

Dillman

MOD

Drafting Standards

Mission Operations
Directorate

REV C

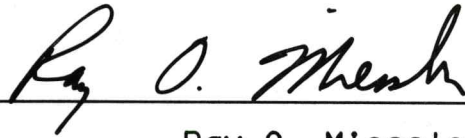
April 1987



National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

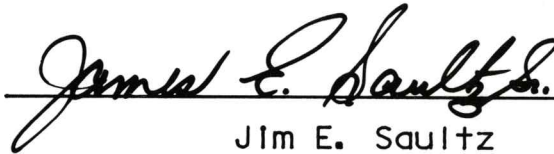
Mission Operations Directorate
Drafting Standards



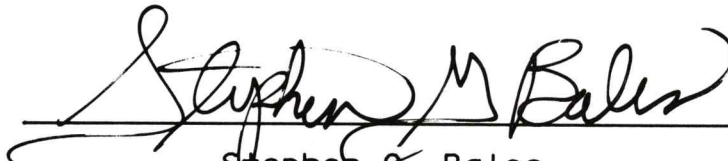
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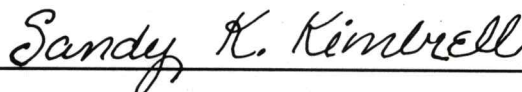
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PREFACE

This document has been prepared for the Mission Operations Directorate, NASA, Lyndon B. Johnson Space Center, Houston, Texas 77058.

The MOD Drafting Standards document presents guidelines to ensure a common drafting philosophy, uniform formats, and appropriate standardized symbology among all elements in the MOD.

This is a user-oriented document and accordingly, will be updated periodically as required.

The entire MOD Drafting Standards document, including all illustrations and text, was done on the JSC Computer Aided Drafting System (CADS). This document demonstrates the accuracy, versatility, and many of the capabilities of the fully computerized system that is presently being used to produce a majority of MOD drawings.

Comments are solicited and should be directed to Ray Miessler DF7, Lyndon B. Johnson Space Center, 713-483-0823

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1 OBJECTIVE

The basic objective of the Mission Operations Directorate (MOD) drafting function is to produce schematics that show power, control, signal flow, plumbing, and mechanical interfaces within and among space vehicle modules. The standards that follow will be adhered to for all MOD programs except for specifically negotiated exceptions.

2 GENERAL DRAWING INFORMATION

2.1 Drafting Philosophy

The design layout of the drawing and its technical accuracy and content shall be the responsibility of the book manager, MOD Branch Chiefs, and engineers, consistent with MOD policies and direction. Matters relating solely to drafting practice shall be the responsibility of the MOD drafting contractor.

2.2 Layout Standards

2.2.1 Borders and Title Blocks. - Drawings will be enclosed by a border of appropriate size and contain a title block. Standard border configurations are as follows:

<u>Horizontal Zones</u>	<u>Vertical Zones</u>	<u>Book Page Size</u>
1-8	A-H (8)	11" X 17"
1-8	A-L (12)	11" X 22"
1-8	A-O (15)	11" X 28"
1-8	A-Q (17)	11" X 32"
1-8	A-S (19)	11" X 36"
1-8	A-V (22)	11" X 38"
1-8	A-W (23)	11" X 38"
A-D (4)	1-8	11" X 17"

Title blocks may be placed at the right or left of the drawing depending upon the direction that the page will face. Figure 2.2.1-1 shows a sample title and signature block for a right-hand foldout drawing. A left-hand title block would have the signature block on the right side of the title block.

3 XXXXX 2

SIGNATURE		DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN			XXX XXX XXX XXX XXX	
DR				
ENGR				
ENGR				
APP				
APP			XXXXX XXXXXX	DWG NO
OMNIPLAN			XXX XXX	X. 3
LTR	PCN		66 X 34	PAGE
				SHEET 2 OF 2

VEHICLE OR PAYLOAD NAME →

DRAWING SIZE →

VEHICLE OR FLIGHT NUMBER →

DWG TITLE →

Figure 2.2.1-1.- Signature and Title Block with Short Title.

2.3 Lettering Sizes

There are three standard text sizes available for use on MOD drawings. A sample of each is shown below at the approximate size it will appear on a CAD checkprint or ink master.

This text is for general use on all drawings.

THIS IS THE SMALLEST TEXT

This text is used for labeling all but the largest of modular boxes and for emphasis in some cases.

MEDIUM SIZE TEXT

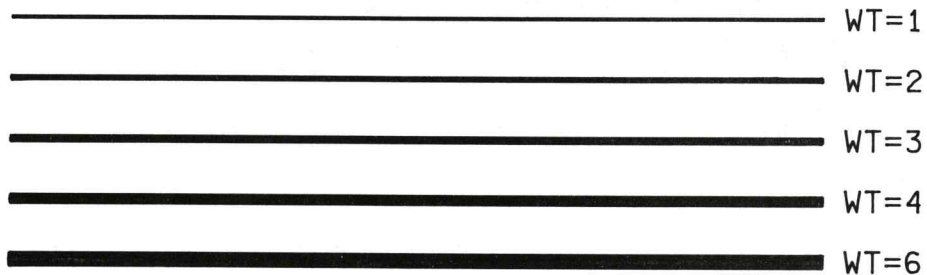
This text is used for labeling the largest modular boxes and interfaces.

LARGE SIZE TEXT

The text for short titles is a standard height and variable width. An example is shown in figure 2.2.1-1.

2.4 Line Weights

The following line weights are available for use in component enclosures. Boxes should have increasing weight as complexity increases.



The line shown below is used for interfacing.



All crew-operated components (switches, valves, circuit breakers, umbilicals, etc.) are enclosed with the dashed box shown below.



2.5 MODULARITY

2.5.1 Modular configurations and current flow. - Modular configurations will be from left to right as shown in figure 2.4.3-1. Modular layout from left to right will always take precedence over current flow. Current flow, when modular layout permits, will be from left to right. (The circuit operation shall be from top to bottom and progress from left to right in order of sequence of operation.) In general, it is a good practice to align common buses on schematics, however, this should not be interpreted as a standard.

2.5.2 Modular nomenclature. - To standardize nomenclature, the following definitions apply to all MOD documentation. Space Shuttle (SS) represents the Orbiter (ORB), External Tank (ET), and two Solid Rocket Boosters (SRB), which represent one Shuttle Vehicle Booster (SVB).

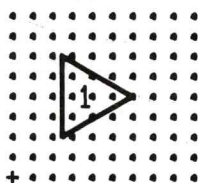
2.5.3 Module Interfaces. - Module Interfaces will be as follows: a double dashed line between modules indicates a separation plane, and a single dashed line indicates a module interface.



Figure 2.4.3-1.- Modular Interfaces.

2.6 Drawing Notes

Notes are used to transmit engineering information that either cannot be transmitted symbolically or can be transmitted more efficiently in words than with symbology. Notes are of two types: general and specific. General notes do not apply to a specific area on the drawing. Specific notes do apply to a specific area or areas of the drawing and are indicated with a note flag (shown below) that appears in the area or areas referenced.



A short note that appears only once on the drawing may be placed in the area affected, thus eliminating the need for the note flag.

Wherever possible, notes that are not placed at the affected area will be placed directly above the title block (or short title) and will be numbered sequentially from the bottom up to allow for new notes to be added. Each note will be numbered, but the flag is not used for general notes. A period is not used at the end of the last sentence of a note.

When a note is deleted, all subsequent notes should be renumbered by the engineer in charge of the drawing.

2.7 Source Documentation

As a result of the 51-L mission, all drawings must be supported with the vendor source schematics or documentation. This will be located directly above the title block. (shown below)

R. I. DRAWINGS REFERENCED:

VS70 - 620202 (ELEC), REV J 6/25/84

VS70 - 623200 (MECH), REV H 5/1/86

G. E. DRAWINGS REFERENCED:

63D717539 (MECH)

80V62A14 (ELEC)

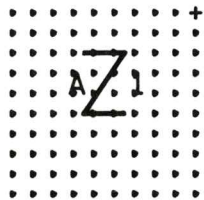
X XXXXXX X

SIGNATURE		DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN			XXX XXX XXX XXX XXX	
DR				
ENGR				
ENGR				
APP				
APP			XXXXX XXXXXX	DWG NO
OMNIPLAN			XXX XXX	X. X
LTR	PCN		66 X 34	PAGE
				SHEET X OF X

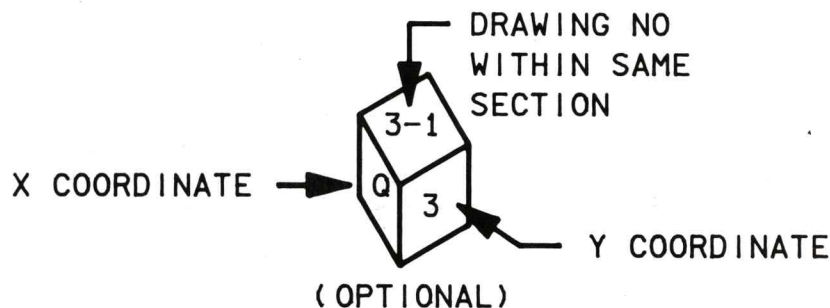
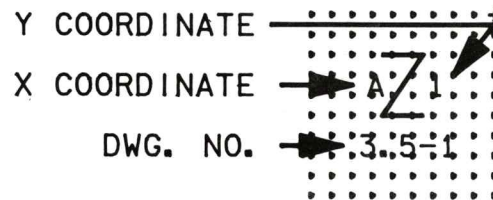
2.8 Technical Zone References

Zone references are used to direct attention from one area to another in the same or another drawing. The 'Z' shown below, with appropriate zone locators, indicates the exact area referenced.

TO SAME DWG.

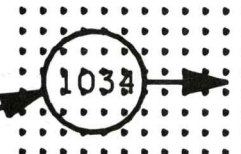


TO DIFFERENT DWG.



PHYSICAL
THERMOSTAT
LOCATION

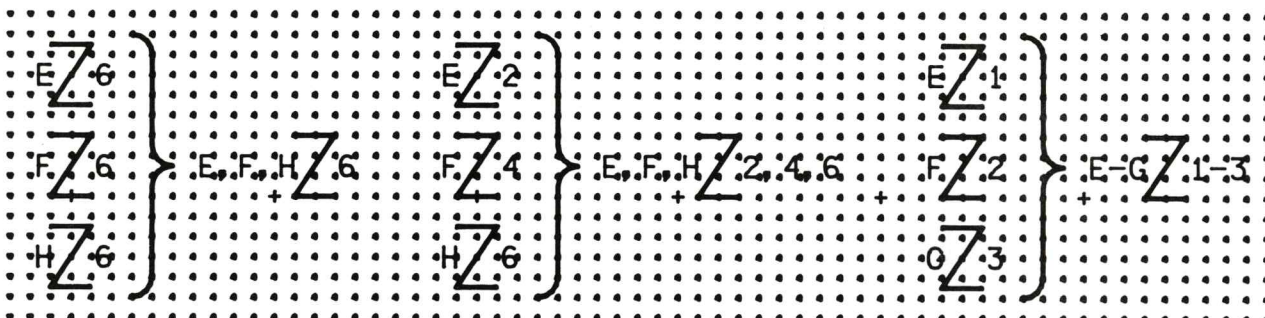
PHYSICAL
LINE HEATER
LOCATION



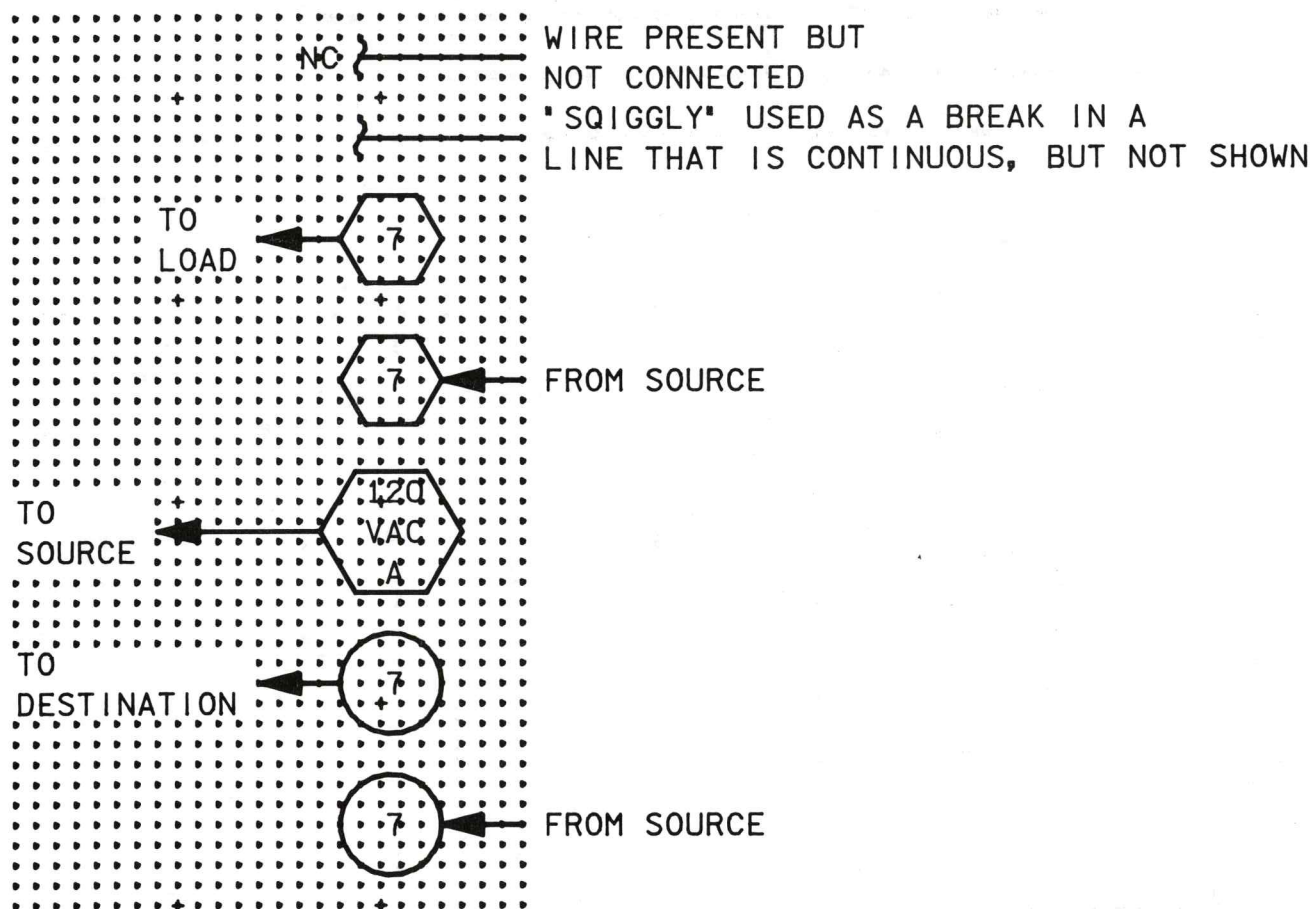
The number shown below the 'Z' indicates that the area referenced is on another drawing. If no number is used, the reference is to the same drawing where the reference appears.

Depending on the utilization of the reference in the drawings, it is often desirable to place a zone reference both to an area and from there back to the original area.

MULTIPLE ZONE REFERENCES



Cross references are of two basic types: The hexagon ('hex') and the circle, which are used with zone references; If no reference is given, the squiggly is appropriate.



The 'hex' is generally attached to a power line and the circle to a signal line; however, the circle might have other applications, for example, attached to a mechanical linkage line. The appropriate zoning should appear next to the 'hex' or circle to direct attention to the location of the corresponding reference. The number within the circle or 'hex' distinguishes it from other references, and consecutive numbering within a system or subsystem is usual in order to prevent confusion. These cross references have several purposes. They can be used to connect one line to another line on the same drawing to save drawing the line for reasons of economy, clarity, avoiding congestion, or aesthetics. Also, they can be used to connect a line on one drawing to a line on another drawing to prevent having to show the same circuitry in two places.

2.9 Layout of parallel and/or redundant components

(shadowboxing). - Parallel and/or redundant components are shown on schematics using a wafering technique. (See Figs. 2.7.1-1 AND 2.7.1-2). (Arrowheads optional for flow).

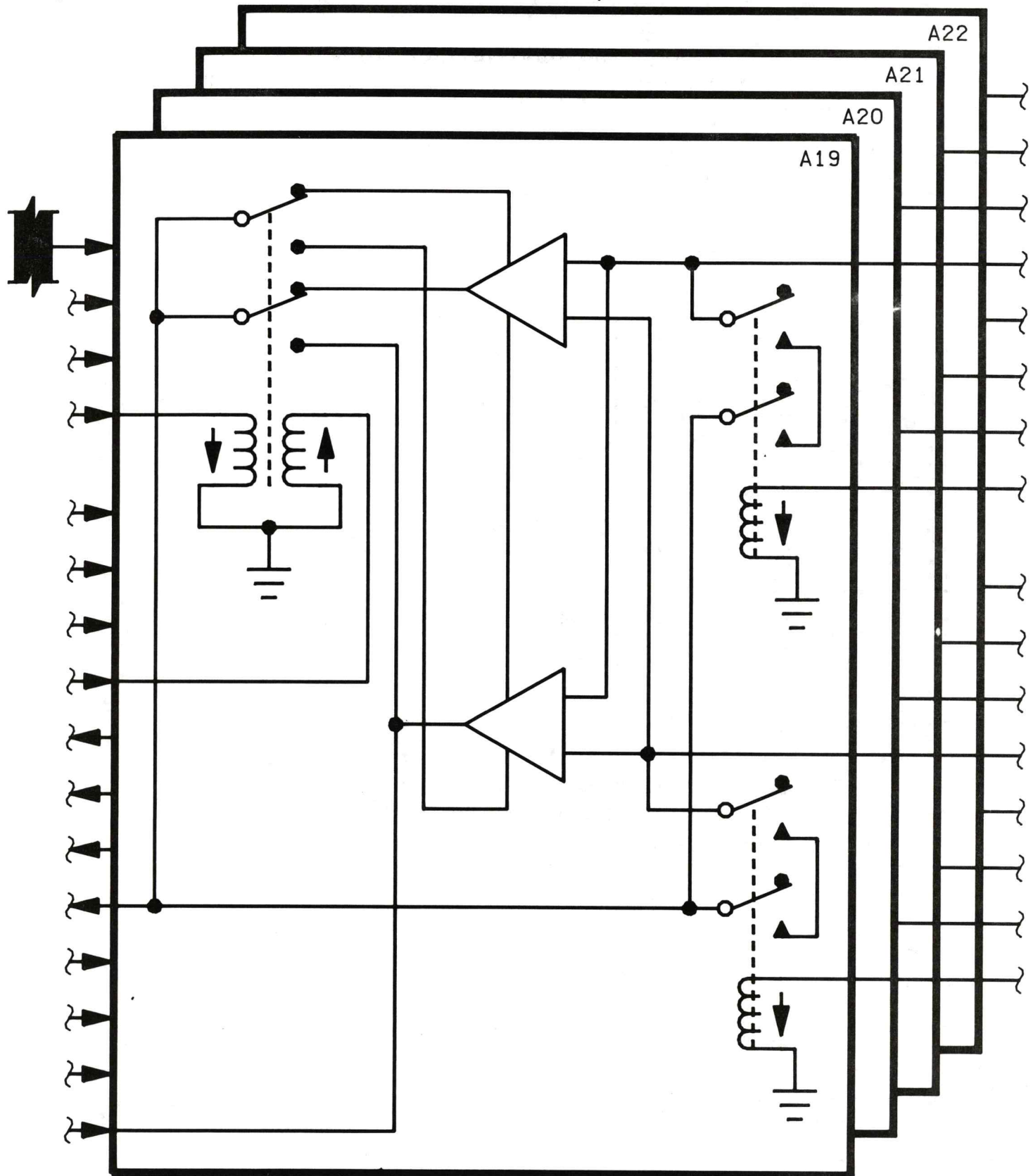
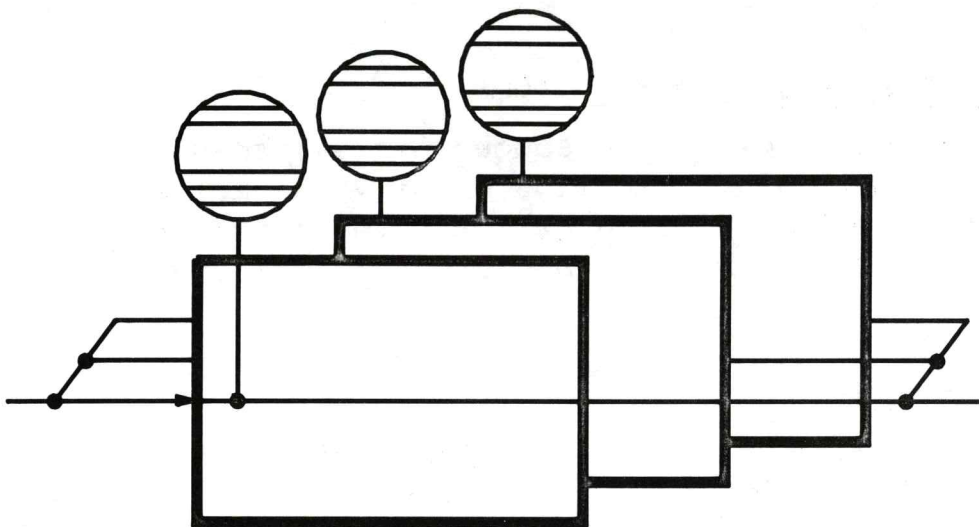
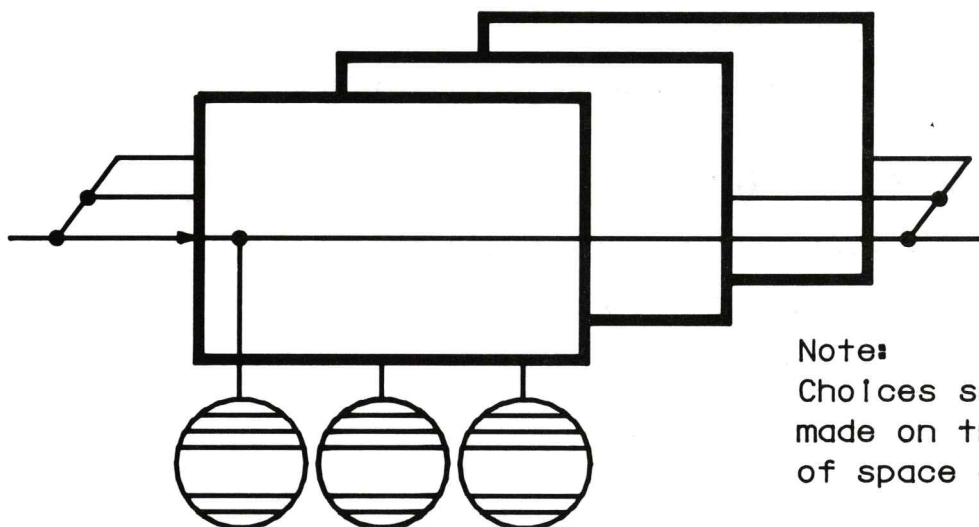


Figure 2.7.1-1.- Sample layout of parallel and/or redundant components.

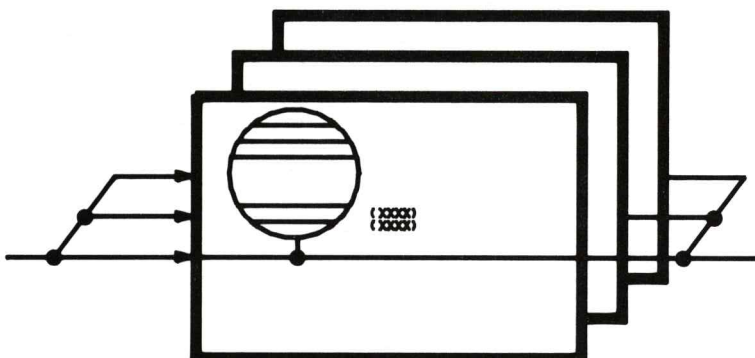


First choice for placement of TM bubbles, angles of input and output lines, and placement of directional flow arrows.



Notes:
Choices should be made on the basis of space constraints.

Second choice for placement of TM bubbles and placement of directional flow arrows.



Third choice for placement of TM bubbles, angle of input and output lines, and placement of directional flow arrows.

Figure 2.8.1-2.- Sample layouts of TM Bubbles and Input and output lines and arrows.

2.10 Drawing Artwork and Nomenclature

All artwork and nomenclature for spacecraft switches, meters, circuit breakers, et cetera, must be exactly as that which appears on the control/display drawings. The control/display drawings should reflect the configuration of the actual spacecraft.

2.11 Drawing Changes

Changes to published drawings will be published in the same manner as changes for the rest of the material in a document. Changes will be identified by letters and/or PCN numbers in the title block and will follow the publication sequence of the document.

2.12 Checkprint Color Code

2.12.1 The following color scheme will be used when marking checkprints:

- A. Red - Indicates a deletion
- B. Yellow - Indicates correct information
- C. Brown - Indicates an addition
- D. Blue - Notes to draftsmen

PROOFMARKS

(USE BLUE FOR PROOFMARKS)

^ Caret; Insert at this point

~ Delete

○ Close up

⊗ Delete and Close up

2* Leave 1 blank line

* 2* Insert space (or 2 spaces)

┐┐ Transpose words

~ Transpose letters

⌣ Insert hyphen

Ⓢ Insert colon

Ⓢ Insert period

Ⓢ Insert comma

STET Let it stand, disregard proof mark

¶ New paragraph

NO ¶ No paragraph

≡ Capitalize

≡┐ Initial cap words

/ Lower case

┐ Move to right

┐ Move to left

┐ ┐ Center

┐ Move to left to point indicated

┐ Move to right to point indicated

the missile

the the system

space craft

In the capsule

2*— This is a sample...
The next attempt...

guidance system
system. The

adapter the

the

three man crew

the following

This is a sample

red, white and blue

STET each and every item

The number is
indented five spaces.

¶ This is an example.

And so it went.

NO ¶ The next attempt

the gemini program

FLIGHT CONTROL DIVISION

the program

┐ The maintenance was

┐ The maintenance was

┐ SECTION TITLE ┐

The Gemini Program
ended in

The Gemini Program
ended in

3 DRAWING SYMBOLOGY

The following pages show the primary symbols and standards used to produce all MOD drawings. Most are shown actual size and are printed in a faded grid, which is in tenths, permitting dimensioning as appropriate.

Standardization symbols will be used for all drawings, and the symbols selected should be in accordance with the symbols illustrated in this document.

Built-up symbols, made by combining basic symbols, may be used provided they constitute a reasonable and intelligible use of the basic symbols.

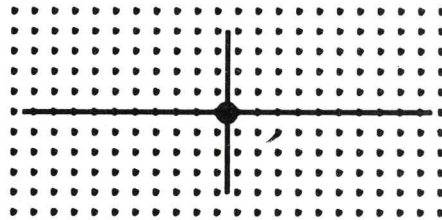
3.1 Line Legend

3.1.1 Electrical line, power, and control. - Arrow denotes signal flow.

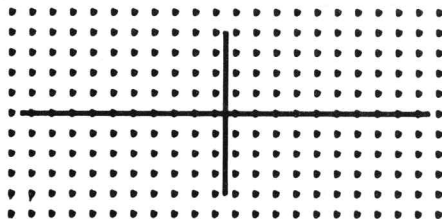


FOR MULTIPLE PARALLEL LINES, ARROWS ARE TO BE ALIGNED WHERE POSSIBLE

A. Electrical connection, mechanical or soldered, tie point

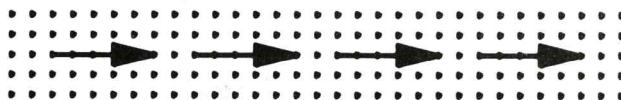


B. Electrical crossover

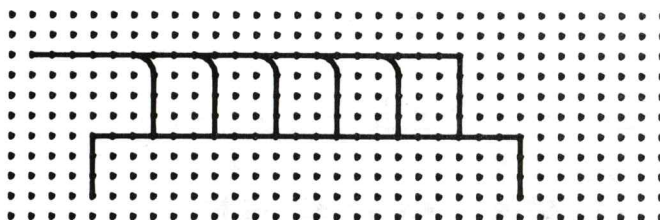


C. Directional flow arrows

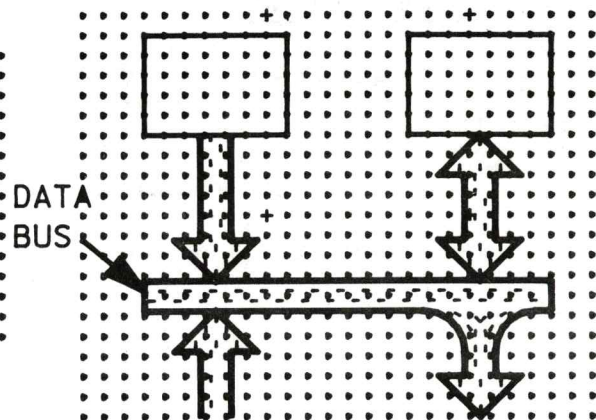
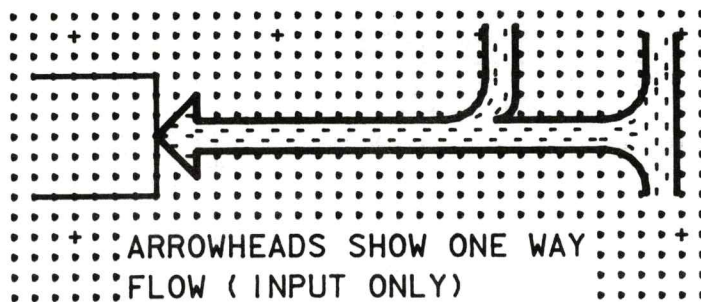
Placed at the discretion of the engineer.



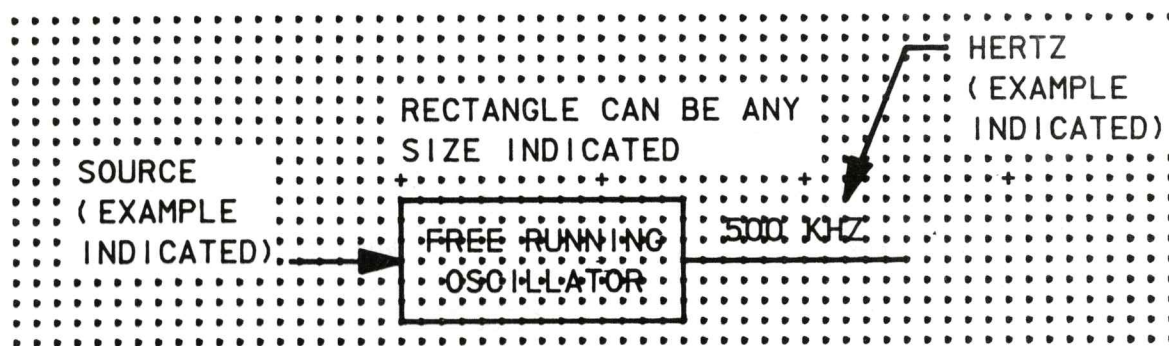
D. Cabling



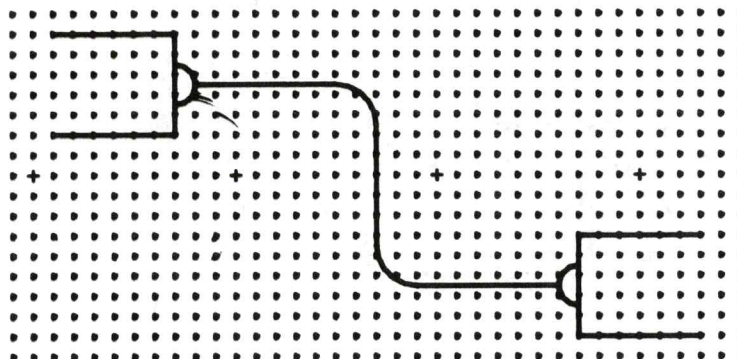
E. Data Bus



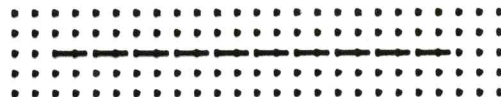
F. Timing Pulses.



3.1.2 RF or coax cable.-



3.1.3 Mechanical Linkage.- Relays, etc.



3.1.4 Mechanical shaft (pump)

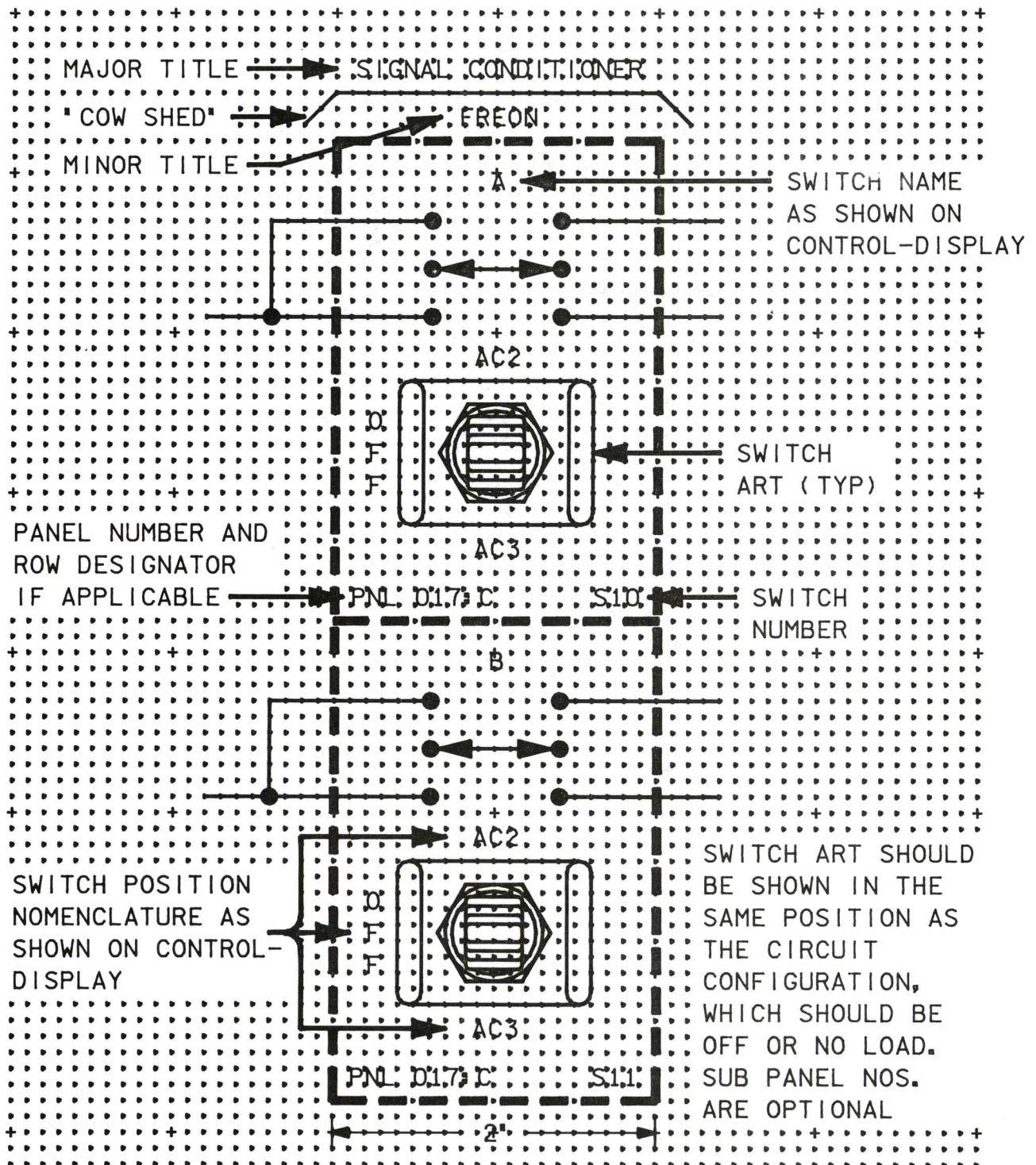


3.2 Electrical symbols and switching

3.2.1 Switches. - Where possible, all switches and relays are shown in the de-energized position. If a switch has momentary contacts (solid triangle), then the de-energized position will be the latching contacts (solid circle).

Guideline 1

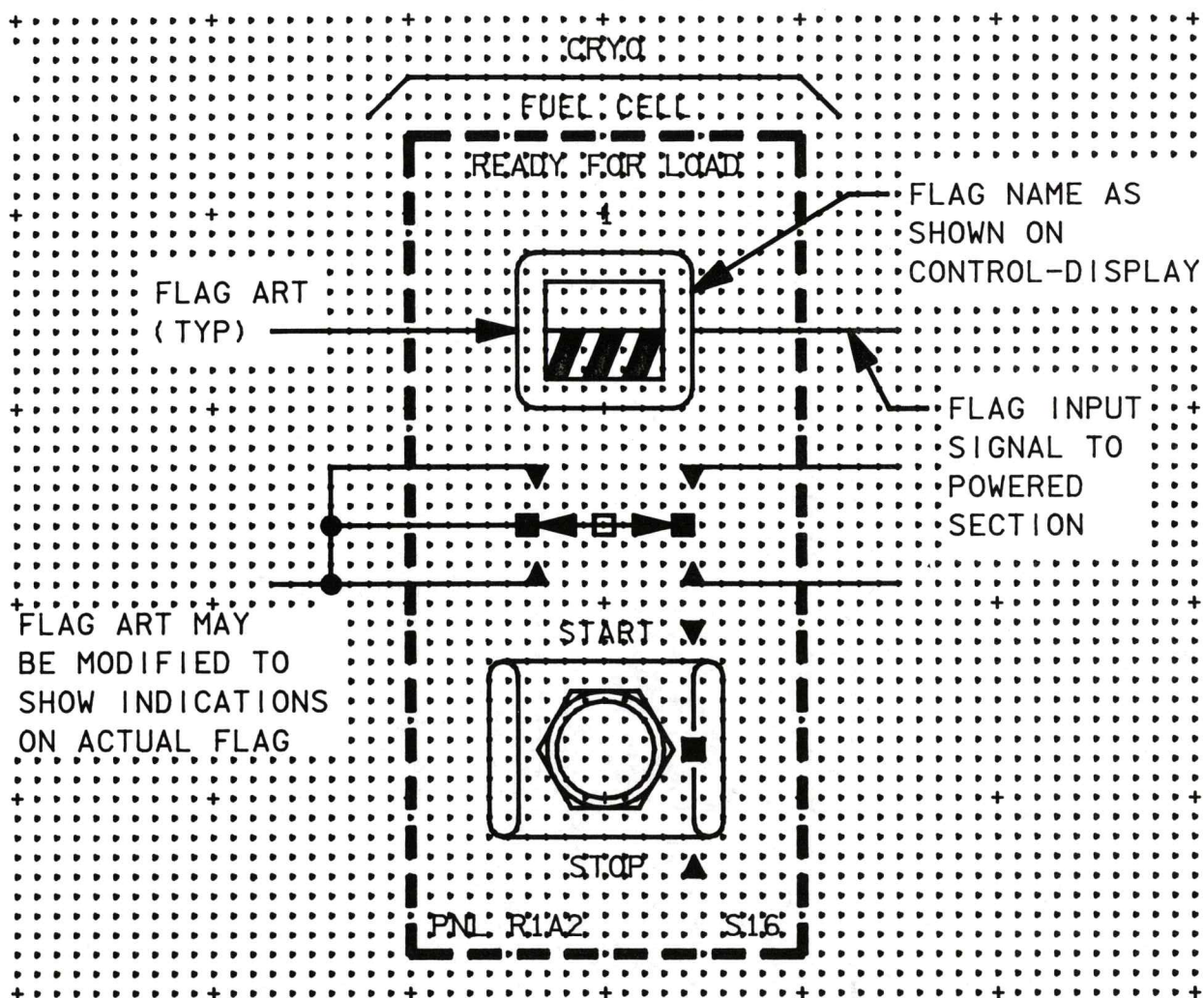
ORB switch format



Guideline 2

Switch-controlled flag

If a flag is directly controlled by a switch, it may be shown in the following manner:

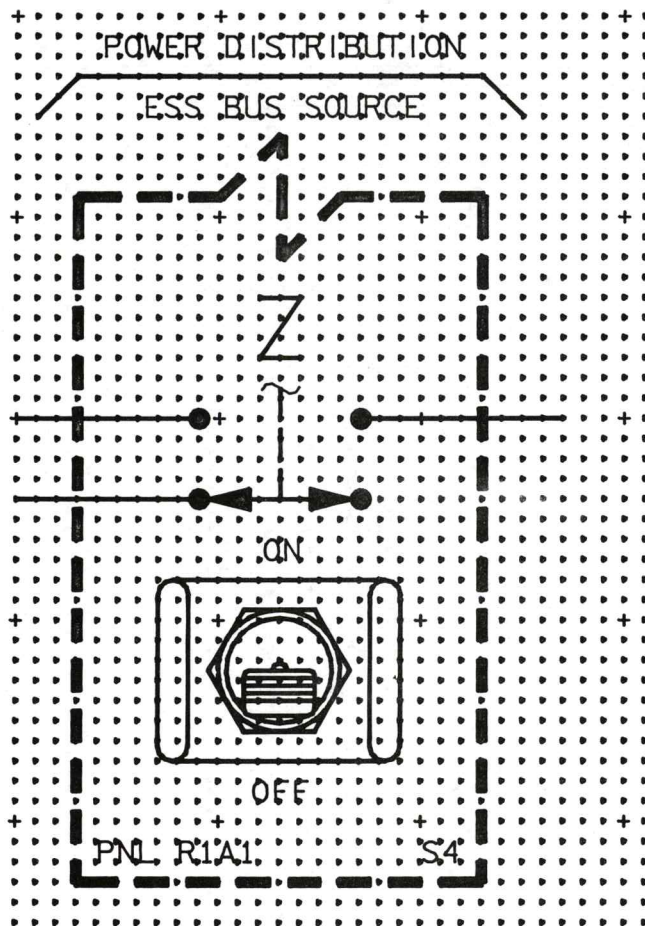
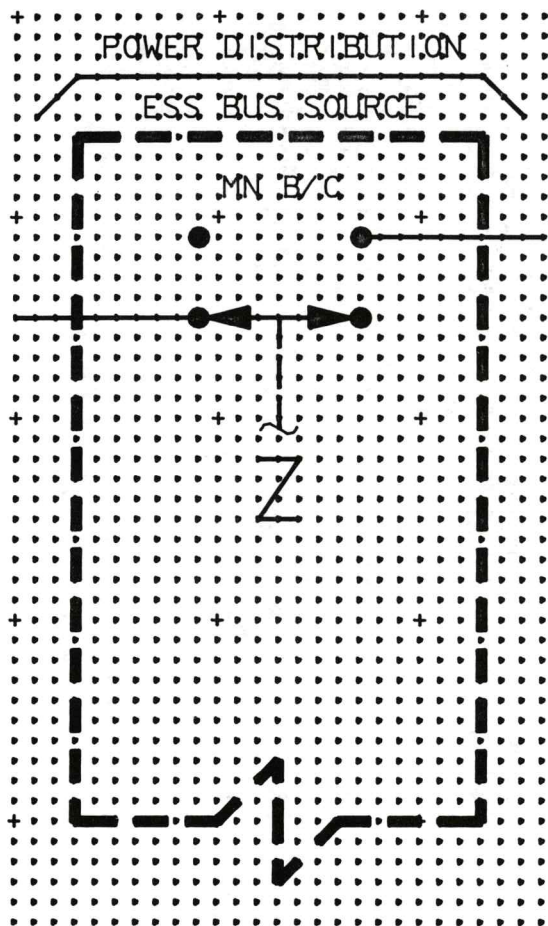


Note

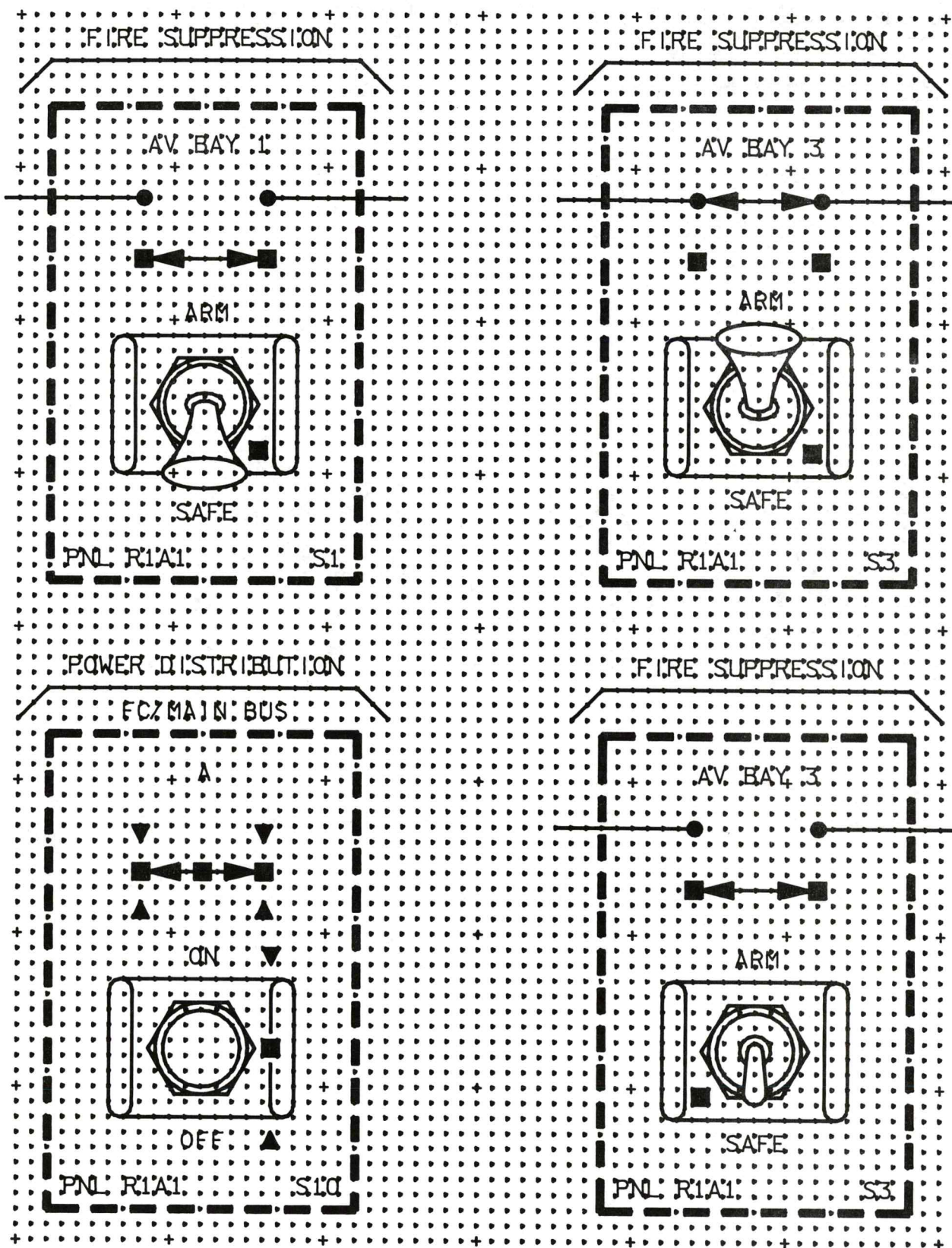
▲ Indicates momentary position

Guideline 3

Divided boxes continued in separate locations



Guideline 4
Lever Lock Switch

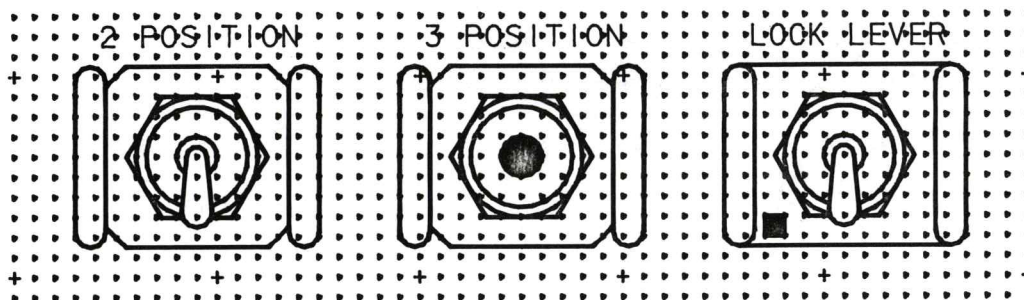


Note

Box ■ Indicates
lock position.

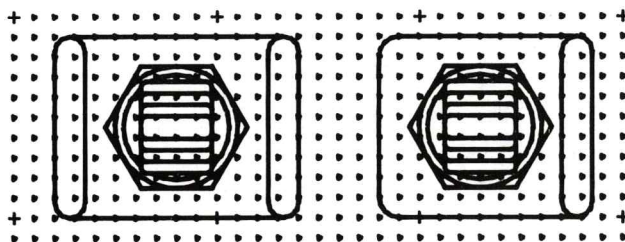
Guideline 5

Spacelab switches

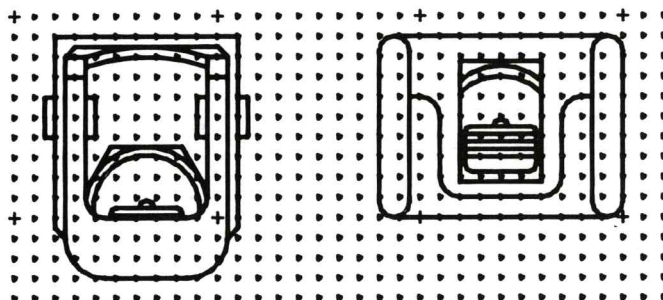


Spacelab switches are wired the same as orbiter switches.

Switch guards.



Covered switch guards.



A. Switch nomenclature definitions

1. Major title - The title given to a group of switches on the panel.
2. Minor title - The title given to a subgroup of switches that has a major title.
3. Switch name - The name of a given switch as it appears on the panel.

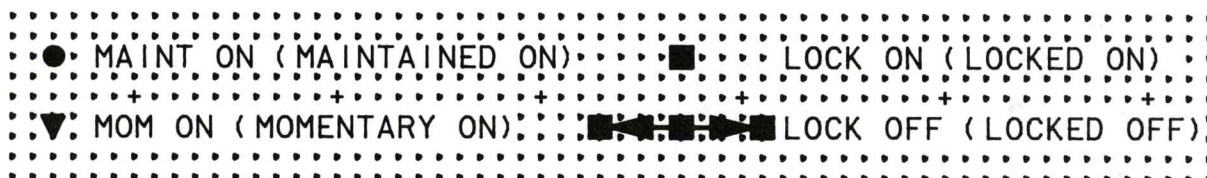
Note 1

If more than one switch should have identical major and minor titles, these switches may be "stacked" without repeating the major and minor titles.

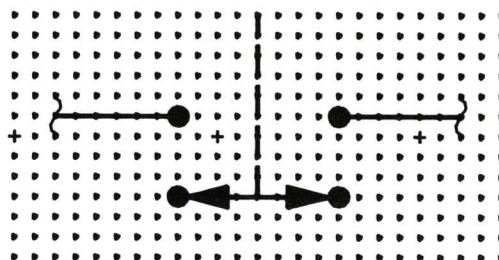
Note 2

Occasionally a minor title will be long and require two lines. This is an acceptable deviation that requires an additional 2 tenths under the "cowshed".

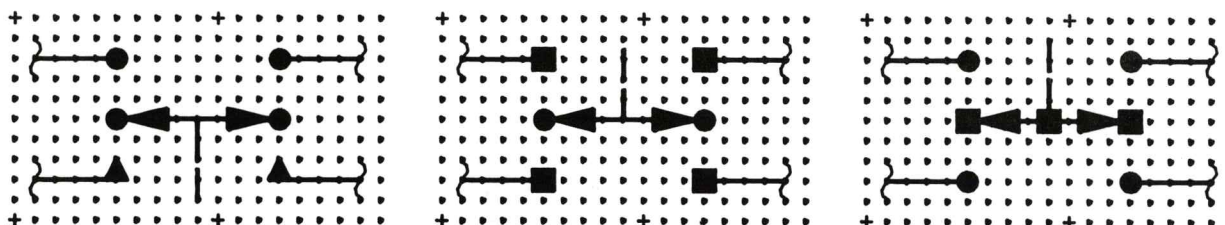
B. Switch contact definitions applicable to manually operated only



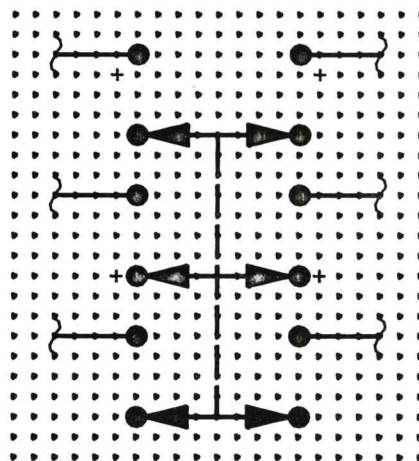
C. Two-position lever switch



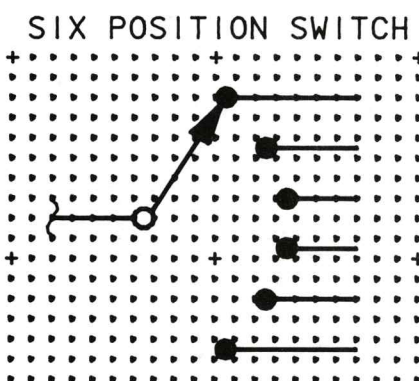
D. Three-position lever switch



E. Two-position-three-pole lever switch



F. Rotary switches



As a practice, whenever possible, rotary switches should be set up and labeled in a clockwise manner, with the off position or the beginning of the switch sequence in the top or bottom in the schematic. The switch direction should match the switch art. (See the following notes.)

Note 1

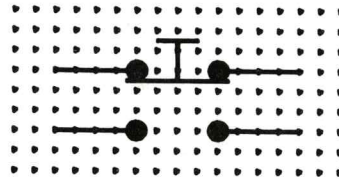
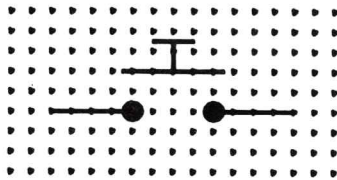
The beginning of switch sequence can usually be determined by either a space in the switch positions or the beginning of a numerical or alphabetical sequence.

Note 2

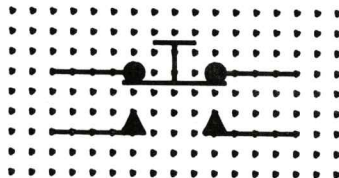
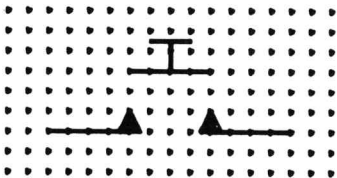
Where there is no method of determining the beginning of a switch sequence, the position of the switch indicator will determine top or bottom position.

G. Pushbutton switches

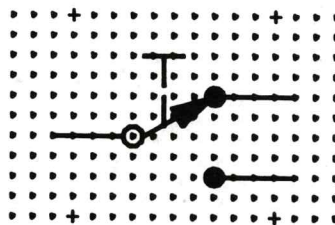
1. Maintain



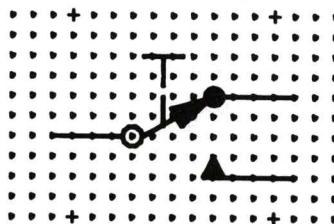
2. Momentary



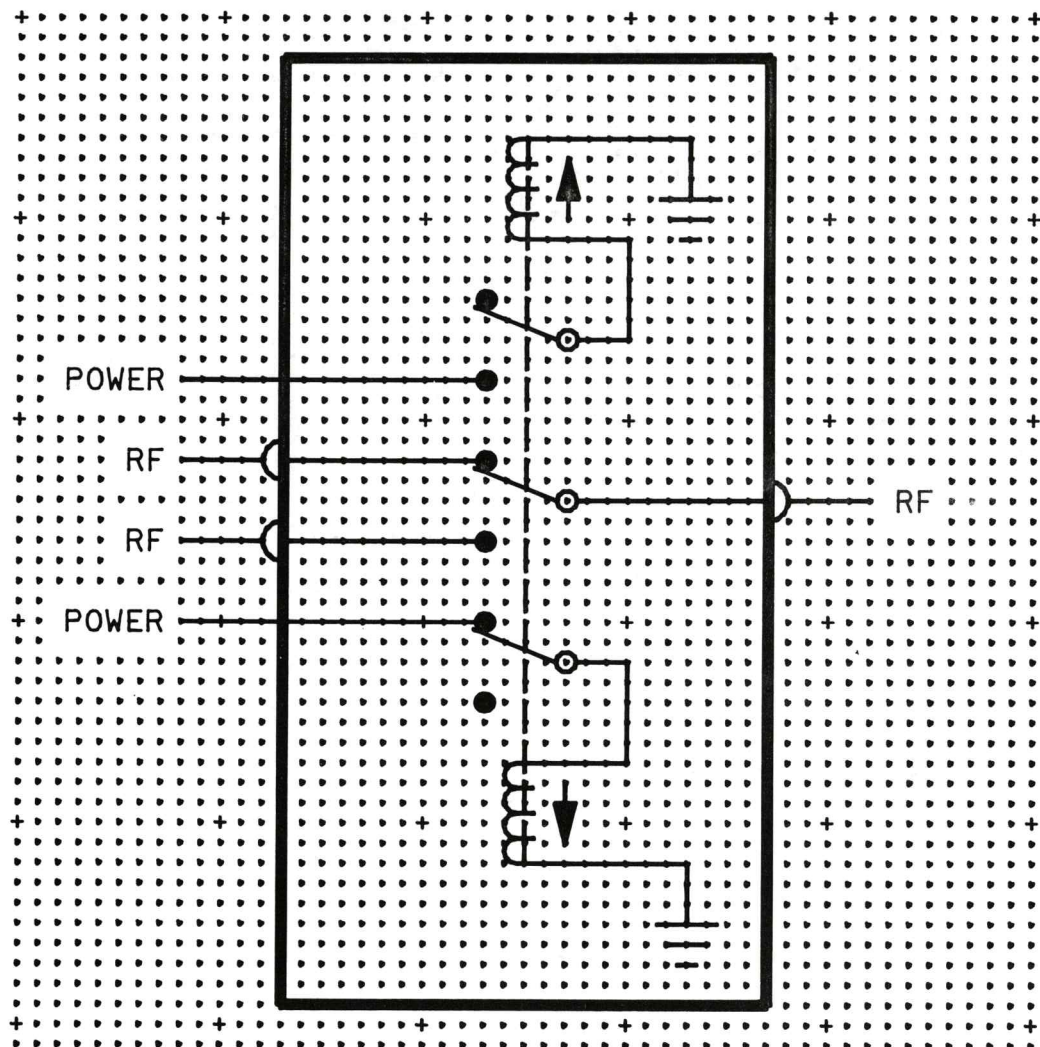
3. Three-contact pushbutton switch (Maintain)



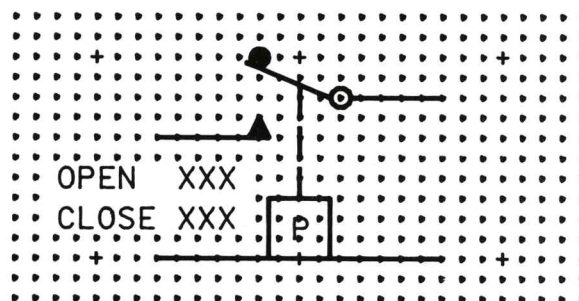
4. Three-contact pushbutton switch (Momentary)



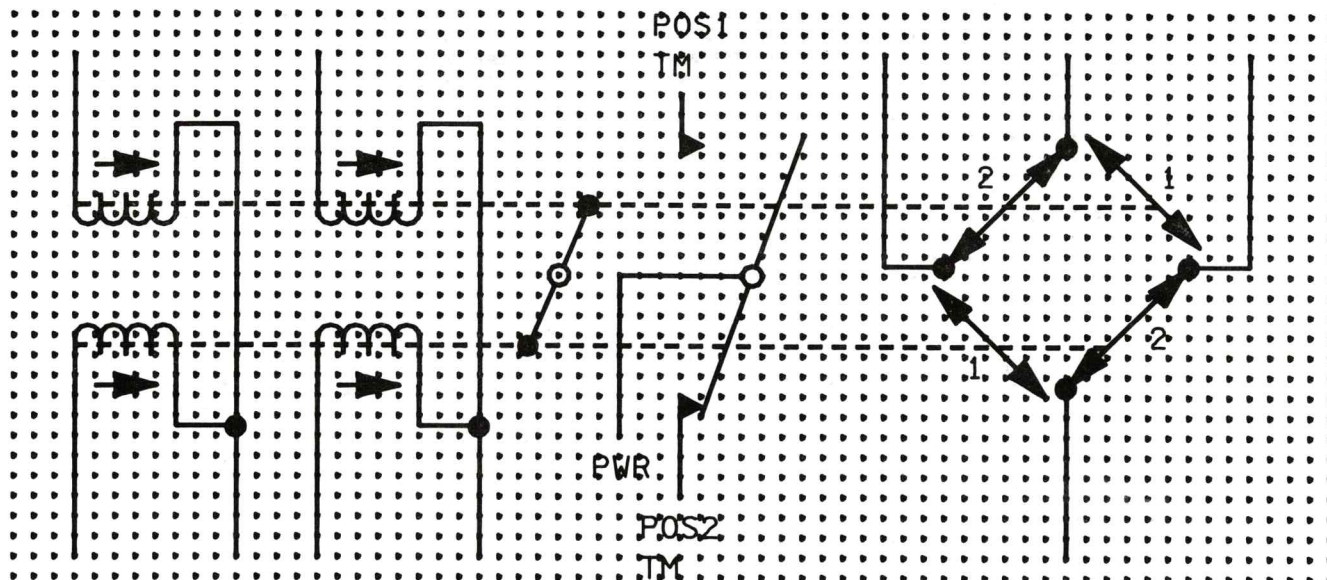
H. Coax switch



I. Pressure switch

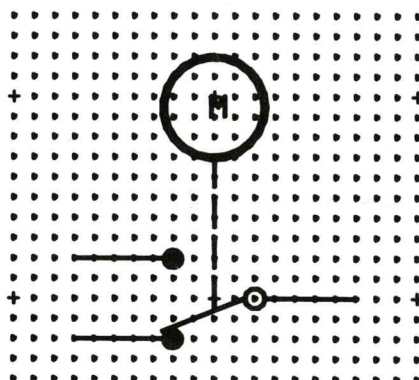


J. RF coaxial antenna relay.

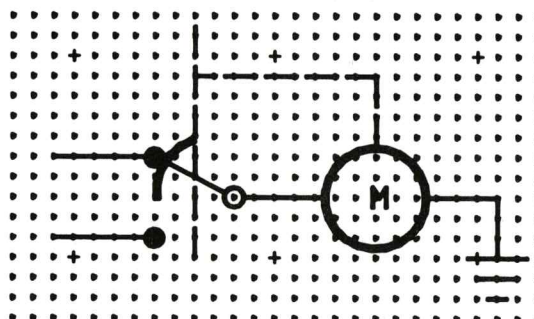


K. Motor switches

1. Break-before-make

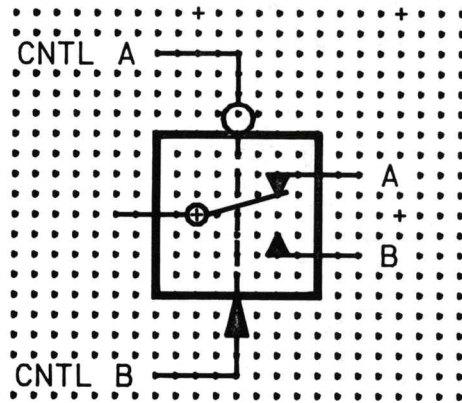


2. Make-before-break



3.2.2 Solid-State switches.-

A. Dual-control solid-state switch

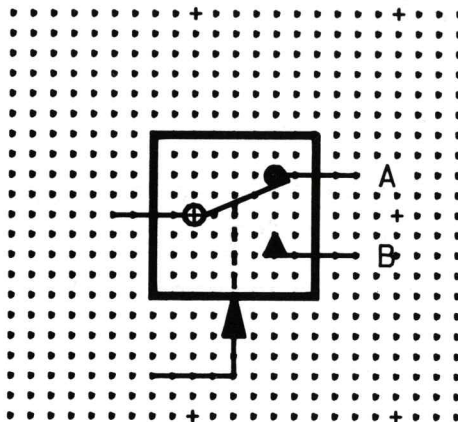


FUNCTION TABLE

CNTL A	CNTL B	OUTPUT
0	0	A
1	1	B
1	0	UN
0	1	UN

UN = UNDETERMINED

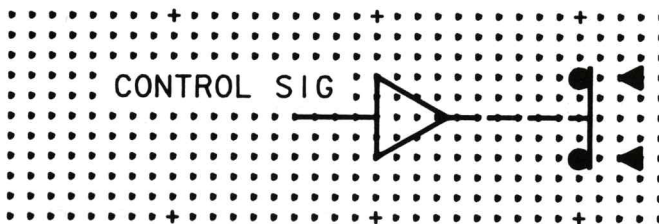
B. Single-control solid-state switch



FUNCTION TABLE

CNTL	OUTPUT
0	A
1	B

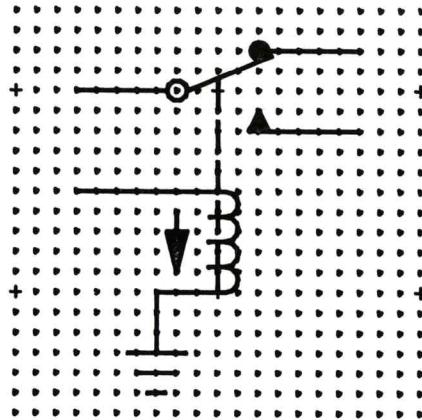
C. Solid-state analog switch



3.2.3 Relays. - The guidelines below will be followed for relays:

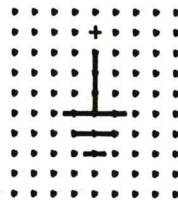
Guideline 1. All relay coils will contain an arrow that will indicate the direction of motion of the wiper when the coil is energized.

Guideline 2. The wiper will always move toward the coil.



Guideline 3. If both Rules 1 and 2 cannot be met, then Rule 1, the arrow, will always take precedence.

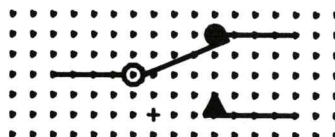
Guideline 4. Ground symbols will always be shown right side up.



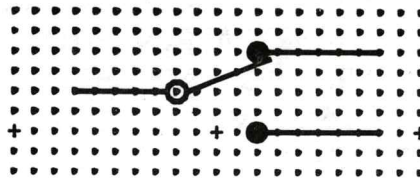
Guideline 5. Grounds will be shown at the bottom of coils wherever possible.

Guideline 6. All relays will be shown in the de-energized position.

A. Momentary contact

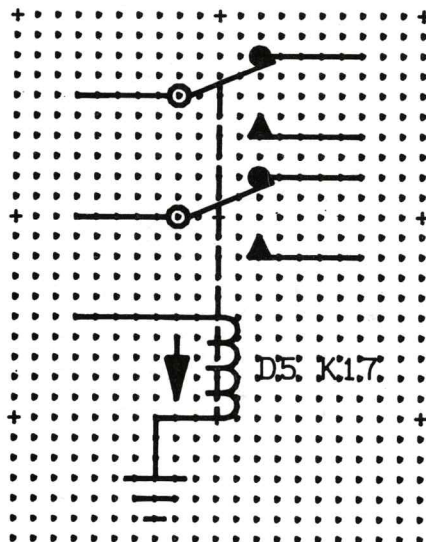


B. Latching contacts

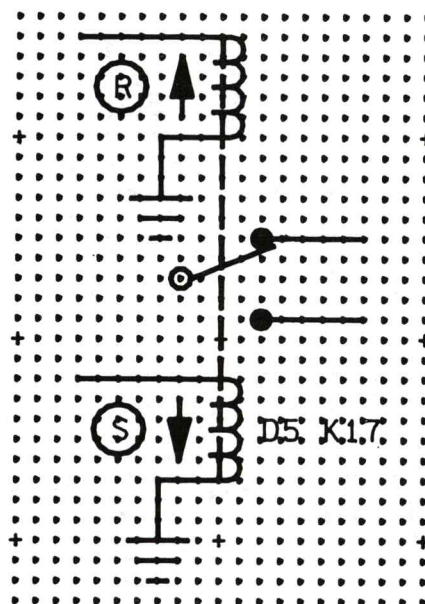


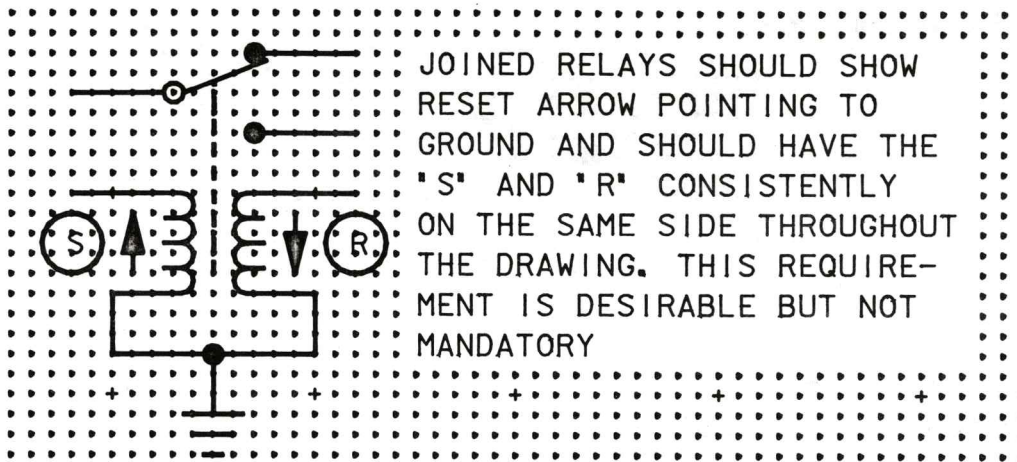
C. Nonlatching relay

Shown in the de-energized position.



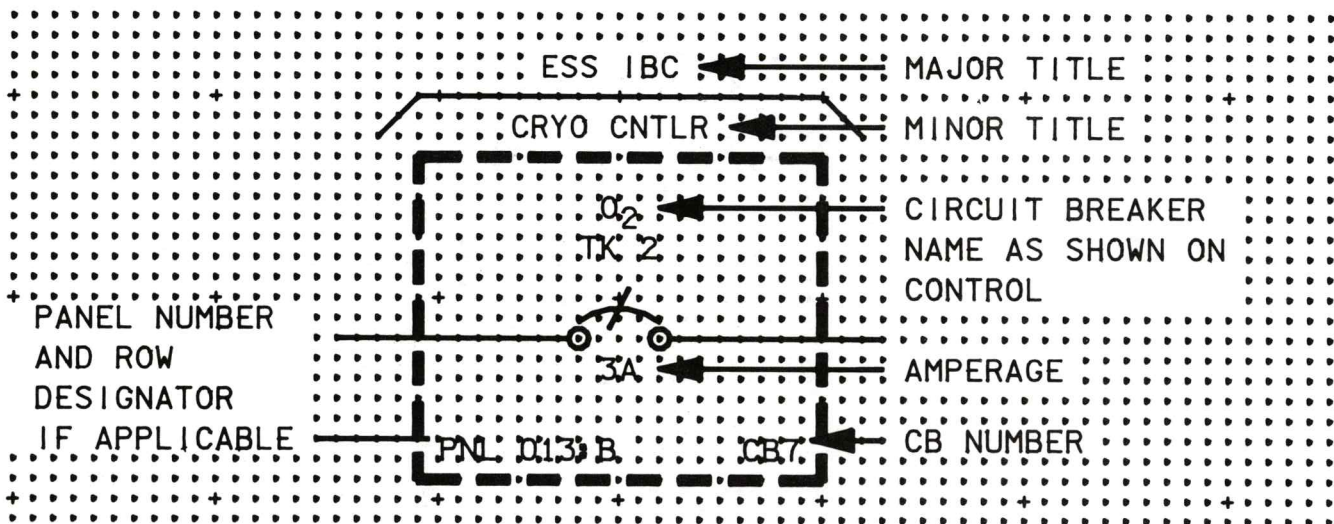
D. Latching relay



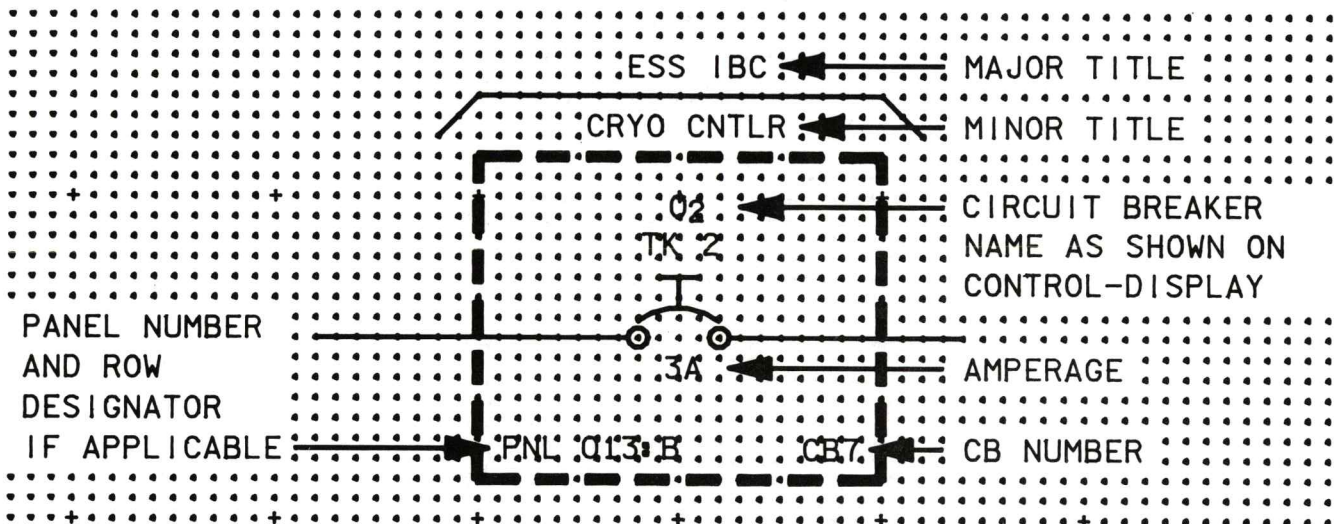


3.2.4 Circuit breakers. -

A. Toggle

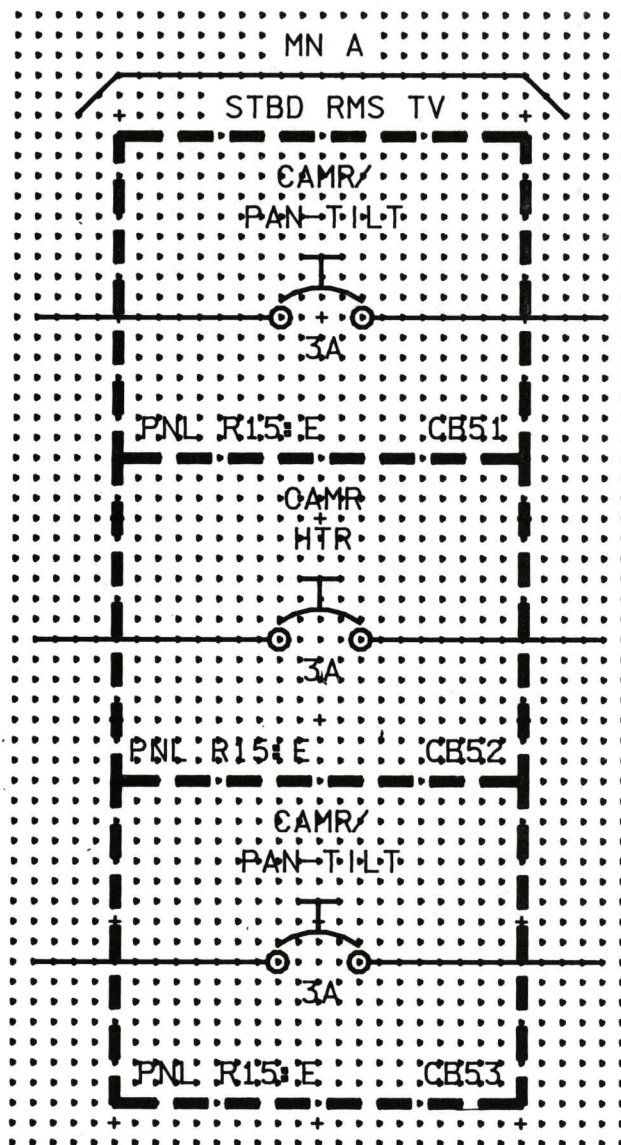


B. Pushbutton



C. Combined circuit breakers

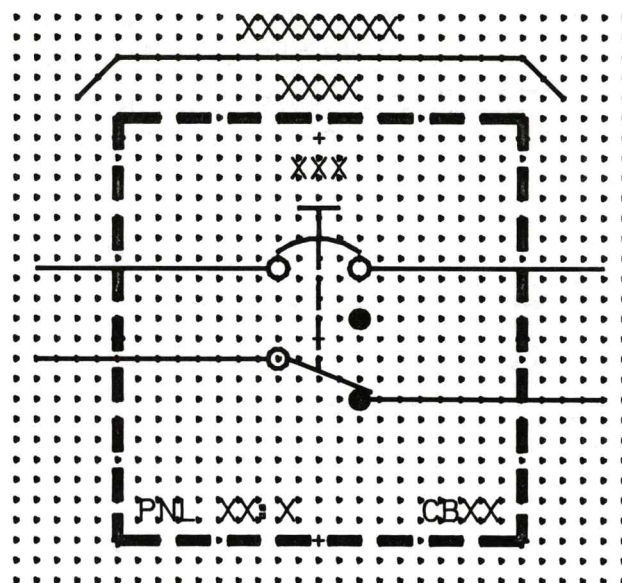
Circuit breakers can be combined or shadowboxed when they have a common major and minor title and the same panel or location numbers. Circuit breakers may be combined by mechanical linkage, with only one pushbutton or toggle switch controlled.



Note

This example shows pushbutton circuit breakers. The same technique could also be used with toggle circuit breakers.

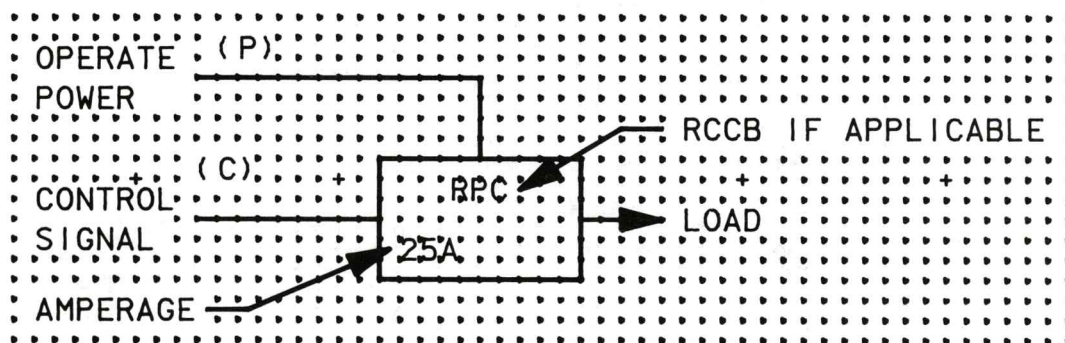
D. Sensed circuit breaker



NOTE

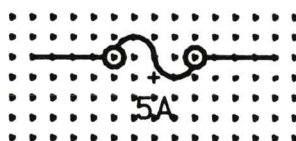
May be either toggle or pushbutton and one or more phases or power sources.

E. Remote power controller or remote-controlled circuit breaker

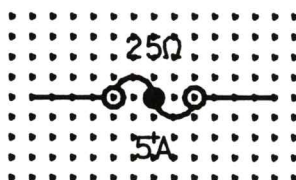


3.2.5 Fuses. -

A. General



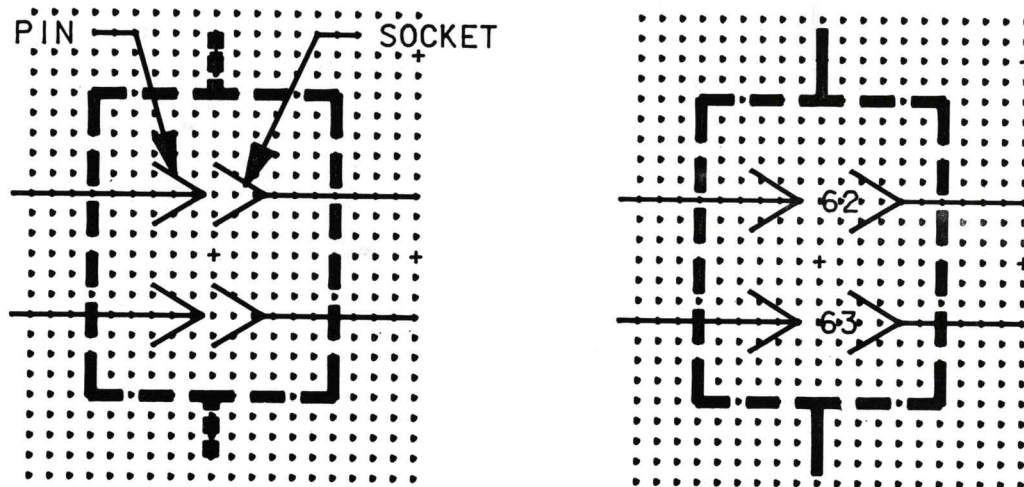
B. Fusistor



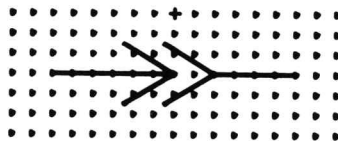
3.2.6 Disconnects.-

A. Pins and sockets

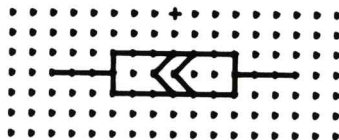
The standard configuration for pins and sockets is shown below. It is enclosed by the same dashed box used for crew components and the "crowsfoot" symbol is used. The use of pin numbers will determine the spacing between the pin and socket symbols.



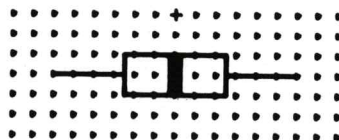
B. Male/Female Electrical Disconnect



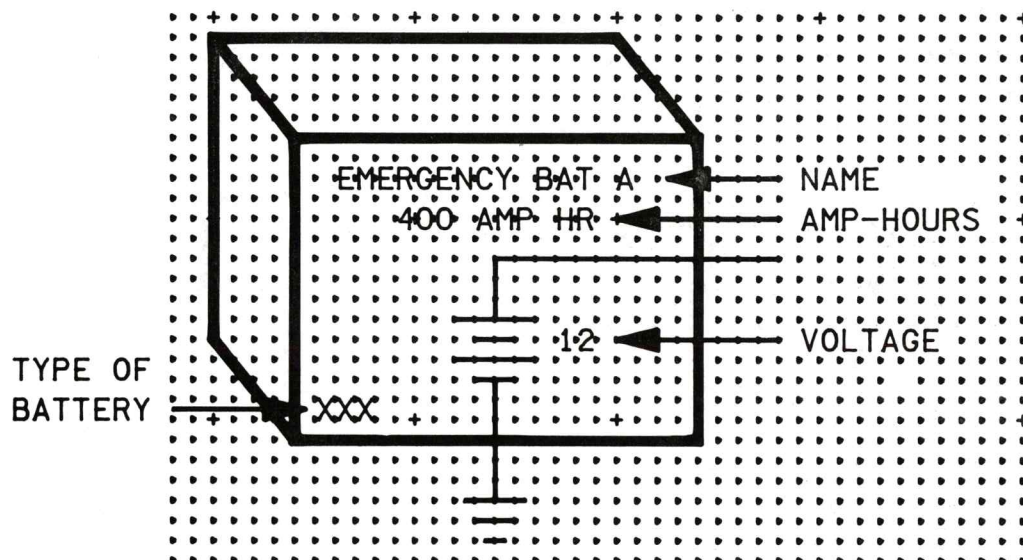
C. Lanyard Disconnect (Electrical)



D. Surface Contact Electrical Disconnect

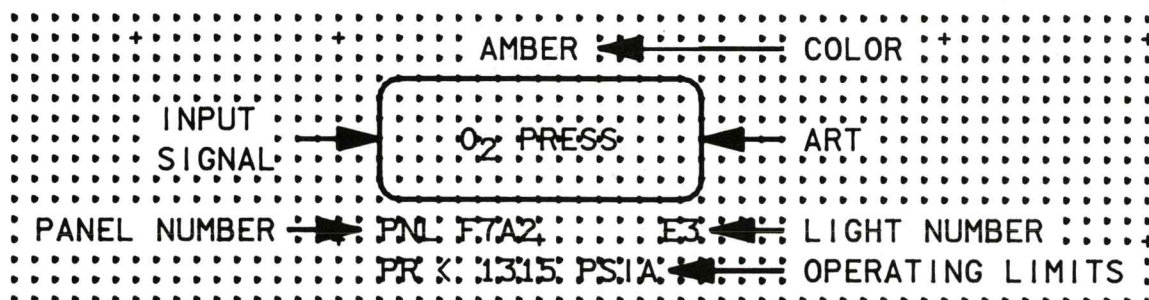


3.2.7 Batteries. - Use no. 4 line weight to outline battery box. Size will vary with number of cells and drawing arrangement.

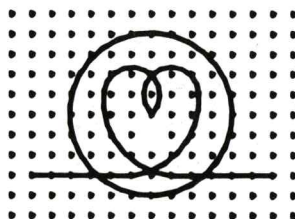


3.2.8 Lights. -

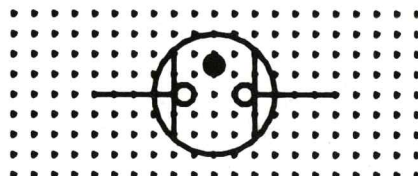
A. Caution and warning



B. Incandescent



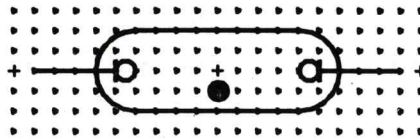
C. Electro luminescent



Note

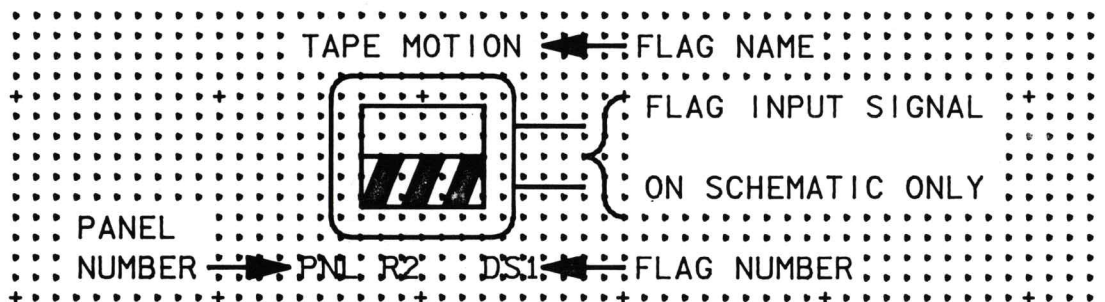
In addition to the light symbols, the actual artwork associated with a panel light may also be added.

D. Fluorescent

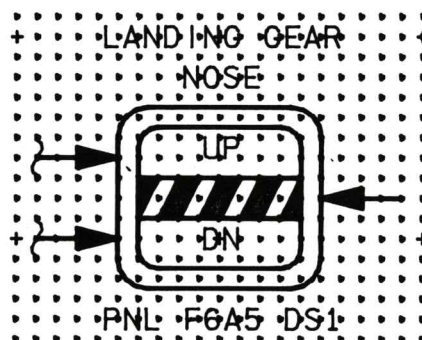


3.2.9 Flags. - Flag symbol artwork will not necessarily reflect switch position of the associated switch.

A. Dual state flag

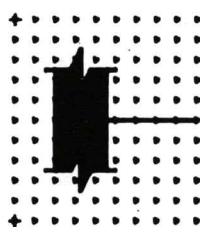


B. Three-position flag



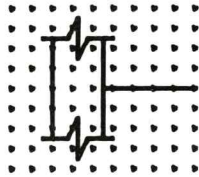
3.2.10 Buses. -

A. Positive or negative bus



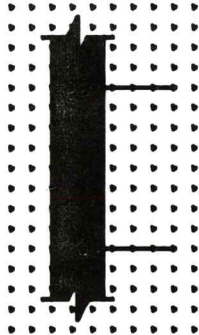
THIS SYMBOL WILL BE USED FOR EITHER A POSITIVE OR A NEGATIVE BUS AND WILL ALWAYS BE LABELED WITH THE APPROPRIATE BUS (ID). BUSES WILL ALWAYS BE SHOWN IN A VERTICAL POSITION.

B. Common or return bus



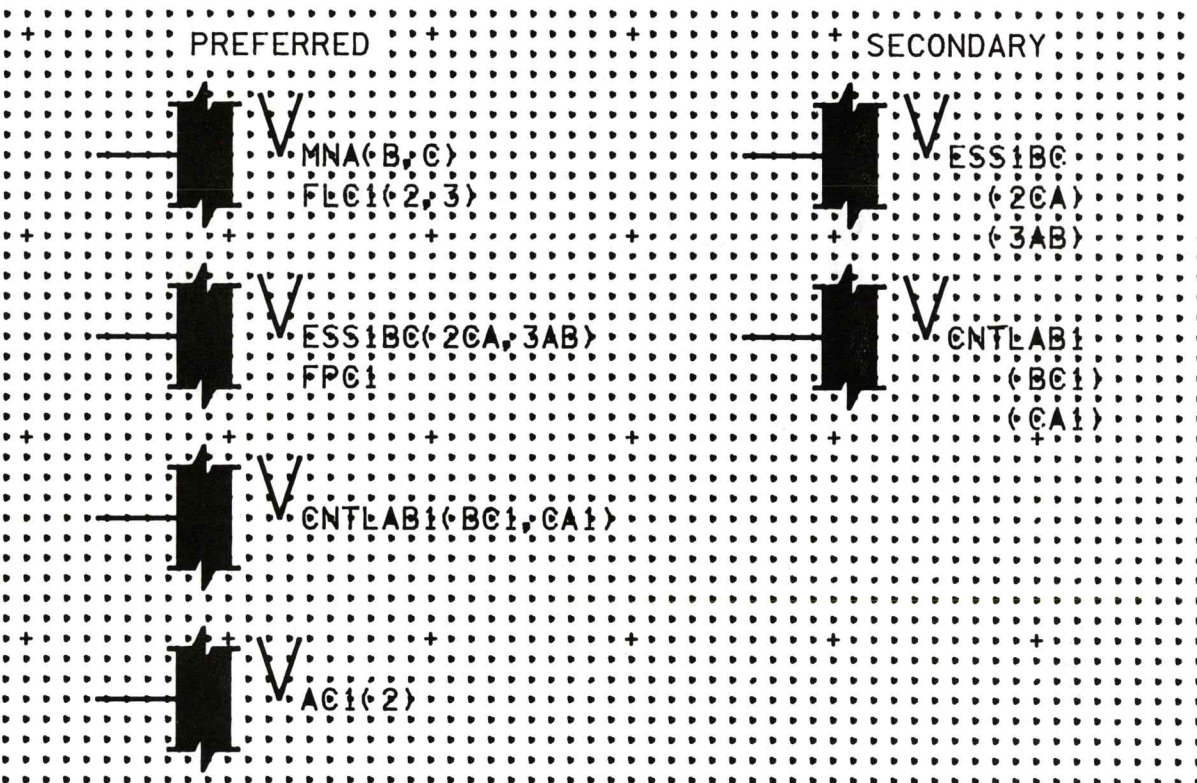
COMMON OR RETURN BUS
SYMBOL WILL ALWAYS BE
LABELED

C. Bus with multiple wires



D. Shadowboxing of buses

Shadowboxing of buses will be as follows. Notice that there is no requirement to show nomenclature for the appropriate system because it is assumed that System 1 is first, System 2 is second, and System 3 is third.

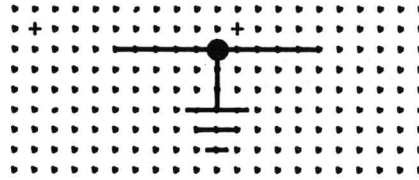


Note

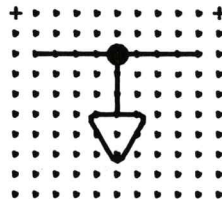
Bus symbols will always be labeled with the appropriate bus ID.

3.2.11 Grounds. -

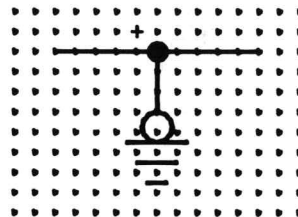
A. System



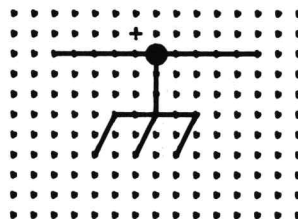
B. Logic



C. Floating



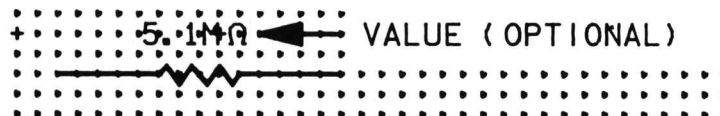
D. Frame or spacecraft structural ground



3.3 Electrical and electronic devices. -

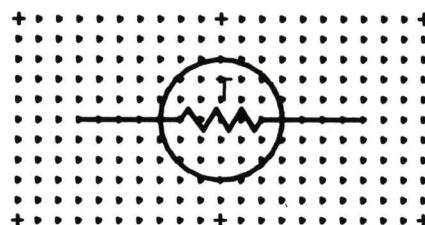
3.3.1 Resistors. -

A. Fixed



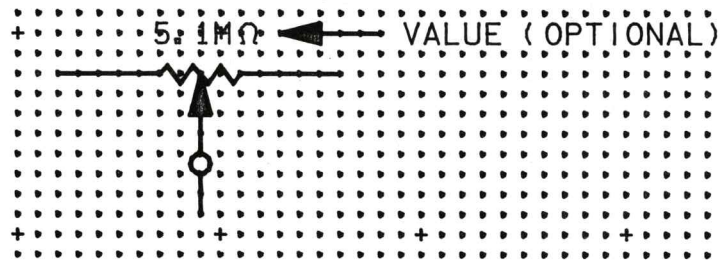
B. Thermistor or resistance thermometer

Any element whose sensing resistance varies with temperature regardless of polarity

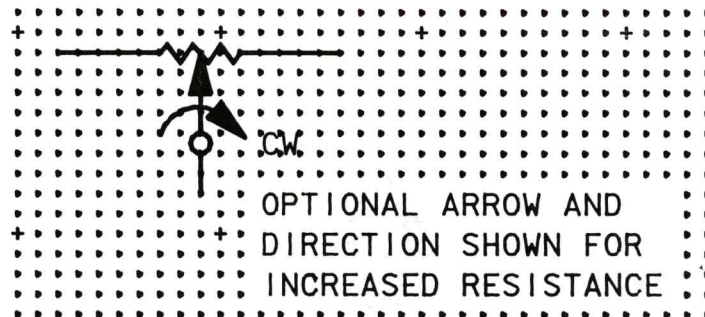


3.3.2 Potentiometers. -

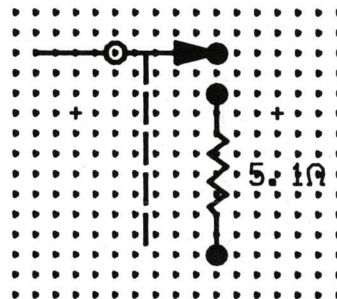
A. Standard



B. Optional



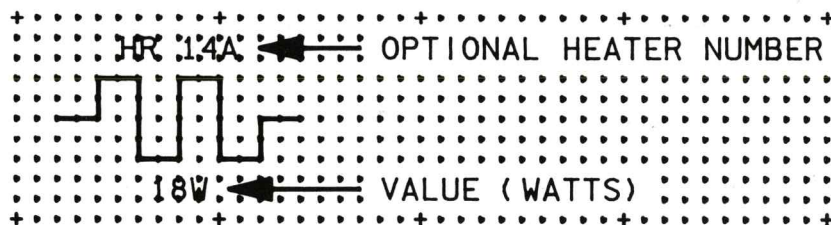
C. Off/on potentiometer



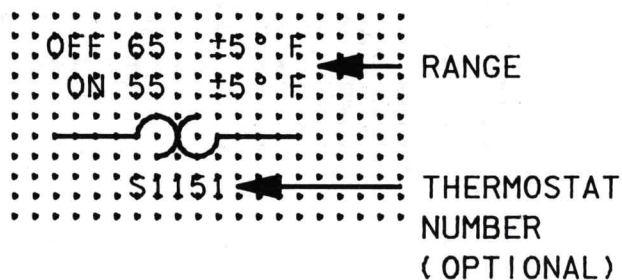
Note

Potentiometer symbol may also be shown vertically.

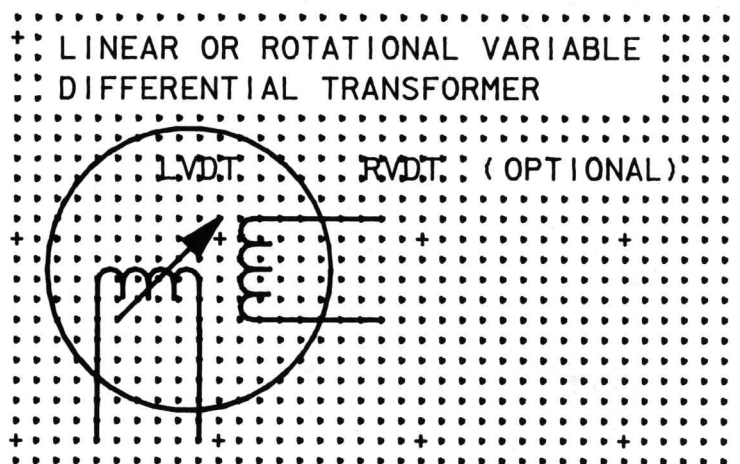
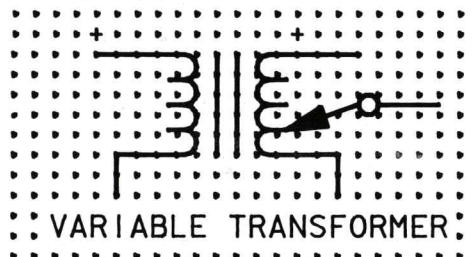
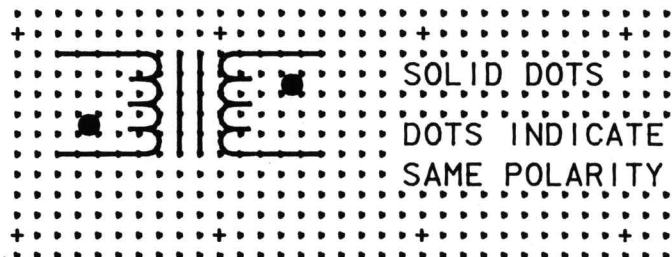
3.3.3 Heater. -



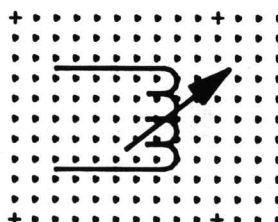
3.3.4 Thermostat. -



3.3.5 Transformers. -

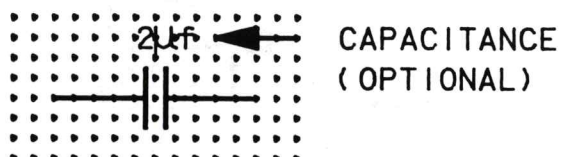


3.3.6 Variable Inductor. -

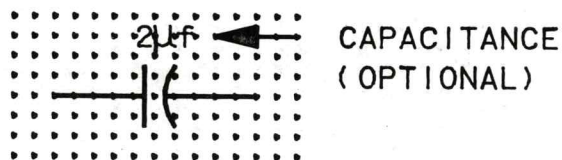


3.3.7 Capacitors. -

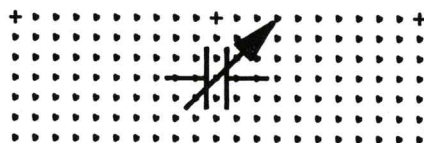
A. Fixed



B. Polarized



C. Variable

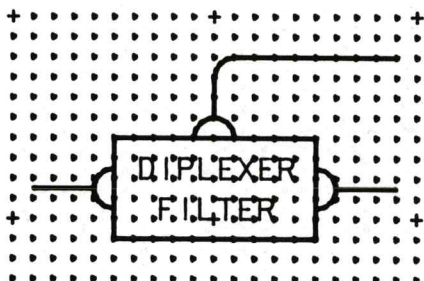


3.3.8 Electrical filters. -

A. Standard filter

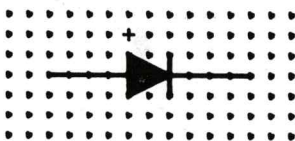


B. Diplexer filter

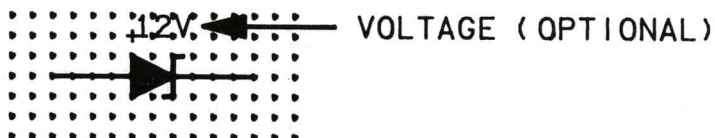


3.3.9 Diodes. -

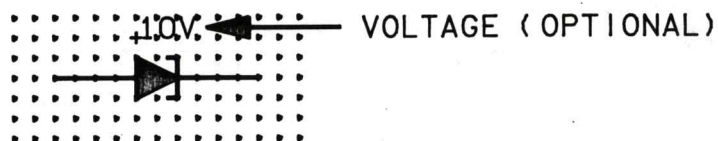
A. General



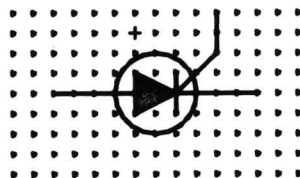
B. Zener



C. Tunnel

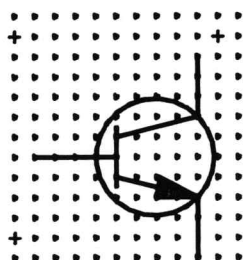


D. Control rectifier (SCR)

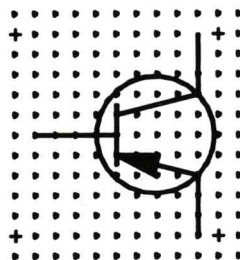


3.3.10 Transistors. -

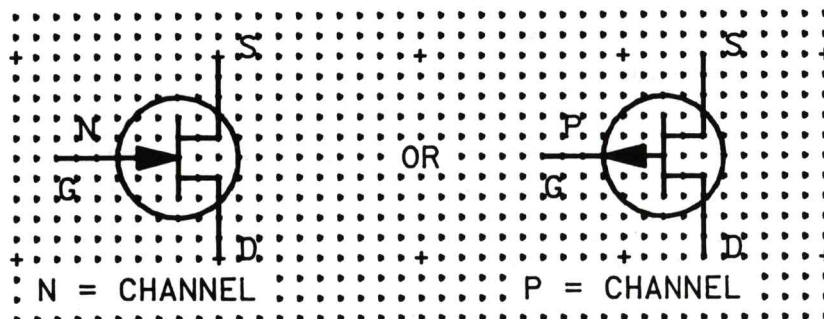
A. NPN



B. PNP transistor



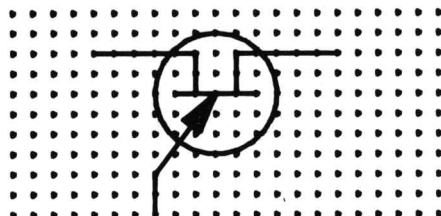
C. Field effect transistor (FET)



A POS V ON G TURNS-ON

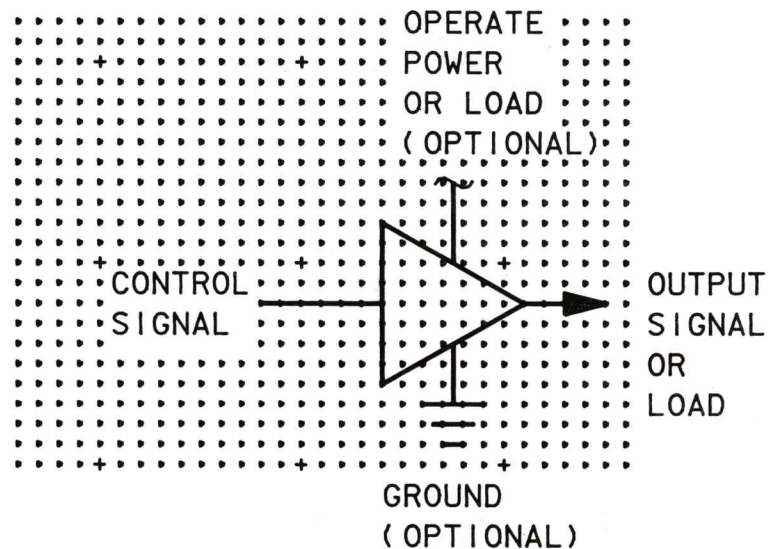
A NEG V ON G TURNS-ON

D. Unijunction transistor

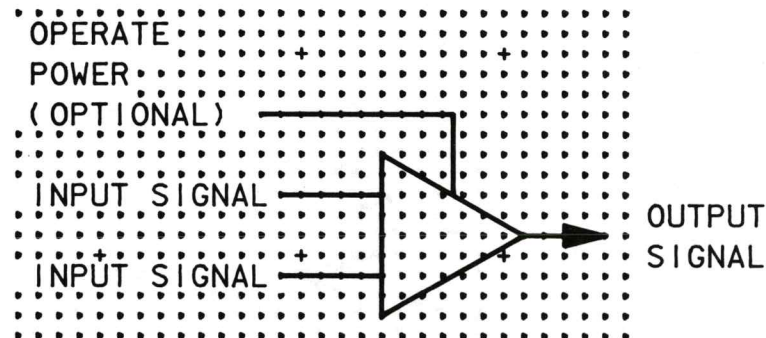


3.3.11 Amplifiers or drivers. -

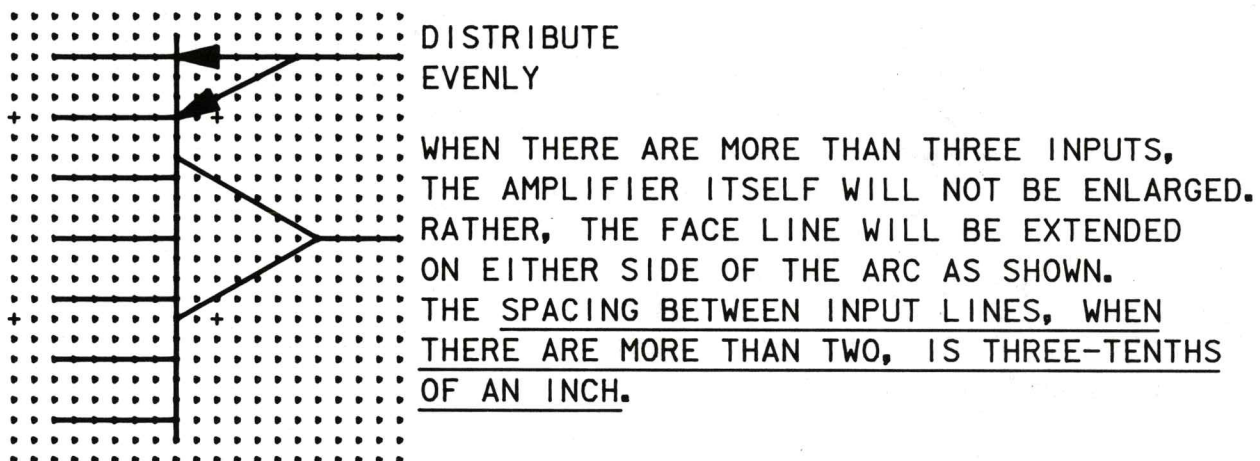
A. General



B. Operational amplifier

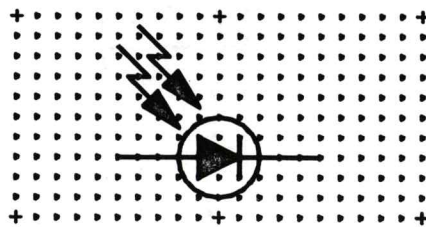


C. Amplifier with more than three inputs

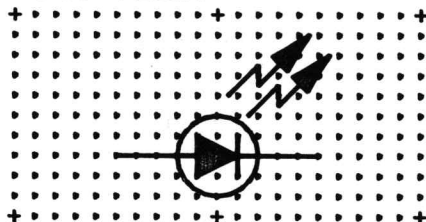


3.3.12 Photoelectric devices. -

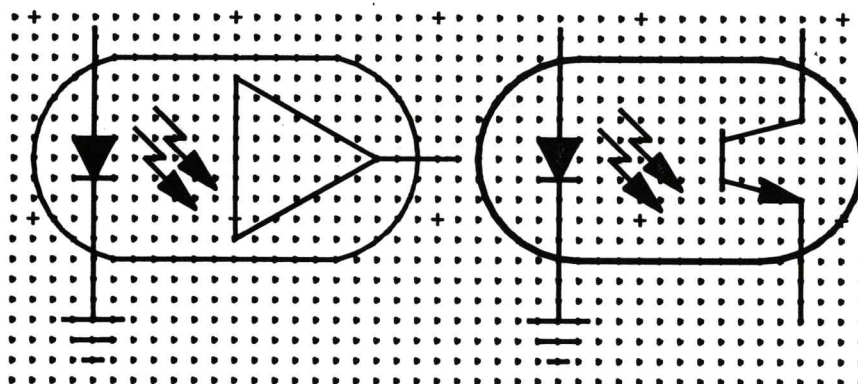
A. Photodiode



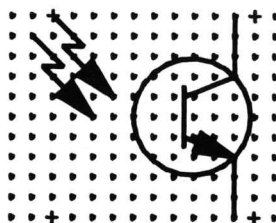
B. Light emitting diode (LED)



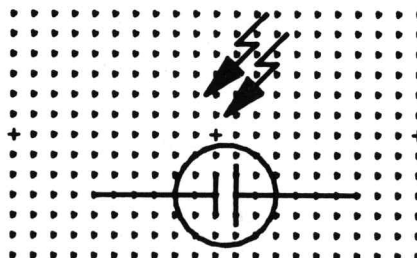
C. Optical couplers or optoisolators



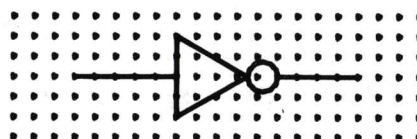
D. Photo transistor



E. Photoelectric cell

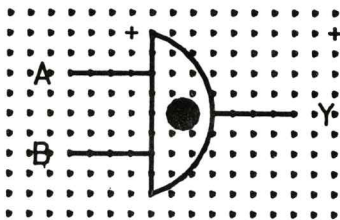


3.3.13 Signal Inverter. -



3.3.14 Gates. -

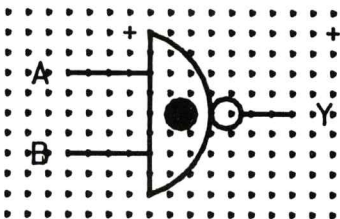
A. And



A	B	Y
1	1	1
1	0	0
0	1	0
0	0	0

$$Y = A \bullet B$$

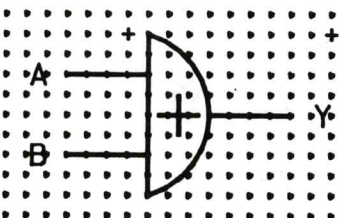
B. Nand



1	1	0
1	0	1
0	1	1
0	0	1

$$Y = \overline{A \bullet B}$$

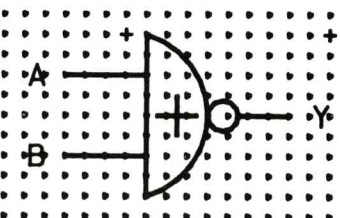
C. Or



1	1	1
1	0	1
0	1	1
0	0	0

$$Y = A + B$$

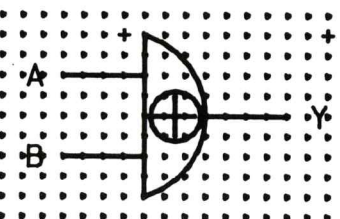
D. Nor



1	0	0
0	1	0
1	1	0
0	0	1

$$Y = \overline{A + B}$$

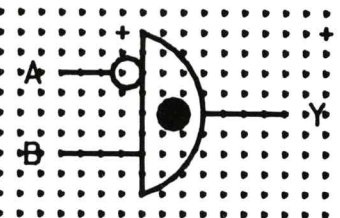
E. Exclusive or



1	1	0
1	0	1
0	1	1
0	0	0

$$Y = A \oplus B$$

F. And (Inverted Input)



1	1	0
1	0	0
0	1	1
0	0	0

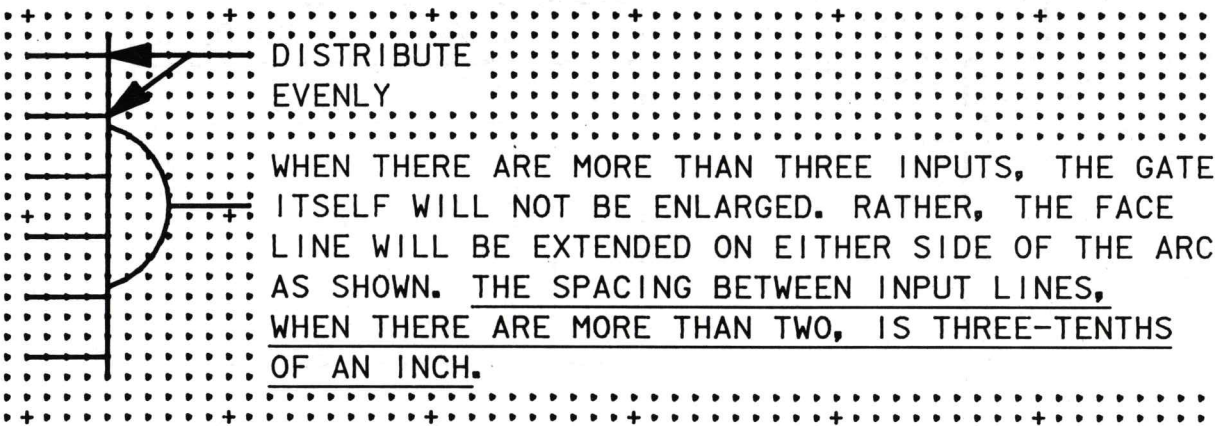
$$Y = \bar{A} \bullet B$$

TRUTH TABLE
IS OPTIONAL

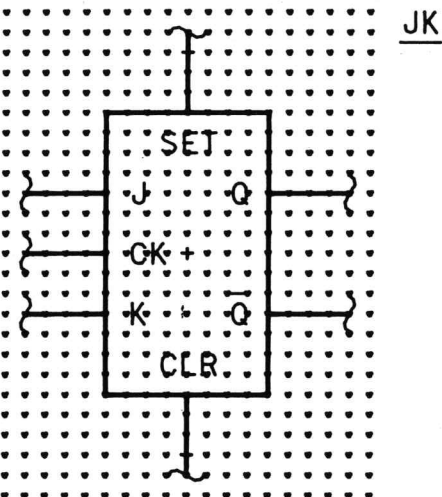
Note

Unshaded circle indicates an inverter.

G. More than three Input lines



3.3.15 Flip/flop. -



FUNCTION TABLE

INPUTS					OUTPUTS	
SET	CLR	CK	J	K	Q	$\bar{Q}$
0	1	X	X	X	1	0
1	0	X	X	X	0	1
0	0	X	X	X	1*	1*
1	1	↓	0	0	No chg	
1	1	↓	1	0	1	0
1	1	↓	0	1	0	1
1	1	↓	1	1	Toggle	

X = IRRELEVANT INPUT

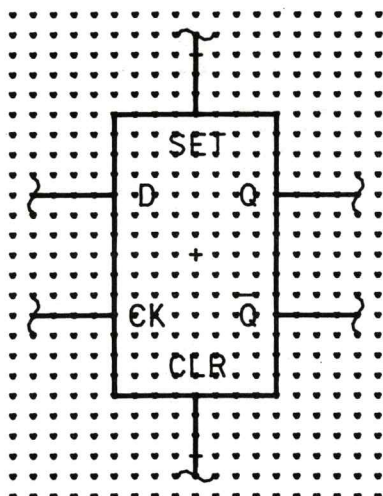
0 = LOW LEVEL

1 = HIGH-LEVEL OR UNCONNECTED INPUT

↓ = TRANSITION FROM 1 TO 0

* THIS CONFIGURATION IS UNSTABLE. IT WILL CHANGE WHEN SET AND CLR INPUTS BECOME 1.

INPUTS WITH CONTINUOUS 1 MAY BE LEFT UNCONNECTED. UNCONNECTED TERMINALS, EXCEPT FOR THE IDENTIFYING TERMINALS J AND K, MAY BE LEFT UNLABELED. FLIP-FLOP IS EDGE-TRIGGERED.

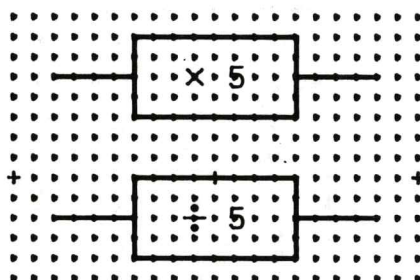


INPUTS				OUTPUTS	
SET	CLR	CK	D	Q	$\bar{Q}$
0	1	X	X	1	0
1	0	X	X	0	1
0	0	X	X	1*	1*
1	1	↑	1	1	0
1	1	↑	0	0	1

NOTES: SAME AS FOR J-K FLIP-FLOP EXCEPT
 ↑ = TRANSITION FROM 0 TO 1

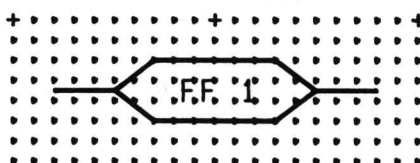
UNCONNECTED TERMINALS, EXCEPT FOR THE IDENTIFYING
 TERMINAL D, MAY BE LEFT UNLABELED.

3.3.16 Multiplier or divider. -



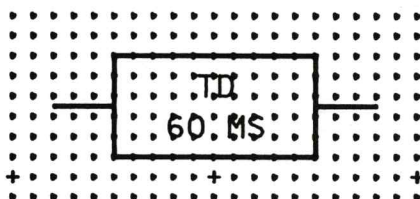
3.3.17 Multiplexer de-multiplexer (MDM). -

For telemetered measurements. MDM symbol not used for
 OI/DFI.

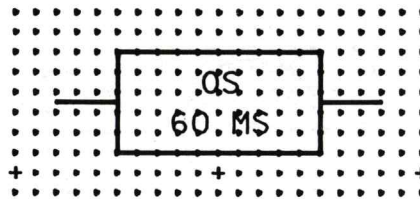


3.3.18 Time delay. -

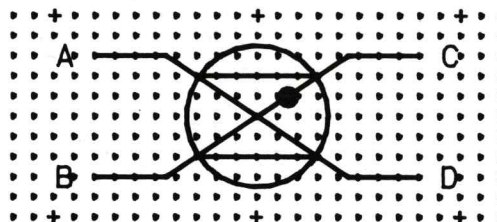
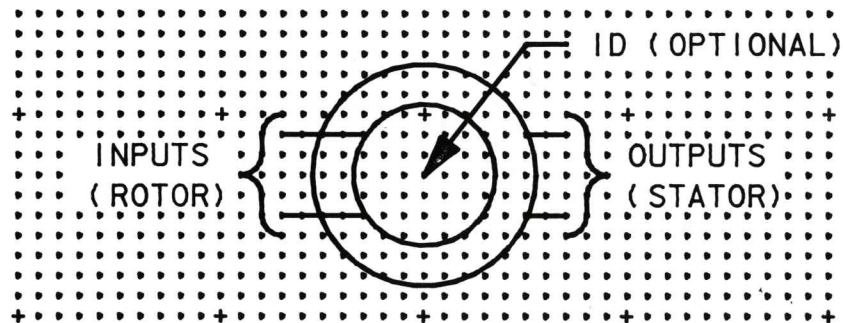
A. Standard



B. One shot



3.3.19 Synchro resolver. -

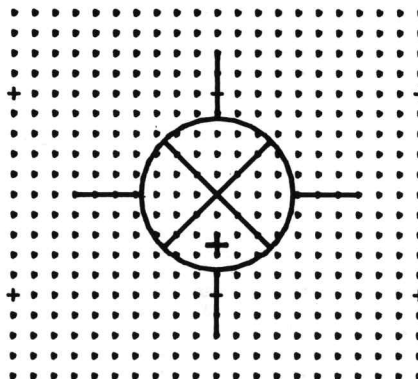


$$C = A \cos \alpha - B \sin \alpha$$

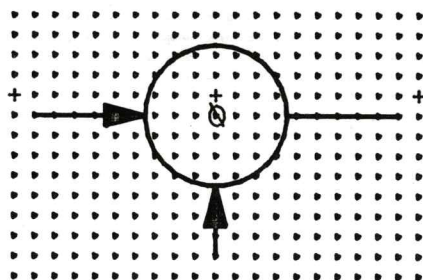
$$D = A \sin \alpha + B \cos \alpha$$

DOT DENOTES $-\sin \alpha$

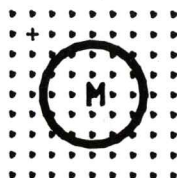
3.3.20 Summing network. - Signs are required.



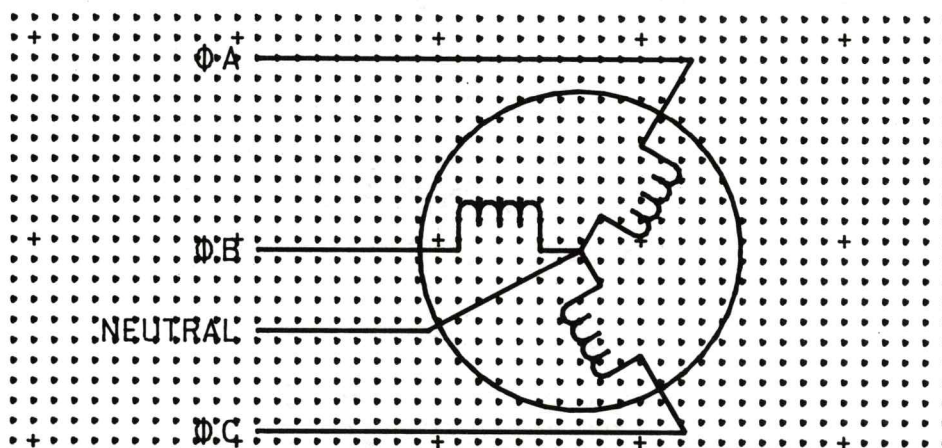
3.3.21 Phase detector. -



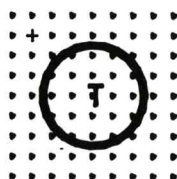
3.3.22 Motor. -



A. Neutral three-phase AC motor.

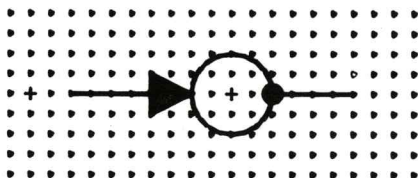


3.3.23 Tachometer. -

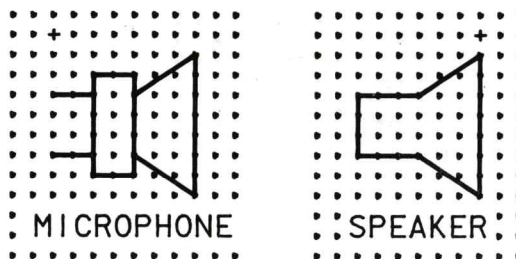


RANGE: 10,000-20,000 RPM

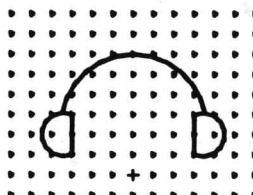
3.3.24 Slip ring. -



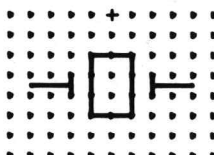
3.3.25 Microphone or Speaker. -



3.3.26 Headset. -

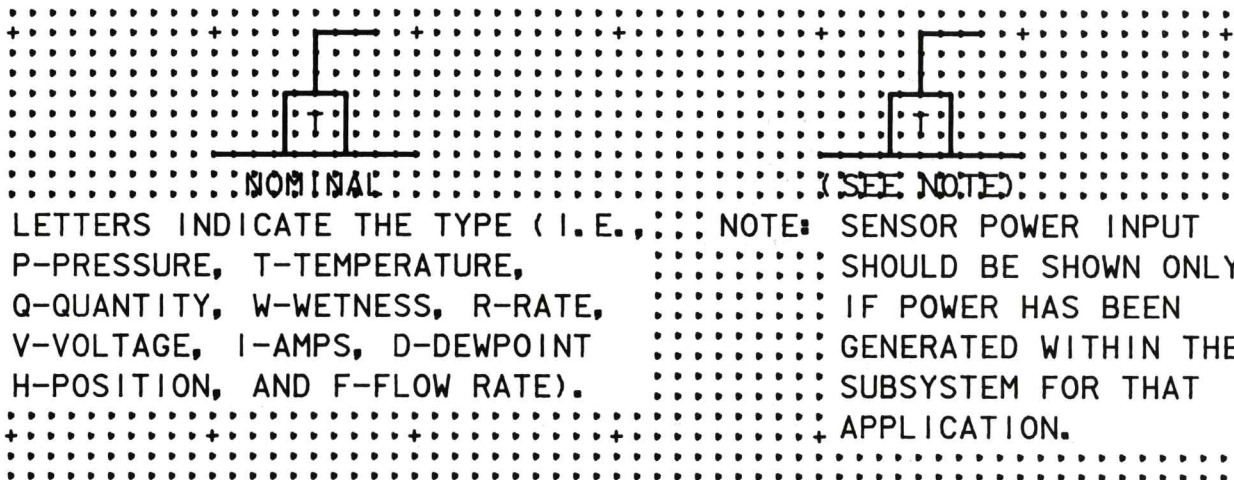


3.3.27 Crystal. -

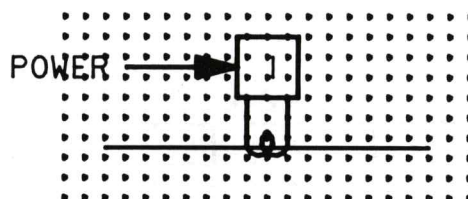


3.3.28 Sensors. -

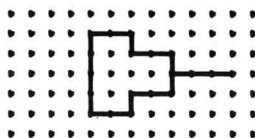
A.



B. Powered sensor (Inductive pickup)

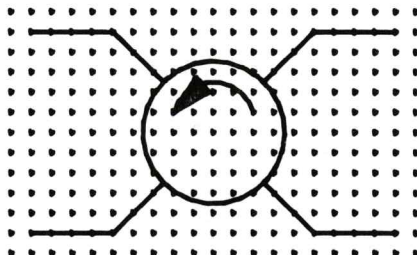


3.3.29 Biomedical Electrode. -

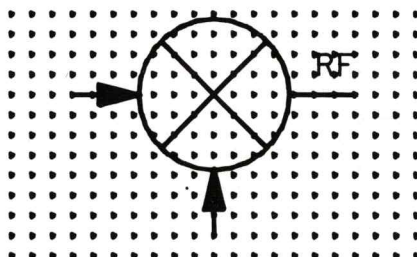


3.4 RF. -

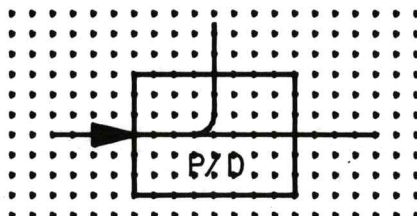
A. RF circulator



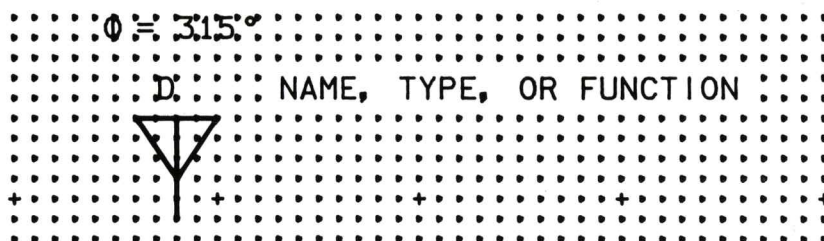
B. RF mixer



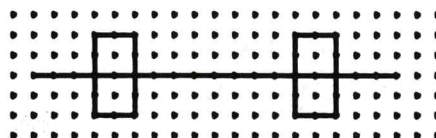
C. RF power divider



3.4.1 Antenna. -



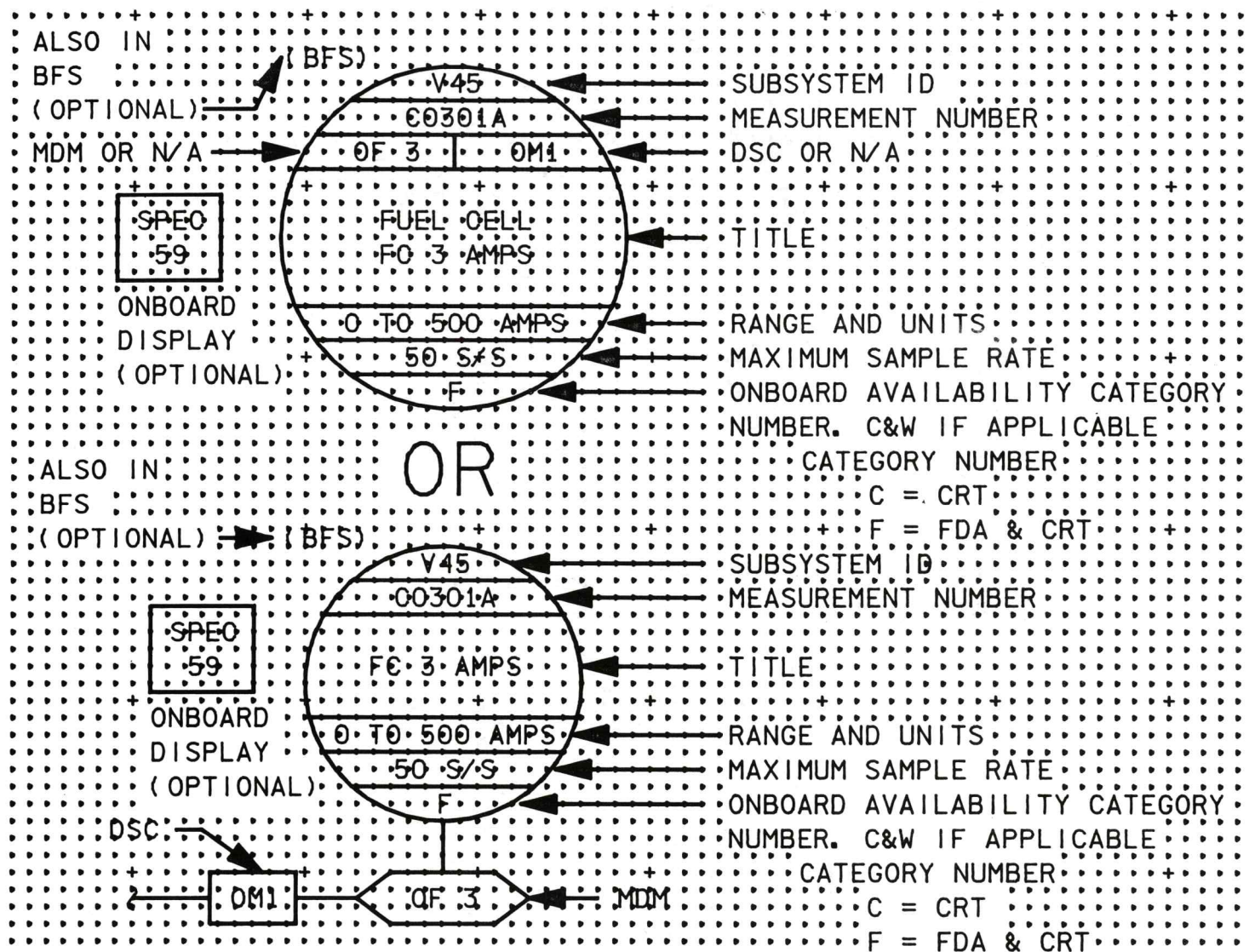
3.4.2 Wave Guide. -



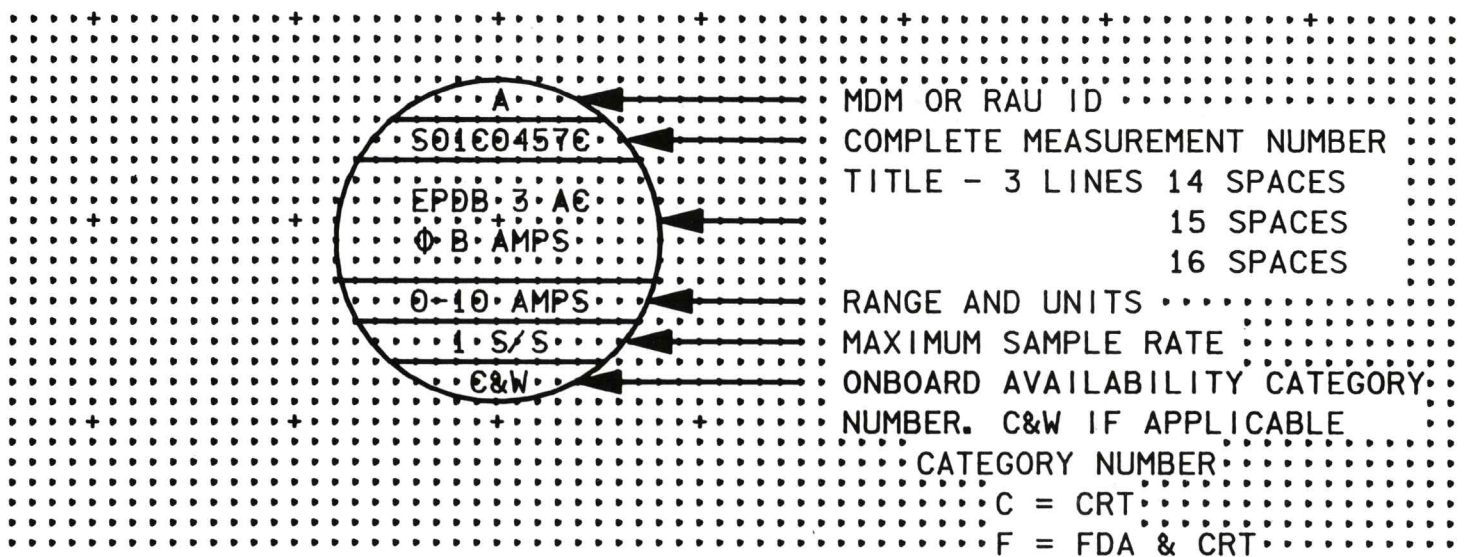
3.5 Telemetry Symbols

3.5.1 Measurements telemetered. -

A. OFI or DFI orbiter

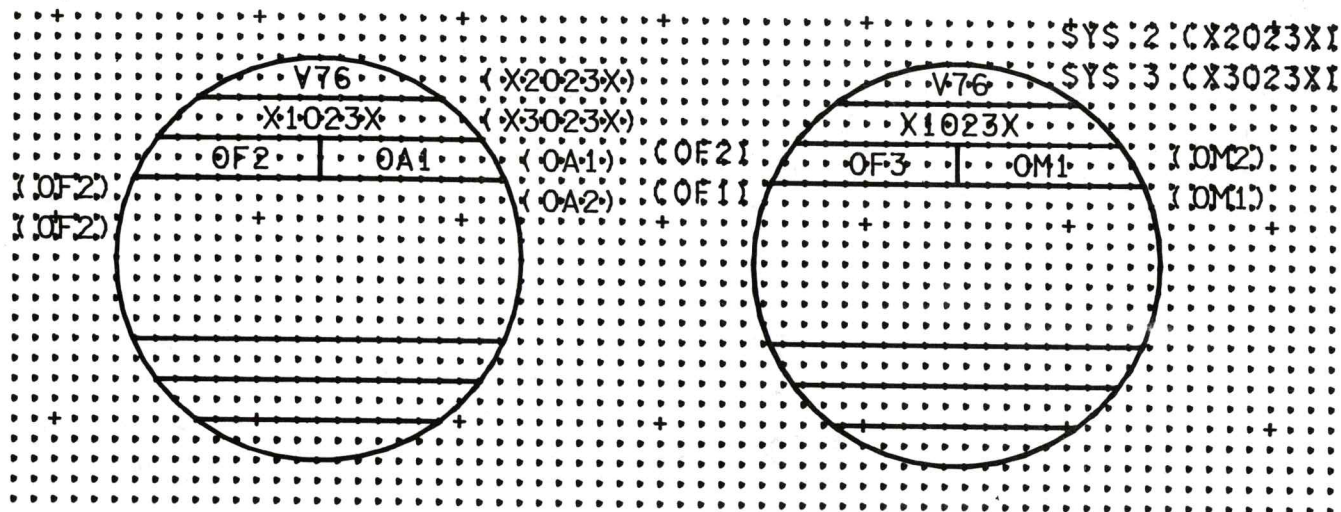


B. OFI or VFI space lab

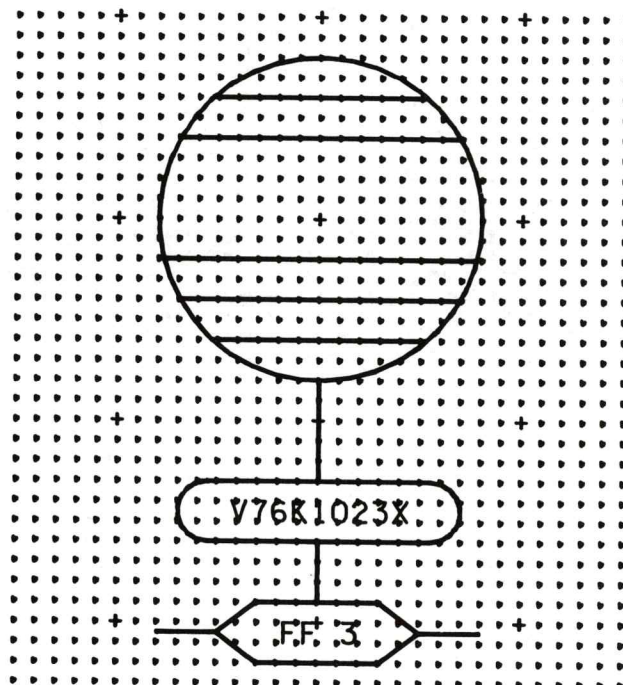


C. Shadowboxing telemetry bubbles

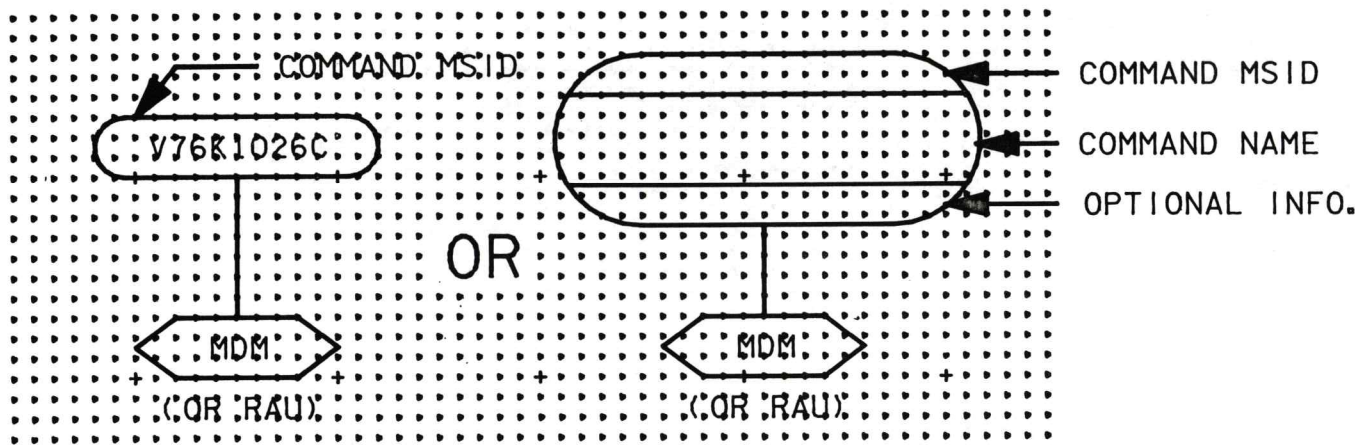
Shadowboxing of telemetry bubbles will be as follows. The extra numbers can be placed on any side of the bubble. Notice the second and third systems are designated if desired.



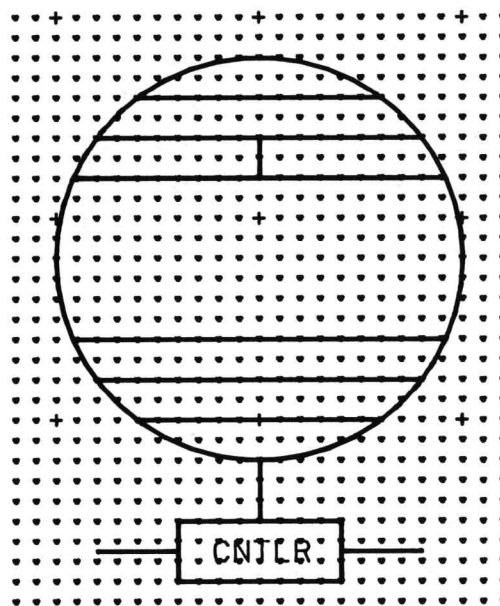
D. Stimuli command or GPC output with GPC downlink. Shadowboxing same as TM bubbles.



E. Stimuli, Command MSID Shadow boxing same as TM



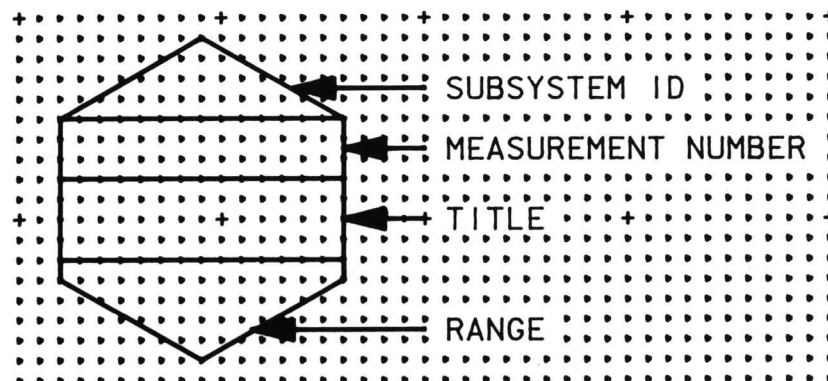
F. For SSME TM transmitted from controller to EIU to GPC



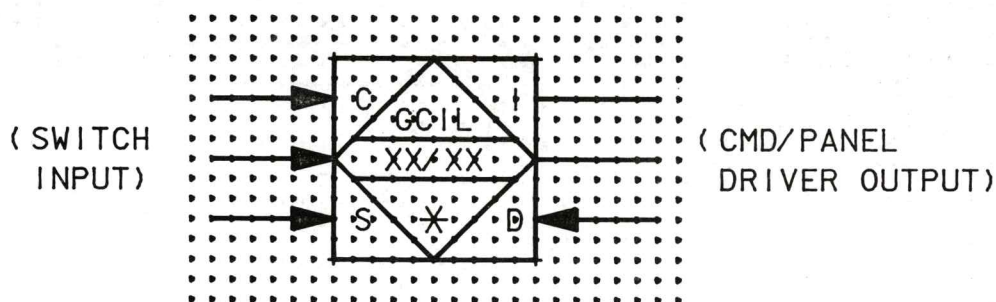
Note

Inputs to controller may come
in from any side.

G. Measurements to GSE



3.5.2 GCIL Ground Commands



NOTES

1. DESIGNATIONS:

- C - COMMAND DRIVER POWER
- I - INTERLOCK OUTPUT (PRESENT WHEN EITHER COMMAND OR PANEL DRIVER ON)
- D - DRIVER SENSE (WHEN HIGH WILL HOLD DRIVER ON WHEN CREW CONTROL SWITCH IS POSITIONED FROM PANEL TO COMMAND)
- S - SERIES INTERLOCK (WHEN HIGH OR NOT CONNECTED ENABLES COMMAND DRIVER TO BE COMMANDED ON)

GCIL - DESIGNATES GCIL COMMAND ROUTING

XX/XX - XX IS THE BOARD DESIGNATOR A3 THRU A-18,
/XX IS THE DRIVER NUMBER 1-16

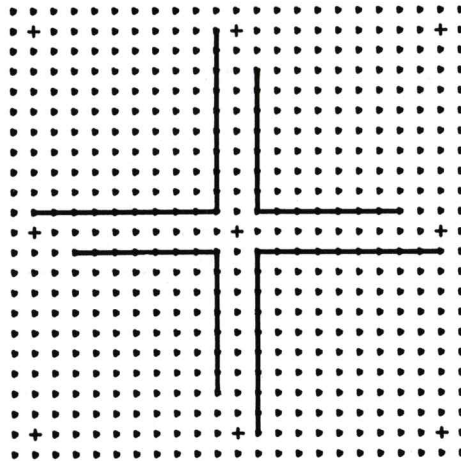
- * PM - FOR S-BAND PM CREW CONTROL SWITCH
- FM - FOR S-BAND FM CREW CONTROL SWITCH
- KU - FOR KU-BAND CREW CONTROL SWITCH
- N - FOR NOT ANY CREW CONTROL SWITCH
- PL - FOR PAYLOAD CREW CONTROL SWITCH
- M - FOR MODE VOLTAGE NOT FROM CREW CONTROL SWITCH (INPUT LINE USED ONLY WITH 'M' DESIGNATION)

2. IN THE CREW CONTROL 'PNL' MODE OR 28VDC INPUT TO 'M', THE SWITCH INPUT POWERS AND ACTIVATES THE PANEL DRIVER WHICH IS ROUTED TO THE OUTPUT.
3. COMMAND NAME WILL BE ADJACENT TO THE SYMBOL.

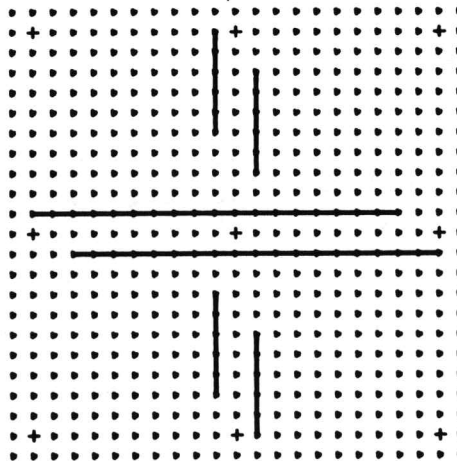
3.6 Pipe Legend

3.6.1 General. -

A. Plumbing Connected



B. Plumbing Crossover



3.6.2 Line Designation. -

WATER



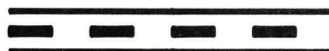
OXYGEN



FUEL



HYDROGEN



HYDRAULIC
FLUID



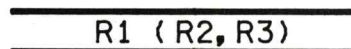
SENSE LINE



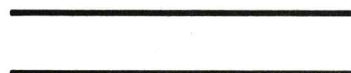
HYDRAULIC
PRESSURE



HYDRAULIC
RETURN



SUIT LOOP

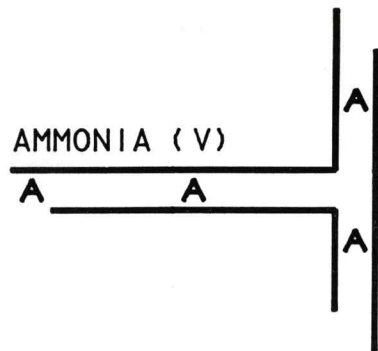


FREON

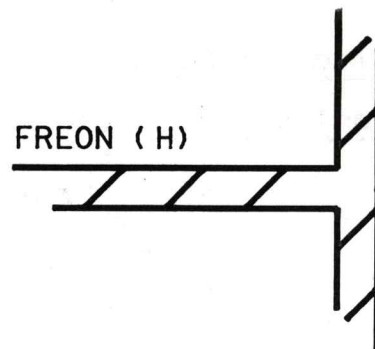


OTHERS

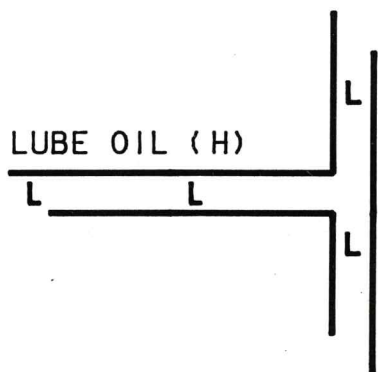




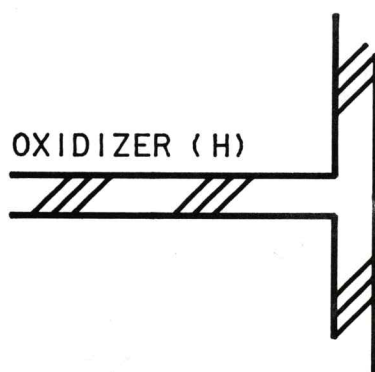
AMMONIA (V)



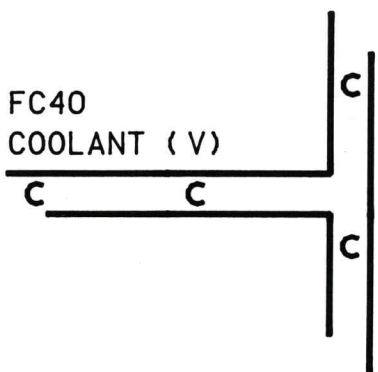
FREON (V)



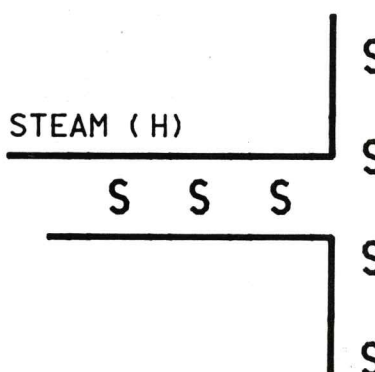
LUBE OIL (V)



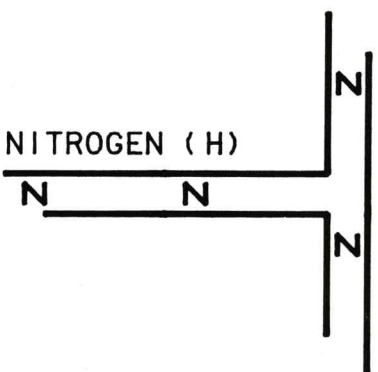
OXIDIZER (V)



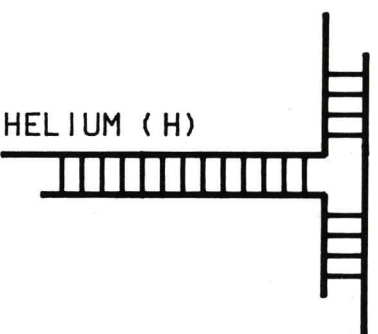
FC40
COOLANT (V)



STEAM (V)



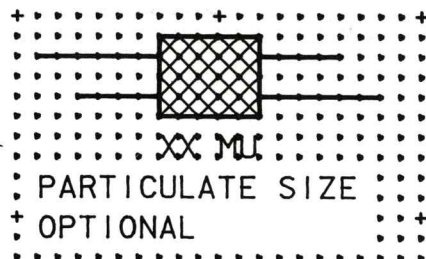
NITROGEN (V)



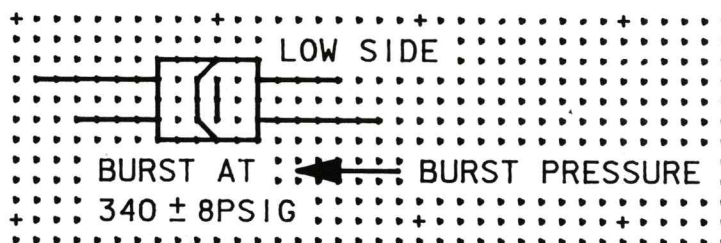
HELIUM (V)

3.7 Mechanical Symbols

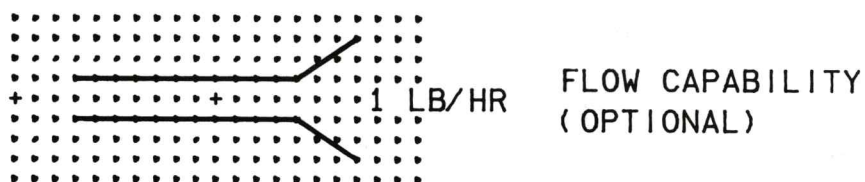
3.7.1 Mechanical Filter. -



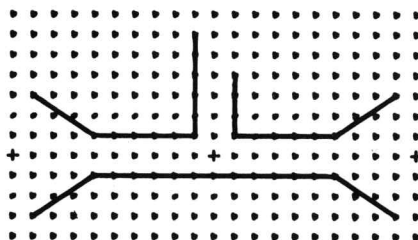
3.7.2 Burst Diaphragm. -



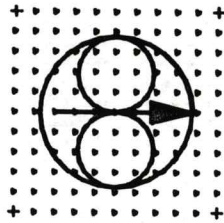
3.7.3 Nozzle. -



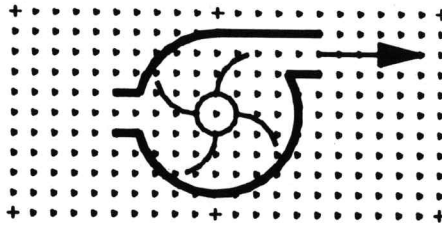
3.7.4 Nonpropulsive vent (NPV). -



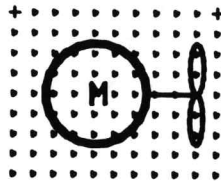
3.7.5 Pump. -



3.7.6 Centrifugal pump. -

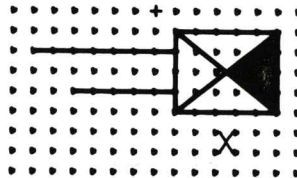


3.7.7 Fan. -



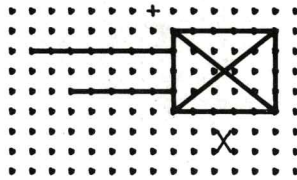
3.7.8 Disconnects. -

A. Self Sealing



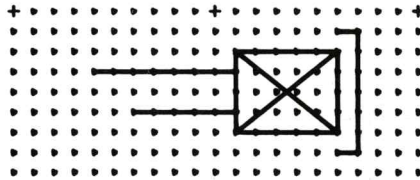
X = M OR F (MALE OR FEMALE)

B. Quick

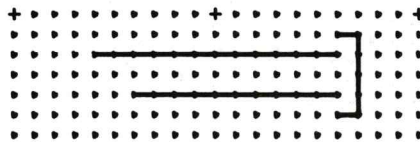


X = M OR F (MALE OR FEMALE)

C. Quick-disconnect capped

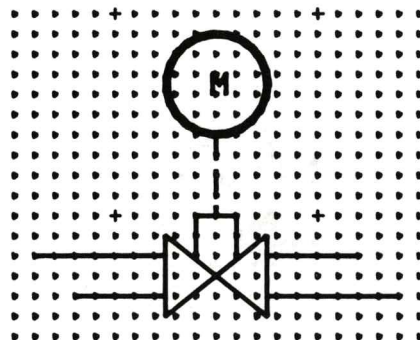


D. Fill and drain or test point - Capped

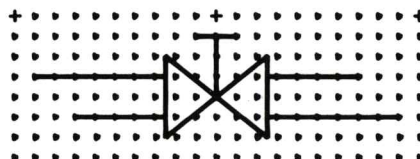


3.7.9 Valves. -

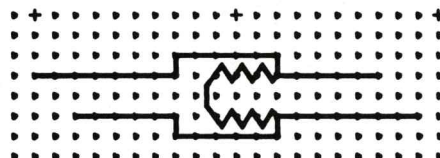
A. Motor-controlled



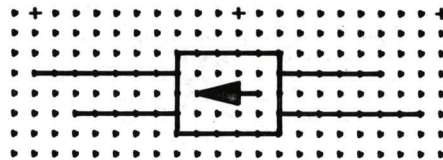
B. Manual-controlled



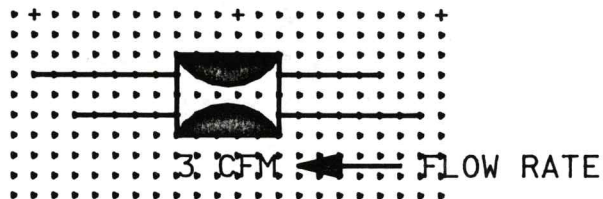
C. Bellows



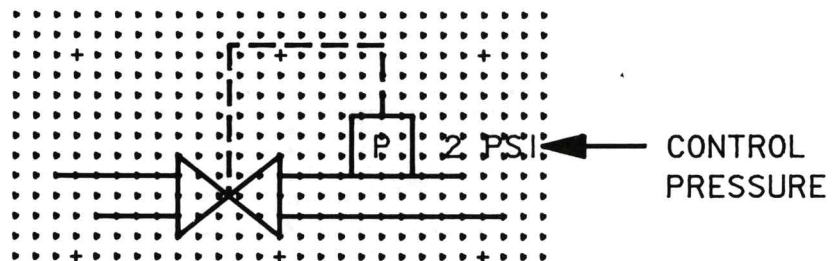
D. Check-valve



E. Orifice or venturi



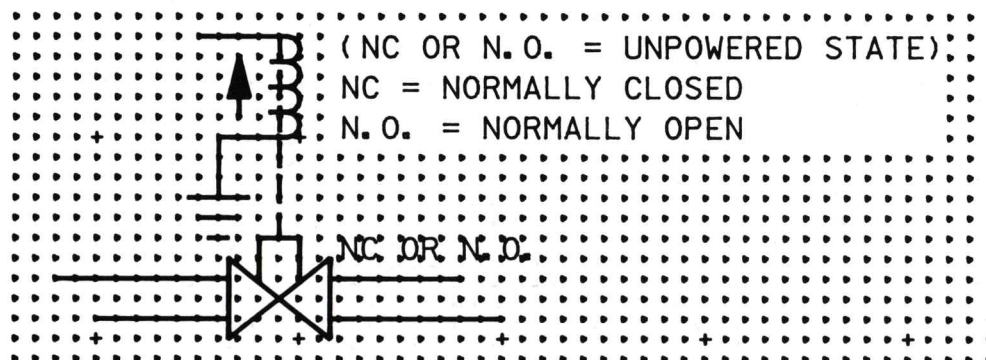
F. Pressure regulator



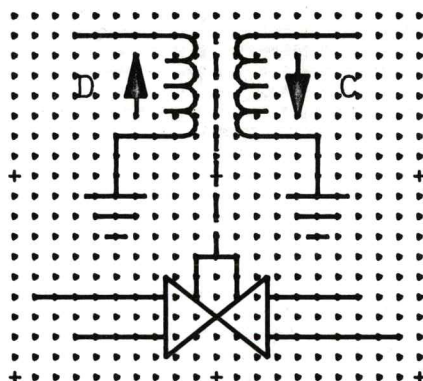
G. Relief valve



H. Spring-loaded solenoid valve

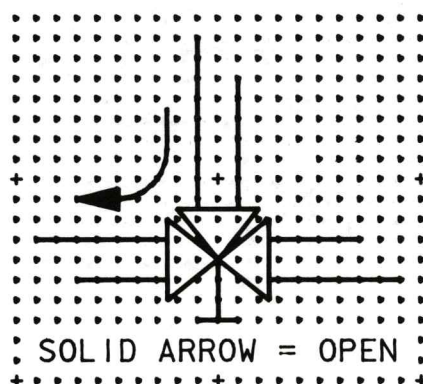


I. Latching solenoid valve

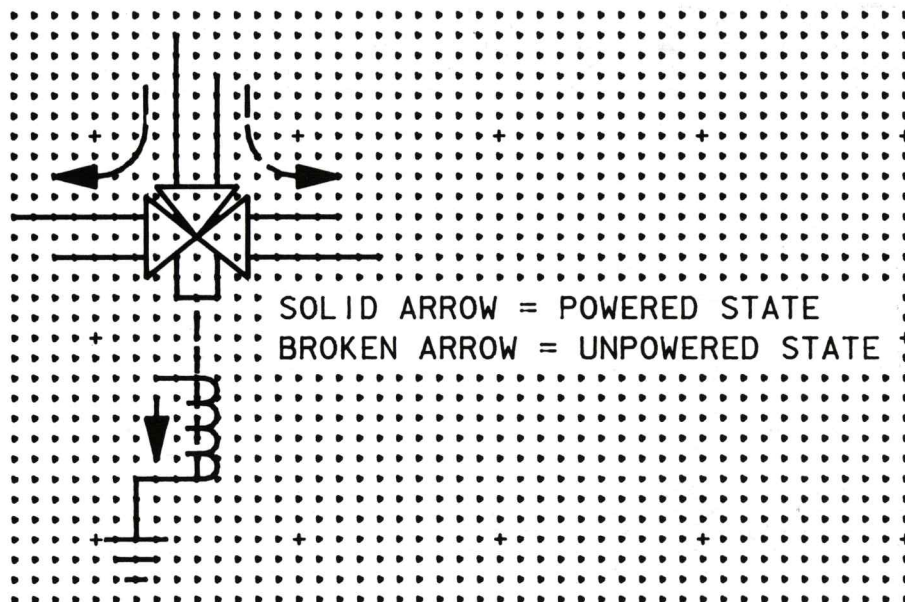


J. Three-way valves

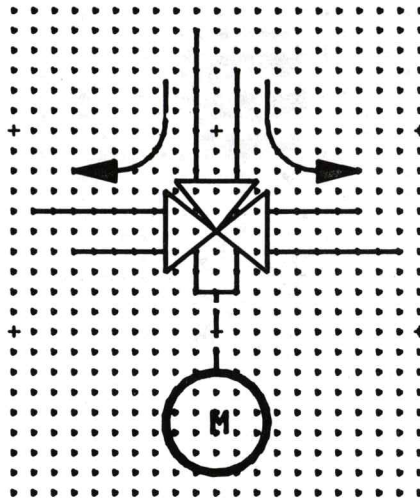
1. Manual



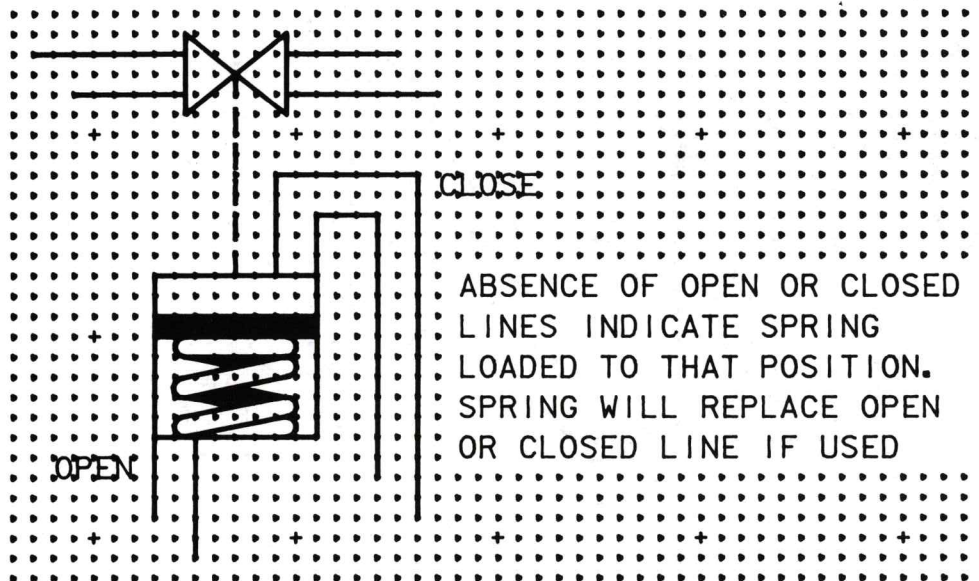
2. Solenoid



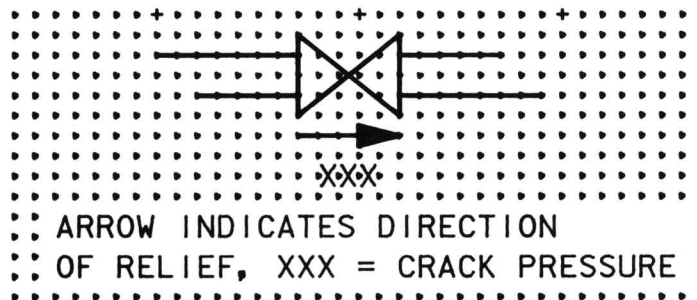
3. Motor-controlled



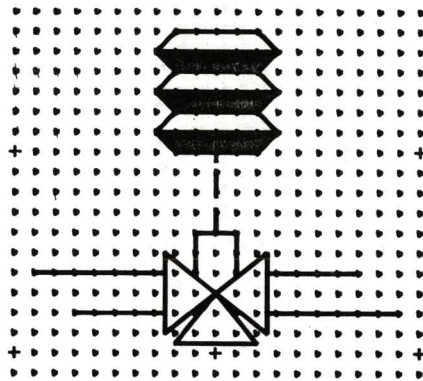
K. Pneumatic valve



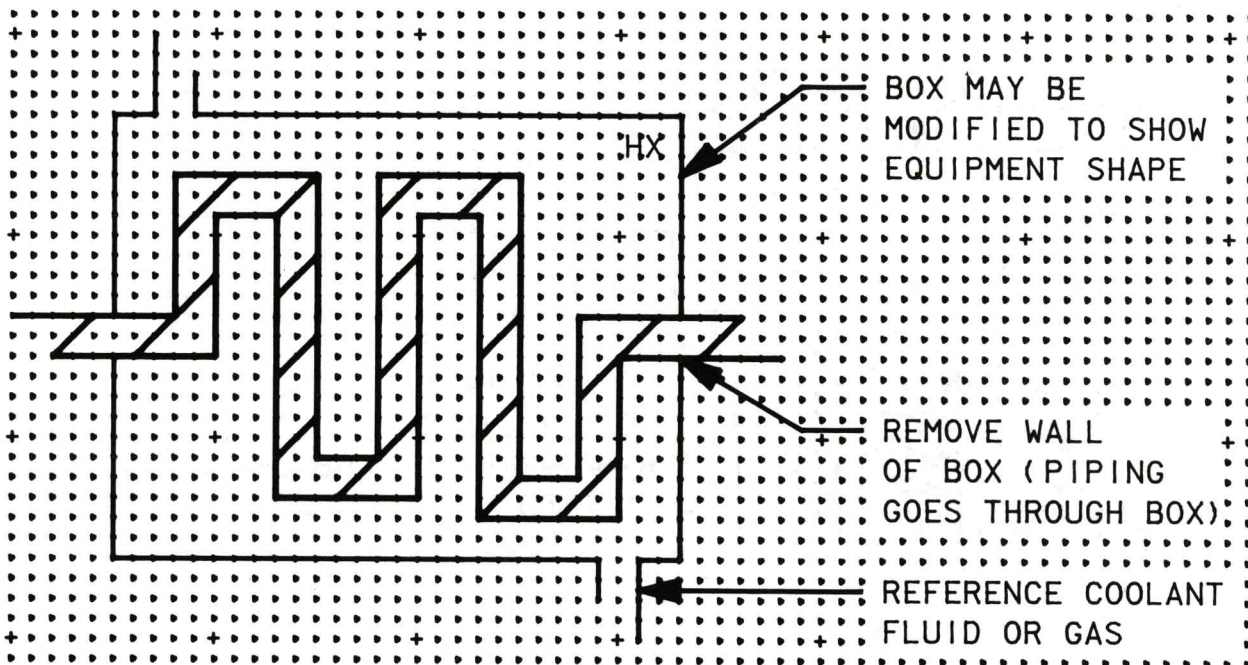
L. Internally relieving valve



M. Aneroid

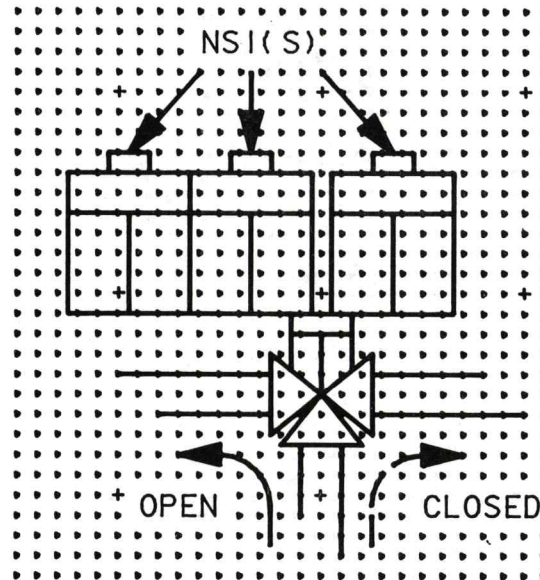


3.7.10 Heat exchanger. -

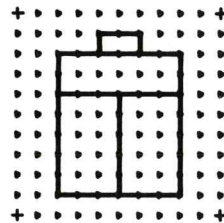


3.8 Pyrotechnic Symbols

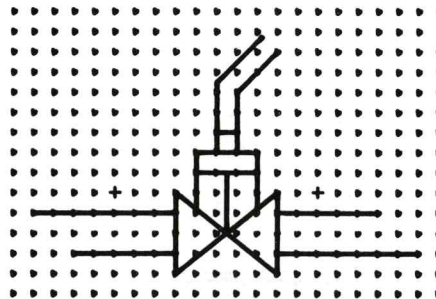
A. Three-way pyrotechnic valve



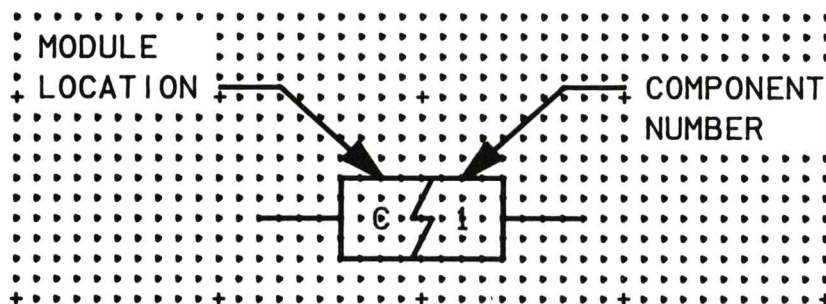
B. Pyro Initiator



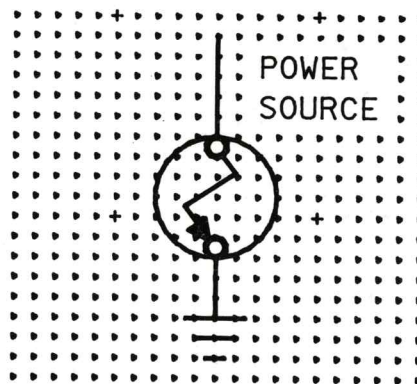
C. Pyro valve with single Initiator



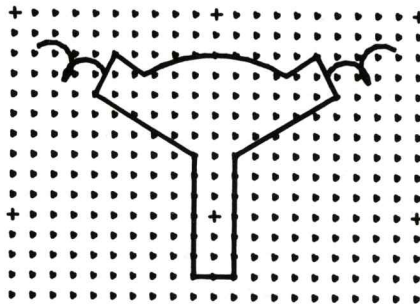
3.8.1 Pyro electrical circuit Interrupter.-



3.8.2 Explosive Initiator. -



A. Spark Ignitor



B. Mild detonating fuse (MDF)

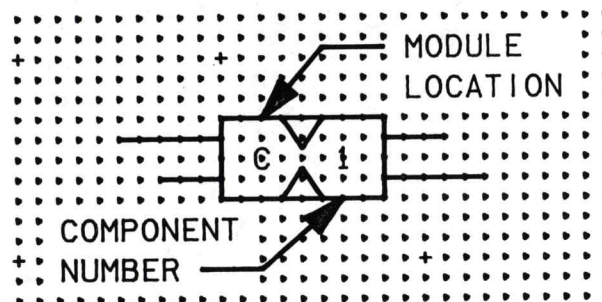


C. Shielded MDF

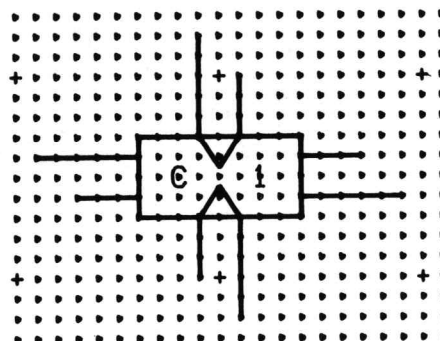


3.8.3 Gullotine. -

A. Electrical



B. Gas-operated



MOD Drafting Standards

Distribution List

NASA-JSC

CB/Shuttle Office	12
DA/E. F. Kranz	1
DA8/Flight Director Office	2
DC4/Support Systems	1
DF/J. Knight	1
DF/S. G. Bales	1
DF2/Communications & Data Systems	6
DF4/Mechanical & Crew Systems	36
DF6/Guidance & Propulsion Systems	17
DF7/Electrical & Environmental Systems	12
DF7/R. O. Miessler	100
DG/R. K. Holkan	1
DG4/Systems Training	12
DG6/Flight Training	18
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DH4/T. A. McDonald	3
DH6/Payload Operations	70

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