

WATERS CORPORATION

ENGINEERING TEST SPECIFICATION AND PROCEDURE

COMPANY CONFIDENTIAL

SYSTEM/ASSEMBLY NAME: **1525 Personality PCB**

PART NUMBER AFFECTED: **21000018320**

TEST EQUIPMENT NAME: **Racal Freedom System Functional Tester**

TEST EQUIPMENT NUMBER: **TE82789**

TEST EQUIPMENT LOCATION: **GES Eltech, Malaysia**

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DOCUMENT NO.: 735000995 /REV. B

Page 1 of 10

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Table of Contents

I.	Introduction to the 1525 Functional Test	3
II.	Functional Test System Features.....	3
III.	Test Descriptions	3
1.	DC Voltages and Currents	3
2.	Communications on CPU 2000 RS232 Port	4
3.	Fan	4
4.	Data Bus Verification	4
5.	IEEE Address Switch Inputs	6
6.	Event Outputs	6
7.	Event Inputs	7
8.	IEEE Handshake (J5).....	7
9.	Pressure Transducer Input (J15).....	8
10.	Pressure Monitor Output (J5).....	8
11.	Motor Driver A and B Outputs	9

EQUIPMENT REQUIRED

Quantity	Part No	Description
1	TE82789	1525 Personality Bd. Racal Functional Test Fixture

DISPOSABLES REQUIRED

Quantity	Part Number	Description
NA		

REFERENCE DOCUMENTATION

Number	Description
810000183	Performance Specification
210000183	Board Assembly Drawing
710000183	Board Schematic

I. Introduction to the 1525 Functional Test

The 1525 Functional Test Fixture mounted to the Racal Freedom Functional Test System is designed to functionally test the Water's Corporation 1525 board.

The UUT should have had an in-circuit test performed prior to testing on this station. This will screen out most catastrophic board problems.

The system uses a vacuum fixture to pull the board down into a bed of nails for test access. Most, but not all, test points are accessed at the UUT's connectors.

II. Functional Test System Features

The fixture used on the Racal Freedom Tester has an ID system to identify the correct fixture in the test code. The fixture incorporates a CPU 2000 board with the latest 1525 firmware. For motor loads, two 1525 pump motors are installed in the fixture for motor drive A and B.

III. Test Descriptions

Note:

- 1) The UUT is powered up with one short connecting J9_15 to J9_16. The short enables the RS232 Communications port on the CPU2000 Board. The short must be present at all times. The UUT reads the shorts upon power up.
- 2) A carriage return is sent to the UUT before each test following Section 4.0 to clear the communications buffers.
- 3) Upon power up, the UUT may take up to 10 seconds to boot-up and allow RS232 communications.

1. DC Voltages and Currents

1.1. +5VA Voltage

5VDC is applied to J12 pins 7(+) and 8(-). The voltage is measured at those points to verify the proper voltage. Test Limits: Lo= 4.75VDC Hi= 5.25VDC

1.2. +5VD Voltage

5VDC is applied to J12 pins 1,3(+) and 2,4(-). The voltage is measured at those points to verify the proper voltage. Test Limits: Lo= 4.75VDC Hi= 5.25VDC

1.3. +24V Voltage

24VDC is applied to J12 pins 6,12(+) and 11(-). The voltage is measured at those points to verify the proper voltage. Test Limits: Lo= 23.5VDC Hi= 24.5VDC

1.4. PMP_PWR Voltage

24VDC is applied to J12 pins 9,10(+) and 5(-). The voltage is measured at those points to verify the proper voltage. Test Limits: Lo= 23.5VDC Hi= 24.5VDC

1.5. VR1_12VDC Voltage

The voltage is measured at the Output of VR1(+) and J12 pin 5(-) to verify the proper voltage. Test Limits: Lo= 11.00VDC Hi= 13.00VDC

1.6. +5VA Current

The current is measured via the HP power supply inquiry of the +5VDC power supplied as described above. Test Limits: Lo= 1mA Hi= 100mA

1.7. +5VD Current

The current is measured via the HP power supply inquiry of the +5VDC power supplied as described above. Test Limits: Lo= 50mA Hi= 1500mA

1.8. +24V Current

The current is measured via the HP power supply inquiry of the +24VDC power supplied as described above. Test Limits: Lo= 10.00mA Hi= 200.00mA

1.9. PMP_PWR Current

The current is measured via the HP power supply inquiry of the +24VDC power supplied as described above. Test Limits: Lo= -10.00mA Hi= 100.00mA

2. Communications on CPU 2000 RS232 Port

A carriage return is sent to the UUT via the RS232 console port J1 on the CPU2000 board (embedded in the fixture, J1_1=Tx, J1_2=Rx, J1_3=Gnd). The port is set default for 38400 baud, 1 stop, 8 bit, no parity, no flow control. A prompt from the CPU2000 is expected to verify the CPU2000's microprocessor is up alive and talking when interfaced with the UUT. The prompt expected is "CONSOLE:>".

3. Fan

The voltage is measured at connector J3 pins 1 and 2. +24VDC is expected at those points. Test Limits: Lo= 23.0VDC Hi= 25.0VDC

4. Data Bus Verification

A series of poke and peek commands are sent to verify the 16 positions of the data bus lines.

4.1. Data Bus 0-15 All Low

A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital low (0x0000).

4.2. Data Bus 0 High

A 'poke -w 0x500000 0x1' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0001).

4.3. Data Bus 1 High

A 'poke -w 0x500000 0x2' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0002).

4.4. Data Bus 2 High

A 'poke -w 0x500000 0x4' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0004).

4.5. Data Bus 3 High

A 'poke -w 0x500000 0x8' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0008).

4.6. Data Bus 4 High

A 'poke -w 0x500000 0x10' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0010).

4.7. Data Bus 5 High

A 'poke -w 0x500000 0x20' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0020).

4.8. Data Bus 6 High

A 'poke -w 0x500000 0x40' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0040).

4.9. Data Bus 7 High

A 'poke -w 0x500000 0x80' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0080).

4.10. Data Bus 8 High

A 'poke -w 0x500000 0x100' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0100).

4.11. Data Bus 9 High

A 'poke -w 0x500000 0x200' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0200).

4.12. Data Bus 10 High

A 'poke -w 0x500000 0x400' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0400).

4.13. Data Bus 11 High

A 'poke -w 0x500000 0x800' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x0800).

4.14. Data Bus 12 High

A 'poke -w 0x500000 0x1000' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x1000).

4.15. Data Bus 13 High

A 'poke -w 0x500000 0x2000' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x2000).

4.16. Data Bus 14 High

A 'poke -w 0x500000 0x4000' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x4000).

4.17. Data Bus 15 High

A 'poke -w 0x500000 0x8000' is sent through the CPU2000 to the UUT. A 'peek -w 0x500000' is sent to read the bus value. Expect to read a Digital high (0x8000).

5. IEEE Address Switch Inputs

The five IEEE address switches are tested in the open and closed state. Each input is shorted to ground one at a time and verified by a peek command to the CPU2000.

5.1. Switches 1 – 5 All Open

A 'peek -w 0x500004' is sent through the cpu2000 to the UUT. Expect to read all high (0x1F).

5.2. Switch 1 Low

A relay shorts J5_30 to J5_25,40. A 'peek -w 0x500004' is sent through the cpu2000 to the UUT. Expect to read switch 1 low (0x1E).

5.3. Switch 2 Low

A relay shorts J5_29 to J5_25,40. A 'peek -w 0x500004' is sent through the cpu2000 to the UUT. Expect to read switch 2 low (0x1D).

5.4. Switch 3 Low

A relay shorts J5_28 to J5_25,40. A 'peek -w 0x500004' is sent through the cpu2000 to the UUT. Expect to read switch 3 low (0x1B).

5.5. Switch 4 Low

A relay shorts J5_27 to J5_25,40. A 'peek -w 0x500004' is sent through the cpu2000 to the UUT. Expect to read switch 4 low (0x17).

5.6. Switch 5 Low

A relay shorts J5_26 to J5_25,40. A 'peek -w 0x500004' is sent through the cpu2000 to the UUT. Expect to read switch 5 low (0x0F).

6. Event Outputs

There are four event output drivers and one event select driver output. A poke command is sent to the CPU2000 and the digital output is measured at the specified output.

6.1. _Event 1 High

A 'poke -w 0x500006 0x0' is sent through the cpu2000 to the UUT. The output is measured at J5_33. Expected Digital High.

6.2. _Event 1 Low

A 'poke -w 0x500006 0x100' is sent through the cpu2000 to the UUT. The output is measured at J5_33. Expected Digital Low.

6.3. _Event 2 High

A 'poke -w 0x500006 0x0' is sent through the cpu2000 to the UUT. The output is measured at J5_34. Expected Digital High.

6.4. _Event 2 Low

A 'poke -w 0x500006 0x200' is sent through the cpu2000 to the UUT. The output is measured at J5_34. Expected Digital Low.

6.5. _Event 3 High

A 'poke -w 0x500006 0x0' is sent through the cpu2000 to the UUT. The output is measured at J5_35. Expected Digital High.

6.6. _Event 3 Low

A 'poke -w 0x500006 0x400' is sent through the cpu2000 to the UUT. The output is measured at J5_35. Expected Digital Low.

6.7. _Event 4 High

A 'poke -w 0x500006 0x0' is sent through the cpu2000 to the UUT. The output is measured at J5_36. Expected Digital High.

6.8. _Event 4 Low

A 'poke -w 0x500006 0x800' is sent through the cpu2000 to the UUT. The output is measured at J5_36. Expected Digital Low.

6.9. _Select_Event 4 High

A relay shorts J5_23 to J5_32. The output is measured at J5_37. Expected Digital High.

6.10. _Select_Event 4 Low

The input at J5_23 is in a normally pulled high state. The output is measured at J5_37. Expected Digital Low.

7. Event Inputs

There are two event inputs. A relay is used to bring a normally high input to ground. The result is measured by a response from the CPU2000.

7.1. Start_Inject Input

A 'set controller.istest true' is sent through the CPU2000 to the UUT. A relay shorts J5_49 to J5_48. The response string from the CPU2000 will be 'Start Command Received'.

7.2. Stop_Inject Input

A relay shorts J5_47 to J5_46. The response string from the CPU2000 will be 'Stop Method Command Received'.

8. IEEE Handshake (J5)

The IEEE is set to Primary Address:1, Secondary Address:0. An I command is sent to the UUT via the IEEE port J5. A response is expected from that command via port J5, to verify an active and functional port. Test Results: The return string should read "I01" along with some additional data.

9. Pressure Transducer Input (J15)

A resistor divider is placed across the pressure transducer input. The voltage is measured for a precision value. Then a High and Low value is calculated that the A/D circuitry (U20 and U21) must fall within. The formula is : $(5.0 \text{ V}) / (\text{meas. 5ANA}) * (\text{meas. VDC}) * (4008 \text{ Bits}) / (3.6927 \text{ VDC}) = \text{Calc. Bits}$. The High and Low are +/- 5 bits from the mean. A response from the CPU2000 provides the 'read' hex value voltage representation. It is converted to decimal representation.

9.1. Low Point Voltage

A ganged relay places a resistor divider across J15_3(+) to J15_1(A/D input) to J15_2,4(-). Where the input voltage is approximately 0.590VDC. The actual value is measured and a High and Low value is calculated from the formula above. For example, if the targeted 0.590VDC value was measured at J15_1 input, then the limits would be 640 Bits +/- 5, or rather 635 to 645 Bits. Test Limits: Lo= -5 Bits Hi= 5 Bits.

9.2. Mid Point Voltage

A ganged relay places a resistor divider across J15_3(+) to J15_1(A/D input) to J15_2,4(-). Where the input voltage is approximately 1.887VDC. The actual value is measured and a High and Low value is calculated from the formula above. For example, if the targeted 1.887VDC value was measured at J15_1 input, then the limits would be 2048 Bits +/- 5, or rather 2043 to 2053 Bits. Test Limits: Lo= -8 Bits Hi= 8 Bits.

9.3. High Point Voltage

A ganged relay places a resistor divider across J15_3(+) to J15_1(A/D input) to J15_2,4(-). Where the input voltage is approximately 3.681VDC. The actual value is measured and a High and Low value is calculated from the formula above. For example, if the targeted 3.681VDC value was measured at J15_1 input, then the limits would be 3995 Bits +/- 5, or rather 3990 to 4000 Bits. Test Limits: Lo= -12 Bits Hi= 12 Bits.

10. Pressure Monitor Output (J5)

Note: This test is contingent on the Pressure Transducer Input Test above passing.

A resistor divider is placed across the pressure transducer input. The corresponding A/D output value from U20 and U21 is read from the CPU2000 communications. Then an output value is calculated for the D/A U19 to produce. The board performance specification details the circuit specifications used here. The formula is: $(\text{meas. Bits converted to decimal}) * (8124 \text{ PSI full scale}) / (4008 \text{ Bits}) = (\text{calculated PSI})$. Then adjusting for offset, $(\text{calculated PSI}) - (924 \text{ PSI offset}) - (173 \text{ PSI offset from 87 bit value}) = (\text{pressure PSI})$. Then converting to VDC, $(\text{pressure PSI}) * (2.0475 \text{ VDC}) / (7200 \text{ PSI full scale}) = (\text{calculated VDC})$. The High and Low are +/- 0.05 VDC from the mean. The voltage output is measured at J5_42(+) and J5_43(-).

10.1. Low Point Voltage

A ganged relay places a resistor divider across J15_3(+) to J15_1(A/D input) to J15_2,4(-). Where the input voltage is approximately 0.590VDC. The actual A/D value is read and a High and Low

value is calculated from the formula above. For example, if the targeted 0.590VDC value was read to be '0x280' or 640 Bits input, then the limits would be 0.0568 VDC +/- 0.05, or rather 0.0068 VDC to 0.1068 VDC.

Test Limits: Lo= -0.05 VDC Hi= 0.05 VDC

10.2. Mid Point Voltage

A ganged relay places a resistor divider across J15_3(+) to J15_1(A/D input) to J15_2,4(-). Where the input voltage is approximately 1.887VDC. The actual A/D value is read and a High and Low value is calculated from the formula above. For example, if the targeted 1.887VDC value was read to be '0x800' or 2048 Bits input, then the limits would be 0.86848 VDC +/- 0.05, or rather 0.81848 VDC to 0.91848 VDC.

Test Limits: Lo= -0.05 VDC Hi= 0.05 VDC

10.3. High Point Voltage

A ganged relay places a resistor divider across J15_3(+) to J15_1(A/D input) to J15_2,4(-). Where the input voltage is approximately 3.681VDC. The actual A/D value is read and a High and Low value is calculated from the formula above. For example, if the targeted 3.681VDC value was read to be '0xF9B' or 3995 Bits input, then the limits would be 1.9960 VDC +/- 0.05, or rather 1.946 VDC to 2.046 VDC.

Test Limits: Lo= -0.05 VDC Hi= 0.05 VDC

11. **Motor Driver A and B Outputs**

A 1525 pump motor is connected to each motor driver output. The motor's output shaft is connected to an encoder wheel and encoder circuit. The output of the encoder circuit is a square wave with a frequency dependent on the speed of the motor shaft. This test commands a motor output on then checks for a square wave output frequency. The DMM takes a burst measurement, then the software calculates the number of negative pulses captured.

11.1. Motor Drive A

11.1.1. Motor Drive A Enable

A "poke -w 0x500006 0x5" command is sent to the CPU2000. The motor is expected to initialize and no errors sent back in response. Only the prompt "CONSOLE:>" is expected to be returned.

11.1.2. Motor Drive A ON

A "poke -w 500000 0x300" command is sent to the CPU2000. The motor is expected to rotate and provide a square wave output frequency from the encoder wheel.

Test Limits: Lo= 8 Pulses Hi= 13 Pulses.

11.1.3. PMP_PWR A_Motor Current

The current is measured via the HP power supply inquiry of the +24VDC power supply.

Test Limits: Lo= 400.00mA Hi= 1300.00mA

11.2. Motor Drive B

11.2.1. Motor Drive B Enable

A “poke –w 0x500006 0xA” command is sent to the CPU2000. The motor is expected to initialize and no errors sent back in response. Only the prompt “CONSOLE:>” is expected to be returned.

11.2.2. Motor Drive B ON

A “poke –w 500002 0x300” command is sent to the CPU2000. The motor is expected to rotate and provide a square wave output frequency from the encoder wheel.

Test Limits: Lo= 8 Pulses Hi= 13 Pulses.

11.2.3. PMP_PWR B_Motor Current

The current is measured via the HP power supply inquiry of the +24VDC power supply.

Test Limits: Lo= 400.00mA Hi= 1300.00mA

12. Seal Wash (J14)

A HyperTerminal command sets the seal wash output toggling low for 250ms every 1 second. The DMM takes a burst measurement, then the software calculates the results.

12.1. Seal Wash Output Off

The voltage is measured at J14_1 (+) and J14_2(-). The output is expected to be at zero vdc.

Test Limits: Lo= -1.0 VDC Hi= 1.0 VDC

12.2. Seal Wash Output On

A “swpprime” command is sent to the CPU2000. The output is expected to toggle low 250ms every 1 second. A DMM burst measurement is analyzed to determine if the output is pulsing.

13. Degasser Handshake (J10, J11)

A HyperTerminal command, “getdgpress” is sent to the CPU2000. A known good degasser board is mounted inside the tester. A successful handshake will verify if the degasser board has all its uut supplied power and communication lines correct.

Test Results: The HyperTerminal response expected is “pressure = -1.000000”. Note: “pressure = 0.000000” is a failure response.