

TROTTER CONTROLS FORT WORTH, TEXAS	TEST SPECIFICATION		NUMBER	REVISION
	REPORT ORDER		TS-0005	A
TITLE GEN II FRDS Maintenance System Tests	BY	CHK'D	MODEL	
	Mark Pump /LA	CG	GEN II FRDS	
	DATE		SERIAL	
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Overview

This document describes the use of the GEN II FRDS Maintenance System Tests. This test is a built in diagnostic feature of the GEN II System and provides maintenance personnel with a diagnostic tool for troubleshooting.

References

Item	Document	Company
1	PS0030 - FRDS GEN2 - Continuous Hyd. System Flush process	Trotter Controls Inc.
2	9001-0011 FRDS GENII - Maintenance Manual	Trotter Controls Inc.
3	PS0031 - FRDS GENII - Sensor Calibration	Trotter Controls Inc.
4	9001-0012 - FRDS GENII - Operators Manual	Trotter Controls Inc.

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Objective

The objective is for a maintenance person, with an understanding of the GEN II FRDS, to be able to perform detailed diagnostics on the system to identify problems.

The user of this test must understand how to navigate the menus and make selections with the Pilot Interface controls.

This document will **not** go into detail on how to use the Pilot Interface controls. For detailed information on the Pilot Interface controls reference the GEN II FRDS manual, Trotter Controls Document no. 9001-0011.

General Precautions

- The gatebox doors may move during the selected tests. Always make sure that ALL personnel are clear of the gatebox during operation or testing of the system.
- If the system power switch is in the armed position and the hydraulic power switch is in the on position, the doors have the potential to open at ANY TIME. Treat the gatebox with utmost respect since the doors are extremely fast and produce enough force to cause amputation or death.
- Never power the system off immediately after exiting SysTest since this can corrupt the systems external memory (will not keep the system from operating properly, but will required operation from the system's internal memory).

When exiting SysTest, always wait for a minimum of 20 seconds before removing power from the system or until the "SaveMemory" message has disappeared. Removing power while the system is saving the results of the SysTest can result in corruption of the external memory.

If the external memory is corrupted, the next system restart will prompt the pilot to use internal memory.

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The SysTest Menu

Use the Pilot Interface controls to select the SysTest menu item from the Main Menu as shown in Figure 1 below.



Figure 1 - Menu Selection

The SysTest submenu contains the following five menu items:

- Pilot (no doors)
- Pilot (ALL)
- Auto Salvo
- Man Salvo
- Maint SysTest

The individual submenu items are described below.

Pilot (no doors):

This submenu item allows the pilot to quickly test system components that DO NOT result in the gate doors being opened for any reason. This set of tests is useful when there are contents in the hopper that should not be released.

This set of tests requires about 45 seconds to run. The tests are performed without the need for operator intervention unless any of the tests fail, in which case an error indicator remains on the screen until cleared by the pilot.

The set of tests that are performed are:

- Switch Test (optional)
- Valve Mon1 Mon2 Test
- Hyd Pump pressure limit test
- Bleed / Edump Pass Fail test

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Pilot (ALL):

This submenu item allows the pilot to quickly test ALL system components, including those that result in the gate doors being opened. Perform this set of tests when the hopper is empty.

The total time required for this set of tests requires about 2 minutes. The tests are performed without the need for operator intervention unless any of the tests fail, in which case an error indicator remains on the screen until cleared by the pilot. The set of tests that are performed are:

- Switch Test (optional)
- Valve Mon1 Mon2 Test
- Valve Wiring Test
- Gate prox switch test
- Hyd Pump pressure limit test
- Bleed / Edump Pass Fail test
- Gate Angle voltage Test

Auto Salvo:

This submenu item allows the pilot to test the primary redundant system (Auto Salvo) for ensuring that a dump occurs when the pilot requests one. This test should be performed only when the hopper is empty.

Hydraulic Power and ARMED switches should be ON, and the MODE switch should be set to AUTO or TIMER when performing this test.

After starting this test, the operator is instructed to press the DUMP (fire) switch. The primary system will inhibit dumping and the redundant system should then initiate an AUTO SALVO. The display should read AUTO SALVO (in large text).

Turn the ARMED switch off to terminate this test after a salvo has occurred.

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Man Salvo:

This submenu item allows the pilot to test the secondary redundant system (Man Salvo) for ensuring that a dump occurs when the pilot requests one. This test should be performed only when the hopper is empty.

Hydraulic Power and ARMED switches should be ON, and the MODE switch should be set to AUTO or TIMER when performing this test.

After starting this test, the operator is instructed to press the DUMP (fire) switch.

The primary system and first redundant SALVO system will intentionally not function and the second redundant electro-mechanical system should then initiate a MAN SALVO. The display should read MAN SALVO (in large text).

Turn the ARMED switch off to terminate this test after a salvo has occurred.

Maint SysTest:

This submenu item allows maintenance personnel to test any or all system components. Unlike the Pilot (no doors) and Pilot (ALL) tests, these tests require the operator to acknowledge the result of each test, whether the test passes or fails. The operator may choose which tests to perform and which tests to skip. The set of tests that may be performed are:

- Switch Test
- Valve Mon1 Mon2 Test
- Valve Wiring Test
- Gate prox switch test
- Hyd Pump pressure limit test
- Bleed / Edump Pass Fail test
- Hyd Pump rate & Bleed/eDump Test
- Continuous Hyd System Flush
- Gate Angle voltage Test

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Switch test

The purpose of the switch test is to verify proper operation of the switches on the PI (Pilot Interface) panel.

Referring to Figure 2 below shows the menu prompt for this test.



Figure 2 - Switch test menu

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test.

Referring to Figure 3 below, the test window is shown.



Figure 3 - Switch Test

Each of the illuminated blocks indicates a position for each of the six PI switches that have **not** been tested.

Moving a single switch at a time turns off each illuminated block, indicating that switch's position has been successfully tested.

An "X" indicates the current position of a switch. A period (".") indicates a switch position that has been previously tested.

Referring to Figure 4 below, the ARMED switch has been tested in the unarmed (down) position and is currently in the Armed (up) position.

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Figure 4 - Switch Test

Changing each of the switches, one at a time will test the switch operation. Changing more than one switch at a time or any switch causing another switch to change (a shorted switch contact) will cause an error.

Once all switches have been tested, pushing the selector knob will exit this test. Pushing the selector knob before all switches have been tested (all of the illuminated blocks turned off) will report an error.

Failure mode causes;

- Selecting or moving more than one switch at a time.
- Bad switch.
- A malfunction inside the Pilot Interface unit.

Bad switches or internal malfunctions of the Pilot Interface require factory service and repair.

If the switch test fails or the pilot aborts the test, error code 021 is saved to the systems internal memory. This error condition will persist until the switch test has successfully passed (see the Persistent System Test Errors section for more details).

Hopper contents warning

If or when the prompt in Figure 5 below is shown, the user must either answer "Yes" to proceed with the process or "No" to abort. This prompt is shown to alert the user to the possibility of contents inside the hopper to help prevent inadvertent fire retardant loss.

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Caution: Never select YES unless you are ready for the gatebox doors to be opened!

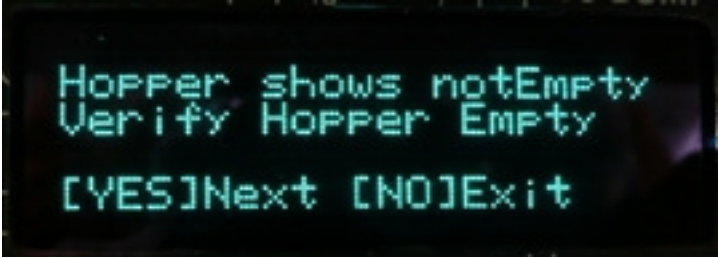


Figure 5 - Hopper contents warning

- Answering [YES] to this screen allows the user to continue with subsequent tests.
- Answering [NO] returns to the Main menu screen.

There are no failure modes related to this menu.

Valve Mon1 Mon2 Test

This test is used to detect the following possible issues;

- External cable connection issues
- Internal PI connection issues
- Internal Relay box connection issues
- External valve connection issues
- Pilot Interface system monitor failures

Understanding the difference between Mon1 and Mon2

Mon1 is the internal monitoring system inside the PI that checks inside the PI unit as well as the cabling to the Relay box.

Mon2 is the internal monitoring system inside the Relay Box that checks inside the Relay Box as well as the cabling to the Multi box and valves.

Referring to Figure 6 below shows the menu prompt for this test.

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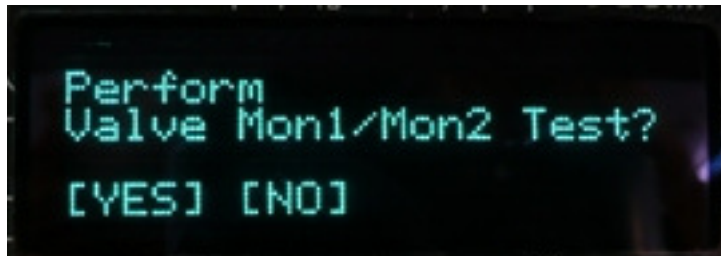


Figure 6 - Valve Mon1 Mon2 Test Menu

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test. Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown. Refer to Figure 7 below.

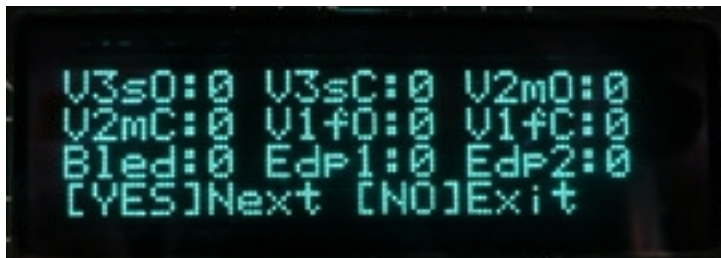


Figure 7 - Test Results

Figure 7 shows a "Passing" test result. This is indicated by the "0" zero shown beside each of the nine valves. Each valve has its own test result.

Table 1 ~ Hydraulic valve symbols used by the SysTest menu display.

- V10 = Valve 1 Open Coil on the hydraulic manifold
- V1C = Valve 1 Close Coil on the hydraulic manifold
- V20 = Valve 2 Open Coil on the hydraulic manifold
- V2C = Valve 2 Close Coil on the hydraulic manifold
- V30 = Valve 3 Open Coil on the hydraulic manifold
- V3C = Valve 3 Close Coil on the hydraulic manifold
- Bled = Pressure bleed valve that bleeds accumulator pressure when power is removed from the system
- Edp1 = Emergency dump valve 1
- Edp2 = Emergency dump valve 1

A hexadecimal number 1-9, A-F indicates a problem with one or more of the tests. The following table will describe the various fault "codes".

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Table 2 - Binary decode of Mon1 / Mon2 errors

MON2		MON1	
8	4	2	1
ON	OFF	ON	OFF

For example, a count of 2 in any field indicates a MON1 ON error for that valve.

Table 3 - Code versus error decode

CODE	MON2 ON	MON2 OFF	MON1 ON	MON1 OFF
0	GOOD	GOOD	GOOD	GOOD
1	GOOD	GOOD	GOOD	FAIL
2	GOOD	GOOD	FAIL	GOOD
3	GOOD	GOOD	FAIL	FAIL
4	GOOD	FAIL	GOOD	GOOD
5	GOOD	FAIL	GOOD	FAIL
6	GOOD	FAIL	FAIL	GOOD
7	GOOD	FAIL	FAIL	FAIL
8	FAIL	GOOD	GOOD	GOOD
9	FAIL	GOOD	GOOD	FAIL
A (10)	FAIL	GOOD	FAIL	GOOD
B (11)	FAIL	GOOD	FAIL	FAIL
C (12)	FAIL	FAIL	GOOD	GOOD
D (13)	FAIL	FAIL	GOOD	FAIL
E (14)	FAIL	FAIL	FAIL	GOOD
F (15)	FAIL	FAIL	FAIL	FAIL

Failure mode causes.

Failure modes in this test vary by Mon1 and Mon2.

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Mon1 Off failure

This indicates that when the target output was supposed to be off, the Mon1 detected it as on.

Most probable causes are as follows:

- A disconnected or loose cable on the back of the Pilot Interface or Relay Box
- Malfunction inside Pilot Interface unit's monitor system

Mon1 On failure

This indicates that when the target output was supposed to be on, the Mon1 detected it as off.

Most probable causes are as follows:

- Malfunction inside Pilot Interface unit's monitor system. (A Mon2 error should follow)

Mon2 Off failure

This indicates that when the target output was supposed to be off, the Mon2 detected it as on.

Most probable causes are as follows.

- Blown fuse. See passive error codes for reported errors or check F2 thru F12 in Relay box.
- Disconnected or loose cable at Relay box
- Disconnected or loose cable at Multibox
- Disconnected or loose cable at Valve body
- Open coil inside of valve. Check valve coil continuity
- Malfunction inside Relay Box unit's monitor system

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Mon2 On failure

This indicates that when the target output was supposed to be on, the Mon1 detected it as off.

Most probable causes are as follows.

- Shorted valve. Check valve coil continuity
- Shorted cabling
- Bad Solenoid Driver regulator board, (5950-0026)
- Malfunction inside Relay Box unit's monitor system

Valve Wiring Test

This test is used to detect mis-wired or crossed valve cables and to indicate which ones are incorrect.

Referring to Figure 8 below shows the menu prompt for this test.



Figure 8 - Valve wiring test menu

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test.

**Caution: This test will move the gate doors so any hopper contents will be lost.
Verify that all personnel are clear.**

Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown.

Refer to Figure 9 below.

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Figure 9 - Test complete and passed

Figure 9 shows that all valves are correctly wired.

A mis-wired valve's "OK" would be replaced by a valve identifier such as.

- V2mO-> V1fO (reference Figure 10)

This indicates that Valve 2 Open is connected to Valve 1 Open. Because of this there would also be a V3fO-> V2mO indicating the other cross-wired state. Swapping these connectors should correct the error.



Figure 10 - Test completed and failed

Failure mode causes.

These failures are due to improperly connected valves and can be solved by connecting the proper valve cable connector to the proper valve.

Gatebox proximity switch Test

This test is used to compare and detect proper operation of the Gatebox proximity switches used to indicate that the gate is fully closed.

Referring to Figure 11 below, the menu prompt for this test is shown.

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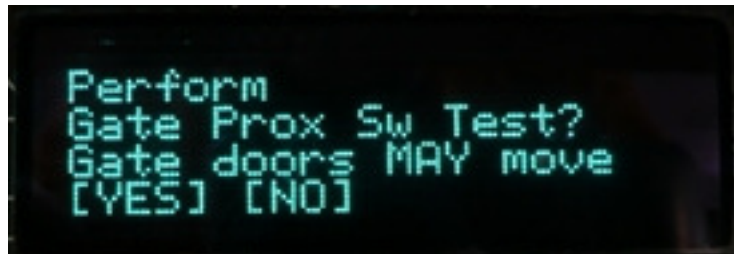


Figure 11 - Gate Prox Switch Test

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test.

Caution: This test will move the gate doors so any hopper contents will be lost. Verify that all personnel are clear.

Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown. Refer to Figure 12 below.



Figure 12 - Test completed and passed

Prox8 and Prox12 refer to the J8 and J12 port numbers of the Multibox that the proximity switch plugs into. This helps identify the proximity switch since it doesn't matter which switch plugs into which port and isn't individually labeled.

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Figure 13 - Test completed and failed

Failure mode causes.

A "Closed FAIL" indicates that the proximity switch did not detect the door closed position. In other words, the proximity switch did not "see" its target and did not exert an output.

The following can cause Closed Fail:

- Disconnected proximity switch
- Damaged proximity switch
- Incorrect mechanical adjustment of the proximity target or gates

An "Open FAIL" indicates that the proximity switch did not detect the door open position. In other words, the proximity switch did not lose its target and did not turn off its output.

The following can cause Open FAIL:

- Shorted proximity switch causing the output to remain on all the time
- Damaged proximity switch or cabling
- Incorrect mechanical adjustment of the proximity target or gates

Hydraulic pump pressure limit test

This tests the mechanical pressure switch used for Manual (EM) and Man Salvo functions. The data shown by this test can be used to judge the health of the mechanical pressure switch.

Refer to Figure 12 below, the menu prompt for this test is shown.

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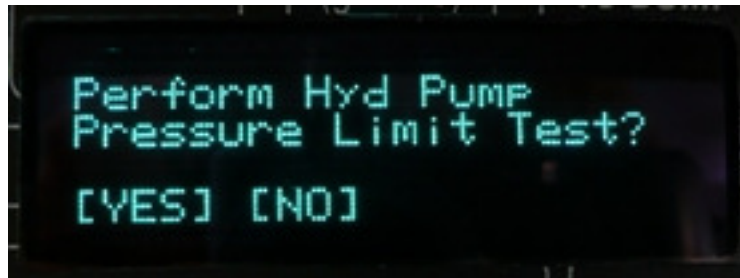


Figure 14 - Hyd. Press Limit Test menu

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next test. Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown. Refer to Figure 15 below.



Figure 15 - Test completed

Figure 15 shows the following:

- The 2800 or less, is the pump turn on pressure in auto mode.
- 3000 or greater, is the pump turning off pressure in auto mode.
- 2500 or lower is when the "Low pressure" LED on the PI panel is turned on.

These values are fixed and won't change from test to test.

- The 2481 or lower is the pump 'turn on' pressure of the mechanical pressure switch.
- The 2918 or higher is the pump 'turn off' pressure of the mechanical pressure switch.
- The mechanical pressure switch is preset from the manufacturer to 'turn off' at 3000PSI.

Failure mode causes.

A failure indicates that the mechanical pressure switch is not operating to specifications.

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- This could be from being stuck 'On' or 'Off' or from making and breaking at pressures outside the specified operational ranges.
 - Replace the pressure switch and retest.
- This could also be caused by a faulty analog pressure sensor. The mechanical switch is compared to the pressure sensed by the analog pressure sensor.
 - Replace the analog pressure sensor and retest
- This could be caused by faulty analog calibration values in the Pilot Interface's internal memory. Contact factory for resolution.

Bleed / Edump pass fail test

This tests proper operation of the Bleed and 2 EDump valves. The test checks the following:

- Bleed holds pressure (Valve Closes)
- Bleed releases pressure (Valve Opens)
- Edump1 holds pressure (Valve Closes)
- Edump1 releases pressure (Valve Opens)
- Edump2 holds pressure (Valve Closes)
- Edump2 releases pressure (Valve Opens)

Refer to Figure 16 below, the menu prompt for this test is shown.

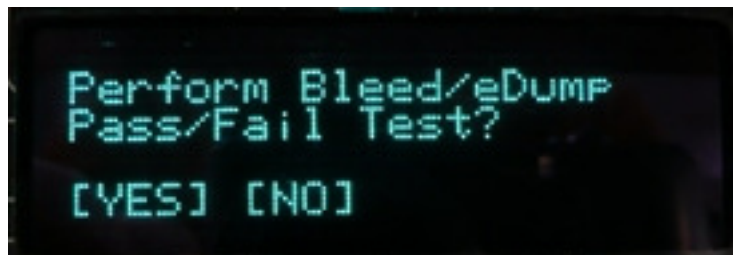


Figure 16 - Bleed / Edump Test Menu

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Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test. Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown. Refer to Figure 17 below.

**Caution: This test may move the gate doors so any hopper contents will be lost.
Verify that all personnel are clear.**

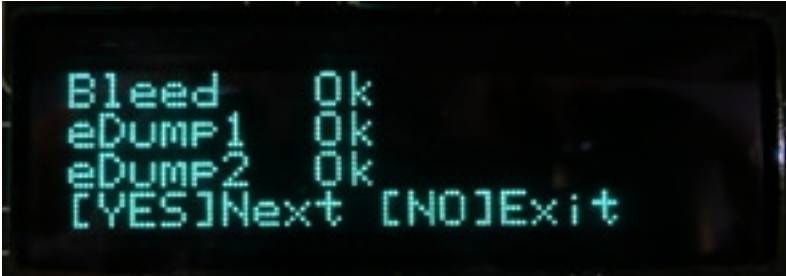


Figure 17 - Test results

If any of the three tested valves do not open (resulting in a significant pressure drop), the result for that test is reported as "FAIL" instead of "Ok".

Failure mode causes.

Failure of any of the following indicates that the valve did not mechanically open and no flow was detected. The Mon1, Mon2 test should have detected a disconnected valve so these errors could only indicate mechanical failure or blockage of flow.

Hydraulic pump rate & Bleed / Edump test

This test monitors the time it takes for the system to build and bleed pressure thru various valves. The test runs the pump more than normal and could drain the battery very quickly.

Refer to Figure 18 below, the menu prompt for this test is shown.

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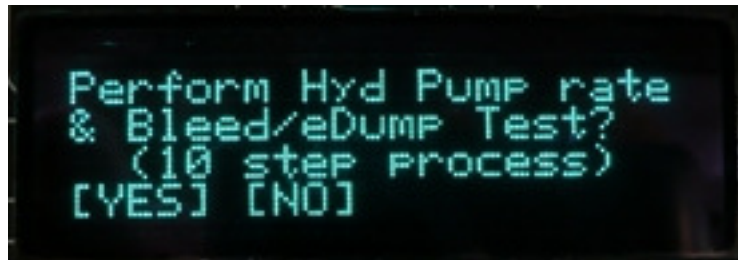


Figure 18 - Hyd. Pump rate & Bleed/Edump test

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test. Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown. Refer to Figure 19 below.



Figure 19 - Test results

This test is somewhat subjective. Temperature differences (which cause hydraulic fluid viscosity change) can alter the results. Temperature will not affect Dexron III ATF as much as typically used hydraulic fluids. The following is a brief description of the screen shown in Figure 19:

- pFull 22.0 indicates that it took 22 seconds to build hydraulic pressure from 0 PSI to 3000 PSI.
- Bleed 5.0 indicates that it took 5 seconds to relieve hydraulic oil pressure from 3000 PSI to 0 PSI through the bleed valve.
- eDmp1 10.2 indicates that it took 10.2 seconds to relieve hydraulic pressure from 3000 PSI to 0 PSI thru the eDump1 valve.
- eDmp2 10.2 indicates that it took 10.2 seconds relieve hydraulic pressure from 3000 PSI to 0 PSI thru the eDump2 valve.

The next three values measure pump cycle times to maintain between 2800 PSI and 3000 PSI.

- onCyc 2.2 indicates that the pump was on for 2.2 seconds.
- offCy 23.7 indicates that the pump was off for 23.7 seconds.

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- Duty% 8.6 indicates the pump duty cycle to maintain pressure between 2800 and 3000 PSI was 8.6%.

Failure mode causes.

There are no failure modes for this test. This only displays general information.

Continuous Hydraulic System Flush

This mode of operation is used to filter any contaminates in the system as well as to operate all of the valves in the system. This should be done any time the oil is changed or major service has been performed on the hydraulic system.

Refer to PS0030 - FRDS GEN2 - Continuous Hyd. System Flush process for detailed instructions on this item.

This is not a test but a procedure to flush and purge the Hydraulic system. Refer to "PS0030 - FRDS GEN2 - Continuous Hyd. System Flush process" for proper usage of this process.

Refer to Figure 20 below, the menu prompt for this test is shown.

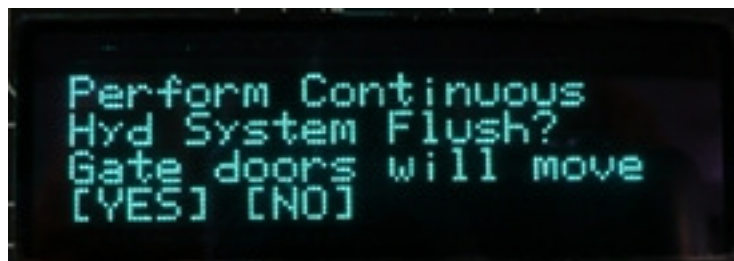


Figure 20 - Continuous Hyd. System Flush

Selecting "Yes" begins the test. Selecting "No" skips this test and moves on to the next Test.

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Failure mode causes.

There are no failure modes for this test. However the test can and will abort if pressure in the system exceeds or fails a set point during certain points of the test. These items that can halt the could indicate:

- Lack of hydraulic fluid in the system
- Failed valve connection
- Failed valve
- Mechanical obstruction of the gate box doors
- Failed pump or pump control

Gate Angle voltage test

This test is used to test the Gate angle sensor for the following:

- Proper zero degree voltage, fully closed reading
- Proper span degree voltage, fully open reading

The Gate angle sensor starts around 4 volts when fully closed and decreases as the gates move in the open direction.

Refer to Figure 21 below, the menu prompt for this test is shown.

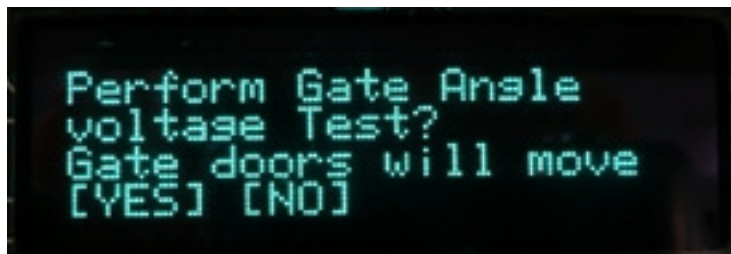


Figure 21 - Gate Angle voltage test menu

Selecting "Yes" begins the test. Selecting "No" skips this test and exits the System test menu.

**Caution: This test will move the gate doors so any hopper contents will be lost.
Verify that all personnel are clear.**

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Follow the additional prompts to begin the test. Once the test is completed, the test results window is shown. Refer to Figure 22 below.

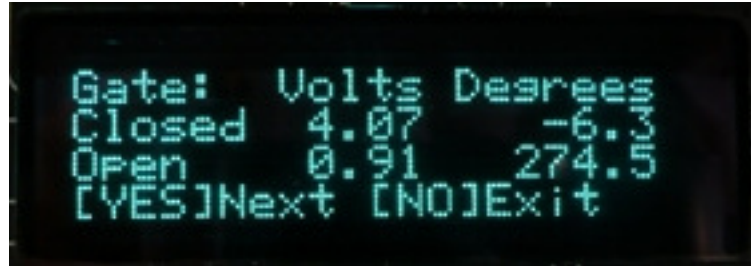


Figure 22 - Gate test results

“Closed” indicates the ‘Gate Closed’ voltage and the calculated door angle. This reading should be between a minimum of 3.9 volts and a maximum of 4.1 volts. The correct voltage for a gate angle of zero degrees is 4.00 volts.

“Open” indicates the ‘Gate Open’ voltage (fully opened) and the calculated door angle. This reading should be between a minimum of .60 volts and a maximum of 1.10 volts.

Failure mode causes.

- Faulty gatebox angle sensor
- Improper adjustment
- Broken wire
- Incorrect analog calibration values in the pilot interface

A voltage reading outside of the normal limits will display in inverse text. Refer to the following for repair, replacement or adjustment of the Gate angle sensor.

- 9001-0011 MAIN - GENII FRDS MANUAL
- PS0031 - FRDS GENII - Sensor Calibration
- Analog calibration values – Contact factory.

System Test Persistent Errors

The FRDS computer saves the results of the system tests to EEPROM so that an error is indicated anytime the system has failed to pass SysTest as expected. This feature has been added to alert the pilot that the system

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previously failed during the pilot initiated system test (SysTest) of the controls and hydraulics hardware.

Two error conditions can be detected and will persist even if power is removed from the system until the hardware is able to pass the system tests.

- "021_Panel Switch Err" - The switch test failed or was aborted by the pilot during the current or previous SysTest.
- "105_Systest Err" - Some hardware item failed during the current or previous SysTest.

Error number 021 indicates that either a panel switch error had occurred during SysTest, or that the operator had aborted the panel switch test without successfully completing the test by testing all possible switch positions.

Error number 105 indicates that **some** error had occurred during a previous run of SysTest, and a successful run of SysTest had not been completed since the error occurred.

Clearing Persistent SysTest Errors

While the RUN PUMP switch and the "Clear Errors" menu item of the "Maint" menu can be used to "clear all errors", these will **NOT** clear the persistent errors 021 and 105. These errors can only be cleared by successfully running a SysTest procedure.

To clear error "021_Panel Switch Err", perform either "PILOT (no doors)", "PILOT (ALL)", or "Maint SysTest" (see sections below for details).

- Make sure to cycle all switches during the switch test per Trotter Controls Document# TS-0005.
- Do not press the data wheel to exit the switch test until all of the switches have been properly cycled and the "illuminated block" indicators for each switch position have gone out as each switch is actuated.
- The error is automatically cleared once the switch test has been properly performed with no detected failures.

To clear error "105_Systest Err", perform the PILOT (ALL) system test.

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- Perform the "PILOT (ALL)" system tests per Trotter Controls Document# TS-0005.
- Do not exit the test or abort during the test sequence.
- The error is automatically cleared once the SysTest has been performed and the hardware is verified to operate properly.
- Note that performing a "Maint SysTest" or a "Pilot (no doors)" SysTest WILL NOT clear error 105. A successful PILOT (ALL) test is the only way to clear this error. Maint SysTest can be utilized to diagnose the cause of the system failure but will not clear the persistent error.

Conclusion of Tests

After conclusion of the test(s) the system returns the user to the Main Menu. This concludes the Maintenance System Tests.