



TWIG-V Wireless Automation System

TWIG^{MC}



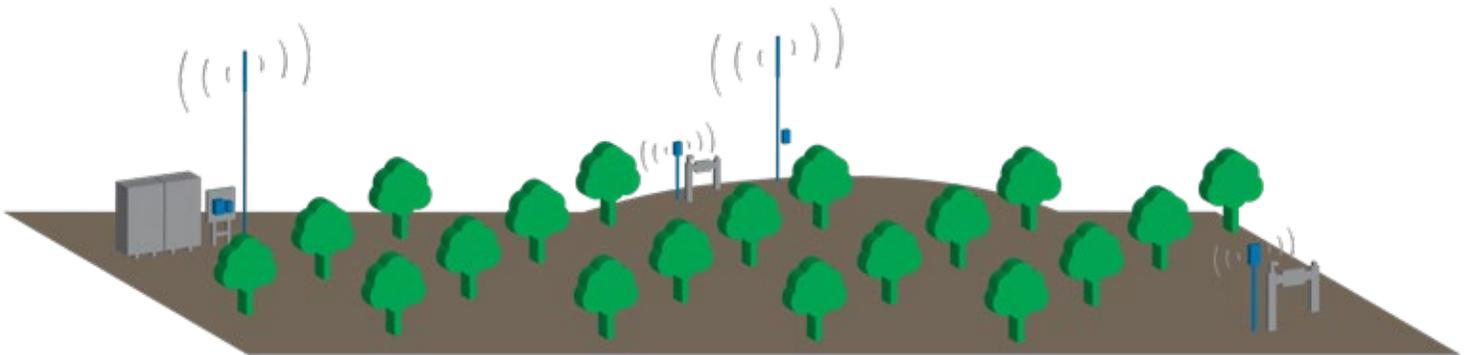
USER GUIDE

PRELIMINARY

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TWIG-V WIRELESS NETWORK



TWIG^{MC}

USER MANUAL

Table of Contents

Safety cautions and Warranty	1
Section 1: Overview of the TWIG-MC, Hubs, and TWIG.....	6
Section 2: Connecting to the TWIG-MC controller	7
Section 3: Get TWIG-MC mobile apps.....	8
Section 4: How to create watering Programs.....	8
Section 5: Assign optional names.....	9
Section 6: Edit Programs using drag and drop	9
Section 7: TWIG-V app for setup and testing valve operation	10
Section 8: Map TWIG-V locations	11
Section 9: Irrigation Programs run manual or automatic start	11
Section 10: Valve control to 'Keep On' or 'Keep Off'	13
Section 11: Tips for the best system.....	14
Appendix A: Antenna Guide and Kits.....	A1
Appendix B: Instructions for installation and update.....	B1
Appendix C: Relay options for TWIG-MC	C1
Appendix D: Specifications and Approval.....	D1
Appendix E: Solar/Battery Kits TWIG-MC.....	E1



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Warning:

TWIG Wireless products should not be used to control mechanisms or devices remotely, including mechanisms or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered. No TWIG Wireless product is intended for use in any application where the safety of life or property is at risk.

The customers and users of devices and mechanisms controlled with TWIG Wireless products must understand and must use all appropriate safety procedures in connection with the devices, including without limitation, using appropriate safety procedures to prevent inadvertent triggering by the user of the device. If someone is going to do service or maintenance on the TWIG Wireless products they must follow the safety instructions identified in this manual.

All TWIG Wireless Products are susceptible to RF interference and interruption that can prevent communication. It is solely the responsibility of the user to understand that failure to connect or trigger TWIG Wireless Products both on or off is possible. The user assumes all risks to life or property caused by RF interference or interruption.

Do not use any TWIG Wireless Products over the limits in this manual. Excessive voltage or extended operation at the maximum voltage could cause product failure. Never use any radio antenna other than the antennas provided for use by Nelson Irrigation Corporation or as specified in this manual.

Do not make any physical or electrical modifications to any TWIG Wireless Product. This will void the regulatory certifications and may cause product failure. Any physical and electrical modifications void the warranty.

Electrical Safety Caution:

Some components of the TWIG Wireless Product may be powered by 120V or 240V AC electricity. Electricity and water are in abundance in irrigation and are a safety concern. Care must be taken to avoid having any electrical power in contact with your body or with water. If it does happen then electrical shock or injury can result. Normal and accepted practices of powering down any components before doing any installation or service work on the devices must be followed.

Also some components of the TWIG Wireless Products may be powered by DC voltage batteries and solar panels. The possibility of an electrical short exists from these devices. Using the normal and accepted electrical safety practices is necessary.

In summary, if the rules are not followed personal safety is compromised. Attempting to perform work while power is on can cause a shock or spark that can ignite a fire, cause injury, or death.

Personal Safety Caution:

Ladders:

Ladder climbing to work above ground level may be required for some maintenance in field projects. Danger exists for falling from a ladder. Use of normal safety practices for ladder loads, angle of lean, rungs and slippage avoidance are recommended.

Antenna safety:

Do not locate an antenna mast near power lines. Look up and live! Make sure that no power lines are where possible contact can be made with the mast. Contact with electric wires can be lethal! See Appendix A for more information.

Keep controller boxes sealed. Avoid insect intrusion. Never leave any access holes open in control boxes. Never leave the door of the box open.

Only the antennas provided by Nelson Irrigation shall be used in the TWIG Wireless Product network.

Caution if system is moved to a new site:

The wireless control system is comprised of selected TWIG Wireless Products which can be relocated from site to site in order to accommodate crop changes. Each site must be evaluated for safety purposes to meet personnel and property safety. Each irrigation site must have a water relief valve installed that can discharge water to relieve excess pressure for safety purposes.

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The Bluetooth word mark and logos are owned by the Bluetooth SIG, Inc.
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LIMITED WARRANTY

Nelson Irrigation Corporation warrants the Nelson Wireless TWIG Control Products (the "Products") against defects in materials and workmanship for one year from the date of retail purchase by the original purchaser ("Warranty Period") when used with Nelson Irrigation valves and casings and as described in the Nelson TWIG documents.

This Limited Warranty does not apply to (1) Products that have been used with valves or casings not manufactured by Nelson Irrigation; (2) consumables (such as batteries); (3) software or mobile app, even if packaged or sold with the Product or embedded in the Product; (4) a Product that has been modified by anyone who is not a representative of Nelson Irrigation; (5) damage caused by use with non-Nelson Irrigation products; (6) damage caused by accident, abuse, misuse, lightning, flood, fire, earthquake, or other external causes; (7) damage caused by operating the Product outside the permitted or intended uses described in the Nelson TWIG documents or with improper voltage or power supply; (8) damage caused by failure to follow the Product instructions; or (9) damage caused by service (including, without limitation, installation, removal, or unauthorized repair, upgrades, or expansions) performed by anyone who is not an authorized representative of Nelson Irrigation. Recovery and reinstallation of software programs and user data are not covered under this limited warranty. Nelson Irrigation does not warrant that the operation of the Product will be uninterrupted or error-free.

EXCLUSIVE REMEDY. Under this limited warranty, if a defect in the Product arises and a valid claim is received by Nelson Irrigation within the Warranty Period, Nelson Irrigation will, at its option and to the extent permitted by law, either (1) repair the Product at no charge, using new or refurbished replacement parts, or (2) exchange the Product with a new or refurbished Product.

DISCLAIMER & LIMITATION OF LIABILITY

The limited warranty written above is the only express warranty Nelson Irrigation provides for the Product, and the above remedy is your sole remedy. To the maximum extent permitted by applicable law, NELSON IRRIGATION EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES AND CONDITIONS OF ANY KIND, WHETHER STATUTORY OR IMPLIED, ARISING FROM COURSE OF CONDUCT OR OTHERWISE, REGARDING THE PRODUCT, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TO THE EXTENT THAT APPLICABLE LAW PROHIBITS THE DISCLAIMER OF IMPLIED WARRANTIES, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT ARE LIMITED IN DURATION TO THE ONE-YEAR PERIOD OF THE EXPRESS WARRANTY ABOVE.

Some States do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

You expressly understand and agree that, to the maximum extent permitted by applicable law, Nelson Irrigation and its subsidiaries and affiliates (collectively, "Nelson Irrigation Parties") shall not be liable to you under any theory of liability - whether contract, tort, strict liability, negligence, breach or failure of any warranty, or otherwise - for any indirect, incidental, special, consequential, or exemplary damages that may be incurred by you in conjunction with the Product or these terms, including a) crop or other consequential damages resulting from any defects or breach of warranty and b) any loss of data, whether or not a Nelson Irrigation Party or its representatives have been advised of or should have been aware of the possibility of any such losses arising. You expressly understand and agree that, to the maximum extent permitted by applicable law, the Nelson Irrigation parties' total liability in connection with the Product or this limited warranty will not exceed the amount you actually paid for the Product.

No agent, employee or representative of Nelson Irrigation Corporation has authority to waive, alter or add to the provisions of this warranty nor to make any representations or warranty not contained herein.

Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

NOTICE REGARDING WIRELESS SERVICE. The Product operates over a wireless network and relies on the availability of wireless services provided by third-parties. Nelson Irrigation does not guarantee the availability of continuous wireless services and does not warrant the Product against wireless service interruptions, hackers, eavesdroppers, or viruses. There is no guarantee of app compatibility with past or future upgrades made to service by third-parties.

INSTRUCTIONS TO OBTAIN WARRANTY SERVICE. To obtain warranty service, contact Nelson Irrigation at 509-525-7660. It is your responsibility to backup any data, software, or other materials you may have stored or preserved on the Product. It is likely that such data, software, or other materials will be lost or reformatted during service, and Nelson Irrigation will not be responsible for any such damage or loss.

SEVERABILITY. If any term is held to be illegal or unenforceable, the legality or enforceability of the remaining terms shall not be affected or impaired.

This warranty gives you specific legal rights, and you may also have other rights that vary by state to state.

GOVERNING LAW. This Limited Warranty shall be governed by the laws of the State of Washington regardless whether choice-of-law rules point to the law of another jurisdiction.

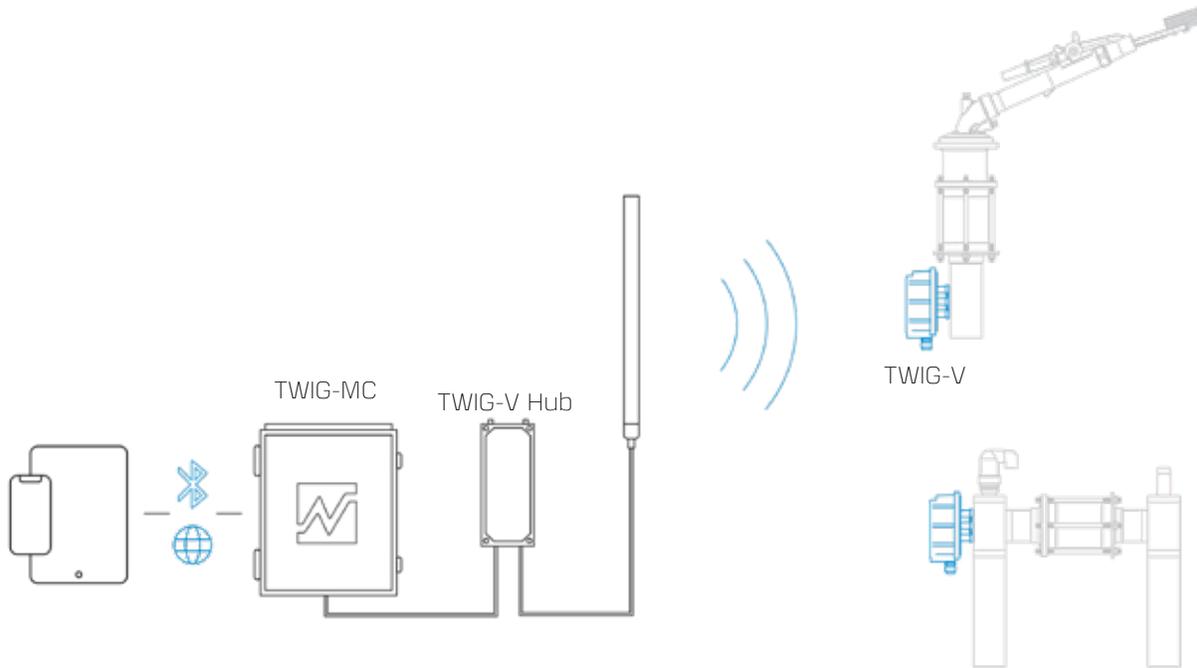
ARBITRATION. Any claim or dispute in connection with this Limited Warranty shall be resolved in a cost effective manner through binding, non-appearance-based arbitration located in the State of Washington, using JAMS commercial arbitration rules. The arbitration shall be initiated through an established alternative dispute resolution provider mutually agreed upon by the parties. The alternative dispute resolution provider and the parties must comply with the following rules: a) the arbitration shall be conducted by telephone, online, and/or be solely based on written submissions, the specific manner of which shall be chosen by the party initiating the arbitration; b) the arbitration shall not involve any personal appearance by the parties or witnesses unless otherwise mutually agreed by the parties; and c) any judgment on the award rendered by the arbitrator may be entered in any court of competent jurisdiction.

If the foregoing arbitration clause does not apply for any reason, you agree to submit to the personal jurisdiction of the state courts located within Walla Walla County, Washington and the federal courts in the Eastern District of Washington for the purpose of litigating all such claims or disputes, which courts shall have exclusive jurisdiction of such claims or disputes. Notwithstanding the foregoing, Nelson Irrigation may seek injunctive or other equitable relief to protect its intellectual property rights in any court of competent jurisdiction. The prevailing party in any claim or dispute in connection with this Limited Warranty shall be entitled to recover its reasonable attorneys' fees and costs whether before or at arbitration, trial, and upon any appeals.

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1.0 - Overview of TWIG-MC, Hubs, and TWIG-V

The TWIG-MC is the master controller for wireless valve automation. Smart phone irrigation management is enabled. Connected Hub manages the radio network to communicate to all TWIG-V valves. Here is a network example:



Part Numbers:

12957-001 Controller, TWIG-MC
13206 Hub –TWIG-V

Part Numbers for TWIG-V with bracket assembly

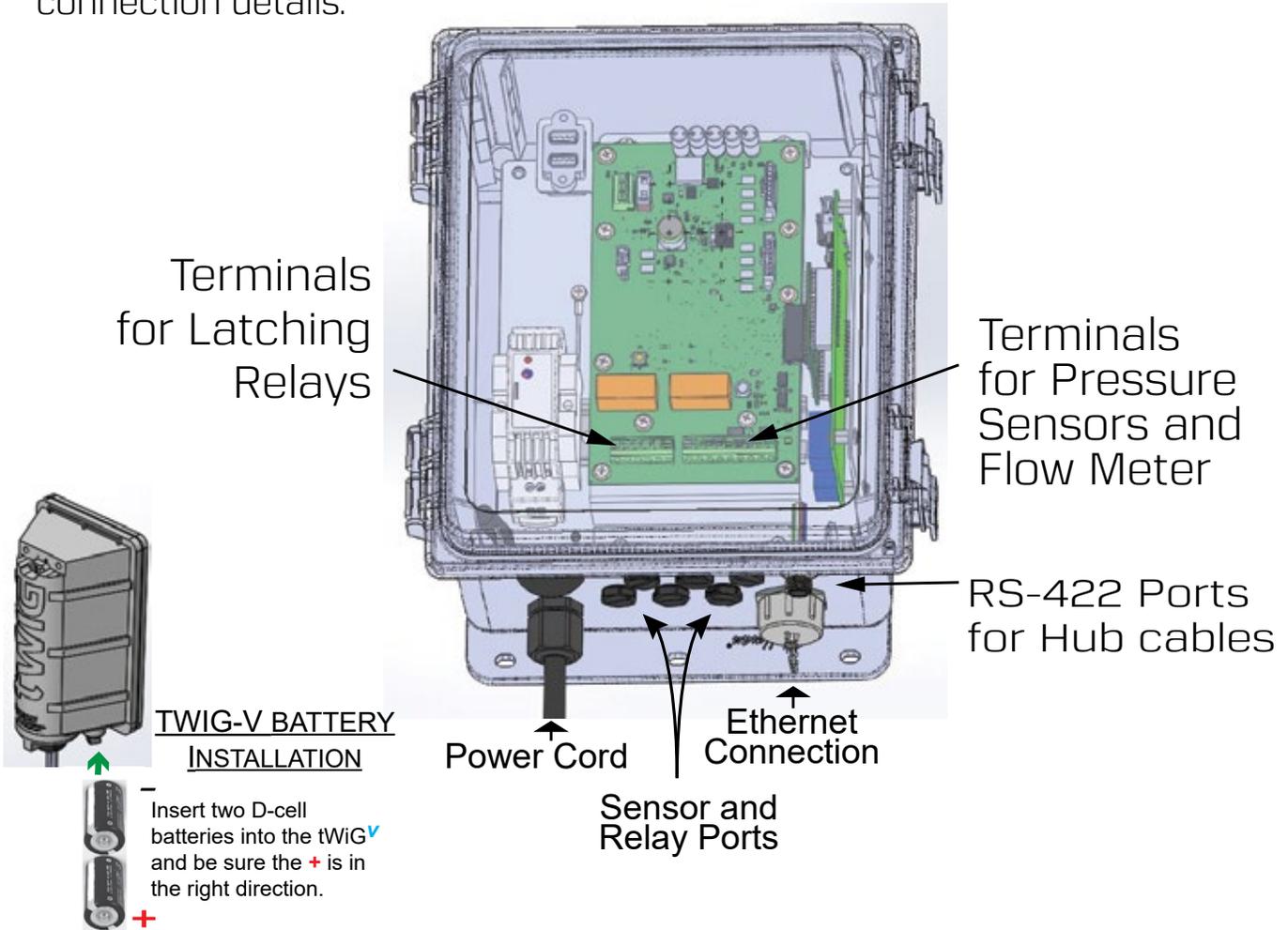
13457-001 TWIG-V 1i with bracket
13457-002 TWIG-V 2i with bracket
13457-011 TWIG-V 1e with bracket
13457-012 TWIG-V 2e with bracket

Irrigation programs are created using the mobile apps to control start, stop or pause schedules. The apps communicate with the TWIG-MC controller via Bluetooth® or a user-provided internet connection. Each TWIG-V Hub or TWIG Hub can manage a combined total of 100 TWIGs and Repeaters. The status of all the valves are easily viewed and edited with the TWIG-MC app.

TWIG-V radios are installed next to valves. They communicate with the Hub. TWIG-V options control a single valve or two valves. Other accessories available are solar power kits, repeaters and pump relays.

2.0 - Connecting to the TWIG-MC controller

Before setup you need to make some connections to the controller ports. Here is a drawing showing the ports available. See Appendix B2 for connection details.



SYMBOL DEFINITIONS

Cancel	Start	Plan view	Drag MAP Shape
Add	Forward	Status view	Scale MAP Shape
Delete	Pause	Map view	Rotate MAP Shape
Time adjust	Back	Options	
Group	Stop	Bluetooth [®]	
2 Finger Tap	Press & Hold	Internet	



The initial connection to TWIG-MC is through Bluetooth only! Not INTERNET.

3.0 - Get TWIG-MC mobile apps

The TWIG-MC controller requires two mobile apps. The TWIG-MC app works with the controller while the TWIG-V app works with the TWIG-V. Follow these steps to download the two apps to your smart phone. See Appendix B3 for more details.

Step 1: In the Apple App Store or Google Play Store search for TWIG-MC



and download it.



Step 2: Then search for the TWIG-V  app and download it.

Step 3: Once you have both apps on your mobile device, you can join your phone to the TWIG-MC. The first time has to use Bluetooth® so you have to be nearby it (within 30 ft.). Be sure the controller has power and your Bluetooth® is turned ON.

Step 4: You have to pair the TWIG-MC controller to your mobile device to gain authorized access. Here is how it is done:

- When the TWIG-MC app is started, a scan will discover your controller.
- Tap on your TWIG-MC name/number when it appears on your screen.
- The first time you connect, you will be asked the TWIG-MC name/number, the channel and Pairing Pattern (see Section B5 for SETTINGS of how the Pairing Pattern is used). For security reasons, you should only share the pairing pattern with people you want to have authorized access.
- After you are paired together with your controller, you can create programs and view status on the system while nearby. Then, if the TWIG-MC is connected to the internet, you can control it remotely using the TWIG-MC app via the internet instead of via Bluetooth®.

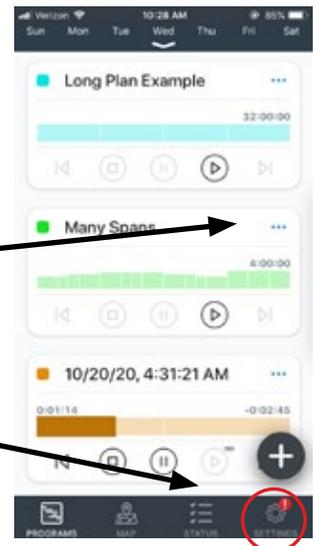
3.1 - Use TWIG-V app for Setup

The TWIG-V are installed at the valves. Use the TWIG-V app to join each TWIG-V to your TWIG-MC controller. TWIG-V connects via Bluetooth® so stand nearby it when joining to it. The app shows you the radio signal bars and battery power volts.

4.0 - How to create watering Programs

Programs set the time schedules to turn the TWIG-V valves on and off. To create a new program or edit an existing one, you must connect you phone to the TWIG-MC using the app. Make sure the controller is powered up then do the following steps:

1. Start the TWIG-MC app and tap on your TWIG-MC ID to connect.
2. Tap a program you want to edit or duplicate. Or tap + to add a new program.
3. The screen shows the time-slots list for TWIG-Vs to use.
4. The order which you tap each TWIG-V name puts it in the next time-slot.
5. To run multiple TWIGs at the same time do 2-finger tap to add TWIGs.
6. Save the program you created then, tap on it when ready to start it.



5.0 - Assign Optional names

You can edit names of the programs, name the TWIG-MC controller and name each TWIG-V.

To edit PROGRAM names tap screen on the three dots ● ● ●

To edit the TWIG-MC controller name use SETTINGS icon.

To rename TWIG-Vs in STATUS list tap on the three dots ● ● ●

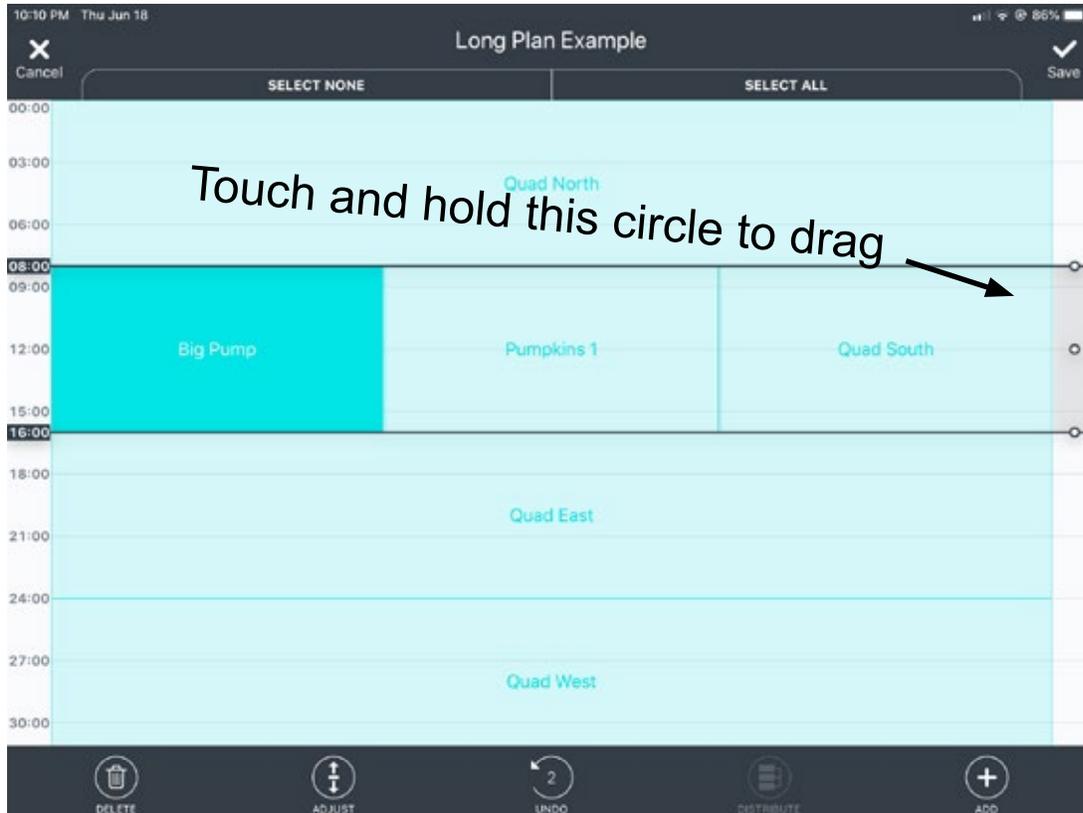


Remember you can rename ONLY when using the TWIG-MC app. You can't use the TWIG-V app to rename TWIGs.

6.0 - Edit programs using drag and drop

You can EDIT time schedules by selecting the TWIG names and moving them to any time slot. See the screen image below and follow these steps:

- Select the Program name and then select 'EDIT'
- Tap the name of the TWIG-V you want to change. Use 2-finger tap to select several TWIG-Vs at a time.
- Use the small circle on the right edge as a drag handle to move the TWIG-V to the new time slot wanted. Then release to drop into the program and save it.



7.0 - TWIG-V app for setup and testing valve operation

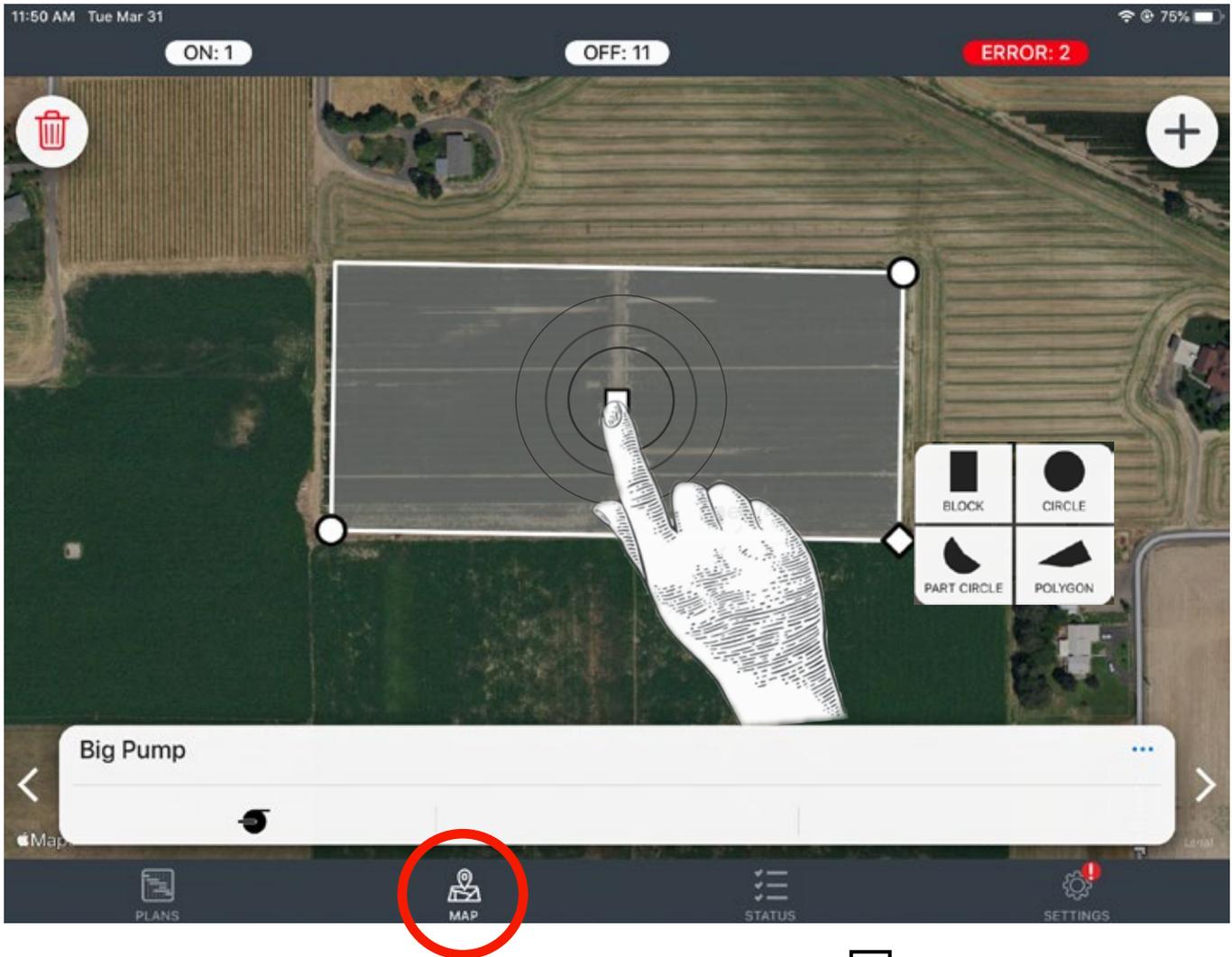
You use the TWIG-V app to check each TWIG-V valves. When you start the app, the Ids of all surrounding TWIG-Vs that can be located nearby will be listed. Select the one to test and tap on OPEN/CLOSE to verify it works.

If you are not within Bluetooth range then a remote status check is done using the TWIG-MC app in the STATUS list which shows battery voltage, radio signal bars and any errors that exist.

8.0 - MAP TWIG-V locations

The MAP tool will show an aerial view of your system. To use MAP click on the icon located at the bottom of the screen (see red circle).

- Touch  and choose the BLOCK shape which best matches your irrigation zone.
- Then touch the MAP screen at the location for the TWIG-V.



- To edit the shape, touch and press down on the  to Drag the shape or use the  to Scale the shape or the  to Rotate the shape as needed.

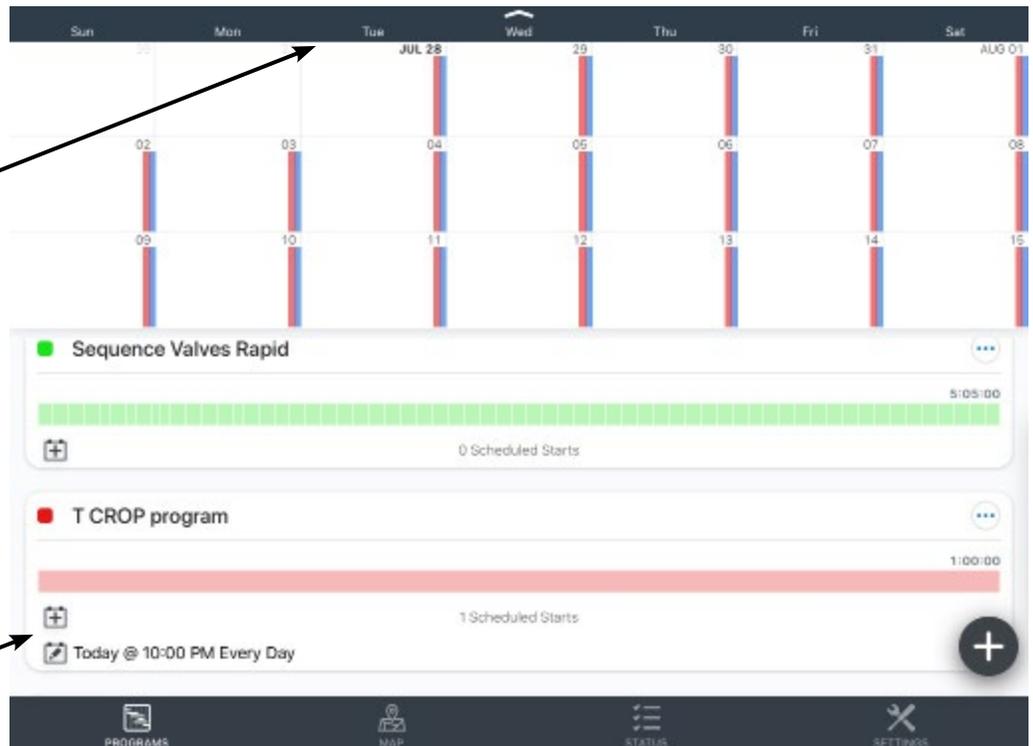
Some useful things you can do with your map:

- view which TWIGs are running and when watering will start and finish.
- easily examine the program sequence
- adjust the shape to visually show the area irrigated by each TWIG-V
- quickly locate any problems that may exist:
- you can also rename or remove any unwanted TWIG radios from the network.

9.0 - Irrigation Programs run manual or automatic start

Each program you create can start manually or automatically as often as you want. You set it up using the calendar symbol. This screen appears when you tap on the week day in heading bar:

Tap here to schedule automatic run times.



Then tap here to set when to start irrigation.

Choose how often to water either Just Once, Every Day or multiple times a week.



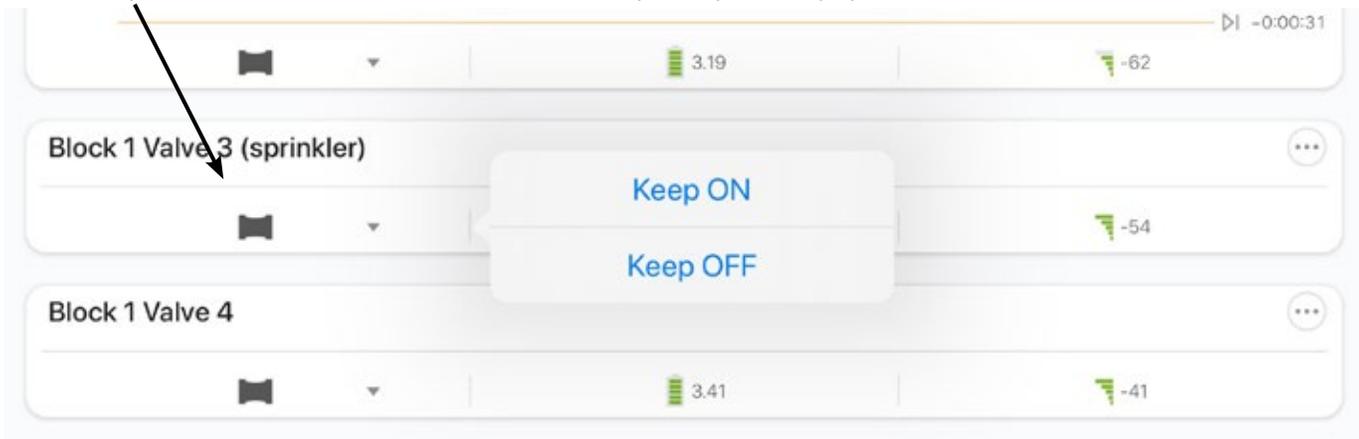
10.0 - Valve control to 'Keep On' or 'Keep Off'

The "Keep ON" and "Keep OFF" features allows you to manually override the program for any valve or pump. Press on any valve or Pump icon in the Status

list of the app. When under manual control, any valve (or latch relay) placed in either Keep-On or Keep-Off, will remain in that state regardless of any programs that may be running for that valve. This Keep-On or Keep-Off setting overrides all instruction any program would indicate.

Following these steps:

- Tap the STATUS list to see all TWIG-V names.
- Tap on the icon of the valve or pump relay you want to manual control.



- Select Keep-On or Keep-Off.
- The valves/relays will remain in the manual control state.
- To change to another state, repeat the same steps to change.
- CAUTION- make sure the irrigation system can handle any manual change in flow. Avoid problems caused by no water flow (pump running while all valves are off) which may result in excessive pressure that could damage system parts.

When you might use Keep On or Keep Off?

Sometimes you don't want to water everything or you need a valve to remain on. This control tool will override all programs, keeping on or keeping off any valves regardless of program schedules. This control is useful in the event people have to be in the field, to manage crop chemical spray or if any essential valve must remain flowing water. This override control will remain in this state until changed.

11.0 - Tips for the best system

Reliability for TWIG-MC wireless control is all about getting the radio signal to the right place every time. If you do that then Nelson TWIG-MC controller and TWIGs will make your valves always work. The network is designed for harsh field conditions and each of the radios are built and tested in the USA.

11.1 Carefully plan the location of the TWIG-MC controller and Hub antenna

>: **The TWIG-MC is the master of the control system.** It is best to locate it near a central place to minimize distance. Often the controller is placed near the pump because typically electric power is available there. Antenna efficiency improves when located at a high point so keep that in mind when planning the controller location. The controller cabinet is designed for outdoor use. However some cover will help it last longer and reduce extreme temperatures and moisture aging.

>: **Repeaters are used to extend the distance of radio control;** If the distance to the valves exceeds a solid signal level of -84 then consider using a Repeater to make the communication reliable. For example a signal of -96 indicates a repeater should be considered. During setup, the repeater is assigned a group of TWIG-Vs to communicate directly to the TWIG-V Hub. See Appendix B12 that illustrates a network example.

11.2 Good wireless practices for TWIG-MC:

Here are some helpful points to avoid communication errors.

- Keep within the recommended range. Locate antennas as high as practical.
- Plan for crop growth so the radio signal is not blocked.
- Never operate with any other battery type than specified by Nelson Irrigation.
- It is not allowed to co-locate (be right next to each other or closer than within 8 inches (20 cm)) with other radios and to transmit simultaneously.
- Never operate with any other antenna than supplied or approved for use.
- TWIG products are pre-approved by the FCC and do not require licensing.
- Installations near an airport are subject to stricter rules. Check with the local regulations.
- The TWIG-Vs and Repeater should be easily accessible for battery replacement.

Appendix A: Antenna Kits and facts

The antennas are the crucial communication link. The successful radio range between the TWIG-V Hub and the TWIG-Vs depends upon good antennas. Antenna kits and antennas for the TWiG system are selected for the best radio network communications. The internal antennas in the TWIG-V are dipole that must be placed in a vertical orientation.

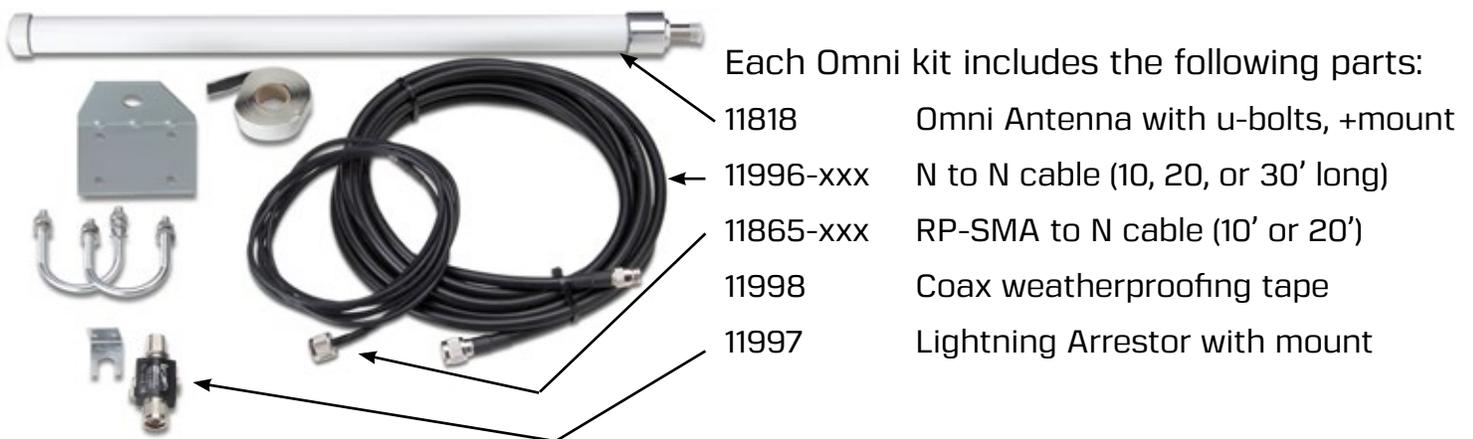
Read more details at the end of this section.

The Nelson Omni antennas are rated 6 dBi. The longest range is achieved using the Omni antenna. Note:

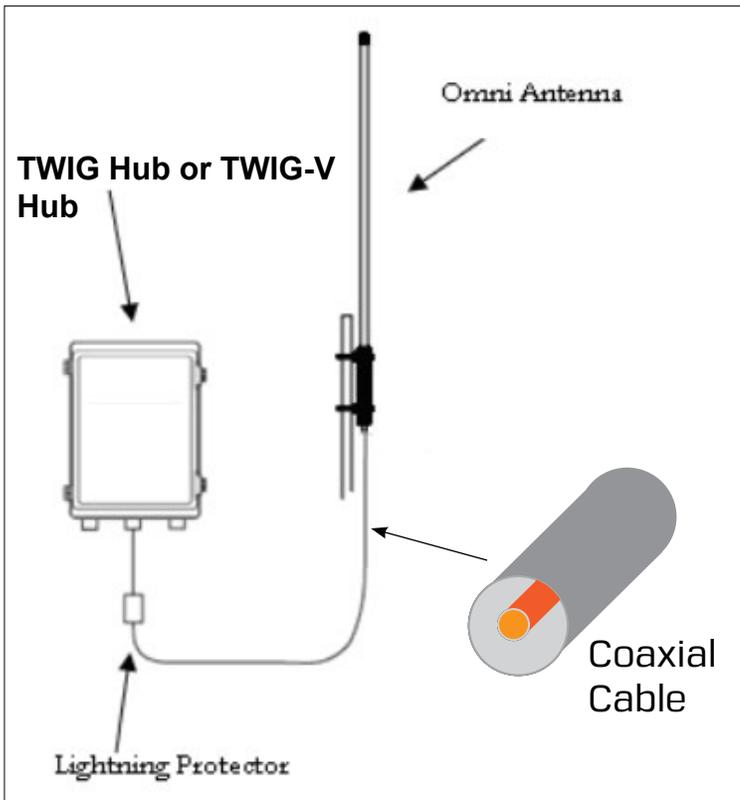
The approved antennas provided by Nelson Irrigation are recommended for the TWiG network. Here are the kit part numbers:

- 12000-010 Omni with 10' cable
- 12000-020 Omni with 20' of cable
- 12000-030 Omni with 30' of cable
- 12000-040 Omni with 40' of cable
- 12000-050 Omni with 50' of cable
- 12281 Di-pole articulating (no cable)

Figure A1 Antenna kit parts list



The only difference between these Omni antenna kits is the length of the co-axial antenna cable. The length should be selected carefully because there is some signal degrading within the cable. Length should not be any longer that needed but long enough that it easily connects. An appropriate length will have enough that a small amount of extra cable can be looped to give room for making the connections. The water proof seal tape must be used to keep moisture from entering the cable junctions.



Sharp bends in the co-axial cable should be avoided.

The U-bolts in the mounting kit can be used to mount the antennas onto a round mast up to 2" O.D. (pipe size 1" to 1 1/2" diameter).

Figure A2 Antenna cable connection

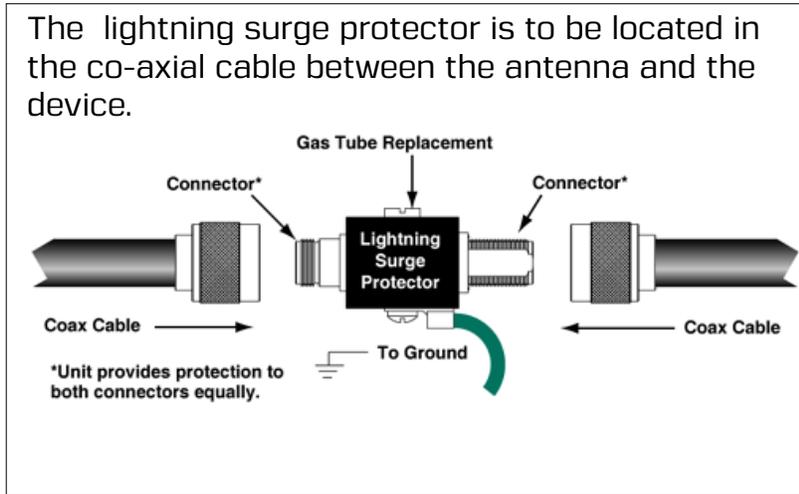
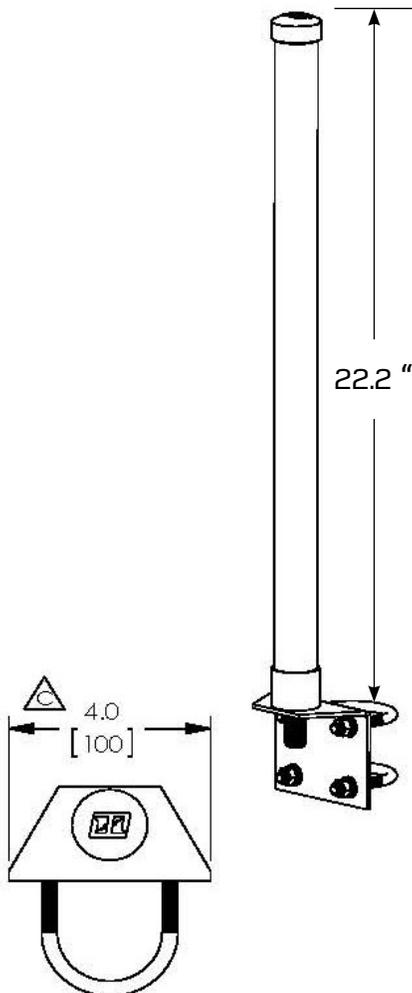


Figure A3 Omni Antenna length



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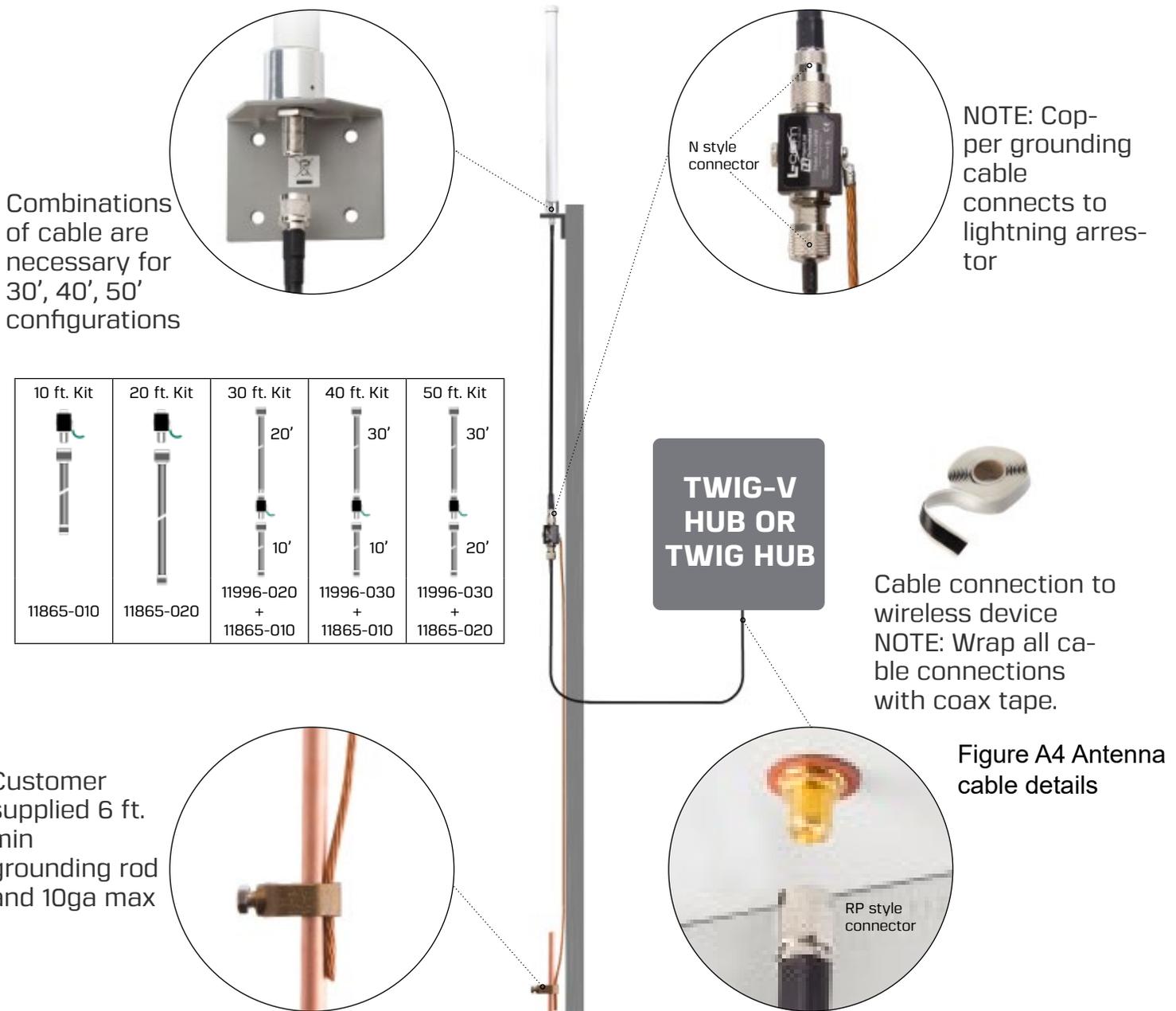
Antenna Assembly



TWIG ANTENNA KITS INCLUDE:

- 11818 Omni Antenna with u-bolts and mounting bracket
- 11865-xxx RP-SMA to N cable (10 or 20' long)
- 11996-xxx N to N cable (20' or 30' long)
- 11997 Lightning Arrestor with mounting bracket
- 11998 Coax weatherproofing tape

Please follow diagram below to assemble.



Combinations of cable are necessary for 30', 40', 50' configurations

10 ft. Kit	20 ft. Kit	30 ft. Kit	40 ft. Kit	50 ft. Kit
11865-010	11865-020	11996-020 + 11865-010	11996-030 + 11865-010	11996-030 + 11865-020

N style connector

NOTE: Copper grounding cable connects to lightning arrestor

TWIG-V HUB OR TWIG HUB



Cable connection to wireless device
NOTE: Wrap all cable connections with coax tape.

Customer supplied 6 ft. min grounding rod and 10ga max

Figure A4 Antenna cable details

RP style connector

OUTDOOR INSTALLATION WARNING

IMPORTANT SAFETY PRECAUTIONS:

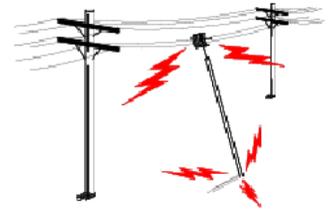
LIVES MAY BE AT RISK! Carefully observe these instructions and any special instructions that are included with the equipment you are installing.

IMPORTANT: Look over the site before beginning any installation, and anticipate possible hazards, especially these:

CONTACTING POWER LINES CAN BE LETHAL. Make sure no power lines are anywhere where possible contact can be made. Antennas, masts, towers, guy wires or cables may lean or fall and contact these lines. People may be injured or killed if they are touching or holding any part of equipment when it contacts electric lines. Make sure there is NO possibility that equipment or personnel can come in contact directly or indirectly with power lines.

Assume all overhead lines are power lines.

The horizontal distance from a tower, mast or antenna to the nearest power line should be at least twice the total length of the mast/antenna combination. This will ensure that the mast will not contact power if it falls either during installation or later.



TO AVOID FALLING, USE SAFE PROCEDURES WHEN WORKING AT HEIGHTS ABOVE GROUND.

- Select equipment locations that will allow safe, simple equipment installation.
- Don't work alone. A friend or co-worker can save your life if an accident happens.
- Use approved non-conducting ladders and other safety equipment. Make sure all equipment is in good repair.
- If a tower or mast begins falling, don't attempt to catch it. Stand back and let it fall.
- If anything such as a wire or mast does come in contact with a power line, **DON'T TOUCH IT OR ATTEMPT TO MOVE IT.** Instead, save your life by calling the power company.
- Don't attempt to erect antennas or towers on windy days.

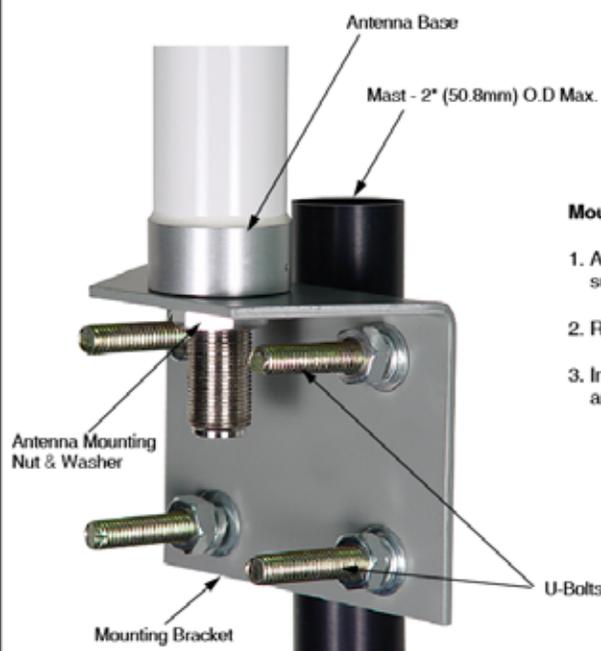
MAKE SURE ALL TOWERS AND MASTS ARE SECURELY GROUNDED, AND ELECTRICAL CABLES CONNECTED TO ANTENNAS HAVE LIGHTNING ARRESTORS. This will help prevent fire damage or human injury in case of lightning, static build-up, or short circuit within equipment connected to the antenna.

- The base of the antenna mast or tower must be connected directly to the building protective ground or to one or more approved grounding rods, using 1 O AWG ground wire and corrosion-resistant connectors.
- Refer to the National Electrical Code for grounding details.
- Lightning arrestors for antenna feed coaxial cables are available from L-com, Inc.

IF A PERSON COMES IN CONTACT WITH ELECTRICAL POWER, AND CANNOT MOVE:

- **DON'T TOUCH THAT PERSON, OR YOU MAY BE ELECTROCUTED.**
- Use a non-conductive dry board, stick or rope to push or drag them so they no longer are in contact with electrical power.
- Once they are no longer contacting electrical power, administer CPR if you are certified, and make sure that emergency medical aid has been requested.

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Installation Instructions

Models: HGV-903U and HGV-906U

Mounting Instructions

1. Attach mounting bracket to mast as shown using (2) U-bolts and supplied hardware.
2. Remove antenna mounting bolt and washer from antenna base.
3. Insert antenna into mounting bracket and secure with washer and antenna mounting nut. Do not over tighten.

IP-00066 Rev. B - 04/14 Page 2/2

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Antenna: The antenna for the TWIG network connects directly to the TWIG-V Hub which manages the radio network. The antenna is to be mounted onto a good high location that is available. Many installations use an existing power pole. When power wires are near by the antenna cable should be placed as far away as possible. Make sure the TWIG-V Hub antenna and the TWIG-V are located in the best possible line-of-sight to get the most successful system.

Tools and materials suggested for antenna installation be available before starting the installation. Since the coax cable must be routed from the antenna to the Hub which may be inside the building the proper drill sizes are necessary.

- | | |
|---|-------------------------|
| Pole, antenna support | Hand Drill, 1/2" drive |
| Open end Wrenches | Screwdriver, Flat blade |
| Screwdriver, Phillips Head | Wire Cutter |
| Wire Stripper | Zip ties |
| Copper ground wire | Grounding rod |
| Lag screws, 5/16" x 3 1/2" (if wood pole) | Electrical Tape |

Seal the connector: Water and corrosion are the enemies of radio signals. The solution is to seal all the antenna connections using the #11998 coax-seal tape included in each antenna kit.

Step 1 Wrap the coax-seal tape around the entire connector fitting and cable making sure all joints are covered.

Step 2 With fingers form a smooth surface seal. Press the tape around the fitting making it smooth and sealed.

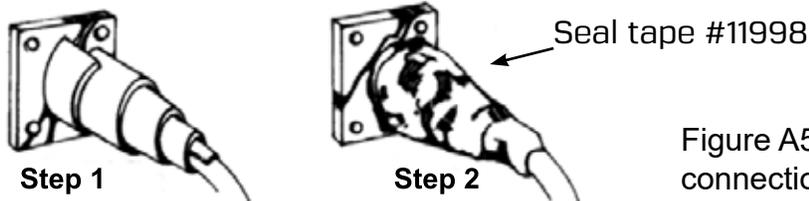


Figure A5 Steps to seal the cable connections.

Appendix B:

Instructions for installation and update.

Contents:

B1 TWIG-MC Hub can control both TWIG-V and legacy TWIGs

B2 Update for TD200 legacy networks

B3 Get mobile apps on to your smart phone:

B4 Make Settings to the TWIG-MC controller

B5 Controller SETTINGS

B6 Get the TWIG-MC on-line INTERNET

B7 TWIG-V installation instructions

B8 TWIG-V Repeater installation instructions

B9 Pressure Transducer Connection

B10 Flow Meter Connection

B11 Connection to the relays inside TWIG-MC controller

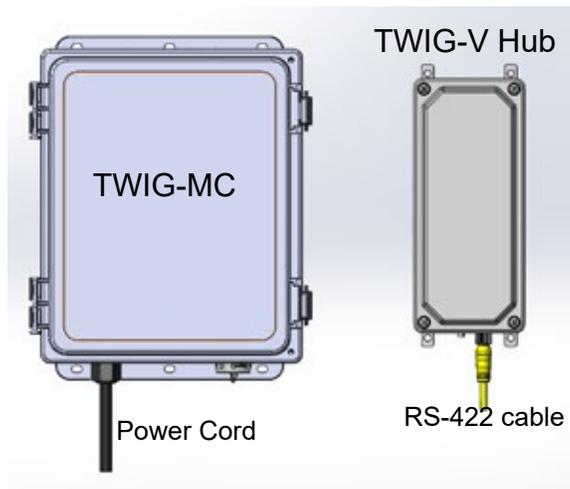
B12 Repeaters to extend the distance for network TWIGs



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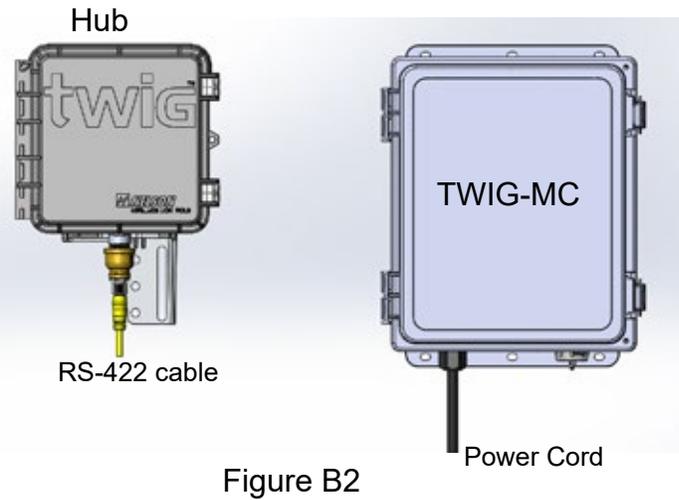
Appendix B: Instructions for installation and update.

B1 The TWIG-MC with Hub can control both TWIG-V and legacy TWIGs: Here is a comparison of the Hubs for the two networks. Figure B1 shows the TWIG-MC system which has Figure B2 shows the Hub that replaces the TD200. In both systems, the TWIG-MC controller is the same. It manages the programs while Hubs manage the wireless radio network. Both Hubs get the power from the TWIG-MC controller.



Part Numbers used together:
12957-001 Controller, TWIG-MC
13206 Hub –TWIG-V

Figure B1 TWIG-V system



Part Numbers used together:
12957-001 Controller, TWIG-MC
13207 Hub –TWIG

Figure B2 TWIG-MC with TWIG Hub for 1st generation TWIG systems

B2 Update for legacy TD200 networks

Installations: While the process is the same for both TWIG-V and the legacy TWIG, the Hubs are different. Both use the same type of Hub antenna. The TWIG-MC and Hub replaces the TD200.

TWIG-MC Installations: Placement of Hubs is important to TWIG-MC operation. The antenna line of sight and distances to valves are crucial. Place the antenna at a high elevation for good radio communication. The TWIG installation generally happens at the same time as installing the system valves. A legacy system likely has the TWIGs there already. Typically each of the zone valves are equipped with TWIGs. The TWIGs get special attention to make certain that the Hub antenna is in a good line of sight for all valves.

TWIG-MC and Hubs: Start by mounting the TWIG-MC and Hub at the location near the best place for the antenna. The enclosure is weather resistant, however it is best to have them protected from direct weather and sun exposure. After both are mounted then connect the RS-422 cordset cable between them. The antenna cable is to be connected to the port as shown here.

TWIG-MC Controller

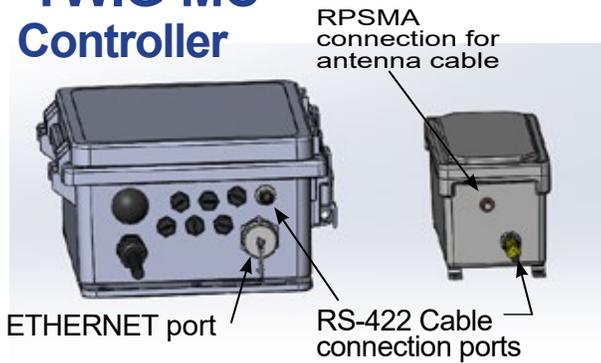


Figure B3 Bottom view TWIG-V system

Hub

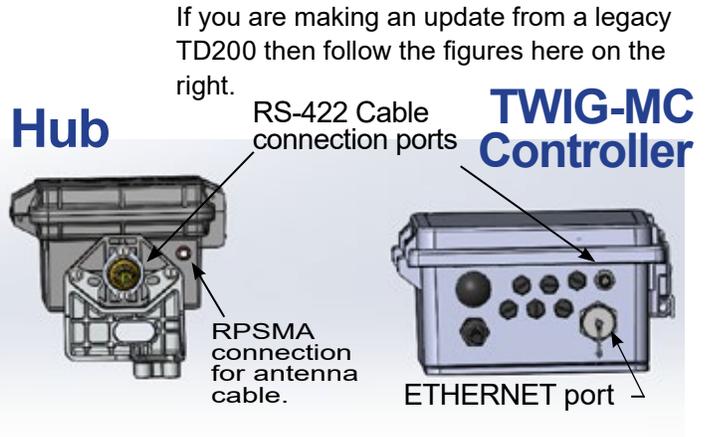


Figure B3a Bottom view of enclosures for legacy network update.

Inside TWIG-MC Controller

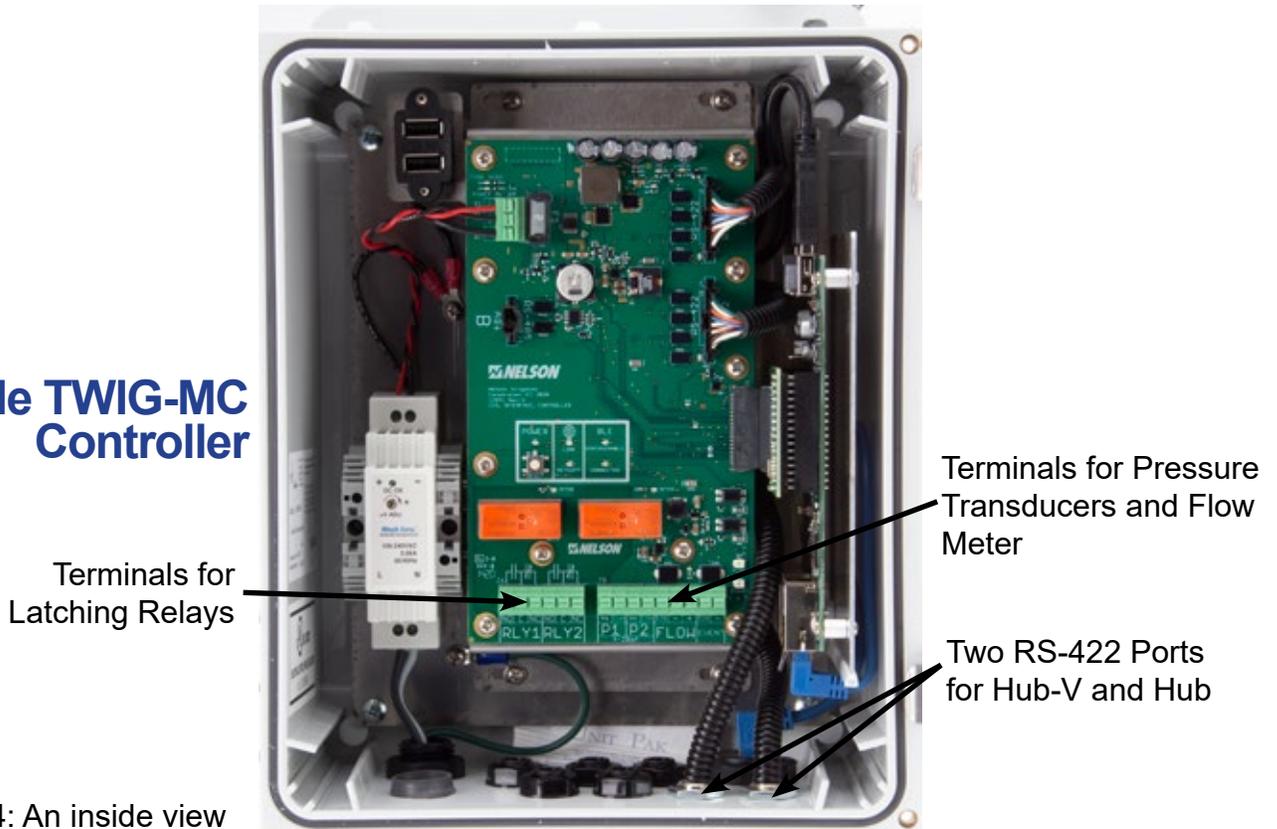


Figure B4: An inside view of TWIG-MC controller

B3 Get the mobile apps on to your smart phone:



In the Apple App Store search for TWIG-MC  and download it. Then find TWIG-V  and download it. Once you have both apps on your mobile device, you are ready to get paired to the TWIG-MC. Make sure your device has Bluetooth switched ON. You must connect to the TWIG-MC controller the first time while you are located nearby it using Bluetooth (distance 30 ft. or less). When the TWIG-MC controller learns (is *paired to*) your mobile device, you get authorized access. Here are the steps how it is done:

- ✓ If not already powered on, plug in the TWIG-MC power cord and wait 2 minutes.
- ✓ When the TWIG-MC app is started, a scan will discover nearby devices.
- ✓ Tap on your TWIG-MC Hub name/number when it appears on your screen.
- ✓ The first time you connect, be sure to have available the TWIG-MC name/number, the channel and Pairing Pattern (see *Section B5 for SETTINGS of how the Pairing Pattern is used*). After you have made the initial pairing, protect this information to secure access to only authorized users.
- ✓ At this step, control is done only while nearby the TWIG-MC. If you want to add remote control you connect to the INTERNET through Ethernet or cell modem cables that you provide.
- ✓ *Remember TWIG-V app is used to manage the TWIG-V and works only when nearby TWIG-Vs.*



B4 Make Settings to the TWIG-MC controller: Start the TWIG-MC app. Choose NEARBY while you are in range of Bluetooth distance (30 ft or less) nearby your controller. The phone app will start a scan. Locate the number printed on your Hub then tap on it when it appears on the phone. Then tap on the SETTINGS symbol at the bottom right corner of the screen.

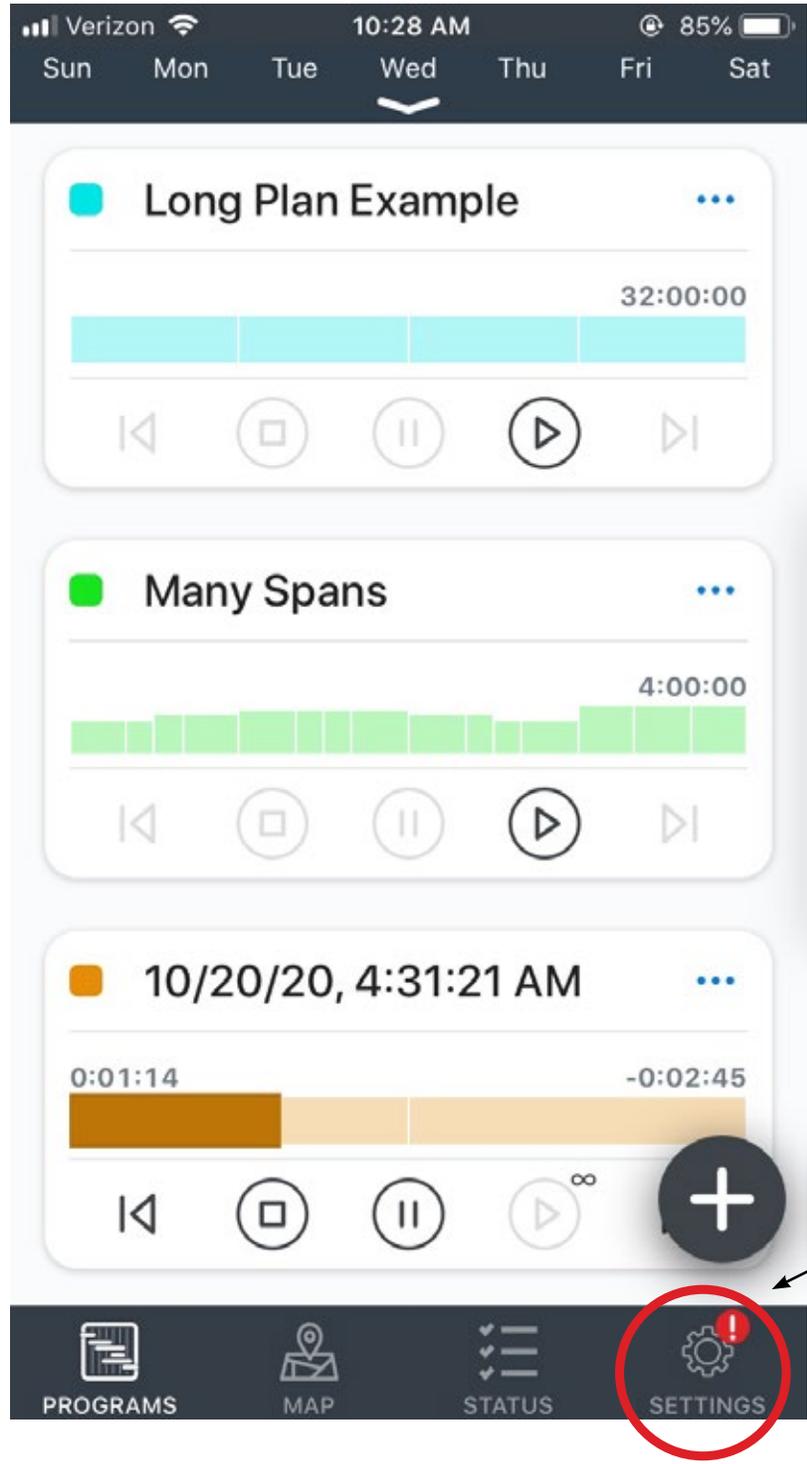


Figure B5 Select SETTINGS



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B5 Controller SETTINGS overview: You can rename your controller and do other settings as shown in Figure B6. If your TWIG-MC shows that a firmware update is available then tap on UPDATE. Remember in order to do that, you have to be nearby and use Bluetooth. Disconnect by tapping on the X which keeps you in the TWIG-MC app and simply disconnects you from your controller.

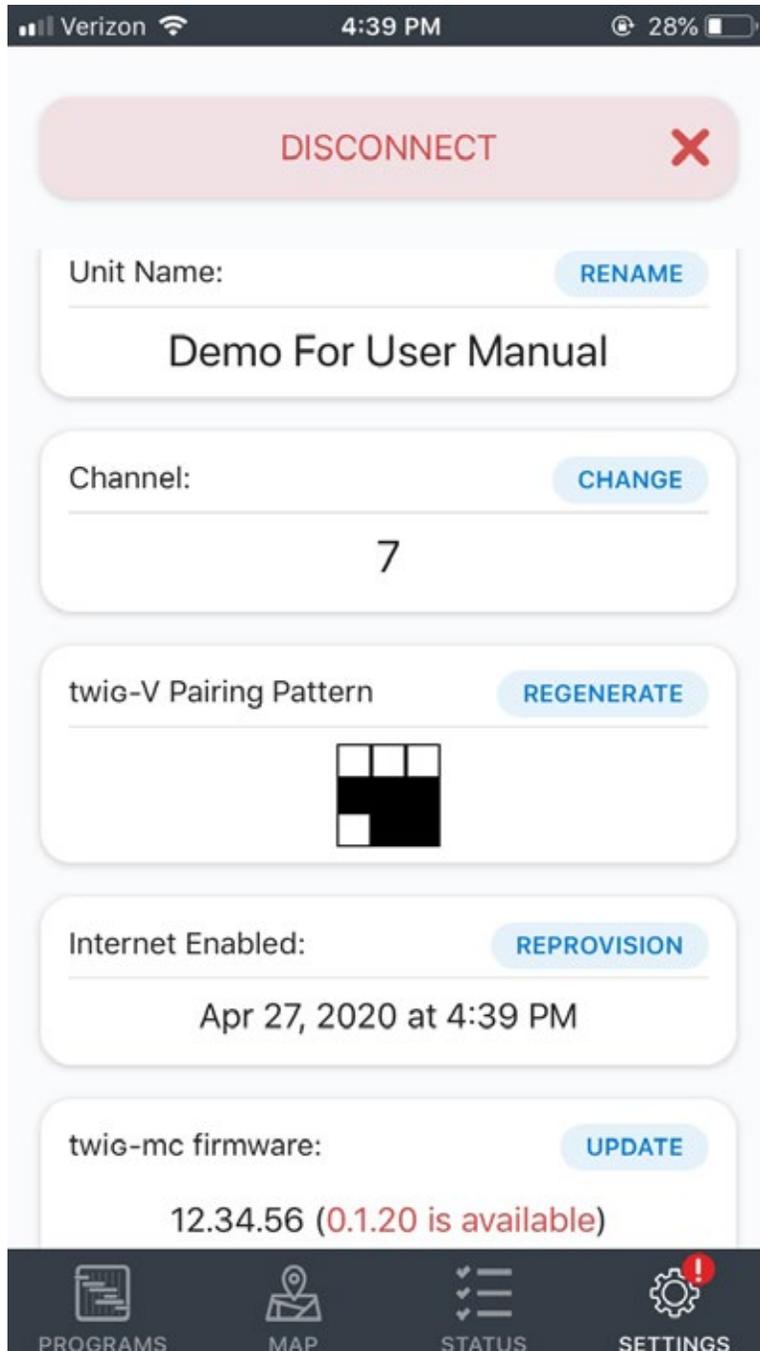


Figure B6

- ← RENAME the TWIG-MC controller to any name you want.
- ← CHANGE the radio channel if other TWIG-MC controllers nearby are on your channel.
- ← REGENERATE the pairing pattern if there is potential the pattern security has been compromised for the TWIG-MC. This only applies to TWIG-V and not to original TWIGs.
- ← REPROVISION is for joining to the internet when an Ethernet cable is connected to the internet and hooked up to the TWIG-MC controller.
- ← UPDATE will have a notice in red text if a newer software version is available. Updates can only be done through Bluetooth and *not remotely*.

B6 Get the TWIG-MC CONNECTED TO THE INTERNET:

You can connect the controller to the internet and operate it remotely using your smart phone. It is INTERNET ready so all you need is to provide the service connection with either the Ethernet or cell modem. See Figure B5 for location of the port where the cable connects to the controller.

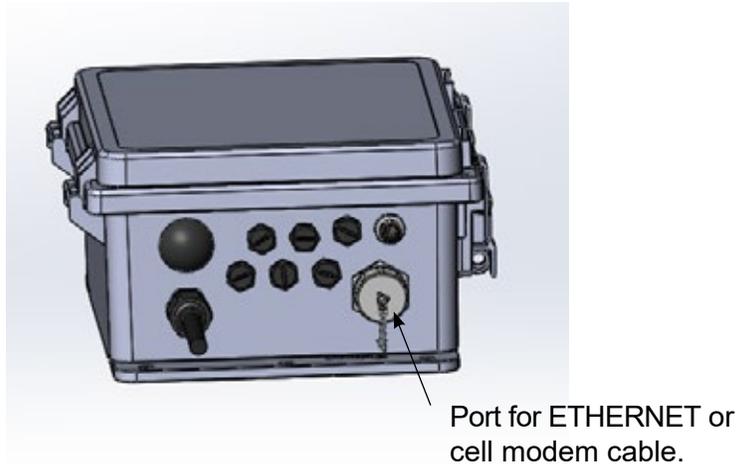


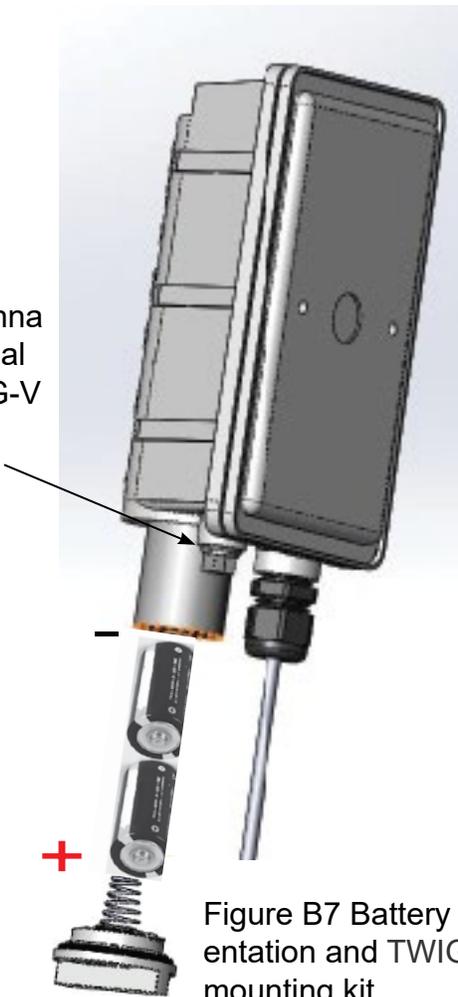
Figure B5 Bottom view TWIG-MC controller box.

Bring your connection cable and plug it in. The TWIG-MC will automatically configure the controller. This provisioning or “initiating” is the process of preparing a network to allow it to provide new services to the TWIG-MC. Remember that your phone must have already been paired with the controller via Bluetooth before your phone will connect to it through the INTERNET.

What happens if the TWIG-MC loses power?

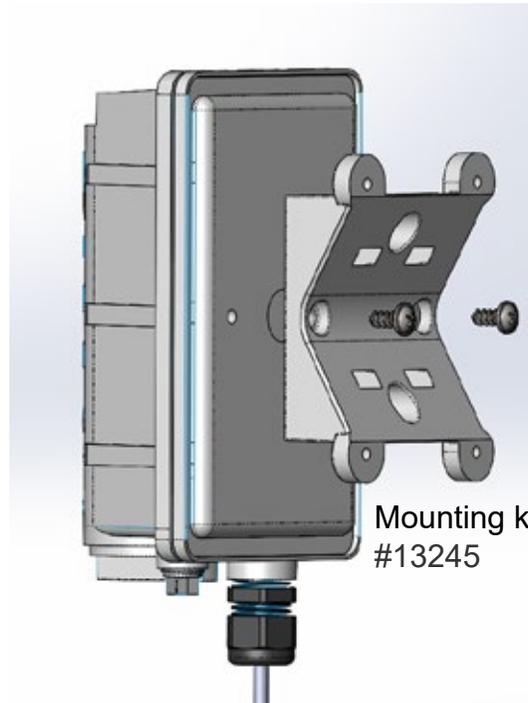
When power is lost to the TWIG-MC controller, any of your programs that were running will remain in the same state as last commanded by the controller. That means the TWIGs remain as they were. If a valve was open it will stay open. Remember that TWIGs operate latch controlled solenoids and relay contacts. When power is restored back to the TWIG-MC the programs will resume to the real time as though the power had remained on.

External antenna port for external antenna TWIG-V models.



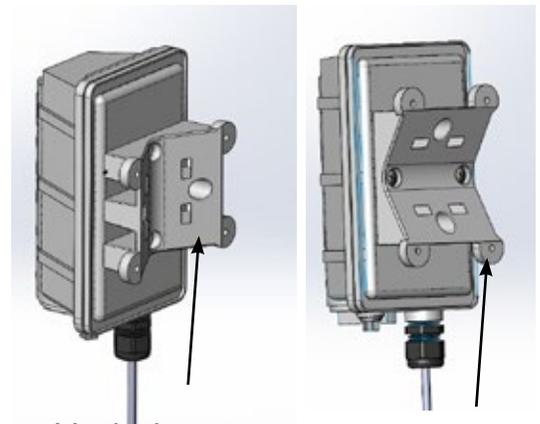
Insert two D-cell batteries into the TWIG-V. Make sure the + is pointed down in the right direction for both batteries.

Figure B7 Battery orientation and TWIG-V mounting kit



Mounting kit #13245

- Part Numbers for TWIG-V with bracket assembly
- #13457-001 TWIG-V 1i with bracket
 - #13457-002 TWIG-V 2i with bracket
 - #13457-011 TWIG-V 1e with bracket
 - #13457-012 TWIG-V 2e with bracket



Vertical post or wall mounting kit orientation.

Horizontal mounting kit orientation.

B7 TWIG-V Installation Instructions:

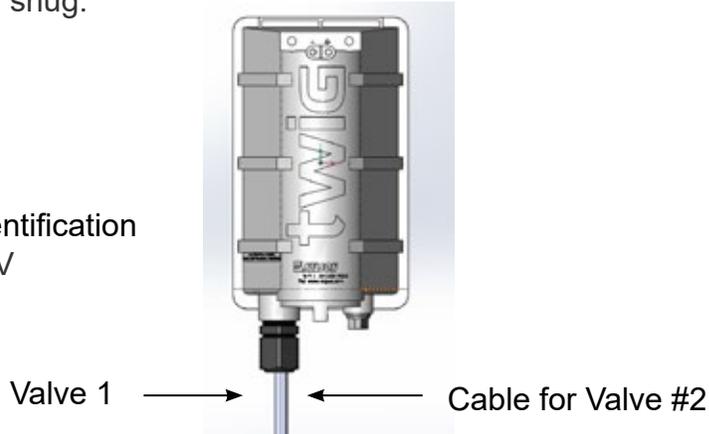
The batteries must be installed before you can use Bluetooth to connect to the TWIG-V and to join to the

TWIG-MC controller. Pay attention to the battery direction when putting them into the TWIG-V. See Figure B7. The + on **both** batteries must be pointed down, **The TWIG-V must be mounted in a vertical orientation.**

For external antenna TWIGs, connect the antenna cable to the RPSMA fitting on the bottom of the enclosure. Tighten until snug.

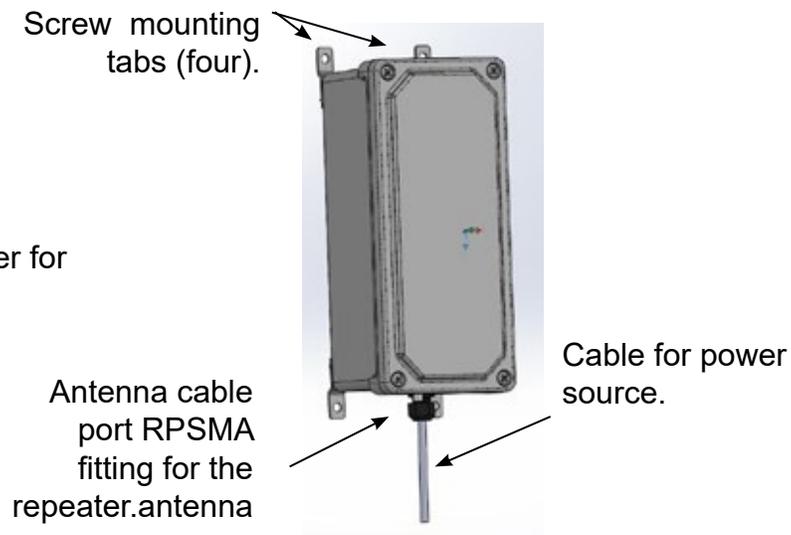
Figure B8
Solenoid cable identification
for 2-valve TWIG-V

Do not over tighten.



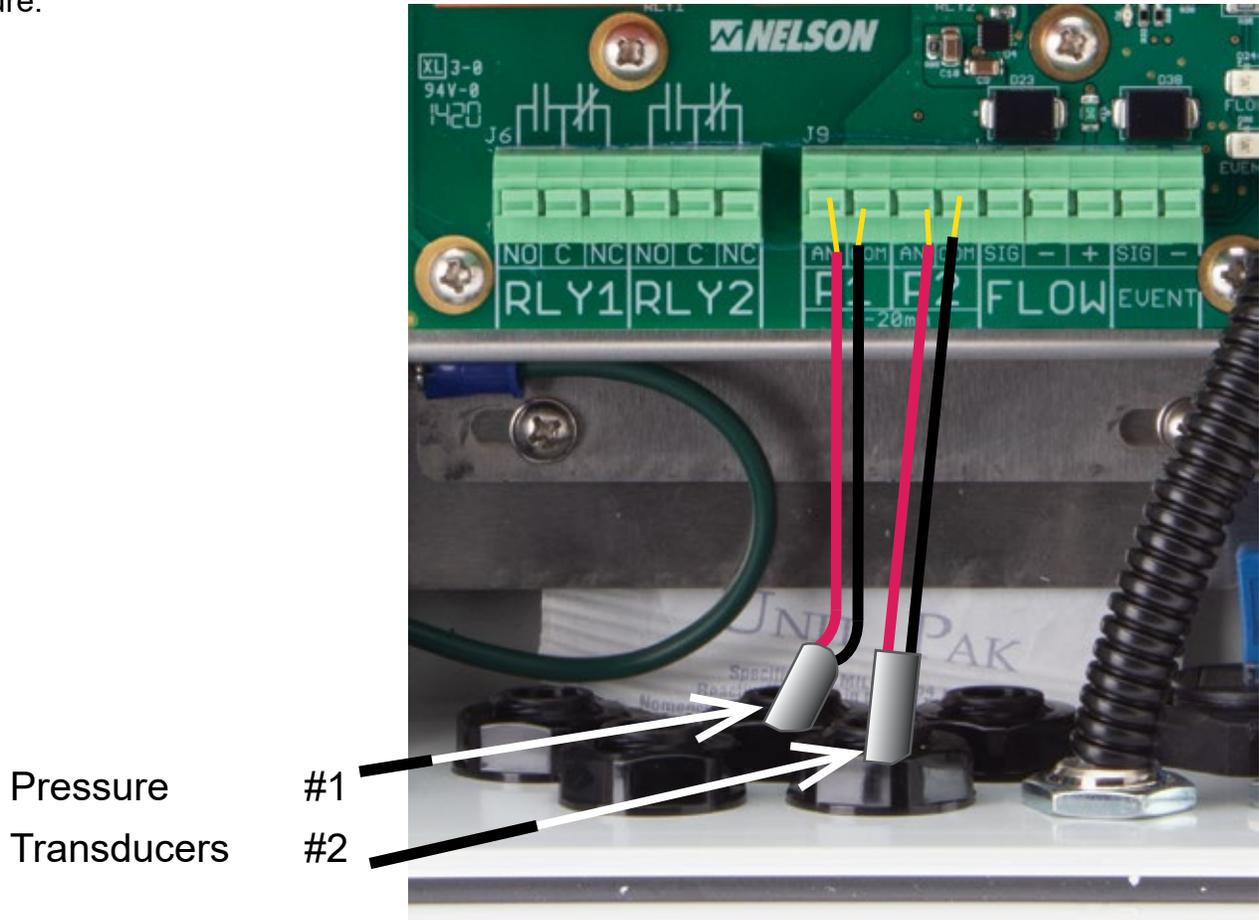
The TWIG-V has a #13245 mounting kit that makes it easy to mount to a vertical post, to a wall or to a horizontal pipe. The mounting kit is secured with 2 screws onto the back of the TWIG-V and can be positioned two ways as shown.

Figure B9 Repeater for
TWIG-V system.



B9 Pressure Transducer Connection

The TWIG-MC has connections for two 4-20 mA pressure transducers. These connections are labeled P1 and P2. The terminals are marked AN and COM. The positive RED wire from the transducer is connected to AN terminal and the negative wire to the COM terminal as shown in this picture:



After the connection is made, the pressure transducer has to be set up in the TWIG-MC App. On the settings page, tap the ... dots on the upper right.



A screen comes up with CONFIGURE

Tap on CONFIGURE to bring up the following window.

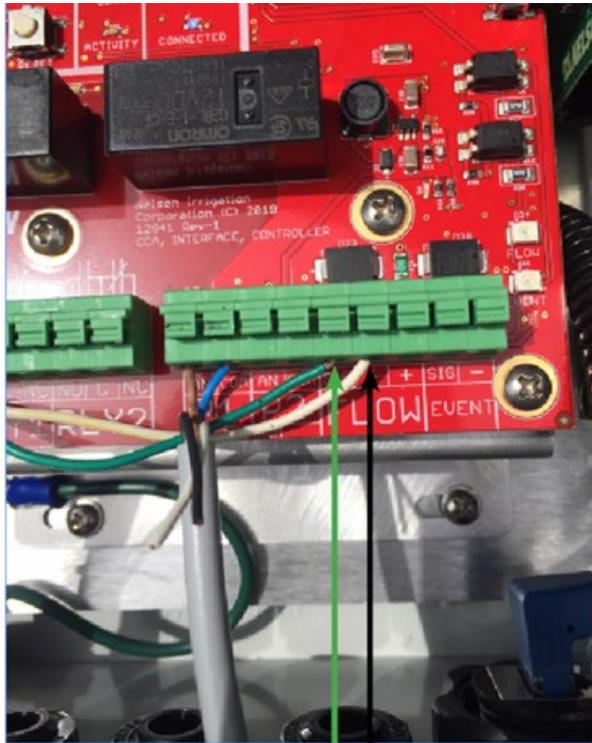


Enter the pressure for the upper limit of the range for the specific transducer. This example had a 300 psi limit. This is how the scale is set for the reading to be reported correctly. Tap on save and the system will report the pressure reading.



B10 Flow Meter Connection

The TWIG-MC has a connection terminal for a pulse flow meter. This connection is labeled FLOW. The terminals are marked SIG, - and +.



Seametric AG2000 flow meter white wire connect to -
Seametric AG2000 flow meter green wire connect to SIG

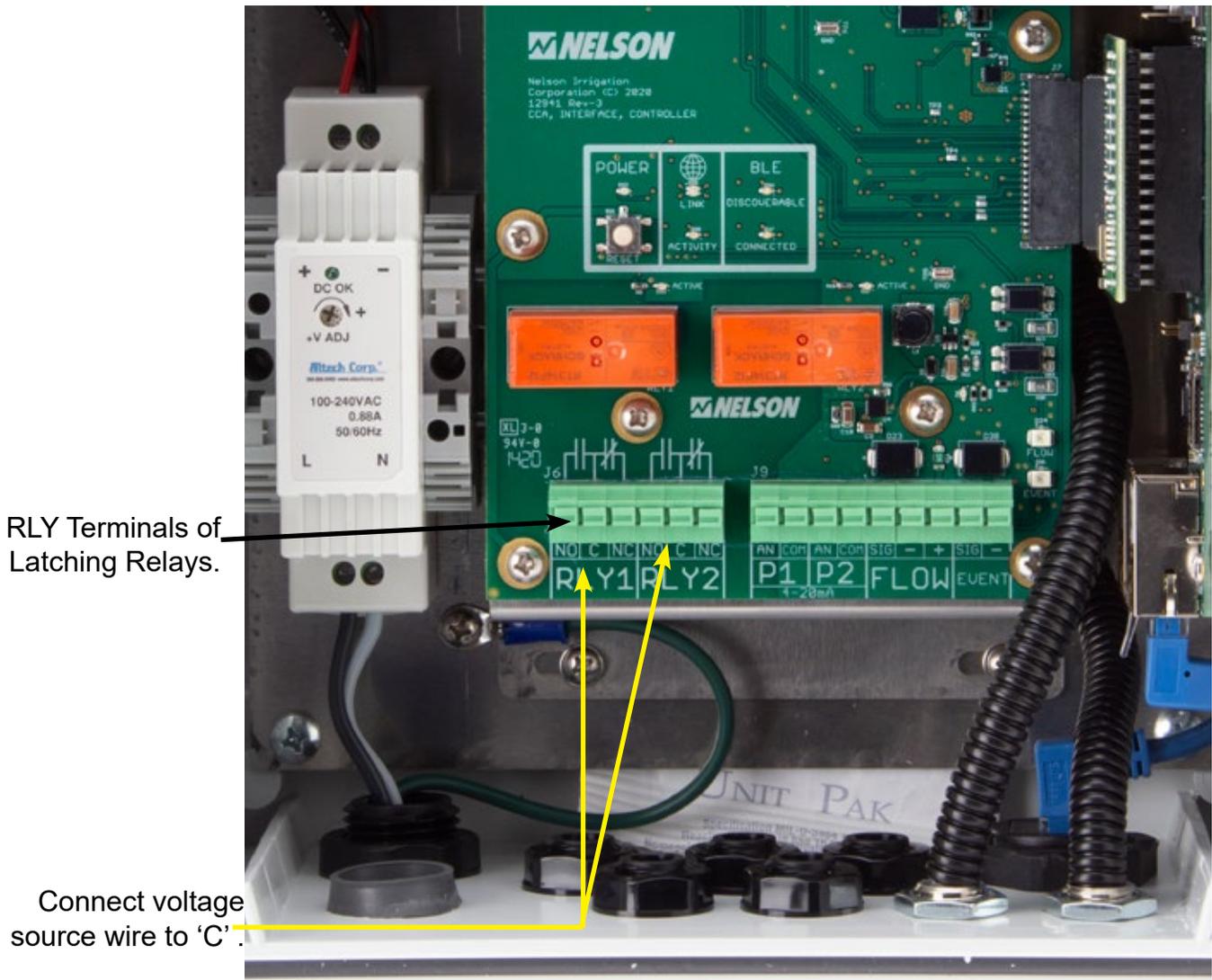
The TWIG-MC controller can receive input from a pulse flow meter such as the SeaMetrics Ag2000 that has a factory installed cable. The white (-) wire connects to the FLOW (-) terminal and the green wire connects to the FLOW (SIG) terminal. Some meters do not have a battery in the meter so these will use the terminal marked + for the controller to power the meter. Use strain relief to keep the wires from pulling on the terminals.

After the connection is made, setup is done by using the TWIG-MC app in the STATUS menu . . . Scroll to the 'Flow Meter' area and tap on the three dots at the upper right near the Flow Meter and configure the value of gallons per pulse. Enter the scale number for the meter to read correctly. For example the 4" SeaMetrics flow meter has a value of 0.06105. Enter the value then tap on Save and the controller will report the flow rate. Check when flow is going through the meter to make a comparison between the flow rate shown on the meter display and the TWIG-MC flow rate. Both the display and the TWIG-MC app flow rate should agree.

Note: A small correction to the scale number may be necessary because of water turbulence at the meter and other calibration differences.

B11 Connection to the relays inside TWIG-MC controller

The TWIG-MC has two latch relays inside that are labeled RLY1 and RLY2 (each have common 'C', normally open 'NO' or normally close 'NC'). The operation responds to switch the 'C' port at the command of the TWIG-MC programs. If the program is set to 'PAUSE' then the contacts shift back to the default normal open or normal close state. These relays are useful to open or close connections to start a pump or other devices at the command of the TWIG-MC controller.



Caution: If power is lost to the TWIG-MC controller the latch contacts remain unchanged from the state already set. Consider the possibility that any pump connected to the RLY terminals will stay connected and possibly remain running in the present latched state even while the controller power is lost. The controller, while without power, will NOT switch contacts or TWIG valves for any programs that were running. When power is restored back again, the programs will resume to real time as if the controller had never lost power.

Relays are rated for voltage 12VDC and 16A/110-250VAC.

B12 Repeaters to extend the distance for network TWIGs

The TWIG-MC can expand control to distant TWIGs by using up to eight repeaters within one network.

Pole mounted Repeater

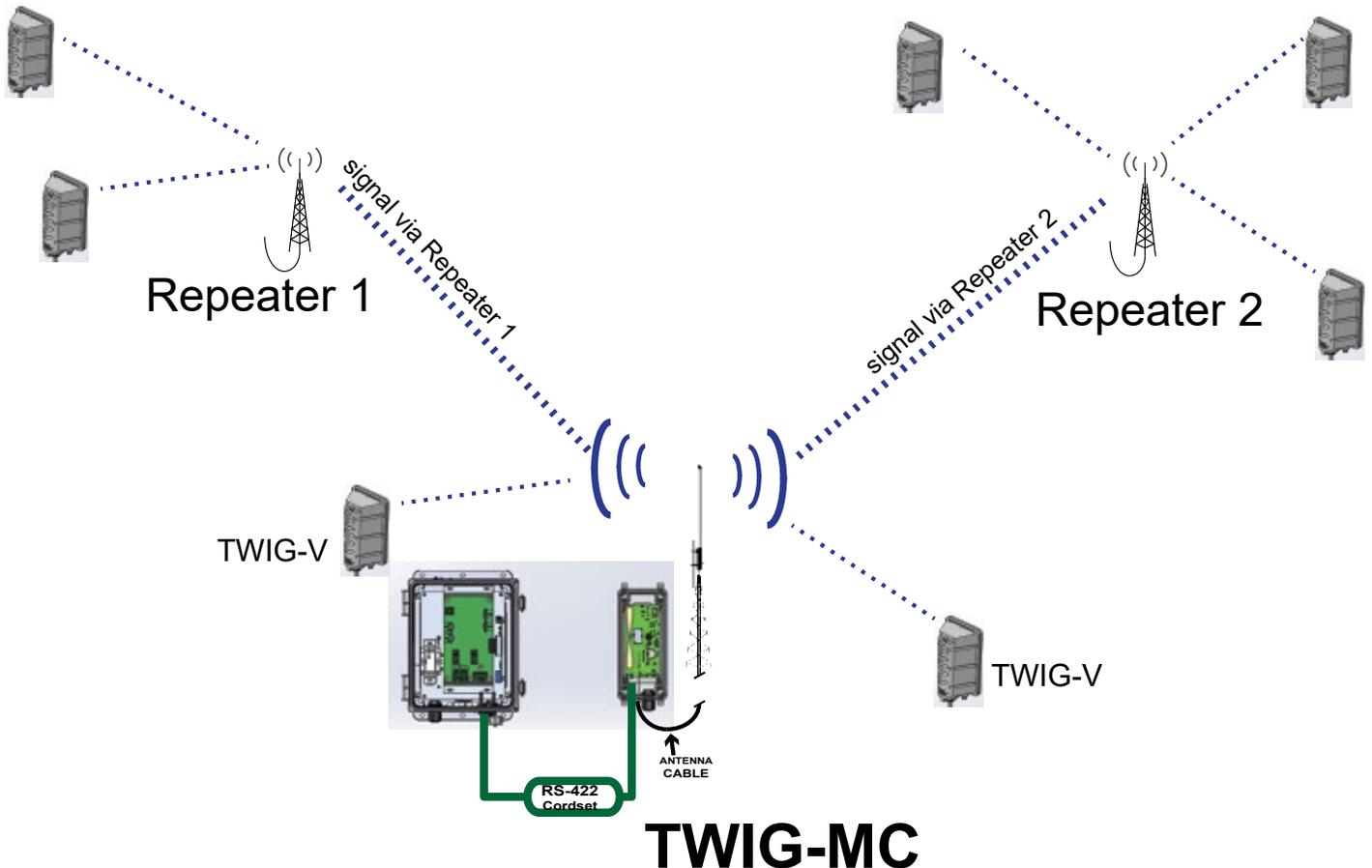


Repeaters: The TWIG-V Repeater may be essential for the wireless network to work well. In many fields it is required to extend the distance range of the radio signals and also to get around obstacles. If the distance to the valves exceeds a solid signal level of **-84** then consider using a Repeater to make the communication reliable. For example a signal of **-96** indicates a repeater should be considered.

The mounting of Repeaters is usually on a pole as shown here. In some field crops the repeater stand is portable so it can move with the system. The Repeater works a large portion of the time. That is why it takes the specified 10 Watt solar panel to keep the batteries charged. .



Repeater on a portable stand.



Maintenance:

Battery care: Several of the network devices require batteries for power. You should plan to replace the two 'D' cell batteries in the TWIGs each year before the irrigation season. It is best that the batteries be removed at the end of the season to reduce the chance of leakage.

Solar Panel: The efficiency of the solar panel will be maintained by keeping the panel surface free of dirt and dull water stains. The field environment can coat the clear panel layer resulting in lower solar power output. An annual cleaning is recommended.

Valve Solenoids: The solenoid should be drained before a freezing temperature happens. Freeze damage is one of the main causes of solenoid failure. Other solenoid problems can be found in the wire connections. Check the operation of the solenoid coil before the irrigation season. The solenoid operation test can be easily done using the TWIG-V app.

Antenna Cable: The antennas can require some annual inspection. When looking for faults, it's important to know that most faults are connector related. Trouble can be loose connectors, corroded connectors, and poorly installed connectors. Most remaining faults are cable related. The problems may include water in the cable, loose weather wrap, pinched cables, poorly installed ground kits, bullet holes, and even nails in the cable! Some faults are antenna related. Check the antenna to make sure it hasn't been damaged.

Appendix C: Relay options for TWIG-MC

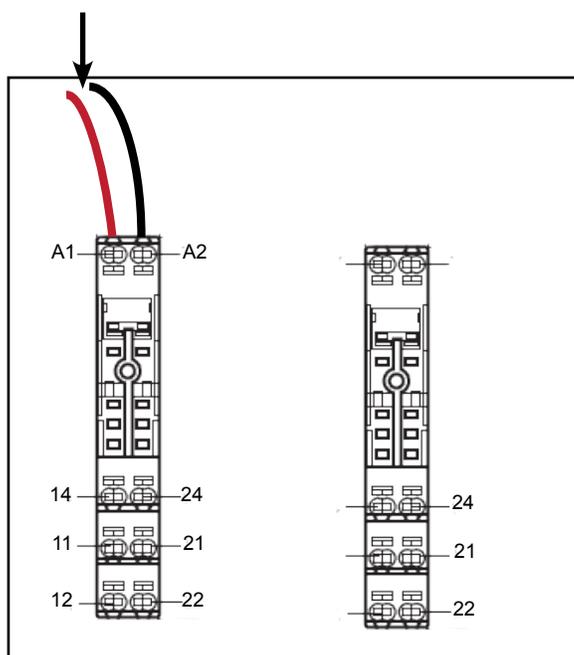
Purpose: To provide for contact switch control of wired and wireless switches in the TWIG-MC .

How to use internal TWIG-MC RLY for wired control: The controller will activate each of the two relay contact switches to work independently. Unused relays are not assigned and the extra terminals left empty. The TWIG-MC keeps the relay(s) contact switches latched ON as long as the controller commands the switches to be on. When the switches are commanded to off the contact will disconnect the relay switches. See B11 for more details about the RLY relays.

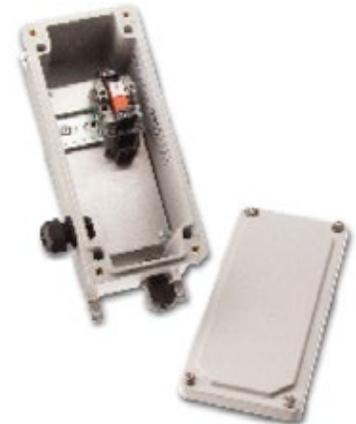
How to use external TWIG for wireless relay control:

The TWIG or TWIG-V is capable of switching one or more dry contact relays. These can be utilized for wireless remote control. The control relays are used as a convenient way to operate master valves, start and stop pumps and alarms.

TWiG^V wires in



Terminals 11 and 12 connect to load. The connection is made when TWiG switch is on and disconnected when switch is off.

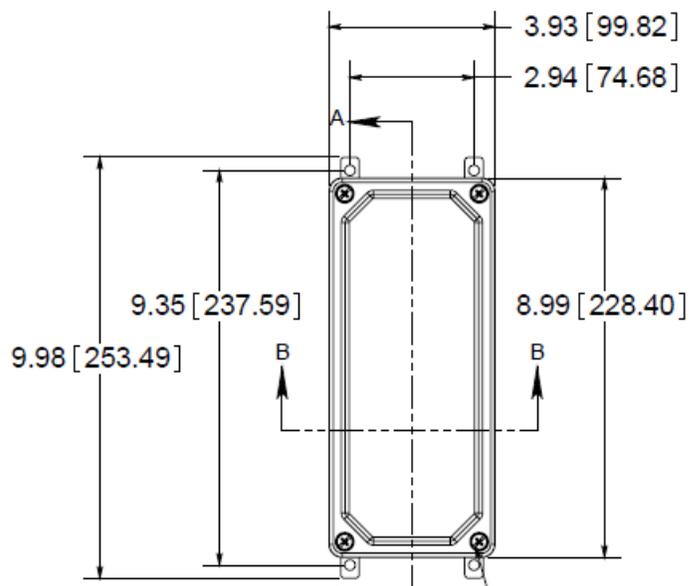


In this drawing, relay terminals inside the box require the correct wire polarity be used. If not the valve or pump operation could be reverse of what is wanted and the irrigation system could be damaged!!!!

Figure C1 Relay

Note: When used as a Pump Relay in a program, care must be taken to have the proper number of valves in the field be opened when the pump relay turns the pump to ON. Damage from excessive pressure can result if no valves are open! **Always have a relief valve in the system!**

Figure C2 TWIG Relay box dimensions:



Relay wiring: The switch(es) in the TWIG relay box are connected when initially installed in the field. These switch(es) latch on and off using a momentary 12V DC pulse of power.

Relays are generally used to activate a pump and/or a Master Valve: A master valve is an electric valve installed at the main water supply of the irrigation zone valves. An electric master valve is typically a larger size but equipped with the same type of 12VDC latch solenoid used for zone valves. Some designers setup the master valve with a 24V AC solenoid on it that requires continuous power to remain open. They do that so if the power to the pump fails then the valve will close. It can be controlled by any one of the TWIG-V 12VDC relays but it is not to be wired directly to a 24 VAC relay. A master valve can be used to shut off the water to the mainline pipe so it can be repaired if necessary.

To activate a pump: The internal contact switches in the TWIG Contact box are latch type which allows a lower voltage signal from the TWIG to close a circuit of higher voltage. The internal contacts can switch current power on and off. The TWIG out-puts enough power to control a pump start relay (generally 24V AC) which in turn closes a relay that completes the higher voltage circuit for the current flow needed by the pump motor. The TWIG used for relays can be assigned in the program to control a Master Valve if wanted.

WARNING: Do not connect the TWIG directly to the pump. The TWIG will be damaged. Connect it to a mechanical relay of the pump start relay ONLY.

To reduce risk of electrical shock, pump must be properly grounded in accordance with the National Electric Code (NEC) and all applicable state and local codes and ordinances.

To reduce risk of electrical shock, always disconnect the pump from the power source before handling or servicing. **Lock out** power and tag.

CAUTION: The pump control must be setup to stop the pump at any time that the master valve is closed. Be careful using the control override 'Keep OFF' which overrides program control. Pump controls are to be provided by others. All wiring of pumps should be performed by a qualified electrician.

Appendix D - Specifications and Approvals

The Nelson Irrigation Corporation wireless TWIG valve control and TWIG-MC controller is a radio irrigation valve system. Communication is by radio in the 900 mega-Hertz frequency range and BLE Bluetooth. The products used in the system complies with the FCC rules and does not require a radio license. The compliance with FCC rules has been established for the antennas provided by Nelson and those are the only antennas that Nelson approves for use.

> TWIG Master Controller:

Controller Enclosure:	Poly-plastic
Controller Enclosure Dimensions (no antenna):	9.70" x 11.12" x 5.38"
Controller radio signal comes from Hub ^V antenna:	The Hub ^V antenna is normally a 6 dbi omni
Controller Weight (with antenna):	5.5 lbs
Enclosure NEMA Rating	4X
Power Options and (input current wireless):	110VAC (4 watts), 12VDC (3.5 watts)
Electrical Connections:	wire leads and terminal blocks (plug if ordered)

> TWIG-V modules:

Enclosure material	Fiberglass reinforced plastic
Enclosure Dimensions:	4.20"x7.50"x3.3"
Weight (with two 'D'cell batteries):	2.94 lbs
Enclosure	Water resistant
Connections:	24 inch wire leads for 1 latch solenoid
Radio Frequency:	902-928 MHz, channels selected by the tWiG ^{mc}
Radio power	slightly less than 250 mW
Address identity:	factory assigned, first number 1=single or 2=dual 5=TWIG ^V +CHECK

> TWIG-V Hub modules:

Enclosure:	Fiberglass reinforced plastic
Enclosure Dimensions:	3.93"x8.99"x4.0"
Weight (with two 'D'cell batteries):	2.94 lbs
NEMA Rating	4X
Connections:	RS-422 cable and antenna, 6 dbi omni
Radio Frequency:	902-928 MHz, channels selected by the tWiG ^{mc}
Radio power	slightly less than 250 mW

> TWIG-V Repeater:

Enclosure:	Fiberglass reinforced plastic
Enclosure Dimensions:	3.93"x8.99"x4.0"
Weight (with batteries):	2.94 lbs
NEMA Rating	4X
Connections:	RS-422 cable and antenna port
Radio Frequency:	902-928 MHz, channels selected by the TWiG ^{mc}
Radio power	slightly less than 250 mW

> Relay modules:

Enclosure:	Fiberglass reinforced plastic
Enclosure Dimensions:	3.93"x8.99"x4.0"
Weight	2.94 lbs
NEMA Rating	4X

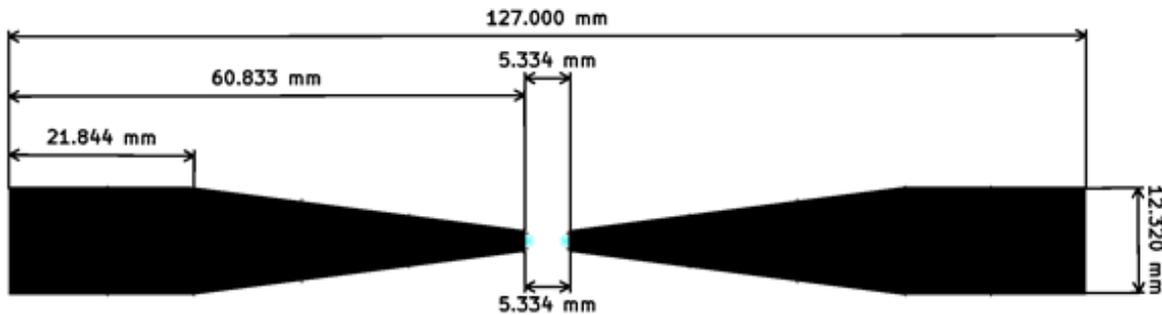
Radio Specifications:

Network Frequency Range	902 – 928 MHz
Channels	50 (Channel 1 = 902.5 MHz Channel 50 = 927.0 MHz)
Output Power	24 dBm
Modulation Type	<u>LoRa</u> [®] i.e. a proprietary spread spectrum modulation scheme that is derivative of Chirp Spread Spectrum modulation
External Antenna Connector	<u>U.F.I.</u> 50 ohms
Internal Antenna Type	Dipole, installed in a vertical orientation
Nominal Bandwidth	500 KHz
Spreading Factor	8
DC Voltage Input Range	1.8 to 5.5 volts
Bluetooth Interface	BLE 4.1
Debug/Programming Port Interface	Debug: <u>Async</u> Serial 230,400 baud, 8/n/1 ... 3.3V tolerant Programming: Atmel-ICE
Console Port Interface	<u>Async</u> Serial 115,200 baud, 8/n/1 ... 3.3V tolerant
Valve Connector Interface	+14.5V differential, 120 <u>msec</u> pulse, duty cycle < 0.1%

4. Approved Antenna Specifications:

4.1. PCB Antenna specifications

The internal antenna configuration for the module utilizes a PCB dipole that must be placed in a vertical orientation. This dipole has the dimensions shown below:



4.2. External Antenna Connector

The external antenna configuration utilizes an on-board a U.FL connector. The outside enclosure must have an RPSMA bulkhead connector. This requirement is accomplished by using a U.FL to RPSMA bulkhead patch cable with a ferrite core inserted over the U.FL connector and secured to the module using a suitable adhesive.

Here is more details about an antenna's power. The TWIG-V Hub antenna is the key to reliability. The gain is a key value that describes the antenna's efficiency. As a transmitting antenna, the value describes how well the antenna converts input power into radio waves. As a receiving antenna, the value describes how well the antenna converts radio waves arriving from a specified direction into electrical power. Antenna gain is usually expressed in decibels, and these units are referred to as "decibels-isotropic" (dBi). For a given frequency, the antenna's effective area is proportional to the power gain. Due to reciprocity, the gain of any antenna when receiving is equal to its gain when transmitting.

Yagi Antenna Specifications:

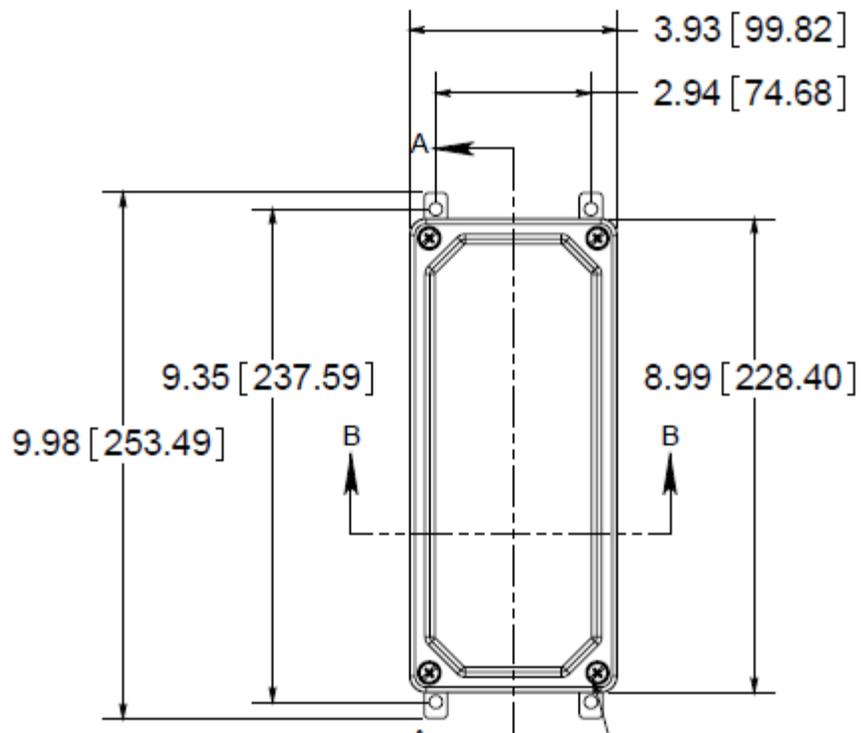
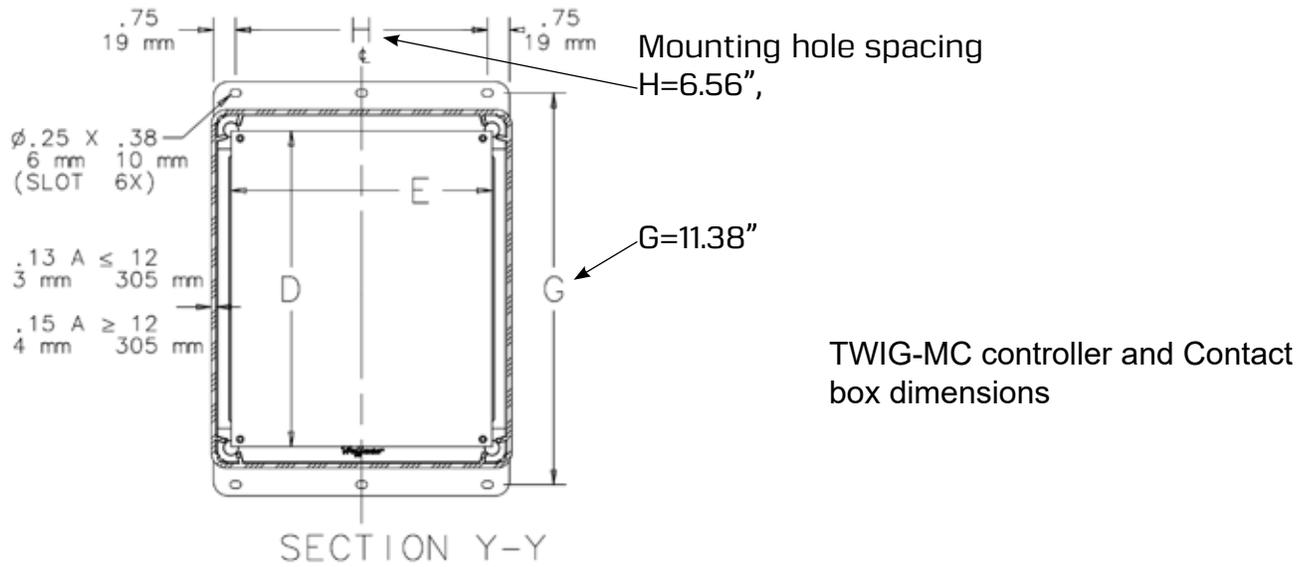
Model	HG912YE-NF
Frequency	824 – 960 MHz
Gain	12 <u>dB</u> i
Polarization	VERTICAL
Horizontal Beam Width	43 degrees
Vertical Beam Width	36 degrees
Front to Back Ratio	18 dB
Impedance	50 ohms
Connector	N-Female

Model	HG909YE-NF
Frequency	824 – 960 MHz
Gain	9 <u>dB</u> i
Polarization	VERTICAL
Horizontal Beam Width	53 degrees
Vertical Beam Width	42 degrees
Front to Back Ratio	15 dB
Impedance	50 ohms
Connector	N-Female

Omni Antenna Specifications:

Model	HG908UP-NF
Frequency	902-928 MHz
Gain	8 <u>dB</u> i
Polarization	VERTICAL
Horizontal Beam Width	360 degrees
Vertical Beam Width	35 degrees
Impedance	50 ohms
Connector	N-Female

Model	HG906UP-NF
Frequency	902-928 MHz
Gain	6 <u>dB</u> i
Polarization	VERTICAL
Horizontal Beam Width	360 degrees
Vertical Beam Width	15 degrees
Impedance	50 ohms
Connector	N-Female



TWIG-V Hub controller box
 dimensions.

5.6. **Agency Statements:**

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.



Appendix E: Solar/Battery kits TWIG-MC

The TWIG-MC and Repeaters TWIG-V DC have battery/solar power options.

These kits are specific to the TWIG-MC or the TWIG-V Repeater. They cannot be interchanged. The support pole is normally 2" diameter or larger and is not provide. It is to be sourced locally.

Solar Kit - 90 Watt

Part number Description
13438 Solar Kit, TWIG-MC which is for
the #12975-003 that uses 12VDC power

TWIG-MC #13438 kit main materials list
90W Solar Panel
Solar Panel Mounting Bracket
Enclosure NEMA 3R with 84 Amp hr
Battery and charge controller



Figure E1
Solar kit #13438 for TWIG-MC

MAJOR COMPONENTS INCLUDED - NOT TO SCALE

EXACT COMPONENTS MAY NOT BE SHOWN.
REFERENCE VIEW ONLY.

Where you could to use these kits:

The 90 Watt kit is for the TWIG-MC controller and the 10 Watt is for the Repeaters. The solar power option brings automation to remote areas where no electricity power source is available. It is a real benefit to mobile systems that change fields after each crop is completed.

Solar Kit-10 Watt for Repeater DC TWIG-V and pump contact

Part number	Description
12224-002	Solar Kit, for TWIG-V #12966-002 Repeater
12075-002	Solar Kit with Battery, for TWIG-V #12966-002 Repeater

Kit materials list

Part No.	Description
12088	10W Solar Panel
12087	Solar Panel Mounting Bracket
12138	Hose Clamps (2 ea.)
12098	Cable Kit (TD200)
12098-001	Cable Kit (Repeater)
12089	Enclosure with Battery and charger



Figure E2
Solar kit for TWIG-V Repeater

Enclosure dimensions for Solar kit #12224 which is for the #12075-002. (view from back)

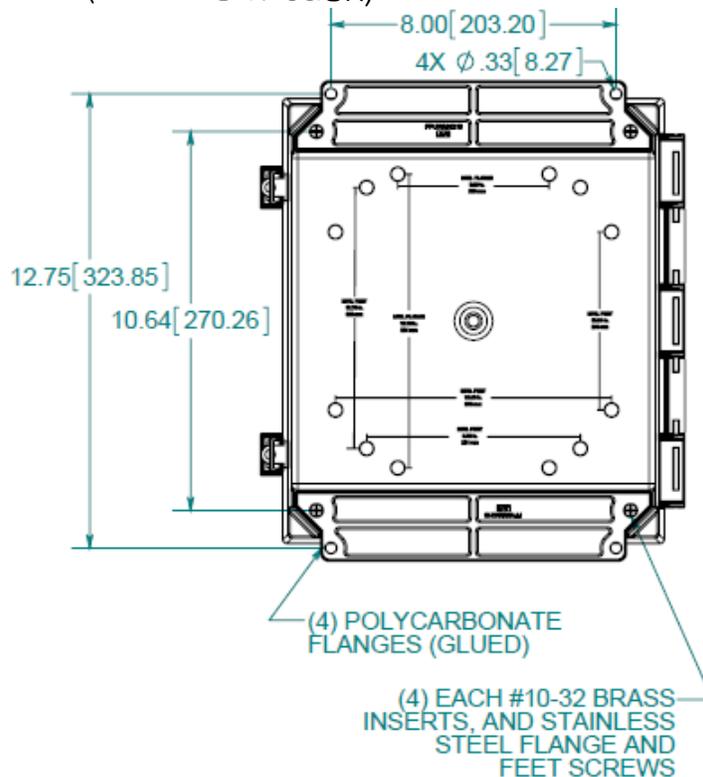


Figure E3
Enclosure, Solar kit 10 Watt for Repeater-DC TWIG-V



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