Conf-811176--2

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UCRL-86639
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COMPUTER-BASED TEST SYSTEM FOR THE TACTICAL AIRFIELD ATTACK MUNITION (TAAM) SAFING, ARMING, AND FUZING SYSTEM

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Sixth Annual Firing Systems Conference
Los Alamos National Laboratory
November 17, 1981

December 1981

Lawrence Livermore Laboratory

UCRL--86639

DE82 010256

Computer-based Test System for the Tactical Airfield Attack Munition (TAAM) Safing, Arming and Fuzing System*

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ABSTRACT

Testing and quality assurance of large numbers of firing systems are an essential part of the development of the Tactical Airfield Attack Munition (TAAM). A computerized test and data acquisition system has been developed to make the testing and quality assurance workload manageable.

The system hardware utilizes an LSI-11/23 computer, a Tektronix 7612 transient digitizer, and various other programmable instruments and power supplies. The system is capable of measuring and analyzing mechanical shock and fireset transient waveforms, automating testing sequences, and making records and comparisons of the test results. The system architecture is flexible for general purpose firing system development work.

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*Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

1.0 INTRODUCTION

Testing and quality assurance of a large number of Safing, Arming, and Fuzing (SAF) systems are an essential part of the development of the Tactical Airfield Attack Munition (TAAM). The TAAM is a non-nuclear warhead being developed for use on the cruise missile. The mission of this weapon system is to attack and destroy military airfields. Figure 1 shows the TAAM in its operational mode and points out the components in the system. The fireset, detonator safing pin, and lockbar shown in the figure are components of the TAAM SAF system, which provide:

- Safing - by preventing inadvertent arming or firing of detonators.
- Arming - by providing for detonator energy storage and enabling environmental sensors.
- Fuzing - when all environmental sensors are satisfied that proper firing environment exists.

Because of the functions provided by the SAF system, it is important that all systems and components be thoroughly tested to assure system safety, quality and reliability.

As the TAAM is developed, a substantial number of SAF systems will be built for use in TAAM developmental testing. Testing during this phase of the program is needed to assure that safe, reliable firing systems are produced for experimental use. Testing is also required to facilitate for SAF system design optimization and component qualification. Data obtained from these tests will be used to establish acceptance standards for future production.

After development is completed, an operational test and evaluation of the TAAM will be conducted. System and component quality and reliability are very important factors during this evaluation phase. As many as 500 TAAM's will be produced for this evaluation and each will require extensive pretesting at the component and assembly level.

To better understand the magnitude of this testing problem we need to look at it in more general terms. Figure 2 shows an overview of the testing requirements for SAF components and systems for both the baseline TAAM SAF design using low energy detonators and for an alternate SAF design which uses a slapper detonator in the follow-through charge. The figure shows when a given test is required for an SAF component or assembly. Points of intersection on the chart are marked with a "D" if testing is required during system design and development or a "P" if testing is required during production.

We can see, for example that with the Baseline Design, as many as 22 tests of components and assemblies must be performed for each SAF system that is produced. During the development phase, perhaps 200 firing systems will be produced for various reasons. To produce these systems up to 4400 individual tests may be performed. When these systems are put into production, 27 different tests may be required per fireset, with thousands of systems being produced. A program like this could result in a requirement for hundreds of thousands of tests.

To make this test and quality assurance workload manageable, an automated test system has been developed. The test system, hereafter called the TAAM Data Acquisition System (DAS), was designed to reduce the manpower required for SAF system testing, data analysis, and documentation.

2.0 TEST SYSTEM FUNCTIONAL REQUIREMENTS

In order for the TAAM DAS to provide the testing utility needed for the TAAM program, it had to meet the following design requirements:

- The system must be computer-based and controlled, and capable of interface to a wide variety of programmable instruments needed for SAF system testing.

o Operation in automatic, semi-automatic, or manual modes to accommodate development and production testing.

o Hardware and software must be easy to expand, modify or reproduce so that expanding testing needs can be easily accommodated.

o The system should provide interactive prompting, when needed, to assure that procedures are properly implemented, system calibration is correct, and that safety procedures are observed.

o Test procedures should be easy to implement, debug, or modify.

o Test data must be easily stored and retrieved.

o Hard copy of results should be available for reports and test documentation.

o The system should provide on-line data analysis capabilities, both generalized and test specific.

3.0 TEST SYSTEM DESIGN

3.1 Test System Hardware

The TAAM DAS is based on an LSI-11/23 minicomputer, and it uses the General Purpose Interface BUS (GPIB) for control and communication with instruments in the system. The GPIB is a standard bus system that is defined by the "IEEE Standard Digital Interface for Programmable Instruments, IEEE Std 488-1978." The GPIB is implemented in the TAAM DAS by using the National Instruments GPIB 11V-1 interface kit.

Several of the TAAM DAS functional requirements are satisfied by the GPIB. For example, using the GPIB assures that a wide variety of test instrumentation can be installed in the system. This assures that the system instrumentation can be easily expanded or modified to meet expanding test needs. The need for automated operation is also satisfied, since all the test instruments can be programmed, controlled, and operated over the bus.

Figure 3 is a block diagram of the TAAM DAS showing the system and components as originally proposed. As mentioned earlier, the LSI 11/23 is the heart of the system. This minicomputer is the primary system controller, providing control and communication with instrumentation, performing data transfers and analyses, and providing interfaces to other system components.

A double density floppy disc drive currently provides one megabyte of storage capacity for on-line storage of system programs and test data. A hard disc drive is also shown in the figure but is not yet installed in the system. The hard disc will provide for mass storage (up to 10 megabytes/disc) when it is installed and the floppies will then be used to make data and programs more transportable. The floppy disc drive will provide a back-up for the hard disc to improve test system reliability, and floppy discs will be used for long term storage of test data.

A Tektronix 4025 Alpha-numeric/graphics terminal is used to provide an interactive operator interface for both testing and program development. Test and analysis results can be displayed graphically on this terminal. A Tektronix 4631 Hard Copy Unit is used to produce hard copies of text or graphical data displayed on the 4025 terminal. This hard copier produces quality copies that can be used for documentation of test results or for test reports.

All the test instrumentation is connected to the TAAM DAS through the GPIB. The following test instruments are currently attached to the system:

- Tektronix 7612D Digitizer
- Hewlett Packard 3456A DVM
- Kepco SN488-122 Power Supply Programmer
    - Kepco ATE 55 LVPS
    - Glassman LG30-PS HVPS

This configuration provides the capabilities needed for most current SAF developmental testing needs. Other instruments shown in Figure 3 will be added to accommodate future needs.

As presently configured, the TAAM DAS is capable of digitizing up to 4096 8-bit data points of transient waveform data, with a maximum sample rate of 200 MHZ. Power supplies needed for firing system testing can be operated under program control, and precise measurements of voltages, currents, and resistances can be made automatically. Figure 4 shows the physical layout of the system.

3.2 Test System Software

The TAAM DAS design requirements led to a rather demanding set of requirements for the software needed to support it. Two of the more important of those requirements are:

- Test and device independence
- Easy test procedure implementation

To satisfy these requirements, a program named "VAMTST" was developed. This program, which is written in FORTRAN provides many other features and capabilities which will be discussed later.

The TAAM DAS software had to be test and device independent because of the large number and the variety of tests needed to support the TAAM program. Device and test independence allow, respectively, new test instruments to be installed in the test system and new test procedures to be implemented with little to no additional software coding needed. VAMTST provides device independence by using the GPIB and a software library supplied by National Instruments, Inc., with the LSI-11 compatible GPIB V11-1 interface board. VAMTST provides an interface to the GPIB software, and the decoding and encoding capabilities needed to accommodate most data and command formats used by GPIB compatible instruments. As a result, a wide and ever-growing variety of GPIB compatible instruments can be easily installed in the test system, and only a minimal amount of instrument dependent coding will ever be needed.

VAMTST provides test independence through the use of a Test Procedure Command File. This file contains a program written in the VAMTST test language. The test language provides the means for control and communication with the instruments on the GPIB, for interaction and communication with a test operator, and for transfer of test data from the test instruments for storage, analysis, or display. The test procedure command file does not require compiling or linking, but is interpreted and executed line by line by VAMTST. As a result, test procedures are easy to implement, debug or modify. Some test dependent coding is required if analyses of test data is needed and the analysis software is not already part of VAMTST. In addition, menus must be updated as new components and tests are added to VAMTST's test repertoire.

VAMTST Structure and Organization

The anticipated size of VAMTST and the need for periodic software maintenance brought about the requirement for a structured, modular software design. The structure and organization of this software is shown in Figure 5. As a result of this structured design, VAMTST is easily overlaid with root and segments as shown in the figure. Software maintainability is improved because software tasks are divided into small, easily understood modules. The function of the major software modules are discussed below.

In the figure, the block representing the main routine is central to the figure and labeled "VAMTST." The first-level routines below the main routine are arrayed vertically on either side of the VAMTST block. The system initialization is accomplished by the block labeled "INITSY." This block identifies the user, and retrieves the current time and date from the RT-11 system. The menu of SAF components recognized by VAMTST is presented to the operator by the block labeled "Get Component Type & Serial Number." The menu of tests cataloged by VAMTST is presented to the operator by the block labeled "GETDEF." The block marked "FILNAM" creates the names of the output files.

The block labeled "AQUIRE" executes the test procedure. The procedure is not part of the software. It is implemented by a series of instructions to VAMTST for specific test-oriented services.

These instructions reside on disk and are interpreted and executed one at a time by the "AQUIRE" block of VAMTST. Once the test data has been acquired, the block labeled "ANALYZ" provides several different analysis functions-some test dependent, and others of a general nature (like FFT and power spectral density algorithms). Upon the completion of the analysis functions, "ANALYZ" stores the acquired test data on disk.

VAMTST's Features and Capabilities

The major features and capabilities provided by VAMTST include:

- Four modes of operation
- Variable levels of interaction
- Data base compatability
- Independent test procedu
- Data analysis
- Test documentation

Each of these are discussed below.

Modes of operation

VAMTST provides four modes of operation:

- o Uniformly -Sampled Data Sequence
- o Non-uniformly Sampled Data Sequence
- o Pass/Fail Result
- o Analysis of data from previous test.

In the uniformly-sampled data sequence mode, the test data is sampled with a uniform-sample interval, and all the test data is transferred from the test instrument at one time. When the non-uniformly sampled data sequence mode is used, data is acquired one data point at a time with sample intervals that are not necessarily uniform. When the first two modes of operation are used, the test data may be displayed graphically, or optionally analyzed using for example an FFT. In the Pass/Fail mode of operation, the result is simply a pass or fail result that is derived from a test-dependent summary calculation. In this mode of operation, only the pass/fail result is displayed or stored and no data is plotted or stored. The Pass/Fail mode is used, typically, in an automated, production testing atmosphere. The fourth mode of operation is not a data acquisition mode, but it allows the operator to analyze or display data acquired from a previous test run.

Levels of Interaction

VAMTST allows a variable level of interaction with a test operator. In a production test atmosphere, the TAAM DAS provides automated testing with VAMTST's operation controlled by command and answer files that provide all test interaction. In a non-production testing mode, semi-automated and manual testing can be performed. In this testing mode, at minimum, the test operator must make selections from menus to identify the type of component being tested, the test to be performed, and the analysis to be performed. Interaction with the operator within a test procedure is completely determined by the coding within the test procedure command file. The interaction may take the form of instructions to the operator via the data terminal or questions requiring Yes/No responses. If a completely automatic or a semi-automatic test is desired, little or no operator interaction is included in that file. Or, a test can be made almost totally manual, allowing the operator to manually set-up instruments, issure triggers to start a test, etc.

Data Base Compatability

The data file structure of VAMTST has been designed so that test data can be easily entered into a data base management system. All data files have a standardized format; only one test data set is stored in any file, and each data file has a unique filename.

File names are based on the type of component being tested, the test being performed and the serial number of the component. Data bases established during TAAM SAF development will be used to determine component and system tolerances, to establish production acceptance standards and to aid in component qualification. Simile, a data base management system developed by Small Business Machines, Inc. is being considered for use in the future with the TAAM DAS.

Independent Test Procedures

Test procedures to be implemented using VAMTST are prepared independently of the VAMTST software. A test procedure is implemented as a set of test language instructions in a test procedures command file that is stored on a floppy disk. Test procedures may be implemented by following the method shown in Figure 6. The procedure should first be written out and types of data analysis needed in the test data summary should be determined. If the required data analysis software does not xist, these routines must be coded and installed in VAMTST. Next the level of interaction with the test operator must be determined. And then, the test procedure must be translated into VAMTST instructions and debugged.

An example of a test procedure which was implemented using the VAMTST test language is shown in Figure 7. This figure shows a simple test that records the bleeddown voltage waveform of an R-C network in a fireset. From this waveform, a summary calculation determines the voltage after 100 seconds. The digitized waveform is stored in a file on a floppy disk along with other test related data.

Data Analysis

VAMTST has provisions for on-line analysis of test data. This feature allows analysis of test data using general purpose algorithms like the FFT, Power Spectral Density, or data comparison. Other general purpose algorithms can easily be added. In addition, test dependent data analysis can be performed that will provide both intermediate and final test results. Test dependent analysis is performed by routines that are, in general, provided by the test designer. Generally these routines are trivial and involve very little coding. Typical test dependent analyses routines might include calculation of risetime, peak voltage or current, or time intervals from digitized waveforms. Scale factors, offsets, and calibration factors are also applied to raw test instrument data by the test dependent routines.

Documentation

VAMTST has a test documentation feature which allows hard copy to be produced of any data displayed on the data terminal. Graphs of waveforms that have been acquired or that result from data analysis may be hard copied, and a test data summar is automatically hard copied upon completion of a test run. The documentation that is produced is suitable for use in laboratory notebooks for test documentation or for use in production reports.

An example of the test data summary is shown in Figure 8. On this data sheet, many pertinent test results are given along with identification of the test operator, the unit under test, and the test date. Figure 9 shows a typical graphic display of test data that may also be used for test documentation.

4. RESULTS

While VAMTST was being developed, the TAAM DAS was used for several important applications. Some of these applications include:

- Testing
  - TAAM/T-33 Baseline Firesets
- Mircroprocessor system Development
  - TAAM/T-33 Event Recorder
  - TAAM In-Line Fuzing Arming Module

Results of these applications are discussed below.

Testing of 36 Baseline firesets was completed using an early version of VAMTST. These firesets were built for use in a series of tests launches of inert TAAM's from a T-33 aircraft. The purpose of the flight tests was to obtain data on alternative parachute systems and to evaluate the TAAM SAF and mechanical system design. The fireset tests were performed in a semi-automatic testing mode with the test operator functioning switches and making test connections. The operator received test procedure instructions via the data terminal screen, and all instrument set up was performed automatically over the GPIB. Some test results that were compiled for several of these firesets are shown in Figures 10, 11 and 12.

This early implementation of VAMTST had test procedures imbedded in the system software and was not as versatile at the present VAMTST implementation. The testing accomplished using this software was completed very satisfactorily and valuable data base for the baseline SAF was developed.

Prior to using this semi-automated test, the baseline firesets were tested manually, and all documentation and data analyses were performed manually. Typically, 2-2.5 man hours were required to complete these tasks in the conventional manner. However, when the TAAM DAS was used, all those tasks were completed in approximately 15-25 minutes or about 1/6 th of the original time.

Microprocessor development projects have also been completed with the help of the test system. The microprocessor hardware and software development capabilities of the TAAM DAS are facilitated by a program that was developed to provide an interface between the LSI-11 and a microprocessor development aid for the Intel 8748 microprocessor called the PROMPT 48. This program, called REMOTE, is used in conjunction with other existing software (an assembler and a simulator), the PROMPT 48, and the LSI-11 to provide complete 8748 microprocessor development capabilities.

Hardware and software for the TAAM In-Line Firing System Arming Module are being developed using the TAAM DAS. The Arming Module, which is an 8748 micro-processor-based design, controls of timers in TAAM stabilization and Orientation System (See Figure 1). An interface was developed that allows the LSI11/23 minicomputer to simulate the cruise missile bus. This interface, which is shown in Figure 3, allows communication with the Arming Module and provides a eans of testing and exercising the Arming module as its hardware and software are developed.

The TAAM/T-33 event recorder, which was used in the flight tests discussed earlier, was also developed with the aid of the test system microprocessor development capabilities. Eight of these microprocessor-based recorders were used to monitor SAF system performance in the flight tests. The recorders, which were installed in the follow-through charge case, stored SAF system performance data in solid state memory for later retrieval.

5. FUTURE PLANS

Plans for future development and use of the TAAM DAS include:

o More firing system testing

- Development of automated multiple component testing capability
- Enhancement of test language and analysis features
- Data base management using Simile
- A more powerful operating system, RSX-11
- Parameter estimation for the In-Line firing system

Firing system testing is the primary function of the TAAM DAS and will continue to be in the future. Test procedures are being implemented for all developmental firing systems now in use in the TAAM program. Data obtained from these tests will be added to a data base of all firing systems used in development.

As new tests are developed, we plan to make enhancements to the VAMTST test language. These improvements will be made as they are needed to implement test procedures. In addition, new analysis routines will be added as needed to expand the TAAM DAS data analysis capabilities. Several sources for these routines are available at LLNL, including the GPDAP and ANALYZE Codes.

Multiple component testing capabilities will be required when production level testing is begun. This capability will allow several like components to be tested in a single test run without operator intervention. Some software development will be needed to add this capability and hardware not currently installed on the GPIB will also be needed.

Installation of the new operating system, RSX-11, and a data base management system, called Simile, will require the installation of a hard disc to the TAAM DAS. The new operating system has advanced file handling capabilities and will allow multiprogramming. Efficient use of RSX-11 requires access to a large, fast mass storage system like a hard disc. Simile will provide on-line data base management facilities for the DAS. Minimum system requirements for running Simile in an LSI11/23 minicomputer include a hard disc for program and data base storage.

A parameter estimator for slapper detonator firing systems is currently being adapted for use in the TAAM DAS. This program which was originally used on a larger computer system, will provide a computer-aided design and diagnostic tool for the TAAM in-line fuzing system.

6. SUMMARY

The requirements for a general purpose, computer-based test system for the TAAM SAF System are discussed. The system provides versatile testing capabilities designed to significantly reduce manpower requirements for testing and documentation of firing system performance. Capabilities of the system hardware and software are discussed and results of system application are presented.

0007M/jmv

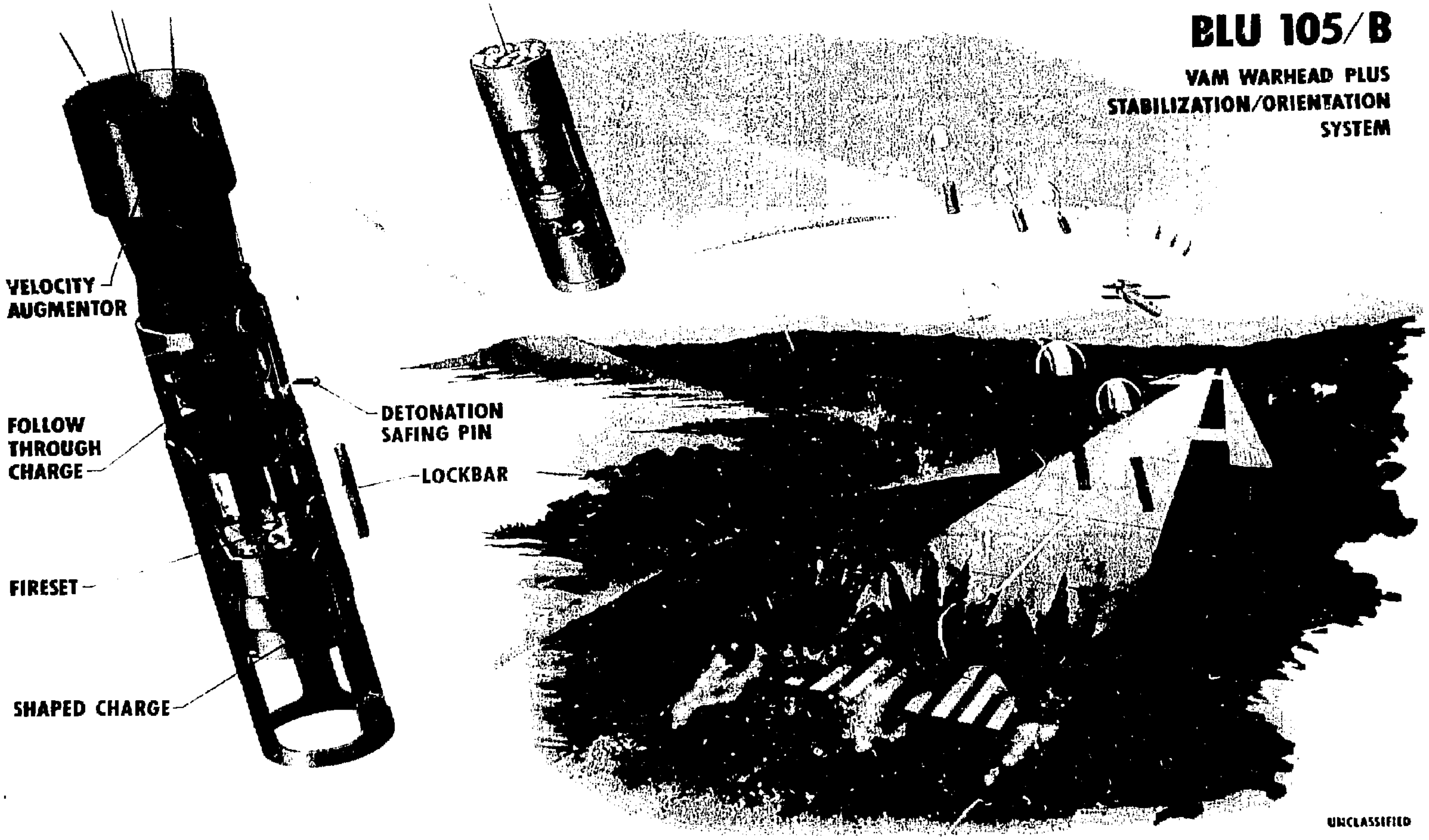

BLU 105/B
VAM WARHEAD PLUS
STABILIZATION/ORIENTATION
SYSTEM
VELOCITY AUGMENTOR
FOLLOW THROUGH CHARGE
FIRESET
SHAPED CHARGE
DETONATION SAFING PIN
LOCKBAR
UNCLASSIFIED

FIGURE 1

TAAM SAF TESTING OVERVIEW

Test Condition or Type of Test	SAF DESIGN												
	Baseline					Slapper or In-Line							
	Capacitors	Switches	Detonators	Miniature Piston Actuators	Assembled SAF's	Capacitors	Switches	Converter Transformers	Spark Gaps	Slapper Detonators	Miniature Piston Actuators	Assembled SAF's	Sub-munition Arming Module
FT Shock [2]	--	--	D/P [1]	--	--	D/P	--	--	D/P	D/P	--	D/P	--
Mortar [3] Tube Shock	D/P	D/P	D/P	D/P	D/P	--	D/P	D/P	--	--	D/P	D/P	D/P
Parachute [4] Deployment Shock	--	D/P	--	--	D/P	--	D/P	--	--	--	--	D/P	--
Temperature [5] Cycling	--	D/P	D/P	D/P	D/P	--	D/P	--	--	--	D/P	D/P	D/P
CERT [6]	--	D/P	--	--	D/P	--	D/P	--	--	--	--	D/P	--
Bench Testing	D/P	D/P	D/P	D/P	D/P	D/P	D/P	D/P	D/P	D/P	D/P	D/P	D/P
Safety	--	--	D/P	D/P	--	--	--	--	--	--	D/P	--	--
Other Environmental Testing	--	--	--	--	P	--	--	--	--	--	--	P	P
Reliability	P	D/P	P	P	P	P	D/P	P	P	P	P	P	P

FIGURE 2

TAAM DAS HARDWARE BLOCK DIAGRAM

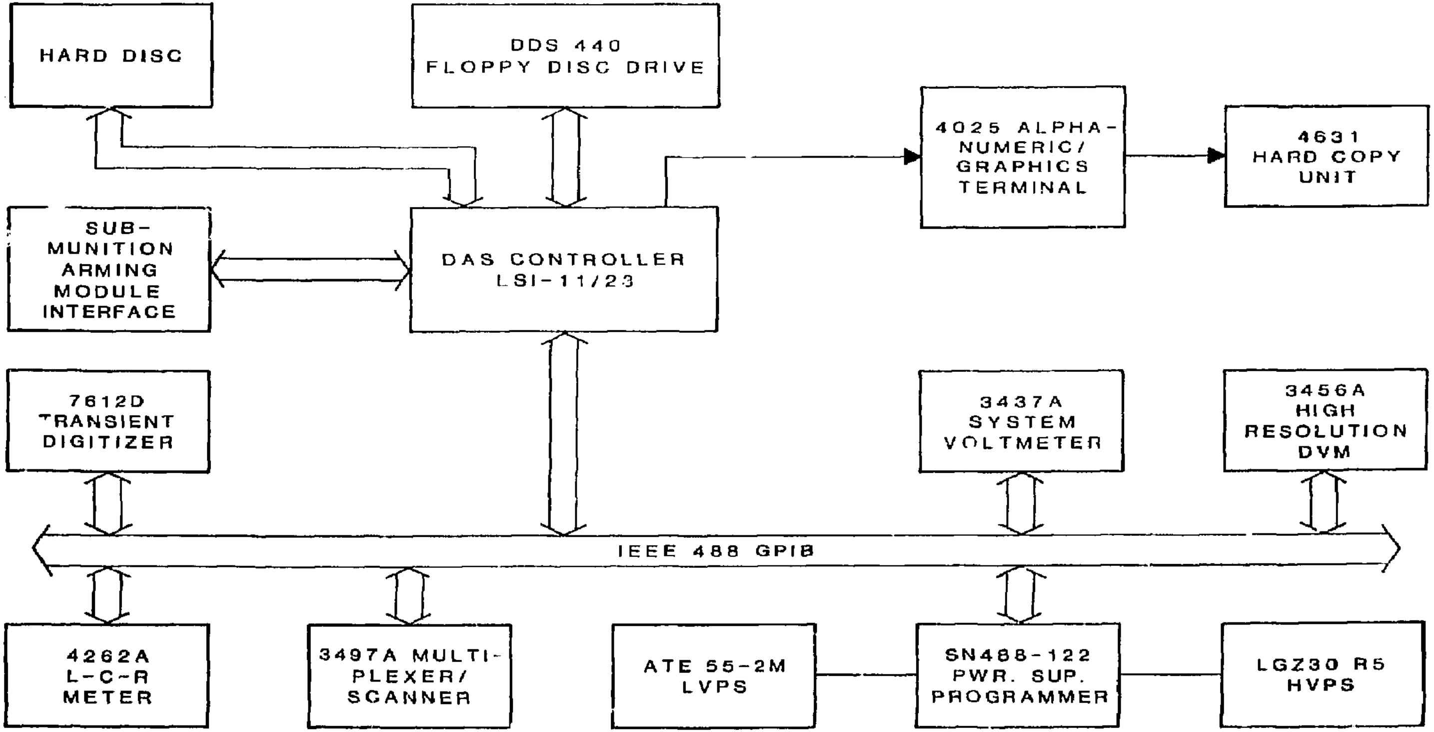


FIGURE 3

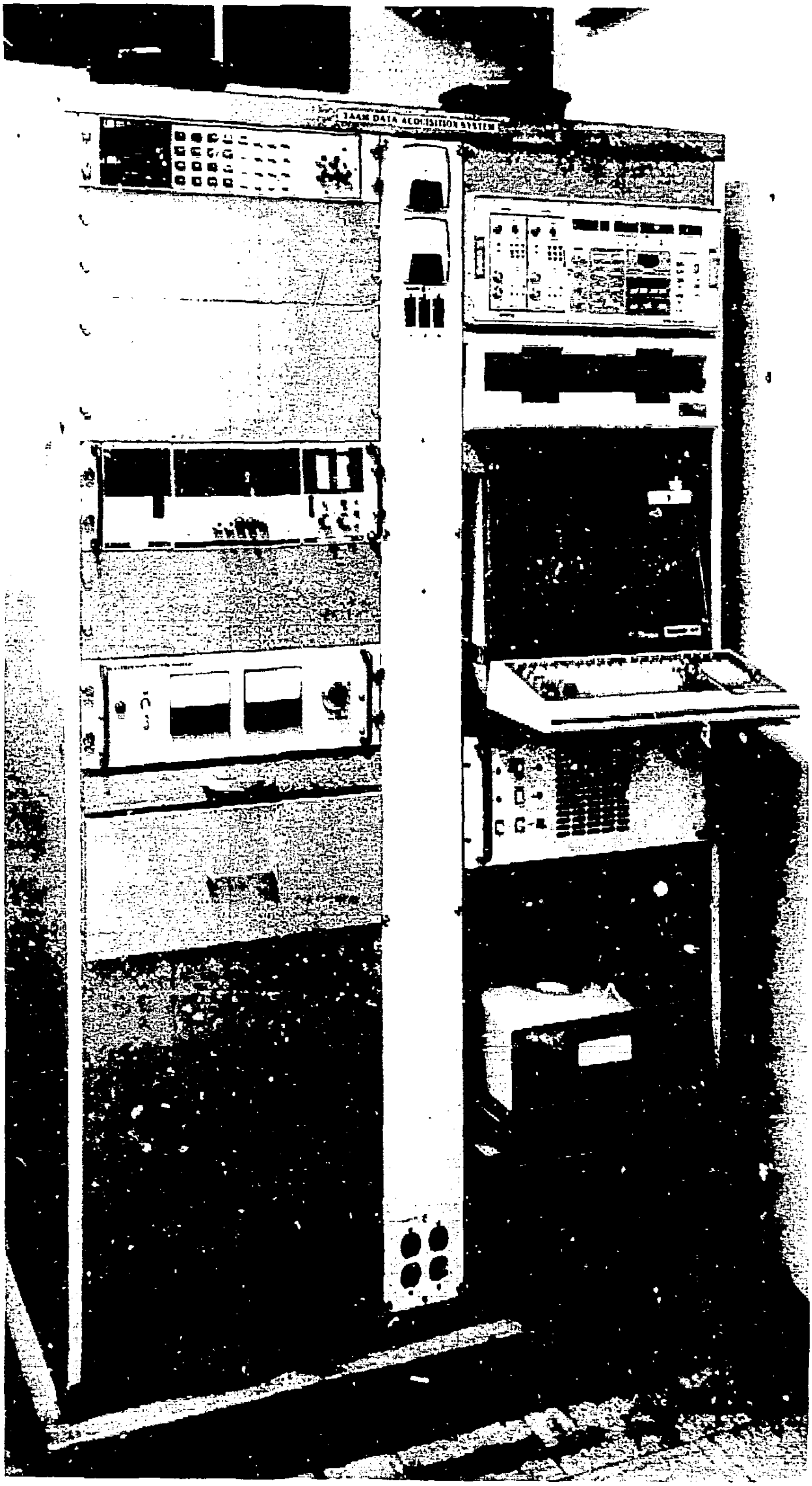


FIGURE 4

VAMTST SOFTWARE ORGANIZATION

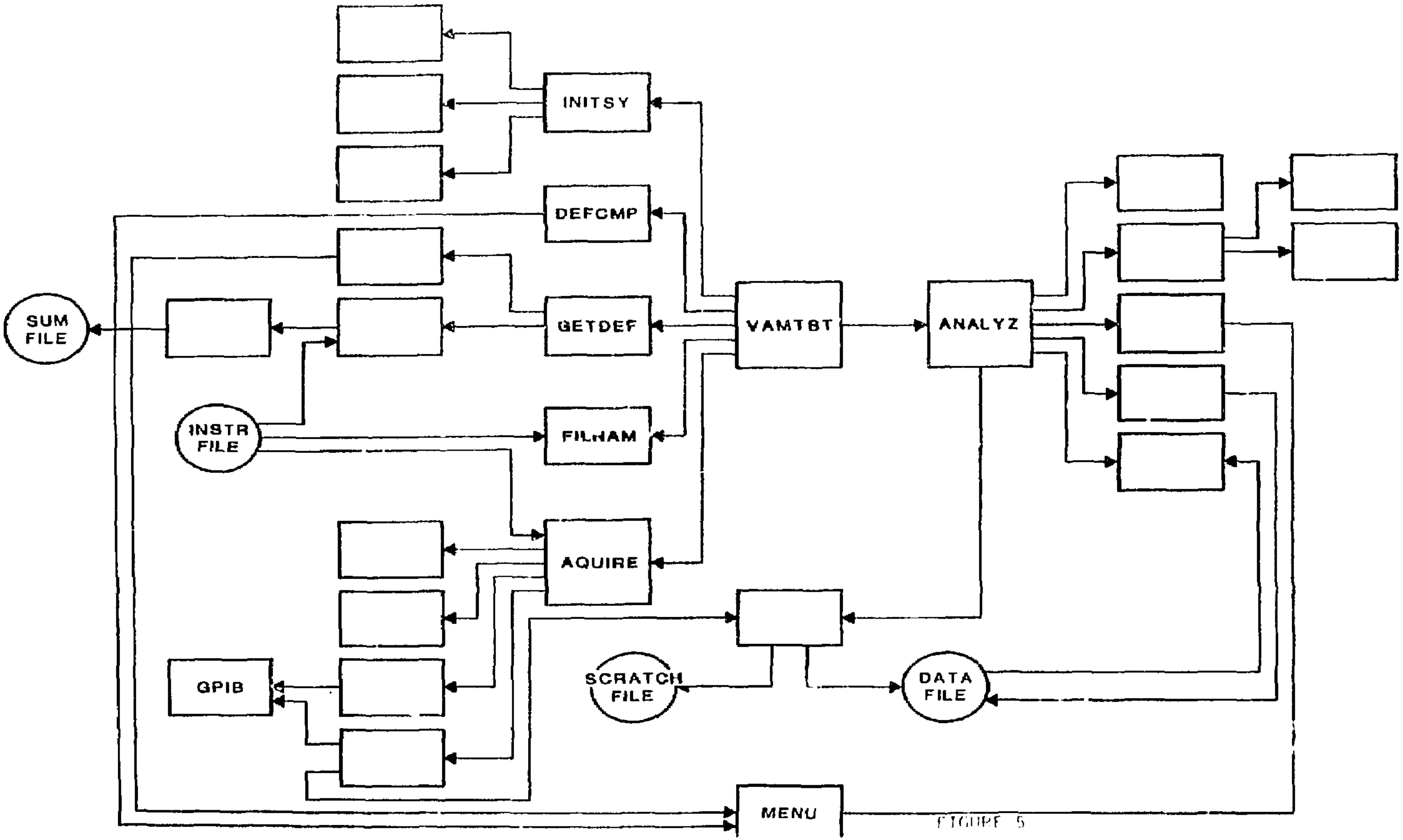
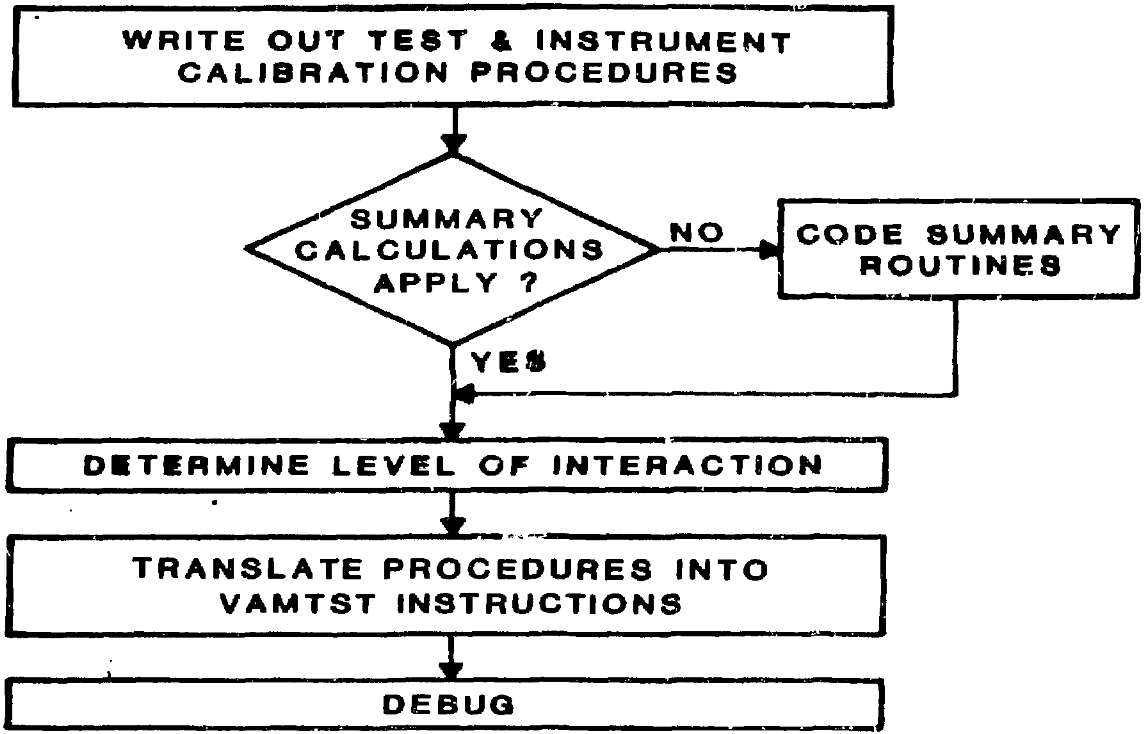


FIGURE 5

IMPLEMENTATION OF A TEST PROCEDURE

ASSUME: NECESSARY INSTRUMENTS ARE ON THE BUS



WRITE OUT TEST & INSTRUMENT CALIBRATION PROCEDURES

SUMMARY CALCULATIONS APPLY ?

NO

CODE SUMMARY ROUTINES

YES

DETERMINE LEVEL OF INTERACTION

TRANSLATE PROCEDURES INTO VAMTST INSTRUCTIONS

DEBUG

FIGURE 6

```
PLOT TITLE IS:                  C1 BLEEDDOWN VOLTAGE
HORIZONTAL AXIS LABEL IS:       TIME(SEC)
VERTICAL AXIS LABEL IS:         VOLTS
HORIZONTAL CALIBRATION FACTOR:  1.000
VERTICAL CALIBRATION FACTOR:    1.000
DATA POSITIONING PARAMETER:     -3.00
EXTENSION FOR FILE NAMES:       9.D06
C
C
C       ****************************************************************
C       THIS IS THE BEGINNING OF THE INSTRUCTIONS FOR THE T-33
C       FIRESET BLEED-DOWN TEST. THIS TEST MEASURES THE VOLTAGE
C       ON THE MAIN STORAGE CAPACITOR AFTER IT HAS BLED-DOWN FOR
C       100 SECONDS. THE BLEED-DOWN VOLTAGE IS CALCULATED FROM
C       THE DATA ACQUIRED FROM THE 7612D.
C       ****************************************************************
C
C
C       SET UP THE 7612D
B0 1\CLK INT;BTA OFF;WRI OFF;RQS ON;REM OFF;TMBS A;REC 1,1024;SBPT 0,2E-1;\\
B0 1\MODE POST,8;LTC LEFT;SRC INT;SLO NEG;HFR OFF;CPL DC;LEV 65;\\
B0 1\TMBS B;REC 1,1024;SBPT 0,20E-2;MODE POST,8;LTC LEFT;SRC INT;\\
B0 1\SLO NEG;HFR OFF;CPL DC;LEV 65;\\
B0 2\BW FUL;CPL DC;RIN HI;VAR OFF;V/D 5.E+0;POL NUR:POS -3.00;INP A;\\
B0 3\BW FUL;CPL DC;RIN HI;VAR OFF;V/D 5.E+0;POL NOR;POS -3.00;INP A;\\
C       GET THE 7612D SCALE FACTORS
        MV 1\4\VSL1?;\\
        MH 1\7\TMBS A;SBPT?\\
C       SET UP THE SCREEN MONITOR, WORKSPACE, AND HOME THE CURSOR
        TT !MON K;!WOR 32 H;!JUMP 10\\
        TT !BELL\\
        TT      TO START THE BLEED-DOWN TEST,!ATT I-E;TYPE RETURN\\
        TT !BELL\\
        TT      !ATT I-E;TEST IN PROGRESS\\
C       ARM AND TRIGGER CHANNEL A OF THE 7612D
        B0 1\ARM A;MTRIG;\\
C       INSERT A 3 SECOND DELAY TO GET POST TRIGGER SAMPLES
        ST 0\\
        ST 5\\
C       THEN TURN OFF THE 36V(PREARM SIGNAL)
        B0 6\20000,\\ SET THE POWER SUPPLY TO ZERO VOLTS
C       POLL THE 7612 UNTIL DATA IS ACQUIRED
        MC 1\1\1\\
C       THEN RING THE BELL
        TT !BELL\\
C       TELL THE OPERATOR ABOUT THE DATA
        TT               !ATT I-E;DATA ACQUIRED\\
C       READ THE DATA FROM THE 7612D AND TRANSFER IT
        B0 1\READ A\\
        MB 1\3\2\128\\
C       RESET THE MONITOR
        TT !MON 33 H K\\
C       THE NEXT INSTRUCTION IS THE LAST ONE OF THIS TEST
        MF
REQUEST SUMMARY CALCULATION:   2
```

FIGURE 7

BASELINE T-33 FIRESET PERFORMANCE RESULTS OF S/N 36

```
********************
*TEST SUMMARY SHEET*
********************
 OPERATOR:                 SMITH
 BASELINE FIRESET #:       036
 DATE:                     10-AUG-81
*RESULTS OF CHARGE TEST*
 CHARGE TIME:               3.20 SECONDS
 ZENER VOLTAGE:            29.84 VOLTS
*RESULTS OF BLEEDDOWN TEST*
 PEAK VOLTAGE:                              29.84 VOLTS
 VOLTAGE AFTER 100 SECONDS:                 10.47 VOLTS
 VOLTAGE DROP:                              19.38 VOLTS
*RESULTS OF RINGDOWN TEST*
 FC/VA DET CURRENT RISE TIME:                 14.50 MICROSECONDS
 FC/VA DET CURRENT PEAK:                      16.63 AMPS
 FT DET CURRENT RISE TIME:                    13.00 MICROSECONDS
 FT DET CURRENT PEAK:                         25.63 AMPS
*RESULT OF NOISE TEST*
 COMPONENT  PASSED
```

FIGURE 8

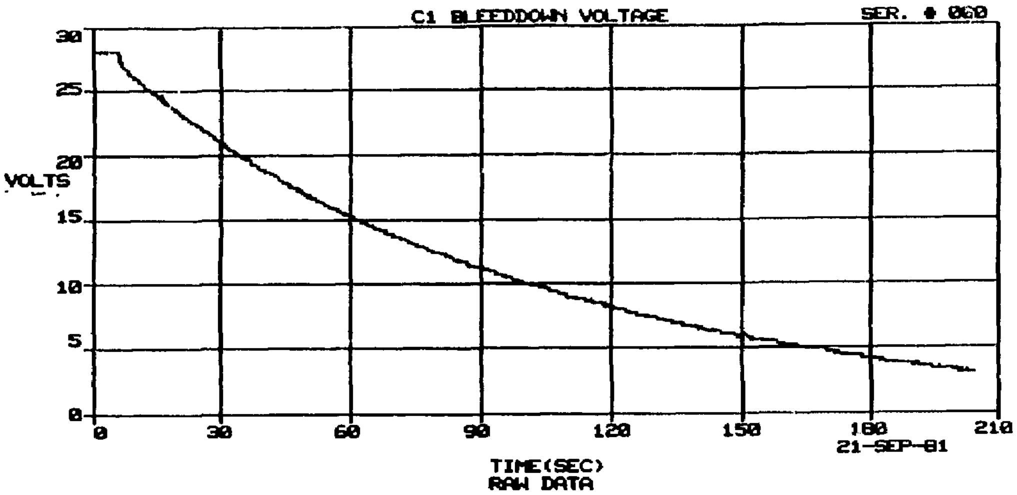


FIGURE 9

PAUSE —)

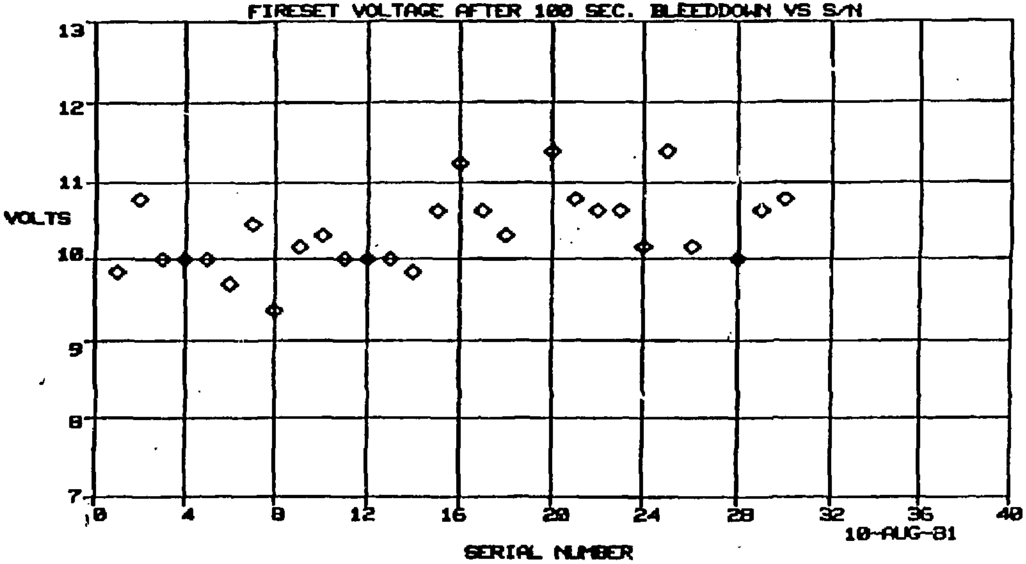

FIRESET VOLTAGE AFTER 100 SEC. BLEEDDOWN VS S/N
VOLTS
13
12
11
10
9
8
7
0
4
8
12
16
20
24
28
32
36
40
10-AUG-81
SERIAL NUMBER

FIGURE 10

TAAM/T-33 FIRESET TEST RESULTS

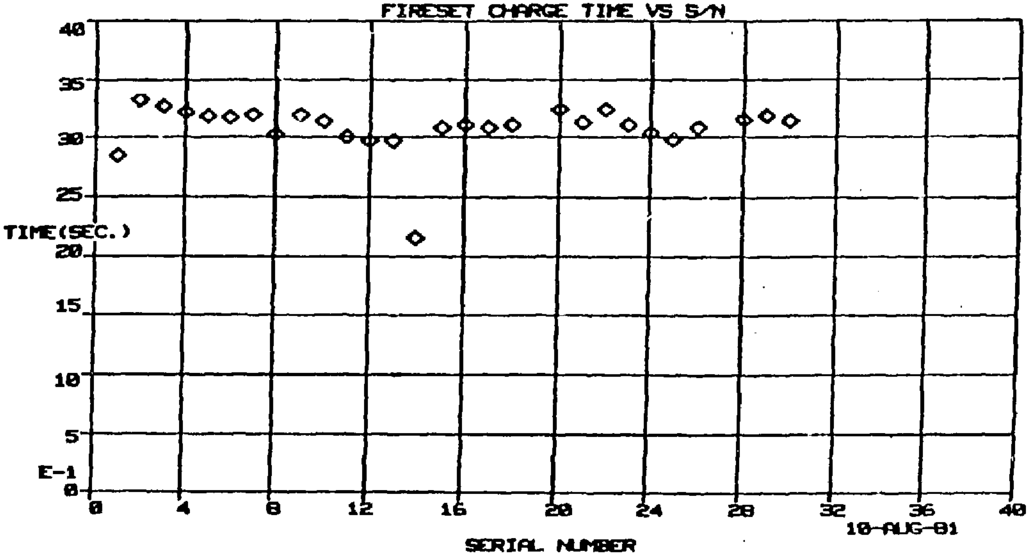


FIGURE 11

TAAM/T-33 FIRESET TEST RESULTS

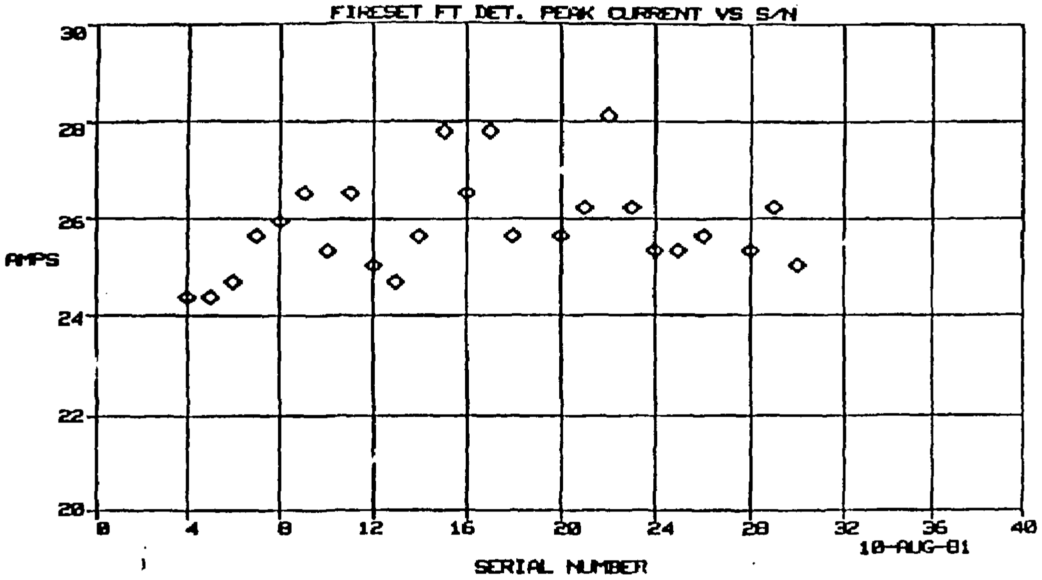


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FIGURE 12