

RM2 IRRIGATION CONTROLLER

User and Installation Manual

V1.10d

August 2018



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Warnings & Cautions:

1. Mains Voltages may be present in the RM2 enclosure
2. A separate earth for lightning protection is required for the BT2 Translators
3. Use only the approved transformers – one for each BT2

4. In high temperature environments the output of the BT2 is de rated when commissioning the system
5. It is important that the maximum BT2 2 wire line current is not exceeded i.e. too many valves on at the same time
6. To ensure correct operation of the BT2 that the incoming supply must be free of harmonic distortion and transients. The use of a line voltage analyser may be required if in doubt.
7. The lightning warranty on decoders or DIAS is not valid if the lightning grounding system is not installed as defined in this document.

RM2 Introduction



The RM-2 Rainmaker irrigation controller provides a solution for large scale irrigation applications. Providing both remote connectivity and water balance control, the RM-2 is a very powerful and scalable irrigation controller. The RM-2 comes with both an Ethernet and an integrated 3G modem providing remote access via your smart phone, tablet, PC or centralised monitoring system. The unit is configured using its own web interface, enabling the user to setup watering stations and program times.

Benefits

- 25% - 40% Savings with Water Balance control
- Remote Monitoring using PC, Smartphones and Tablets over GPRS,3G Wi-Fi, Radio & Satellite
- Water Balance & Timed irrigation
- Up to 508 2 wire decoder stations
- Decoders proven in over 300,000 stations in 20 years
- Centralised control will work with most SCADA Systems
- Multi language support

Market Sectors

- Agriculture Irrigation
- Large Scale City Watering
- Golf Irrigation

Web Page Configuration

The RM-2 has an integrated web server allowing users to configure the RM-2 using a standard web browser. This means it does not need to rely on a 3rd party server, with its associated additional fees. The web interface will display historic alarms and the current status of each watering station. The web interface allows the user to test individual or groups of stations by using the manual override feature. This is very useful during the commissioning phase of the project.

Installation

Site Survey

It essential that a full site survey is carried before any installation is carried out.

- Mains Supply (230VAC) – It is recommended to check integrity of Mains supply to RM2 enclosure. This can be carried out using a Line voltage tester. Spikes and harmonics must not be present.
- RM2 environment Temperature - Calculate the maximum temperature that the RM2 will be exposed to. We recommend the use of air conditioning or sun shade in high ambient temperatures.

High temperatures will de-rate the maximum BT2 2 wire current.

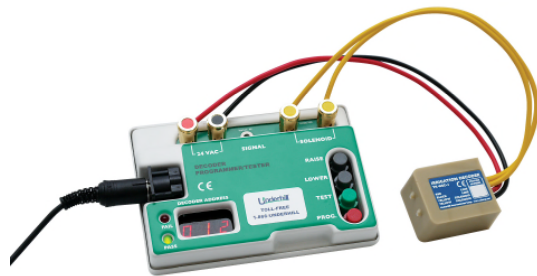
- Site Security – ensure adequate will be achieved for the RM2 enclosure

Decoder – Programming

The RM-2 irrigation controller works best if the decoders are numbered with the low addresses nearest the controller increasing as they get further away.

Testing a Decoder

- All decoder manufacturers offer a decoder tester/programmer
- The tester may be used to enter the decoder's station number before installation
- To be of use, the tester has to be low cost or not enough will be available for each crew
- Some decoder controllers have a built-in decoder tester/programmer.



Connecting:

To connect a wire to the programmer, press the top of the terminal and feed the bared wire into the hole at the front. Releasing the terminal will grip the wire. Connect the decoder's *red* wire to the *red* terminal marked '24v A.C.' Connect the decoder's *black* wire to the *black* terminal marked '24v A.C.' Connect the decoder's *solenoid output* wires to the two yellow terminals marked 'SOLENOID'. With the Tonick multi-solenoid decoders, the wires are colour coded with a common *brown* wire as the solenoid return: Yellow=channel 1, Orange=channel 2, Green=channel 3 and Violet=channel 4. Please ensure the unused wires are not touching each other.

Programming:

With the desired pair of solenoid wires connected, press the grey 'Raise' or 'Lower' buttons to alter the red displays to the address to be programmed. Holding the button down will cause the numbers to change more rapidly.

TK-DEC-1/PC decoders TW-TK-DEC-1 may be programmed to addresses between 1-63. Tonick TW/2W, TW/NT and DIAS to between 1-127

When the desired address is displayed, press the red '*Program*' button. After three seconds either the '*Pass*' (green) or '*Fail*' (red) lamps will illuminate. If passed, the decoder will have been programmed and tested for the correct switching response at that address.

When programming Tonick multi-solenoid decoders, change over the solenoid wire, leaving the brown in place and repeat for the other solenoid outputs. The indelible pen supplied can be used to write the address on the decoder.

Notes on programming:

If during programming, the displays dim then go back to zero, there is a shorted solenoid output. Check the unused outputs of the Tonick multi-solenoid decoder. Make sure no wires are touching.

Addresses 000 cannot be programmed into the decoders.

Avoid programming identical addresses into a Tonick multi-solenoid decoder, only one output will respond to a subsequent switch on/off command.

Testing:

Both TK-DEC-1/PC and Tonick decoders can be tested. Factory default is address 1 for single output and correspondingly 1, 2, 3, 4 for a Tonick TW/2W-4 quad output decoder

With the decoder connected (as previously described), press the green '*Test*' button. All possible addresses will be cycled in quick succession until one responds. The displays will stop, showing the address programmed (or set on the switches) and the green '*Pass*' lamp will illuminate.

If there is no response from the decoder, the displays will show 127 and the red '*Fail*' lamp will illuminate.

If a decoder is attached and the display shows 000 with the '*Pass*' lamp illuminated, it means the decoder output is working but has not yet been programmed with an address.

If during the testing the displays dim then go back to zero, there is a shorted solenoid output. Check the unused outputs of the Tonick multi-solenoid decoder. Make sure no wires are touching.

Decoder – Installation & Cabling

Buried cables installation

The general method of installation of electrical cables shall meet the following:

1. Cables shall not be excessively pulled, stretched, excessively bound, nor yanked during installation. Cables shall be laid on a firm even trench bed so as to be evenly supported throughout their entire length. Care shall be taken to ensure that cables are not cut, or scraped during installation;
2. A one-meter slack shall be provided by means of a loop laid horizontally for every 100 m of cable laid and at each trench tee or 90° bend. A minimum slack of 1 m shall be provided at each connection to allow the connection to be raised above ground for inspection;
3. cable connections shall always be housed in an access chamber;
4. depth: Cables shall not normally be laid above the pipe but on the bottom of the trench alongside the pipe;
5. Installation in common trench: A minimum distance of 0,3 m shall separate the cable carrying low voltage power from the extra low voltage cable. Where this is the case the extra low voltage cable may be above the pipes
6. Road crossing: Cable shall be protected in conduit of appropriate diameter and material according to the diameter and number of cables to protect. The conduits shall be protected against crushing by backfill material compacted as recommended by the statutory authorities;
7. Bridge crossing on private properties: Cable shall be protected in conduits of appropriate diameter and material according to the diameter and number of cables to protect. The conduit shall be securely fastened on to the structure. Conduits shall be sufficiently long to protect the cables leaving and entering the trenches;
8. As-laid plan: During the cables installation, cables route and location of the electrical connections shall be accurately recorded on the as laid plan.

Decoder – Installation & Cabling continued

Wire Jointing:

Joints on the 2Wire path shall be water tight and each should have a strain relief

The following illustrations describe non-exclusive examples.

Wire Joiners & Tools

Field cable life and immunity from lightning damage are enhanced by making waterproof joints. The DBY-style grease filled cable sleeves protecting crimped joints offer the fastest and most efficient way of making waterproof joints that are easy to service in years to come.

The HITUF cable stripper removes the outer jacket without nicking the inner conductor insulation

The Crimp Tool joins wires together using the PL5/10/16 crimps. When inserted in the grease-filled sleeve, each joint is waterproof but easily accessible for voltage measurement.

The Wire Stripper effortlessly removes the inner conductor insulation.

WS

CT

HTS

DBY-MED

DBY-SMALL

PL16

PL10

PL5

ordering

CONNECTORS	
DBY-MED	Medium grease filled sleeves
DBY-SMALL	Small grease filled sleeves
PL16	Jumbo crimps, uninsulated
PL10	Large crimps, uninsulated
PL5	Small crimps, uninsulated
TOOLS	
CT	PL5/10/16 Crimp Tool
HTS	HITUF Cable Stripper
WS	Wire Strippers

Data Sheet



DBY Direct Bury Splice Kit

Application:

Use part DBY, which includes a Scotchlok[®] Y Electrical Spring Connector, to electrically connect two or more pre-stripped copper wire ends in a pigtail application and moisture seal the connection for direct burial.

Wire:

Common AWG wire combinations
(Copper wire only, sol or str)

2-3 # 16	1 # 18 to 1-2 # 14
2-3 # 14	1 # 18 to 1-2 # 12
2 # 12	1 # 16 to 1-2 # 12
	1 # 14 to 1 # 12

Consult technical service for complete list of wire combinations.

Construction:

Connector –	steel spring , shell , flame retardant pvc insulator
Tube –	polypropylene
Gel –	thixotropic calcium organic complex

Application Data:

Application Temperature:	32°F to 120°F (0°C to 40°C)
Operating Temperature:	221°F to -40°F (105°C to -40°C)

Voltage Rating: 30 Volts

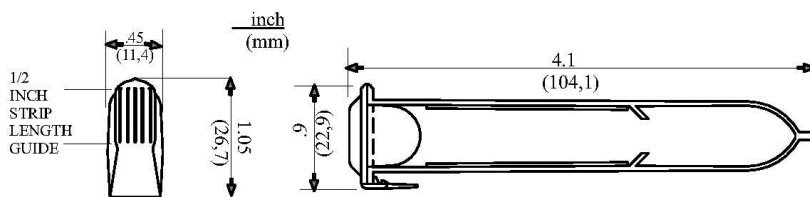
Not for use in direct ultraviolet exposure

Weight of one kit: (2 splices) .0612 lbs
(27,92gm)

Storage: Do not store above 120°F (49°C)

Engineering Specification:

The device, 3M Brand DBY Direct Bury Splice Kit, shall splice and effectively moisture seal two or more conductors. The electrical connector shall be a Scotchlok[®] Y. The device shall be installed per manufacturer's instructions and all applicable codes.



IMPORTANT NOTICE TO PURCHASER:
All statements, technical information and recommendations related to the Seller's products are based on information believed to be reliable, but the accuracy or completeness thereof is not guaranteed. Before utilizing the product, the user should determine the suitability of the product for its intended use. The user assumes all risks and liability whatsoever in connection with such use.

All statements or recommendations of the seller which are not contained in the Seller's current publications shall have no force or effect unless contained in an agreement signed by an authorized officer of the Seller. The statements contained herein are made in lieu of all warranties express or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose which warranties are hereby expressly disclaimed.

SELLER SHALL NOT BE LIABLE TO THE USER OR ANY OTHER PERSON UNDER ANY LEGAL THEORY, INCLUDING BUT NOT LIMITED TO NEGLIGENCE OR STRICT LIABILITY, FOR ANY INJURY OR FOR ANY DIRECT OR CONSEQUENTIAL DAMAGES SUSTAINED OR INCURRED BY REASON OF THE USE OF ANY OF THE SELLER'S PRODUCTS.

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Austin, Texas 78726 – 9000

11 / 1 / 91



Decoder – Installation & Cabling continued

WATERPROOF WIRE CONNECTORS

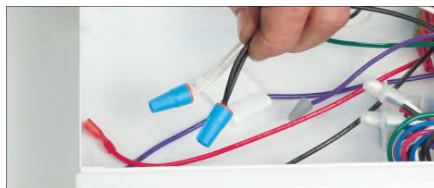
SA-101 WIRE CONNECTOR		STOCK NO	STANDARD SHIPPING UNIT
	<p>Our connectors have less than .1% voltage leakage to ground, the lowest in the industry. This means by keeping moisture out and electricity in you will reduce your service call-backs and increase system efficiency.</p> <ul style="list-style-type: none"> • Wire range: 9 #20 to 2 #14 w/2 #18. • Zero failure rate with over 25,000,000 in use worldwide. • Pre-filled with XR compound, or empty. • Fast, reliable splicing - reducing labor costs. • Your choice of wire nuts or crimp. (sleeves) • UV resistant. 	SA101	2,400
SA-102 WIRE CONNECTOR		STOCK NO	STANDARD SHIPPING UNIT
	<p>Has all the benefits of the SA101, but designed to accommodate up to three 10-gauge UF wires. Ideal for low voltage lighting cable. Note that our connectors conveniently work with crimp sleeves or wire nuts.</p> <ul style="list-style-type: none"> • Wire range: up to 3 #10. • Zero failure rate after 18 years in use. • Works great for low voltage lighting. • Pre-filled with XR compound, or empty. • Your choice of wire nuts or crimp. (sleeves) • UV resistant. 	SA102	2,400

DRYCONN®
WATERPROOF CONNECTORS



PRODUCT SPECIFICATIONS & MEASUREMENTS

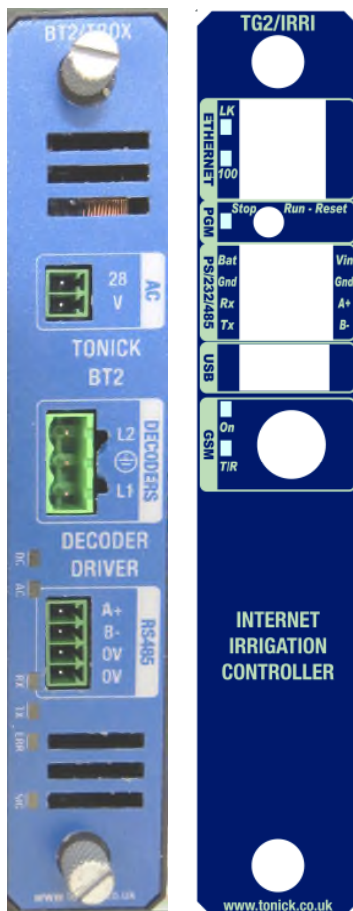
Max. Voltage: 600V max. building wire
(1000V max. signs or luminaries)
Connector Size: 27/32" x 7/16"
Wire Type: Copper/Copper
Wire Range: Min #22/Max #12
Temperature Rating: 105 °C (221 °F)
Silicone Sealant Temperature: -45 °F to 400 °F
UL Designation: SWP*



Blind Translator (BT2) Setup & Configure

Wiring BT2

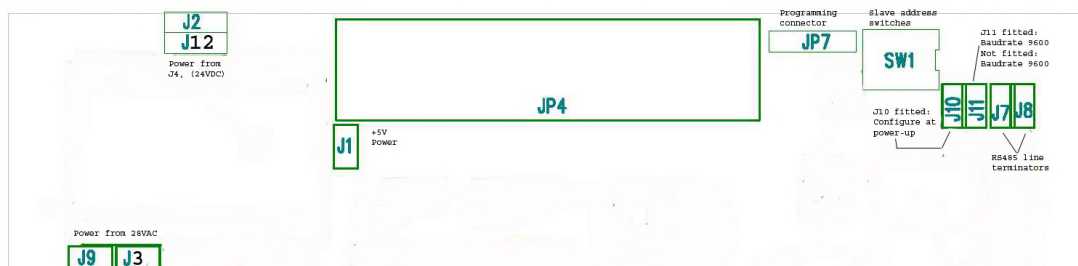
1. Connect 24VAC output of YOBS24001300A transformer to AC on BT2
2. Connect live of decoder 2Wire path to L1 on BT2
3. Connect Neutral of decoder 2Wire path to L2 on BT2
4. Connect cabinet's lightning earth insulated bus bar to central earth terminal between L1 and L2
5. Connect TG2 RS485 A+ to BT2 B- (as labelled). **NOTE: If the RX LED is permanently on when running, please reverse BT2 B- and BT2 A+ connections**
6. Connect TG2 RS485 B- to BT2 A+ (as labelled)
7. Connect TG2 RS485 GND to BT2 0V
8. The BT2 is powered from the 24VAC and not from the MS-RACK5 24VDC on its DIN41612 connector (JP4).



Blind Translator (BT2) Setup & Configure continued

BT2 Modbus RS485 configuration

Jumpers at the back of the BT2 module. Plan view.



- J2, J12, J3, J9 and J1 are factory set. No user changes permissible.
- Leave J10 inserted to record the settings of the Modbus slave address switches SW1 every time the interface powers up.
- Baud rate is factory set to 9600Baud. J11 state not important
- Remove line termination resistors jumpers J7 & J8 on all but the furthest electrical BT2 on the RS485. Always remove these jumpers as a pair.
- Set SW1 slave address on DIL switches. Down = logic 1. Viewed from the rear, the left hand switch is binary 1, middle is binary 2 and right is binary 4

Pre installation cable checking

For full details of this procedure, please read the appendix Field Wiring Fault Finding:

Field Wiring Check

1. Remove 2Wire path from the controller, connect the transformer instead
2. Measure the 2Wire path's current with all decoders connected. Does the measured current = the sum of all the decoder standby currents? (3mA x number of decoders)
3. If too high, a faulty decoder or lightning protection unit, if too low, some decoders disconnected.
4. Earth one side then the other of the transformer, place clamp meter over the whole cable to measure the total earth leakage. Look for less than the controller manufacturer's quoted maximum figure .
5. Go to the far end of the 2 Wire path, expose its wire connections and measure the voltage across it, with and without a solenoid load. A volt drop under load of no more than 3 or 4 volts indicates no bad joints in the main 2 wire path. Remake this wire connection
6. You may then conclude the whole 2Wire path is good or bad in less than ½ hour!



TEST SHEET TO RECORD BASIC WIRING CHECKOUT RESULTS

Controller Model	Path 1	Path 2	Path 3	Path 4	Notes:
Number of Decoders					
Step1: Ground Potential (V) between PE and lightning earth					Just 1 reading, covers all paths
Step2: Zero OK?					Keep clamp away from transformer
Step 3: Standby Currents (mA)					
Step 4: Signal Lead Currents (mA)					Only if a 3 wire system
Step 5: Earth Leakage green-red					
green-black (mA)					
green-yellow (mA)					Only if a 3 wire system
Step 6: Transformer output voltage (V)					Measure at the transformer
voltage (no solenoid), power to power (V)					At furthest point from controller
voltage with solenoid, power to power (V)					At same point
voltage with solenoid, power1 to signal (V)					Only if 3 wire system
voltage with solenoid, power2 to signal (V)					Only if 3 wire system

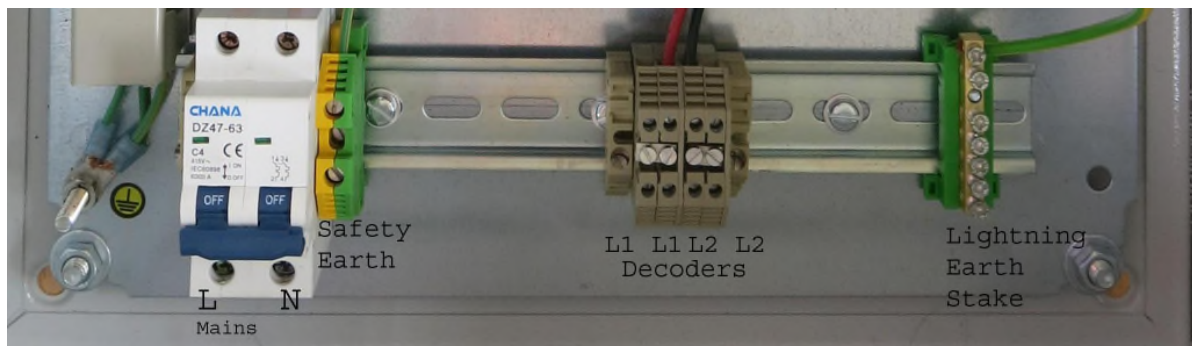
RM2 Installation - Earthing

There are two distinct earths (grounds) in the RM-2. They must be physically separate.

(1) **Protective Earth (PE).** This is the normal safety earth that is part of the 230VAC mains supply. All metal parts of the RM-2 cabinet must be connected to this.

(2) **Lightning Earth**

The BT2 (Earth Stake Terminal) must be connected to an earth stake or plate EST from adjacent BT2/Tbox can be connected together to just 1 earth stake or plate. Use a star connection from each BT2 EST to an INSULATED DIN rail terminal block, then a #11AWG/4mm² wire to the earth stake or plate.



In dry sandy soils, it is helpful to put a water source, fed from the main pipeline, to keep the grounding area wet. This may usefully be a low flow rate drip line or bubbler.

For details on grounding against lightning, please see the appendix
ASIC Guideline 100-2002 (January 2, 2002)

For Earth Grounding Electronic Equipment in Irrigation Systems

WARNING:

The lightning warranty on the TK-DEC-1 decoders is not valid if the lightning grounding system is not installed as defined in this document,

Panel Installation –
Panel Installation –
Panel Installation –
Panel Installation –

System Panel Installation

- Site panel out of direct sunlight and ensure correct IP for environment. Installed by qualified installers.
- Ensure mains supply is suitable for RM2
- Harmonic distortion and Electrical noise can have an effect on the operation of the BT2 and decoders.
- The BT2 current output has to be de-rated at internal panel temperatures in excess of +50 degrees Centigrade

System Commissioning & Testing

Supply Voltage Checks – Supply polarity & Protective Earthling

- Check Mains Supply has been correctly wired. Check Live, Neutral and the protective earth (PE) is correctly connected.
- Check 24AC Supply for the BT2 is correctly wired
- Check DC supply for the RM2 is correctly wired

Power up RM2 & BT2

- Power up RM2 & BT2 – ensure relevant LEDs are lit/flashing
- If the BT2 RX light is permanently on, RS485 A and B are wired the wrong way around.

System Commissioning & Testing – Preliminary Connections

As soon as the RM-2 is powered up, it helps to try to operate decoders in manual

Connect an Ethernet cable on the laptop/tablet/PC to the Ethernet port on the TG2/IRRI the orange “LK” LED should be flashing/flickering and probably the “100” LED will be on full time.

The green “PGM” LED will be flashing twice a second

With the SIM fitted the orange GSM “ON” LED will be illuminated and the “T/R” LED will flash every few seconds.

Open the browser and enter <https://192.168.1.99/License.htm>

Note the spelling and the capital L

RM2 SOFTWARE LICENSE

RM2 SOFTWARE LICENSE KEY

ENTER

Software Licensed	Date Of Registration	22:00:06	30/08/2014
Backup Key			
AF9FBB40FCB7CF3524646561EA42B89F708254818A85F6C12E73F1198B8337F0			

Please Contact Tonick Watering for a RM2 Software License Key.

Note: RM2 Serial Number is required for RM2 Software License

Tonick Watering +44(0)1346 531193 support@tonick.co.uk

16 : 13 : 39 31 / 8 / 2014 Software Version V1.6
Licensed Serial No. 13425

This may be in red with “unlicensed” at the bottom

Once you have this screen, you may want to add it to your BookMarks or Favourites.

If Unlicensed and the screen with a red background:

Plug the supplied USB stick into the laptop/tablet/PC and navigate to the folders. Navigate to “sitename”\TboxCPU\“sitename”KEYxxxxx.txt and open it.

Copy the long key to clipboard e.g.

89BD71D37BDB5BF280AB3712B6C047AE038C55D58C1E0C30E2C34A14DEDF01E

and paste it into **RM2 SOFTWARE LICENSE KEY**. Then press the <return> key

Ignore the BACKUP KEY values.

If all goes well, the screen background should turn in a few seconds from red to blue and “unlicensed” becomes “licensed”

Set up the defaults

Enter <https://192.168.1.99/Engineers123.htm> into the Browser. Watch the spelling, capital E
Bookmark or add to favourites if you want

بلدية مدينة أبوظبي
ABU DHABI CITY MUNICIPALITY

Network Irrigation Controller

SITE NAME SITE NO: 0

ENGINEERS PAGE

Main
Communication

PASS CODE

Language English

Clear Program A **Reset To Defaults**

Clear Program B **Clear Manual Overrides**

Clear Program C

Clear Watering Timers Station No. 1 Qty. 8

Preset Watering Timers Station No. 1 Qty. 1 Sec 0

Preset Water Balance Station No. 0 Qty. 0 % 0

RM2 Internal Temp Alarm 50 DegC **RM2 Min Supply Volts Alarm** 0 Volts

Maximim No.of Decoders 5 **Start Up Options** Restart Current Block

17 : 47 : 14 7 / 8 / 2018 Software Version V1.13 B1 OS 142 455 Licensed Serial No. 5058

Click in the **PASS CODE** box. The panel opens up

Numeric value

1234

7 8 9 DEL

4 5 6 +/-

1 2 3 Enter

0 . <-

Click on the keys 1 2 3 4 then Enter

DEL deletes the whole entry

← deletes the last key (backspace).

Click on **Reset to Defaults**

Other working parameters can be reset here too, but none other, at the moment.

Enable the Blind Translators (BT2/TBOX)

In the browser put <https://192.168.1.99/> this will navigate to the RM-2 main page
Bookmark or add to favourites if you want.

From this page. Click on the 'Translators' tab on the left.

Tonick Watering *Network Irrigation Controller*

SITE NAME Tonick Scotland SITE NO: 1

MAIN PAGE

SITE NUMBER 1
SITE NAME Tonick Scotland

SITE ADDRESS
Wilsonwells Croft
Crimond
Fraserburgh
Aberdeenshire
U.K.

SITE NOTES

BT2 COMMUNICATION
#1 ● #2 #3 #4

NETWORK
LAN IP Address 192.168.1.99
Modem IP Address 0.0.0.0
Modem Signal Strength 0

OVERVIEW
Number Of BT 1
Irrigation Today (Hours) 3.90
Watering Budget (%) 100
Eto (mm) 3.00
RM2 Internal Temp (Deg C) 31.0
RM2 Input Voltage 23.56

13 : 38 : 49 21 / 1 / 2015 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

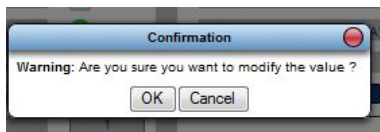
This provides status on each of the Blind Translators marked BT2/TBOX on the label, also known as decoder drivers.

Using the 'BLIND TRANSLATOR NUMBER' drop down box, select each BT2 in turn and click the 'BT Enable' tick box. The 'Comms OK' button show go green in a few seconds, showing the TG2/IRRI is successfully communicating.

Look on the front of the BT2/TBOX. The yellow "TX" and "RX" LEDS should be flashing.

If the BT2 RX light is permanently on, RS485 A+ and B- are wired the wrong way around.


Click on the “**LINE**” button.



Then click OK in the confirmation pop-up.

After a few seconds the green dot should appear meaning the 2 wire path is now energised for that BT2.

The “SIG” LED on the BT2 module should now be green



Network Irrigation Controller

SITE NAME

SITE NO: 0

Main

Translators

Trends

BLIND TRANSLATOR PAGE

BLIND TRANSLATOR NUMBER

1

Software Version

1.7

Decoder Type


Underhill

RS485 Communication

BT Enable

☒

Comms OK



Comms Cycle

4139

Comms Errors

0

Last Error

0

Reset

Last Time of Good Comms

10:26:22

29:12:2014

Line Current Trend

Blind Translator Status

Low Current Threshold (mA)

64

New Value

0

High Current Threshold (mA)

907

New Value


0

Total 2 Wire Currnet (mA)


0

Update


Line




Busy Flag




Line High Current (mA)




Resettable Fus Tripped



Stations Failures Present



Cant Implement Signalling



10 : 26 : 24

29 / 12 / 2014

Software Version V1.7

OS 131 331

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Serial No. 13425

Look at this section in the page

The screenshot shows a web interface titled "Blind Translator Status". It contains three rows of data: "Low Current Threshold (mA)" with a value of 64, "High Current Threshold (mA)" with a value of 907, and "Total 2 Wire Current (mA)" with a value of 17. To the right of these values is a "New Value" column with input fields for 0, 0, and an "Update" button. Below the "Total 2 Wire Current" row is a "Line" button and a green indicator light.

Blind Translator Status		New Value
Low Current Threshold (mA)	64	0
High Current Threshold (mA)	907	0
Total 2 Wire Current (mA)	17	<input type="button" value="Update"/>

●

The 'Total 2 Wire Current (mA) should read, in milliamps, the sum of all the decoders on that cable.

- Old Tonick decoders (single, dual, triple and quad o/ps) 7mA
- New Tonick decoders (A4 datecode onwards) 3mA
- TK-DEC-1/PC decoders 3mA
- DIAS 4.5mA

This is the most important preliminary test.

- Too high a current and there are some bad stations or shorts,
- Too low a current and some of the wiring is disconnected.

Make a note of the currents with nothing on, for review at any later stage.

When converting from a Tonick RM-1 controller to an RM-2:

- CABLE 0 = BT2 #1
- CABLE 1 = BT2 #2
- CABLE 2 = BT2 #3
- CABLE 3 = BT2 #4

If all currents are within limits to say 5%, proceed to turn on decoders

Operate Decoders in Manual

Click on **MAIN**

Select **DECODERS** and the following screen will appear.

The screenshot shows the 'Tonick Watering Network Irrigation Controller' interface. At the top, it displays 'SITE NAME' and 'SITE NO: 0'. The main section is titled 'DECODERS PAGE'. On the left is a sidebar with buttons: 'Main', 'Decoders', 'Master Decoder', 'BT1 Log', 'BT2 Log', 'BT3 Log', 'BT4 Log', and 'Event Log'. The 'Decoders' button is highlighted. The main area contains a 'BLIND TRANSLATOR NUMBER' dropdown set to '1', a 'Total 2 Wire Current (mA)' display showing '0', and a 'Line' button. Below this is a 'MANUAL OVERRIDE' section with a 'Clear All Manual' button, a 'Decoder No.' input set to '1', a 'Qty' input set to '1', a 'State' dropdown, a 'Manual ON' dropdown, and an 'Apply' button. The central part of the screen is a table titled 'DECODERS' with columns 01 through 10 and rows 00 through 120. Each cell in the table contains a small dot. At the bottom, a status bar shows '10 : 30 : 48', '29 / 12 / 2014', 'Software Version V1.7', 'OS 131 331', 'Licensed', 'Serial No. 13425'.

For each Blind Translator, one or more decoders may be turned on or off

Select the **BLIND TRANSLATOR** in the drop-down box

- Set the start decoder number on the "Decoder No." box, then press the <return> key.
- Initially set 1 decoder at a time in "Qty", then press the <return> key.
- Open the drop-down box next to "State" and select **MANUAL ON**.
- Note the "Total 2 Wire Current (mA)", then click on **APPLY**
- After a few seconds, the box surrounding the dot will turn blue showing it is now in manual.
- *If the decoder turn-on is successful*, the dot in the middle will turn green.
- Note the "Total 2 Wire Current (mA)". This will now be the sum of all the decoder currents plus that taken by the 'on' stations solenoid

- *If the decoder turn-on is UN-successful, the dot in the middle will not change colour and the “Total 2 Wire Current (mA)” will not change significantly.*

HINT:

Old Tonick decoders (datecode before A4, January 2004) are polarity sensitive. If more than one station refuses to turn on, reverse the polarity of the two wire path L1 and L2 on the BT2/TBOX “DECODERS” connector, then try again. New Tonick decoders and TK-DEC-1/PC do not care which way round they are connected.

To turn all stations off, either click **Clear All Manual** or select the decoders you want off in the “Decoder No.” and “Qty” boxes, select “Manual Off” in the “State” drop down box than click **APPLY**. When using this latter, make sure to click Clear **All Manual** before leaving the page.

Please note the “Total 2 Wire Current (mA)” and document this for each station when on.

System Commissioning & Testing – Connecting to a PC

Connecting the RM2 to a PC

The RM2 can be logged into by three different ways, Ethernet, USB & GPRS/3G. We would recommend that you first connect using the Ethernet connection. The RM2 factory default settings for the Ethernet IP address is 192.168.1.99. To connect your PC to the RM2 you will need to manually set up the Ethernet port on your PC within the same subnet as the RM2. On some PC's you may need to use an Ethernet cross over cable if your Ethernet port does not support Auto MDI-X.

Setup PC to connect to the RM2 using Ethernet example:

Within the Network settings for the PC, setup the IP address manually to 192.168.1.100, subnet mask to 255.255.255.0 and the gateway can be left at 0.0.0.0.

To check the connection, we would recommend you ping the RM2.

Web interface

The RM2 has a web interface to enable the user to configure the RM2 using a standard browser i.e. Internet explorer, Firefox or Safari. Using the following URL <https://192.168.1.99> the browser should open the home page on the RM2. **A password will be required.**

Updating the TG2 Software

Tonick can email a "Plug and Go" file in a .zip which can be unzipped into a USB stick.

When unzipped, the files should be in a folder off the root called Repository
Plug the USB stick into the TG2 and then wait 1 minute for the stick to register.
Then hold the switch to the right and wait for the PGM LED to flash GREEN six times, wait for the sixth one to go off, then release the switch which will spring back to the centre position

Now wait until the PGM LED starts flashing normally, green, twice per second, until the USB stick may be unplugged (the process can take a few minutes).



Main Page:

Tonick Watering *Network Irrigation Controller*

SITE NAME Paul Office SITE NO: 0

MAIN PAGE

SITE NUMBER 0
SITE NAME Paul Office

SITE ADDRESS UK

SITE NOTES

BT2 COMMUNICATION

#1 #2 #3 #4

NETWORK

LAN IP Address 192.168.1.99
Modem IP Address 0.0.0.0
Modem Signal Strength 0

OVERVIEW

Number Of BT 1
Irrigation Today (Hours) 0.00
Watering Budget (%) 100
Eto (mm) 11.00
RM2 Internal Temp (Deg C) 34.9
RM2 Input Voltage 24.54

5 : 42 : 10 21 / 6 / 2016 Software Version V1.11 OS 135 376 Licensed Serial No. 13762

STOP: clicking on this button will stop all manual and automatic programs that are currently operating. It will not effect programs that will run later.

If you want to stop the controller from watering until further notice: set Budget% to zero in the Weather page and select all programs to Timed, not Water Balance.

Hydrozones: The definition of the crop to be watered, the soil type and Sun/shade. Stations are assigned to a hydrozone so they know how much to water when using Water Balance.

Stations: Details about the station, its name, decoder number and hydrozone type. A precipitation rate calculator is on this page. Also, a linkage to which master valve/pumping station it needs to be fed from. A sub menu gives information on how much water it has delivered and the current water balance.

Programs: The definition of a watering program. Which stations to operate together and their order of watering.

Decoders: The current on/off/failed status of each station and optional manual operation.

Sensors: Access and set up sensors for soil moisture, flow, pressure, water level.

Translators: Details about the decoder interfaces connected, either in the cabinet or remotely through RS485 serial communications. These are called "Blind Translators" or BT2, as they

translate valve on/off commands from the TG2/IRRI into decoder on/off commands and the interface has no keyboard and display of its own, hence the "Blind".

Alarms: The log of alarm events and alterations to the programs and configuration

Water Balance: An overview of the water balance of each station

Network: The setup and status of the Ethernet and GPRS/3G network communication parameters

Weather: Current and past ETo and rainfall. Optional manual entry of ETo and rainfall. The Water Budget is set here

Site Information: Address, and other contact details. List of recipients for alarms and alerts

Date/Time: Set the date and time

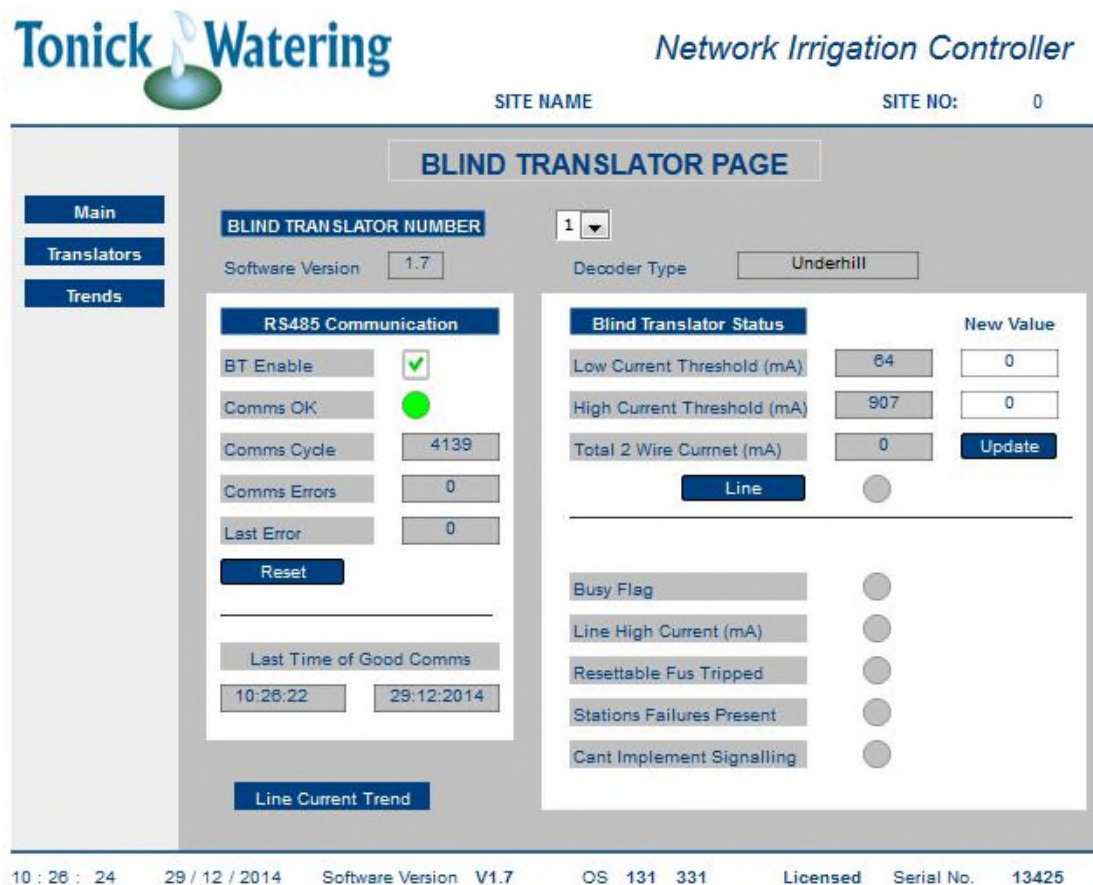
Event Log: A log of everything that has happened.

System Commissioning & Testing – RM2 2 Wire Check

RM2 2 wire current check

- 2 wire check – Power up the BT2 and check that the standby current is equal to the number of decoder's x 3ma. i.e. 30 decoders on 2 wire line must equal around 90ma. From the Web interface left hand menu, select the translator button and observe the Total 2 Wire Current (mA) value.

Translator Web page



Tonick Watering *Network Irrigation Controller*

SITE NAME SITE NO: 0

BLIND TRANSLATOR PAGE

BLIND TRANSLATOR NUMBER 1

Software Version 1.7 Decoder Type Underhill

RS485 Communication	
BT Enable	<input checked="" type="checkbox"/>
Comms OK	<input checked="" type="checkbox"/>
Comms Cycle	4139
Comms Errors	0
Last Error	0
<button>Reset</button>	
Last Time of Good Comms	
10:26:22	29:12:2014

Line Current Trend

Blind Translator Status		New Value
Low Current Threshold (mA)	64	0
High Current Threshold (mA)	907	0
Total 2 Wire Current (mA)	0	<button>Update</button>
<button>Line</button>		
<hr/>		
Busy Flag	<input type="checkbox"/>	
Line High Current (mA)	<input type="checkbox"/>	
Resettable Fus Tripped	<input type="checkbox"/>	
Stations Failures Present	<input type="checkbox"/>	
Cant Implement Signalling	<input type="checkbox"/>	

10:26:24 29/12/2014 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

System Commissioning & Testing – Decoder Testing

Single Decoder testing

In the decoder menu of the RM2 – select manual operation and select one decoder at a time and switch the decoder on and off by selecting the “Manual ON” and Manual OFF” from the drop down box. Remember to press the “Apply” button to carry out the command. If the decoder is working properly the decoder indicator will illuminate green when the decoder is switched on. Also confirm valve is working correctly by observing water delivery. Also confirm the valve current is within limits. Ensure the decoder is set back to “Automatic” when you have finished testing the decoder

Decoder’s web page

Main

Decoders

Master Decoder

BT1 Log

BT2 Log

BT3 Log

BT4 Log

Event Log

DECODERS PAGE

BLIND TRANSLATOR NUMBER

▼

MANUAL OVERRIDE

Clear All Manual

Decoder No.

Qty

State

Manual ON

▼

Apply

Total 2 Wire Current (mA)

Line

DECODERS

	01	02	03	04	05	06	07	08	09	10
00	●	●	●	●	●	●	●	●	●	●
10	●	●	●	●	●	●	●	●	●	●
20	●	●	●	●	●	●	●	●	●	●
30	●	●	●	●	●	●	●	●	●	●
40	●	●	●	●	●	●	●	●	●	●
50	●	●	●	●	●	●	●	●	●	●
60	●	●	●	●	●	●	●	●	●	●
70	●	●	●	●	●	●	●	●	●	●
80	●	●	●	●	●	●	●	●	●	●
90	●	●	●	●	●	●	●	●	●	●
100	●	●	●	●	●	●	●	●	●	●
110	●	●	●	●	●	●	●	●	●	●
120	●	●	●	●	●	●	●	●	●	●

10 : 30 : 48
29 / 12 / 2014
Software Version V1.7
OS 131 331
Licensed
Serial No. 13425

System Commissioning & Testing – Irrigation Methods

Irrigation Methods

The RM2 supports two types of irrigation methods, Timed and Water Balance. The Timed irrigation works on a simple process of watering for a fixed time (multiplied by the Budget%) for every irrigation program. The water balance works on the principle of keeping the soil moisture level in the root zone between two values, given ETo and rainfall. The RM2 will alter the station on time as needed. If the ETo and rainfall has not been updated for 14 days, then the RM2 will fall back to timed irrigation.

Stations and Decoders

Station Setup:

Each station is linked to a decoder. Station 1 is mapped to decoder 1 and BT2 #1 which is Modbus Address 1

34

Decoders 1-127(TW/2W) and 1-63 (TK-DEC-1/PC) are mapped to stations 1-127 and 1-63 respectively. DIAS (Decoder In A Solenoid) is mapped to stations 1-127

Station Number	BT2 Modbus Address	Decoder Address	Notes
1	1	1	
2	1	2	
3	1	3	
63	1	63	
64	1	64	Can only use TW/2W Decoders at this address
128	2	1	
129	2	2	
255	3	1	
256	3	2	
382	4	1	
383	4	2	

System Commissioning & Testing – Watering Programs

Watering Programs

The RM2 has three watering programs, A, B & C with 12 start times in each program. These may be selectively sub-divided into A1/A2, B1/B2 etc. to provide 6 programs. A program sub-divided can have 6 starts for the x1 and another 6 for the x2.

Each watering program can be configured for either timed or water balance irrigation.

If timed is selected for the program, the duration of the irrigation time for each station is fixed within the station setup, but subject to modification using the Budget% in the Weather page.

If water balance is selected, the irrigation time for the station will vary according to the environmental conditions, but is not affected by the Budget% in the Weather page.

To allow 'deficit watering', or to turn all watering off, turn all program starts to 'Basic (fixed time)' in Program Timers, untick 'Enable Nominal ETo' in Weather, then alter the budget% as needed. 0% turns all watering off.

The programs can be selected for every day, specific days, day intervals or odd or even days.

12 starts per day is useful if a little water must be applied often, such as when growing turf, or for dust suppression. Also, on a heavy soil with a slope, only a little water can be put on at a time to avoid runoff. Some other controllers have a separate function of Cycle & Soak. The RM2 achieves the same effect by using multiple starts, wherein the watering time is divided equally among the starts.

Day intervals is useful for trees etc. that only require water every 'x' days where 'x' is greater than 7

When assigning station numbers to a block in the watering program the following points must be considered.

1. Do not exceed the current output capability of the BT2, bearing in mind the cabinet internal temperature. See de-rating table later
2. Rather than running a clump of valves together, particularly at the end of a long cable, space the valves to be watered along the cable and walk the irrigation along. e.g. program block 1. valves 50, 30, 20, 10. program block 2. valves 51, 31, 21, 11. etc.
3. In the preceding paragraph for example, the BT2 will always turn on the stations from highest to lowest, with a new decoder coming on about every $\frac{1}{2}$ – $\frac{3}{4}$ second. 50 first, then 30, then 20, then 10. If decoders are numbered starting at 1 nearest the controller, then in ascending order along the line, turn on will be made easier, as full voltage will be available for the furthest valves.
4. Any station failing to turn operate (electrically) will not affect the others in the block. Its failure will be logged however.

BT2 De-rating with Cabinet Temperature

Cabinet degC	Max I (mA)
50	1200
55	1050
60	900
65	750
70	600

The actual electrical load taken by valves can be modelled using the free Excel calculator *WireRunsPureACwip.xls* from Tonick Watering Ltd. Contact: tony@tonick.co.uk

System Commissioning & Testing – Decoder Programs

Decoder Programs

The decoder program is used to run a group/block of decoders in a programmed sequence. The decoder program start is triggered from the watering programs with each watering program having its own decoder program. The decoder program works in blocks with block 1 being the first block of decoders in the program. This is also known as an “Irrigation Program Group”. When all the programmed decoders in block 1 have completed their irrigation times, the decoder program moves onto the next decoder block. If there are no decoders programmed in the block, the program moves immediately onto the next block until all the blocks have been completed.

On a two-wire decoder system there is a maximum number of decoders that can be run at one time due to the current capacity of the BT2 and the current consumption of the valve solenoids. Therefore we only run a handful of decoders (software maximum of 10) at one time so we don’t trip the BT2. Always check the total current consumption of all the valve solenoids to calculate the maximum number of decoders that can be selected at one time.

WARNING:

Do not exceed the current maximum for the BT2, which depends on the cabinet internal temperature. See the de-rating table.

Depending on the number of BT2’s connected to the RM2 the size of the decoder block and number of blocks will vary.

Number of BT2's	Maximum of Decoders per block	Number of Program Blocks	Maximum No of Decoders
1	10	127	127
2	20	70	254
3	30	47	381
4	40	35	508

NOTE:

The decoder address is entered into the block, not the station number.

Main
Program A Timer
Program B Timer
Program C Timer
Program Names
No Water Days
Decoder Program
Program Status
Program Log

DECODER PROGRAM

PROGRAM A test program BLOCK # 1 < >

NO OF BLIND TRANSLATORS 1 PROGRAM SPLIT

DECODERS

	01	02	03	04	05	06	07	08	09	10
BT1	3	0	0	0	0	0	0	0	0	0

Apply New Settings

Here the blue 01, 02,10 represent the boxes that can hold the decoder addresses. For example, if block 1 in program A holds addresses 1, 12, 16, 30 and 42, they will run together. This will be in a swift sequence, about ½ second apart, in the order 42, 30, 16, 12, 1. Each will run for its programmed time and be switched off. When the longest has finished, the program will step onto block 2, running the decoders in that block.

System Commissioning & Testing – How the RM-2 Waters

The RM-2 may be used in Water Balance, or basic timed irrigation.

Water Balance,

is where it decides how long to water each station, depending on the ETo for yesterday and 'Rain So Far Today'.

Timed Irrigation,

ignores the water balance and instead uses the value in **BASIC DAILY WATERING TIME** (seconds). This is the Total Time for that day and may be divided up if the station is called more than once.

The value in **Budget Watering %** in 'Weather' is used as a multiplier of the basic daily watering time

The type of watering Water Balance or Timed, is set in a drop box **IRRIGATION TYPE** in Program Starts

Watering Programs web page

Tonick Watering *Network Irrigation Controller*

SITE NAME Paul Office SITE NO: 0

WATERING PROGRAM A

IRRIGATION TYPE Water Balance BLOCK DELAY(S) 180

Manual Start ☐ Decoder Run Time (S) 0

STATUS RUNNING ☐ BLOCK 0

test program

Start Time 1	19:42	<input checked="" type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 2	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 3	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 4	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 5	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 6	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 7	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 8	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 9	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 10	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 11	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing
Start Time 12	00:00	<input type="checkbox"/>	Enable	<input type="checkbox"/>	Dosing

PROGRAM DAYS

☒ Monday ☒ Tuesday ☒ Wednesday ☒ Thursday ☒ Friday ☒ Saturday ☒ Sunday

☐ Odd ☐ Even

☐ Day Interval 0

Start Date for Day Interv. 0 0 0

6 : 03 : 54 21 / 6 / 2016 Software Version V1.11 OS 135 376 Licensed Serial No. 13762

In this example screen, the irrigation is set to water starting at 19:42, watering is every day of the week.

Alternatively, the day of the week can be set, or for the USA market, every odd or even date to comply with local watering ordinances.

The program, be it fixed times or water balance, can be manually started immediately with each station in the program to run for a fixed time (seconds). This will not affect any previously entered watering times, or the water balance, but is useful for diagnostics



Timed Irrigation: Altered by ETo

As previously mentioned, the 'Budget Watering %' in the 'Watering' page will adjust the 'Basic Watering Time' by that percentage. This can be set by re-writing the value into the register.

The screenshot displays the 'Tonick Watering' logo and 'Network Irrigation Controller' title. The site name is 'Dennis RM2' and the site number is '0'. The 'WEATHER' page features a sidebar with navigation options: Main, HydroZones, Stations, Programs, Decoders, Sensors, Translators, Alarms, Water Balance, Network, Weather, Site Information, and Date Time. The main content area includes input fields for 'Yesterdays ETo(mm)' (1.0), 'Rainfall So Far (mm)' (0.0), 'Enter Manual Eto (mm)' (0.0), 'Nominal ETo' (4.0), and 'Budget Watering %' (25.0). There is an 'Enter' button and a checkbox for 'Enable Nominal ETo' which is checked. Below these fields is a large display area with a grid of icons and a list of 'ETo (mm)' and 'Rainfall (mm)' entries. At the bottom, a status bar shows the time '11 : 27 : 30', date '14 / 4 / 2016', software version 'V1.10', OS '136 393', license status 'Licensed', and serial number '14450'.

Budget% can also be automatically set by filling in the 'Nominal ETo' and ticking the box 'Enable Nominal ETo', as in the above example.

When this happens, Budget % is automatically adjusted to the ratio
$$\left(\frac{\text{YesterdaysETo}}{\text{NominalETo}} \right) \times 100$$

A kind of weather based irrigation can be implemented using this technique, where the budget % is adjusted daily by downloading 'YesterdaysETo' through SCADA or daily entering 'Manual ETo'

The challenges in using this method are:

1. Knowing what time to put into 'Basic Daily Watering Time' in the first place
2. Putting a value into 'YesterdaysETo' that takes into account *usable* rainfall, as 'Rainfall So Far' will not be used.

Watering Trees

Tree watering is species-based, e.g. a Washington Palm should have 120L peak per day, a Delonix Regia will require approx. 100L per day peak at mature height. Each species will have a different application rate ...it's not one flow fits all.

The peak water usage is based on species type. The designer must also take into account water quality, proximity of hard scape (reflective heat) , planting zone (coastal / parkland) etc.

Sometimes bubblers are specified, but these suffer from several disadvantages

- they get vandalised
- sand buries them
- water floods and does not percolate
- flows are too high to allow specific application per species

Instead, use sub surface pressure compensated drip line with high flow emitters. Then the exact number of emitters can be allocated per species.

For example: 4 trees in a row 80L, 60L , 100L and 120L per day, all can have commensurate number of point emitters on the same drip line, so a 30 minute run time will apply the correct volume to all .

The sub surface dripline is not vandalised, applies water slowly and if it becomes buried, it does not matter .

Irrigate daily to match daily ET

To water trees correctly, Water Balance must be used. Use the NOMINAL ETo feature in the weather page

See below.

Watering Trees (continued)

Select a hydrozone and on the plant-type drop down box, select trees.

Set the daily water needs in Litres at Nominal ETo. Enter the number of Litres in 'Volume/Day (Litres)'.

The Nominal ETo for this daily amount of water is set in the Weather page 'NOMINAL ETo'. In the screen below it is reproduced to help. It is not editable from here.

Tonick Watering *Network Irrigation Controller*

SITE NAME: Dennis RM2 SITE NO: 0

HYDROZONES

HYDROZONE NUMBER: 1 NAME: trees_d2_L50_sandy

PLANT WATER LOSS

Month of Peak Summer	January
Plant Type	Trees
Turf Height of Cut(HOC)mm	25
Sun or Shade	Sun, South Facing
Custom Plant Kc	0
Wetted Diameter (Metres)	2
Volume/Day (Litres)	50 at 4.00 mm/Day
Plant Water Loss mm(ETo)	15.92

HYDROZONE SOIL/ROOT

Select Soil Type	Sandy
Field Capacity(FC)(mm/mm)	0.14
MAD (mm/mm)	0.09
Permanent Wilt Point(mm/mm)	0.06
Water Up To % of FC	97
Allow ET down to % of MAD	98
Root Depth(mm)	1000

MAX USABLE RAIN CALCULATOR

Soil Type	Sandy
Slope	3
Maximum Useable Rainfall (mm/hr)	38.10

CALCULATED WATER BALANCE

Upper Water Balance Th(mm)	135.80
Lower Water Balance Th(mm)	93.88
Difference (mm)	41.92

Apply

12 : 27 : 06 14 / 4 / 2016 Software Version V1.10 OS 136 393 Licensed Serial No. 14450

As the dripline will circle the tree before being routed to the next, enter the wetted diameter in metres. 'Wetted Diameter (Metres)'

Subsurface horizontal and vertical percolation can be neglected, as the Precipitation Rate (PR) for the Sub Surface Emitter uses the same wetted diameter value, picked up from this

Hydrozone. In the maths, this allows it to be cancelled out when determining *the station run time*.

Watering Trees (continued)

To set up the emitter to water a tree (or line of trees) select a decoder which operates the valve to the drip line:

Select a hydrozone for the tree concerned.

Select 'Sub Surface Emitter' from the drop down 'Irrigation Method'

Enter the total delivery in Litres per hour from all the emitters surrounding that tree into 'Total SS Emitter Volume L/Hr'

Tonick Watering *Network Irrigation Controller*

SITE NAME: Dennis RM2 SITE NO: 0

STATION - DELIVERY

BLIND TRANSLATOR: 1 DECODER NUMBER: 1 STATION NUMBER: 1
HYDROZONE NUMBER: 1 trees_d2_L50_sandy
STATION NAME: trees_young

DELIVERY METHOD

Irrigation Method: Sub Surface Emitter
Manual Precip Rate (mm/hr): 0
Manual DU %: 0
Plants Trimmed: ☐
Heads Perpendicular: ☐
Nozzles Matched: ☐
Correct Spacing: ☐
Pressure Regulating Nozzle: ☐
Total SS Emitter Volume L/Hr: 100

Effective Field Precipitation Rate (mm/hr): 31.83
Maximum Allowable PR (mm/hr): 38.10

SUB MASTER DECODER

Blind Translator: - Decoder Number: 0

Apply

12:33:06 14/4/2016 Software Version V1.10 OS 136 393 Licensed Serial No. 14450

The formula will pick up the Wetted Diameter from the selected hydrozone. If a nonsensical number is used in the calculation (wrong Hydrozone for instance) the result will show as "NaN" (Not a number).

"Plants Trimmed", "Heads Perpendicular" etc., have no effect on the calculation.

Main
Delivery
Watering
-
-
-
-
-
-
-

STATIONS - WATERING

BLIND TRANSLATOR 1
DECODER NUMBER 1
STATION NUMBER 1

STATION NAME trees_young

HYDROZONE NUMBER 1
HYDROZONE NAME trees_d2_L50_sandy

WATER BALANCE

Yesterday's ETo (mm)	1
Water Balance at Midnight	93.00
Irrigation So Far Today (mm)	0.00
Rain So Far Today (mm)	0
Present Water Balance (mm)	92.00
Upper Water Balance (mm)	140.00
Lower Water Balance (mm)	92.00
Permanent Wilt point (mm)	60.00

WATER BALANCE WATERING TIME

Watering Time Needed (Sec) 5429

BASIC DAILY WATERING TIME


Basic Daily Watering Time (Sec) 1800

Watering Time So Far (Sec) 0

Budget Watering % 25

Actual Watering Time (Sec) 1357

Apply



Tonick Watering

Network Irrigation Controller

SITE NAME Tonick Watering
SITE NO: 1234

Main

Delivery

Watering

-

-

-

-

-

-

-

STATIONS - WATERING

BLIND TRANSLATOR 1 ▾

DECODER NUMBER 1 < >

STATION NUMBER 1

STATION NAME

HYDROZONE NUMBER 1

HYDROZONE NAME

WATER BALANCE

Yesterday's ETo (mm)	4
Water Balance at Midnight	15.70
Irrigation So Far Today (mm)	0.00
Rain So Far Today (mm)	0
Present Water Balance (mm)	11.70
Upper Water Balance (mm)	14.00
Lower Water Balance (mm)	9.20
Permanent Wilt point (mm)	6.00

WATER BALANCE WATERING TIME

Watering Time Needed 810

BASIC DAILY WATERING TIME

Basic Daily Watering Time (Sec) 200

Watering Time So Far (Sec) 0

Budget Watering % 100
 Actual Watering Time 810

Apply Settings

16:23:20
21/07/2014
Software Version
V1.3
Serial No.
13221

Note that with both Water Balance or timed irrigation, the watering time will be divided by the number of instances that the station is to be operated in the current 24 hours from midnight to midnight. All three programs A, B and C will be scanned for instances of the station

For example:

total watering time = 10 minutes (600 seconds) with 1 start in program A and another in C during the day. Therefore, time duration during each start = 5 minutes (300 seconds). Manual operations, either from the Manual watering screen or from other automatic programs will subtract from this total time set in **BASIC DAILY WATERING TIME** (seconds)

This may be reset however in the Engineering Screen

Cycle & Soak

Is a term used when the total amount of water to be applied is split over several instances (the cycle) with a gap in between to allow the water to soak-in (the 'soak'). This is easily achieved in the RM-2, by programming several starts of the same program. The time interval

between starts is the soak time, when the total amount of watering time is split amongst the starts.

Enter <https://192.168.1.99/Engineers123.htm> into the Browser. Watch the spelling, capital E
Bookmark or add to favourites if you want

Click in the **PASS CODE** box. The panel opens up

Click on the keys 1 2 3 4 then Enter

DEL deletes the whole entry

<- deletes the last key (backspace).

Next to 'Clear Watering Timers'.

Select the first Station Number BT2 #1 (1-127), BT2 #2 (128-255), BT2 #3 (256-383), BT2 #4 (384-511). then the Qty of stations following. Then Click on 'Clear Watering Timers'.

This will then reset the Watering Time So Far back to zero.

Example: decoder 2, 3, 4, 5, 6 in BT2 #2.

Set 129 into Station No. and 5 into Qty. then click 'Clear Watering Timers'.

Running a one-off extra program

is useful for instance, to water-in fertiliser on parts of the installation, but where the routine watering needs to be done as originally programmed. In this scenario, use say, program C to set the stations to be watered, run it, then go to the engineer's page and reset the timers. If the stations are not contiguous, the process must be repeated for each station watered in C with Qty. set to 1.

It is permissible to call the same station more than once in the same program. Each instance will be taken into account when dividing up the time.

Multiple starts

are useful when implementing a 'Cycle & Soak' on perhaps a sloping clay soil area, dust suppression, or watering new turf. In these cases, putting on the full amount of water would just run off and be wasted. Instead, calling many starts at regular intervals in the same day will apply BASIC DAILY WATERING TIME (seconds) divided by the number of starts.

HOWEVER:

No station will be watered for less than 2 minutes (shown as 120 seconds). This is because pipes may not fill in that short time, or sprinkler valves may not fully open, resulting in reduced irrigation compared to that needed. To circumvent this, if there are for example 10 instances of 2 minutes (=20 minutes total) called for in the 24 hours (midnight to midnight), the first instance will be skipped, leaving the remainder as $20 \text{ minutes} / 9 = 2.22 \text{ minutes}$ (shown as 133 seconds). Thereafter there will be 9 watering instances of 2.22 minutes in that day.

System Commissioning & Testing – RM2 Web Page Menus

Tonick Watering *Network Irrigation Controller*

SITE NAME Paul Office SITE NO: 0

MAIN PAGE

SITE NUMBER 0
SITE NAME Paul Office

SITE ADDRESS UK

SITE NOTES

BT2 COMMUNICATION
#1 #2 #3 #4

NETWORK
LAN IP Address 192.168.1.99
Modem IP Address 0.0.0.0
Modem Signal Strength 0

OVERVIEW
Number Of BT 1
Irrigation Today (Hours) 0.00
Watering Budget (%) 100
Eto (mm) 11.00
RM2 Internal Temp (Deg C) 34.9
RM2 Input Voltage 24.54

5 : 42 : 10 21 / 6 / 2016 Software Version V1.11 OS 135 376 Licensed Serial No. 13762

RM2 Web Page Menus

Main Headings:

Hydrozones: The definition of the crop to be watered, the soil type and Sun/shade. Stations are assigned to a hydrozone so they know how much to water.

Stations: Details about the station, its name, decoder number and hydrozone type. A precipitation rate calculator is on this page. Also, a linkage to which master valve/pumping station it needs to be fed from. A sub menu gives information on how much water it has delivered and the current water balance.

Programs: The definition of a watering program. Which stations to operate together and their order of watering.

Decoders: The current on/off/failed status of each station and optional manual operation.

Translators: Details about the decoder interfaces connected, either in the cabinet or remotely through RS485 serial communications. These are called "Blind Translators" or BT2, as they

translate valve on/off commands from the TG2/IRRI into decoder on/off commands and the interface has no keyboard and display of its own, hence the "Blind".

Alarms: The log of alarm events and alterations to the programs and configuration

Water Balance: An overview of the water balance of each station

Network: The setup and status of the Ethernet and GPRS/3G network communication parameters

Weather: Current and past ETo and rainfall. Optional manual entry of ETo and rainfall

Site Information: Address, and other contact details. List of recipients for alarms and alerts

Date & Time: sets and displays the date and time. If required the controller can use Network Time Protocol, to always keep it in sync with the overall system.

Event Log: logs the decoder on and off times. Useful for forensic work on station failure problems. What went on with what etc.

System Commissioning & Testing – Hydrozone web page

HydroZone Web Page

This page allows the definition of a hydrozone. This collection of data defines the watering needs and is used by the RM-2 to decide how long to water each station when using **Water Balance** irrigation.

If **Timed Irrigation** only is being used, hydrozones are not needed, just the watering time in each station's definition is used.

Tonick Watering *Network Irrigation Controller*

SITE NAME: SITE NO: 0

HYDROZONES

HYDROZONE NUMBER: 1 NAME: grass-50mm

PLANT WATER LOSS	
Month of Peak Summer	July
Plant Type	Cool Season Grasses
Turf Height of Cut(HOC)mm	50
Sun or Shade	Sun, South Facing
Plant Water Loss mm(ETc)	1.02

MAX USABLE RAIN CALCULATOR	
Soil Type	Sandy-Loam
Slope	0
Maximum Useable Rainfall (mm/hr)	19.05

HYDROZONE SOIL/ROOT	
Select Soil Type	Sandy-Loam
Field Capacity(FC)(mm/mm)	0.20
MAD (mm/mm)	0.14
Permanent Wilt Point(mm/mm)	0.09
Water Up To % of FC	100
Allow ET down to % of MAD	100
Root Depth(mm)	200
Upper Water Balance Th(mm)	40.00
Lower Water Balance Th(mm)	29.00
Difference (mm)	11.00

Apply

16 : 20 : 23 20 / 1 / 2015 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

In the above example, cool season grass is defined with a root depth of 200mm and a height of cut of 50mm

Definition of the soil type as Sandy-Loam gives from internal tables, a field capacity FC of 0.2mm of water in 1mm of soil, a Maximum allowed depletion (MAD) of 0.14mm of water in 1mm of soil, and a Permanent wilt point (PWP) of 0.09mm of water in 1mm of soil.

These figures multiplied by the root depth of 200mm give the maximum amount of water in the root zone of 40mm (in 200mm) and an MAD figure of 29mm in the root depth. Water Balance will keep the moisture levels withing these two thresholds.

Tonick Watering *Network Irrigation Controller*

SITE NAME: SITE NO: 0

HYDROZONES

HYDROZONE NUMBER: 2 NAME: datepalm-1m

PLANT WATER LOSS

Month of Peak Summer: July

Plant Type: Shrubs

Turf Height of Cut(HOC)mm: 25

Sun or Shade: Sun,South Facing

Plant Water Loss mm(ETc): 0.60

MAX USABLE RAIN CALCULATOR

Soil Type: Sandy

Slope: 0

Maximum Useable Rainfall (mm/hr): 38.10

HYDROZONE SOIL/ROOT

Select Soil Type: Sandy

Field Capacity(FC)(mm/mm): 0.14

MAD (mm/mm): 0.09

Permanent Wilt Point(mm/mm): 0.06

Water Up To % of FC: 100

Allow ET down to % of MAD: 100

Root Depth(mm): 1000

Upper Water Balance Th(mm): 140.00

Lower Water Balance Th(mm): 92.00

Difference (mm): 48.00

Apply

16 : 21 : 25 20 / 1 / 2015 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

In this example, a date Palm with a root depth of 1m (1000mm) in Sandy soil is defined.

Because the root depth is much deeper, the upper and lower water balance threshold are much greater. This type of plant will need watering less frequently than grasses and flowers. It is best included in a separate program, or at least, like plants in the same program block. If placed in with flowers, it will hold that block up until the palm has finished watering before the next block can be started.

The soil type and slope of the area defines the maximum rate at which water that can be applied before run off occurs. A good irrigation design will ensure that the emitters will not exceed this.

If rainfall occurs in a deluge, only the Maximum Usable Rainfall times the rain duration will be added to the Rainfall So Far, used in water balance

Main
HydroZones
Stations
Programs
Decoders
Translators
Alarms
Water Balance
Network
Weather
Site Information
Date Time

HYDROZONES

HYDROZONE NUMBER: 3
NAME: annuals-100mm

PLANT WATER LOSS

Month of Peak Summer: July
Plant Type: Shallow-rooted Annuals
Turf Height of Cut(HOC)mm: 25
Sun or Shade: Filtered, Part Sun
Plant Water Loss mm(ETc): 0.72

MAX USABLE RAIN CALCULATOR

Soil Type: Loam
Slope: 3
Maximum Useable Rainfall (mm/hr): 12.70

HYDROZONE SOIL/ROOT

Select Soil Type: Loam
Field Capacity(FC)(mm/mm): 0.28
MAD (mm/mm): 0.19
Permanent Wilt Point(mm/mm): 0.12
Water Up To % of FC: 100
Allow ET down to % of MAD: 100
Root Depth(mm): 99
Upper Water Balance Th(mm): 25.74
Lower Water Balance Th(mm): 18.81
Difference (mm): 6.93

Apply

16 : 22 : 03
20 / 1 / 2015
Software Version V1.7
OS 131 331
Licensed
Serial No. 13425

In this example, shallow rooted flowers are defined in a loam soil. As the difference in thresholds is only 6.93mm, with an ETc of 0.72mm per 1mm of ETo, the flowers will need watering every 6.93/(0.72x ETo).

At say 5mm/day, this will be $6.93 / (0.72 \times 5) = 6.93 / 3.6 =$ every 2 days.

The Principles and practice Water Budget Irrigation is very well explained in the tutorial <http://cwi.csufresno.edu/wateright/sched1.asp>

Detailed tables within the RM-2 software allow the derivation of the upper and lower thresholds for soil moisture, within which the water balance algorithm keeps the plant's root zone.

Up to 32 different hydrozone combinations may be defined.

When using Water Balance irrigation, each station must be linked to a hydrozone. From the linked hydrozone is extracted 'Max allowable PR', 'Upper & Lower Water Balance thresholds' and the 'Permanent Wilt Point' PWP

The heart of the WB algorithm is

$$WB_{\text{now}} = WB_{\text{yesterday}} + IRRIGATION_{\text{sofar}} + RAIN_{\text{sofar}} - ET_{\text{yesterday}}$$

System Commissioning & Testing – HydroZone web page

HydroZone Web Page continued

As the day progresses, this equation is modified by adding $IRRIGATION_{sofar}$, each time a start is actioned and the station is watered

At midnight, the WB_{now} becomes the $WByesterday$ and the $EToyesterday$ is updated from Central via a GPRS broadcast, or from a connected weather station or by manual entry.

The WB_{now} is clipped to be between 0 mm and FC mm

Use of Hydrozones in Agriculture

Unlike turf or shrubs, crops grow and change their characteristics as they grow. Root depth increases and K_c changes.

Each station is linked to a hydrozone which is used by the RM-2 to decide how long to water. As the crop grows, either this hydrozone must be edited or the station re-linked to a different hydrozone.

It is extremely likely that many stations will be linked to one hydrozone. So if a new one is to be referenced, the user must edit each station's details to reference the new one. Alternatively, the existing one may be edited to reflect the new K_c and root depth, in which case only one edit is required.

Definitions:

PR Precipitation Rate of the water emitter in mm/hour.

PWP Permanent Wilt Point. The level in mm of water in the soil root zone where the plant will die.

FC Field Capacity. The maximum level in mm of water in the root zone that a particular soil can hold.

MAD The Maximum Allowed Depletion (or Managed Allowed Depletion) level in mm of water in the root zone of soil when irrigation must recommence. Typically 50% of the difference between FC and PWP.

PAW or **AVPW**. The plant's available water level in mm in the root zone of the soil, being the difference between FC and PWP.

ET_c and **ET_o**. Yesterday's Evapotranspiration (water loss in mm) for the actual plant (ET_c) and the reference ET given from the weather station (ET_o).

K_c The crop coefficient. Thus is relatively how much Evapotranspiration is seen by the crop compared to reference ET_o $ET_c = ET_o \times K_c$. K_c may be greater or less than 1.0

System Commissioning & Testing – Station Delivery web page

Station Delivery Web Page

This page allows configure the parameters for the station delivery.

The screenshot shows the 'STATION - DELIVERY' configuration page for the Tonick Watering Network Irrigation Controller. The page has a sidebar with navigation links: Main, Delivery, Watering, and Master Decoder. The main content area is titled 'STATION - DELIVERY' and contains several configuration sections. At the top, there are fields for 'BLIND TRANSLATOR' (set to 1), 'DECODER NUMBER' (set to 1), and 'STATION NUMBER' (set to 1). Below these are 'HYDROZONE NUMBER' (set to 1) and a text field for 'grass-50mm'. The 'STATION NAME' is set to 'FrontLawn'. The 'DELIVERY METHOD' section includes a dropdown for 'Rotors, Plastic Nozzle' and a list of checkboxes for 'Manual Precip Rate (mm/hr)', 'Manual DU %', 'Plants Trimmed', 'Heads Perpendicular', 'Nozzles Matched', 'Correct Spacing', and 'Pressure Regulating Nozzle'. The 'SUB MASTER DECODER' section has fields for 'Blind Translator' and 'Decoder Number'. At the bottom, there are fields for 'Effective Field Percipitation Rate (mm/hr)' (13.04) and 'Maximum Allowable PR (mm/hr)' (19.05). An 'Apply' button is located at the bottom right. The footer shows the date and time (16:25:27, 20/1/2015), software version (V1.7), OS (131 331), license status (Licensed), and serial number (13425).

Tonick Watering Network Irrigation Controller

SITE NAME SITE NO: 0

STATION - DELIVERY

BLIND TRANSLATOR 1 DECODER NUMBER 1 STATION NUMBER 1

HYDROZONE NUMBER 1 grass-50mm

STATION NAME FrontLawn

DELIVERY METHOD

Irrigation Method Rotors, Plastic Nozzle

Manual Precip Rate (mm/hr) 0

Manual DU % 0

Plants Trimmed ☒

Heads Perpendicular ☒

Nozzles Matched ☒

Correct Spacing ☒

Pressure Regulating Nozzle ☒

Effective Field Percipitation Rate (mm/hr) 13.04

Maximum Allowable PR (mm/hr) 19.05

SUB MASTER DECODER

Blind Translator -

Decoder Number 0

Apply

16:25:27 20/1/2015 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

Delivery Method – Used to select the Irrigation Method i.e. Rotors, Drip Lines, MPR Rotators etc. This rate is used by the water balance software to work out how long to water, once given the number of mm needed to be applied.

Manual Precipitation Rate -

Where the preset delivery types are not applicable, a manual entry for Precipitation Rate (PR) and Distribution Uniformity (DU) may be entered

Total Watering time (mins) = PR/60 x mm_needed

A distribution uniformity of less than 100% (perfect) will reduce the raw PR entered. Also poor installation as in 'plants trimmed', 'heads perpendicular' etc. un-ticked will reduce the effective PR.

Note that with Water Balance or timed irrigation, the watering time will be divided by the number of instances that the station is to be operated in the current 24 hours.

For example: total watering time = 10 minutes with 2 starts during the day. Therefore time duration for each start = 5 minutes.

It is permissible to call the same station more than once in the same program. Each instance will be taken into account when dividing up the time.

HOWEVER:


No station will be watered for less than 2 minutes (shown as 120 seconds). This is because pipes may not fill in that short time, or sprinkler valves may not fully open, resulting in reduced irrigation compared to that needed. To circumvent this, if there are for example 10 instances of 2 minutes (=20 minutes total) called for in the 24 hours, the first instance will be skipped, leaving the remainder as 20 minutes/9 = 2.22 minutes (shown as 133 seconds). Thereafter there will be 9 watering instances of 2.22 minutes in that day.

System Commissioning & Testing – Station Watering web page

This page shows the watering status of the station.

The Blind Translator number (1-6) and decoder number (the address in the decoder 1-127 or 1-63) can be set, when all the watering data on that station will be shown, including its station number.

Station Watering Web Page



Network Irrigation Controller

SITE NAME Tonick ScotlandSITE NO: 1

STATIONS - WATERING

BLIND TRANSLATOR1

DECODER NUMBER1

STATION NUMBER1

STATION NAMEFrontLawn

HYDROZONE NUMBER1

HYDROZONE NAMEgrass-50mm

WATER BALANCE

Yesterday's ETo (mm)	3
Water Balance at Midnight	35.50
Irrigation So Far Today (mm)	0.02
Rain So Far Today (mm)	0
Present Water Balance (mm)	34.50
Upper Water Balance (mm)	40.00
Lower Water Balance (mm)	29.00
Permanent Wilt point (mm)	18.00

WATER BALANCE WATERING TIME

Watering Time Needed1463

BASIC DAILY WATERING TIME

Basic Daily Watering Time (Sec)0

Watering Time So Far (Sec)6

Budget Watering %100

Actual Watering Time1463

Apply

21 : 12 : 5920 / 1 / 2015Software Version V1.7OS 131 331LicensedSerial No. 13425

In this example, decoder address 1 on Blind Translator 1 (BT2, no.1) has been given the name FrontLawn and uses the hydrozone no. 1 called Grass-50mm.

In the Water Balance box, yesterday's ETo was 3mm, and this resulted in a water balance depletion to 35.50mm. Virtually no irrigation so far today and no rain. Thus if a program is to replenish the water back up to 40.00mm, with the precipitation rate of the emitter, it will require 1463 seconds of watering = 24 minutes and 38 seconds.

Should water balance not be used, the watering time in "Basic Daily Watering Time" x Budget % will be used instead.

This illustrates a really important point:

When used with Water Balance, the watering times will be worked out by the RM-2. It only needs yesterday's ETo and Rainfall So far.

If timed irrigation is used instead, someone has to manually alter the times, or at least manipulate the "Budget Watering %" depending on the weather and to know by how much to alter it.

System Commissioning & Testing – Master Decoder web page

This Master Decoder web page is used to configure the Master Decoder. The Master Decoder is optional and can use any decoder connected to any of the BT2's. If the Master Decoder is enabled, the master valve will be selected if any decoder is selected. This is typically used for opening a main water valve or starting a pump.

Master Decoder web page

The screenshot shows the 'Master Decoder' configuration page of the Tonick Watering Network Irrigation Controller. The page has a header with the logo and site information. A left sidebar contains navigation buttons for 'Main', 'Delivery', 'Watering', 'Flow', and 'Master Decoder'. The main content area is titled 'MASTER DECODER' and contains a form with the following fields: 'Master Decoder Enable' (checkbox), 'Blind Translator' (dropdown menu), 'Decoder Number' (text input), 'Station Number' (text input), and 'Master Decoder Status' (circular indicator). An 'Apply Settings' button is located at the bottom right of the form. The footer displays system information: '16:28:03', '21/07/2014', 'Software Version V1.3', and 'Serial No. 13221'.

Tonick Watering *Network Irrigation Controller*

SITE NAME Tonick Watering **SITE NO:** 1234

MASTER DECODER

MASTER DECODER

Master Decoder Enable ☐

Blind Translator

Decoder Number

Station Number

Master Decoder Status ☐

Apply Settings

16:28:03 21/07/2014 Software Version **V1.3** Serial No. **13221**

Master Decoder Enable – Enable or Disable Master Decoder

Blind Translator – Selects the Blind Translator number for the Master Decoder

Decoder – Selects the Decoder Number to use for the Master Decoder

Station – Displays the Station Number for the Master Decoder based on the BT2 number and Decoder Number

Master Decoder – Displays the current status of the Master Decoder

System Commissioning & Testing – Watering Programs web page

The RM2 has three watering programs, A, B & C with 12 start times in each program. Each watering program can be configured for either timed or water balance irrigation. If timed is selected for the program then the duration of the irrigation time for each station is fixed within the station setup. If water balance is selected the irrigation time for the station will vary according to the environmental conditions. The programs can be selected for every day, specific days, day intervals or odd or even days.

Watering Programs web page

The screenshot shows the 'Watering Program A' configuration page. At the top, the 'Tonick Watering' logo is on the left, and 'Network Irrigation Controller' is on the right. Below the logo, 'SITE NAME' is 'Tonick Scotland' and 'SITE NO.' is '1'. The main heading is 'WATERING PROGRAM A'. On the left is a sidebar with navigation buttons: 'Main', 'Program A Timer', 'Program B Timer', 'Program C Timer', 'No Water Days', 'Decoder Program', 'Program Status', 'Program Log', and 'Event Log'. The main content area has 'IRRIGATION TYPE' set to 'Water Balance' and 'BLOCK DELAY(S)' set to '30'. Below this, 'Manual Start' is a button, and 'Decoder Run Time (S)' is '0'. A 'STATUS' section shows 'RUNNING' with a green dot and 'BLOCK' with '0'. A table lists 12 'Start Time' entries, each with a time field (all '00:00'), an 'Enable' checkbox (all checked), and a 'Dosing' checkbox (all unchecked). On the right, 'PROGRAM DAYS' are listed with checkboxes for 'Monday' through 'Sunday' (all checked), 'Odd', 'Even', and 'Day Interval' (unchecked). At the bottom, 'Start Date for Day Interv.' is '0/0/0'. The footer shows '15:22:33', '21/1/2015', 'Software Version V1.7', 'OS 131 331', 'Licensed', 'Serial No. 13425'.

Start Time	Time	Enable	Dosing
Start Time 1	01:00	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Start Time 2	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 3	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 4	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 5	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 6	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 7	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 8	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 9	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 10	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 11	00:00	<input type="checkbox"/>	<input type="checkbox"/>
Start Time 12	00:00	<input type="checkbox"/>	<input type="checkbox"/>

Irrigation Type – This is used to select the irrigation type, Timed or Water Balance

Running – This indicator shows if the Watering program is running

Block – If the Watering Program is running this will indicate the current decoder program block. If Block shows zero then the Watering Program is not running

System Commissioning & Testing – Watering Programs web page cont.

Start Times – This sets the time the watering Program will start. There are 12 watering times which can be enabled or disabled.

Dosing – This enables or disables the dosing decoder for the selected start time. Used to enable/disable fertigation or pH adjustment dosing equipment.

Program Days – This configures which days run the watering program. You can select specific days of the week or it can be run on odd and even days of the month or it can be run every number of days.

Monday – runs watering program on Monday if enabled

Tuesday - runs watering program on Tuesday if enabled

Wednesday - runs watering program on Wednesday if enabled

Thursday - runs watering program on Thursday if enabled

Friday - runs watering program on Friday if enabled

Saturday - runs watering program on Saturday if enabled

Sunday - runs watering program on Sunday if enabled

Odd - runs watering program on odd Days of the month i.e. 1st, 3rd, 5th etc. of the month if enabled. Do not set a day of the week when using this

Even - runs watering program on even Days of the month i.e. 2nd, 4th, 6th etc. of the month if enabled. Will skip watering on 31st and 1st if set.

Day Interval – Runs watering program at the interval specified. Useful for plants that only need watering at intervals longer than 7 days.

Start Date for Day Interval – Starts the Day Interval at this date

Manual Start:

This is used to run a program with a fixed time for each station that is set in **Decoder Run Time (Seconds)**. When used, this ignores any time in 'Basic Watering Time' or from Water Balance. This does NOT increment 'Watering So Far' or alter the water balance. BEST for wetting down after fertiliser application, or following the water around.

Block Delay:

sets a delay between blocks. Useful to ensure all decoders in that block have turned their valves off before the next block turns more on.

The BT2 when given a bulk change of stations, i.e. several stations off and several on in one command from the CPU, will turn the new stations on BEFORE turning the old off. This can be useful with pumping systems where there must always be an outlet for the water unless the pump is to be damaged. In this case, the block delay should be set to say 1 second.

If on the other hand the BT2s are being used to turn on the maximum number of stations Ohms Law and cabinet temperature will allow, all the old must be turned off before the new are turned on. In this case 30 seconds or more between blocks is mandated

System Commissioning & Testing – No Watering Days web page

This web page can be used to configure specific days of the year when no watering happens. This is generally used for city stadium/parks watering when events are to take place.

No Watering Days web page

The screenshot shows the 'No Watering Days' configuration page. At the top, the 'Tonick Watering' logo is on the left, and 'Network Irrigation Controller' is on the right. Below the logo, the site name is 'Tonick Watering' and the site number is '1234'. The main heading is 'NO WATERING DAYS'. Below this is a toggle switch labeled 'NO WATERING DAY ACTIVE' which is currently off. A table allows configuration for 8 days. Each row has columns for Day, Day of Month, Month, Year, and an Enable checkbox. The status bar at the bottom shows the time as 17:16:29, date as 21/07/2014, software version as V1.3, and serial number as 13221.

	DAY	MONTH	YEAR	ENABLE
Day 1	1	1	2013	<input type="checkbox"/> Day 1 Enable
Day 2	1	1	2013	<input type="checkbox"/> Day 2 Enable
Day 3	1	1	2013	<input type="checkbox"/> Day 3 Enable
Day 4	1	1	2013	<input type="checkbox"/> Day 4 Enable
Day 5	1	1	2013	<input type="checkbox"/> Day 5 Enable
Day 6	1	1	2013	<input type="checkbox"/> Day 6 Enable
Day 7	1	1	2013	<input type="checkbox"/> Day 7 Enable
Day 8	1	1	2013	<input type="checkbox"/> Day 8 Enable

17:16:29 21/07/2014 Software Version V1.3 Serial No. 13221

No Watering Day Active – Indicates if current day is a no watering day

Day - The Day of the Month (1-31) that you would like to have no watering

Month - The Month of the Year (1 -12) that you would like to have no watering

Year - The Year that you would like to have no watering

Day # Enable – Enables or Disables the No watering day

System Commissioning & Testing – Decoder Program web page

The decoder program web page shows the first block (block 1) for Watering Program A. The web page identifies that there are two Blind translator currently installed. Use the “<” & “>” to cycle through the decoder program blocks.

Decoder Program Web Page

Tonick Watering *Network Irrigation Controller*

SITE NAME Tonick Watering SITE NO: 1234

DECODER PROGRAM

PROGRAM A BLOCK NUMBER 1 < >

NO OF BLIND TRANSLATORS 2

		DECODERS									
		01	02	03	04	05	06	07	08	09	10
BLIND TRANSLATORS	BT1	1	2	3	4	5	7	0	0	0	0
	BT2	10	12	13	0	0	0	0	0	0	0

Apply New Settings

10:15:22 20/07/2014 Software Version V1.3 Serial No. 13221

Program – used to select the decoder program for watering programs A, B & C

Block Number – Used to select the block number for the decoder program

No Of Blind Translators – Displays the number of Blind Translators

Apply Settings – Used to save the settings

System Commissioning & Testing – Decoder Program web page

Tonick Watering *Network Irrigation Controller*

SITE NAME SITE NO: 0

DECODER PROGRAM

PROGRAM **A** BLOCK NUMBER **1** < >

NO OF BLIND TRANSLATORS **1**

DECODERS

	01	02	03	04	05	06	07	08	09	10
BT1	1	12	30	42	16	0	0	0	0	0

Apply New Settings

11 : 07 : 26 29 / 12 / 2014 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

Here the blue 01, 02,10 represent the boxes that can hold the decoder addresses. In this example, block 1 in program A will start decoders with addresses 1, 12, 16, 30 and 42 together. This will be in a swift sequence, about ½ second apart, in the order 42, 30, 16, 12, 1. Each will run for its programmed time and be switched off. When the longest has finished, the program will step onto block 2, running the decoders in that block.

It is important not to mix shallow rooted plants with a short watering run time in the same block with deep rooted plants. Because, when the root depth is much deeper, the upper and lower water balance threshold are much greater. This type of plant will need watering less frequently than say, grasses and flowers. It is best included in a separate program, or at least, like plants in the same program block. If placed in with flowers, it will hold that block up until the deep rooted has finished watering before the next block can be started.

Depending on the number of BT2's connected to the RM2 the size of the decoder block and number of blocks will vary.

Number of BT2's	Maximum of Decoders per block	Number of Program Blocks	Maximum No of Decoders
1	10	127	127
2	20	70	254
3	30	47	381
4	40	35	508

When assigning station numbers to a block in the watering program the following points must be taken into account.

1. Do not exceed the current output capability of the BT2, bearing in mind the cabinet internal temperature. See de-rating table below
2. Rather than running a clump of valves together, particularly at the end of a long cable, space the valves to be watered along the cable and walk the irrigation along. e.g. program block 1. valves 50, 30, 20, 10. program block 2. valves 51, 31, 21, 11. etc.
3. In the preceding paragraph for example, the BT2 will always turn on the stations from highest to lowest, with a new decoder coming on about every $\frac{1}{2}$ – $\frac{3}{4}$ second. 50 first, then 30, then 20, then 10. If decoders are numbered starting at 1 nearest the controller, then in ascending order along the line, turn on will be made easier, as full voltage will be available for the furthest valves.
4. Any station failing to turn operate (electrically) will not affect the others in the block. Its failure will be logged however.

BT2 De-rating with Cabinet Temperature

Cabinet degC	Max I (mA)
50	1200
55	1050
60	900
65	750
70	600

The actual electrical load taken by valves can be modelled using the free Excel calculator *WireRunsPureACwip.xls* from Tonick Watering Ltd. Contact: tony@tonick.co.uk

System Commissioning & Testing – Decoder Program Status web page

Program Status Web Page

The progress of a program may be inspected by clicking on **Program Status**

The screenshot shows the 'PROGRAM STATUS' web page for a Tonick Watering Network Irrigation Controller. The page has a header with the logo and site information: SITE NAME 'Tonick Scotland' and SITE NO: '1'. A left sidebar contains navigation buttons: Main, Program A Timer, Program B Timer, Program C Timer, No Water Days, Decoder Program, Program Status (highlighted), and Program Log. The main content area is titled 'PROGRAM STATUS' and features a dropdown menu set to 'Program A', radio buttons for 'A', 'B', and 'C' (with 'A' selected), and a 'BLOCK' field showing '0' and '30'. Below this is a table with 10 columns labeled 01 to 10. The first two rows are labeled 'Station #' and 'Time Left' on the left. The 'Station #' row shows zeros for all stations, and the 'Time Left' row also shows zeros. Below these are several empty rows for additional stations. At the bottom, a status bar displays: 12:51:03, 22 / 1 / 2015, Software Version V1.7, OS 131 331, Licensed, Serial No. 13425.

	01	02	03	04	05	06	07	08	09	10
Station #	0	0	0	0	0	0	0	0	0	0
Time Left	0	0	0	0	0	0	0	0	0	0

For each BT2 there are two rows.

The 'Station#' displays the decoder address being run

The 'Time Left' shows the number of seconds left to run for that station#

When all the stations have gone to zero seconds, the block has finished and the program will advance to the next block

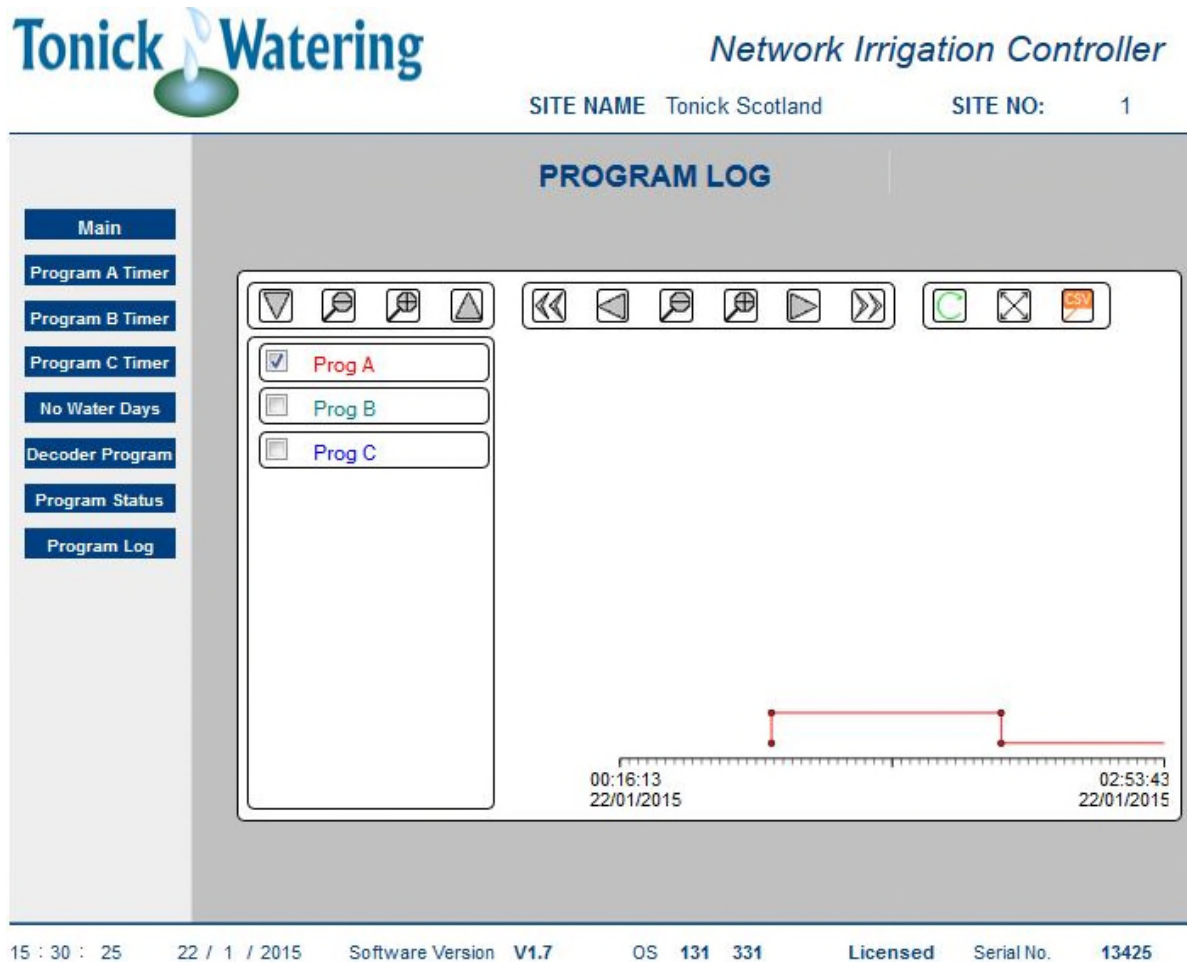
PROGRAM selects the program to be monitored

BLOCK displays the block number. Zero indicates the program is not running

To the right of the block number is the inter-block delay, which counts down as the delay elapses from one block to another. When it reaches zero, the next block starts and it goes back up to the inter-block delay value as set in the Program Timer.

System Commissioning & Testing – Decoder Program Log web page

A graphical time line of the program activities can be seen by clicking the [PROGRAM LOG](#)



Here the activity of program A is shown as a graph.

Buttons along the top allow scrolling the time line and zooming

If required, this can be displayed as a CSV spreadsheet format by pressing the “CSV” button. When pasted into say Notepad, it can then be imported from there into an Excel spreadsheet.

System Commissioning & Testing – Decoder Event web page

Useful information can be obtained on program past operation or other events by selecting the **EVENT LOG**

The screenshot shows the Tonick Watering Network Irrigation Controller web interface. The header includes the logo, site name 'Tonick Scotland', and site number '1'. A left sidebar contains navigation buttons for Main, HydroZones, Stations, Programs, Decoders, Translators, Alarms, Water Balance, Network, Weather, Site Information, Date Time, and Event Log. The main content area is titled 'EVENT LOG' and displays a table of events.

Time	Name	Value
22/01/2015 02:06:28	ProgramARunning	0
22/01/2015 02:03:55	BT1DecoderR_003	0
22/01/2015 01:34:32	BT1DecoderR_003	1
22/01/2015 01:33:59	BT1DecoderR_002	0
22/01/2015 01:16:41	BT1DecoderR_002	1
22/01/2015 01:16:09	BT1DecoderR_001	0
22/01/2015 01:00:06	BT1DecoderR_001	1
22/01/2015 01:00:01	ProgramARunning	1
21/01/2015 16:19:22	BTRestartsBT1	17
21/01/2015 10:58:08	BTRestartsBT1	16

At the bottom of the table, there is a filter dropdown menu set to 'All', a unit toggle set to 'ms', and a refresh button.

The results may be filtered using the drop down box.

“ms” toggles the time stamp between to the nearest whole second and milliseconds.

In this example:

on 22nd January 2015

Program A started running at 01:00:01 (one second after 1am)

Decoder address 1 on BT1 turned on at 01:00:06 and off again 01:16:09, roughly 16 minutes (960 seconds) (which was block1 of program A

There was a 30 second delay (inter-block delay

Decoder address 2 on BT1 turned on at 01:16:41 and off again at 01:33:59, roughly 17 minutes.

Program A finished at 02:06:28

System Commissioning & Testing – Decoder web page

The Decoder web page is used to see the status of all the decoders for the selected BT2. On this page you can observe the current total 2 wire current and switch the 2 wire output off. There is a manual override

Tonick Watering *Network Irrigation Controller*

SITE NAME SITE NO: 0

DECODERS PAGE

BLIND TRANSLATOR NUMBER 1 Total 2 Wire Current (mA) 0

Line

MANUAL OVERRIDE Clear All Manual

Decoder No. 1 Qty 1 State Manual ON Apply

	01	02	03	04	05	06	07	08	09	10
00										
10										
20										
30										
40										
50										
60										
70										
80										
90										
100										
110										
120										

10:30:48 29/12/2014 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

Decoder Web Page

Total 2 Wire Current – This displays the total 2 wire current in milliamperes (mA) on the selected Blind Translator

Line (ON/OFF) – This toggles the 2 wire voltage output on the Blind Translator ON and OFF

Manual Override Decoder No. – Enter the decoder Number to manually control

Qty – This selects the number of Decoders to switch starting from the Decoder No.

State – This selects the state you want the decoder in Manual ON, Manual OFF and Automatic

Apply – Apply button is used to activate the manual override setting

Clear All Manual clears all manually operated stations back to automatic.

When put to manual, after a few seconds, the box surrounding the dot will turn blue.
If the decoder turn-on is successful, the dot in the middle will turn green.

Note the “Total 2 Wire Current (mA)” will be the sum of all the decoder currents plus that taken by the 'on' stations solenoids

If the decoder turn-on is UN-successful, the dot in the middle will not change colour and the “Total 2 Wire Current (mA)” will not change significantly.

Tonick Watering Network Irrigation Controller

SITE NAME Tonick Scotland SITE NO: 1

DECODERS PAGE

BLIND TRANSLATOR NUMBER 1

MANUAL OVERRIDE Clear All Manual

Decoder No. 1 Qty 3 State Manual ON Apply

Total 2 Wire Current (mA) 483

Line ●

DECODERS										
	01	02	03	04	05	06	07	08	09	10
00	●	●	●	○	○	○	○	○	○	○
10	○	○	○	○	○	○	○	○	○	○
20	○	○	○	○	○	○	○	○	○	○
30	○	○	○	○	○	○	○	○	○	○
40	○	○	○	○	○	○	○	○	○	○
50	○	○	○	○	○	○	○	○	○	○
60	○	○	○	○	○	○	○	○	○	○
70	○	○	○	○	○	○	○	○	○	○
80	○	○	○	○	○	○	○	○	○	○
90	○	○	○	○	○	○	○	○	○	○
100	○	○	○	○	○	○	○	○	○	○
110	○	○	○	○	○	○	○	○	○	○
120	○	○	○	○	○	○	○	○	○	○

15 : 45 : 08 22 / 1 / 2015 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

In this example:

BT2 no. 1 has decoders with addresses 1, 2, 3 in manual and successfully on.

The current in the 2Wire path is 483mA, being the sum of all the decoder standby currents on that path, plus the sum of the solenoid currents on the decoders 1, 2, 3.

System Commissioning & Testing – Translator web page

The Translator web page is used to display the current status of the selected Blind Translator (BT2). It allows the user to enable the Blind Translator, show the communication status and to set current thresholds for the Blind Translator.

Translator Web Page

Tonick Watering *Network Irrigation Controller*

SITE NAME SITE NO: 0

BLIND TRANSLATOR PAGE

BLIND TRANSLATOR NUMBER 1

Software Version 1.7 Decoder Type Underhill

RS485 Communication

BT Enable ☒ Comms OK ● Comms Cycle 4139 Comms Errors 0 Last Error 0

Reset

Last Time of Good Comms 10:26:22 29:12:2014

Line Current Trend

Blind Translator Status

		New Value
Low Current Threshold (mA)	64	0
High Current Threshold (mA)	907	0
Total 2 Wire Current (mA)	0	Update

Line ●

Busy Flag ●

Line High Current (mA) ●

Resettable Fus Tripped ●

Stations Failures Present ●

Cant Implement Signalling ●

10 : 26 : 24 29 / 12 / 2014 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

Blind Translator Number – This drop down box allows you to select the Blind Translator to view

Software Version – Current Software Version of the Blind Translator

Decoder Type – Will Show the Decoder type setting of the Blind Translator i.e. TK-DEC-1/PC or Tonick

BT enable – Enables or Disables the current selected Blind Translator

Comms OK – Indicator to show if the Communication to the BT is OK

System Commissioning & Testing – Translator web page continued

Comms Cycle – This shows the current communication cycle. This value will increment every time the BT is polled for data

Comms Errors – Communication Errors, this value will increment if there are communication errors between the RM2 and BT

Last Error – Will Show the last communication error code

Reset – This button will reset the communication cycle and errors value to zero

Last Time of Good Comms – This will display a date and time of the last time there was good communication between the RM2 and the BT2

Total 2 Wire Current (mA) – Displays the current consumption on the 2 Wire output

Line ON/OFF – This button toggles the BT2 line output on and off. The indicator will show the current status of the Line output.

Busy Flag – Display the current status of the busy flag on the BT2. This is set during signalling or when reading a sensor decoder.

Line High Current – Display the current status of the Line High current flag on the BT2. The BT2 will set this flag if more than 1600mA is sensed for about 10 seconds.

Resettable Fuse Tripped – Display the current status of the Resettable Fuse tripped on the BT2. A thermally resettable fuse is used to protect against main line short circuits on the 2 wire path.

Stations Failures Present – Display the current status of the Stations Failures Present flag on the BT2

Can't Implement Signalling – Display the current status of the Can't Implement Signalling flag on the BT2


Low Current Threshold – Displays the current low current threshold in the BT2. This value can be modified by entering a new value in the New Value box and pressing Update. This threshold is used to determine if a decoder has switched on or off successfully. If the change of 2 wire current exceeds this threshold after an on or off command, success is logged.

High Current Threshold – Displays the current high current threshold in the BT2. This value can be modified by entering a new value in the New Value box and pressing Update. This threshold is used to detect bad solenoids taking too high a current. If such is detected, the station will be turned off and an error logged.

System Commissioning & Testing — Alarms web page

The Alarms web page is used to show historical view of alarms on the RM2. Each alarm has a start time indicating when the alarm was first triggered and an end time of when the alarm was cleared.

Alarms Web Page



Network Irrigation Controller

SITE NAME Tonick WateringSITE NO: 1234

Main

HydroZones

Stations

Programs

Decoders

Translators

Alarms

Water Balance




Network

Weather

Site Information

Date Time

ALARMS

	Start Time	End Time	Description	Id
	22/07/2014 09:13:47	22/07/2014 09:18:17	Blind Translator 1 Station Failure - Decoder/s 1,2,3,4,5,7,	2
	21/07/2014 16:15:19	-	GPRS Connecting	1
	21/07/2014 16:15:19	-	New Program	-

10:12:01

22/07/2014

Software Version

V1.3

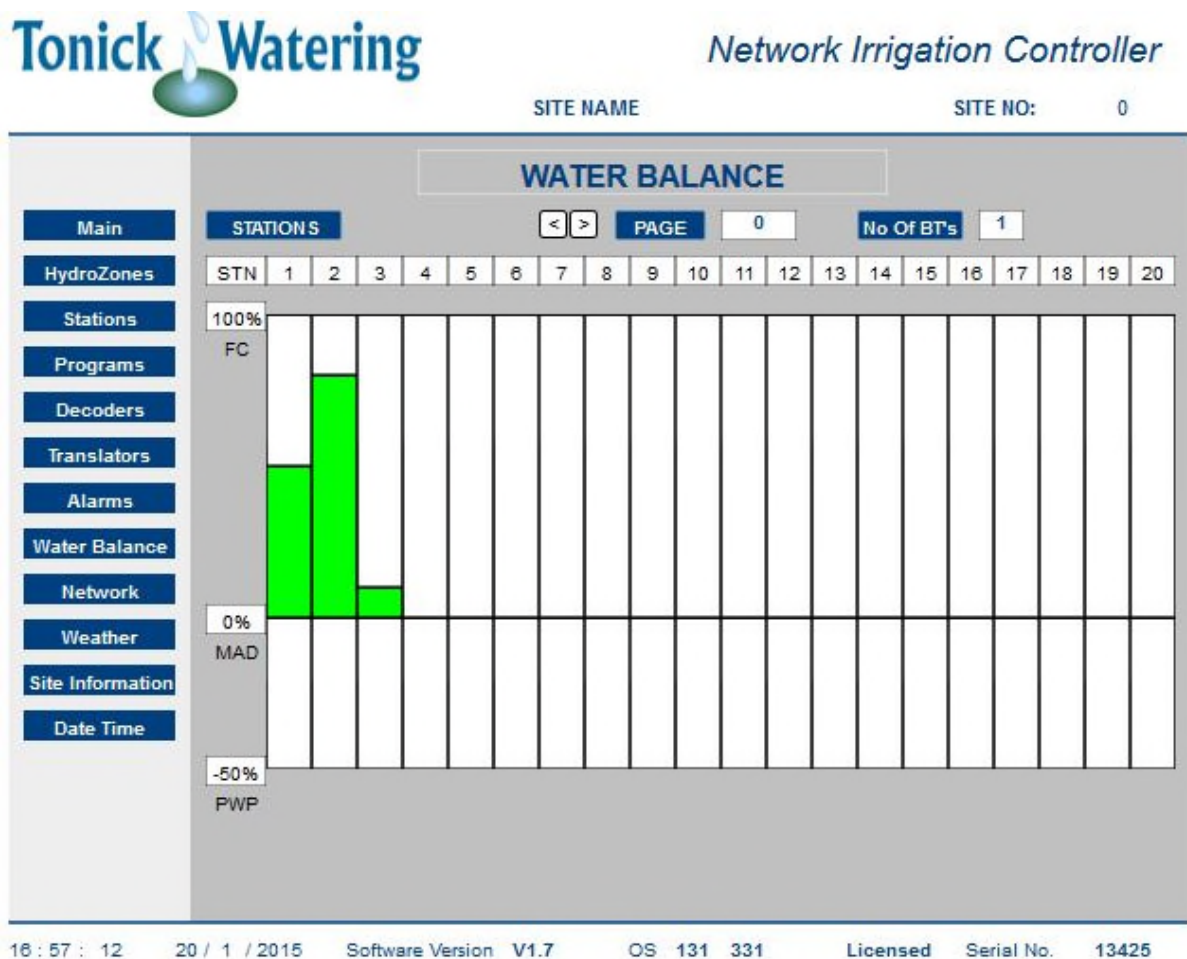
Serial No.

13221

System Commissioning & Testing – Water Balance web page

The Water Balance web page is used to show current water balance status of all the stations in a quick and easy format. The bars will be scaled in a uniform percent even though the actual values may differ from station to station.

Water Balance Web Page



The Water Balance algorithm will try and keep the station's root zone between FC and MAD. In this region the bar will be green. Below this the bar will display in red

Definitions:

PWP Permanent Wilt Point. The level in mm of water in the soil root zone where the plant will die.

FC Field Capacity. The maximum level in mm of water in the root zone that a particular soil can hold.

MAD The Maximum Allowed Depletion (or Managed Allowed Depletion) level in mm of water in the root zone of soil when irrigation must recommence.

PAW or AVPW. The plant's available water level in mm in the root zone of the soil, being the difference between FC and PWP.

The STN indicates the station who's waterbalance is being displayed.

Below is the relationship between stations, BT2 number and decoder Addresses.

Stations and Decoders

Station Setup:

Each station is linked to a decoder. Station 1 is mapped to decoder 1 and BT2 #1 (Modbus Address 1)

Decoders 1-127(TW/2W) and 1-63 (TK-DEC-1/PC) are mapped to stations 1-127 and 1-63 respectively

Station Number	BT2 Modbus Address	Decoder Address	Notes
1	1	1	
2	1	2	
3	1	3	
63	1	63	
64	1	64	Can only use TW/2W Decoders at this address
128	2	1	
129	2	2	
255	3	1	
256	3	2	
382	4	1	
383	4	2	

RM2 V1.9 and up: - Sensor Decoders

RM2 version 1.9 software onwards, now includes 2 wire sensor decoders which support a number of different process sensors including Flow, Pressure and Water content. The RM2 now supports up to 8 sensor decoders per Blind Translator. The sensors decoders are configured, logged and displayed through the Sensor web pages on the RM2.

Each Blind Translator supports up to 8 sensor decoders, sensor decoder 1 is sampled at a much higher rate than Sensor Decoders 2 – 7. Every minute two Sensor Decoders are sampled, Sensor 1 is sampled every minute with one of the other sensors (2-7) being sampled. If only 4 sensor decoders are enabled i.e. 1,5,7,8 then Sensor 1 is sampled every minute and Sensors 5, 7 & 8 are sampled every three minutes.

Example of Sensor sampling:

First minute	– Sensor 1 & 5 Sampled
Second Minute	– Sensor 1 & 7 Sampled
Third Minute	- Sensor 1 & 8 Sampled
Fourth Minute	- Sensor 1 & 5 Sampled

Sensor 1 is recommended for flow measurement where the number of pulses from the flow meter are high and therefore the flow sensor decoder needs to be read frequently (TK-FLO-CC) or a frequency input is needed (TK-FLO-FREQ). However, you can still use flow measurement on Sensor decoders 2 to 8 as long as the sensor sample rate reads the sensor decoder before it overflows twice (TL-FLO-CC).

Sensor decoders 2 to 8 are recommended for Pressure & Water content.

When a TK-FLO-CC Flow sensor is selected, the flow rate is calculated on a rate per minute. The TK_FLO-FREQ gives a flow (actually velocity) counted over a 2 second period, then divided to produce a frequency of pulses/second

If a sensor decoder is enabled but does not get a valid response the display will show a “-1”.

MAIN PAGE

SITE NUMBER 0

SITE NAME

SITE ADDRESS

SITE NOTES

BT2 COMMUNICATION

#1

#2

#3

#4

NETWORK

LAN IP Address 192.168.1.99

Modem IP Address 0.0.0.0

Modem Signal Strength 0

OVERVIEW

Number Of BT 2

Irrigation Today (Hours) 1.04

Watering Budget (%) 100

Eto (mm) 1.00

RM2 Internal Temp (Deg C) 33.6

RM2 Input Voltage 24.51

STOP

Main

HydroZones

Stations

Programs

Decoders

Sensors

Translators

Alarms

Water Balance

Network

Weather

Site Information

Date Time

Event Log

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The Sensor Web Pages are accessed from the main menu

Sensor Setup

Main

Sensor Display

Sensor Config

Sensors BT1

Sensors BT2

Sensors BT3

Sensors BT4

SENSOR CONFIG

BLIND TRANSLATOR NUMBER

2 ▼

#	En	Sensor Type	Name	Units	T Units	Pulse Weight
1	<input checked="" type="checkbox"/>	Flow ▼	Main Flow	L/Min	L	0.568
2	<input checked="" type="checkbox"/>	Pressure KPa ▼	Header Pressure	PSI		0
3	<input checked="" type="checkbox"/>	Water Content ▼	Green 1	%		0
4	<input checked="" type="checkbox"/>	Water Content ▼	Green 2	%		0
5	<input checked="" type="checkbox"/>	Water Content ▼	Green 3	%		0
6	<input checked="" type="checkbox"/>	Water Content ▼	Green 4	%		0
7	<input checked="" type="checkbox"/>	Water Content ▼	Green 5	%		0
8	<input checked="" type="checkbox"/>	Water Content ▼	Green 6	%		0

Apply

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Serial No. 13762

- #** Sensor Decoder address
- En** Enable or Disable the Sensor
- Sensor Type** FLO-CC, FLO-FREQ, Pressure KPa, Pressure PSI or Water Content
Note Pressure KPa and Pressure PSI is the same sensor scaled in KPa or PSI
- Name** Type the Sensor name here.
- Units** Type here the Sensor Units. If the pressure sensor is selected, then use either KPa or PSI
- T units** Flow Totaliser units for FLO-CC – Enter here the Flow Totaliser units. This should be the same units as the sensor units. NOTE: Flow Check only uses litres/minute; L/Min
- Pulse Weight** This is used to set FLO-CC flow sensor pulse value i.e what each pulse represents from the flow sensor TK-FLO-CC.
- Apply** Save configuration

Sensor Display



Network Irrigation Controller

SITE NAME

SITE NO: 0

SENSOR DISPLAY

BLIND TRANSLATOR NUMBER 2 ▼

#	Name	Value		Flow Totaliser		Errors
1 Fl	Main Flow	11.73	L/Min	12636	L	0
2 Pk	Header Pressure	-1.00	PSI			2
3 Wc	Green 1	-1.00	%			2
4 Wc	Green 2	-1.00	%			2
5 Wc	Green 3	-1.00	%			3
6 Wc	Green 4	-1.00	%			2
7 Wc	Green 5	-1.00	%			2
8 Wc	Green 6	-1.00	%			2

[Reset](#)

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Note: *The Errors column shows the number of failed sensor reads. This can be used to diagnose issues with enabled sensor decoders. The Reset button allows you to reset all the sensor error counts*

-1.00 indicates a non-valid reading or no reading yet

SENSOR DISPLAY

BLIND TRANSLATOR NUMBER 1 ▼

#	Name	Value		Flow Totaliser	Errors
1 Wc	test	5.00	%		0
2 FI					
3 FI					
4 FI					
5 FI					
6 FI					
7 FI					
8 FI					

[Reset](#)



Main

Sensor Display

Sensor Config

Sensors BT1

Sensors BT2

Sensors BT3

Sensors BT4

Flow Alarms

Flow Monitor

Flow Check

Flow Sensor

SENSOR DISPLAY

BLIND TRANSLATOR NUMBER

1 ▼

#	Name	Value	Flow Totaliser	Errors
1 Hz	Flow Freq	22.00	0	2
2 FI				
3 FI				
4 FI				
5 FI				
6 FI				
7 FI				
8 FI				

Reset

Sensor Trend Page - Sensor BT#

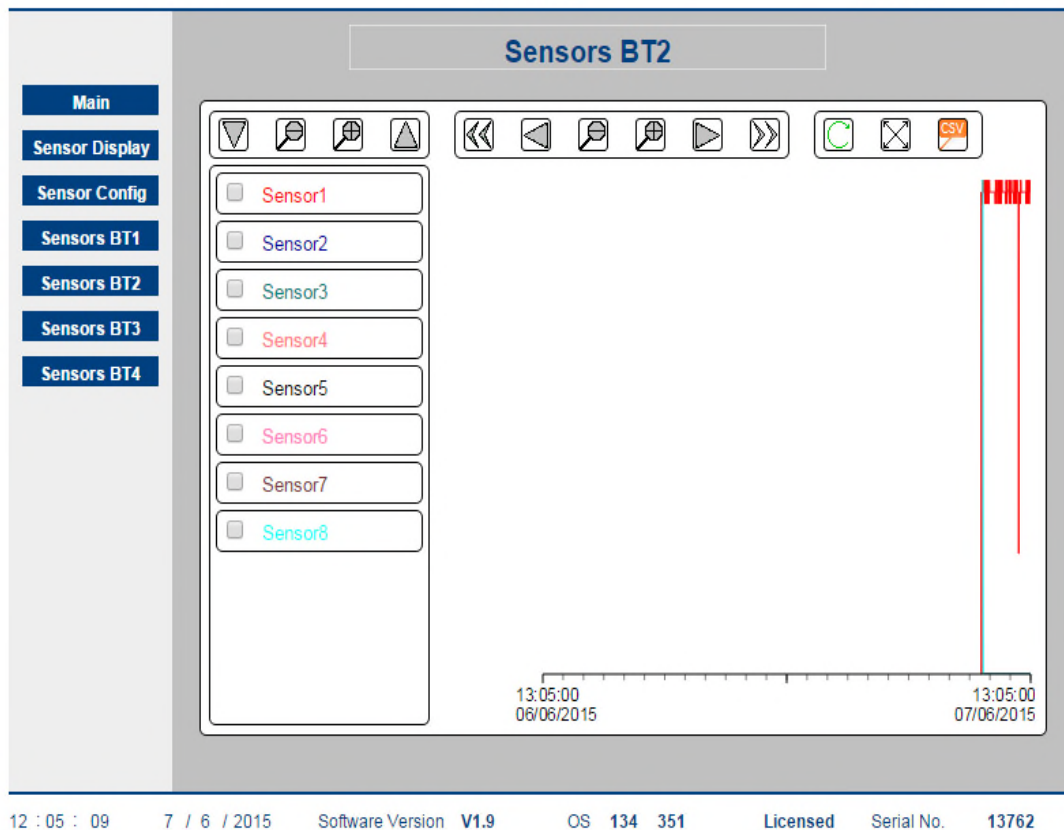


Network Irrigation Controller

SITE NAME

SITE NO:

0

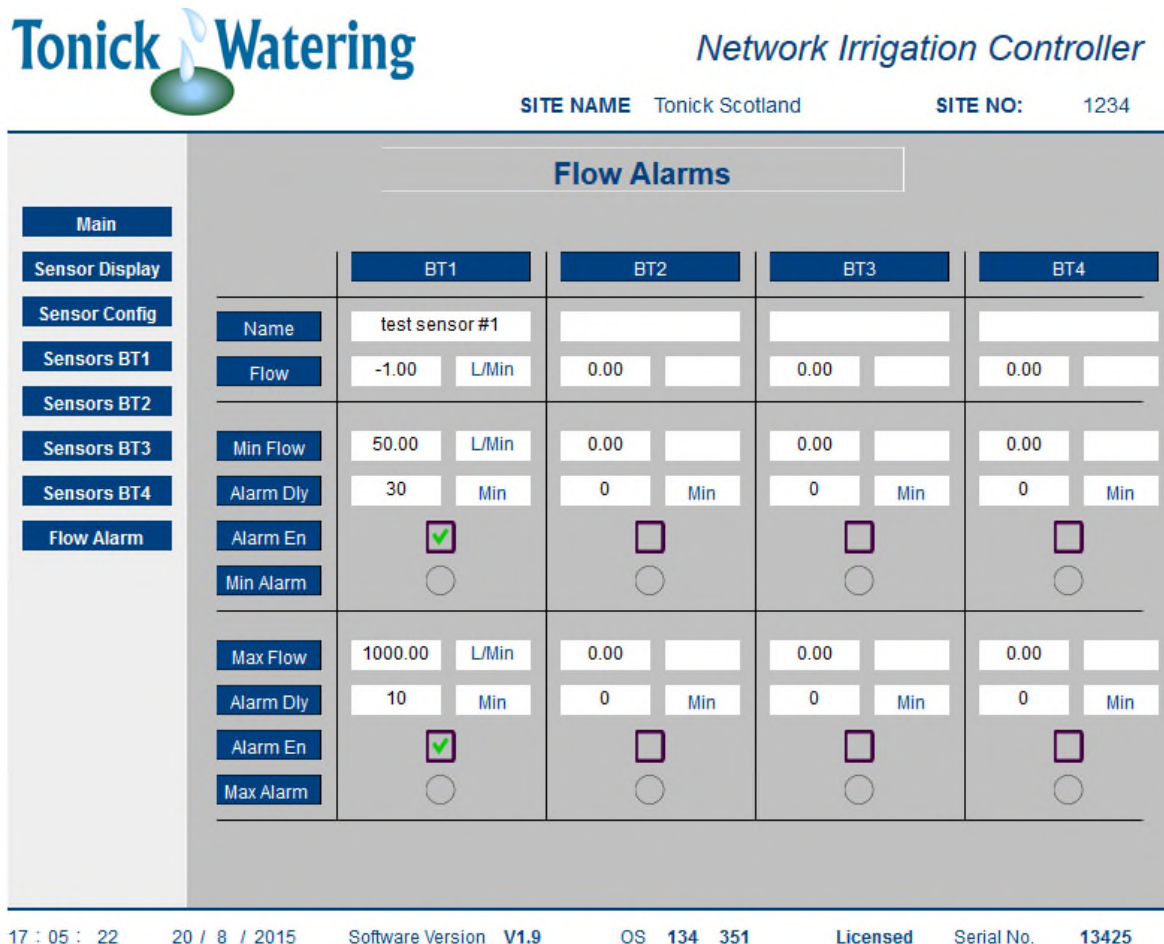


To follow the actual values, click on the tick box next to the sensor of interest. Dots will appear on the graph and hovering the cursor over a dot will display its reading as logged

Flow Alarms TK-FLO-CC

This is best used when Flow Check is not active. It is designed to be used with one TK-FLO-CC at sensor address #1

When using a TK-FLO-CC at sensor #1, provision is made for high and low flow alarms from



Tonick Watering Network Irrigation Controller

SITE NAME Tonick Scotland SITE NO: 1234

Flow Alarms

	BT1	BT2	BT3	BT4
Name	test sensor #1			
Flow	-1.00 L/Min	0.00	0.00	0.00
Min Flow	50.00 L/Min	0.00	0.00	0.00
Alarm Dly	30 Min	0 Min	0 Min	0 Min
Alarm En	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Min Alarm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Max Flow	1000.00 L/Min	0.00	0.00	0.00
Alarm Dly	10 Min	0 Min	0 Min	0 Min
Alarm En	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Max Alarm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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sender number one on each Blind translator.

When using a TK-FLO-FREQ, use the Flow-Check instead.

The Low Flow alarm is to detect water leaks.

To allow for hand watering, the Min Flow is set to allow a hosepipe to be used when there is no automatic irrigation. In this example, a hose with a maximum delivery of 50 L/min can be used for up to 30 minutes, before a water leak alarm is generated. This alarm is only active when there are no stations running

The high flow alarm is to detect bursts.

In this example more than 1000 L/Min for more than 10 minutes will generate a high flow alarm. This alarm is active at all times.

The alarm log may be inspected to see when the high flow happened. By noting the time of the alarm. The event log may then be inspected to see which stations were active at that time, if any.

Dynamic Flow Monitoring “FLOW CHECK”

Software version 1.11 and above introduces powerful dynamic flow monitoring of individual stations during a program run.

As a separate exercise, the individual flow of each station may be memorised, or manually entered.

If enabled, when a program is being run, the collective flows are totalised and if different by more than a specified percentage, an alarm is raised.

Monitoring of flow is done by one or more Tonick TK-FLO-FREQ sensor decoders. These interface to a paddle wheel type insertion flow meter, producing a pulse frequency of between 1-255Hz, proportional to water velocity in the pipe.

The manufacturer of the insertion flow meter publishes two constants “Offset” and “K”. Based on the pipe diameter and the end flow units required (L/Sec, GPM etc.),
$$\text{FLOW} = (\text{freq} + \text{Offset}) \times K$$

If enabled, there are flow readings made at the same intervals as defined in “RM2 V1.9 and up: - Sensor Decoders” both during a watering program and outside it. The first is 'x' seconds after the block has started and the second, in the inter-block gap after 'y' seconds. This latter can only be done if the watering program's inter-block gap is longer than 'y'

During a program the individually recorded and stored flows are totalised, and if different by more than a specified percentage, plus an offset+/-, an alarm is raised.

Outside of a program running, all stations should be off and the flow zero. If greater than the +/- offset, an alarm is raised.

e.g if % tolerance is 10% and +/- is 1L/min and last flow was 12.3L/min, then if the 'off' flow is greater than $(10\% \times 12.3) \pm 1L = 2.23 \text{ L/min}$ or 0.23 L/min , an alarm will be raised after the alarm delay figure in seconds

TIMING

The reading of a sensor takes about 2 ½ seconds. This is interleaved with decoder on/off commands.

For example:

'x' seconds after a block has started, with 40 decoders on at the same time (10 per BT2 and 4 BT2s), there may be several flow sensors to be read. Allowing 5 seconds per flow sensor (as a contingency), the station run times in a block must exceed 'x' + (no of flow sensors x 5) seconds, otherwise some stations will have turned off before the associated flow sender is interrogated. This will obviously throw up an alarm.

Flow Sensor Configuration

This screen is reached by clicking Main/Sensors/FlowSensor



FLOW SENSOR CONFIG

BLIND TRANSLATOR NUMBER

1

Units

L/min

60 Hz
☐

#	ADR	En	Flow Chk	Name	Offset	K	Last Value
1	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		5	1	22.00
2	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
3	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
4	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
5	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
6	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
7	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
8	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
9	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00
10	0	<input type="checkbox"/>	<input type="checkbox"/>		0	0	0.00

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OS 142 455
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Serial No. 5058

Illustration 1: Setting up the TK-FLO-FREQ Senders

1

The maximum allowed number of TK-FLO-FREQ senders on each Blind Translator (BT) interface is 8. They can of course, be mixed with other Sender types, Flow Totaliser, Pressure, Water Level, Soil Moisture, Digital Inputs.

BLIND TRANSLATOR NUMBER (BT2 No.) identifies to which BT2 the senders are connected
Units is a global label identifying the units of flow for the whole flow monitoring and all TK-FLO-FREQ senders on all BT2s. This is free text.

Currently, all FLOW CHECK is in Litres/minute (L/min)

Note: All units on flow must be the same

60Hz when ticked tells the RM-2 that 60Hz line frequency is being used on the 2wire path connecting the valve decoders (or DIAS) and the Senders.

assigns a unique number to that flow sender on that BT2. **"FLOW SENSOR#"**
 e.g. BT1 has 1-8, BT2 has 11-18 etc.

ADR the TK-FLO-FREQ address is assumed set to 1 for # = 1, and 1 for #=11, etc.

En when ticked, enables periodic reading of that sender

Flow Chk when ticked enables the sender to be used with flow checking

Offset is the manufacturer's supplied constant to turn frequency into flow units

K is the manufacturer's supplied constant to turn frequency into flow units

Last Value is the last reading in the flow units specified.

APPLY actions the changes.

Notes:

*The RM-2 will **not** convert units if the "Units" box is changed.*


*All units for all TK-FLO-FREQ senders **MUST** be the same and if Flow check is enabled, must be in Litres/minute (L/Min).*

Flow Check Setup

This screen is reached by clicking Main/Sensor/FlowCheck

بلدية مدينة أبوظبي

ABU DHABI CITY MUNICIPALITY



Network Irrigation Controller

SITE NAME

SITE NO: 0

Main

Sensor Display

Sensor Config

Sensors BT1

Sensors BT2

Sensors BT3

Sensors BT4

Flow Alarms

Flow Monitor

Flow Check

Flow Sensor

FLOW CHECK SETUP

☒ Enable Flow Check Monitoring

STATIONS ON - DELAY BEFORE READ

10

s

ALL STATIONS OFF - DELAY BEFORE READ

10

s

SET STATION FLOW S.P

BT # 1

DECODER # 2

STATION # 2

STATION

STATION STATUS

FLOW SENSOR # 1

UPDATE

CURRENT FLOW S.P

22.00

L/min

UPDATE STATION FLOW S.P

CURRENT FLOW VALUE

22.00

L/min

SAVE CURRENT FLOW VALUE

FLOW SENSORS #

BT # 1

UNITS L/min

1	22.00	2	0.00	3	0.00	4	0.00	5	0.00
6	0.00	7	0.00	8	0.00	9	0.00	10	0.00

FLOW ALARMS

FLOW ERROR

10

%

+/-

1

L/min

ALARM DELAY

0

s

15 : 26 : 58

7 / 8 / 2018

Software Version V1.13 B1

OS 142 455

Licensed

Serial No. 5058

In the illustration above.

Enable Flow Check Monitoring turns this procedure on and off. (global)

STATIONS ON-DELAY BEFORE READ specifies the number of seconds after the program watering block has started, before the flows are totalised and compared with the actual total flows measured. Recommended not less than 120 seconds

STATIONS OFF-DELAY BEFORE READ specifies the number of seconds after the program watering block has finished, before the actual total flows are measured. The reading should be zero, but if more than +/- L/min, an alarm will be raised. Recommended not less than 120 seconds after block finished.

Note: The inter-block delay must be longer than 'delay before read'

ALARM DELAY in seconds, delays the onset of a flow alarm in case of pipe emptying or other settling of water in the network.

SET STATION FLOW

By selecting the BT number and decoder number, a station on it can be associated with a particular flow meter.

This flow meter may not necessarily be on the same BT2. 'Flow Sensor #' 1-8 is on BT2 no.1, 11-18 on BT2 no. 2, 21-28 on BT2 no. 3 and 31-38 on BT2 no. 4

Flows can either be manually entered into **UPDATE CURRENT FLOW S.P.**, or the station manually turned on and the flow learned by clicking the **SAVE CURRENT FLOW VALUE** button.

The value so learned will not be displayed in the Current Flow S.P. unless the station number is changed to another, then back again to the value before (a Windows limitation)

Note:

It is essential, when learning flows, that other stations are not running, nor are there any leaks. Wait for the flow to settle before clicking.

The screenshot shows a software interface for setting station flow. It includes a title bar 'SET STATION FLOW S.P.' and several input fields: 'BT #' with a dropdown menu showing '1', 'DECODER #' with a text box containing '2', and 'STATION #' with a text box containing '2'. Below these are three rows of controls: the first row has a 'STATION' toggle switch (currently off), a 'STATION STATUS' indicator (a green dot), and a 'FLOW SENSOR #' text box containing '1' next to an 'UPDATE' button; the second row has a 'CURRENT FLOW S.P.' text box containing '20' with 'L/s' units, and an 'UPDATE STATION FLOW S.P.' button; the third row has a 'CURRENT FLOW VALUE' text box containing '10' with 'L/s' units, and a 'SAVE CURRENT FLOW VALUE' button.

BT# selects the BT2

DECODER# selects the decoder address in that BT2

STATION# reminds the user what is the unique station number assigned by the RM2 for that station.

FLOW SENSOR# Enter here the flow sensor that is nearest 'upstream' of the station which will measure its flow. Use the number allocated by the RM-2 in the FLOW SENSOR CONFIG screen in the # column. The flow sensor does not have to be in the same BT2 at the station.

UPDATE to lock in the value

STATION toggles the station on/off.

STATION STATUS round button to the right, goes green when the station is successfully on.

Note: A Master Valve and a Sub-Master valve may be turned on as a result.

CURRENT FLOW S.P. This holds the expected flow in L/Min in the FLOW SENSOR CONFIG screen. It can either be manually entered, by typing in a value, then clicking

UPDATE STATION FLOW S.P. Alternatively, it can be learned from the **CURRENT FLOW VALUE** when the **SAVE CURRENT FLOW S.P.** button is clicked. The value so learned will not be displayed in the Current Flow S.P. unless the station number is changed to another, then back again to the value before (a Windows limitation)

CURRENT FLOW VALUE shows the flow in the units programmed. This value is copied into the **CURRENT FLOW S.P.** If the **SAVE CURRENT FLOW VALUE** button is clicked, the station number advanced, then returned to that value

FLOW SENSORS

FLOW SENSORS #		BT #	3	UNITS	L/s				
21	0	22	0	23	0	24	0	25	0
26	0	27	0	28	0	29	0	30	0

This part of the FLOW SENSOR SETUP screen allows the viewing of up to 10 flow sensors. However in Flow Check only the first 8 are usable.

UNITS is copied from that set in the FLOW SENSOR CONFIG screen. It is read-only.

This example, refers to the flow sensors in BT2 no.3. The values 21-30 will change to 1 -10 if BT2 no.1 had been selected. etc.

After a station is turned on, the user may browse any of the 40 possible sensors in any of the BT2s to see what may be flowing.

In a tree structure of flow meters, there may be flow in upstream meters as well as the one most associated with the station selected.

FLOW ALARMS

FLOW ALARMS	
FLOW ERROR	10 %
ALARM DELAY	0 s

This part of the FLOW SENSOR SETUP screen enables alarms to be active when stations are on and/or off.

FLOW ERROR is the maximum deviation in flow from that expected by the sum of all the individual flows, plus a + or – figure. With pressure compensated valves and emitters, this may be set to +/-3% typically. For non-pressure regulated hydraulics, a figure of 10%-15% is more realistic. Setting the tolerance too tightly will result in false alarms.

When measuring the flow with all stations off, the flow must be less than the +/- figure. Obviously, flow should be zero, but this provides a buffer against false positive alarms.

ALARM DELAY When set in seconds, this will inhibit an alarm to allow ignoring water settling in the pipe network.

FLOW Monitor

This screen is reached by clicking Main/Sensors/FlowMonitor



Network Irrigation Controller

SITE NAME

SITE NO: 0

FLOW MONITOR

Flow Units

BT1			BT2			BT3			BT4		
FLOW	S.P	A	FLOW	S.P	A	FLOW	S.P	A	FLOW	S.P	A
0	30	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	40	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>
0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>	0	0	<input type="radio"/>

Main

Sensor Display

Sensor Config

Sensors BT1

Sensors BT2

Sensors BT3

Sensors BT4

Flow Alarms

Flow Monitor

Flow Check

Flow Sensor

10 : 45 : 41 15 / 6 / 2016 Software Version V1.11 OS 135 376 Licensed Serial No. 13762

This screen allows the monitoring of up to 32 flow sensors, 8 on each BT2. These are of the TK-FLO-FREQ. the bottom 2 on each BT2 are not used.

Each column shows the Flow sensor # from 1-10, numbered from the top.

In this example, flow sensor #1 and flow sensor #4 have setpoints in them (**S.P.**), because decoders are on in a block which are being monitored.

In this example, the measured flow on #4 and #1 is zero, because the demonstration hardware is not set up in the lab, but the **FLOW** would indicate the actual flow as measured by #1 and #4.

In a real live site, the **A** button to the right of **S.P** would be RED if the measured flow deviated by more than in the **FLOW ERROR % plus +/-**

The **S.P** is a dynamic value which is set by the number of decoders running in the current block that are assigned to that flow sensor.


In the above example screen, a block is running decoders 1, 2 & 4.

Decoder 1 has a setpoint of 10L/sec, decoder 2 has a setpoint of 20L/sec, both assigned to flow-meter #1 Thus setpoint 1 = 10 + 20 = 30 L/Sec

Additionally, decoder 4 is on having a setpoint of 40L/sec and assigned to flow-meter #4. Thus setpoint 4 is 40L/sec

Remember, the flow reading will start 'x' seconds after the start of a block and optionally 'y' seconds into the inter-block gap. Until these readings are taken, the value in **FLOW** will not be current.

Alarm Log:



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Network Irrigation Controller

SITE NAME: SITE NO: 0

ALARMS

- Main
- HydroZones
- Stations
- Programs
- Decoders
- Sensors
- Translators
- Alarms
- Water Balance
- Network
- Weather
- Site Information
- Date Time
- Event Log

Start Time	End Time	Description	Id
8 13:21:50	-	Flow Check Alarm - Flow Sensor 1 - Prog A-0 Prog B-0 Prog C-0 Flow=0.000, FlowMinSP=17.000, FlowMaxSP=23.000	21
8 13:17:15	07/08/2018 13:19:01	Flow Check Alarm - Flow Sensor 1 - Prog A-0 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=-1.000, FlowMaxSP=1.000	20
8 11:07:43	07/08/2018 13:08:04	Flow Check Alarm - Flow Sensor 1 - Prog A-36 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=-1.000, FlowMaxSP=1.000	19
8 11:07:02	07/08/2018 11:07:23	Flow Check Alarm - Flow Sensor 1 - Prog A-9 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=32.660, FlowMaxSP=42.140	18
8 11:02:51	07/08/2018 11:08:35	Flow Check Alarm - Flow Sensor 1 - Prog A-9 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=44.360, FlowMaxSP=56.440	17
8 21:01:29	-	Software Licensed Ok 88CE914A49A318ABCD81ACC5738BA9BFB5A5150F3C831C1106BBC36620DF6058	16
8 11:07:49	07/08/2018 11:00:10	Flow Check Alarm - Flow Sensor 1 - Prog A-42 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=-1.000, FlowMaxSP=1.000	15
8 11:07:02	06/08/2018 11:07:29	Flow Check Alarm - Flow Sensor 1 - Prog A-9 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=32.660, FlowMaxSP=42.140	14
8 11:02:53	06/08/2018 11:08:35	Flow Check Alarm - Flow Sensor 1 - Prog A-9 Prog B-0 Prog C-0 Flow=22.000, FlowMinSP=44.360, FlowMaxSP=56.440	13

17:22:16
7 / 8 / 2018
Software Version V1.13 B1
OS 142 455
Licensed
Serial No. 5058

In the highlighted illustration: an alarm was generated at 13:17:50 and stopped at 13:19:01
“ProgX-0” indicated the program was not running. The setpoint was therefore the +/- 1L/min,
but flow was measured by flow sensor #1 (BT1, address 1) at 22.000 L/min. i.e a leak.
If a program was running, the Prog x would indicate the block in which the alarm occurred.

System Commissioning & Testing – Weather web page

The Weather web page is used to show the current and historical weather conditions. It can be used to enter manually the ETo value which is used when using water balance. It can also be used to adjust the Budget Watering which can be used to throttle back the watering times. This budget is global, affecting all stations by an equal percentage. It will apply to both times and water balance calculations. Less than 100% is called 'Deficit Watering'.

Weather Web Page

Tonick Watering *Network Irrigation Controller*

SITE NAME Dennis RM2 SITE NO: 0

WEATHER

Yesterdays ETo(mm) 1.0 Rainfall So Far (mm) 0.0

Enter Manual Eto (mm) 0.0 **Enter**

Nominal ETo 4.0 Enable Nominal ETo ☒ Budget Watering % 25.0

☐ ETo (mm)
☐ Rainfall (mm)

00:00:01 01/01/1970 01:00:00 01/01/1970

11 : 27 : 30 14 / 4 / 2016 Software Version V1.10 OS 136 393 Licensed Serial No. 14450

Yesterday's ETo - The daily Reference Evapotranspiration for yesterday

Enter Manual ETo (mm) - Used to manually enter the ETo when it has not being sent to the controller or measured with an attached weather station.

If in Water Balance, where ETo has not been updated for the preceding 14 days, the watering will fall back to timed watering, even if set to Water Balance

Rainfall So far – Used to enter the rainfall so far since midnight

Budget Watering % - When set to 100%, all times, whether from Water Balance or Basic Watering Time (fixed time) will be as entered or as computed. If set to say, 50%, only half the watering time will be applied. Values allowable between 0% and 200%

To turn watering off completely – set the Budget % to zero.

ENABLE NOMINAL ETo as described in the Water Balance section, there is a way to alter the budget % based on yesterday's ETo

If this box is ticked, Budget Watering % is ratioed by $(\text{YesterdaysETo})/(\text{NominalETo})$.
e.g. in the above illustration, budget is now 25% which is 1mm/4mm

NOMINAL ETo Enter a figure here where the watering times actually used are as programmed into BASIC DAILY WATERING TIME in 'Stations-Watering' page. i.e. Budget will be 100%

When this happens, Budget % is automatically adjusted to the ratio
$$(\text{YesterdaysETo}/\text{NominalETo}) \times 100$$

A kind of weather-based irrigation can be implemented using this technique, where the budget % is adjusted daily by downloading 'YesterdaysETo' or daily, entering 'Manual ETo'

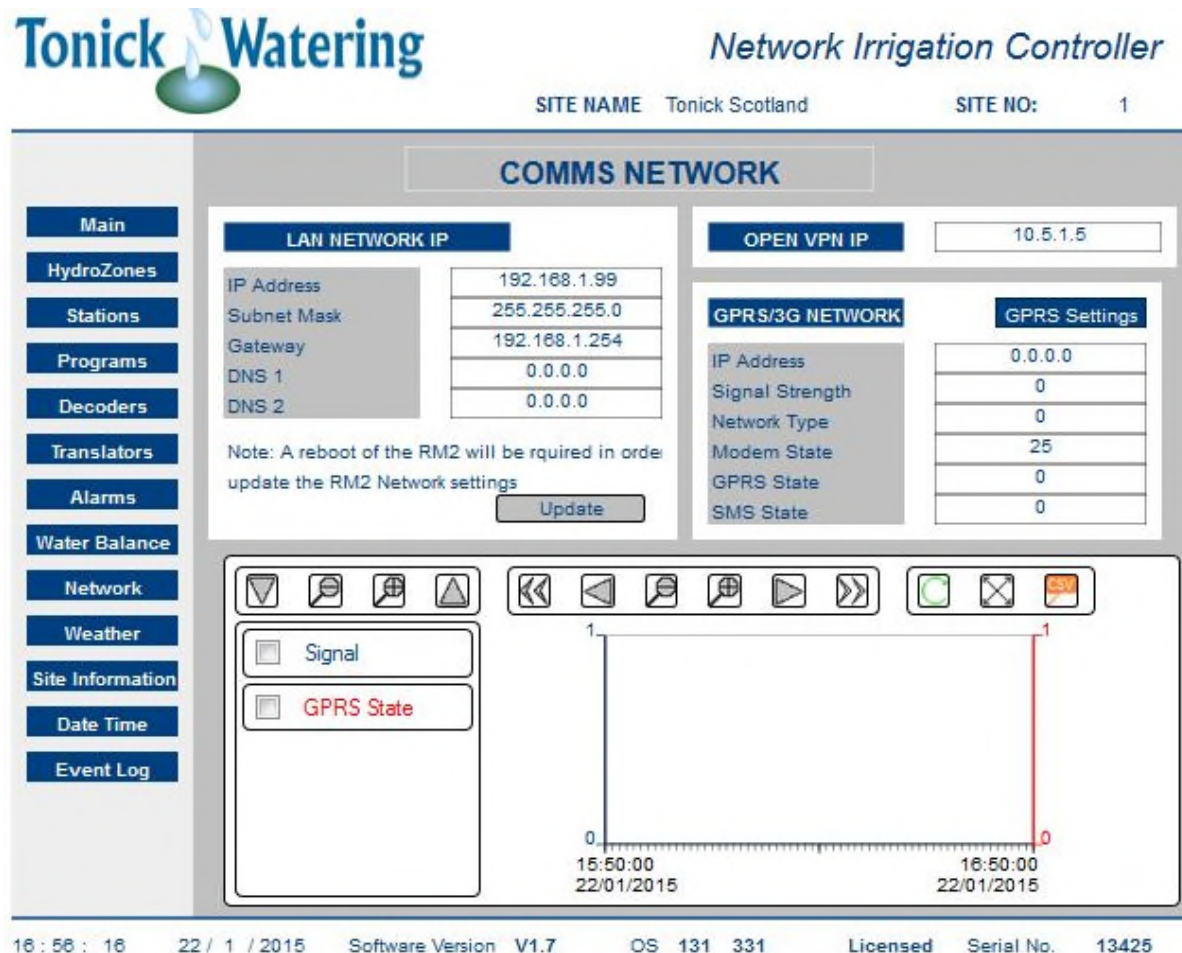
The challenges in using this method are:

1. Knowing what time to put into 'Basic Daily Watering Time' in the first place
2. Putting a value into 'YesterdaysETo' that considers *usable* rainfall, as 'Rainfall So Far' will not be used with this method.

System Commissioning & Testing – Network web page

The Network web page is used to display the LAN, GPRS/3G and VPN status.

Network Web Page



LAN Network IP – Display the current IP address for the Ethernet port of the RM2

Open VPN – Displays the current IP Address for the Open VPN

GPRS/3G IP Address - Display the current IP address for the GPRS/3G modem of the RM2

GPRS/3G Signal Strength - Display the current GPRS/3G modem signal strength of the RM2

GPRS/3G Network Type - Display the current Network Type for the GPRS/3G modem of the RM2. 0=GPRS & 1=3G

Modem State - Display the current modem state for the GPRS/3G modem of the RM2

GPRS State - Display the current GPRS state for the GPRS/3G modem of the RM2. 0=GPRS Disconnected, 1=GPRS Connecting, 2= GPRS Connected

SMS State - Display the current modem state for the GPRS/3G modem of the RM2


GPRS SETTINGS when clicked will go to the GPRS setup page

System Commissioning & Testing – GPRS Setup web page continued

The GPRS Setup web page is used to setup the GPRS/3G data connection for the RM2. In order for the RM2 to connect on a GPRS/3G network the modem requires the Access Point Name (APN) settings to be filled out. Contact your cellular provider for this information

GPRS Setup Web Page

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ABU DHABI CITY MUNICIPALITY



Network Irrigation Controller

SITE NAMESITE NO: 0

COMMS NETWORK

LAN NETWORK IP

IP Address	192.168.1.99
Subnet Mask	255.255.255.0
Gateway	192.168.1.1
DNS 1	0.0.0.0
DNS 2	0.0.0.0

Note: A reboot of the RM2 will be required in order to update the RM2 Network settings

Update

OPEN VPN IP

0.0.0.0

GPRS/3G NETWORK

IP Address	0.0.0.0
Signal Strength	0
Network Type	0
Modem State	255
GPRS State	0
SMS State	0

GPRS Settings

Signal

GPRS Connected

14:00:00
07/08/2018

15:00:00
07/08/2018

18 : 01 : 567 / 8 / 2018Software Version V1.13 B1OS 142 455LicensedSerial No. 5058

Click GPRS Settings....



Main

HydroZones

Stations

Programs

Decoders

Sensors

Translators

Alarms

Water Balance

Network

Weather

Site Information

Date Time

Event Log

GPRS SETUP

GPRS/3G Network

IP Address	0.0.0.0
Signal Strength	0
Network Type	0
Modem State	255
GPRS State	0
SMS State	0

Byte Count

Current APN

Enable Modem ☐

Reset

APN1 SETUP

APN1 ▼

APN

Authentication ☐

APN Username

APN Password

APN2 SETUP

APN

Authentication ☐

APN Username

APN Password

18 : 09 : 45
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APN – Enter the Access Point Name for your current Network provider here

Authentication – Tick this box if your cellular provider requires authentication i.e username and password

APN Username– Enter the Access Point Name Username for your current Network provider here

APN Password – Enter the Access Point Name Password for your current Network provider here

System Commissioning & Testing – Site Information web page

The Site information page is used to enter free text for information about the RM2 location and contact details

The screenshot shows the 'Site Information' page of the Tonick Watering Network Irrigation Controller. The page has a blue header with the logo and title. A sidebar on the left contains navigation buttons for various system functions. The main content area is titled 'SITE INFORMATION' and contains several form fields for entering site details. The status bar at the bottom displays system time, date, version, and serial number.

Tonick Watering *Network Irrigation Controller*

SITE NAME Tonick Scotland SITE NO: 1

SITE INFORMATION

SITE NAME Tonick Scotland

SITE NUMBER 1

SITE ADDRESS

Wilsonwells Croft

Crimond

Fraserburgh

Aberdeenshire

SITE NOTES

COUNTRY U.K.

CONTACT 1 NAME Tony Ware

CONTACT 1 TEL 07595 894484

CONTACT 2 NAME

CONTACT 2 TEL

17 : 08 : 30 22 / 1 / 2015 Software Version V1.7 OS 131 331 Licensed Serial No. 13425

SITE NOTES is a convenient place to put information about failures, repairs or modifications

System Commissioning & Testing – Date & Time web page

The Date and Time web page is used to set the date and time in the RM2

The screenshot shows the 'DATE TIME' configuration page of the Tonick Watering Network Irrigation Controller. The interface includes a sidebar with navigation links: Main, HydroZones, Stations, Programs, Decoders, Translators, Alarms, Water Balance, Network, Weather, Site Information, Date Time (selected), and Event Log. The main content area is titled 'DATE TIME' and contains several configuration sections:

- UTC Offset (Hours):** A text box with the value '0'.
- DATE:** A section with a 'DATE' label and the value '22 / 1 / 2015'. Below it are three input fields: 'DAY' (22), 'MONTH' (1), and 'YEAR' (2015).
- TIME:** A section with a 'TIME' label and the value '17 : 12 : 57'. Below it are three input fields: 'HOUR' (17), 'MINUTE' (12), and 'SECONDS' (57).
- NTP:** A section with an 'NTP' label. It includes an 'NTP Server' text box, an 'NTP Auto Update Time' text box with the value '00:00', and an 'NTP Auto Update Enab' checkbox. A 'Manual Sync' button is also present.

The footer of the page displays the following information: 17 : 12 : 56, 22 / 1 / 2015, Software Version V1.7, OS 131 331, Licensed, Serial No. 13425.

NTP Network Time Protocol can be set up for automatic time updates from the Internet.

Appendix A – BT2 Specification



Tonick's 2 wire decoder system has the following strengths and advantages.

- Decoder design proven in nearly 300,000 stations over 20 years
- 'Rock solid' lightning protection. Warranty includes damage by lightning
- No earth stakes required along the line, just one at the controller
- Most types of cable are acceptable, no special polyethylene or twisted pair cable is necessary
- Indifferent to truly horrendous earth leakage on the field cable
- Decoder communications protocol robust and proven in over 3000+ installations
- Decoder completely waterproof, all internal materials compatible with the potting compound.

What the Tonick decoder system does NOT do.

- It does not use DC anywhere, so cable destruction due to electrolytic action is avoided
- It applies full AC to the solenoid, so the number of stations on concurrently is limited compared to others that apply DC to the solenoid.
- Decoder distances are limited compared to others that use DC on solenoids or latching solenoids

The design of the Tbox Decoder Adaptor incorporates the latest Surface Mount Components, lead free as Per EU directive

Additional features are incorporated as follows:

- Conformally coated to allow operation in 95% humidity (non-condensing)
- Operation rated to ambient +70 degC (with de-rating)
- Relay Output Decoder (for Pump Starts)
- Sensor Decoders for moisture, flow and water pressure

Appendix A – BT Specification continued

BT2 Software Revisions:

V1.0 Preliminary.

V1.1 Renamed 'Status' as 'Actual' to remove ambiguity

Added bit 7 in Status register 40-001, Station Failures

V2.0 Cased version added.

Conformal coating higher ambient and humidity

Specified for operation up to +70 degC ambient.

Software Version No. unchanged at V1.0 (returned as 10 decimal, 0A hex)

Removed references to plug-in keyboard/display

V3.0 Derived from UI Modbus V2.0.

Tonick TW/2W series of decoders: 1-127 stations

Software version number reported as V1.1 encoded as 11 decimal.

V3.1 Sensor decoder operation added

Software version number reported as V1.2. encoded as 12 decimal

V3.2 Pressure sensor decoder and custom pressure sensor added

V3.3 BT2/TBOX version

V3.4 Modbus reply will be delayed during sensor decoder read. Modbus reply timeout will need lengthening.

Software version number will be reported as V1.6 encoded as 16 decimal

More explanation on the status register, 40-001

V3.5 Extra status bit in 40-001, bit 10. set if any kind of station failure. Only resettable by host controller's comms. Watchdog timeout lengthened from 8 to 16 seconds. Rewritten section on turning stations on and off using function 16H. Sensor decoder reply latency reduced to 2 seconds from 4. Software version now V1.9

Appendix A – BT2 Specification continued

Supply Voltage - 24 ~32 Vrms AC 50 or 60Hz. Transformer recommended: 26VAC 34VA 1300mA output, either (a) 230VAC 50Hz input OR (b) 115VAC 60Hz input. Customer sourced transformers must be pre-qualified by Tonick as suitable for the Warranty to be valid. AC supply must be spike and transient free, no drop outs or brown outs and substantially free of harmonics, particularly 3rd harmonic.

Supply Current - Up to 1 .3A

Output Voltage - 23 ~ 31 Vrms AC

Output Current (Max continuous) 1 .2A at Ambient +50degC
0.6A at Ambient +70degC
Linearly derate between +50 and +70degC

Note: Full Line output voltage will be continuously applied to the solenoids connected to 'on' decoders. Attention must be given to the specifications of these solenoids. DO NOT EXCEED THE MAXIMUM OUTPUT CURRENT OF THE TBOX DECODER ADAPTOR.

Line Signalling Up to 127 Tonick 2 Wire TW/2W (Watermation-style), or up to 63 TK-DEC-1/PC 2Wire Landscape decoders (TK-DEC-1/PC). Up to 10 active (Subject to total solenoid loads)

Allow 45 seconds after power-up, before switching decoders

Approvals CE (European) marked and compliant
RoHS (European) compliant & lead free

CPU 8 bit RISC. 8MIPs . 64K flash / 4K RAM / 4K EEPROM.

Firmware Re-writable application in general flash space. Uses Kanda Keyfob programmer.

Appendix A – BT2 Specification continued

Communications	RS485 half duplex (+-80V fault, 15kV discharge) 9600 Baud, N,8,2 (Other formats on request) Jumper selectable A, B line biasing resistors and 130 Ohm line terminating resistor
Isolation	1KV between decoder line/ transformer AC input and RS485 circuitry

Slave address programmable 1...7 using the on-board DIL switches.

Factory Set: Slave address 1

Connections

The TBOX DECODER ADAPTOR should be wired as follows.

AC and **AC** terminals should be wired to the transformer supply

L1 is the Field Cable 'Live' terminal (referred to as the 'line')

L2 is the Field Cable 'Neutral' terminal

EST The Earth Stake terminal (EST) MUST be connected to a properly bedded earth stake or plate via a 4mm² (#11 AWG) or larger earth wire. This earth system is not to be regarded as an electrical safety earth. Connection of the EST to a building and/or an electrical earth is NOT permitted. If it was, a lightning strike on the field cable would be conducted into the building and/or its electrical installation.

RS485 Terminals

A (D0), B (D1) are half duplex RS485 signals. B is more +ve than A during line idle conditions

COM is the ground of the RS485 circuitry, and must be connected to the RS485 0V of host controller.

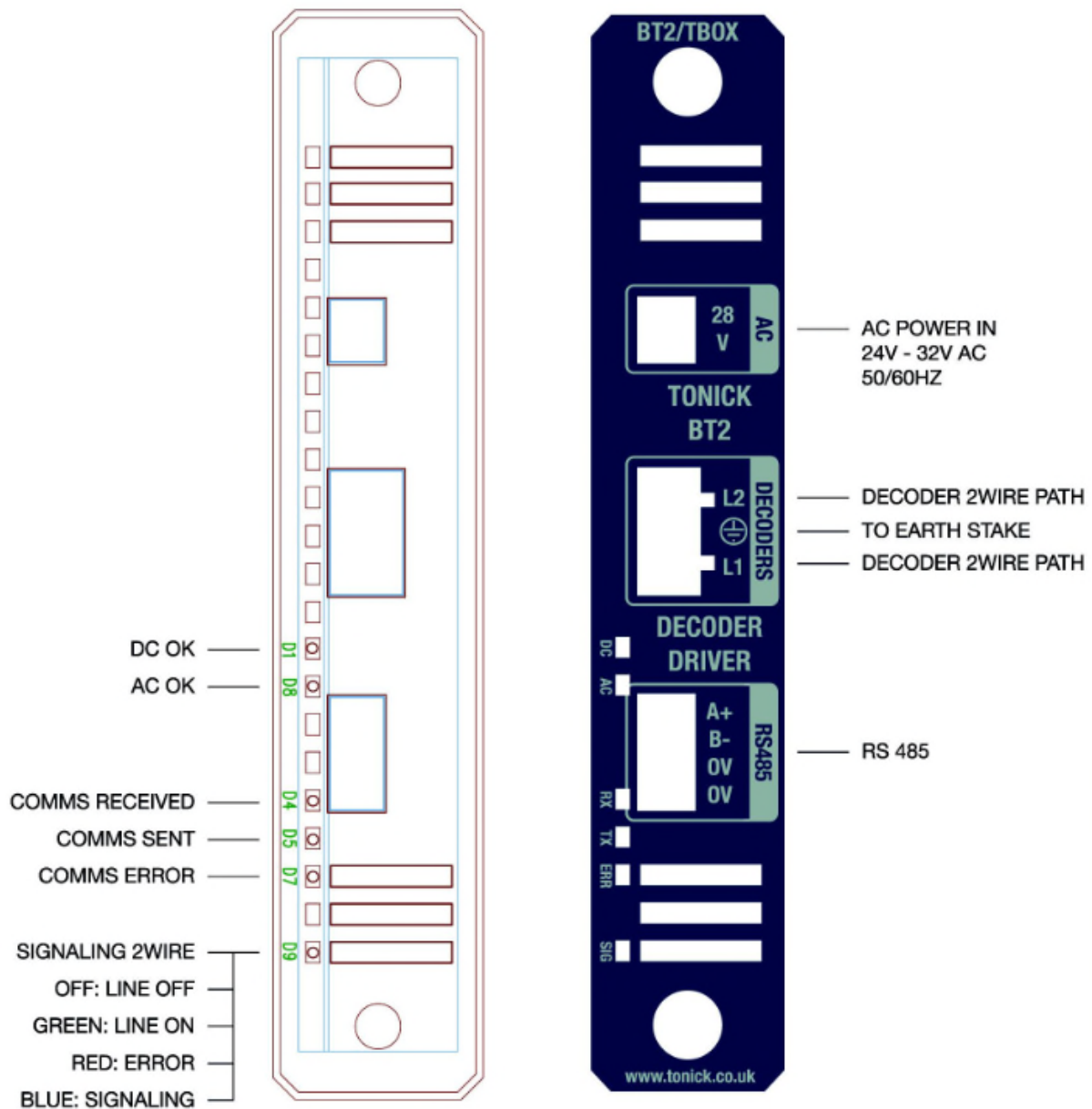
The RS485 is optically isolated from the TBOX Decoder Adaptor decoder circuits by at least 1KV to help protect against lightning surges propagating into the host controller.

Environmental _General

Storage	0 to 70 Degrees Centigrade 5% to 95 % humidity (non -condensing)
Operation	+5 to +70 degrees centigrade. De-rated from 1.2A output at +50degC to 0.6A output at +70degC 5 to 95 % humidity (non –condensing).
Conformally coated with Acrylic, except fan and terminals	

Appendix A – BT2 Specification continued

Tbox Decoder Adaptor Housing:



NOTE: RS485 A+ and B- may be in different order on some models of label.

HARDWARE

The communication hardware specification for TONICK TBOX DECODER ADAPTOR MODBUS RTU is 9600Baud RS485 1 Start, 8 Data, No parity, 2 Stop bits. The port is isolated to 1000V from the 2 wire paths and is +-80V fault tolerant on A and B. It will also withstand up to 15kV discharge from both direct and human body models. The isolation is intended to resolve lightning strike issues on the 2 wire paths, so protecting the host controller. The 0V comms must be wired to the TBOX 0V, making a 3 wire RS485 connection.

TBOX Decoder Adaptor supports a maximum of 127 Tonick 2 wire TW/2W or 63 TK-DEC-1/PC W-TK-DEC-1 decoders on its 2 wire path line, factory selected.

The TBOX Decoder Adaptor hardware will drop the relevant line if a current greater than approx 1.6A is detected for more than 10 seconds. Additionally it detects line short circuits and will drop the relevant line within 20mS. Both these events set error bits in the 16 bit signaling status register 40-001 accessed with function code 03H. An algorithm in the firmware attempts to make a decision about whether a line current fault can be attributed to a particular decoder. If it can, an error will be recorded for that decoder. Note: The short-circuit detection may not be triggered if there is significant line resistance between the controller and the short-circuit.

The Earth Stake terminal (EST) MUST be connected to a properly bedded earth stake or plate via a 4mm² (#11 AWG) or larger earth wire. This earth system is not to be regarded as an electrical safety earth. Connection of the EST to a building and/or an electrical earth is NOT permitted. If it was, a lightning strike on the field cable would be conducted into the building and/or its electrical installation. Conversely, a lightning surge on the power line will be transmitted to the decoder field cable and cause possible decoder damage.

Wiring

The TBOX Decoder Adaptor should be wired as follows.

AC and **AC** terminals should be wired to its transformer supply.

L1 is the Field Cable 'Live' terminal (referred to as the 'line' or 2 wire path)

L2 is the Field Cable 'Neutral' terminal

EST (Earth Stake Terminal) must be connected to the earth stake (see above for recommendations) EST from adjacent BT2/Tboxes can be connected together to just 1 earth stake or plate. Use a star connection from each BT2 EST to an INSULATED DIN rail terminal block, then a #11AWG/4mm² wire to the earth stake.

RS485 Terminals

A+ (D0), **B-** (D1) are half duplex RS485 signals. **B** is more +ve than **A** during line idle conditions

COM is the ground of the RS485 circuitry, and must be connected to the RS485 0V of TBOX controller.

The RS485 is optically isolated from the 2Wire decoder circuits by at least 1KV to help protect against lightning surges propagating into the TBOX controller.

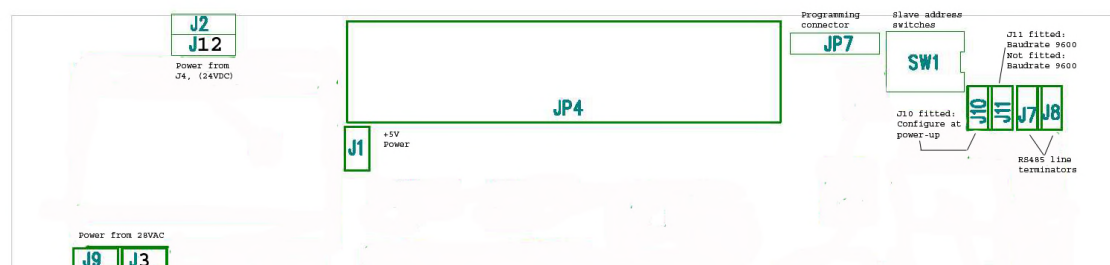
RS485 Line Termination

A line termination network is fitted to each BT2/Tbox. This can be put out of circuit by removing both J7 and J8. Only the last BT2 should have these in circuit

Address Select DIL switches SW1; Jumper in J10 whilst powering up. Sets slave address. Remove J10 after

DIL Position; Off = 0, On = 1

1 slave addr	0	0	1
2 slave addr	2	0	1
3 slave addr	4	0	1



Appendix B – BT2 Sensor Decoders

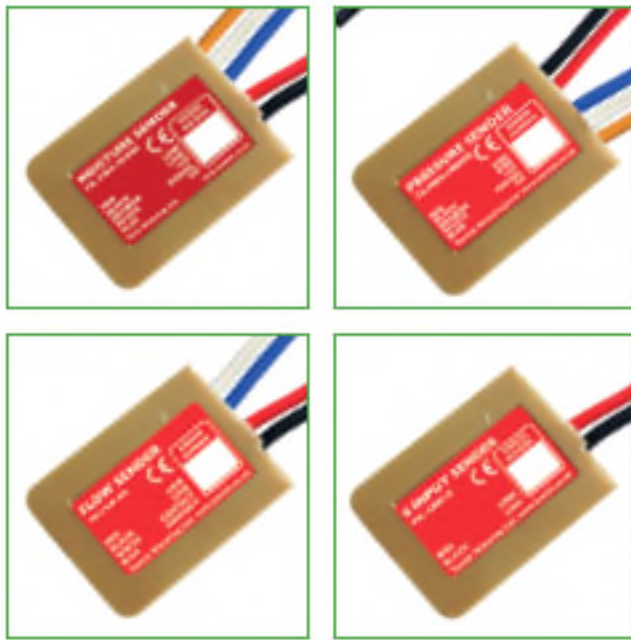
SENSOR DECODERS

There can be up to 8 sensor decoders in addition to the 127/63 valve decoders. These are separately addressed as 1-8, but do not interfere with decoders 1-8

There are currently 7 types.

1. **Volumetric soil Moisture Content (VMC)**, returning 0-55% in 1% increments
2. **Contact closure counting**. Measuring up to 5 closures/second from volt-free contacts. Counting into 7 bits in a byte 0x00-0x7F, wrapping around. The top bit is the contact position. 1=closed, 0=open.
3. **Flow Frequency monitoring**. For use with insertion flow meters. Reads frequency 1-255Hz
4. **8 digital inputs**. Measuring 12-30V AC or DC on each input with respect to a common. A voltage present returns a 1 in the byte. Inputs are isolated up to 1KV from the 2wire path.
5. **Gauge pressure, 0-10BAR** using an IP68 custom sensor, G1/4 male thread
6. **Gauge pressure, -1 to +6BAR** using an IP68 custom sensor, G1/4 male thread
7. **Differential pressure +/- 1BAR**. Useful for filter backwash triggering

More details on these sensors are in the brochure 'Tonick Watering Sensor Decoders'



TK-VWC-VH400	Moisture Sender decoder, inc VH400 Probe, 2m cable
TK-FLO-CC	Flow Sender, Contact closure
TK-PRES-10BARG	Pressure sending decoder with TD1000 10BAR Pressure sensor
TK-UNI-8	8 digital input sensor decoder 12/24V AC or DC input.
LATCHING SOLENOID CONVERTER	
TW/LATCH-1	AC to Latching Solenoid converter

Appendix C – BT2 Modbus Registers

HOLDING REGISTER DESCRIPTIONS

B Read- fn 03H. Preset- fn 16H C		Read- fn 03H. Preset- fn 16H	
address	Desired	address	Actual
40-008	outputs 1-16	40-016	Actual 1-16
40-009	outputs 17-32	40-017	Actual 17-32
40-010	outputs 33-48	40-018	Actual 33-48
40-011	outputs 49-64	40-019	Actual 49-64
40-012	outputs 65-80	40-020	Actual 65-80
40-013	outputs 81-96	40-021	Actual 81-96
40-014	outputs 97-112	40-022	Actual 97-112
40-015	outputs 113-126	40-023	Actual 113-126
		D	Read- fn 03H. Preset- fn 16H
		40-024	Sensor address
		40-025	Sensor trigger/results

For example: Turn on decoder 10

Set bit #9 in 'desired' holding register 40-008 (decoder 1 is in bit #0), using Write Multiple Registers Fn 16H

Wait about 1 second

Poll Holding Register 40-001, using Read Multiple Registers Fn 03H. Test bit 0. If zero, Busy is finished.

Test bit #9 in 'Actual' Holding Register 40-016

Desired & Actual should be the same; if not, a failure.

Bit 7 in Status register 40-001 will be set if the last station switched fails on or off. HOWEVER if followed by a successful on or off this bit will be cleared

Bit 10' Latched Station Failures' will be set if any station switched fails on or off. It will remain set until cleared by writing it to zero using Fn 16H

IMPORTANT:

When using TK-DEC-1/PC TK-DEC-1 decoders 1-63, do not set bits in 40-012 to 40-015 and 40-020 to 40-023

Use only 40-008 to 40-011 and 40-016 to 40-019

Appendix C – BT2 Modbus registers continued

A Read- fn 03H. Preset- fn 16H		40-001	Interface Status
address	description	bit#	description
		0	Busy flag. 1 = busy
40-001	Interface Status	1	Line high current (R/W)
40-002	Current change threshold lower (mA) (R/W)	2	
40-003	Current change threshold upper (mA) (R/W)	3	Resettable line fuse tripped (R/W)
40-004	Total 2 wire line current (mA) Read-only	4	
40-005	Top byte: S/w version x 10. bottom: decoder type	5	Line on (1), line off (0) (R/W)
40-006	\$AA55 hex. (user changeable)	6	
40-007	Front panel LED values (read-only)	7	Station failures present
		8	AC Supply OK
		9	
		10	Latched Station failures (R/W)
		11	
		12	
		13	

		14	Can't Implement Signalling
		15	

- R/W next to an interface status bit means it can be written to from the comms. All other IFSTATUS bits are read-only and will not be affected by the values supplied in the comms (Fn. 16H), 16 bit write data. Read-only bits will be refreshed within 1 second to their true values.
- If Line high current or resettable fuse tripped, the status bits will be set even if the 2 wire decoder power is off. These will need to be written to zero to clear them.
- 40-006 may be written to a value different from \$AA55. If the BT2 has rebooted, this value will be restored. This can be used by the OEM controller to detect a reboot by the BT2
- 40-005 publishes the software version x 10 in the top byte. e.g. version 1.5 will be published as 15 decimal, \$0F hex. The bottom byte is the code for the type of decoder. 0 = TK-DEC-1/PC TK-DEC-1, 1 = Tonick TW/2W. It too will be refreshed at boot.
- Latched Station Failure (bit 10) will be set if there is a fail to turn on or fail to turn off in the cluster of stations commanded. It will remain set until written to zero. 'Station Faultless Present' (bit 7) reflects the success of the last station switched. If multiple stations in the 16 command, a failure in one station followed by a success in a subsequent will clear this bit. 'Latched Station Failures' will remain set however.

Switching Method Using Read/Write Registers

To switch up to 5 decoders at once.... (But be careful of Ohms Law and not turn on too many at once; 2 at a time per line is more usual)

- Write DESIRED holding registers 40-008 to 40-015, Bank B, with function 16H, with bits set accordingly (up to 5 changes)
- Poll register 40-001, bit 0, Bank A, with function 03H until bit 0 is zero, i.e. Busy finished. Allow about 1 second per decoder operation. Attempts to re-write DESIRED while Busy flag is set, will be blocked and a ModBus exception response 06 returned.
- OR...poll using Fn 11H. When status returned is 0000, signalling has finished, otherwise it is Hex FFFF
- Make sure line has not overloaded by checking bits 1 & 3 in register 40-001.
- Look at bit 10 of STATUS 40-001 'Latched Station Failures' . If set, an error has occurred. This bit remains set until cleared by writing it to zero with fn 16H on 40-001
- Read ACTUAL holding registers 40-016 to 40-023 with function 03H. Compare like bits in Banks B & C. If different, an error has occurred
 - Desired 1, Actual 0... fail to turn on
 - Desired 0, Actual 0 and Latched Station Failures set... fail to turn off (but interface has done it using an emergency off)
 - Desired 1, Actual 1...successful on
 - Desired 0, Actual 0 and Latched Station Failures clear...successful off
- Reading ACTUAL registers whilst Busy flag is set, may give erroneous results, but will not generate a ModBus error code.
- If fail to turn off, the ACTUAL bit is automatically set back to 0. This reflects the true state of the station, i.e. off. However bit 10 of STATUS 40-001 'Latched Station Failures' will be set. This latter bit will stay set until reset by writing it to zero by the host controller through the comms.
- If fail to turn on, reset its DESIRED (output) bit back to 0 with function 16H to clear the fault indication

The line (2 wire path) will be turned on automatically with the first decoder on and left on until manually turned off by writing bit 5 of register 40-001 to zero.

The line can be turned on in the absence of any on decoders by writing bit 5 of register 40-001 to one. A write to this location will only modify bits 1, 3, 5, 10 and 15. All other bits in this register will be unaffected by the write data supplied in the comms.

Turning the line on without operating any decoders is very helpful for doing faultfinding on the relevant 2 wire path.

Turning the line off will reset all its bits in Banks B & C to zero.

To maintain compatibility with future developments of TBOX Decoder Adaptor, the user should NOT read or write to registers that are not currently implemented.

Remember that 'Busy flag' must be polled (and seen to be zero) before examining the corresponding ACTUAL bit.

The TBOX Decoder Adaptor automatically turns the relevant line on if decoders are desired on and left on until manually turned off by writing bit 5 of register 40-001 to zero. Set/reset of Bit 5 in Holding Register 40-001 will force the line on and off, but only until the reception of the next message that alters the DESIRED bits (even if nothing is changed).

Decoders are switched one at a time in roughly 0.5 second intervals. Decoders will be switched on in the order biggest address...smallest address. e.g. Decoders 1, 3, 5, 126, will be turned on:- 126, then 5, then 3 then 1.

NOTE: If simultaneously turning stations on and off in the same 16H command. The ON stations will be turned on first before the off stations are turned off second.

Successful operation of a decoder station is determined by the measured change in line current as a result of the attempt at switching. The values for determining a correct change in current can be inspected in registers 40-002 and 40-003, accessed through function 03H. As shipped, the unit expects a minimum change of 67mA and a maximum change of 920mA. These values are adequate for most applications. If a new value is required, the register may be set using Fn 16H in mA.

Line Current Monitoring

The TBOX Decoder Adaptor continuously monitors line current (2 wire path), and will turn off the relevant line, if a current above the maximum of 1.6A is measured for more than 10 seconds. The capability of TBOX Decoder Adaptor to supply current is determined by its transformer. The transformer recommended is 26VAC, 34VA. The TBOX Decoder Adaptor also monitors the line, looking for a short circuit, and will drop the line within a maximum of 20mS of a short being detected.

The 2 wire path for decoders is monitored every second its results in mA may be read in register 40-004. Resolution is 5mA, and any reading less than 10mA will be read as zero.

Situations that set the Fuse Tripped (bit3) and or Line high Current (bit 1) will drop the line for safety, but leave the flags set. The user must reset these flags using Fn. 16H, or reboot.

Note. Short Circuits on the line that are many ohms (cable length) away from TBOX Decoder Adaptor may not trigger this instant action, and in the event of extreme field cable lengths, may not even trigger an overload; both Overload and Short circuit events can be polled for via the status register, and also set the 'Line Faults' red LED.

After an overload or fuse trip, the current will read 0mA, but the flags in register 40-001 will reflect what has happened. This can be read with Fn. 03H, read multiple 16 bit registers with number of registers =1.

Before further 'on' commands will be actioned, these flags must be set to zero with Fn. 16H, write 16 bit registers.

Failed Stations

These will be indicated by a mismatch between corresponding bits in DESIRED and ACTUAL. Bit 7 of IFSTATUS 40-001 will be set if there is a mismatch in any of the 126 stations.

Sensor Decoders

There can be up to 8 sensor decoders in addition to the 126 valve decoders. These are separately addressed as 1-8, but do not interfere with decoders 1-8

There are currently 4 types.

- Volumetric soil Moisture Content (VMC), returning 0-55% in 1% increments
- Contact closure counting. Measuring up to 5 closures/second from volt-free contacts. Counting into 7 bits in a byte 0x00-0x7F, wrapping around. The top bit is the contact position. 1=closed, 0=open.
- 8 digital inputs. Measuring 12-30V AC or DC on each input with respect to a common. A voltage present returns a 1 in the byte. Inputs are isolated up to 1KV from the 2wire path.
- (NEW) Gauge pressure, 0-10BAR using an IP68 custom sensor, G1/4 male thread

More details on these sensors are in the brochure 'Tonick Watering Sensor Decoders'

Accessing the Sensors

The interface to the sensor decoders is by two 16 bit holding registers

40-024 Sensor address

40-025 Sensor Trigger/results

To trigger a sensor read, Using command 16-write multiple holding registers

- Load Sensor address with a number between 1 and 8
- And load the trigger/results register with -1, 0xFFFF
- Wait 1 second
- Using command 03- read multiple holding registers: Poll 40-001 bit 0 (Busy) until busy =0. Up to 2 +/- ½ seconds total until busy goes back to zero.
- The Modbus reply to any poll will be delayed by up to 2 +/- ½ seconds whilst the sensor decoder is actually being read. At the end of this time (or earlier if the read is finished) the Modbus reply will come back from the poll. ENSURE THE CONTROLLER MODBUS TIMEOUT DELAY IS SET TO A SUITABLY LONG FIGURE
- Using command 03- read multiple holding registers: Read 40-025 for the result.
- As an alternative to polling 40-001, 40-024 and 40-025 may be read using 03- read multiple holding registers. When the data is ready, the register 40-025 will no longer contain -1 0xFFFF.

If there is a response from the sensor decoder, the bottom 8 bits of 40-025 will be the sensor value returned and the top 8 bits will be set to 0x01 i.e. 0x01ss, where ss is 8 bits of sensor data.
If no response from the sensor decoder, all 16 bits will be 0x0000

The Modbus reply to any poll will be delayed by up to 2 +/- ½ seconds whilst the sensor decoder is actually being read. At the end of this time (or earlier if the read is finished) the Modbus reply will come back from the poll. ENSURE THE CONTROLLER MODBUS TIMEOUT DELAY IS SET TO A SUITABLY LONG FIGURE

Any attempt to change DESIRED (switch a decoder on/off) will be delayed until the response (or response timeout) is back from the sensor decoder.

LEDS:

The LEDs register 40-007 hold the following data which is mimicked on the front panel LEDS. 1 = LED on, 0 = LED off. It can be read using Fn. 03H, but not written using Fn. 16H

- Bit 0: DC Power OK Green, D1
- Bit 1: Modbus Frame being received Yellow, D4
- Bit 2: Modbus Frame being sent Yellow, D5
- Bit 3: ModBus comms error Red, D7
- Bit 4: Line AC present Orange, D8
- Bit 5: decoder signaling Blue)
- Bit 6: Line energized Green) Tri-colour LED, D9
- Bit 7: Last decoder Faulty Red)

Bit 5 (blue) is only on during the transmission of a decoder on/off command.

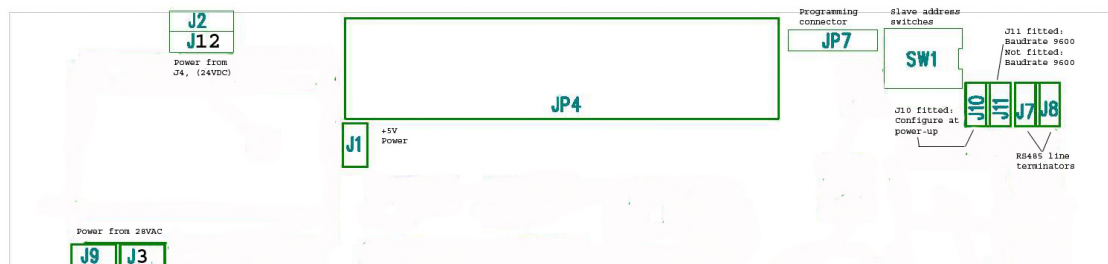
Slave Address Selection:

As shipped the TBOX Decoder Adaptor is set to slave address 1 and 9600 Baud.

Address Select DIL switches SW1: Jumper in J10 whilst powering up. Sets slave address. Remove J10 after

DIL Position; Off = 0, On = 1

1 slave addr 0	0	1
2 slave addr 2	0	1
3 slave addr 4	0	1



To change address, plug in jumper and turn on the interface power. The address on the DIL switches 0...7 will be mimicked on LEDS D5 (=1), D4 (=2), and D1(=4), with the baud rate of 9600 on D8 together with a Red LED on D9.

On power-up with J10 not fitted, a Green LED on D9 will show for 3 seconds during boot, and the following LEDs will mimic the settings before continuing.

D5	Address bit 1
D4	Address bit 2
D1	Address bit 4
	Led on = 1, led off = 0
D8	Led on = 9600 Baud

For example: powering up the interface with J10 empty will result in no changes from previous settings.

With all DIL switches on, and J10 plugged in whilst powering up, the settings will become: 9600 Baud, slave address 7

The baud rate of 9600 cannot be changed.

The TBOX DECODER ADAPTOR MODBUS: Communications Protocol

The Tonick TBOX Decoder Adaptor ModBus is a variant on the Tonick Watering Translator with neither LCD display nor keypad. It is engineered as a module for incorporation with a TBOX controller and is powered from a single external **24V-32V** AC RMS transformer of 35VA rating. Tonick 2-wire TW/2W or TK-DEC-1/PC TK-DEC-1 landscape decoders may be operated. The communications command set has been extended to compensate for the inability to alter parameters from a keypad or observe data on an LCD. Up to 10 decoders out of 127 may be active when powering 24VAC solenoids (**subject to Ohm's Law and 1.2A total line current at +50degC**). Diode type solenoids are not well tolerated when operating more than 2 at a time.

This protocol defines what the Tonick TBOX Decoder Adaptor must do and hence the Comms messages that must pass between the controller and it. The TBOX controller is referred to as the 'master' or 'Host' and the Adaptor(s) as the 'slave(s)'. The Tonick TBOX Decoder Adaptor can have a slave address between 1...7, as commanded by a DIL switch assembly at the rear of the interface..

The electrical spec is RS485 half duplex, multi-drop with line turnaround controlled by each talker on an as-needed basis. Code is asynchronous, 1 start, 8 data, no parity, 2 stop, at 9600baud. Protocol is binary, ModBus RTU. The normal line state is for the master to keep its end in transmit (or the line biased in the mark state) and the slaves in receive. Slaves will never initiate a message on their own. All slaves remain silent in receive until talked to by master. Errored messages received by slaves are met with silence, not NAK.

Message checksum is ModBus CRC16.

The TBOX Decoder Adaptor has biasing resistors in its RS485 A, B lines and a 130 Ohm line terminating resistor, so that with nothing driving the line, signal 'B' is 300mV more positive than signal 'A', keeping the line in the (mark) idle state. This prevents all receivers from picking up a continuous stream of 0's (the break condition). This network can be disabled by removing two jumpers at the back of the interface.

The Tonick TBOX Decoder Adaptor uses an RS485 transceiver with reduced slew-rate. The electrical capacity of the RS485 bus is 32 receivers.

This document draws on information contained in the following Modicon Documents: -

- *MODBUS over Serial Line – Specification and Implementation Guide V1.02 Dec 20 2006*
- *Modicon Modbus Protocol Reference Guide **PI-MBUS-300 Rev.J***

TONICK TBOX DECODER ADAPTOR resolves a query complete by 4 character periods, or 750uS (whichever is the greater for the baud rate) of line idle. TONICK TBOX DECODER ADAPTOR does NOT respond to any message that times-out. A break of 4 characters / 750uS initiates the interpretation of the query received. The host controller therefore needs to be sure that commands are sent as single bursts of characters with no significant inter-character breaks or delays.

The TONICK TBOX DECODER ADAPTOR MODBUS protocol is implemented using RTU transmission mode (Binary). Message framing is achieved by line idle durations as described above. Please refer to the Modicon documents mentioned above if a fuller understanding of ModBus and its implementation on serial lines is required.

The TONICK TBOX DECODER ADAPTOR MODBUS implementation embraces the MODBUS function numbers such that decoder stations are accessed as bits in holding registers 40-008 to 40-015 called DESIRED and corresponding STATUS (Actual) in the same bits in holding registers 40-016 to 40-023, whilst data values (such as line sensitivity) are accessed in holding registers 40-001 to 40-007.

In general, slave specific Comms counts and errors counts are recorded, but TONICK TBOX DECODER ADAPTOR does not record successful message counts for the bus as a whole. Available counts are available on Fn 11H; these counts are reset to zero at power-up.

ModBus standard decrees that register number 1 is transmitted within a ModBus messages as address 0000. The addresses discussed below are the addresses that would appear in the master program. The numbers that are transmitted within messages will be one less.

Each decoder address/station is controlled by a DESIRED bit in a holding register and a STATUS bit in another holding register. An error flag can be generated by software in the host controller, if after a signaling has finished, the DESIRED and STATUS differ.

Function Summary

(n/u means not used)

Modbus Commands implemented on TONICK TBOX DECODER ADAPTOR are:-

01 Read Coil Status - not implemented.
02 Read i/p Status - not implemented
03 Read multiple (holding) Registers.
04 n/u
05 Force Single Coil - not implemented
06 n/u
07 n/u
08 Diagnostics (loopback)
09 n/u
10 n/u
11 Fetch Comms Event Counter – Returns busy status and a count of successful comms implementations
12 n/u
13 n/u
14 n/u
15 Force multiple coils – not implemented
16 Preset multiple (holding) registers.
17 Report Slave ID – Returns the H/W code for this device and software Version. No.
18 n/u
19 n/u2
20 n/u
21 n/u

Functions outside of the range quoted above are not allowed.

Note:

Fun 17. Returns TONICK TBOX DECODER ADAPTOR information – slave ID, on/off, Serial Number, H/W Version, S/W Version.

Information is returned as: -

<ADD> <FUN> <COUNT> <Slave ID> <On/off> <Ser# Hi> <Ser# Lo> <H/W Ver> <S/W Ver> <CRC Hi> <CRC Lo>
Where <slave ID> = 01, <On/off> = HEX FF = (always) on;

Fun. 11. Returns a status of \$FFFF (hex) if the Signaling in Process bit is set.

Please refer to *Modicon Modbus Protocol Reference Guide PI-MB US-300 Rev.J* for details of these commands.

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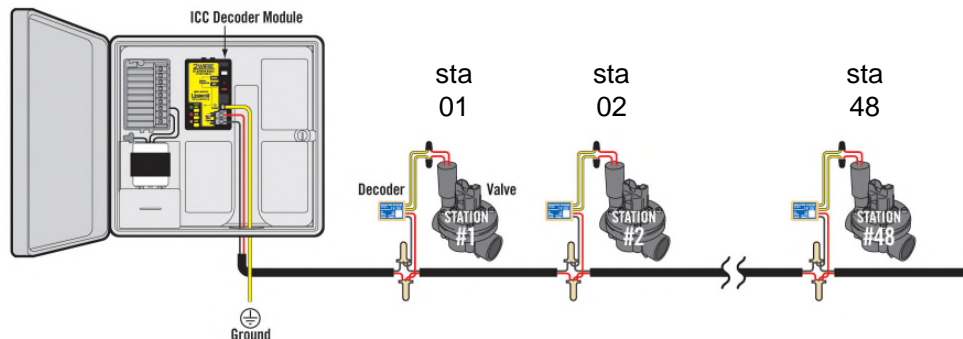
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2Wire Com Path Fault Finding Procedures

By Tony Ware B.Sc.
Chief Designer,
Underhill International Corporation

Typical 2Wire Decoder System



Single leg 2Wire path out to valves & each decoder has a unique “address”



Almost all modern irrigation systems rely on many pre-numbered decoders connected along a common 2 wire path, each connected to a solenoid valve. The controller feeds typically 24V to 32V AC down the path, together with a digital signal commanding a decoder to turn on or off. The decoder, whose number matches the signal, obeys the command, all the others ignore it.

This scheme saves copper cables and with the right equipment is easy to repair, being only 2 wires rather than a huge bundle

The problem with any shared path is that a fault somewhere along the cable can sometimes affect the whole system. However with some low cost measuring equipment and the following simple techniques, the fault can be more quickly located than even multi-wire.

Possible Root Causes

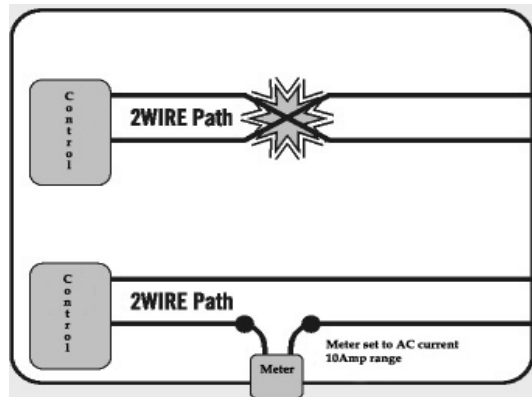
- Short circuit on the 2Wire path
- Open circuit on the 2Wire path
- Short circuit on a solenoid
- Short circuit on the 2Wire path
- Short circuit on decoder or dead decoder
- 2Wire leakage to earth

Each of these field conditions is identified in more detail in the following slides



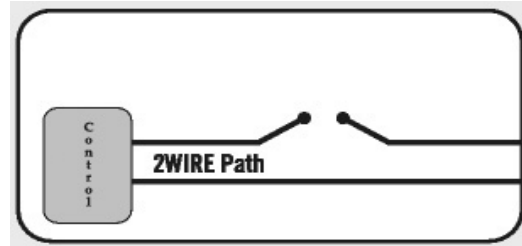
Short Circuit on the 2wire Path

- High currents flow and the controller shuts down to protect itself.
- It is not obvious where the short is.



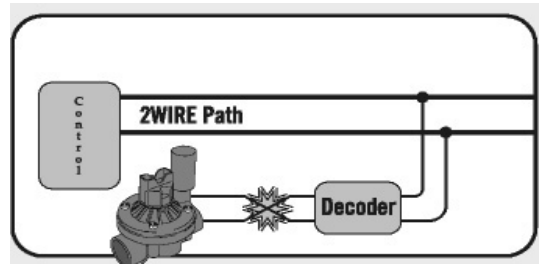
Open Circuit on the 2Wire Path

- All decoders up to the open will work, those beyond will not
- Equivalent to a break in the common line in a multi-wire system



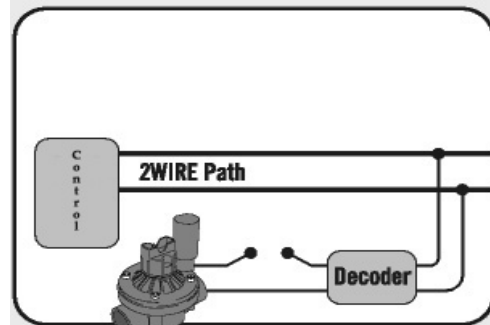
Short Circuit Solenoid

- Shows up when a decoder is operated
- Sometimes stops the system working afterwards due to voltage loss down the main 2 wire path, preventing an off command from reaching the decoder.
- Some 2Wire systems are more clever, will report a fault and not try to turn on the solenoid



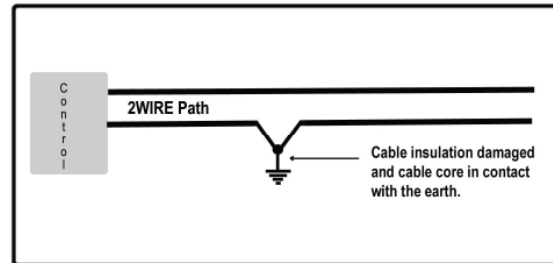
Open Circuit Solenoid or Dead Decoder

- Station does not respond
- Can also be a dead decoder



2Wire Cable Leakage to Earth

- When a cable or wire splice is not well insulated, some electricity can leak to earth. This causes problems for some controllers, either refusing to control at all, or sometimes giving erratic operation, leading to the controller being suspect.
- Earth leakage must be repaired first as it can interfere with the diagnosis of other faults.



Troubleshooting

- Invest in the right tools to troubleshoot
- The “Halving” method of troubleshooting is one way to approach isolating a field wiring issue



Tests are best done with loops broken as the 'halving procedure' doesn't work on loops

Investing in the Right Tools

- Portable Transformer 230VAC in, 30VAC out with at least 5A.
- Some 2Wire control product will not operate under short circuit conditions. This device is connected directly to the 2Wire path bypassing a controller to locate field wiring issues
- Only the red and black connectors are used for 2wire applications



Investing in the Right Tools

- Digital Clamp Meter Underhill
p/n TW-DCM
- Uses “inductance” to measure
current along 2Wire path
without having to exposed wire
connections or a conductor



Principle of Operation.

When a current flows, it produces a magnetic field. This is how the solenoid can lift its plunger. If a ring of magnetic material is placed around a wire carrying a current, it can be used to detect and measure that current. If the ring can open like the jaws of a crab's claw, be placed around the wire, then closed, there is no need to break the wire to measure the current. Such a device is called a Current Clamp Meter. However, most clamp meters have been designed to measure hundreds of amps and are not sensitive enough to measure the current taken by an individual decoder. However a **Leakage Clamp Meter** can easily measure to less than zero point one of a milliamp (0.1mA) and can be used to check a decoder's standby current, which is often a reliable indication of its goodness. Also knowing the standby currents of decoders allows an estimate of the number on a branch of the cable! Most modern decoders take between 0.5mA to 5mA when not operating a solenoid.

Make sure the jaws shut fully. Keep the open ends of the jaws clean and free from grit and water. A build up of rust or deposits will cause false readings.

Digital Clamp Multi-meter

- To be of use, must be a 'leakage' clamp meter. Ordinary ones are not sensitive enough.
- When measuring currents, keep the jaws at least 1 foot away from any solenoid that is on and the faultfinding transformer, or it will read incorrectly.



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Investing in the Right Tools

- Portable valve checker to actuate a solenoid w/o using a controller



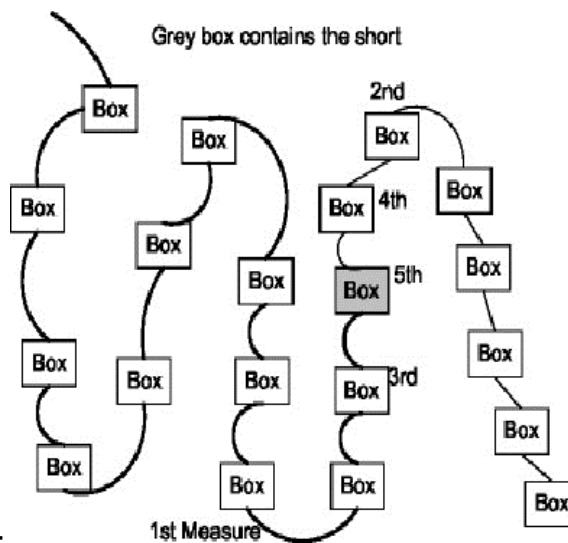
Investing in the Right Tools

- A known working solenoid
- A programmed decoder – (factory default is Sta 01)
- Wire Splice kits



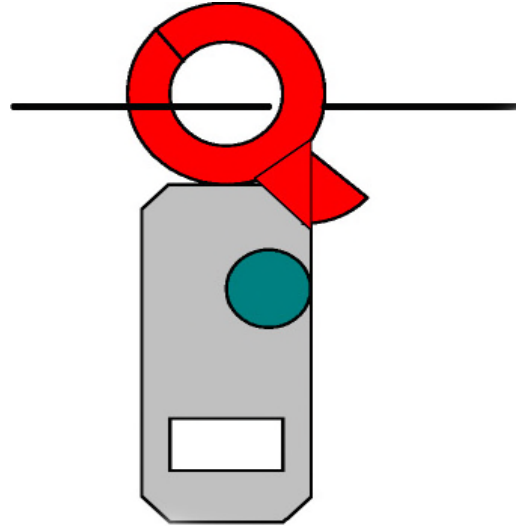
The “Halving” Procedure

- Develop to safe time to isolate a field wire issue. Usable for any type of cable fault. Shorts, opens, high resistance joints or cable leakage to ground.
- Start half way. Make the measurement.
- Decide which half the problem is in.
- Go half way on the problem half. Repeat
- Using this technique, 20 boxes can be covered in just 5 measurements.. See diagram.



How to measure current without breaking the wire

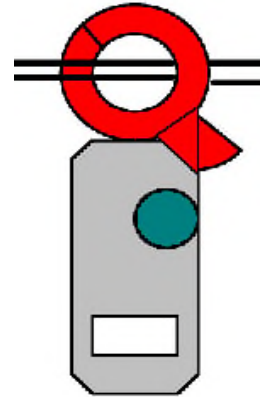
- Currents are measured by opening the red jaws by pressing the red trigger with the thumb and clamping the jaws around the wire.



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Normally place the clamp around just one of the wires, not both.

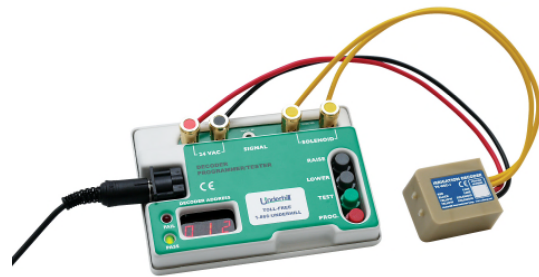
- It is important to understand that if both flow and return wires carry the same current and are placed inside the jaws, *the multimeter will read zero*



When the test equipment system is set up for testing earth leakage, the flow and return will have different currents in them as some is leaking back through the ground, therefore the meter will read the difference in the two conductors = leakage through the earth.

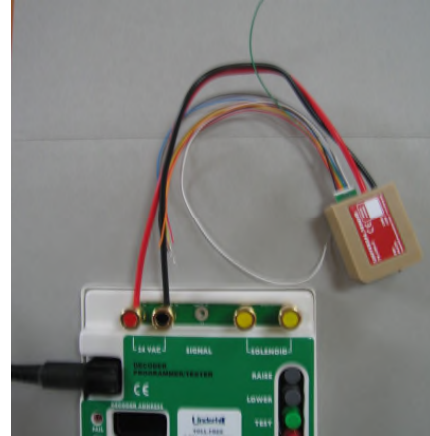
Testing a Decoder

- All decoder manufacturers offer a decoder tester/programmer
- The tester may be used to enter the decoder's station number before installation
- To be of use, the tester has to be low cost or not enough will be available for each crew
- Some decoder controllers have a built-in decoder tester/programmer.



Testing a Pressure/Flow/Moisture Sender

- Underhill Senders must be programmed from 1-8.
- There may be up to 8 Senders on each 2Wire Path
- Program, then test each sender on the decoder programmer/tester prior to installing.



Fault Tracing Short Circuits

- If at any time, faults are suspected, or the controller behaves erratically, it is best to test the wiring to the decoders using a power transformer (as illustrated) and a current clamp meter.
- Note position of green wire connectors for this troubleshooting procedure



A big power transformer, such as the one illustrated plugs into the 230V power and produces 30V AC at up to 5 Amps to power up the 2 wire path.

The field wiring is removed from the controller and the transformer's output is connected to it instead. Because of its size, the transformer can still produce a powerful voltage in the presence of quite serious field wiring faults.

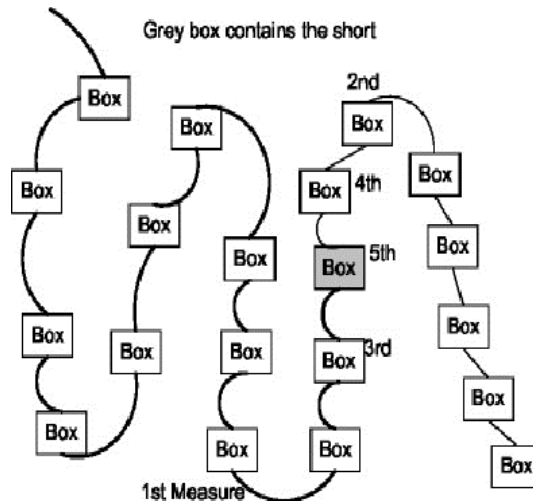
30VAC is not known to damage any 2Wire decoder type.

Because it lacks signalling circuitry, the transformer itself cannot turn decoders on or off. However, this is not a disadvantage for the sort of faults that would shut down or damage a controller.

When used with a current clamp meter, digital voltmeter and a spare solenoid, the transformer allows fault finding with the minimum of effort and confusion.

Beyond the short, the current will be much less

- In the figure, the thick connecting lines indicate higher than normal currents measured. Once you are past the short, the currents will either fall to near zero (if the voltage is cut off downstream) or go back to near normal.
- To measure the short circuit currents, place the clamp meter over just one of the 2 wire path wires.

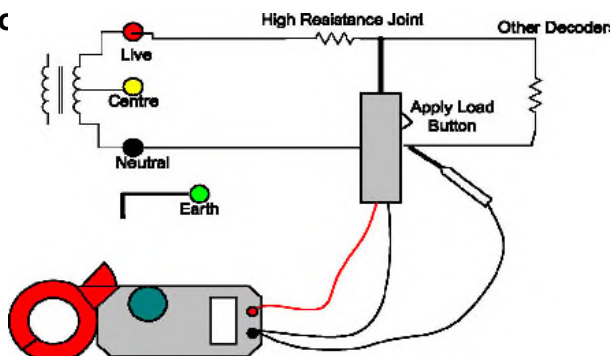


If the joints are made so that the individual wires in the main cable are not accessible individually, the main cable will have to be split open to reveal the individual conductors. Remember it is the currents in the main 2 wire path cable you are trying to measure, not those in the decoders attached.

Once the area of the short is found, the exact cause can be identified. Check for warm decoders or joints, especially if the short is several amps. Place the current clamp over individual wires to see which ones are carrying the current. Do not forget that a current flowing 'out' from the transformer must 'return' down the other conductor.

Fault tracing high resistance joints

- Connect the portable transformer live and neutral to the 2 wire path
- Go halfway down the line, expose the wiring joints
- Measure voltage across the line, with and without a solenoid load
- The picture right, shows a push- button solenoid load simulator. A spare solenoid will do just as well.
- A volt drop more than 3 or 4 volts under load indicates a high resistance joint upstream.
- Go halfway down the faulty half and repeat
- Using the halving technique you can cover 20 valves using 5 measurements



High resistance joints can be identified by connecting the transformer then measuring the voltage down the cable at each joint with the load probe or a spare solenoid and multimeter. If you do not have a load probe, get a helper to touch the wires of a spare solenoid to the multimeter probes while measuring the volts.

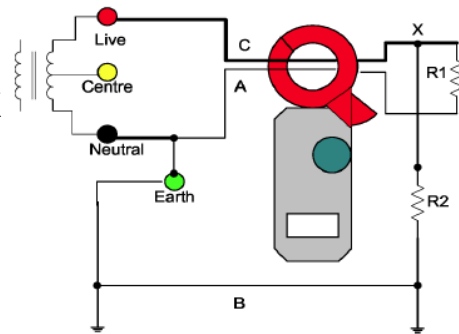
Set the meter to Volts AC (V~). When the 'apply load' button is pressed on the probe or the solenoid is attached, the voltage will drop. A voltage drop exceeding about 3 or 4 volts indicates a high resistance in one of the joints. As you travel back towards the transformer, you will eventually pass the bad joint and the voltage drops under load will go back to normal.

In a 2 wire system, just measure between the two joints in the box. An excessive voltage drop will tell you that one or other side is high resistance, but not which side.

As before, the 'halving procedure' search technique can be used to reduce the number of measurements made

Tracing leakage to earth

- With one side of the transformer grounded (earthed), leakage currents can flow back through the ground causing unequal currents in the main 2 wire path. Green cable to either black or red terminal on yellow box
- In the diagram, point X represents a leakage point to earth through some value of resistance R2. R1 is representative of a quantity of decoders. Current flows 'out' of the transformer through C and splits at X to flow 'back' through A and B. The resistors R1 and R2 are effectively in parallel and see almost all the transformers voltage. The clamp meter will read the difference between the currents in A and C which is equal to that flowing in B.

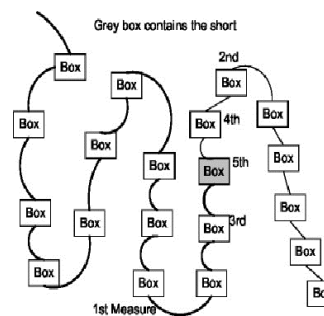


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Place the clamp meter over whole main 2 wire cable. Connect the green earth link to the terminal on the transformer that produces the greatest reading on AC mA. Go out on the course placing the clamp meter round the whole main cable. When the leakage reading drops significantly you are past the leakage fault, i.e. it is between you and the controller.

Finding the location of earth leakage

- With one side of the transformer grounded, (green connector inserted in red or black input) the clamp meter is placed around the whole of the main 2Wire cable.
- In this diagram, the clamp meter will read much lower when past the grayed box marked '5th'.



Phantom Earth Leakage

- When placed over the whole field cable, the current clamp will measure the current imbalance among the conductors. This is caused by some current flowing through the ground back to the transformer (one side of which will be deliberately earthed). However, another reason is cable loops.
- Field cables are sometimes looped and connected back to themselves to lower their resistance, which means less voltage drop when solenoids are on. The currents for the decoder/solenoid can flow in both sides of the loop. If however one wire in one side of the loop is broken or has a high resistance joint, the current in it will favor the good side of the loop. We then have a situation where the total currents when measured in a cable are not equal and opposite. This will show up as a phantom leakage current which can be quite large.



Any other tests are best done with loops broken as the 'halving procedure' doesn't work on loops. When finally rejoining the loops, check the resistance and loaded voltage with the load probe

Phantom Earth Leakage – Cont'

- The symptoms are as follows:
 - The 'leakage current' stays substantially the same if the earth connection is removed from the transformer.
- Resolving the problem:
 - Break the loop (or loops). After breaking, the good half will have nearly full volts on it, the bad substantially less. If in doubt use the load probe or a spare solenoid.



Field Wiring Check

1. Remove 2Wire path from the controller, connect the transformer instead
2. Measure the 2Wire path's current with all decoders connected. Does the measured current = the sum of all the decoder standby currents? (3mA x number of decoders)
3. If too high, a faulty decoder or lightning protection unit, if too low, some decoders disconnected.
4. Earth one side then the other of the transformer, place clamp meter over the whole cable to measure the total earth leakage. Look for less than the controller manufacturer's quoted maximum figure .
5. Go to the far end of the 2 Wire path, expose its wire connections and measure the voltage across it, with and without a solenoid load. A volt drop under load of no more than 3 or 4 volts indicates no bad joints in the main 2 wire path. Remake this wire connection
6. You may then conclude the whole 2Wire path is good or bad in less than ½ hour!



TEST SHEET TO RECORD BASIC WIRING CHECKOUT RESULTS

Controller Model	Path 1	Path 2	Path 3	Path 4	Notes:
Number of Decoders					
Step1: Ground Potential (V) between PE and lightning earth					Just 1 reading, covers all paths
Step2: Zero OK?					Keep clamp away from transformer
Step 3: Standby Currents (mA)					
Step 4: Signal Lead Currents (mA)					Only if a 3 wire system
Step 5: Earth Leakage green-red					
green-black (mA)					
green-yellow (mA)					Only if a 3 wire system
Step 6: Transformer output voltage (V)					Measure at the transformer
voltage (no solenoid), power to power (V)					At furthest point from controller
voltage with solenoid, power to power (V)					At same point
voltage with solenoid, power1 to signal (V)					Only if 3 wire system
voltage with solenoid, power2 to signal (V)					Only if 3 wire system

TEST SHEET TO RECORD BASIC WIRING CHECKOUT RESULTS

WORKED EXAMPLE

Controller Model	Path 1	Path 2	Path 3	Path 4	Notes:
TW2					
Number of Decoders	23	30			To check TW2W
Step1: Ground Potential (V)	1/2V				Just 1 reading, covers all paths
Step2: Zero OK?	OK				Keep clamp away from transformer
Step 3: Standby Currents (mA)	72	88			
Step 4: Signal Lead Currents (mA)	—	—			Only if a 3 wire system
Step 5: Earth Leakage green-red (mA)	41	12			
green-black (mA)	15	5			
green-yellow (mA)	—	—			
Step 6: Transformer output voltage (V)	29V	29V			Measure at the transformer
voltage (no solenoid) power to power (V)	27	28			At furthest point from controller
voltage with solenoid power to power (V)	20	26			At furthest point from controller
voltage with solenoid power1 to signal (V)	—	—			Only if 3 wire system
voltage with solenoid power2 to signal (V)	—	—			Only if 3 wire system

Date 19/3/2009
 Contact Name Tony Wares
 Position Faultfinder
 Phone no.
 Company
 Golf Course A golf course

Path 1.
 $23 \times 3 \text{ mA} = 69 \text{ mA}$
 Path 2.
 $30 \times 3 \text{ mA} = 90 \text{ mA}$
 expected standby currents -

TW2W -
 3mA/decoder
 at 60Hz.
 30V.

For advice on the significance of these results,
 please: Fax to Underhill Technical
 Support.

Fax: 949-305-7051

Email tware@uicorp.net

CONCLUSIONS

- (1) Standby currents are near enough. No faulty decoders.
- (2) 7V drop with 1 solenoid on Path 1.
 Probable high resistance joint
- (3) At least 1 badly insulated joint on Path 1 leaking to ground.

Cable Check - Conclusions

- If the wiring system passes all the above tests, it is safe to reconnect the controller and proceed with a station decoder test. Obviously for multi 2 Wire path controllers, the electrical tests must be repeated for each path. If any test fails, carry out the appropriate faultfinding procedures in the previous sections.
- With this test equipment and simple procedures it is usually possible to clear a fault in less than half a day, sometimes just half an hour.



American Society of Irrigation Consultants



ASIC Guideline 100-2002 (January 2, 2002) For Earth Grounding Electronic Equipment in Irrigation Systems

For the latest rev. go to
http://www.asic.org/design_guides.htm

American Society of Irrigation Consultants

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E-mail: info@asic.org

1.0 Scope

Defines minimum requirements for earth grounding electronic equipment in irrigation systems based on the requirements of the National Electrical Code (NEC) and sound practices of the Institute of Electrical & Electronics Engineers (IEEE), to ensure personnel safety and equipment reliability.

1.1 Purpose

A guide for irrigation industry persons who are involved in the design, manufacturing, distribution, installation and maintenance of electronic equipment in residential, commercial, institutional, golf course, and agricultural projects.

1. Implementation

Specifications for earth grounding of electronic equipment shall be written and administered by the irrigation professional, herein referred-to as "the designer."

2.0 References

The following documents and references were used as a basis for this guideline. This material is subject to revisions.

NFPA 70, *National Electrical Code*®, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, USA, <http://www.nfpa.org/>, 1999.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269, USA, <http://www.nfpa.org/>, 1997.

IEEE Std 142-1991, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)*, The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street New York, NY 10017, USA, <http://www.standards.ieee.org/>, 1991.

IEEE Std 1100-1999, *IEEE Recommended Practice for Powering and Grounding Electronic Equipment (The Emerald Book)*, The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street New York, NY 10017, USA, <http://www.standards.ieee.org/>, 1999.

Sunde, E.D., *Earth Conduction Effects in Transmission Systems*, Dover Publications, 1968.

Morrison and Lewis, *Grounding and Shielding in Facilities*, John Wiley & Sons, 1990.

Morrison, *Grounding and Shielding Techniques*, John Wiley & Sons, 1998.

Rufus and Gibilisco, *Principles and Practices of Impedance*, McGraw-Hill Professional Publishing, 1987

Lightning Protection and Grounding Solutions for Communication Sites, Polyphaser Corp., 2225 Park Place, Minden, NV 89423, USA, <http://www.polyphaser.com/>, 2000

"The Link" (Technical Bulletin, Issue 5), ERICO, Inc., 34600 Solon Road, Solon, OH 44139, USA, www.erico.com, 1999

Earth Resistance Calculators (from web-site), LORESCO INTERNATIONAL, P.O. Box 1089, Hattiesburg, MS 39403, USA, www.loresco.com, 2000.

3.0 Safety

The requirements of the National Electrical Code shall prevail, to ensure safety. Local electrical codes may apply additionally as determined by the designer. Prevailing local codes shall only enhance requirements of the NEC.

4.0 Definitions

Should - As used in this guideline, designates a suggestion or recommendation.

Shall - As used in this guideline, designates a mandatory requirement.

Approved Equal - "Approved equal" shall mean approved by the designer.

Ground - A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

Service Entrance/Switch Gear Panel - Equipment for delivering electric energy from the serving utility to the wiring system of the premises served, commonly known as the circuit breaker or fuse box.

Service Entrance Ground - Ground circuit installed at the service entrance by the utility company.

Supplementary Ground - A ground circuit for irrigation equipment located away from the Service Entrance.

Bonding - Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

Bonding Conductor - A solid bare copper wire or copper strap connecting supplementary grounds to each other and to the service entrance ground.

Exothermic Welding - Chemical/molecular bonding of two metals using a "Cadweld One-Shot"¹, or approved equal.

Brazing/Welding - Chemical/molecular process for bonding two metals using a torch. Welding rods shall contain a minimum of 5% silver.

Ground Rod Clamp - A copper alloy device used to mechanically connect a copper conductor to a ground rod.

Grounding Conductor - Solid bare copper wire or copper strap used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Electrode - A ground rod or ground plate

Ground Rod - A UL listed "copper clad" grounding electrode having minimum dimensions of 5/8" diameter and 8' of length. Construction is high tensile steel with a 10 mil copper skin, manufactured to the requirements of NEC article 250-52 (c). Usually installed in a vertical position.

Ground Plate - An electrode made to the requirements of NEC article 250-52 (d). The material used shall be a copper alloy intended for the purpose with a minimum thickness of 0.060". Each plate shall expose a minimum of 5 ft² of surface area to contact the soil. Grounding conductors shall be attached to the plate using a welding process. Splices made to the grounding conductor shall be made using a welding process. Dissimilar metals and solder connections shall not be allowed. Usually installed in a horizontal position.

Impedance - Opposition to electrical flow in an alternating current circuit. It is the sum of the effects of opposition to electrical flow caused by resistance, capacitance, inductance, and the frequency of the lightning discharge signal. In grounding grids, inductance causes the majority of the impedance.

Inductance - A phenomenon that opposes the flow of electricity as a function of signal frequency and the geometry of the electrodes and grounding conductors. The higher the frequencies of the lightning pulse, the higher the opposition. As the geometry of the grounding grid becomes more complex, its inductance increases.

Grounding Circuit - A combination of copper clad ground rods, copper ground plates, and copper conductors. Several typical designs are given in figures 2 to 8.

Grounding Grid - An installed grounding circuit, which may include bonding and shielding copper conductors.

Shielding - A technique that employs shallowly installed copper conductors to intercept lightning energy from being induced onto underground wires and cables connected to equipment.

5.0 Designer

The design of the earth grounding system shall be provided by a competent irrigation professional and shall comply with the requirements of national and local electrical codes.

6.0 Installer

¹ CADWELD One-Shot is a registered trademark of ERICO Electrical Products

An individual, contractor, licensed electrician, or organization deemed qualified by the designer, to install and test the grounding grid while meeting all applicable local and national electrical codes.

7.0 Measuring Resistance

Earth resistance shall be measured and recorded after the installation of the grounding grid(s), and every three months thereafter for the first year. This data should be used to determine the most critical times of the year, based on soil moisture content and lightning frequency. The resistance shall be tested and recorded every six months thereafter, at these most critical dates, to ensure that proper contact with the soil is maintained at all times. Resistance measurement shall be made using commercially available instruments, in accordance with the latest requirements of NFPA 780. Follow instrument manufacturer's specific operating instructions.

Readings of 5 to 10 ohms are desirable. The effectiveness of the circuit is a function of its impedance, which cannot be measured in the field in a practical manner. Sound practices and proper installation are more important in assuring quality results than this reading. The minimum requirements of the NEC shall be met, which are:

- a) A resistance reading of no more than 25 ohms, or
- b) A two electrode ground grid

In installations with multiple equipment locations, the resistance readings of like grounding circuits should be compared for consistency. Large variances in readings point to different soil conditions, or soils with varying degrees of moisture content, or improper installation.

8.0 Grounding Electrodes

Irrigation system grounding circuits consist of ground rods, ground plates, copper strips, straps, and solid copper wire. Ground rods are usually adequate for safety and for protection of electro-mechanical equipment. However, when protecting electronic equipment, ground plates shall be used by themselves or in conjunction with ground rods. Plates exhibit low inductance/impedance characteristics and are better suited for the protection of electronic equipment. It may be necessary to use access boxes and to label grounding conductors at the equipment for the convenience of electrical inspectors.

9.0 Moisture Content

Soil needs moisture to conduct electricity. Moisture content within the sphere of influence, as defined in paragraph 11.3 below, of the electrodes shall be a minimum of 15% by weight. If this minimum level of moisture is not present, it shall be added by using irrigation products such as bubblers, sprinklers, drip emitters, etc.

10.0 Soils and Soil Amendments

Soil resistivity (with at least 15% moisture) varies considerably depending on soil type. Generally speaking, clay soils give low resistance and sandy soils high resistance.

Soil resistivity can be significantly reduced with proper soil amendments, which are commonly referred to as "Earth contact" or "Ground enhancement" materials. Only soil amendments such as PowerSet®, PowerFill®, and GEM®², which are specifically made for the application, shall be allowed. Corrosive soil amendments such as salts, minerals, fertilizers, concrete, etc. shall not be used. "Bentonite clay products" shall not be used because of their swelling/shrinking characteristics.

11.0 Lightning and Grounding Theory

11.1 - Path of lightning - Lightning is a high voltage-high current electrical discharge made up of a broad range of frequencies. It follows the path of least impedance, not the path of least resistance. In order for a grounding grid to be effective it should provide a discharge path to earth that has much lower impedance than the path to the electronic equipment. A large portion of the impedance of a grounding circuit is due to its inductance. Circuits containing flat electrodes give lower impedance and the best results. Round electrodes and conductors should be minimized.

² PowerSet® and PowerFill® are registered trademarks of LORESCO International. GEM® is a registered trademark of ERICO Electrical Products

11.2 - Skin Effect – This is a phenomenon that explains the behavior of electrical flow in conductors at various frequencies of current. At low frequencies (direct current and 60 cycles per second), electricity flows through the complete cross-section of the conductor. At higher frequencies, it flows only on the skin of the conductor or grounding electrode. For example, at 1 Mega-Hertz, which is about the midrange of lightning frequencies, the skin of a conductor/electrode that carries electrical flow is only 0.026" thick. Ground rods and wires offer very little skin for conducting, while plates are all skin.

11.3 - Sphere of influence - Electrodes need a certain amount of the soil surrounding them to effectively dissipate lightning energy. This space is known as the sphere of influence and is shown in figures 1A and 1B for ground rods and ground plates, respectively. This is the basis for determining proper electrode spacing, so they do not compete for the same soil.

12.0 Installation Requirements

12.1 Electronic equipment and wires/cables connected to the electronic equipment shall be installed outside of the sphere of influence of the ground grid. This is necessary, to avoid re-injecting the discharged lightning energy into the equipment and the underground wires and cables.

12.2 Space grounding electrodes to prevent overlapping of spheres of influence. Rod spacing shall be twice the rod length. Examples – space 8-foot rods 16 feet apart, space 10-foot rods 20 feet apart. See figures 2 to 8 for spacing of electrodes in various ground grids.

12.3 During the installation process, it is usually necessary to bend grounding conductors as they are installed inside the equipment, through conduit, and inside buildings. Sharp bends in conductors create complex ground geometry that shall be avoided. Straight wire runs and simple geometry provide significantly better grounding. These bends must have a minimum included angle of 90° and a minimum radius of 8", which equates to a standard 1 ½" PVC sweep ell. Bonding/shielding conductors shall be installed 12" to 15" below the ground surface, directly over the major bundles of wires/cables, and shall be connected to all the grounding grids at the equipment locations.

12.4 Ground rods shall be driven a minimum of 8' into the ground in a vertical or oblique position. The angle of the rod relative to the vertical shall be no more than 45°.

12.5 Ground plates shall be installed in a horizontal position a minimum of 30" below ground level and below the frost line. The plate shall be installed flat at the bottom of the trench.

12.6 "Earth contact materials", as referenced in 10.0 above, may be poured in the trench in powder form or they can be mixed with water to create a slurry. The latter minimizes dust particles in the air and makes for a cleaner installation. When mixing earth contact material, use 3.5 gallons of water with 50 pounds of material. Proper protective equipment shall be worn per the manufacturer's instructions.

12.7 Conduit and sweep ells used in grounding grids shall be plastic, as metallic types increase the inductance of the grounding conductors.

12.8 Ground clamps should be used to connect grounding conductors to ground rods on a temporary basis. Once satisfactory results are achieved, the clamps shall be replaced by permanent welded connections. Solder shall never be used in making connections as it melts during a lightning discharge.

12.9 The basic tools necessary for installing a grounding grid are:

- A machine capable of cutting a trench that is 6" wide and 36" deep.

- A sledgehammer or power hammer to drive ground rods into the soil.
- A ground rod sleeve that prevents the top of a ground rod from mushrooming when it is being driven into the soil.
- A flint igniter to start the exothermic reaction in a Cadweld One-Shot.

13.0 Grounding Circuit Designs

Varying types of installations, site conditions, and lightning frequency shall dictate the optimum grounding circuit to be used. Ground rods may not be practical in job sites with rocky soils.

14.0 Typical Grounding Grids

The type of grounding grid designed for a piece of electronic equipment is a function of the total length and size of the wires connected to it. Ground rods and plates can be used in sand and clay soils. Ground plates and bare copper wires are used in rocky soils. Typical grids for various pieces of electronic equipment and soil conditions are shown in figures 2 to 8.

14.1 - Irrigation Controllers - A 64-station controller has many more wires connected to it than does a 12-station controller. As more wires are connected to a piece of electronic equipment, more lightning energy enters the equipment, and a more substantial grounding grid must be used. Use the following chart to determine the appropriate design from figures 2 to 8.

Stations per Controller Location	Use Figure Shown for:	
	Non-Rocky Soils	Rocky Soils
64	2 or 3	3
96	4 or 5	5
128	6 or 7	7
256	8	8

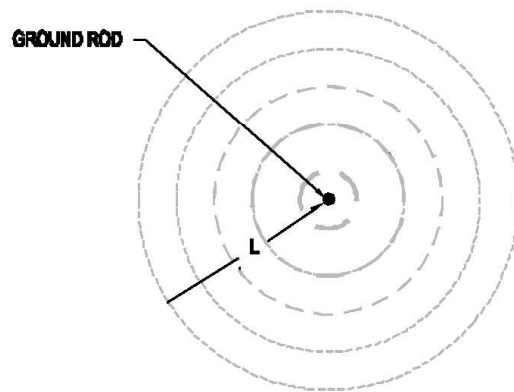
14.2 – For Irrigation Central Computer, Weather Stations and Pump Station Control Panels - Choose from figures 2 or 3, depending on soil conditions.

14.3 – If after following the guidelines of the above charts and ensuring that the installation and soil moisture content are correct, the resistance readings are more than 10 ohms, the grounding grid shall be upgraded to a recommended figure of the next number of stations.

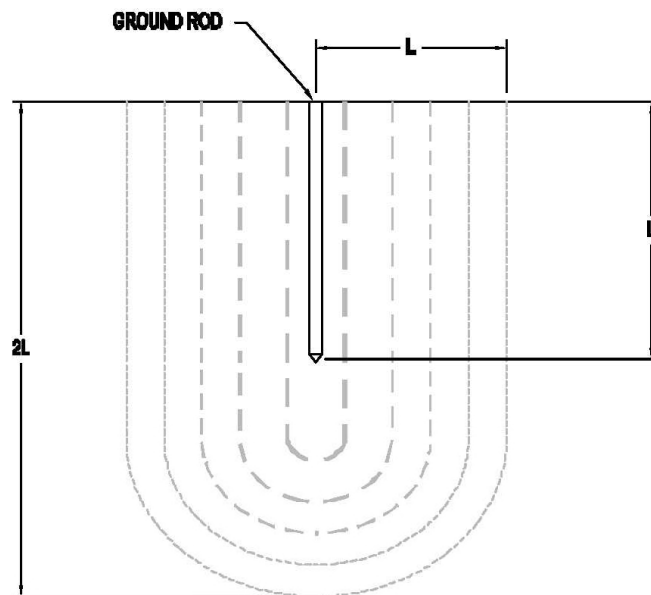
Example: A 48-station controller is grounded as in figure 3. The moisture content is confirmed to be at least 15%, the installation is correct, and the resistance is measured to be 18 ohms. In this case the grounding grid must be upgraded to figure 4 or 5.

Disclaimer: The American Society of Irrigation Consultants (ASIC) has made every effort to ensure that the information and recommendations contained within are correct. However, neither ASIC nor any of its members warrants nor accepts any liability for the use of this information. National and local electrical codes should always be followed. Wiring, grounding, shielding, and bonding irrigation system components often require competent engineering judgment on a case-by-case basis. Competent engineering assistance should be sought from professional members of ASIC.

TOP VIEW



SIDE VIEW

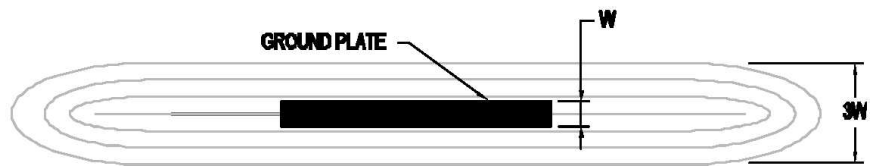


1A

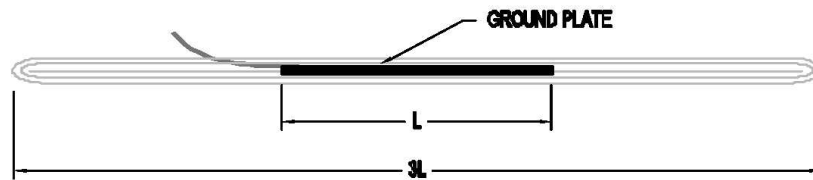
GROUND ROD SPHERE OF INFLUENCE
NO SCALE



TOP VIEW



SIDE VIEW

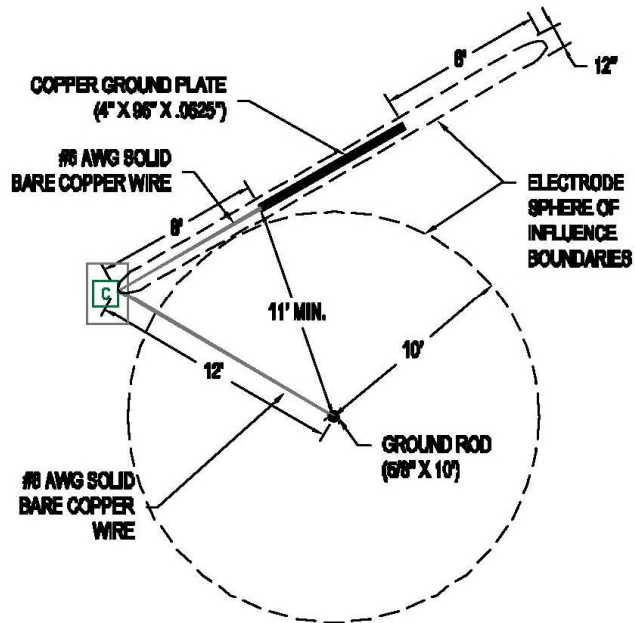


1B

GROUND PLATE SPHERE OF INFLUENCE NO SCALE

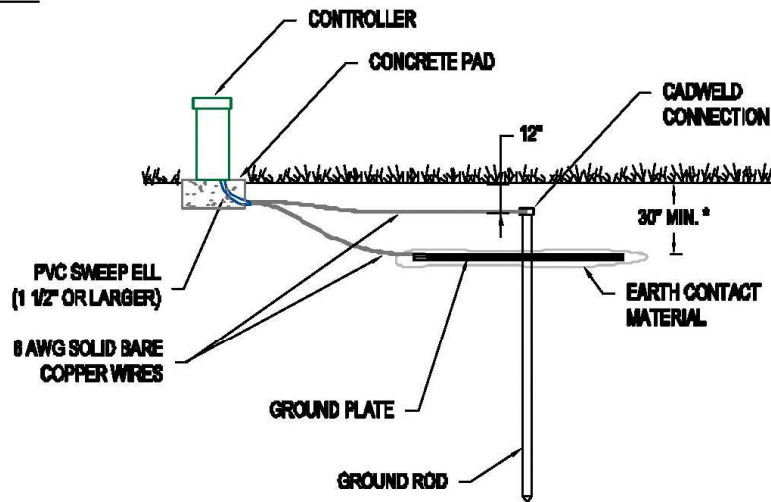


TOP VIEW



DO NOT INSTALL ANY OTHER WIRES OR CABLE
 WITHIN THE SPHERE OF INFLUENCE

SIDE VIEW



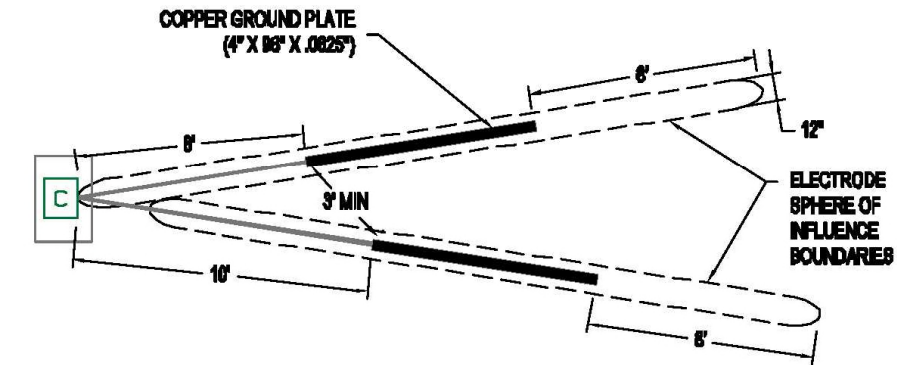
* OR BELOW FROSTLINE, WHICHEVER IS DEEPER

2

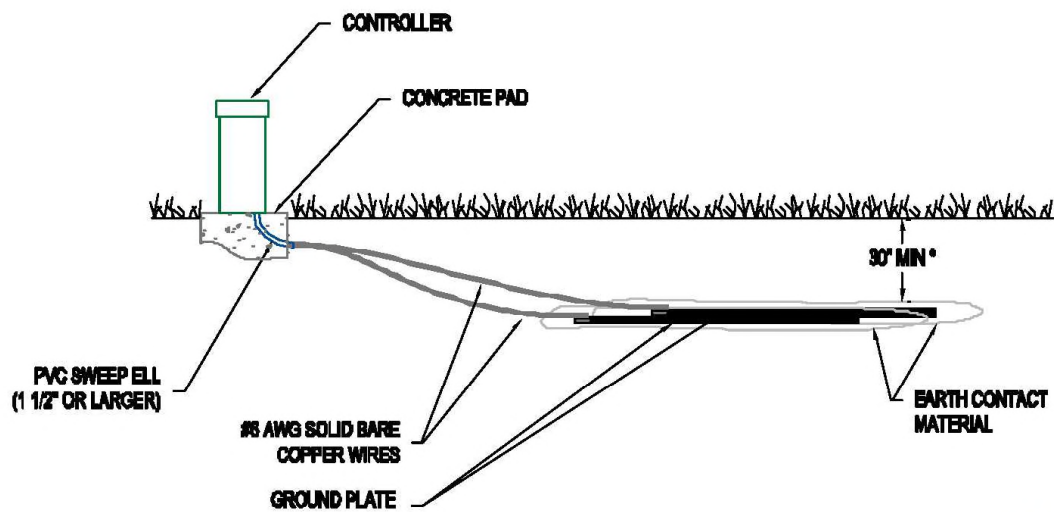
FIGURE 2 - UP TO 64 STATIONS, NON-ROCKY SOILS
 NO SCALE



TOP VIEW



SIDE VIEW



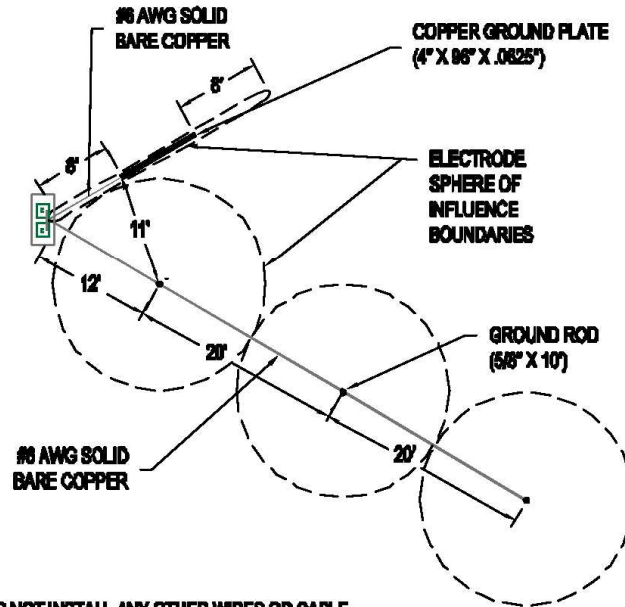
* OR BELOW FROSTLINE, WHICHEVER IS DEEPER

3

FIGURE 3 - UP TO 64 STATIONS, ALL SOILS
NO SCALE

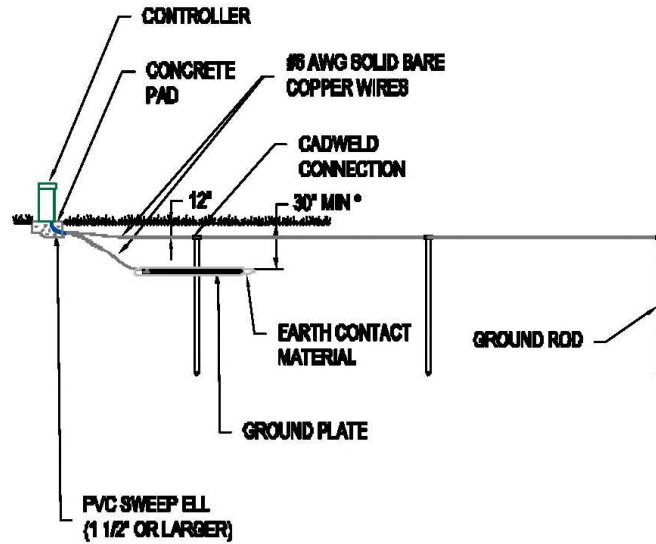


TOP VIEW



DO NOT INSTALL ANY OTHER WIRES OR CABLE WITHIN THE SPHERE OF INFLUENCE

SIDE VIEW



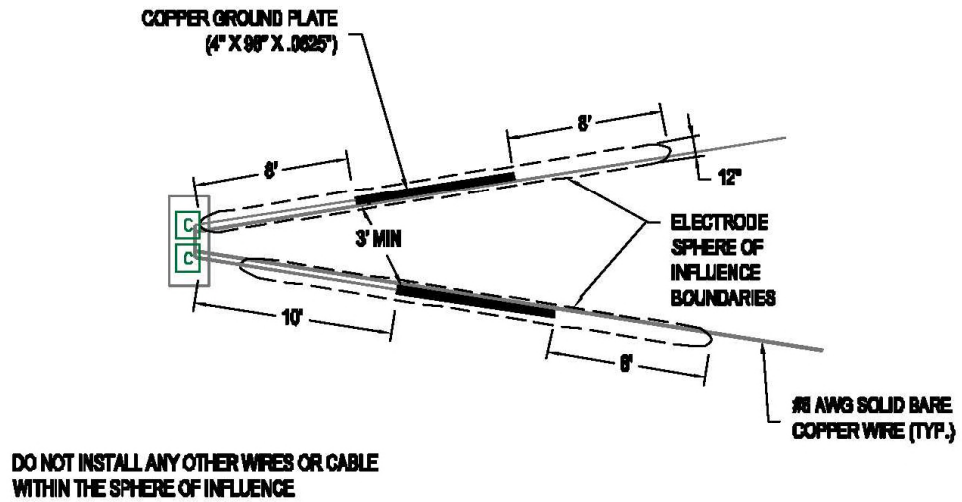
* OR BELOW FROSTLINE, WHICHEVER IS DEEPER

4

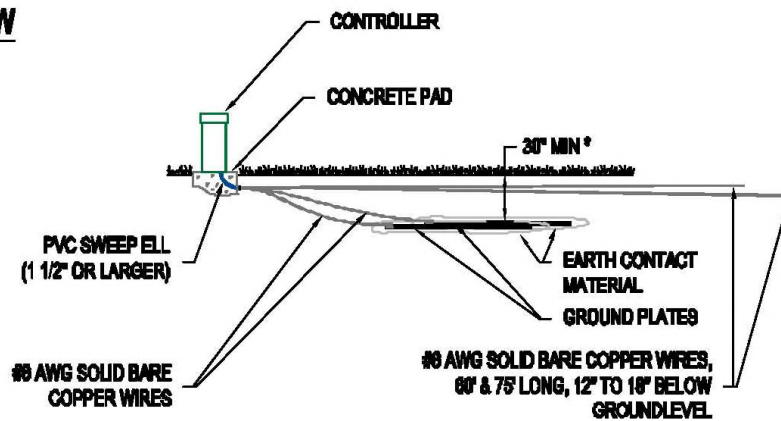
FIGURE 4 - UP TO 96 STATIONS, NON- ROCKY SOILS
NO SCALE



TOP VIEW



SIDE VIEW



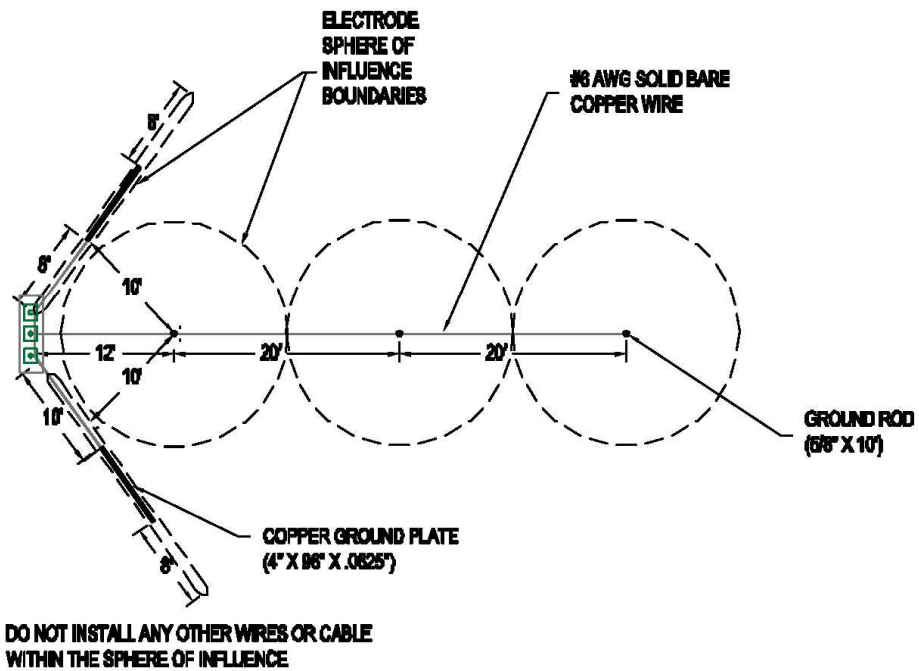
* OR BELOW FROSTLINE, WHICHEVER IS DEEPER

5

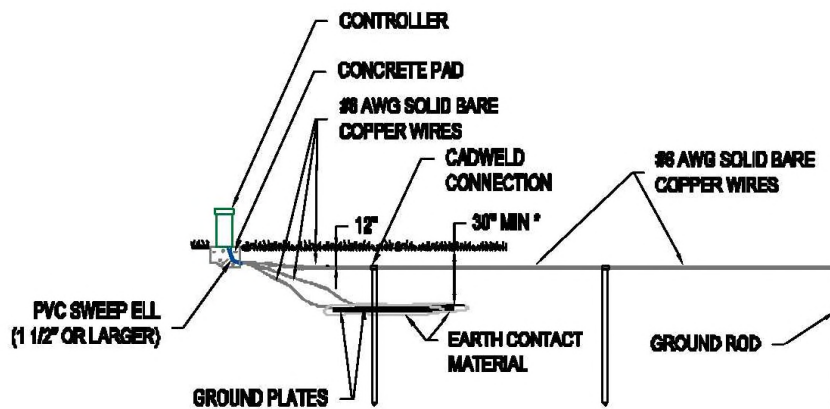
FIGURE 5 - UP TO 96 STATIONS, ALL SOILS
NO SCALE



TOP VIEW



SIDE VIEW



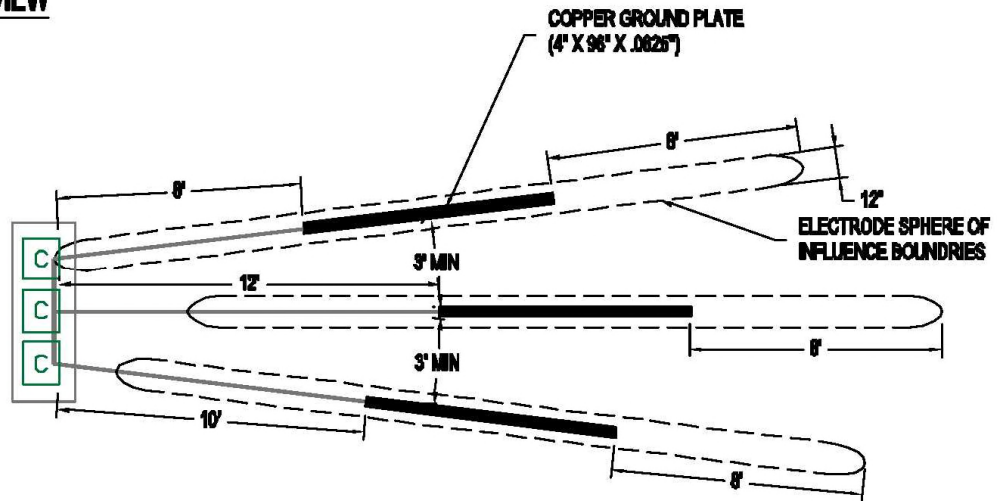
* OR BELOW FROSTLINE, WHICHEVER IS DEEPER

6

FIGURE 6 - UP TO 128 STATIONS, NON-ROCKY SOILS
NO SCALE

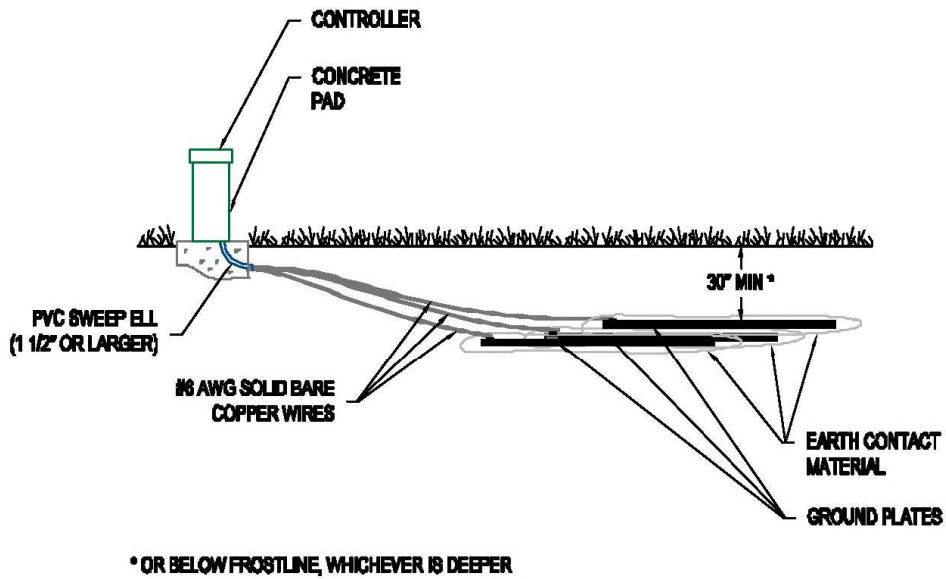


TOP VIEW



DO NOT INSTALL ANY OTHER WIRES OR CABLE
 WITHIN THE SPHERE OF INFLUENCE

SIDE VIEW



* OR BELOW FROSTLINE, WHICHEVER IS DEEPER

7

FIGURE 7 - UP TO 128 STATIONS, ALL SOILS
NO SCALE



SIDE VIEW



8 **FIGURE 8 - UP TO 256 STATIONS, ALL SOILS**
NO SCALE

