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British Standard

Engineering diagram drawing practice

Part 2. Recommendations for electrotechnology diagrams

Dessins techniques — Schémas

Partie 2. Recommandations relatives aux schémas électrotechniques

Technische Zeichnungen, Schaltbilder und Diagramme

Teil 2. Schaltbilder für die Elektrotechnik

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Foreword

This Part of BS 5070 has been prepared under the direction of the General Mechanical Engineering Standards Committee and, together with Parts 1 and 3*, supersedes BS 5070 : 1974 which is now withdrawn. The 1974 edition set out recommendations for drawing practice to be followed in preparing engineering diagrams in all fields of engineering with a view to securing uniformity between one drawing office and another in the same industry. It also aimed to increase uniformity between one field of engineering and another in the basic principles involved and in the designations for different types of diagram.

Attention is drawn to BS 5070 being a companion standard to BS 308; the latter covers engineering drawing practice used in a wide range of engineering disciplines. Commonly, as a diagram can be called a 'drawing' and a drawing can be called a 'diagram', it is useful to summarize the difference in the scopes of these standards. BS 308 covers what are commonly accepted to be drawings that define shape, size and form. BS 5070 covers the drawing of diagrams that are normally associated with flow of one sort or another and which relate components (usually indicated by symbols) functionally one to another by the use of lines, but do not depict their shape, size or form; neither do they in general indicate physical connections or locations.

From experience with the 1974 edition it was decided that for this first revision, whilst bearing in mind the long term aim of uniformity of conventions, there was a need for more comprehensive treatment of the varying requirements of differing industries and for more careful attention to their presentation. BS 5070 is therefore now revised in Parts by which the practice and conventions of several disciplines and industries are collected into three groups. Part 1 covers general principles common to all subsequent Parts, which in turn deal particularly with electrotechnology; control, flow and systems; and logic.

This standard gives recommendations for the drawing of engineering diagrams using the symbols given in relevant British Standards. It does not itself originate symbols. The diagrams in this standard contain symbols as they

appear in the particular standards current at the time this publication was prepared. However, although every effort has been made to ensure that correct and current symbols have been used, it has to be recognized that the particular symbols standards are themselves subject to periodic review. It is therefore stressed that the relevant symbols standards, and not this standard, have to be consulted to obtain definitive symbols.

The recommendations of this standard have been established having regard to the requirements of microfilming. Diagrams prepared in accordance with this standard should be suitable for microfilming and reduced-size reproduction techniques.

During the course of this revision particular attention has been paid to developments in computer aided machine draughting and it has been established that such machines are currently capable of complying with this standard. Any minor exceptions due to the limitations of a particular system would not be expected to prejudice the understanding of a diagram otherwise claimed to comply with this standard.

It is recognized that though this standard is published in a number of Parts, there may be instances when certain recommendations and descriptions are repeated. This has been kept to a minimum and it is hoped that all the needs of any specialized engineering discipline are contained in the Part of this standard that deals with those specific needs.

This Part of this standard deals with all forms of diagrams in electrical, electronics and telecommunications engineering.

Part 1 of this standard deals with general principles of diagram drawing and is the base document from which the other Parts are developed. Part 3 of this standard deals with a variety of non-electrical diagrams including those concerned with control and flow; transfer of materials (both solids and fluids, i.e. liquids, vapours and gases); and energy transfer (hydraulic, pneumatic and mechanical). Part 4 of this standard deals with logic diagrams.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

*An additional Part 4 is also in preparation.

Notes on the presentation of this standard

NOTE 1. The figures illustrating the text in this standard are independent and each is selected solely for its simplicity and clarity to illustrate only the text to which it relates. They are not the only possible examples and they are not intended as design examples or to be full working diagrams, but otherwise are drawn according to the basic recommendations of this standard.

NOTE 2. Numerical values of components given in the figures throughout are arbitrarily chosen to assist in illustrating the point under consideration; they are typical and are not given as recommendations.

NOTE 3. In the figures in this standard, a convention is adopted of using capital letters for notes that would appear as part of the drawing and lower case letters are used for notes explaining the point under consideration in relation to the text. An exception to this may be found in some diagrams where unit symbols are customarily written in lower case.

Recommendations

1 Scope

This Part of BS 5070 gives recommendations for the practice to be followed in preparing electrical and electronics diagrams. It covers all aspects of diagram presentation except the choice of symbols for particular components; this is the subject of BS 3939.

Appendix A gives details of component identification references and appendix B gives examples of the types of diagram described in this Part of this standard.

This Part of this standard should always be used in conjunction with BS 3939 and BS 5070 : Part 1.

NOTE 1. The relevant Part of BS 5775 should be complied with for the correct application of units and symbols for quantities.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 5070 the following definitions apply.

2.1 circuit element. The smallest division of a component that can be individually referenced on a diagram, e.g. the individual contacts or coil of a relay; the logic gate within an integrated circuit package.

2.2 component. The smallest assembly of circuit elements that cannot physically be divided, e.g. a relay containing contacts and coil or an integrated circuit package that contains several gates.

2.3 data highway. A group of signals operating according to a predetermined protocol.

2.4 line. A graphic convention showing how devices (represented by symbols) are connected. A variety of types of line, some with embellishments, are used to represent connections having different functions (see table 1).

2.5 symbol. A symbolic graphic convention representing a discrete manufactured device contributing to the function of a system or circuit (see appendix A).

3 Principal types of diagram

The following list of the main classifications of diagrams used in electrotechnology has been prepared in order to reduce ambiguity and to achieve standardization in terminology.

- (a) Block diagram.
- (b) Circuit diagram.
- (c) Wiring or connection diagram.
- (d) Interconnection diagram.
- (e) Supplementary diagram.

Various organizations use different names for various types of diagrams, but careful analysis will show that these can be classified under one of the types listed in (a) to (e) or combinations of these types.

The diagram types are considered in detail together with recommendations for their production, in clauses 5 to 9.

Where a number of diagrams are to be prepared covering a complete system it is recommended that a hierarchical system be adopted where the highest level diagram is a relatively simple block diagram defining the base system concept, and subsequent diagrams expand this information progressively until the series of diagrams at the lowest level show detailed circuit information, i.e. circuit diagrams or wiring diagrams.

The diagrams at the top of the structure are generally referred to as 'high level' diagrams whereas those at the base are termed 'low level' diagrams.

The number of levels of diagrams contained within the structure is a function of system complexity. Simple systems would generally not comprise more than three levels, but complex systems might require twice this number of levels or more. Parts of a hierarchical system of diagrams are illustrated in appendix B (see figure 39).

Each type of diagram has a particular function, e.g. a circuit diagram ignores physical considerations and emphasizes electrical function (see 6.1) whereas a wiring diagram emphasizes connection details without necessarily considering electrical flow. It is important to decide the job that the diagram is intended to perform before it is drawn.

4 Principles of presentation

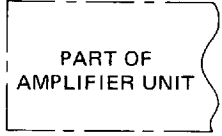
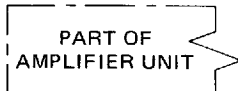
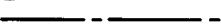
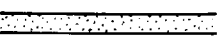
4.1 Types of lines and their application

4.1.1 General. Table 1 shows typical applications of different line types.

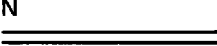
4.1.2 Junctions and cross-overs of lines. No more than two conducting paths should be shown to come to a point thus forming a junction, i.e. point of equal potential. Junctions of more than two conductors have always to be shown staggered as in figure 1(a). Conductors that cross each other and connect at the cross-over should be similarly staggered. It is essential that they are not shown as in figure 1(b) except where the branches fan out from a point on a main conductor as shown in figure 1(c). A bold dot should be placed at the junction. It is however permissible to omit the dot but its use or non-use has to be consistent on any set of diagrams. Conductors that cross without joining should do so at right angles and without change of direction at the point of crossing (see figure 1(d)). Looping and breaking one line as shown in figure 1(e) is deprecated.

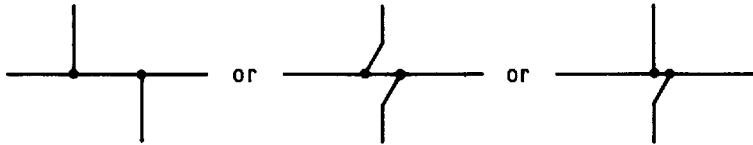
Terminations are shown by open circles at the end of a line, e.g. as in figure 30.

Table 1. Types of line

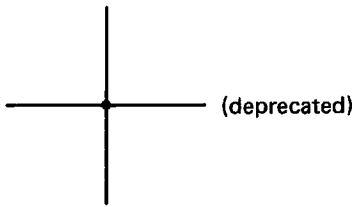
Line*	Description	Application
A 	Continuous double width	Where slight emphasis over a single width line is required, e.g. outline of some components or symbols
B 	Continuous single width	Main contents of a diagram connecting lines, symbols, etc.
C 	Continuous thin irregular	Used to indicate that a physical boundary is only partially shown, e.g.  See also type D line
D 	Continuous thin straight with zig-zags	Used to indicate that a physical boundary is only partially shown, e.g.  See also type C line
F 	Short dashed	Screening, planned extension or mechanical linkage. May be emphasized by thickening to double or quadruple width. See also type N line
G 	Chain	Boundaries (functional or physical). See 4.3
K 	Chain double dashed	Secondary boundaries. See 4.3
L 	Continuous quadruple width	Where considerable emphasis over a single or double width line is required, e.g. common (e.g. 0 V) lines or where emphasis of a signal path or heavy current conductor is required.
M 	Toned broad lines	Data highways. NOTE. It is recommended that shading, toning or hatching is used to emphasize that this is one line and not two parallel conductors.

*These line designations correspond to those given in BS 308 : Part 1 where appropriate.

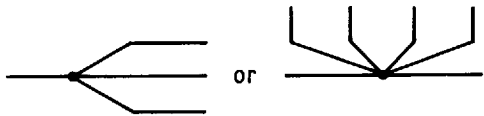
Table 1. (concluded)		
Line*	Description	Application
N 	Double continuous	Mechanical linkage. See also type F line
P 	Chequered	Rotating or reciprocating shafts. See BS 3238 for details of proportions and qualifying arrows for rotation and reciprocation
*These line designations correspond to those given in BS 308 : Part 1 where appropriate.		



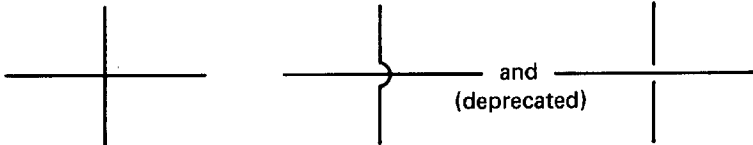
(a)



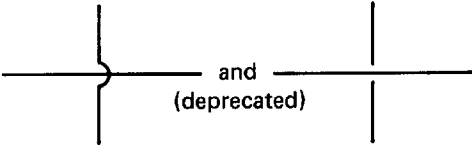
(b)



(c)



(d)



(e)

Figure 1. Junctions and cross-overs

Where data highways cross, it is recommended that they should do so as shown in figures 2(a) and (b). This is because if they crossed in the manner of figure 2(c), a symmetrical box is formed at the cross-over which draws the eye and may cause confusion.

4.1.3 Simplification by the omission of lines. BS 3939 : Part 3 depicts the symbols representing groups of lines as one single line. The techniques described in this subclause are extensions of the principle of simplified representation to avoid a multiplicity of long parallel lines across a diagram. Figure 3 illustrates a method where most of the length of the lines is omitted and the connections are indicated by suitable references at each end. Figure 4 shows a variation of this method where the lines are depicted by a single line. This single line may be emphasized by drawing it thicker if required. In both these examples, it is essential to ensure correct interconnections by unambiguously identifying the terminating points.

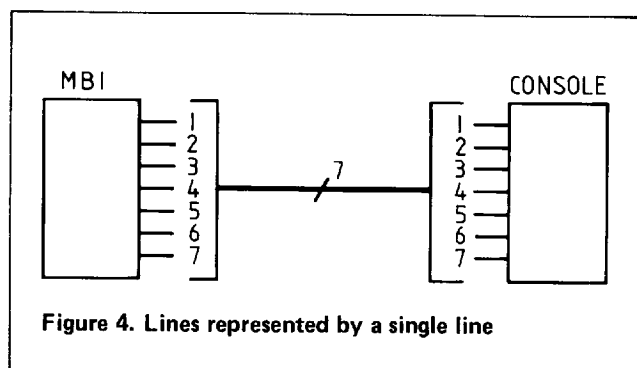
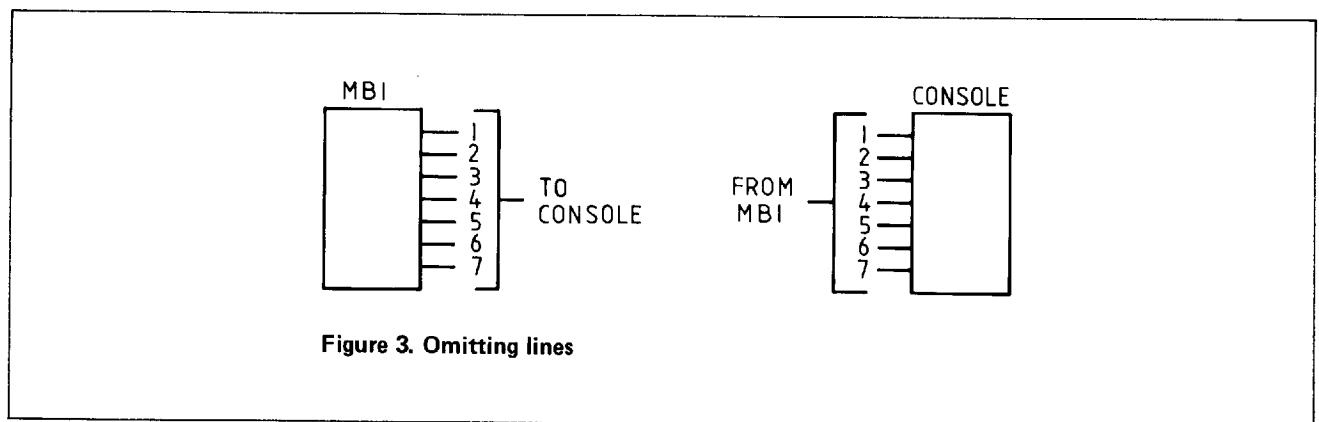
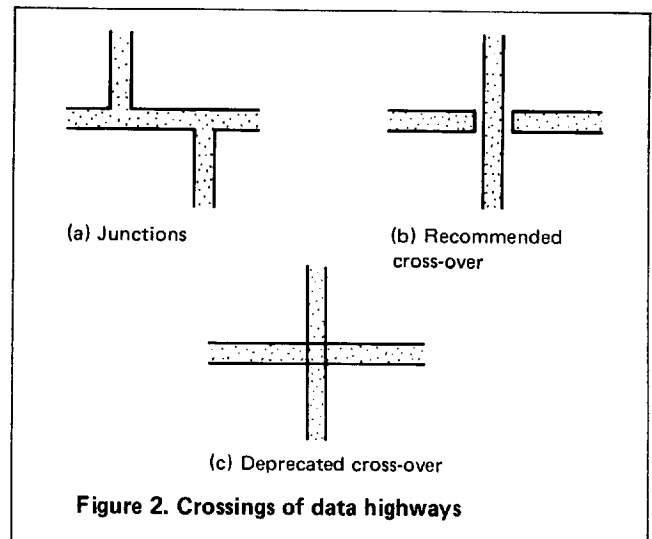


Figure 5 illustrates the use of a diagrammatic loom. The loom should be emphasized by being thicker than other lines. The loom can be drawn threading through the diagram with lines entering or leaving it, suitably annotated, as required. Angles or arcs of circles may be used to clarify the routing by drawing the arcs or angles in the direction of entering or leaving the loom as shown in figure 5. Note that

this convention does not necessarily depict an actual cable loom; unless stated, it is purely a diagrammatic or symbolic loom.

Figure 6 shows a similar method to that shown in figure 5, but in this case the loom or data highway usually depicts a group of lines belonging to a clearly defined set of data, e.g. 16 bits of digital information. Hence the method shown in figure 6 would be usually seen on a digital circuit diagram but figure 5 would more normally be seen on a wiring diagram.

Figure 7 illustrates a method of omitting a single line and placing opposing arrowheads at the short ends of the line with a reference. The grid reference of the opposite arrow may be added as an aid and location if required. The arrows should be drawn pointing directly at each other to draw the eye in the direction of the opposite arrow.

NOTE. The method used to identify the lines in figures 3 to 5 is arbitrary. In practice, the actual identification will vary according to the type of diagram, e.g. actual termination codes, wire colours or signal names may be used.

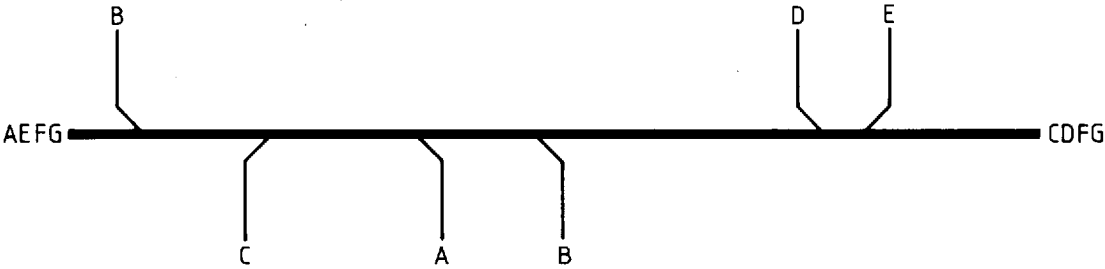


Figure 5. Wires shown in a diagrammatic loom

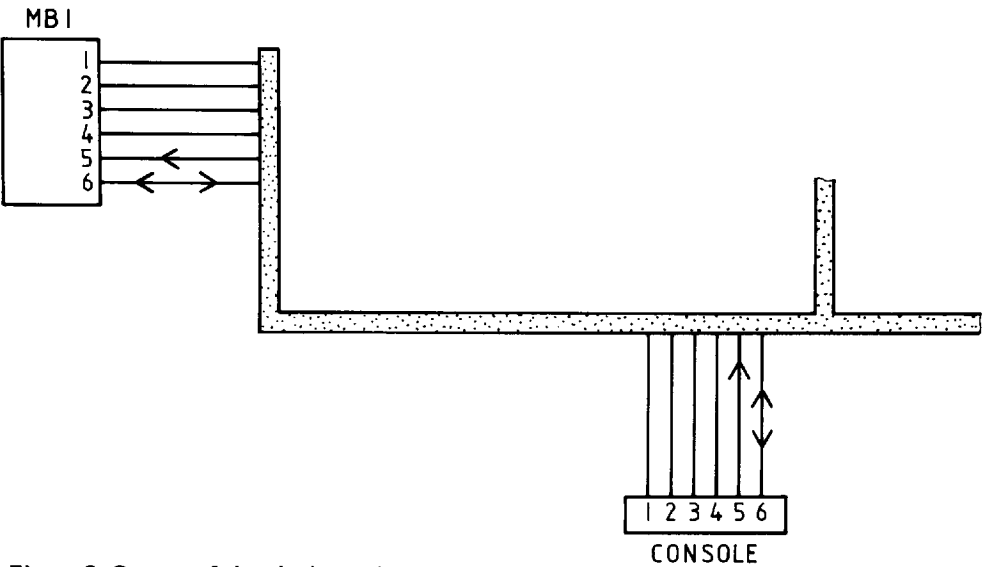


Figure 6. Groups of signals shown in a data highway

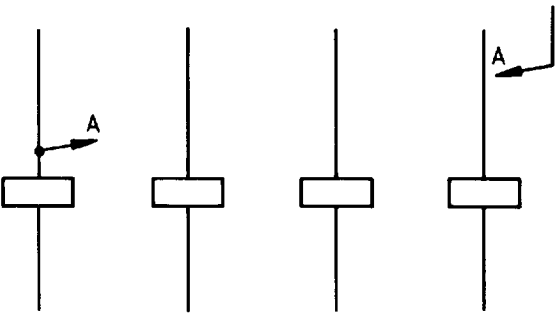
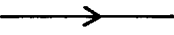
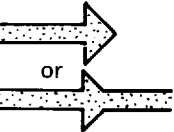


Figure 7. Omitting a single line

Table 2. Applications of arrows

Arrow	Description	Application
	Closed, filled or unfilled	Used at the ends of lines as a pointer. Should not be shown in the middle of a line
	Open	Signal or data flow paths. Can be used in the middle of a line, or at the end
	Broad	Data highways. Can be used in the middle of a line, or at the end

NOTE 1. Included angles for arrowheads are given in Part 1.
NOTE 2. Conventional data flow is from left to right and/or top to bottom and arrows are not usually required when this convention is followed.

4.1.4 Arrows. The particular uses of arrows are shown in table 2.

4.2 Component values and references

4.2.1 Prefixes for multiples and submultiples. Multiples and submultiples and their symbols are given in BS 5775.

4.2.2 Conventional indication. Nominal values should normally be indicated as follows:

(a) *Resistance.* Values are shown less the Ω unit symbol as:

Up to 999 ohms	e.g. 47
1 to 999 kilo-ohms	e.g. 22 k
1 to 999 mega-ohms	e.g. 3.3 M
1 giga-ohm and upwards	e.g. 1.5 G

(b) *Capacitance.* Values in the smaller ranges are shown less the F unit symbol as:

Up to 999 picofarads	e.g. 47 p
1 to 999 nanofarads	e.g. 100 n

Values of 1 to 999 microfarads are shown without any unit symbol.

Values of 1 farad and upwards are shown with the F unit symbol, e.g. 20 F.

(c) *Inductance.* Values in the smaller ranges are shown less the H unit symbol as:

Up to 999 microhenrys	e.g. 27 μ
1 to 999 millihenrys	e.g. 85 m

Values of 1 henry and upwards are shown without any unit symbol.

(d) *Duration.* Time values are given in seconds and are shown in the conventional manner, with multiple and submultiple prefixes to the unit symbol (s), as given in BS 5775.

(e) *Frequency.* Values are given in hertz and are shown in the conventional manner, with multiple and submultiple prefixes to the unit symbol (Hz), as given in BS 5775.

NOTE. Contrasting with the foregoing customary conventions for diagrams, actual components may have their values marked using a variation which dispenses with the decimal marker. In that system, e.g. 2.2 k Ω is marked as 2k2, 0.59 pF is marked as p59, 2.5 mH is marked as 2m5. In either system the identity of any components appearing to have similar values will be obvious from the graphical symbol and the appearance of the component.

4.2.3 Component references. General identifying references for components of a similar type are given in appendix A. By way of example, the general component reference for a resistor is R and that for an integrated circuit is IC.

Specific component references refer to a particular component and therefore should be unique in any system. Suggestions for building up a specific component reference, for say a relay, are:

- identify the general component reference, in this case it would be RL;
- choose a qualifying reference that would be helpful in suggesting the function of a relay, e.g. the relay associated with the 'door open' function could be RLDO; or
- simply choose a numeric or alphabetic qualifying reference, e.g. RL1 or RLA. There are advantages in

choosing numerical references because alphabetic codes are limited to 26 unless the range is extended by using AA, AB, etc.

If numerical codes are used, supplementary alphabetic codes can be added to indicate slave relays or relays added at a later date, i.e. in a system using RL1, RL2, etc.; if a slave relay is used in parallel with RL1, the new relay can be called RL1A. Alternatively parallel relays can be RL1a and RL1b.

If the system consists of several units and the numerical references start from one in each unit, there will be more than one RL1 in the system. In this case the reference has to be prefixed by its unit code; this serves to provide a unique code and aids location of the component, e.g. CU1-RL1 for RL1 in Control Unit 1 (CU1).

The code may be broken down into groups by using a hyphen (CU1-RL1), a stroke (CU1/RL1), or, if no confusion is likely to arise, the code need not be broken (CU1RL1).

NOTE 1. The position of the hyphen should be chosen to break the code at a meaningful point, e.g. a relay contact would normally be broken thus:

RL1-1 and not RL-1-1

The system may consist of several groups of units distributed in a variety of locations in which case the reference can be extended to suit, e.g. R14-CU1-RL1 would be the component reference for RL1 in control unit 1 housed in rack 14. Extensions are virtually infinite, e.g. S3-B44-RM6-R14-CU1-RL1 could be the specific component reference for RL1 in control unit 1 in rack 14 in room 6 in building 44 on site 3. The coding for such references should be clearly defined for any system and if necessary a key should be shown.

Note that the full component reference need not be referred to every time, i.e. the component references on a diagram of a unit need only use that part of the code that is necessary, e.g. RL1 need not be referred to as R14-CU1-RL1 on the wiring diagram of CU1 but merely RL1.

Figure 8 shows an example of a key that defines location codes of a system consisting of a basic unit, 12, that is divided into specific areas, e.g. 12A-8A5-RL1 refers to RL1 on the board in position 5 in unit A which is in location 8 in rack A.

Where a component consists of several circuit elements, these have to be identified by a more detailed breakdown of the component reference, e.g. an integrated circuit may have the component reference IC1 but may consist of four separate logic gates. It is recommended that the gates are specified as IC1a, IC1b, IC1c and IC1d where gate 'a' is the gate using the lowest numbered package pins and gate 'd' is the gate using the highest numbered package pins. Multiple resistors and transistors contained within packages can be specified in a similar manner, i.e. RP17a, RP17b and TR6a and TR6b.

NOTE 2. Upper case characters may be used instead of lower case if required. If it is required to accentuate lower case characters, these may be underlined.

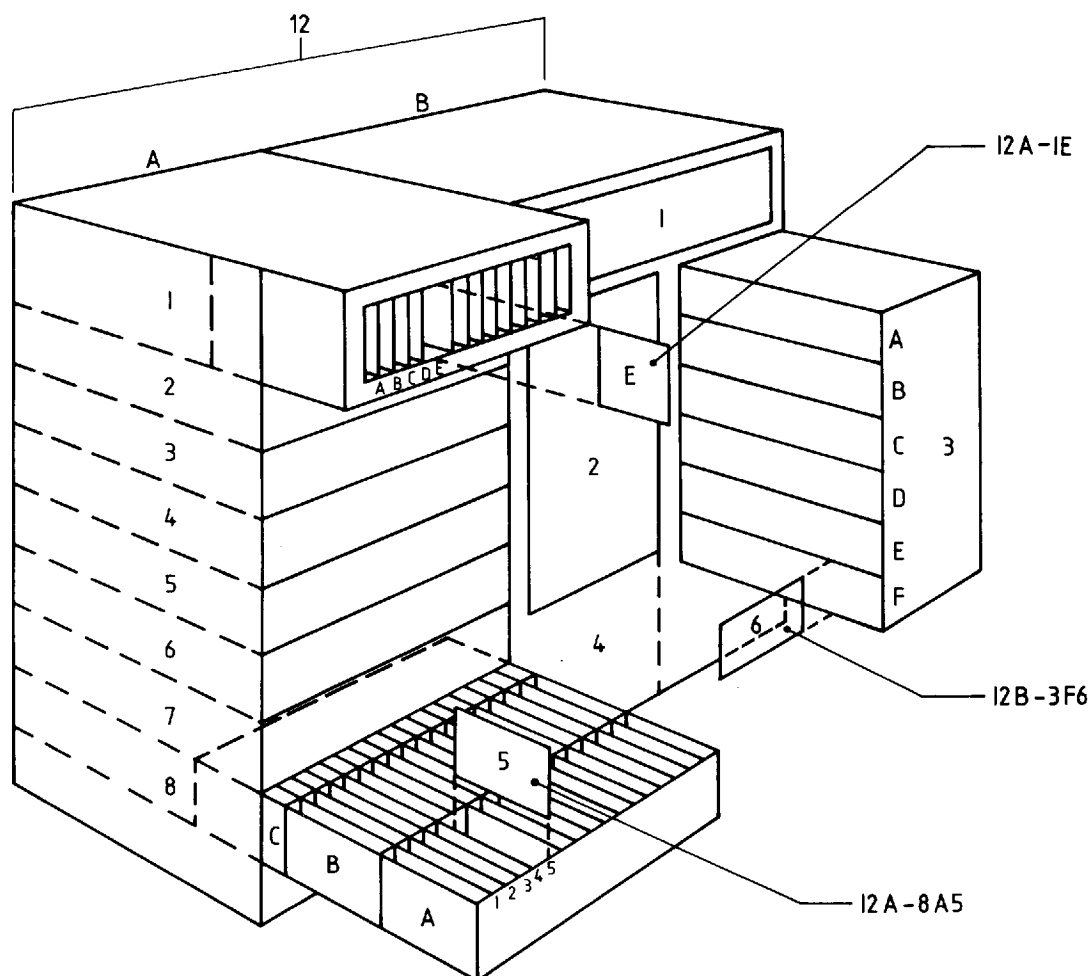


Figure 8. Key defining location codes

Relays are components that consist of a number of circuit elements that are typically a coil and a number of contact sets. (For these purposes a contact set is defined as a group of contacts that perform the action of a switch.)

The recommended method for specifying the coil is by a fraction with the component reference of the relay shown as the numerator and the number of contact sets or switches as the denominator, e.g. RL1/3 would be the coil of RL1 which controlled three contact sets. The individual contact sets would be referred to as RL1-1, RL1-2, etc.

The connecting terminals, tags or pins of components are referred to by extending the component reference with a stroke or a hyphen. Thus the third terminal on terminal block 5 would be written TB5-3 or TB5/3 and pin A on plug three would be PL3-A or PL3/A.

NOTE 3. Care should be taken when referring to pins of relays because the hyphen is used to prefix the contact number. To avoid confusion a hyphen should be used for a relay contact and a stroke should be used for relay terminals, e.g. RL1-3 is contact set 3 on relay RL1 and RL1/3 is pin 3 on relay RL1.

4.3 Boundary frames

When it is desirable in a diagram to show that part of it represents a functional unit, constructional unit, section, subsection, etc. (e.g. group of apparatus, relay set), this can be done by a type G or type K chain line (see table 1). The boundary frame may have an irregular shape in order to maintain a regular presentation of the diagram (see figure 9).

Boundary frame lines should not intersect with component symbols except for terminals which may be placed either directly on the boundary frame line, just inside the unit, or omitted (see figure 9).

When a unit is indicated by a boundary frame, the internal circuitry may be represented in a simplified form provided a reference to a more detailed description is given. Methods of indicating connections are shown in figure 10.

A case may occur in which a diagram within a boundary frame representing a unit contains symbols for parts which do not belong to that unit. Such symbols should be shown within a boundary frame type K line (see table 1) with the addition of a designation or note. This is shown in figure 11 where the primary boundary frame line surrounds a unit Q6 consisting of a contactor, thermal relay and fuses. Switches S1 and S2 are functionally related items but are not located in unit Q6.

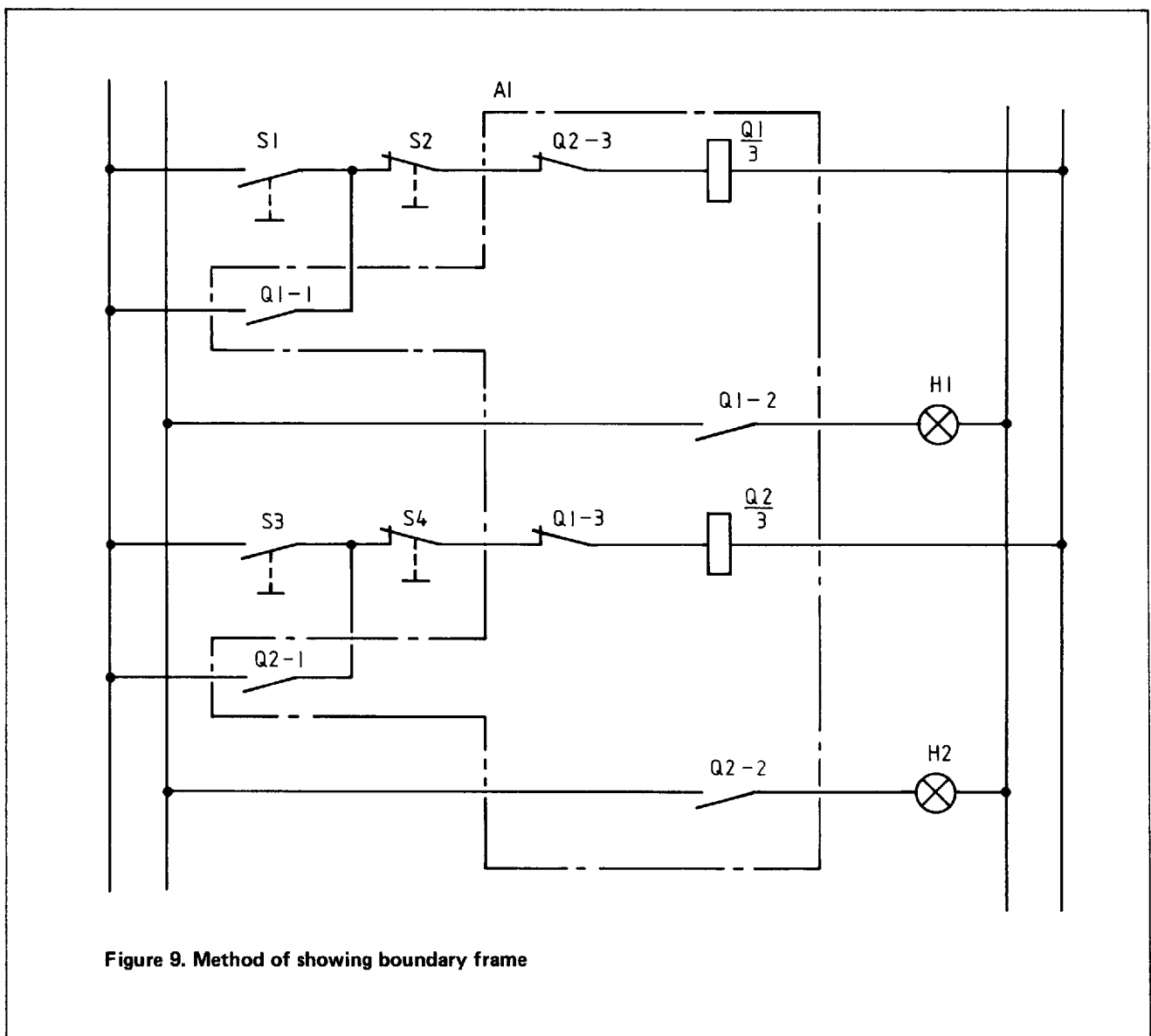


Figure 9. Method of showing boundary frame

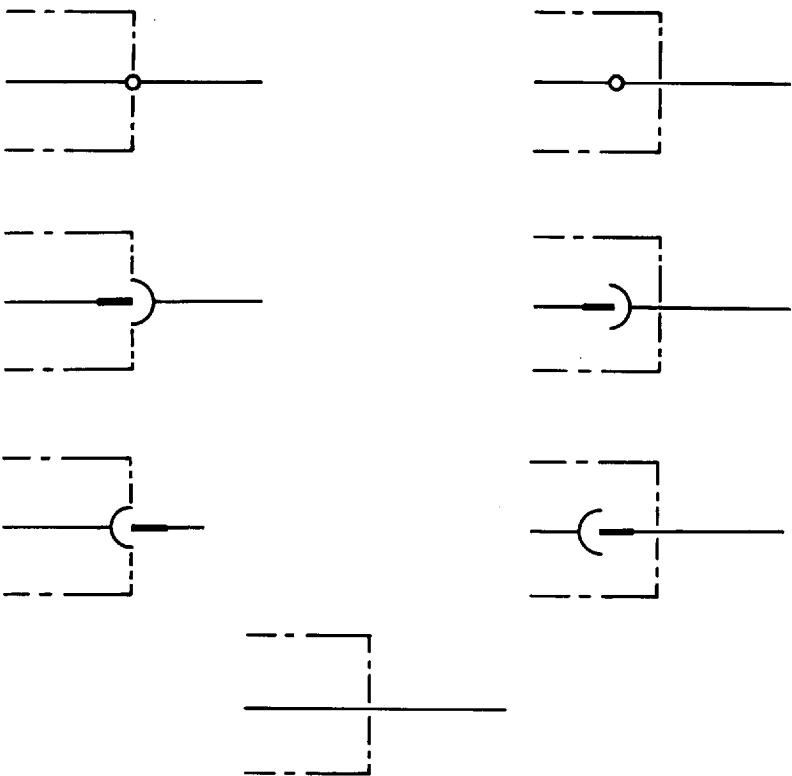


Figure 10. Methods of crossing boundary frames with or without connections

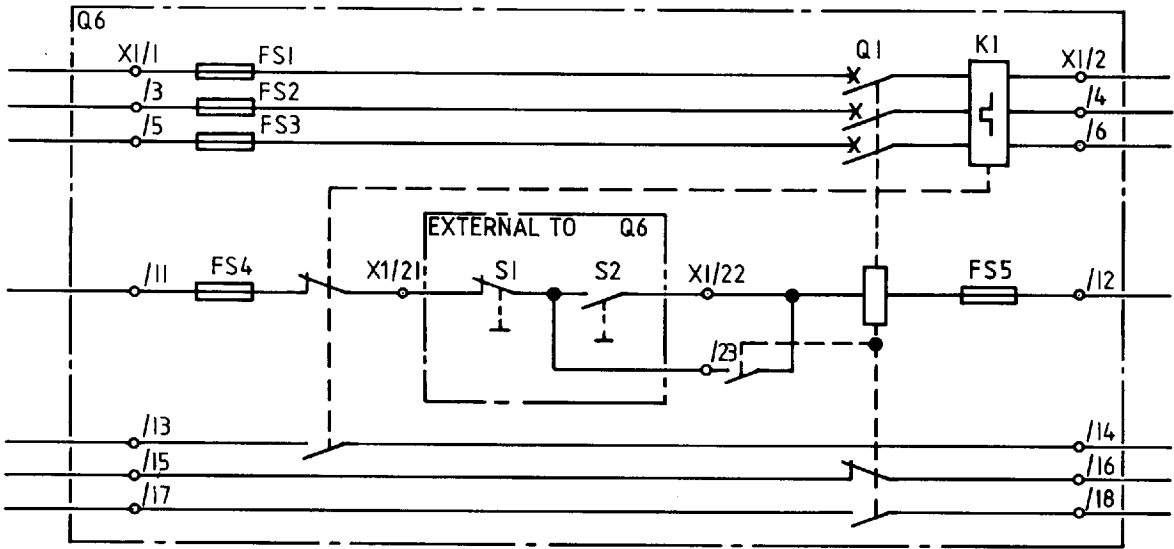


Figure 11. Boundary frame with ancillary components

5 Block diagram

5.1 General

A block diagram is a relatively simple diagram in which an installation or equipment, together with its functional interrelationships, is represented by block symbols, symbols or block outlines with annotations, without necessarily showing all the connections.

Its purpose is to show the essentials of an installation or equipment in sufficient detail to satisfy the purpose for which the diagram is intended. For example, a diagram intended to explain the basic overall concept of a system will generally comprise a relatively simple diagram with block outlines representing hardware items or functional concepts with appropriate interconnecting lines between blocks, whereas a block diagram intended for use as a diagnostic tool would require a greater depth of detail and would include indications of test points, interface connections, voltage levels, simple waveform parameters, etc.

It is therefore essential to consider the purpose of the diagram at an early stage to avoid over-elaboration or undue simplification.

In complex systems, it is often desirable to prepare a hierarchy of block diagrams whereby the user is guided through simple basic concepts down to detailed information suitable for fault diagnosis purposes.

5.2 Presentation

5.2.1 Block outlines. Block outlines are normally simple geometric shapes, e.g. square, rectangular, triangular or circular. The proportions will be chosen to accommodate the connections needed.

The actual drawn size is dependent on many factors, such as annotations or symbols that may be required inside the outline.

The block outline should be drawn using a continuous thick line.

5.2.2 Contents within a block outline. The appropriate function symbol should be selected from BS 3939. When selecting it is important to remember that the symbol represents a function and *not* the means used to achieve that function. For example, a monostable circuit may be

used to perform the function of a pulse generator and would be shown as in figure 12(a).

Where no suitable functional symbol exists, an empty block outline may be used with a description written inside the block. If space does not allow this method the description may be placed adjacent to the outline.

Where several block symbols represent features contained within a unit or equipment, it is recommended that the unit outline is indicated by a chain line, as in figure 12(b).

5.2.3 Connecting lines. Connecting lines between block outlines should be drawn using a continuous line. Where it is necessary to emphasize a particular connection, a thicker line may be used (see 4.1).

5.2.4 Supplementary information. Depending on the purpose of a block diagram, supplementary information may be added, e.g. as follows.

- (a) Origins and destinations of input and output signals. (It should be noted that, by definition, inputs are 'from' and outputs 'to' on diagrams dealing with functional flow.)
- (b) Signals, names or descriptions written along inter-connecting lines.
- (c) Test points and connections where the circuit may be readily disconnected and/or monitored.
- (d) Voltage levels or simple waveforms indicated at accessible interface connection or test points.
- (e) Controls used to modify the shape of signals may be indicated at the appropriate point on the block diagram, the circuit reference of the control and its panel marking (if available) should be included (see figure 13).

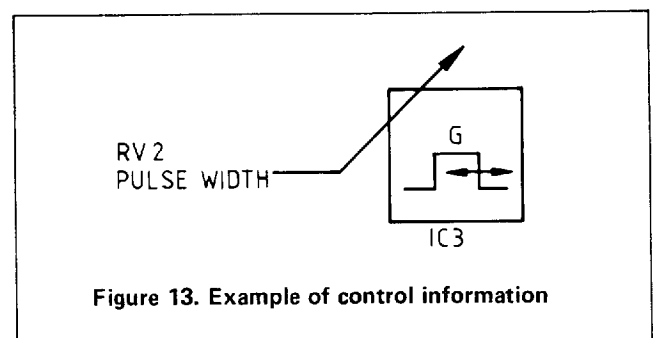


Figure 13. Example of control information

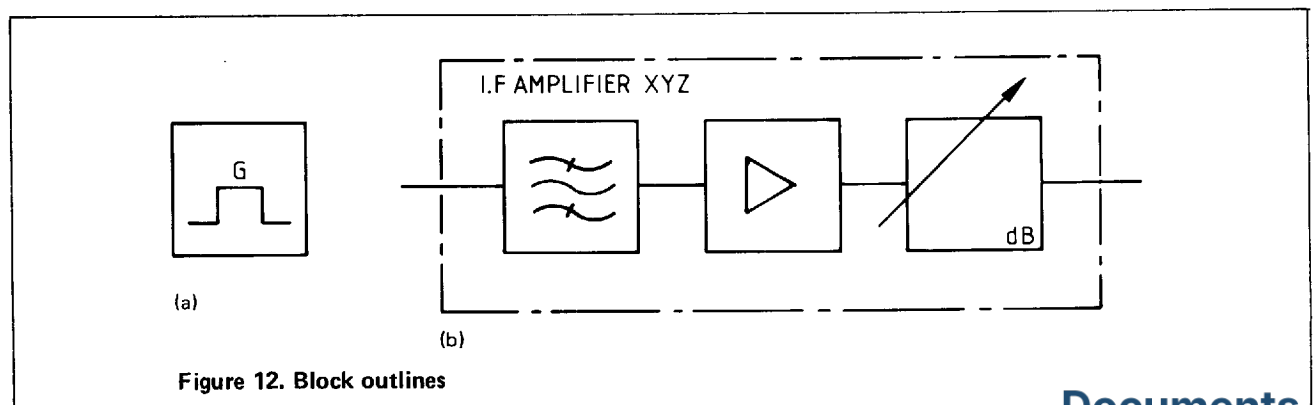


Figure 12. Block outlines

6 Circuit diagram

6.1 General

A circuit diagram shows in full the function of a circuit, depicting all its essential parts and connections by means of graphical symbols. Its arrangement should show the operation as clearly as possible without regard to the physical layout of the various items, parts or connections.

Its purpose is to facilitate the understanding of the circuit and to enable the analysis and calculation of circuit characteristics.

6.2 Presentation

6.2.1 Layout. Circuit diagrams should be drawn so that the sequence from cause to effect is shown from left to right and/or from top to bottom. Where this is impracticable, the sequence should be shown by arrows, either at the end of the line or in the line.

Circuits should be arranged in functional or operational groups.

Lines representing conductors should be straight with a minimum number of cross-overs and changes of direction.

6.2.2 Connections. The connections on a circuit diagram should be shown without regard to actual termination points, unless the connection is important to the operation of the circuit.

NOTE. It is this feature that distinguishes a circuit diagram from a wiring diagram. The difference is shown in figure 14.

6.2.3 Detached representation. Some components comprise a number of circuit elements which have functions relating to different parts of the circuit, e.g. a relay consisting of a coil and a number of contacts or an integrated circuit containing a group of logic gates. Such components are best depicted using detached representation. In this method circuit elements are shown detached from each other and placed on the diagram where their function dictates without regard to their physical relationship. The opposite (attached representation) is not recommended on circuit diagrams because it increases the length of connecting lines and the number of cross-overs.

In detached representation, the separated circuit elements have to be related to each other. In most cases the reference of the circuit elements relates them by means of the main component reference (see 4.2.3), for example contact RL1-3 is a contact set controlled by the coil of RL1 which has reference RL1/4.

Similarly, logic gates IC7-2 and IC7-4 are both circuit elements contained in component IC7. However, there is often the need to have an aid to finding the location of the circuit elements when they are distributed around a large diagram or even among more than one diagram. The following are some suggested methods of doing this.

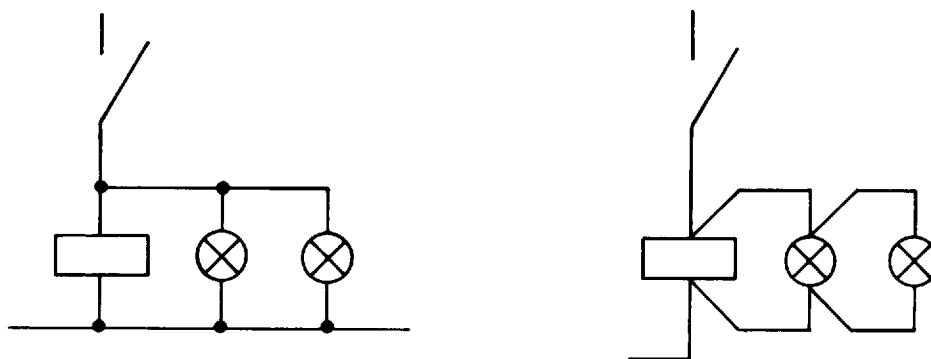
(a) For relays, a subsidiary diagram of the contacts is drawn below the coil. The grid reference of the position of these contacts is shown on this diagram. Similarly the grid reference of the coil is shown adjacent to each contact in the body of the main diagram.

(b) For relays, a schedule is prepared that lists all the relays and indicates the location of the coils and all contacts. This method can cover large systems where there are many different diagrams, both wiring diagrams and circuit diagrams, and can show the unit in which a relay is physically mounted and where the coil and contacts are shown on the various circuit diagrams. This schedule is best shown as a separate diagram.

(c) For logic gates housed in integrated circuits, an integrated circuit list (as described in 6.2.9) can be used to list the grid references of the positions of the various gates distributed around the diagram.

In some simple circuits it may be desirable to indicate related parts of a symbol by means of a dotted line (indicating mechanical linkage); this is permissible only if the clarity of the function is not impaired. In all other cases the detached representation, suitably cross referenced, should be used.

When the mechanical linkage symbol is used, all symbols operated by the linkage should have the same direction of movement (see figure 15).



(a) Correct

(b) Incorrect

Figure 14. Circuit diagram connections

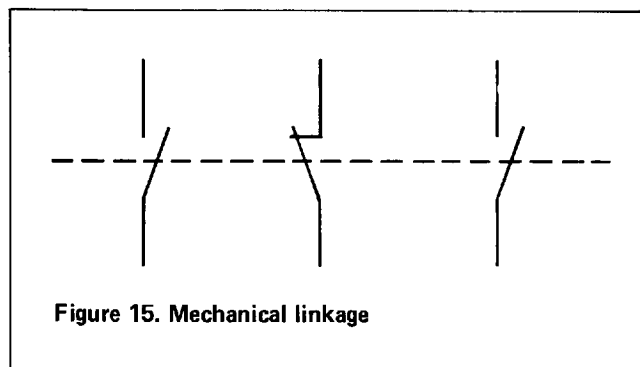


Figure 15. Mechanical linkage

6.2.4 Component location. The physical location of components would normally be found by reference to assembly drawings or by using a component reference that included the location code as described in 4.2.3. However this does not aid location of a component on that diagram and a circuit component location grid should be used. An example is shown in appendix B (see figure 45) where a horizontal table is drawn at the top of the diagram which contains the component references written vertically above their position on the diagram.

6.2.5 Component reference allocation. Subclause 4.2.3 describes how component references are constructed whereas this subclause defines how the component references are allocated on the diagram. Where component references are chosen so that they run sequentially on the actual equipment, e.g. integrated circuits on a printed circuit board or relays in a chassis, they are easier to locate if they are mounted with their component references running sequentially. If this procedure is adopted it is unlikely that the component references will appear sequentially across the diagram. However, if the allocation of component references is not dictated by this or other considerations, they can be allocated so that they run sequentially on the diagram.

With this method, the references should be in vertical sweeps that progress from left to right across the diagram as in figure 16(a). Where a circuit has clear functional groups, the sweep should be grouped as in figure 16(b).

Where component references are allocated in this way but some have to be given references that are out of sequence,

they have to be listed in a table drawn horizontally across the top of the drawing. The component reference that is out of sequence should be written in this table vertically above the component.

6.2.6 Condition of contacts. Circuit diagrams should present the circuit of an apparatus in its unoperated, no-current condition, i.e. no supplies connected. Where it is essential to depart from this principle, attention is drawn to this fact by a note on the diagram. Similarly, a note on the diagram should clearly indicate the state of the apparatus if it is possible that it may rest in two or more stable states, e.g. an aircraft system may require a note if it is shown in the 'on the ground condition'. Devices for emergency, standby, alarm, etc. should be shown in the positions they occupy during normal service; if they are not, a note should indicate this. It is essential to ensure that parts of multi-switching devices are shown in mutually consistent positions whatever the state of the system.

6.2.7 Power supply lines for electrical circuit diagrams. Wherever possible the circuit should be shown between parallel lines representing the power supply.

6.2.8 Power supply lines for electronic diagrams. The function of an electronic circuit can often be more clearly shown if the voltage rails are depicted by short horizontal lines. When this technique is used, each line has to be clearly marked with its voltage and the line should be drawn with the most positive voltage uppermost. The source of the various voltage rails should also be indicated on the diagram. If there is one common reference rail on the diagram, it is permissible to show this line thicker than other voltage rails (see 4.1).

A suggested convention for labelling voltage rails is as follows.

- The two output poles of a power supply with one pole connected to a common reference voltage would be, for 5 V supply: +5 V and 0 V (assuming the negative pole is the one connected to the reference level).
- The three outputs of a power supply with the centre pole connected to a common reference voltage would be, for 15 V supply: +15 V, 0 V and -15 V.
- The two output poles of a power supply not referenced to any other voltage would be, for a 5 V supply: 5 V +ve and 5 V -ve.

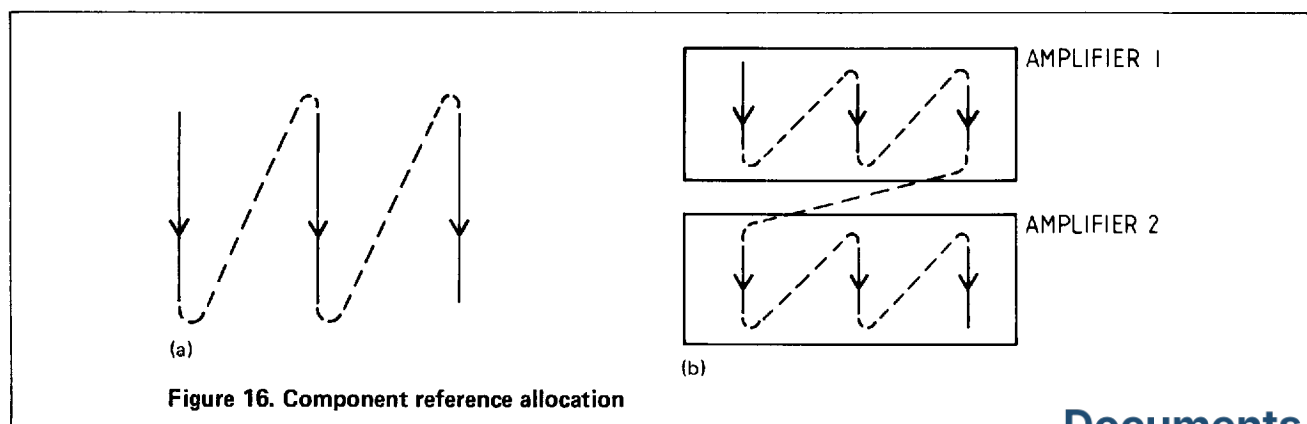


Figure 16. Component reference allocation

6.2.9 Power supplies and decoupling components for integrated circuits. The main functions of integrated circuits are usually shown in the body of the circuit. Where the addition of connections for supporting features such as power supplies and decouplings would complicate the diagram unnecessarily, it is recommended that such information be presented in a table on the drawing sheet. This may include identification of connection pins, related component references and their location by grid reference. This information is important in detached representation (see 6.2.3). The table should also contain a description or

refer to a type number of the integrated circuit; this is an aid to circuit analysis. Examples of such tables are shown in figures 17 to 19.

It should be noted that these tables are not intended to be comprehensive parts or components lists. Also, it is possible to show decoupling capacitors in the main body of the diagram without detracting from the clarity of the data or signal flow, e.g. an operational amplifier. In this case, a table is not necessary.

INTEGRATED CIRCUIT TABLE						
CIRCUIT REF.	TYPE NO.	POWER SUPPLIES			GRID REFS.	PINS OF UNUSED ELEMENTS
		- 5 V	0	+5 V		
IC1	54LS02	—	7	14	A4, C3, F2	8, 9, 10

Figure 17. Integrated circuit table showing power supply connections and location

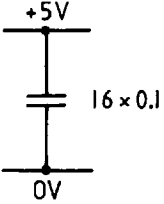
IC DECOUPLING TABLE		
IC CCT REF	CAP CCT REF	
IC1	C8	
IC2	C9	
IC7	C15	

Figure 18. Decoupling table concerned with one power supply

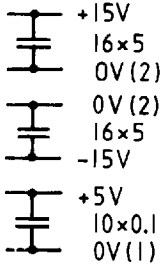
IC DECOUPLING TABLE				
IC CCT REF	+5 V OV(1)	+15 V OV(2)	-15 V OV(2)	
IC1	C10	C15	C20	
IC2	C1	C5	C17	
IC21	C20	C22	C23	

Figure 19. Decoupling table concerned with several power supplies

6.3 Presentation of fundamental circuits

6.3.1 General. Commonly used fundamental circuits should follow a standard layout. Recognition of the function of the circuit is made easier if a familiar pattern is seen.

6.3.2 Two- and four-terminal passive networks. Two-terminal passive networks should be shown with the terminals at the same end (see figure 20(a)). Four-terminal passive networks, e.g. as filters, smoothing circuits,

attenuators and phase shift networks, should be shown with the terminals at the corners of an imaginary rectangle (see figure 20(b)).

6.3.3 Bridge circuits. Figure 21 shows the following bridge circuits.

A typical bridge circuit is shown in figure 21(a).

A single-phase bridge rectifier is shown in figure 21(b).

A three-phase bridge circuit is shown in figure 21(c).

