TESTING TO MIL-STD-704

Since the release of MIL-STD-704 on 6 October 1959, through the latest revision of MIL-STD-704C on 30 December 1977, testing to this standard widely varied because of a lack of commercially available test equipment. Due to the relatively long life cycle of aircraft, all of the revisions, except the original MIL-STD-704 are in effect today. MIL-STD-704A is most often specified because of the preponderance of aircraft generation equipment deisgned to meet it. The standard revisions all describe the characterictics of aircraft electric power generating equipment, including voltage and frequency transient surges that can be expected to exist on AC and DC power buses. These are usually the result of either switching loads on and off or as a result of power bus transfer from one generator to another. In addition, limits for distortion, phase imbalance, frequency modulation, and voltage spikes are defined for aircraft power generation equipment.

The designer of aircraft equipment which uses the aircraft power must be aware of MIL-STD-704 characteristics. In addition, he is much more likely to produce equipment which performs as required during and after normal and abnormal electric power generation system operation if he is required to demonstrate compliance by testing. The nebulous "design goal" is thus transformed to the concrete and attention getting "pass/fail" statement at the conclusion of the test.

THE POWER SUPPLY DESIGN

The problem of designing equipment to meet the requirements of MIL-STD-704 is the responsibility of the equipment's power supply design. Since the power supply usually 1) must not lose regulation during the normal electric system operation and 2) contains whatever overvoltage and undervoltage protective circuits which are required, it is essential that the power supply design consider the characteristics of the power to be delivered to the system. Many power supplies can be made to operate satisfactorily on relatively "clean" laboratory power. But to design a supply that operates efficiently and maintains regulation during the normal power voltage and frequency transient surges, and allows automatic return of system performance at the completion of abnormal power voltage and frequency transient surges, requires considerably more effort. Since testing is far more cost effective than analytical methods, it is essential that the power supply designer have access to a programmable source which will produce the over and undervoltage transient surges of MIL-STD-704.

LINEAR vs SWITCHING REGULATORS

In the past, linear regulator design was popular because it could be made reliable and relatively EMI free. Switching power supply designs have come of age because they operate more efficiently and can be made to hold regulation over a wider range of input power voltages required by MIL-STD-704. The EMI problem usually associated with switching power supplies can be minimized by choosing a switching frequency sufficiently high to be easily filtered and still be within the required efficiency constraints.

EMC INFLUENCE

EMC Laboratories need to be responsive to the need for testing electric power utilization equipments which have MIL-STD-704 as a firm requirement. Due to the importance of an equipment's power supply in determining conducted interference emissions and susceptibility, early developmental evaluation tests are often done on the fully loaded, stand alone power supply. The input power EMI filter can then be selected based on the test results. It is important that the power supply also be tested to the overvoltage and undervoltage transient surges of MIL-STD-704 at the same time. Then, interference free operation as well as compatible performance of the power utilization equipment with the aircraft power bus will be assured. Because of the stringent leading power factor requirement levied by MIL-STD-704, the transient surge evaluation test should include a determination of fully loaded power supply power factor with, when available, the proposed EMI powerline filter. It is also essential that the EMI powerline filter be able to withstand the stress of the transient overvoltage surges.

TEST EQUIPMENT AVAILABLE

Three known methods can be used to produce transient surges required by MIL-STD-704. The oldest methods involve the use of a motor-generator which can be mechanically braked to produce transient surges. The versatility of this method is quite limited due to lack of control and difficulty in achieving repeatability.

A second test method uses a power amplifier driven by an oscillator. Using this approach it is practical to generate both the power voltage and frequency transients required. Unfortunately, newer power amplifiers are usually of solid state design, and, as such are not very forgiving of spikes produced by the equipment under test. Vacuum tube amplifiers are less available today since the advent of solid state technology.

A third method uses power thyristors to supply power from selected transformer taps. Although less versatile than the power amplifier, advantages include increased reliability, efficiency, and greater output power per dollar invested.

EVOLUTION OF MIL-STD-704

Numerous evolutionary changes in MIL-STD-704 have taken place since its release in October of 1959. Some of these include:

1) Reduction of the ±600 volt spike voltage requirement on 28 VDC lines to ±56 volts (notice 2 to MIL-STD-704A dated 1 May 1970 substitutes MIL-E-6051D requirements, which in turn specifies the spike requirements of test method CS06 of MIL-STD-461A).

2) Replacement of the locus of equivalent step functions of power voltage with actual power voltage as a function of time (MIL-STD-704A was the latest revision to define several locii of equivalent step functions).

3) Reduction of the maximum voltage expected under abnormal 28 VDC power bus conditions from 80 VDC to 50 VDC.

FROM DC GENERATOR TO TRU

MIL-STD-704 and MIL-STD-704A require equipments utilizing 28 VDC power from the aircraft to withstand transient surges up to 80 volts for 70 milliseconds - an almost 300% increase in supply voltage. Recent aircraft have generated DC power not from DC generators but from AC generators by using transformer rectifier units (TRU's). Since limits for AC transient surge voltages on AC generators never exceed 50% of the steady state voltage, it follows that a DC surge voltage at the output of a TRU would never exceed 50% of the steady state DC voltage. MIL-STD-704B and MIL-STD-704C have reduced accordingly the maximum surge voltage to 50 Volts DC for aircraft 28 VDC power buses.

FOR ADDITIONAL HELP

Because of the infrequency with which MIL-STD-704 testing has been required in the past, it is likely that designers and test laboratories may need further assistance in interpreting and applying MIL-STD-704 design and test requirements. It is recommended that any questions be directed to:

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