

AVIONICS TESTING ON THE CASS

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ABSTRACT

In 1992 Naval Surface Warfare Center Crane was tasked to develop a test program for the band 10 sector front end for the Consolidated Automated Support System (CASS) test bench. This paper provides a description of our experience at avionics test development on the CASS. A brief history and description of the CASS is given as background.

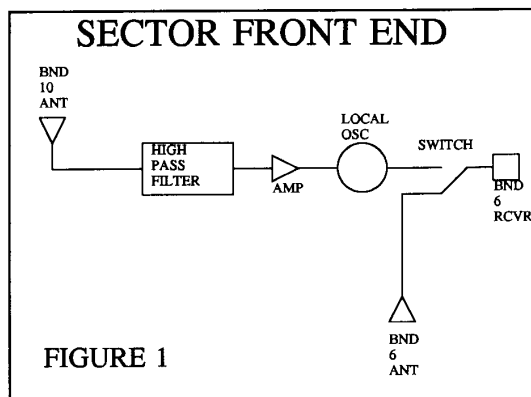
INVOLVEMENT

NSWC DIV Crane is a recognized leader in electronics countermeasures through our support of such major projects as: the AN/ALQ-99 tactical jamming system which is platformed on the EA-6B (navy and marine aircraft) and the EF-111A (airforce), and assigned to protect fleet surface units and other aircraft by detecting and jamming hostile radars and communications; the AN/ASQ-155 ballistics computer set, the central processing and control aboard the A6E aircraft; the AN/ALQ-149 command, control, communications center and radar jamming system, used to protect the fleet and aircraft by jamming hostile radars and communications; the AN/USQ-113 radio communications set on the NKC-135A, EC-24A, EP-3, and the EA-6B aircraft used for communications, monitoring, and jamming, in addition to counter-countermeasures radio communications; and the AN/ALQ-165(V) airborne self protection jammer used for the self protection of F-14 aircraft in a hostile air defense environment.

With regards to the latter project, our involvement with the CASS officially began in 1992. We were involved in both the preliminary design review for several systems and an engineering effort aimed at transitioning several factory tests written for Teradyne

equipment to the CASS.

Presently we are working on a Weapons Replaceable Assembly (WRA) Test Program Set (TPS) for the band 10 sector front end, an enhancement to the ALQ-99 Tactical Jamming System, which is a radar noise jammer located on the EA-6B aircraft. The purpose of the ALQ-99 is to locate, identify, and deny enemy integrated defense platforms, and thereby protect our aircraft. The Sector Front End (SFE) allows signals received in the band 10 frequency range to be down-converted in frequency and processed by the existing band 6 receiver.



As shown in figure 1, the band 10 antenna receives the signal which is then filtered by the high pass filter and then passed through an amplifier to a local oscillator which down converts the signal so that it can be processed by the band 6 receiver. There are 6 SFEs in the "football" of the EA-6B each covering 60 degrees azimuth of the horizon. While simple in appearance, the SFE has rigid testing requirements for switch leakage, filter capabilities, noise injection, etc.

BACKGROUND

Avionics Testing

Testing avionics presents special challenges such as size, complexity, and close proximity of the components. Avionics assemblies, by their nature require as much compactness as is possible and operate at wide temperature and frequency ranges. This presents an interesting set of problems as a unit operating at 100MHz aboard a carrier in the Indian Ocean may not operate at 25,000 ft.

In addition, many of the modules are so intricately interrelated that a failure on module 'A' could initially indicate a failure on module 'B'. This interaction between assemblies must be thoroughly understood before an adequate test can be developed. Crosstalk, ambient noise, and transmission line problems all can be introduced as the overall circuit density increases along with the frequency of operation.

Cass History

In the early '70's, spurred by a growing number of Automated Test Equipment (ATE) problems, the Assistant Secretary of the Navy for Research and Development formed a committee to address the situation. In 1976 the committee released the "Report on Navy Issues Concerning Automatic Test, Monitoring, and Diagnostic Systems Equipment", or the "Marcy Report". Some of the issues were: proliferation, calibration, training, hardware and software maintenance, and TPS deficiencies. Based on conclusions from the Marcy Report, the Navy solicited for the design and production of a comprehensive ATE. From five initial companies, General Electric was awarded a contract in 1986. GE began CASS delivery in 1992.¹

Cass Description

The standard CASS configuration, the hybrid, is composed of 5 racks. Rack 1 controls and conditions the bench power. A battery backup allows the bench to continue normal operation for 5 seconds during a power outage, after which time the station begins a process of aborting tests and proceeds with an orderly shutdown.

Rack 2 provides UUT power. Eight units provide +/-

32VDC. One unit provides +/- 100VDC, and two units provide +/- 450VDC. AC power is programmable up to 135VRMS, with a frequency range from 55 to 1200 Hz. Three phase power is also available.

Rack 3 contains the CPU, a Microvax 3 from Digital Equipment Corporation, running at 3 MIPS, with a 32 Mbyte main memory, a 380 Mbyte hard disk, and a 325 Mbyte/side removable optical disk.

Rack 4 contains the General Purpose Interface (GPI), some of the analog equipment, and the Digital Test Unit (DTU). The bench interface, the GPI, allows access to 1486 pins through a 19 module frame. The DTU, supplied by Teradyne, has 336 channels and operates at 20 MHz in the normal mode. Interleaving allows limited use at 40MHz. The DTU is compatible with Teradyne's LASAR, a digital automatic test program generator.

Rack 5 houses the DTU power supplies, the remainder of the analog instruments, and support equipment for the Electrical-Optical (EO), Radio Frequency (RF), and Communication, Navigation, Identification (CNI) configurations. Rack 5 also contains space for future expansion.

Rack 6 contains the nonhybrid instrumentation for a specific configuration.²

ATE COMPARISON CHART

NOMENCLATURE	CAT IIID	HTS	CASS
INTERFACE	528 PINS	742 PINS	1486 PINS
DIGITAL	432 PINS	369 PINS	336 PINS
DIGITAL FREQ	10 MHZ	10 MHZ	20 MHZ
DC PS RANGE	+/- 200V	+/- 200V	+/- 450V
PULSE GEN FREQ	50 MHZ	25 MHZ	250 MHZ
RMVBL DISK	10 MB	10 MB	325 MB
CNTR/TIMER FREQ	100 MHZ	70 MHZ	200 MHZ
YEAR RELEASED	1980	1985	1992

TABLE 1

As we see in table 1, the CASS's capabilities exceed those of earlier ATE's. This may be accounted for by the improvement in the computer control and the advancements of instrumentation. While it does appear that the digital testing portion of the CASS took a step back, the CASS has bi-directional capabilities which were not present in the other ATE.

TEST DEVELOPMENT PROCESS

Statement of Work

The first step in the development process is establishing a Statement of Work (SOW). As with a contract, a SOW is usually the result of negotiation between the TPS procurer and the developer. It is the job of the TPS developer to review the unit under test (UUT) source documentation and determine if it is sufficient to fulfil the procurer's requirements. Time spent up front on a project before a SOW has been decided on can eliminate unpleasant surprises and make the difference between a successful venture and a dismal failure.

The first thing we look for is incomplete UUT documentation. Missing information can make the development process more difficult and time consuming, if not impossible. Custom-made components such as ASICs can require a large amount of documentation. Many PALs and PLAs are built so that they cannot be reverse engineered. Without the JDEC files a test engineer would need a thorough functional description or a Boolean equivalent, complete with timing requirements.

ROM chips should have memory data and a functional description in the UUT documentation. We performed an initial assessment on a digital card with a 2K ROM on it with no corresponding data table. When we requested this information we were informed that they didn't have it and we would have to do the job without this data. The cards were not conformally coated, and the ROM was in a header socket and easily removed so it would be a relatively easy task to remove the chip and read the data. However, the ROM card was wired into a microprocessor and we suspected that the ROM contained an Assembly Language Program. If this were true then we not only needed to read the data but disassemble it and comment it so we would know what it was supposed to do, a time-consuming task.

Functional descriptions in the procurer's UUT source documentation enables the test developer to comply with the Red Team requirement for the Performance Test to:

"...emulate the avionics system to the extent necessary to ensure the UUT will function properly in the next higher assembly..."³

A detailed functional description translates into a comprehensive Performance Test. Unfortunately, most functional descriptions are one or two paragraph summaries of what the card does, leaving the TPS developer with insufficient data to write a thorough test. Another card we looked at had an 8-bit dip switch on it that drove a baud rate generator. With no information telling what positions the switch was to function at, we faced 256 potential dip-switch positions for Performance Test.

Even with good UUT documentation, there is no guarantee that the procurer's requirements can be fulfilled. Without first modelling digital cards and generating test vectors, ambiguity groups for LASAR-generated test programs cannot be computed without first modelling the cards and generating test vectors. Because it is unlikely that an effort of this magnitude could be accomplished prior to the establishment of the SOW, it is difficult to predict whether a LASAR-generated test program will meet Red Team ambiguity group requirements. Additionally, if the card has a bus on it or a high fan-out count, it is very likely that the test program will not pass the suggested Red Team ambiguity group requirements.

After a careful review of the UUT source data and the procurer's needs, we discuss any problem areas, such as time constraints, ambiguity groups, missing documentation, and CASS/UUT incompatibilities. With these issues resolved, or at least understood, we adapt the Red Team package to the specific TPS and submit a statement of work for approval. We also submit a list of deliverables, a milestone chart, a cost breakdown, a conceptual interface device (ID), a conceptual test strategy, and a conceptual id self-test strategy.

Preliminary Design Review Preparation

Upon acceptance of the SOW, we prepare for the Preliminary Design Review (PDR). Two basic tasks are fulfilled for PDR. First, a test strategy is developed, complete with functional flow charts, fault accountability table (fault field), and CASS/UUT incompatibility workarounds. The second task is ID design. This includes system interconnect diagrams, parts list, a rough schematic, and cable drawings. We

check delivery lead time on critical items and, if we're reasonably sure of our design, fill out purchase orders and process them. Connectors are a consistent problem area, with lead times of up to 180 days.

Critical Design Review Preparation

After PDR three basic tasks come up. First, the test strategy is converted into ATLAS code. Program structure and style generally adheres to the Red Team package. This covers such items as indentation rules, comments, program header information, statement numbering, entry points, and test flow. The requirements for messages displayed on the plasma display panel are contained within MIL-STD-2077A.

Second, we build the ID. The Red Team Package calls for standard parts to be used in the ID. These parts are designated by MIL-STD 965. Any deviation from this list requires the approval of a nonstandard parts waiver. According to a recent Designated Government Acceptance Representative (DGAR) meeting, NAWC at Lakehurst processes the waivers for electronic parts and NAWC at Indianapolis for mechanical parts.

Third, we begin to assemble the required documentation. The Technical Data Package provides ID drawings, parts lists, and any other information necessary to build a new ID without added engineering effort. The Test Program Instruction (TPI) contains user information on using the program to test the UUT. Compliance with the Red Team Package requires some of the TPI, such as system interconnect diagrams, to be available on CASS graphics through the ATLAS program. We're developing our graphics on a PC and then processing them (essentially a compression routine) to make them CASS compatible. We're presently using CASSGRAF from NADEP Jacksonville to convert the PC graphics files for the CASS.

Sell-Off

After the Critical Design Review (CDR) test integration officially begins, followed by sell-off. Sell-off consists of a First Article of Test (FAT) at the developer's site, and continues with a more thorough acceptance test at the procurer's site, referred to as TECHEVAL. A transportability demonstration shows that the program will run on more than one CASS. Transportability problems involving the frequency-timer interval counter (FTIC)

have already been encountered.

CONCLUSIONS

In this paper we have outlined an example of the test development process for a CASS TPS, along with some of our experiences in the field.

References

1. General Electric Company, An Overview of the Consolidated Automated Support System, 1992, p. 4.
2. Ibid.
3. Red Team Package, Attachment 2, 1992, p. 8.