

U S A   S T A N D A R D  
D R A F T I N G   P R A C T I C E S

# ELECTRICAL AND ELECTRONICS DIAGRAMS

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USAS Y14.15 - 1966  
(REAFFIRMED 1973)

Including  
PROPOSED USA STANDARD  
FOR CONNECTION DIAGRAMS  
AND TERMINAL DIAGRAMS

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# ELECTRICAL AND ELECTRONICS DIAGRAMS

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USAS Y14.15 - 1966

USA STANDARD APPROVED includes the following:

- 15-1 Scope
- 15-2 Definitions
- 15-3 General Information
- 15-4 Single-Line Diagrams, General
- 15-5 Single-Line Diagrams (Electronics and Communications)
- 15-6 Single-Line Diagrams (Power Switchgear and Industrial Control)
- 15-7 Schematic Diagrams, General
- 15-8 Schematic Diagrams (Electronics and Communication)
- 15-9 Schematic Diagrams (Power Switchgear and Industrial Control)

PROPOSED USA STANDARD includes the following:

- 15-10 Connection Diagrams
- 15-12 Terminal Diagrams

This USA Standard is one of nearly 3000 standards approved as American Standard by the American Standards Association. On August 24, 1966, the ASA was reconstituted as the United States of America Standards Institute. Standards approved as American Standard are now designated USA Standards. There is no change in their index identification or technical content.

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## Foreword

Subcommittee 15 – Electrical and Electronic Diagrams – was formed on April 26, 1964, as a subcommittee of Sectional Committee Y14-Standards for Drawings and Drafting. When formed, this subcommittee was charged with the responsibility of preparing a drafting standard covering “electrical schematic, wiring and block diagrams for use in the communications, electronic, electric power, industrial control, telephone, telegraph and allied industries.” A natural addition to this scope was the inclusion of military considerations through participation by representatives of the Department of Defense.

The creation of such a standard, acceptable to the manufacture of electrical equipment and to industrial, military and utility users, often in areas which were themselves undergoing development, has been an exercise in cooperation and compromise. The overriding purpose of all of the participants has been to issue a single USA standard which could be used as a reference in purchasing equipment, cited as authority in contract and military specifications and applicable as a guide for drafting and design personnel responsible for drawings for production or for use wholly within a plant or company.

For this standard to be so widely applicable it had to be made broad and permissive; therefore compromise was essential, particularly in terminology, but such compromise had the beneficial effect of expediting its issue and of making it generally available. We hope its effect is to unify drafting practices and that future revisions will reflect increasing uniformity by eliminating multiple options and establishing preferred methods and nomenclature.

Paragraphs 15-1 to 15-9 inclusive were approved by the Sectional Committee, the sponsors and the USA Standards Institute, and were designated USA Standard on December 2, 1966.

Paragraphs 15-10 and 15-12 were approved by the Sectional Committee on July 20, 1966 for issue on a trial basis to provide an opportunity for industry to comment before final adoption of these paragraphs as a USA Standard. If this standard is referred to, all paragraphs (including 15-10 and 15-12) apply unless specific exception are indicated.

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# USA STANDARD DRAFTING PRACTICES

## Electrical and Electronics Diagrams

### 15-1 Scope

This standard contains definitions and general information applicable to most of the commonly used Electrical and Electronics Diagrams. It also includes detailed recommendations on preferred practices for use in the preparation of Electrical and Electronics Diagrams. The recommended practices covered by this standard are ground rules designed to eliminate divergent Electrical and Electronics Diagram drafting techniques. The illustrations shown represent good drafting practices. They are not intended as engineering design guides.

### 15-2 Definitions

The following diagram definitions have been adopted as standard.

#### 15-2.1 *Single-Line or One-Line Diagram*

A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

#### 15-2.2 *Schematic or Elementary Diagram*

A diagram which shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The Schematic Diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component device or parts. (See 15-8.10 for Schematics prepared for maintenance purposes.)

#### 15-2.3 *Connection or Wiring Diagram*

A diagram which shows the connections of an installation or its component devices or parts. It may cover internal or external connections, or both, and contains such detail as is needed to make or trace connections that are involved. The Connection Diagram usually shows general physical arrangement of the component devices or parts.

#### 15-2.4 *Interconnection Diagram*

A form of Connection or Wiring Diagram which shows only external connections between unit assemblies or equipment. The internal connections of the unit assemblies or equipment are usually omitted.

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### 15-2.5 Terminal Diagram

A diagram relating the functionally depicted internal circuit of an item or device to its terminal physical configuration, and locating the terminals with respect to the outline or orientation markings of the item.

### 15-2.6 Other Terms

In various portions of the electrical and electronics field, long standing usage of a few terms has varied widely.

A **DEVICE** in the electric power field is often a **PART** in the electronics field; generally these are elemental circuit items such as fuses, meters, relays, resistors, or switches. In this sense, **PART** has a specific meaning different from the usual dictionary definition implying a portion.

**COMPONENT** is ambiguous, for it

- (a) has long established usage meaning a **PART** in the electronic sense,
- (b) has been defined as a subassembly (one or more circuits made up of devices or parts), and
- (c) also means a subsystem or a system (for example, a power supply).

**EQUIPMENT** in this standard implies an assembly of devices designed to perform one or more specific independent or operational functions; it includes units, sets, and systems.

**ITEM** is used in the usual dictionary sense.

**COMPONENT DEVICE** in this standard is applied to parts, devices, apparatus, assemblies, or units.

### 15-3 General Information

The following sub-paragraphs cover basic material which is applicable to all diagrams.

#### 15-3.1 Other Reference Standards

The following other standards are referenced in various sub-paragraphs of this standard. When the issues listed below are superseded by a revision approved by the issuer, the revision shall apply.

### USA Standards<sup>1</sup>

- C6.1-1956 – Terminal Marking for Electrical Apparatus
- C37.2-1962 – Manual and Automatic Station Control, Supervisory, and Associated Telemetering Equipments
- C37.11-1957 – (R1962) Requirements for Power Circuit Breaker Control
- C37.20-1965 – Switchgear Assemblies Including Metal Enclosed Bus
- C42 (various sections) – Definition of Electrical Terms
- C83.1-1956 – Color Coding for Numerical Values of Components for Electronic Equipment
- Y14 – Drafting Manual
- Y14.1-1957 – Section 1 – Size and Format
- Y14.2-1957 – Section 2 – Line Conventions Sectioning, and Lettering
- Y32.2-1962 – Graphic Symbols for Electrical and Electronic Diagrams
- Y32.2a-1964 – Supplement No. 1 to Y32.2-1962
- Y32.14-1962 – Graphic Symbols for Logic Diagrams
- Y32.16-1965 – Electrical and Electronic Reference Designations
- Z32.13-1950 – Abbreviations for Use on Drawings

### IEEE Standards<sup>2</sup>

260 Symbols for Units

### NEMA Standards<sup>3</sup>

- IC1-1965 – Industrial Control
- SG4-1963 – High Voltage Power Circuit Breakers
- SG5-1959 – Power Switchgear Assemblies

The text hereinafter may reference these other standards in brief form; for example:

USA Standard Y32.2 or NEMA Standard IC1.

When this standard is used as a U.S. Military requirement, for those topics covered by separate USA and Military Standards, the equivalent approved U.S. Military Standard shall be used in lieu of the specified USA Standard.<sup>4</sup>

<sup>1</sup>USA Standards Institute, New York, New York

<sup>2</sup>Institute of Electrical and Electronics Engineers, Inc., New York, New York

<sup>3</sup>National Electrical Manufacturers Association, Inc., New York, New York

<sup>4</sup>As of the date of this Standard:

| In lieu of<br>USA<br>Standard | Use   |
|-------------------------------|---|
| Y14, Y14.1                    |   |
| Y14.2                         | MIL-STD-100   |
| Y32.2                         | MIL-STD-15-1  |
| Y32.14                        | MIL-STD-806 or<br>MIL-STD-00806 (NAVY)<br>as applicable |
| Z32.13                        | MIL-STD-12  |



## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-3.2 Diagram Titles

When a diagram takes the form of one of the types defined in 15-2, the name of the type of diagram should be included in the title. For example: SINGLE-LINE DIAGRAM (not DIAGRAM, LINE, SINGLE).

### 15-3.3 Combined Forms of Diagrams

Many Schematic Diagrams become more useful when they include pertinent wiring information; many Interconnection Diagrams gain in utility when part or all of the connections within individual units are shown. Provided approved standards are observed, combined forms of diagrams may be used when the net result is helpful to the user. When this principle is applied, however, the diagram title should still conform to the requirements of 15-3.2, the title being selected on the basis of the major purpose of the diagram.

### 15-3.4 Drawing Size and Format

Drawing sizes and formats used with diagrams shall conform with USA Standards Y14.1. In general, the smallest size standard format compatible with the nature of the diagram should be selected. When interrelated diagrams are sectionalized and prepared on different drawings, or as multiplesheet drawings, suitable cross references should be provided. Separate sheets of multiplesheet drawings should be the same size.

### 15-3.5 Line Conventions and Lettering

The selection of line thickness as well as letter size should take into account size reduction or enlargement, when it is felt that legibility will be affected. A line of medium thickness is recommended for general use on diagrams. A thin line may be used for brackets, leader lines, etc. When emphasis of special features such as main or transmission paths is essential, a line thickness sufficient to provide the desired contrast may be used. Line thickness and lettering used with diagrams shall, in general, conform with USA Standard Y14.2 and local requirements to facilitate microfilming. Line conventions, relative thickness and suggested applications for use on Electrical and Electronics Diagrams are shown in Figure 3-1.

#### 15-3.5.1 Lower Case Letters

When necessary (to avoid ambiguity) to indicate or distinguish between upper and lower case letters that appear on an item or in a national standard, any of the following alternatives shall be used:

- (a) Lower case letters (enlarged, when necessary, for proper reproduction).
- (b) Upper case letters followed by asterisks (for example, A\* signifies a, A\*BC\* signifies aBc, etc.).

(c) Upper-case letters, underlined.

The meaning of the asterisk or underline shall be explained in a drawing note.

| LINE APPLICATION   | LINE THICKNESS                       |              |
|--|--------------------------------------|--------------|
| FOR GENERAL USE  | <u>MEDIUM</u>                        |              |
| MECHANICAL CONNECTION:<br>SHIELDING, & FUTURE<br>CIRCUITS LINE | <u>MEDIUM</u>                        |              |
| BRACKET-CONNECTING<br>DASH LINE                                | <u>MEDIUM</u>                        |              |
| USE OF<br>THESE<br>LINE<br>THICK-<br>NESSES<br>OP-<br>TIONAL   | BRACKETS, LEADER<br>LINES, ETC.      | THIN         |
|  | MECHANICAL-GROUPING<br>BOUNDARY LINE | THIN         |
|  | FOR EMPHASIS                         | <u>THICK</u> |

FIGURE 3-1  
LINE CONVENTIONS FOR DIAGRAMS

### 15-3.6 Graphic Symbols

Graphic symbols used for diagrams shall conform with USA Standard Graphic Symbols for Electrical and Electronics Diagrams, Y32.2, or other national-level standards if the symbol is not covered in the USA Standard. If no suitable symbol exists, any special symbol used shall be explained by a note on the diagram. Symbols or parts of symbols (except letters and numbers) which lend themselves to being rotated or reversed may be so oriented for simplification of circuit layout. The terminal symbol (o) may be added as required to any of the basic symbols. Graphic symbols may be drawn to any proportional size that suits a particular diagram, provided the selection of size takes into account the anticipated reduction or enlargement. For most diagrams intended for manufacturing purposes, or for ultimate use in a reduced form (2.5 to 1 max.), it is recommended that symbols be drawn approximately 1.5 times the size of those shown in the USA Standard Y32.2. The use of a symbol in the illustrations of this standard does not preclude the use of alternatives shown in Y32.2.

#### 15-3.6.1 Representation of Electrical Contacts

Switch symbols shall be shown in the position of no applied operating force. For switches which may be in any one of two or more positions with no operating force applied or switches actuated

## USA STANDARD DRAFTING PRACTICES

by some mechanical or electrical means, a drawing note shall identify the functional phase shown in the diagram. Relay contacts shall be shown in the de-energized or nonoperated condition.

### 15-3.7 Abbreviations

Abbreviations used on diagrams should conform with USA Standard Abbreviations for Use on Drawings, Z32.13, or other national-level standards if the abbreviation is not covered in the USA Standard. If no suitable abbreviation exists, a special abbreviation may be used, but must be explained by a note on the diagram.

### 15-3.8 Layout of Diagrams

The layout of diagrams shall be such that the main features are prominently shown. The parts of the diagram should be spaced to provide an even balance between blank spaces and lines. Sufficient blank area should be provided in the vicinity of symbols to avoid crowding of notes or reference information. Large spaces, however, should be avoided, except that space provision may be made for anticipated future circuits if deemed necessary.

#### 15-3.8.1 Grouping of Parts

When a circuit contains parts which need be shown grouped, the grouping may be indicated by means of a boundary (phantom) line enclosure. The phantom line enclosure may be omitted if sufficient space is provided between parts. Typical groupings are unit assemblies, subassemblies, printed circuits, hermetically sealed units, contactor parts, relays, etc. The dash line used to indicate shielding also implies that the parts enclosed by the dash line are grouped.

### 15-3.9 Drawing Number Reference Location

When diagrams are reproduced for instruction book or similar purposes, it may be desirable to retain the original drawing number within the reproduced area. This drawing number (if included) should be shown close to the lower right edge of the diagram, in a lettering size comparable to that used for notes and other detailed reference material.

### 15-3.10 Diagram Revisions

Provision shall be made on all types of Electrical and Electronics Diagrams for recording revisions. The record of changes made in each revision shall be identified by either a number, letter or character and the date of the revision. When it is possible to make a brief detailed ex-

planation of the revision, this is desirable. When detailed explanation is not practicable, a revision note covering the general nature of the revision should be included. A reference to a change order document may be shown in lieu of an explanation.

### 15-3.11 Wire Color Information

Wire colors may be indicated by giving either color designations or numerical color codes. Indication of color designations is preferable when many colors and color combinations such as BK-W are to be shown. When numerical color codes are used, care should be taken to avoid confusion with other numerical references. Recommended single and two letter color designations for use specifically on diagrams and corresponding color identifications by numerical code are as follows:

| Wire Color   | Designation<br>(USAS Z32.13) | Numerical Code<br>(USAS C83.1) |
|--------------|------------------------------|--------------------------------|
| Black        | BK                           | 0                              |
| Brown        | BR                           | 1                              |
| Red          | R                            | 2                              |
| Orange       | O                            | 3                              |
| Yellow       | Y                            | 4                              |
| Green        | G                            | 5                              |
| Blue         | BL                           | 6                              |
| Violet       | V                            | 7                              |
| (Purple)     | (PR)                         |                                |
| Gray (Slate) | GY (S)                       | 8                              |
| White        | W                            | 9                              |

### 15-4 Single-Line Diagrams, General

The Single-Line Diagram conveys basic information about the operation of a circuit or a system of circuits, but omits much of the detailed information usually shown on Schematic or Connection Diagrams. This form of presentation lends itself to simplified diagrams of complex circuits and to diagrammatic representation of communication or power systems, in which a single line represents a multi conductor communication or power circuit.

### 15-5 Single-Line Diagrams (Electronics and Communications)

Figure 5-1 is a typical Single-Line Diagram applied to a complex audio system. In general, the practices established in 15-7 apply equally well to the preparation of Single-Line Diagrams.

ELECTRICAL AND ELECTRONICS DIAGRAMS

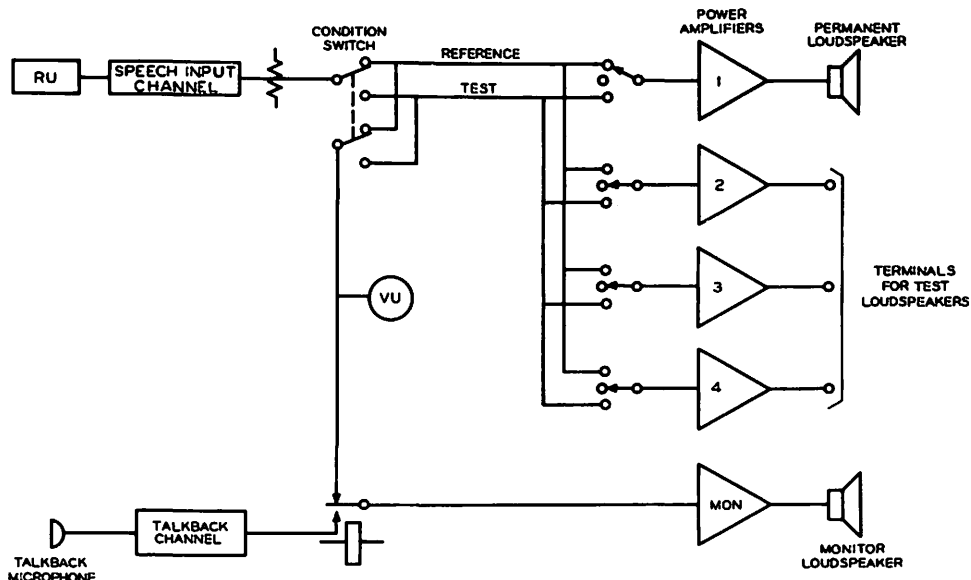


FIGURE 5-1 – TYPICAL SINGLE-LINE DIAGRAM (ELECTRONICS AND COMMUNICATIONS)

15-6 Single-Line Diagrams (Power Switchgear and Industrial Control)

The following sub-paragraphs contain detailed information specifically applicable to Power Switchgear and Industrial Control Single-Line Diagrams. This material is to be used as a supplement to the general standards of 15-4.

15-6.1 General Information

The Single-Line or One-Line Diagram is a key diagram showing the overall relationship between circuits and their component devices or parts. Only a single line is used to show an AC or DC system as illustrated in Figure 6-1. Thick connecting lines indicate primary circuits. Medium connecting lines indicate the connections to the current and potential sources. Small circles portray relays, meters and instruments, and small rectangles depict resistors, transfer and selector switches. Power circuit devices and relays are identified by device function designations (USA Standard C37.2); meters, instruments and switches by abbreviations and letter combinations (refer to 15-3.6 and 15-3.7).

15-6.2 Contents

A Single-Line Diagram shows connections of major equipment, protective relays, meters, and instruments. Consideration shall be given to inclusion of the following information:

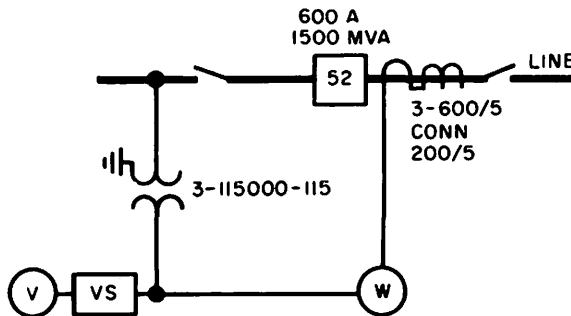


FIGURE 6-1 – PORTION OF A TYPICAL SINGLE-LINE DIAGRAM

15-6.2.1 Ratings

Ratings which are essential to an overall understanding of the system shall be included. Detailed ratings should be stated on the Connection Diagram. Generator ratings, for example, include: kilowatt capacity, power factor, voltage, number of phase windings, cycles and revolutions per minute as shown in Figure 6-2.

NOTE: Industrial Control Single-Line Diagrams may omit equipment ratings when they are used as standard drawings applying to more than one rating.

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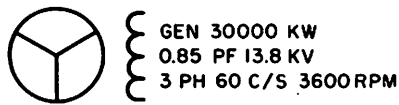


FIGURE 6-2 – TYPICAL GENERATOR RATINGS

15-6.2.2 *Winding Connection Symbols*

Winding connection symbols should be shown for all power equipment. Typical wye connections and wye-delta connections of a transformer are indicated in Figure 6-3.

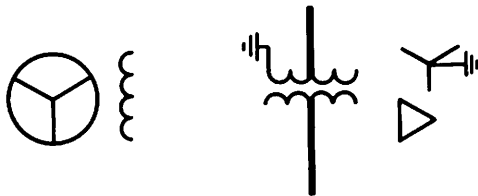


FIGURE 6-3 – TYPICAL WINDING SYMBOLS

When it is desirable to use the winding connection symbols as phasors this should be so noted and the phase rotation and sequence included. Note that the delta-wye symbols of the transformer and the "Y" symbol of the generator in Figure 6-4 have been properly oriented for the system relationships.

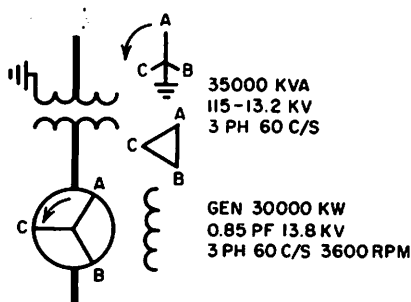


FIGURE 6-4 – TYPICAL ORIENTED GENERATOR AND TRANSFORMER PHASOR SYMBOLS

15-6.2.3 *Neutral and Ground Connections*

The neutral and ground connections should be shown for all power circuits as indicated in Figure 6-5.

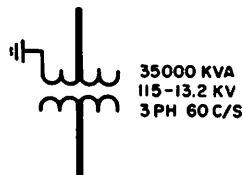


FIGURE 6-5 – TYPICAL TRANSFORMER NEUTRAL GROUND SYMBOL

15-6.2.4 *Feeder Circuits*

When available the rating and type of load should be stated for each feeder circuit as illustrated in Figure 6-6.

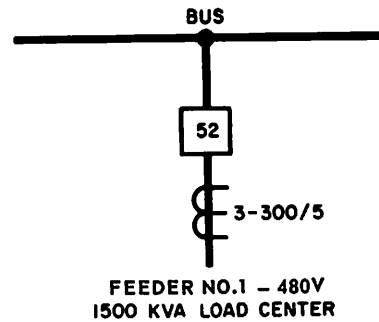


FIGURE 6-6 – TYPICAL MARKING OF FEEDER CIRCUIT LOAD

15-6.2.5 *Protective Relaying*

Show the operating source, current or potential, or both, by connecting lines or by notes for each relay which functions as a protective device. See Figures 6-7, 6-11, 6-12 and 6-13.

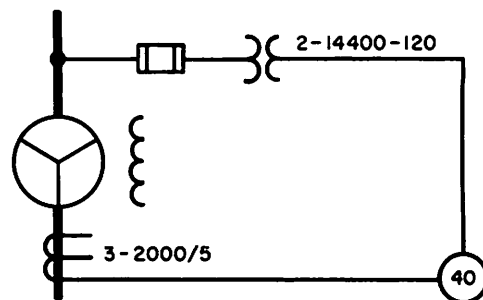


FIGURE 6-7 – TYPICAL PROTECTIVE RELAY CONNECTIONS

15-6.2.6 *Instruments, Meters and Associated Switches*

Show the operating source, current or potential, or both, by connecting lines or by notes for each device. See Figures 6-8, 6-11 and 6-12.

## ELECTRICAL AND ELECTRONICS DIAGRAMS

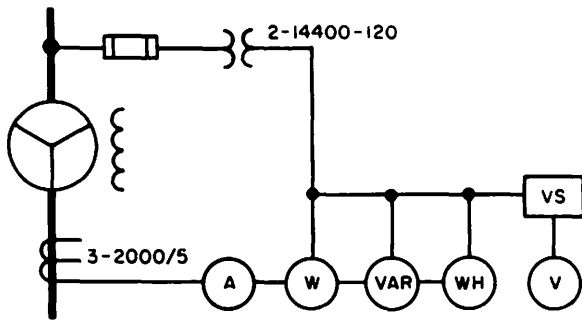


FIGURE 6-8 – TYPICAL INSTRUMENT AND METER CONNECTIONS

### 15-6.2.7 Power Circuit Breaker Mechanism

Indication of the mechanism end of the power circuit breaker may be shown to permit proper orientation of bushing current transformers. See Figure 6-9 (shown below), and 15-9.1.6.



FIGURE 6-9 – ILLUSTRATION SHOWING CIRCUIT BREAKER MECHANISM SYMBOL

### 15-6.2.8 Ratios of Instrument Transformers

Current transformers should show the number of transformers and the ampere ratio; Figure 6-10(A). For current transformers with multiple ratios, the connected ratio should also be indicated; Figure 6-10(B). If only one or two transformers are present in a three-phase system, the phase location of these transformers should also be shown; Figure 6-10(C).

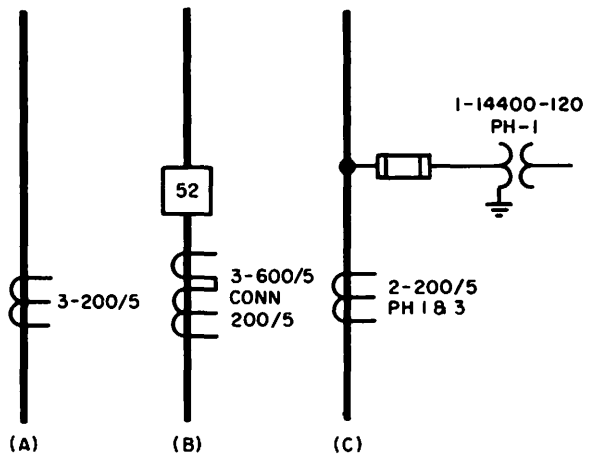


FIGURE 6-10 – TYPICAL INSTRUMENT TRANSFORMER SYMBOLS AND MARKINGS

### 15-6.3 General Layout

The arrangement of the diagram should be made to give the utmost in clarity. The following requirements shall be observed in the preparation of the diagram:

#### 15-6.3.1 Graphic Symbols

Symbols for Single-Line Diagrams are intended to indicate the operating functions. These symbols are shorthand graphic representations and are not necessarily intended to represent the physical likeness of the device nor contain complete electrical connections. Graphic symbols shall be applied as described in 15-3.6.

#### 15-6.3.2 Abbreviations

Abbreviations shall be applied as described in 15-3.7.

#### 15-6.3.3 Device Designations

Device designations shall be applied as described in 15-9.2.3.

#### 15-6.3.4 Course of Main Circuits

Course of main circuits should be shown in the most direct path and logical sequence. Information in 15-7.1 also applies to the Single-Line Diagram.

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15-6.3.5 *Horizontal and Vertical Lines*  
 Lines between symbols should be horizontal or vertical with a minimum of line crossings, and with spacing to avoid crowding. Information in 15-7.2 also applies to the Single-Line Diagram.

15-6.3.6 *Voltage Arrangement*  
 The arrangement of the diagram should preferably show the higher voltages at top or left of

the drawing and successively lower voltages towards the bottom or right of the drawing.

15-6.4 *Typical Single-Line Diagrams*  
 Typical Single-Line Diagrams that illustrate good drafting practice are shown in Figure 6-11, 6-12 and 6-13. The choice between Figure 6-11 and Figure 6-12 is optional.

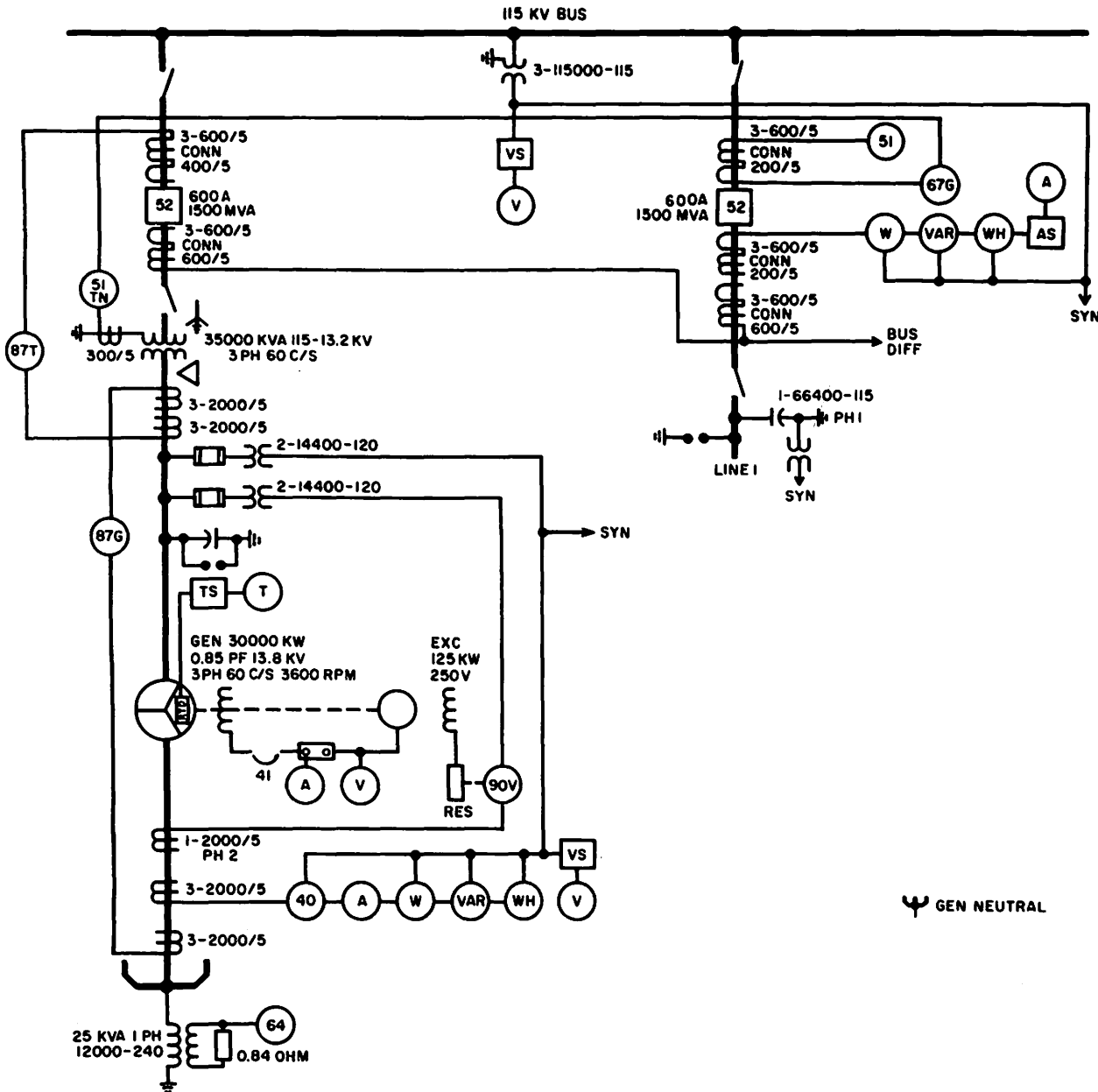


FIGURE 6-11 - TYPICAL POWER SWITCHGEAR SINGLE-LINE DIAGRAM WITH COMPLETE DEVICE DESIGNATIONS

ELECTRICAL AND ELECTRONICS DIAGRAMS

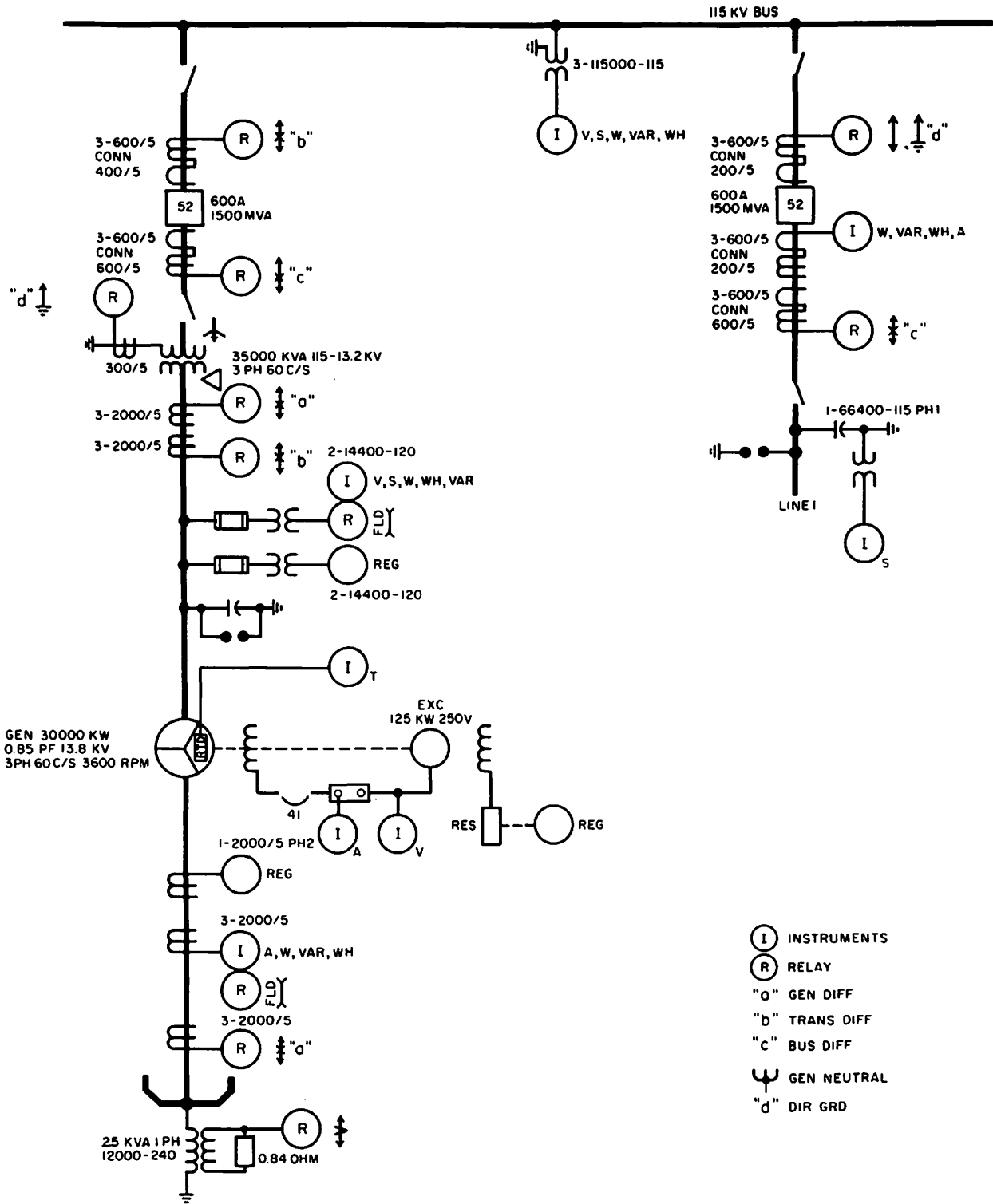


FIGURE 6-12 - TYPICAL POWER SWITCHGEAR SINGLE-LINE DIAGRAM WITH ABBREVIATED DEVICE DESIGNATIONS

USA STANDARD DRAFTING PRACTICES

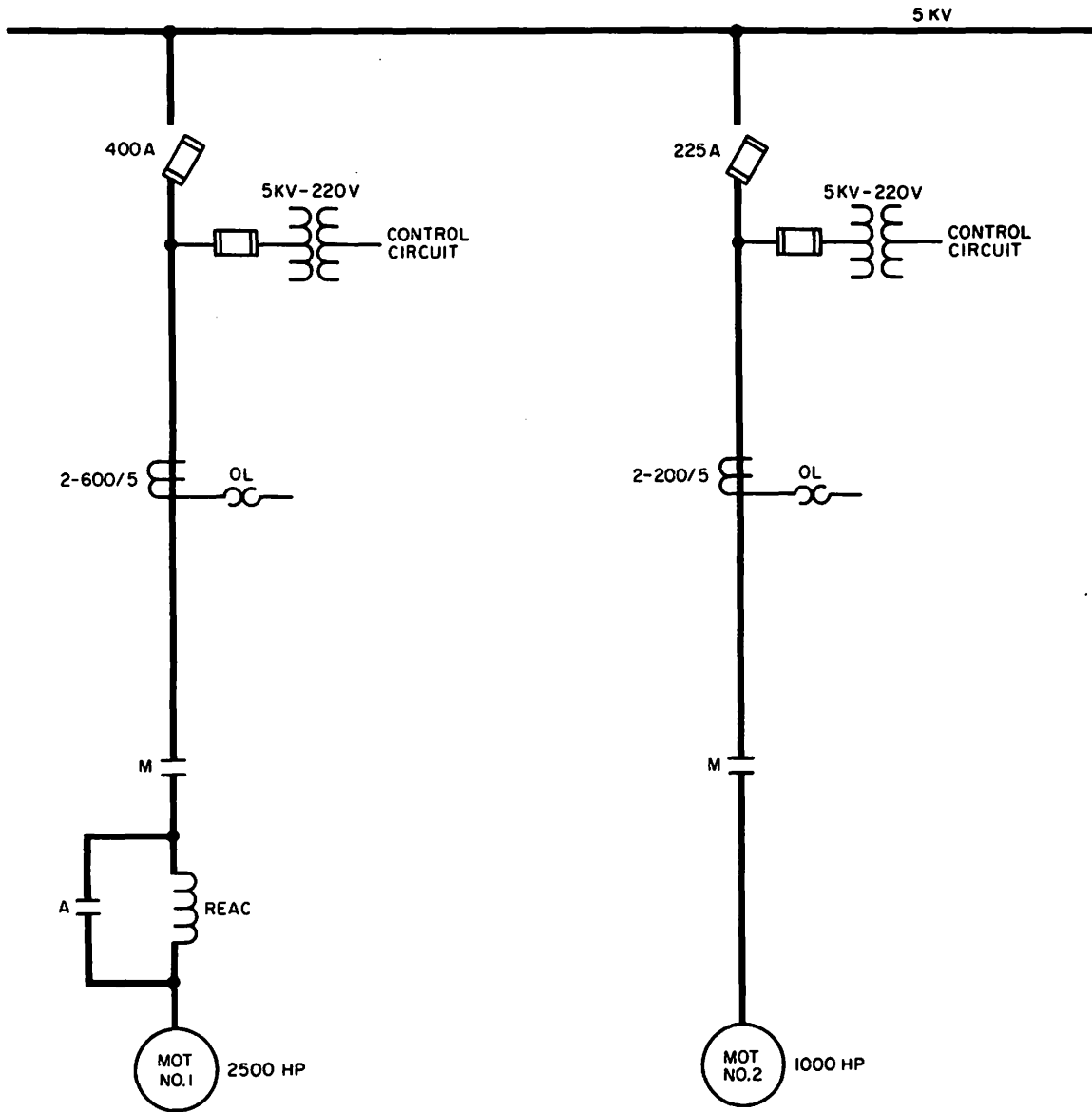


FIGURE 6-13 - TYPICAL INDUSTRIAL CONTROL SINGLE-LINE DIAGRAM



## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-7 Schematic Diagrams, General

The following subparagraphs contain general information for use in the preparation of Schematic Diagrams.

#### 15-7.1 Layout

The Schematic Diagram shall use a layout which follows the circuit, signal, or transmission path either from input to output, source to load, or in the order of functional sequence. Long interconnecting lines between parts of the circuit should be avoided. Draw similar basic circuits in a similar form (this does not prevent the use of simplified drafting practice to depict repeated circuits).

#### 15-7.2 Connecting Lines

Connecting lines should be drawn with as few bends and crossovers as possible. Except for such circuits as "multi-vibrators" and "bridges," connecting lines and the symbols joined by them should be drawn horizontally and vertically.

##### 15-7.2.1 Spacing

Spacing between parallel lines after reduction to ultimate use size (see 15-3.6) shall be a minimum of 0.06 inch. The longer parallel lines shall be arranged in groups, preferably three to a group, with approximately double spacing between groups; see Figure 7-3. In determining the grouping, functional relation of the lines should also be considered.

##### 15-7.2.2 Junctions and Crossovers

All junctions of connecting lines should be shown as single junctions, as shown in Figure 7-1(A), the preferred method, or Figure 7-1(B). Figure 8-17 illustrates the practice of Figure 7-1(B). When layout considerations prevent the exclusive use of the single junction methods of Figure 7-1(A) or 7-1(B), multiple junctions may be shown as in Figure 7-1(C). Figure 7-1(D) illustrates the use of both the "no-dot" single junction and "dot" multiple junction methods in an array of lines where spacing precludes the exclusive use of the "no-dot" single junction method of Figure 7-1(A)

#### 15-7.3 Interrupted Paths

Connecting lines, whether single or in groups, may be interrupted at convenient points and identified, with the destination indicated. Letters, numbers, abbreviations, or other identifiers for interrupted lines shall be located as close as possible to the point of interruption.

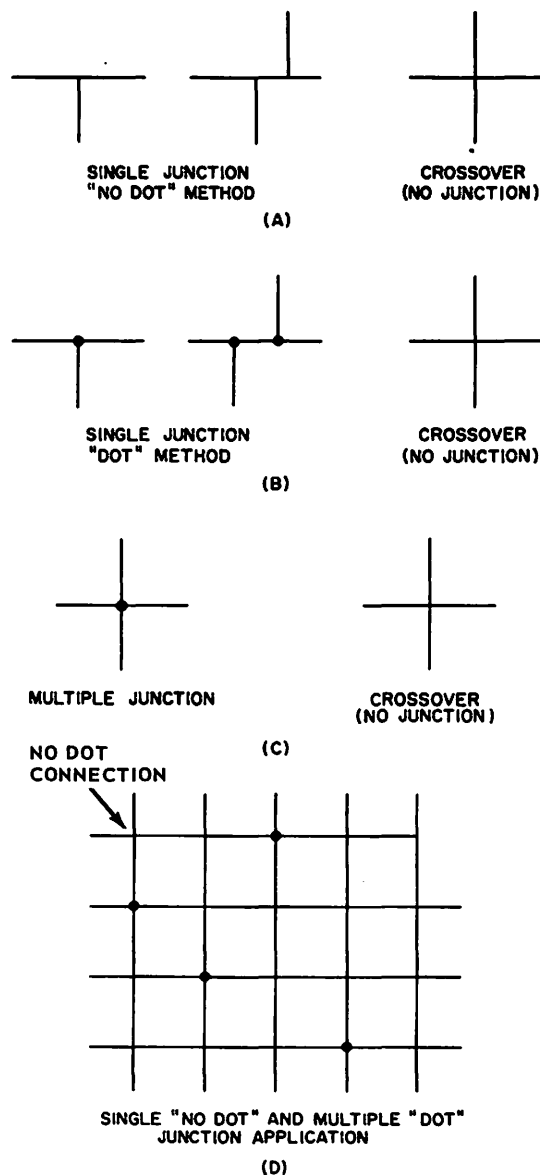


FIGURE 7-1 - JUNCTIONS AND CROSSOVERS

#### 15-7.3.1 Interrupted Single Lines

For single interrupted lines, the line identification may also serve to indicate destination as shown in Figure 7-2 for the power and filament circuit paths. In general, identification practice for single interrupted lines shall be the same as for grouped and bracketed lines described in 15-7.3.2.

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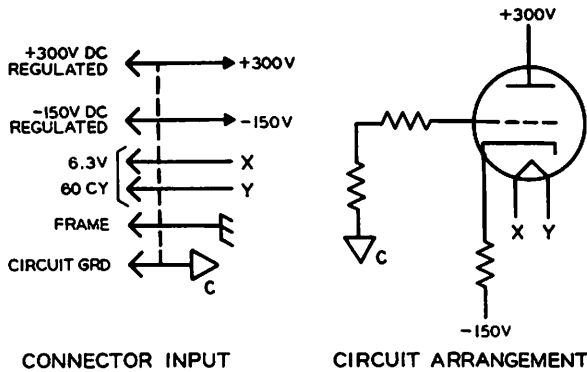


FIGURE 7-2 - IDENTIFICATION OF INTERRUPTED LINES

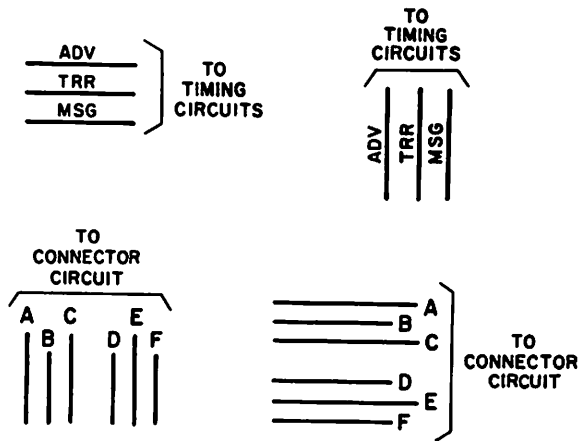


FIGURE 7-3 - TYPICAL ARRANGEMENT OF LINE IDENTIFICATIONS AND DESTINATIONS

15-7.3.2 Interrupted Grouped Lines

When interrupted lines are grouped and bracketed, and depending on whether the lines are horizontal or vertical, line identifications shall be indicated as shown in Figure 7-3. Bracket destinations or connections may be indicated either by means of notations outside the brackets as shown in Figure 7-3, or by means of a dash line as shown in Figure 7-4. When the dash line is used to connect brackets, it shall be drawn so that it will not be mistaken for a continuation of one of the bracketed lines. The dash line shall originate in one bracket and terminate in no more than two brackets.

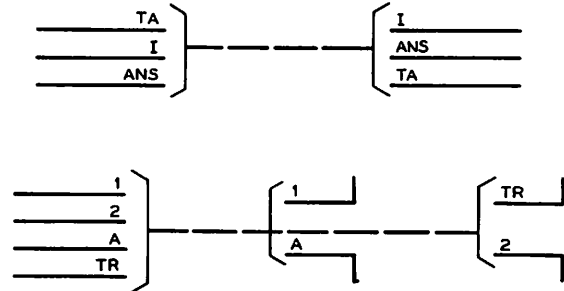


FIGURE 7-4 - TYPICAL INTERRUPTED LINES INTERCONNECTED BY DASH LINES

15-7.4 Mechanical Linkages

When mechanical functions are closely related to certain electrical functions, it may be desirable to link the mechanical components with graphic symbols of the Schematic Diagram. A typical example of how this may be done is shown in Figure 7-5.

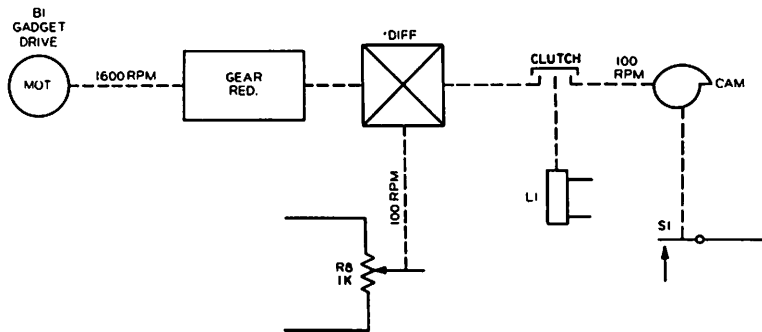


FIGURE 7-5 - TYPICAL SCHEMATIC DIAGRAM SHOWING MECHANICAL LINKAGES

## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-8 Schematic Diagrams (Electronics and Communication)

The following subparagraphs contain detailed information which is specifically applicable to Schematic Diagrams of the type used with electronic and communication equipment. This material is to be used as a supplement to the general standards of 15-7.

#### 15-8.1 Layout

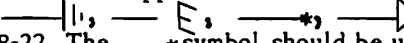


In general, Schematic Diagrams should be arranged so that they can be read functionally from left to right. Complex diagrams should generally be arranged to read from upper left to lower right, and may be laid out in two or more layers. Each layer should be read from left to right.

The overall result shall be a circuit layout which follows the signal or transmission path from input to output, or in the order of functional sequence. Where practical, terminations for external connections should be located at the outer edges of the circuit layout.

#### 15-8.2 Drawing Zones

Zones (coordinates) should be shown on a complex Schematic Diagram to aid in the location of specific items; see Figure 8-19. If a Schematic Diagram is prepared mainly for maintenance purposes and is likely to be reproduced in a technical manual or its equivalent, it is preferred that the coordinate system begin in the upper left. This preference is based on beginning the reference designation suffix number assignment from the same area on the Schematic Diagram (see 15-8.6). However, when the diagram is prepared on a zoned drawing format, the format zones may be used.

#### 15-8.3 Circuit Return and Connection Symbols

For the application of circuit return symbols , see Figure 8-22. The  symbol should be used when there is a specific potential difference with respect to a potential reference level, and the  symbol should be used when the common connections are at an unspecified potential level. Asterisks shall be replaced in accordance with USA Standard Y32.2.

#### 15-8.4 Terminals

Terminal circles should be omitted unless required for clarification. See switch S1 in Figure 8-19 for a typical application of the standard terminal symbol to a complex switch. For preferred terminal representation of spring contacts for relays, jacks and key switches, see Figure 8-17, graphic symbols J1, S1, K1. When terminal symbols are omitted from the terminations of a part, or an enclosed or shielded group of parts, terminal markings should be placed immediately outside the enclosure. See parts T2, T3, T4, T5,

T7, and T8 of Figure 8-19 for examples of terminal markings.

#### 15-8.4.1 Identification of Terminals (General)

Terminal identifications shall be added to graphic symbols to indicate actual physical markings which appear on or near part terminations. When the terminals of parts (such as relays, switches, or transformers) are not shown or marked on the part, number or letter identifications should be arbitrarily assigned. This practice will facilitate use of the circuit information for Connection Diagram preparation and circuit testing. When terminal identifications are arbitrarily assigned, the Schematic Diagram should include an explanatory note (see Figure 8-17, note 4) and a simplified terminal orientation diagram which relates assigned symbol terminal nomenclature to functional markings on the equipment and physical features of the part. For examples of terminal numbering and simplified terminal orientation diagrams for the drawing note, see Figures 8-1, 8-2, 8-3, 8-17, and 8-19.

When terminals or leads of multilead parts are identified on the part by a wire color code, letter, number or geometric symbol, this identification shall be shown on or near the connecting line adjacent to the symbol. For an example, see transformer T10 (color of leads) and capacitor C40 (geometric symbol) of Figure 8-19.

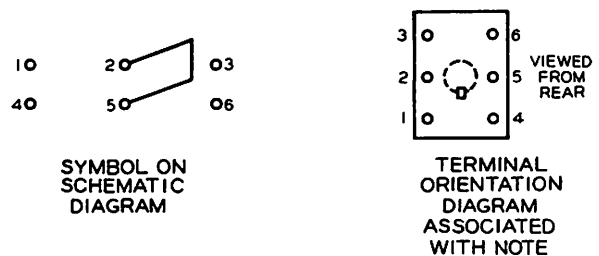


FIGURE 8-1 - TERMINAL IDENTIFICATION  
EXAMPLE - TOGGLE SWITCH

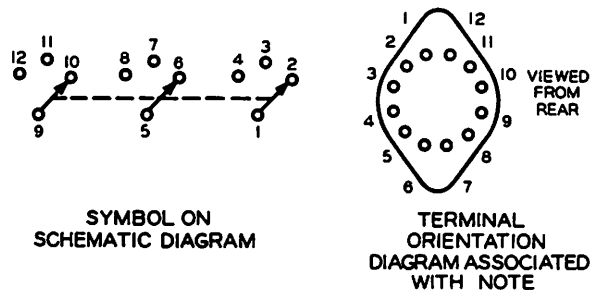


FIGURE 8-2 - TERMINAL IDENTIFICATION  
EXAMPLE - ROTARY SWITCH

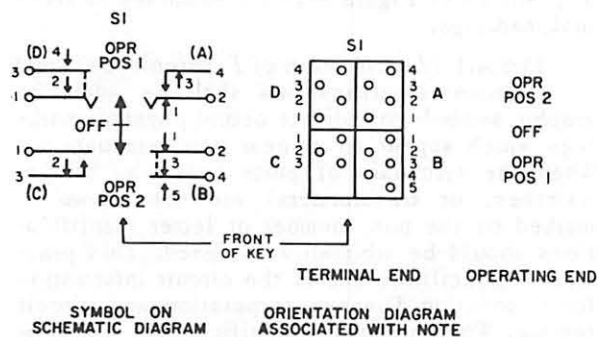


FIGURE 8-3A - TERMINAL IDENTIFICATION AND ORIENTATION TYPICAL LEVER SWITCH (KEY)

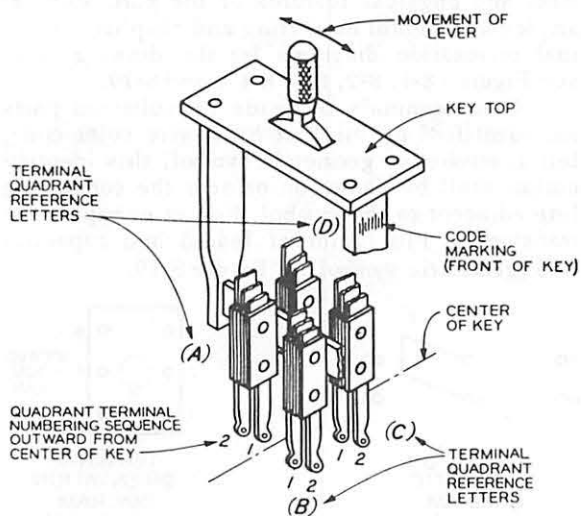


FIGURE 8-3B - RELATIONSHIP OF KEYTOP FRONT AND SPRING TERMINAL QUADRANTS TYPICAL LEVER SWITCH (KEY)

15-8.4.1.1 Adjustable Resistor Terminal Identification

When rotary type adjustable resistors are shown on Schematic Diagrams, it is often desirable to indicate direction of rotation. For indicating direction of rotation, it is customary to refer to the rotary motion as clockwise or counterclockwise when rotation is viewed from the knob or actuator end of the control. The preferred method of terminal identification is to designate with the letters "CW" the terminal adjacent to the movable contact when it is in an extreme clockwise position. This method is

shown in Figure 8-4(A). If device terminals are not marked, numbers may also be used with the resistor symbol, wherein number 2 is assigned to the adjustable contact as shown in Figure 8-4(B). Additional fixed taps may be numbered sequentially, 4, 5, etc., as shown in Figure 8-4(C).

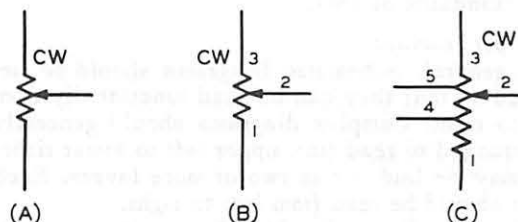


FIGURE 8-4 - TERMINAL IDENTIFICATION EXAMPLE - ADJUSTABLE RESISTOR

15-8.4.1.2 Switch Terminals and Circuit Functions

The relation of switch position to circuit function shall be shown on Schematic Diagrams. For simple toggle switches, it may be sufficient to identify position with notations such as ON-OFF. For more complex switches, position-to-function relations may be shown either near the switch symbol or at a more convenient location on the drawing. Figure 8-5 shows how either form of representation may be used for a multi position rotary switch.

When rotary switches perform involved functions such as those illustrated in Figure 8-6, the tabular form of presenting supplementary information is preferred. In tabular listings, dashes link the terminals that are connected. For example, in position 2 of Figure 8-6, terminals 1 and 3 are connected, as are terminals 5 and 7, and 9 and 11. For an additional example of this method, see Note 4 of Figure 8-19.

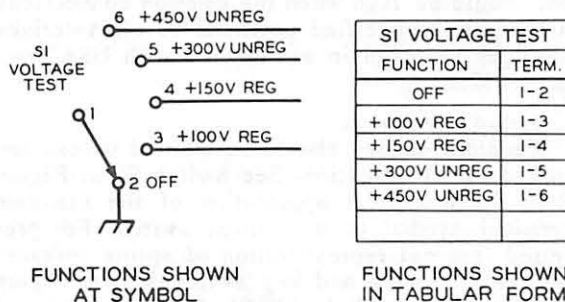


FIGURE 8-5 - POSITION-FUNCTION RELATIONSHIPS FOR ROTARY SWITCHES (OPTIONAL METHODS)

## ELECTRICAL AND ELECTRONICS DIAGRAMS

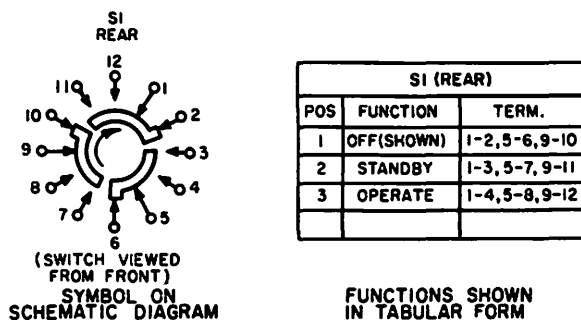


FIGURE 8-6 – POSITION-FUNCTION RELATIONSHIPS FOR ROTARY SWITCHES (TABULAR METHOD ONLY)

**15-8.4.1.3 Electron Tube Pin Identification**  
 Tube pin numbers shall be shown outside the tube envelope and immediately adjacent to the connecting line, as shown in Figure 8-7.

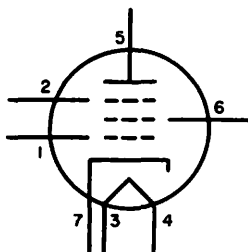


FIGURE 8-7 – TERMINAL IDENTIFICATION – ELECTRON TUBE PINS

**15-8.4.1.4 Connector Coaxial Contact Identification**

In showing and identifying contacts of coaxial connectors, the Single-Line Diagram representation of Figure 8-8 is preferred. The complete diagram representation of Figure 8-9 may be used when it is essential to show shield continuity.

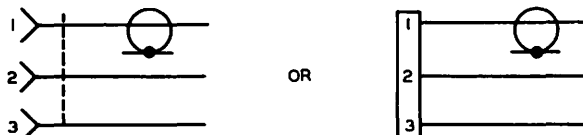


FIGURE 8-8 – SINGLE-LINE DIAGRAM REPRESENTATION

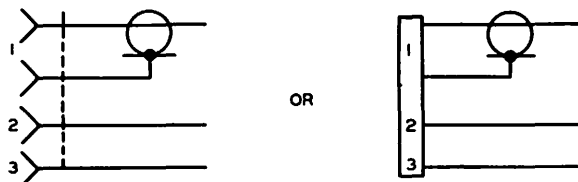


FIGURE 8-9 – COMPLETE DIAGRAM REPRESENTATION

**15.8.4.1.5 Integral Circuit Package, Circuit Pack or Subassembly Terminations**

These terminations usually fall into one of the three types shown on the left side of Figure 8-23. The recommended circuit schematic representation for each of the termination methods is shown adjacent, to the right, of the physical arrangements. While use of the mechanical-grouping boundary line is shown to be optional for arrangement 8-23(B), its use in this application is nevertheless recommended whenever possible.

**15-8.4.1.6 Circuit Pack Representation in Overall and Other Schematic Diagrams**

Circuit packs shown in overall and other Schematic Diagrams may be represented in one of the following ways:

(a) Pack circuitry may be repeated in detail and shown enclosed with a mechanical-grouping boundary line in a manner similar to the representation of AR1 in Figure 8-22;

(b) Pack circuitry may be represented with specific graphic symbols. This method is recommended in place of (a) when pack circuitry readily lends itself to symbolic representation, and the use of such graphic symbols is compatible with the type of Schematic Diagram to be prepared. An example of symbol application is shown at the right in Figure 8-23. For information on symbols that may be used for this purpose, see USA Standard Y32.2 and Y32.14.

**15-8.5 Division of Parts**

To clarify the circuit layout, portions of multi-element parts may be separated, with portions of the graphic symbol shown at different locations on the Schematic Diagram.

**15-8.5.1 Identification of Parts by Suffix Letter**

Subdivisions of parts may be identified by adding a suffix letter to the reference designation of the part. For example, C1A, C1B might identify electrically separate sections of a dual capacitor designated C1. Suffix letters may also be used to identify subdivisions of a complete part when the individual parts are shown enclosed or are associated as in a compact unit. See crystal unit of Figure 8-10 for an example of this method.

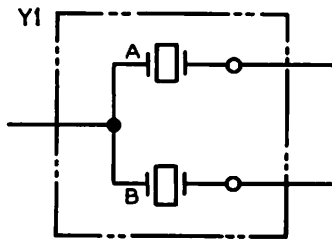


FIGURE 8-10 – IDENTIFICATION OF PARTS BY SUFFIX LETTERS

**15-8.5.2 Identification of Rotary Switch Parts**  
 When parts of rotary switches are designated S1A, S1B, S1C, etc., the suffix letters A, B, C, etc., shall start from the knob or actuator end and be assigned sequentially away from this position. Each section of the switch shall be shown viewed from the same end as shown in Figure 8-11. When both sides of a rotary switch section are used to perform separate switching functions, the front (knob or actuator end) and rear symbols should be differentiated by appropriately modifying the reference designation, for example, S1A FRONT and S1A REAR. See switch S1 of Figure 8-19.

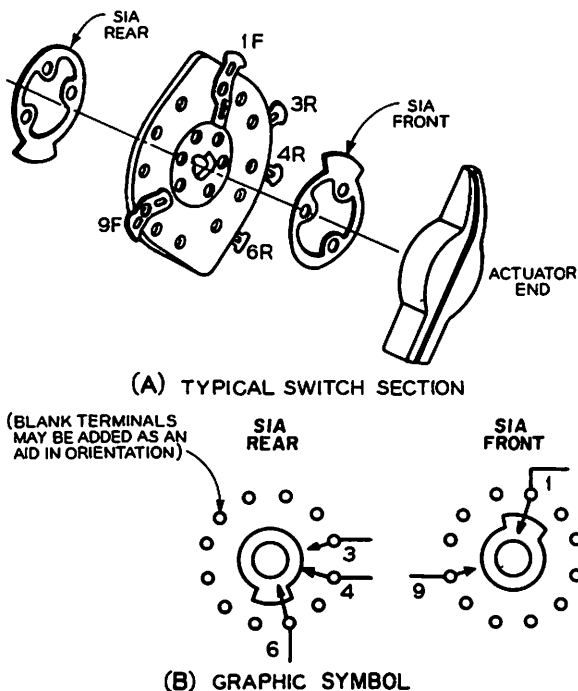


FIGURE 8-11 – TYPICAL DEVELOPMENT OF A GRAPHIC SYMBOL – COMPLEX ROTARY SWITCHES

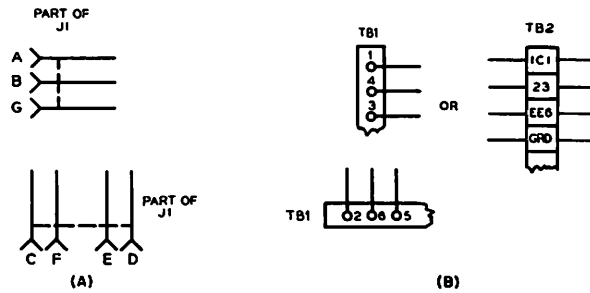


FIGURE 8-12 – IDENTIFICATION OF PORTIONS OF ITEMS

**15-8.5.3 Identification of Portions of Items**  
 When portions of connectors, terminal boards or rotary switch sections are functionally separated on the diagram:  
 (a) the words "PART OF" may precede the reference designation of the entire portion as shown in Figure 8-12(A) and in Figure 8-19, switch section S1A REAR, or  
 (b) the portion may be shown incomplete as in Figure 8-12(B) with broken line and "PART OF" omitted.

**15-8.5.4 Identification of Individual Terminals of Parts**  
 When the separation of the portions of connectors or terminal boards on the same drawing becomes extensive, the separated portions may be identified as individual terminals as shown in Figure 8-13. If individual terminals from different portions (such as connectors) are intermixed, mechanical-connecting lines shall be omitted.

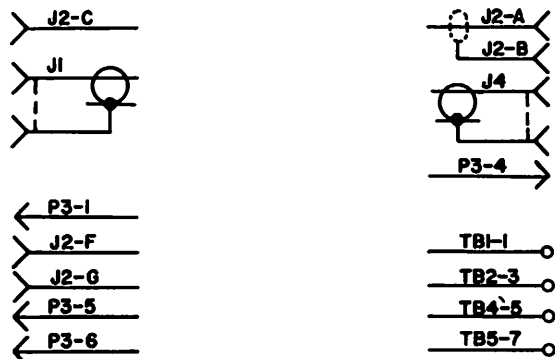


FIGURE 8-13 – IDENTIFICATION OF INDIVIDUAL TERMINALS

## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-8.5.5 Detached Contact (Contact Separation) Methods

Switching circuit functions may be more clearly shown, and bends and crossovers substantially reduced by showing the contacts of switching devices separated from each other and from the operating device (coil). Unused contacts need not be delineated on diagram if listed separately.

In Figure 8-17, relay contacts have been shown spaced from the coils to facilitate understanding the circuit functions. Mechanical linkage lines shown between elements of multi-element switching devices and reference designations for identifying individual contacts may both be omitted when the association of elements is clear. Functional designations not intended to convey surface marking information may be aligned along one edge of the Schematic Diagram instead of being shown at the graphic symbol.

The circuit function presentation of Figure 8-17 may be improved by completely separating the switching device elements as shown in Figure 8-18. The association of the elements is shown by means of reference designations and contact designations. If the Schematic Diagram is complex, it may be necessary to show the complete graphic symbol of the contacting device elsewhere on the diagram with zone locations of the device elements. In Figure 8-18, the switching function symbols are used instead of the contact symbols shown in Figure 8-17.

### 15-8.6 Reference Designations

Reference designations are combinations of letters and numbers which identify items shown on the Single-Line or Schematic Diagram. These reference designations serve to identify the same items on related documents, such as the Assembly Drawing and Connection Diagram. All graphic symbols of separately replaceable items shall be identified by an appropriate reference designation located as near as practicable to the graphic symbol. In addition, items not separately replaceable may be identified as required. Mounting devices for electron tubes, lamps, fuses, etc., are not usually shown or identified on Schematic Diagrams. For application of partial reference designation prefixes see 15-8.10.1. The use of reference designations in this Standard conforms to the Unit Numbering Method of Y32.16. The use of other reference designation methods shall conform to the requirements of the particular application, and the method shall be explained.

#### 15-8.6.1 Letters

For the selection of reference designation letters, refer to USA Standard, Electrical and Electronics Reference Designations Y32.16.

### 15-8.6.2 Numbers

The number portion of the reference designation shall follow the letter or letters without hyphen or space and shall be of the same size and on the same line; for example, C1, S14, and MG5. The assignment of numbers should preferably start with the lowest number in the upper left-hand corner of the Schematic Diagram and proceed consecutively from left to right and top to bottom throughout the drawing.

When items are eliminated as a result of a drawing revision, remaining items should not be renumbered. For circuits showing many items, a table may be used to show which numbers are not used and the highest numbered reference designations, as shown in Figure 8-14.

This table may include any or all types of items and shall be located conveniently near notes or other tabular information.

|                                 |                      |
|---------------------------------|----------------------|
| HIGHEST REFERENCE DESIGNATIONS  |                      |
| R65                             | C35                  |
| REFERENCE DESIGNATIONS NOT USED |                      |
| R7, R9<br>R60, R62              | C11, C14<br>C19, C23 |

FIGURE 8-14 - TYPICAL TABLE INDICATING OMITTED AND HIGHEST NUMERICAL REFERENCE DESIGNATIONS

### 15-8.6.3 Type Designations

Electron tubes, semiconductors and other devices with standard type designations shall be identified by reference designation and type designation. Below the type designation, the circuit function may also be indicated. This information should be located immediately adjacent to the symbol, preferably above it, as shown in Figures 8-15, 8-19, and 8-23.

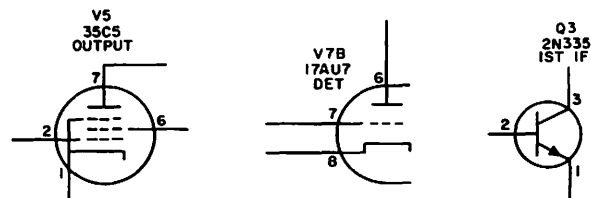


FIGURE 8-15 - REFERENCE DESIGNATION, TYPE DESIGNATION AND FUNCTION - ELECTRON TUBES AND SEMICONDUCTORS

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15-8.7 Numerical Values

Numerical values of resistance, capacitance, inductance, voltage, etc., should be specified in a numerical form requiring the indication of the fewest ciphers (zeros). This can best be done by using the multipliers of Table 8-1 in combination with a basic unit; for typical applications see 15-8.7.2, 15-8.7.3, and 15-8.7.4. In these applications the symbol of method 1 is shown. Method 2 may also be used.

Table 8-1 Multipliers

| Multiplier             | Prefix | Symbol   |          |
|------------------------|--------|----------|----------|
|                        |        | Method 1 | Method 2 |
| $10^{12}$              | tera   | T        | T        |
| $10^9$                 | giga   | G        | G        |
| $10^6$<br>(1,000,000)  | mega   | M        | M        |
| $10^3$<br>(1000)       | kilo   | k        | K        |
| $10^{-3}$<br>(.001)    | milli  | m        | MILLI    |
| $10^{-6}$<br>(.000001) | micro  | $\mu$    | U        |
| $10^{-9}$              | nano   | n        | N        |
| $10^{-12}$             | pico   | p        | P        |
| $10^{-15}$             | femto  | f        | F        |
| $10^{-18}$             | atto   | a        | A        |

15-8.7.1 Commas

Four digit numerical values shall be shown without commas. For example, 4700 and not 4,700.

15-8.7.2 Resistance

Resistance values should be expressed in ohms, kilohms or megohms as follows:

| Range in Ohms      | Express as         | Example                      |
|--------------------|--------------------|------------------------------|
| Less than 1000     | ohms               | .031<br>470                  |
| 1000 to 99,999     | ohms or kilohms    | 1800<br>15,853<br>10k<br>82k |
| 100,000 to 999,999 | kilohms or megohms | 220k<br>.22M                 |
| 1,000,000 or more  | megohms            | 3.3M                         |

15-8.7.3 Capacitance

Capacitance values should be expressed in picofarads or in microfarads as follows. (The term "picofarad" has replaced the older term "micro microfarad.")

| Range in Picofarads | Express as  | Example                    |
|---------------------|-------------|----------------------------|
| Less than 10,000    | picofarads  | 152.4pF<br>4700 pF         |
| 10,000 or more      | microfarads | .015 $\mu$ F<br>30 $\mu$ F |

15-8.7.4 Inductance

Inductance values should be expressed in henries, millihenries, or microhenries. For example, 2 $\mu$ H should be used instead of .002mH and 5mH should be used instead of .005H or 5000 $\mu$ H.

15-8.7.5 Notes

To avoid repeating abbreviations of units of measurement which are generally applicable throughout the diagram, a general drawing note may be used and only the numerical value need be specified on the diagram. A recommended form of the note is:

UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS. CAPACITANCE VALUES ARE IN MICROFARADS.

or  
CAPACITANCE VALUES ARE IN PICO FARADS.

An alternative note for specifying capacitance values is:

CAPACITANCE VALUES SHOWN AS NUMBERS EQUAL TO OR GREATER THAN UNITY ARE IN pF AND NUMBERS LESS THAN UNITY ARE IN  $\mu$ F.

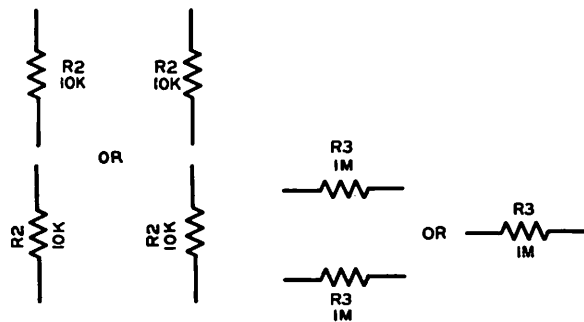


FIGURE 8-16 - METHODS OF NUMERICAL VALUE AND REFERENCE DESIGNATION PLACEMENT



## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-8.7.6 Numerical Value and Reference Designation Placement

Numerical values and reference designations shall be located as near as feasible to the symbol. Preferable arrangements are shown in Figure 8-16. Multiplier symbols are shown to indicate multiples of a basic unit.

### 15-8.8 Functional Identification of Parts

Some parts may require special functional identification. Such information may be applied when it will contribute substantially to the readability of the circuit. Functional designations which are to be marked on chassis or panel surfaces shall be shown on the diagram adjacent to the applicable symbol.

### 15-8.9 Test Points

In addition to the reference designation, test points shall be identified on a diagram, by one of the following methods:

- (a) with the letters "TP" followed by a number suffix. The number suffix should be assigned on the diagram in sequence for troubleshooting convenience.
- (b) with a special distinguishing symbol to indicate the test point category (for example, major, secondary, or minor). Test points within each category may be identified by designation numbers or letters.
- (c) with the test function indicated below the reference designation.

### 15-8.10 Additional Circuit Information

The following additional information, as applicable, may be included on Schematic Diagrams. When diagrams are specifically prepared for maintenance purposes, as much of this information as is applicable shall be included. Additional information should not be limited to the items noted in this paragraph.

- DC resistance of windings and coils (if more than one ohm)
- Critical input or output impedance values
- Wave shapes (voltage or current) at significant points
- Wiring requirements for critical ground points, shielding, pairing, etc.
- Power or voltage ratings of parts
- Indication of operational controls or circuit functions
- Caution notation for electrical hazards at maintenance points

Circuit voltage values at significant points (tube pins, test points, terminal boards, etc.)

Significant circuit resistance values at designated reference points (information may be in tabular form)

Zones (grid system) on complex Schematics.

When technical data is prepared from engineering drawings, zone reference may be the same.

Circuit element zone locations (on complex Schematics) in tabular form on the drawing or associated document when such location information will facilitate use of the Schematic.

Signal flow direction in main signal paths shall be emphasized.

### 15-8.10.1 Partial Reference Designation Prefix

When it is necessary that a Schematic Diagram convey for maintenance purposes the location of a part within an overall unit consisting of one or more subassemblies, the notation REF DESIG PREFIX followed by an appropriate reference designation prefix shall be used, as shown in Figure 8-22. The notation and prefix shall be placed in the upper left corner of the mechanical-grouping boundary line enclosure of the subassembly immediately below or following the subassembly name. By preceding the part or subassembly reference designation, the prefix conveys location within each sub-assembly level of the unit. For example, the reference designations of parts within A1 would be prefixed by 3A1, indicating that part is in subassembly A1 and that A1 is within unit 3. For parts within amplifier AR1, the prefix is 3A1AR1. The complete locational reference designation for C2 of AR1, for example, would be 3A1AR1C2.

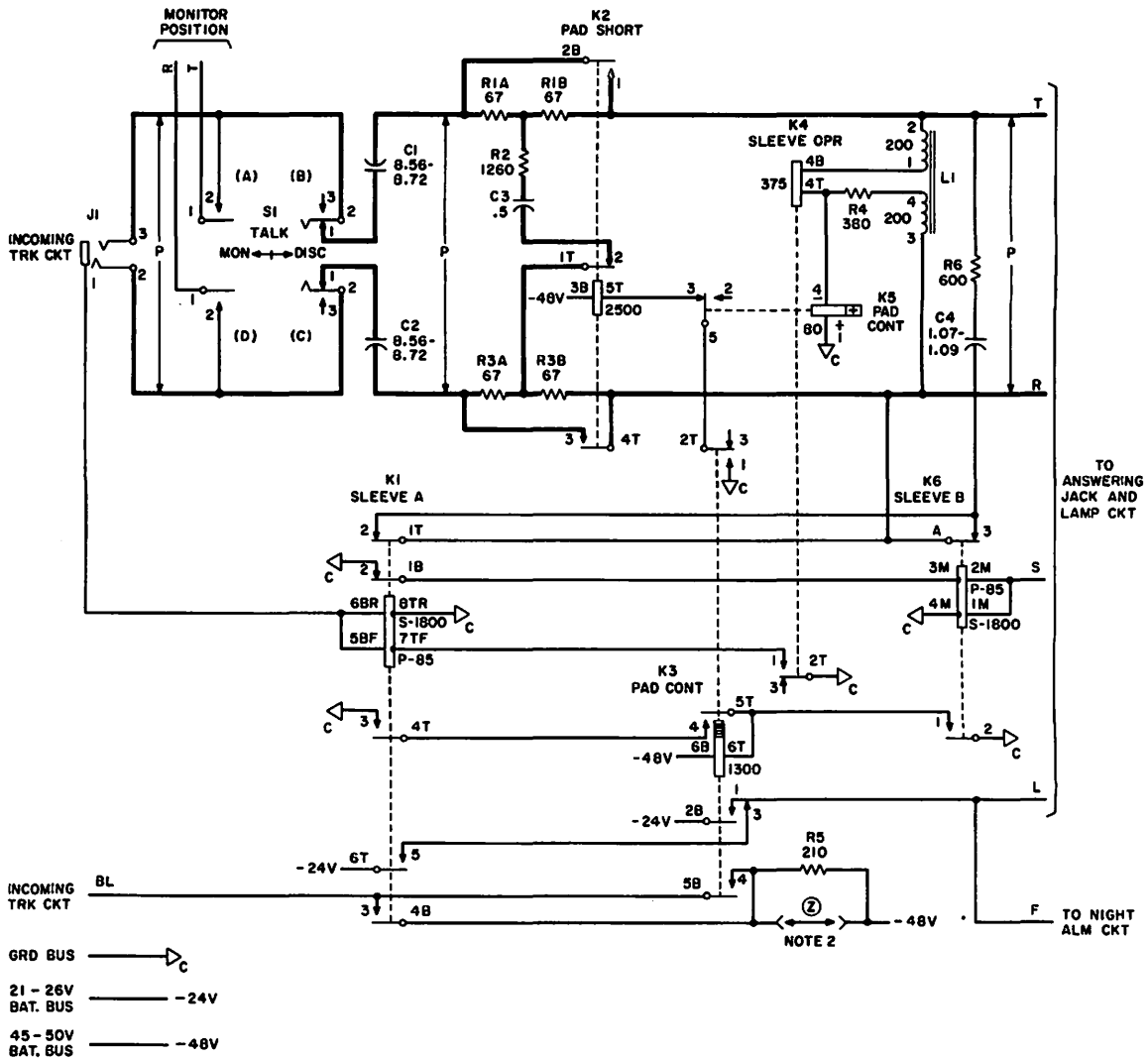
### 15-8.11 Examples of Schematic Diagrams for a Complete Item

Figure 8-19 is an example of a conventional Schematic which adequately serves manufacturing purposes.

Figure 8-20 is an example of a schematic wherein each stage is identified for ease in understanding its function. In this form it may be readily converted to add or emphasize maintenance information in accordance with 15-8.10, in which case it will be similar to Figure 8-21.

Figure 8-21 is an example of a maintenance schematic in which the signal path is emphasized.

USA STANDARD DRAFTING PRACTICES



- NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTANCE VALUES ARE IN OHMS CAPACITANCE VALUES ARE IN MICROFARADS
  2. PROVIDE "Z" OPTION WHEN BUSY LAMP CIRCUIT IS USED
  3. FOR INFORMATION CONCERNING RELAY TERMINAL IDENTIFICATION. SEE STANDARD PRACTICE XXX
  4. TERMINAL NUMBERING FOR SI IS FOR REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS AND MARKINGS IS SHOWN IN DIAGRAM BELOW.

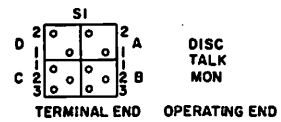


FIGURE 8-17 - TYPICAL SWITCHING-CIRCUIT SCHEMATIC DIAGRAM (USE OF JUNCTION DOTS OPTIONAL)

# ELECTRICAL AND ELECTRONICS DIAGRAMS

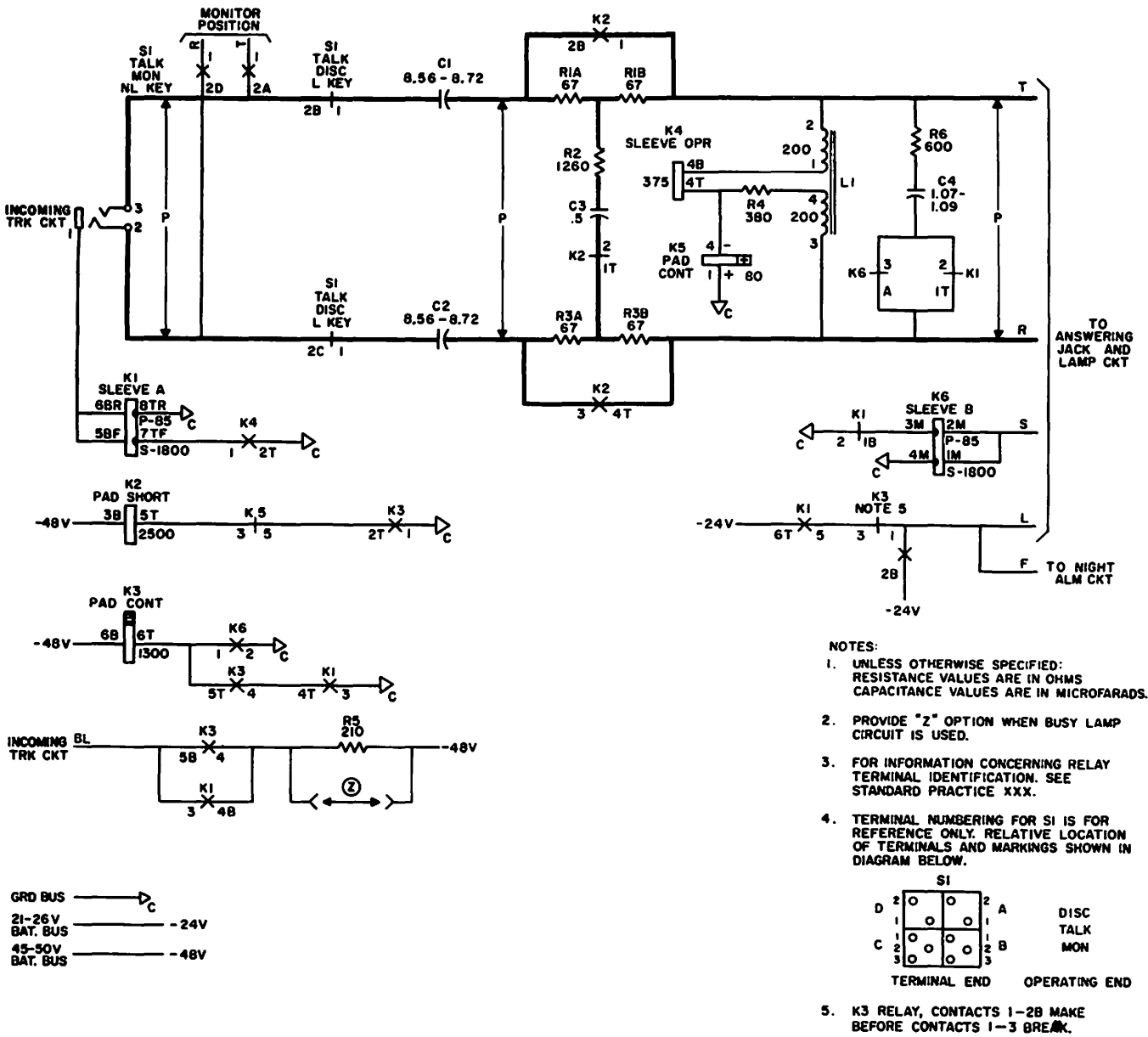


FIGURE 8-18 – CONTACT-SEPARATION METHOD OF SCHEMATIC REPRESENTATION  
(CIRCUIT SAME AS SHOWN IN FIGURE 8-17)

USA STANDARD DRAFTING PRACTICES

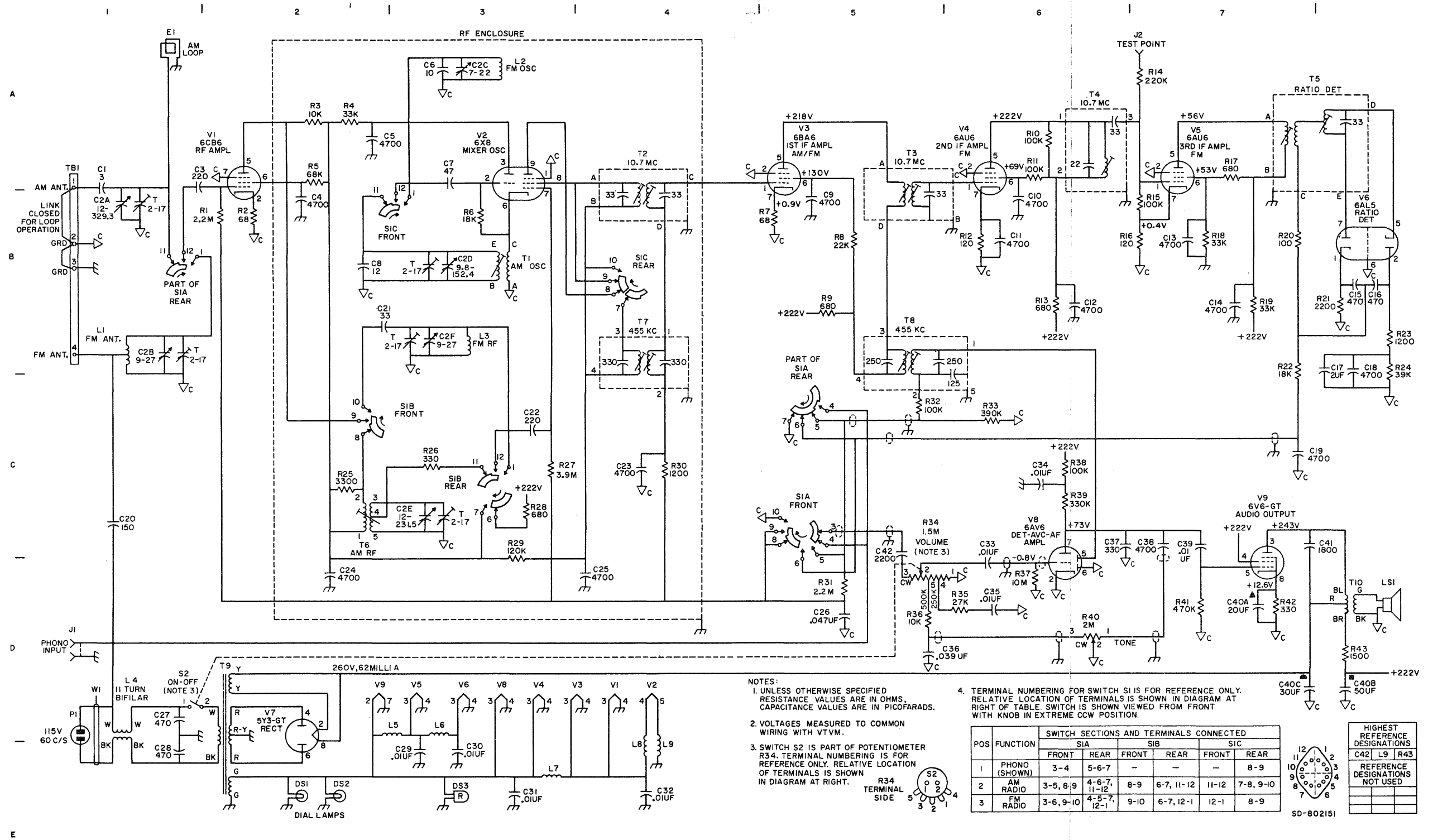


FIGURE 8-19 - TYPICAL SCHEMATIC DIAGRAM (SEE 15-8.11 FOR OTHER FORM)

ELECTRICAL AND ELECTRONICS DIAGRAMS

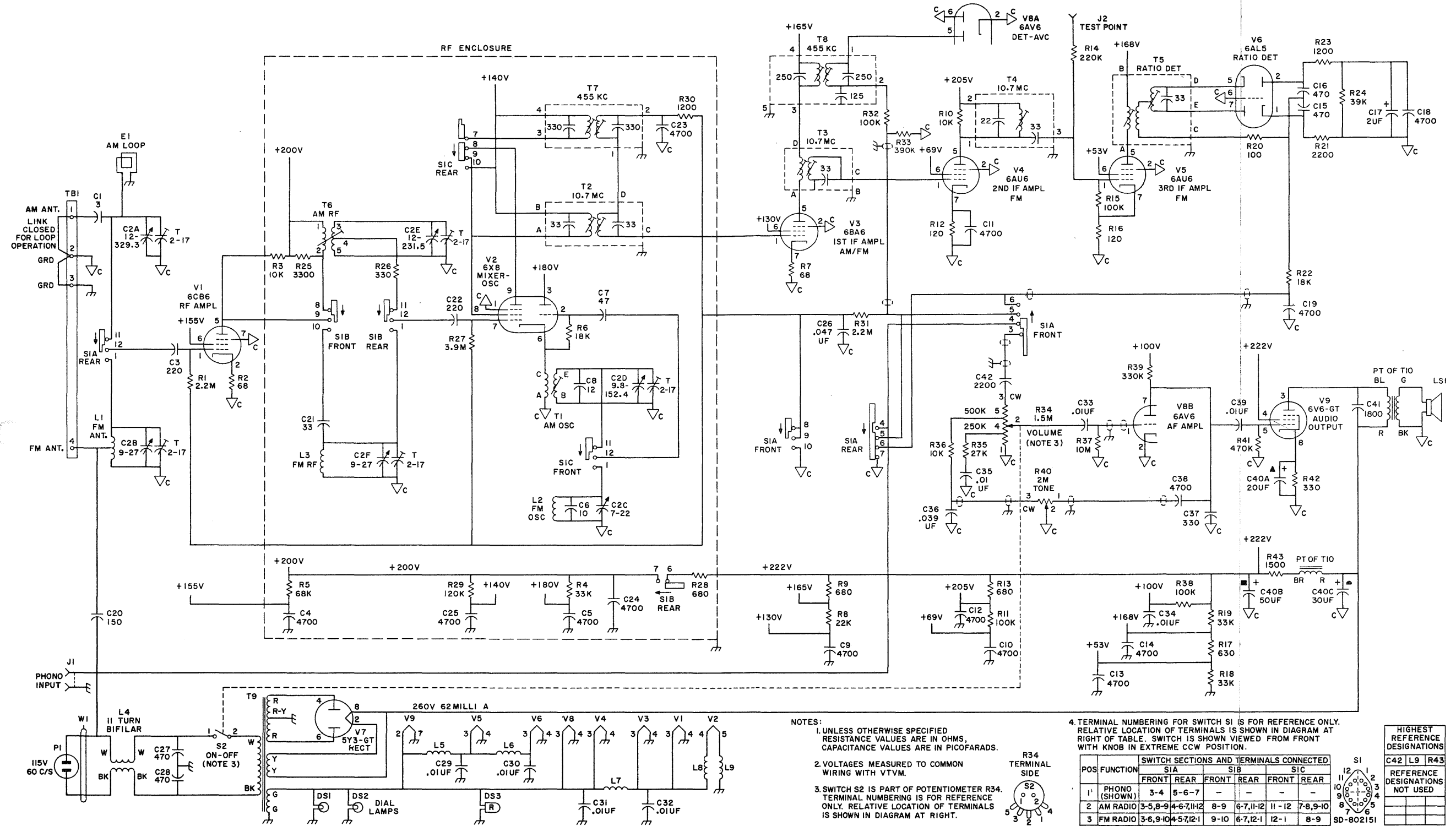


FIGURE 8-20 - TYPICAL SCHEMATIC DIAGRAM

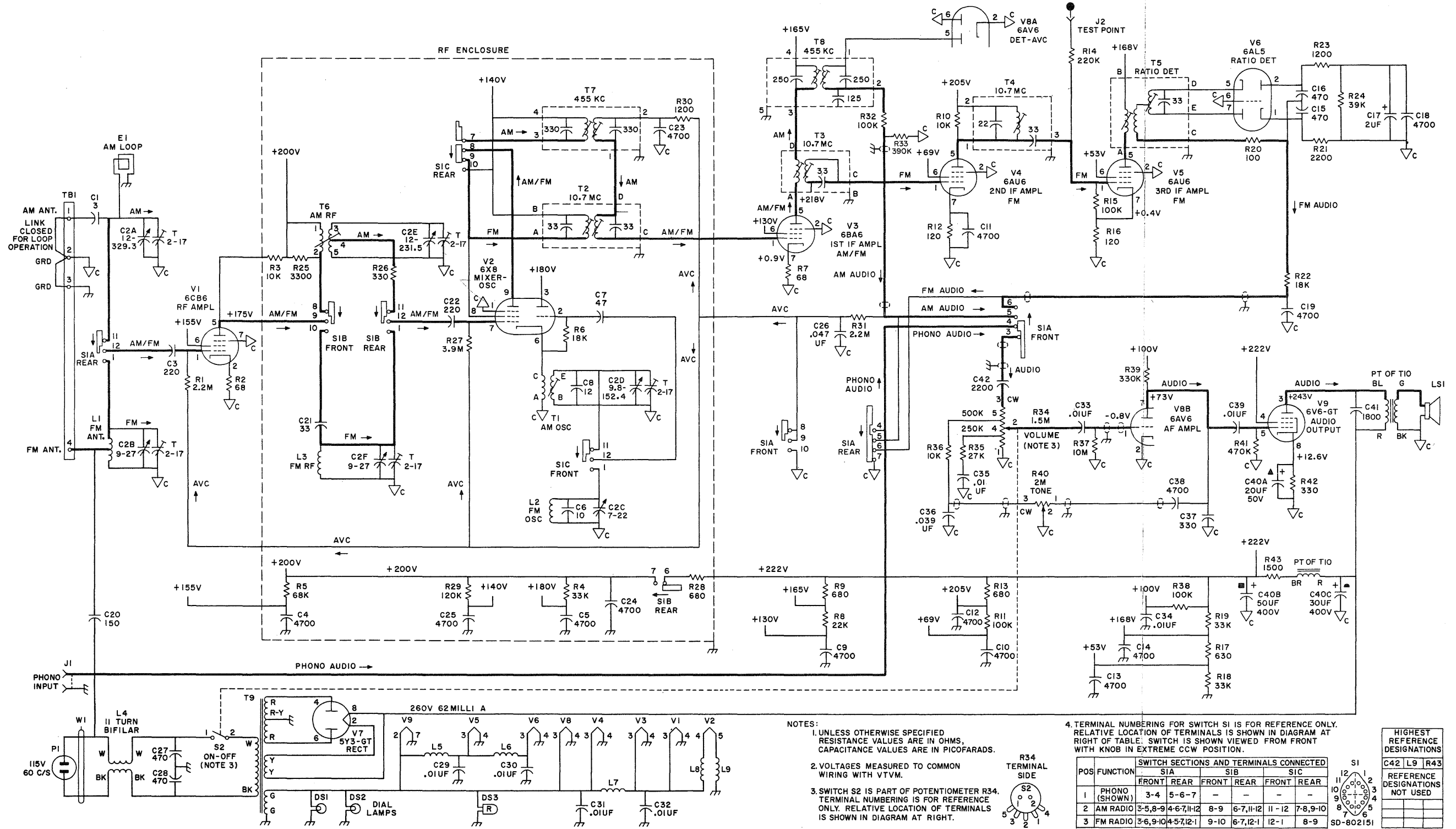


FIGURE 8-21 - TYPICAL MAINTENANCE TYPE-SCHEMATIC DIAGRAM

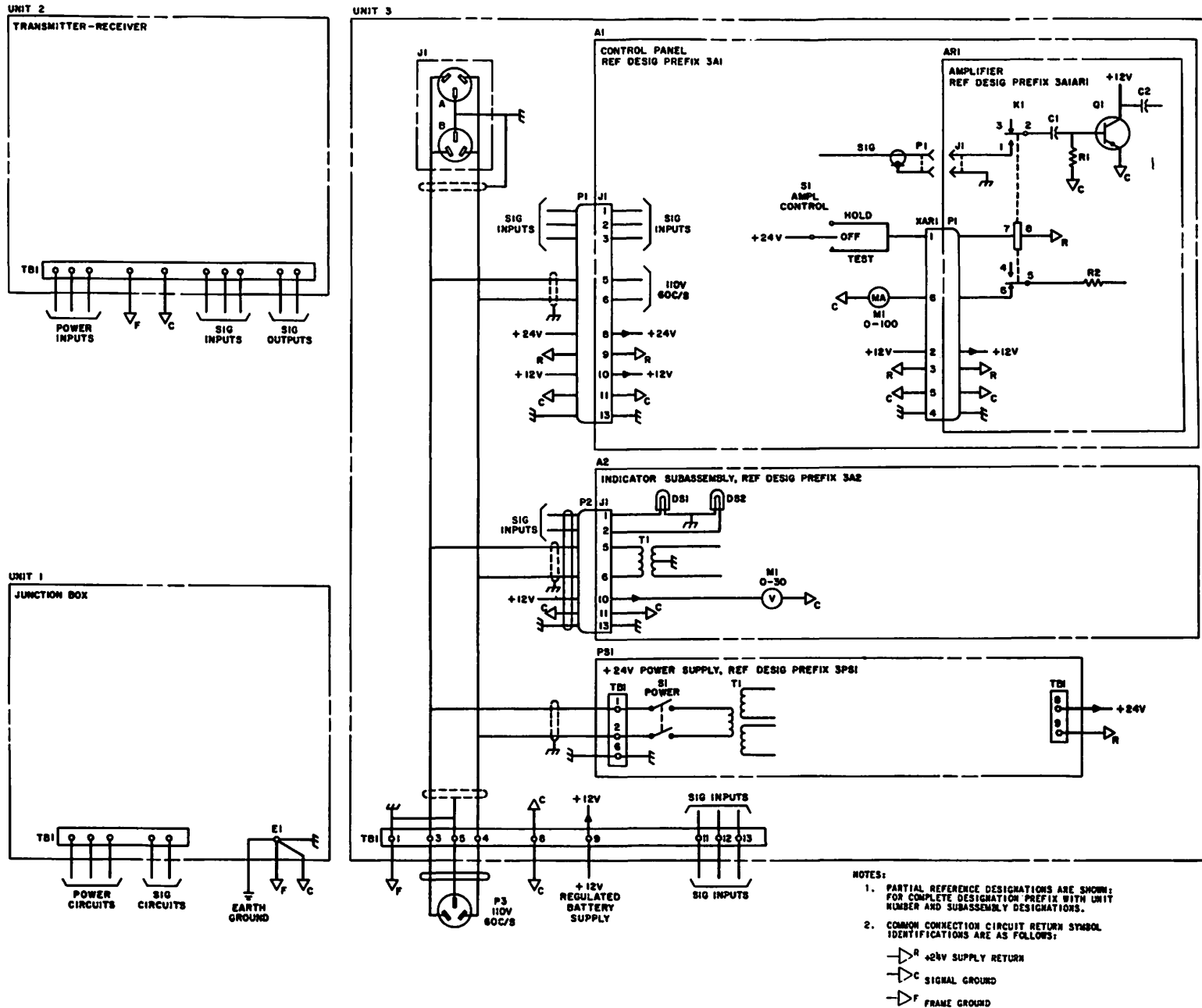
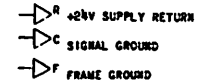


FIGURE 8-22 - TYPICAL APPLICATION OF CIRCUIT RETURN SYMBOLS

- NOTES:
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND SUBASSEMBLY DESIGNATIONS.
  2. COMMON CONNECTION CIRCUIT RETURN SYMBOL IDENTIFICATIONS ARE AS FOLLOWS:



15-8.12 Single-Line Diagrams for Microwave Circuits

Single-line symbols shall be used in representing coaxial and waveguide parts on microwave-circuit Schematic Diagrams. For the auxiliary portions of the circuit such as power supply or controls, single-line or complete symbols may be used. For sample diagram, see Figure 8-24.

15-8.12.1 Transmission Path Recognition Symbol

Type of transmission path, such as coaxial or waveguide, need be indicated only at each end of a path as long as the path remains of the same type. See waveguide path from CP1 to MT2 via A4, A5 and A6 on Figure 8-24. Additional recognition symbols may be shown as required for further clarification.

15-8.12.2 Connector and Flange Symbols

Transmission path separable connectors or equipment flanges shall be identified only when it is necessary to indicate the electrical function or separable feature of these parts. See representation of M2 and W1 in Figure 8-24.

15-8.12.3 DC Continuity and Discontinuity

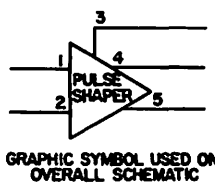
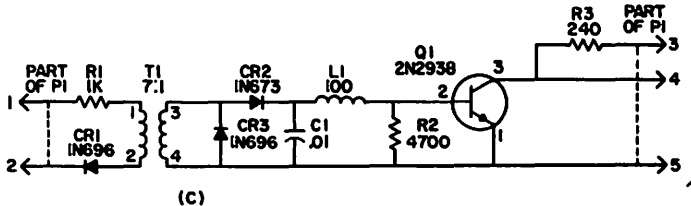
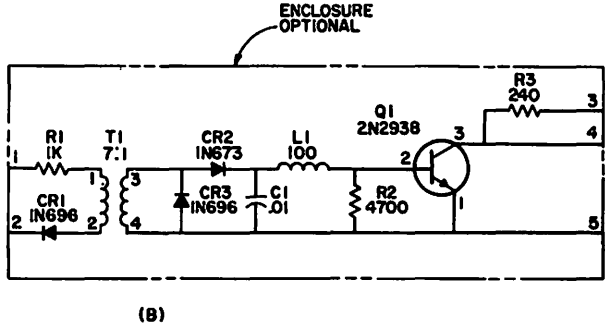
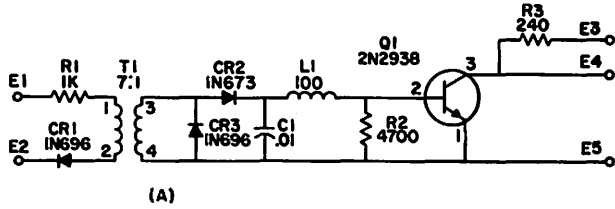
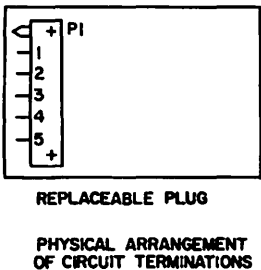
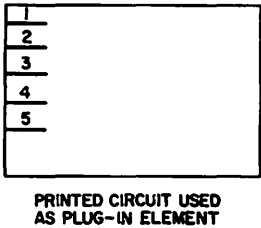
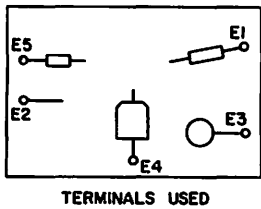
When the circuit includes DC and RF signals, DC continuity should be clearly shown. See A3 and A5 of Figure 8-24. MT2 illustrates method of indicating DC discontinuity. The discontinuity symbol is used to indicate absence of direct electrical connection between a waveguide and the outer conductor of a coaxial cable at a point where the transmission paths change from waveguide to coaxial or vice versa.

15-8.12.4 Pressure Seals

When it is necessary to indicate that certain path sections of waveguide are sealed from other paths of the circuit, a note similar to note 1 of Figure 8-24 shall be used. This particular note indicates that the path from E1 via A1HY1, CP1, A2S2, DC1, and Z1 is a sealed path.

15-8.12.5 Subassemblies

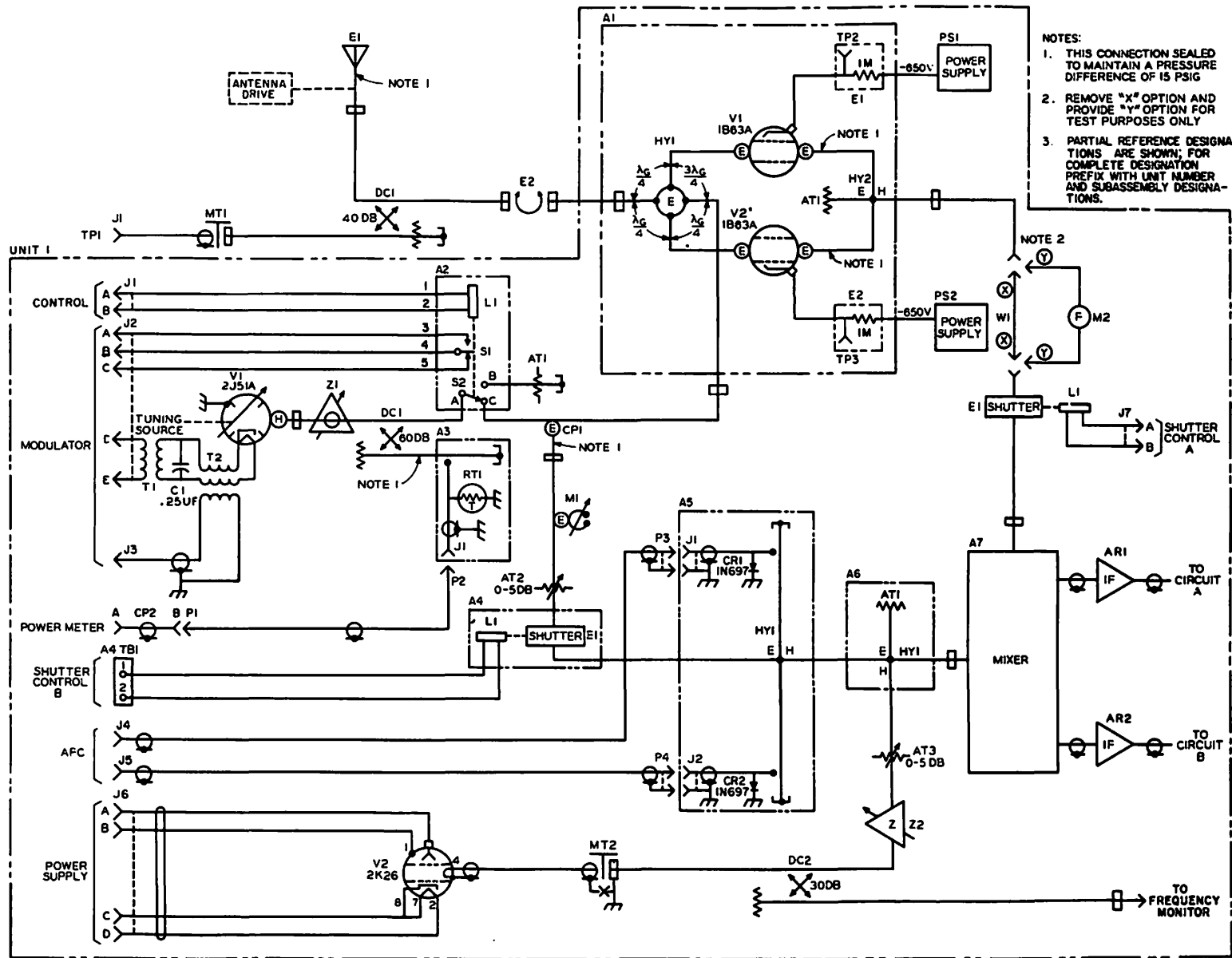
Subassemblies such as mixers may be shown with all parts represented as shown in A7 of Figure 8-24, or, if such detailed representation is not essential, a general overall symbol may be used as shown for A7.



SCHEMATIC REPRESENTATIONS

FIGURE 8-23 - SCHEMATIC REPRESENTATION IN RELATION TO TERMINATION METHOD USED





- NOTES:
1. THIS CONNECTION SEALED TO MAINTAIN A PRESSURE DIFFERENCE OF 15 PSIG
  2. REMOVE "X" OPTION AND PROVIDE "Y" OPTION FOR TEST PURPOSES ONLY
  3. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN; FOR COMPLETE DESIGNATION PREFIX WITH UNIT NUMBER AND SUBASSEMBLY DESIGNATIONS.

FIGURE 8-24 - TYPICAL MICROWAVE-CIRCUIT SCHEMATIC DIAGRAM

USA STANDARD DRAFTING PRACTICES

15-9 Schematic Diagrams (Power Switchgear and Industrial Control)

The following subparagraphs contain detailed information specifically applicable to Power Switchgear and Industrial Control Schematic Diagrams. This material is to be used as a supplement to the general standards of 15-7.

15-9.1 Contents

A Schematic Diagram shows in the simplest manner the circuits and functions of the component devices or parts of the electrical equipment. Consideration shall be given to inclusion of the following information.

15-9.1.1 Device Ratings (Fuses, Resistors, etc.)

Note: Industrial Control Schematic Diagrams may omit device ratings when they are used as standard drawings applying to more than one rating.

15-9.1.1.1 Rating Location

Device ratings should be located close to the device symbol to assure correct identification. For example, see ratings of 40 amperes for the fuse, Figure 9-1(A); 3300 ohms for the resistor, Figure 9-1(B); 200/5 (amperes) for the current transformer, Figure 9-1(C); and the voltage ratio for the 115000-115 volt potential transformers, Figure 9-1(D). Polarity marks shall be shown on all instrument transformers.

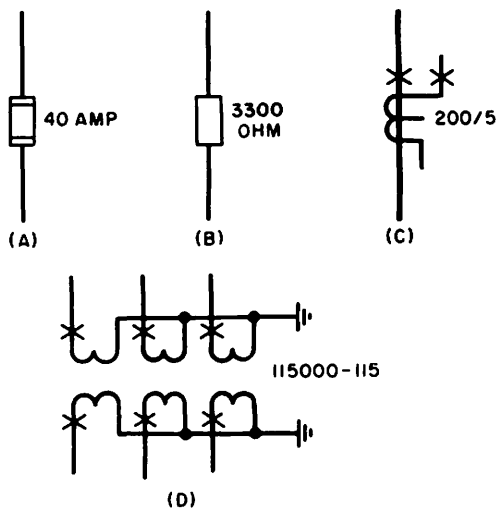


FIGURE 9-1 - TYPICAL LOCATIONS FOR DEVICE RATINGS

15-9.1.1.2 Current Transformers

Where current transformers are the multi-ratio type, both the maximum current ratio and the ratio of the tap to which the external circuit is connected should be shown as indicated in Figure 9-2.

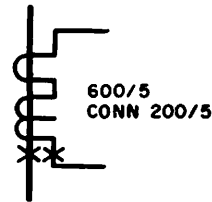


FIGURE 9-2 - TYPICAL MULTI-RATIO CURRENT TRANSFORMER RATING

15-9.1.2 Explanatory Notes

Where the function is not clear, explanatory notes should be added for clarification. For example, the note adjacent to device 23 in Figure 9-3 indicates that the contact closes at 40 F on decreasing temperature. Where notes are lengthy or need repeating they may be shown at a common location with proper reference at the point of application.

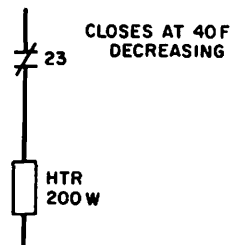


FIGURE 9-3 - TYPICAL DEVICE FUNCTION EXPLANATORY NOTE

## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-9.1.3 Wire and Terminal Designations

Wire or terminal (or both) designations identify the conductors and terminals and facilitate checking of circuits. The use of wire or terminal (or both) designations should be determined by the overall adaptability to the design, assembly, installation, and maintenance of equipment. Simple designations are desirable as illustrated in Figure 9-4.

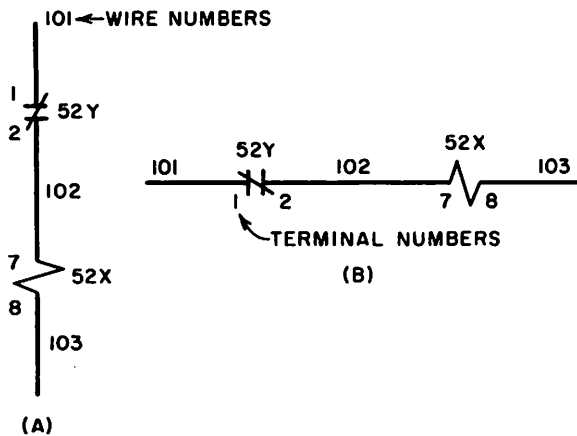


FIGURE 9-4 - TYPICAL TERMINAL AND WIRE DESIGNATIONS

#### 15-9.1.3.1 Designation Location

Whenever possible, all wire designations should be located either above or to the right of its line, and terminal designations either below or to the left of its symbol as indicated in Figure 9-4. However, any other consistent system of wire and terminal designation location may be used.

#### 15-9.1.4 Wire Designations

Wire designations are usually arbitrary identifications assigned to specific conductors. These may comprise a series of numbers, characters or symbols, or combinations of each, or both. The following are a few examples:

- |               |                        |
|---------------|------------------------|
| 1, 2, 3, etc. | 1-1, 1-2, 1-3, etc.    |
| A, B, C, etc. | A-A, A-B, A-C, etc.    |
| +, -, ±, etc. | A+, A-, 1A+, etc.      |
|               | 1-A1, 2-A1, 3-A1, etc. |

#### 15-9.1.4.1 Designations Denoting a Function

Designation numbers, characters and symbols also denoting a function may be chosen. The following are a few examples:

| Designation | Function        |
|-------------|-----------------|
| 1           | Phase 1         |
| 2           | Phase 2         |
| 3           | Phase 3         |
| A           | Phase A         |
| B           | Phase B         |
| C           | Phase C         |
| P           | Positive        |
| N           | Negative        |
| C           | Close           |
| T           | Trip            |
| R           | Red Lamp        |
| G           | Green Lamp      |
| A           | Alarm           |
| AP          | Alarm Positive  |
| A+          | Alarm Positive  |
| 1-1         | Unit 1, Phase 1 |
| 1-2         | Unit 1, Phase 2 |
| 1-3         | Unit 1, Phase 3 |
| A-A         | Unit A, Phase A |
| A-B         | Unit A, Phase B |
| A-C         | Unit A, Phase C |
| L1          | Line 1          |
| L2          | Line 2          |
| L3          | Line 3          |
| +           | Positive        |
| -           | Negative        |
| ±           | Neutral         |

#### 15-9.1.4.2 Designations Denoting Location

Designations may also be used to denote location as well as function. Figure 9-5 illustrates standard identification of bushing type current transformers and leads. See NEMA SG4 Part 3. Designation 1Y1, for example, denotes that the connection originates on circuit breaker pole 1 as indicated by the first digit, the letter Y denotes the upper transformer (further removed from the breaker contacts) and the last digit 1, the secondary winding tap number.

#### 15-9.1.4.3 Assigned (Wire) Designations

The assigned wire designation for a continuous electrical connection should be retained whenever practicable until the circuit characteristic is altered. Figure 9-11 illustrates good drafting practice in this respect. In many instances it is not practicable to retain the same wire designation throughout because of established terminal marking standards, differences in

design, drafting and manufacturing practices. However, the same designation shall be used between any two interconnected points. Figure 9-10, "52 Closing Circuit" and "52 Tripping Circuit," illustrates good drafting practice in this respect.

15-9.1.5 Terminal Designations

Standard terminal designations have been applied to electric power apparatus such as motors, generators, transformers, etc., and are covered in USA Standard Terminal Markings for Electrical Apparatus C6.1 and for power circuit breakers in USA Standard Power Circuit Breaker Control C37.11. Where no standard terminal designation exists, arbitrarily chosen designations may be used similar to the method described in 15-9.1.4.

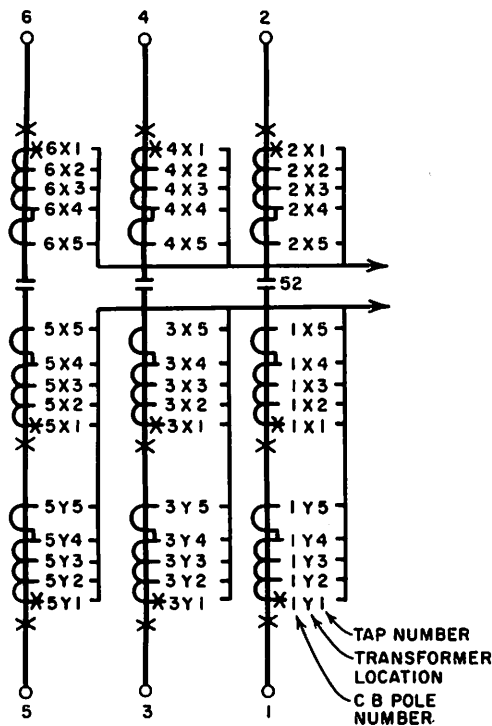


FIGURE 9-5 - STANDARD IDENTIFICATION OF BUSHING CURRENT TRANSFORMERS

15-9.1.5.1 Interconnecting Unrelated Terminal Designations

Figure 9-6 illustrates good drafting practice when interconnecting electrical equipments which have unrelated terminal designations. This figure shows in schematic form a typical industrial control circuit. The location of the various

devices has been shown for illustrative purposes only. The terminals for each of the panels where these devices are located shall be shown in their proper position in the circuit. The interconnecting wires required between the panel terminals can thus be seen. Reference may be made to the associated interconnection diagrams. However, any other consistent system of device, terminal and interconnecting designations may be used.

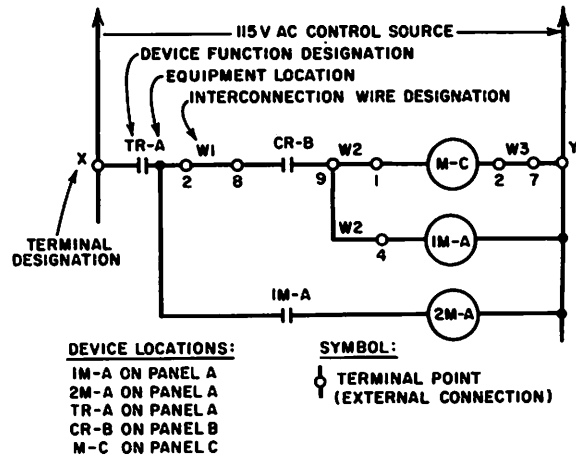


FIGURE 9-6 - TYPICAL SCHEMATIC DIAGRAM SHOWING TERMINAL AND INTERCONNECTION DESIGNATIONS

15-9.1.6 Mechanism End of Power Circuit Breaker

The location of the breaker mechanism M determines the designation numbers of the breaker bushings and their associated current transformers. Refer to NEMA SG4, Part 3. The breaker mechanism location with respect to the phase identification is required for the proper connections of the current transformers. See Figures 9-7(A) and 9-7(B).

15-9.2 General Layout

The arrangement of the diagram should show all circuits in the clearest manner. The following requirements shall be observed in the preparation of the diagram.

## ELECTRICAL AND ELECTRONICS DIAGRAMS

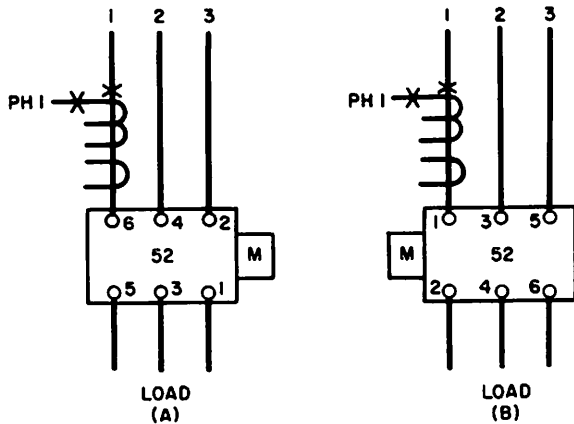


FIGURE 9-7 – PROPER LOCATION OF MECHANISM WITH RESPECT TO BREAKER BUSHINGS

### 15-9.2.1 Graphic Symbols

Symbols for Schematic Diagrams are intended to indicate the operating functions. These symbols are shorthand graphical representation and are not necessarily intended to represent the physical likeness of the device nor contain complete electrical connections. Graphic symbols shall be applied as described in 15-3.6.

### 15-9.2.2 Abbreviations

Abbreviations shall be applied as described in 15-3.7.

### 15-9.2.3 Device Function Designations

#### 15-9.2.3.1 Device Function Designations for Power Switchgear

Device function designations as applied to Power Switchgear shall conform with USA Standard Manual and Automatic Station Control, Supervisory, and Associated Telemetering Equipments, C37.2 or other national-level standards if the device function designation is not covered in the USA Standard. Those device letters which denote parts of the main device, and those which cannot or need not form part of the device function designation, are generally written directly below the device function designation, as for example,  $\frac{52}{LC}$  or  $\frac{CS}{T}$ . If two or more devices with the same function designation and suffix letter (if used) are present in the same equipment, they may be distinguished by numbered suffixes, as for example, 51-1, 51-2, and 51-3, when necessary.

#### 15-9.2.3.2 Device Function Designations for Industrial Control

Device function designations as applied to Industrial Control shall conform with NEMA

Standard IC1, Part 3 until a USA Standard is issued.

### 15-9.2.4 Device Contacts

When necessary to understand the function of a circuit, the sequence of operation of contacts within a control or protective device should be shown on the Schematic Diagram, or reference made to the appropriate drawings. Consideration should also be given to cross-referencing contacts of relays or other devices which are used in circuits remote from the operating coil. In addition, the unused contacts of the devices may also be shown.

### 15-9.2.5 Circuit Arrangements

The circuits should be arranged in functional sequence, left to right or top to bottom. However, this should not be followed rigidly where excessive line crossings would impair the clarity of the diagram. In Figure 9-8, the pressure switch PS when closed energizes device TR, whose time closing contact then energizes device ICR, which in turn energizes device M.

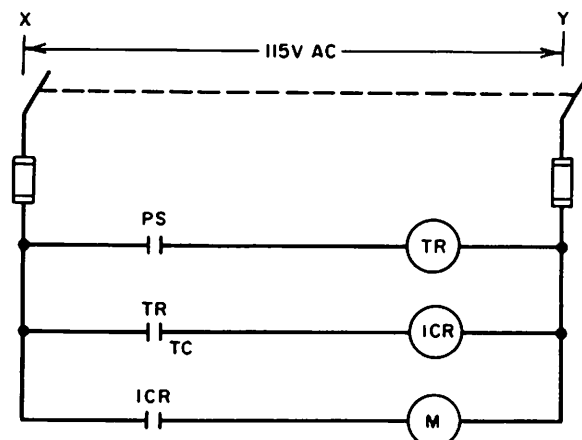


FIGURE 9-8 – EXAMPLE OF CIRCUIT ARRANGEMENT IN FUNCTIONAL SEQUENCE

### 15-9.2.6 Control Sources

Control sources should be shown by means of horizontal or vertical parallel lines with detailed circuits between and perpendicular to them. Note AC source X and Y shown in Figure 9-8.

### 15-9.2.7 Physical Relationship

Physical relationship between portions of a device are usually disregarded. In Figure 9-8, the coil and contacts of device ICR are shown separated to facilitate tracing the circuit and its function.

## USA STANDARD DRAFTING PRACTICES

### 15-9.2.8 *Course of Circuit*

Course of each circuit should be shown in the most direct path. Refer also to 15-7.1.

### 15-9.2.9 *Horizontal and Vertical Lines*

Lines between symbols should be horizontal or vertical with a minimum of line crossings, and with spacing to avoid crowding. Refer to 15-7.2.

### 15-9.2.10 *Phasing Indication*

Phasing of alternating current components should be indicated so that there is general agreement with the actual physical arrangement and suitable notes applied where necessary. When physical arrangement is not the governing factor, the phasing should be indicated in sequence, 1, 2, 3, N from left to right or top to bottom.

### 15-9.2.11 *Polarity Indication*

Polarity of direct current components should be indicated with a "P" or "+" for positive, "N" or (-) for negative, and "PN" or  $\pm$  for neutral. Direct current busses should be shown in sequence, positive, neutral, negative from left to right or top to bottom when physical arrangement is not the governing factor.

### 15-9.3 *Typical Schematic Diagrams*

Typical Schematic Diagrams that illustrate good drafting practices are shown in Figures 9-9, 9-10 and 9-11.

### 15-10 *Connection Diagrams*

Material for this paragraph has not yet been approved as USA Standard. Material approved by the Sectional Committee has been published as a Proposed USA Standard for trial use (see page 39). Industry comments are welcomed and will be considered before final adoption of this section as a USA Standard.

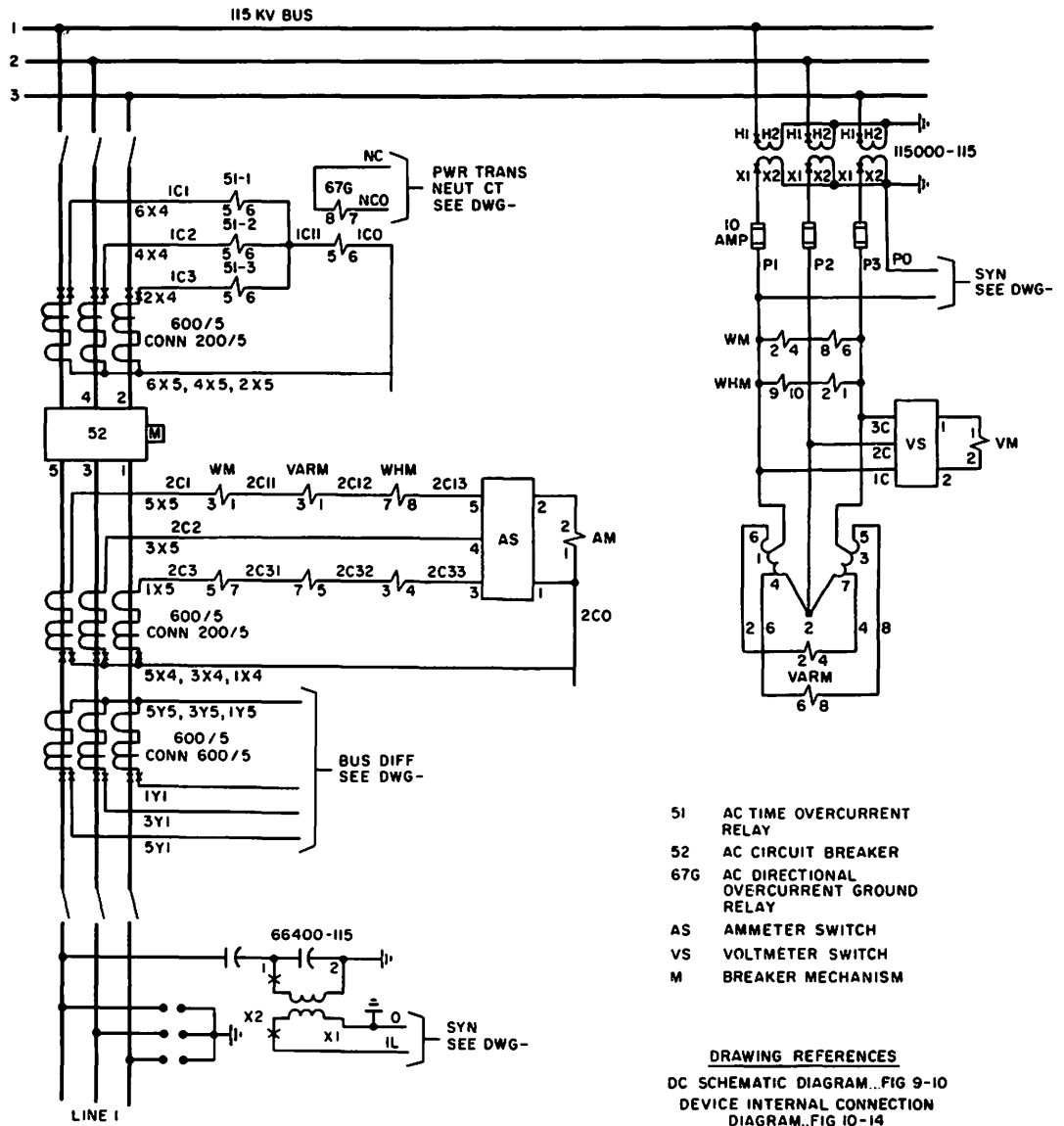
### 15-11 *Interconnection Diagrams*

Material for this paragraph has not yet been approved for circulation as a Proposed Standard.

### 15-12 *Terminal Diagrams*

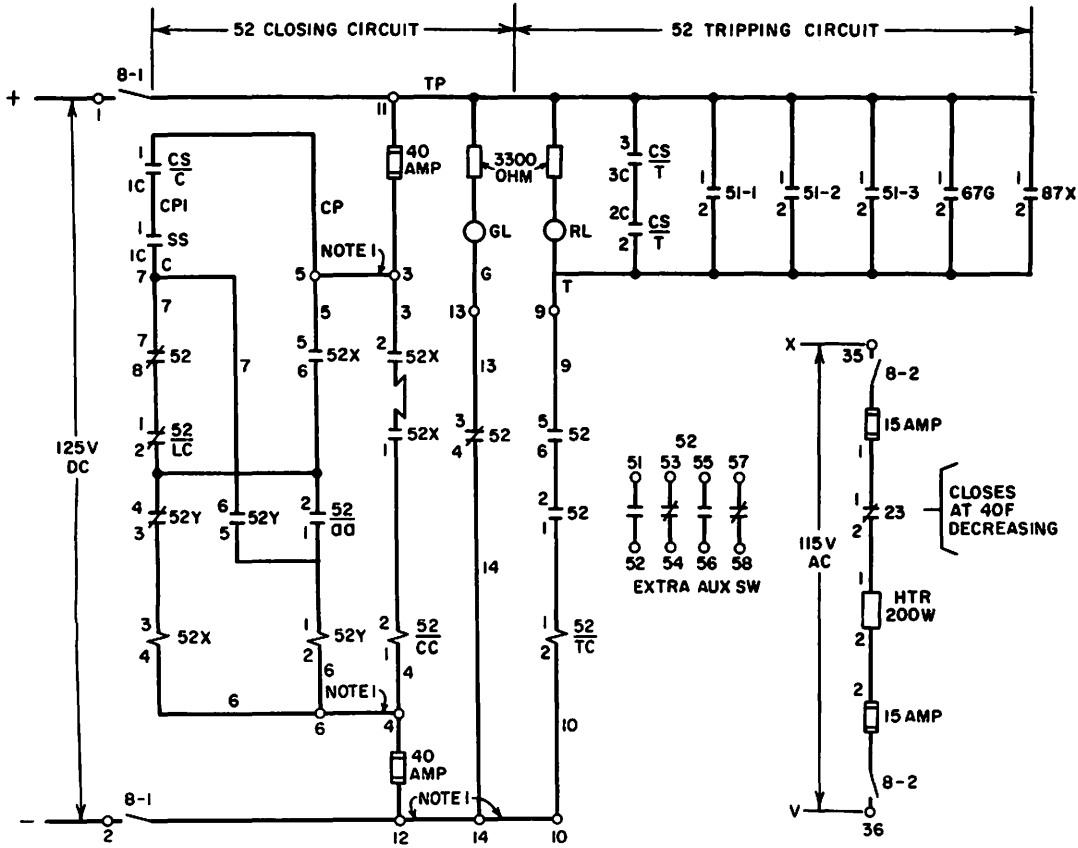
Material for this paragraph has not yet been approved as USA Standard. Material approved by the Sectional Committee has been published as a Proposed USA Standard for trial use (see page 66). Industry comments are welcomed and will be considered before final adoption of this section as a USA Standard.

# ELECTRICAL AND ELECTRONICS DIAGRAMS



**FIGURE 9-9 – TYPICAL POWER SWITCHGEAR AC SCHEMATIC DIAGRAM  
(USING BOTH TERMINAL AND WIRE DESIGNATIONS)**

## USA STANDARD DRAFTING PRACTICES



- |   |   |
|---|---|
| <p>8 CONTROL POWER DISCONNECTING SWITCH</p> <p>23 TEMPERATURE CONTROL DEVICE</p> <p>51 AC TIME OVERCURRENT RELAY</p> <p>52 AC CIRCUIT BREAKER</p> <p>OO AUXILIARY SWITCH OPEN WHEN THE OPERATING MECHANISM IS IN THE NON-OPERATED POSITION</p> <p>CC CLOSING COIL</p> <p>LC LATCH CHECK SWITCH</p> <p>TC TRIP COIL</p> <p>52X CLOSING RELAY</p> <p>52Y ANTI-PUMP RELAY</p> <p>67G AC DIRECTIONAL OVERCURRENT GROUND RELAY</p> | <p>87X DIFFERENTIAL PROTECTIVE AUXILIARY RELAY</p> <p>CS CONTROL SWITCH</p> <p>C CLOSE</p> <p>T TRIP</p> <p>HTR HEATER</p> <p>SS SYNCHRONIZING SWITCH</p> <p>○ AC CIRCUIT BREAKER TERMINAL BLOCK STUDS FOR EXTERNAL CONNECTIONS</p> <p>GL GREEN LIGHT</p> <p>RL RED LIGHT</p> <p>NOTE 1 JUMPERS INSTALLED BY MANUFACTURER</p> |
|---|---|

**DRAWING REFERENCES**  
 AC SCHEMATIC DIAGRAM..FIG 9-9  
 DEVICE INTERNAL CONNECTION DIAGRAM..FIG 10-14

**FIGURE 9-10 – TYPICAL POWER SWITCHGEAR DC SCHEMATIC DIAGRAM (USING BOTH TERMINAL AND WIRE DESIGNATIONS)**



# ELECTRICAL AND ELECTRONICS DIAGRAMS

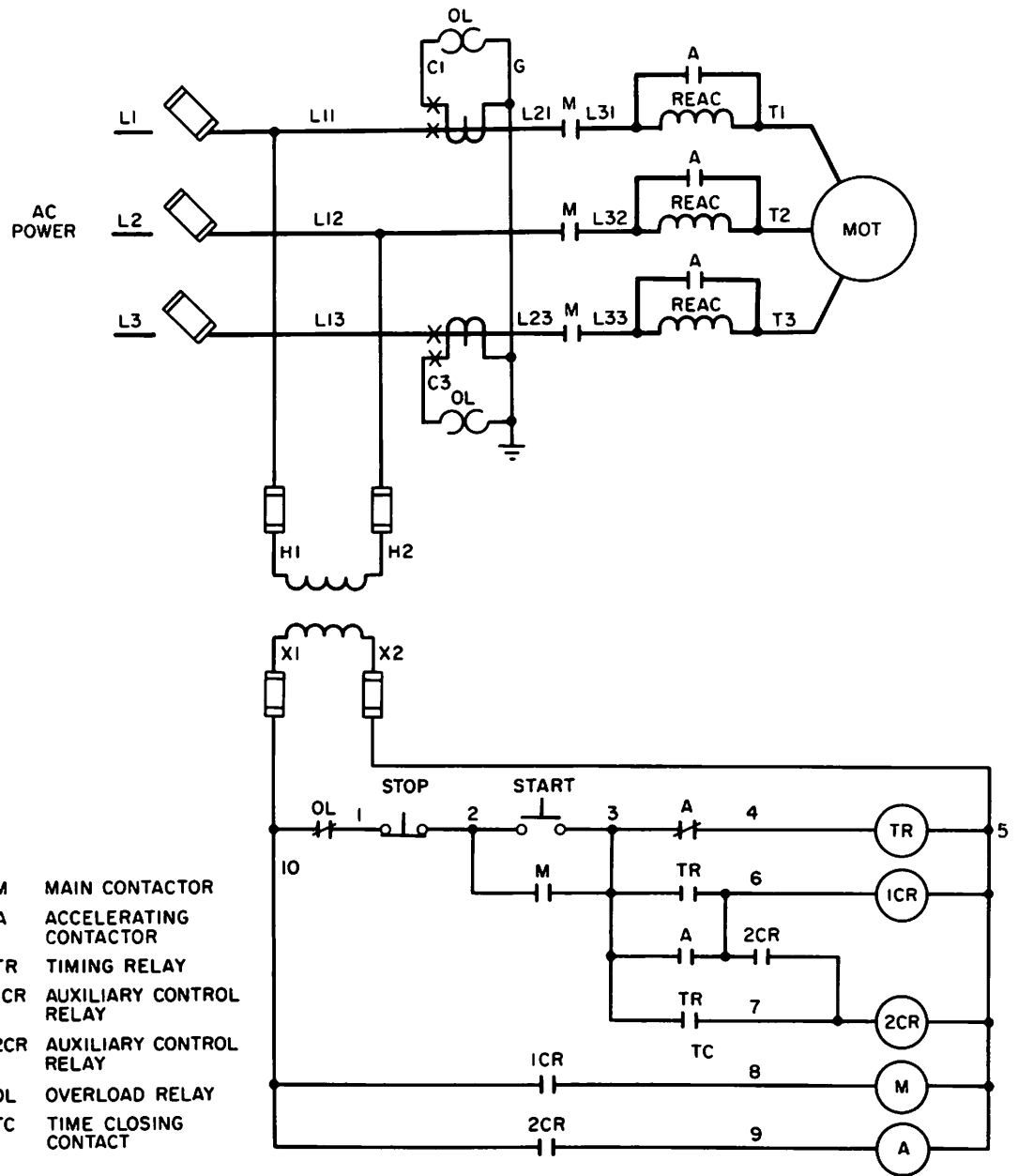


FIGURE 9-11 – TYPICAL INDUSTRIAL CONTROL SCHEMATIC DIAGRAM

PROPOSED  
USA STANDARD  
DRAFTING PRACTICES

ELECTRICAL AND  
ELECTRONICS DIAGRAMS

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15-10 CONNECTION DIAGRAMS  
15-12 TERMINAL DIAGRAMS

## ELECTRICAL AND ELECTRONICS DIAGRAMS

### 15-10 Connection Diagrams

The following subparagraphs contain information generally applicable to the preparation of all types of Connection Diagrams.

#### 15-10.1 Purpose

(a) Furnish information showing electrical connections between component devices or parts.

(b) Facilitate determination of electrical connection adequacy.

(c) Facilitate maintenance of equipment.

(d) Supplement Schematic Diagrams by relating circuit information with the actual wiring and location of component devices or parts.

#### 15-10.2 Types

Connection Diagrams covered in this standard fall into three classifications. These are the continuous-line type, the interrupted-line type and the tabular type. These classifications are based on the method of indicating connections between component devices or parts and whether the approach for conveying this information is or is not essentially diagrammatic. The various methods permit a selection which will satisfy the requirements of a wide range of equipment design.

##### 15-10.2.1 Continuous-Line Type

In this type of diagram, continuous lines, generally representative of the actual between-terminal conductors or cable paths, are shown from symbol to symbol. Two somewhat similar methods whereby continuous-line diagrams may be prepared will be referred to as:

(a) Point-to-Point (15-10.4.1)

(b) Highway or Cable (15-10.4.2)

##### 15-10.2.2 Interrupted-Line Type

Instead of continuous lines as used in the preceding method, connecting lines in this type of diagram start at a symbol and are interrupted a short distance away. Two rather similar methods whereby interrupted-line type of diagrams may be prepared will be referred to as:

(a) Base-line (15-10.5.1)

(b) Feed-line (15-10.5.1)

##### 15-10.2.3 Tabular Type

In the tabular arrangement of information, 15-10.6, connections between component devices or parts are listed in a FROM-TO type of tabulation which includes all the information necessary to identify the connections. A symbolic or pictorial representation showing the relative location of the component devices or parts, with or without connecting lines, should be referenced on or accompany the tabulation.

#### 15-10.3 Common Requirements

While there are differences in the methods of preparation, and types of diagrams mentioned in the preceding paragraphs, there are certain re-

quirements which are common to all of them. The paragraphs that immediately follow cover these common requirements, and while they will apply to a greater extent to continuous- and interrupted-line diagrams, the same requirements are applicable to tabular-type diagrams. The common requirements paragraphs are followed by paragraphs on specific requirements applicable to the different types of diagrams covered in this standard.

##### 15-10.3.1 Equipment Views

The view or views of an equipment that are required for a Connection Diagram are those which will most clearly show the terminals or wiring sides of the component devices or parts as they are mounted in the equipment. In most instances, one view as seen from the wiring side of the items should be sufficient. This view will generally correspond to the view of the items as seen during wiring. More than one view is usually required when the equipment is wired from both front and rear. Component devices or parts with more than one level of terminals may also require more than one view. Typical examples of the type of equipment arrangement for which more than one wiring view is needed are shown in Figures 10-1(B) and 10-2(B). The Connection Diagram representations of these views are shown in Figures 10-1(C) and 10-2(C).

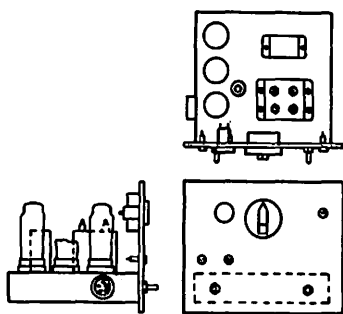
##### 15-10.3.2 Principal and Auxiliary Wiring View Selection

When practicable, the side of the equipment or mounting surface that shows a majority of the wired items from the wiring side should be selected as the view for establishing a plane of reference for the Connection Diagram. This plane thus becomes the principal plane of reference. For example, when wired items mount in planes perpendicular to or at an angle to the selected principal plane, these auxiliary planes shall be rotated or revolved into the principal plane or planes of the diagram.

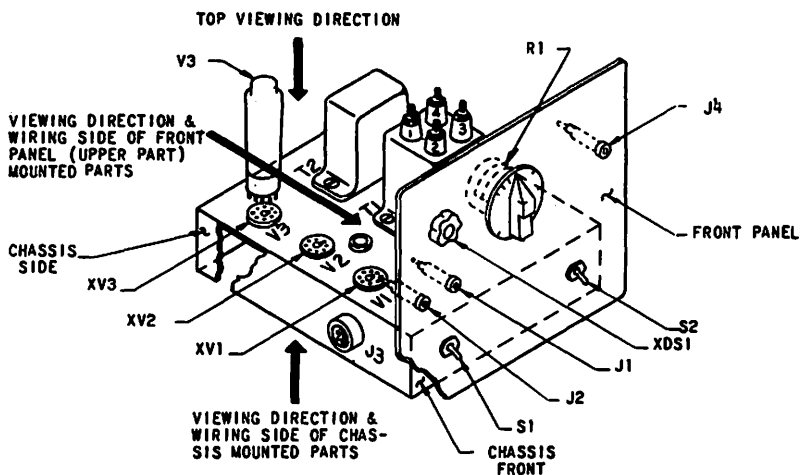
Planes that are merely revolved in position should be shown adjoining the principal plane or view. See rotation of sides of equipment shown in Figures 10-1(C) and 10-2(C). Planes such as those identified in Figure 10-1(C) as auxiliary planes should be oriented exactly as these equipment planes would appear when viewed from a normal wiring position.

Auxiliary planes may be positioned at the same location where they have been revolved or they may be shown slightly apart from the principal view with an appropriate identification; see Figure 10-1(C). Views represented as auxiliary planes shall be enclosed with phantom lines in order to define the boundary limits of these planes.

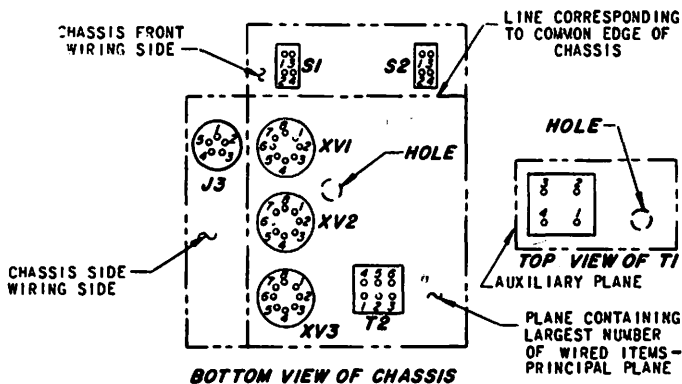
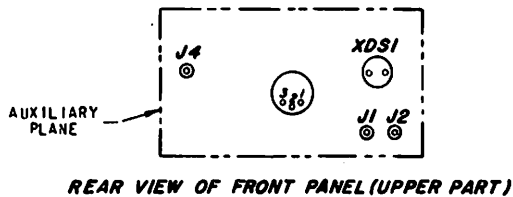
PROPOSED USA STANDARD DRAFTING PRACTICES



(A) VIEW AS MIGHT BE SHOWN ON EQUIPMENT DRAWING



(B) DIRECTIONS FROM WHICH EQUIPMENT MUST BE VIEWED FOR WIRING AND PREPARATION OF CONNECTION DIAGRAM



(C) CONNECTION DIAGRAM VIEWS OF EQUIPMENT

FIGURE 10-1 - VIEWING DIRECTIONS - TYPICAL FOR CHASSIS-TYPE EQUIPMENT

## ELECTRICAL AND ELECTRONICS DIAGRAMS

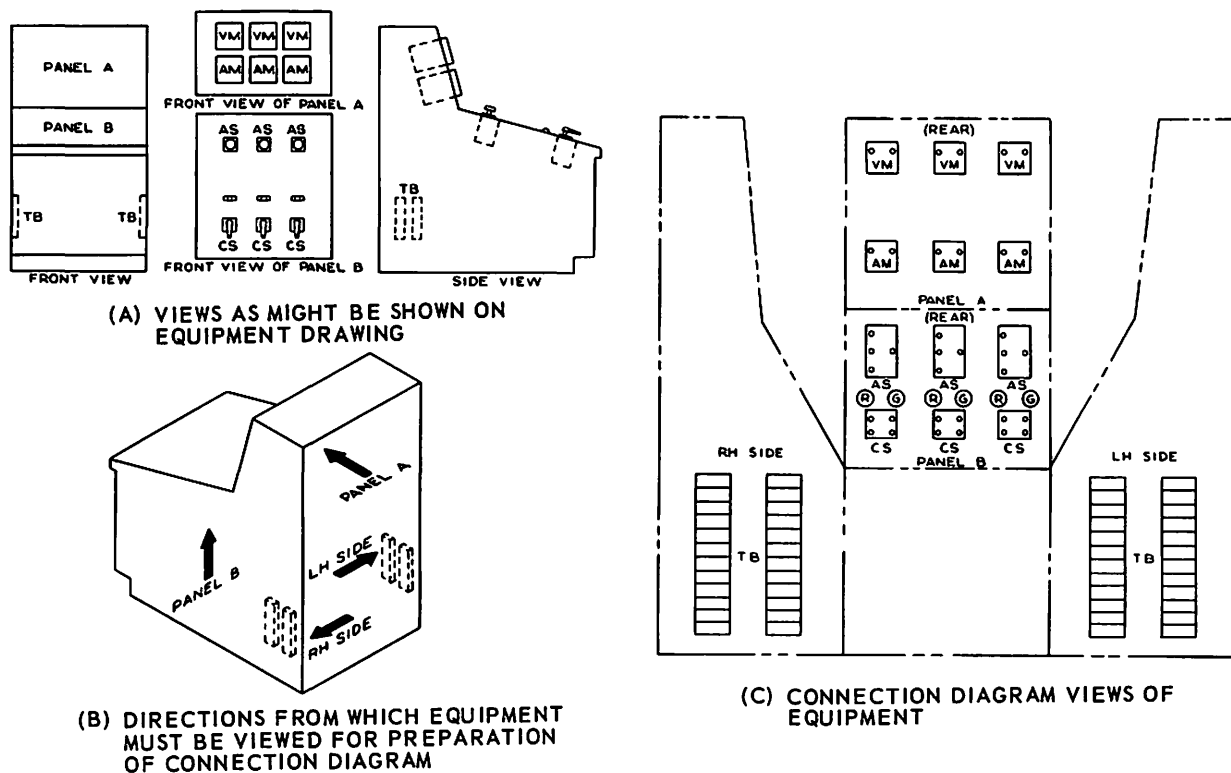


FIGURE 10-2 - VIEWING DIRECTION - TYPICAL FOR CABINET TYPE OF EQUIPMENT

It should be noted that the viewing planes referred to in this paragraph are primarily for purposes of showing terminals diagrammatically in as simple a manner as possible. For this reason, the methods of view representation are not bound by the rules governing the relationship of views projected orthographically.

### 15-10.3.3 Representation of Component Devices and Parts

Symbols for connection diagrams are intended to represent each item or terminal of the equipment that is to be wired. Component devices and parts may be represented with symbols in one of two ways. The symbols may be of simple geometric shape (rectangle or circle) or the symbols may be of the circuit schematic type. When the rectangular or circular shape is used only terminal circles are shown within these shapes. The circle shall be used only when the component device or part shape closely approximates a circle; otherwise a rectangle shall be used. When circuit schematic symbolization is required as shown in Figures 10-15 and 10-16, USA Standard Y32.2 shall be consulted.

### 15-10.3.4 Component Devices or Parts Symbol Size

No attempt should be made to show exact differences in size among component devices or parts especially when they are basically similar in shape or function. Differentiation between maximum and minimum sizes shall be accomplished so that the largest shall not appear too large nor the smallest too small. For example, a symbol of suitable size may be used to represent similar items when physical size variation is minor. In general, the symbol shape shall be drawn as small as it is convenient to do so, consistent with a clear, well proportioned representation, and large enough to contain item or terminal designations.

### 15-10.3.5 Terminals

Component device or part terminals, standoff terminals and binding posts, when shown, should be represented as small circles. To insure clarity on full size drawings, a circle diameter of not less than 0.06 inch shall be used. Terminals should be shown as circles even when physical appearance differs markedly from the circular form.

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15-10.3.5.1 *Perpendicular Planes*

To facilitate showing terminals that are in a plane perpendicular to the item mounting surface, the sides of the item containing the terminals may be revolved into the plane of the drawing as shown in Figure 10-3.

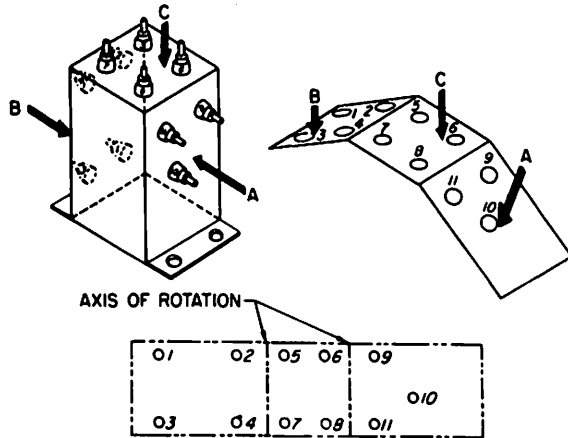


FIGURE 10-3 - REPRESENTATION OF TERMINALS OCCURRING IN PLANES NOT PARALLEL TO THE MOUNTING SURFACE

15-10.3.5.2 *Terminal Boards or Strips*

The terminals of terminal boards or strips may be represented in one of three ways:

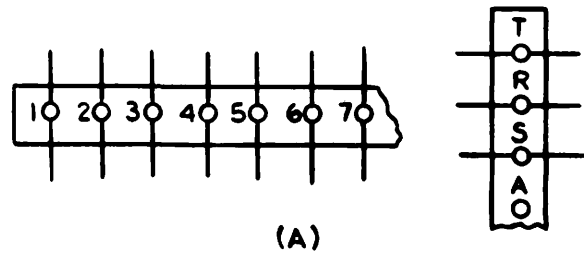
- (a) as circles enclosed in a rectangle, as shown in Figure 10-4(A).
- (b) without enclosing rectangles and with the terminals arranged in an order convenient for wiring; see Figure 10-4(B).
- (c) as subdivided rectangles, where the subdivisions represent terminals; see Figure 10-4(C).

15-10.3.6 *Arrangement of Component Devices or Parts*

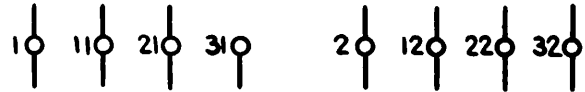
The arrangement of symbols in the diagram shall closely approximate the relative location of the items as shown on the assembly drawing or as located on the actual equipment; see Figures 10-1 and 10-2. Within reasonable limits, symbol placement may differ from the actual arrangement in order to avoid unnecessary crowding of connecting lines and designations, or to simplify the layout.

15-10.3.6.1 *Critical Location*

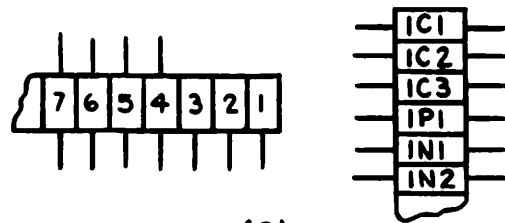
When part locations are electrically critical to the extent that locations must be specified precisely, a two or three dimensional delineation may be used. This delineation shall show the relative location of the critically sensitive parts and wiring with respect to other parts, wires or areas. For this purpose, the outlines of



(A)



(B)



(C)

FIGURE 10-4 - REPRESENTATION OF TERMINALS ON TERMINAL BOARDS OR STRIPS

the parts may be simplified, if essential information is not omitted. Notes in combination with a simplified view may be used when this method will satisfactorily convey locational requirements and thereby reduce drafting effort.

15-10.3.7 *Equipment Device or Part Orientation*

Diagrams shall show front views of front-connected items or rear views of rear-connected items, or a combination of both to clearly indicate connections. The diagram or sections of diagram shall be marked to show the appropriate view and orientation. When orientation cannot be clearly shown, reference should be made to physical arrangement drawings or to supplementary notations or designations. For items which cannot be clearly located in relation to the main assembly, additional information should be given to assure proper connection. When an item is mounted perpendicular to a panel, the end that is nearest the panel shall be indicated. For such indication, see X designation in Figure 10-9 and note for R2 in Figure 10-10.

15-10.3.8 *Designations*

Designations for equipments, items, component devices, parts, etc., shown on Connec-

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tion Diagrams shall correspond to those shown on the associated Schematic or Elementary Diagram.

**15-10.3.8.1 Axial Lead and Pigtail Parts**  
 Identification of lead-mounted parts is preferably indicated by showing the part designation within the part symbol outline; see Figures 10-12, 10-17, and 10-20. For all other parts, designations may be shown either outside or inside the part symbol depending on preference.

**15-10.3.8.2 Terminal or Wire Designations**  
 Terminal and wire designations shall agree with designations assigned on the related Schematic, Elementary Diagrams or Assembly Drawings. If these designations have not been assigned on the related drawings, then the indication of them on the Connection Diagram shall agree with markings on the equipment.

**15-10.3.8.3 Wiring Tie Point Designations**  
 Terminals which are used as wiring tie points or connection points, but which are not identified on the Schematic Diagram, shall be assigned "WT" numbers on the Connection Diagram. For example, WT1, WT2, etc. See Figures 10-20 and 10-24(B).

### 15-10.3.9 Device or Part Rating, Type, Range or Scale Indication

Rating, type, range or scale of a device or part should be indicated as shown in the examples of Figure 10-5. To assure correct identification, the rating of circuit breakers, contactors, instrument transformers, fuses, resistors, etc., should be located close to the associated symbol, or shown in tabular form. The type, rating, range or scale of protective relays, instruments, meters, etc., should be located within or close to the symbol unless this information is provided on other drawings or documents to which reference is made; see also Figure 10-15.

### 15-10.3.10 Wire or Cable Size and Type

#### 15-10.3.10.1 Identification

The preferred method of identifying wire and cable construction is by means of a drawing note. In such a note, the general rule is to identify the wire size. The type of wire construction may be specified by code or specification number. Several typical forms of wire identification covering various wire items are given in the following examples along with an explanation of each item of identification.

Direct identification of size . . . . .14AWG      No. 14 American Wire Gauge Wire

Direct identification of size . . . . .0640 diameter      Nominal dia .0640 No. 14 AWG wire (14AWG)

Direct identification of size and type of insulation . . . . . 22DNCCB      22AWG wire with covering of double nylon, single cotton, and cotton braid

Identification of size directly and of insulation by code or specification number . . .L20P      One pair of 20 AWG wires with covering per code L or Specification

Identification of size and type of insulation with code letter . . . . B      Wires per B code covering size and type

#### 15-10.3.10.2 Method of Identification on Diagram

When all or most of the wires on a Connection Diagram are of the same size and type, wire specification shall be given in a drawing note, for example:

ALL WIRES SHALL BE 22AWG STRANDED PER (Spec. No.) UNLESS OTHERWISE SPECIFIED. Wires which differ from the general specification covered in the note may be identified directly on or within the feed line; see Figures 10-10 and 10-17. This may be done also with a leader line

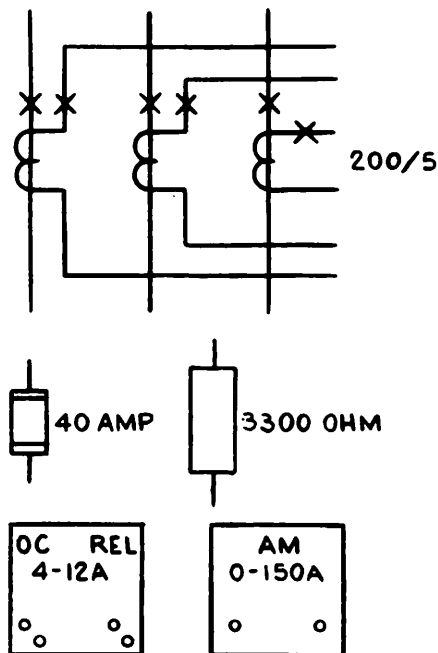


FIGURE 10-5 - DEVICE OR PART RATING, TYPE, RANGE, SCALE INDICATION

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directed to the feed line, see EU designation at part location 13 in Figure 10-20. In the tabular type of Connection Diagram, this information shall be shown in the appropriate column.

### 15-10.3.10.3 Wire Color or Color Code Placement

Wire color designations (15-3.11), whether letters or numbers, shall be placed, in general, at both ends of a connecting line or as near as possible to each terminal end. However, a single appearance of the color designation may be sufficient when the ends of a continuous connecting line are obvious. When wire color is the only wire data shown on a connecting or feed line, the color designation may be shown within the line; otherwise the data should be shown above the line.

### 15-10.3.11 Direct or Surface Wiring

The designation "DIR" (direct wiring) or "SUR" (surface wiring) applies to wiring which is not part of the cable assembly (wiring harness) but which is run from terminal to terminal according to the following methods:

- (1) DIR – wires run directly from terminal to terminal with a minimum of slack.
- (2) SUR – wires run from terminal to terminal in the most convenient manner. When it is necessary to distinguish these wires from wires which are included in a cable assembly, the designations DIR or SUR should be used to identify these wires as being apart from cable assembly wires.

For typical examples of DIR and SUR wire specifications, see Figure 10-17 and for typical drawing note, see Figure 10-20, note 3.

### 15-10.3.12 Critical Wiring

When circuit functions are so sensitive as to be affected by wire path, direction, or position, the wiring involved is regarded as "critical." Critical conditions may involve not only wire path but also positioning of pigtail parts which mount by the leads furnished; see 15-10.3.6.1. Such critical wiring requirements can frequently be covered by drawing notes. However, in exceptional cases, a two or three dimensional delineation drawn to scale may be required for a more precise specification of requirements.

### 15-10.3.13 Leads – Pigtail (PGT)

The term "pigtail lead" is used in referring to leads which are furnished with the item and are permanently connected to it. When it is necessary to distinguish these leads (usually when colored and of the nonaxial type) from other wiring, the leads shall be designated PGT. When it is readily apparent that the PGT lead is of the axial type, the designation may be omitted; see

Figure 10-17, parts designated respectively T2 and R2.

### 15-10.3.14 Phasing Indication

Phasing of alternating current equipment should be indicated so that there is general agreement with the actual physical arrangement and suitable notes shall be used when necessary; see Figure 10-16. When physical arrangement is not the governing factor, the phasing should be indicated in sequence 1, 2, 3, N from left to right or top to bottom.

### 15-10.3.15 Polarity Indication

Polarity of direct current devices should be indicated with a P or + for positive, N or – for negative, and PN or  $\pm$  for neutral; see Figure 10-15. Direct current busses should be shown in sequence positive, neutral, negative from left to right or top to bottom when physical arrangement is not the governing factor. When it is necessary to indicate the polarity or orientation of terminals, the feature whereby the polarity or orientation is indicated on the equipment, device or part shall be noted on the diagram; see CR1 and CR2 in Figures 10-12 and 10-20.

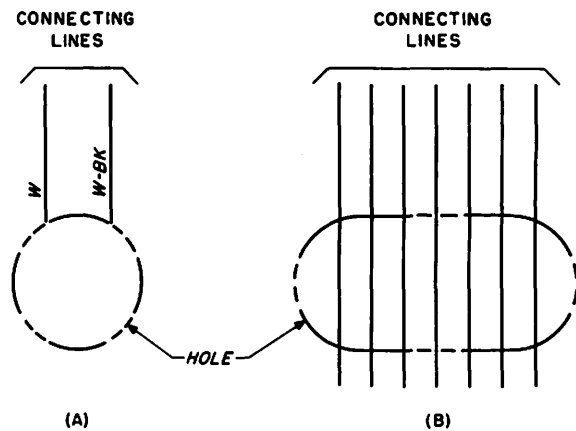


FIGURE 10-6 – METHODS OF SHOWING PASSAGE OF CONNECTING LINES THROUGH HOLES

### 15-10.3.16 Holes

Openings, circular or otherwise, in mounting surfaces through which wires pass shall be indicated with a phantom line and identified as HOLE 1, HOLE 2, etc.; see Figures 10-17 and 21. When connecting lines representing the wires are shown passing through the hole, the lines may be drawn to the edge of the hole or run across it depending on which method is more convenient for the type of Connection Diagram being prepared. The method of Figure 10-6(A)



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should be used when a hole is shown in separated views (principal and auxiliary) on the drawing. In this method corresponding feed lines should be identified with wire color or other wire data. The method of Figure 10-6(B) should be used when a view is rotated in place as illustrated in Figure 10-20.

### 15-10.3.17 Additional Cable Stitch Indication

The designations ST1, ST2, ST3, etc., are used to indicate additional cable stitches when such additions are required. The additional stitch designation is intended to be used when several wires of the same color connect to the same item as shown in Figure 10-7. At installation and during maintenance, connection of these wires is considerably facilitated if the wires of like color emerge from the cable body at separate cable stitches, rather than from a single stitch as would normally be the case. For a typical application of an additional designation, see yellow wires connecting to electron tube socket XV1 of Figure 10-17. The need for additional stitches should be avoided, if possible, by the proper choice of wire color. Loops such as illustrated in Figure 10-7 require only one stitch.

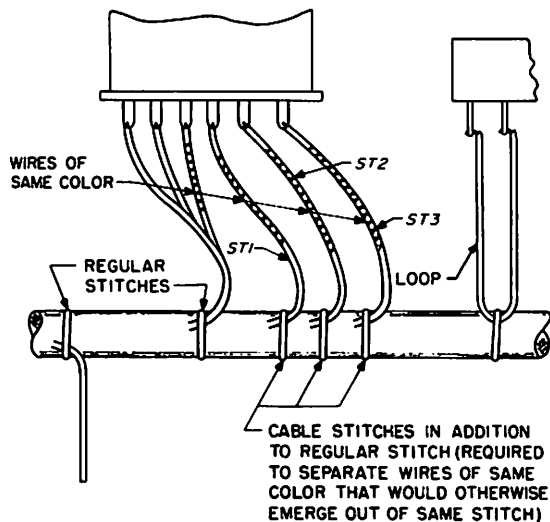


FIGURE 10-7 - VIEW OF TYPICAL CABLE SECTION SHOWING REGULAR AND SERIES OF ADDITIONAL STITCHES

### 15-10.3.18 Prewired Connections

Prewired connections may be indicated by any one of the following methods:

(a) Dash lines used for indicating connection from terminal to terminal with no regard as to whether the lines are shown inside or outside of the symbol outline.

(b) Solid lines shown within the symbol outline.

(c) Drawing note directed to connecting line with a leader line indicating that connection is prewired.

Method (a) or (b) should be supplemented by a drawing note explaining the line symbols used. Solid lines outside of the symbol outline shall always indicate wiring which must be provided. For typical application of method (a) see Figure 10-17 and for method (b) see Figure 10-13.

### 15-10.3.19 Twisted Wire Designations

To indicate that two or more wires are twisted, letter designations may be used in accordance with the following:

P - Two twisted wires, Pair

T - Three twisted wires, Triple

Q - Four twisted wires, Quad

For typical applications of the symbol for pair, see Figures 10-10, 10-11 and 10-20.

### 15-10.3.20 Symbols

USA Standard Y32.2 electrical and electronics diagram graphic symbols frequently used for wiring on Connection Diagrams are shown in Figure 10-8 for ease of reference.

### 15-10.3.21 Drawing Notes

Drawing notes should be placed preferably at the right side of the drawing sheet, as shown in Figures 10-10, 10-19, and 10-20. In general the notes may include information on:

- wires which are included in or excluded from the cable assembly
- soldering procedures, if any, which need to be specified
- such wiring designations or symbols which need to be identified or explained
- gage and type of wiring
- any additional wiring information or instruction.

## 15-10.4 Continuous-Line Type

### 15-10.4.1 Point-to-Point Diagrams

In point-to-point Connection Diagrams, separate connecting lines represent the actual terminal-to-terminal connections which are to be provided on the equipment; see Figures 10-9 and 10-10. On this type of Connection Diagram, connecting line layout or arrangement is not intended to convey actual or preferred conductor path location. However, connection sequence should be determined on the basis of the most suitable path from terminal to terminal and according to whether wiring harnesses, raceways, cleats, etc., will be provided. Another determining factor will be whether the path of cable (harness) is indicated on the Assembly Drawing.

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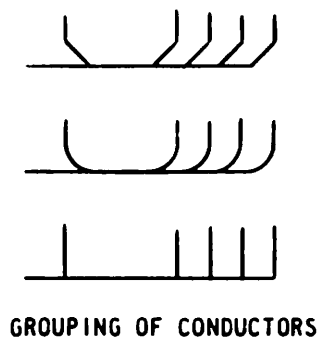
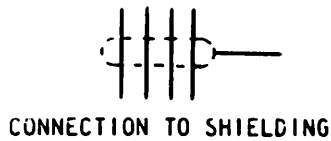


FIGURE 10-8 - GRAPHIC SYMBOLS COMMONLY USED ON CONNECTION DIAGRAMS

15-10.4.1.1 *Application*

The point-to-point method is useful mainly for the representation of wiring information for the less complex equipments that may consist of relatively few items. If use of the point-to-point method results in a diagram difficult to read because of the number of adjacent and crossing connecting lines, another of the subsequent methods in this standard should be considered.

15-10.4.2 *Highway or Cable Diagrams*

The Highway or Cable Connection Diagram is basically similar to the Point-to-Point Diagram with the exception that groups of connecting lines are merged into lines called highways or cables instead of being shown in their entire run as individual lines; see Figures 10-11, 10-12, 10-13, 10-15 and 10-16.

15-10.4.2.1 *Feed Lines*

From the component device or part terminals, short lines which will be referred to as "feed lines" are drawn perpendicular to the highway or cable line. At the point where the feed line enters the highway or cable line, direction of wire run in the highway may be indicated when necessary with an inclined or curved line; see Figure 10-11. Crossovers of inclined or curved portions of feed lines should be avoided by choice of angle or radius.

15-10.4.2.2 *Wire Data*

When wire data is shown on feed lines, it should include wire destination (item reference designation, wiring path number, or lead designation) and if required also wire color, code, or type. This information may be shown adjacent to or within the feed line; see Figures 10-12 and 10-16. If wire data (color, type, etc.) is not specified on feed lines or in drawing notes, this information shall be shown in a separate wire data list. This list may appear on the same sheet, or on a separate sheet of the same drawing or on a separate drawing.

15-10.4.2.3 *Highway or Cable Lines*

In highway layout, unidentified branching points shall be avoided. Either additional highways or a method of branch identification such as shown in Figure 10-13 should be used. More than one highway or cable line may also be used to facilitate indication of wire runs or to indicate grouping of particular wires into cable assemblies (harness); see Figures 10-12 and 10-13.

Another use of a separate highway or cable line is to indicate which wires have to be segregated for electrical reasons. A drawing note with the aid of a symbol, if necessary, shall identify the highways or cable as being part of the same or different cable assemblies.

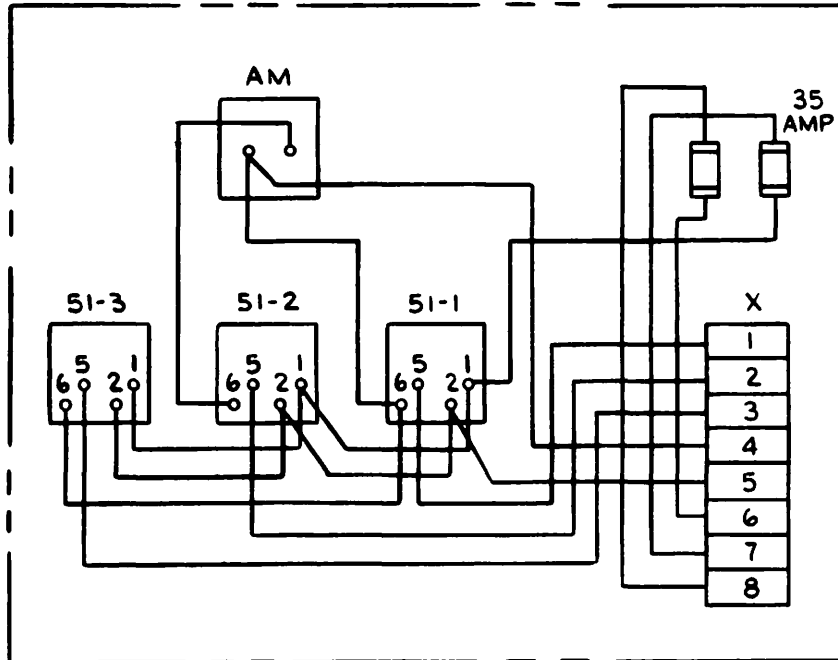


FIGURE 10-9 – TYPICAL POINT-TO-POINT CONNECTION DIAGRAM

**15-10.4.2.4 Critical and Segregated Wiring**  
Critical wiring shall not be included in a cable or highway line, but shall be run separately in accordance with 15-10.3.12. Wires which must be segregated for electrical reasons from other wires but which are not otherwise critical may also be shown separately or run directly from terminal to terminal.

#### 15-10.5 Interrupted Line Type

##### 15-10.5.1 Basic-Line or Feed-Line Diagrams

In the base-line and feed-line methods of preparing Connection Diagrams, connecting lines start at a symbol and are interrupted a short distance away. In the base-line method these lines are terminated in a base line for convenience of alignment, while in the feed-line method, no base line is used.

Point-to-point continuous lines, if used, are limited usually to the indication of short-connection runs between terminals of the same or adjacent parts or to the indication of axial-lead part connections. Except for these uses of continuous lines, continuity between the interrupted lines is conveyed by destination information at the ends of the feed lines. This destination may be given as letters or numbers which locate the

symbol on the diagram. Connection continuity may be further facilitated by the indication of wire colors on the feed lines. Wire color indication is particularly helpful when several wires emerge from a cable arm as a group and connect to a cluster of terminals on an item.

For explanation of nomenclature applicable to the base-Line or feed-Line methods and for typical Connection Diagrams prepared according to these methods, see Figures 10-17, 10-18, 10-19, and 10-20.

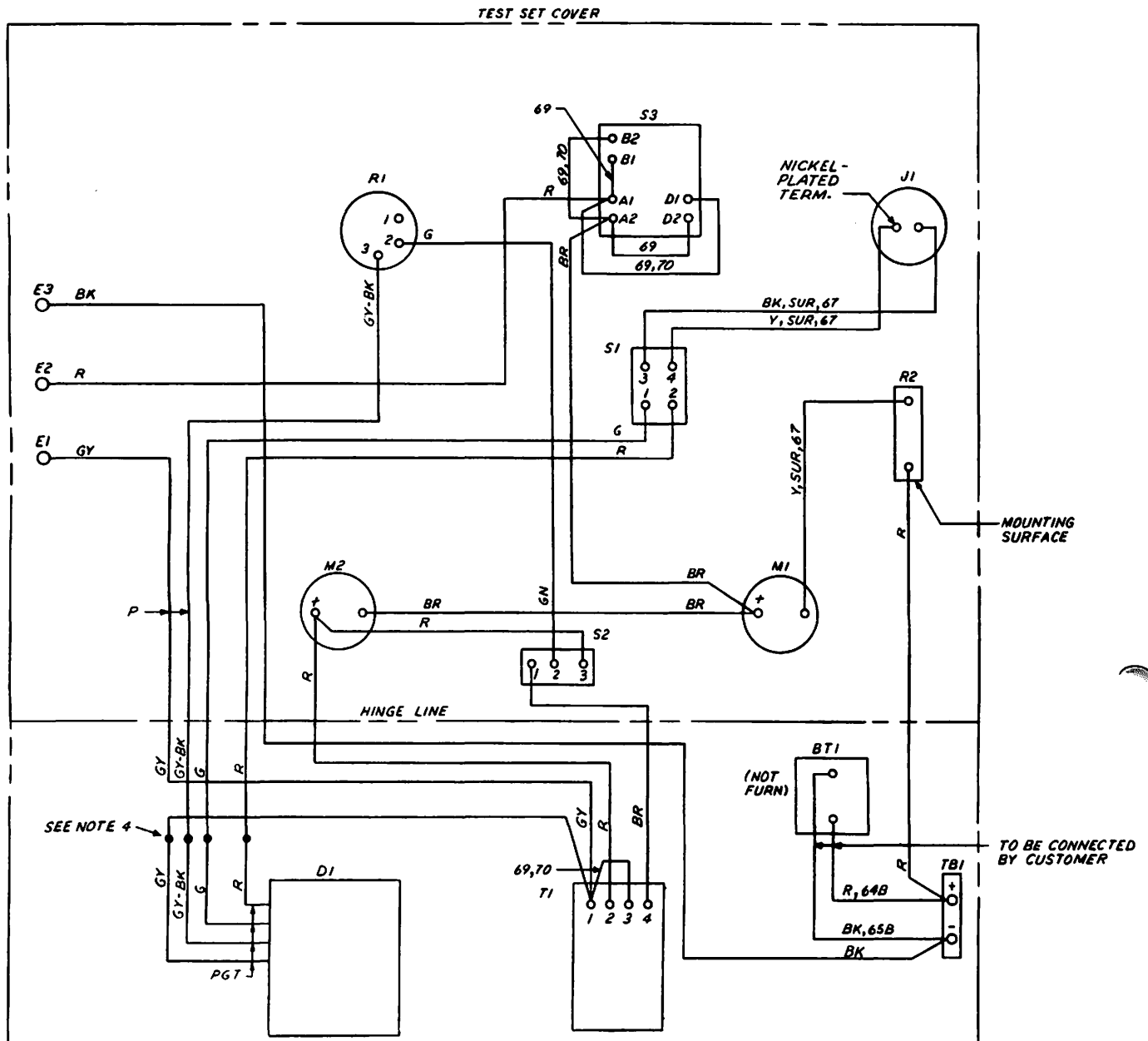
##### 15-10.5.1.1 Layout

In addition to representing relative component device or part locations, space between symbols shall also be provided for the accommodation of base lines and feed lines.

##### 15-10.5.1.2 Component Device or Part Locations – Base-Line Method

For the establishment of item locations in the base-line method, location numbers shall be assigned in numerically ascending sequence starting with one, from left to right and top down or equivalent logical order. When required, location numbers may be assigned on the basis of major mounting surface divisions, but following

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NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL WIRES ARE INCLUDED IN THE CABLE ASSEMBLY XXXXX.
2. ITEM NUMBERS REFERRED TO ARE SHOWN IN PARTS LIST OF ASSEMBLY DRAWING XXXXX.
3. ALL SOLDERING SHALL BE IN ACCORDANCE WITH Q0-S-524 METHOD C.
4. SPLICE AND SOLDER AND WRAP WITH ONE LAYER OF TAPE ITEM 58 AND TWO LAYERS OF TAPE ITEM 60.
5. SUR-WIRING-WIRE TO BE DRESSED BACK AND RUN ALONG THE MOUNTING SURFACES IN THE MOST CONVENIENT MANNER.
6. PGT - LEADS FURNISHED WITH PART.

FIGURE 10-10 - TYPICAL POINT-TO-POINT CONNECTION DIAGRAM AND NOTES

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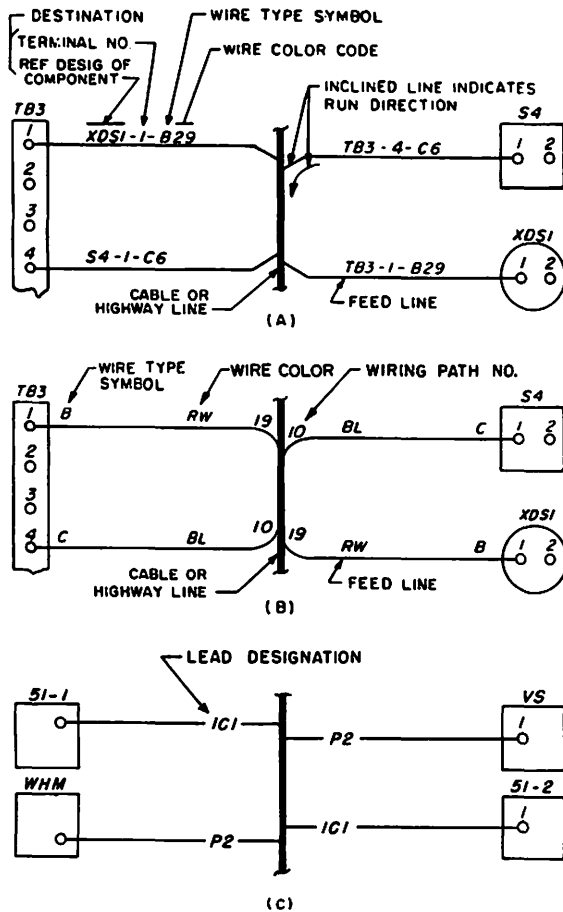


FIGURE 10-11 – METHODS OF INDICATING FEED LINE WIRE DATA AND DESTINATIONS ON HIGHWAY OR CABLE CONNECTION DIAGRAMS

the left to right and top down numerical sequence within each division; see Figures 10-19 and 10-20. Location numbers are not assigned to items which can be shown connected on a point-to-point basis and for which feed lines will not be brought into the base line; for example, see R2 of Figure 10-17 and WT1, WT2, etc., of Figure 10-20.

### 15-10.5.1.3 Component Device or Part Locations – Feed-Line Method

For the establishment of item locations in the Feed Line method, each item is assigned an individual arbitrary alphabetical designation. The letters can be assigned consecutively from left to right and top to bottom or equivalent logical sequence. Connections are conveyed by means of a short feed line from item terminals followed by the item designation and terminal to which it is connected; see Figure 10-18.

### 15-10.5.1.4 Location Numbers and Letters

Location numbers and letters should be made bold and approximately twice the height of the lettering used in the body of the drawing. Location numbers and letters should be placed above the symbol slightly to the left.

When items are shown joined, it may be more convenient to show location identification within the symbol outline, generally in upper left hand corner; see Figure 10-19.

### 15-10.5.1.5 Additions

Location numbers and letters may be reserved to allow for future additions. For items added between two existing consecutively located items, identification may be shown with dash numbers or some similar distinguishing method.

### 15-10.5.1.6 Base-Line Representation

Base lines shall be conveniently located with respect to the symbols. When it is desired to specifically show that a diagram pertains to a particular circuit, the base line may be shown continuous, or it may be broken into segments in such a manner that continuity is maintained through linking feed lines. The presentation of such circuit distinction or unity is illustrated in Figure 10-20.

When indication of circuit unity on a connection diagram is not a consideration, the base line may be broken into as many separate base lines as may be convenient from a drawing layout standpoint without necessarily linking the base lines through feed lines.

Location numbers may be shown adjacent to the base line instead of adjacent to or in the symbol. Identification of the base line with location numbers may be advantageous when the arrangement of the component device or part arrangement on the equipment does not conform to a uniform (mounting plate) or symmetrical pattern. A thick or an extra thick line may be used for representing the base line when emphasis of this line is desired.

### 15-10.5.1.7 Feed-Line Representation

A single feed line may represent more than one wire to a terminal if clarity is not sacrificed. When this is done, it is recommended that the feed line represent wires of the same gage and type. When the base-line method is used, feed lines which terminate at the base line from opposite sides shall not intercept the base line at the same point, but shall be staggered to avoid the impression of circuit continuity through the base line.

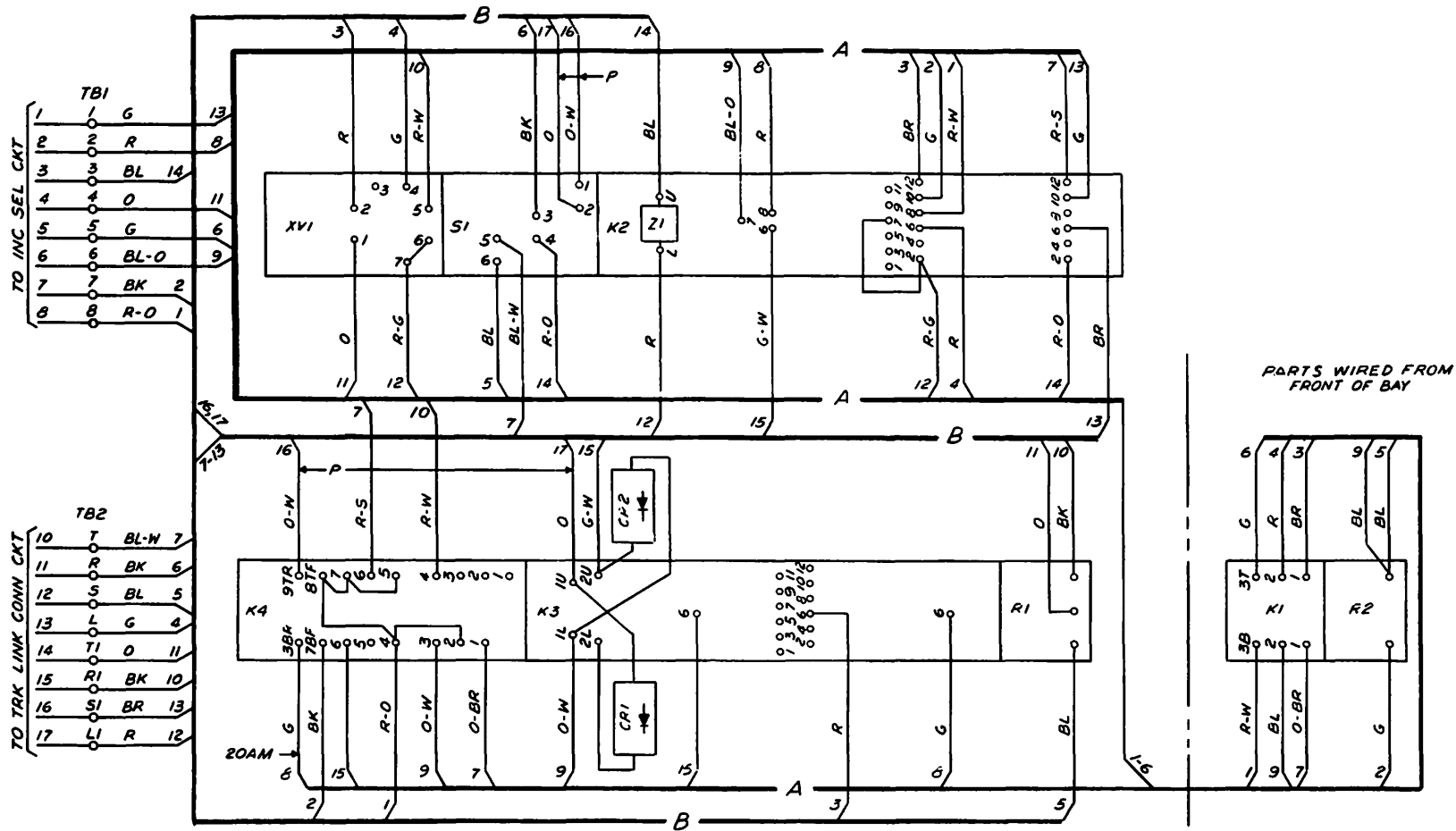
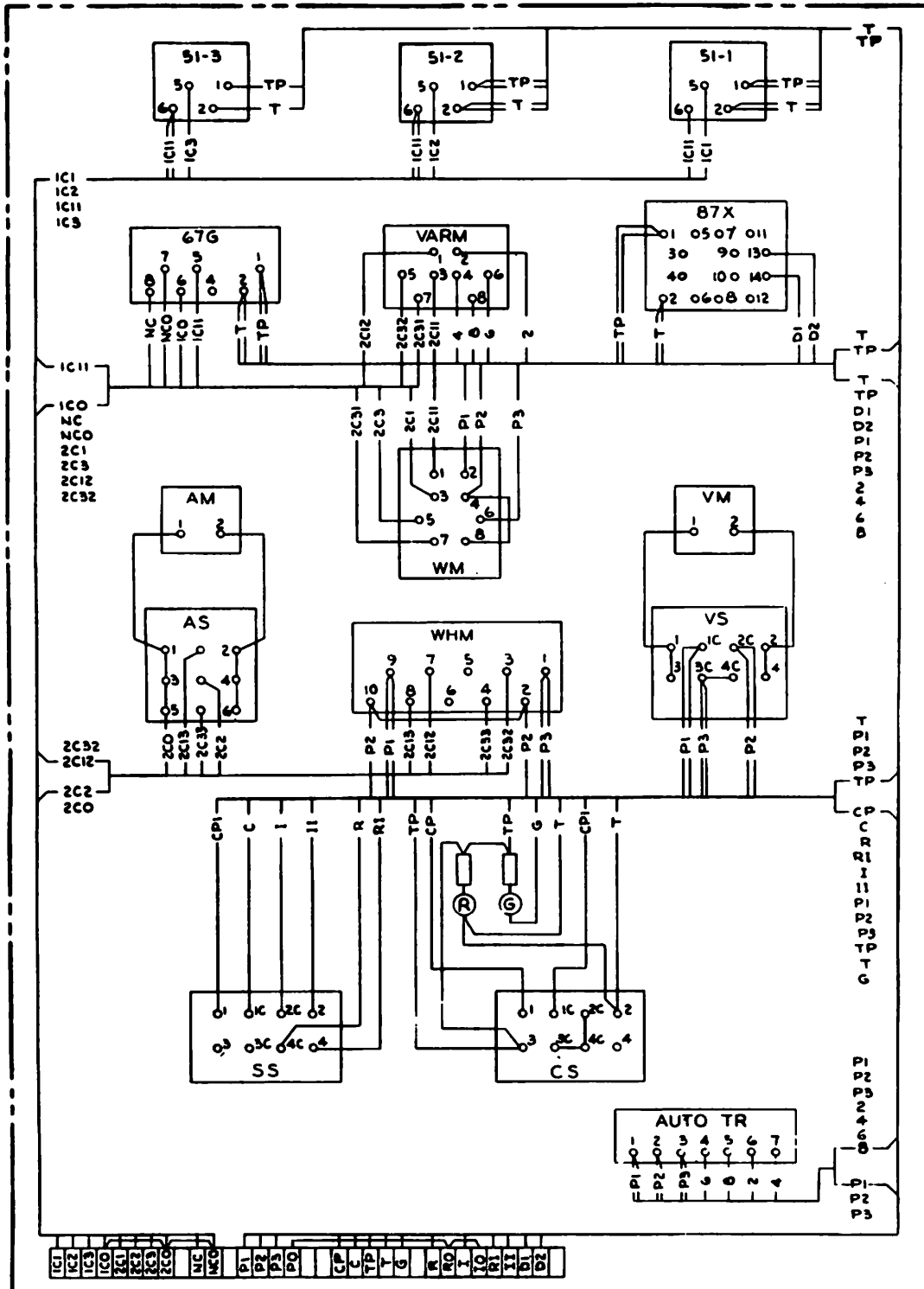


FIGURE 10-12 - TYPICAL HIGHWAY OR CABLE CONNECTION DIAGRAM

ELECTRICAL AND ELECTRONICS DIAGRAMS



RELAY AND CONTROL PANEL—REAR VIEW

NOTES:

1. ALL WIRES ARE 14 AWG.
  2. CONNECTIONS SHOWN COMPLETELY WITHIN OUTLINES ARE PREWIRED.
- FIGURE 10-13 – TYPICAL HIGHWAY OR CABLE CONNECTION DIAGRAM –  
RELAY AND CONTROL PANEL (SEE ALSO FIGURE 10-14)

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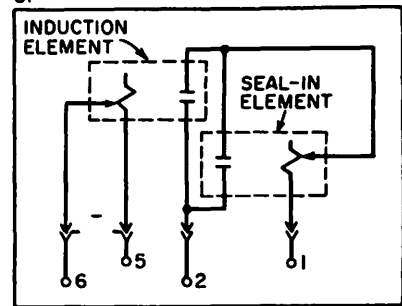
AS

| CONTACTS<br>HANDLE END | POSITIONS |   |   |
|------------------------|-----------|---|---|
|                        | 3         | 2 | 1 |
| 1 C 2                  | X         | X |   |
| 2                      |           |   | X |
| 3 C 4                  | X         |   | X |
| 4                      |           | X |   |
| 5 C 6                  |           | X | X |
| 6                      | X         |   |   |

VS

| CONTACTS<br>HANDLE END | POSITIONS |     |     |     |
|------------------------|-----------|-----|-----|-----|
|                        | 3-1       | 2-3 | 1-2 | OFF |
| 1 IC 2C 2              | X         |     | X   |     |
| 2                      |           | X   | X   |     |
| 3 3C 4C 4              |           | X   |     |     |
| 4                      | X         |     |     |     |

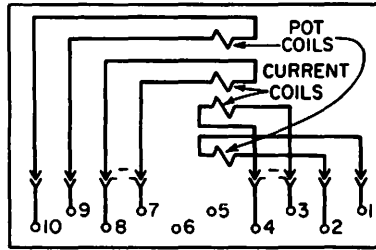
5I



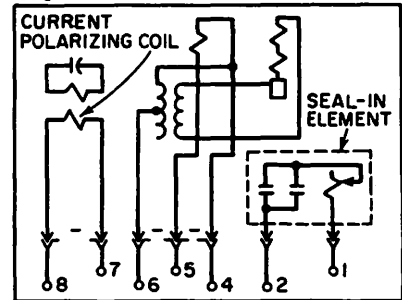
C5

| CONTACTS<br>HANDLE END | POSITIONS |       |      |
|------------------------|-----------|-------|------|
|                        | CLOSE     | NORM. | OPEN |
| 1 IC 2C 2              | X         |       |      |
| 2                      |           |       | X    |
| 3 3C 4C 4              | X         |       | X    |
| 4                      | X         |       |      |

WHM



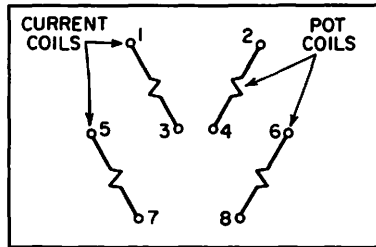
67G



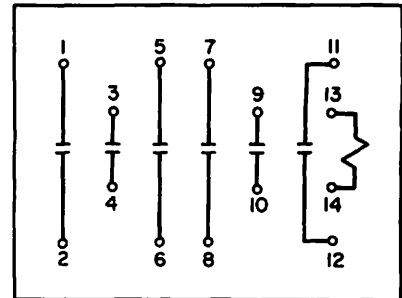
SS

| CONTACTS<br>HANDLE END | POSITIONS |     |
|------------------------|-----------|-----|
|                        | ON        | OFF |
| 1 IC 2C 2              | X         |     |
| 2                      | X         |     |
| 3 3C 4C 4              | X         |     |
| 4                      | X         |     |

WM & VARM



87X



AUTO TR-FV

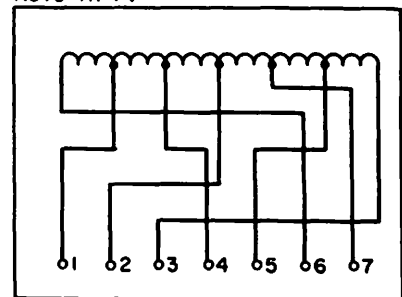
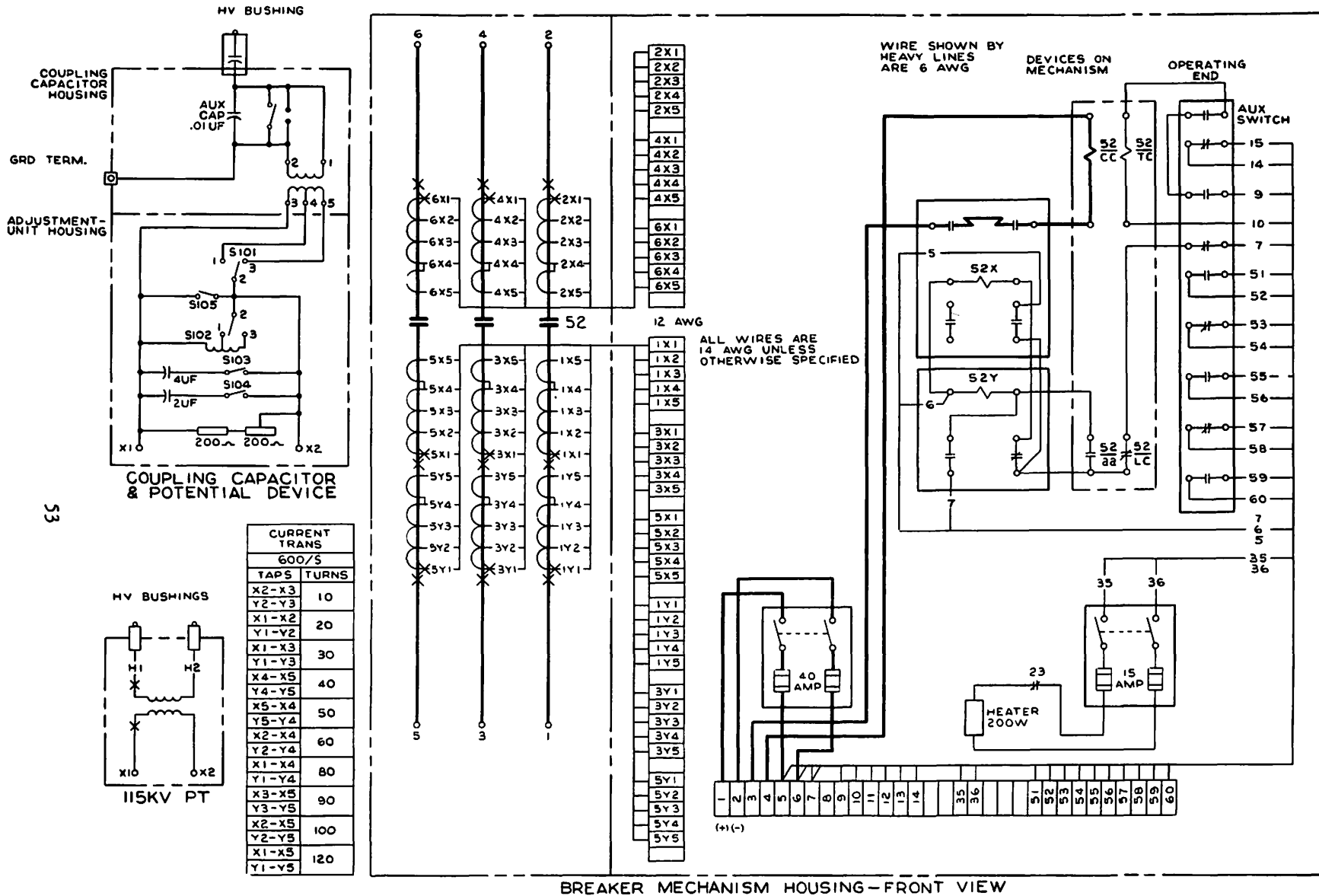


FIGURE 10-14 - INTERNAL CONNECTION DIAGRAMS FOR FIGURE 10-13





ELECTRICAL AND ELECTRONICS DIAGRAMS

FIGURE 10-15 - TYPICAL HIGHWAY OR CABLE CONNECTION DIAGRAM - BREAKER MECHANISM HOUSING

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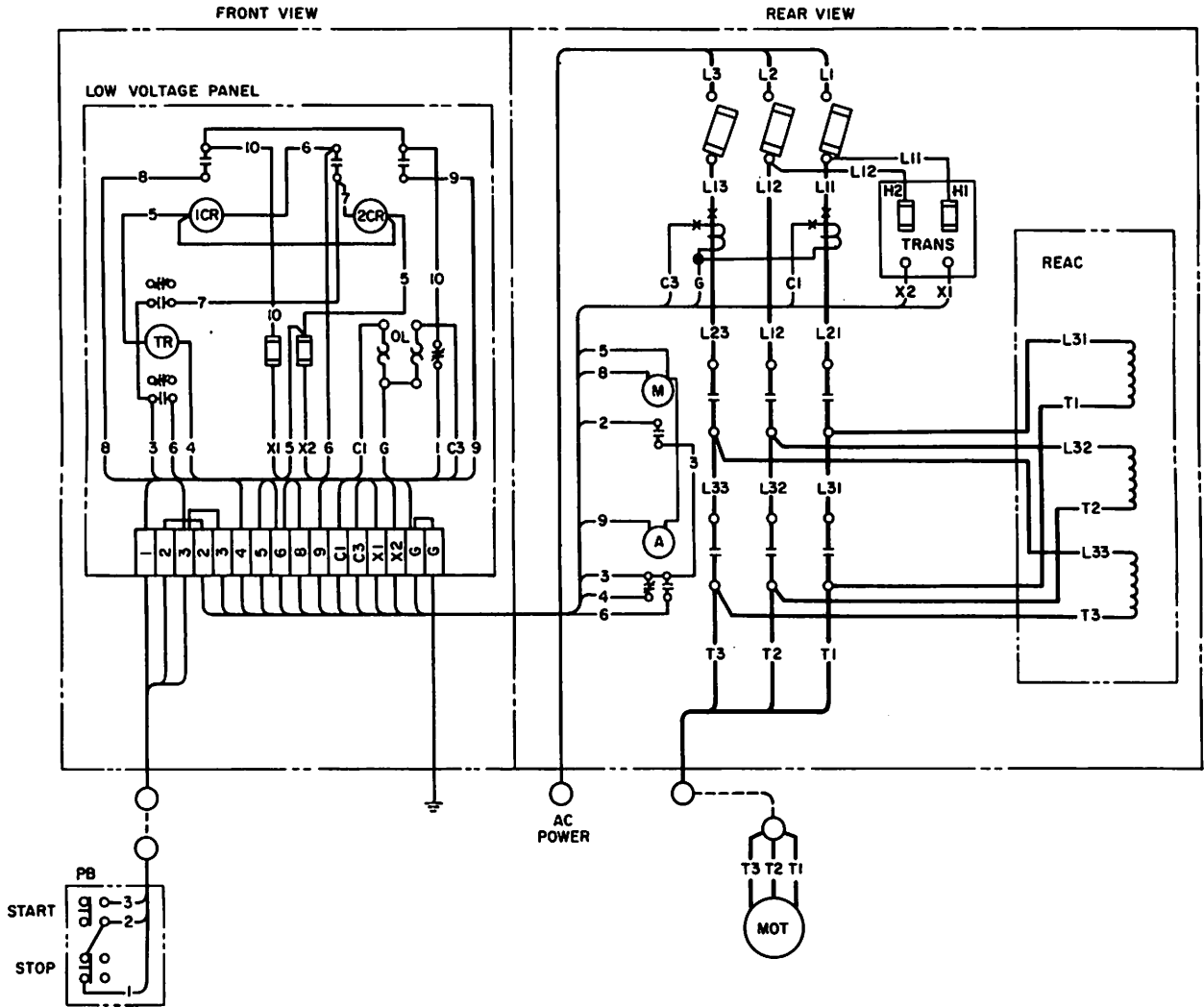


FIGURE 10-16 - TYPICAL HIGHWAY OR CABLE CONNECTION DIAGRAM

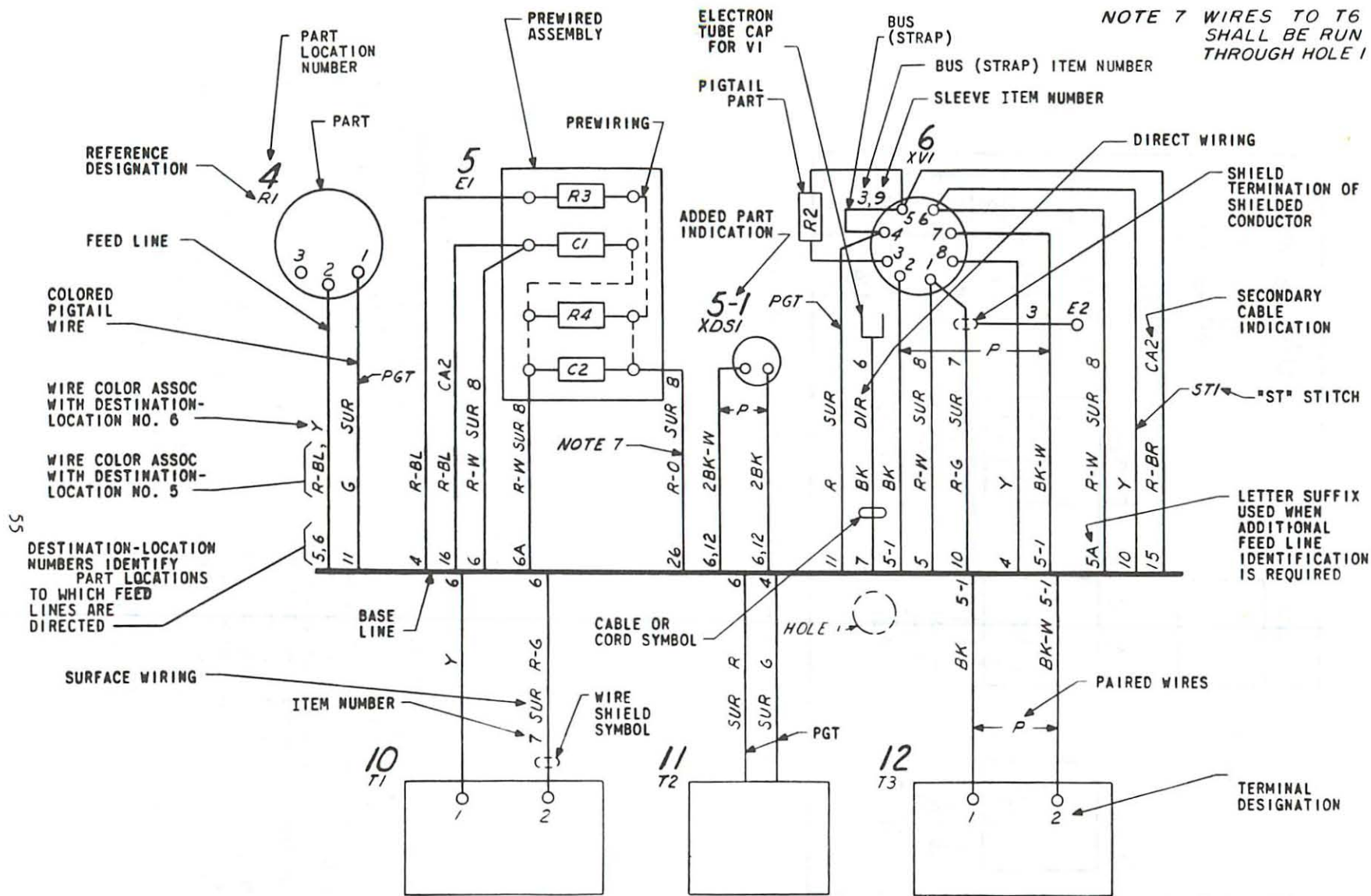


FIGURE 10-17 - EXPLANATION AND APPLICATION OF BASE-LINE CONNECTION DIAGRAM NOMENCLATURE AND METHOD, USING A PORTION OF A TYPICAL DIAGRAM. (BASICALLY THE SAME FOR FEED-LINE METHOD, SEE FIGURE 10-18)

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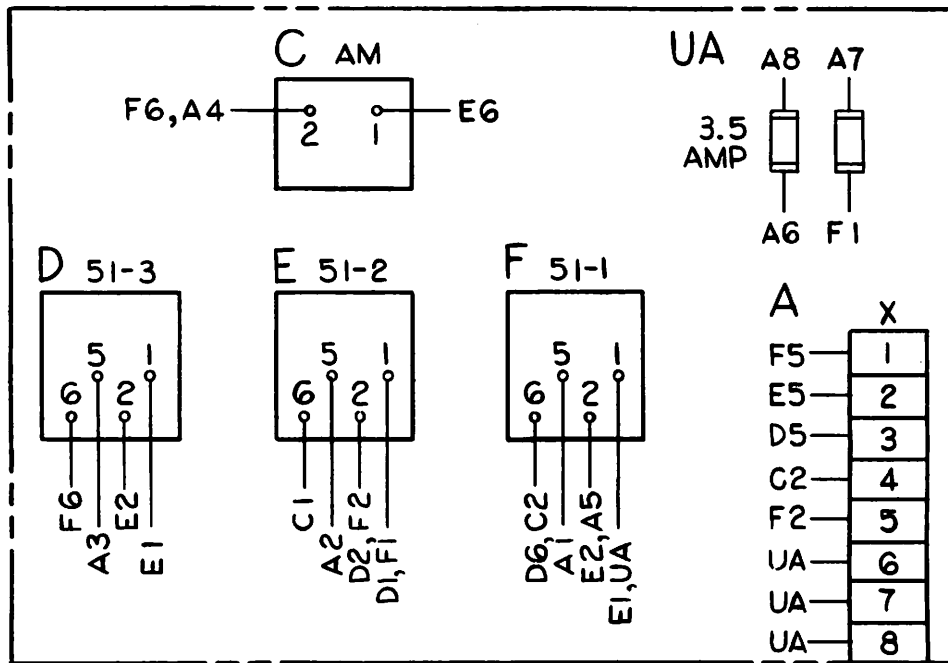


FIGURE 10-18 - TYPICAL FEED-LINE CONNECTION DIAGRAM

15-10.5.1.8 *Wire Color Indication*

Wire colors, when shown, shall be indicated on each feed line. On a feed line that represents two or more wires, each of a different color, the colors shall be indicated in the same order in which the destination location numbers appear on the feed line, see Figure 10-17, R1. When the wires are mostly of the same color, the colors shall be covered by a drawing note; see Note 2, Figure 10-20. In general, the wire color should be shown approximately midway on feed lines.

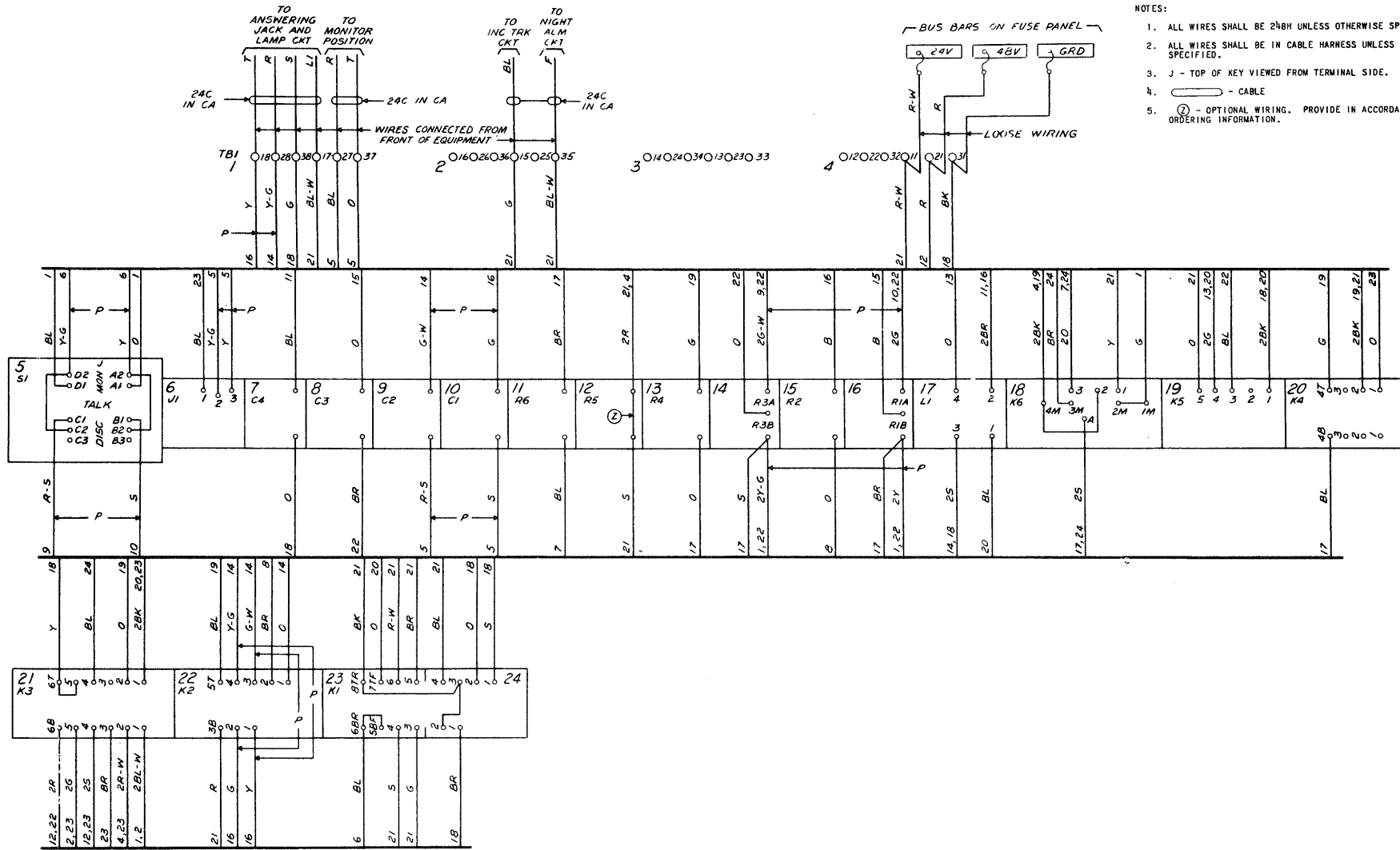
15-10.5.1.9 *Wires - Pigtail*

Bare pigtail wires furnished with the parts shall be run directly to terminals on a point-to-

point basis whenever possible. Insulated pigtail wires furnished with the parts shall be designated "PGT." Colors of colored pigtail wires shall be indicated on the feed lines; see Figure 10-17.

15-10.5.1.10 *Letter Suffixes for Wire Identification*

When two or more terminals of one part are to be connected to terminals of another part with wire of the same color (surface or direct wiring); a suffix letter shall be added to the feed line destination number as a means of differentiating similarly colored wires; see Figures 10-17 and 10-20.



- NOTES:
1. ALL WIRES SHALL BE 24BH UNLESS OTHERWISE SPECIFIED.
  2. ALL WIRES SHALL BE IN CABLE HARNESS UNLESS OTHERWISE SPECIFIED.
  3. J - TOP OF KEY VIEWED FROM TERMINAL SIDE.
  4. - CABLE
  5. - OPTIONAL WIRING. PROVIDE IN ACCORDANCE WITH ORDERING INFORMATION.

CONT

FIGURE 10-19 - TYPICAL BASE LINE CONNECTION DIAGRAM (FOR ASSOCIATED SCHEMATIC, SEE FIGURE 8-17)

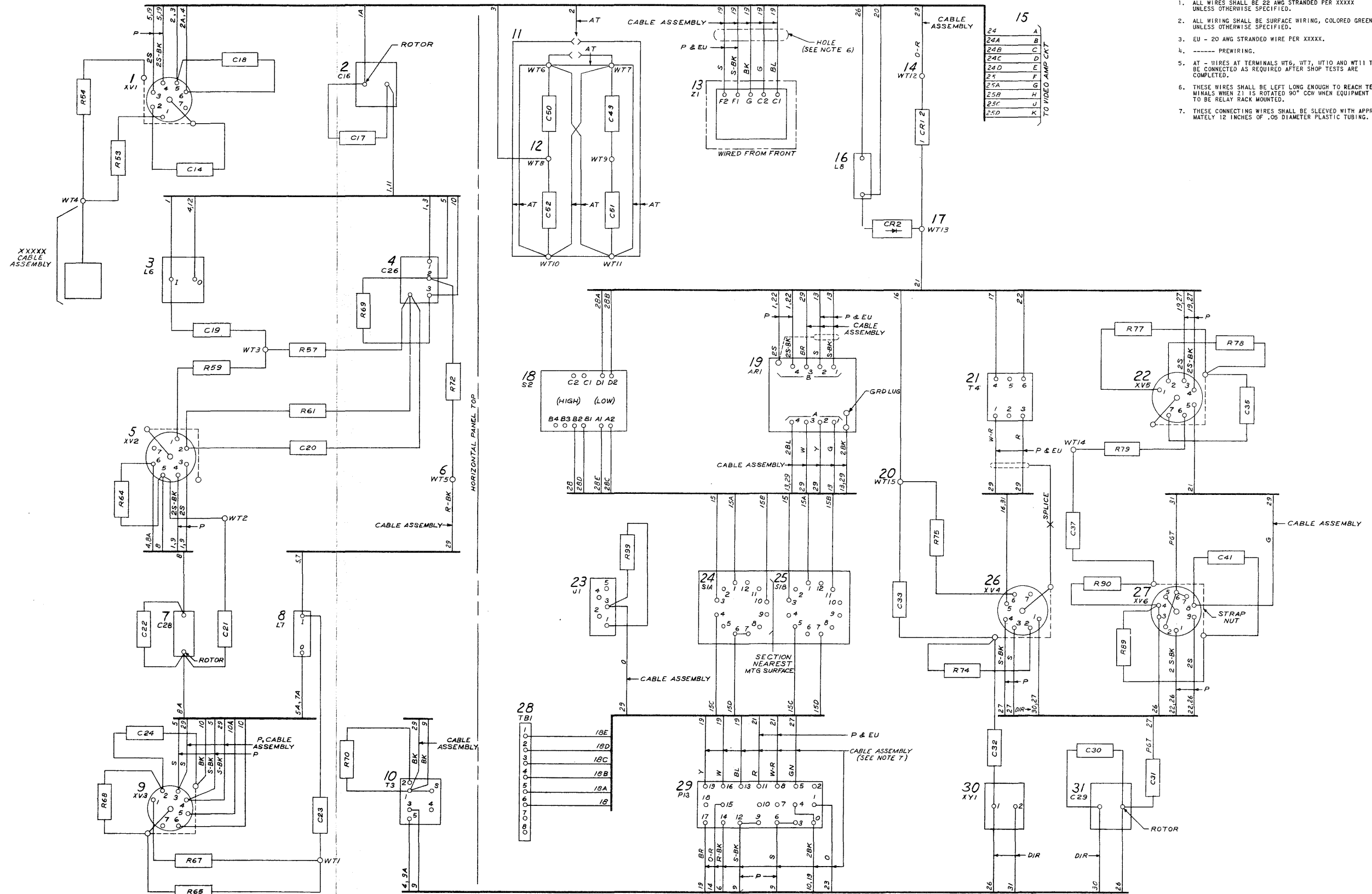


FIGURE 10-20 - TYPICAL BASE LINE CONNECTION DIAGRAM

## ELECTRICAL AND ELECTRONICS DIAGRAMS

| WIRE DATA |              |     |        |      |            |         |             |             |         |              |
|-----------|--------------|-----|--------|------|------------|---------|-------------|-------------|---------|--------------|
|           | WIRE OR ITEM |     |        | FROM |            | PATH    | TO          |             | REMARKS |              |
|           | TYPE         | AWG | COLOR  | LG   | LOCATION   |         | NOTES       | LOCATION    |         | NOTES        |
| (A)       | 330769       | 18  | G-BK-R | 16.3 | 23 C101-2  | --      | -3          | 23 XV103-7  | --      | 300          |
| (B)       | 331367       | 22  | G-Y-BK | 26.2 | 23 C118-1  | --      | HOLE 7, "8" | 23 C127-3   | --      | FEEDBACK "K" |
| (C)       | 33784        | 18  | BARE   | 3.1  | 23 C119-1  | --      | DIR         | 23 XV108-2  | --      | --           |
| (D)       | 350133       | 16  | R      | 18.2 | 23 C121-2  | 2       | -3          | 23 TB103-38 | 2       | VOICE        |
| (E)       |              | 20  | BK     | --   | 23 CHASSIS | 3,6     | --          | 23 TB103-39 | 4,5     |              |
| (F)       | 370358       | --  | BK     | 27.0 | 23 J102    | 7       | -3          | 23 P204     | 8       | IF INPUT     |
| (G)       | 33785        | 20  | BARE   | 2.2  | 23 S101A-7 | 9,FL    | DIR         | 23 S101B-3  | --      | --           |
| (H)       | R226         | --  | ----   | --   | 23 T101-12 | 10-1/2" | --          | 23 XV101-3  | 10-1"   | --           |
| (J)       | 360111       | 20  | W-R-BL | 36.5 | 23 T103-5  | --      | -3          | 23 TB101-1  | 11      | MON OUT      |
|           |              | 20  | W-R-Y  | --   | T103-6     | --      | --          | TB101-2     | 11      |              |

### WIRING CONDITIONS FOR DATA AS INDICATED.

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>(A) SINGLE WIRE IN CABLE*</li> <li>(B) SINGLE WIRE - SURFACE WIRE</li> <li>(C) SINGLE WIRE - DIRECT</li> <li>(D) SHIELDED WIRE - LEAD</li> <li>(E) SHIELDED WIRE - SHIELD CONN</li> </ul> | <ul style="list-style-type: none"> <li>(F) COAX LEAD TO COAX FITTING</li> <li>(G) SLEEVED STRAP WITH FULL LENGTH SLEEVE*</li> <li>(H) PART ADDED AT WIRING*</li> <li>(J) PAIR</li> </ul> |
|--|--|

\*USUALLY FOUND IN CHASSIS WIRING ONLY

| NOTES:   |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. WIRES SHALL BE RUN AND TERMINATED IN ACCORDANCE WITH SPECIFICATION XXXX UNLESS OTHERWISE SPECIFIED.</li> <li>2. TERMINATE IN ACCORDANCE WITH FIG. A OF SPECIFICATION YYYY.</li> <li>3. SHIELD CONNECTION SHALL BE 2 IN. LONG.</li> <li>4. SHIELD CONNECTION SHALL BE 1/4 IN. LONG.</li> <li>5. USE WIRE TERMINAL ZZZZ-31.</li> <li>6. SOLDER DIRECTLY TO CHASSIS AS CONVENIENT, WITHIN ONE INCH OF SHIELDED CONDUCTOR JUNCTION.</li> </ol> | <ol style="list-style-type: none"> <li>7. TERMINATE PER SPECIFICATION WWWW, FIG. 12 (UG-2731/U).</li> <li>8. TERMINATE PER SPECIFICATION WWWW, FIG. 37.</li> <li>9. USE SLEEVE, SPECIFICATION VVVV, OF SIZE AND LENGTH SPECIFIED (FL INDICATES FULL LENGTH BETWEEN SOLDERED CONNECTIONS.).</li> <li>10. USE SLEEVE, SPECIFICATION VVVV, 26 SIZE, OF LENGTH SPECIFIED.</li> <li>11. USE WIRE TERMINAL ZZZZ-35.</li> </ol> |

FIGURE 10-21 - COMPREHENSIVE METHOD OF TABULATING WIRING CONDITIONS

### 15-10.6 Tabular Type

In the tabular method, wiring information is arranged in tabular form (sometimes called a Running List) rather than shown on feed lines of a diagram; see Figures 10-21 and 10-25(A). Such tabular listing of wiring information may be accompanied or supplemented with component device or part locational information shown diagrammatically; see Figure 10-22. However, when locations within an equipment can be readily determined through the application of a coordinate locational system established for the equipment, the diagrammatic information may be omitted entirely or reduced substantially.

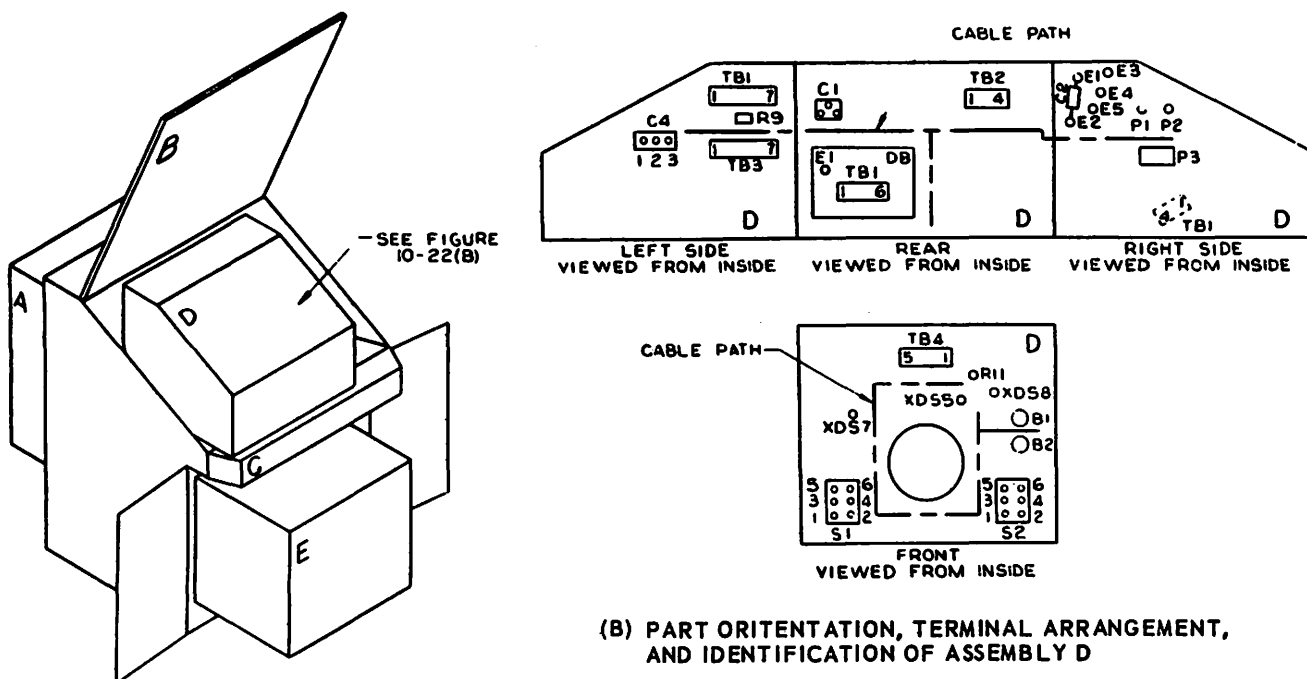
### 15-10.6.1 Wiring Information Arrangement

Details of tabular arrangement of information and number of items covered may vary with individual needs. The following basic information shall be included as applicable.

(a) FROM-TO Information. The terms "From" and "To" are used to differentiate between the ends of a connection. "From-to" information shall include the identity (location and designation, terminals, etc.) for each connection point end. Notes, manufacturing information, etc., may also be included in the connection point information.

(b) WIRE Information. Wire information shall identify the wire size and type used for each

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(A) SIMPLIFIED DIAGRAM SHOWING RELATIVE LOCATIONS IN A MAJOR EQUIPMENT

(B) PART ORIENTATION, TERMINAL ARRANGEMENT, AND IDENTIFICATION OF ASSEMBLY D

FIGURE 10-22 - DIAGRAM SHOWING RELATIVE LOCATION OF ITEMS IN AN EQUIPMENT

connection. The portion of such information which is common to a majority of the connections may be included in a general note; see 15-10.3.10. Wire gage, color or code should be included in the tabulation when this information is needed to facilitate connection and maintenance; see Figures 10-21 and 10-25(A).

(c) PATH, ROUTING, VIA Information. Information concerning wire path, raceways, cable routes, hole locations, etc., should be included in the tabulation when such information is not shown elsewhere and its indication is essential to the proper wiring of the equipment. As an alternative to showing path or route information in the tabulation, it may be shown instead in the supplementary equipment diagram accompanying the tabulated information.

(d) NOTES, FUNCTION, or REMARKS. Wire run requirements such as sleeving data, wire terminals, special jumpers, and functional lead designations applicable from one point of connection to the other may be included.

15-10.6.2 Tabulation Sequence

The sequence selected for listing entries in a table should be compatible with the applica-

tion of the information and the type of equipment involved. This application will determine the sequence selection on the basis of whether the information is to be used mainly for manufacture, installation or maintenance or any combination of these. The type of equipment structure (chassis, panel, cabinet, bay or frame) and the manner in which component devices or parts are arranged are also factors in the sequencing. The type of equipment will usually determine the method of item designation (identification) used, it may be reference, locational or functional. Tabulation sequence and the listing method used shall be specified on the diagram.

15-10.6.2.1 Listing Methods

Connections between component devices or parts may be listed in a sequence based on one or more of the following considerations:

(a) Component device or part location in or on equipment chassis, panel, bay, frame, etc. (Conveyance of this location will depend upon the system of designation used; reference, locational, or functional.) A listing sequence of entries in the table based on a top-down and left-to-right scan of the wiring side of the equipment is preferred from a wiring performance stand-



| PANEL WIRE TABLE       |                   |            |
|------------------------|-------------------|------------|
| WIRE                   | CONN              | ORDER      |
| PANEL A                |                   |            |
|                        |                   | NO. 14 RED |
| G                      | OL, TB            |            |
| 1                      | OL, TB            |            |
| 3                      | TR, TB            |            |
| 5                      | ICR, 2CR, 2FU, TR |            |
| 6                      | ICR, 2CR          |            |
| 7                      | 2CR, TR           |            |
| 8                      | ICR, TR           |            |
| 10                     | ICR, 2CR, 2FU, OL |            |
| PANEL B                |                   |            |
|                        |                   | NO. 14 RED |
| G                      | ICT, 3CT          |            |
| H1                     | IFU, TRANS        |            |
| H2                     | IFU, TRANS        |            |
| L11                    | IFU, LSW-FU       |            |
| L12                    | IFU, LSW-FU       |            |
| 3                      | M, A              |            |
| 5                      | M, A              |            |
| INTER PANEL WIRE TABLE |                   |            |
|                        |                   | NO. 14 RED |
| C1                     | OL, ICT           |            |
| C3                     | OL, 3CT           |            |
| G                      | TB, ICT           |            |
| X1                     | 2FU, TRANS        |            |
| X2                     | 2FU, TRANS        |            |
| 2                      | TB, M             |            |
| 3                      | TB, A             |            |
| 4                      | TR, A             |            |
| 5                      | TR, A             |            |
| 6                      | 2CR, A            |            |
| 8                      | TR, M             |            |
| 9                      | 2CR, A            |            |

ALL POWER WIRING TO BE 3/0 BLACK TYPE TW

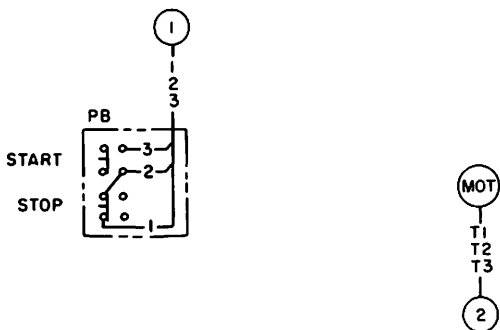
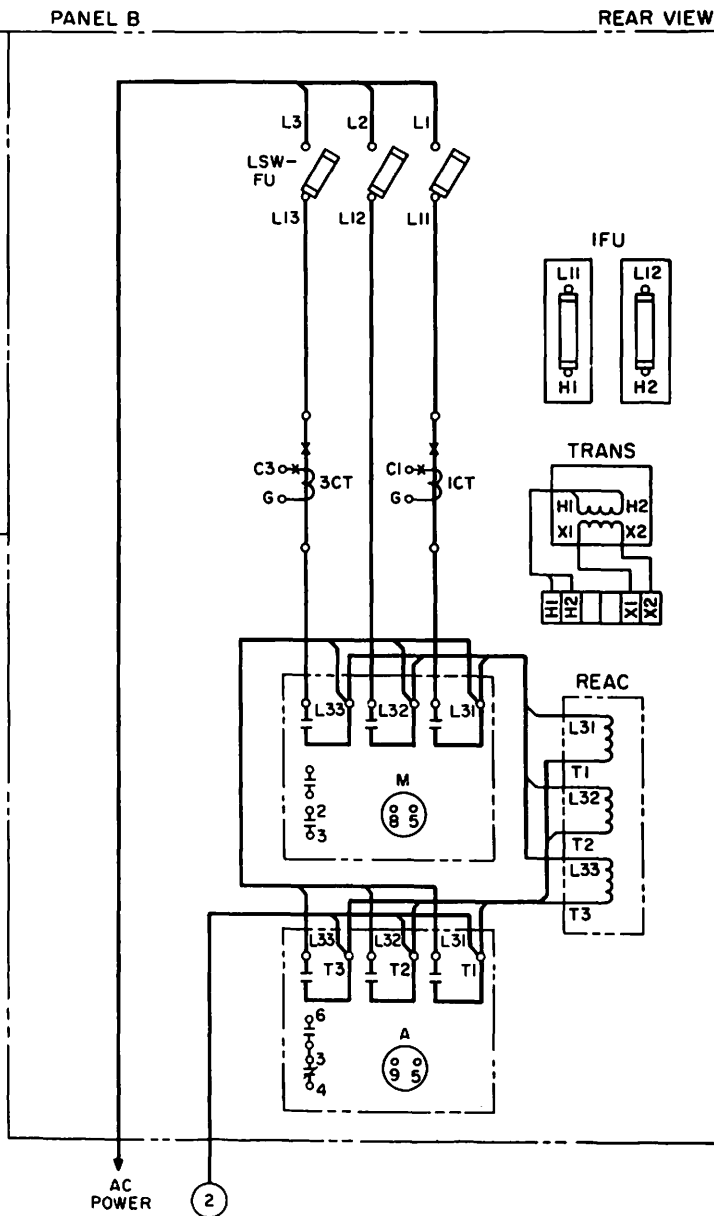
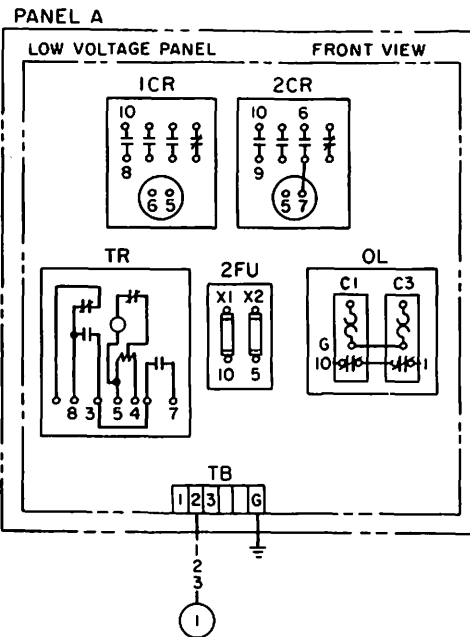


FIGURE 10-23 - TYPICAL CONNECTION DIAGRAM - WITH TABULATION FOR THOSE CONNECTIONS NOT SHOWN DIAGRAMMATICALLY

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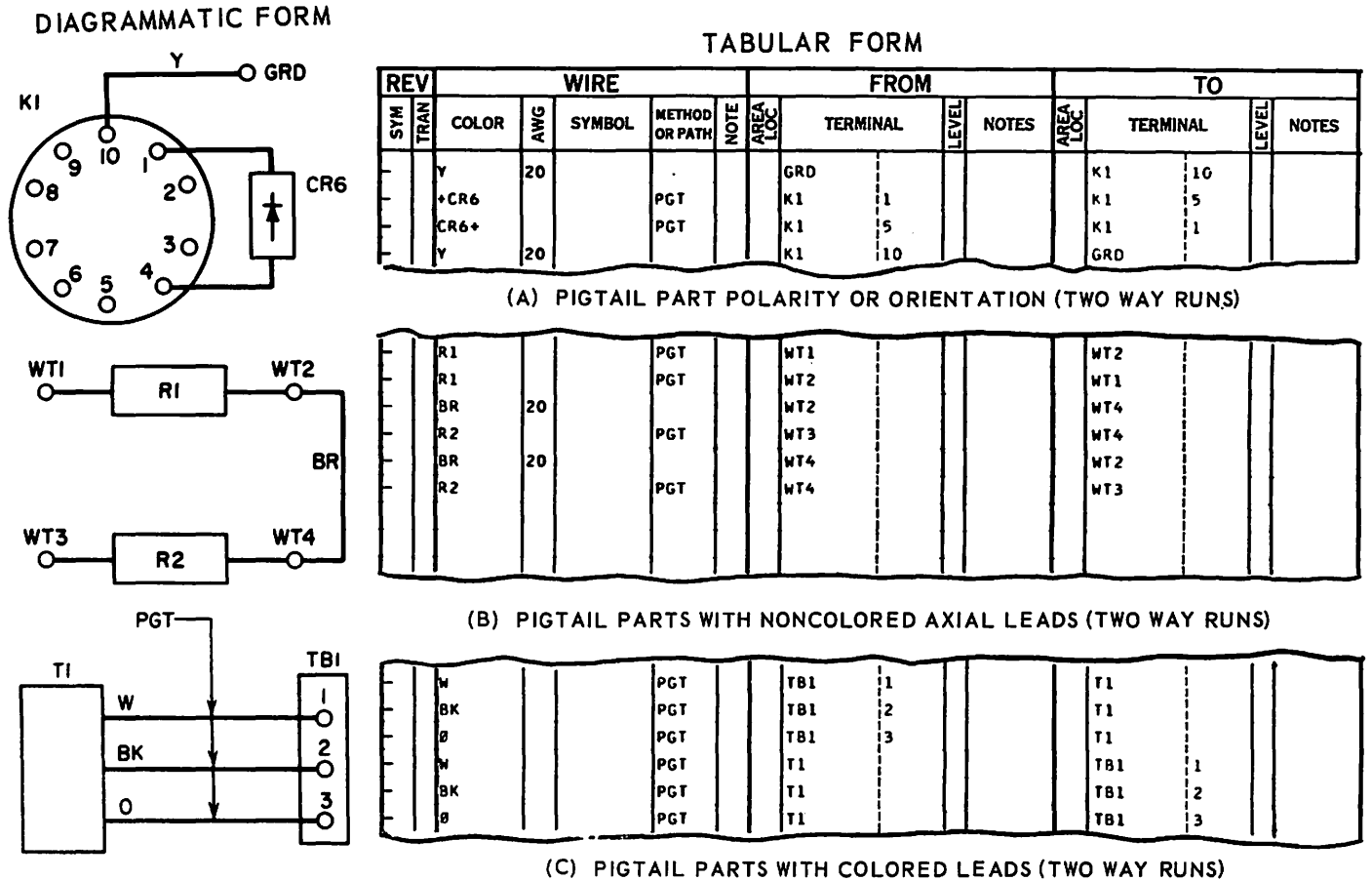


FIGURE 10-24 - PIGTAIL COMPONENT ENTRIES IN A TYPICAL TABULAR LISTING

point. This method results in each wire being listed twice, once in each direction.

(b) Wiring techniques of the same type, such as wires in cable harness, direct or surface wiring, or leads of pigtail parts, etc.

(c) Wire description, such as color, gage, material, length, etc.

(d) Wires (leads) carrying similar signals, potentials, etc.

15-10.6.3 Placement of Lists

Lists may be shown as follows:

(a) On the same drawing sheet showing a layout of the equipment as illustrated in Figure 10-23.

(b) On separate sheets as shown in Figure 10-25(A). When the separate sheet practice is used, the equipment layout information may be shown on another drawing or the information may be made part of the tabular list multisheet drawing.

15-10.6.4 Terminal Identification

If items are identified in the table with reference designations, terminals may be identified with numbers or letters separated from the designation by a dash or space as shown in Figures 10-21 and 10-25(A). When the designation is given in terms of its function or location, it is preferable to provide a separate column for terminal identification.

15-10.6.5 Pigtail Parts

Pigtail part information (when listed) shall be entered in the tabular list as follows:

(a) Surface-Mounted Parts with Colored Pigtails. Colors of color pigtail wires shall be entered in a wire description column; see Figure 10-24(A).

(b) Lead-Mounted (axial lead) Parts with Noncolored Pigtails. The reference designations of lead-mounted parts, such as R1, C6, or CR3, shall be entered in a wire description column;

ELECTRICAL AND ELECTRONICS DIAGRAMS

| REV |      | WIRE  |     |        |                |      | FROM     |          |        |       | TO       |          |       |       |
|-----|------|-------|-----|--------|----------------|------|----------|----------|--------|-------|----------|----------|-------|-------|
| SYM | TRAN | COLOR | AWG | SYMBOL | METHOD OR PATH | NOTE | AREA LOC | TERMINAL | LEVEL  | NOTES | AREA LOC | TERMINAL | LEVEL | NOTES |
|     |      | W-R   |     | ST1    | CA2            |      |          | TB1      | 2      |       |          | A1       | B     |       |
|     |      | MS1   |     |        | CA1            |      |          | TB1      | 2      |       |          | TB1      | 1     |       |
|     |      | W     |     | ST1    | CA2            |      |          | TB1      | 3      |       |          | A1       | A     |       |
|     |      | W-R-Y |     | ST1    | CA2            |      |          | TB1      | 4      |       |          | A1       | C     |       |
|     |      | BK-W  |     | P1     | CA2            |      |          | TB1      | 5      |       |          | M1       | NEG   |       |
|     |      | W     |     | P1     | CA2            |      |          | TB1      | 6      |       |          | M1       | POS   |       |
|     |      | BK    |     |        | PGT            |      |          | TB1      | 7      |       |          | T2       |       |       |
|     |      | B     |     |        | PGT            |      |          | TB1      | 8      |       |          | T2       |       |       |
|     |      | V     |     |        | CA1            |      |          | TB1      | 9      |       |          | A2       | 6     |       |
|     |      | W-B   |     |        | CA1            |      |          | TB1      | 10     |       |          | A2       | 2     |       |
|     |      | R-G   |     | SS4    | CA1            |      |          | T1       | 1      |       |          | XV1      | 1     |       |
|     |      | B     |     |        | CA1            |      |          | T1       | 2      |       |          | A2       | 8     |       |
|     |      | R     |     | SP1    | CA1            |      |          | T1       | 3      |       |          | P1       | A*    |       |
|     |      | R-BL  |     | SP1    | CA1            |      |          | T1       | 4      |       |          | P1       | C     |       |
|     |      | Y     |     |        | CA2            |      |          | T1       | 5      |       |          | XV1      | 8     |       |
|     |      | BK    |     |        | PGT            |      |          | T2       |        |       |          | TB1      | 7     |       |
|     |      | B     |     |        | PGT            |      |          | T2       |        |       |          | TB1      | 8     |       |
|     |      | BK    |     | H1     | DIR            |      |          | V1       | CAP    |       |          | J1       |       |       |
|     |      | BK    |     |        | SUR            |      |          | WT1      |        |       |          | A2       | 4\$   |       |
|     |      | BK    |     |        | CA1            |      |          | WT1      |        |       |          | P1       | C\$   |       |
|     |      | R-Y   |     | SS3    | CA1            |      |          | XV1      | 1      |       |          | A2       | 7     |       |
|     |      | R-G   |     | SS4    | CA1            |      |          | XV1      | 1      |       |          | T1       | 1     |       |
|     |      | CBM   |     |        | CA1            |      |          | XV1      | 1\$    |       |          | XV1      | 1\$   |       |
|     |      | CBM   |     |        | CA1            |      |          | XV1      | 1\$    |       |          | XV1      | 1\$   |       |
|     |      | CBM   |     |        | CA1            |      |          | XV1      | 1\$    |       |          | XV1      | 2\$   |       |
|     |      | B-W   |     | SS2    | CA1            |      |          | XV1      | 2      |       |          | R3       | 2     |       |
|     |      | CBM   |     |        | CA1            |      |          | XV1      | 2\$    |       |          | XV1      | 1\$   |       |
|     |      | BR    |     |        | CA1            |      |          | XV1      | 3      |       |          | A2       | 3     |       |
|     |      | R2    |     |        | PGT            |      |          | XV1      | 4      |       |          | XV1      | 7     |       |
|     |      |       |     |        |                |      |          | XV1      | 5      |       |          |          |       |       |
|     |      |       |     |        |                |      |          | XV1      | 6      |       |          |          |       |       |
|     |      | R2    |     |        | PGT            |      |          | XV1      | 7      |       |          | XV1      | 4     |       |
|     |      | STRAP |     |        |                |      |          | XV1      | 7      |       |          | XV1      | 8     |       |
|     |      | Y     |     |        | CA2            |      |          | XV1      | 7 (ST1 |       |          | A1       | E     |       |
|     |      | W     |     | ST1    | CA2            |      |          | A1       | A      |       |          | TB1      | 3     |       |
|     |      | W-R   |     | ST1    | CA2            |      |          | A1       | B      |       |          | TB1      | 2     |       |

Continued on page 64

(A) TABULAR CONNECTION DIAGRAM (EQUIVALENT TO BASE-LINE CONNECTION DIAGRAM FIGURE 10-25 (B))

FIGURE 10-25

PROPOSED USA STANDARD DRAFTING PRACTICES

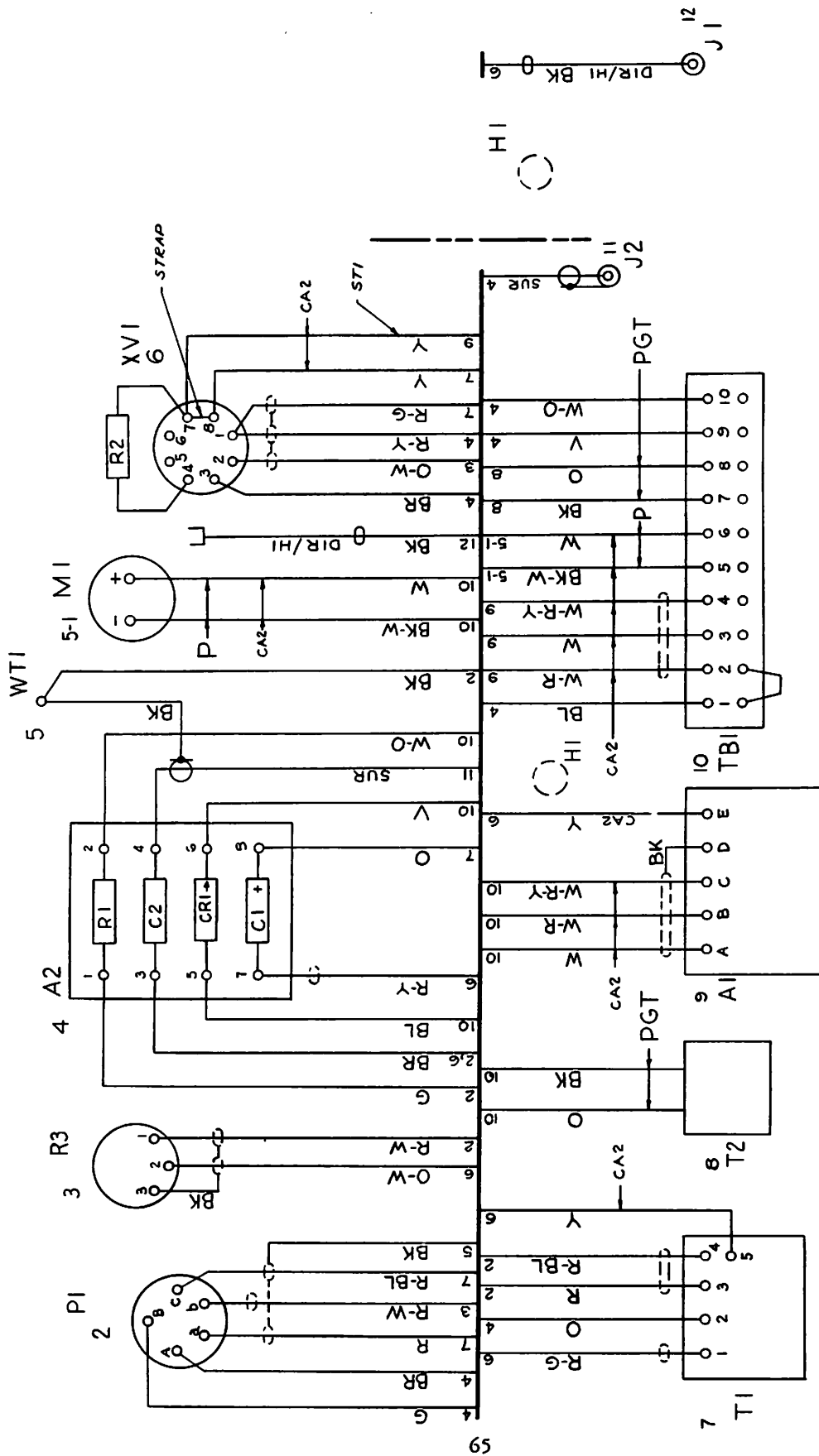
Continued from page 63

| REV | WIRE        |       |     |        |                   | FROM |             |          | TO    |       |             |          |       |       |
|-----|-------------|-------|-----|--------|-------------------|------|-------------|----------|-------|-------|-------------|----------|-------|-------|
|     | SYM<br>TRAN | COLOR | AWG | SYMBOL | METHOD<br>OR PATH | NOTE | AREA<br>LOC | TERMINAL | LEVEL | NOTES | AREA<br>LOC | TERMINAL | LEVEL | NOTES |
|     |             | W-R-Y |     | ST1    | CA2               |      | A1          | C        |       |       | TB1         | 4        |       |       |
|     |             | BK    |     |        | CA2               |      | A1          | C\$      |       |       | A1          | D        |       |       |
|     |             | BK    |     |        | CA2               |      | A1          | D        |       |       | A1          | C\$      |       |       |
|     |             | Y     |     |        | CA2               |      | A1          | E        |       |       | XV1         | 7(ST1)   |       |       |
|     |             | G     |     |        | CA1               |      | A2          | 1        |       |       | P1          | B        |       |       |
|     |             | W-B   |     |        | CA1               |      | A2          | 2        |       |       | TB1         | 10       |       |       |
|     |             | BR    |     |        | CA1               |      | A2          | 3        |       |       | P1          | A        |       |       |
|     |             | BR    |     |        | CA1               |      | A2          | 3        |       |       | XV1         | 3        |       |       |
|     |             |       | RF  |        | SUR               |      | A2          | 4        |       |       | J2          |          |       |       |
|     |             | BK    |     |        | SUR               |      | A2          | 4\$      |       |       | WT1         |          |       |       |
|     |             | BL    |     |        | CA1               |      | A2          | 5        |       |       | TB1         | 1        |       |       |
|     |             | V     |     |        | CA1               |      | A2          | 6        |       |       | TB1         | 9        |       |       |
|     |             | R-Y   |     | SS3    | CA1               |      | A2          | 7        |       |       | XV1         | 1        |       |       |
|     |             | Ø     |     |        | CA1               |      | A2          | B        |       |       | T1          | 2        |       |       |
|     |             | BK    |     | H1     | DIR               |      | J1          |          |       |       | V1          | CAP      |       |       |
|     |             |       | RF  |        | SUR               |      | J2          |          |       |       | A2          | 4        |       |       |
|     |             | BK-W  |     | P1     | CA2               |      | M1          | NEG      |       |       | TB1         | 5        |       |       |
|     |             | W     |     | P1     | CA2               |      | M1          | PØS      |       |       | TB1         | 6        |       |       |
|     |             | BR    |     |        | CA1               |      | P1          | A        |       |       | A2          | 3        |       |       |
|     |             | R     |     | SP1    | CA1               |      | P1          | A*       |       |       | T1          | 3        |       |       |
|     |             | G     |     |        | CA1               |      | P1          | B        |       |       | A2          | 1        |       |       |
|     |             | R-W   |     | SS1    | CA1               |      | P1          | B*       |       |       | R3          | 1        |       |       |
|     |             | R-BL  |     | SP1    | CA1               |      | P1          | C        |       |       | T1          | 4        |       |       |
|     |             | BK    |     |        | CA1               |      | P1          | C\$      |       |       | WT1         |          |       |       |
|     |             | R-W   |     | SS1    | CA1               |      | R3          | 1        |       |       | P1          | B*       |       |       |
|     |             | COM   |     |        | CA1               |      | R3          | 1\$      |       |       | R3          | 2\$      |       |       |
|     |             | Ø-W   |     | SS2    | CA1               |      | R3          | 2        |       |       | XV1         | 2        |       |       |
|     |             | COM   |     |        | CA1               |      | R3          | 2\$      |       |       | R3          | 1\$      |       |       |
|     |             | BK    |     |        | CA1               |      | R3          | 2\$      |       |       | R3          | 3        |       |       |
|     |             | BK    |     |        | CA1               |      | R3          | 3        |       |       | R3          | 2\$      |       |       |
|     |             | BL    |     |        | CA1               |      | TB1         | 1        |       |       | A2          | 5        |       |       |
|     |             | MS1   |     |        | CA1               |      | TB1         | 1        |       |       | TB1         | 2        |       |       |
|     |             | Y     |     |        | CA2               |      | XV1         | 8        |       |       | T1          | 5        |       |       |

- NOTES \$ DENOTES TERMINATION OF SHIELD AND IS PREFIXED BY THE DESIGNATION OF THE TERMINAL TO WHICH THE SHIELDED WIRE CONNECTS.
- COM DENOTES TERMINATION OF A SHIELD COMMONED WITH A SECOND SHIELD BY A SINGLE TERMINATION.
- MS DENOTES MECHANICAL STRAP
- SS DENOTES SHIELDED SINGLE
- SP DENOTES SHIELDED PAIR
- ST DENOTES SHIELDED TRIPLE
- \* DENOTES LOWER CASE LETTER

FIGURE 10-25 – COMPARISON OF TABULAR AND PICTORIAL FORMS OF CONNECTION DIAGRAM FOR THE SAME ASSEMBLY

ELECTRICAL AND ELECTRONICS DIAGRAMS



(B) BASE-LINE CONNECTION DIAGRAM (EQUIVALENT TO TABULAR CONNECTION DIAGRAM (A))

FIGURE 10-25 (CONT'D)

## PROPOSED USA STANDARD DRAFTING PRACTICES

see Figure 10-24(B). The terminals to which the ends of the part connect shall be listed in the FROM and TO columns.

### 15-10.6.5.1 Polarity or Orientation of Axial-Lead Parts

When it is necessary to indicate polarity or orientation based on marks such as + or - that appear on the part, an appropriate symbol shall be used; see Figure 10-24(C). When such symbols are used, an explanatory note shall be included.

### 15-10.6.6 Supplementary Data

Tabular lists that appear on separate sheets as multisheet drawings should be supplemented with equipment layout information showing the following:

(a) Relative location of all portions of units that have to be wired within or on the equipment. If all the portions are not shown in detail in the layout, reference to drawings containing the detailed information should be indicated.

(b) Terminal arrangement and identification of unmarked terminals of items. The data should show a wiring side view of the terminal arrangement. A recommended sequence assignment of terminal identification is a left-to-right and top-to-bottom order.

(c) Special wiring arrangements shown pictorially which cannot be conveyed with tabular information alone.

(d) Paths of cable harnesses when such paths are not readily determined. For typical illustrations showing general equipment layout information, see Figure 10-22.

## 15-11 Interconnection Diagrams (In Process)

### 15-12 Terminal Diagrams

The following subparagraphs contain information specifically applicable to diagrams of the type often supplied for multi-terminal enclosed or sealed devices, such as electron tubes, semiconductor devices, packaged circuits and similar items. For typical Terminal Diagrams, see Figures 12-1 and 12-4.

The function of a Terminal Diagram may also be performed by a Pictorial Diagram showing:

(a) the physical relations of the terminals to the device outline, and

(b) the terminal designations assigned or marked together with a table or a Schematic Diagram relating the circuit or device parts to the terminal designations.

#### 15-12.1 Circuit Representation

The circuit of the item depicted shall be represented using graphic symbols in the usual manner. An envelope symbol or an enclosing

circle shall be shown if applicable; in all other cases the mechanical-grouping boundary line shall be used to outline the circuit.

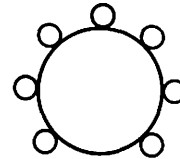
Circuits composed of more than one component part shall have the individual parts identified, preferably by reference designations. Component part values shall be indicated and be placed either adjacent to the part symbols or in a separate tabulation. Circuits composed of many interconnected component parts are preferably shown by a Schematic Diagram (see Figures 8-23 and 12-4), accompanied by an Assembly Drawing showing the necessary physical relationships and terminal designations.

#### 15-12.2 Terminal Representation and Arrangement

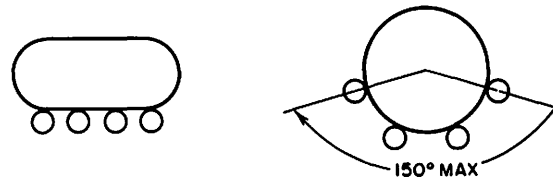
The terminals of the items shall be represented using the applicable graphic symbols located adjacent to the envelope or boundary line and arranged as follows:

(a) The terminals shall be located in the order they appear when the item is viewed from outside the terminal face of the device.

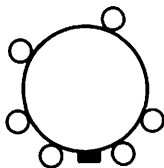
(b) If the device terminals are in a circular arrangement, the actual angular spacing between the terminals should be approximated on the Terminal Diagram.



(c) If the terminals are in an essentially linear arrangement, the Terminal Diagram may show the terminals in either a linear array along one side of the elongated envelope symbol (preferable), or within a maximum angle of 150 degrees around the circular envelope symbol.



(d) If terminals are omitted in an otherwise standard terminal array, the remaining terminals shall not be respaced.



Connect the terminals to the circuit inside the outline; see Figures 12-1 through 12-4.

### 15-12.3 Orientation Features

Symmetrical terminal configurations usually have an orientation reference in the form of:

- (a) a locating guide or mechanical index, a physical feature to prevent incorrect insertion of the device in its mounting (key, bayonet pin, terminal omission in symmetrical pattern, etc.), or
- (b) a reference mark or visual index positively located with respect to the terminal group, or
- (c) terminal markings.

Orientation symbols shall be indicated at their proper location on the Terminal Diagram; see Figures 12-2(E) and 12-3.

### 15-12.4 Terminal Arrangement Designations

Devices having a base or terminal arrangement conforming to an established mechanical design standard shall have the standard designation for the terminal arrangement shown adjacent to the Terminal Diagram; see Figure 12-1. However, on diagrams intended for other than engineering or design purposes, mechanical design standard designations may be omitted.

### 15-12.5 Terminal Identification

If terminal identifications have been assigned, they shall be shown on the Terminal Diagram at the assigned positions.

New terminal configurations should have their terminal identifications assigned as follows:

- (a) Terminals or contact pins should be identified by numbers.
- (b) Terminals should be designated in succession, based on the maximum possible number of terminals. If terminals are omitted, the remaining terminals shall not be renumbered; see Figure 12-1(B).
- (c) For circular configurations, or elsewhere if applicable, terminal numbering shall begin with the first terminal, the center of which is past (in a clockwise direction) the datum line (15-12.5.1) as viewed from outside the terminal face of the device. If omission of a terminal in an otherwise equally spaced array identifies the datum line, the position of the omitted terminal shall not be numbered.

(d) For terminals in an essentially equally spaced linear array, the terminal positions shall be numbered progressively beginning with the terminal nearest the reference mark and counting any intermediate positions which could provide space for a terminal; see Figure 12-3.

(e) Terminals in one linear array shall be numbered progressively from the left side, where the left side is defined as having the most terminals. This shall be employed only if (d) is not applicable.

(f) If a device has several standard terminal groups, the terminal identifications may be established independently for each group.

(g) If a terminal configuration has terminals in concentric circles of decreasing diameters, the terminal positions on the circles shall be numbered sequentially continuing from the highest numbered position on the outer circle, always numbering in a clockwise direction along a decreasing spiral. The datum line is the reference used for the outer pin circle only.

(h) In the case of devices with terminals emerging from more than one plane the numbering shall start on the end:

- (1) Opposite to the end containing a threaded stud or hole.
- (2) Opposite to the end with the smallest number of terminals.
- (3) Opposite to the end identified by a band, dot, or other applied visual identification.
- (4) Opposite to the end with the larger ferrule, flange, insert, etc.

(i) A terminal at the center of the terminal arrangement shall be identified as the CENTER terminal lead or pin, and shall not be given a terminal number.

(j) Whenever polarity of a device is to be indicated, a polarity symbol + or - should be used.

#### 15-12.5.1 Terminal Group Datum Lines

The datum line is a radial line used as a starting point for numbering terminals in a circularly arranged array.

A datum shall be chosen in the following order of preference. If two cases apply, the method appearing first in the list shall be used.

- (a) The radial line from the center of the terminal group through the center of the key, keyway, or index.
- (b) The radial line midway between the two terminals which obviously comprise a gap in an otherwise equally spaced circular terminal array.
- (c) The radial line midway between:
  - (1) The two large contact terminals
  - (2) The two small contact terminals
- (d) The radial line 180° from the locating radius of the most isolated terminals.

PROPOSED USA STANDARD DRAFTING PRACTICES

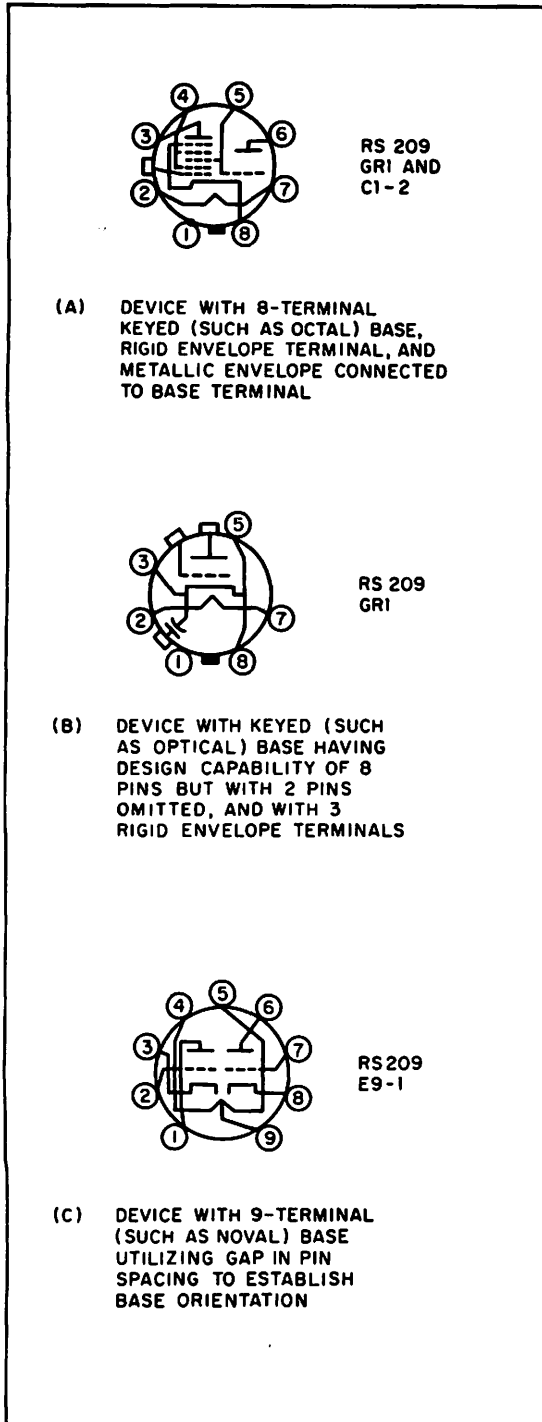


FIGURE 12-1 - TYPICAL ELECTRON TUBE BASING OR TERMINAL DIAGRAMS

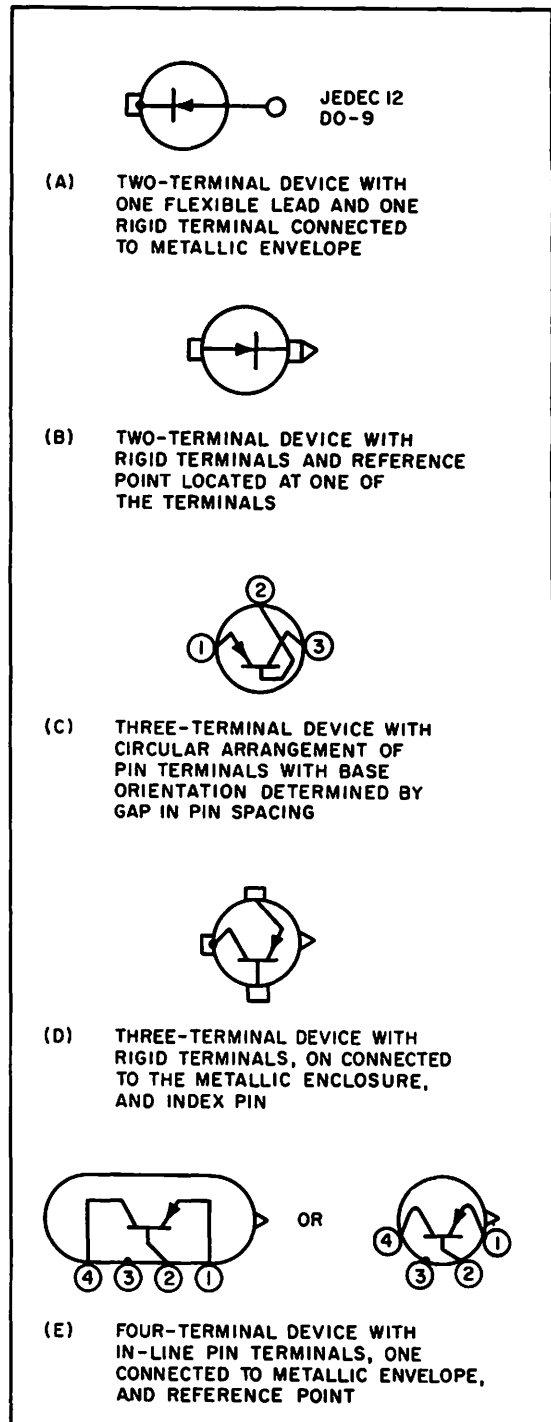


FIGURE 12-2 - TYPICAL SEMICONDUCTOR DEVICE OR TERMINAL DIAGRAMS



ELECTRICAL AND ELECTRONICS DIAGRAMS

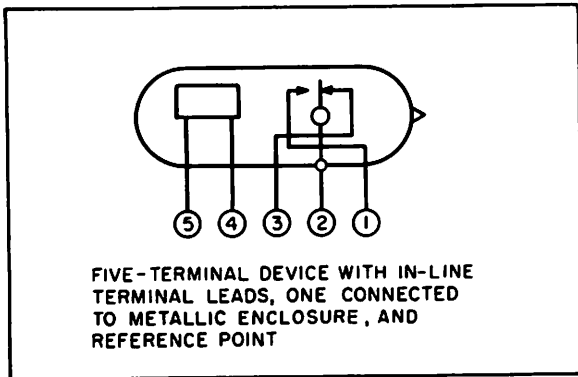


FIGURE 12-3 - TYPICAL RELAY TERMINAL DIAGRAM

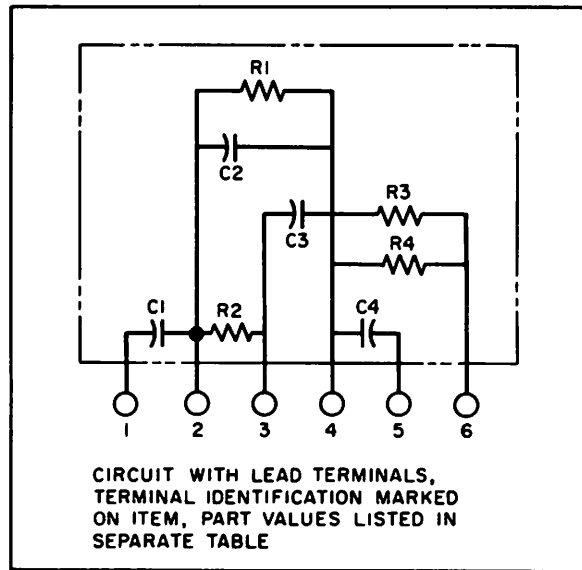


FIGURE 12-4 - TYPICAL PACKAGED CIRCUIT TERMINAL DIAGRAM

- (e) The radial line  $180^\circ$  from the locating radius of the bayonet pin.
- (f) The radial line  $180^\circ$  from the mid point:
  - (1) Of the two most closely spaced terminals.
  - (2) Of the two most widely spaced terminals.
- (g) The radial line from the center of the terminal group through the center of the index

terminal. In order of preference the index terminal is defined as:

- (1) The terminal having the smaller cross-sectional area at the point of emergence from the case.
- (2) The terminal having the greatest axial length.

# USA Standards of Particular Interest to Designers, Architects and Draftsmen

## TITLE OF STANDARD

|   |                                |
|---|--------------------------------|
| <b>USA Standard Drafting Practices</b>  |                                |
| Section 1 Size and Format . . . . .   | Y14.1-1957                     |
| Section 2 Line Conventions, Sectioning and Lettering . . . . .                                    | Y14.2-1957                     |
| Section 3 Projections . . . . .   | Y14.3-1957                     |
| Section 4 Pictorial Drawing . . . . .   | Y14.4-1957                     |
| Section 5 Dimensioning and Notes . . . . .  | Y14.5-1966                     |
| Section 6 Screw Threads . . . . .   | Y14.6-1957                     |
| Section 7 Gears, Splines and Serrations . . . . .   | Y14.7-1958                     |
| Section 8 Castings . . . . .  | In Preparation                 |
| Section 9 Forgings . . . . .  | Y14.9-1958                     |
| Section 10 Metal Stampings . . . . .  | Y14.10-1959                    |
| Section 11 Plastics . . . . .   | Y14.11-1958                    |
| Section 12 Die Castings . . . . .   | In Preparation                 |
| Section 13 Springs, Helical and Flat . . . . .  | In Preparation                 |
| Section 14 Mechanical Assemblies . . . . .  | Y14.14-1961                    |
| Section 15 Electrical and Electronics Diagrams . . . . .  | Y14.15-1966                    |
| Section 16 Tools, Dies and Gages . . . . .  | In Preparation                 |
| Section 17 Fluid Power Diagrams . . . . .   | Y14.17-1966                    |
| Section 18 Drawings for Optical Parts . . . . .   | In Preparation                 |
| Section 19 Engineering Drawings for Photographic Reproduction . . . . .                           | In Preparation                 |
| <b>Graphical Symbols for:</b>   |                                |
| Metallizing Symbols . . . . .   | Y32.12-1960                    |
| Welding . . . . .   | Y32.3-1959                     |
| Plumbing . . . . .  | Y32.4-1955                     |
| Pipe Fittings, Valves and Piping . . . . .  | Z32.2.3-1949 (Reaffirmed 1953) |
| Heating, Ventilating and Air Conditioning . . . . .   | Z32.2.4-1949                   |
| Use on Railroad Maps and Profiles . . . . .   | Y32.7-1957                     |
| Heat-Power Apparatus . . . . .  | Z32.2.6-1950 (Reaffirmed 1956) |
| Fluid Power Diagrams . . . . .  | Y32.10-1958                    |
| Process Flow Diagrams in Petroleum and Chemical Industries . . . . .                              | Y32.11-1961                    |
| Nondestructive Testing Symbols . . . . .  | Y32.17-1962                    |
| Abbreviations for Use on Drawings . . . . .   | Z32.13-1950                    |
| <b>Letter Symbols for:</b>  |                                |
| Hydraulics . . . . .  | Y10.2-1958                     |
| Rocket Propulsion . . . . .   | Y10.14-1959                    |
| Mechanics for Solid Bodies . . . . .  | Z10.3-1948                     |
| Structural Analysis . . . . .   | Z10.8-1949                     |
| Heat and Thermodynamics . . . . .   | Y10.4-1957                     |
| Physics . . . . .   | Z10.6-1948                     |
| Aeronautical Sciences . . . . .   | Y10.7-1954                     |
| Radio . . . . .   | Y10.9-1953                     |
| Meteorology . . . . .   | Y10.10-1953                    |
| Acoustics . . . . .   | Y10.11-1953 (Reaffirmed 1959)  |
| Chemical Engineering . . . . .  | Y10.12-1955 (Reaffirmed 1961)  |
| Petroleum Reservoir Engineering and Electric Logging . . . . .                                    | Y10.15-1958                    |
| Abbreviations for Scientific and Engineering Terms . . . . .                                      | Z10.1-1941                     |
| Guide for Selecting Greek Letters Used as Letter Symbols<br>for Engineering Mathematics . . . . . | Y10.17-1961                    |
| Shell Theory . . . . .  | Y10.16-1964                    |