INCH-POUND
MIL-PRF-32168
July 27, 2004

PERFORMANCE SPECIFICATION

VARIABLE SPEED DRIVE SYSTEM FOR INDUCTION AND SYNCHRONOUS MACHINES

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

1. SCOPE

1.1 Scope. This specification covers an electronic variable speed drive (VSD) system (see 6.3.12) used to control 3-phase alternating current induction and synchronous machines.

1.2 Classification. VSD systems are classified using the following ratings:

1.2.1 Voltage rating. VSD system user voltage ratings are as follows:

Nominal Input Voltage Rating	PIN Code
440	1
Other	2

1.2.2 Power rating. VSD system power ratings are as follows:

Power Rating (HP)	Motor FLA	PIN Code	Power Rating (HP)	Motor FLA	PIN Code	Power Rating (HP)	Motor FLA	PIN Code
0-10	14	A	50-150	180	C	200-275	360	E
10-50	68	B	150-200	260	D	275-375	460	F

1.2.3 Configurable control scheme. VSD system configurable control schemes are as follows:

Configurable Control Scheme Type	PIN Code
Scalar	1
Closed Loop Vector	2
Open Loop Vector	3
Combination of Scalar, Closed Loop Vector, and Open Loop Vector	4

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AMSC N/A FSC 6130

1.2.4 Cooling type. VSD system cooling types are as follows:

Cooling Type	PIN Code
Air	A
Chilled Water	B
Seawater	C
Other	D

1.2.5 Regeneration capability. VSD system regeneration capability is as follows:

Regeneration Capability	PIN Code
Regenerative	1
Non-regenerative	2

1.2.6 Front-end type. VSD system front-end types are as follows:

Front End Type	PIN Code
Active	A
Passive	B
Other	C

1.2.7 Frequency range. VSD system frequency ranges are as follows:

Frequency Range	PIN Code
0-60 Hz	1
Other	2

1.2.8 Dynamic braking. VSD system dynamic braking capabilities are as follows:

Dynamic Braking	PIN Code
Dynamic Brake	A
No Dynamic Brake	B

1.2.9 Machine type. The VSD system controls the following machines:

Machine Type	PIN Code
Induction	A
Synchronous	B

1.2.10 Load. The type of loads the VSD system controls are as follows:

Load	PIN Code
Constant Torque	1
Variable Torque	2
Constant Power	3

1.3 Part or identifying number (PIN). PINs to be used for VSDs acquired to this specification are created as follows: (see 1.2.1 through 1.2.10 for PIN Code designations)

M Prefix	Specification Number	Hyphen	Voltage Rating	Power Rating	Configurable Control Scheme	Cooling Type	Regeneration Capability	Front End Type	Frequency Range	Dynamic Braking	Machine Type	Torque Load
M	32168	-	1	C	3	A	1	A	1	B	A	2

The example above is for a 440-volt, 150-HP, open loop vector, air cooled, regenerative, active front end VSD system with a frequency range of 0-60 Hz and no dynamic brake which controls an induction motor connected to a variable torque load.

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 must meet all specified requirements documents 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 STANDARD

FED-STD-595/26307 Gray, Semi-Gloss

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-E-917 Electric Power Equipment, Basic Requirements
MIL-E-2036 Enclosures for Electric and Electronic Equipment, Naval Shipboard
MIL-DTL-15090 Enamel, Equipment, Light Gray, (Navy Formula No. 111)
MIL-DTL-24643 Cables and Cords, Electric, Low Smoke, for Shipboard Use, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (Type I – Environmental and Type II – Internally Excited)
MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-882	Standard Practice for System Safety
MIL-STD-889	Dissimilar Metals
MIL-STD-901	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-STD-1310	Standard Practice for Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety
MIL-STD-1399-300	Interface Standard for Shipboard Systems, Electric Power, Alternating Current (Metric)
MIL-STD-1474	Department of Defense Design Criteria Standard, Noise Limits

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.daps.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 45	IEEE Recommended Practice for Electric Installations on Shipboard
IEEE 802.3	Information Technology – Telecommunications and Information Exchange Between Systems – LAN/MAN Specific Requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical layer Specifications

(Copies of this document are available online at www.ieee.org or from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.)

UNDERWRITERS LABORATORIES, INC. (UL)

UL 94	Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

(Copies of this document are available online at www.ul.com or from the Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.)

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 or regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Materials.

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 Hazardous materials. Materials for use in the construction of VSDs shall have no effect on the health of personnel when the materials are used for their intended purpose. Regardless of other requirements, materials and parts containing asbestos, cadmium, lithium, mercury, or radioactive material shall not be used. Materials, which may not be used, are specified in MIL-E-917.

3.2.3 Fasteners. Materials for all bolts, nuts, studs, screws, and similar fasteners shall be corrosion-resistant passivated or of a material rendered resistant to corrosion. Sheet metal screws are acceptable if they successfully pass shock and vibration tests when installed in equipment which is qualification tested for MIL-STD-901 shock and MIL-STD-167-1 vibration test as specified for deliverable equipment. Galling shall be prevented. Tapped holes shall be reinforced where shearing of thread can occur.

3.2.4 Rubber or synthetic rubber material. Rubber or synthetic rubber material used in the construction of the VSD system shall not deteriorate due to contact with any fluid used for operation or maintenance of the VSD system.

3.2.5 Metals. Metals shall be of corrosion-resistant type or suitably treated to resist corrosion due to fuels, salt, spray, or atmospheric conditions likely to be met in storage or normal service. Corrosion resistant metals are specified in MIL-E-917.

3.2.6 Dissimilar metals. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in contact with each other. Dissimilar metals are defined in MIL-STD-889.

3.2.7 Encapsulant. Any epoxy coating or encapsulant used shall meet the requirements of UL 94 for reduced flammability.

3.3 Design.

3.3.1 Enclosure. The VSD system shall be mounted in an enclosure constructed in accordance with MIL-E-2036.

3.3.2 Enclosure size for air cooled VSD systems. The VSD system size shall not exceed the following footprints and overall volume as specified (see 6.2):

Power Rating (HP)	Motor FLA	Footprint
0-10	14	24" x 12" x 35"
10-50	68	24" x 24" x 44"
50-150	180	35" x 24" x 60"
150-200	260	40" x 24" x 60"
200-275	360	40" x 28" x 60"
275-375	460	40" x 28" x 63"

3.3.3 Enclosure size for water cooled VSD systems. VSD systems cooled by either seawater or chill water shall not exceed the following dimensions as specified (see 6.2):

Power Rating (HP)	Motor FLA	Dimensions
0-10	14	30" x 30" x 10"
10-50	68	30" x 30" x 10"
50-150	180	40" x 40" x 20"
150-200	260	40" x 40" x 20"
200-275	360	50" x 40" x 25"
275-375	460	50" x 40" x 25"

3.3.4 Component mounting. Mounting of components shall meet the requirements of IEEE 45. No components other than indicator lights, switches, control pads, and communication ports for PCs shall be mounted external to the enclosure.

3.3.5 Hazards. Warnings and other markings shall be applied in accordance with MIL-STD-882 and MIL-E-917 to aid personnel in avoiding hazards.

3.3.6 Label plates. A label plate shall be mounted on the VSD system and shall include the manufacturer's name, CAGE Code, address, and phone number; VSD device model number; VSD device serial number; and the VSD device rated voltage, current, frequency range and horsepower. More than one label may be utilized to provide all information specified herein.

3.3.7 Paint. The VSD system enclosure shall be painted machinery gray, in accordance with FED-STD-595/26307. The paint scheme selected by the manufacturer shall be compatible with shipboard maintenance practices as detailed in Naval Ships' Technical Manual (NSTM), Chapter 631 and for use with Navy Formula 111 as formulated in accordance with MIL-DTL-15090.

3.3.8 Repairable/replaceable/consumable components. When specified, a list of repairable, replaceable, and consumable parts with part numbers shall be provided with delivery of the VSD system as specified (see 6.2).

3.3.9 Electrical safety. The VSD system will be constructed in accordance with safety requirements as defined in MIL-E-917.

3.4 Performance characteristics.

3.4.1 Power quality. The VSD system shall maintain voltage and current power quality in accordance with MIL-STD-1399-300 Type I power for all operating conditions of the VSD system and load.

3.4.2 Bonding and grounding. The VSD system shall be bonded and grounded in accordance with MIL-STD-1310 and MIL-E-2036.

3.4.3 Voltage, current, and power rating. The voltage, current, and power rating of the VSD system shall be as specified (see 6.2), using 1.2.1 and 1.2.2. The input voltage rating of the VSD system shall match the nominal user voltage rating of the shipboard electrical power system. The current rating of the VSD system shall be not less than the FLA rating of the motor. The VSD system shall smoothly control the motor output speed from standstill to rated speed. The VSD system shall also continuously operate the motor at any horsepower within the range specified for control functions (see 3.4.14) and under the environmental conditions described in 3.5.

3.4.4 Torque load. The VSD system shall operate with either of the following types of loads as specified (see 6.2):

a. Constant power (see 6.3.3)
b. Constant torque (see 6.3.4)
c. Variable torque (see 6.3.13)

3.4.5 Machine type. The VSD system shall operate one of the following types of machines as specified (see 6.2):

a. Induction
b. Synchronous

3.4.6 Configurable control schemes. The VSD system shall provide one of the following user configurable control schemes as specified (see 6.2):

a. Closed loop vector (see 6.3.2)
b. Open loop/sensorless vector (see 6.3.7)
c. Scalar (V/Hz) (see 6.3.10)
d. Control schemes a, b, and c above

3.4.7 Cooling. The VSD system shall operate with one of the cooling mediums as specified (see 6.2). The VSD system shall have condensation drains to remove condensation caused by the cooling system. Condensation caused by the cooling system shall not adversely affect the operation of the VSD system.

a. Air with a temperature range of 32 ºF to +122 ºF (0 ºC to +50 ºC)
b. Chilled water with a temperature range of +41 ºF to +86 ºF (+5 ºC to +30 ºC)
c. Seawater with a temperature range of +28.4 ºF to +95 ºF (-2 ºC to +35 ºC)
d. Other

3.4.8 Regeneration capabilities. The VSD system may be configured to provide regeneration capabilities as specified (see 6.2):

a. Non-regeneration (see 6.3.6)
b. Regeneration (see 6.3.9)

3.4.9 Front-end type. The VSD system shall have the following front ends as specified (see 6.2):

a. Active front end (see 6.3.1)
b. Passive front end (see 6.3.8)
c. Other

3.4.10 Frequency range. The VSD system shall provide the frequency range required by the application as specified (see 6.2).

3.4.11 Dynamic brake. The VSD system may be configured to use dynamic braking (see 6.3.5) to provide speed control as specified (see 6.2).

3.4.12 VSD features. Additional features may need to be specified (see 6.2), however, the VSD shall have the following performance features at a minimum:

a. Digital user interface keypad with full function LED or LCD display for viewing operational parameters.
b. Provisions for remote/local control and programming of motor operation and adjustable parameters.
c. Circuits provided for proportional integral derivative (PID) process control.
d. An internal means of deactivating parameter adjustments, via the keypad, to eliminate unauthorized data entry. Indication of the microprocessor's health and troubleshooting parameters shall also be available via the keypad digital display.
e. Efficiency rating of at least 93 percent at full load for the VSD system.
f. Means for adjusting output carrier frequency.
g. Separate communications port to ensure proper interface with a personal computer (PC).
h. Capability of receiving power directly from a DC source.

3.4.12.1 Parameter adjustments. Additional parameters may be specified (see 6.2), however, at a minimum, the VSD shall be user programmable for the following functions using the digital user interface keypad or PC interface:

a. Access authorization to controller functions (password protection)
b. Motor operating modes
c. Minimum and maximum switching frequency
d. Minimum and maximum motor speed
e. Motor overload current
f. Programmable torque and speed profile
g. Acceleration/deceleration time
h. Torque/current limiting

3.4.12.2 Standard displays. At a minimum, the following displays shall be user selectable from the keypad:

a. DC link voltage
b. Motor torque
c. Motor speed
e. Output frequency
f. Output current
g. Output torque
h. Output voltage
i. Output power

3.4.12.3 Protective controls and status indicators. At a minimum, the VSD shall provide the following controls and indicators that shall be menu selectable. Additional protective features may be required as specified (see 6.2).

a. Over current
b. Over voltage
c. Under voltage
d. Loss of AC power
e. Drive over temperature
f. Ground fault
g. Communication fault
h. Self-diagnostic tool to identify internal system faults prior to operation

3.4.12.4 Software tool. The VSD shall provide a Windows based software tool shall be capable of adjusting parameters, displaying actual values, and controlling the VSD in lieu of the keypad. The software tool shall also be capable of loading custom programs, storing VSD settings, and plotting real time graphs of VSD system parameters.

3.4.12.5 Controls and options. At a minimum, the VSD shall provide the following controls and options:

a. Capability for selectable external start/stop control, either 2-wire or 3-wire.
b. Capability for two analog inputs configurable to receive $\pm$10 VDC, 0 to 20 V, 0 to 20 mA, or 4 to 20 mA. The analog inputs shall be programmable for function control.
c. Capability for four digital inputs configurable to receive 24 VDC. The digital inputs shall be programmable for function control.
d. Capability for two digital output contacts rated for 3 A at 230 VAC and programmable for function control.
e. Capability for two analog outputs programmable for function control.

3.4.12.6 Ethernet. The VSD system shall provide industry standard Ethernet communication capabilities embedded either in the VSD processor or through an Ethernet communication module.

3.4.12.7 Network connection. The VSD processor shall have a selectable option of using IEEE 802.3 as the interface to a network.

3.4.13 Service life. The service life of the VSD system for the specified operating environment shall be twenty (20) years.

3.4.14 Control functions. The VSD system shall provide customized control functions in accordance with the specification application and output power as specified (see 6.2). Examples of constraints which may define control functions are:

a. Duty cycle of the motor and load
b. Types and quantity of indicator lights for the operator interface
c. Ladder logic control diagram defining the operating sequence of the VSD system, motor and load.
d. Acceleration time
e. Deceleration time
f. Minimum speed
g. Maximum speed
h. Load inertia

3.4.15 Motor characteristics: The VSD system must operate a motor with nameplate data as specified (see 6.2).

3.5 Environmental conditions.

3.5.1 Enclosure protection. The degree of protection the enclosure shall provide the VSD system shall be in accordance with MIL-E-2036 as specified (see 6.2).

3.5.2 Ambient temperature operation. The VSD system shall perform reliably while continuously operating at its full load amperage at an ambient temperature of +122 ^{0}F (+50 ^{0}C) and with its cooling medium at maximum temperature. Equipment shall not be damaged nor shall the operational performance be degraded when the equipment is restored to the operating temperature range after having been exposed for long periods in the non-operating temperature range.

3.5.3 Relative humidity. The VSD system shall operate satisfactorily during and subsequent to exposure to relative humidity ranging up to 95 percent for both continuous and intermittent periods, including conditions wherein condensation occurs on the equipment.

3.5.4 Shock. The VSD system shall meet specified performance after being subjected to shock levels in accordance with MIL-S-901, Type A.

3.5.5 Vibration. The VSD system shall meet specified performance after being subjected to vibration levels in accordance with MIL-STD-167-1.

3.5.6 Electric power interface. The VSD system shall be capable of maintaining the required power output when connected to an electrical shipboard power system with characteristics defined in MIL-STD-1399-300 for Type I power.

3.5.7 Electromagnetic interference. The VSD system shall meet the applicable electromagnetic interference requirements for surface ships found in the Requirements Matrix of MIL-STD-461: CE102, RE101, RE102, CS101, CS114, CS116, RS101, RS103. Additional tests may be as specified (see 6.2).

3.5.8 Airborne noise. At a minimum, the VSD system shall meet Grade D noise requirements as defined in MIL-STD-1474 for shipboard systems.

4. VERIFICATION

4.1 Classifications of inspections. The inspections specified herein are classified as follows:

a. First article inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be performed on one complete VSD system. This inspection shall include the examination specified in 4.4 and the tests specified in Table I and 4.5.1 through 4.5.7.

4.3 Conformance inspection. Conformance inspection shall include the examination specified in 4.4 and the tests specified in Table I and 4.5.1 through 4.5.7.

4.4 Examination. Each VSD system shall be examined for compliance with the requirements of 3.2 through 3.3. Any redesign or modification of the contractor's standard product to comply with specified requirements, or any necessary redesign or modification following failure to meet the specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximu m efficiency shall constitute cause for rejection.

TABLE I. First article tests and conformance inspections.

Tests	Requirement Paragraph	First Article Test	Conformance Inspection
Examination	3.2-3.3	4.4	4.4
Performance	3.4	4.5.1	4.5.1
Enclosure Protection	3.5.1	4.5.2	
Ambient Temperature Operation	3.5.2	4.5.3	
Relative Humidity	3.5.3	4.5.4	
Shock	3.5.4	4.5.5	
Vibration	3.5.5	4.5.6	
Electric Power Interface	3.5.6	4.5.7	
EMI	3.5.7	4.5.8	
Airborne Noise	3.5.8	4.5.9	

4.5 Methods of inspection.

4.5.1 Performance. A performance inspection shall be conducted by using switches and other material to simulate the control inputs necessary to provide the proper output. At all times the VSD system must control a load during the performance test. The test load must be representative of the final installation load. The VSD system shall be tested for conformance to the interface requirements as specified in MIL-STD-1399-300 for Type I power and still meet performance requirements. Failure to meet the requirements of these tests shall be cause for rejection.

4.5.2 Enclosure protection. The VSD enclosure shall be tested in accordance with MIL-E-2036 to the degree of protection specified in 3.5.1.

4.5.3 Ambient temperature operation. The VSD system shall be tested for conformance to the ambient temperature operation requirements specified in 3.5.2 in accordance with MIL-STD-810. Failure to meet the requirements of this test shall be cause for rejection.

4.5.4 Relative humidity. The VSD system shall be tested for conformance to the relative humidity requirements specified in 3.5.3 in accordance with MIL-STD-810. Failure to meet the requirements of this test shall be cause for rejection.

4.5.5 Shock. The VSD system shall be tested for shock in accordance with MIL-S-901, Type A. Shock test acceptance shall be contingent upon the ability of the VSD system to continuously operate during the shock test and to control a load which is representative of the final installation load after the shock test. Failure to meet the

requirements of this test shall be cause for rejection. Vibration or resilient mounts may be utilized to ensure the device components and enclosure shall operate satisfactorily when tested in accordance with shock requirements of MIL-S-901, Type A. Wire connections, terminal strips, and other device components shall not crack or become dislodged during testing.

4.5.6 Vibration. The VSD system shall be tested for vibration in accordance with MIL-STD-167-1. Failure to meet the requirements of this test shall be cause for rejection. Vibration or resilient mounts may be utilized to ensure the device components and enclosure shall operate satisfactorily when tested in accordance with vibration requirements of MIL-STD-167. Wire connections, terminal strips, and other device components shall not crack or become dislodged during testing.

4.5.7 Electric power interface. The VSD system shall be tested to determine whether it can supply control functions and outboard power when connected to the shipboard system electrical power with characteristics defined in MIL-STD-1399-300 for Type I power. Failure to meet the requirements of this test shall be cause for rejection.

4.5.8 Electromagnetic interference. The VSD system shall be tested for electromagnetic interference in accordance with MIL-STD-461 for surface ships. The VSD system shall operate a motor load and be configured as intended for shipboard installation. Cables using proper shielding and meeting MIL-DTL-24643 will be used. Failure to meet the requirements of this test shall be cause for rejection.

4.5.9 Airborne noise. The VSD system shall be tested for noise limits in accordance with MIL-STD-1474.

5. PACKAGING

5.1 Packaging. For acquisition purposes, packaging 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, those personnel shall 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 command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The VSD system specified herein is intended for use on either AC induction motors or AC synchronous motors (permanent magnet motors, etc.) that require speed control. By having the ability to control the speed of motors, fluid systems with motor driven pumps can be operated at peak efficiency. Additionally, the VSD will **also** provide starting torque control and regulate starting current.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. When first article is required. (see 3.1)
c. Enclosure size. (see 3.3.2 and 3.3.3)
d. Input voltage rating (see 3.4.3)
e. Current (FLA) rating . (see 3.4.3)
f. Power rating. (see 3.4.3)
g. Torque load. (see 3.4.4)
h. Induction or synchronous. (see 3.4.5)
i. Configurable control scheme. (see 3.4.6)
j. Type of cooling. (see 3.4.7)
k. Regeneration capabilities. (see 3.4.8)
l. Front-end type. (see 3.4.9)
m. Frequency range. (see 3.4.10)
n. Dynamic brake. (see 3.4.11)

o. VSD features (see 3.4.12)
p. Parameter adjustments . (see 3.4.12.1)
q. Additional protective features. (see 3.4.12.3)
r. Control functions. (see 3.4.14)
s. Motor nameplate data. (see 3.4.15)
t. Enclosure protection. (see 3.5.1)
u. Additional electromagnetic interference tests. (3.5.7)
v. Packaging requirements. (see5.1)

6.3 Definitions.

6.3.1 Active front end. The inverter portion of the Variable Speed Drive consists of electronic devices that are actively switched based upon a controlled program

6.3.2 Closed loop vector. Closed loop vector is a control scheme where the volts per hertz ratio is not constant and there is a feedback device to control motor speed. This is usually used for loads requiring a high degree of speed or torque control, especially at low speed.

6.3.3 Constant power. Applications that demonstrate an inverse speed torque profile. As speed increases, torque decreases. The lowest speed provides the maximum torque (traction motors , machine tools).

6.3.4 Constant torque. Constant torque is the load in which the torque required is constant for all speeds (e.g., elevators).

6.3.5 Dynamic breaking. Dynamic breaking is a method for slowing a motor using a resistor to dissipate kilowatts from the load during deceleration. It is used only with variable speed drives with passive front ends and is connected to the DC link to prevent the DC link voltage from becoming too large.

6.3.6 Non-regeneration. The variable speed drive allows kilowatts to flow only in one direction which is from the power system to the load.

6.3.7 Open loop / sensorless vector. Open loop/sensorless vector is a control scheme where the volts per hertz ratio is not constant and there is no feedback device to control motor speed. This is also used for loads requiring a high degree of speed or torque control.

6.3.8 Passive front end. The inverter portion of the Variable Speed Drive consists of electronic devices that are passively switched based upon voltage polarity across the devices terminals

6.3.9 Regeneration. The variable speed drive allows kilowatts to flow either from the power system to the load and from the load to the power system.

6.3.10 Scalar. Scalar control scheme ensures the ratio of volts per hertz supplied by the VSD system to the motor is constant for all speeds. This is typically used in applications that do not require a high degree of control.

6.3.11 Variable speed drive (VSD). A VSD is a solid state electronic device, which adjusts voltage and frequency to control the torque and speed of the motor that is connected to it.

6.3.12 Variable speed drive system. A VSD system includes the VSD, associated power conditioning equipment, and enclosure necessary to make the VSD acceptable for military use as a stand-alone system.

6.3.13 Variable torque. Variable torque is a load in which the torque required varies with speed (e.g., pump and fan loads).

6.4 Subject term (key word) listing.
Motor Control
Variable Frequency Drive
Variable Speed Drive
VFD
VSD

Custodians:
Army - CR
Navy - SH
Air Force - 99

Preparing Activity:
Navy - SH
(Project 6130-0419)

Review Activities:
Navy AS, BC, CG, EC, NW
Air Force – 71
DLA – GS, GS2

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at www.dodssp.daps.mil.