Hunter®

Hunter Control System Design Guide

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Hunter Industries control systems are easier to design than ever before, with the introduction of the TriSend™ central interface. The latest system architecture allows the designer to incorporate maximum versatility at the lowest cost.

For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

Field-Resident Memory: Hunter control systems are *download* systems, meaning that the irrigation information is sent out to the Field Controllers ahead of time, and is stored in each Field Controller.

Many Hunter systems start out with standalone controllers for grow-in irrigation, and the computerized central is added later when construction is completed. However the complete central package should be planned from the beginning for smooth implementation of central communications in the future.

Major Components

Hunter central control systems are comprised of 3 major components:

1. The Central Software (and computer).
2. The Central Interface (TriSend – use with all Hunter central control systems)
3. Field Controllers (or "satellites").

Note: *Genesis® and VSX™ controllers can NEVER be mixed in the same system. However, the only difference between the two is the facepack, or keypad assembly. You can upgrade a Genesis controller to VSX in the future, by changing the facepacks.*

All Hunter central systems may also include:

- Maintenance Radio (use with all Hunter central control systems)
- Data Retrieval Units (use with all Hunter central control systems)
- Weather Station (use with all Hunter central control systems)

Design Process

Step 1: Determine the type of **control system software**. At this time, Hunter Industries offers Genesis III™ for simple control, Surveyor™, for full-featured mainstream central control, and Vista®, for very precise control of large systems with graphics derived directly from the AutoCAD as-built drawing of the installation. Consult with your Hunter Industries representative if you are unsure of which control system to use.

This decision will also determine which Field Controllers to use, since Genesis III requires Genesis Field Controllers, while Surveyor and Vista require the VSX series controllers.

Step 2: Choose a Hunter **computer** for the central software. Genesis III may run on either the GENPC or PREMPC computer. Vista and Surveyor must use the PREMPC computer.

PREMPC is a very fast computer, with enhanced graphics and RAM memory also using the Windows operating system. It is supplied with a 19" flat screen LCD monitor.

Specifications for Hunter central computer hardware are updated regularly to keep pace with the ever-evolving computer industry, and are available from your Hunter Industries representative.

Step 3: Choose a location for the **TriSend** central interface. The TriSend is used with all configurations of all Hunter central control systems, and is designed to be installed within a short distance (25 feet/8 meters) of the central computer.

Step 4: Determine the **communications type** for each device in the system (standalone, hardwire, or radio).

Modern Hunter systems with the TriSend™ central interface can mix and match radio and hardwire technologies within the same system. This means you can hardwire your closest Field Controllers to the central interface, and use radio to control the farthest controllers, or those across a right-of-way that would be expensive or impossible to reach with direct wire. The communications type will be invisible to the user, and control signals will automatically use the correct technology to reach a given controller (or Data Retrieval unit).

Standalone controllers are used when central control is not required, and:

- When central communications will be added in the future.
- In small systems.

Hardwire communications* are used when central control is desired, and:

- The system is new construction, and open trenches are available for routing communications cable to all Field Controllers.
- When radio communications are not possible, because of terrain (hills blocking signals) or frequency (no channels available in the area).
- User preference.

Radio communications** are used when central control is desired, and:

- It is too costly, or not possible, to trench communications wire.
- The system is a retrofit (controller upgrade in an existing sprinkler system) and controllers are placed at pre-existing timer locations (note:110VAC or 220VAC power must be available at each controller location).
- There is a concern that future excavation and/or lightning might disrupt communications wire.
- User preference.
- Certain controllers' locations in a generally-hardwired system are inaccessible.

Step 5: Determine **how many stations** each Field Controller will control (up to 60 stations each in 10-station increments, or 103 stations in decoder systems), and the approximate **locations** for the Field Controllers. Locate Field Controllers in high, dry locations, out of direct spray from sprinklers. Radio controllers must be located according to a properly conducted **site survey** before the controllers are installed, to insure reliable communications.

Step 6: Determine which **type of field activation** the controller will use (conventional electric or two-wire decoder).

"Conventional" Electric: The standard US controller/solenoid configuration, with a "hot" 24VAC wire run to each valve solenoid, and a field common ground wire returning to the ground lug on the Field Controller.

Two-wire Decoder: Genesis® and VSX™ controllers may be ordered as decoder controllers, which sends station activation signals and solenoid power together, over a single pair of wires, to a string of decoders located in the field near each valve. Decoders save a great deal of copper wire, and simplify diagnostics. Decoder controllers require lightning suppression modules installed inline. All Viking Field Controllers (VGFCxx [Genesis] or VVFCxx [VSX], where xx = S for Standalone, R for Radio, HW for Hardwire) are shipped with 103 station capability; there are no size increments. See the section on decoder controllers for further information.

* Maintenance Radio (through the central) is available for remote control of hardwire controllers.
**Straight Talk™ Maintenance Radio is a standard feature on all Hunter Industries Radio controllers.

Step 7: Source the **primary AC power** and size the AC power wire for the controllers. ***Never use an electrical source for Field Controllers or Data Retrieval units that is shared by a Variable Frequency Drive Pump!*** It is best to separate the AC power source for the controllers from pump stations altogether.

110VAC controllers have a maximum power consumption of 1 amp each; 220VAC controllers have a maximum power consumption of .62 amps each. These are maximum power draw figures, regardless of the number of solenoids activated, and include the power required by the communications equipment and the facepack "brain." When sizing wire it should be assumed that any or all controllers may operate at or near their maximums simultaneously.

Power conditioning devices may be installed in the controller AC power lines to mitigate fluctuating or "dirty" power. These devices maintain a power output within 5% or less of the specified operating voltage (within the specified limits of the power conditioner) and help prevent surges, transients, and electrical noise. Power line conditioners are available in a wide variety of configurations and capacities, such as those from Sola/Hevi-Duty (available through Paige Electric) or equals.

Step 8: Read the section on standalone controllers for requirements and considerations for ***all*** Hunter installations. Then, go to the section for communications (hardwire or radio) as applicable.

Conventional Controllers

"Conventional" refers to the station output of the Field Controllers, with a standard "hot" 24VAC wire run to each valve solenoid, and a field common ground wire returning to the ground lug on the Field Controller. The term conventional is used to distinguish this type of operation from decoder controllers, which are described in a subsequent section.

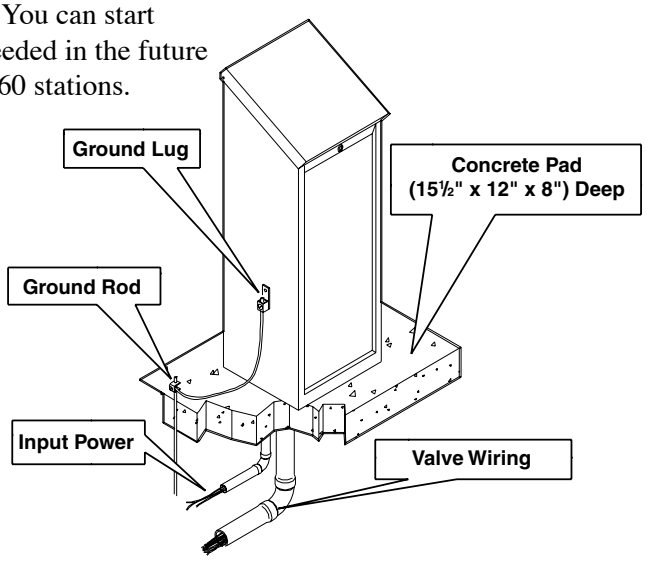
You may mix conventional and decoder controllers in the same Genesis® or VSX™ system. Hunter control software will automatically recognize the output configuration of each type of controller.

Size: Genesis and VSX conventional controllers are available (or expandable) in increments of 10 stations, with a minimum size of 20 stations. In most cases you can order the size required for a job pre-configured with the desired number of stations. However, you may also expand the controller after initial installation if the need arises.

Each increment of 10 stations requires a Triac board and a Lightning Protection Board. Expansion kits are available in 10-station increments which package both boards together (GFCKTEXP10, or GFCKTEXP10S with the Switch option). You can start with a 20-station controller and expand as needed in the future (in increments of 10) up to the maximum of 60 stations.

Switches: Lightning Protection Boards in conventional controllers can have a "Switch" option (**SW**, at or near the end of the model number). This is a three-position On/Off/Auto switch for each station. It allows any station to be:

- Manually switched On, immediately.
- Manually turned Off and removed from any scheduled irrigation.
- Set in the Auto position, which allows normal operations at scheduled times.



Power Options: Hunter controllers are configured for 110VAC, 60 Hz operation, unless their model number ends in "**SV**". "**SV**" indicates 220VAC, 50 Hz operation.

Grounding: *All Hunter Field Controllers must be grounded to* ***10 Ohms*** *or less*. Grounding is critical to lightning and surge protection. Good electrical grounding may be difficult to obtain, but it is required. Grounding should be checked with a Ground Resistance Tester, or "megger," quarterly. Grounding may be achieved through one or more copper rods or plates. Soil treatments are available which improve grounding. For more detailed information on grounding irrigation control systems, refer to the American Society of Irrigation Consultants guideline ASIC 100-2002 available at www.asic.org.

For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

Model Number Creation: Conventional Controllers					
Style	***Prefix***	***Station Size***	***Comm Type***	***Switch Option***	***Power Option***
Genesis Steel Pedestal	GFC	20 30 40 50 60	S = Standalone HW = Hardwire R = Radio	Blank = No Switches SW = Switches	Blank = 110VAC SV = 220VAC
Genesis Steel Wall Mount	GWC				
Genesis Plastic Pedestal	GFCP				
Genesis Plastic Wall Mount	GWCP				
VSX Steel Pedestal	VFC				
VSX Steel Wall Mount	VWC				
VSX Plastic Pedestal	VFCP				
VSX Plastic Wall Mount	VWCP				

Standalone Controllers

Standalone Field Controllers are the basic building block of ***all*** Hunter control configurations, including decoder systems. The principles of all sound designs and installations begin with this simple pedestal or wall-mount assembly. The standard Field Controller has non-volatile, field-resident memory (it contains its own permanently stored programs) and heavy-duty lightning protection for the power input as well as each station output.

It is possible to completely program and irrigate your project using only standalone Field Controllers. A central computer and communications may be added at any time after the initial installation, or the entire system may be ordered and installed as a communicating central system from the beginning, as described in the next section.

Decoder Controllers

Decoder Controllers are internally quite different from conventional Field Controllers. Programming and communications functions are the same as conventional controllers, however, and you may combine decoder controllers and conventional controllers in the same Genesis® or Vista® system.

Decoder Controllers add a "V" to the beginning of the model number to indicate decoder operation ("VGFC-" for Genesis GFC controllers, and "VVFC-" for VSX™ decoder controllers, for example). They do not have station sizes, because all Decoder Controllers are 103 stations each.

Note: *There is no "Switch" option for decoder controllers*. Decoder systems use a transmitter/power supply in the Field Controller to communicate with, and power, individual decoders located near each valve in the field. All decoders (**GVIKDEC**, **MINIDEC1**, or **GVIKDEC4**) are connected to a single pair of wires (**GVIKCBL1** or **GVIKCBL2**). Each

decoder has its own unique address. Decoders are, in turn, wired to the valve solenoids and activate them normally when powered.

The GVIKDEC single-station decoder, or the individual outputs of GVIKDEC4, can each activate one or two solenoids. Solenoids can be up to 100 feet (30 meters) away from the decoder. The MINIDEC1 decoder is designed to be mounted within a G800 series rotor compartment, within a few inches (cm) of the solenoid.

Decoder controllers are always 103 stations, plus an additional decoder for Pump/Master Valve operation. They can power and run up to 20 stations simultaneously. Decoder systems reduce the amount of wire used in the field, and may also reduce the total number of Field Controllers in a system (due to their high 103 station capacity).

A decoder controller may have up to 5 two-wire "paths" to the field, as long as the total number of decoders on a given controller does not exceed 103. You may also splice, or "T," the path for short runs to out-of-the-way locations.

Decoder wire paths from one Field Controller may not be connected to another Field Controller.

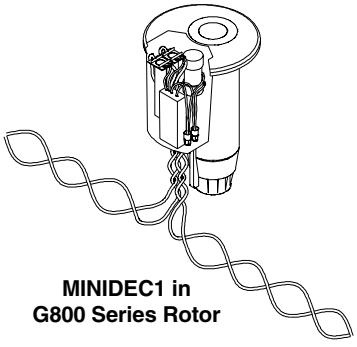
All connections or splices in decoder wire paths must be made in valve boxes (except for the MINIDEC1 decoder-in-head configuration), with high-voltage waterproof connectors. See the Decoder Installation Specification for detailed information.

For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

***Model Number Creation: "Viking" Decoder Controllers** (103-station capacity)*			
Style	***Prefix***	***Comm Type***	***Power Option***
Genesis Decoder Steel Pedestal	VGFC	S = Standalone HW = Hardwire R = Radio	Blank = 110VAC SV = 220VAC
Genesis Decoder Steel Wall Mount	VGWC		
Genesis Decoder Plastic Pedestal	VGFCP		
Genesis Decoder Plastic Wall Mount	VGWCP		
VSX Decoder Steel Pedestal	VVFC		
VSX Decoder Steel Wall Mount	VVWC		
VSX Decoder Plastic Pedestal	VVFCP		
VSX Decoder Plastic Wall Mount	VVWCP		

Decoders: Hunter currently offers three types of decoder:

- **GVIKDEC** single-station decoders (able to activate up to 2 solenoids simultaneously).
- **GVIKDEC4** 4-station decoders (able to activate 4 separate stations, each with up to 2 solenoids connected, maximum 4 solenoids at once).
- **MINIDEC1** is a slimmed-down version of the single-station decoder, for use in the G800 series valve-in-head rotors. The MINIDEC1 will mount inside the flange compartment of the rotor itself, to eliminate the need for a separate valve box. MINIDEC1 is designed to activate a single solenoid only.



MINIDEC1 in G800 Series Rotor

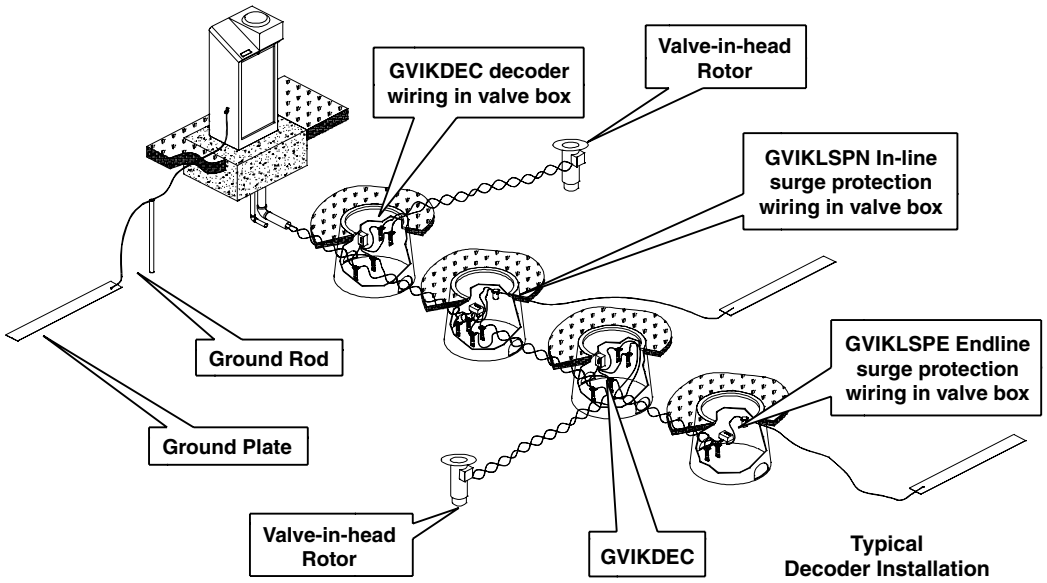
The decoders are generally installed in a valve box within 100 feet/30m of the solenoid(s) or, in the case of MINIDEC1, directly inside the G800 series rotor case. Connection to the solenoid is generally with standard twisted pairs of a suitable gauge for the distance involved. This distance may be increased, but only at the expense of greater exposure to lightning damage.

The GVIKDEC4 has the ability to treat each of its multiple outputs as a separate station, and is essentially the same as four **GVIKDEC**s in a single box. They are an excellent choice wherever multiple solenoids are within a reasonable distance (100 feet/30m) of the decoder.

Surge Suppression: Decoders controllers have their own unique surge suppression modules:

- **In-line** Suppression modules (**GVIKLSPN**). As a rough rule of thumb, add one GVIKLSPN every 1000 feet (300 meters), or every 10 decoders, whichever is first. Add more in very high lightning areas. A lightning hit can take out all decoders between any two surge suppressors.
- **End-line** Suppression modules (**GVIKLSPE**). Add one at the end of each wire path.

These modules are designed to wire in-line with the decoder wire pair (GVIKCBL) and have wire leads with matching color codes (red and blue) to facilitate proper connection. They also have bare wire leads for attachment to copper ground rods or plates. In-line modules have 2 ground leads, but they may be connected to a single ground rod; end-line modules have one ground lead. See the Decoder Installation Specification for more information on installation and grounding of decoder systems.



Typical Decoder Installation

Central Communications Options

With the introduction of the TriSend™ central interface, it is now possible to combine radio and hardwire communications in the same Hunter control system. You may hardwire some of your Field Controllers or Data Retrieval units, and connect to others via radio, as cost, distance, and other criteria dictate. The system operator need not be concerned how each controller communicates, as the software will track how each controller is connected to the system.

Choosing communications options: While the system designer is now free to mix communications technologies within a system to achieve the best results at the lowest possible system cost, there are some physical characteristics of each type of communications that may influence the decision.

Hardwire communications require no FCC license, and are easy to install when pipe trenches are open. There are no concerns about busy frequencies and no site survey requirements. However, communications wiring adds some vulnerability to lightning damage, and is liable to accidental damage during installation, or as a result of maintenance operations or rodent activity. Buried wire damage can be difficult to trace and repair, and some areas may be inaccessible to wire altogether.

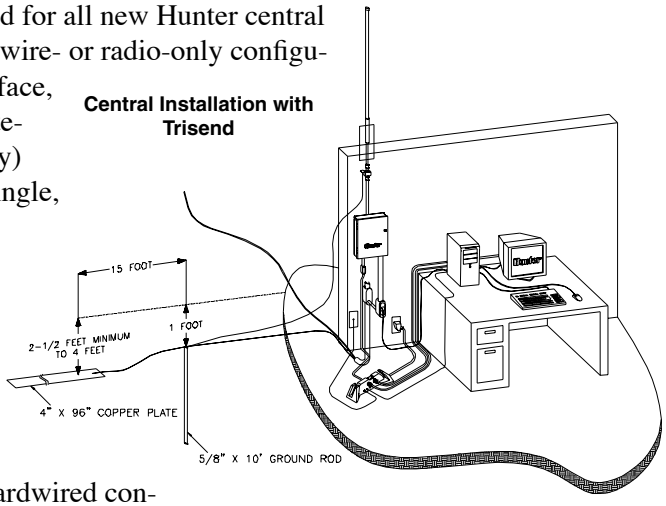
Radio communications are somewhat less susceptible to lightning damage, or cut wires. Radio does not require extensive trenching and is ideal for retrofitting sites which must remain open to traffic. Radio can also be used to reach controllers across rights-of-way or terrain obstacles which would be expensive or impossible to hardwire. However, radio requires an FCC license and a site survey prior to establishing controller locations (to ensure radio coverage). Installations in some urban areas may have difficulty finding a "clean" channel for communications and may experience delays in uploading or downloading information during periods of heavy interference.

Additionally, Data Retrieval units will experience longer reporting intervals in radio-configured systems (every 30 seconds in radio versus every 5 seconds in hardwire). Since Data Retrieval generates near-continuous communications in the polling mode, it may be advisable to hardwire Data Retrieval units when possible, even if the rest of the system is radio. If the polling interval is not a major concern, frequency availability is good, and a Data Retrieval location is difficult to reach with hardwire, radio is a viable medium for Data Retrieval.

The TriSend™ Central Interface

The TriSend™ central interface is required for all new Hunter central systems. TriSend replaces the earlier hardwire- or radio-only configurations with a truly universal central interface, which handles hardwire, radio, and Maintenance Radio (for hardwire controllers only) communications simultaneously from a single, all-weather, steel wall-mount enclosure.

Central Installation with Trisend



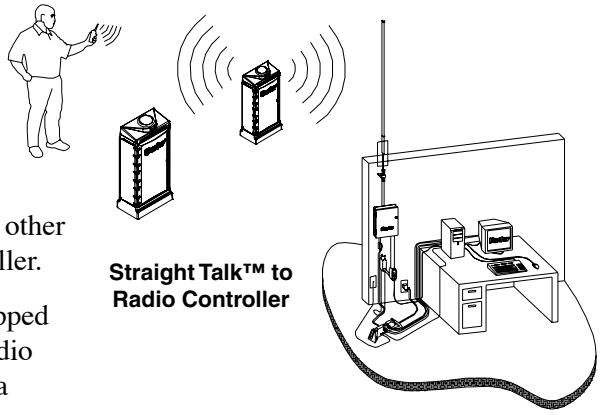
TriSend normally comes equipped with both hardwire communications and a radio module. The only options to a basic TriSend at this time are 220VAC operation (SV), or a hardwire-only version (NR). Note that NR versions will not have Maintenance Radio ability for hardwired controllers, unless a radio module is added later. See also the section "Modem Central Systems" for other Trisend configurations.

TriSend is normally mounted to an inside wall within 25 feet (8 meters) of the central computer, and requires a permanent, unswitched 110VAC power source, or 220VAC in the SV version. TriSend is supplied with its own surge suppression kit for the AC lines in 110VAC versions. International customers may wish to locally source a 220VAC surge protection strip with appropriate local approvals for additional surge protection.

Hardwire connections to the field are made directly inside the enclosure, by routing the GCBL communications cable into the building, through conduit into the enclosure itself, and terminating on the hardwire output board. Radio connections are made from the internal radio module to a 50 foot (15 meters) or shorter coaxial antenna cable, and then to the antenna itself. The **RA5M** mast antenna is about 5 feet (2 meters) tall and is normally mounted on or near the roof. A lightning surge suppressor is recommended near the base of the antenna at the point of connection to the coaxial cable, with a dedicated ground wire from the suppressor to earth ground.

Model Number Creation: Central Interface		
Central Interface (one per site)	***Communications***	***Power Options***
TRISEND	R = Radio Module NR = Hardwire only (no radio)	Blank = 110VAC SV = 220VAC

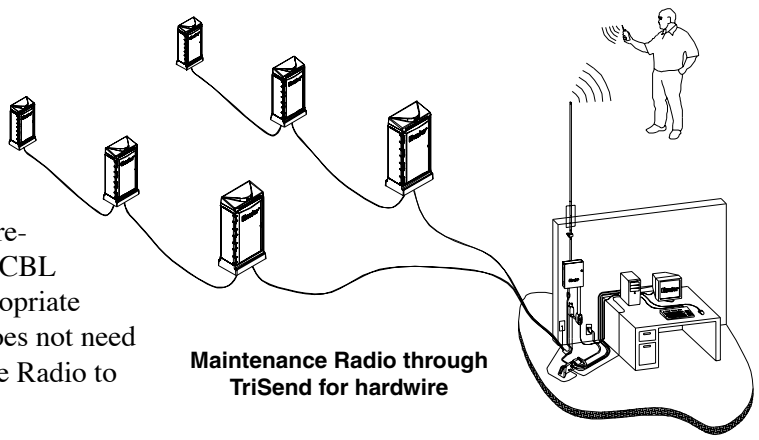
Maintenance Radio: Maintenance Radio allows a handheld Two-Way radio (walkie-talkie **TRNR**) to remote control individual stations at the Field Controllers. The operator can also include a run time for activated stations, start individual programs or presets, step sequentially through stations, and perform other tasks without actually visiting the Field Controller.



Straight Talk™ to Radio Controller

Radio Field Controllers are automatically equipped with Hunter's Straight Talk™ Maintenance Radio capability. They use the same radio and antenna provided for central communications to respond directly to the handheld Two-Way radio.

For hardwire controllers, Maintenance Radio commands are received (and confirmed) at the TriSend™ central interface, then retransmitted to the field over the GCBL communications cable to the appropriate Field Controller. The computer does not need to be switched on for Maintenance Radio to function.



Maintenance Radio through TriSend for hardwire

The system operator does not need to remember which controllers are hardwired and which are radio to operate Maintenance Radio. The operator addresses the specific controller by number, and the TriSend will recognize whether the signals are for hardwired controllers or not.

Maintenance Radio may be added to a hardwire-only central in kit form at any time after the initial installation.

The Maintenance Radio through the central electronics use the same radio module and base antenna (**RA5M**) normally used to contact radio Field Controllers.

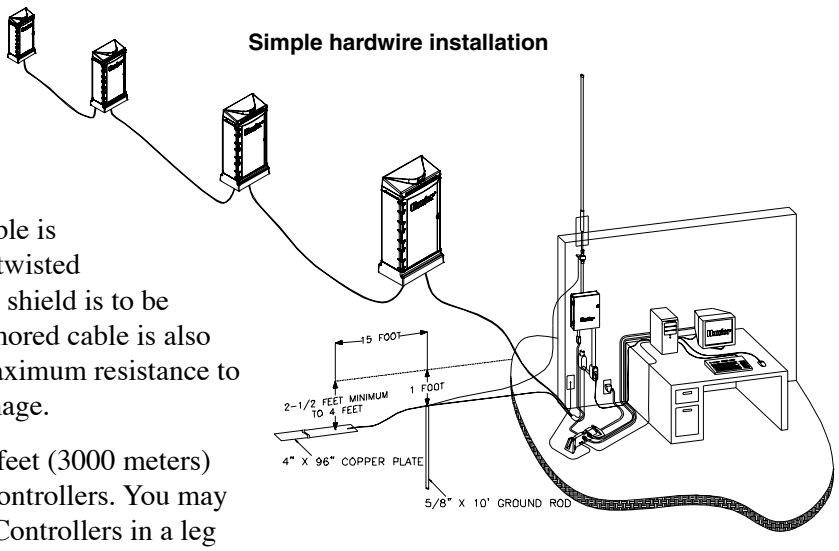
For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

Hardwire Communications

Hardwire Field Controllers are the same as standalone Field Controllers, with the addition of a hardwire communications board.

The communications cable (**GCBL**) connects the Field Controllers to one another, and to the central computer, through the central interface.

Simple hardwire installation



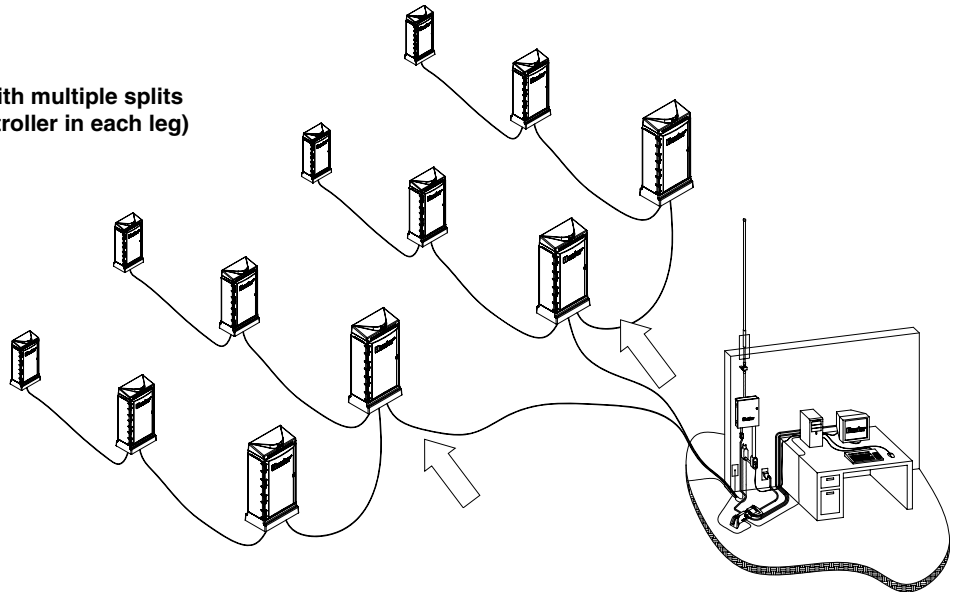
GCBL communications cable is composed of two 18AWG twisted pairs, shielded, and the foil shield is to be **grounded** at each end. Armored cable is also available (**GCBLA**) for maximum resistance to rodent and installation damage.

You may run up to 10,000 feet (3000 meters) of **GCBL** between Field Controllers. You may have any number of Field Controllers in a leg (up to 999 maximum per system).

A chain of controllers connected by the communications cable (GCBL) is called a “leg”. Two separate legs can be wired from the central interface to the field.

The legs do not connect to each other, and no special termination is required at the end of a leg.

Hardwire with multiple splits (at first controller in each leg)



You can also “split” either (or both) of the legs at the first Field Controller in a leg. This allows the most cost-effective route to each Field Controller, by allowing the four shortest possible wire runs. The communications is split at the terminal strip, on the hardwire communications board inside the Field Controller – ***never splice the cable itself***.

RA5M is connected to the TriSend central interface with coaxial radio cable (**RG850NFNF**). The cable is also supplied with appropriate connectors, usually type “N female” standard radio connectors.

For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

Radio Communications

Radio Field Controllers are standalone Field Controllers, with the addition of the radio communications board, a radio module, and the radio antenna on the lid of the pedestal.

It is critical that each proposed radio Field Controller location be tested before installation. This is part of the **site survey** that is required for every Genesis radio installation.

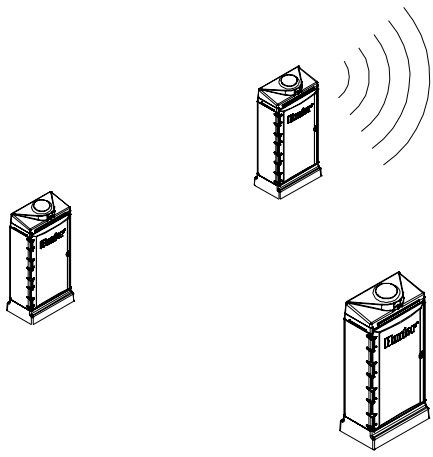
All communications in Hunter radio systems are via UHF radio signal (450 – 470 MHz).

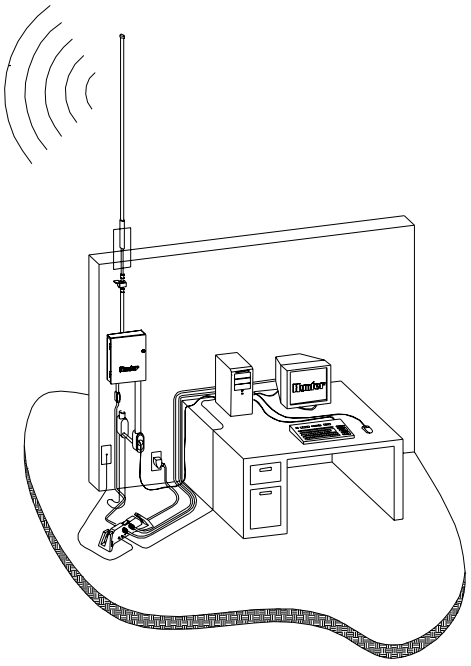
Maintenance Radio capability is automatic in radio systems. Any **TRNR** handheld Two-Way radio, on the same frequency, can access the radio Field Controllers directly with the Straight Talk™ feature. Maintenance Radio commands do not go through the central and do not require any additional hardware at the central.

Radio communications may be added to standalone Field Controllers at any time. Remember that the lid on steel Field Controllers must be changed at the same time, to add the Stealth Antenna lid. Plastic controllers may be drilled for routing of the antenna cable.

Important: Radio Notes

- **Radio Systems (including Maintenance Radio) must be licensed.**
- All Radio Systems must have a **site survey** performed and documented.
- The frequency is no longer included in the **model number,** but must be specified at the time of order.





Simple Radio installation

The Site Survey

The mandatory site survey consists of two separate elements:

- Scanning for clear frequencies.
- Checking each proposed controller location for reliable communications.

Scanning: Use a good quality handheld scanner (preferably with a detachable antenna) and program your proposed frequencies into it. Scan the frequencies for activity during the entire visit to the site. Listen for voice or data traffic. Eliminate the noisiest channels immediately, then zero in on the quieter channels to determine the best one to use. If all channels are busy, see the Site Survey guide or contact Hunter Industries for a list of other frequencies to try.

Checking the controller sites: This requires two people, each with a UHF walkie-talkie (power should be approximately 2 Watts). One person remains at the proposed central site (usually the superintendent's office) and monitors the radio. The other person travels to each proposed Field Controller location, and calls the first person. Each person slowly counts to 10, and verifies that the other can hear the entire count without static or break-up. Use Hunter Industries Site Survey form to check off each Field Controller site as it is surveyed.

Tips for site selection: The single most important factor in radio communications is the **positioning of the antennas**. Radio is similar to light; the antennas are like light bulbs. When considering a central or Field Controller location, imagine how much light you would see from the location you are try to reach; this is a rough indicator of how successful the communications from that site will be.

Field Controllers should be located on level or high ground. The Stealth antenna lid is only 36 inches (1 meter) above ground, so even a slight hill can effectively block signal to it.

Trees are generally not a major obstacle for radio communications (think of them as stacks of semi-transparent colored beer bottles, in the light bulb analogy). If a signal is already weak due to large distances or intervening buildings, dense trees can block the remaining signal. The proximity of power lines is also not a major problem for FM radio (though care should be taken to prevent accidental antenna contact with them).

Do not locate controllers:

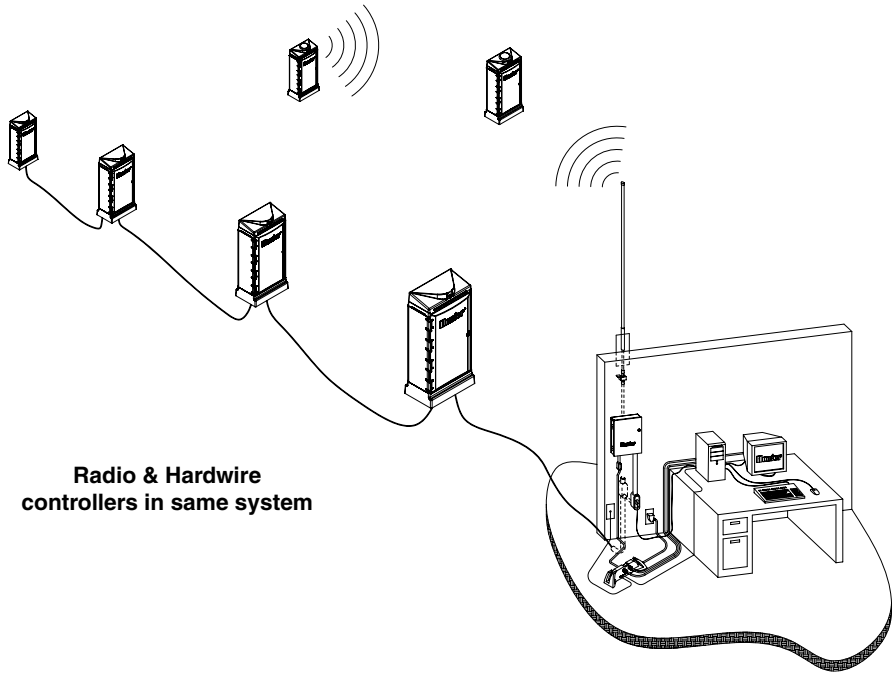
- In recessed areas (hollows and valleys).
- On the opposite side of a hill from the central.
- Directly behind brick or steel buildings.
- Directly behind steel fence posts or similar objects.

Sometimes such locations are unavoidable. If so, communications must be improved with a remote antenna, or another solution (such as hardwire) must be found. A location that has trouble communicating during a site survey will not improve over time and will spoil an otherwise good control system.

- The **RASREM** remote Stealth antenna allows the antenna to be located within 12 feet (3.5 meters) of a controller, and may provide sufficient elevation for acceptable communications.
- The **RA6F** Yagi directional antenna can be remotely mounted even further from the controller, and provides a very focused radio beam which is aimed directly at the central antenna. Use RG850 antenna cable with RA6F, up to 50 feet (15 meters). Generally these antennas are not specified as part of the system, but are used as problem-solving tools for specific locations.

The location of the central computer is where the base antenna will be installed. If the central is in a hollow or valley, plan to get the antenna up as high as possible. This may require a separate antenna tower. You can legally elevate an antenna up to 20 feet over an existing man-made structure in most cases.

These are general guidelines and are never a substitute for the actual site survey. Hunter Field Services is available to assist with unusual or difficult applications.



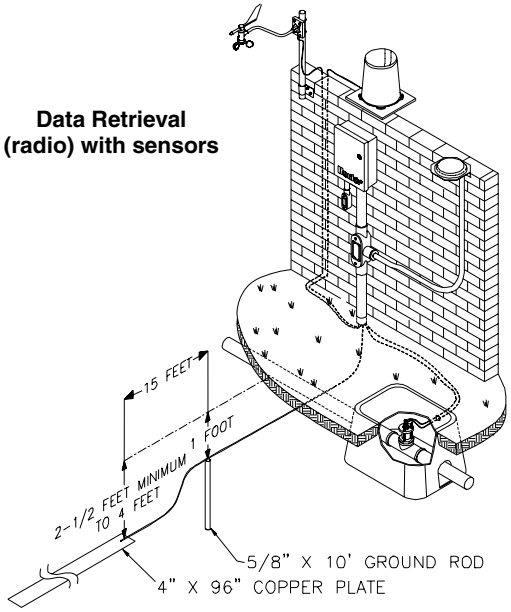
Radio & Hardwire controllers in same system

Data Retrieval

Data Retrieval is a unit designed to collect information from up to 6 sensors in the field, and send it to the central computer. The central software can record this information and display a variety of reports, and can also be programmed to recognize and react to alarm conditions (with full or partial system shutdowns).

Data Retrieval units communicate like Field Controllers. There are hardwire and radio versions, but there is no standalone. They are often located near pump stations, or centrally to other sensors. Data Retrieval units are housed in the same weatherproof, steel cabinet as the TriSend™ central interfaces, and are designed to be wall or pole-mounted.

- **Hardwire** versions are wired anywhere into a hardwire communications "leg," just like Field Controllers.
- **Radio** versions are located anywhere within the range of the radio central (as determined by the site survey). Radio Data Retrieval units do not include an antenna, but usually use the **RASREM** remote Stealth antenna.



Data Retrieval (radio) with sensors

Data Retrieval units have the same grounding requirements as Field Controllers and central interfaces.

Data Retrieval units can monitor inputs from:

- Flow Sensor (**GENDATFL**). Up to 3 flow sensors may be connected to a single Data Retrieval unit.
- Rain Catchment (**GENDATRC**).
- Wind Speed and Direction Sensor (**GENDATAN**).
- Contact Closures (normally open, or normally closed). This includes any of Hunter's Mini-Clik® family of sensors.

Most sensors are connected to the Data Retrieval unit with GCBL cable. Refer to the Data Retrieval specifications or installation instructions for detailed descriptions of sensor connections.

Model Number Creation: Data Retrieval		
Data Retrieval Unit	***Communications***	***Power Options***
DAT	R = Radio Module HW = Hardwire	Blank = 110VAC SV = 220VAC

For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

Weather Stations

Hunter supports two complete weather stations, and including their own communications, an on-board data logger, and all sensors necessary to produce reliable evapo-transpiration (ET) data. They also include their own dedicated software, which communicates directly and automatically with the central control software to allow automatic recalculation of irrigation schedules.

CWS4 uses its own communications port on the central computer, and communicates over a dedicated **GCBL** cable. It is *never* wired into a Genesis hardwire communications leg. Since it has its own hardwire communications path to the computer, it works equally well with hardwire or radio systems.

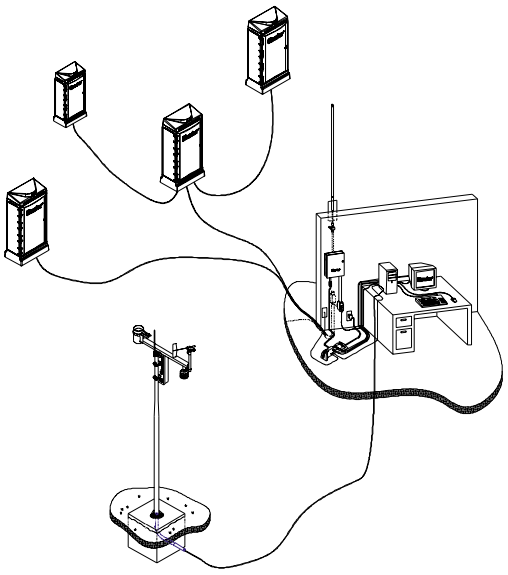
TW916 and related TurfWeather station models include built-in spread spectrum wireless communications, or an optional hardwired version. The wireless TW stations require no license in North America and have optional Solar Power.

Install either weather station:

- In direct sunlight.
- Where it will <u>not</u> be hit by sprinkler spray, or near or under trees.
- Where the climatic conditions most closely match those of the plants you are irrigating.

For the most up-to-date product information, please refer to our web site www.HunterIndustries.com.

Weather Station with separate hardwire connection



Modem Central Systems

Modem central systems are actually a form of TriSend™ central interface communications, but allow the central computer to operate one or more sites remotely via telephone lines. The central computer dials remote modem-equipped TriSend centrals and operates radio and/or hardwire controllers at distant locations.

In modem centrals, no central interface is installed at the computer's location. Instead, the **TRISENDRMOD** remote central interface is installed at the remote location. A modem central system uses the internal modem in the central computer to dial **TRISEND**s at the remote locations. At the remote location, the TriSend communicates via radio and/or hardwire to the local Field Controllers. Additional locations only require an additional **TRISENDRMOD**. The **TRISENDRMOD** plugs directly into a telephone line (standard RJ11 telephone jack), and connects to the hardwire Field Controllers via **GCBL,** like regular hardwire systems, or radio controllers through an **RA5M** antenna.

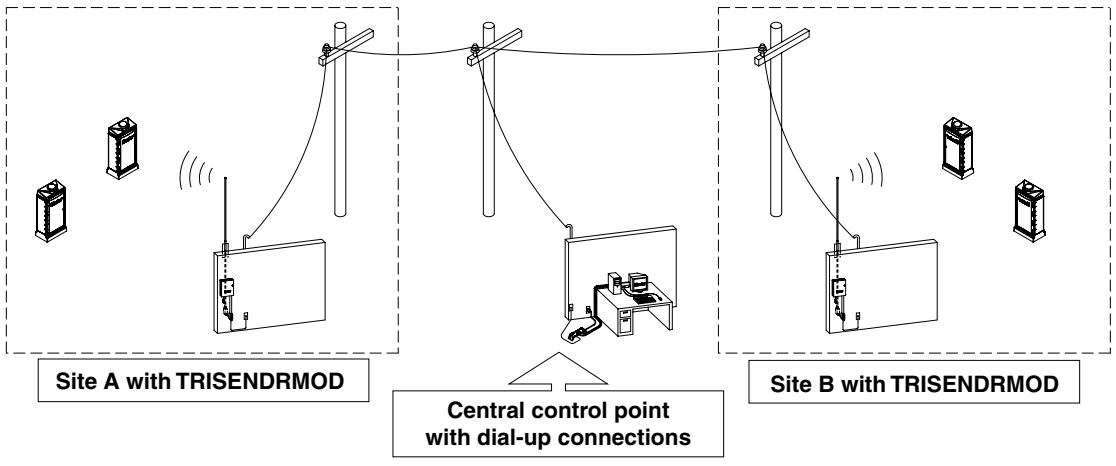
Existing TriSend central interfaces can be upgraded to modem communications by ordering and installing **TRIMODKT** modem kits, and connecting to a telephone line.

This allows the operator to dial-up a remote location from the computer, communicate with the Field Controllers when necessary, and then hang up and dial another location. The computer does not need to be "on line" with each system to irrigate, because the field resident memory in the Field Controllers runs irrigation schedules on its own. The remote system can be any distance from the central computer, as long as there are telephone connections at either end.

The **TRISENDRMOD** is in a steel wall-mounted cabinet and may be mounted outdoors. It contains its own modem and the communication outputs, in a single enclosure. This enclosure should be mounted within 25 feet of a direct telephone line connection. Radio versions require an RA5M base antenna and, of course, an FCC license.

It is strongly recommended that TriSend modem communications are connected to a dedicated telephone line. This prevents the system from experiencing busy signals when communications may be needed.

Genesis® and VSX™ radio controllers both support Straight Talk™ Maintenance Radio commands regardless of the installation type, and hardwire systems have a Maintenance Radio interface built in to the TriSend even in remote modem applications.



Charts

Each Hunter Industries electrical component has a maximum amperage draw, which must be considered when designing the electrical requirements of a system.

As a general rule, wire should be sized for the maximum possible current for each device, since it is theoretically possible for all of the controllers on a given electrical circuit to operate at maximum current simultaneously.

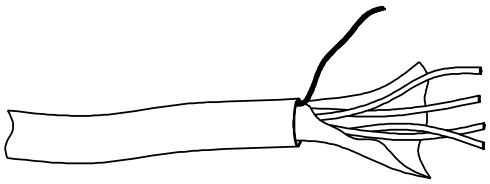
*Genesis®/VSX™ Field Controllers Primary Current Requirements in Amps (Hunter VIH or ICV Valves)**															
	Line Voltage	*Controller Only*	*Totals with Number of Active Hunter Industries solenoids*												
			1	2	3	4	5	6	7	8	9	10	11*	12*	13*	14*
Standalone	115VAC	.25	.31	.37	.42	.47	.53	.58	.63	.67	.72	.77	.81	.86	.90	.94
Hardwire	115VAC	.26	.32	.38	.43	.49	.54	.59	.64	.68	.73	.78	.82	.87	.91	.95
Radio	115VAC	.52	.58	.64	.69	.74	.79	.85	.89	.94	.98	1.03	1.07	1.11	1.16	1.20
	Line Voltage	*Controller Only*	*Number of Hunter Industries solenoids*												
			1	2	3	4	5	6	7	8	9	10	11*	12*	13*	14*
Standalone	220VAC	.16	.19	.23	.26	.29	.33	.36	.39	.42	.45	.48	.50	.53	.56	.58
Hardwire	220VAC	.16	.20	.24	.27	.30	.33	.37	.40	.42	.45	.48	.51	.54	.56	.59
Radio	220VAC	.32	.36	.40	.43	.46	.49	.53	.55	.58	.61	.64	.66	.69	.72	.74

* Station draws are for typical Hunter solenoids only, and are based on worst-case holding (not inrush) current.

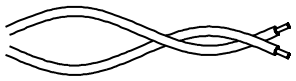
Other Hunter Components, Primary Current Requirements in Amps		
Component	***Line Voltage***	***Amps***
TriSend Central interface, with radio & hardwire (both)	115VAC 230VAC	.45 max .25 max
Data Retrieval, Hardwire	115VAC 230VAC	.24 max .14 max
Data Retrieval, Radio	115VAC 230VAC	.45 max .25 max
CWS4 Weather Station	115VAC 230VAC	1 Amp, max .62 max

Wire & Cable types used in Hunter Systems

GCBL Communications Cable: (Two twisted pairs, shielded & grounded):



GVIKCBL1 & 2 Decoder Wire (twisted solid, red and blue):



Charts (continued)

Wire Data: Standard Annealed Copper at 20˚ C					
American Wire Gauge	*Metric Wire Gauge*	*Diameter Mils*	*Diameter mm*	*Resistance Per mft Ohms*	*Per km Ohms*
1		289.3	7.348	0.9239	0.4065
	7		7		0.448
2		257.6	6.543	0.1563	0.5128
	6		6		0.6098
3		229.4	5.827	0.1971	0.6466
4		204.3	5.189	0.2485	0.8152
	5		5		0.08781
5		181.9	4.62	0.3134	1.028
	4.5		4.5		1.084
6		162	4.115	0.3952	1.297
	4		4		1.372
7		144.3	3.665	0.4981	1.634
	3.5		3.5		1.792
8		128.5	3.264	0.6281	2.061
	3		3		2.439
9		114.4	2.906	0.7925	2.6
10		101.9	2.588	0.9988	3.277
	2.5		2.5		3.512
11		90.7	2.3	1.26	4.14
12		80.8	2.05	1.59	5.21
	2		2		5.49
13		72	1.83	2	6.56
	1.8		1.8		6.78
14		64.1	1.63	2.52	8.28
	1.6		1.6		8.58
15		57.1	1.45	3.18	10.4
	1.4		1.4		11.2
16		50.8	1.29	4.02	13.2
	1.2		1.2		15.2
17		45.3	1.15	5.05	16.6
18		40.3	1.02	6.39	21
	1		1		22
19		35.9	0.912	8.05	26.4
	0.9		0.9		27.1
20		32	0.813	10.1	33.2

Table of Voltage Losses for Annealed Copper Wire 25˚C (77˚F) (Loss per 1000 feet of wire)									
Amperes	***18***	***16***	***14***	***12***	***10***	***8***	***6***	***4***	***2***
0.1	0.65	0.41	0.26	0.16	0.1	0.06	0.04	0.03	0.02
0.15	0.98	0.61	0.39	0.24	0.15	0.1	0.06	0.04	0.02
0.2	1.3	0.82	0.52	0.32	0.2	0.13	0.08	0.05	0.03
0.25	1.63	1.02	0.65	0.41	0.26	0.16	0.1	0.06	0.04
0.3	1.95	1.23	0.77	0.49	0.31	0.19	0.12	0.08	0.05
0.35	2.28	1.43	0.9	0.57	0.36	0.22	0.14	0.09	0.06
0.4	2.6	1.64	1.03	0.65	0.41	0.26	0.16	0.1	0.06
0.45	2.93	1.84	1.16	0.73	0.46	0.29	0.18	0.11	0.07
0.5	3.26	2.05	1.29	0.81	0.51	0.32	0.2	0.13	0.08
0.6	3.91	2.45	1.55	0.97	0.61	0.38	0.24	0.15	0.1
0.7	4.56	2.86	1.81	1.13	0.71	0.45	0.28	0.18	0.11
0.8	5.21	3.27	2.06	1.3	0.82	0.51	0.32	0.2	0.13
0.9	5.86	3.68	2.32	1.46	0.92	0.58	0.36	0.23	0.14
1	6.51	4.09	2.58	1.62	1.02	0.64	0.4	0.25	0.16
1.1	7.16	4.5	2.84	1.78	1.12	0.71	0.44	0.28	0.17
1.2	7.81	4.91	3.1	1.94	1.22	0.77	0.48	0.3	0.19
1.3	8.46	5.32	3.35	2.11	1.33	0.83	0.52	0.33	0.21
1.4	9.11	5.73	3.61	2.27	1.43	0.9	0.56	0.35	0.22
1.5	9.77	6.14	3.87	2.43	1.53	0.96	0.6	0.38	0.24
1.6	10.42	6.54	4.13	2.59	1.63	1.03	0.77	0.4	0.25
1.7	11.07	6.95	4.39	2.75	1.73	1.09	0.69	0.43	0.27
1.8	11.72	7.36	4.64	2.92	1.84	1.15	0.73	0.46	0.29
1.9	12.37	7.77	4.9	3.08	1.94	1.22	0.77	0.48	0.3
2	13.02	8.18	5.16	3.24	2.04	1.28	0.81	0.51	0.32
2.1	13.67	8.59	5.42	3.4	2.14	1.35	0.85	0.53	0.33
2.2	14.32	9	5.68	3.56	2.24	1.41	0.89	0.56	0.35
2.3	14.97	9.41	5.93	3.73	2.35	1.47	0.93	0.58	0.37
2.4	15.62	9.82	6.19	3.89	2.45	1.54	0.97	0.61	0.38
2.5	16.28	10.23	6.45	4.05	2.55	1.6	1.01	0.63	0.4
2.6	16.93	10.63	6.71	4.21	2.65	1.67	1.05	0.66	0.41
2.7	17.58	11.04	6.97	4.37	2.75	1.73	1.09	0.68	0.43
2.8	18.23	11.45	7.22	4.54	2.86	1.79	1.13	0.71	0.45
2.9	18.88	11.86	7.48	4.7	2.96	1.86	1.17	0.73	0.46
3	19.53	12.27	7.74	4.86	3.06	1.92	1.21	0.76	0.48
3.2	20.83	13.09	8.26	5.18	3.26	2.05	1.29	0.81	0.51
3.4	22.13	13.91	8.77	5.51	3.47	2.18	1.37	0.86	0.54
3.6	23.44	14.72	9.29	5.83	3.67	2.31	1.45	0.91	0.57
3.8	24.74	15.54	9.8	6.16	3.88	2.44	1.53	0.96	0.6
4	26.04	16.36	10.32	6.48	4.08	2.56	1.61	1.01	0.64
4.2	27.34	17.18	10.84	6.8	4.28	2.69	1.69	1.06	0.67
4.4	28.64	18	11.35	7.13	4.49	2.82	1.77	1.11	0.7
4.6	29.95	18.81	11.87	7.45	4.69	2.95	1.85	1.16	0.73
4.8	31.25	19.63	12.38	7.78	4.9	3.08	1.93	1.21	0.76
5	32.55	20.45	12.9	8.1	5.1	3.21	2.02	1.27	0.8
5.2	33.85	21.27	13.42	8.42	5.3	3.33	2.1	1.32	0.83
5.4	35.15	22.09	13.93	8.75	5.51	3.46	2.18	1.37	0.86
5.6	36.46	22.9	14.45	9.07	5.71	3.59	2.26	1.42	0.89
5.8	37.76	23.72	14.96	9.4	5.92	3.72	2.34	1.47	0.92
6	39.06	24.54	15.48	9.72	6.12	3.85	2.42	1.52	0.95
6.2	40.36	25.36	16	10.04	6.32	3.97	2.5	1.57	0.99
6.4	41.66	26.18	16.51	10.37	6.53	4.1	2.58	1.62	1.02
6.6	42.97	26.99	17.03	10.69	6.73	4.23	2.66	1.67	1.05
6.8	44.27	27.81	17.54	11.02	6.94	4.36	2.74	1.72	1.08
7	45.57	28.63	18.06	11.34	7.14	4.49	2.82	1.77	1.11

Charts (continued)

To use the Table of Voltage Losses for Annealed Copper Wire on the previous page:

To find the voltage loss for a two wire circuit, multiply the loss per 1000 feet figure above by **twice** the actual wire length expressed in thousands.

For a single wire, multiply the loss per 1000 feet value, above by the actual wire length in thousands.

Note: Remember, amperages are additive along a wire where current is demanded by more than one appliance.

Note: Voltage losses are calculated from the formula: V = IR

Where: I = current in amperes, R = resistance in ohms per 1000 ft, V = voltage

Reference Chart Approximate Number of Wires to be Installed in Conduit or Tubing Maximum no. of wires in conduit or sleeving													
Wire Size (AWG)	***½"***	***¾"***	***1"***	***1¼"***	***1½"***	***2"***	***2½"***	***3"***	***3½"***	***4"***	***5"***	***6"***	***Wire Size (AWG)***
18	6	12	20	35	49	80	110	175					18
16	5	10	16	30	42	67	97	150					16
14	4	6	10	18	25	40	56	88	120	150			14
12	3	5	7	15	20	33	50	75	102	130	205		12
10	1	3	6	13	16	27	40	63	85	110	170		10
8	1	2	4	6	9	16	25	35	50	65	105	150	8
6	1	1	3	3	5	10	15	22	32	40	63	92	6
4		1	1	2	4	7	10	16	24	30	48	70	4
2		1	1	2	2	5	9	12	18	22	36	54	2
0			1	1	2	3	5	8	12	15	24	36	0
0			1	1	1	2	4	7	10	14	21	31	0
0				1	1	2	3	6	8	11	18	26	0
0				1	1	1	2	5	7	10	15	22	0

Estimating Pipe Size			
	Copper Pipe	***Galvanized (Sch. 40 Steel)***	***PVC Pipe***
Nominal Pipe Size	***Approximate String Length in Inches***		
½"	2"	2⅝"	2⅝"
⅝"	2¾"	–	–
¾"	2¾"	3⅝"	3⅝"
1"	3½"	4⅛"	4⅛"
1¼"	4⅝"	5⅜"	5⅜"
1½"	5⅛"	6"	6"
2"	6¾"	7⅞"	7⅞"

To determine the nominal size of a pipe, wrap a string around the pipe and compare its length to the chart above.

AWG Table								
(AWG) no.	***Wire diameter (mm)***	***Area (mm^2)***	***(AWG) no.***	***Wire diameter (mm)***	***Area (mm^2)***	***(AWG) no.***	***Wire diameter (mm)***	***Area (mm^2)***
6/0	14.73	170.30	10	2.59	5.27	25	0.455	0.163
5/0	13.12	135.10	11	2.30	4.15	26	0.405	0.128
4/0	11.68	107.20	12	2.05	3.31	27	0.361	0.102
3/0	10.40	85.00	13	1.83	2.63	28	0.321	0.0804
2/0	9.27	67.50	14	1.63	2.08	29	0.286	0.0646
0	8.25	53.40	15	1.45	1.65	30	0.255	0.0503
1	7.35	42.40	16	1.29	1.31	31	0.227	0.0400
2	6.54	33.60	17	1.15	1.04	32	0.202	0.0320
3	5.83	26.70	18	1.024	0.823	33	0.180	0.0252
4	5.19	21.20	19	0.912	0.653	34	0.160	0.020
5	4.62	16.80	20	0.812	0.519	35	0.143	0.0161
6	4.11	13.30	21	0.723	0.412	36	0.127	0.0123
7	3.67	10.60	22	0.644	0.325	37	0.113	0.0100
8	3.26	8.35	23	0.573	0.259	38	0.101	0.00795
9	2.91	6.62	24	0.511	0.205	39	0.0897	0.00632

For more details and the latest information,
be sure to visit us at www.HunterIndustries.com!

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