CS3000 Designer’s Guide

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- Irrigation Controllers
- 2-Wire
- Transient Protection and Grounding
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**Introduction**

The Calsense CS3000 Designer's Guide is a detailed packet of design information for the Calsense CS3000 product line. Please call Calsense directly at (800) 572-8608 or (760) 438-0525 for further information and product support.

**Calsense Philosophy**

Calsense embraces the Internet of Things with its always-connected CS3000 irrigation controller. Available with a range of internet-connected communication options including Cellular, Ethernet, and Wi-Fi, the CS3000 automatically synchronizes report data, diagnostics, and programming to the cloud real-time. Additionally, leveraging Calsense's *FLOWSENSE™* technology, multiple controllers sharing one or more points of connection distribute their data as changes occur making the data available from any controller in the chain. This enables users to interact seamlessly with their controllers whether they’re in the field, at their office, or from any internet-connected device anywhere, at anytime.

Calsense, a California-based company that designs and manufactures computerized irrigation controllers, 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 experiences. 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 cloud-based central controller application, Command Center Online.

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 Controllers**

**Stations**
- 8  8-station base model with support for one conventionally-wired POC
- 16 16-station base model with support for one conventionally-wired POC
- 24 24-station base model with support for one conventionally-wired POC
- 32 32-station base model with support for one conventionally-wired POC
- 40 40-station base model with support for one conventionally-wired POC
- 48 48-station base model with support for one conventionally-wired POC
- 2W 2-Wire base model which supports up to 128 2-Wire stations

**Enclosure**

**Note:** All enclosures include transient protection and field-replaceable modules
- WM  Wall-Mount stainless-steel powder-coated enclosure with no antenna holes
- WM1 Wall-Mount stainless-steel powder-coated enclosure with one stubby antenna hole
- WM2 Wall-Mount stainless-steel powder-coated enclosure with two stubby antenna holes
- S  Heavy-Duty stainless-steel pedestal enclosure with no antenna holes
- S1 Heavy-Duty stainless-steel pedestal enclosure with one stubby antenna hole
- S2 Heavy-Duty stainless-steel pedestal enclosure with two stubby antenna holes
- SD Double-Wide heavy-duty stainless-steel pedestal enclosure for two CS3000 controllers with no antenna holes*
- SD1 Double-Wide heavy-duty stainless-steel pedestal enclosure for two CS3000 controllers with one stubby antenna hole*
- SD2 Double-Wide heavy-duty stainless-steel pedestal enclosure for two CS3000 controllers with two stubby antenna holes*
- SD3 Double-Wide heavy-duty stainless-steel pedestal enclosure for two CS3000 controllers with three stubby antenna holes*
* Double-Wide heavy-duty stainless-steel pedestal enclosures are available in the following configurations. Other options to be specified separately:

CS3-8  Includes two (2) CS3000 base model irrigation controllers with 8 conventionally-wired station outputs and support for one conventionally-wired POC, mounted side-by-side

CS3-2W Includes two (2) CS3000 2-Wire base model irrigation controllers which each support up to 128-stations using 2-Wire Station Decoders, mounted side-by-side

CS3-8-2W Includes two (2) CS3000 irrigation controllers - one 8-station base model and one 2-Wire mounted side-by-side. 8-station base model supports a single conventionally-wired POC and up to 48 conventionally-wired stations with additional 8-station modules. 2-Wire model supports up to 128-stations using 2-Wire Station Decoders.

How to Specify Optional Equipment

Communication Options

CS3-GR Cellular modem to provide communication with cloud-based Command Center Online web application. Requires antenna and Calsense Data Access Service plan, purchased separately.

CS3-WEN Wi-Fi device to provide communication with cloud-based Command Center Online using a customer’s existing Wireless Ethernet network. Requires antenna, purchased separately.

CS3-EN Ethernet device to provide communication with cloud-based Command Center Online using a customer’s existing Ethernet network

CS3-SR Spread Spectrum Radio to provide wireless communication between controllers. Requires antenna, purchased separately.

CS3-M-KIT Hardwire communication card and terminal board to provide communication between controllers using Paige P7171D communication cable. For controllers in wall-mount enclosures (models -WM, -WM1, and -WM2).

CS3-MSSE-KIT Hardwire communication card and terminal board to provide communication between controllers using Paige P7171D communication cable. For controllers mounted in heavy-duty stainless-steel and double-wide pedestals (models -S, -S1, -S2, -SD, -SD1, -SD2-, and -SD3).

Field-Replaceable Add-on Modules

CS3-8STA-KIT 8-station add-on card and terminal board to add up to 8 conventionally-wired stations to an existing controller. A single CS3000 supports up to 6 of these kits for a total of 48-stations.

CS3-2WIRE-OPT 2-Wire terminal with cover. Used to add up to 80 2-Wire decoders to CS3000 conventionally-wired base model controller

CS3-FL *FLOWSENSE™ option which allows sharing of cloud communication option, programming, flow, and weather data among multiple controllers. Each controller requires a *FLOWSENSE*-compatible communication option such as hardwire (models CS3-M-KIT and CS3-MSSE-KIT) or spread-spectrum radio (model CS3-SR).
<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS3-W-KIT</td>
<td>Weather card and terminal board which allows connection of ET Gage (model ETG), Rain Bucket (model RB-1), Wind Gage (model WG), third-party Rain Switch, and/or third-party Freeze Switch</td>
</tr>
<tr>
<td>CS3-POC-KIT</td>
<td>POC card and terminal board used to add a conventionally-wired POC (master valve and flow meter) to a 2-Wire controller</td>
</tr>
<tr>
<td>CS3-L-KIT</td>
<td>Lights card and terminal board which allows operation of up to 4-independent light circuits</td>
</tr>
</tbody>
</table>

**2-Wire Decoders**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-2W-2ST</td>
<td>2-Wire station decoder with 2-station outputs</td>
</tr>
<tr>
<td>CS-2W-POC</td>
<td>2-Wire point-of-connection (POC) decoder with 1 flow meter input and 1 master valve output</td>
</tr>
<tr>
<td>CS-2W-MOIST</td>
<td>2-Wire Moisture Sensor decoder with 1-station output and attached moisture sensor (coming early 2016)</td>
</tr>
</tbody>
</table>

**Weather Sensors**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETG</td>
<td>ET Gage</td>
</tr>
<tr>
<td>ETGE</td>
<td>Vandal-resistant stainless-steel enclosure for ET Gage (model ETG)</td>
</tr>
<tr>
<td>RB-1</td>
<td>Tipping Rain Bucket</td>
</tr>
<tr>
<td>WG-1</td>
<td>Wind Gage</td>
</tr>
</tbody>
</table>

**Flow Sensors**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM 1B</td>
<td>1-inch brass tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FM 1.25B</td>
<td>1.25-inch brass tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FM 1.5B</td>
<td>1.5-inch brass tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FM 2B</td>
<td>2-inch brass tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FM 1.5</td>
<td>1.5-inch PVC Sch 80 tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FM 2</td>
<td>2-inch PVC Sch 80 tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FM 3</td>
<td>3-inch PVC Sch 80 tee-mounted Flow Meter</td>
</tr>
<tr>
<td>FMBX</td>
<td>Insertion-style Flow Meter for 3-inch and larger pipe. Screws into 2-inch NPT pipe saddle (not included).</td>
</tr>
<tr>
<td>FMI INSERT</td>
<td>Replacement Flow Meter insert for all Flow Meters except for FMBX and FM 2B</td>
</tr>
<tr>
<td>FMIX INSERT</td>
<td>Replacement Flow Meter insert for FMBX and FM 2B</td>
</tr>
</tbody>
</table>

**Transient Protection**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP-110</td>
<td>AC line protection</td>
</tr>
</tbody>
</table>

**Antennas and Communication Accessories**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR-STUBBY</td>
<td>Cellular stubby antenna with 3-ft. antenna cable</td>
</tr>
<tr>
<td>GR-STICK</td>
<td>Cellular stick antenna. Does not include antenna cable.</td>
</tr>
<tr>
<td>WEN-STUBBY</td>
<td>Wi-Fi stubby antenna. Does not include antenna cable.</td>
</tr>
<tr>
<td>Product Name</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ANT-CABLE-WEN</td>
<td>Wi-Fi antenna cable - 3-ft. length</td>
</tr>
<tr>
<td>SR-STUBBY</td>
<td>Spread Spectrum Radio stubby antenna with 3-ft. antenna cable</td>
</tr>
<tr>
<td>SR-STICK</td>
<td>Spread Spectrum Radio omni-directional stick antenna. Does not include antenna cable.</td>
</tr>
<tr>
<td>SR-YAGI</td>
<td>Spread Spectrum Radio directional yagi antenna. Does not include antenna cable.</td>
</tr>
<tr>
<td>SR-FILTER</td>
<td>Spread Spectrum Radio radio frequency filter</td>
</tr>
<tr>
<td>ANT-PROT</td>
<td>Antenna cable surge protection device</td>
</tr>
<tr>
<td>LMR-600-DB</td>
<td>Antenna cable with end connectors for cable lengths greater than 100-ft. Special-order, custom lengths only.</td>
</tr>
</tbody>
</table>

**Replacement Cards and Terminals**

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS3-8STA-C</td>
<td>Replacement 8-station card</td>
</tr>
<tr>
<td>CS3-8STA-T</td>
<td>Replacement 8-station terminal board</td>
</tr>
<tr>
<td>CS3-POC-C</td>
<td>Replacement POC card</td>
</tr>
<tr>
<td>CS3-POC-T</td>
<td>Replacement POC terminal board</td>
</tr>
<tr>
<td>CS3-W-C</td>
<td>Replacement weather card</td>
</tr>
<tr>
<td>CS3-W-T</td>
<td>Replacement weather terminal board</td>
</tr>
<tr>
<td>CS3-L-T</td>
<td>Replacement lights card</td>
</tr>
<tr>
<td>CS3-L-T</td>
<td>Replacement lights terminal board</td>
</tr>
<tr>
<td>CS3-M-C</td>
<td>Replacement hardwire communication card</td>
</tr>
<tr>
<td>CS3-M-T</td>
<td>Replacement hardwire communication terminal board. For wall-mount enclosures only.</td>
</tr>
<tr>
<td>CS3-MSSE-T</td>
<td>Replacement hardwire communication terminal board. For heavy-duty stainless-steel pedestal and double-wide pedestal enclosures only.</td>
</tr>
</tbody>
</table>

**Data Access Service Plans**

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMM-1MN</td>
<td>1-month prepaid data access service plan for 1-cellular modem communicating with 1 or 2 controllers (billed monthly)</td>
</tr>
<tr>
<td>COMM-1MN-M</td>
<td>1-month prepaid data access service plan for 1-cellular modem communicating with up to 35-controllers (billed monthly)</td>
</tr>
<tr>
<td>COMM-1YR</td>
<td>1-year prepaid data access service plan for 1-cellular modem communicating with 1 or 2 controllers (billed annually)</td>
</tr>
<tr>
<td>COMM-1YR-M</td>
<td>1-year prepaid data access service plan for 1-cellular modem communicating with up to 35-controllers (billed annually)</td>
</tr>
<tr>
<td>COMM-5YR</td>
<td>5-year prepaid data access service plan for 1-cellular modem communicating with 1 or 2 controllers (billed every 5-years)</td>
</tr>
<tr>
<td>COMM-5YR-M</td>
<td>5-year prepaid data access service plan for 1-cellular modem communicating with up to 35-controllers (billed every 5-years)</td>
</tr>
</tbody>
</table>
Irrigation Controllers

CS3000

The Calsense CS3000 Irrigation Controller is an important water conservation and management tool. Some of its major water management features include flow monitoring and weather-based irrigation which uses daily evapotranspiration (ET) to automatically calculate station run times based upon landscape details such as plant material, head type, sun exposure. The CS3000 provides a wide range of programming flexibility, including:

- Unlimited programs which can water individual stations or interspersed to maximize system capacity and reduce watering time
- The ability to assign landscape details as plant material, head type, sun exposure to groups of stations to simplify programming of stations with similar characteristics
- Support for managing flow on up to four mainlines and 12-points of connection simultaneously when sharing flow with multiple controllers
- Automatic 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
- Ability to accommodate multiple types of irrigation schedules including irrigating even days, odd days, prescribed days of the week, and interval scheduling ranging from every other day up to every four weeks
- Unique predictive water budget feature which maximizes savings during drought conditions
- 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
- Electrical alerts, such as short circuits and no currents, to help the user troubleshoot field wiring and solenoid problems
- Permanent memory stores all controller programming and setup data, including date and time, in non-erasable memory
- Available in multiple station counts including 8, 16, 24, 32, 40, or 48 stations. If less than 48 stations are purchased initially, additional stations can be added at any time in the field.
- Supports up to 128-stations when using 2-Wire. This can either be 128 2-Wire stations or, when combined with conventional-wired stations, up to 80 2-Wire stations and up to 48 conventional-wired stations.

Flow Monitoring

The CS3000 Irrigation Controller works with the Calsense Flow Meter (model FM) and third-party hydrometers 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 malfunctions or shut down valves.

Since the CS3000 Irrigation Controller uses real-time flow measuring, it monitors and maintains a record of all water usage. Scheduled irrigation usage is recorded on a mainline, point of connection, and station-by-station basis. 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 18.
**Station Groups**

Station Groups, which replace traditional programs, provide a simple method to assign landscape characteristics to multiple stations at one time. For example, a group can be created to manage all of the turf valves which operate rotors in full sun. Each group encapsulates a variety of other settings as well including the irrigation schedule, percent adjust factor, line-fill times, and on-at-a-time rules.

**Daily Evapotranspiration (ET)**

Out of the box, the CS3000 irrigates 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) or the Calsense WEATHERSENSE feature of Command Center Online.

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. Additionally, by using the on-site physical conditions such as plant material, head type, and exposure, the controller automatically determines how long to run each cycle for and soak between cycles to minimize run-off. Using a station adjust factor, each station can be adjusted by the user to compensate for further considerations such as soil conditions.

For more information about the various methods of retrieving real-time ET, see Weather Sensors on page 26.

**2-Wire**

The 2-Wire option, either included at time of purchase or added by calling out the CS3-2WIRE-OPT option provides support for up to 128 2-Wire stations connected to a single controller. This option also provides support for up to six points of connection (POC). Currently, two 2-Wire decoders are available: a POC decoder which can operate a single master valve and flow meter, and a 2-station decoder which can operate up to two irrigation valves. For more information about the 2-Wire option, see 2-Wire on page 11.

**Reports**

The CS3000 Irrigation Controller includes a wide range of water reports available directly at the controller. Available reports include:

- A summary of all usage for each irrigation mainline
- Usage for each point of connection connected to the mainline
- Station-by-station usage
- 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 cloud-based Calsense Command Center Online web application.

**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 2-Wire option provides for up to 11-additional master valve outputs for a total of 12 per FLOWSENSE® chain. For irrigation systems where multiple controllers share one or more master valves, the FLOWSENSE option (model CS3-FL) should be used.
For more information about using multiple master valves on a single controller, see Flow Meters on page 18. For information about Sharing Points of Connections, see page 24.

**Pump Start Output**
The Pump Start output provides a 24-VAC source to activate a pump start relay for systems using a pump circuit to energize a 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 CS3-FL) should be used.

For information about Sharing Points of Connections, see page 24.

**Light, Gate, and Water Features**
The CS3000 Irrigation Controller provides an optional lights feature (model CS3-L-KIT), which is used to operate up to four light, gate, or water feature relays.

For more information about lights, see Lights (model CS3-L-KIT) on page 43.

**Central Control**
The CS3000 Irrigation Controller supports cloud-based central control from any internet-connected device through the Calsense Command Center Online web application. This fully-featured web application provides communication using a variety of internet-connected options including Ethernet, Wireless Ethernet (Wi-Fi), and Cellular modem.

Command Center Online allows the user to monitor and program their controllers, as well as run various water usage reports from any internet-connected device including PCs, tablets, and smart phones. Weather data collected from an ET Gage, Tipping Rain Bucket, or WEATHERSENSE can also be shared to any CS3000 on the system.

Calsense’s cloud-based central control software also includes the ability to turn stations on and off remotely using any internet-connected device including PCs, tablets, and smart phones. Along with the ability to turn on up to six valves simultaneously, it provides real-time flow information, details if a mainline break occurs, real-time weather data if you have an on-site weather devices, and so on. As time goes on, more features will be made available including features that customers request as they find new uses for the product. Customers can e-mail requests directly to ideas@calsense.com.

For more information about the central control options, including supported browsers, see Central Control on page 31.

**Installation**
When choosing a location for the CS3000 Irrigation Controller, consider the accessibility of 120-VAC power wires and the routing of the wires connected to the irrigation remote control valves. 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 a minimum of 15-inches on the left to fully open.

For wall mounting, be sure to mount the CS3000 Irrigation Controller on a flat, secure surface. For best viewing, the liquid crystal display (LCD) should be at eye level of the typical user.
Calsense CS3000 Irrigation Controllers are electrically installed like any standard controller. The controller is supplied with low voltage using a step-down transformer. Factory-labeled terminals are connected to field valve wires, while field common wires are connected to the CS3000 Irrigation Controller commons.

**Figure 1 - Wall-Mounted Gray Box (model -WM)**

**Electrical**

Calsense CS3000 Irrigation Controllers are electrically installed like any standard controller. The controller is supplied with low voltage using a step-down transformer. Factory-labeled terminals are connected to field valve wires, while field common wires are connected to the CS3000 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)
- 56-VA transformer (output - Class 2, rated 24-VAC, maximum total load 2.0A)
- 24-VAC output to valves
- 24-VAC output to master valve
- 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.

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 in conjunction with the master valve or pump start relay. When using 2-Wire, a total of six solenoids can be energized on the 2-Wire path at one time.

Notes

- Any single output may be loaded to 2.0A
- The total load of all outputs must not exceed 2.0A
2-Wire

2-Wire Option (model CS3-2WIRE-OPT)
The Calsense 2-Wire technology provides easy and cost effective installation and expansion of any landscape project using the Calsense CS3000 Irrigation Controller with the Calsense 2-Wire decoder system. Each decoder offers built-in robust lightning and surge protection, making it durable and reliable.

Decoders not only receive commands from the controller but also send real-time information back. Diagnostic information is gathered automatically from each decoder on a continual, real-time basis and recorded and transmitted back to the controller as well as the Command Center Online web application.

Smart technology enables easy assignment of any decoder to a station at the controller in any order after field installation using the serial number of the decoder.

Installation Guidelines
The 2-Wire decoders connect to a 2-Wire cable that runs from the irrigation controller. This 2-Wire cable can either be Regency’s Hunter® Decoder Cable or Paige P7354D. The maximum 2-Wire cable length is 7,000-feet. Up to 6-valves can be energized simultaneously at any point along the 2-Wire cable.

A grounding rod is required every 300-feet along the 2-Wire path as well as a single ground rod at the end of the cable run.

Because the 2-Wire decoder sends electronic pulses back to the controller, all electrical connections must be waterproof and moisture-resistant. Calsense recommends using 3M™ Scotchcast™ 3570G Connector Sealing Packs (formerly 3M Scotchlok™ 3570 Connector Sealing Packs) for all electrical connections including splices along the 2-Wire path.

2-Station 2-Wire Decoder (model CS-2W-2ST)
The 2-Station decoder operates up to 2-solenoids using uniquely colored wires for each station. A single controller can operate up to 128 2-Wire stations, spread across a maximum of 70 physical 2-Station decoders. It is intended that all wire runs between valves and 2-Wire decoders be direct pulls and have no splices except at the decoder location.

The 2-Wire decoders use #14 AWG direct burial wire to connect to remote control valves. The maximum wire run between the decoder and the valve is 100-feet.

Use 3M Scotchcast #3570G-N epoxy packs for ALL wire splices.

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**Figure 2 - 2-Station Decoder Detail (model CS-2W-2ST)**

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11 CS3000 Designer’s Guide
**POC 2-Wire Decoder (model CS-2W-POC)**

The POC decoder operates a single master valve and Calsense Flow Meter (model FM). A single controller can operate up to six POC decoders with a maximum of 12-POCs in a chain of controllers using FLOWSENSE™ technology. It is intended that all wire runs between valves and 2-Wire decoders be direct pulls and have no splices except at the decoder location.

The 2-Wire decoders use #14 AWG direct burial wire to connect to remote control valves. The maximum wire run between the decoder and the flow meter is 20-feet while the maximum wire run between the decoder the master valve is 100-feet.

**Note:** POC Decoders do not support hydrometers at this time.

![Figure 3 - POC Decoder Details (model CS-2W-POC)](image-url)
Transient Protection and Grounding

Transient Protection

The Calsense CS3000 Motherboard, included with each CS3000 controller, prevents transient surges from entering the CS3000 (Figure 4) from the field by offering transient protection on each of the field-replacable modules. Lightning strikes can cause considerable damage to irrigation equipment. The Calsense Motherboard protects against this by using transors, 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 Motherboard supports field-replacable modules which include terminal strips for the connection of the irrigation field wires, 2-Wire cable, and Calsense accessories such as an ET Gage and a Tipping Rain Bucket.

The Calsense Motherboard is pre-mounted in both the wall mount and stainless steel enclosure.

Figure 4 - Wall-Mount CS3000 Motherboard
**Grounding Instructions**

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 copper ground 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 CS3000 Motherboard to the copper ground 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. Braz the wire to the rod for at least one circumference of the rod.

When using 2-Wire decoders, 5/8-inch x 8-foot copper ground rod is required every 300-feet along the 2-Wire path. Additionally, a ground rod must be installed at the end of each 2-Wire cable run.

**WARNING:** Never connect the ground rod or field common to the FM Red on the POC Terminal strip. This will disable the over-current protection and could result in damage to the controller.

**Lightning Warranty**

The 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

Wall-Mounted Gray Box (model WM, WM1, and WM2)
The Calsense Wall-Mounted Gray Box is a completely assembled unit, pre-mounted with a Calsense controller. The box is constructed of weather- and vandal-resistant stainless steel. The unit comes complete with transient and lightning protection and factory-labeled terminals. It also features a security-tight locking mechanism, louvered vents with splash guards, and bee/wasp screens. The -WM1 and -WM2 options include pre-drilled holes for radios antennas for use with controllers using Cellular modem, Wireless Ethernet (Wi-Fi), and Spread Spectrum Radio. All Wall-Mounted Gray Boxes come with 10-year warranties and are fully UL-approved. A minimum of two inches of clearance above the controller is necessary for the door to be removed after installation. Additionally, the door needs a minimum of 15-inches on the left to fully open.

Figure 5 - Wall-Mount Enclosure with Two Antenna Holes (model WM2)
**Heavy-Duty Stainless Steel Enclosure (model S, S1, and S2)**

The Calsense Heavy-Duty Stainless Steel enclosure is a complete factory-assembled unit, pre-mounted with a 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 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 S1 and S2 options include pre-drilled holes for radios antennas for use with controllers using Cellular modem, Wireless Ethernet (Wi-Fi), and Spread Spectrum Radio. All SSE enclosures come with 10-year warranties and are fully UL-approved.

![Figure 6 - Stainless Steel Enclosure with One Antenna Hole (model S1)](image-url)
Heavy-Duty Double-Wide Stainless Steel Enclosure (model SD, SD1, SD2, SD3)

The Double-Wide Heavy-Duty Stainless Steel Enclosure is a complete factory-assembled unit, pre-mounted with a combination of any two Calsense CS3000 Irrigation Controllers (Figure 7). When ordered, the Double-Wide enclosure includes either two CS3000 8-conventional station (model CS3-8-SD) or two CS3000 2-Wire (model CS3-2W-SD) controllers with further expansion available by purchasing station kits. There is also a third model available which includes a single 8-conventional station controller and one 2-Wire controller (model CS3-8-2W-SD).

The enclosure is constructed of weather- and vandal-resistant stainless steel. The unit comes complete with 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 D1 and D2 models include pre-drilled holes for radio antennas for use with controllers using Cellular modem, Wireless Ethernet (Wi-Fi), and Spread Spectrum Radio. All double-wide SSE enclosures come with 10-year warranties and are fully UL-approved.

![Figure 7 - Double-Wide Stainless Steel Enclosure with One Antenna Hole (model SD1)](image-url)
**Flow Meters**

The Calsense Flow Meter enables Calsense CS3000 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 downstream of the Flow Meter tee. 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 CS3000 Irrigation Controller must not exceed 2,000 feet. When using a 2-Wire POC decoder, the flow maximum length of #14 AWG wire between the Flow Meter and decoder is 20-feet.

![Figure 8 - Tee-Type Flow Meter Installation](image)

**Tee-Type Flow Meter (model FM)**

The Calsense Tee-Type Flow Meter is designed for mainlines ranging from 1.5- to 3-inches with both PVC and brass models available. The CS3000 irrigation controller is pre-programmed with all of the settings necessary to operate a Tee-Type Flow Meter out-of-the-box.

**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. It is constructed of brass and bronze hardware and is provided with a bronze 2-inch NPT externally-threaded hex adapter for mounting.
Hydrometers

The Calsense CS3000 also includes native support for Bermad 900-M Reed Switch and Netafim Pulse Reed Switch series hydrometers. Allowable hydrometer sizes range from 1.5" to 10". Reed switches that are supported include 1-pulse per 1-gallon and 1-pulse per 10-gallon switches.

Note: Hydrometers are currently not supported on a 2-Wire path. They must be wired to the POC terminal on the controller.

Flow Meter Details

Flow Meter Sizes

Calsense Flow Meters are available in a variety of models, each supporting a different size. See Table 1.

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, consider using multiple Flow Meters configured as a bypass manifold to read both high and low flowing valves. See Bypass Manifold on page 22 for more information.

<table>
<thead>
<tr>
<th>Flow Meter Size</th>
<th>Minimum Upstream Pipe Length</th>
<th>Minimum Downstream Pipe Length</th>
<th>Pipe Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>10&quot;</td>
<td>5&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>1.25&quot;</td>
<td>12.5&quot;</td>
<td>6.25&quot;</td>
<td>1.25&quot;</td>
</tr>
<tr>
<td>1.5&quot;</td>
<td>15&quot;</td>
<td>7.5&quot;</td>
<td>1.5&quot;</td>
</tr>
<tr>
<td>2&quot;</td>
<td>20&quot;</td>
<td>10&quot;</td>
<td>2&quot;</td>
</tr>
<tr>
<td>3&quot;</td>
<td>30&quot;</td>
<td>15&quot;</td>
<td>3&quot;</td>
</tr>
</tbody>
</table>

**Table 1: Available Flow Meter Sizes and Models**

<table>
<thead>
<tr>
<th>Model</th>
<th>Min Flow (0.5 fps)</th>
<th>Recommended Range</th>
<th>Max Flow (15 fps)</th>
<th>PSI Loss @ gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM-1B</td>
<td>2 gpm</td>
<td>3 gpm</td>
<td>50 gpm</td>
<td>0.5 psi @ 36 gpm</td>
</tr>
<tr>
<td>FM-1.25B</td>
<td>3 gpm</td>
<td>5 gpm</td>
<td>81 gpm</td>
<td>0.5 psi @ 69 gpm</td>
</tr>
<tr>
<td>FM-1.5B</td>
<td>4 gpm</td>
<td>7 gpm</td>
<td>105 gpm</td>
<td>0.5 psi @ 96 gpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Min Flow (0.5 fps)</th>
<th>Recommended Range</th>
<th>Max Flow (15 fps)</th>
<th>PSI Loss @ gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM-1.5</td>
<td>4 gpm</td>
<td>7 gpm</td>
<td>105 gpm</td>
<td>0.5 psi @ 96 gpm</td>
</tr>
<tr>
<td>FM-2</td>
<td>6 gpm</td>
<td>11 gpm</td>
<td>166 gpm</td>
<td>0.5 psi @ 165 gpm</td>
</tr>
<tr>
<td>FM-2B</td>
<td>6 gpm</td>
<td>11 gpm</td>
<td>166 gpm</td>
<td>0.5 psi @ 165 gpm</td>
</tr>
<tr>
<td>FM-3</td>
<td>12 gpm</td>
<td>24 gpm</td>
<td>363 gpm</td>
<td>0.5 psi @ 390 gpm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>Min Flow (0.5 fps)</th>
<th>Recommended Range</th>
<th>Max Flow (15 fps)</th>
<th>PSI Loss @ gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMBX</td>
<td>0.5 fps</td>
<td>1 fps</td>
<td>15 fps</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Table 2: 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 Command Center Online. 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 down or off, every station on the controller indicates this alert.

When used with a Flow Meter, the CS3000 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. For configurations consisting of multiple mainlines, a break on one mainline only affects the points of connection feeding that mainline, allowing other mainlines to continue operating like normal.

Restrictions
Certain hydraulic restrictions should be considered when designing an irrigation system with a Calsense Flow Meter. Since the CS3000 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 CS3000 Irrigation Controller flows. If a loop system exists or there are several irrigation controllers fed off of one mainline, the FLOWSENSE® option should be used to manage the system efficiently. See Sharing Points of Connections on page 24 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 upstream 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.

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:

<table>
<thead>
<tr>
<th>Flow Meter</th>
<th>Maximum Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM-1B</td>
<td>400 psi</td>
</tr>
<tr>
<td>FM-1.25B</td>
<td>400 psi</td>
</tr>
<tr>
<td>FM-1.5B</td>
<td>400 psi</td>
</tr>
<tr>
<td>FM-2B</td>
<td>200 psi</td>
</tr>
<tr>
<td>FM-1.5</td>
<td>100 psi</td>
</tr>
<tr>
<td>FM-2</td>
<td>100 psi</td>
</tr>
<tr>
<td>FM-3</td>
<td>100 psi</td>
</tr>
</tbody>
</table>

Table 3: Maximum Flow Meter Pressure Ratings
Electrical Installation
Wires from the Flow Meter to the CS3000 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. If connecting the Flow Meter to a 2-Wire POC Decoder, the Flow Meter must be within 20-feet of the decoder. The Flow Meter has two wire leads, a black and a red. At the controller, the black wire from the Flow Meter attaches to the GND terminal on the POC terminal strip, while the red wire attaches to FM RED. The Flow Meter wires should be separated from other control wires when pulled up at the CS3000 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 CS3000 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 with 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 22 for more information about using wire splices.

Multiple Flow Meters
The 2-Wire option enables a Calsense CS3000 Irrigation Controller to receive up to 6-separate Flow Meter inputs on projects with more than one water source. Additionally, it supports operation of up to 6-master valves. When reading flow from multiple Flow Meters, the CS3000 not only tallies the readings for reporting purposes, but also provides a breakdown of flow by point of connection to help manage water budgets based on water meter readings.

Bypass Manifold
A bypass manifold enables the controller to measure low flow readings on a large mainline using two or three 2-Wire POC decoders (model CS-2W-POC). It does so by utilizing one or two (Figure 10) 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 the most accurate flow is read across the widest range possible. A single controller may operate a single bypass manifold.

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).

Note: A bypass manifold can only be assembled using 2-Wire decoders. A conventionally-wired POC attached to a POC terminal cannot be used as part of a bypass manifold.
Figure 10 - Three-Tier Bypass Manifold
Sharing Points of Connections

**FLOWSENSE (model CS3-FL)**

The Calsense enhanced *FLOWSENSE*® option, specified as CS3-FL, allows multiple controllers to share an internet-connected central communication option, 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. This sharing is accomplished through a two-way communication link between the controllers in the field, using the Hardwire (models CS3-M and CS3-MSSE) or Spread Spectrum Radio (model CS3-SR) options.

The *FLOWSENSE* technology is designed to allow the user to setup and operate this feature directly in the field with the Calsense CS3000 controller. No other software is required. The *FLOWSENSE* option uses innovative technology to communicate between controllers and manage the proper operation of irrigation valves.

Benefits of the *FLOWSENSE* option include:

- Ability to share a single internet-connected central communication device
- Synchronizes programming across controllers so any controller on the chain can be programmed from any other controller in that chain
- Eliminates the need for additional 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 mainline 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 each mainline. This minimizes the water window; thus, the allowable mainline flow rate is never exceeded, ensuring pumps operate at their capacity and each irrigation mainline functions at maximum efficiency. The user is able to select the maximum mainline 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 CS3000 also introduces the capability of managing flow on up to four mainlines simultaneously. The final result is up to four irrigation mainlines operating at maximum efficiency, all controlled in the field solely by the CS3000 Irrigation Controllers. Additionally, turning on stations by using the manual feature or any internet-connected device including smart phones ensures that, even during programmed irrigation, the maximum capacity of each mainline is not exceeded.

**Flow Monitoring**

Similar to a single controller, *FLOWSENSE* accurately pinpoints valves with high flows caused by broken sprinklers, 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 mainline capacity.
**Communication Options**
Communication between CS3000 controllers is possible using a Hardwire link (models CS3-M and CS3-MSSE), a Spread Spectrum Radio (model CS3-SR), or a combination of the two. This provides maximum flexibility when designing a system spanning a large area.

**Hardwire**
Using the hardwire communication option (models CS3-M-KIT and CS3-MSSE-KIT), the *FLOWSENSE* option links up to 12-controllers using 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 CS3-M-KIT and CS3-MSSE-KIT)* on page 37.

**Spread Spectrum Radio**
Using the Spread Spectrum Radio communication option (model CS3-SR) for *FLOWSENSE* provides the ability to link several CS3000 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 CS3-SR)* on page 36.

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

ET Gage (model ETG)

Using a Calsense ET Gage, CS3000 Irrigation Controllers can use real-time daily evapotranspiration (ET) to calculate station run times automatically. To connect to an ET Gage, the controller must have a weather option (model CS3-W-KIT). The ET Gage is designed to evaporate water at the same rate as tall fescue (Figure 11).

The ET Gage sends daily ET numbers to the CS3000 Irrigation Controller, which stores the last 60-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 CS3000 irrigated, it will total the first three numbers in the table. The controller then multiplies this number by the station’s crop coefficient and distribution uniformity 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 11 - ET Gage installed in Vandal-Resistant Enclosure
Readings from the ET Gage can be shared automatically between CS3000 Irrigation Controllers using FLOWSENSE® technology or the Calsense Command Center Online web application.

Placement of the ET Gage
Placement of the ET Gage is very important. 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.

ET Gage Cable
Use Paige P7171D communication cable, installed in conduit, to connect the ET Gage to a CS3000 controller with the weather option (model CS3-W-KIT). 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 11).

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 T-handle assembly is manufactured from 5/8-inch round 304 stainless steel.
**Tipping Rain Bucket (model RB-1)**

The Calsense Tipping Rain Bucket allows a CS3000 controller with the weather option (model CS3-W-KIT) interface to keep a record of accumulated rainfall (*Figure 13*). 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.

The CS3000 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 CS3000 controllers using *FLOWSENSE* technology or the Calsense Command Center Online web application.

![Rain Bucket Diagram](image)

**Rain Bucket Cable**

The Tipping Rain Bucket is shipped with 25-feet of two-conductor cable. The maximum length of cable is 200-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 CS3-W interface. Runs are to be direct pulls without splices.

**Wind Gage (model WG-1)**

Wind speed can be monitored by a Calsense CS3000 controller using a Calsense Wind Gage (*Figure 14*). The irrigation controller connected to the Wind Gage must have a weather option (model CS3-W-KIT). The Wind Gage sends pulses to the CS3000, which automatically pauses irrigation once the wind speed
exceeds a user-set limit. As wind subsides, the CS3000 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 Calsense Command Center Online; however, it can be shared using the FLOWSENSE® option.

Figure 14 - 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 weather interface. Runs are to be direct pulls without splices.
WEATHERSENSE

WEATHERSENSE is a feature available in the cloud-based Calsense Command Center Online central control software which retrieves real-time evapotranspiration (ET) and rain data without the need for an on-site ET Gage or Rain Bucket. This information can be shared to controllers in the field automatically on a daily basis.

This service provides real-time ET to any location within the United States using aggregated data from more than 25,000 weather stations combined with computer-modeled near-surface weather conditions. The high-resolution modeled data ensures current conditions are accurate even in areas with localized micro climates. Simply enter your controllers’ coordinates or place your controllers on a map using Command Center Online, and you’ll be able to start getting pinpoint weather down to each controllers’ exact latitude and longitude.

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. To take full advantage of the controller’s features, the weather option (model CS3-W-KIT) provides maximum flexibility including individual terminals for rain and freeze sensors. Without this option, some of the controller’s features will be disabled when irrigation is halted due to a rain or freeze event.
Central Control

Command Center Online

Calsense Command Center Online is a cloud-based 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. Engineered for easy and reliable access, all that is needed is a user name and password to start obtaining data from Ethernet, Wireless Ethernet (Wi-Fi) and Cellular controllers in the field.

![Diagram of Command Center Online](image)

Figure 15 - Command Center Online Overview

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.

Calsense provides several flexible options for the communication between the central computer and the field units. The primary ways to communicate with CS3000 controllers are Cellular, Wireless Ethernet (Wi-Fi), and Ethernet. Each of these options can also be shared by a chain of controllers with the FLOWSENSE® option (model CS3-FL) using Hardwire or Spread Spectrum Radio.
Accessible remotely from any internet-connected device, Command Center Online also features the ability to turn stations on and off. Besides the ability to turn on up to six valves simultaneously, it provides real-time flow information, details if a mainline break occurs, real-time weather data if you have an on-site weather devices, and so on. As time goes on, more features will be made available including features that customers request as they find new uses for the product.

The Command Center Online web application 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, Calsense’s own WEATHERSENSE service may be used.

**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 Edge™ 20.0 or higher
  - Microsoft Windows Internet Explorer® 8.0 or higher
  - Google® Chrome™ 34 or higher
  - Mozilla Firefox™ 28 or higher
  - Apple® Safari® 5.1.7 or higher
Communication Options

Calsense offers a wide range of communication options to provide designers with the greatest flexibility and most cost-effective solutions possible when designing a complex system.

Cellular Radio (model CS3-GR)

The Calsense Cellular communication option (model CS3-GR) enables the CS3000 controller to communicate with the Command Center Online web application using the Internet. Figure 16 shows an example of a CS3000 controller communicating with the cloud-based Command Center Online central control software using the CS3-GR option.

This option includes an external radio that connects to the Internet through an access point name (APN) using a current-generation cellular connection such as HSPA+.

Benefits of choosing the Cellular communication option include:

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

![Figure 16 - Cellular Communication](image)

Requirements

To use a Calsense Cellular modem, the following is required:

- A Data Service Access plan purchased from Calsense; see Data Access Service Plans on page 42 for more information
- Cellular coverage at the controller location

Wireless Ethernet (model CS3-WEN)

The Calsense Wireless Ethernet communication option (model CS3-WEN) enables a CS3000 controller to communicate with the Command Center Online web application using an existing Wireless Ethernet (WiFi) network. Figure 17 shows an example of a CS3000 controller communicating with the cloud-based Command Center Online central control software using the CS3-WEN option either wirelessly or connected to an Ethernet network.

This option includes an external device which supports dual-band IEEE 802.11n (802.11a/b/g/n), providing increased wireless speed, improved reliability, and extended transmission range over previous Wireless Ethernet options. The device can be configured directly at the controller and supports IP address assignment via a DHCP server or using a static IP address. The device establishes an outbound
TCP/IP connection from the controller to Command Center Online, allowing a user to remotely monitor and manage their irrigation systems without the recurring charges associated with cellular communications.

The Calsense Wireless Ethernet option includes robust enterprise-level security options including AES, SSL, SSH, and EAP for data encryption and authentication.

Some of the specific security protocols supported include:

- WEP, WPA and WPA2/IEEE 802.11i Security
- CCMP, TKIP, and WEP Encryption
- PSK and IEEE 802.1X Authentication
- LEAP, EAP-TLS, EAP-TTLS, PEAP Enterprise-Level Authentication

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 17 - Wireless Ethernet Communication**

**Requirements**

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

- An existing wireless Ethernet (IEEE 802.11a/b/g/n) infrastructure network
  
  **Note:** 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 TCP port 16001 allowed through any firewalls or routers between the controller and the internet
**Ethernet (model CS3-EN)**

The Calsense Ethernet communication option (model CS3-EN) enables a CS3000 controller to communicate with Command Center Online using an existing Ethernet network. Figure 18 shows an example of a CS3000 controller communicating with the cloud-based Command Center Online central control software using the CS3-EN option.

This option includes an external device with a single Ethernet port. The device can be configured directly at the controller and supports IP address assignment via a DHCP server or using a static IP address. The device establishes an outbound TCP/IP connection from the controller to the Command Center Online web application, allowing a user to remotely monitor and manage their irrigation systems without the recurring charges associated with cellular communications.

Benefits of choosing the Ethernet communication option include:

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

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**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 TCP port 16001 allowed through any firewalls or routers between the controller and the internet

- 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
Spread Spectrum Radio (model CS3-SR)

The Calsense Spread Spectrum Radio communication option (model CS3-SR) enables two or more controllers to communicate with one another 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 19 shows an example of two controllers communicating using spread spectrum radio.

Benefits of choosing the Spread Spectrum Radio communication option include:

- Does not require any trenching or wires
- Provides a communication path for FLOWSENSE® technology to share a single internet-connected communication option, programming information, and flow

Figure 19 - Spread Spectrum Communication

Requirements

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

- Each controller must have the FLOWSENSE option (model CS3-FL)
- A maximum of 12-controllers can be linked using FLOWSENSE technology
- An optional radio survey, to be conducted by Calsense prior to installing any spread spectrum equipment. This service may be requested by a Calsense Sales Representative. This helps ensure adequate coverage at the proposed controller locations.
**Hardwire (model CS3-M-KIT and CS3-MSSE-KIT)**

The Calsense Hardwire communication option (models CS3-M-KIT and CS3-MSSE-KIT) enables communication between two or more controllers using Paige P7171D communication cable. *Figure 20* shows an example of two controllers communicating using Hardwire.

Benefits of choosing the Hardwire communication option are:

- Lowest cost for side-by-side installations
- Provides a communication path for *FLOWSENSE®* technology to share a single internet-connected communication option, programming information, and flow

**Requirements**

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

- Each controller must have the *FLOWSENSE* option (model CS3-FL)
- A maximum of 12 controllers can be linked using *FLOWSENSE* technology
- 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.
- Communication cable direct pulled installed in conduit
- Expansion loops in accordance with appropriate NEC codes for pulls of more than 100-feet (*Figure 21*). Splices are not recommended.
• 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 22).

Figure 21 - Pull Box Detail

Figure 22 - Wire Splice Detail
Communication Accessories

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

Stubby Antenna
Calsense Stubby Antennas are omnidirectional surface-mount antennas designed for all environments and applications. 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 Cellular Stubby Antenna (model GR-STUBBY) is a broadband surface-mount cellular antenna which operates at 3 dBi and 5 dBi, depending on the frequency
- The Calsense Spread Spectrum Radio Stubby Antenna (model SR-STUBBY) is 3 dBi
- The Calsense Wireless Ethernet Stubby Antenna (model WEN-STUBBY) is 3dB-MEG

Note: ANT-CABLE-WEN, purchased separately, is required to connect this antenna to the Wi-Fi device.

Stick Antenna
Calsense Stick Antennas are fiberglass omnidirectional antennas used to extend the range of a radio (Figure 23).

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 Cellular Stick Antenna (model GR-STICK) is a broadband cellular antenna which operates at 0 dBi and 3 dBi, depending on the frequency
- The Calsense Spread Spectrum Radio Stick Antenna (model SR-STICK) is often recommended in situations of poor coverage. 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 23).

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 Spread Spectrum Radio Yagi Antenna (model SR-YAGI) is 6 dBi
Figure 23 - Antenna Mounting - Stick and Yagi

NOTES:
1) Galvanized pole, nipples and fittings to be 2 inch.
2) When mounting a stick whip antenna and a yagi antenna at the top of the pole and the yagi must be mounted at least one foot below the stick whip antenna.
3) Vapor wrap antenna cable where it comes out of the bell reducer and also where it connects to the antenna.
4) Concrete base to be at least 18 inches by 36 inches
5) Mounting brackets and vapor wrap are included with antenna.
**Spread Spectrum Radio Filter (model SR-FILTER)**

The optional 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 may be required when using a either a SR-STICK or SR-YAGI antenna.

![Spread Spectrum Radio Filter](image)

**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, SR-STICK, and SR-YAGI antenna.

![Antenna Cable Surge Protector](image)
Data Access Service Plans

Calsense offers 1-month, 1-year, and 5-year prepaid data access service plans for use with the Cellular modem (model CS3-GR) communication option. These prepaid plans allow the use of cellular service 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 plan. The multiple controller plans support up to 35-controllers (12 if using CS3000 controllers) sharing a single access service plan.

Note: A multiple controller plan is required for cellular radios connected to a chain of two or more controllers.

The Calsense Data Access Service is offered in 6 varieties:

- **COMM-5YR** provides one or two 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 one or two controllers with 12-consecutive months, or one year, of data communication service
- **COMM-1YR-M** provides multiple controllers with 12-consecutive months, or one year, of data communication service
- **COMM-1MN** provides one or two controllers with one month of data communication service
- **COMM-1MN-M** provides multiple controllers with one month of data communication service
Calsense

Lights

Lights (model CS3-L-KIT)
The Calsense CS3000 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 can be ordered using the CS3-L-KIT model number. This option includes the hardware and firmware for four isolated light circuits. The Lights schedules operate independently from the irrigation programs. The output is 24-volt AC (VAC) and is used to operate a relay (Figure 26). Each lights output has a 14-day rolling schedule with two start and stop times during each 24-hour period.

Figure 26 - Lights Relay Wiring