

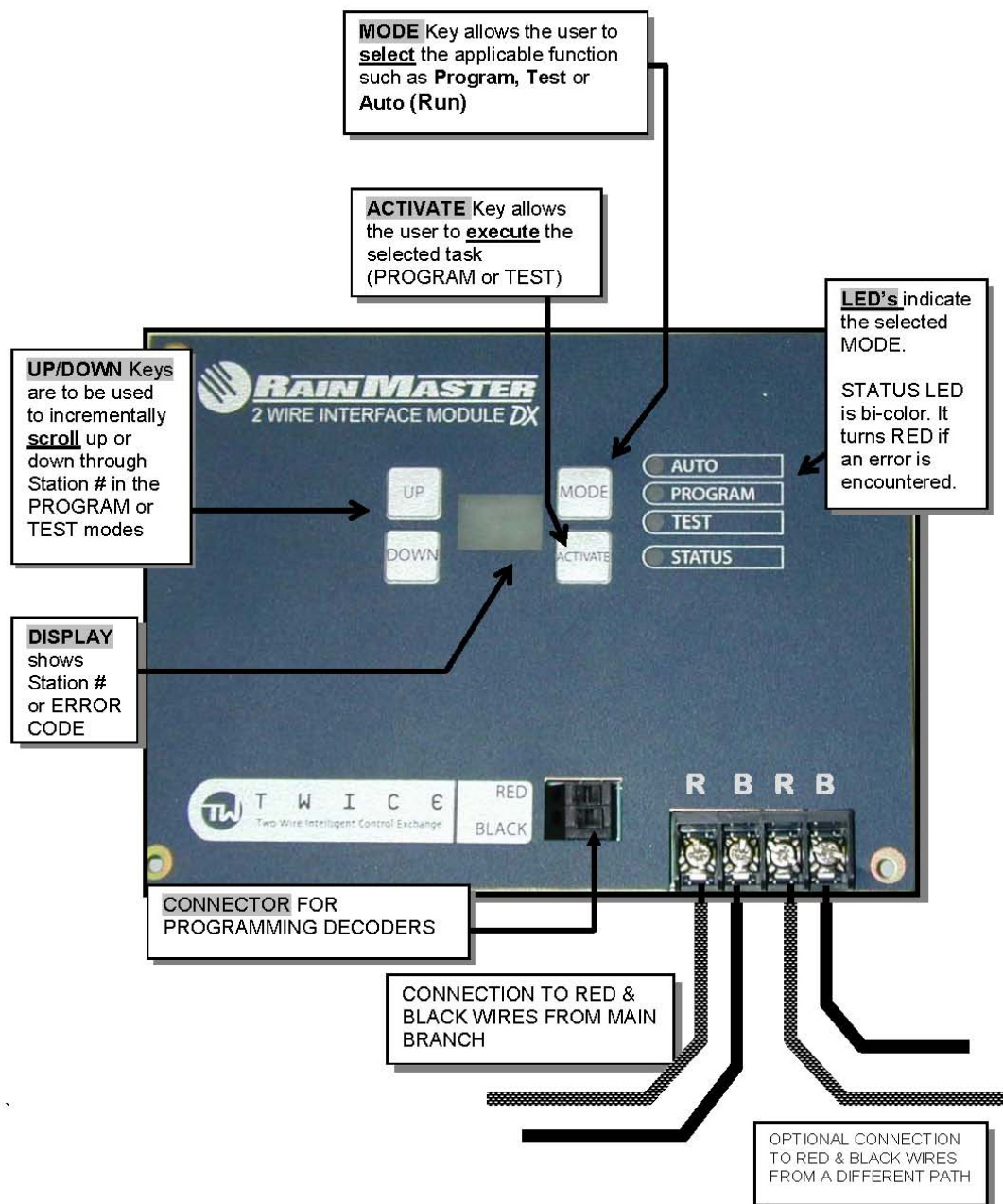
## Operation

### Overview

This interface module will provide an easy way to add a 2 wire communication capability to the RainMaster **DX2** controller. The module provides a seamless transition from conventional wiring (wire per valves plus common) to a 2 wire topology with valve decoders. The module will interpret controller valve on/off commands to the corresponding 2 wire protocol to activate the corresponding station valves.

### User Interface

#### Layout



## 4.0 TWICE (TWO-WIRE) CONTROLLER CAPABILITIES

The controller shall utilize a two-wire connection path to each station decoder.

- The Two-Wire path shall support a variety of connectivity configurations including: single path, dual path, loop, and grid configurations, and combinations thereof.
- The communications along the two-wire path shall be bi-directional between the controller and each decoder.
- The TWICE Interface module shall confirm station ON commands by receiving an appropriate response from the corresponding station decoder.
- Station decoders shall intelligently monitor the electrical current at any solenoid and report any short or open circuit back to the TWICE interface module.
- The TWICE interface module shall display diagnostic error conditions to the operator. These diagnostic errors shall include:
  - E1 - No station decoder found (cannot communicate from the TWICE module to the designated station decoder)
  - E2 - Short circuit on the two wire path
  - E3 - Open circuit of a station solenoid
  - E4 - Over current due to shorted solenoid
  - E5 - Station decoder communication error
  - E6 - High temperature shutdown
  - E7 – Decoder Programming Failure
- The TWICE Interface module shall allow the user to program the station number into any decoder.
- The TWICE Interface module shall allow the user to read and display the station number which has been programmed into any decoder.
- The TWICE Interface module shall allow the user to test the entire two wire network of decoders and report any error(s) status back to the operator. Errors shall be reported with appropriate error codes as well as with a STATUS diagnostic LED.
- THE TWICE Interface shall allow the user to test any single station for proper operation. Any error condition shall be reported in the display. When the station test is successful, the display shall report the firmware version of the decoder followed by the electrical current drawn by the solenoid.
- The TWICE Interface module shall automatically display the STATUS of each valve via a diagnostic LED when operating in the AUTO mode. Stations that are irrigating properly (communicating with the appropriate decoder and having a nominal electrical current draw on it solenoid) will illuminate the STATUS led with a green color. Otherwise the station has an error and will illuminate the STATUS led with a red color. When no irrigation stations are on, the display will display any station(s) which may have had an error condition. The display will rotate with erred stations until the operator clears them.
- Station decoders shall be available in 1, 2, and 4 output varieties.
- The DX-TWICE interface module shall allow for a maximum of 48 stations, two Master Valves, one pump and one N.O. Output.
- The maximum distance from the controller to any decoder shall be limited to 5,000 feet. This distance assumes usage of Rain Master's two-wire 14 (AWG) gauge cable, RMIS Part No. TW-CAB-14.
- The maximum distance for the two-wire loop configuration, shall not exceed 10,000 feet.
- The maximum distance between any lightning arrestors/ground rods shall be no more than 600 feet.

## DECODER NUMBER ASSIGNMENT

The TWICE DX2 Module has pre-allocated ranges for various station numbers as follows:

Decoder #1- 48 –VALVES

Decoder # 96: Pump

Decoder #97 N.O. Output

Decoder # 98: Secondary Master Valve

Decoder #99 Primary Master Valve

### Summary

	<b>AUTO</b>	<b>PROGRAM</b>	<b>TEST</b>
<b>DISPLAY</b>	<ul style="list-style-type: none"> <li>○ “- -“ is the “idle” display when no stations are running and there are no errors</li> <li>○ If active stations, then ½ second blank, 2 second station number with status LED (Red if there are errors and Green if no errors)</li> </ul>	<ul style="list-style-type: none"> <li>○ “E1” displayed until a decoder is attached – two second blink to look for decoder</li> <li>○ “00” is decoder that is un-programmed</li> <li>○ Station number if decoder is programmed</li> <li>○ Station number, then error code</li> </ul>	<ul style="list-style-type: none"> <li>○ Station Number to test (0 to 36, and 99)</li> <li>○ After test is run, ½ second blank, 2 second station number, 2 second decoder version or error code (E1), and if not E1 error, 2 second valve current or error code</li> </ul>
<b>MODE Key</b>	<ul style="list-style-type: none"> <li>○ Change to PROGRAM if not active</li> </ul>	<ul style="list-style-type: none"> <li>○ Change to TEST</li> </ul>	<ul style="list-style-type: none"> <li>○ Change to AUTO</li> </ul>
<b>UP Key</b>	<ul style="list-style-type: none"> <li>○ Nothing</li> </ul>	<ul style="list-style-type: none"> <li>○ Increment station number</li> </ul>	<ul style="list-style-type: none"> <li>○ Increment station number</li> </ul>
<b>DOWN Key</b>	<ul style="list-style-type: none"> <li>○ Nothing</li> </ul>	<ul style="list-style-type: none"> <li>○ Decrement station number</li> </ul>	<ul style="list-style-type: none"> <li>○ Decrement station number</li> </ul>
<b>ACTIVATE Key</b>	<ul style="list-style-type: none"> <li>○ If not active, clear the displayed error code</li> </ul>	<ul style="list-style-type: none"> <li>○ Program decoder to specified station number</li> </ul>	<ul style="list-style-type: none"> <li>○ Run test on station number, or test all stations if station number is zero</li> </ul>
<b>ACTIVATE Key – 2 sec. Hold</b>	<ul style="list-style-type: none"> <li>○ Clear all station error messages</li> </ul>	<ul style="list-style-type: none"> <li>○ Program decoder to specified station number</li> </ul>	<ul style="list-style-type: none"> <li>○ Run test on station number, or test all stations if station number is zero</li> </ul>
<b>UP + DOWN Keys</b>	<ul style="list-style-type: none"> <li>○ TWICE firmware version number</li> </ul>	<ul style="list-style-type: none"> <li>○ TWICE firmware version number</li> </ul>	<ul style="list-style-type: none"> <li>○ TWICE firmware version number</li> </ul>
<b>ACTIVATE + UP Keys</b>	<ul style="list-style-type: none"> <li>○ Show TWICE temperature (Centigrade)</li> </ul>	<ul style="list-style-type: none"> <li>○ Show TWICE temperature (Centigrade)</li> </ul>	<ul style="list-style-type: none"> <li>○ Show TWICE temperature (Centigrade)</li> </ul>

## **Modes**

There are three operating modes of the DX-TWICE module.

### **AUTO**

- Interprets the valve ON/OFF states of the controller and activates corresponding decoders on the 2 wire system.
- When a station is turned on the station address will be displayed until the station is turned OFF. The Status LED will indicate error conditions with RED, and no errors with GREEN.
- When multiple stations are turned on, the station addresses will be displayed, rotating every two seconds, until turned OFF, with a ½ second blank at the beginning of each station number. The Status LED will indicate error conditions with RED, and no errors with GREEN.
- After a program is finished, all malfunctioning stations will be displayed on the LED two-digit display with a ½ second blank at the beginning of each station number, the station number for 2 seconds followed by a corresponding error code for 2 seconds. This sequence will continue until the activate button is pressed to clear the error code, or until the fault condition clears itself (next water cycle).
- If more than one station has malfunctioned then each station along with the corresponding error code will be displayed sequentially in a running loop.
- In the Auto mode the Activate button will clear the error code currently displayed. Therefore each Fault code must be cleared individually.
- A two-wire over current error will be displayed with a 60 second count-down timer, alternating on ½ second intervals. This error message will be displayed continually until the over current error is cleared. After this 60 second interval, the controller can continue to activate stations, providing the 2 wire does not result in another over-current condition. This error code must be cleared by the operator.
- An over temperature condition will cause the TWICE module to shut down with the error code being continually displayed until the temperature drops to a save level.

*Note: If the controller fails to refresh the station state in the TWICE module within two minutes, all stations will be shut off until the controller sends updated station state information. This is preventative so that stations cannot run continually if the controller communicate with the TWICE module fails.*

### **PROGRAM**

- The program function can only be enabled when the system is idle.
- When program mode is enabled the PROGRAM LED will energize and the display will show an "E1" code until a decoder is connected.
- The TWICE module will poll the programming outlet for a decoder every two seconds, causing a short blink of the displayed code.
- When a decoder is connected to the outlet, the display will change based on the state and status of the decoder:
- If the decoder is not programmed, the display will show "00".
- If the decoder has been programmed, the display will show the decoder station number, such as "23".
- If the decoder causes an over current condition, the display will show "E 2".

- If the decoder cannot communicate reliably, the display will show “E 5”.
- With a decoder connected the up/down arrows are used to select a new station number (or sequence of station numbers) for the decoder.

*Note: A two-valve decoder will use two consecutive addresses and a four-valve decoder will use four consecutive station numbers (selecting address 17 will result in a two-valve decoder using station numbers 17 and 18).*

*Note: a system with decoders that have duplicate station numbers will likely water multiple stations at the same time (not guaranteed) and will have communication errors on the duplicate stations.*

- Pressing the ACTIVATE button will send the new station number (or sequence of station numbers) to the decoder.
- If the programming is successful the STATUS LED will light green.
- If unsuccessful, the STATUS LED will light red, and a corresponding error code will be displayed: E1, E2, E5, or E7.

*Note: if a decoder repeatedly returns E5 and/or E7, it is broken and cannot be used (return for failure analysis)*

## **TEST**

There are two tests: (1) test all valves and (2) test a single valve.

- The test function can only be enabled when the system is idle.
- When test mode is enabled the TEST LED will energize and the display will show a station number. The initial station number will be ‘00’, which is used to indicate all stations.
- The station number can be changed with the UP and DOWN buttons.
- If the test is successful the STATUS LED will light green.
- If unsuccessful, the STATUS LED will light red.
- A decoder test consists of the following:
  - Power up the 2 wire
  - Read version of decoder
  - Activate valve on decoder and take voltage/current reading
  - Turn valve off and power down the 2 wire
- Pressing the ACTIVATE button with a station number of zero, will perform a test on all stations.
- All stations with errors will be displayed after the test is completed, with their corresponding error code.
- Pressing the ACTIVATE button with a non-zero station number will perform a test on the specified decoder station.



**Test Results**

Result	1 <sup>st</sup> Sequence ½ sec	2 <sup>nd</sup> Sequence 2 sec	3 <sup>rd</sup> Sequence 2 sec	4 <sup>th</sup> Sequence 2 sec
<b>No Errors</b>	Blank	Station Number "17"	Amperage "24" = 0.24 A	Decoder Version "3.6"
<b>E1</b>	Blank	Station Number	(skip)	"E1"
<b>E2</b>	Blank	60 second count down	(skip)	(skip)
<b>E3</b>	Blank	Station Number	"C3"	Decoder Version
<b>E4</b>	Blank	Station Number	"C4"	Decoder Version
<b>E5</b>	Blank	Station Number	"C5"	Decoder Version
<b>E6</b>	Blank	"C6"	(skip)	(skip)

**Error Code Table**

The following codes are displayed on the two-digit display when errors are encountered, and before they are cleared.

Code	Description	Cause/Action
<b>E1</b>	No decoder found (not able to perform any communications)	Cause: wiring error, bad decoder, bad TWICE, no decoder when in program mode  Action: check wiring, move decoder close to TWICE, replace decoder, replace TWICE
<b>E2</b>	Two wire over current	Cause: shorted wiring, wire connected to dirt, improper connections, failed decoder (shorted), valve connected directly to two-wire. A shorted condition for more than ¼ second will cause this error.  Action: troubleshoot wiring problems by 1) undo the last thing you did when it worked before, break the two-wire network in half to isolate the problem (then in half again as needed)...
<b>E3</b>	Open circuit at solenoid	Cause: the decoder detects no solenoid current when activated, broken decoder, open solenoid, poor connections/wiring between decoder and solenoid.  Action: check decoder to solenoid connections, ohm solenoid, replace solenoid, replace decoder ...

Code	Description	Cause/Action
E4	Short Circuit at solenoid	Cause: decoder measures excessive current in solenoid, shorted or failed solenoid, improper connections, solenoid wires connected to two-wire, ... Action: check wiring, replace solenoid, replace decoder ...
E5	Decoder Communication Error (a valve-on command may be successful, but a read valve power command fails)	Cause: poor quality wiring between TWICE and decoder (length, connections, high resistance, two-wire connected to dirt), failing decoder, failing TWICE (gives errors on "all" decoders), multiple decoders with same address, ... Action: test two-wire quality (end-to end resistance, resistance to earth ground, isolate decoder in error (test close to TWICE), check for duplicate addresses, valve wire in dirt/water, ...
E6	High Temperature Shut Down	Cause: high temperature (85° C board), failed temperature sensor, ... Action: shade controller, replace TWICE, install AC, ...
E7	Decoder Programming Failure.	Cause: multiple decoders at one time, decoder removed before program cycle completes, failed decoder (EEPROM), failing TWICE, ... Action: retry, replace decoder, replace TWICE ...

### Errata

This identifies needed firmware changes in the TWICE module and valve decoders.

Change Needed	Effort/Risk
<input type="radio"/> None	<input type="radio"/>

### Issues

- The programming pins have polarity...this needs to be taken care of on the front screen (red wire on top, black wire on bottom).

Additional information may be found in the DX-TWICE instruction manual. It can be downloaded as a PDF from the Rain Master website: [www.rainmaster.com](http://www.rainmaster.com)

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