3ϕ, 60 Hz (Protected)	188 to 216‡, 60 Hz	180 to 224‡, 58 to 60 Hz	
	208, 3ϕ, 60 Hz (Essential)	188 to 216‡, 60 Hz	180 to 224‡, 58 to 62 Hz	
	117, 1ϕ, 60 Hz (Protected)	109 to 125§, to 60 Hz	104 to 129§, 58 to 60 Hz	
	117, 1ϕ, 60 Hz (Essential)	109 to 125§, to 60 Hz	109 to 129§, 58 to 62 Hz	

* Measured at power distributing frame.

† Measured at frame filter outputs.

‡ Measured line to line.

§ Measured line to neutral.

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
NO. 2 ESS				
	+24	25 to 26.25* 24 to 26.25†	21.75 to 26.25* 20.75 to 26.25†	+30
	−48	50.75 to 52.50* 49.75 to 52.50*	43.75 to 52.50* 42.75 to 52.50†	−55
	+6	6.5 to 6.9‡ 5.9 to 6.9§	6.5 to 6.9‡ 5.9 to 6.9§	
	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	
	117, 1ϕ, 60 Hz (Protected ac)	109 to 125¶, 60 Hz	104 to 129¶, 58 to 60 Hz	
	208, 3ϕ, 60 Hz (Essential ac)	188 to 216**, 60 Hz	180 to 224**, 58 to 62 Hz	
	117, 1ϕ, 60 Hz (Essential ac)	109 to 125¶, 60 Hz	109 to 129¶, 58 to 62 Hz	

* Measured at power distributing frame.

† Measured at frame filter outputs.

‡ Measured at converter output.

§ Measured at equipment frame fuse panel bus bar.

¶ Measured line to neutral.

** Measured line to line.

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
NO. 3 ESS				
	+24	24.5 to 26*	22.0 to 26.5*	+30
	−48	50.75 to 52.5†	42.75 to 52.5†	
	+48	50.0 to 52.0*	47.0 to 53.0*	+55
	−130	126 to 134*	122 to 138*	−142
	+130	126 to 134*	122 to 138*	+142
	117, 1ϕ, 60 Hz (Protected)	110 to 125 60 Hz	100 to 130 59 to 61 Hz	
	117, 1ϕ, 60 Hz (Essential)	109 to 125 60 Hz	109 to 129 58 to 62 Hz	

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* Measured at power distributing frame.

† Measured at 151A DC Power Plant.

4. SWITCHING SYSTEMS (Cont)

NO. 101 ESS CONTROL UNIT	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
	−48	49.75 to 52.50	43.75 to 52.5	—
	+24*	23.35 to 24.95	23.35 to 24.95	+30
	+12*	11.20 to 12.0	11.20 to 12.0	+18
	+6*	6.1 to 6.4	6.1 to 6.4	+9
2A Switch Unit (Nonreserve and Reserve)				
AC Input to 2A SU Power Supply	117±10% 1ϕ, 60 Hz	105 to 129, 59.9 to 60.1 Hz	105 to 129, 59.9 to 60.1 Hz	—
DC Output From 2A SU Power Supply	+6†	6.0 to 7.2	6.0 to 7.2	+9
	+24†	20.9 to 26.4	20.9 to 26.4	+30
	+24† Filtered	20.5 to 26.4	20.5 to 26.4	+30
	−24†	22.5 to 26.4	22.5 to 26.4	−30
3A Switch Unit (Nonreserve)				
AC Input to 3A SU Power Supply	117, 1ϕ, 60 Hz	105 to 129, 1ϕ, 59.9 to 60.1 Hz	105 to 129, 1ϕ, 59.9 to 60.1 Hz	—
DC Output to 3A SU System	+6	6.0 to 7.2	6.0 to 7.2	+9
	+24	20.9 to 26.4	20.9 to 26.4	+30
	+24 Filtered	20.5 to 26.4	20.5 to 26.4	+30
	−24	22.5 to 26.4	22.5 to 26.4	−30

* Obtained from converter.

† Obtained from rectifier supply.

4. SWITCHING SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
3A Switch Unit (Reserve)				
DC Input to 3A SU Converter	+24	20.9 to 26.4	20.9 to 26.4	+30
DC Output to 3A SU System	+6*	6.0 to 7.2	6.0 to 7.2	+9
	+24* Filtered	20.5 to 26.4	20.5 to 26.4	+30
	−24*	22.5 to 26.4	22.5 to 26.4	−30
4A Switch Unit (Nonreserve)				
AC Input to 4A SU Power Supply	117, 1ϕ, 60 Hz	105 to 129, 1ϕ, 59.9 to 60 Hz	105 to 129, 1ϕ, 59.9 to 60 Hz	—
DC Output to 4A SU System	+6†	6.0 to 7.2	6.0 to 7.2	+9
	+24†	20.9 to 26.4	20.9 to 26.4	+30
	+24† Filtered	20.5 to 26.4	20.5 to 26.4	+30
	−24†	22.5 to 26.4	22.5 to 26.4	−30
4A Switch Unit (Reserve)				
DC Input to 4A SU Converter	+24	20.9 to 26.4	20.9 to 26.4	+30
	−48	49.75 to 52.5	43.75 to 52.5	−55
DC Output to 4A SU System	+6*	6.0 to 7.2	6.0 to 7.2	+9
	+24* Filtered	20.5 to 26.4	20.5 to 26.4	+30
	−24*	22.5 to 26.4	22.5 to 26.4	−30

* Obtained from converter.

† Obtained from rectifier supply.

5. SIGNALING CIRCUITS AND EQUIPMENT

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
MULTIFREQUENCY SIGNALING				
Multifrequency Pulsing Receiving Circuit (SD-95536-01; Common Systems)	+130 −48	125 to 135 48 to 50 or 50 to 52	125 to 135 45 to 50 or 45 to 52	
	115, 60 Hz	108 to 126, 60 Hz	108 to 126, 60 Hz	
Multifrequency Pulsing Receiving Circuit (SD-95087-01; Common Systems)	−48	48 to 50 or 50 to 52	45 to 50 or 45 to 52	
Multifrequency Current Supply Circuit	−24 or −48	22 to 26 48 to 50 or 50 to 52	20 to 28 45 to 50 or 45 to 52	
	+130	125 to 135	120 to 140	
Multifrequency Pulsing Receiving Circuit (SD-99493-01; Common Systems)	−48	48 to 50 or 50 to 52	45 to 50 or 45 to 52	
Multifrequency Receiving Circuit (SD-1A246-01; →No. 1 ESS, SD-3H402-01, No. 3 ESS)	−48	*	42.75 to 52.5	
Multifrequency Transmitter Circuit (SD-1A175-01; →No. 1 ESS, SD-3H404-01, No. 3 ESS)	−48	*	42.75 to 52.5	
SINGLE FREQUENCY SIGNALING				
Electron Tube Single Frequency Signaling Circuits—1600-2000 Hz	−24 or −48	22 to 26 48 to 50 or 50 to 52	22 to 26 45 to 50 or 45 to 52	
	+130	125 to 135	125 to 135	
Electron Tube Single Frequency Signaling Circuit—2600 Hz	−48	45 to 50 or 50 to 52	45 to 50 or 50 to 52	
	+130	125 to 135	125 to 135	

* The normal voltage range is that of switching equipment with which the signaling equipment is associated.

5. SIGNALING CIRCUITS AND EQUIPMENT (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
Type E Single Frequency Signaling Circuits—2600 Hz E1A, E1B, E2B, E3B, E1C, E1D, E1E, E1EK, E1F, E1FK, E1S, E1L, E1LA, E1SA, E2L-21	−48	45 to 50	45 to 50	
E1AK, E1AKD, E1BK, E1BKD, E2BK, E2BKA, E3BK, E3BKA, E4B, E1CK, E1CKB, E2C, E3C, E4C, E1DK, E1DKC, E2D, E3D, E4D, E5D, E1J, E2L (except E2L-21), E1P, E1R, E2S, E2LA, E2SA	−48	45 to 52	42 to 53	
Type F Single Frequency Signaling Circuits—2600 Hz	−48 −24*	45 to 52 22.5 to 25.5	42 to 53 —	

* The −24 volt nominal voltage for type F single frequency signaling is derived from regulated J87304A 48- to 24-volt power converter only.

6. TRAFFIC SERVICE SYSTEMS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
SWITCHBOARDS				
No. 1*	−24	22 to 26	20 to 28	
	−48	48 to 50	40 to 56	
No. 3, 3C, 3CF, 3CL*	−24	23 to 26	22 to 26	
	−48	48 to 50	45 to 52	
No. 5, 5C, 5D	−24	23 to 26	21 to 26	
	−48	48 to 50	45 to 50	
No. 11 Manual Machine Ringing	−24	22 to 26	22 to 28	
	−48	48 to 50	45 to 50	
No. 12 Manual	−48	48 to 50 or 50 to 52	40 to 56	
DSA Switchboard No. 13C, 13D, 14C, 14D, 15C, 15D*	−24	24 to 26	22 to 26	
	−48	48 to 50	45 to 52	
DESKS				
Information Desk No. 2	−24	22 to 26	20 to 28	
	−48†	48 to 50	45 to 50	

* Switchboards No. 1, 3C, 3CF, 3CL, and DSA also require +48 volt battery supplied by the central office when used with dial-tone-first feature in same buildings with SXS or CSBR No. 1. These switchboards, when located in the same building as CSBR No. 5, require +130 and −130 volt battery for coin control. Otherwise, coin control supply of central office is used.

† Required when used for regular intercept service and two or more classes of intercept service are provided.

6. TRAFFIC SERVICE SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
Information Desk No. 3, 4, 6A, or 6B	−24	22 to 26	20 to 28	
	−48*	48 to 50	45 to 50	
Information Desk No. 3A, 3B, 4A, 4B, 6C, 6D, 6E, or 6F	−24	22 to 26	20 to 28	
	−48	48 to 50	45 to 50	
Information Desk No. 7 or 7A	−24	22 to 26	20 to 28	
	−48*	48 to 50	45 to 50	
Operating Room Desk No. 19	−24	22 to 26	20 to 28	
	−48*	48 to 50	45 to 50	
Operating Room Desk No. 23A, 23B, or 23C	−48	48 to 50	45 to 50	
	+100 Coin†	100 to 120	—	
	+130 PLT and TLG†	125 to 135	—	
AUXILIARY SERVICES POSITIONS				
No. 1A, 2A, 2B, 2C	−48	48 to 50	45 to 50	
No. 3A, 3B	+24	24.0 to 26.5	20.75 to 26.25	
No. 4A	−48	50.75 to 52.5	42.75 to 52.5	
TRAFFIC SERVICE POSITION SYSTEM (TSPS) NO. 1‡				
	+24	25.0 to 26.25§ 24.0 to 26.25¶	21.75 to 26.75§ 20.75 to 26.25¶	+30
	−48	50.75 to 52.5§ 49.75 to 52.5¶	43.75 to 52.5§ 42.75 to 52.5¶	−55
	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	

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* Required when used for regular intercept service and two or more classes of intercept service are provided.

† Required for test circuit if desk accommodates regular intercept service and machine intercept service.

‡ The +24, −48, +130, and −130 volt supplies are all dedicated at the base location. At remote sites, the −48 volts may be obtained from existing power plants, but the +24, +130, and −130 volt supplies are dedicated. The +24 and −48 volt power plants must be of the 111A or 326A type.

§ Measured at power distributing frame.

¶ Measured at frame filter outputs.

6. TRAFFIC SERVICE SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
	208,3ϕ, 60 Hz (Protected)	188 to 216*, 60 Hz	182 to 224*, 58 to 62 Hz	
	117, 1ϕ, 60 Hz (Protected)	109 to 125†, 60 Hz	104 to 129†, 58 to 62 Hz	
	117, 1ϕ, 60 Hz (Essential)	109 to 125†, 60 Hz	109 to 125†, 58 to 62 Hz	
AUTOMATIC INTERCEPT SYSTEM (AIS)				
	+24	25.0 to 26.25‡	21.75 to 26.25‡	
		24.0 to 26.25§	20.75 to 26.25§	
	−48	50.75 to 52.50‡	43.75 to 52.50‡	
		49.75 to 52.50§	42.75 to 52.50§	
	117, 1ϕ, 60 Hz (Protected)	109 to 125¶, 60 Hz	104 to 129¶, 58 to 60 Hz	
	117, 1ϕ, 60 Hz (Essential)	109 to 125¶, 60 Hz	109 to 125¶, 58 to 60 Hz	
	+6	6.5 to 6.9** 5.9 to 6.9††	6.5 to 6.9** 5.9 to 6.9††	

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* Measured line to line.

† Measured line to neutral.

‡ Measured at the power distributing frame.

§ Measured at the equipment frame filter output.

¶ Measured between line and neutral.

** Measured at converter output.

†† Measured at equipment frame fuse panel bus bar.

7. TRAFFIC MANAGEMENT SYSTEMS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
TRAFFIC MEASUREMENT SYSTEM NO. 1A				
	+48	—	45 to 52	
	117, 60 Hz	—	105 to 125, 60 Hz	
TRAFFIC DATA RECORDING SYSTEM NO. 1A				
Traffic Data Summarizer	117, 60 Hz	—	105 to 129, 60 Hz	
Traffic Data Converter	115, 60 Hz		103.5 to 131.5, 58 to 60 Hz	
	−24	22 to 26	21 to 26	
	−48	48 to 50	45 to 50	
Traffic Remote Recorder	117, 60 Hz	—	105 to 129, 60 Hz	
SERVICE OBSERVING SYSTEMS				
Special Studies Set No. 1A	−48	48 to 50	42.75 to 52.5	
No. 4, 6, 7, 9, 10, 11 Service Observing Desks	−24	22 to 26	20 to 28	
	−48	48 to 50 or 50 to 52	40 to 56	
No. 12 Service Observing Desk and Associated Service Observing Circuits	−48	48 to 50	45 to 50	
	+130	125 to 135	125 to 135	
Portable Service Observing Sets	−24	—	21 to 26	
No. 4 Set	−38	—	31 to 43	
	−48	48 to 50	40 to 56	
No. 6 Set	−24	—	20 to 28 21 to 26	
	−48	—	45 to 50 42.75 to 52.5 40 to 56	
	+130	125 to 135	125 to 135	
No. 7 Set	−48	48 to 50	42.75 to 52.5	
AUTOMATIC MESSAGE ACCOUNTING CENTER NO. 1	−52	—	50 to 53.25	

7. TRAFFIC MANAGEMENT SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
ANNOUNCEMENT SYSTEMS				
1B	−24	24 to 26	20 to 28	
	−48	48 to 50	45 to 50	
2D	−24	24 to 26	20 to 28	
	−48	48 to 50	45 to 50	
3A	−24	24 to 26	20 to 28	
	−48	48 to 50	45 to 50 40 to 56 or 42.75 to 52.5	
4A	−24	24 to 26	20 to 28	
	−48	48 to 50	45 to 50 or 40 to 56	
6A	117, 60 Hz	105 to 129	105 to 129	
	−24	24 to 26	20 to 28	
	−48	48 to 50	45 to 50 or 40 to 56	
8A	117, 60 Hz	105 to 129	105 to 129	
	−48	48 to 50	45 to 50	
	+130	115 to 120 125 to 135	100 to 120 125 to 135	
9A	117, 60 Hz	105 to 129	105 to 129	
	−48	48 to 50	45 to 50 or 40 to 56	
	+130	115 to 120 125 to 135	100 to 120 125 to 135	
11A	117, 60 Hz	105 to 129	105 to 129	
	−48	48 to 50	45 to 50	
	117, 60 Hz	105 to 129	105 to 129	
100A	117, 60 Hz	105 to 129	105 to 129	
Common (J1C012)	117, 60 Hz	105 to 129	105 to 129	

7. TRAFFIC MANAGEMENT SYSTEMS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
TEST DESKS				
Repair Service Desk No. 2	−24	22 to 26	20 to 28	
	−48	48 to 50	40 to 56	
Cable Test Desk No. 3	−24	22 to 26	20 to 28	
	−48	48 to 50	40 to 56	
Local Test Cabinet No. 3	−24	22 to 26	20 to 28	
	−48	48 to 50 or 50 to 52	40 to 56	
Local Test Desk No. 14	−24	22 to 26	20 to 28 Manual 22 to 26 Dial	
	−48	48 to 52	40 to 56 Manual 45 to 52 Dial	
	+48	48 to 52	45 to 52	
	−72	71 to 75	66 to 75	
	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	
Local Test Desk No. 15B	−48	48 to 52	45 to 52	
	+130	125 to 135	125 to 135	
	117, 60 Hz	105 to 129	105 to 129, 60 Hz	
Local Test Desk No. 16	−24	22 to 26	20 to 28 Manual 22 to 26 Dial	
	−48	48 to 52	40 to 56 Manual 45 to 52 Dial	
	+48	48 to 52	45 to 52	
	−72	71 to 75	66 to 75	
	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	

7. TRAFFIC MANAGEMENT SYSTEMS (Cont)

	NOMINAL COLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
Line Status Verifier (LSV)	−24	22 to 26	20 to 28 Manual 22 to 26 Dial	
	−48	48 to 52	40 to 56 Manual 45 to 52 Dial	
	+130	125 to 135	125 to 135	
TESTBOARDS				
No. 5	−48	48 to 50	45 to 50	
	−24	22 to 26	22 to 26	
No. 17B, 17C, 17D	−48	48 to 50	45 to 50	
	−24	22 to 26	21 to 26	
	+130	125 to 135	120 to 140	
No. 18B	−48	48 to 50 or 50 to 52	45 to 50	
	−24	22 to 26	21 to 26	
	+130	125 to 135	120 to 140	
No. 17E, 19A, 20A, 21A, 22A, 24A	−48	48 to 50	45 to 50	
	−24	22 to 26	22 to 26	
	+130	125 to 135	125 to 135	
No. 23B	−24	22 to 26	22 to 26	
	−48	48 to 50	45 to 50	
	+130	125 to 135	125 to 135	
	117, 1ϕ, 60 Hz	105 to 129, 60 Hz	105 to 129, 60 Hz	
SWITCHED MAINTENANCE ACCESS SYSTEMS (SMAS)				
SMAS No. 1A	−48	48 to 50	45 to 50	
	−24	22 to 26	21 to 26	
	+130	125 to 135	125 to 135	
SMAS No. 2A	−48	48 to 50	45 to 50	
SMAS No. 3A	−48	45 to 50	43 to 52	
	−24	23 to 25	22 to 26	
	+24	23 to 25	22 to 26	

8. "TOUCH-TONE" CALLING

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
TOUCH-TONE Calling Detector Circuit (SD-3H401-01, No. 3 ESS)	+24	*	20.75 to 26.25	← ┐ ← ┘
TOUCH-TONE Calling Receiving Circuit—Type A3 (Common Systems)	−48	48 to 50 or 50 to 52	45 to 50 or 45 to 52	
TOUCH-TONE Calling Receiving Circuit—Type B1 (No. 1 ESS)	+24	*	20.75 to 26.25	
TOUCH-TONE Calling Receiving Circuit—Type C (PBXs)	−48	48 to 50 50 to 52	44 to 50 44 to 52	
TOUCH-TONE Calling Receiving Circuit—Type D (Key Telephone Systems)	−24	*	20 to 26	

* The normal voltage range is that of switching equipment with which the signaling equipment is associated.

9. REPEATERS AND CARRIERS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE		EMERGENCY VOLTAGE LIMITS	REMARKS
VF REPEATERS					
22A1	−24 or	20 to 26.25		±3*	
44A1	−48 and	40 to 56	±2%*		
V1	+130 or	125 to 136		115 to 140	
V3	+152	151.8		130 to 160	
V4	−24	20 to 26		19 to 28	
	−48	40 to 52		38 to 54	
E1	−24 or	20 to 28		17 to 29	
E2	−48 and	40 to 56		34 to 62	
E3	+130	125 to 136		115 to 140	
E6		40 to 56		±6*	
E7	−48	±5%*			
306A (Unigauge)					
WIDEBAND LOOP REPEATERS (WLRs)					
WLR1 to WLR5	−48	42 to 54		±6*	
	+130	125 to 136	±2%*	115 to 140	
	-130	125 to 136		115 to 140	
AMPLIFIERS					†
12C	−24 or	20 to 26.25		±3*	
14C	−48 and	40 to 56	±2%*	±6	
	+130 or	125 to 136		115 to 140	
	+152	151.8		130 to 160	
258A&B	−48	40 to 56 ±2%*		±6*	
ECHO SUPPRESSORS					
1A	−24 or	20 to 26.5		±3*	
	+130	125 to 136 ±2%		115 to 140	
2A	−24	22 to 26		20 to 27	
3A	−48	49 to 52		43 to 52	
4A	−48	48 to 50		42.75 to 51.5	
		51 to 52		42.75 to 52.5	
MULTIPORT CONFERENCE BRIDGE (J68657)	−48	48 to 50 or 51 to 52		42.75 to 51.5 42.75 to 52.5	

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* From normal voltage, which may be any value between the normal range shown.

† Nonregulated supplies with normal limits of 20 to 28, 40 to 56, and 125 to 135 volts, and emergency limits of 20 to 28, 40 to 56, and 115 to 150 volts may be used for message transmission but with some service impairment and reduction in tube life.

9. REPEATERS AND CARRIERS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
C CARRIER				
C1 Carrier Repeater	115, 60 Hz		105 to 125, 60 Hz	
C5 Carrier Terminal	−24 +130 55, 60 Hz	22 to 26 125 to 135	20 to 28 120 to 140	
C5 Terminal	22, 50 or 60 Hz			
J AND K CARRIERS—MAIN OR TERMINAL STATIONS				
J and K1—Filament	−24	20 to 26.25 ±2%*	±3*	
Plate	+130	125 to 136 ±2%* 125 to 135 ±2%*	120 to 140 (Main) 125 to 135 (Terminal)	
J and K1—Grid	−16		15.5 to 17.25	
K2 Nontwist-Twist	−24 −40 +130	24.5 to 26.5 47 to 49 125 to 135	20 to 26.5 46 to 50 125 to 135	
J AND K1 CARRIERS—AUXILIARY STATION				
Filament	+21.7 Volt Tap on Plate Battery +43.4 +65.1 +86.8 +108.5 +130.2 +152			
Plate	+152 or +130 −24	140 to 160 125 to 135 22 to 26	131 to 160 120 to 140 20 to 28	
Grid	−16		15.5 to 17.25	

* From normal voltage, which may be any value between the normal range shown.

9. REPEATERS AND CARRIERS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
K2 CARRIER—MAIN, TERMINAL, AND AUXILIARY STATIONS				
Filament	60, 60 Hz	±3%	54 to 66, 60 Hz	
K2 CARRIER—AUXILIARY STATIONS				
Plate	+152 or +130	140 to 160 125 to 135	131 to 160 120 to 140	
	−24	22 to 26	20 to 28	
J and K1—Grid	−16			
L1 CARRIER—MAIN AND TERMINAL STATIONS				
	−24	22.5 to 25.75 ±0.5	±3*	
	−48	48 to 50 or 50 to 52	44 to 52	
	+130	125 to 135	125 to 135	
	230, 60 Hz (From Motor-Alternator Plant)			
L3 CARRIER—MAIN AND TERMINAL STATIONS				
	−24	22.5 to 25.75 ±0.5	±3* 125 to 135	
	+130	125 to 135		
	230, 60 Hz (From Motor-Alternator Plant)			
L3 CARRIER—TELEVISION TERMINALS				
T3, R3	230† 56 to 60.5 Hz	±1%	±5%	
	−24	22 to 26	20 to 28	

* From normal voltage, which may be any value between the normal range shown.

† Normally derived from L3 alternator or inverter.

9. REPEATERS AND CARRIERS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
L4 CARRIER				
Main Station	−24	22 to 23.9	20.0* to 28†	
11-Cell Battery Plant	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	
	115, 60 Hz	—	90 to 136	
12-Cell Battery Plant	−24	23.5 to 26.0	21.5‡ to 28.0†	
	+130	125 to 135	125 to 135	
	−130	125 to 135	125 to 135	
	115, 60 Hz	—	90 to 136	
L5 CARRIER				
Main Station 11-Cell Battery Plant With End Cells (300 Type)	−24	22.5 to 23.9	20.5 to 28.0	
12-Cell Battery Plant With End Cells (300 Type)	−24	24.0 to 26.0	22.0 to 28.0	
12-Cell Battery Plant Without End Cells (100 Type)	−24	24.5 to 26.0	20.5 to 28.0	
413A Plant	140	149 to 152	120 to 159	
620A Plant	−24 reg	−24 reg	−24 reg	
CARRIER TELEPHONE TERMINALS				
LMX-2, L-Type Multiplex Equipment per J68857, J68858, J68867, and J68918	−24	22 to 26	20§ to 29	
N1 CARRIER SYSTEM				
Terminals	−48	46 to 52	±6¶	
	+130	125 to 136	±8¶	
Repeaters	+130	125 to 136	115 to 140	
	−130	125 to 136	110 to 140	

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* The minimum extreme voltage is 19.5, except MMX-2 (master group multiplex) which is 18.5.

† The maximum transient voltage is 29.0.

‡ The minimum extreme voltage is 21.0, except the high voltage line converter and J68820 switch control which is 19.5 and MMX-2 (master group multiplex) which is 18.5.

§ The dc-to-dc converter may not regulate, and some amplifiers may degrade below -22 volts.

¶ From normal voltage, which may be any value between the normal range shown.

9. REPEATERS AND CARRIERS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
N2 CARRIER SYSTEM				
Terminals	−48	46 to 52	42.7 to 52.5	
	+130	125 to 136 ±2%	±8*	
	−130	125 to 136 ±2%	±8*	
Packaged Terminals	−48	46 to 52	45† to 52.5 or 42.75† to 52.5	
	+130	125 to 136 ±2%	±8*	
	−130	125 to 136 ±2%	±8*	
Repeaters	+130	125 to 136 ±2%	115 to 140	
	−130	125 to 136 ±2%	110 to 140	
N3 CARRIER SYSTEM				
Packaged Terminals	−48	46 to 52	45† to 52.5 or 42.75‡ to 52.5	
	+130	125 to 136 ±2%	±8*	
	−130	125 to 136 ±2%	±8*	
N3-L JUNCTIONS				
	−48		42.75 to 52§	
	+130	125 to 136	±8*	
	−130	125 to 136	±8*	
O-1 CARRIER				
Terminals	−48	46 to 52	±6*	
	+130	125 to 136	±8*	
Repeaters	−48	46 to 52	±6*	
	+130	125 to 136 ±2%	115 to 140	
	or			
	+130	125 to 136	115 to 140	
U-1 CARRIER TERMINAL				
U-1 Subscriber Loop Carrier	−48	46 to 52	42 to 53	

* From normal voltage, which may be any value between the normal range shown.

† N carrier packaged bays, including E-type SF signaling.

‡ N carrier packaged bays, including F-type SF signaling.

§ Minimum emergency limit measured at frame power, alarm, and miscellaneous panel.

9. REPEATERS AND CARRIERS (Cont)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
MISCELLANEOUS CARRIER EQUIPMENT				
Wire Line Entrance Links (J68874) 64-kHz Preamplifier (J68909) Independent 64-kHz Line Pilot Supply (J68911) 64-kHz Line Pilot Monitor (J68872) Restoration Patch Bay (J68876) A5 Channel Bank (J68853)	−24	22 to 26	20 to 29	
1A Compandor	−24 +130	20 to 28 125 to 135	20 to 28* 115 to 140*	
308- to 64-kHz Converter PFS-2A Primary Frequency Supply PFS-2B Primary Frequency Generator LMW-1 through -6 Wideband Modems	−24	22 to 26	20 to 28	
N2WT-1 Wideband Terminal	−48	44 to 52	40 to 52	
10. RADIO TELEPHONE SYSTEMS				
Mobile Radio Land Transmitters	117, 50 or 60 Hz	102 to 112 112 to 122 122 to 132	102 to 132, 50 or 60 Hz	
Mobile Radio Land Receivers	117, 50 or 60 Hz +6 dc	103.5 to 128.5, 50/60 Hz or 5.7 to 6.6 dc	103.5 to 128.5, 50/60 Hz or 5.7 to 7.5 dc	
Mobile Radio Transmitters and Receivers	+6 or +12	—	5.7 to 7.5 10.7 to 15	
221A, 221B, Radio Telephone Equipment	115, 50 or 60 Hz	110 to 117	105 to 125	
LD-T2 Transmitter LD-B1 Branching Amplifier	3ϕ, 230, 1ϕ, 115, 50 or 60 Hz	225 to 232 110 to 117	218.50 to 241.50 105 to 126	
LE-T1 Transmitter LE-R1 Receiver	1ϕ, 115, 50 or 60 Hz	110 to 117	109.25 to 120.75	

* Nonregulated supplies with normal limits of 20 to 28 and 125 to 135 volts and emergency limits of 20 to 28 and 115 to 150 volts may be used for message transmission but with some service impairment and reduction in tube life.

11. TELEVISION SYSTEMS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
A2 Video System	115, 60 Hz	105 to 125	–	
A2A or A2B Video System	115, 60 Hz	105 to 125 60 ±0.7 Hz	–	
A2AT Video System	−24	22 to 28	21 to 28	
	+24	22 to 28	21 to 28	
	or 115, 60 Hz	105 to 125	100 to 130 58 to 63 Hz	
	−48*	45 to 50	40 to 56	
A4 Video System	−24	22 to 28	21 to 30	
	+24	22 to 28	21 to 30	
	or 115, 60 Hz	105 to 125	100 to 130 58 to 63 Hz	
	−48*	45 to 50	40 to 56	
J-44102 Television Operating Center (TOC)	−24	22 to 26	20 to 28	
	+130	125 to 135,	120 to 140	
	115, 60 Hz	50 to 60 Hz	–	
J-44107 Television Operating Center (TOC)	−24	22 to 26	20 to 28	
	115, 60 Hz	105 to 125, 60 ±0.7 Hz	–	
	115, 60 Hz	105 to 125, 50 to 60 Hz	–	
1B Clamper Amplifier	115, 60 Hz	105 to 125, 50 to 60 Hz	–	
J-44107AH Video Amplifier	−24	22 to 28	21 to 28	
	or −24	22 to 28	21 to 28	
	+24	22 to 28	21 to 28	
	or 115, 60 Hz	105 to 125	100 to 130, 57 to 63 Hz	
	−48*	45 to 50	40 to 56	
J-44107AJ-1X3 Splitting Amplifier	−24	21 to 28	20 to 28	
	or −24	21 to 28	17 to 28	
	+24	21 to 28	17 to 28	
	or 115, 60 Hz	100 to 125	90 to 130, 58 to 63 Hz	
TIDI Sound	115, 50/60 Hz	110 to 120, 58/63 Hz	105 to 129, 58/63 Hz	

* Alarm battery supply.

12. MICROWAVE RADIO TELEPHONE SYSTEMS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
TD-2 Radio Relay	-12	11 ±0.1	9.9 to 11.5	
	−24	22 to 26	20 to 26	
	+130	135 to 137*	116 to 140	
	+250	255 to 259	224 to 266	
TD-3 Microwave System	−24	22 to 26	21 to 26	
TE-1, TE-2 Microwave	115, 60 Hz	—	105 to 125, 60 Hz	
TH-1 Microwave System	1ϕ, 230, 60 Hz (Firm ac)	230 ±1%, 60 Hz ±1%	230 ±5%, 60 Hz ±3%	
	+140†	140 to 160	131 to 160	
TH-3	−24	21 to 27	20 to 28	
TJ Microwave System	1ϕ, 117, 60 Hz	—	117 ±10%, 60 Hz ±5	
	−48	42 to 53	42 to 53	
TL-2, TM-1, and TM-1A Microwave System	−24	23 to 27	22 to 28.1	
3A FM Terminal	−24	23 to 26	21 to 27	
3B FM Terminal	−24	23 to 26	21 to 27	
4A FM Terminal	−24	23 to 26	21 to 27	
3A Wire Line Entrance Link	−24	22.5 to 25.75 +0.5	±3‡	
100A Protection Switching System	+24	23 to 26	21 to 27	
	−24	23 to 26	21 to 27	
300A Protection Switching System	+24	21 to 27	21 to 27	
	−24	21 to 27	21 to 27	
400A Protection Switching System	−24	23 to 26	20 to 28	
400B Protection Switching System	−24	23 to 26	20 to 28	

* Where +130 volts is not derived from 425A power plant, normal voltage range may be 124 to 136.

† 70-cell battery plant.

‡ From normal voltage, which may be any value between the normal range shown.

13. SURVEILLANCE AND CONTROL SYSTEMS

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
E1 and E2 Status Reporting and Control System	−24 +24	21 to 27 21 to 27	20 to 29 20 to 29	
SUPERVISORY CONTROL				
Broadband Restoration Status Assembling System	−24 +24	21 to 27 21 to 27	19 to 29 19 to 29	
Cable Pressure Telemetry	115, 50/60 Hz	110 to 125	105 to 129	
BROADBAND RESTORATION—ORDER WIRES				
Order Wire, Data Order Wire and Order Wire Conference Circuits	−24 −48	22 to 26 45 to 50	20 to 29 40 to 55	
2-Wire Key Conference Circuit	−24 −48	20 to 28 40 to 56	20 to 29 40 to 56	
Automatic Continuity for Order Wires	−24 −48 +130	22 to 26 45 to 50 125 to 135	20 to 29 44 to 52 120 to 140	
Local Manual Control and Local Status Indicating Circuit for Restoration Office Requiring Locked Commands	−24 +24 +130	21 to 27 21 to 27 125 to 135	20 to 29 20 to 29 120 to 140	
Office Display Circuit	+24 −48	20 to 28 40 to 56	20 to 29 40 to 56	
A. Broadband Switching Systems				
1x8, 8x8, and 16x16 Switch Matrix, Switch Network and Control Circuits	−24	21 to 27	20 to 29	
B. Order Wires				
General Purpose 4-Wire Order Circuit	−24 +24	22 to 27 22 to 27	20 to 29 20 to 29	

14. DIGITAL TRANSMISSION FACILITIES

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
T1 AND T1C DIGITAL LINES				
Repeater Bays	−48	46 to 52	42.5 to 53	
	+130	125 to 135	115 to 140	
	−130	125 to 135	110 to 140	
T2 DIGITAL LINE				
Intermediate Power Station Bay	−48	46 to 52	42.7 to 52.5	
	+130	125 to 135	125 to 140	
	−130	125 to 135	110 to 140	
Span Terminating Bay	−48	46 to 52	42.7 to 52.5	
	+130	125 to 135	125 to 140	
	−130	125 to 135	110 to 140	
D-TYPE CHANNEL BANKS				
D1A, D1B, D1C, D1D, D2, D3, Unitized D3, D4, and DCT	−48	45 to 50	42.5 to 53	
DIGITAL MULTIPLEXES				
M12 and M12A Digital Multiplex/Demultiplex	−24	20 to 26	20.5 to 28*	
	−48	48 to 52	42.75 to 53†	
DATA BANKS AND MODEMS				
T1WB-1, T1WB-2, T1WB-3 Wideband Banks	−48	46 to 50	42 to 52.8	
T1WB-4 and T1WB-5 Wideband Banks	−24	22 to 26	20 to 28	
	−48	45 to 50	42.5 to 53	
T1WM-1 Wideband Modem	−48	46 to 50	42 to 53	
T1WM-4 Wideband Modem	115, 60 Hz	110 to 120	105 to 135	
MISCELLANEOUS				
Combined D1B Bank and Repeaters; also T1/OS-D3 and T1/OS-D4	−48	45 to 50	42.5 to 53	
	+130	125 to 135	115 to 140	
	−130	125 to 135	110 to 140	
DSX1 and DSX2 Patch and Cross-Connect	−24	22 to 26	20 to 29	
	−48	45 to 50	42.5 to 53	

* Maximum allowable transient < 1 second 29.

† Maximum allowable transient < 1 second 55.

15. TIME ASSIGNMENT SPEECH INTERPOLATION (TASI)

	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS	MAXIMUM TRANSIENT VOLTAGE
TASI				
	−24	24 to 26	22 to 26*	
	+24	24 to 26	22 to 26	
	−48	44 to 52	40 to 56	
	+130	125 to 135	120 to 140	
TASI B†				
	+24	21 to 28	21 to 28	

16. COIN CONTROL

COIN CONTROL SUPPLIES (CC+ AND CC-)

VOLTAGE RANGE	PANEL AND NO. 1 CSBR	NO. 5 CSBR	SXS NO. 1 355A	ESS NO. 1, NO. 2, AND NO. 3
116 to 120				
Ringing and CC Gen	X		X	
Rectifier (with dry cell reserve)	X		X	
Converter	X		X	
100 to 120				
Dry cells only			X	
Converter	X		X	
112 to 120				
Dry cells only			X	
125 to 135				
Rectifier (with battery reserve)		X		
Converter		X		X

* Minimum and maximum are not only emergency limits, but also extremes. Voltage in excess of this value may damage solid state circuit components.

† Battery supply shall be a dedicated 111A battery plant.

17. 20-HZ RINGING

CONTINUOUS RINGING SUPPLIES—CENTRAL OFFICES

A. 105 Volts ± Continuous, Not Audible

GENERATOR	AC VOLTAGE	DC COMPONENT	SYSTEM OF USE
KS-5430-01	100 to 120	—	PBX Ringing Feeders
KS-5492-01	95 to 130	—	35E97
KS-5523	95 to 130	—	35E97
KS-5546	90 to 130 110 to 130*		No. 1, 350, 355 SXS, 35E97
KS-15532	100 to 120	—	No. 1 CSBR, No. 5 CSBR, No. 1 SXS
KS-15670	101 to 110	—	PBX Ringing Feeders
KS-15816	101 to 110	—	Panel, No. 1 CSBR, No. 5 CSBR, No. 1 SXS
KS-15529 (109B)	102 to 110†	—	355 SXS, No. 5 CSBR
110A	102 to 110	—	No. 1 ESS
J87266E	102 to 110†	—	No. 1 ESS, PBX Ringing Feeders, No. 5 CSBR, No. 1 SXS
J87322	102 to 110†	—	No. 1 ESS, PBX Ringing Feeders, No. 5 CSBR, No. 1 SXS
J87326	102 to 110†	—	No. 2 ESS, PBX Ringing Feeders, No. 1 SXS
J87824	102 to 110†	—	No. 3 ESS

B. 85 Volts ± Continuous, Not Audible

KS-15532	80 to 95	—	No. 1 CSBR, No. 5 CSBR, No. 1 SXS (AC/DC Offices Only)
KS-15816	81 to 90	—	Panel, No. 1 CSBR, No. 5 CSBR, No. 1 SXS (AC/DC Offices Only)
‡	80 to 130		Traffic Management, Line Status Verifier

C. ± Audible, Continuous Audible

KS-5319-04	75 to 90	—	CADW System
KS-5492-01	75 to 90	—	35E97

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* With voltage regulator.

† Under power failure conditions, the 102- to 110-volt range may be 90 to 110 volts.

‡ The line status verifier can use any generator listed in Sections 17A and 17B.

17. 20-HZ RINGING (Cont)

GENERATOR	AC VOLTAGE	DC COMPONENT	SYSTEM OF USE
KS-5523	75 to 90	—	35E97
KS-5546	84 to 88*	—	No. 1, 350 SXS
	72 to 88	—	350 SXS
	65 to 90	—	355 SXS
KS-15532	84 to 88	—	No. 1 CSBR, No. 5 CSBR, No. 1 SXS (Superimposed Office Only)
KS-15816	84 to 88	—	Panel, No. 1 CSBR, No. 5 CSBR (Superimposed Office Only)
KS-5756	94 to 101	—	No. 1 CSBR, No. 5 CSBR, SXS (DLL in Superimposed Office or With 8-Party SXS in AC/DC Office)
KS-5815	94 to 101	—	No. 1 CSBR, No. 5 CSBR, SXS (DLL in Superimposed Office or With 8-Party SXS in AC/DC Office)
KS-20392	94 to 101	—	No. 1 CSBR, No. 5 CSBR, SXS (DLL in Superimposed Office or With 8-Party SXS in AC/DC Office)
D. AC/DC Audible Continuous With Negative DC Component (Except as Specified)			
KS-5546	84 to 88*	45 to 50†	No. 1, 350, 355 SXS
	72 to 88	45 to 50†	No. 1, 350 SXS
	75 to 110	45 to 50†	355 SXS, 35E97
KS-15532	84 to 88	45 to 50	No. 1 CSBR, No. 5 CSBR, No. 1 SXS
		66 to 75	No. 5 CSBR (Unigauge)
KS-15816	84 to 88	45 to 50	Panel, No. 1 CSBR, No. 5 CSBR, SXS
		45 to 50	Panel (AC/DC Office Arranged for Flash Removal)
		66 to 75	No. 5 CSBR (Unigauge)
KS-15529 (109B)	84 to 88‡	45 to 50†	355 SXS, No. 5 CSBR
J87322	84 to 88‡	45 to 50	No. 1 CSBR, No. 1 SXS
J87326	84 to 88‡	45 to 50	No. 1 SXS

* With voltage regulator.

† The 45- to 50-volt range will be 45 to 52 volts when the 48-volt plant is arranged for these limits.

‡ Under power failure conditions, the 84- to 88-volt range may be 75 to 90 volts.

17. 20-HZ RINGING (Cont)

E. Superimposed—Audible, Superimposed + Audible, Continuous With Positive and Negative DC Component

GENERATOR	AC VOLTAGE	DC COMPONENT	SYSTEM OF USE
KS-5546	84 to 88*	36 to 40	No. 1, 350, 355 SXS
	72 to 88	36 to 40	No. 1, 350 SXS
	65 to 90	36 to 40	355 SXS
	84 to 88	45 to 50	No. 1, 350, 355 SXS — 8-Party Semiselective Ringing in AC/DC Offices
	72 to 88*	45 to 50	No. 1, 350 SXS — 8-Party Semiselective Ringing in AC/DC Offices
	75 to 110	45 to 50	355 SXS — 8-Party Semiselective Ringing in AC/DC Offices
KS-15532	84 to 88	36 to 40	No. 1 CSBR, No. 5 CSBR, SXS
	84 to 88	45 to 50	No. 1 CSBR, SXS — 8-Party Semiselective Ringing in AC/DC Offices
KS-15529 (109B)	84 to 88†	36 to 40	No. 5 CSBR
	84 to 88†	45 to 52	355 SXS
	94 to 101*	45 to 50	No. 5 CSBR, 355 SXS (DLL)
J87322	84 to 88†	36 to 40	No. 5 CSBR, No. 1 SXS
	94 to 101*	45 to 50	
J87326	84 to 88†	36 to 40	No. 1 SXS
	94 to 101*	45 to 50	

F. AC/DC (Not Audible) Continuous With Negative DC Component

110A	84 to 88	42.75 to 52.5	No. 1 ESS
J87266	84 to 88	42.75 to 52.5	No. 1 ESS
J87322	84 to 88	42.75 to 52.5	No. 1 ESS
J87326	84 to 88	42.75 to 52.5	No. 2 ESS
J87824	84 to 88	42.75 to 52.5	No. 3 ESS ←

G. Superimposed—Superimposed + (Not Audible) Continuous With Positive and Negative DC Component

110A	84 to 88	36 to 40	No. 1 ESS
	94 to 101	42.75 to 52.5	No. 1 ESS (DLL)
J87266	84 to 88	36 to 40	No. 1 ESS
J87322	84 to 88	36 to 40	No. 1 ESS
J87326	84 to 88	36 to 40	No. 2 ESS
J87824	94 to 101	42.75 to 52.5	No. 3 ESS ←

H. AC/DC (Not Audible) Continuous With Positive DC Component ←

J87824	84 to 88	42.75 to 52.5	No. 3 ESS ←

* With voltage regulator.

† Under power failure conditions, the 84- to 88-volt range may be 75 to 90 volts.

17. 20-HZ RINGING (Cont)

MACHINE RINGING

RINGING SUPPLY	DESCRIPTION	SYSTEM
MR R1 BR1,2,3	Machine ringing "one ring"; consists of ac/dc aud interrupted, with -48 volts dc during silent interval; for 2-party selective ringing (ac/dc is not audible in ESS No. 1 and No. 2)	Panel, No. 1 CSBR, No. 1 SXS, and 350A
Code 1 Gen BR1,2,3		No. 5 CSBR, 355A SXS, ESS No. 1, and No. 2
MR Sup- MR Sup+ BR1,2,3	Machine ringing "one ring"; consists of sup- aud, sup+ aud interrupted, with -48 or +48 volts dc during silent interval; for 4-party selective ringing	Panel, No. 1 CSBR, No. 1 SXS, and 350A
Code 1 Gen BR1,2,3 Code 1+		No. 5 CSBR, 355A SXS
MR R2 BR1,2,3	Machine ringing "two rings"; consists of ac/dc aud interrupted, with -48 volts dc during silent interval; for 4-party semiselective ringing	Panel, No. 1 CSBR, No. 1 SXS, and 350A
Ring 2 Gen		SXS 355A
Code 2 Gen		CSBR No. 5
Code 2+ Code 2 Gen	Machine ringing "two rings"; consists of sup- aud, sup+ aud interrupted with -48 or +48 volts dc during silent interval; for 8-party semiselective ringing	CSBR No. 5
R1 GRD R2 GRD	Ground interrupted at one-ring and 2-ring rate; operates ringing relay in connector circuit; for 8-party semiselective ringing	No. 1 SXS
Code 1 GRD Code 2 GRD		355A SXS
Code 3,4,5 Gen	Code ringing; consists of ac/dc aud interrupted, with -48 volts dc during silent interval; used with code 1 and code 2 gen for 5-code, 10-party ringing	CSBR No. 5
Code 1,2,3,4,5 GRD	Interrupted grd; operates ringing relay in connector circuit; for 5-code, 10-party ringing	SXS No. 1, 350A, and 355A
Code 3+	Code ringing consists of sup+ aud interrupted, with +48 volts dc during silent interval; replaces code 2+ and code 3- when both 5-code, 10-party, and 8-party semiselective ringing are required in an office	CSBR No. 5

17. 20-HZ RINGING (Cont)

RINGING SUPPLY	DESCRIPTION	SYSTEM
→ Code 1 Gen	Simulated one brush machine ringing. Processor controlled "one ring"; consists of ac/dc (not audible) interrupted with -48 volts dc during silent interval	No. 3 ESS
Coded A,B,D,E, F GRD Code 1 GRD Code 2 GRD	Ground codes for use in connection with reverting call selectors	SXS No. 1, 350A, 355A
Codes A,B,C GRD Code 1 GRD Code 2 GRD	Ground codes for use in connection with reverting call trunks with 4-party selective and 8-party semi-selective offices	CSBR No. 5
RR	Ground pulse for revertive ringing for 5-code ringing	CSBR No. 5, SXS No. 1, 350A, 355A
Code 1 HV BR1,2,3	Machine ringing "one ring"; consists of ac/dc audible (-72 volts dc) interrupted, with -72 volts dc during silent interval; for 2-party selective ringing in Unigauge offices	CSBR No. 5

18. SIGNALS AND TONES

PRECISE CALL PROGRESS TONES

A. Audible Ringing (440 + 480 Hz)

DESIGNATION	NOMINAL VOLTAGE VRMS	BALANCED OR UNBALANCED DISTRIBUTION	SUPER-IMPOSED ON	PRIMARY USE	PRINCIPAL SYSTEM OF APPLICATION
→ AR	0.36	Balanced	—	Continuous Audible Ring	No. 1, No. 2, No. 3 ESS, TSPS No. 1
AR1	0.79	Balanced	—	Continuous Audible Ring	No. 5 CSBR – 4W Autovon, Autovon PBX and Stations
AR2	3.80	Balanced	—	Continuous Audible Ringing Superimposed on 20 Hz	No. 1, 350A, 355A, SXS No. 1, No. 5 CSBR
AR30	0.36	Balanced	—	Precedence Audible Ringing	No. 1 ESS – 4W Autovon, 2W Autovon Centrex
AR BR1,2,3	0.36	Balanced	—	Audible Ringing Interrupted To Agree With Machine Ringing Cadence	No. 1, No. 2 ESS

18. SIGNALS AND TONES (Cont)

B. Busy Tone (480 + 620 Hz)

DESIGNATION	NOMINAL VOLTAGE VRMS	BALANCED OR UNBALANCED DISTRIBUTION	SUPER-IMPOSED ON	PRIMARY USE	PRINCIPAL SYSTEM OF APPLICATION
→ BT	0.20	Balanced	—	Continuous Busy Tone	No. 1 ESS, No. 2 ESS, No. 3 ESS
→ BT60*	0.20	Balanced	—	Line Busy	No. 1 ESS, No. 2 ESS, No. 3 ESS
→ BT120*	0.20	Balanced	—	Paths Busy (Reorder)	No. 1 ESS, No. 2 ESS, No. 3 ESS, TSPS No. 1
BT1	0.28	Balanced Unbalanced	— -48V	Continuous Busy Tone	No. 5 CSBR—4W Autovon and CCSA
BT2	0.60	Unbalanced	-48V	Continuous Busy Tone	No. 1, 350A SXS
BT2	0.60	Unbalanced	GRD	Continuous Busy Tone	No. 355A SXS
BT2-60	0.60	Unbalanced	-48V	Line Busy	No. 1, 350A
BT2-60	0.60	Unbalanced	GRD	Line Busy	355A SXS
BT2-120	0.60	Unbalanced	-48V	Paths Busy (Reorder)	No. 1, 350A
BT2-120	0.60	Unbalanced	GRD	Paths Busy (Reorder)	355A SXS
BT3	0.49	Unbalanced	-48V	Continuous Busy Tone	No. 1 CSBR, No. 5 CSBR
BT4	1.38	Unbalanced	-48V	Continuous Busy Tone	No. 1 CSBR—4W CCSA
BT5	0.20	Unbalanced	-48V	Continuous Busy Tone	No. 1 CSBR
LT120	0.686	Balanced	—	Paths Busy	Dual Access Switch Autovon

C. High Tone (480 Hz)

→ HT	0.29	Balanced	—	Permanent Signal Tone Zip Tone	TSPS No. 1, No. 1 ESS, No. 2 ESS, No. 3 ESS
HT60	0.29	Balanced		Unassigned	No. 1 ESS
HT120	0.29	Balanced		Ringer Test	No. 1 ESS
HT1	0.95	Unbalanced	GRD	Permanent Signal Tone Class of Service	No. 1, 350A, 355A SXS, No. 1 and No. 5 CSBR
HT6	2.8	Unbalanced	GRD	Permanent Signal Tone Class of Service Ringer Test	No. 1 CSBR

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* In initial No. 1 ESS installations, these tones are designated LT, LT60, LT120.

18. SIGNALS AND TONES (Cont)

D. Miscellaneous Tone (440 Hz)

DESIGNATION	NOMINAL VOLTAGE VRMS	BALANCED OR UNBALANCED DISTRIBUTION	SUPER-IMPOSED ON	PRIMARY USE	PRINCIPAL SYSTEM OF APPLICATION
MT	0.20	Balanced	—	Conference Notification	No. 1 ESS
MT1	0.48	Balanced	—	Call Waiting	No. 1 ESS, No. 2 ESS, No. 3 ESS
MT2	2.00	Balanced	—	Busy Verification	No. 1 ESS

E. Preempt Tone (440 + 620 Hz)

PT	0.36	Balanced	—	Continuous	No. 1 ESS
PT1	0.58	Balanced	—	Preemption Tone	No. 5 CSBR—4W Autovon and Autovon PBXs and Stations

F. Station Alerting Tone (2600 Hz)

RA	0.32	Balanced	—	Routine Alerting	No. 1 ESS—4W Autovon
PA	0.32	Balanced	—	Priority Alerting	No. 1 ESS—4W Autovon

G. Simulated Audible Ringing (520 + 560 Hz)

SAR	0.95	Balanced	—	Call Tracing (Inactive)	No. 1 ESS

H. TOUCH-TONE Dial Tone (350 + 440 Hz)

TT	1.20	Balanced	—	Continuous Dial Tone	No. 1 ESS, No. 2 ESS, No. 3 ESS
TT1	1.80	Unbalanced	-48V		No. 1 CSBR, No. 5 CSBR, Panel
TT2	23.0	Unbalanced	GRD		No. 1, 350A, 355A SXS (Selector Shelves)
TT3	1.7	Unbalanced	-48V		No. 1, 350A, 355A SXS (Converters or Originating Registers)
TT5	1.47	Unbalanced	-48V		No. 5 CSBR—4W Autovon and CCSA
TT6	0.45	Balanced	—		No. 1 ESS—4W Autovon

18. SIGNALS AND TONES (Cont)

NONPRECISE CALL PROGRESS TONES

SIGNAL OR TONE	DESCRIPTION	NOMINAL TONE -VOLTAGE	APPLICATION	SYSTEM
HT1	High Tone Superimposed on Ground	1-1/2	Trunk Assignment Tone, Permanent Signal	Panel, CSBR, CSBR Tandem
	High Tone Superimposed on Ground	1-1/2	Trunk Assignment Tone, Coin Return	355A SXS
HT3	High Tone Superimposed on Ground	9	Permanent Signal	Panel, CSBR
HT4	High Tone Superimposed on Ground	6	Number Checking Tone	Panel, SXS
LT	Low Tone Superimposed on Ground	—	Class of Service Tone	355A and 356A SXS
LT1	Low Tone Superimposed on Ground	1-1/3	Line Busy, Tandem Reorder	Panel
	Low Tone Superimposed on 48V	1	Line Busy Overflow From Terminating Office Circuits	CSBR
LT1 (LT1R)	LT on Ground	—		355A
LT1-C LT1-D	Low Tone Superimposed on 48V	2	Prevention of Talk Over Selector Busy Tone	
LT1 120* i/m BR2 Paired With LTR	Low Tone Superimposed on 48V and Interrupted at 120 i/m; LTR Is Paired Return Path to Ground	2	Paths Busy Toll Line Busy	No. 1, 350A
LT1 60 i/m BR7	LT on 48V	2	Flash and Tone	No. 1 SXS
LT1 120 i/m TB	Low Tone Superimposed on Ground and Interrupted at 120 i/m	—	Paths (Trunks) Busy	355A and 356A SXS
LT1 60 i/m* BT	Low Tone Superimposed on Ground and Interrupted at 60 i/m	—	Line Busy A&M Only for 355A-Where Connectors Are Not Arranged To Prevent Talking Over Busy Tone	355A and 356A SXS

* The present standard is 60 i/m for line-busy and 120 i/m for paths-busy interruptions. This is also required for through toll dialing. Older offices may have both line and paths busy interrupted at either 60 or 120 i/m.

18. SIGNALS AND TONES (Cont)

SIGNAL OR TONE	DESCRIPTION	NOMINAL TONE VOLTAGE	APPLICATION	SYSTEM
LT2	Low Tone Superimposed on 48V	1/2	Dial Tone	Panel, CSBR
LT2	Low Tone Superimposed on 48V	10	Dial Tone, Vacant Level, Coin Collect, Dial Jack, Dial Test	No. 1, 350A SXS
	Low Tone Superimposed on Ground	—	Dial Tone	355A SXS
LT4	Low Tone Superimposed on Ground	2/3	Paths Busy, Vacant Code, Coin Collect	Panel
	Low Tone Superimposed on 48V Battery	2	Vacant Code, Overflow From Local Office Circuits	CSBR
LT4 60 i/m BR4	Low Tone Superimposed on 48V and Interrupted at 60 i/m	1/2	Line Busy (Local) A&M Only—Where Connectors Are Not Arranged To Prevent Talking Over Busy Tone	No. 1, 350A SXS
LT5 60 i/m BT	Low Tone Superimposed on Ground and Interrupted at 60 i/m	2	Line Busy Where Connectors Are Arranged To Prevent Talking Over Busy Tone	355A SXS
LT5 60 i/m BR2	Low Tone Superimposed on 48V Battery and Interrupted at 60 i/m When Obtained From Tone Alternator	2	Line Busy (Local) Where Connectors Are Arranged To Prevent Talking Over Busy Tone	No. 1, 350A
	When Obtained From Other Than Tone Alternator	1	Line Busy (Local)	No. 1, 350A
LT6 60 i/m BR2	Low Tone Superimposed on 48-volt Battery and Interrupted at 60 i/m Obtained From Other Than Tone Alternator	2	Line Busy (Local) Where Connectors Are Arranged To Prevent Talking Over Busy Tone	No. 1, 350A SXS
PKU BR1,2, or 3	Ground Interrupted	—	Pickup for Ringing	SXS, Panel, CSBR

18. SIGNALS AND TONES (Cont)

SIGNAL OR TONE	DESCRIPTION	NOMINAL TONE VOLTAGE	APPLICATION	SYSTEM
30 i/m BR1 24V 30 i/m BR3 48V	A Long Ground Pulse at 30 i/m, 24V or 48V Return, But Not Both	—	No Circuit Signal	Toll, Dial
60 i/m BR1*	Ground Interrupted at 60 i/m, 24V Return	—	Pulsing Relays in Trunk Busy Circuits	Toll
60 i/m BR3*	Ground Interrupted at 60 i/m, 48V Return	—	Line Busy and Flashing Recall Signal	No. 5 CSBR, SXS
120 i/m BR1	Ground Interrupted at 120 i/m, 24V Return	—	Reorder Signal	Toll
120 i/m BR3	Ground Interrupted at 120 i/m, 48V Return	—	Paths Busy and Flashing Recall Signal	No. 5 CSBR, SXS Line Status Verifier

19. AC SUPPLIES—MISCELLANEOUS 60 HZ† (SEE X-64644)

SUPPLIES	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS
Inwats Timer	22	20 to 24	17 to 28
Calculagraph Motors Position Clocks	22‡	20 to 24	17 to 28
Crossbar Zone and Overtime Timers Crossbar District Junctor Timers	22‡	20 to 24	17 to 28
AMA Master Timers	22‡	20 to 24	17 to 28
Crossbar District Junctor Condenser and OGT Test	12	-	-
Busy Signal and Line Indicating Lamps	8 to 11.5 in 0.5-Volt Steps 5 to 8.5 in 0.5-Volt Steps		

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* In areas where 120 i/m is used, the 60 in this designation should be changed to 120.

† Voltage and frequency under normal operating conditions are dependent upon variation of the commercial power service and usually may be expected to be ±5 percent on voltage and ±0.3 Hz or better on frequency. See X-64644 for details on voltage and frequency in the USA. Voltage and frequency variations during failure of the commercial ac service are dependent on the reserve engine-driven alternator, if provided. These are usually ±5 percent on voltage, with a frequency range of 3 Hz, which may be set at either 59 to 62 or 60 to 63 with different reserve plants. If automatic battery-driven converters are provided for particular loads, the voltage is normally about ±10 percent and frequency when speed regulated 59 to 60 Hz or closer and when not speed regulated 50 to 70 or 40 to 60 Hz dependent upon the converter provided.

‡ Reserve supplies, when provided for these services, should not exceed 60 Hz in frequency.

20. MAGNETIC RECORDERS AND ASSOCIATED COMPONENTS

RECORDER-COMPONENT	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS
KS-12055 Recorder Reproducer	117, 60 Hz -48	105 to 129 48 to 52	105 to 129 44 to 53
KS-12068 Recorder Reproducer	117, 60 Hz -48	105 to 129 48 to 52	105 to 129 42.5 to 52.5
KS-16534 Recorder Reproducer	117, 60 Hz -48	105 to 129 48 to 52	105 to 129 44 to 53
KS-16535 Coupling Unit	-48	48 to 52	44 to 53
KS-16537 Control Unit	117, 60 Hz	105 to 129	105 to 129
KS-16586 Coupling Unit	-48	48 to 52	44 to 53
KS-16587 Distribution Unit	-48	48 to 52	44 to 53
KS-16588 Coupling Unit	-48	48 to 52	44 to 53
KS-16657 Recorder Reproducer	117, 60 Hz	105 to 129	105 to 129
KS-16658 Mechanism	117, 60 Hz	105 to 129	105 to 129
KS-16659 Control Unit	117, 60 Hz	105 to 129	105 to 129
KS-16660 Reproducer	117, 60 Hz	105 to 129	105 to 129
KS-16661 Amplifier	117, 60 Hz	105 to 129	105 to 129
KS-16665 Demagnetizer	117, 60 Hz	105 to 129	105 to 129
KS-16687 Recorder Reproducer	117, 60 Hz	105 to 129	105 to 129
KS-16746 Recorder Reproducer	117, 60 Hz	105 to 129	105 to 129
KS-16765 Announcement Set	117, 60 Hz	105 to 129	105 to 129
KS-19124 Recorder Reproducer	117, 60 Hz	105 to 129	105 to 129
KS-19125 Recorder	+72	72 to 78	63 to 78
KS-19297 Recorder Repeater	117, 60 Hz -48	105 to 129 48 to 52	105 to 129 44 to 53
KS-19315 Announcement Equipment	117, 60 Hz -48	105 to 129 48 to 52	105 to 129 44 to 53
KS-19325 Recorder	117, 60 Hz	105 to 129	105 to 129
KS-19326 Recorder	117, 60 Hz	105 to 129	105 to 129
KS-19647 Recorder	208, 60 Hz	187 to 229	187 to 229
KS-19671 Recorder Reproducer	117, 60 Hz	105 to 129	105 to 129
KS-19725 Announcement System	117, 60 Hz +24	105 to 129 24 to 26	105 to 129 20.75 to 26.75
KS-19829 Recorder	117, 60 Hz or 208, 60 Hz	105 to 129 187 to 229	105 to 129 187 to 229

20. MAGNETIC RECORDERS AND ASSOCIATED COMPONENTS (Cont)

RECORDER-COMPONENT	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS
KS-19897 Recorder	- 117, 60 Hz	105 to 129	105 to 129
	or		
	208, 60 Hz	187 to 229	187 to 229
KS-20017 Recorder	-48	48 to 52	42.5 to 52.5
KS-20571 Recorder	117, 60 Hz	105 to 129	105 to 129
53A, B, C Control Unit	-48	48 to 52	44 to 53

21. MISCELLANEOUS APPARATUS OR EQUIPMENT

APPARATUS OR EQUIPMENT	NOMINAL VOLTAGE	NORMAL VOLTAGE RANGE	EMERGENCY VOLTAGE LIMITS
Remote Message Repeater J98623	-48	48 to 52	44 to 52
	+48	48 to 52	44 to 52
	-130	125 to 135	125 to 135
2A Range Extender	-48	48 to 52	45 to 52
53A1 and 54A1 Power Units (Subscriber Loop Multiplex)	-50	48 to 52	42.5 to 52.5*
55A1 Power Unit (Subscriber Loop Multiplex)	±130	125 to 135	120 to 140†
KS-16001 Dehydrator	115, 60 Hz	110 to 120	105 to 125
KS-16153 Dehydrator	208, 60 Hz	198 to 218	187 to 253
KS-16468 Dehydrator	115, 60 Hz	110 to 120	105 to 125
KS-16432 Air Dryer	115, 60 Hz	110 to 120	105 to 125
KS-16523 Air Dryer	208, 60 Hz	198 to 218	187 to 253
KS-20183 Air Dryer	115, 60 Hz	110 to 120	105 to 125
KS-20336 Air Dryer	208, 60 Hz	198 to 218	187 to 253
D Air Dryer AT-8224	115, 60 Hz	110 to 120	105 to 125
J63006 Cable Pressure Telemetry Central Control Circuit	115, 60 Hz	110 to 120	105 to 125
1000-Hz Ringers—Oscillators and Receivers	130	125 to 135	120 to 140
TRANSMISSION MEASURING			
Transmission Test Equipment-Rack Mounted	-25	22 to 26	22 to 26
	-48	44 to 52	44 to 52
	130	125 to 135	125 to 135
	115, 50/60 Hz	105 to 125	105 to 125

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* Maximum transient limit -60.

† Maximum transient limit ±150.