	CICADA ENGINEERING SPECIFICATION	DOCUMENT NO. TFTR-10B3-H302A
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SUBJECT Digital Output (Relay Contacts)		PREPARED BY J. Bosco J. Bosco

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REVISIONS

DATE	DESCRIPTION
5/1/78 Rev. A	Paragraphs 5.9, 6.5, 6.7 and 6.9.1

1.0 Abstract

The purpose of this specification is to define the characteristics of a CAMAC module with relay contact outputs.

2.0 Reference Documents

2.1 IEEE Standard Modular Instrumentation and Digital Interface System (CAMAC) IEEE Std. 583-1975.

2.2 CAMAC - A Modular Instrumentation System for Data Handling AEC. TID-25875.

2.3 Printed Circuit Board Fabrication and Assembly Specification, Document TFTR-10A2-H54A.

2.4 Electronic Schematic Specification, Document TFTR-10A2-H55.

2.5 Reliability, Quality Control and Temperature Cycling, Document TFTR-10A2-H58.

3.0 Introduction

The module defined by this specification will serve as a CAMAC interface between elements of the TFTR and the CICADA computer system. This module will be housed in a CAMAC crate and will be controlled by the CAMAC Dataway. Data received from the Dataway will be used to control 16 output relay contacts. The relay output contacts will be used to control a variety of devices, for example, power supplies and valves.

4.0 Basic Features

4.1 This CAMAC module will contain 16 SPST relays with floating contact outputs. The relay outputs will be available on a standard 36 pin card edge connector at the rear of the CAMAC card. The contact rating must be a minimum of 24 volts DC or AC (RMS) at 500mA. Contact protection must be provided on the module.

4.2 The electrical components of this module are to be mounted on a high quality printed circuit board (see specification 2.3). Component placement shall be such as to minimize undesired electrical coupling. As an example, the relays shall be located near the output connector so that the contact switching will have less effect on other module components.

4.3 The relays will be controlled by Dataway commands. The mode of operation will be determined by the position of two manual switches. The switches are to be located on the module but must not be accessible from the front panel. One switch will either select the momentary or latched mode of the relay contacts. The momentary time interval will be 200 milliseconds and the latched state is maintained until a new command or reset is received. The second switch will select one of the following three conditions: (1) all 16 relays normally open, (2) all 16 relays normally closed, or (3) 8 relays normally open and 8 normally closed. The normally open or normally closed condition is defined as the state of the relay with power applied after a Dataway clear or initialize command. With power off, all 16 relays must be in the normally open state. During module power-up, all 16 relays must be automatically initialized to the normal state, taking into account the setting of the second switch described above.

4.4 The module must respond in the same way to Dataway commands whether it is in the momentary or latched state except that Selective Clear (Command #2 below) will have no effect on the relays in the momentary mode.

4.5 The states of the relays will be controlled by Dataway lines W1-W16 and the appropriate command. When the condition of 8 normally open, 8 normally closed relay operating mode is selected, the 8 normally open relays will be controlled by lines W1-W8 and the 8 normally closed relays by lines W9-W16 and the appropriate command.

4.6 The commands which the module must respond to are listed below:

Command #	Code	Action
1	F(18) A(0)	Selective set relays 1 to 16
2	F(21) A(0)	Selective clear relays 1 to 16
3	C + Z	Sets all relays to normal condition
4	F(0) A(0)	Outputs relay states to Dataway lines R1-R16; outputs encoded switch settings on lines R22-R24.
5	F(6) A(0)	Outputs module identifying number on R1-R12; outputs encoded switch settings on outputs R22-R24.

5.0 Mechanical Characteristics

5.1 This module must conform to the mechanical requirements outlined in reference specifications 2.1 and 2.2.

5.2 The electrical components of this module are to be mounted on a high quality flame retardant epoxy glass printed circuit board such as NEMA type FR-4 or equivalent. See reference specification 2.3.

5.3 This module is to contain all necessary mechanical components for insertion into a standard CAMAC crate. See reference specifications 2.1 and 2.2.

5.4 All components are to be identified with a standard manufacturer's part number or standard method of marking (e.g., resistor color coding).

5.5 All electrical components are to be mounted on only one side of the board.

5.6 The condition of this module is to be monitored by LED's which can be viewed from the module front panel. See Figure 10.1 for the suggested front panel layout. The front panel must be of aluminum and both sides are to have an iridite (conducting) finish. The color of the letters shall be chosen to contrast with the iridite finish and may be engraved or silk screened.

5.7 The 36 pin card edge connector must mate with a Viking 3V18 connector (or equivalent). The card edge connector must be marked with pin 1 on top and pin 18 on the bottom on each side of the card. It is not necessary to mark each pin.

5.8 All components are to be assigned an identifying part name (e.g., R1, C2, etc.) which is to be cross-referenced to the manufacturer's part number on the electrical schematic associated with this module. See reference specification 2.4.

5.9 The relays are to be mounted in low profile sockets with gold plated contacts. This requirement is deleted.

6.0 Electrical Characteristics

6.1 This module must conform to the electrical requirements outlined in reference specifications 2.1 and 2.2.

6.2 Whenever possible, low power circuitry (such as the 74LS series) shall be used to minimize power dissipation.

6.3 The module must derive its input power from the standard $\pm$24 volt and $\pm$6 volt CAMAC supply voltages.

6.4 The +6 and -6 volt supply voltages must be bypassed on the module with electrolytic capacitors of at least 33 microfarads. The +24 and -24 volt supply voltages must be bypassed with electrolytic capacitors of at least 6.8 microfarads. In addition, at least half the integrated circuits must contain a ceramic bypass capacitor of at least .01 microfarads on their supply voltage lines. The .01 microfarad capacitors should be located as close as possible to the integrated circuits.

6.5 The +5 volt and ground lines for TTL logic shall be carried on insulated sandwich type busses which are located under the dual in-line IC packages. This requirement is deleted.

6.6 All inputs to this module, which control the relays, are through the Dataway and the input characteristics are to be as defined in references listed under 2.1 and 2.2.

6.7 The relay output contacts are to be capable of switching 24 volts DC or AC (RMS) at 500mA. Contact protection for inductive loads is to be provided on the module. The contact protection must limit the voltage on opening the contacts to a maximum of 75 volts. When open, the leakage current through the contacts must be less than 25 microamperes at rated voltage over the full temperature range. When closed, the contacts must have a DC resistance of 0.20 ohm or less at rated current.

6.7.1 The output contacts must be isolated from each other and from ground by an equivalent DC resistance of at least 100 megohms. The contacts must be capable of withstanding 100 volts DC or AC (RMS) to other sets of contacts or ground.

6.8 The condition of the output contacts is under the control of data transferred into the module from the Dataway. The contacts must fully open or close within a maximum of 10 milliseconds after being commanded from the Dataway.

6.9 The CAMAC commands listed in section 4.6 are described in detail below.

6.9.1 Command #1 (Selective Set)

This command must activate the affected relays to the state opposite from their normal position, i.e. a normally open relay is closed and a normally closed relay is opened. The relays that are affected are those for which the corresponding write (W) line is a logical "1".

If the module has been selected to be in the latched mode, the relay conditions established by the Selective Set command must be maintained until a Selective clear, Clear, or Initialize command is received. If the module has been selected to be in the momentary mode, the affected relays must momentarily activate the desired state once and only once for each Selective Set command. The momentary activation time is defined as having a value of 200 milliseconds with a tolerance of $^{-0}_{+20}$%. It shall be possible to activate individual relays independent of the state of other relays. The relays will be activated through Dataway commands which can occur at a maximum rate of one command every ten (10) microseconds. In the momentary mode the activation time of two hundred (200) milliseconds for an individual relay shall not be affected by the state of other relays. In the momentary mode a Selective Set command to an activated relay will be ignored.

6.9.2 Command #2 (Selective clear)

This command must return affected relays to their normal state. The affected relays are those for which the corresponding write (W) line is a logical "1". This command will have no effect on the relays in the momentary mode.

6.9.3 Command #3 (Clear or Initialize)

These commands must set all relays to their normal state as defined by the position of the mode switch.

6.9.4 Command #4 (Read Register)

These commands gate the relay state on read lines R1-R16 in a one to one correspondence. The point to be read is the relay coil and not the relay contacts. A read line which returns a logical "1" in response to this command is defined as presently having the corresponding relay in the activated state, i.e. a normally open relay is closed and a normally closed relay is open. If the module is in the momentary state, all read lines will return logical "0"'s to this command. See the description under 6.9.5 below for the assignment of lines R22-R24.

6.9.5 Command #5 (Read Module Number & State)

This command gates the module identification number (decimal 302, binary 000100101110) on the read lines R1-R12 with the LSB on R1. The selected module operating mode is to be encoded and gated onto read lines R22 to R24 as defined by the table below.

Condition	R22	R23	R24
Latched	1	X	X
Momentary	0	X	X
All 16 relays normally open	X	0	0
All 16 relays normally closed	X	0	1
8 relays normally open; 8 normally closed	X	1	0

6.9.6 X must be returned as a logical "1" on the command accepted bus line for all commands which the module is equipped to perform.

6.9.7 Q must be returned as a logical "1" for all the addressed commands received by the module.

6.9.8 The module shall not generate or respond to CAMAC signals L, I or B.

6.9.9 The condition of the relay coils is to be monitored by 16 LED's mounted on the module front panel. The corresponding LED's will light for the duration of time that a relay is energized. Five additional front panel LED's are to monitor the selected module condition as defined below:

LED #1: Lit in Latched condition; off otherwise

LED #2: Lit in Momentary conditon; off otherwise

LED #3: Lit when 16 N.O. condition is selected; off otherwise

LED #4: Lit when 16 N.C. condition is selected; off otherwise

LED #5: Lit when 8 N.O. and N.C. condition is selected; off otherwise

One other LED will light whenever the module is addressed and be held on for a duration of approximately 200 milliseconds. All 22 LED's described are to have front panel labels with abbreviations acceptable.

6.10 All components on this module must have a MTBF rating as specified in reference 2.5 with the exception of the relays which shall be rated for at least 10^6 cycles of operation with rated resistive loads.

7.0 Environmental Data

7.1 The module must operate over an ambient temperature range of 0 to +50°C.

7.2 The module must operate over a relative humidity range of 10% to 90%. It is not a requirement that the module operate under conditions of water condensation.

7.3 The module must operate, as defined, in the presence of an external magnetic field changing at a maximum rate of 100 gauss per second with a peak magnitude of 50 gauss in any direction.

7.4 The module must operate in a radiation environment of 1 rad/second (peak) with a total integrated lifetime dose of 1000 rad.

8.0 Safety

8.1 All components of this module must be of flame retardant material.

8.2 The relay contacts must be enclosed to minimize the possibility of igniting combustible materials.

8.3 The desired failure mode is for the relay contacts to be open.

9.0 Testing

9.1 The module shall undergo all tests normally performed by the Seller. A description of the tests performed on this module and the results obtained shall be furnished by the Seller. Successful performance of the tests in sections 9.1 and 9.2 does not relieve the Seller of the responsibility of certifying that all requirements specified herein are met.

9.2 In addition to the test performed in section 9.1, the specific tests outlined in Table 10.1 shall be performed by the Seller. The table specifies the test conditions; the Seller is to provide the data in the test measurement column and the name of the person performing the test. The test measurements shall be made with instruments which have an accuracy of ±10% or better. The tests specified in Table 10.1 are to be performed after the module has undergone the temperature cycling test specified in reference 2.5. The module is to be mounted in a CAMAC crate and powered from the standard ±6 volt and ±24 volt CAMAC supply. The module function codes are to be tested on the CAMAC dataway through the use of a computer or manual test device which can supply appropriate data and timing. The dataway timing is to meet the conditions specified in reference 2.1. If the tests specified in Table 10.1 have already been performed as part of the Seller's normal tests, the results can be recorded in Table 10.1, i.e., the tests do not have to be repeated. All the tests must be successfully executed before the module will be accepted.

10.0 Quality Control

10.1 This equipment shall meet all applicable requirements specified in reference 2.5.

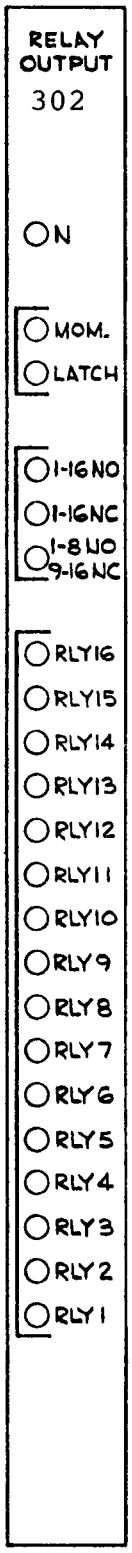

FIG. 10.0 FRONT PANEL LAYOUT

Test #	Reference Section	Test Condition	Test Measurement	Test performed by
1	6.7	Relay contacts closed and carrying 500mA DC. Each relay is to be tested but only the highest contact voltage is to be recorded.	Contact voltage in volts	
2	6.7	Relay contacts open with 24 volts DC across them. Each relay is to be tested but only the highest leakage current is to be recorded.	Leakage current in microamps	
3	6.7	Supply 50 volt, 10 microsecond pulses between open relay contacts. Each relay to be tested but only highest current to be recorded.	Pulse current in milliamps	
4	6.7.1	Supply ± 100 volts DC from ground to a set of closed relay contacts. Each relay to be tested but only highest current to ground to be measured.	Current to ground in microamps	
5	6.7.1	Supply ± 100 volts DC from one set of closed relay contacts sequentially to all other sets of closed contacts and measure the current. Only the highest current need be recorded.	Contact to contact current in microamps	
6	6.8	Perform Selective Set command that closes a normally open relay. Use latched mode. Measure the time from command initiation to contact closure after contact bounce has ceased. Each relay to be tested but only longest time to be recorded.	Time in milli-seconds	
7	6.9.1	Perform Selective Set commands in latched mode. Each relay to be tested.	Do relays function as specified? Yes--- No----	

Table 10.1 Tests

Test #	Reference Section	Test Condition	Test Measurement	Test performed by
8	6.9.1	Perform Selective Set Commands in momentary mode. Each relay to be tested.	Do relays function as specified and do closures fall within specified time? Yes--- No----	
9	6.9.1	Relays in momentary mode activated sequentially at 10 microsecond intervals.	Do relays activate for specified time? Yes--- No----	
10	6.9.2	Perform Selective Clear Command to each relay.	Do relays respond as specified time? Yes--- No----	
11	6.9.3	Perform clear and Initialize functions for each relay for each of the three mode switch settings.	Do relays respond as specified? Yes--- No----	

Table 10.1 Tests (continued)

OUTPUT CONNECTOR

Outputs are at rear card edge connector located above the dataway connector. Mate is Viking 3V18 or equivalent. When viewing the front of the module Pin 1 LEFT is the left (component) side of the board; RIGHT is the solder side. The outputs and corresponding pin numbers are as listed.

Output		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
P2 Pin	Left	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number	Right	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

RELAY OUTPUT VS. AUX. CONNECTOR P2 PIN NUMBER