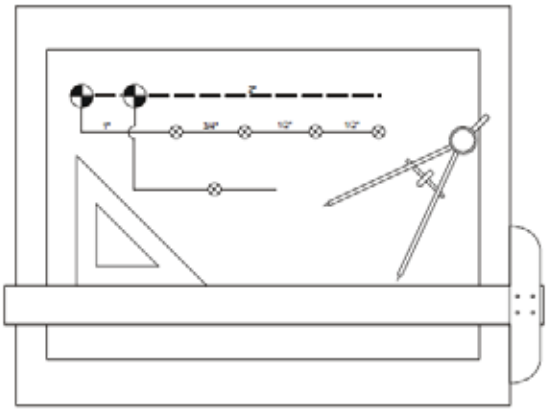
CALSENSE®



Designer's Guide

This document contains the following sections:

- Introduction
- How to Specify
- Irrigation Controllers
- Handheld Radio Remotes
- Transient Protection and Grounding
- Enclosures
- Sharing Points of Connections
- Flow Meters
- Weather Sensors
- Central Computer and Software
- Communication Options
- Communication Accessories
- Data Access Service Plans
- Other Options

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Introduction

The Calsense Designer's Guide is a detailed packet of design information for the full Calsense product line. Please call Calsense directly at (800) 572-8608 or (760) 438-0525 for further information and product support.

Calsense Philosophy

Calsense is a California-based company that designs and manufactures computerized irrigation controllers used for water conservation and water management. Each field unit is a powerful standalone micro-controller that can do more than some central systems available in today's irrigation market. Calsense's philosophy is to succeed at placing innovative, state-of-the-art technology in the hands of landscape maintenance personnel so that water, labor, and time management become a reality.

Calsense specializes in easy-to-use water management systems and provides customers with the strongest after-sales factory training and field service program available in the irrigation industry. Calsense responds quickly to customer needs and engineers products to reflect those needs. It is Calsense's combination of consistent hands-on education in the field and specialized quality products that work, which produces the success that Calsense customers experience. Please contact a Calsense customer to hear feedback and personal experience. Our continued growth is based on our customers' success!

Calsense Service

Calsense understands the need to provide hands-on field training upon product installation. The purchase price of our product includes this service. The Calsense technical support and educational training program includes six on-site field visits during the first year of installation by one of our professional field service technicians. Our trained technicians help maintenance personnel learn the complete operation of all Calsense products, including our central computer software, Command Center.

For service or repair, please call (800) 572-8608 or (760) 438-0525. Hours of operation are Monday through Friday, 8:00 AM to 5:00 PM Pacific Time.

How to Specify

How to Specify Controllers

Controller Model

ET2000e	ET, rain, and soil moisture driven Irrigation Controller (includes powder-coated box)

Number of Stations

-6	6 station Irrigation Controller
-8	8 station Irrigation Controller
-12	12 station Irrigation Controller
-16	16 station Irrigation Controller
-24	24 station Irrigation Controller
-32	32 station Irrigation Controller
-40	40 station Irrigation Controller
-48	48 station Irrigation Controller

Communication Options

-GR	Internal GPRS Radio Cellular Modem (requires Calsense Data Access Service plan)
-EN	Internal Ethernet device
-WEN	Internal Wireless Ethernet (Wi-Fi) device
-R	Embedded Analog Phone Modem
-FOM	External Fiber Optic Modem
-LR	Internal Local Radio
-SR	Internal Spread Spectrum Radio
-M	Wire linkable for Hardwire

Other Controller Options

-F	Interface to connect two additional Flow Meters and/or master valves
-G	Interface to connect an ET Gage (model ETG)
-RB	Interface to connect a Tipping Rain Bucket (model RB-1)
-WG	Interface to connect a Wind Gage (model WG-1)
-L	Hardware and firmware for 4 additional lights circuits
-RRe	Integrated Radio Remote Receiver Board (required to use RRe-TRAN)
-FL	*FLOWSENSE*® communication option

How to Specify Optional Equipment

Weather Sensors

ETG	ET Gage
ETGE	Vandal-Resistant Stainless Steel ET Gage Enclosure (for use with model ETG)
RB-1	Tipping Rain Bucket
WG-1	Wind Gage

Flow Meters

FM-1B	1-inch brass tee mounted Flow Meter
FM-1.25B	1.25-inch brass tee mounted Flow Meter
FM-1.5B	1.5-inch brass tee mounted Flow Meter
FM-2B	2-inch brass tee mounted Flow Meter
FM-1.5	1.5-inch PVC tee mounted Flow Meter
FM-2	2-inch PVC tee mounted Flow Meter
FM-3	3-inch PVC tee mounted Flow Meter
FMBX	Insert type Flow Meter, screws into 2-inch NPT pipe saddle, for 3-inch and larger pipe (saddle not included)
FMI	Flow Meter replacement insert for all Flow Meters except for FM-2B and FMBX
FMIX	Flow Meter replacement insert for FMBX and FM-2B

Moisture Sensors

1000-S	Soil Moisture Sensor

Radio Remotes

RRe-TRAN	Handheld Radio Remote Transmitter for -RRe Integrated Radio Remote Receiver Board

Central Computer and Software

COMM-1	Command Center central water management software for Microsoft® Windows®
CS-5	Client/Server software which supports up to 5 concurrent connections to a single database
CS-10	Client/Server add-on which, when added to CS-5, supports up to 10 concurrent connections to a single database
COMP-2	Central computer
DL-2	Portable Data logger
LR-HUB	Local Radio Hub - requires a communication option, such as a phone modem, to communicate with central computer
SR-HUB	Spread spectrum radio hub - requires a communication option, such as a phone modem, to communicate with central computer

Transient Protection

TP-1	Transient Protection Board only (specify number of stations and options) - TP-1 must be mounted in TBP for outdoor use
TPB	Outdoor box for TP-1 Transient Protection Board
TP-110	Transient Surge Arrestor for AC line protection
TPP	Wall-Mounted Transient Protection Package - includes: TP-1, TPB, and TP-110

Pedestals and Enclosures

SSE	Heavy-Duty Stainless Steel Enclosure - includes TP-1 and TP-110
SSE-R	Heavy-Duty Stainless Steel Enclosure - includes TP-1, TP-110, and appropriate DOME antenna
SSE-D	Heavy-Duty Stainless Steel Enclosure for two controllers - includes two TP-1 and one TP-110
SSE-D-R	Heavy-Duty Stainless Steel Enclosure for two controllers - includes two TP-1, one TP-110, and appropriate DOME antennas
SSE-PED	Heavy-duty Stainless Steel Pedestal for mounting SSE or SSE-R enclosure on a StrongBox® metered enclosure
SSE-BREAKER	15 amp circuit breaker for SSE, SSE-R, SSE-D, and SSE-D-R
PD-1	Powder-Coated Stainless Steel Pedestal for use with controller box

Antennas and Communication Accessories

GR-STUBBY	Stubby antenna with 2-foot cable - for use with GPRS Radio
GR-STICK	Stick antenna with no cable - for use with GPRS Radio
WEN-STUBBY	Stubby antenna with 2-foot cable - for use with Wireless Ethernet device
LR-DOME	Dome antenna with no cable - for use with Local Radio
LR-DOME-RRe	Dome antenna with no cable - for use with Local Radio and -RRe Integrated Radio Remote Receiver Board
LR-DOME-SR	Dome antenna with no cable - for use with Local Radio and Spread Spectrum Radio
LR-STICK	Stick antenna with no cable - for use with Local Radio
LR-YAGI	Yagi antenna with no cable - for use with Local Radio
SR-DOME	Dome antenna with no cable - for use with Spread Spectrum Radio
SR-DOME-RRe	Dome antenna with no cable - for use with Spread Spectrum Radio and -RRe Integrated Radio Remote Receiver Board
SR-STUBBY	Stubby antenna with 2-foot cable - for use with Spread Spectrum Radio
SR-STICK	Stick antenna with no cable - for use with Spread Spectrum Radio
SR-YAGI	Yagi antenna with no cable - for use with Spread Spectrum Radio
RRe-DOME	Dome antenna with no cable - for use with -RRe Integrated Radio Remote Receiver Board
RRe-WHIP	Whip antenna with no cable - for use with -RRe Integrated Radio Remote Receiver Board

LR-FILTER	Local Radio radio frequency filter
SR-FILTER	Spread Spectrum Radio radio frequency filter
ANT-PROT	Antenna cable surge protection device
TP-MOD	Phone modem surge protection device

Data Access Service Plans

COMM-1MN	Data Access Service Plan for 1 GPRS Radio communicating with 1-2 controllers, 1-month prepaid communication charge
COMM-1MN-M	Data Access Service Plan for 1 GPRS Radio communicating with multiple controllers, 1-month prepaid communication charge
COMM-1YR	Data Access Service Plan for 1 GPRS Radio communicating with 1-2 controllers, 1-year prepaid communication charge
COMM-1YR-M	Data Access Service Plan for 1 GPRS Radio communicating with multiple controllers, 1-year prepaid communication charge
COMM-5YR	Data Access Service Plan for 1 GPRS Radio communicating with 1-2 controllers, 5-years prepaid communication charge
COMM-5YR-M	Data Access Service Plan for 1 GPRS Radio communicating with multiple controllers, 5-years prepaid communication charge

Note to the designer:

Each project varies and is unique. With the flexibility of the Calsense Command Center Central Software, a system can be designed using any combination of communication options. If specifying Command Center for the Web, only ET2000e controllers with the GPRS communication (model -GR) are supported.

Irrigation Controllers

ET2000e

The Calsense ET2000e Irrigation Controller is an important water conservation and management tool. Some of its major water management features include flow monitoring, moisture-based irrigation, and the use of daily evapotranspiration (ET) to automatically calculate station run times. The ET2000e provides a wide range of programming flexibility, including:

- Seven programs, which can be programmed to water individually or interspersed to maximize system capacity and reduce watering time
- Cycle and soak scheduling to water each station for a fixed cycle time and allow the water to soak in between cycles, maximizing infiltration and minimizing runoff
- 7-day, 14-day, 21-day, or 28-day watering schedule
- 12-month master schedule to pre-program an irrigation schedule for an entire year, saving the trouble and expense of changing the schedule every month
- Moisture-based irrigation, which allows the controller to stop irrigation when the soil reaches a preset moisture content; requires Soil Moisture Sensor (model 1000-S), purchased separately
- Manual programs, which allow the user to schedule stations to run for a preset time, up to 6 times per day, for hydro-seeding and new planting
- Water-use budget, which continually compares actual usage to a user budget. If the usage exceeds the allowed budget, the controller notifies the user with an over-budget message.
- Electrical alerts, such as short circuits and no currents, to help the user troubleshoot field wiring and solenoid problems
- On-screen context-sensitive help provides programming instructions and tips from any screen on the controller
- Permanent memory stores all controller programming and setup data, including date and time, in non-erasable memory
- Available in multiple station counts including 6, 8, 12, 16, 24, 32, 40, or 48 stations. If less than 48 stations are purchased initially, additional stations can be added at any time.

Flow Monitoring

The ET2000e Irrigation Controller works with the Calsense Flow Meter (model FM) to continuously monitor real-time flow through the irrigation mainline, 24 hours a day. This feature detects and alerts the user to mainline breaks, high flows caused by broken risers and pipes on each individual station, and low flows due to malfunctioning or shut down valves.

Since the ET2000e Irrigation Controller uses real-time flow measuring, it monitors and maintains a record of all water usage. Scheduled irrigation usage is recorded on a station-by-station basis and on a total controller basis for the current month and the previous month. Unscheduled water usage, along with non-controller water usage, is recorded and shown using built-in reports. Examples of the non-controller usage include use of quick-couplers or manually bleeding of valves.

For more information about flow monitoring, see *Flow Meters* on page 27.

Daily ET

The ET2000e can irrigate based on real-time evapotranspiration (ET) allowing the controller to automatically calculate each station's run time before irrigation. This ET data can come from an on-site ET Gage (model ETG), a Campbell Scientific Weather Station (model ET107), or the *WEATHERSENSE* feature of Command Center.

At the start of an irrigation day, typically 8:00 PM, the previous day's ET value is stored for historical purposes. The controller then uses the new daily ET value to calculate each station's irrigation time based on the total ET for all days since the last irrigation. Using a daily ET factor, each station can be adjusted by the user to compensate for considerations such as soil conditions, exposure, and plant material.

For more information about the various methods of retrieving real-time ET, see *Weather Sensors* on page 35.

Reports

The ET2000e Irrigation Controller includes a wide range of water reports available directly at the controller. Available reports include:

- A summary of this month's usage compared to last month's usage
- A 24-month summary
- A water usage versus budget report
- A complete station-by-station history which includes the date and start time of each cycle, programmed minutes, programmed inches, number of cycles, actual flow rate, expected flow rate, and any alerts that occurred during irrigation.

Additional reports can be viewed and printed from the Calsense Command Center Software, purchased separately.

Master Valve Output

The master valve output provides a 24 Volt AC (VAC) source to operate an irrigation system using a master valve. A master valve is necessary if the irrigation system is to have mainline break protection. The multiple Flow Meter interface (model -F) provides support for two additional master valves, for a total of three per controller. For irrigation systems where multiple controllers share one or more master valves, the *FLOWSENSE*® option (model -FL) should be used.

For more information about using multiple master valves on a single controller, see *Flow Meters* on page 27. For information about *Sharing Points of Connections*, see page 23.

Moisture Sensing

The ET2000e Irrigation Controller can use Calsense Soil Moisture Sensors (model 1000-S) to automatically determine the appropriate irrigation time for each station based on the moisture content in the soil. To accomplish this, the user sets a threshold using a history of moisture readings. During programmed irrigation, the controller irrigates each station until the moisture content reaches the user setpoint. The controller then stops watering that valve and any that share that same moisture sensor until the next scheduled irrigation.

For more information about using moisture sensors, see *Soil Moisture Sensor (model 1000-S)* on page 39.

Pump Start Output

The Pump Start output provides a 24 VAC source to activate a pump start relay for systems requiring a non-variable frequency drive (VFD) pump. Because this pump is set by program, the pump may turn on

for some stations but not others. For irrigation systems where multiple controllers share one or more pumps, the *FLOWSENSE* option (model -FL) should be used.

For information about *Sharing Points of Connections*, see page 23.

Light, Gate, and Water Features

The ET2000e Irrigation Controller provides an optional lights feature (model -L), which is used to operate up to four light, gate, or water feature relays.

For more information about lights, see *Lights (model -L)* on page 69.

Central Control

The ET2000e Irrigation Controller supports central communications through two optional central software packages. The Calsense Command Center Central Water Management Software (model COMM-1), purchased separately, is a fully-featured central software package installed on a computer with the Microsoft® Windows® operating system. This software provides communication using a variety of options, including Ethernet, wireless Ethernet (Wi-Fi), cellular modem (GPRS), and analog phone modem.

The Command Center for the Web service provides fundamental central control from any web-accessible computer without the need to purchase the Command Center Central Water Management Software. However, the web-based service is only compatible with ET2000e controllers using the GPRS communication option (model -GR).

Both packages allow the user to monitor and program their controllers, as well as run various water usage reports from their office. Weather data collected from an ET Gage, Tipping Rain Bucket, Campbell Scientific Weather Station, or *WEATHERSENSE* can also be shared to any controller on the system.

For more information about the central control options, including the minimum system requirements, see *Central Computer and Software* on page 43.

Installation

When choosing a location for the ET2000e Irrigation Controller, consider the accessibility of 120 VAC power wires and the routing of the wires connected to the irrigation remote control valves. If using the included controller box for a wall-mount or pedestal installation, a minimum of two inches of clearance above the controller is necessary for the door to be removed after installation (*Figure 1*). Additionally, the door needs 11.5 inches on the left to fully open.

For wall mounting, be sure to mount the ET2000e Irrigation Controller on a flat, secure surface. For best viewing, the liquid crystal display (LCD) should be at eye level of the shortest user.

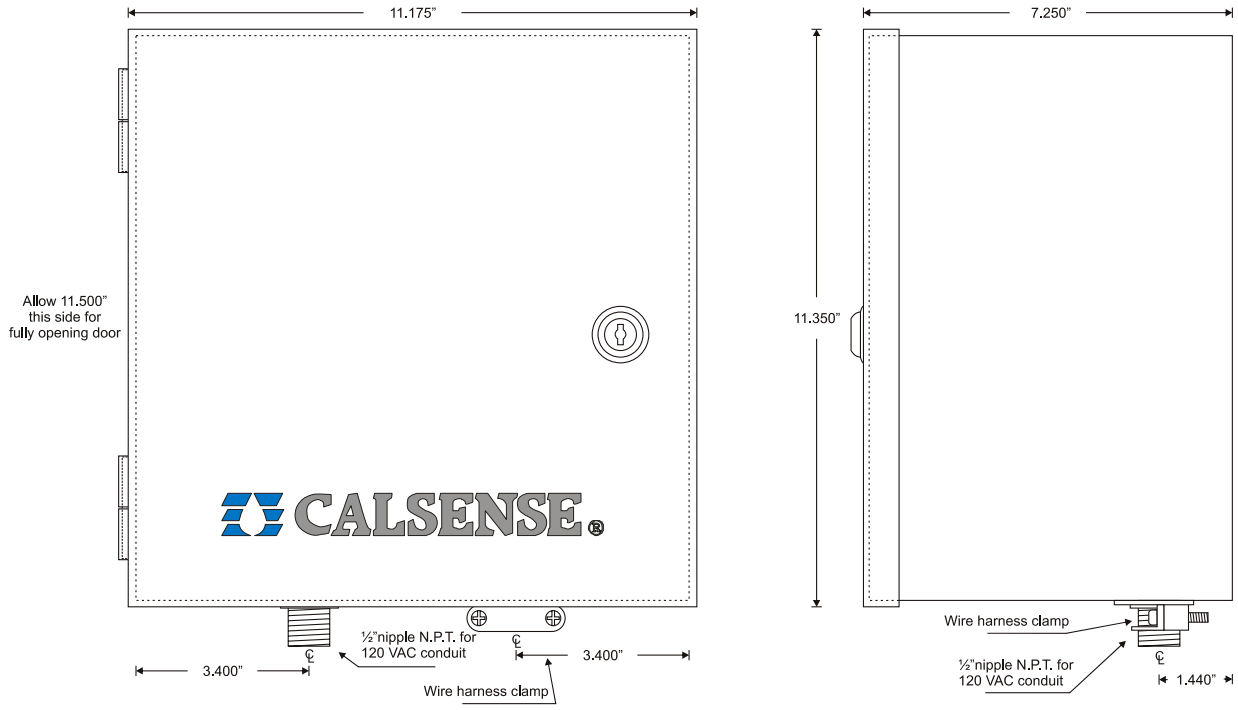

Figure 1 - Controller Box

Electrical

Calsense ET2000e Irrigation Controllers are electrically installed like any standard controller. The controller is supplied with low voltage using a step-down transformer. Color-coded connector cables with controller station wires are connected to field valve wires, while field common wires are connected to the ET2000e Irrigation Controller commons.

Specifications

- UL approved
- Input: 120 VAC, 60 Hz, 1.0A (120 VAC power lines as input power connected to the input wires of the transformer)
- 40 VA transformer (output - Class 2, rated 24 VAC, maximum total load 1.5A)
- 24 VAC output to valves
- 24 VAC output to master valve(s)

- 24 VAC output for use with pump start relay
- Electrical surge protection

Electrical Hook-up

Perform all 120 VAC electrical and grounding hook-up per local and National Electric Code.

Enclose the 120 VAC power line in conduit approved for grounding and connect securely to the transformer nipple. The conduit should be grounded, as it will serve as the controller's ground.

Terminal strips for wiring controller station wires to field wires are highly recommended. For information about the Calsense Transient Protection Board (model TP-1) and proper grounding, see *Transient Protection and Grounding* on page 15.

The transformer can supply enough power to operate six 0.25 amp (A) solenoids. If a master valve or pump start relay is used, the transformer can operate five 0.25A solenoids. If additional power is necessary for master valves or pump relays which draw too much amperage, an auxiliary transformer relay assembly may be built (*Figure 2*).

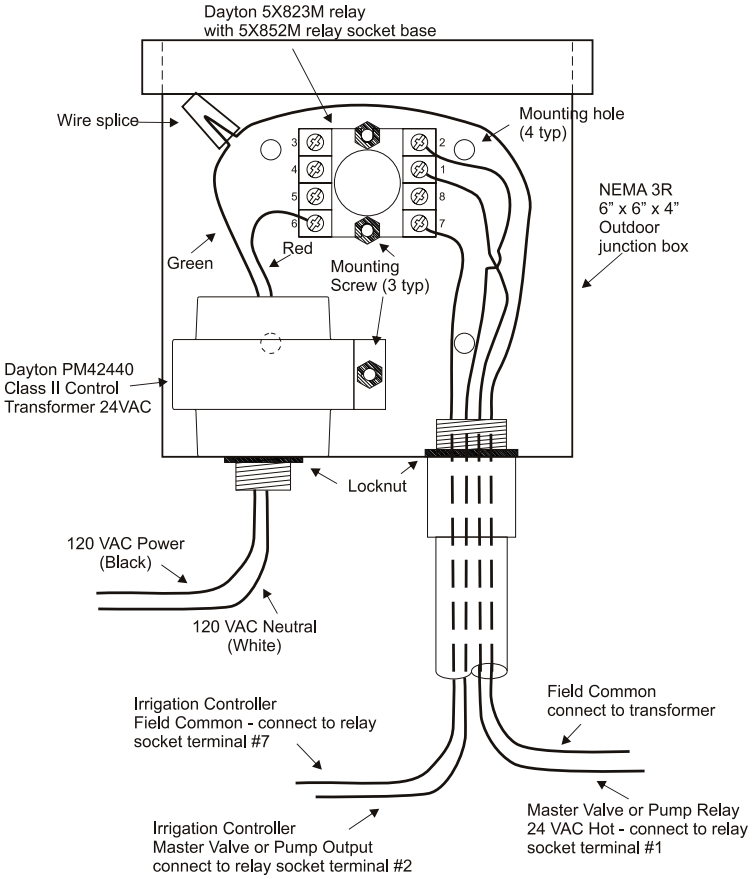

Figure 2 - Auxiliary Transformer Relay Assembly

24 Volt AC Power Consumption

The power consumption of the 24 VAC power supplied to the controller by the transformer from the 120 VAC power line is 0.30A for each solenoid valve that is on, as well as an additional 0.30A while the backlight is on (*Table 1*). The backlight remains on for 10 minutes after a day is pressed on the controller.

	ET2000e	-EN	-WEN	-GR	-R	-FOM	-LR	-SR	-M
Idle	6.30	1.50	1.90	2.90	1.10	--	1.80	1.00	0.50
w/ Backlight	10.50	1.50	1.90	2.90	1.10	--	1.80	1.00	0.50
Transmitting	10.50	1.90	3.10	4.00	1.30	--	3.10	2.20	1.10

Table 1: 120 Volt AC Power Consumption Chart in Watt hours

11.6 Volt AC Power Consumption

The power consumption of the 11.6 VAC power supplied to the controller by the transformer from the 120 VAC power line is 0.170A stand by, and 0.225A while watering. The hardwire communication option (model -M) consumes an additional 0.120A at all times. The phone modem option (model -R) consumes an additional 0.270A at all times.

24 VAC Loading Examples

The following table provides loading examples with remote control valves and relays. The total load must never exceed 1.50A. Some solenoids may draw more or less than the 0.30A used in the example.

	Station (solenoid)	Station (solenoid)	Station (solenoid)	Master Valve (solenoid)	Pump (relay)	Total
Case 1	0.30A	--	--	0.30A	0.20A	**0.80A**
Case 2	0.30A	0.30A	--	0.30A	0.20A	**1.10A**
Case 3	0.30A	0.30A	0.30A	0.30A	0.20A	**1.40A**

Table 2: 24 VAC Loading Examples

Notes

Any single output may be loaded to 1.5A

The total load of all outputs must not exceed 1.5A

If using this information for sizing a solar panel, allow a margin of 20% (1.2 times current in above tables) for transformer efficiency.

Handheld Radio Remotes

RRe-TRAN

The Calsense RRe-TRAN is a handheld radio remote used with the Calsense ET2000e Irrigation Controller (*Figure 3*). When combined with the Calsense Radio Remote Receiver Board option (model -RRe), the RRe-TRAN provides the ability to turn stations on, turn lights on and off, open or close a master valve, and make basic programming changes.

Controllers are added to the radio remote in the field by pressing a few keys. Also, using the Calsense RRe Interface Software (included), the user can organize their controllers into logical sites and regions and send them to the remote using the included infrared adapter.

The RRe-TRAN handheld radio remote comes with a carrying case, four AA 2500 mAh 1.2-Volt Nickel-Metal Hydride (NiMH) rechargeable batteries, a 9 VDC power adapter/charger, an infrared adapter, and a CD which includes the RRe Interface Software.

Note: The RRe-TRAN operates using the Multi-Use Radio Service (MURS) unlicensed two-way radio service so no license is necessary.

For more information about the RRe Interface software, see *RRe Interface* on page 45.

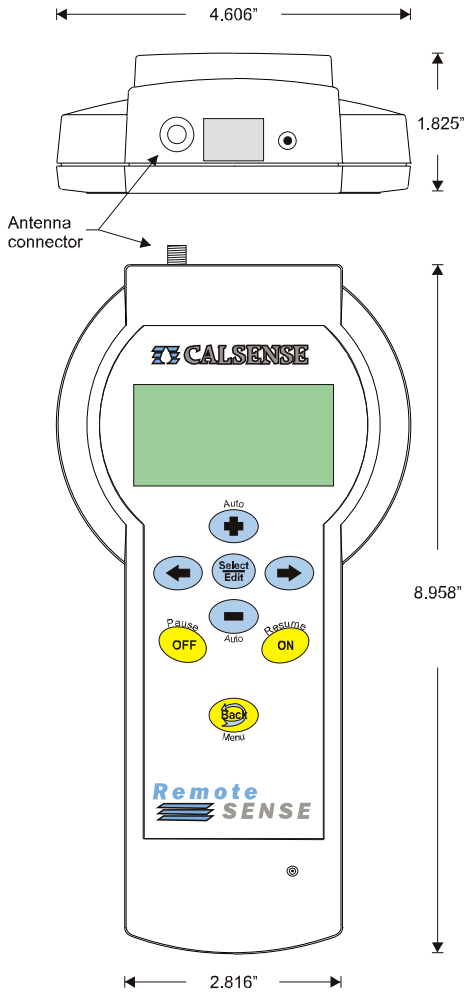

Figure 3 - RRe-TRAN Handheld Radio Remote

Transient Protection and Grounding

Transient Protection Board (model TP-1)

The Calsense Transient Protection Board prevents transient surges from entering the ET2000e Irrigation Controller (*Figure 4*). Lightning strikes can cause considerable damage to irrigation equipment. The Calsense Transient Protection Board protects against this by using transorbs, solid-state devices, which direct or switch the incoming transient away from the controller to a ground rod.

Note: Transient protection is only as good as the ground rod installed.

The Calsense Transient Protection Board has factory-labeled terminal strips for the connection of the irrigation field wires, central communication cable wires, and various Calsense accessories, such as an ET Gage and a Tipping Rain Bucket.

Note: When ordering, specify number of stations and options.

The Calsense Transient Protection Board is approximately the same height and width as a Calsense ET2000e Irrigation Controller. It can be mounted directly below the controller, on a wall, or in an enclosure. If exposed to weather, it should be mounted inside a *Transient Protection Board Box (model TPB)*.

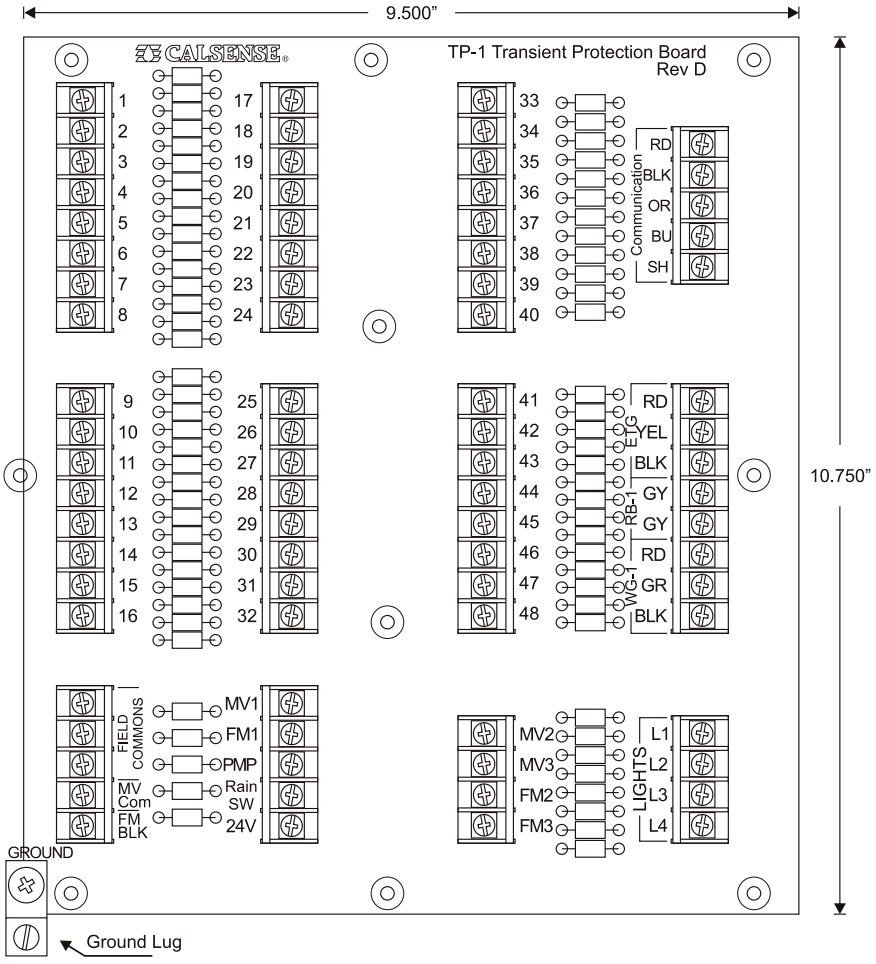

Figure 4 - Transient Protection Board

Transient Surge Arrestor (model TP-110)

The Calsense Transient Surge Arrestor is a secondary surge protector designed for 120-VAC electrical service. It is used in addition to the Transient Protection Board to provide increased protection against voltage transients on the power supply lines. The TP-110 is CSA certified and meets ANSI/IEEE C62.11 standards.

Transient Protection Board Box (model TPB)

The Transient Protection Board Box is a gray powder-coated stainless steel box for outdoor installation of the Transient Protection Board (model TP-1).

Transient Protection Package (model TPP)

The Transient Protection Package offers all of the Calsense transient protection equipment in one package. This wall-mount transient protection package includes one TP-1, one TPB, and one TP-110 (*Figure 5*).

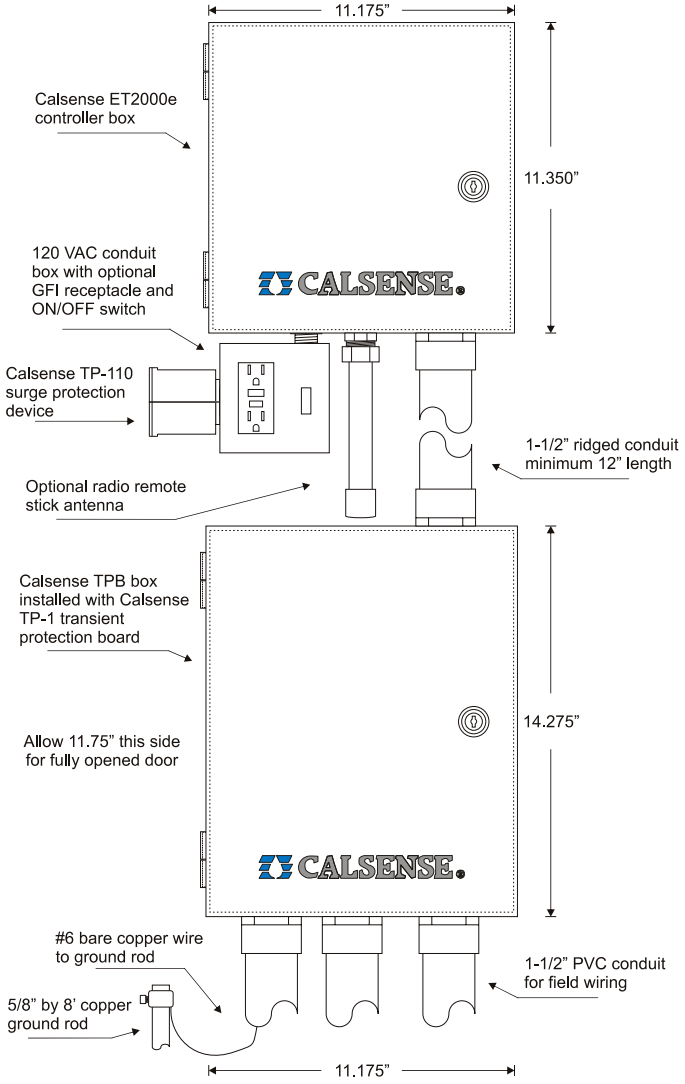

Figure 5 - Transient Protection Package

Grounding Instructions

Non-Lightning Prone Areas

Standalone System

Standalone systems in non-lightning prone areas require no ground rod. The case of the controller must be grounded from the conduit nipple of the transformer to earth or safety ground, in accordance with the local or National Electrical Code.

Standalone systems are defined as individual controllers installed and connected only to valves and meters. If multiple controllers are connected together in any way such as, but not limited to, sharing master valves, flow meters, or communications, this is not a standalone system. The only exception is that standalone controllers may share the same AC power line wiring.

Central Communications or Shared Systems (Non-Standalone)

Install one 5/8-inch x 8-foot copper grounding rod per irrigation controller. Do not connect multiple controllers to the same ground rod. The top of each rod should be installed inside of a 10-inch round valve box. If a pedestal is being mounted, the ground rod may be installed through the pedestal base. The ground rod should be installed as close as practical to the controller. Under no circumstances shall the rods be shortened.

Use brass clamps specifically designed to secure the copper wire to the grounding rods. Sand both the rod and the inside of the clamp to remove all oxide from the contact surfaces.

Connect a #6 AWG solid copper wire from the copper rod to the field common (white wires in the black harness) of the controller.

WARNING: Never connect the ground rod or the white wire (field common) to the black wire (flow return) of the black wiring harness. This will disable the over-current protection and could result in damage to the controller.

Lightning Prone Areas

All Systems, Standalone, and Central Communications Systems:

Install one 5/8-inch x 8-foot copper grounding rod, one TP-1 Transient Protection Board, and one TP-110 Surge Protector per irrigation controller. Do not connect multiple controllers to the same ground rod. The top of each rod should be installed inside of a 10-inch round valve box. If a pedestal is being mounted, the ground rod may be installed through the pedestal base. The ground rod should be installed as close as practical to the controller. Under no circumstances shall the rods be shortened.

Use brass clamps specifically designed to secure the copper wire to the grounding rods. Sand both the rod and the inside of the clamp to remove all oxide from the contact surfaces.

Connect a #6 AWG solid copper wire from ground lug of the TP-1 to the copper rod. There should be no kinks or sharp bends in the wire.

As an alternative to clamping, each wire may be wrapped around the rod and brazed in place. Braze the wire to the rod for at least one circumference of the rod.

Lightning Warranty

This standard warranty will be extended to cover lightning damage if the controllers and/or central system is installed in accordance with our installation instructions for each item installed, the National Electric Code, and these grounding instructions.

Enclosures

Heavy-Duty Stainless Steel Enclosure (model SSE and SSE-R)

The Calsense Heavy-Duty Stainless Steel enclosure is a completely assembled unit, ready for any Calsense controller (*Figure 6*). The controller is mounted at a 25° angle for easy access and viewing. The enclosure is constructed of weather- and vandal-resistant stainless steel. The unit comes complete with a TP-1 and TP-110 for transient and lightning protection, factory labeled terminals, GFI outlet, and keyed switch. It also features a security-tight locking mechanism, louvered vents with splash guards, and bee/wasp screens. The SSE-R includes a pre-mounted radio antenna for use with controllers using Local Radio, Spread Spectrum Radio, and RRe-TRAN Handheld Radio Remote. Both SSE and SSE-R enclosures come with full 10-year warranties and are fully UL approved.

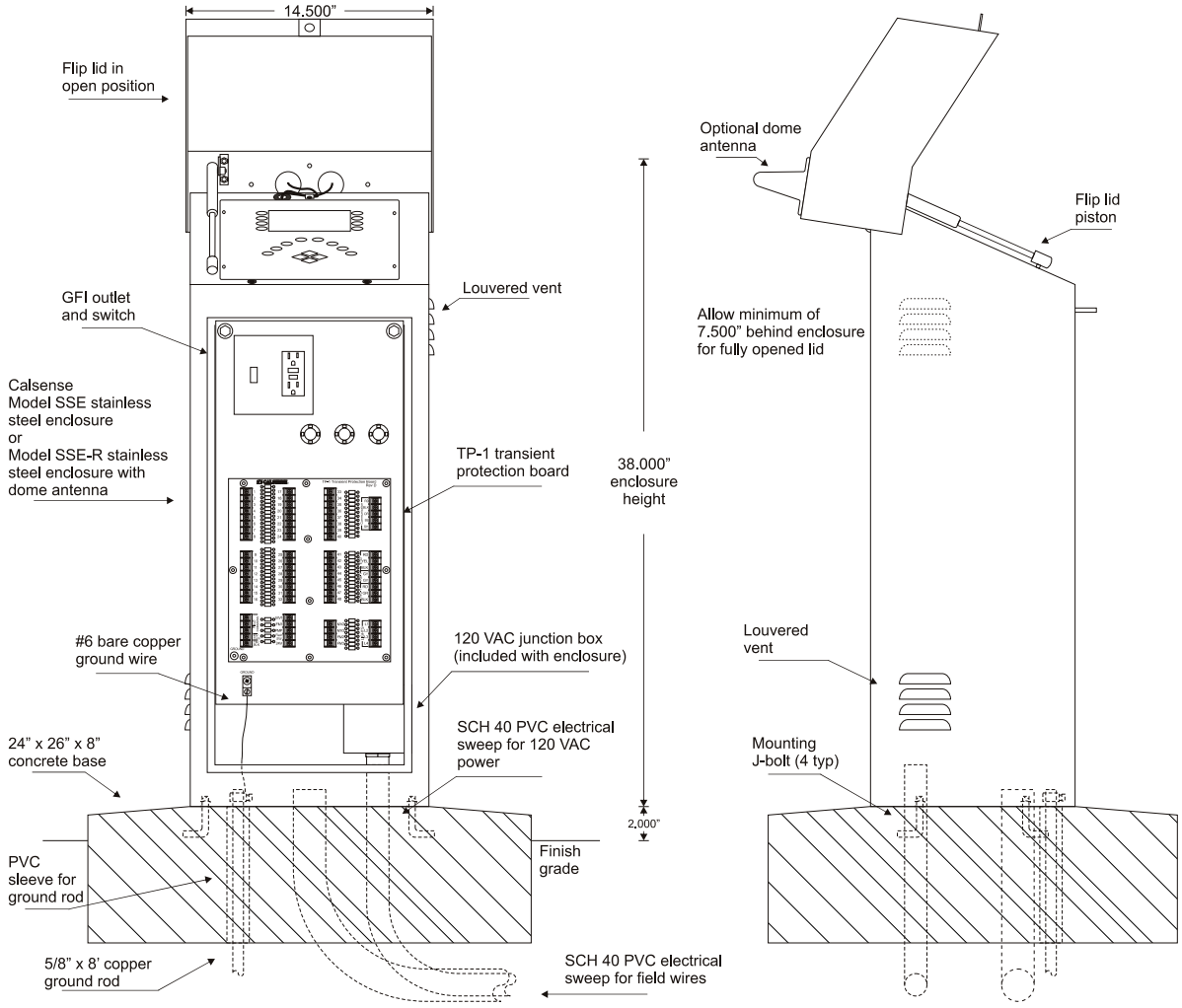

Figure 6 - Stainless Steel Enclosure

Heavy-Duty Double-Wide Stainless Steel Enclosure (model SSE-D and SSE-D-R)

The Double-Wide Heavy-Duty Stainless Steel Enclosure offers protection for any combination of two Calsense ET2000e Irrigation Controllers (*Figure 7*). The enclosure provides a secure, vertical mounting surface for each controller where no mounting surface is available. The model SSE-D comes pre-wired when two controllers share central communications and the flow management benefits of the *FLOWSENSE*® option. The SSE-D-R includes pre-mounted radio antennas for use with controllers using Local Radio, Spread Spectrum Radio, and RRe-TRAN Handheld Radio Remote. Both SSE-D and SSE-D-R enclosures come with full 10-year warranties and are fully UL approved.

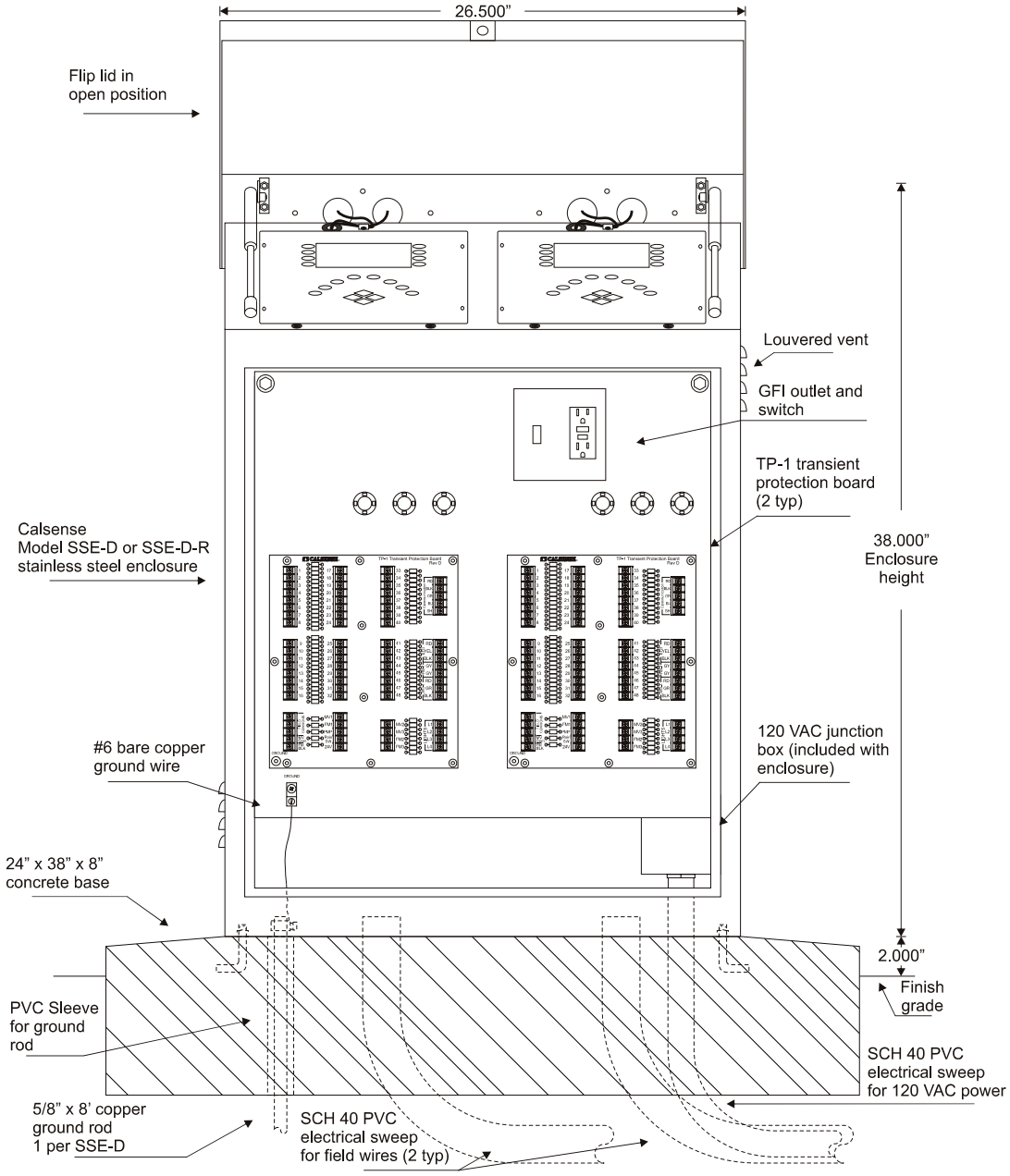

Figure 7 - Double-Wide Stainless Steel Enclosure

Stainless Steel Backplate (model SSBP)

The Calsense Stainless Steel Backplate is a convenient way to accommodate an indoor wall-mount installation of ET2000e controllers (*Figure 8*). Assembly includes a GFI and receptacle. Knowing the dimensions of the plate, 22 inch x 32 inch, landscape architects and irrigation designers can allocate the corresponding wall space and be assured of proper placement of the ET2000e Irrigation Controller and Transient Protection Box (model TPB) with TP-1 board when specified.

When specified at the same time, the SSBP assembly includes the correct installation of the TP-110 Transient Surge Arrestor.

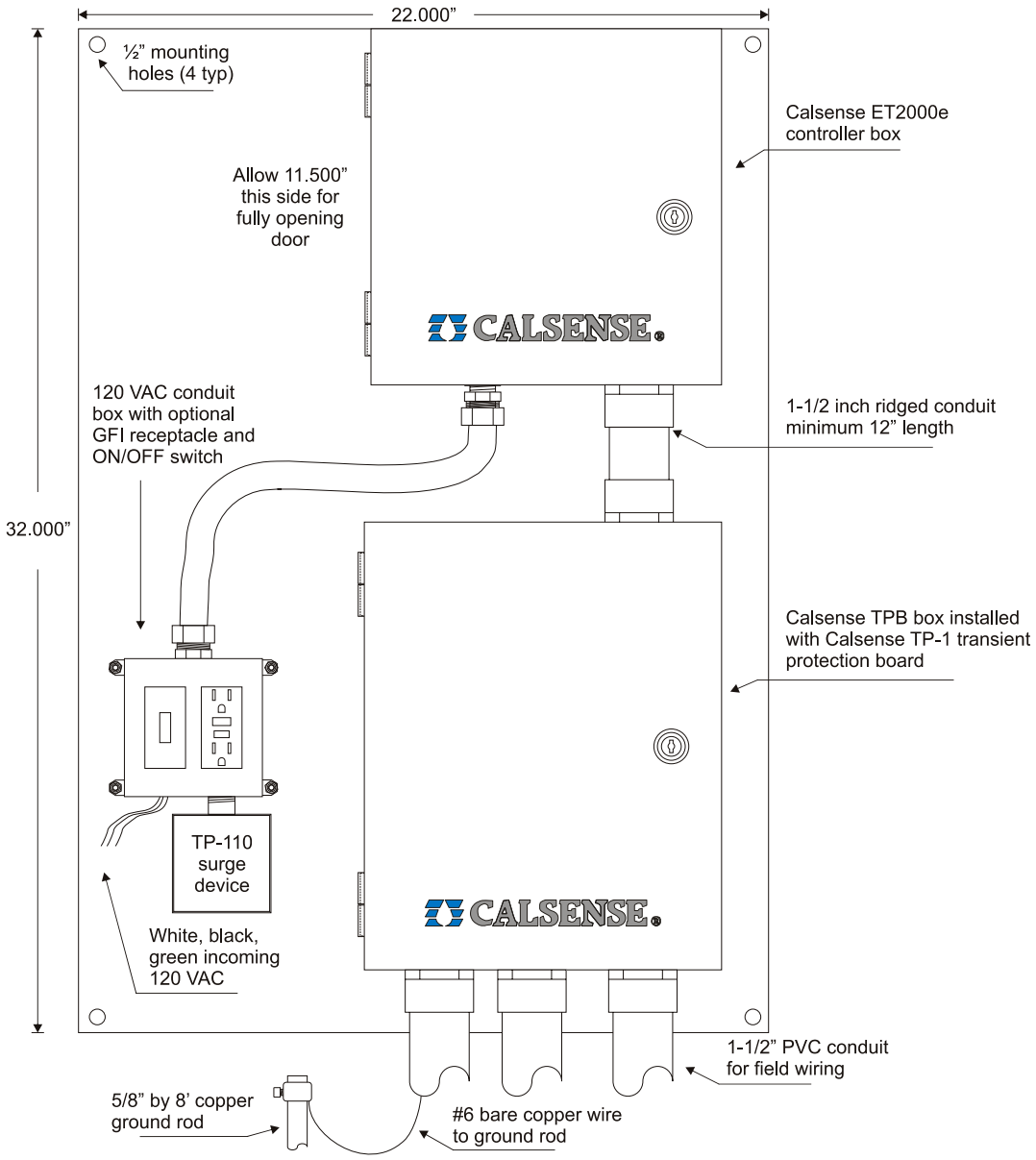

Figure 8 - Stainless Steel Backplate

Stainless Steel Pedestal (model SSE-PED)

The Calsense Stainless Steel Pedestal is a heavy-duty fully-enclosed riser designed for use with the SSE and SSE-R Stainless Steel Enclosures. This 14-inch high, corrosion- and vandal-resistant pedestal provides security and protection of field wiring when additional controller elevation is needed.

This is required as part of the StrongBox® SSE-MPS-BASE template kit when specifying a StrongBox Metered Enclosure in combination with the Calsense SSE Stainless Steel Enclosure.

Stainless Steel Powder Coated Pedestal (model PD-1)

The Calsense Powder-Coated Pedestal Mount is a cost-effective means for controller installation in secure areas. The Calsense controller box sits directly atop the matching pedestal. The pedestal contains mounting brackets for an optional Transient Protection Board (model TP-1), making for a clean installation of valve field wires. The pedestal is mounted to a concrete base, using hardware supplied with the pedestal.

Stainless Steel Enclosure Breaker (model SSE-BREAKER)

The Calsense Stainless Steel Enclosure Breaker is a 15 amp Square-D single-phase circuit breaker and housing. It is designed to provide added electrical protection to the controller enclosure components and satisfy local or state requirements where necessary. It is installed internally onto the back wall of the Calsense Stainless Steel (model SSe) when specified. Access to the breaker housing is gained through the front lockable cover plate of the SSE enclosure that opens to reveal a fully-hinged fold-down transient protection panel.

Sharing Points of Connections

FLOWSENSE (model -FL)

The Calsense *FLOWSENSE*® option, specified as -FL, allows multiple controllers to share master valves, flow meters, and pumps, as well as real-time weather data from devices such as an ET Gage, Tipping Rain Bucket, and/or third-party rain and freeze sensors (*Figure 9*). This sharing is accomplished through a two-way communication link between the controllers in the field, using the Hardwire or Spread Spectrum Radio options.

The *FLOWSENSE* technology is designed to allow the user to setup and operate this feature directly in the field with the Calsense ET2000e controller. No central computer or other software is required. The *FLOWSENSE* option uses innovative technology to communicate between controllers and manage the proper operation of irrigation valves.

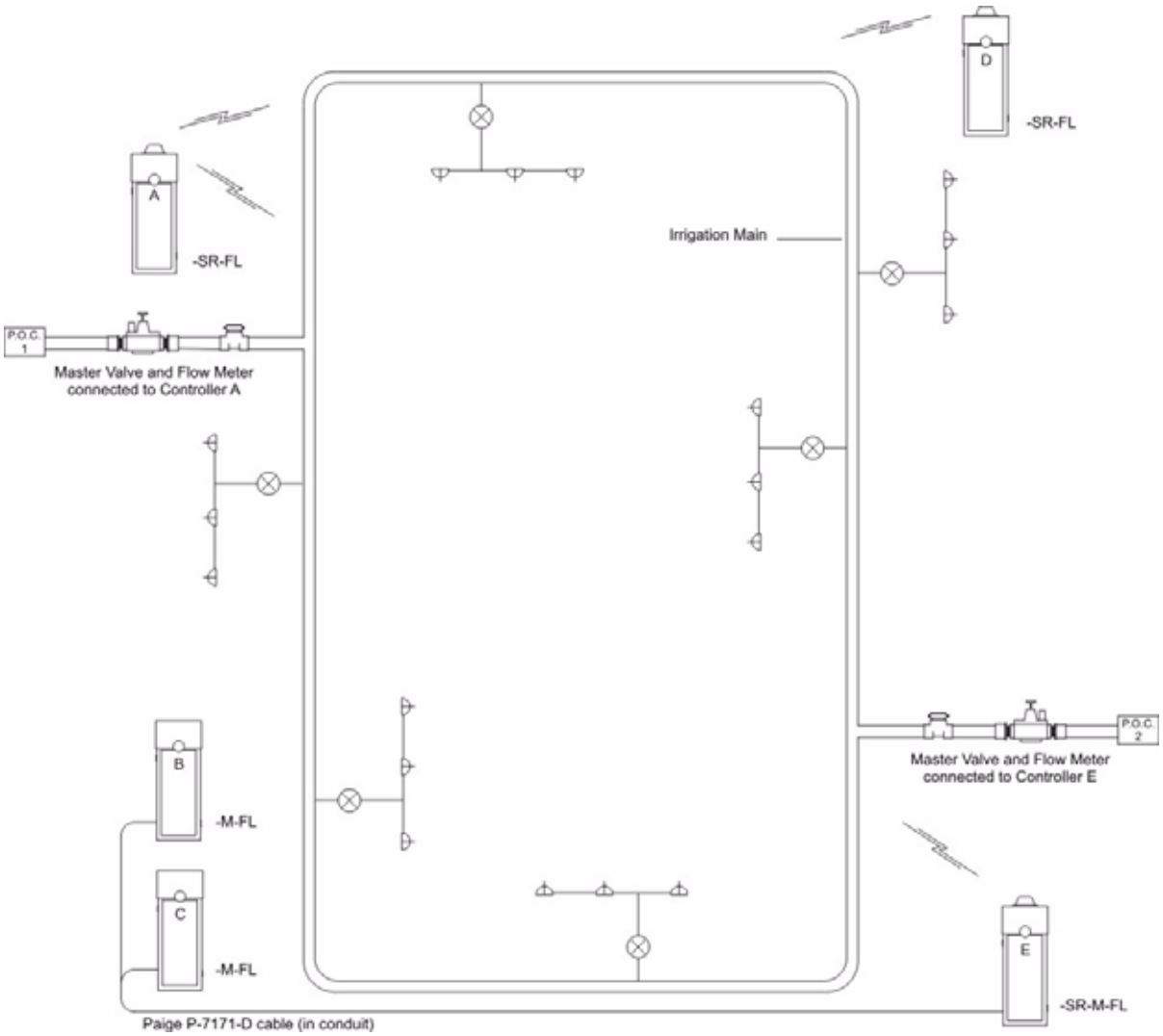

Figure 9 - *FLOWSENSE* Overview

Benefits of the *FLOWSENSE* option include:

- Eliminates the need for relays when sharing pumps or master valves with several controllers
- Manages the number of valves that can be turned on at a time based on system flow capacities
- Eliminates scheduling conflicts with multiple controllers
- Provides water management capabilities with or without a Flow Meter

Water Management

With *FLOWSENSE*, the user has the ability to control the number of valves turned on based on the flow capacities of the system. This minimizes the water window; thus, the allowable system flow rate is never exceeded, ensuring pumps operate at their capacity and the entire irrigation system functions at maximum efficiency. The user is able to select the maximum system flow rate both with and without pumps. In addition, the user can control the number of valves coming on for areas of the main line based on mainline capacities.

The final result is an irrigation system operating at maximum efficiency, all controlled in the field solely by the ET2000e Irrigation Controllers. Additionally, turning on stations by using the manual key or a handheld radio remote ensures that, even during programmed irrigation, the maximum capacity of the system is not exceeded.

Flow Monitoring

Similar to a single controller, *FLOWSENSE* accurately pinpoints valves with high flows caused by broken risers or pipes and low flows. When such a flow event occurs, affected valves are identified, shut down, and alerts are generated to notify the user for quick and easy repair. The controllers also identify electrical problems, such as shorted solenoids and broken wires.

When a faulty valve is detected and shut off, another valve is turned on. Thus, *FLOWSENSE* is always working to shorten the water window and maximize pump efficiencies while not exceeding the irrigation system capacity.

Communication Options

Communication between ET2000e controllers is possible using a Hardwire link, a Spread Spectrum Radio, or a combination of the two. This provides maximum flexibility when designing a system spanning a large area. In the event of a permanent communication problem, such as a broken hardwire, the controllers automatically revert to standalone operation, allowing irrigation to continue even though the communication link is broken.

As soon as the *FLOWSENSE* communication link is re-established, the controllers immediately operate as a single system again.

Hardwire

The *FLOWSENSE* option, using the Hardwire communication option (model -M), links up to 12 controllers using a standard Paige P7171D communication cable. This communication method is well suited for irrigation systems where controllers are in close proximity to one another or already have conduit running between them.

For more information about the hardwire communication option, see *Hardwire (model -M)* on page 54.

Spread Spectrum Radio

Using the Spread Spectrum Radio communication option (model -SR) for *FLOWSENSE* provides the ability to link several ET2000e controllers using embedded radios. These radios operate in an unlicensed

frequency band and deal with interference by hopping through multiple frequencies. This hopping technique is pre-programmed into the controllers and ensures the system communicates efficiently. For more information about this communication option, see *Spread Spectrum Radio (model -SR)* on page 53.

Note: Calsense recommends that a radio survey be conducted by Calsense to confirm proper radio coverage for efficient system communication.

Flow Meters

Tee Type Flow Meter (model FM)

The Calsense Flow Meter enables Calsense ET2000e Irrigation Controllers to measure the flow rate of an irrigation system, making it an important management tool in detecting mainline breaks, broken risers, and closed or stuck valves. It is installed in the main line after the water meter or backflow preventer. The master valve can be installed on either side of the Flow Meter.

When installing a Flow Meter, the mainline pipe is typically sized down to accommodate the fitting of the Flow Meter. The intended direction of the flow is indicated by an arrow on top of the Flow Meter. There must be free, unrestricted pipe of the same size as the Flow Meter, with a length of at least 10 times the Flow Meter size upstream and 5 times the Flow Meter size down-stream of the Flow Meter tee (*Figure 10*). This applies to distance from any valve, pipe fitting, water meter, or backflow device.

The Flow Meter should be easily accessible, housed in a rectangular valve box marked 'FM'. There should be six to eight inches of pea gravel beneath the Flow Meter in the valve box. Additionally, the length of #14 gauge (AWG) wire connecting the Flow Meter to the ET2000e Irrigation Controller must not exceed 2,000 feet.

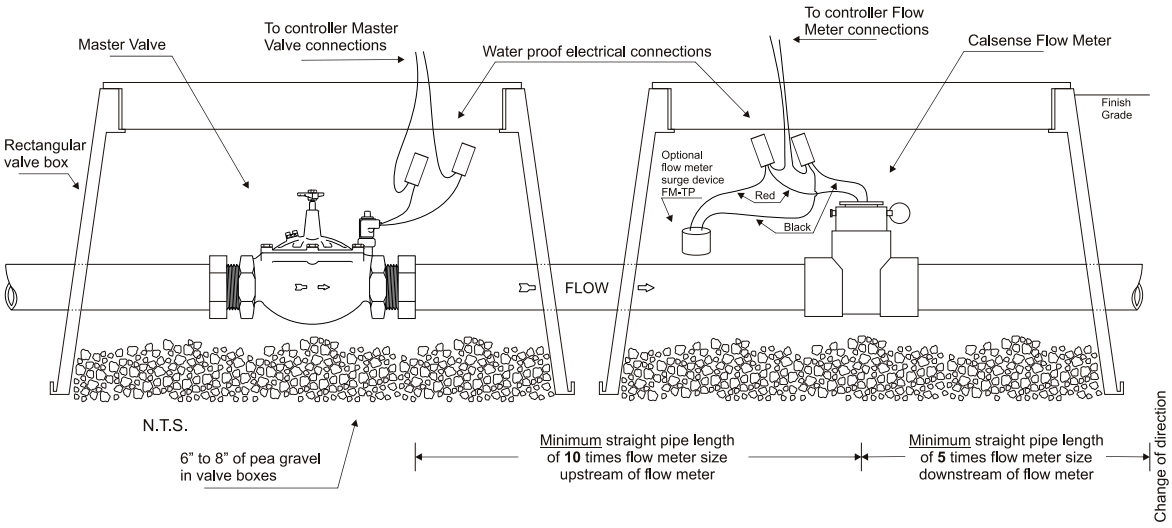

Figure 10 - Tee Type Flow Meter Installation

Insert Type Flow Meter (model FMBX)

The Calsense Insert Type Flow Meter is designed to be used for mainline pipes ranging in size from 3 to 18 inches. It is mounted to the pipe using a pipe saddle or welded-on threaded fitting which are not included (*Figure 11*). It is constructed of brass and bronze hardware and is provided with a bronze 2-inch NPT externally-threaded hex adapter for mounting. The accuracy of flow measurement is highly dependent on proper location of the sensor. It should be positioned on top of a horizontal pipe and located along the pipe where 10 times the pipe diameter upstream and 5 times the pipe diameter downstream of the Flow Meter provide no flow disturbances. There should be no pipe bends, fittings, or valves within these minimum distances.

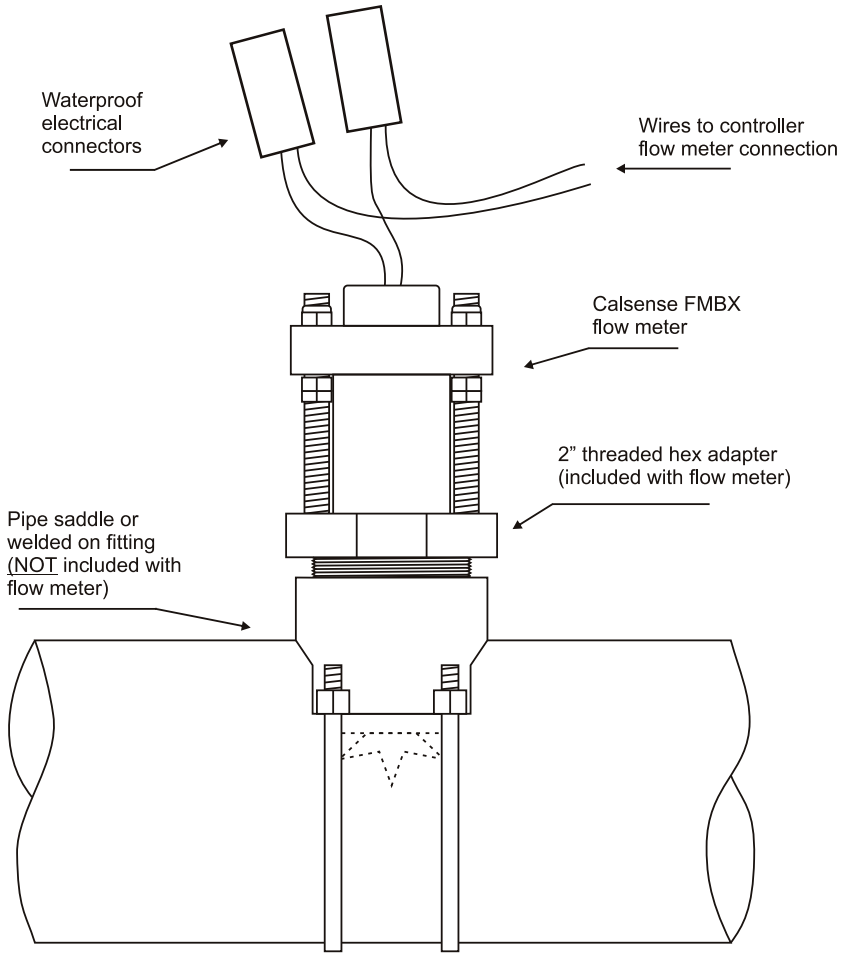

Figure 11 - Saddle-Mounted Flow Meter Installation

Flow Meter Details

Flow Meter Sizes

Calsense Flow Meters are available in a variety of models, each supporting a different size, as indicated in the following table:

Flow Meter Size	Minimum Upstream Pipe Length	Minimum Downstream Pipe Length	Pipe Diameter
1"	10"	5"	1"
1.25"	12.5"	6.25"	1.25"
1.5"	15"	7.5"	1.5"
2"	20"	10"	2"
3"	30"	15"	3"

Table 3: Available Flow Meter Sizes and Models

The correct Flow Meter size to use is NOT determined by the size of the irrigation mainline, but rather by the station flow rates. Selection of Flow Meter size depends on the following factors:

- Maximum flow rate (in gpm) for the system
- Minimum flow rate (in gpm) for the system
- Permissible pressure loss through the flow meter

The maximum flow rate is the full-scale reading of a Flow Meter, and must not be exceeded by the flow rate of any station in an irrigation system. The minimum flow rate is the lowest flow rate at which a Flow Meter will measure flow. If the flow rate of a station does not exceed this minimum, the flow reading for the station will be inconsistent and may result in a no-flow alert whenever the station irrigates.

To determine the correct Flow Meter size when designing an irrigation system, first determine the station with the highest flow rate on the system. Next determine the station with the lowest flow rate on the system. Then make sure that both flow rates are within the operating range of the selected Flow Meter size in the table below. For systems with a large mainline, you may consider using multiple Flow Meters configured as a bypass manifold to read both high and low flowing valves. See *Bypass Manifold* on page 32 for more information.

Model	Min Flow (0.5 fps)	Recommended Range		Max Flow (15 fps)	PSI Loss @ gpm
		Min flow (1 fps)	Max Flow (15 fps)		
FM-1B	2 gpm	3 gpm	50 gpm	50 gpm	0.5 psi @ 20 gpm
FM-1.25B	3 gpm	5 gpm	81 gpm	81 gpm	0.5 psi @ 45 gpm
FM-1.5B	4 gpm	7 gpm	106 gpm	212 gpm	0.5 psi @ 45 gpm
Model	**Min Flow (0.5 fps)**	**Recommended Range**		**Max Flow (30 fps)**	**PSI Loss @ gpm**
		Min flow (1 fps)	**Max Flow (15 fps)**		
FM-1.5	4 gpm	7 gpm	106 gpm	212 gpm	0.5 psi @ 60 gpm
FM-2	6 gpm	11 gpm	166 gpm	333 gpm	0.5 psi @ 100 gpm
FM-2B	6 gpm	11 gpm	166 gpm	333 gpm	0.5 psi @ 100 gpm
FM-3	12 gpm	24 gpm	363 gpm	727 gpm	0.5 psi @ 320 gpm
Model	**Min Flow (0.5 fps)**	**Recommended Range**		**Max Flow (15 fps)**	**PSI Loss @ gpm**
		Min flow (1 fps)	**Max Flow (15 fps)**		
FMBX	0.5 fps	1 fps	15 fps	30 fps	n/a

Table 4: Recommend Flow Meter Operating Ranges

Operation

The Flow Meter consists of an impeller and a sensing device which measures the flow in gallons per minute (GPM). As irrigation progresses, the controller acquires an expected flow rate for each station. By comparing a station's actual flow rate to this expected flow rate, a broken head or riser will immediately trigger a high flow, causing the affected station to shut off and the controller to turn on the next station. This also generates an alert which is displayed on the station's programming screen, in the

Alerts report, and at the central computer. This process continues each irrigation until the station is repaired.

Similarly, if a remote control valve does not open, has an obstruction, or has a measured flow rate below the Flow Meter minimum, the controller indicates a low flow on the display. If the backflow preventer or water meter has been turned off, every station on the controller indicates this alert.

When used with a Flow Meter, the ET2000e monitors the system's flow continuously and closes all of the master valves in the system in the event of a mainline break. The thresholds for a mainline break are user-configurable with unique values for irrigation, a master valve override, and all other times.

Restrictions

Certain hydraulic restrictions should be considered when designing an irrigation system with a Calsense Flow Meter. Since the ET2000e Irrigation Controller independently acquires each station's expected flow rates, the Flow Meter must be installed in a pipe through which ALL AND ONLY the water regulated by the ET2000e Irrigation Controller flows. If a loop system exists or there are several irrigation controllers fed off of one main line, the *FLOWSENSE*® option should be used to manage the system efficiently. See *Sharing Points of Connections* on page 23 for more information.

Permissible Pressure Loss

The permissible pressure loss is important due to pressure losses through the Flow Meter, the pipe upstream of the Flow Meter, and the pipe downstream of the Flow Meter. The pipe must be the same diameter as the Flow Meter to keep turbulence to a minimum. The length required up-stream of the Flow Meter is ten times the Flow Meter size. For example, a 1.5-inch Flow Meter requires a minimum upstream pipe length of 15 inches. The length required downstream of the Flow Meter is five times the Flow Meter size. For example, a 1.5-inch Flow Meter requires a minimum downstream pipe length of 7.5 inches. The table below provides pressure losses for several Flow Meters with appropriate pipe extensions.

	10 gpm	20 gpm	30 gpm	40 gpm	50 gpm	60 gpm	70 gpm	80 gpm	90 gpm
FM-1B	0.60	2.20	5.00	8.80	--	--	--	--	--
FM-1.25B	0.20	0.60	1.20	2.10	3.30	4.80	6.50	8.50	10.00

	80 gpm	100 gpm	140 gpm	180 gpm	240 gpm	280 gpm	320 gpm	360 gpm
FM-1.5	0.50	0.60	.80	--	--	--	--	--
FM-1.5B	0.50	0.60	.80	--	--	--	--	--
FM-2	0.10	0.20	0.40	0.70	1.20	--	--	--
FM-2B	--	0.50	0.90	1.60	2.60	--	--	--
FM-3	--	--	--	--	0.10	0.20	0.20	0.30

Table 5: Pressure Loss in Pounds Per Square Inch (PSI) at Various Flow Rates

Maximum Flow Meter Pressure

It is also important not to exceed the maximum recommended pressure rating of a Flow Meter. If necessary, a pressure regulator should be placed upstream of the Flow Meter. The following table provides the maximum recommended pressure rating for each Calsense Flow Meter:

Flow Meter	Maximum Pressure
FM-1B	400 psi
FM-1.25B	400 psi
FM-1.5B	400 psi
FM-2B	200 psi
FM-1.5	100 psi
FM-2	100 psi
FM-3	100 psi

Table 6: Maximum Flow Meter Pressure Ratings

Electrical Installation

Wires from the Flow Meter to the ET2000e Irrigation Controller should consist of one black and one red standard #14 AWG irrigation wire. The maximum wire run between Flow Meter and controller is 2,000 feet. The Flow Meter has two wire leads, a black and a red. At the controller, the black wire in the black wire harness is connected to the black Flow Meter wire and the red wire in the black wire harness is connected to the red Flow Meter wire. The Flow Meter wires should be separated from other control wires when pulled up at the ET2000e Irrigation Controller site.

Caution: If 24 VAC is applied to the Flow Meter wires while testing field wires to determine proper sequencing, the sensing unit in the Flow Meter will be damaged and the Flow Meter insert will need to be replaced.

It is very important that all electrical connections are tight and dry. Any water leaking into a connection will cause Flow Meter problems. Additionally, there should never be any buried splices between the Flow Meter and the ET2000e Irrigation Controller. Use only Calsense recommended electrical connectors.

Wire and Electrical Connectors

Since the Calsense Flow Meter operates by sending low-voltage digital pulses to the controller, all electrical connections must be waterproof and moisture-resistant. It is highly recommended that all wire running between the controller and Flow Meter be direct pulls and have no splices. If wire splices are unavoidable, they must be installed in a valve box. Calsense recommends using 3M™ Scotchcast™ 3570G Connector Sealing Packs (formerly 3M Scotchlok™ 3570 Connector Sealing Packs) or Spears® DS-100 Dri-Splice Connectors with DS-300 Dri-Splice Sealant. See *Figure 31* for more information about using wire splices.

Multiple Flow Meter Interface (model -F)

The -F interface enables Calsense ET2000e Irrigation Controllers to receive up to three separate Flow Meter inputs on projects with more than one water source. Additionally, it supports operation of up to three master valves. In most cases, when reading flow from multiple Flow Meters, the controller tallies the readings.

The only exception is a *Bypass Manifold*, where only one Flow Meter is operated at a time. The first Flow Meter is wired to the ET2000e Irrigation Controller using the standard Calsense red and black Flow Meter wires. The second and third Flow Metes are wired to the ET2000e Irrigation Controller using an additional wire harness supplied as part of the -F option.

Bypass Manifold

A bypass manifold enables the controller to measure low flow readings on a large mainline using the -F option. It does so by utilizing one (*Figure 12*) or two (*Figure 13*) smaller Flow Meters attached to a large main. When irrigation or a master valve override starts, the controller uses the bypass manifold to dynamically manage flow through the appropriate size Flow Meter using the actual flow rate of the system. This flow rate is monitored continuously and the controller determines which level is optimally suited to read the flow. Once the appropriate level is determined, the master valves of the other levels are closed and that level is opened. This process continues throughout irrigation, dynamically opening and closing the master valves to ensure flow is read across the widest range possible.

When designing a bypass manifold, the smallest master valve in the system can either be normally closed or normally open to allow for use of quick couplers. However, the other master valves used by the bypass manifold must be normally closed. Additionally, Flow Meters should be sized smallest to largest, and the smallest Flow Meter cannot be a saddle-mounted Flow Meter (model FMBX).

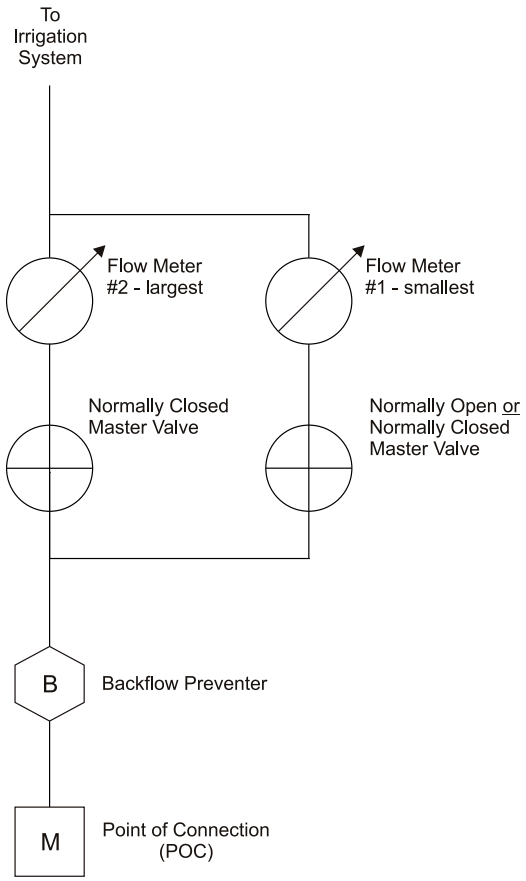

Figure 12 - 2-Tier Bypass Manifold

Note: If using a two-tier bypass manifold, the controller's third master valve and flow meter inputs can be used to supplement the bypass manifold or to independently manage a non-irrigation point of connection (not shown), such as those used for wash-downs or other flow monitoring purposes.

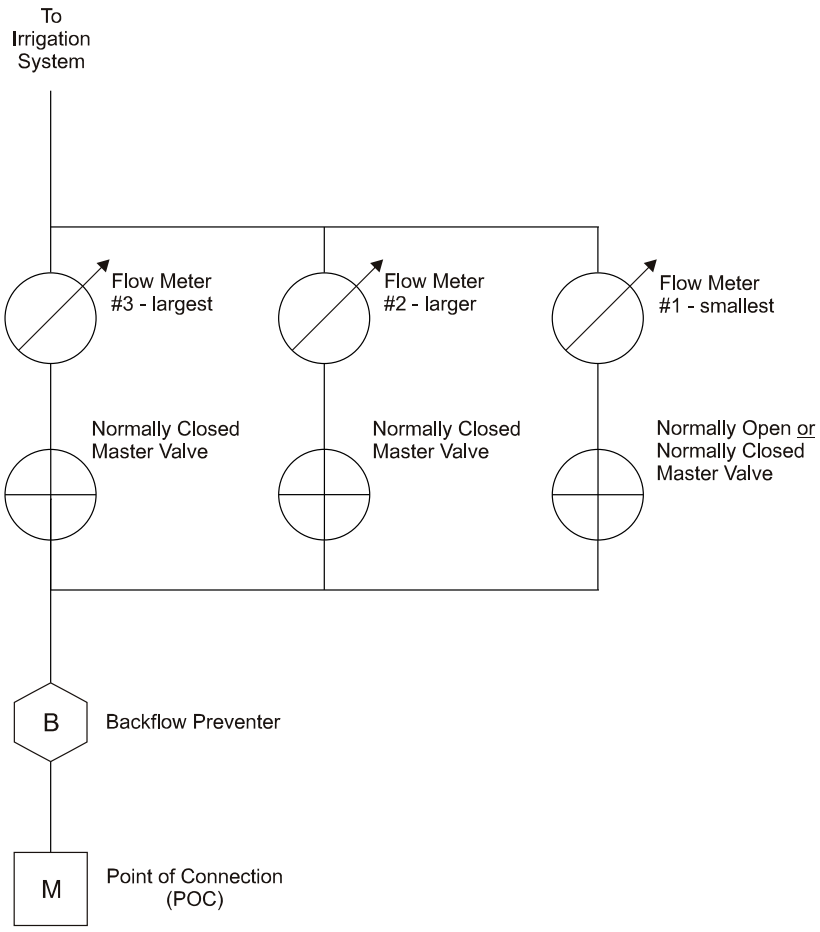

Figure 13 - 3-Tier Bypass Manifold

Weather Sensors

ET Gage (model ETG)

Using a Calsense ET Gage, ET2000e Irrigation Controllers can use real-time daily ET to calculate station run times automatically. To connect to an ET Gage, the controller must be specified to include the -G interface. The ET Gage is designed to evaporate water at the same rate as tall fescue (*Figure 14*). Measurements comparing the ET Gage to weather stations computing ET using the Penman-Monteith evapotranspiration formula show better than 95% accuracy.

The ET Gage sends daily ET numbers to the ET2000e Irrigation Controller, which stores the last 28 days of ET. When it comes time to irrigate a station, the controller tallies the ET numbers since the last irrigation. For example, if it has been three days since the ET2000e irrigated, it will total the first three numbers in the table. The controller then multiplies this number by the station's ET factor, which is used to adjust for irrigation efficiency and crop type, to calculate how much water to apply. Then, using the station's precipitation rate, the run time is calculated. If there is no signal from the ET Gage, historical ET data is substituted.

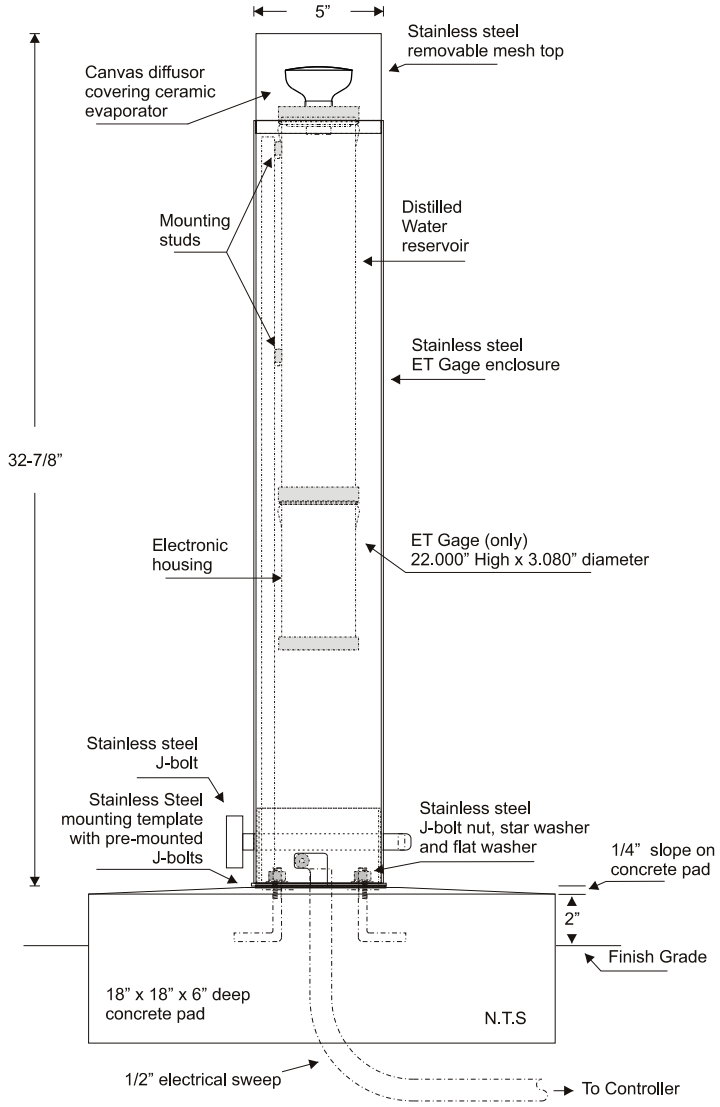

Figure 14 - ET Gage installed in Vandal-Resistant Enclosure

Readings from the ET Gage can be shared automatically between ET2000e Irrigation Controllers using *FLOWSENSE*® technology or using Calsense Command Center Central Water Management Software.

Placement of the ET Gage

Placement of the ET Gage is very important. The top surface of the gage should be 2 feet 10 7/8 inches above grade(*Figure 14*). The location should be representative of the area to be irrigated and free of any obstructions to sunlight and wind. For example, it should not be located next to a wall or under the shade of shrubs or trees. It is also important to place the gage in an area where water from sprinkler heads does not hit the top surface of the gage.

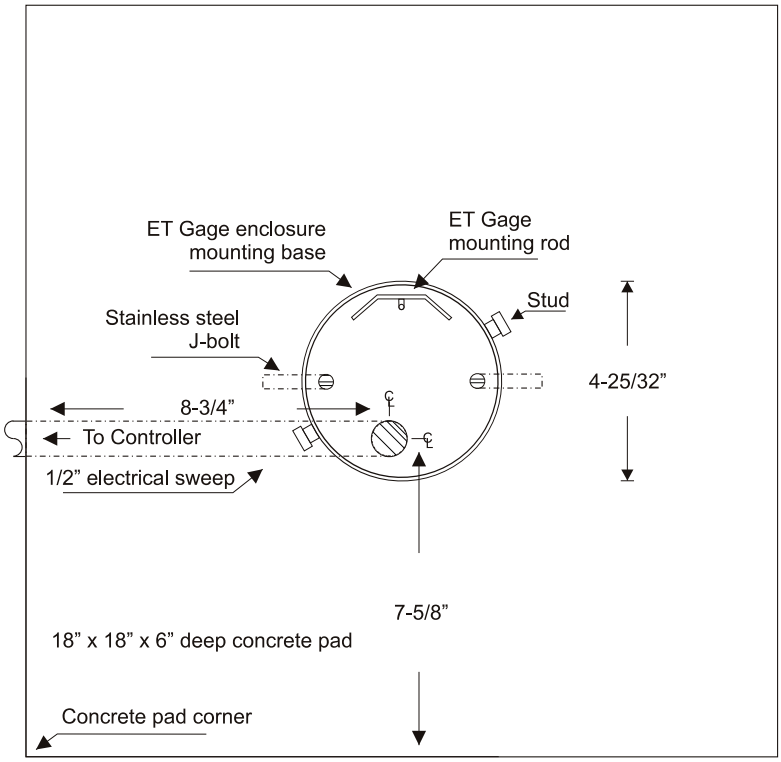

Figure 15 - ET Gage Enclosure base (top view)

ET Gage Cable

Use Paige P7171D communication cable, installed in conduit, to connect the ET Gage to an ET2000e controller with the -G interface. The maximum length of cable is 1,000 feet. For runs under 100 feet, 18-gauge multi-conductor irrigation wire, in conduit, may be substituted. Runs are to be direct pulls without splices.

Vandal-Resistant Enclosure (model ETGE)

The Calsense ET Gage Vandal-Resistant Enclosure is used primarily as a cover for the ET Gage. This helps prevent damage to the gage from tampering, vandalism, or animal interference (*Figure 14*).

The enclosure base post is made from #16-gauge 304 stainless steel. The body assembly is manufactured from 5-inch diameter 304 stainless steel tubing. The mesh screen is 16-gauge (AWG) 0.25-inch stainless steel. The two T-handle assemblies are manufactured from 5/8-inch round 304 stainless steel.

Tipping Rain Bucket (model RB-1)

The Calsense Tipping Rain Bucket allows an ET2000e controller with the -RB interface to keep a record of accumulated rainfall (*Figure 16*). The Tipping Rain Bucket consists of a tipping mechanism that measures every 0.01 inches of rainfall. The measured water drains out of the bottom of the housing. Therefore, the bucket requires no attention or service of any kind.

The ET2000e controller connected to the Tipping Rain Bucket receives this information and, using the rate and actual amount of rainfall, offsets each station's run times accordingly.

Rain measurements from the Tipping Rain Bucket can be shared automatically between controllers using *FLOWSENSE* technology or using the Calsense Command Center Central Water Management Software.

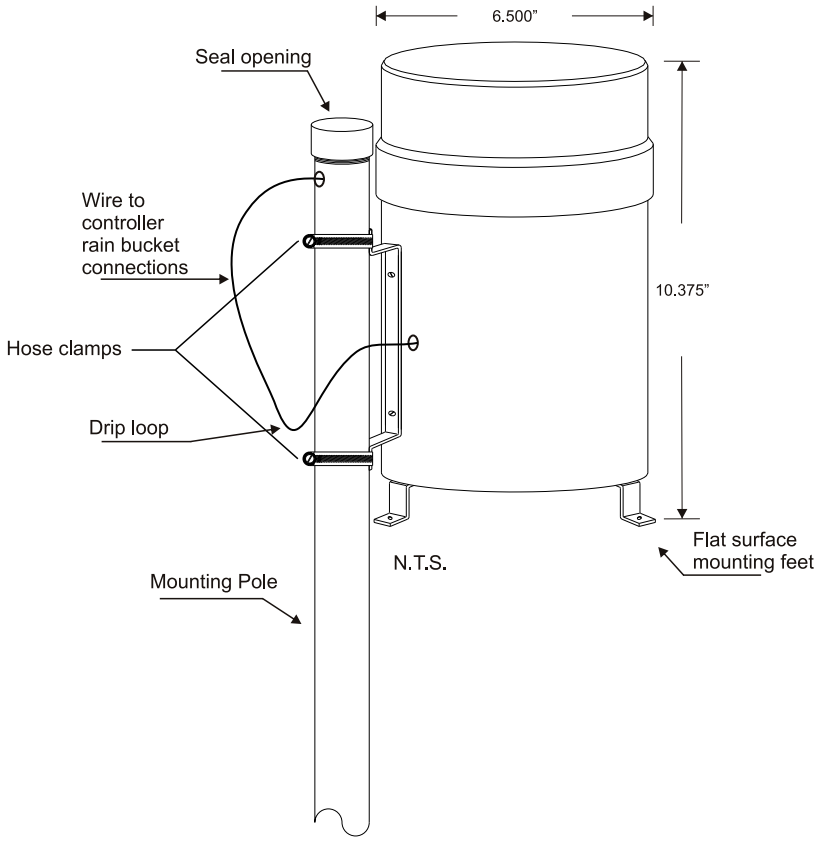

Figure 16 - Rain Bucket

Rain Bucket Cable

The Tipping Rain Bucket is shipped with 25 feet of two-conductor cable. The maximum length of cable is 1,000 feet using Paige P7171D communication cable. For runs under 100 feet, 18-gauge multi-conductor irrigation wire, in conduit, may be substituted. It is highly recommended that the cable be installed in conduit to connect the Tipping Rain Bucket to a controller with the -RB interface. Runs are to be direct pulls without splices.

Wind Gage (model WG-1)

Wind speed can be monitored by a Calsense ET2000e controller using a Calsense Wind Gage (*Figure 17*). The irrigation controller connected to the Wind Gage is specified with a -WG interface option. The Wind Gage sends pulses to the ET2000e, which automatically pauses irrigation once the wind speed exceeds a

user-set limit. As wind subsides, the ET2000e controller resumes irrigation where it left off. It can accurately read winds from 0 to 135 MPH.

The Wind Gage cannot share data with other controllers through the Calsense Command Center Central Water Management Software; however, it can be shared using the *FLOWSENSE*® option.

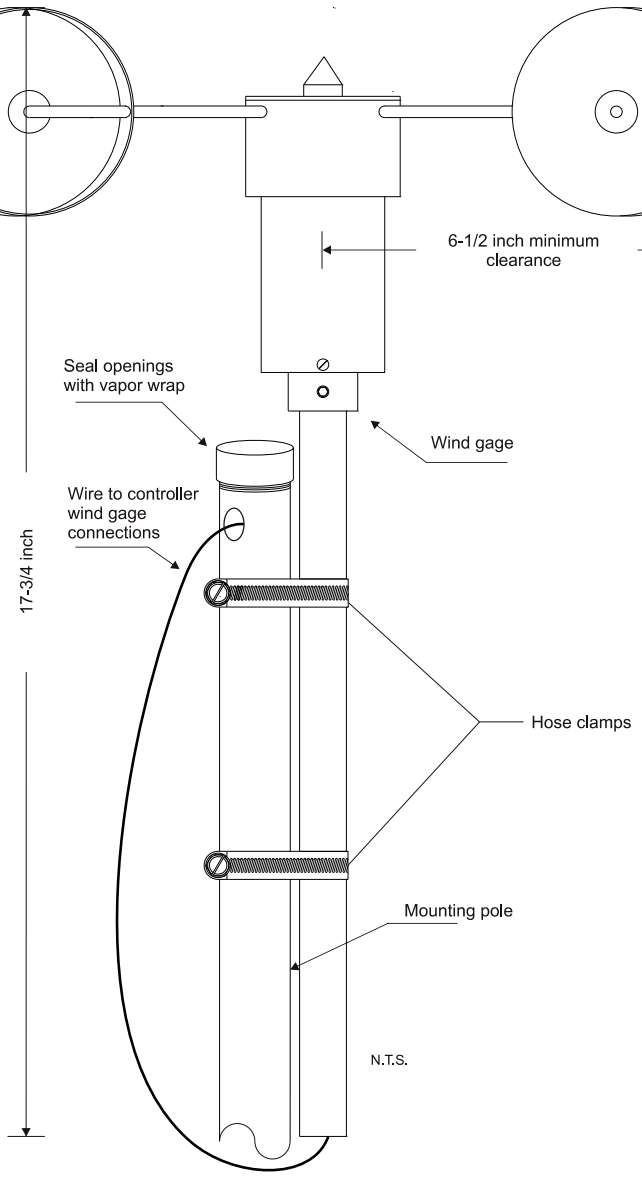

Figure 17 - Wind Gage

Wind Gage Cable

The Wind Gage is shipped with 60 feet of two-conductor cable. The maximum length of cable is 1,000 feet using Paige P7171D communication cable. For runs under 100 feet, 18-gauge multi-conductor irrigation wire, in conduit, may be substituted. It is highly recommended that the cable be installed in conduit, to connect the Wind Gage to a controller with the -WG interface. Runs are to be direct pulls without splices.

Soil Moisture Sensor (model 1000-S)

The Calsense Moisture Sensor is a solid-state tensiometer that measures moisture content in the soil (*Figure 18*). The sensor includes data transmission circuitry that sends moisture level readings to the controller over the same field wires that operate the valve. The entire unit is encased in epoxy to protect the electronics from moisture. There is no maintenance or calibration required for the life of the sensor, and it is unaffected by temperature, salinity, or changes in pH.

Using the Soil Moisture Sensor to measure the available water in the pore space of soil, the Calsense ET2000e determines how much of each station's programmed time is necessary to maintain a set moisture level before irrigation begins. This is based on the actual moisture reading compared to the user-determined moisture setpoint. At the beginning of each irrigation cycle, the controller measures the current moisture reading. If the moisture reading is higher than the setpoint, the controller does not irrigate the station and sets a flag in the reports to notify the user. In the event the controller fails to receive a valid sensor reading, the controller automatically irrigates the full amount of programmed time for all stations operating under that sensor.

When using Soil Moisture Sensors, a representative station for each different climatic- and plant-material zone should have its own sensor. This station becomes a master station. Slave stations are stations without sensors that are assigned to a master station and share similar water requirements. The user chooses groups of stations controlled by the same Soil Moisture Sensor during initial setup of the irrigation controller. Stations can be easily changed or moved from one sensor to another through programming. It is recommended that 1 sensor be used for every 4 active irrigation valves. For example, an ET2000e-24 controller requires 6 moisture sensors, while an ET2000e-32 requires 8.

Note: If the irrigation design involves operating multiple valves using a single sensor, the valves must be similar in vegetation, exposure, and so on for moisture sensing to work properly.

Placement Guidelines

A Calsense Field Service Representative can help make the placement decision of Soil Moisture Sensors. A note to the contractor to contact Calsense in determining sensor placement should be listed on the plans or in the specification. It is required that the contractor completes the following before Soil Moisture Sensor placement:

- Irrigation controller installed and operational
- Remote Control Valve (RCV) field wires connected to the irrigation controller according to plan
- All lateral systems complete with heads on and RCVs wired
- Plant material in shrub areas planted

The following placement guidelines should be followed when flagging moisture sensor locations:

- Location is representative of the areas being managed
- Location is not quickly flooded during irrigation
- Location is not subject to damage or disturbance during maintenance
- Location is irrigated evenly from 2 sprinkler heads on the same valve
- Sensor is placed in the root zone of healthy plants
- When controlling slopes, sensor is located two-thirds up from the toe of slope

Installation Guidelines

Installation of moisture sensors is the responsibility of the contractor. Proper sensor installation is extremely important. Moisture sensors must be installed correctly to achieve accurate moisture readings. All sensor locations should be marked on the plans, as well as in the field. Correct sensor placement and installation should be verified before the project is signed off. The project inspector should call Calsense before project is signed off. Calsense recommends the following 'Note To Contractor' be placed on the plans:

> CORRECT SENSOR PLACEMENT AND INSTALLATION ARE VERY IMPORTANT. CALSENSE DETERMINES SENSOR PLACEMENT AND INSTRUCTS ON HOW TO INSTALL A SOIL MOISTURE SENSOR. SENSORS ARE THEN INSTALLED BY THE CONTRACTOR. SENSOR PLACEMENT AND INSTALLATION WILL BE VERIFIED BEFORE PROJECT IS SIGNED OFF.

The Calsense Soil Moisture Sensor is wired in parallel with station solenoids, so the moisture data is transmitted over the same wires that are used to operate the solenoids. There are no additional wires run from the valve to the irrigation controller. The choice of groups of stations controlled by the same sensor is done solely within the controller programming, so there is no additional wire run between valves to form station groups.

Note: Sensor should be submerged in water for 15 minutes before installation and covered with compacted soil.

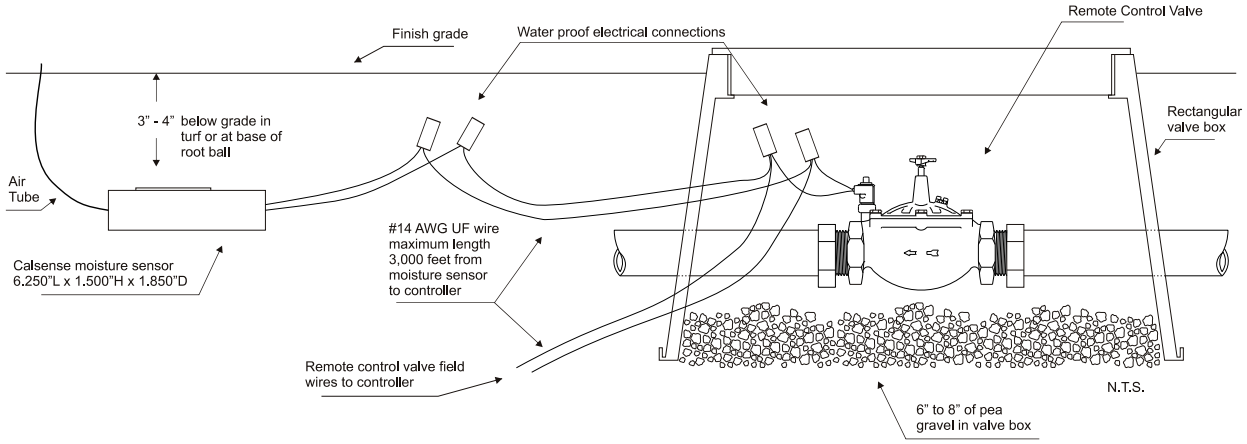

Figure 18 - Moisture Sensor

Moisture Sensor Wire

The Soil Moisture Sensor uses #14 AWG direct burial wire to connect to remote control valves. The maximum wire run between the sensor and the valve is 3,000 feet. Because the moisture sensor sends electronic pulses back to the controller, all electrical connections must be waterproof and moisture-resistant. It is intended that all wire runs between valves and moisture sensors be direct pulls and have no splices except at the sensor location. Calsense recommends using 3M™ Scotchcast™ 3570G Connector Sealing Packs (formerly 3M Scotchlok™ 3570 Connector Sealing Packs) or Spears® DS-100 Dri-Splice Connectors with DS-300 Dri-Splice Sealant for splices.

Campbell Scientific Weather Station

The Campbell Scientific® ET107 Weather Station is an automated system designed for commercial agriculture and irrigation scheduling. The station calculates potential evapotranspiration (ETo), which is the amount of water lost from the soil due to evaporation and plant transpiration. Calculating a crop's

evapotranspiration rate aids in the development of an irrigation schedule that provides sufficient water for the crops without overwatering. The weather station also provides daily rain totals, which are measured using a Tipping Rain Bucket.

The weather information is retrieved from the weather station using a data logger software package provided by Campbell Scientific. Currently, two such applications are available - LoggerNet and Visual Weather. Both are compatible with the Calsense Command Center Central Water Management Software and collect data from the ET107 on a predetermined schedule. Beyond data collection, Visual Weather also offers the ability to view and print reports and export ETo and rain data in various formats.

Command Center does not directly interact with the Weather Station. Instead, when the data logger software starts, Command Center establishes a connection to the data logger software. As weather is received by the data logger, it is sent to Command Center, which stores the information in the database. When the scheduled weather-sharing task occurs, this information is retrieved from the database and daily ETo and rain data is sent to each of the controllers in the weather-sharing task.

For more information about Campbell Scientific and its products, visit the Campbell Scientific website at *http://www.campbellsci.com*.

WEATHERSENSE

WEATHERSENSE is a free feature available in both the Calsense Command Center Central Water Management Software and Command Center for the Web, which retrieves real-time evapotranspiration (ET) data without the need for an on-site ET Gage or weather station (*Figure 19*). This information can be shared to controllers in the field the same way that traditional weather sharing works.

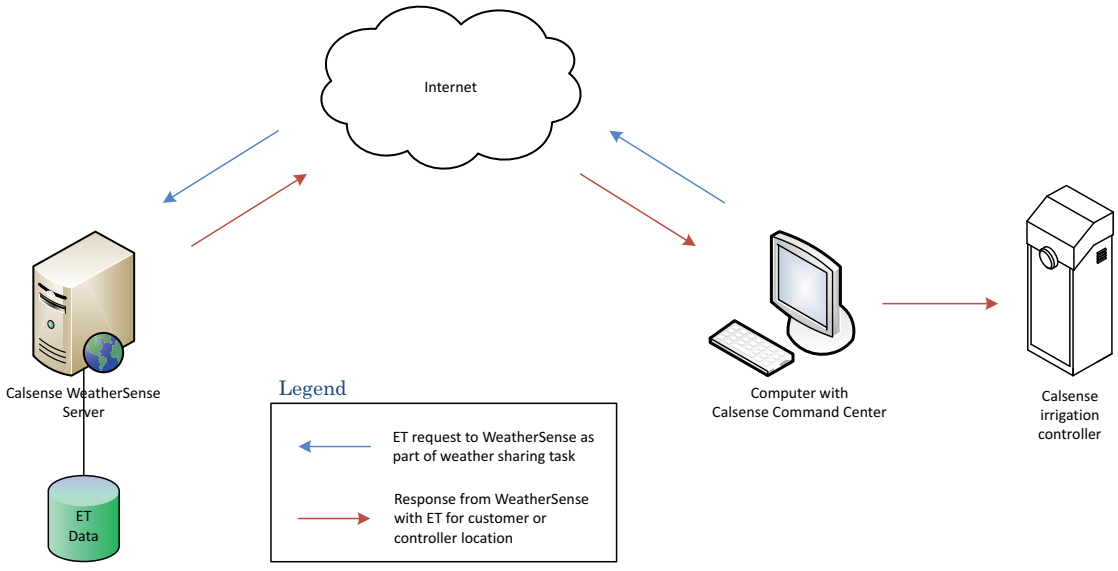

Figure 19 - *WEATHERSENSE* Overview

WEATHERSENSE gathers ET data from multiple weather sources. Calsense uses this data to provide local weather information to nearly any customer in the United States. When weather sharing occurs, Command Center accesses the *WEATHERSENSE* server and retrieves ET for the last 24 hours from the controller's location. This ET value is then shared to each of the controllers in the weather-sharing task.

Note: Rain information is not available using *WEATHERSENSE*. If a site relies heavily upon rain to limit water usage, consider using a Tipping Rain Bucket attached to an ET2000e controller with the -RB option.

Third Party Rain/Freeze Sensors

Third-party rain and freeze sensors typically operate by breaking the connection between the field common wire and the controller.

Sensors must be wired according to Calsense requirements (*Figure 20*). If using a different weather sensor, including a wireless sensor, contact Calsense at (800) 572-8608 for a wiring diagram.

Caution: DO NOT install a rain and/or freeze sensor other than directed as doing so will disable some of the controller's features.

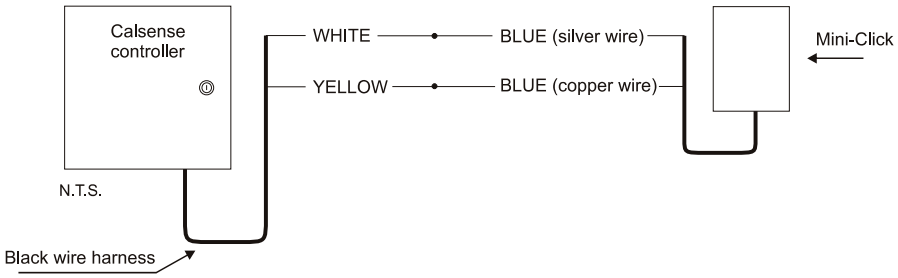

Figure 20 - Hunter Mini-Clik Wiring

Central Computer and Software

Command Center (model COMM-1)

The Calsense Command Center Central Water Management Software is a centralized software package designed to provide complete irrigation control. It is specifically designed for easy operation and requires no prior computer experience. Flow and electrical issues in the field are pinpointed in a Daily Alerts report that lists the exact causes and locations of problems, enabling maintenance crews to handle them effectively.

Each irrigation controller's programming may be viewed and adjusted from the Command Center Software. Calsense provides several flexible options for the communication between the central computer and the field units. The four primary ways to communicate with ET2000e controllers are Ethernet, wireless Ethernet (Wi-Fi), cellular modem (GPRS), and analog phone modem. Each of these options can also be shared by groups of controllers which communicate using Hardwire, Local Radio, or Spread Spectrum Radio. The central system is capable of using any combination of one or more of these communication methods.

The Command Center Software can also send and receive real-time weather data to and from any irrigation controller to which it is linked. It can receive daily ET data from a Calsense ET Gage (model ETG) and rainfall from a Calsense Tipping Rain Bucket (model RB-1) and send them to other field controllers. For sites without an ET Gage or Rain Bucket, a Campbell Scientific ET107 Weather Station or Calsense's own *WEATHERSENSE* service may be used.

Note: Rain information is not available using *WEATHERSENSE*. If a site relies heavily upon rain to limit water usage, consider using a Tipping Rain Bucket attached to an ET2000e controller with the -RB option.

Minimum System Requirements

Note: Virtualized hardware using Microsoft® Hyper-V® or VMware® is supported as long as it meets the minimum system requirements. However, performance may be slower when working in a virtualized environment.

- Microsoft Windows® 2000 (Server or Professional) SP4 or later, Windows XP Professional, Windows Vista® (Business or Ultimate), Windows 7®, Windows Server® 2003, or Windows Server 2008 including R2
- 1 gigahertz (GHz) or higher 32-bit (x86) or 64-bit (x86_64) recommended (550 MHz required)
- 512 megabytes (MB) of RAM or higher recommended (256 MB required)
- 250 MB of free hard disk space on the system partition
- At least 1 serial port if using -RRe Interface, an external modem, or a GPRS Radio
- A Keyspan USA-19HS High-Speed USB Serial Adapter if no serial port is available
- CD-ROM or DVD-ROM drive
- Super VGA display supporting 1024 x 768 or higher resolution
- Network adapter that supports TCP/IP

Client/Server (model CS-5 and CS-10)

The Calsense Command Center Client/Server software (models CS-5 and CS-10) is a fully-featured, high-performance, two-tier client/server data management system that allows multiple users to access a single Command Center database.

This system uses Advantage Database Server™, a relational database management system (RDBMS), which moves the processing of database requests to the database server, increasing performance and dramatically reducing network traffic. Once installed, the server self-configures as demand increases or decreases, reducing common maintenance tasks associated with other database servers and eliminating the need for a formal database administrator.

The Command Center software, purchased separately, is installed at each client computer and links to the database via an internal local area network (LAN), virtual private network (VPN), or the Internet. *Figure 21* shows an example of such a configuration.

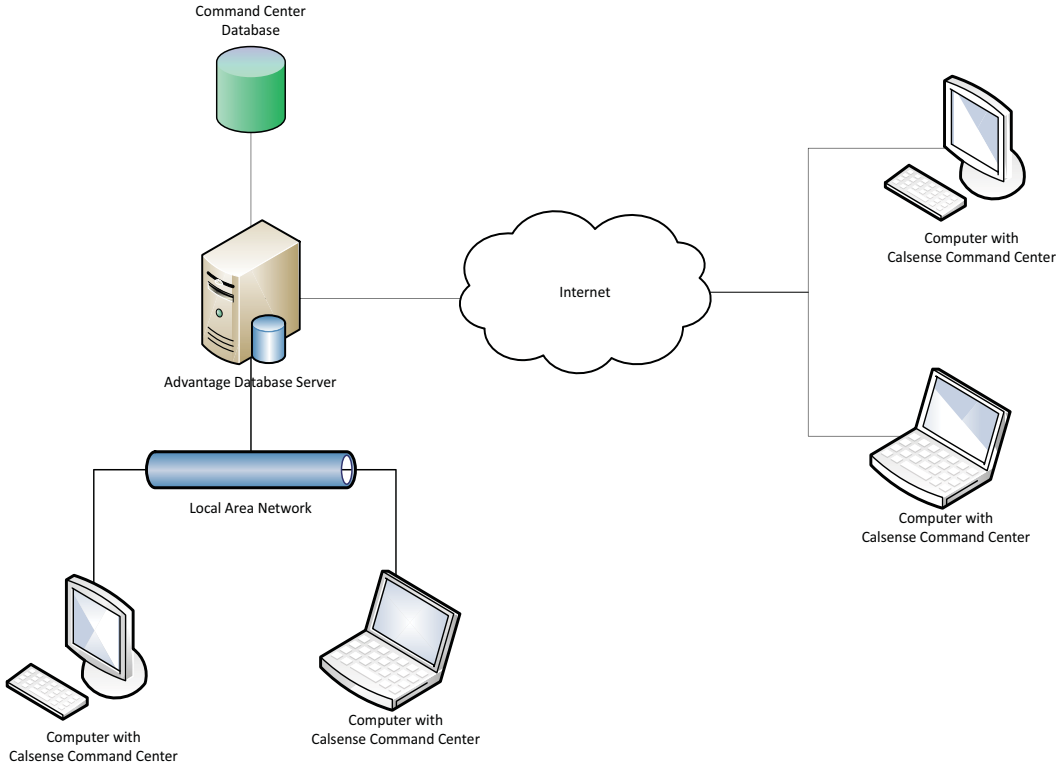

Figure 21 - Example of a Client/Server system

Minimum System Requirements

Note: Virtualized hardware using Microsoft Hyper-V or VMware is supported as long as it meets the minimum system requirements. However, performance may be slower when working in a virtualized environment.

- Microsoft Windows 2000 (Server or Professional), Windows XP Professional, Windows Server 2003, Windows Vista (Business or Ultimate), Windows 7, Windows Server 2008, or Novell NetWare 5.x or later

  Note: Microsoft Windows 7 and Windows Server 2008 R2 are only supported with Advantage Database Server 9.1 or later.

- 550 MHz or higher 32-bit (x86) or 64-bit (x86_64) processor

  Note: 64-bit processors are only supported with Microsoft Windows Server 2003 and later.

- 512 MB of RAM or higher recommended. 256 MB required.
- 50 MB of available hard disk space on the system partition. 300 MB if Command Center is installed on the database server as well.
- 1 gigabyte (GB) of available hard disk space on the volume where the database will be stored
- CD-ROM or DVD-ROM drive
- Network adapter that supports TCP /IP
- If the database will be accessed remotely via the internet:
    - Internet access with at least 768 Kbps
    - A static public IP address or domain name

Command Center for the Web

Command Center for the Web offers fundamental central-control capabilities for the Calsense ET2000e Irrigation Controller through a web browser. Engineered for easy and reliable access, all that is needed is a user name and password to start obtaining data from controllers in the field.

Each customer's service is unique and password protected, so data is secure. User accounts are issued and managed by an administrator account so that only authorized users can access controller information.

Programming changes can be made to the irrigation system without having to go to the field. Daily weather information can be shared automatically to adjust station run times so that water and labor costs are managed. Decisions made and actions taken are based on real-time conditions of the landscape through the reporting capabilities of the system.

System reports include complete records of the details for every irrigation cycle, water usage versus water budget amounts, the gallons and percentages of water savings, and what events and changes have occurred at the controller. Additionally, system administrators have management reports listing sites and users for their company.

Note: Only ET2000e controllers with the GPRS communication option (model -GR) are compatible with Command Center for the Web.

Minimum System Requirements

- A broadband internet connection such as DSL, cable, or mobile broadband. Connection via dial-up service is not supported.
- A compatible web browser. Supported web browsers include:
    - Microsoft Windows Internet Explorer® 7.0 or higher
    - Mozilla Firefox™ 3.0 or higher
    - Apple® Safari® 3.1 or higher

RRe Interface

The RRe Interface Software, built into the Calsense Command Center Software or shipped separately with the RRe-TRAN handheld radio, provides the ability to manage multiple RRe-TRAN handhelds from a central computer. It offers the ability to not only name controllers in the field, but also logically organize the controllers into sites and regions. This list of controllers can then be copied to the radio remote using the infrared adapter included with the RRe-TRAN.

Minimum System Requirements

Note: Virtualized hardware using Microsoft Hyper-V or VMware is supported as long as it meets the minimum system requirements. However, performance may be slower when working in a virtualized environment.

- Microsoft Windows 2000 (Server or Professional) SP4 or later, Windows XP Professional, Windows Vista (Business or Ultimate), Windows 7, Windows Server 2003, or Windows Server 2008 including R2
- 1 GHz or higher 32-bit (x86) or 64-bit (x86_64) recommended (550 MHz required)
- 512 MB of RAM or higher recommended (256 MB required)
- 250 MB of free hard disk space on the system partition
- At least 1 serial port
- A Keyspan USA-19HS High-Speed USB Serial Adapter if no serial port is available
- CD-ROM or DVD-ROM drive
- Super VGA display supporting 1024 x 768 or higher resolution
- Network adapter that supports TCP/IP

Central Computer (model COMP-2)

For customers with no computer to install Command Center on, Calsense offers a desktop central computer that can be purchased. It comes with the latest compatible version of Microsoft Windows and Microsoft Office®, an LCD flat panel display, and a color printer. It is also guaranteed to meet the minimum system requirements necessary to operate the Command Center Software.

Note: The Calsense Command Center Software must be purchased separately. If ordered at the same time as the central computer, it will be pre-installed on the computer.

Portable Data Logger (model DL-2)

For customers who are looking for portability, Calsense offers a portable data logger in the form of a laptop. It comes with the latest compatible version of Microsoft Windows and Office and is guaranteed to meet the minimum system requirements necessary to operate the Command Center Software.

Note: The Calsense Command Center Software must be purchased separately. If ordered at the same time as the data logger, it will be pre-installed on the computer.

Communication Options

Calsense offers a wide range of communication options to provide designers with the greatest flexibility possible when designing a complex system.

GPRS Radio (model -GR)

The Calsense GPRS communication option (model -GR) enables a computer running the Calsense Command Center Software to communicate with an ET2000e controller using the Internet. *Figure 22* shows an example of a single computer communicating via the Internet with a controller using the -GR option.

This option includes an external radio that connects to the Internet through an access point name (APN) using a third generation (3G) connection such as HSPA+, HSUPA, HSDPA, or UMTS.

Benefits of choosing the GPRS communication option include:

- Delivers reliable long distance data communication via the Internet
- Does not require any trenching or wires

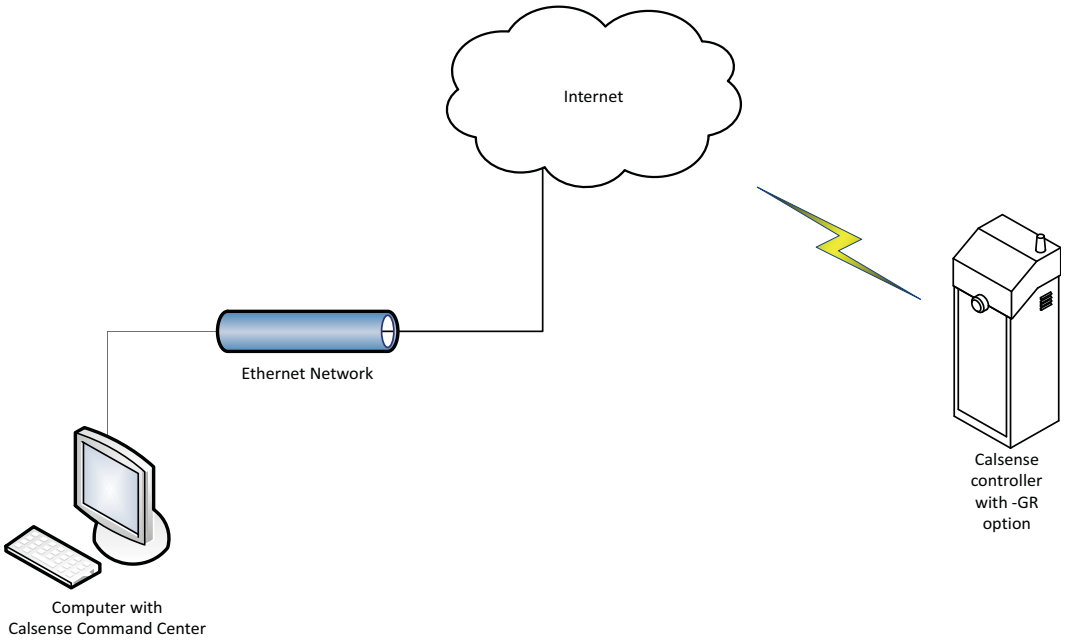

Figure 22 - GPRS Communication Using the Internet

Requirements

To use a Calsense GPRS Radio, the following is required:

- A Data Service Access plan purchased from Calsense; see *Data Access Service Plans* on page 67 for more information
- GPRS coverage at the controller location
- Broadband internet access using cable, DSL, or mobile broadband

  Note: Communication via dial-up service is not supported.

- Any firewalls or routers between the central computer and the internet must allow outbound TCP connections via port 12345

Wireless Ethernet (model -WEN)

The Calsense Wireless Ethernet communication option (model -WEN) enables a computer running the Calsense Command Center software to communicate with an ET2000e controller using an existing wireless Ethernet (Wi-Fi) network. *Figure 23* shows a simple example of how computers can communicate with a single controller using the -WEN option either wirelessly or connected to an Ethernet network.

This option includes an external device that supports both IEEE 802.11b and 802.11g wireless networks. The device can be configured to use a dynamic IP address assigned by a DHCP server or using a manually entered static IP address. The device accepts incoming TCP/IP connections from the Calsense central software, allowing a user to remotely monitor and manage their irrigation systems.

For security, the -WEN option supports the following protocols:

- IEEE 802.11i-PSK with AES-CCMP Encryption
- WPA-PSK
- TKIP Encryption
- 128-256 bit Rijndael AES Encryption, NIST AES FIPS-197 CERT#120
- 64/128-bit WEP

Benefits of choosing the Wireless Ethernet communication option include:

- Uses an existing wireless Ethernet network
- Does not require any trenching or wires
- Does not require any additional licensing

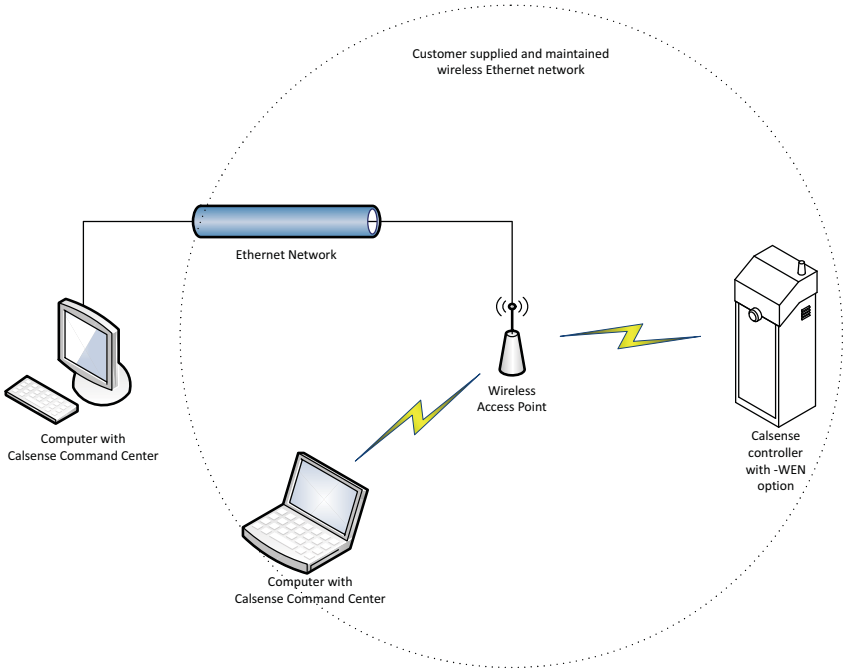

Figure 23 - Wireless Ethernet Communication

Requirements

To connect a Calsense Wireless Ethernet device to your network, the following is required:

- An existing wireless Ethernet (IEEE 802.11b or 802.11g) infrastructure network

  Notes:

  IEEE 802.11a and IEEE 802.11n networks are not supported.

  Ad-Hoc networks are not supported.

- A network that uses Internet Protocol version 4 (IPv4)

  Note: Internet Protocol version 6 (IPv6) is not supported.

- Outbound TCP connections via port 2000 allowed through any firewalls or routers between the central computer and controller
- A dedicated IP address - this can either be assigned by a DHCP server using IP reservations or statically

  Note: Dynamic IP addresses without IP reservations are not supported.

Ethernet (model -EN)

The Calsense Ethernet communication option (model -EN) enables a computer running the Calsense Command Center software to communicate with an ET200e controller using an existing Ethernet network. *Figure 24* shows a simple example of one computer communicating with a single controller using the -EN option.

This option includes an external device with a single Ethernet port. The device can be configured to use an IP address assigned by a DHCP server using IP reservations or a manually entered static IP address. The device accepts incoming TCP/IP connections from the Calsense central software allowing a user to remotely monitor and manage their irrigation systems.

Benefits of choosing the Ethernet communication option include:

- Uses an existing Ethernet network
- Does not require any additional equipment or licensing

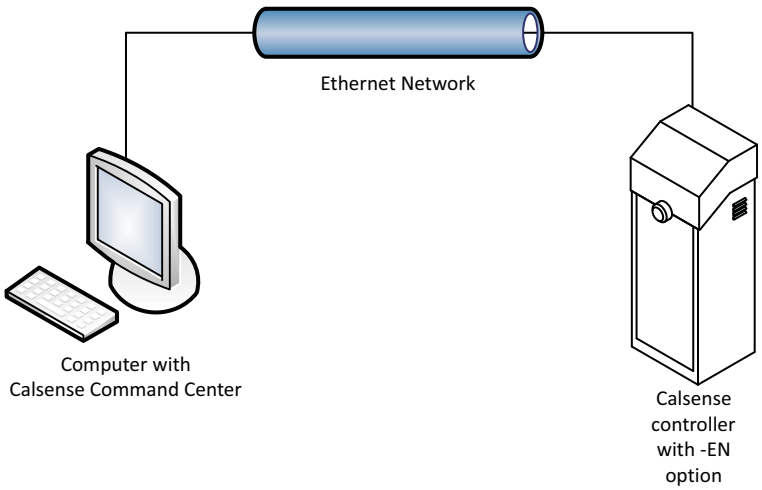

Figure 24 - Ethernet Communication

Requirements

To connect a Calsense Ethernet device to your network, the following is required:

- An existing Ethernet network

  Note: Gigabit and greater networks are only supported if the network auto-negotiates down to 100 Mbps.

- A network that uses Internet Protocol version 4 (IPv4)

  Note: Internet Protocol version 6 (IPv6) is not supported.

- Outbound TCP connections via port 2000 allowed through any firewalls or routers between the central computer and controller
- A dedicated IP address - this can either be assigned by a DHCP server using IP reservations or statically

  Note: Dynamic IP addresses without IP reservations are not supported.

- Category 5 (CAT-5) or greater cable to connect the device to the network
- A maximum cable length of 100 meters (328 feet) between the controller and a switch or router

Phone Modem (model -R)

The Calsense Phone Modem communication option (model -R) enables a computer running the Calsense Command Center software to communicate with a controller using an analog phone line. *Figure 25* shows an example of a single computer communicating to a controller using a phone modem.

This option includes an embedded 56.6 Kbps V.92 modem with an integrated RJ-11 phone jack. This modem accepts incoming calls from the Calsense central software, allowing the user to remotely monitor and manage their irrigation systems without the need to purchase additional equipment or pay licensing fees.

Benefits of choosing the phone modem option are:

- Uses existing analog phone lines in the field
- Does not require any additional equipment or licensing

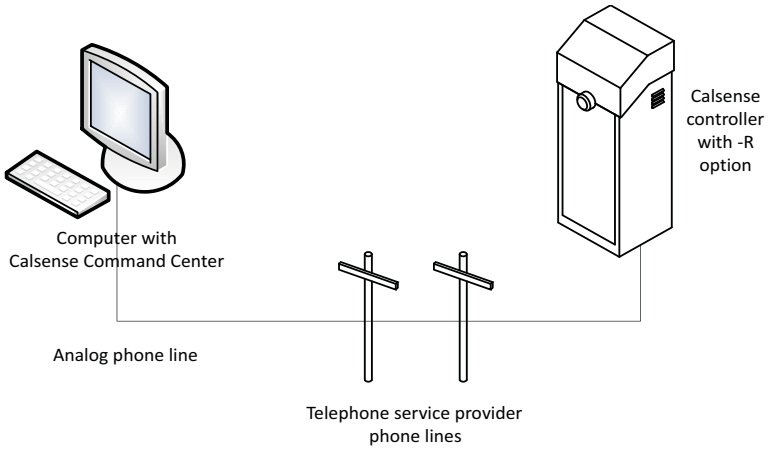

Figure 25 - Phone Modem Communication

Requirements

To use a Calsense Analog Phone Modem, the following is required:

- RJ-11 phone jack with active phone line installed at controller location
- A plain old telephone service (POTS) analog phone line at the central computer (dedicated line recommended)
- A POTS analog phone line at the controller (dedicated line recommended)

  Note: Calsense does not support the use of digital phone lines to communicate with controllers. This includes the use of Voice over IP (VoIP) systems.

Fiber Optic Modem (model -FOM)

The Calsense Fiber Optic Modem communication option (model -FOM) enables a computer running the Calsense Command Center software to communicate with an ET2000e controller using an existing fiber optic network. *Figure 26* provides an example system with 3 controllers using the -FOM option.

Benefits of choosing the Fiber Optic Modem communication option include:

- Uses an existing fiber optic network
- Does not require any additional equipment or licensing
- Modem is self-healing and will failover to the next loop in the event of a failure

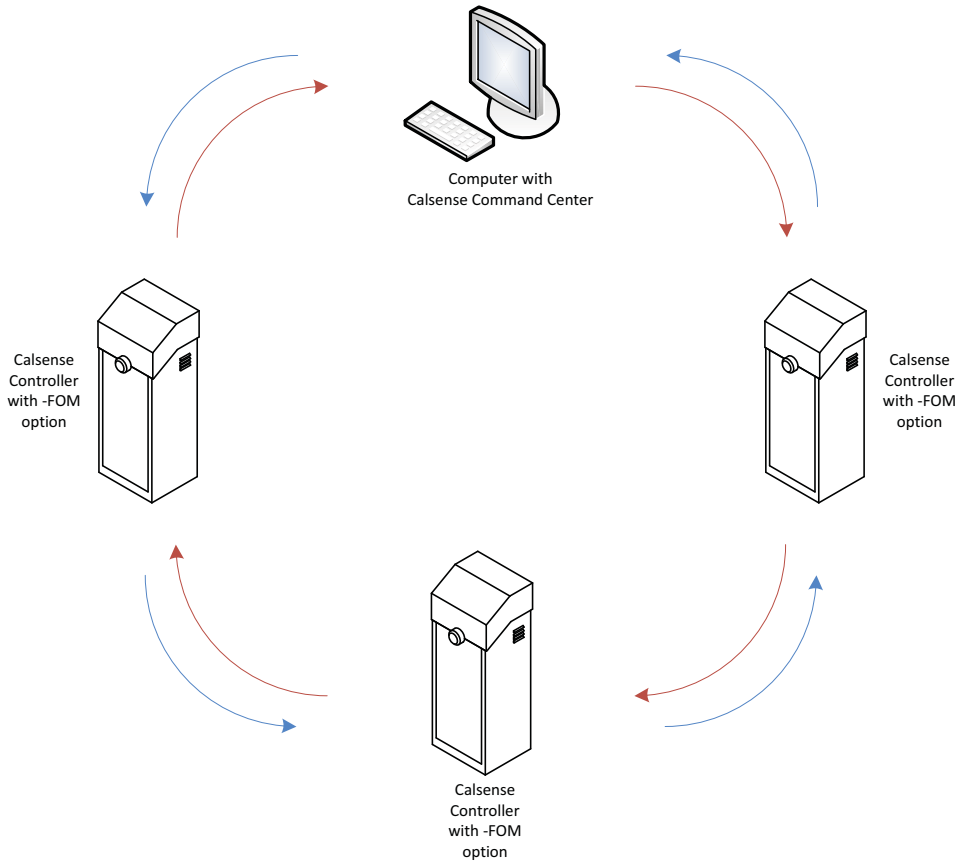

Figure 26 - Fiber Optic Modem Communication

Requirements

To use a fiber optic modem, the following is required:

- Fiber optic modem connected to the central computer
- Calsense SSE or SSE-D stainless steel enclosure
- An existing two loop (A and B) fiber optic network

Local Radio (model -LR)

The Calsense Local Radio communication option (model -LR) enables a computer running the Calsense Command Center software to communicate with an ET2000e controller through a local radio system. A local radio is a 2 watt, narrowband UHF 450-470 MHz radio modem.

A local radio system has a single local radio hub and one or more controllers in the field with the Local Radio communication option. The hub manages data flow between the central computer and surrounding controllers. *Figure 27* shows a sample of how a hub communicates to local radio controllers in the field.

Benefits of choosing the Local Radio communication option are:

- Does not require any trenching or wires
- Provides reliable long range communication
- Multiple controllers can share a single central communication device

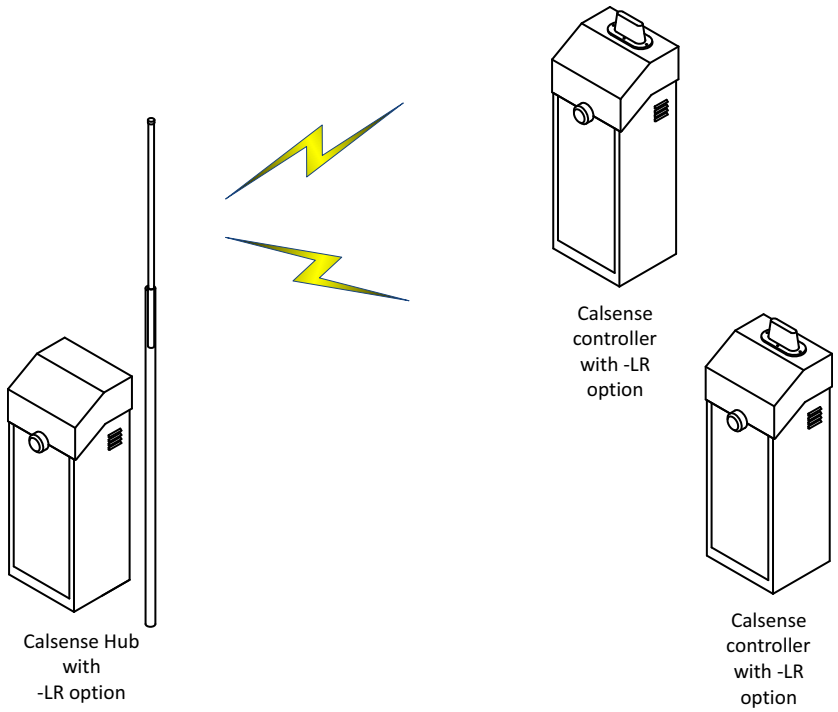

Figure 27 - Local Radio Communication

Requirements

To use a Calsense local radio, the following is required:

- A Calsense Local Radio Hub
- A radio survey conducted by Calsense prior to installing any local radio equipment:

  This service is provided free-of-charge and must be requested by the designer. This helps ensure adequate coverage at the proposed controller locations and determine the ideal location for the Local Radio Hub to be installed.
- A Federal Communications Commission (FCC) license to operate the local radio system:

  Upon completion of a radio survey, Calsense prepares all required FCC paperwork. Although this service is free-of-charge, there is a one-time fee that must be paid to the FCC to license the frequency. A nominal renewal fee follows this every two years to maintain the license.
- Final FCC approval completed prior to any local radio equipment being ordered.

Radio Range

The hub radio should have an LR-STICK (omnidirectional) or LR-YAGI (directional) antenna attached to a pole or roof of a nearby structure. The controller can have an LR-DOME, LR-STICK, or LR-YAGI antenna. Unobstructed range (line of sight visibility) of a system with dome antennas is between one and two miles. Up to three miles can be obtained with LR-YAGI antennas. Tall trees, valleys, buildings, and hills can severely attenuate the signal. A radio site survey will need to be done by Calsense to verify complete coverage and for antenna recommendations.

Caution: Before committing a project to Local Radio, the designer should contact Calsense to test and verify signal strengths at site locations.

FCC Licensing

Customers must obtain an FCC license to operate the Local Radio system. Frequency coordination (selection) is handled through the Personal Communications Industry Association (PCIA) - (800) 759-0300 - and an application is submitted to the FCC. It is not difficult to obtain a license. There is a PCIA fee and FCC license fee that must be paid as well.

Spread Spectrum Radio (model -SR)

The Calsense Spread Spectrum Radio communication option (model -SR) enables two or more controllers to communicate using spread spectrum radios. A spread spectrum radio is a 1 watt radio modem that uses the 902-928 MHz ISM (Industrial, Scientific, and Medical) band. *Figure 28* shows an example of two controllers communicating using spread spectrum radio.

This option also enables a computer running the Calsense Command Center software to communicate with a controller through a spread spectrum radio System. A spread spectrum radio system has a single spread spectrum radio Hub and one or more controllers in the field with the -SR option. The hub manages data flow between the central computer and surrounding controllers.

Benefits of choosing the Spread Spectrum Radio communication option include:

- Does not require any trenching or wires
- Does not require FCC licensing
- Multiple controllers can share a single central communication device

- Can be used as a communication path for *FLOWSENSE*® technology

Figure 28 - Spread Spectrum Communication

Requirements

To use a Calsense spread spectrum radio, the following is required:

- A Calsense Spread Spectrum Radio Hub (optional if only used for *FLOWSENSE* communication)
- An optional radio survey, to be conducted by Calsense prior to installing any spread spectrum equipment. This service is provided free-of-charge and may be requested by a Calsense Sales Representative. This helps ensure adequate coverage at the proposed controller locations.
- A maximum of 12 controllers using *FLOWSENSE* technology in a single chain

Hardwire (model -M)

The Calsense Hardwire communication option (model -M) enables communication between two or more controllers using Paige P7171D communication cable. *Figure 29* shows an example of two controllers communicating using Hardwire.

Benefits of choosing the Hardwire communication option are:

- Lowest cost for side-by-side installations
- Multiple controllers can share a single central communication device
- Can be used as a communication path for *FLOWSENSE* technology

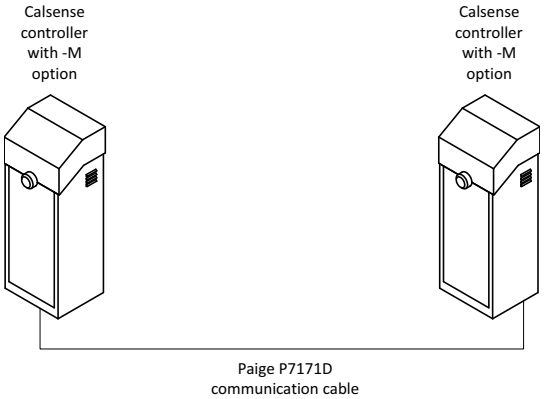

Figure 29 - Hardwire Communication

Requirements

To connect two or more Calsense hardwire controllers together, the following is required:

- Paige P7171D communication cable installed in conduit. For runs of less than 100 feet, 18-gauge multi-conductor irrigation wire in conduit may be substituted.
- A maximum length of 5,000 feet for all Paige P7171D communication cable for one communication chain. If more than 5,000 feet is necessary, multiple 5,000 feet cable runs can be combined using a controller with two -M options (model -M-M) as an amplifier.
- Communication cable direct pulled installed in conduit
- Expansion loops in accordance with appropriate NEC codes for pulls of more than 100 feet (*Figure 30*). Splices are not recommended.

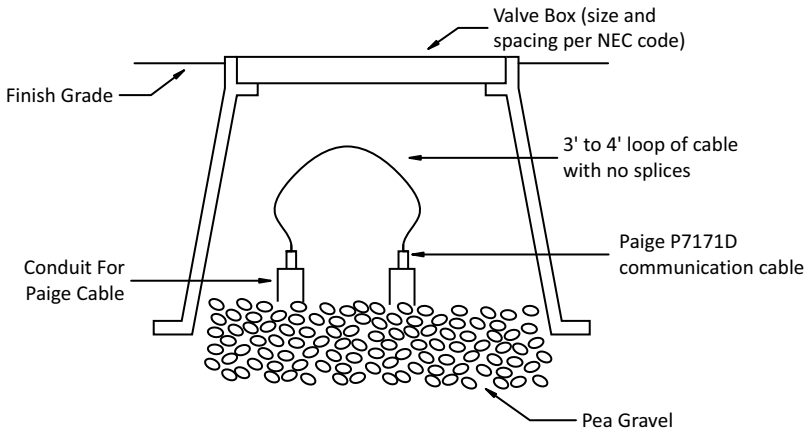

Figure 30 - Pull Box Detail

- If wire splices are unavoidable, splices must be completely insulated from soil and moisture using 3M™ Scotchcast™ 3570G Connector Sealing Packs (formerly 3M Scotchlok™ 3570 Connector Sealing Packs) or Spears® DS-100 Dri-Splice Connectors with DS-300 Dri-Splice Sealant (*Figure 31*).

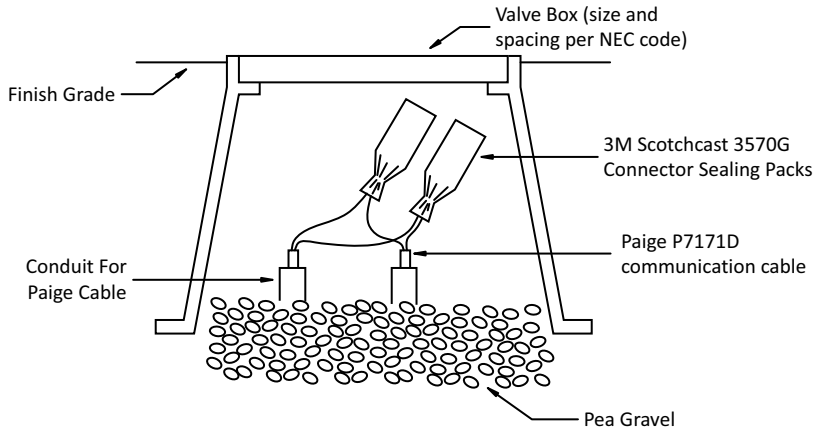

Figure 31 - Splice Detail

- A maximum of 32 controllers linked together in a single communication chain

- A maximum of 12 controllers using *FLOWSENSE* technology in a single chain

Hardwire Line Amplifier (model LA-2 PC)

The Calsense line amplifier (model LA-2 PC) allows communication directly from a central computer to hardwire controllers in the field without the need for an additional central communication device. This device connects to an RS-232 serial port on the computer and is wired directly to the Paige P7171D cable in the field (*Figure 32*).

Note: If connecting an LA-2 PC to a *FLOWSENSE* chain, the controller it connects to must have a dedicated -M option used for central traffic. This means the controller has to be specified either as -M-M if using hardwire for *FLOWSENSE* traffic, or -M-SR if using spread spectrum radio.

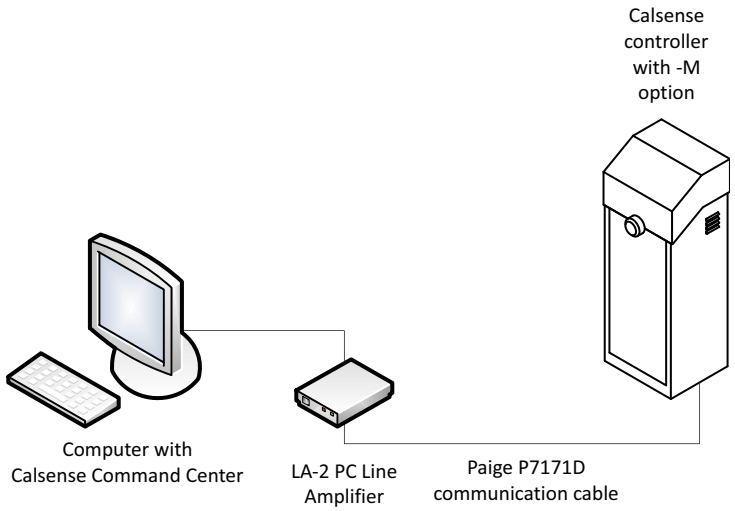

Figure 32 - LA-2 PC Line Amplifier

Sharing a Central Communication Option with *FLOWSENSE* chains

With properly designed *FLOWSENSE* chains, sites with multiple chains can share a single central communication option. This is accomplished by using either hardwire (model -M) or spread spectrum radio (model -SR) controllers to bridge from one *FLOWSENSE* chain to other chains or non-*FLOWSENSE* controllers.

There are three such scenarios:

- *Bridging Chains using -M-M Controllers*
- *Bridging Chains using -M-SR Controllers*
- *Bridging Chains using a -SR Hub*

Bridging Chains using -M-M Controllers

This scenario involves using controllers with two hardwire (model -M) communication options to share a single central communication link with multiple hardwire *FLOWSENSE* chains or non-*FLOWSENSE* controllers (*Figure 33*). This is ideally suited for small sites or sites where Paige P7171D communication cable already exists between the controllers.

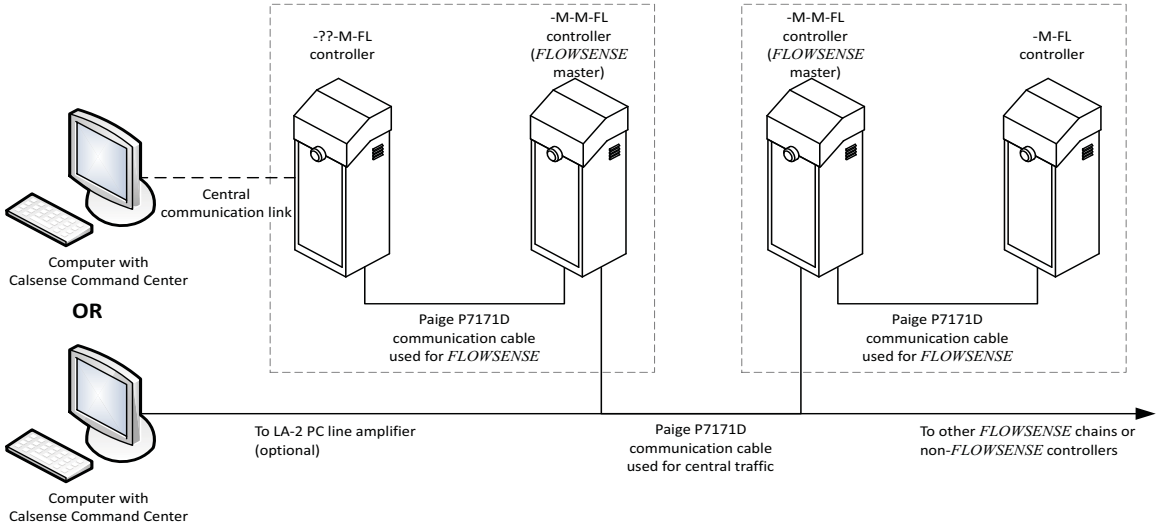

Figure 33 - Bridging chains using -M-M controllers

The rules for this scenario are:

- The central communication option, indicated as -?? in the figure, can be nearly any option including -GR, -EN, -WEN, -R, -FOM, -LR, or -M if using an LR-2 PC line amplifier. It cannot be -SR.

  Note: If using -M with an LA-2 PC line amplifier, the LA-2 PC connected to the central computer connects to the -M-M-FL controller, not the -M-FL controller

Bridging Chains using -M-SR Controllers

This scenario involves using a controller with the spread spectrum radio (model -SR) communication option to bridge multiple hardwire *FLOWSENSE* chains or non-*FLOWSENSE* controllers (*Figure 34*). This scenario is common for sites where hardwire *FLOWSENSE* chains are spread across a large area with no way to run Paige P7171D communication cable between them.

Note: Bridging spread spectrum radio *FLOWSENSE* chains using hardwire in this method is not supported. See *Bridging Chains using a -SR Hub* for a way to accomplish this using a spread spectrum radio hub.

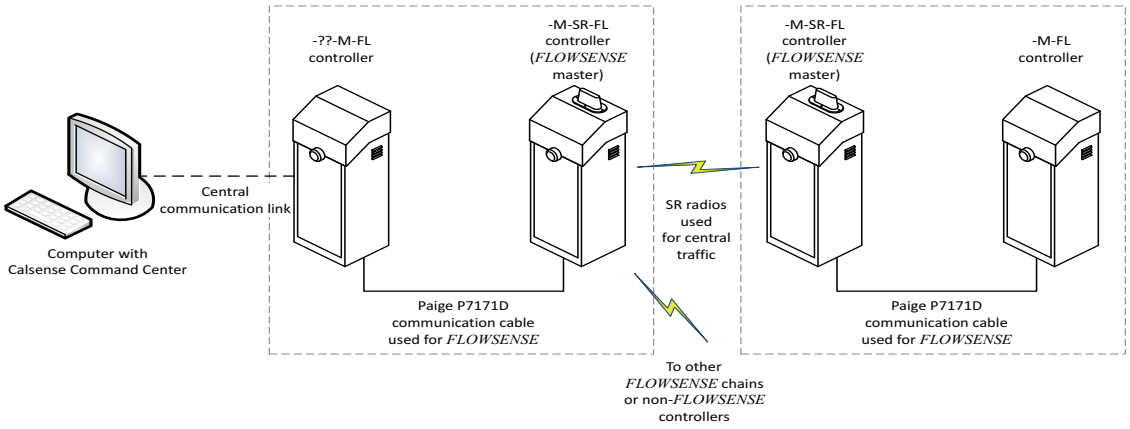

Figure 34 - Bridging chains using -M-SR controllers

The rules for this scenario are:

- The central communication option, indicated as -?? in the figure, can be nearly any option including -GR, -EN, -WEN, -R, -FOM, or -LR. It cannot be -M or -SR

  Note: This scenario does not support using an LA-2 PC line amplifier for central communication. This requires a separate hub/controller. See *Bridging Chains using a -SR Hub* for more information.

Bridging Chains using a -SR Hub

This final scenario involves using a non-*FLOWSENSE* spread spectrum radio (model -SR) hub or controller to communicate to multiple *FLOWSENSE* chains or non-*FLOWSENSE* controllers (*Figure 35*). This scenario is common for sites where *FLOWSENSE* chains are spread across a large area with no way to run Paige P7171D communication cable between them.

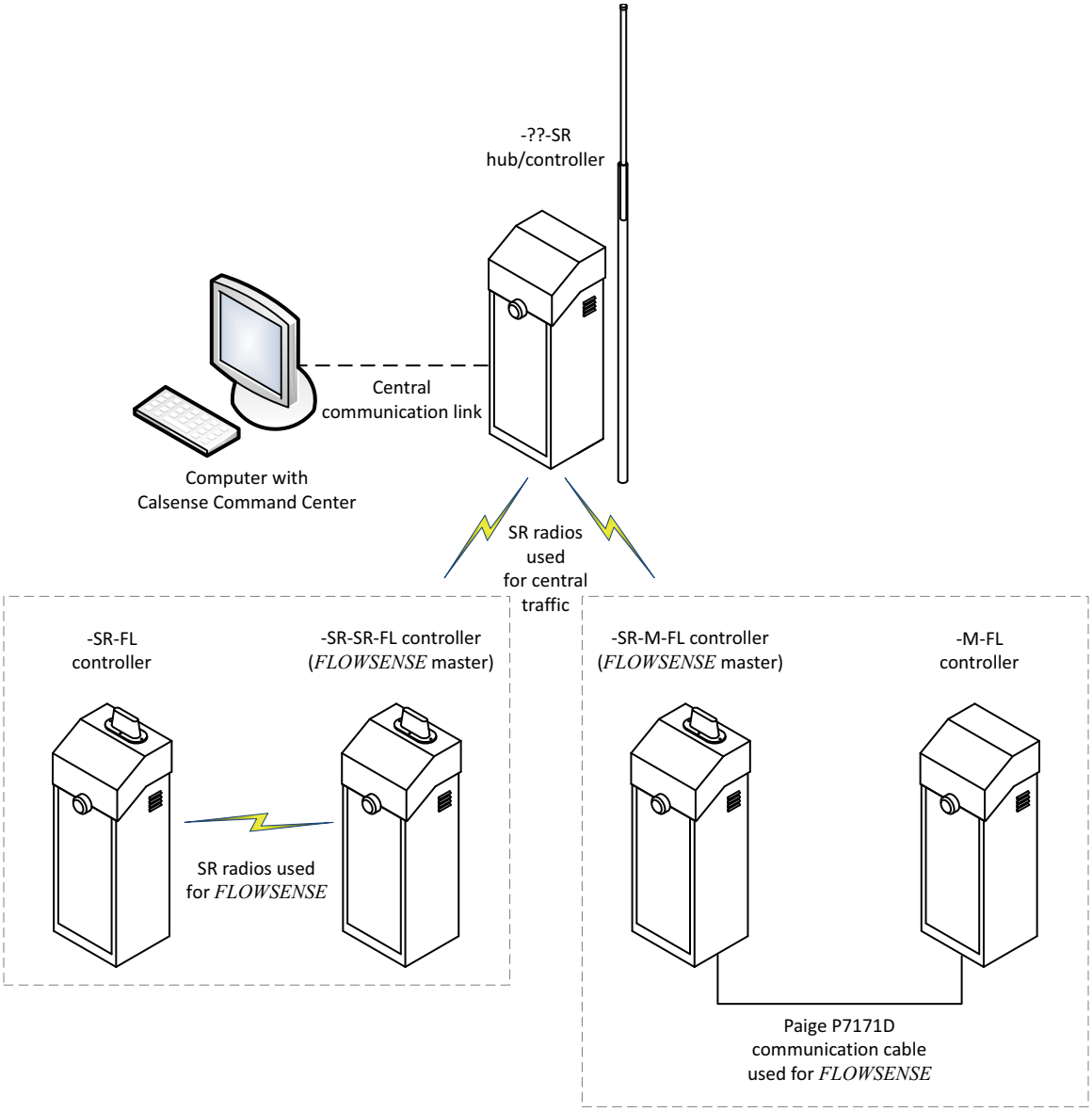

Figure 35 - Bridging chains using a -SR hub

The rules for this scenario are:

- The central communication option, indicated as -?? in the figure, can be nearly any option including -GR, -EN, -WEN, -R, -FOM, -LR, or -M if using an LA-2 PC line amplifier
- The -SR hub/controller cannot be part of a *FLOWSENSE* chain

Communication Accessories

Antennas

An antenna, purchased separately, is required to use many of Calsense's communication options. Calsense offers a variety antennas, each designed to accommodate specific situations.

Dome Antenna

Calsense Dome Antennas (models LR-DOME, LR-DOME-RRe, SR-DOME, SR-DOME-RRe, RRe-DOME, and LR-DOME-SR) are omnidirectional, low-profile transit antennas designed for all environments and applications (*Figure 36*). The maximum cable length is dependent upon signal strength. Dome antennas are intended to be used with the cables included with the radio; however, they may be extended with prior approval from Calsense.

Note: If ordered at the same time as the controller, the SSE-R and SSE-D-R Stainless Steel Enclosures include the appropriate dome antenna.

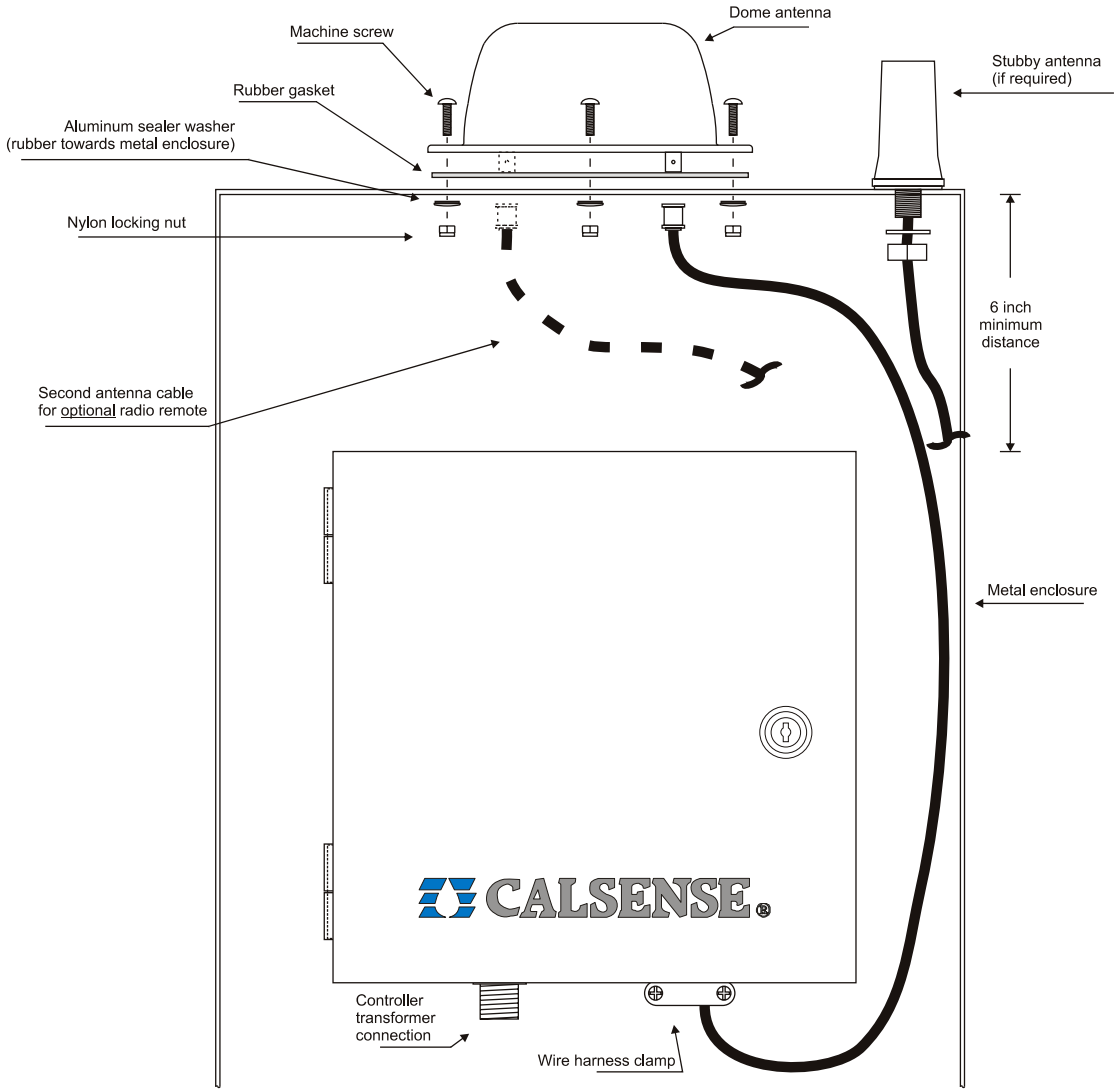

Figure 36 - Mounting Dome and Stubby Antenna

Stubby Antenna

Calsense Stubby Antennas are omnidirectional surface-mount antennas designed for all environments and applications (*Figure 36*). The maximum cable length is dependent upon signal strength. Stubby antennas come with their own cables; however, they may be extended with prior approval from Calsense.

- The Calsense GPRS Stubby Antenna (model GR-STUBBY) is 3 dBi
- The Calsense Spread Spectrum Radio Stubby Antenna (model SR-STUBBY) is 3 dBi and is normally used in situations with weak signal strength or where controllers require 3 antennas, such as a local radio antenna, radio remote antenna, and spread spectrum radio antenna

  Note: If ordered at the same time as the controller, the SSE-R and SSE-D-R Stainless Steel Enclosures include the SR-STUBBY antenna if necessary.
- The Calsense Wireless Ethernet Stubby Antenna (model WEN-STUBBY) is 3dB-MEG

  Note: LMR-195-DB cable, specified separately, is required if mounting a WEN-STUBBY antenna outside of an enclosure.

Stick Antenna

Calsense Stick Antennas are fiberglass omnidirectional antennas used to extend the range of a radio (*Figure 37*).

Note: LMR-400-DB or LMR-600-DB cable, specified separately, is required if mounting a stick antenna. The maximum length of LMR-400-DB cable is 100 feet. Longer distances may be available with prior approval from Calsense.

- The Calsense GPRS Stick Antenna (model GR-STICK) is a dual-band antenna. For the 821-846 MHz range, the antenna is 0 dBi; for the 1850-1950 MHz range, the antenna operates at 3 dBi.
- The Calsense Local Radio Stick Antenna (model LR-STICK) is often recommended for use with a local radio hub. This antenna is available in 0, 3, 5, and 7 dBi.
- The Calsense Spread Spectrum Radio Stick Antenna (model SR-STICK) is often recommended for use with a spread spectrum hub. This antenna is available in 0, 3, and 6 dBi.

Yagi Antenna

Calsense Yagi Antennas are aluminum directional antennas typically used to extend the communications range of a specific controller location (*Figure 37*).

Note: LMR-400-DB or LMR-600-DB cable, specified separately, is required if mounting a yagi antenna. The maximum length of LMR-400-DB cable is 100 feet. Longer distances may be available with prior approval from Calsense.

- The Calsense Local Radio Yagi Antenna (model LR-YAGI) is 7.1 dBi
- The Calsense Spread Spectrum Radio Yagi Antenna (model SR-YAGI) is 6 dBi

Radio Remote Antenna

The Calsense Radio Remote Antenna (model RRe-ANT) is an omnidirectional PVC stick antenna.

Note: If no other antenna is ordered, this antenna is included with -RRe option at no additional charge.

Radio Remote Whip Antenna

The Calsense Radio Remote Whip Antenna (model RRe-WHIP) is an omnidirectional antenna used in situations where the RRe antenna must be wall- or pole-mounted (*Figure 37*). Using LMR-195-DB cable,

the maximum length of cable is 100 feet. Longer distances may be available with prior approval from Calsense.

Note: LMR-195-DB cable, specified separately, is required if mounting a whip antenna.

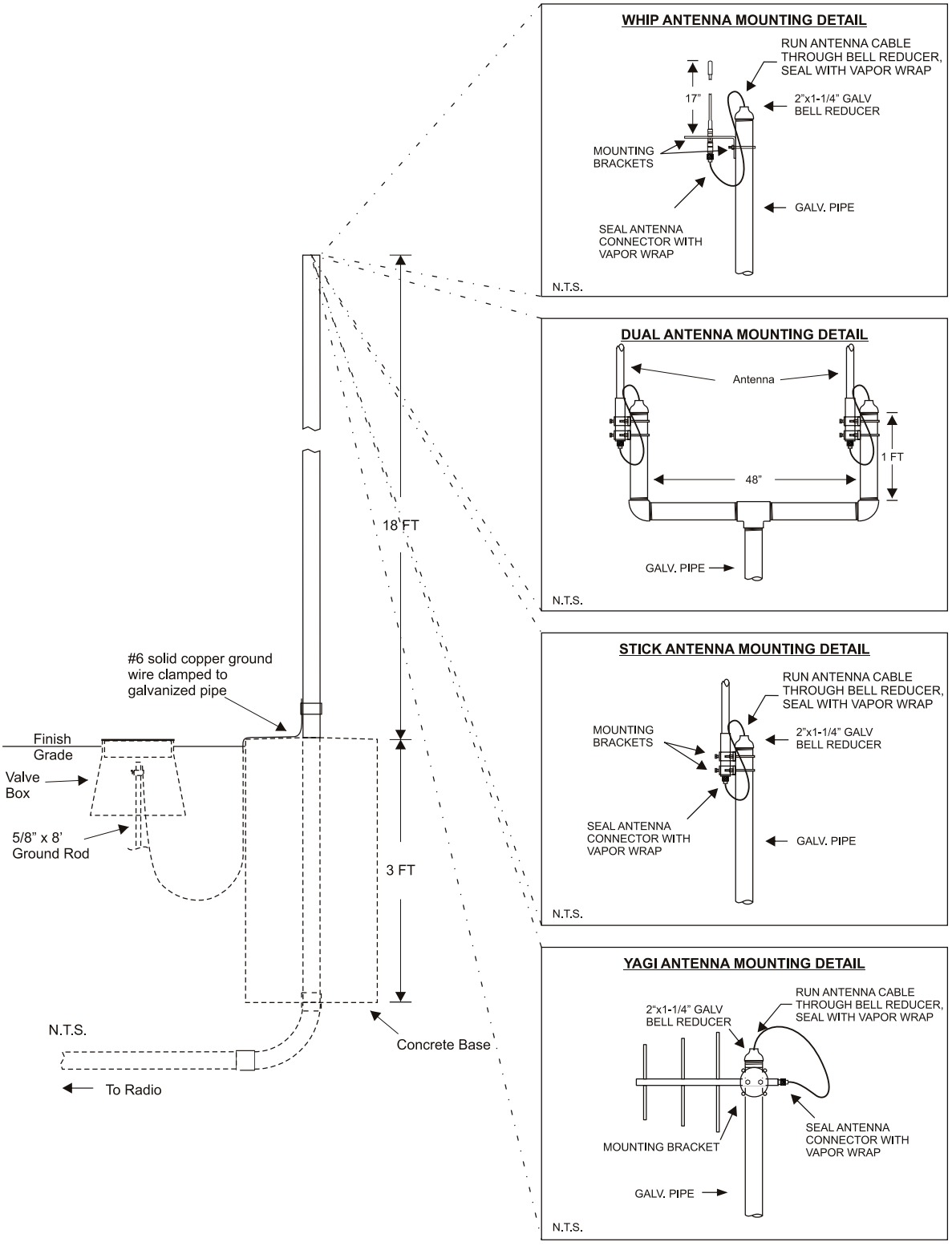

Figure 37 - Antenna Mounting--Stick, Yagi, and Whip

Local Radio Filter (model LR-FILTER)

The Calsense Local Radio Frequency Filter (model LR-FILTER) is a cavity resonator used to help prevent interference from unwanted frequencies by filtering them out (*Figure 38*). It is required when using a LR-STICK antenna and recommended when using an LR-YAGI.

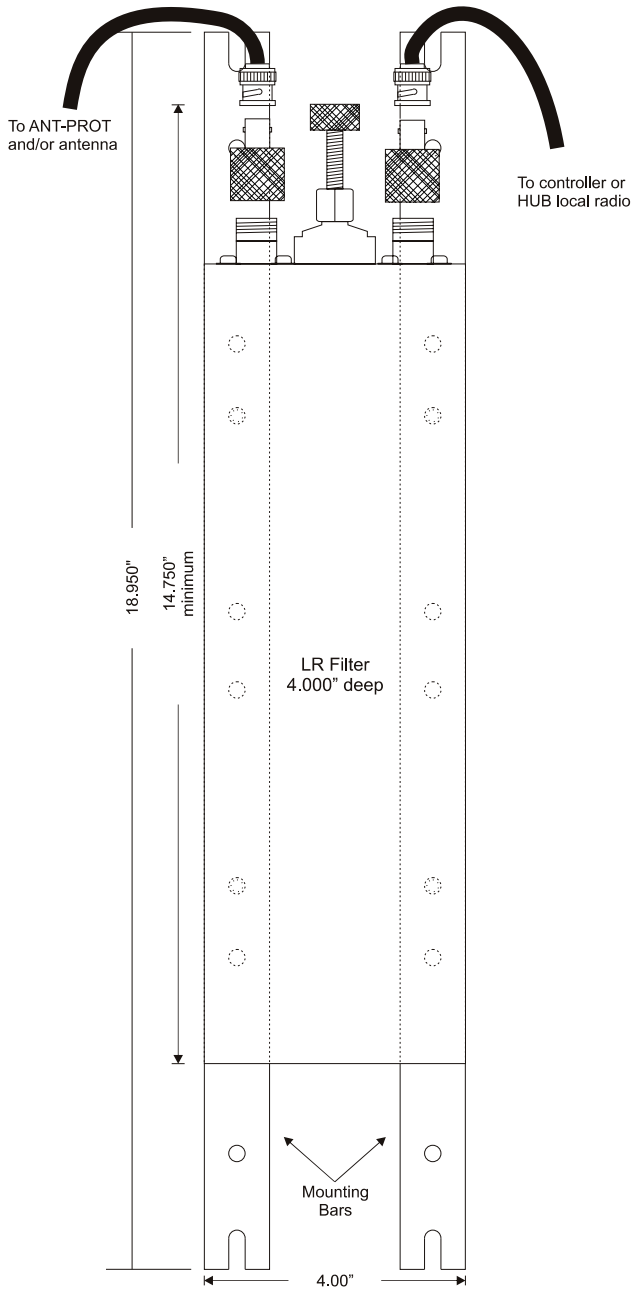

Figure 38 - Local Radio Filter

Spread Spectrum Radio Filter (model SR-FILTER)

The Calsense Spread Spectrum Frequency Filter (model SR-FILTER) is a bandpass filter used to help prevent interference from unwanted frequencies by filtering them out. It is required when using a SR-STICK antenna and recommended when using an SR-YAGI.

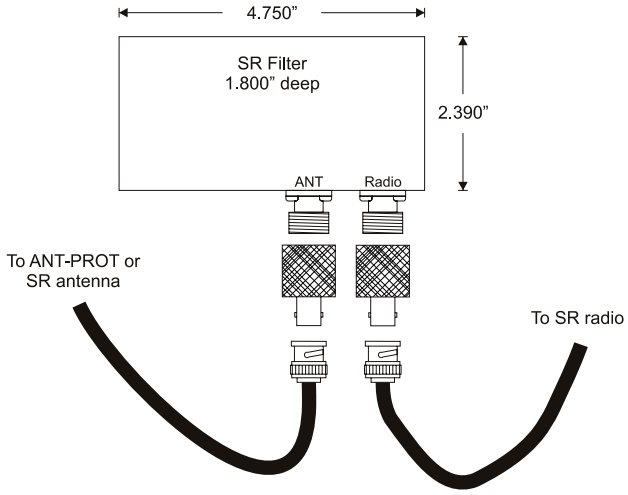

Figure 39 - Spread Spectrum Radio Filter

Antenna Cable Surge Protector (model ANT-PROT)

The Calsense Antenna Cable Surge Protector (model ANT-PROT) helps protect the radio equipment and the radio frequency (RF) filter from lightning strikes. An ANT-PROT is required when using a GR-STICK, LR-STICK, or SR-STICK antennas and recommended when using an LR-YAGI or SR-YAGI.

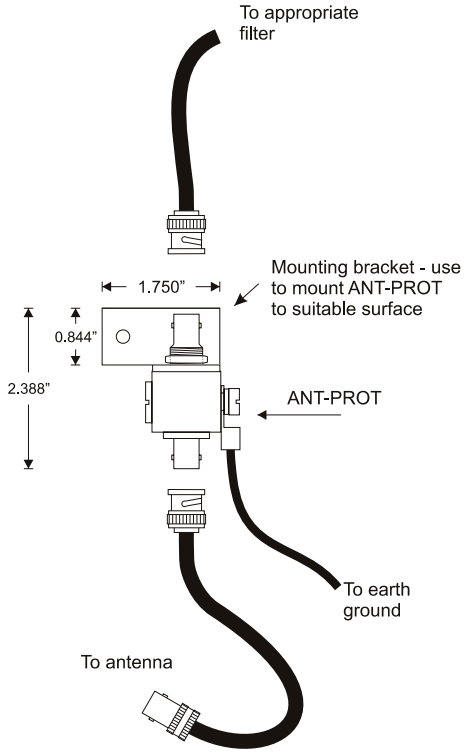

Figure 40 - Antenna Cable Surge Protector

Phone Modem Surge Protector (model TP-MOD)

The Calsense Phone Line Surge Protector (model TP-MOD) helps protect the phone modem and controller from lightning strikes and other power surges that may occur over the phone line.

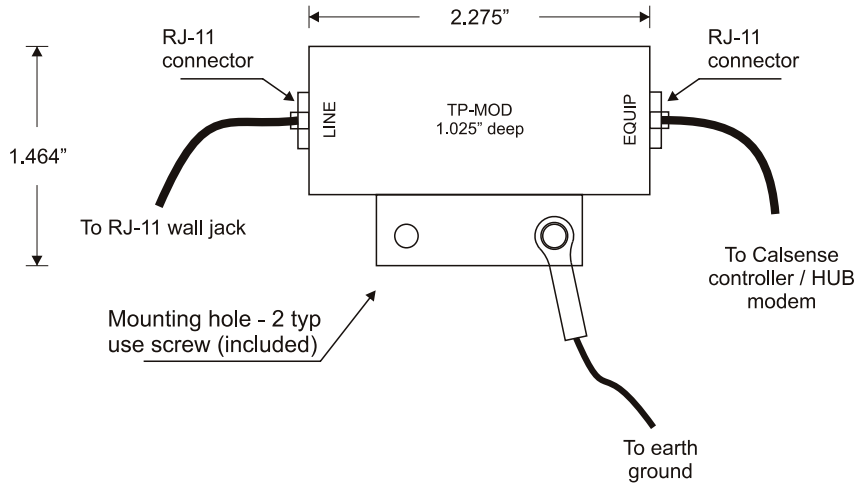

Figure 41 - Phone Modem Surge Protector

Data Access Service Plans

Calsense offers 1 month, 1 year, and 5 year prepaid data access service plans for use with the GPRS (model -GR) communication option. These prepaid plans allow the use of GPRS without the need to sign a contract with a third-party service provider. Any changes to the service are handled by Calsense, as are any firmware updates and programming changes that may need to be done to the radio during the term of the contract. The multiple controller plans support up to 35 controllers sharing a single access service plan.

Note: A multiple controller plan is required for GPRS radios connected to hubs, central computers, and chains of more than two controllers.

The Calsense Data Access Service is offered in 6 varieties:

- COMM-5YR provides 1 or 2 controllers with 5 consecutive years of data communication service
- COMM-5YR-M provides multiple controllers with 5 consecutive years of data communication service
- COMM-1YR provides 1 or 2 controllers with 12 consecutive months, or 1 year, of data communication service
- COMM-1YR-M provides multiple controllers with 12 consecutive months, or 1 year, of data communication service
- COMM-1MN provides 1 or 2 controllers with 1 month of data communication service
- COMM-1MN-M provides multiple controllers with 1 month of data communication service

Other Options

Lights (model -L)

The Calsense ET2000e Irrigation Controller provides four optional programs that can be used to control various devices such as lights, gates, or water features. The additional light circuits are added at the time of ordering by specifying the -L interface. This option includes the hardware and firmware for four isolated light circuits. The Lights programs operate independently from the irrigation programs. The output is 24 volt AC (VAC) and is used to operate a relay (*Figure 42*). The program has a 14-day rolling schedule with two start and stop times during each 24-hour period.

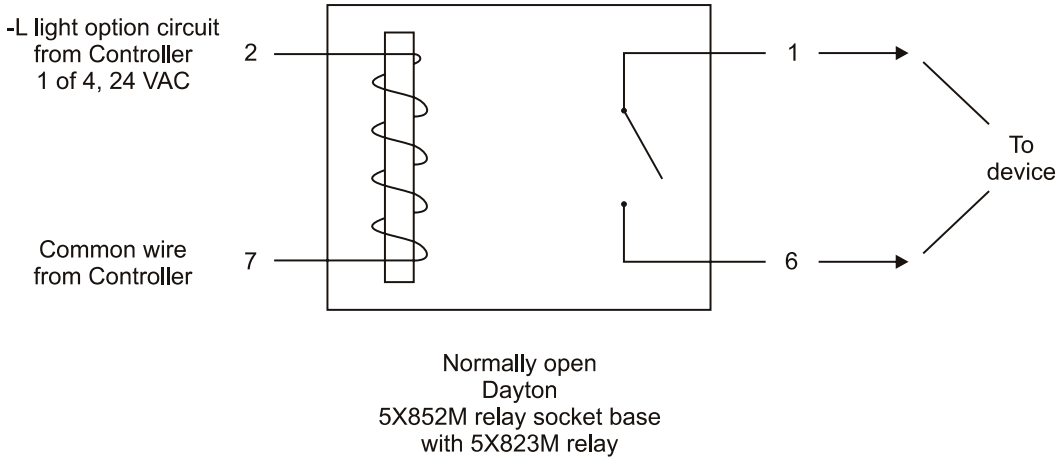

Figure 42 - Lights Relay Wiring