A complete schematic drawing of complex equipment may be too large for practical use. For this reason, most technical manuals present partial or simplified schematics for individual circuits or units.

As stated earlier in chapter 6, simplified schematics normally omit parts and connections that are not essential to understanding circuit operation. In studying or troubleshooting equipment, the technician often makes a simplified drawing, including only those items that contribute to the purpose of the drawing. When you are using the schematic drawings in this manual, technical manuals, textbooks, and other publications, notice the various techniques for simplifying schematics, thereby increasing their usefulness in maintenance work.

7.1.2 Drawings

The drawings used by an IC Electrician include block diagrams, signal flow charts, wiring diagrams, and mechanical drawings. As with schematics, the IC Electrician will be familiar with some drawings from past experience. The use of block diagrams and signal flow charts to present the overall picture of equipment function is widespread. Although they do not contain the details that are needed in accomplishing maintenance tasks, they are obviously valuable in training situations and in providing overall continuity when personnel are working with partial schematics.

7.2.0 SYMBOLIC INTEGRATED MAINTENANCE MANUAL

The IC Electrician is responsible for maintaining many different types of complex electrical/electronics equipment, usually, the diagnostic logic shortcomings of a young maintenance force result in longer than necessary equipment downtime. In some cases, equipment damage is introduced by trial-and-error maintenance actions. Some faults cannot be located and repaired by the unit level maintenance personnel because they lack experience or are not familiar with the equipment. Then too, personnel of all experience levels are frequently transferred and encounter new equipment. A relatively new troubleshooting aid, the *Symbolic Integrated Maintenance Manual (SIMM)*, should help the troubleshooter identify more readily the general location of a fault. Though this manual presents a rather complete circuit analysis, in no way does it prevent the requirement for local analysis and a well-informed technician. The SIMM represents a major change in the methods of presenting technical data and the methods of diagnosing electronic system faults. Through the use of new information display techniques and symbology, blocks, and color shading, the job of fault isolation in complex electronic systems is made easier, faster, and surer.

The overall objective of the *SIMM* is to display more descriptive and illustrative data per page; eliminate unnecessary words, discussion, and illustrations; organize all required data so rapid access is afforded, and display complete circuit element dependencies as simply as possible.

The *SIMM* helps organize the technical details of an equipment or system, providing users with all the information the y need to learn to operate and maintain the equipment or system. The style of writing and the use of circuit-identifier codes (coding that assists recognition of the circuit character) and coded symbols enable the trainee to learn faster. Circuit diagrams and associated text are presented on facing pages.

The text is concise; yet it defines the circuit operation precisely. Block diagrams relate the level of physical containment (unit, assembly, subassembly, sub-subassembly) with the hardware to the functional circuits. Associated text is likewise presented on a facing page. Coded symbols and abbreviations indicate the kind of signals being processed, and circuit-identifier codes identify the circuit represented by uniquely shaped blocks. Maintenance dependency charts, based upon positive logic, provide a unique, fast method of trouble analysis, include operating procedures, and reveal to a degree the designed-in equipment maintainability. The emphasis on symbology, a concise writing style, and memory devices permit a reduction in page count with no loss in technical content.

The *SIMM* is developed around the following three basic building blocks:

- Blocked schematic
- Blocked text
- Precise-access blocked diagram

7.3.0 BLOCKED SCHEMATIC

By definition, a blocked schematic is a schematic diagram laid out in block form (fig. 7-1). It distinguishes the functions and physical aspects of the hardware by using shaded areas of blue and gray. The blue-shaded areas show the functional features of a circuit (lowest definable basic circuit, filter, voltage divider, oscillator, amplifier, relay contact, meter, coil, switch, and so on) and the gray-shaded areas show the hardware (chassis, drawer, module, and so on).

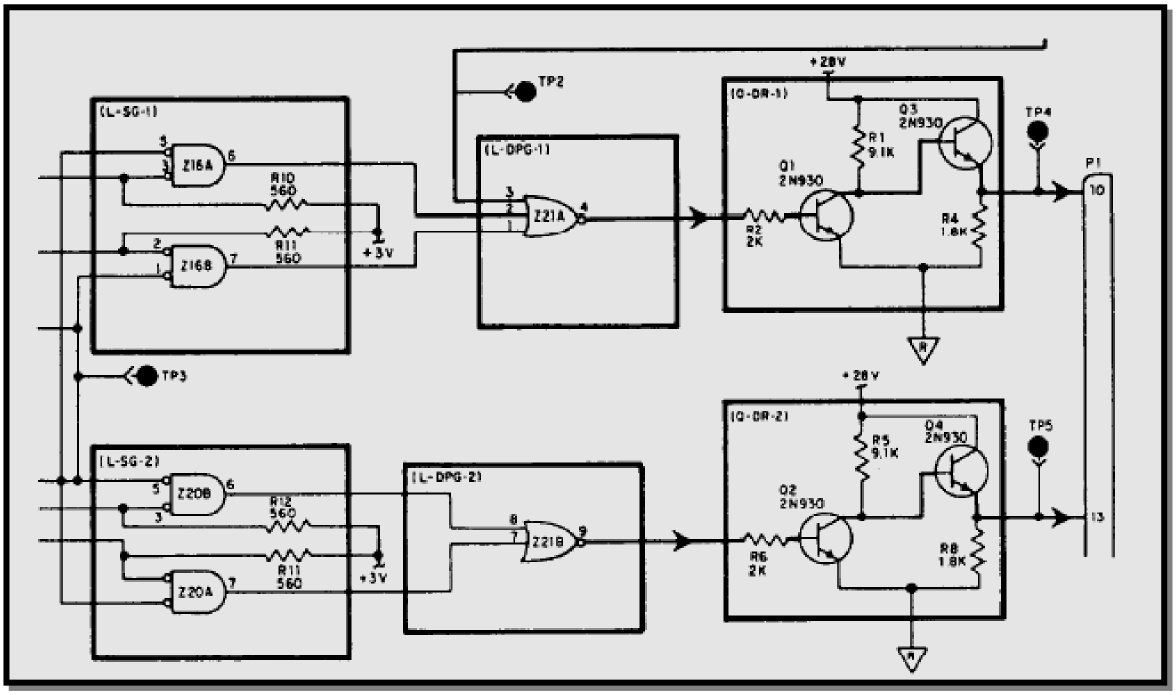

Figure 7-1.- Blocked schematic.

Each blue area includes ALL circuit elements that are involved in accomplishing the circuit function; these areas are called functional entities. Each functional entity is easily and simply identified by a circuit-identifier code, such as Q-DR-1 or L-DPG-2. For example, in Q-DR-1 (a driver stage), Q is the active element (a transistor); DR is the abbreviation for driver; and 1 indicates the first occurrence of that type of functional entity in the assembly. Functional entities are connected by signal flow lines that show the kinds of signals being processed by the coded shape of an arrowhead superimposed on the lines.

7.4.0 BLOCKED TEXT

The blocked text (fig. 7-2) is presented on a page facing the blocked schematic. The arrangement of the blocked text matches that of the blocked schematic.

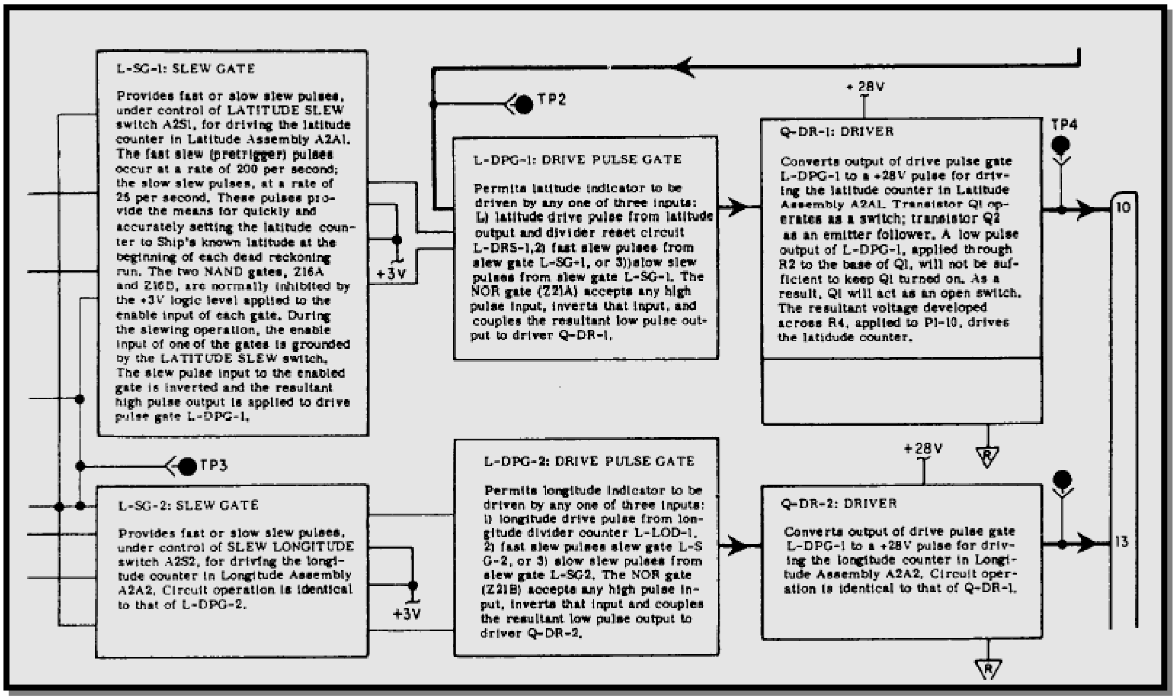

Figure 7-2.- Blocked text.

Notice that concise text, suitable to the component being described, replaces the circuit elements in the respective blue-shaded area. Paragraph numbers, references to illustrations, complete sentence structures, and formal grammatical rules are not necessary to impart all needed information. The use of facing pages, similar block arrangements of text and components being described, enables a rapid association between text and blocks, text and circuit detail, and circuit detail and blocks. Like the blocked schematic, each blue-shaded area includes a circuit-identifier code for identification of the components being described. The greatest value of this code is realized on high-level diagrams where much information must be confined to a small space.

7.5.0 PRECISE-ACCESS BLOCKED DIAGRAM

A precise-access blocked diagram is the next higher level diagram (fig. 7-3). It emphasizes levels of physical containment (units, assemblies, and so on) of the components with respect to their enclosures. Four basic shapes are used as symbols on this diagram to show the kind of circuit through which the signal is being processed. These symbols are shown in figure 7-4.

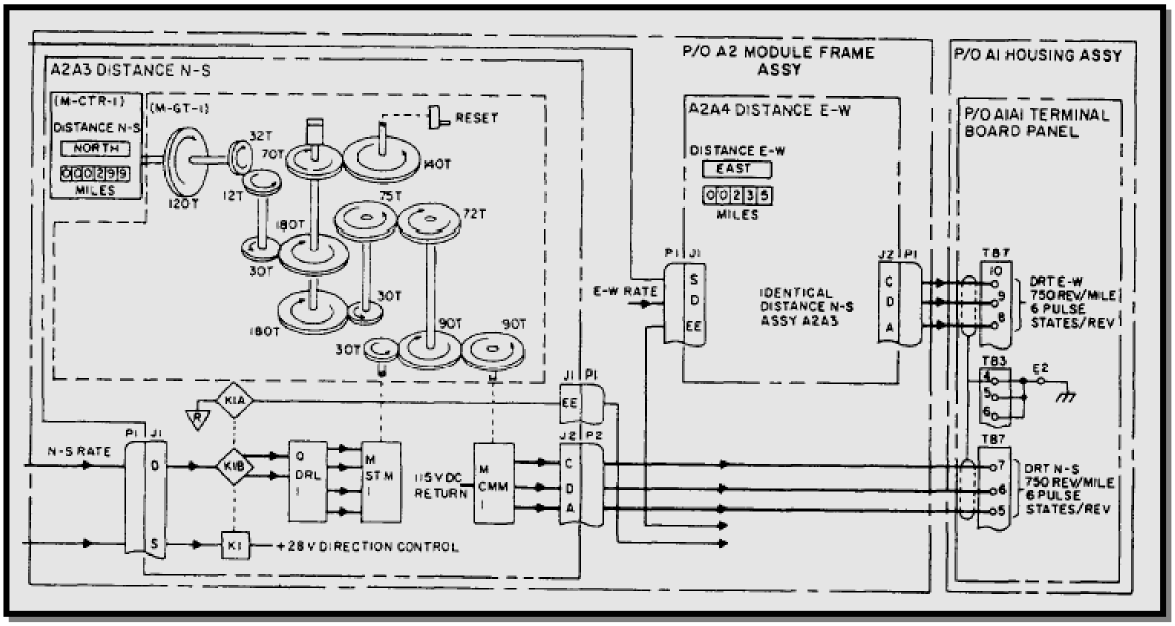

Figure 7-3.- Precise-access blocked diagram.

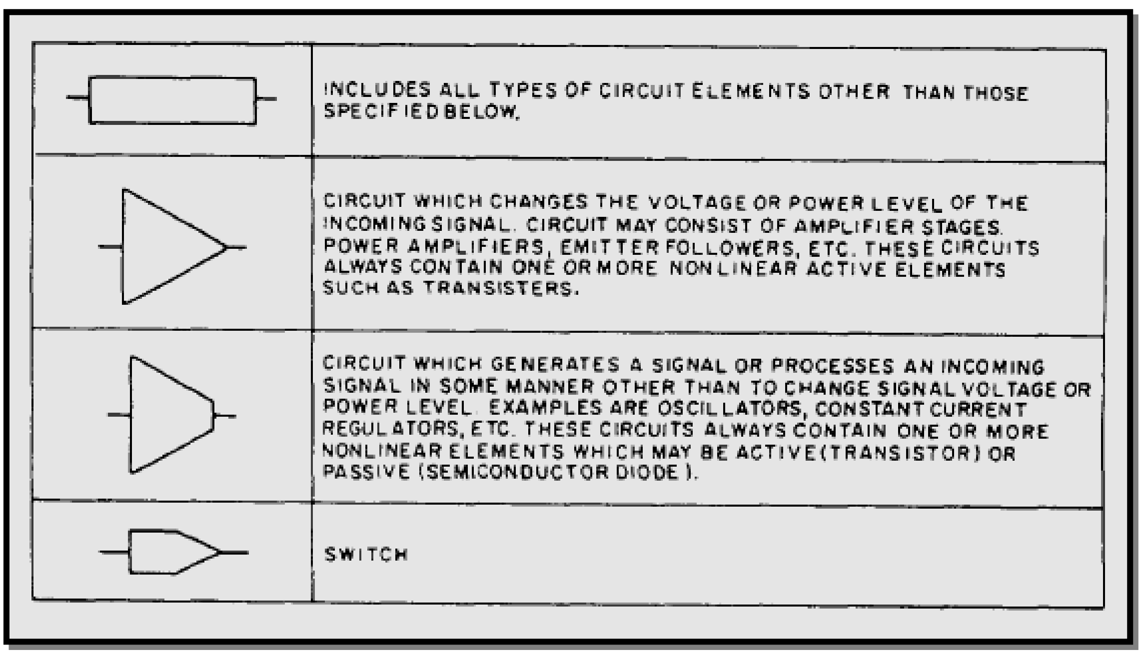

Figure 7-4.- Functional circuit symbols used on precise-access block diagrams.

In each basic shape is inscribed the circuit-identifier code that identifies the actual component. In addition, the coded arrows superimposed on the signal-flow lines that tie these shapes together are again used to identify the signals being processed. Also superimposed over these block diagrams are shades of gray that indicate the level of containment of the components or other circuit elements in the equipment through which the signal or signals pass. Again there is blocked text on the facing page (fig. 7-5).

Detailed cabling information between all assemblies is shown on the precise-access blocked diagram. In cases of large complex equipment, however, power circuit cabling is detailed on power distribution diagrams.

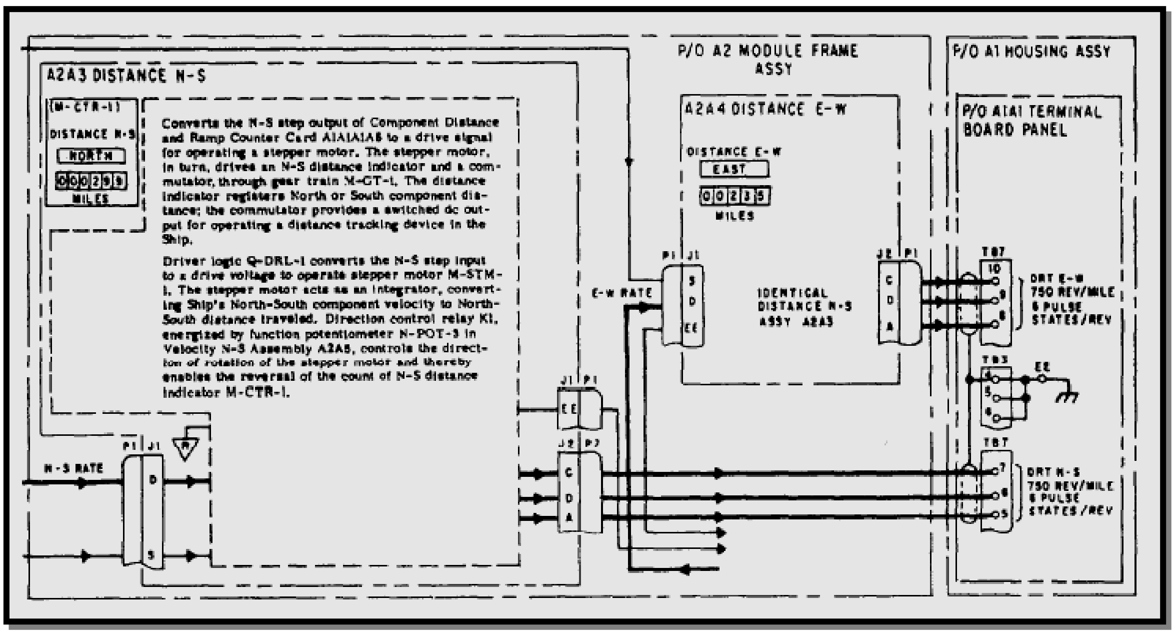

Figure 7-5.- Precise-access blocked text.

7.6.0 OPERATING PROCEDURES

Procedures that explain how to operate equipment under normal and emergency conditions are included in the operating procedures. Manuals for some equipment contain an operating chart that establishes a turn-on and checkout procedure. The chart displays chronologically all indications that can be recognized from outside the equipment. The indications are events, such as meter readings, lights, synchro rotating, or motor running noise that can be recognized by the human senses. Shaded bands stretching across the chart show the time lapse between events. All simultaneous events for a given step of the procedure appear on one horizontal line. Monitors are indicated in a solid black background box with white lettering.

Front panel indicators and other recognizable indications with front panel markings, as applicable, and their associated cabinet nomenclature are located along the top of the chart, if an event fails to happen fault isolation is simplified by the indexing on the operator's chart. This indexing will lead the troubleshooter to the proper maintenance dependency chart and the circuit chain upon which the missing event depends. The troubleshooter merely associates the operational step and the event that did not occur to find the pertinent circuit chain. A vertical column on the left side of the page contains the turn-on procedure in a sequence of steps consistent with the engineering designed plan of turn-on. Also in the left-hand column, boxed and indented, are checkout procedural steps that can be performed at any time during operation. These checkout steps will give an indication of the functional performance and will provide a sound basis for selection of operator, preventive-maintenance checks.

7.7.0 MAINTENANCE DEPENDENCY CHART

One of the most important features of the *SIMM* is its troubleshooting tool, the maintenance dependency chart (MDC). In addition to front panel marked indicators displayed across the top of the page, it contains the various assemblies or circuit elements through which a signal passes, as well as their chassis or cabinet locations. Each horizontal line results in an action, such as a lamp lighting, a synchro rotating, a meter indicating, or an indication of signal availability. These actions are called events. Each horizontal line (event line) is a representation of the circuit that develops the event on its line. The MDC has the unique advantage of permitting the simple display of many events and their relationships in a limited space.

The technique of isolating a fault is based upon a positive approach. It is an analysis of circuitry to verify whether the things that should have happened did happen. The event, if normal, is either readily observable or its signal can be measured. If either the action or signal is not present, components or circuits upon which the event is dependent can be readily ascertained.

With other methods of troubleshooting, it was impractical to present all the combinations that could cause a malfunction; for example, a trouble in 1 of 43 events resulting from parallel actions could represent approximately one trillion possible symptoms. Accordingly, the negative approach to fault isolation or the so-called symptom-probable cause- remedy method is inadequate for the complexities that often occur in electronic circuits.

MDCs, often more detailed and involved than the samples shown in figure 7-6, views A and B, are required to represent the complex circuitry of modern electronics systems. To help you understand an MDC, the definitions of its key terms and symbols are given in the following sections:

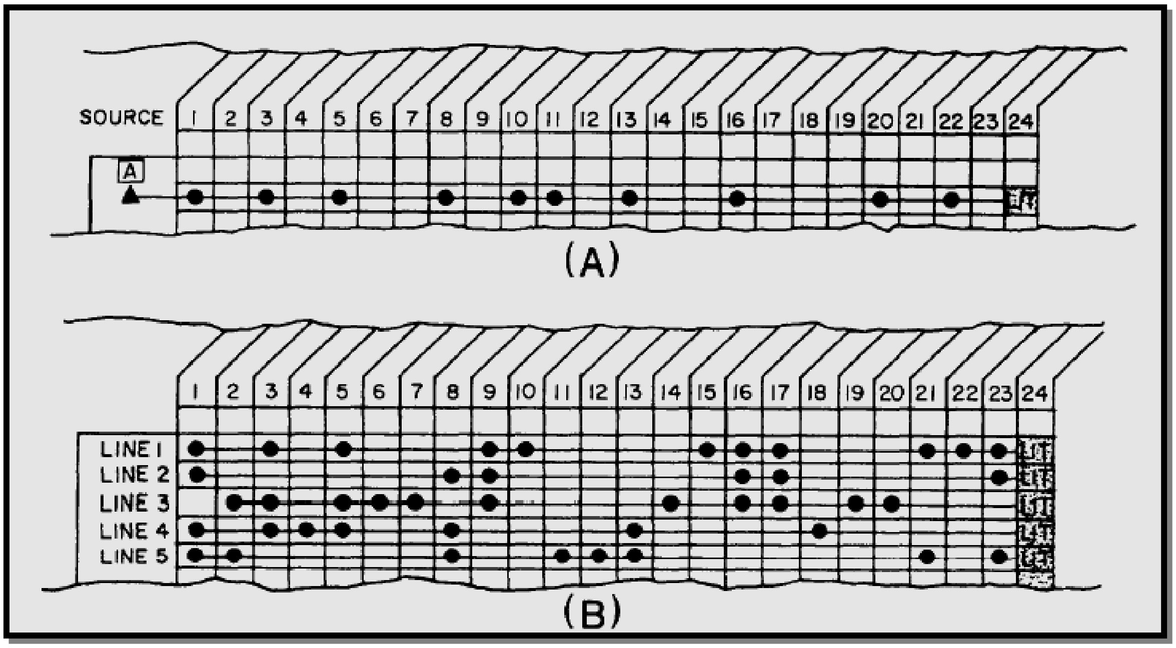

Figure 7-6.- Maintenance dependency charts: (A) Single event line showing dependency marker; (B) Multiple event lines showing parallel and unique functional Items.

EVENT–An action or an availability of a signal at a point in a circuit. The event may be characterized as motor running, temperature normal, lamps lit, lamps out, instruments indicating, signal or voltage available or not available, relay solenoids or thrusters energized, and so on.

FUNCTIONAL ENTITY–A group of circuit elements that together form a basic functional circuit, such as a filter network, a voltage divider network, an amplifier stage, an oscillator stage, and a flip-flop stage.

CIRCUIT ELEMENT–An individual piece or part for which no further breakdown can be made insofar as fault isolation is concerned. Relay or switch contacts, relay coils, resistors, capacitors, motors, and fuses are examples; printed-circuit boards are not.

DEPENDENCY MARKER–The solid black triangle (▲) is used as a dependency marker. On an event line, it shows that an action or availability of a signal occurring on its line is dependent upon the occurrence of an action or availability of a signal directly above its apex. The signal or action above the dependency marker must be available and within specification for the event on the line of the dependency marker to result, if all the circuits and parts symbolically represented along the line are also performing properly.

A solid black rectangle and white lettering represent a front panel indicator or an event recognizable from outside the cabinetry; an outlined rectangle with black lettering is a circuit point at which measurement might at some time be made. This circuit point may not be readily accessible. Internal test points that are readily accessible will be shown as gray-shaded rectangles.

The dot (·) represents a circuit element or a functional entity. One aspect or state of circuit or component is represented by (·), and relay contacts are shown by (/·) or (·/), for continuity with relay energized or de-energized, respectively.

7.7.1 How to Use the Maintenance Dependency Chart

Assume that in the illustration of a signal event line, figure 7-6, view A, dots (·) represent the basic circuits (oscillator stages, amplifier stages, and soon) or circuit elements (relay contacts, relay cards, and so on) that provide an action LIT at the end of a circuit chain (event line). The solid triangle (▲) is a dependency marker.

The action LIT depends on the availability of a power source at the A block and on the proper operation of each of the circuits or circuit elements (·) represented along the event line. Now, if the lamp that indicates the action fails to light, any item along the event line, as well as the source, A, is a suspect item. Complex interrelated circuits often use some of the same circuits or circuit elements for more than one purpose. Thus, in multiple circuits, where many functional items are common to more than one circuit chain (event line), as shown in figure 7-6, view B, notice that actions (column 24) that occur at the end of these circuit chains are a result of certain common items employed in the parallel generation of the events shown on other circuit lines and some items that are unique to a single line.

Look again at the multiple event line illustration (fig. 7-6, view B) for the purpose of analysis. If the lamp does not light on line 4 but does light on lines 1, 2, 3, and 5, it becomes apparent that the circuits or circuit elements represented by the dots in columns 4 and 18 are the only ones that can be suspected as faulty. All items represented by dots in other columns are proven good because of the proper occurrence of the action LIT on lines 1, 2, 3, and 5.

For each major circuit, consistent with the precise-access blocked diagrams and blocked schematics, there is a corresponding MDC. Troubleshooting is accomplished by analyzing the charts. Faults must lie between the first bad event and the last good event. Acetate coverings for MDCs may be provided, or the charts maybe plasticized, so a grease or carbon pencil can be used for marking out areas that prove good. Marking out all known areas and actions that can be proven good rapidly reveals suspect areas. The use of a pencil to mark out all proven good items is recommended because technicians cannot normally remember all the areas or dependencies that they have proven good.

7.8.0 INDEXING OF RELATED INFORMATION

Indexing is another important feature of the *SIMM.* The *SIMM* method of indexing (fig. 7-7) allows access to any bit of information relative to an assembly in a matter of seconds. The index is organized on the basis of major assemblies and then is broken down to the contained assemblies. Since each of the assemblies is full y treated within a four- or six-page data package, and the organization of details is always consistent, access to the desired kind of detail is almost immediate. The MDC is used to identify the functional entity or circuit element that is suspected, the assembly in which it is contained, and the cabinet containing the assembly. Accordingly, in using the index you need only find the cabinet nomenclature and look to the page number for the contained assembly data package.

EXPLANATION OF CIRCUIT IDENTIFIER CODES

CATEGORY	DEFINITION
C	Composite circuit (one which is subfunctionalized): composite functional entities containing one or more of the functional entities (L, Q, X, N, M) given in this list are preceded by C.
L	Logic circuits.
Q	Circuits containing one or more nonlinear elements which may be either active or passive: functional entities containing transistors are preceded by Q.
X	Circuits containing one or more nonlinear elements which may be either active or passive: functional entities containing semiconductor diodes are preceded by X.
N	Linear networks: functional entities containing several linear components (resistor, capacitors, etc.) arranged in a network or containing a single element used as a network are preceded by N.
M	Circuits containing mechanical devices such as gears, clutches, cams, mechanical stops, etc. are preceded by M.

EQUIPMENT DATA

Figure 7-7.- Functiona1 index and explanation of codes.

7.9.0 ALIGNMENT PROCEDURES

Alignment procedures for each functional section of the set or system, as necessary, are included on as few pages as possible. The method of identifying alignment procedures is the same as for making other identifications from the MDC. The alignment procedures are directly keyed from the signal specifications listed on the MDC. If a particular event shown on the MDC is below specification and correctable by alignment, the step in the alignment chart is easy to find. Each part of the MDC treats a major functional segment of equipment. Likewise, the alignment actions are organized (charted) for each major fictional segment of the equipment. The identification system for the charts is used for the alignment procedure chart. For example, alignments that affect events on the MDC, part 2, will be found on the alignment chart, part 2, and so on. When required, alignment of subassemblies outside the set environment will be contained with the other details of individual assemblies in the data package for the assembly.

7.10.0 PARTS LOCATION AND IDENTIFICATION

Equipment and assembly halftones and line drawings are overlaid with a blue-colored grid on which coordinates are placed to assist in parts location. Associated with the parts-location illustration is a cross-reference table identifying the items by reference designations, their coordinate positions, and significant military-type numbers or manufacture' part numbers.

7.11.0 REPAIR OF MECHANICAL ASSEMBLY

Mechanical assemblies, gear trains, and so on, are illustrated to the extent necessary to assure sufficient data for repair. When assemblies are illustrated in exploded form, index numbers are cross-referenced to contractors' drawing numbers or to contractors' vendors' part numbers. Subassemblies, such as synchro motors, that frequently are identified by non-readily translatable military-type numbers also include sufficient meaningful data for ordering purposes. When complex assembly and disassembly procedures are involved but not obvious, detailed procedures are given. Exploded views on the same or facing pages will describe and illustrate these procedures.

7.12.0 IMPROVEMENTS

Compared to the already described *SIMM*, newer editions of the manual will show improvements in method of presentation, use of MDC, and size.

Instead of the blocked text, the improved manuals use a keyed text method of presentation in which the text material is arranged in tabular format and keyed to the diagram by circled numbers, as shown by figure 7-8.

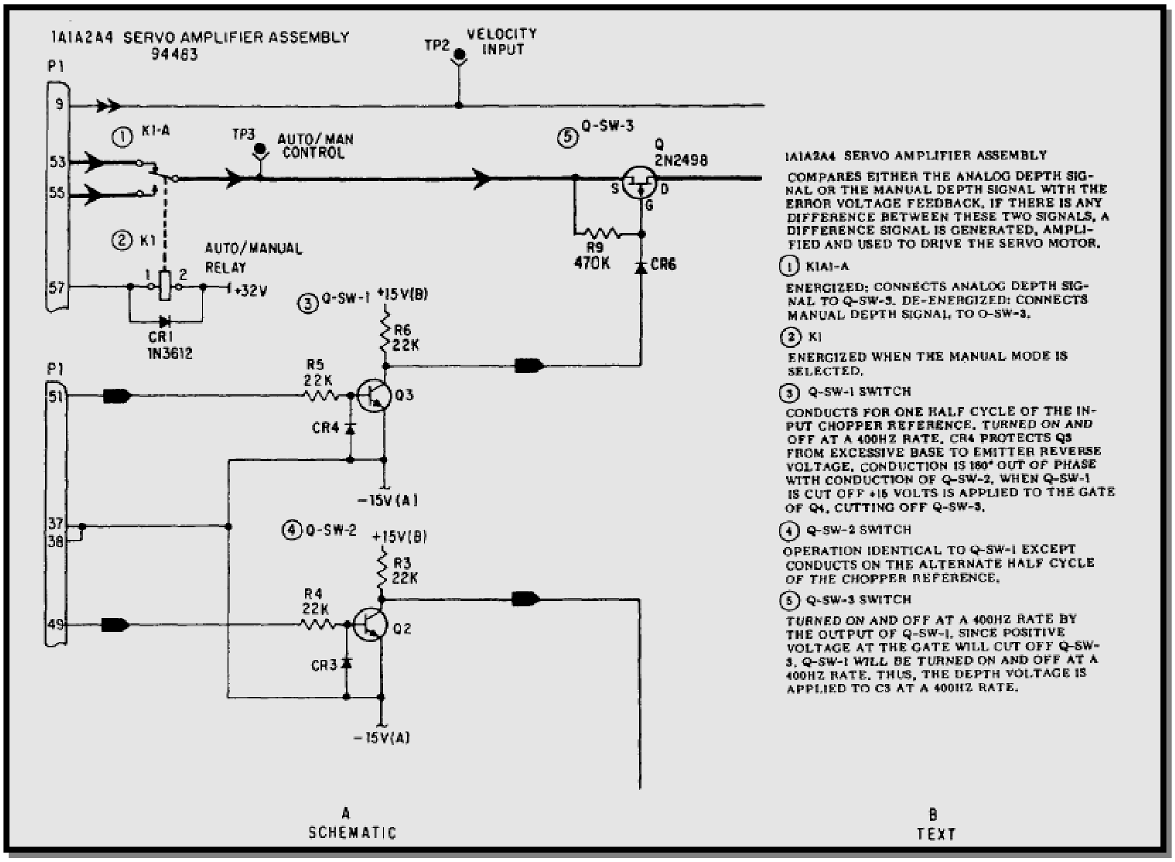

Figure 7-8.- SIMM keyed text.

This method permits significantly more text material to be presented than the blocked text method. Besides being used with the schematic diagrams, the keyed text is also used with the precise-access block diagrams (called functional block diagrams) and the overall block diagrams (called the function description diagrams).

Instead of only one MDC for each major function, newer manuals will have additional MDCs for the functional block and schematic diagrams. The MDCs also will be provided with an acetate or Mylar overlay so troubleshooters can use grease pencils to mark their progress. The size of the new *SIMM* will be 11 by 27 inches, instead of 15 by 35 inches. This new size gives it a folded dimension of 9 by 11 inches, the same size as conventional manuals.