

INCH-POUND

MIL-PRF-32150

11 April 2005

## PERFORMANCE SPECIFICATION

### STATIC AUTOMATIC BUS TRANSFER SWITCH (SABT) ON SURFACE AND SUBMARINE NAVAL VESSELS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers the Static Automatic Bus Transfer Switch (SABT), herein referred to as the SABT or the unit, for use on surface and submarine naval vessels.

1.2 Classification. SABTs have the following characteristics: (Part of identifying number (PIN) codes are provided along with the classifications to avoid unnecessary duplication of information in 1.3.)

1.2.1 Voltage. SABT voltages are as follows:

Voltages	PIN Code
120 VAC (60 Hz)	1
208 VAC (400 Hz)	2
450 VAC (60 Hz)	4
Other	6

1.2.2 Frequency. SABT frequencies are as follows:

Frequencies	PIN Code
60 Hz	A
400 Hz	F

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data that may improve this document should be sent to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to [commandstandards@navsea.navy.mil](mailto:commandstandards@navsea.navy.mil), with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

1.2.3 Configuration type. SABB configuration types are as follows:

Configuration Type (CT) Description	PIN Code
SABB has control circuit time delay and is instantaneous and selective.	01
SABB has control circuit time delay and full phase protection and is instantaneous and selective.	02
SABB has control circuit time delay and line circuit delay or in-phase monitor and is selective.	03
SABB is instantaneous and non-selective.	04
SABB has control circuit time delay on voltage sensing, instantaneous transfer on frequency sensing and contains an in-phase monitor.	05
Same as configuration type 03 except SABB is non-selective.	06
SABB senses voltage and frequency, is instantaneous and non-selective, has transfer stabilization time, and has an operating transfer time of up to 70 milliseconds maximum upon voltage failure.	07
Similar to configuration type 07 with additional current sensing on load terminals to inhibit transfer during overload conditions.	08
Configuration type not used at this time for SABBs.	09
SABB has control circuit time delay 0 to 3.5 seconds or line circuit time delay 0 to 3.5 seconds (and has in-phase monitor and is selective).	10
Note: The frequency A and configuration type 03 SABB, upon loss of normal source and reconnection to emergency source while feeding a single motor load of 50 HP or greater, has insufficient control circuit time delay (0.3 seconds) to avoid large power transients. This type SABB is not recommended for single motor loads greater than 50 HP. Consider configuration type 10.	

1.2.4 Special features. SABB special features are as follows:

Special Feature	PIN Code
Special feature(s)	S
No special feature(s)	X

1.2.5 Current rating. SABB current ratings are as follows:

Current Rating	PIN Code
050 to 400 amps	XXX

1.2.6 Cabinet integrity. SABB cabinet integrity is as follows:

Cabinet Integrity	PIN Code
Drip-proof	D
Splash-proof	S
Watertight	W

1.3 Part or identifying number (PIN). PINs to be used for SABTs acquired to this specification are created as follows: (see 1.2.1 through 1.2.6 for PIN Code designations)

M Prefix	Specification Number	Hyphen	Voltage	Frequency	CT	Special Features	Current Rating (maximum)	Cabinet Integrity
M	32150	-	2	F	04	X	400	S

The example above (M32150-2F04X400S) is for a 208-V, 400-Hz, instantaneous and non-selective, no special feature, 400-amp maximum current rating, splash-proof SABT.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they meet all specified requirements cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

### 2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

#### FEDERAL STANDARDS

FED-STD-595                      Colors Used in Government Procurement

#### DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901                      Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for

MIL-E-917                      Electric Power Equipment Basic Requirements

MIL-E-2036                      Enclosures for Electric and Electronic Equipment, Naval Shipboard

MIL-DTL-15024                      Plates, Tags, and Bands for Identification of Equipment, General Specification for

MIL-P-15024/5                      Plates, Identification

MIL-S-16036                      Switchgear, Power, Naval Shipboard

MIL-PRF-19500/519                      Semiconductor Device, Diode, Light Emitting, Red Types JAN1N6092 JANTX1N6092, JAN1N6609 (Clear Lens) JANTX1N6609 (Clear Lens), and Panel Mounted Assembly Types JANM19500/51901, JANTXM19500/51902, JANM19500/51903 (Clear Lens), and JANTXM19500/51904 (Clear Lens)

MIL-PRF-19500/572                      Semiconductor Device, Diode, Light Emitting, Types 1N6493, 1N6494, 1N6495, 1N6500, 1N6501, and 1N6502 JAN and JANTX

MIL-PRF-19500/708                      Displays, Diode, Light Emitting, Solid State, Red, Numeric and Hexadecimal, with On Board Decoder/Driver Types 4N51, 4N52, 4N53 and 4N54 JAN and JANTX

MIL-R-19523                      Relays, Control

#### DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-108	Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment
MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (Type I-Environmental and Type II-Internally Excited)
MIL-STD-202	Test Methods Standard Electronic and Electrical Component Parts
MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-681	Identification Coding and Configuration Type of Hookup and Lead Wire
MIL-STD-740-2	Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment
MIL-STD-1310	Standard Practice for Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety
MIL-STD-1399	Interface Standard for Shipboard Systems
DOD-STD-1399-070	Interface Standard for Shipboard Systems, Section 070 - Part 1, D.C. Magnetic Field Environment
MIL-STD-1399-300	Interface Standard for Shipboard Systems, Section 300, Electric Power, Alternating Current (Metric)
MIL-STD-1474	Noise Limits
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

#### INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1394	Standard for a High Performance Serial Bus
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(Copies of this document are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 or online at [www.ieee.org](http://www.ieee.org).)

#### UNDERWRITERS LABORATORIES, INC.

UL 1008	Standard for Transfer Switch Equipment (DoD adopted)
UL 60950	Safety of Information Technology Equipment

(Copies of these documents are available from COMM 2000, 1414 Brook Drive, Downers Grove, IL 60515 or online at [www.ul.com](http://www.ul.com).)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Qualification. SABTs furnished under this specification shall be products that are authorized by the qualifying activity on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Materials. The contractor shall select materials capable of meeting all of the operational and environmental requirements specified herein in accordance with MIL-E-917.

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.2.2 Electrical insulation. Electrical insulating materials shall be in accordance with the requirements of MIL-S-16036.

3.2.3 Parts. Parts, when used in SABTs, shall be in accordance with the requirements of MIL-E-917.

3.2.4 Light emitting diodes. Light emitting diodes (LEDs) shall meet the requirements of MIL-PRF-19500/519, MIL-PRF-19500/572, or MIL-PRF-19500/708.

3.2.5 RS-232 connection. The SABT shall provide an RS-232, USB2.0, or firewire IEEE 1394 (or similar, if supported by industry standards) port for a remote computer for the purpose of controlling the SABT electrical parameters and to allow programming of setpoints. A software program shall be provided to interface with the SABT for the purpose of establishing these parameters and setpoints during shipboard installation.

3.2.6 Relays. If electro-mechanical relays are used, they shall meet the requirements of MIL-R-19523 and shall have operating voltages as specified in 3.4.2.4.4. Dashpots operating with oil or air as the retardant for controlling the speed of operation of a relay shall be hermetically sealed.

3.2.7 Creepage and clearance distances. Electrical creepage and clearance distances shall be in accordance with MIL-E-917.

3.2.8 Nameplates. Manufacturer identification other than that allowed for the nameplates shall not appear on the equipment. Markings shall be in accordance with MIL-DTL-15024 and MIL-P-15024/5.

3.2.9 Plating. SABT bus bars shall be silver plated in accordance with MIL-S-16036, in areas of current-carrying contact with lugs, terminals, bus ties, screw bolts and so forth. The contact surfaces of bus bars shall be silver-plated up to 1 inch past the joint area. In lieu of this, the entire bus may be silver surfaced, or on each copper bus bar, an area around each hole may be silvered, provided the silvered area around the hole is not less than a 1/8-inch wide band. Threaded surfaces, used as electrical contact surfaces, shall have silver thickness of at least 0.0002 inch.

3.2.10 Cable entrance. The unit shall enable cable entry and exit from the top or the bottom of its enclosure. The cable entrance plates shall be blank to facilitate terminals or stuffing tubes for passage of cables. The plates shall be sealed to the level of effectiveness of the enclosure.

3.2.11 Wire, wiring methods, and marking. Wire, wiring methods and marking shall be in accordance with the requirements of MIL-E-917. Color-coded wire may be used in accordance with MIL-STD-681.

3.2.12 Terminal markings for supply lines and loads. Terminal markings for supply lines and loads of SABTs shall be in accordance with Table I. Like phases shall be arranged in the same manner. The phase rotation shall be A, B, C, respectively, from right to left (facing the front), top to bottom, and front to back.

TABLE I. Terminal markings.

Sources and load	AC
Normal (N) source	SA, SB, SC
Emergency (E) source	EA, EB, EC
Load	L1, L2, L3
Normal (N) source	S1A, S1B, S1C
Alternate (A) source	S2A, S2B, S2C
Load	L1, L2, L3

3.2.13 Diagrams. Each SABT switch shall include a wiring diagram and a schematic diagram. The information shall be protected in accordance with Method 1 of MIL-E-2036 and shall be attached to the inside of the enclosure door in accordance with MIL-E-2036. Wiring diagrams shall include wire numbers, component identification and fuse size and type, if applicable.

3.2.14 Paint. Paint used on the SABTs shall be in accordance with the requirements of MIL-E-917. Color shall be No. 26307 as specified by FED-STD-595.

3.3 Weight and size. Unless otherwise specified (see 6.2), the SABT shall weigh not more than 300 pounds and shall be not more than 40" H x 30" W x 20" D in size.

#### 3.4 Performance characteristics.

3.4.1 Special features. When applicable, special features shall be as specified (see 6.2).

3.4.2 Modes of operation. The SABT shall provide two modes of operation; automatic and manual.

3.4.2.1 Automatic operation. During the automatic mode of operation, the SABT shall monitor the power supplied from both the normal power source and the alternate power source. A source shall be considered "available" when:

- a. None of the semiconductor switches servicing that source are open (if the unit utilizes semiconductor switch technology), and
- b. Its voltage is within a preset range when the frequency trips are disabled, or
- c. Both its voltage and frequency are within preset ranges when the frequency setpoints are enabled.

Whenever the normal source is recognized by the internal logic as not available, the unit shall transfer to the alternate source provided the alternate source is available. If the unit uses semiconductor switch technology and a shorted semiconductor switch is detected, the SABT shall transfer to the source that has the shorted semiconductor switch and inhibit a transfer to the opposite source. The SABT shall provide two automatic transfer modes, in-phase transfer and random transfer. The SABT shall allow for operation with a designated source, in which case the unit shall preferentially power the load from that source, provided it is available, or without a designated source, in which case the unit shall not re-transfer to the initially active source following a command for transfer and a restoration of the initially active source to an available status.

3.4.2.2 In-phase transfer mode. The SABT shall have a programmable in-phase transfer voltage setpoint (see Table II), which shall be higher than the random voltage setpoint. Upon the voltage of the normal power source dropping to the in-phase voltage setpoint, the unit shall initiate a transfer provided the alternate power source is available and both sources are in phase. If a control circuit time delay is selected, the transfer shall occur after the voltage has been below the in-phase transfer voltage threshold for a period longer than this time delay. If the re-transfer feature is enabled, and the initially active source was the normal source, an automatic re-transfer may occur only if allowed by the in-phase monitor following restoration of the normal source to an available status.

TABLE II. Transfer threshold setting.

Set Points	120 V SABT	208 V	450 V SABT
In-Phase Transfer Voltage	96 V – 102 V	166 V – 177 V	358 V - 383 V
Random Transfer Voltage	72 V – 84 V	124 V – 146 V	271 V – 317 V

3.4.2.3 Random transfer mode. Provided the alternate source is available, the SABT shall initiate a transfer when the normal source voltage falls below the random transfer setpoint setting for a time period longer than that set by the control circuit time delay. If the re-transfer feature is enabled, and the initially active source was the normal source, an automatic re-transfer may occur only if allowed by the in-phase monitor following restoration of the normal source to an available status.

3.4.2.4 Manual operation. To ensure fail-safe mode of operation, the SABT shall have a manual mode for transferring power sources. During the manual mode of operation, the SABT automatic functions shall be disabled. Manual transfer shall be initiated by activating a switch on the front panel. A manual transfer can occur without the SABT checking the quality of the primary and alternate power sources. Once initiated, a manual transfer shall force the SABT to transfer from the normal source to the alternate source (or vice versa).

3.4.2.4.1 Manual control circuit isolation. The manual mode of operation shall be capable of functioning independently of the SABT control circuitry and shall be capable of initiating a transfer in the event of a power loss or other failure to the SABT control circuitry as long as either the normal or alternate power source is energized. The control circuitry is that circuitry which affects the successful automatic transfer from one power source to the other. The SABT shall also have the ability to transfer back to automatic mode.

3.4.2.4.2 Selector switch. SABTs shall be provided with a selector switch that controls manual or automatic SABT operation.

3.4.2.4.3 Preferred source selector switch and control circuit. Two-way SABTs with normal (ship's service) and alternate (ship's service) supply sources shall be provided with a preferred source selector switch that controls the selection of the preferred source of power.

3.4.2.4.4 Operating voltages. The SABT shall operate with tolerances in accordance with MIL-STD-1399-300 as specified (see 1.2.1 and 6.2).

3.4.2.4.5 Setpoint voltages. Setpoint voltage for frequency and configuration types (see 1.2.2 and 1.2.3) CT01, CT02, CT03, CT06, F01, and F02 shall be between 60 and 70 percent. For frequency and configuration types CT04 and F04, the setpoint voltage shall be between 75 and 85 percent. A tighter tolerance may be specified (see 6.2). For frequency and configuration types CT03, CT05, CT06, and CT09 supplied with an in-phase monitor, the in-phase transfer shall operate between 80 and 85 percent (see Table II). For configuration types CT07 and CT08, setpoint voltage shall be 76 to 80 percent of rated line voltage.

3.4.2.4.6 Pick-up voltage. Pick-up voltage shall be between 85 and 95 percent of rated line voltage. A tighter tolerance may be specified for frequency and configuration types CT04, F04, and CT05. For frequency and configuration types CT07 and CT08, pick-up voltage shall be 86 to 90 percent of rated line voltage.

3.4.2.4.7 Timing. Unless otherwise specified (see 6.2), instantaneous action or time delay shall be provided as specified by configuration type (see 1.2.3).

3.4.2.4.8 Instantaneous transfer. On types requiring instantaneous transfer, the transfer time shall not exceed 8 milliseconds.

3.4.2.4.9 Control circuit time delay. Control circuit time delay shall be adjustable from 0 to 3.5 seconds. The control circuit time delay is the time an under voltage condition must be continuously present in order for the unit to recognize a fault and initiate a transfer. When set to zero, the unit will initiate a transfer upon initial detection of the under voltage condition.



3.4.2.4.10 Line circuit time delay. When specified by configuration type (see 1.2.3), SABTs shall be provided with a time delay adjustable from 0 to 3.5 seconds between the opening of the normal source and the closure to the alternate source. The control circuit time delay and the line circuit time delay may be incorporated into a single function, provided that the time delay of 4 seconds for the combination of both time delays are not exceeded and minimum control circuit time delay is met.

3.4.2.4.11 Transfer stabilization time. When specified by configuration type (see 1.2.3), re-transfer shall be adjustable to inhibit transfer from 0 to 10 seconds to allow for source stabilization.

3.4.2.4.12 Operating frequency. The SABT shall operate in accordance with MIL-STD-1399-300. Operating frequency shall be as specified (see 1.2.2, 1.2.3, and 6.2). For frequency and configuration type CT05, transfer shall be initiated when the frequency drops 2 to 3 Hz below rated. Unless otherwise specified (see 6.2), if transfer is not initiated before the voltage drops below 20 to 30 percent of rated, instantaneous random transfer shall occur. For CT07 and CT08, transfer shall be initiated when the frequency falls to 89 to 93 percent of rated line frequency unless otherwise specified (see 6.2), provided the frequency of the alternate source is 95 to 98 percent of rated line frequency or greater.

3.4.2.4.13 Full phase protection. Unless otherwise specified (see 6.2), full phase protection shall be provided (see 1.2.3). Operating voltages shall be in accordance with 1.2.1.

3.4.2.4.14 In-phase monitor control circuit. Unless otherwise specified (see 6.2), SABTs shall be provided with an in-phase monitor that will limit the motor inrush current to its starting current upon completion of transfer (see 1.2.3). This is equivalent to completing transfer when the two sources are within selected phase angle difference setting of each other.

3.4.2.4.15 Transfer inhibit on overload. Unless otherwise specified (see 6.2), transfer shall be inhibited if the load current supplied by the switch exceeds  $125 \pm 5$  percent of the switch ampere rating (see 1.2.3). This feature shall be capable of being enabled or disabled.

3.4.3 Transfer test. The SABT shall include an automatic mode test. The test shall simulate a power source fault to verify that the SABT transfers power to the other source.

3.4.4 Self-diagnostics. The SABT shall incorporate self-fault diagnostics to the printed circuit board level. If a failure should occur, a summary indicator shall be shown on the front panel and an audible alarm shall sound. If a solid-state power conduction component on the non-conductive power source side fails shorted, the SABT shall automatically transfer power to that side to minimize source-to-source leakage current.

3.4.5 Maintainability. The maintainability capability provided for the unit when combined in a target system platform shall make it possible for the assigned maintenance personnel to perform necessary unit equipment repairs at the organizational level within the mean time to repair (MTTR) criteria specified herein. The MTTR shall not exceed 30 minutes. The maximum time to repair ( $M_{max}$ ) at the 95<sup>th</sup> percentile shall not exceed 60 minutes. Time to repair shall be the sum of the time required for:

- a. Fault localization (including diagnostic execution time)
- b. Fault isolation
- c. Disassembly
- d. Interchange/repair
- e. Reassembly
- f. Setpoint adjustment
- g. Repair validation

3.4.6 Performance monitoring (PM) mode. A performance monitoring capability shall be provided to support operation and maintenance. Performance monitoring shall be capable of monitoring the normal mode of operation of the SABT for the purpose of detecting and reporting errors. This capability shall also apply to stand-by hardware elements.



3.4.6.1 PM detection and reporting. Performance monitoring shall be designed such that faults can be detected and isolated using a recommended fault localization test. Performance monitoring shall also be designed such that 95 percent of all operational faults or processing errors and failures that occur over time shall be detected and reported.

3.4.6.2 False PM alerts. At least 98% of all PM test results shall be free of false alerts.

3.4.7 Fault localization. A fault localization (FL) capability shall be provided to localize SABL hardware faults and failures.

3.4.7.1 Fault localization detection and reporting. FL shall be designed such that faults detected in the hardware are isolated to the module.

3.4.7.2 False FL indications. At least 99% of all FL test results shall be free of false alerts. A FL false alert is a FL failure detection that cannot be associated with an actual hardware failure.

3.4.8 Control panel. The SABL control panel shall provide the operator with the controls and indicators necessary to monitor the status of the normal and alternate power sources. All SABL controls and indications shall be located on the front of the unit. Indication of phase angle detection may be instrumented with a blinking amber indicator. Out of phase condition shall not be labeled as an error condition.

3.4.8.1 Indicator and audible alarm. The SABL control panel shall use a series of indicators to provide operational status of the unit. The convention used for these indicators will be consistent and operator-friendly such that green will indicate “go” or “good”, yellow (if used) will indicate “caution”, and red will indicate “stop” or “bad”. Indicators shall identify the status of power to the loads, the status of each power source, the mode of operation the unit is in, the presence of an internal logic fault, and identification of the preferred power source. If air-cooled, a method to indicate partial or complete loss of cooling air shall also be provided. A display shall be provided to act as a counter for the number of load transfers performed by the unit, as well as to provide indications in the event of an SABL fault. Phase angle differences greater than the preset value between the two input power sources, if monitored, shall be displayed. Additionally, an audible alarm shall sound when a fault is detected. This alarm:

- a. Shall act in concert with visual indicators that will allow the operator to identify the fault.
- b. Shall not latch as a result of a temporary fault that immediately clears with no operator action.
- c. When acknowledged, shall stop sounding but the visual alarm shall remain if the fault does not clear.
- d. Shall be such that the audible feature can be preemptively disabled, in which case the fault shall still be indicated via visual clues as discussed in step a above.

3.4.8.2 Controls.

3.4.8.2.1 Indicator test switch. The SABL shall provide a switch for the purpose of indicator testing. Depressing the switch will cause all indicators to light for a short time without disruption to the load.

3.4.8.2.2 Mode selection switch. The SABL shall provide a mode selection switch for the purpose of choosing manual or automatic modes. If the switch is in manual mode position, the automatic mode functions are disabled. If the switch is in automatic mode position, the automatic mode functions are enabled.

3.4.8.2.3 Control enable switch. The SABL shall provide a control enable switch for the purpose of enabling the manual operator switch, the transfer test switch and the fault reset switch. This switch, as well as the manual operator switch, transfer test switch, and fault-reset switch, shall be of the momentary action type.

3.4.8.2.4 Manual operator switch. The SABL shall provide a manual operator switch for the purpose of transferring power sources in manual mode. The control enable switch must be depressed to enable the manual operator switch.

3.4.8.2.5 Transfer test switch. The SABL shall provide a transfer test switch for the purpose of initiating a transfer test. The control enable switch must be depressed to enable the transfer test switch.

3.4.8.2.6 Fault reset switch. The SABT shall provide a switch for the purpose of resetting faults. This switch will, however, not be able to reset any fault, which is still present and whose presence would correctly inhibit a shift. (Example: a condition whereby the alternate source is below the minimum acceptable voltage). The control enable switch must be depressed to enable the fault-reset switch.

3.4.9 Fusing of control circuits and indicator circuits. SABTs shall not have fused control circuits and indicator circuits.

3.4.10 Manual bypass mechanism. A manual bypass mechanism for the SABT shall be located in a readily accessible position. A manual bypass mechanism shall have a mechanical position indicator to identify selected source.

3.4.11 Auxiliary switches. Unless otherwise specified (see 6.2), SABTs over 100 amps shall be provided with one double pole, double throw (DPDT) auxiliary switch, and SABTs 100 amps and under shall be provided with one single pole, double throw (SPDT) auxiliary switch for remote indication of the supply line connected to the load circuit or for a function limiting device, or both. The auxiliary switch contacts shall be wired to a terminal board in the SABT for connection to the remote equipment. Auxiliary switches shall have a minimum rated continuous current of 5 amps and a rated voltage of 500 VAC and 250 VDC and meet the endurance requirements as specified in Method II, Table VII.

3.4.12 External control cable connections. Terminal boards or studs shall be provided for external control connections if more than 12 external control wires are required. Terminal boards and studs shall be accessible from the front of the enclosure with the front panel open, and the control wire connection points shall be accessible and identified.

3.4.13 Grounding. Grounding shall be in accordance with MIL-STD-1310.

3.4.13.1 Chassis grounding. All external parts capable of electrical conduction shall be at ground potential at all times in accordance with MIL-STD-1310. Each chassis within the enclosure shall be electrically bonded to minimize electromagnetic interference (EMI). The DC resistance measured from the conductive frame of any assembly receiving primary power and the unit electrical bond point shall not exceed 0.1 ohm.

3.4.13.2 Signal grounding. A single point ground (SPG) system shall be used within the SABT and shall be DC isolated from the chassis/safety ground. To achieve this SPG system, all signal circuits and secondary DC power returns shall be referenced to a single point within the unit. The signal shall be DC isolated from chassis ground.

3.4.13.3 Line-to-ground impedance. The insulation resistance or impedance to ground shall be measured with all operating components attached and connected in the SABT's normal operational condition with no internal wiring disconnected. Insulation resistance of SABTs shall be not less than 10 megohms as specified in MIL-E-917.

3.4.13.4 Operational source-to-source impedance. The source-to-source impedance, an inherent characteristic of the semiconductor switch circuit, shall be no less than 1.3 megohms at 20 °C (68 °F) with a minimum load of 25 amps and 0.5 megohm at 50 °C (122 °F). If specified (see 6.2), a higher source-to-source impedance may be required.

3.4.14 Electrostatic discharge (ESD) protection requirements. The use of electrostatic discharge (ESD) sensitive components is discouraged. When specific parts, modules, connectors/receptacles or subassemblies sensitive to damage by ESD are used, the devices shall be clearly marked with ESD labeling in accordance with MIL-STD-1686. The symbol shall be located in a position readily visible to personnel when that assembly is incorporated into its next higher assembly.

3.4.15 Ungrounded circuits. SABTs shall operate in ungrounded circuits.

3.4.16 Duty. SABTs shall operate continuous duty.

3.4.17 Electromagnetic interference (EMI). When specified (see 6.2), all enclosures shall employ EMI door gaskets and shielding of control and indicator openings to provide EMI shielding of the enclosed electronics in accordance with MIL-STD-461.

3.4.18 Conducted emissions. The SABL shall not exceed the CE101 and CE102 limits of MIL-STD-461. Additionally, the upper limit of CE101 shall be extended to 20 KHz.

3.4.19 Conducted susceptibility. The SABL shall meet the specified performance requirements per the CS101, CS114, and CS116 limits of MIL-STD-461.

3.4.20 Conducted susceptibility spikes, power leads. The SABL shall not exhibit any malfunction, degradation of performance, or deviation from specified indications when tested in accordance with 4.6.7.

3.4.21 Radiated emissions, AC magnetic field. The SABL shall not exceed the RE101 limits of MIL-STD-461.

3.4.22 Radiated emissions, AC electric field. The SABL shall not exceed the RE102 limits of MIL-STD-461.

3.4.23 Radiated susceptibility, AC magnetic field. The SABL shall meet the specified performance requirements in an AC magnetic field in accordance with the RS101 limits of MIL-STD-461.

3.4.24 Radiated susceptibility, DC magnetic field. The SABL shall be compatible with the magnetic field environment interface constraints of DOD-STD-1399-070, Part 1.

3.4.25 Radiated susceptibility, AC electric field. The SABL shall meet the specified performance requirements in an electric field per the RS103 limits of MIL-STD-461.

3.4.26 Radiated susceptibility, magnetic and electric fields, spikes and power frequencies. The SABL shall not exhibit any malfunction, degradation of performance or deviation from specified indications when tested in accordance with MIL-STD-461 and 4.6.13.

3.4.27 Power. The SABL shall operate in accordance with MIL-STD-1399-300 and shall not introduce negative electrical characteristics to exceed the values specified therein during steady-state operation and during transfer. The SABL shall not introduce transients or noise in excess of that defined and allowed by MIL-STD-1399-300.

3.4.28 Safety. The SABL shall operate in a safe manner such that two procedural errors, or the malfunction of any single hardware or software component or element shall not result in catastrophic hazards, causing death, system loss, or severe environmental damage, or critical hazards, causing severe injury, severe occupational illness, or major system or environmental damage. Safety requirements for the equipment shall be in accordance with MIL-E-917. A safety ground shall be provided on all equipment in accordance with UL 60950.

3.4.29 Personnel electrical safety.

3.4.29.1 High voltage protection. Protection from dangerous voltages (30 to 500 Vrms or 30 to 500 VDC) shall be provided by the use of guards, grounding, and warning placards in accordance with MIL-E-917. Assemblies operating at potentials exceeding 500 Vrms or 500 VDC shall be completely enclosed. The maximum discharge time shall be ten seconds to discharge components or assemblies from their operating voltages to 30 Vrms or less.

3.4.29.2 High current protection. Protection from shock hazards that can occur from contact with current producing circuitry of 21 mA AC or 80 mA DC at a potential of greater than 30 VDC or 30 Vrms shall be provided. For high current (greater than or equal to 25 amps) power sources, positive design measure shall be incorporated by the use of guards, barriers, and warning placards.

3.4.29.3 Chassis leakage current protection. All electrical parts capable of electrical conduction shall be at ground potential in accordance with MIL-STD-1310 and shall limit leakage current for personnel safety in accordance with MIL-STD-1399-300.

3.4.29.4 Source-to-source leakage current for maintenance. Leakage current to the non-energized side of the SABT shall be limited to zero leakage current to allow for safe load center maintenance.

3.4.30 Electrical bonding. Electrical bonding shall be in accordance with MIL-STD-1310.

3.4.31 Mechanical hazards. Suitable protection shall be provided to prevent contact with moving mechanical parts such as gears, fans, and belts when the equipment is operating. Sharp projections on cabinets, doors, and similar parts shall be avoided. Rack-mounted equipment shall maintain the center of gravity as low as possible to minimize tipping over. Door or hinged covers shall be rounded at the corners, provided with stops to hold them open, and shall be removable. SABT design shall include provisions to prevent accidental pulling out of drawers or rack mounted equipment components, which would cause equipment damage or injury. Equipment power switches, if used, shall be located so that accidental contact shall not place the equipment in operation, secure the equipment, or change its mode of operation.

3.4.32 Component heat removal. If forced air-cooling is used, the unit shall generate no more than the structureborne or airborne noise acceptance criteria as specified in MIL-STD-740-2. A complete or partial loss of cooling air shall be indicated prior to the unit overheating or an over temperature alarm being reached. The unit shall be capable of operating normally for a period of at least 24 hours at rated load, in 50 °C (122 °F) ambient air, with a loss of one-third, minimum, of the active cooling capacity, and support the rated load for a minimum of 6 hours, in 28 °C (82 °F) ambient air, with a loss of all (100%) of the active cooling capacity.

3.4.33 Transfer positions. SABTs shall be two-way.

3.4.34 Line voltages. Line voltages shall be in accordance with MIL-STD-1399-300.

3.4.35 Control voltages. 60-Hz SABTs shall have 120- or 450-V rated control circuits. Control power transformers are permitted. 400-Hz SABTs shall have DC control circuits energized via a rectifier. 400-Hz SABTs shall have 120- or 240-V rated control circuits. A dropping resistor may be provided for use when 120 V is selected for 240-VDC configuration types.

3.4.36 Line phases. SABTs shall operate in three-phase circuits.

3.4.37 Phase angle difference. The SABT shall have an adjustable phase angle difference range of from 1.0 to 60 degrees. The phase angle difference is the largest phase difference at which an in-phase transfer is still allowed. An indication shall be displayed by an amber indicator when the phase angle difference is greater than the allowable setting.

3.4.38 In-phase transfer voltage. The SABT shall have an adjustable in-phase transfer voltage range from 80 to 85 percent rated voltage.

3.4.39 Random transfer voltage. The SABT shall have an adjustable random transfer voltage range from 60 to 70 percent rated voltage.

3.4.40 Pickup voltage. The SABT shall have an adjustable pickup voltage range from 85 to 95 percent rated voltage.

3.4.41 Over-frequency setpoint. The SABT shall have an adjustable over-frequency setpoint range from 103 to 108 percent operating frequency.

3.4.42 Over-frequency pickup. The SABT shall have an adjustable over-frequency pickup range from 100 to 105 percent operating frequency.

3.4.43 Under-frequency setpoint. The SABT shall have an adjustable under-frequency setpoint range from 83 to 95 percent operating frequency. When the active source frequency falls below the under-frequency setpoint, and the frequency trips are enabled, the unit shall transfer to the inactive source, provided this source is available.

3.4.44 Under-frequency pickup. The SABT shall have an adjustable under-frequency pickup range from 95 to 100 percent operating frequency.

3.4.45 Over-frequency and under-frequency inhibit. The SABT shall provide a means to program the unit in such a way as to disable the frequency features, in which case transfers due to over-frequency and under-frequency conditions shall not occur.

3.4.46 Compatibility with active ground fault detector circuit. When specified (see 6.2), an SABT connected to both power sources and to the loads shall:

- a. Have a source-to-source impedance as high as possible, but no less than 0.5 megohm at 50 °C.
- b. Have a minimum source-to-ground impedance of at least 10 megohms.
- c. Not cause a low-impedance to ground fault condition detected on one source to be imposed on, transferred to, or reflected on the other source.

3.4.47 Endurance and overload. SABTs and SABT auxiliary switches shall meet endurance and overload requirements when tested in accordance with 4.6.18 and Table VII, unless otherwise specified (see 6.2).

3.4.48 Short-circuit withstandability. SABTs shall meet the short-circuit withstandability requirements specified in Table IV.

TABLE IV. SABT short-circuit withstandability.

Continuous rating (A)	Short-circuit current (A) at pf 0.15-0.20		Duration (seconds)	
	60 Hz	400 Hz	60 Hz	400 Hz
To 50	10000	10000	0.017	0.021
51 to 100	15000	10000	.017	.021
101 to 250	20000	10000	.025	.028
251 to 400	30000	10000	.028	.033

3.4.49 Dielectric withstanding voltage. SABTs shall meet the dielectric withstanding voltage requirements when tested in accordance with MIL-E-917.

3.4.50 Enclosures. Enclosures for the SABT shall be drip-proof, watertight, or splash-proof, as specified (see 6.2) and shall meet the performance requirements of MIL-E-2036 for Class I enclosures for electronic equipment.

### 3.5 Environmental conditions.

3.5.1 Ambient temperature. The SABT shall operate over an ambient temperature range of 32 to 122 °F (0 to 50 °C) in accordance with MIL-E-917.

3.5.2 Humidity. The SABT shall operate in a 95% relative humidity environment in accordance with MIL-E-917.

3.5.3 Pressure. The SABT shall operate within performance limits of MIL-STD-202 while subjected to an atmospheric pressure from 24 to 36 inches of mercury.

3.5.4 Temperature rise. The SABT shall operate in an ambient temperature of 122 °F (50 °C) with no more than a 59 °F (15 °C) temperature rise for surface ships and a 77 °F (25 °C) rise for submarines as specified in MIL-S-16036.

3.5.5 Inclined operation. SABTs shall perform satisfactorily when inclined at all angles up to 45 degrees from vertical in any direction.

3.5.6 Shock. SABTs shall meet Grade A, Class I, Type A high impact shock tests as specified in MIL-S-901.

3.5.7 Vibration. SABTs shall meet Type I vibration tests specified in MIL-STD-167-1.

3.5.8 Protection against arcs. The interior of enclosing cases shall be protected by insulating material selected in accordance with the requirements of MIL-E-917.

3.5.9 Airborne noise. When specified (see 6.2), airborne noise requirements shall be in accordance with MIL-STD-1474.

3.5.10 Structureborne noise. When specified (see 6.2), structureborne noise requirements shall be in accordance with MIL-STD-740-2.

#### 4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2)
- b. Conformance inspection (see 4.3)

4.2 Qualification inspection. Qualification inspection shall be performed on one complete SABT of each rating and shall include the examinations and tests specified in Table V.

4.3 Conformance inspection. Conformance inspection shall be performed to verify that the SABT meets specification requirements prior to acceptance and shall include the tests specified in Table V.

4.4 Inspection conditions. All inspections shall be performed in accordance with the test conditions specified in the general requirements of MIL-STD-202.

TABLE V. Qualification tests and conformance inspections.

Tests	Requirement Paragraph	Qualification Test	Conformance Inspection
Examination	3.2 – 3.3, 3.4.6 – 3.4.13.2, 3.4.28, 3.4.29.1, 3.4.29.2, 3.4.30 through 3.4.45	4.5	4.5
Operational	3.4.2 through 3.4.4	4.6.1.1 through 4.6.1.12	4.6.1.1 through 4.6.1.12
Line-to-Ground Impedance	3.4.13.3	4.6.2	--
Operational Source-to-Source Impedance	3.4.13.4	4.6.3	--
EMI	3.4.17	4.6.4	--
Conducted Emissions	3.4.18	4.6.5	--
Conducted Susceptibility	3.4.19	4.6.6	--

TABLE V. Qualification tests and conformance inspections - continued.

Tests	Requirement Paragraph	Qualification Test	Conformance Inspection
Conducted Susceptibility Spikes, Power Leads	3.4.20	4.6.7	--
Radiated Emissions, AC Magnetic Field	3.4.21	4.6.8	--
Radiated Emissions, AC Electric Field	3.4.22	4.6.9	--
Radiated Susceptibility, AC Magnetic Field	3.4.23	4.6.10	--
Radiated Susceptibility, DC Magnetic Field	3.4.24	4.6.11	--
Radiated Susceptibility, AC Electric Field	3.4.25	4.6.12	--
Radiated Susceptibility, Magnetic and Electric Fields, Spikes and Power Frequencies	3.4.26	4.6.13	--
Power	3.4.27	4.6.14	--
Chassis Leakage Current Protection	3.4.29.3	4.6.15	--
Source-to-Source Leakage Current for Maintenance	3.4.29.4	4.6.16	--
Compatibility with Active Ground Fault Detector Circuit	3.4.46	4.6.17	--
Endurance and Overload	3.4.47	4.6.18	--
Short-Circuit Withstandability	3.4.48	4.6.19	--
Dielectric Withstanding Voltage	3.4.49	4.6.20	--
Degree of Enclosure	3.4.50	4.6.21	--
Ambient Temperature	3.5.1	4.6.22	--
Humidity	3.5.2	4.6.23	--
Pressure	3.5.3	4.6.24	--
Temperature Rise	3.5.4	4.6.25	--
Inclined Operation	3.5.5	4.6.26	--
Shock	3.5.6	4.6.27	--
Vibration	3.5.7	4.6.28	--
Airborne Noise	3.5.10	4.6.29	--
Structureborne Noise	3.5.11	4.6.30	--

4.5 Examination. Each SABL shall be examined for compliance with the requirements specified in Table V. This element of inspection shall encompass all visual examinations and dimensional measurements. The examination shall be conducted using the classifications of defects as specified in Table VI as applicable. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.



TABLE VI. Classification of defects.

Categories	Defects	Related Requirements Paragraph
001	Prohibited materials are used.	3.2
002	Insulating material not as specified or not provided as required.	3.2.2
003	Supply line and load terminal markings not as specified.	3.2.12
004	Manual operation for SABT switch not provided as required.	3.4.2.4
005	Preferred source selector switch not provided as specified.	3.4.2.4.3
006	Time delay circuits not provided as specified or instantaneous is not within maximum time limit specified.	3.4.2.4.7, 3.4.2.4.8, 3.4.2.4.9, 3.4.2.4.10
007	Full phase protection not provided as specified.	3.4.2.4.13
008	Power available indicator not provided for manual bus transfers.	3.4.8.1
009	Test switch not provided for SABT switches.	3.4.8.2.5
010	Fusing of control circuits and indicator circuits not as specified.	3.4.9
011	Manual bypass mechanism not external to the enclosure or located in a readily accessible position and manual operating mechanism does not have mechanical position indicator for supply line indication.	3.4.10
012	Transfer positions are not two-way as specified.	3.4.33
013	Number of line phases not as specified for SABTs.	3.4.36
101	Parts not in conformance with applicable specifications.	3.2.3 and 3.5.8
102	Light emitting diodes not as specified.	3.2.4
103	Relays not as specified.	3.2.6
104	Information plates, identification plates, and marking not as specified.	3.2.8
105	Cable entrances not as specified.	3.2.10
106	Wire, wiring methods, and marking not as specified.	3.2.11
107	Diagrams and descriptions of operation not provided as specified.	3.2.13
108	Auxiliary switches not as specified.	3.4.11
109	Terminal boards not provided or wire connection points not accessible and identifiable.	3.4.12
110	Degree of enclosure not as specified.	3.4.50
201	Creepage and clearance distances not as specified.	3.2.7
202	Painting not as specified.	3.2.14

#### 4.6 Methods of inspection.

##### 4.6.1 Operational tests.

4.6.1.1 Automatic operation. SABTs shall be operated to determine that the operating voltages are as specified in 3.4.2.4.4. Not less than five transfers and five re-transfers shall be made under conditions of constant temperature, frequency, and rate of change of voltage. Testing shall also be performed using asynchronous sources at worse case scenario of 180 degrees out of phase.

4.6.1.2 Manual operation. When manual mode has been selected (see 3.4.2.4), automatic control circuit devices shall not be operated while the manual-automatic selector switch is in the manual position; the SABTs shall not automatically transfer.

4.6.1.3 Preferred source selection. The preferred source selector switch shall be switched to each position and the SABTs shall be operated to determine that the actual preferred source is as selected.

4.6.1.4 Timing. Timing, time delay, and operating transfer time as specified by the SABT configuration type (see 1.2.3), shall be measured five times to determine conformance with the required time periods as specified in 3.4.2.4.7. Adjustable time delay devices shall be operated over their adjustable range to determine that the specified time range can be achieved. When instantaneous is specified, the voltage shall be reduced quickly to approximately five equal intervals from 20 percent rated voltage to specified setpoint voltage including maximum and minimum setpoint. The SABT shall pick up the non-preferred source within 0.05 seconds after initial time delay is completed. The switch shall not transfer at the maximum setpoint.

4.6.1.5 Restoration of power during time delay transfer. SABTs provided with line circuit time delay shall be tested for re-transfer and shall have full voltage restored from reduced and zero voltage, at the start, mid, and end of the off position with voltage maintained on emergency or alternate supply. The switch may complete the transfer cycle before returning to the normal supply. No additional delay in time shall occur.

4.6.1.6 Test switch. The SABT's test switch shall be operated to determine that it simulates a voltage failure and a transfer action occurs.

4.6.1.7 Full phase protection. When specified (see 6.2), the SABTs shall be operated to determine the operating voltage of each phase. Not less than five transfers and five re-transfers per phase voltage test shall be made under conditions of constant temperature, frequency and rate of change of voltage.

4.6.1.8 In-phase monitor. SABTs furnished with in-phase monitors shall be operated five times in each direction including the low voltage setpoint (minimum of 80 percent voltage or as specified in 3.4.2.4.14). The frequency of the two sources shall be a nominal 60 Hz. After these operations are completed the voltage shall be rapidly reduced to below random transfer setpoint for instantaneous random transfer verification. When frequency sensing is specified, the switch shall be operated five additional times in each direction. The voltage shall be set at 5 points including 114 percent or greater and 85 percent or less. These tests shall be conducted by one of the two following methods:

a. The tests shall be performed with a load consisting of a motor of sufficient size to maintain a voltage greater than 30 percent for minimum of 0.50 second after the power is suddenly disconnected.

b. The tests shall be performed with any convenient load. A calibrated phase angle sensing instrument shall be used to record the phase angle displacement between the normal and alternate sources at the completion of transfer. In each operation, except the instantaneous random transfer when voltage is reduced to below random transfer setpoint, the phase angle difference at the completion of transfer shall not exceed 60 degrees.

4.6.1.9 Frequency sensing. The frequency as specified (see 6.2) shall be tested five times at the high and low frequency pickup points to determine compliance with the frequency requirements as specified (see 3.4.41 through 3.4.46).

4.6.1.10 Overload transfer inhibit. When transfer inhibit on overload has been specified (see 6.2), a transfer operation shall be initiated by failing voltage on the connected source to determine that transfer shall not occur if the load current is above overload inhibit value specified in 3.4.2.4.15.

4.6.1.11 Power available indicator. SABTs shall be operated to determine that each power available indicator operates properly when power is supplied and removed from each supply line.

4.6.1.12 Other required tests.

- a. Standard Operation Test - Examine proper SABT baseline operability.
- b. Diagnostic Fault Test - Inject faults such as a shorted or open semiconductor switch and examine proper diagnostic operation as to whether the SABT will transfer, etc.

4.6.2 Line-to-ground impedance. Line-to-ground impedance tests shall be conducted in accordance with Method 302 of MIL-STD-202. Test conditions shall be as follows:

- a. Test potential - Test Condition "B" (500 V plus/minus 10 percent).
- b. Points of measure - Between each electrically isolated circuit and all other circuits connected together to ground (frame, chassis or enclosure)
- c. Electrification time - 60 seconds minimum for insulation suitability test, and only sufficient time to take resistance readings for all other tests.
- d. Temperature at time of test - Temperature of parts to be tested shall be measured and recorded. Insulation resistance measurements shall be corrected to 25 °C. Correction shall be made on the basis of insulation resistance doubling for each 15 °C increase in temperature.

4.6.3 Operational source-to-source impedance. The SABT shall be tested for source-to-source impedance at 20 °C (68 °F) and 50 °C (122 °F) as follows:

4.6.3.1 Source-to-source impedance at 20 °C. Refer to Figures 1 and 2 to set-up the SABT at 20 °C. Proceed as follows for verifying source-to-source impedance at 20 °C. Ensure the specified test temperature remains constant throughout verification.

CAUTION: Make sure that the AC and DC power sources are isolated and use caution when changing connections.

- a. Refer to Figure 1. Apply 450VAC, 60Hz to CB1 and CB2 and set the load to 25 amps.
- b. Apply 500 VDC to source #1 Phase A to ground, Phase B to ground and Phase C to ground at one time. Measure and record DC leakage at I1a, I1b, and I1c.
- c. Close CB 1, measure and record leakage currents at I1a, I1b, I1c, I2a, I2b and I2c. Leakage currents should not exceed 0.25mA.
- d. Close CB2 and CB3.
- e. Operate the SABT at a 25-amp load for two hours. Measure and record leakage currents at I1a, I1b, I1c, I2a, I2b, and I2c.
- f. Source-to-source impedance equal to 500 VDC divides the difference of leakage currents obtained in steps c and e. Source-to-source impedance should be greater than 1.3 megohm.
- g. Open CB1, CB2, and CB3.
- h. Refer to Figure 2. Move the 500 VDC power supply to source #2 input and the 100 K load to source #1 input. Change the Preferred Source switch on the SABT control panel as required.
- i. Close CB2, measure and record leakage currents at I1a, I1b, I1c, I2a, I2b and I2c. Leakage currents should not exceed 0.25mA.
- j. Close CB1 and CB3.
- k. Operate the SABT at a 25-amp load for two hours. Measure and record leakage currents at I1a, I1b, I1c, I2a, I2b and I2c.
- l. Source-to-source impedance equal to 500 VDC divides the difference of leakage currents obtained in steps i and k. Source-to-source impedance should be greater than 1.3 megohm.

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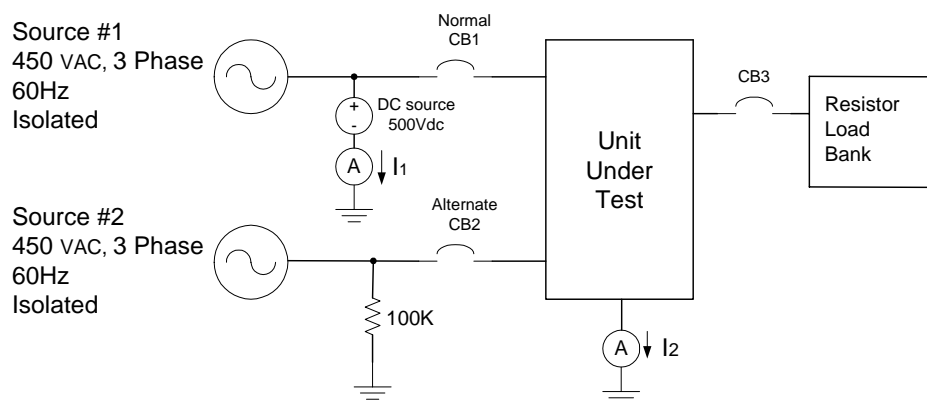


FIGURE 1. SABL active ground detector test (DC test source to normal).

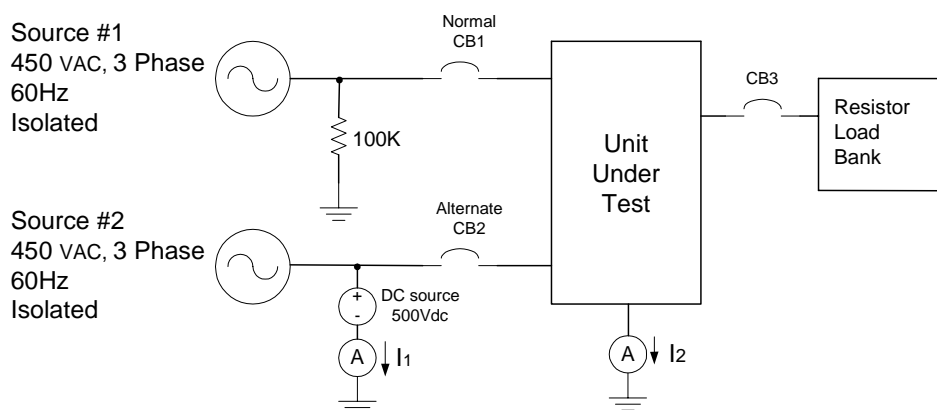


FIGURE 2. SABL active ground detector test (DC test source to alternate).

4.6.3.2 Source-to-source impedance at 50 °C. Proceed as follows for verifying the SABL source-to-source impedance at 50 °C. Ensure test temperature remains constant throughout verification.

- a. Refer to Figure 1, apply 450 VAC, 60Hz to CB1 and CB2 and set the load to 25 amps.
- b. Apply 500 VDC to source #1 Phase A to ground, Phase B to ground and Phase C to ground at one time. Measure and record DC leakage at I1a, I1b, and I1c.
- c. Close CB 1, measure and record leakage currents at I1a, I1b, I1c, I2a, I2b and I2c. Leakage currents should not exceed 0.5mA.
- d. Close CB2 and CB3.
- e. Operate the SABL at a 25-amp load for two hours. Measure and record leakage currents at I1a, I1b, I1c, I2a, I2b, and I2c.
- f. Source-to-source impedance equal to 500 VDC divides the difference of leakage currents obtained in steps c and e. Source-to-source impedance should be greater than 0.5 megohm.
- g. Open CB1, CB2, and CB3.
- h. Refer to Figure 2. Move the 500 VDC power supply to source #2 input and the 100 K load to source #1 input. Change the Preferred Source switch on the SABL control panel as required.
- i. Close CB2, measure and record leakage currents at I1a, I1b, I1c, I2a, I2b and I2c. Leakage currents should not exceed 0.5mA.
- j. Close CB1 and CB3.

- k. Operate the SABL at a 25-amp load for two hours. Measure and record leakage currents at 11a, 11b, 11c, 12a, 12b and 12c.
- l. Source-to-source impedance equal to 500 VDC divides the difference of leakage currents obtained in steps i and k. Source-to-source impedance should be greater than 0.5 megohm.
- m. Open CB1, CB2 and CB3.

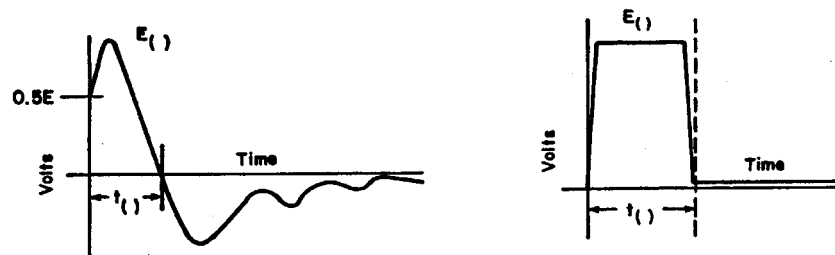
4.6.4 Electromagnetic interference. When specified (see 6.2), the SABL shall be tested for electromagnetic interference (EMI) in accordance with MIL-STD-461.

4.6.5 Conducted emissions. The SABL shall be tested for conducted emissions in accordance with MIL-STD-461, procedures CE101 and CE102. The upper limit of procedure CE101 shall be extended to 20 KHz.

4.6.6 Conducted susceptibility. The SABL shall be tested for conducted susceptibility in accordance with MIL-STD-461, procedures CS101, CS114 and CS116.

4.6.7 Conducted susceptibility, power line spike. The SABL AC and DC power leads, including grounds and neutrals, which are not grounded internally to the equipment, and interconnecting control leads, which provide AC or DC power to the SABL, shall be tested. The SABL shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated when the test spike, having the waveform shown on Figure 3, is applied to the AC and DC power input leads for a period of time not less than 1 minute at each phase position and for a total test period not exceeding 15 minutes in duration. The values of  $E_c$  and  $t_c$  are given below. The spike shall be superimposed on the power line voltage waveform.

- Spike #1  $E_1 = 200$  volts;  $t_1 = 10$  microseconds  $\pm 20\%$
- Spike #2  $E_2 = 200$  volts;  $t_2 = 0.15$  microseconds  $\pm 20\%$



**NOTE:** The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage (s) and pulsewidth (s).

FIGURE 3. Acceptable wave shapes for CS06.

4.6.8 Radiated emissions, AC magnetic field. The SABL shall be tested for radiated emission, AC magnetic field in accordance with MIL-STD-461, procedure RE101.

4.6.9 Radiated emissions, AC electric field. The SABL shall be tested for radiated emissions, AC electric field in accordance with MIL-STD-461, procedure RE102.

4.6.10 Radiated susceptibility, AC magnetic field. The SABL shall be tested for radiated susceptibility, AC magnetic field in accordance with MIL-STD-461, procedure RS101.

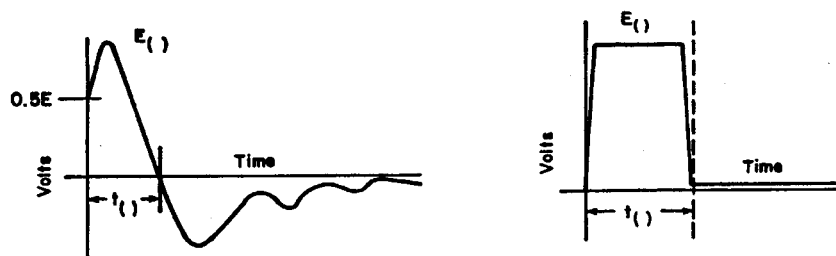
4.6.11 Radiated susceptibility, DC magnetic field. The SABL shall be tested for radiated susceptibility, DC magnetic field in accordance with DOD-STD-1399-070, Part 1.

4.6.12 Radiated susceptibility, AC electric field. The SABT shall be tested for radiated susceptibility, AC electric field in accordance with MIL-STD-461, procedure RS103.

4.6.13 Radiated susceptibility, magnetic and electric fields, spikes and power frequencies.

4.6.13.1 Spikes. The SABT shall not exhibit any malfunction, degradation of performance or deviation from specified indications when subjected to the test spike having a wave form as shown in Figure 4. The values of  $E_1$  and  $t_1$  are as follows:

Spike #1  $E_1 = 400$  volts;  $t_1 = 5$  microseconds  $\pm 20\%$



**NOTE:** The test sample shall be subjected to the spike(s) with the waveform shown and with the specified voltage(s) and pulsewidth(s).

FIGURE 4. Acceptable wave shapes for RS02.

4.6.13.2 Power frequency. The SABT shall not exhibit any malfunction, degradation of performance or deviation from specified indications when 20 amperes are applied to the test wire at 60 and 400 Hz.

4.6.14 Power test. Power tests shall be conducted in both steady-state and transient modes for the following in accordance with MIL-STD-1399-300 during steady-state operation and during transfer at 180 degrees out of phase, with line capacitance to ground of 100  $\mu$ f per phase and a load with a power factor of 1 at 20 amps:

- Voltage and frequency tolerance
- Voltage and frequency transient tolerance
- Voltage spike
- Emergency condition
- Grounding
- User equipment power profile (at no load)
- Current waveform
- Equipment (insulation resistance)
- Voltage and frequency modulation

4.6.15 Chassis leakage current. The SABT shall be tested for chassis leakage current in accordance with MIL-E-917.

4.6.16 Source-to-source leakage current for maintenance. Using a standard ammeter and volt ohmmeter (VOM), the SABT shall indicate a reading of 0 voltage and 0 current as required by 3.4.29.4.

4.6.17 Compatibility with active ground fault detector circuit. When specified (see 3.4.46 and 6.2), the SABL shall be tested with an active ground fault detector circuit utilizing a 500 VDC power supply and shall:

- a. Have a source-to-source impedance as high as possible, but no less than 0.5 megohm at 50 °C.
- b. Have a minimum source-to-ground impedance of at least 10 megohms.
- c. Not cause a low-impedance to ground fault condition detected on one source to be imposed on, transferred to, or reflected on the other source.

4.6.18 Endurance and overload. SABLs shall be tested for overload and endurance in accordance with Table VII. Switches shall be energized for a minimum of 1/6 of a second before and after transfer. Operation cycles shall be initiated by the loss of power from either source. The SABL must be powered down between operation cycles. Unless otherwise specified (see 6.2), Method II is applicable to AC SABLs without time delay and not for switchboard service, and Method I is applicable to all other SABLs. These tests may be conducted on one set of contacts. However, in no case shall the specified operating cycles cause damage to components from excessive heating. SABLs shall fail the overload and endurance tests if they fail to perform their intended operating functions during or after the tests without adjustment, calibration or replacement of parts.

TABLE VII. Endurance and overload test conditions.

SABL	Overload test conditions				
	Number of cycles of operations	Test current (percent rated)	Test voltage (percent rated)	Load power factor	Time limit
AC (method I)	50	600	100	0.40-0.50	1 hour
AC (method II)	50	150	100	0.70-0.80	1 hour 40 minutes
	Endurance test conditions				
	Number of cycles of operations	Test current (percent rated)	Test voltage (percent rated)	Load power factor	Minimum make and break operating cycles
AC (method I)	6000	100	100	0.80	6 per minute
AC (method II)	6000	100	100	0.80	6 per minute

4.6.19 Short-circuit withstandability. SABLs and SABL auxiliary switches shall be tested for short-circuit withstandability in accordance with MIL-S-16036. The SABLs shall be subjected to and pass the dielectric withstanding voltage test as specified in Table IV after the short-circuit withstandability tests without adjustment, calibration or replacement of parts. The test circuit current shall be measured, instrumented, and calibrated in accordance with UL 1008. SABLs shall fail the short-circuit withstandability tests if one or more of the following occurs during the test:

- a. Electrical malfunction occurs that prevents one transfer and re-transfer action by manual means.
- b. Electrical malfunction occurs to prevent transfer and re-transfer at rated conditions.

4.6.20 Dielectric withstanding voltage. Dielectric withstanding voltage tests shall be conducted in accordance with Method 301 of MIL-STD-202. Test conditions shall be as follows:

- a. Magnitude of test voltage:
  - (1) For circuits rated 60 V or less, the rms test voltage shall be 900 V.
  - (2) For circuits rated more than 60 V but not greater than 450 V, the rms test voltage shall be twice rated circuit voltage plus 1000 V.
  - (3) For all testing, voltage shall not be applied or removed at other than zero voltage.



- b. Nature of test voltage - The test voltage shall approximate a true sine wave of a frequency of 60 Hz.
- c. Points of configuration type - The test voltage shall be applied successively between each electrically isolated circuit and ground with all other circuits grounded. The test voltage shall be applied between stationary and rotating windings of rotating equipment when the equipment is at a standstill.
- d. Duration of test - The duration of test shall be not less than 60 seconds. The test voltage shall be removed by adjustment of its value to zero, not by sudden interruption.
- e. Definition of failure - Any evidence of arcing, flashover, odor, or punctured insulation shall be interpreted as a failure. Tripping of the test equipment shall also constitute failure.

4.6.21 Degree of enclosure. SABTs shall be tested in accordance with MIL-E-2036 for Class I enclosures, as supplemented by MIL-STD-108, to determine the effectiveness of the enclosure as specified in 3.4.50. The SABT enclosure shall be subjected to a water sprinkle rate of 6.9 in/hr (1000 cubic inches per hour per square foot of area covered) for 12 minutes (8 minutes operating and 4 minutes off) minimum in each of five different orientations; vertical and inclined 45 degrees forward, backward, to the right, and to the left. Failure of the equipment to operate satisfactorily or accumulation of water within the enclosure shall be cause for rejection. Additionally, the unit shall not be a hazard to personnel in case of minor water intrusion.

4.6.22 Ambient temperature. The SABT shall be designed for continuous reliable operation within specified limits over an ambient temperature range of 0 to 50 °C (32 to 122 °F). The SABT shall not be damaged nor shall the operational performance be degraded when restored to operating temperature range after exposure for long periods, 24-hour minimum, in a non-operating air temperature range of -25 to +60 °C (-13 to +140 °F). Test shall be conducted in accordance with MIL-STD-202.

4.6.23 Humidity. The SABT shall be subjected to humidity testing in accordance with MIL-STD-202.

4.6.24 Pressure. The SABT shall operate within the specified performance limits while subjected to an atmospheric pressure from 24 to 36 inches of mercury in accordance with MIL-STD-202. The SABT shall reliably operate within specified performance limits after exposure to an atmospheric overpressure of 2 atmospheres (14.7-psi positive differential on SABT).

4.6.25 Temperature rise. SABTs shall be subjected to a temperature rise test. The test shall be conducted with the SABTs carrying rated current, with control circuit energized. Component temperature rises shall be measured by the resistance method or by thermographic equipment. Sufficient thermocouples (or equivalent temperature sensors) shall be installed on representative current-carrying parts such as coils, contacts, and terminals. Temperature rises shall be measured at the hottest point where current-carrying parts are closest to insulating material. The test shall be conducted in accordance with MIL-E-917 and shall be continuous until the measured temperature rises have not increased by more than 1 °C in each of and for three consecutive 20-minute test periods or until a constant temperature is reached as specified in UL 1008. Temperature rises shall not exceed the values specified in (see 3.5.4). The ambient temperature of the equipment shall not be allowed to vary by more than 5 °C for 2 hours preceding the test.

4.6.26 Inclined operation. SABTs shall be operated at rated voltage and frequency when inclined 45 degrees forward, backward, right and left from its normal vertical orientation. Control circuits for SABTs shall be operated in each of the four inclined positions to ensure proper operation. SABTs shall be switched to all operating positions in each of the four inclined positions. The SABT shall be energized and fully operating and cycled at a rate of 5 to 7 cycles per minute through an arc of ±60° for a period of at least 30 minutes. The unit under test shall then be rotated around its vertical axis by 90° and the inclination test repeated for that mounting direction. The inclination machine shall then be fixed at an angle of 15° from the vertical in one direction and the unit operated for 30 minutes then the machine rotated through the vertical to the opposite 15° angle with the vertical and be operated for another 30 minutes.

4.6.27 Shock. SABTs shall be subjected to shock tests in accordance with MIL-S-901 for Grade A, Class I, Type A equipment with weight classification as required by the weight of the equipment. The SABT shall be tested in the same mounting configuration as the one chosen for shipboard installation. The tests shall be conducted with the SABT carrying current, at rated voltage and frequency. Control circuits shall be energized as in actual service. An oscillograph shall be used to check the closed contacts for excessive contact bounce and to check the open contacts

for momentary closures. SABT mounting shall be as specified for standard mounting for bulkhead mounted equipment in accordance with MIL-S-901. Fuses (or other indicators which provide a positive indication) shall be connected in a manner to detect any momentary shorting between live parts or live parts and ground. The SABTs being tested shall not be reconditioned or adjusted during the testing. SABTs shall fail the test if it cannot perform its intended operating functions during and after such tests or if one or more of the following occurs during the tests:

- a. Contact occurs between live parts and the enclosure.
- b. Enclosure door opens.
- c. Structural parts are damaged or loosened.
- d. Functional parts are damaged or loosened.
- e. Inadvertent transfer of load due to the force of shock blow.
- f. Main line contacts have contact bounce in excess of 0.02 second per bounce.
- g. Closed auxiliary contacts momentarily open or open auxiliary contacts momentarily close.

Note: The SABTs shall be thoroughly examined after the tests to determine whether there is evidence of items c and d above. The vibration test shall follow the shock test.

4.6.28 Vibration. SABTs shall be subjected to Type I vibration tests in accordance with MIL-STD-167-1. The tests shall be conducted with the SABT in each operating position with the SABT carrying rated current at rated frequency. Control circuits shall be energized as in actual service. An oscillograph or other suitable instrument shall be used to check correct power transfer and operation of any auxiliary contacts. Fuses (or other indicators which provide a positive indication) shall be connected in a manner to detect any momentary shorting between live parts or live parts and ground.

4.6.28.1 Conditions. The SABT shall retain structural integrity when the vibration exists along each of the three rectilinear orientation axis of the SABT as installed on shipboard (i.e., vertical, athwartship, and fore and aft). The SABT shall be tested in the same mounting configuration as the one chosen for shipboard installation (if shock or isolation mounts are utilized, these shall not cause resonance), and shall be subjected to:

- a. An exploratory vibration sweep from 4 Hz to 33 Hz @ 0.010-inch peak amplitude with the sweep in 1-Hz increments and held at each discrete frequency for a minimum of 15 seconds,
- b. A variable frequency test with the following amplitude and frequency profile: five-minute dwell at 1-Hz increments from 4 Hz to 15 Hz @ 0.030-inch peak amplitude; five-minute dwell at 1-Hz increments from 16 to 25 Hz @ 0.020-inch peak amplitude; five-minute dwell at 1-Hz increments from 26 to 33 Hz @ 0.010-inch peak amplitude, and
- c. A two-hour endurance test at the highest frequency resonance (resonance defined as any frequency where the transmissibility is 2 to 1 or greater) and applicable five-minute dwell amplitudes found during the exploratory sweep. If no resonance can be found, the two-hour endurance test shall be run at 33 Hz.

4.6.28.2 Indications of failure. An SABT shall fail the test if it cannot perform its intended operating functions during and after such tests, or if one or more of the following occurs during the tests:

- a. Contact between live parts and the enclosure.
- b. Enclosure door opens.
- c. Structural parts are damaged or loosened.
- d. Functional parts are damaged or loosened.
- e. Inadvertent transfer of load.
- f. Re-transfer operation is initiated.
- g. Closed auxiliary contacts momentarily open or open auxiliary contacts momentarily close.
- h. The SABTs shall be thoroughly examined after the tests to determine whether there is evidence of items c and d above. The SABTs shall be subjected to and pass the dielectric withstanding voltage test (see 4.6.20) after the vibration tests.

4.6.29 Airborne noise. When specified (see 6.2) the SABT shall be tested for airborne noise in accordance with MIL-STD-1474.

4.6.30 Structureborne noise. When specified (see 6.2), the SABT shall be tested for structureborne noise in accordance with MIL-STD-740-2.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contact in the responsible packaging activity.

## 6. NOTES

(This section contains information of a general or explanatory nature that maybe helpful, but is not mandatory.)

6.1 Intended use. SABTs are intended for use in Naval shipboard applications as devices that automatically or manually transfer power supply lines via its internal solid-state components to a connected load. When accomplished automatically, control circuits determine when and in what manner the transfer will occur.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. PIN (see 1.3).
- c. Specific issue of the individual documents referenced, if required (see 2.2.1 and 2.3).
- d. Different weight and size requirements (see 3.3).
- e. Special features (see 3.4.1).
- f. Operating voltage (see 3.4.2.4.4).
- g. Special setpoint voltages, if required (see 3.4.2.4.5).
- h. Timing or time delay, other than as specified (see 3.4.2.4.7).
- i. Operating frequency (see 3.4.2.4.12).
- j. Special frequency variation or time delay requirements for frequency sensing SABTs (see 3.4.2.4.12).
- k. Full phase protection for SABTs, if not allowed (see 3.4.2.4.13).
- l. In-phase monitor control circuit for SABT switches, if required or prohibited (see 3.4.2.4.14).
- m. Setting for inhibiting transfer on overload (see 3.4.2.4.15).
- n. Special auxiliary switch requirements, if necessary (see 3.4.11).
- o. When a higher source-to-source impedance is required (see 3.4.13.4).
- p. EMI criteria, if required (see 3.4.17).
- q. Active ground fault detection requirement (see 3.4.46).
- r. Special endurance and overload requirements, if required (see 3.4.47).
- s. Degree of enclosure (see 3.4.50).
- t. Airborne noise limits, if required (see 3.5.9).
- u. Structureborne noise limits, if required (see 3.5.10).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products, which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-32150 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to [commandstandards@navsea.navy.mil](mailto:commandstandards@navsea.navy.mil).

6.4 Definitions. For the purpose of the following definitions, the SABT is assumed to be in automatic mode with the normal source supplying the loads unless specifically indicated otherwise. Note that in the manual mode the SABT will remain lined up to the operator-selected power source regardless of the availability of either source.

Also, it is assumed that the SABB is based on semiconductor switch technology. If this is not the case, reference to semiconductor switches should be appropriately interpreted.

6.4.1 Active source. The “active” source is the source that is actually powering the load. The active source is indicated on the front panel.

6.4.2 Available source. A power source that has no open semiconductor switches and whose voltage is above the pickup voltage setpoint. Additionally, if the over/under frequency transfer features are enabled, the source frequency will also have to be between the under frequency transfer and the over frequency transfer for the source to be considered available. When a source is available, it will be so indicated on the front panel.

6.4.3 Continuous duty. Operation at substantially constant load for an unlimited period of time is considered continuous duty.

6.4.4 Control circuit time delay. The time duration that a power source under voltage condition (either in-phase or random) must be continuously present in order for the SABB to initiate a transfer. This time can be set to zero, in which the transfer is initiated immediately upon under voltage detection. (see 3.4.2.4.9)

6.4.5 Control circuits. Control circuits are solid-state (semiconductor) circuits that sense and control the transfer from normal to alternate power sources and re-transfer or otherwise control operation of the SABB.

6.4.6 Delay transfer. Programmable time period during a random transfer event during which the SABB will wait when transferring between two sources.

6.4.7 Fault. A condition whereby:

- a. A power source voltage or frequency falls outside its preset limits, causing it to become not available. Or:
- b. A problem is detected with a component or power supply internal to the SABB, including open and shorted semiconductor switch(es).

A fault of the type described in a above will always trigger a transfer or a transfer inhibit. In either case, an audible alarm will sound (unless the audible feature is disabled) and a fault/status code will be displayed on the digital readout. Most faults of the type described in a above can be cleared when conditions external to the SABB change (i.e., restoration of a source from not available to available status). A fault of the type described in b above (i.e., open semiconductor switch) may cause a transfer, or (i.e., shorted semiconductor switch) may cause a transfer inhibit, or no action to occur (i.e., fan failure); however, the fault will still be indicated with an audible alarm and a fault/status code. Type b faults will generally not clear until corrective maintenance is conducted on the SABB.

6.4.8 Full phase protection. Full phase protection occurs when an SABB device monitors all phase voltages of one power source and initiates transfer of the connected load from the active power source to another when voltage of the active power source drops below a predetermined value. The device initiates transfer of the connected load back to the preferred power source when all voltages of the preferred source return to within specified limits.

6.4.9 In-phase monitor. An in-phase monitor is a device used to sense the phase angle between the normal and alternate sources prior to load transfer. It is used with a two way instantaneous type SABB switch to initiate transfer only when the two sources are nearly synchronized thereby limiting the motor inrush current to below normal starting current levels and avoiding inadvertent circuit breaker tripping.

6.4.10 In-phase transfer voltage. The in-phase transfer voltage is the voltage threshold below which the unit senses an in-phase under-voltage condition. If the condition is on the active source, and it persists longer than the control circuit time delay, the source will no longer be considered available and the SABB will initiate a transfer to the inactive power source. Transfer will be initiated only if the inactive source is available. If the Phase angle difference feature is enabled, transfer will occur only if the phase mismatch between the sources is less than the preset phase angle difference. Note that the SABB operates in the in-phase transfer mode whenever the active power source voltage has been below the in-phase transfer voltage for a period of time corresponding to the control circuit time delay and voltage is still above the random transfer voltage setpoint.

6.4.11 Instantaneous. A qualifying term indicating that no delay is purposely introduced in the action of the SABT switch.

6.4.12 Normal source, alternate source. This establishes an arbitrary convention to distinguish between the two sources. Which source is normal and which is alternate depends entirely on which set of bus bars the cables from the two available power sources are connected to inside the SABT and hence is independent of which source should supply the load under normal operation. The term “normal” should therefore not be confused with “preferred”.

6.4.13 Operating transfer time. Operating transfer time is the time measured from the instant of monitored voltage source deviation to the recognition of an available alternate source, exclusive of any purposely introduced time delay.

6.4.14 Over frequency pickup. Over frequency pickup is the frequency threshold below which a power source that has previously exceeded the over frequency setpoint is considered to have reverted to an available state.

6.4.15 Over frequency setpoint. The frequency above which a power source is no longer considered available.

6.4.16 Overload average. The rms current of one of the power source phases deemed excessive for continuous operation. When this condition is sensed together with voltage below the random setpoint, the SABT senses a problem with the load and inhibits transfer to the inactive source regardless of this source’s availability.

6.4.17 Overload peak. The fast rising peak amplitude of the source current deemed excessive. When this condition is sensed together with voltage below the random setpoint, the SABT senses a problem with the load and inhibits transfer to the inactive source regardless of this source’s availability.

6.4.18 Phase angle difference. Phase angle difference is monitored only if the phase angle difference feature is enabled. The phase angle difference is measured between the normal and alternate sources.

6.4.19 Phase angle difference feature. A feature that, when enabled, allows the unit to monitor the phase mismatch between power sources. When the feature is disabled, transfer will occur instantaneously upon the active source voltage reaching the in-phase transfer voltage setpoint. In other words, transfer will occur without the time delay and regardless of the phase mismatch between sources. Disabling the phase angle difference feature will also allow re-transfer (if enabled) to occur regardless of phase mismatch between sources, as long as the preferred source has been restored to an available state.

6.4.20 Pickup voltage. The pickup voltage of a device is the minimum voltage at which the device starts to operate. Also, the lowest voltage of a power source at which the SABT will consider that source available, provided the other monitored parameters (over frequency and under frequency) are also within their acceptable ranges and there are no open semiconductor switches on that source.

6.4.21 Preferred source. The source to which the SABT will automatically re-transfer the load in the event both power sources become available. Either normal or alternate source can be selected to be preferred. If the re-transfer feature is not active, however, the term effectively has no meaning. When a source is selected as designated, it will be so indicated on the front panel.

6.4.22 Random transfer voltage. The voltage threshold of the active power source at which the SABT initiates a random transfer to the inactive power source, provided the inactive source is available. When this threshold is reached, transfer will occur regardless of phase mismatch between power sources. Note that when the phase angle difference feature is disabled, transfer will occur on the basis of the in-phase transfer voltage setpoint only. However, even in this case, the random transfer voltage will be utilized (in concert with an overload condition) by the SABT control logic to determine that a problem with the load has occurred and inhibit transfers.

6.4.23 Re-transfer. The automatic switching of loads from the non-designated to the designated source after a transfer has occurred earlier and subsequently the designated source has become available. If the phase angle difference feature is enabled, the re-transfer is performed only with the sources within the maximum allowed phase

angle difference, otherwise it will occur regardless of phase mismatch between sources. The re-transfer feature can be disabled, in which case, there is effectively no designated source; the SABT will not automatically re-transfer loads after the normal source has been restored to an available state. An indicator on the front panel is lit if the re-transfer feature is enabled.

6.4.24 Re-transfer time. Re-transfer time is the interval of time where the normal source has reached predetermined setpoints for availability at which time the re-transfer from the alternate to the normal is permitted. Re-transfer time is not applicable when the re-transfer feature is disabled because in this case the unit will not re-transfer to the designated (normal) source.

6.4.25 SABT. The SABT is a solid-state, self-acting device for transferring one or more load cable connections from one power source to another.

6.4.26 SABT operation. SABT operation is the transfer or the re-transfer of the connected load from one power source to another.

6.4.27 SABT source. Either the Normal or Alternate source may be selected as the preferred source for a given application. The preferred source is usually the Normal supply line or source.

6.4.28 Short-circuit withstandability. Short-circuit withstandability is the ability of the SABT switch switching mechanism to carry the required short-circuit current without permanent damage for the period of time necessary for circuit protective devices in the system to clear the fault.

6.4.29 Transfer. Transfer is the switching of loads from the active to the inactive source. It is triggered by the SABT upon sensing that the active source is outside preset transfer limits while the inactive source is available.

6.4.30 Transfer control override. The transfer control override is a situation in which a shorted semiconductor switch is detected on a source, in which case the SABT will transfer to (or remained lined up to) the source with the shorted semiconductor and inhibit further transfers.

6.4.31 Transfer time delay. Transfer time delay is an intentionally introduced delay in the operation of an SABT. Also, the preset amount of time allotted between transfer initiation (disconnecting the active source from the load) and completion (connecting the inactive source to the load). When time delay has elapsed, a transfer is completed. This time can be set to zero, in which case the transfer is instantaneous.

6.4.32 Under frequency pickup. Under frequency pickup is the frequency threshold above which a power source that has previously gone below the under frequency setpoint is considered to have reverted to an available state.

6.4.33 Under frequency setpoint. Under frequency setpoint is the frequency below which a power source is no longer considered available.

## 6.5 Acronyms.

EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FL	Fault Localization
PM	Performance Monitoring
RMS	Root Mean Square
SABT	Static Automatic Bus Transfer Switch



6.6 Key words.

ABT  
Silicon control rectifier  
Switch gear  
Switching mechanism

Custodians:

Army - CR4

Navy - SH

Air Force - 99

Preparing Activity:

Navy - SH

(Project 6110-0447)

Reviewing Activities:

Navy - AS, CG

Air Force - 03, 19

DLA - GS, GS2

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