5700A/AN LESSONS LEARNED

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Abstract

Since incorporating the Fluke 5700A/AN into the NAVAIR Metrology and Calibration Program, NAVAIR incurred unacceptably high repair costs and down time. This paper examines the root causes of the problem and the lessons learned as a result of the investigation.

Introduction

The Fluke 5700A/AN meter calibrator is a precision instrument designed to calibrate general purpose measuring and test equipment. It provides a source of direct and alternating voltage, direct and alternating current, and resistance. This unit is highly accurate and very user friendly, and because of these reasons, it was selected as the standard meter calibrator for use throughout the NAVAIR Metrology and Calibration (METCAL) program. Furthermore, because of its versatility, NAVAIR does not limit the use of the 5700A/AN to solely calibrating meters, it is also used in the calibration of other Ground Support Equipment (GSE) and General Purpose Electronic Test Equipment (GPETE). In all, the 5700A/AN meter calibrator is used in approximately 480 Instrument Calibration Procedures (ICPs).

Unfortunately, NAVAIR has incurred high repair-costs and significant down-time since incorporating the 5700A/AN meter calibrator as a standard in the NAVAIR METCAL Program. Because of these unanticipated problems, an investigative effort was undertaken in an attempt to identify the primary cause(s) so that effective solutions could be implemented.

This paper describes the data collection method used to acquire failure information, the investigation into the failures of seven 5700A/AN meter calibrators, and the lessons learned as a result of the investigation. Finally, this paper contains recommendations for utilizing the

5700A/AN, which includes revisions to ICPs, appropriate safeguards, and good measurement practices.

Survey

The method employed to gather the data pertaining to the failures of the 5700A/AN was a survey form printed in the Metrology Bulletin (METBUL – July, 1997 and December, 1998). When completed, the survey form provided pertinent information about the use of the 5700A/AN at the time of failure, such as: the model number of the Test Instrument (TI), the ICP that was being performed, and the environmental conditions. This survey data was then reviewed to determine if there was any commonality such as an ICP or type of TI.

During the data collection phase of the project, the survey form was modified to provide additional information to help characterize the failures. The information added to the form included diagnostic error-codes to aid in troubleshooting, the procedure revision date to ensure that the most current ICP was in use, and characterization of the failure as either electronic or physical in order to separate 5700A/AN failures caused by physical abuse; e.g., damage sustained in shipping vice failures caused by normal use in accordance with approved NAVAIR ICPs. Additionally, the contact information was
updated to provide both a mailing address as well as a FAX number to facilitate submitting the survey to the proper point-of-contact.

Review of 28 surveys revealed that 12 of the 5700A/ANs failed at power up, 8 failed during the calibration of the unit, and the remaining 8 failed while being used to perform the calibration of a TI. Of these eight 5700A/ANs, 7 involved ICPs used to calibrate GSE. This indicated a possible problem with how the 5700A/ANs are being employed in those procedures. Based on the survey results, it was decided to further investigate these 7 ICPs.

5700AAN Failure Characterization

The 5700A/AN failures can be caused by several factors. First, the units are beginning to age, and therefore the failure rate is naturally increasing. Second, they are being damaged in use, but the problem is not discovered until later. And third, the 5700A/ANs are being subjected to unexpected conditions, such as the application of reverse voltage, which can either result in a catastrophic or a soft[1] failure. For the purposes of this paper, the term "reverse voltage" refers to an unexpected voltage present at the TI test points that is fed back into the 5700A/AN when it is connected to the TI.

According to the Fluke Manufacturing Company, "the CMOS technology used in the 5700A/AN could sustain damage from a reverse voltage being applied to the unit, and the resulting fault may not show up for several months." Furthermore, the exact amount of reverse voltage required to damage the 5700A/AN is not known; however, voltages of less than 3 volts may be enough to damage the 5700A/AN. This supports the hypothesis that the 5700A/ANs could be subjected to reverse voltages that result in a soft failure.

[1] A soft failure is the result of a reverse voltage exposure that is not sufficient to cause an immediate catastrophic failure, but rather eventually results in later failure.

Of the seven 5700A/ANs that were reported as damaged while calibrating GSE, all 7 had catastrophic failures.

In order to determine the most likely instances when the 5700A/AN was subjected to reverse voltages, it is necessary to examine the reported failures and the ICPs in use at the time the 5700A/AN failed. The 3 most likely factors that contribute to the 5700A/AN being subjected to reverse voltage are: the TI being defective, operator error, and procedural errors. Table 1 shows these probable contributing factors as they relate to the reported 5700A/AN failures. For instance, if the survey indicated that the TI was found to be defective, then TI Failure was included as a probable contributing factor. Likewise, if the operator indicated that he had made a mistake in the setup or connections, or the 5700A/AN was substituted incorrectly, then Operator Error was selected as a probable contributing factor. And finally, if the review of the procedure showed that the procedure lacked safeguards or contained illogical sequences, then the Procedural Error was listed as a probable contributing factor.

TI Failure[2]	Operator Error[3]	Procedural Error[4]	Undetermined[5]
2	3	5	1

Table 1. 5700A/AN Failure Characterization

In 4 of the 7 cases, more than one factor may have contributed to the failure of the 5700A/AN. In 5 cases, the procedure may have contributed to the failure. In 1 case, the survey data did not indicate any abnormal situations or problems with the TI, nor was there any indication of operator error. Additionally, a review of the procedure showed the procedure incorporated safeguards and good measurement practices; however, the repair data revealed that the A3 Motherboard was damaged, which is a strong indicator that the 5700 was subjected to a reverse voltage. In this case, there was not enough information provided to determine the probable cause.

Procedure Analysis

Each ICP was examined to determine: the workload supported; the frequency of its performance; the relationship between Section 1 Performance Specifications and Section 2 Minimum Use Specifications regarding the use of the 5700A/AN; how the 5700A/AN was used in the ICP; if a substitute, either methodology or instrument, for the 5700A/AN should have been used; if the construction of the ICP contributed to the failure of the

[2] TI Failures: These are instances when the survey respondent indicated that the TI was defective, resulting in damage to the 5700A/AN.

[3] Operator Error: These are instances where the operators actions contributed to the 5700A/AN failure, such as improperly substituting the 5700A/AN for another standard or improperly connecting the 5700A/AN to the TI.

[4] Procedural Error: These are instances where the procedure may have contributed to the failure due to a lack of safeguards.

[5] Undetermined: These are instances where there is no data to support any conclusion.

5700A/AN; and, how the procedure could be improved to avoid damaging the meter calibrator. An example of suggested revisions to improve each ICP is provided.

A number of conclusions were reached during the analysis of the procedures. Many of the conclusions were the same or very similar between the ICPs examined. A summary of these conclusions are:

- Ensure that the technician places the meter calibrator in standby mode any time the test connections or functions are changed.
- Verify that test points are not energized before connecting the meter calibrator to the TI.
- If the TI performance specifications do not require the accuracy of the 5700A/AN, use another instrument or methodology in place of the 5700A/AN.
- Ensure that WARNINGS or CAUTIONS appear in the ICP and are appropriately placed in the ICP.

Conclusion

The most likely cause of damage to NAVAIR 5700A/AN meter calibrators is the unintentional application of voltage to its output terminals from an external source. It was determined that this condition is most likely to occur during the calibration of GSE. Several of the GSE ICPs examined during this project lacked fundamental measurement practices and safeguards, and therefore could have contributed to damaging the 5700A/AN. This indicates that greater caution must be exercised when using the 5700A/AN to perform these procedures, such as verifying that no voltages are present at the test points prior to connecting the 5700A/AN to the TI, and ensuring that the 5700A/AN is in standby mode any time the test configuration or output function is changed.