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Superseded by ARP5015

Solid-State Frequency Converter 400 Hertz, 3-Phase Output

RATIONALE

This document is cancelled and superseded by ARP5015. The original sponsors created ARP5015 with the intention of cancelling ARP1940 upon completion. Everything included in ARP1940 is addressed in ARP5015 with more modern terms and references.

CANCELLATION NOTICE

This document has been declared "CANCELLED" as of March 2012 and has been superseded by ARP5015. By this action, this document will remain listed in the Numerical Section of the Aerospace Standards Index noting that it is superseded by ARP5015.

Cancelled specifications are available from SAE.

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1. SCOPE:

1.1 This specification covers the requirements for solid-state frequency converters with 480 [or 380] V 3-phase, 60 [or 50] Hz input and 115/200 V, 3-phase, 400 Hz output capable of powering aircraft type loads requiring MIL-STD-704D quality power.

The frequency converter shall be a self-contained unit suitable for the environment of intended use. Typical applications include dedicated use at passenger loading bridges (mounted under the bridge in telescoping bridge applications or fixed installation at base of stationary type loading bridges) with weatherproof enclosures or hangar/lab use where indoor fixed or portable units can be used.

2. GENERAL:

2.1 Applicable Publications: The publications listed below form a part of this specification to the extent referenced herein. The publications are referred to in the text by the basic designation only.

The publications listed below can be obtained by ordering through the following address:

Military Standards/Specification

Commanding Officer
Naval Publications and Forms Center
Attn: NPFC 3015
5801 Tabor Avenue
Philadelphia, PA 19120

NEMA Publications

National Electrical Manufacturers Association
2101 L. St. N.W.
Washington, DC 20037
(203) 457-8400

ANSI Publications

American National Standards Institute
1430 Broadway
New York, NY 10018
(212) 354-3300

UL Standards

Underwriters Laboratories
333 Pfingsten Road
Northbrook, IL 60062
(312) 272-8800

2.1 (Continued):

IEC Publications

International Electrotechnical Commission
3, rue de Varembe
CH-1211 Geneve 20 Switzerland
(022) 340150

ATA Publications

Air Transport Association
1709 New York Avenue NW
Washington, DC 20006
(202) 626-4000

SAE Publications

Society of Automotive Engineers, Inc.
400 Commonwealth Drive
Warrendale, PA 15096
(412) 776-4841

2.1.1 Military Standards:

MIL-STD-704D - Aircraft Electrical Power Characteristics

2.1.2 National Electrical Manufacturers Association (NEMA) Publications:

ICS 1.1-84 - Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
ICS 6-83 - Enclosures for Industrial Control Devices and Systems

2.1.3 American National Standards Institute (ANSI) Publications:

C84.1-1982 - Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)

2.1.4 Underwriters Laboratories (UL) Standards:

UL 1446-1980 - Systems of Insulating Materials - General
Revised 3/86

2.1.5 International Electrotechnical Commission (IEC) Publications:

38-1975 - IEC Standard Voltages
Amendment 1-1977

2.1.6 Air Transport Association (ATA) Publications:

ATA-101 REV 4 - Ground Equipment Technical Data

2.1.7 Society of Automotive Engineers, Inc. (SAE) Publications:

SAE J1175 MAR85 - Bystander Sound Level Measurement Procedure for Small Engine Powered Equipment

2.2 General Requirements: Provide a solid-state frequency converter with accessories, auxiliary equipment, and associated work as specified.

2.2.1 Materials: All materials shall be new, unused, and suitable for the purpose intended.

2.2.1.1 Magnetic Devices: All power transformers and inductors shall be Class 180 in accordance with UL 1446.

2.2.1.2 Electrical Design: The circuitry shall consist of the following major sections:

- Input rectifier stage
- 400 Hz inverter stage
- Rectifier/inverter control and drive logic
- Protection, alarm and control features for unit, aircraft and bridge interface
- 400 Hz output circuit

2.2.1.2.1 Input Rectifier Stage: The input circuit shall provide a smooth "walk-in" on start-up to minimize inrush on the utility power line. The input circuit shall provide sufficient isolation and reduction of the rectifier-induced harmonic noise from reflecting on the input utility line.

2.2.1.2.2 Inverter Stage: The inverter section shall consist of power semiconductor units to provide a derived sine wave output.

2.2.2 Environmental Conditions: The frequency converter shall be capable of withstanding or operating satisfactorily when exposed to the following conditions:

a. Ambient temperatures ranging from -40 to +52°C (-40 to +125°F) when operating.

b. Nonoperating temperatures ranging from -40 to +60°C (-40 to +140°F).

c. Relative humidity 10 to 100% (noncondensing).

d. Altitude - Operation at any altitude up to 6600 feet (2000 meters) above sea level without derating.

e. Wind-Loading (outdoor) - Operation up to 90 mph.

2.2.3 Life Expectancy: The frequency converter shall be designed for a minimum life expectancy of 15 years with routine servicing and periodic adjustment. Periodic inspections other than routine servicing shall not be required at intervals of less than 2000 h.

3. PRODUCT:

3.1 Material and Equipment: Materials and equipment shall conform to the referenced specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.

3.1.1 Efficiency: When operated at nominal input voltage and full load at 0.8 power factor lagging, the efficiency of the frequency converter shall not be less than 92%.

3.1.2 Electromagnetic Interference: The electromagnetic interference emission characteristics of the unit shall be compatible with aircraft environment.

3.1.3 Audible Noise Level: The converter noise level shall not exceed an "A" scale measurement of 71 dB at a distance of 6 ft (2m) from the unit using procedures in accordance with SAE J1175.

3.1.4 Wiring: All wiring shall have ample service loops and be protected from abrasion. Wiring and wiring harnesses shall be properly secured. All terminals shall be identified in accordance with the wiring diagram.

3.1.5 Electrical Characteristics:

3.1.5.1 Input:

a. Nominal voltage - 480 [380] V nominal (416 to 508 V) [(342 to 418 V)] in accordance with ANSI C84.1 voltage range B [IEC 38]. Other optional input voltages include 208; 240 V, 575 V (60 Hz) and 220 V (50 Hz).

b. Configuration - 3-phase.

c. Frequency - 60 [or 50] Hz

3.1.5.2 Output:

a. Power rating - [__kW/__kVA]

[Standard ratings
30 kW/37.5 kVa, 32 kW/40 kVA, 40 kW/50 kVA, 48 kW/60 kVA, 60 kW/75 kVA, 72 kW/90 kVA, 80 kW/100 kVA, 96 kW/120 kVA and 100 kW/125 kVA]

b. Output voltage - 115/200 V rms

c. Configuration - 3-phase, 4-Wire

d. Frequency - 400 Hz

e. Power factor - 0.8 lagging

3.1.5.3 Inrush Current: The inrush current shall not exceed 100% of rated full load current after the first half cycle (8 to 10 ms).

3.1.5.4 Frequency Stability: Under steady-state conditions within the converter rating, the frequency shall remain within ±0.1% of the nominal 400 Hz.

3.1.5.5 Transient Performance: When the frequency converter is initially operating at rated input frequency and rated voltage, and following any sudden change in load of up to 100% of rated load, the transient output voltage shall not deviate beyond the limits of Figure 5 of MIL-STD-704.

3.1.5.6 Voltage Operating Range: The frequency converter output voltage shall be capable of being adjusted over a minimum range of ±10% from rated voltage. Adjustment shall be ±15% for the purpose of checking protective device settings.

3.1.5.7 Voltage Modulation: At any load from no load to full load, voltage modulation shall not exceed 0.5%.

3.1.5.8 Harmonic Distortion: The maximum total harmonic distortion at any load shall not exceed 3% when measured line-to-line and line-to-neutral. The maximum single harmonic shall not exceed 2.0% of the fundamental at the steady-state voltage and shall not otherwise exceed the distortion spectrum limits of Figure 3 of MIL-STD-704.

3.1.5.9 Crest Factor: The crest factor shall be 1.41 ± 0.1.

3.1.5.10 Voltage Unbalance: Variation between line-to-neutral voltages shall be not more than 3 V under the condition of a single-phase, line-to-neutral unbalance load of 10% of rated current and no other load on the frequency converter or in accordance with the limits of Figure 1 of MIL-STD-704, whichever is greater.

3.1.5.11 Phase Balance (Voltage): With the frequency converter operating at rated voltage, rated frequency and any load within the rated kVA/kW, the maximum difference in the three line-to-neutral voltages shall not be more than 2.0% of rated line-to-neutral voltage.

3.1.5.12 Voltage Regulation: The voltage regulation from no load to rated load and from rated load to no load shall be not more than 1% of the rated voltage. The above regulation will be maintained with input line voltage variations of ±10%.

3.1.5.13 Overload: After reaching a stabilized temperature at full-rated load, the frequency converter shall be capable of carrying an overload equal to 125% of its rated load for a minimum of 5 min while maintaining the output voltage within the regulation band. The frequency converter shall also be capable of supplying 150% of load current for a minimum of 10 s.

3.1.5.14 Short-Circuit: The frequency converter shall not be damaged by a line-to-line or line-to-neutral short circuit. Short circuit current shall be 200% minimum.

3.2 Control, Instrumentation, and Protective Devices:

3.2.1 Controls: The frequency converter shall be so designed that it can be started and stopped by means of momentary push buttons. All necessary devices for accomplishing this shall be mounted on the control panel. All push button functions shall also be setup for remote operation.

3.2.2 Control Circuit Transformer: A transformer with a fused secondary shall be provided for operation of control and indicating devices.

3.2.3 Fuses: Fuses shall be suitably marked as to circuit designation.

3.2.4 Output Isolation: The converter shall be connected to the output terminals through an electrically isolating device with E & F interlock circuit. The isolating device shall be of sufficient capacity to handle rated load, overload, and short-circuit capacities specified. The isolating device shall be located between the inverter and the output terminals. The device may contain or may be controlled by any of the protective devices specified herein. The manual operating mechanisms for this device shall be mounted on the control panel. The isolating device shall be electrically interlocked with the input circuitry so that when the frequency converter is shut down, the output will be immediately electrically isolated from the load. This isolation may use solid state components.

3.2.5 Line Drop Compensation: The voltage regulation means shall include an adjustable line drop compensator for maintaining the voltage regulation at a single point distant from the frequency converter. This compensator shall be adjustable at full load to at least 5% of rated voltage at the unit output terminals.

3.2.6 Voltmeter: The output voltmeter shall have a single 0 to 150 V scale in order to read line-to-neutral voltages. The accuracy of the meter shall be 2% or better. Test jacks shall be connected across the voltmeter for use by an external meter.

3.2.7 Selector Switch: Selector switch shall be provided for monitoring the three line-to-neutral output voltages.

3.2.8 Indicating Lights and Controls:

3.2.8.1 Input Indicator: An indicator light shall be provided which shows that the input is energized.

3.2.8.2 Converter On/Off Push Buttons: A push button switch shall be provided to start and stop converter operation. An indicator light shall show whether the converter is ON or OFF.

3.2.8.3 Lamp Test: A push button shall be provided which will energize all lamps on the control panel to test if they are operating.