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Container Module Tester

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Sandia Laboratories

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CONTAINER MODULE TESTER

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ABSTRACT

This report describes the design, operation, and calibration of the container module tester. This tester was developed to test the container module of the plutonium protection system.

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CONTAINER MODULE TESTER

I. Introduction

The Container Module (CM) was designed as a component part of the Plutonium Protection System (PPS) to provide additional protection for sealed cans of plutonium. An integral part of the CM is an electronic circuit board which is used to monitor both the upward deformation and temperature of the plutonium can and, in addition, the temperature of the upper portion of the CM. The board contains a permanent memory (PROM) which is used to store inventory data such as can serial number and plutonium canning date. A dynamic memory is included on the board which can be used to store temporary data pertinent to container movement or storage activities.

A Container Module Tester (CMT) was designed to exercise and establish base line data for each container module.

The CMT has the capability of reading the PROM, board temperature, can temperature, and deformation within the CM. It also is used to load and check the dynamic memory.

The tester is shown in Figures 1 through 4; the tester block diagram is contained in Figure 5.

Figure 1. Container Module Tester, Panel View

Figure 2. Container Module Tester, Rear View

Figure 3. Container Module Tester, PCB

Figure 4. Container Module Tester, Power Supplies

Figure 5. Block Diagram

II. Physical Description

Overall Physical Data

Control Panel Dimensions for the CME-100 System (cm)

Front Panel:

Height: 32.0 in. (81.3 cm)

Width: 7.0 in. (17.8 cm)

Top Panel:

Height: 3.5 in. (8.9 cm)

Width: 36.5 in. (92.6 cm)

Depth: 13.0 in. (33.0 cm)

Weight: 94.5 lbs (42.4 kg)

Front Panel Controls and Readouts

Figure 1 shows a front view of the CME-100 control panel. The following is a brief description of each of these features, in bold.

POWER Switch - This switch applies 110 V to the power supplies.

POWER Indicator - This indicator lights whenever the power is on.

ENABLE Switch - This switch enables a relay in the CME which enables power to the CME current board.

ENABLE Indicator - This indicator lights whenever the CME is on.

LOAD Switch - This switch loads the data from the DYNAMIC CODE switches (0-31) located on the CME, into the first registers in the CME.

CHUCK Switch - This switch shifts the data in the first register of the CME to the second register and loads the data from the DYNAMIC CODE switches into the first register in the CME.

ALARM Indicator - This indicator flashes when the DYNAMIC CODE check is in error.

START Switch - This switch initiates the counter when the AUTO/MAN switch is in the AUTO position.

0-15/16-31 Switch - When in the 0-15 position, the LOCATION switch will address locations 0-15 and when in the 16-31 position, the LOCATION switch will address locations 16-31.

AUTO/MAN Switch - This switch is used to select AUTO or MANUAL LOCATION addressing.

LOCATION Switch - This switch is used to manually select locations 0-31.

TABLE I
CMU-to-CMU Cable Pin Identification

34 J101 2-16-26S Pin Functions	Container Module PTO 6-16-26S	Cable	Container Module J101 6-16-26S
A = Location D	A	LOCATION D	A
B = Memory MSD, MSB	B	MSD MSB MEMORY	B
C = Memory MSD, 3SB	C	MSD 3SB MEMORY	C
D = Memory MSD, LSB	D	MSD LSB MEMORY	D
E = Memory MSD, 2SB	E	MSD 2SB MEMORY	E
F = Memory LSD, MSB	F	LSD MSB MEMORY	F
G = Ground	G	GROUND	G
H = Memory LSD, LSB	H	LSD LSB MEMORY	H
J = Memory LSD, 3SB	J	LSD 3SB MEMORY	J
I = Location A	I	LOCATION A	I
L = Memory LSD, 2SB	L	LSD 2SB MEMORY	L
M = Location B	M	LOCATION B	M
N = Location C	N	LOCATION C	N
P = -6 V	P	-6 VOLTS	P
R = Enable	R	ENABLE	R
S = Clock	S	CLOCK	S
T = Dynamic Code Data	T	DYNAMIC CODE	T
U = Temp 1	U	TEMP 2	U
V = Temp 2	V	TEMP 1	V
W = Continuity	W	CONTINUITY	W
X = Pressure	X	PRESSURE	X
Y = +15 V	Y	+15 VOLTS	Y
Z = NC	Z	NC	Z
a = Location E	a	LOCATION E	a
b = NC	b	NC	b
c = NC	c	NC	c

III. Operating Procedures

3.1. Starting the Machine in Operating Mode:

1. Press the STOP switch.
2. Press the AUTO/MAN switch.
3. Press the FLOW/STOP switch.
4. Press the RUN/RELEASE switch.

3.2. AUTO:

1. Set the AUTO/MAN switch to AUTO.
2. Turn the START switch. The CME will exit from location 0 through 05 and will stop at location 06. The address below the CPMCE display will show 06 and the data below the CME will show 00000000. The location and MEMORY data are on the display.
3. Press the ALARM/CHECK switch. The CME will fast cycle to location 20 and stop. At location 20, the CME will stop at location 00 and stop at location 01.
4. Press the AUTO/MAN switch to MAN. This will take the CME out of the AUTO mode. The address below the CME will show 00 at the end of a cycle.

3.3. AUTO Mode:

1. Set the AUTO/MAN switch to MAN.
2. Turn the FLOW/STOP switch to 0-15 position. This will allow a check of locations 0-15.
3. Press the FLOW/STOP/RELEASE switch.
4. Set the AUTO/MAN switch to 16-31 position. This will allow a check of locations 16-31.
5. Press the FLOW/STOP/RELEASE switch. This third cycle of the switch is for location 16-31. Table II will show the switch numbers to the correct memory locations 16-31.

3.4. AUTO:

1. The AUTO/MAN switch can be in either position. The PROM occupies locations 0-29 and the data location will be displayed on the appropriate indicators during either mode.

DYNAMIC CODE Check

1. Set the AUTO/MAN switch in MAN.
2. Turn the FLOW/CHECK switch in any position but 0-5.
3. Set code in by rotating DYNAMIC CODE switches to desired positions.
4. Press the FLOW switch.
5. Press the ALARM/CHECK switch.
6. Turn the LOCATION switch in position 30, and then 31. The code on the switches should now be displayed on the indicators.

TABLE II
Log prior, $H_0 = 0.68$

	<u>Search</u>	<u>Log Likelihood</u>
	0	0
	1	1
	2	2
	3	3
	4	4
	5	5
	6	6
0 - 15	7	7
	8	8
	9	9
	10	10
	11	11
	12	12
	13	13
	14	14
	15	15
	0	16
	1	17
	2	18
	3	19
	4	20
	5	21
	6	22
16 - 32	7	23
	8	24
	9	25
	10	26
	11	27
	12	28
	13	29
	14	30
	15	31

The next step is to find the value of α that minimizes the cost function $J(\alpha)$. This is done by setting the derivative of $J(\alpha)$ with respect to α equal to zero and solving for α . The resulting value of α is the optimal value of α that minimizes the cost function.

The optimal value of α is found by setting the derivative of $J(\alpha)$ with respect to α equal to zero and solving for α .

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α	$J(\alpha)$	$J'(\alpha)$
0.0	1.0	0.0
0.1	0.9	0.1
0.2	0.8	0.2
0.3	0.7	0.3
0.4	0.6	0.4
0.5	0.5	0.5
0.6	0.4	0.6
0.7	0.3	0.7
0.8	0.2	0.8
0.9	0.1	0.9
1.0	0.0	1.0

TEMP 1 Calibration Procedure

- a. Connect CMT cal box to CMT.
- b. Turn on power.
- c. Set toggle switch to TEMP 1 position.
- d. Set LOCATION switch to 25 position.
- e. Adjust GAIN 1 control for a readout of 25 on the TEMP 1 indicator. (When facing the front panel, a clockwise (CW) rotation of the control will increase the reading.)
- f. Put rotary switch in 10 position and adjust OFF 1 control for a 99 reading. (When facing the front panel, a CW rotation of the control will decrease the reading.) This is achieved when the OFF 1 control is turned CW until the 99 reading does not change. Now adjust OFF 1 control for a 10 on the indicator.
- g. Put ROTARY switch in 100 position and adjust GAIN 1 control for a 95 reading. This is accomplished by decreasing the control until there is no change in the readout. Now adjust GAIN 1 control for the 95 reading.
- h. Adjust between the 10 and 100 positions until a good balance is reached.
- i. Set ROTARY switch in 25 position and adjust GAIN 1 control for a 25 indication.

TEMP 2 Calibration Procedure

The TEMP 2 calibration is performed identically to TEMP 1 except that GAIN 2 and OFF 2 controls are used and the CMT cal box is set in the TEMP 1 position.

PRESSURE Calibration Procedure

- a. Connect CMT cal box to CMT.
- b. Turn on power.
- c. Pull PRESSURE control out and adjust LEVEL PRES control for a negative reading. Then adjust for a +10 reading. (When facing the front panel, a CW rotation of the control will decrease the reading.)
- d. Push PRESSURE control in and adjust GAIN PRES control for a decreasing reading until there is no change. Now adjust for a reading of 99. (When facing the front panel, a CW rotation of the control will increase the reading.)
- e. Adjust between the in and out position of the PRESSURE control until a ± 2 count of the +10 and +50 reading is achieved.

V_1 and V_2 in $\mathcal{F}_1$ and $\mathcal{F}_2$

Let us first consider the case of $\mathcal{F}_1$. The vector V_1 is the sum of the vectors V_1^1 and V_1^2 in $\mathcal{F}_1$. The vector V_1^1 is the vector in $\mathcal{F}_1$ that is the projection of the vector V_1^1 in $\mathcal{F}_1$ onto the plane $\mathcal{F}_1$. The vector V_1^2 is the vector in $\mathcal{F}_1$ that is the projection of the vector V_1^2 in $\mathcal{F}_1$ onto the plane $\mathcal{F}_1$. The vector V_1 is the vector in $\mathcal{F}_1$ that is the projection of the vector V_1 in $\mathcal{F}_1$ onto the plane $\mathcal{F}_1$.

Figure 6: V_1 in $\mathcal{F}_1$ and $\mathcal{F}_2$

Figure 6 shows the vector V_1 in $\mathcal{F}_1$ and $\mathcal{F}_2$. The vector V_1 in $\mathcal{F}_1$ is the vector in $\mathcal{F}_1$ that is the projection of the vector V_1 in $\mathcal{F}_1$ onto the plane $\mathcal{F}_1$. The vector V_1 in $\mathcal{F}_2$ is the vector in $\mathcal{F}_2$ that is the projection of the vector V_1 in $\mathcal{F}_2$ onto the plane $\mathcal{F}_2$. The vector V_1 in $\mathcal{F}_1$ is the vector in $\mathcal{F}_1$ that is the projection of the vector V_1 in $\mathcal{F}_1$ onto the plane $\mathcal{F}_1$. The vector V_1 in $\mathcal{F}_2$ is the vector in $\mathcal{F}_2$ that is the projection of the vector V_1 in $\mathcal{F}_2$ onto the plane $\mathcal{F}_2$. The vector V_1 in $\mathcal{F}_1$ is the vector in $\mathcal{F}_1$ that is the projection of the vector V_1 in $\mathcal{F}_1$ onto the plane $\mathcal{F}_1$. The vector V_1 in $\mathcal{F}_2$ is the vector in $\mathcal{F}_2$ that is the projection of the vector V_1 in $\mathcal{F}_2$ onto the plane $\mathcal{F}_2$.

Figure 6

Figure 7. Pressure Amplifier Waveforms

Signal Conditioning Circuits

The data from the temperature and pressure amplifiers are fed to the multiplexer U3. The multiplexer is controlled by a counter U5 which in turn is controlled by a 6-Hz clock U8. The output of the multiplexer is buffered by U4-4 and then applied to the A/D converter U7 which is controlled by the 6-Hz clock. The output of the A/D is binary and is converted to BCD by U13, U14, and U15. The data from the decoder is then fed to the temperature and pressure indicators. This data must be strobed into the proper indicators and is accomplished in the following manner.

The end-of-conversion (EOC) pulse from the A/D is fed to a one-shot U10-1. This pulse is the strobe enable and is used to control the gate circuit U22. The counter U5, which is the same counter that controls the multiplexer, controls the gate circuit U22 and U33 to correlate the strobe and data. The data is updated every time the strobe is present. This timing correlation is illustrated in Figure 8. The sign indicator is controlled by U11 and the X2 amplifier in U4-2. Referring to Figure 7, it can be seen that as the input goes negative, the comparator output switches high. This high signal indicates a minus (-) on the readout. The opposite is true for the plus (+) indication.

Figure 8. Timing Correlation

DATA Indication

Memory data is presented to the memory readouts DS13 through DS16. DS13 and DS14 are the right indicators and DS15 and DS16 are the left indicators. The data is strobed into the indicators every time the least significant location A is changed. When the location is changed to an even spot, (A) goes negative and triggers one shot U31, which applies a strobe pulse to the left indicators. When the location is changed to an odd spot, (A) goes positive and triggers one shot U32, which applies a strobe pulse to the right indicators.

LOCATION MANUAL

When the AUTO/MAN switch S6 is in the MAN position, gates U16, U19-3 and U19-4 are enabled and U17 and U19-2 are disabled. The manual location data is generated by the LOCATION switch S12 and thus data is fed to U16, U41-2 and U19-4. It is then inverted by U19 and U19-3. This signal, the data is sent to the CM and a decode circuit U35 which selects locations 30 and 31. This is also applied to a binary to BCD converter U36. After the decode, it is presented to the memory readouts DS17 and DS18.

The 0-15/16-31 switch (S7) controls location E. With the switch in the 0-15 position, location E is held low and keeps input 2 of the most significant digit (MD) of the location readout (D16) disabled. When this switch is in the 16-31 position, location E goes high and input 2 of the MD will be enabled. This switch is only enabled in the manual mode.

LOCATION AUTO

With the AUTO/MAN switch in the AUTO position, gates U17, U19-2, and U19-3 are enabled and gates U16 and U19-4 are inhibited. Counters U9 and U12 are in a reset state and their outputs are high causing gates U19-1 and U24-1 outputs to be low which inhibits gates U23-1 and U23-2.

When the START switch (S5) is pushed, pin 13 of U41-1 goes low and clears counters U9 and U12. This causes U19-1 and U24-1 outputs to go high thus enabling U23-1 and U23-2. The 6-Hz clock via U26-3 is then gated into the counters.

The counter will count to location 29. At this point, U24-1 will go low thus disabling U23-1 and no further clock pulses reach the counter causing it to stop at 29. To get locations 30 and 31, the CHECK switch (S3) must be activated. When it is pushed in, U21 goes low clearing counter U26 and J-K U27. The output of U27 goes high, thus enabling the 100-kHz clock U25. When S3 is released, U21 goes high, thus turning on the 100-kHz clock. The clock output is fed to a counter U26 and it counts to 15 and outputs a positive pulse. When this pulse goes negative, the output of the J-K U27 goes negative which inhibits the 100-kHz clock. This negative going signal also goes to a one-shot, U10-2, which outputs a positive pulse of 35 ms enabling U20-1. This allows the 400-Hz clock U25 pin 8 to be fed into U23-3 which is still enabled and finally to the counters U9 and U12. The counters now count to locations 30 and 31 and when done, U19-1 goes low which inhibits U23-3 thus causing the count to stop at location 31. The automatic mode is now back at its quiescent stage.

When the CHECK switch (S3) is depressed during a run, U20-1 goes low which disables U23-1 and inhibits the 6-Hz clock. At the same time, U20-2 is enabled allowing the 400-Hz clock to be fed into the counters U9 and U12. This action allows the locations to be addressed quickly.

The outputs of the counters U9 and U12 are fed to a control gate U17 and inverted by U13. At this point the operation is the same as explained in the manual mode.

DYNAMIC CODE

The DYNAMIC CODE is presented to shift register U20 and U29 by means of the DYNAMIC CODE switches S8 through S11. When the LOAD switch S4 is depressed, U21 goes low clearing counter U26, J-K U27 and enables the 100-kHz clock. This low signal also goes to shift registers U27 and U29 causing the data present at its inputs to be loaded in. Now when the switch is released, U21 goes high, enabling U23-2 and the 100-kHz clock. The clock output is fed to a counter U26 and it counts to 15 and outputs a positive pulse which goes negative at count 16. This negative going signal causes the J-K U27 output to go negative which will inhibit the 100-kHz clock after 16 counts.

500 kHz clock output is also inverted by U23-2 and then fed to the CM and shift registers U27 and U28. These two halves shift the data out of U26 and U29 and load the data into the next register of the CM.

The operation of the CHARGE switch (S1) does the same thing as the LOAD switch except that the first register of the CM is shifted to the second register of the CM and the data from the U26 and U29 are loaded in the first register of the CM.

4.2. RM Circuit

The alarm circuit is activated only in locations 30 and 31 (Dynamic Code Memory) locations as decoded by U35. At any location besides 30 and 31 the outputs of U21 are high, causing U21-4 to be low, thus inhibiting U30. When locations 30 and 31 are sensed, the outputs of U21 are simultaneously high and low causing U21-4 to go high and enabling U30. The outputs of U30 are applied to inverters U32-2 through U32-6 and U33-1 through U33-4. Their outputs are fed to U34. If the memory data is valid, the inputs will be simultaneously high and low causing U34 to go high and the output of U30 pin 3 to be low thus forcing alarm clock U4 inhibited. But when the data is sensed by the CM, it sends all lows to the inverters thus causing U32 to be low, causing U34 to be presented to the U30 input pin 2 and inverter U33-4. Location 30 strobe (STL) is presented to this data in. The output pin 6 goes high and U21 goes low and is presented to U30 output 12. Location 31 strobe (STL) is used to clock this data in. The output pin 3 goes high causing alarm clock U4 which in turn enables Q1 which turns on the alarm indicator DS4.

APPENDIX
Drawings and Diagrams

NOTES
 1. FOR GENERAL REQUIREMENTS SEE 77000000.

TEMPLATE VIEW

Control Module Tester CAL Box
 (Dwg No. T57823)

Logic Diagram, Container Module Tester
(Dwg No. CK-T43371)

Tester, Container Module
(Dwg No. T43371)

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