TORO Count on it.

Sentinel® Design Guide:
A Specification Resource

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What is Sentinel?

The Toro Sentinel system is composed of both irrigation controller satellites and software to control those satellites. The Sentinel WMS software, installed on a Windows® computer workstation or computer server (henceforth referred to as "the central"), can communicate with up to 999 Sentinel satellites. The Sentinel satellite retains program information and performs irrigation schedules without the central in constant communication with the satellites. Each Sentinel satellite has the capability to operate up to 204 individual valves via conventional wiring, two-wire or spread spectrum 900mhz output boards. Sentinel controllers can run individual irrigation stations based on standard programming, soil moisture sensors, or evapotranspiration.

Basic Controller Program Features

- 16 programs per field satellite
- 8 start times per program
- Repeats & soak time by program or station
- ET-based control by program
- Precipitation rates and plant factor adjustments by station
- Soil moisture control by program
- Up to 16 soil moisture sensors per satellite
- Rain Off from 0 to 250 days by controller, program or station, across the system.
- Percent Scale from 0–255% by controller, program or station, across the system.

Ethernet Ready

Each Sentinel satellite controller comes standard with a Cat5 Ethernet port. The Ethernet port allows for direct connectivity from a network system or cellular data modem. The Sentinel Ethernet port can be configured to a static IP, subnet and default gateway required by the customer's network.

Hand-Held Ready

Sentinel satellite controllers can be operated manually via a web-enabled smart phone, (applies when the Sentinel controller is connected via Ethernet network Cat5 cable), or via a Sentinel UHF radio hand-held unit. Hand-held control allows the user to manually activate stations or programs, quick advance station to station, cancel individual station operation or entire controller, clear alarms, and set stations in rain delay.

Soil Moisture Sensing

Each Sentinel satellite controller comes with a connector to add a Pro Series wireless soil moisture sensor base station. By adding the Pro Series wireless base station, the Sentinel satellite reads up to 16 Pro Series wireless soil moisture sensors wirelessly in the field. The communication is via 900Mhz spread spectrum communications for exact desired placement in the field. When using Pro Series wireless soil moisture sensors, the Sentinel satellite controller will automatically learn moisture values, then allow the operator to set both low and high thresholds by program for automatic moisture control. Soil moisture sensors can be used in conjunction with ET with Sentinel.

Evapotranspiration (ET)

The Sentinel controller irrigates based on real-time evapotranspiration (ET) allowing the controller to automatically calculate each station's run time before irrigation begins. This ET data comes from Toro's Precision® ET, an on-site weather station or from historical evapotranspiration data.

Flow Sensing

The Sentinel irrigation controller works with the Toro Flow Sensor (model series TFS) and other pre-approved sensors to continuously monitor real-time flow through the irrigation mainline, 24 hours a day. This feature detects and alerts the user to mainline and lateral line breaks, high flows caused by broken risers and pipes on each individual station, low flows and zero flow due to malfunctioning or shut down valves.

Flow Optimization

The Sentinel WMS software allows the user to setup a hydraulic tree for individual or groups of controllers. Irrigation stations within programs are automatically assigned to run at optimum flow allowances. Flow optimization can work automatically in conjunction with daily evapotranspiration changes.

Reports

The Sentinel WMS software provides several automatically generated reports including:

- Daily Alarms by Station
- Day, Week, Month & Year Water Usage
- Daily ET
- Daily Rainfall
- Daily Station Runtimes

Sentinel satellite controller reports log to a pre-assigned computer folder on a workstation or server for permanent storage and retrieval. These reports automatically email out to select users by individual controller assignment. Reports automatically export to a customized Excel file for detailed analysis of actual water usage to budgeted, actual ET & rainfall to historical amounts and annual financial savings.

WS1 - Wall Mount Powder-Coated Small Metal Cabinet

Stations:
  12, 24, 36, 48 (conventional)

Dimensions:
  10¼" W x 15¼" H x 5¼" D
  (260 x 387 x 133 mm)

Electrical:
  Input power: 120 VAC, 60 Hz
  Station Output Power: 24 VAC
  1.0 Amp per station
  2.0 Amp total load

Surge protection:
  24 V output boards,
  6 KV @ 10 KV

WS2 - Wall Mount Powder-Coated Metal Cabinet

Stations:
  204 (Two-Wire)

Dimensions:
  14" W x 13" H x 6" D
  (355 x 330 x 152 mm)

Electrical:
  Input power: 120 VAC, 60 Hz or
  220/240 VAC (50/60 Hz)
  Station Output Power:
  Up to 38 VAC maximum
  3.0 Amps maximum output

Surge protection:
  on decoder cable, grounding
  every 1,000' (305 m)
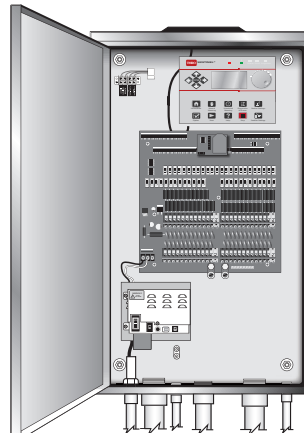
WS5 - Stainless Steel Wall Mount

Stations:
  12, 24, 36, 48 (conventional)
  60, 72, 84, 96 (special build)
  204 (Two-Wire)

Dimensions:
  17⅛" W x 30¾" H x 8 5/8" D
  (435 x 781 x 219 mm)

Electrical:
  Input power: 120 VAC, 60 Hz
  Station Output Power: 24 VAC
  1.0 Amp per station
  2.0 Amp total load

Surge protection:
  24 V output boards,
  20 KV @ 10 KV
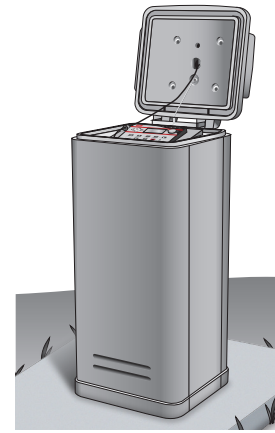
PP1 - Plastic Pedestal (Green)

Stations:
  12, 24, 36, 48 (conventional)
  60, 72, 84, 96 (special build)
  204 (Two-Wire)

Dimensions:
  17" W x 40" H x 16" D
  (432 x 1016 x 406 mm)

Electrical:
  Input power: 120 VAC, 60 Hz
  Station Output Power: 24 VAC
  1.0 Amp per station
  2.0 Amp total load

Surge protection:
  24 V output boards,
  20 KV @ 10 KV

PS1 - Stainless Steel Pedestal

Stations:
  12, 24, 36, 48 (conventional)
  60, 72, 84, 96 (special build)
  204 (Two-Wire)

Dimensions:
  17⅛" W x 30¾" H x 8 5/8" D
  (435 x 781 x 219 mm)

Electrical:
  Input power: 120 VAC, 60 Hz
  Station Output Power: 24 VAC
  1.0 Amp per station
  2.0 Amp total load

Surge protection:
  24 V output boards,
  20 KV @ 10 KV

Additional cabinet sizes are available through Toro Custom Build services. Contact Toro for more information: 951-785-3381.

Sentinel Satellite Controller

Sentinel satellite controllers communicate directly with the Sentinel WMS software when connected via UHF radio, ethernet cat5 cable, or cellular data modem. A Sentinel satellite controller can pass communications through its on-board UHF radio to other Sentinel controllers that are within radio range (radio site survey required).

Sentinel front

Sentinel back

Handheld remote

Rain sensor

Rain bucket

Cellular

Decoder

Flow sensor

Valves
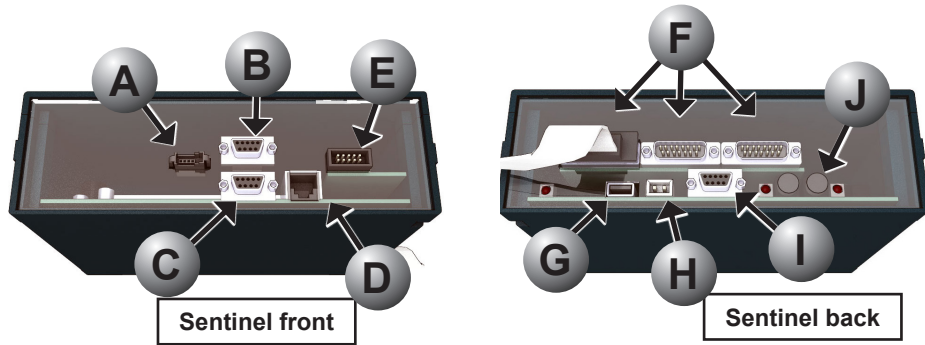
Moisture sensor

Sentinel Controller Legend	
Letter	**Description**
A	Soil moisture receiver connector
B	front serial port
C	data retrieval port / flow sensor
D	ethernet port
E	UHF radio port
F	station outputs
G	USB port
H	power input
I	back serial port
J	fuse holders

Sentinel Controllers

The Sentinel controller can activate remote control valves wired, wirelessly (spread spectrum), or by two-wire.

Wired:
(communication within the same enclosure)
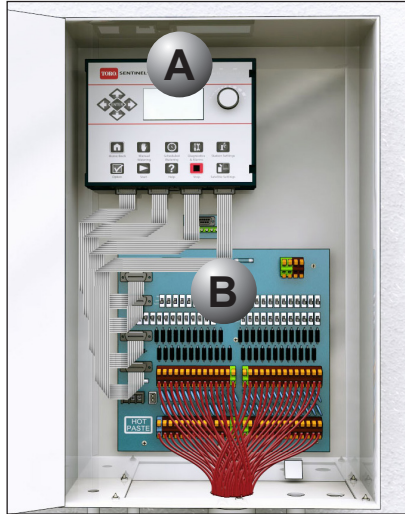
Wireless Short-range:
(communication within the same enclosure)
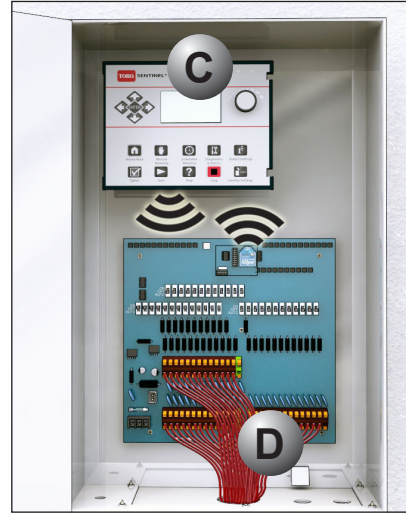
2-Wire:
(communication via 2-wire path)
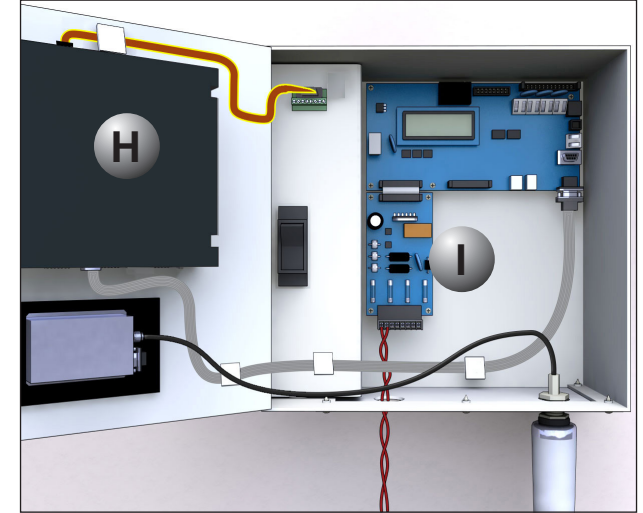
Wireless Long-range:
(communication from one satellite to another)

Radio: XTend RF module

Range dependant on site survey. Contact Toro for details.

Letter	Description
A	Timing Module
B	48-station conventional-wired cabled output boards
C	Timing Module with short-range wireless modem
D	36-station conventional-wired output boards with short-range wireless modem
E	Timing Module with short-range and long-range wireless modems
F	12-station conventional-wired output boards with short-range wireless modem
G	48-station conventional-wired output board with long-range wireless modem
H	Timing Module
I	2-Wire Output Boards

Toro's Sentinel controllers come in 3 different models: **Conventional-wired with Faceplate**, **Conventional-wired No Faceplate**, and **Two-Wire**. The No-Faceplate and Two-Wire models are identical to the Standard model except as noted below.

Conventional-wired with Faceplate

The Sentinel satellite controller comes standard with a programmable faceplate. From the faceplate most programming is accessible. The Sentinel satellite controller can also be programmed entirely from the Sentinel WMS software. In the field, the Sentinel software is accessible via NSN Connect on a web-enabled device. The satellite controllers retain all program information and current time during extended power outages.

Conventional-wired Faceplate Sentinel satellite controllers come standard with:

- 2 Serial Ports
- Cat5 Ethernet Port
- Soil Moisture Sensing Connection
- USB Connection
- UHF Radio Connection
- Data Retrieval Port – 2 Flow & Contact Sensor
- Station Output Connections (Conventional Wire Only)
- Conventional or Wireless Output Boards
- 1 GB of memory
- Large multi-line LCD
- Quick input dial
- Status identification lights
- Diagnostics from the faceplate
- Radio test from the faceplate
- Firmware updates from the faceplate
- 3-way switches on output board
- Secondary surge protection on output board

Station Counts

All Sentinel satellite controllers are capable of operating up to 204 irrigation stations. Sentinel conventional-wired controllers are available in 12, 24, 36 and 48 stations. Conventional-wired controllers using wireless output boards can operate up to 96 stations through Toro's Sentinel custom builds.
Contact Toro for more information: 951-785-3381.

With the addition of a 900 MHz spread spectrum radio, Sentinel satellite controllers can operate additional stations, up to 204. (See section on output board communication.)

Sentinel satellite controllers communicate to the output boards either directly via ribbon cables (p.7, Wired) or wirelessly using spread spectrum radio.

Program Features

Conventional-wired Faceplate Sentinel satellite controllers can be programmed entirely from the faceplate to perform irrigation without any Sentinel WMS software. The satellite controllers retain all program information and current time during extended power outages.

- 16 programs per field satellite
- 8 start times per program
- Repeats & soak time by program or station
- ET-based control by program
- Precipitation rates and plant factor adjustments by station
- Soil moisture control by program
- Up to 16 soil moisture sensors per satellite
- Rain Off from 0 to 250 days by controller, program or station, across the system.
- Percent Scale from 0–255% by controller, program or station, across the system.

Typical Standard Spec:

SB24WS1U
- 24-station Sentinel Controller
- Faceplate
- Powder-coated Steel Wall-Mount
- UHF Radio
- Ethernet ready
- Soil sensing ready

See Specifications page 36.

Conventional-wired with Faceplate

Powder-coated Wall Mount

- Small painted wall-mount enclosure
- Level three surge protection
- Onboard network connection

- Onboard Pro Series wireless soil sensing connection
- UHF radio
- ATX antenna

wired

Part Number	Station Count
SB12WS1U	12
SB24WS1U	24
SB36WS1U	36
SB48WS1U	48
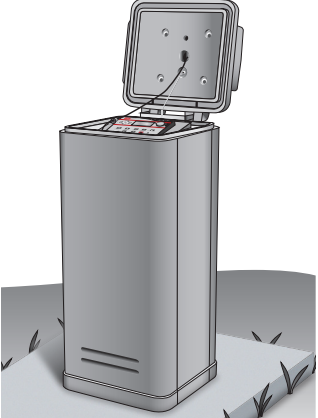
wireless

Part Number	Station Count
SBW12WS1U	12
SBW24WS1U	24
SBW36WS1U	36
SBW48WS1U	48

Green Plastic Pedestal Mount

- Green plastic pedestal mount enclosure
- Level three surge protection
- Onboard network connection

- Onboard Pro Series wireless soil sensing connection
- UHF radio
- VRA antenna

wired

Part Number	Station Count
SB12PP1U	12
SB24PP1U	24
SB36PP1U	36
SB48PP1U	48

wireless

Part Number	Station Count
SBW12PP1U	12
SBW24PP1U	24
SBW36PP1U	36
SBW48PP1U	48

Stainless-steel Wall Mount

- Large stainless steel enclosure
- Level three surge protection
- Onboard network connection

- Onboard Pro Series wireless soil sensing connection
- UHF radio
- VRA antenna

wired

Part Number	Station Count
SB12WS5U	12
SB24WS5U	24
SB36WS5U	36
SB48WS5U	48

wireless

Part Number	Station Count
SBW12WS5U	12
SBW24WS5U	24
SBW36WS5U	36
SBW48WS5U	48

Stainless-steel Pedestal Mount

- Large stainless steel enclosure
- Level three surge protection
- Onboard network connection

- Onboard Pro Series wireless soil sensing connection
- UHF radio
- VRA antenna

wired

Part Number	Station Count
SB12PS1U	12
SB24PS1U	24
SB36PS1U	36
SB48PS1U	48

wireless

Part Number	Station Count
SBW12PS1U	12
SBW24PS1U	24
SBW36PS1U	36
SBW48PS1U	48

Conventional-wired No Faceplate

Toro's "No Faceplate" Sentinel controller is identical to the Conventional-wired Faceplate Sentinel satellite controller in performance and capabilities except that all programming is from the Sentinel WMS software. The No-Faceplate option saves money on hardware and provides more program security in the field. Three-way switches on the output boards allow for manual operation of individual stations in the field. Hand-held functions remain the same as with standard Sentinel satellite controller.

Station Counts

All Sentinel satellite controllers are capable of operating up to 204 irrigation stations. No-Faceplate Sentinel conventional-wired controllers are available in 12, 24, 36 and 48 stations. Conventional-wired controllers using wireless output boards can operate up to 96 stations through Toro's Sentinel custom builds. Contact your local Toro Sentinel distributor for more information: 951-785-3381.

With the addition of a 900 MHz spread spectrum radio, Sentinel satellite controllers can operate additional stations, up to 204. (See section on output board communication.)

No-Faceplate Sentinel satellite controllers communicate to the output boards either directly via ribbon cables (p.7, Wired) or wirelessly using spread spectrum radio.

Typical "No Faceplate" Spec:

SBN24WS1U
- 24-station Sentinel Controller
- No Faceplate
- Powder-coated Steel Wall-Mount
- UHF Radio
- Ethernet ready
- Soil sensing ready

See Specifications page 36.

The Sentinel No Faceplate typically comes in a small, painted wall-mount enclosure (illustration, left).

Powder-coated Wall Mount

Features:

- Small painted wall-mount enclosure
- Level three surge protection
- Onboard network connection
- Onboard Pro Series wireless soil sensing connection
- UHF radio
- ATX antenna

wired / **wireless**

Part Number	Station Count	Part Number	Station Count
SBN12WS1U	12	SBWN12WS1U	12
SBN24WS1U	24	SBWN24WS1U	24
SBN36WS1U	36	SBWN36WS1U	36
SBN48WS1U	48	SBWN48WS1U	48

Program Features

No-Faceplate Sentinel satellite controllers must be programmed using Sentinel WMS software. The Sentinel software is accessible in the field using NSN Connect on a web-enabled device. The satellite controllers retain all program information and current time during extended power outages.

- 16 programs per field satellite
- 8 start times per program
- Repeats & soak time by program or station
- ET-based control by program
- Precipitation rates and plant factor adjustments by station
- Soil moisture control by program
- Up to 16 soil moisture sensors per satellite
- Rain Off from 0 to 250 days by controller, program or station, across the system.
- Percent Scale from 0–255% by controller, program or station, across the system.

Two-Wire Decoder

Toro's Two-Wire Decoder Sentinel controllers are identical to the Conventional-wired Faceplate Sentinel satellite controllers in performance and capabilities except that signals for valve control are sent over a dedicated two-wire path to Toro decoders. Sentinel satellite controllers operate either AC-powered valves or DC-latching solenoids depending on model of controller specified.

Sentinel AC Two-Wire Features

- Operates up to 204 stations standard
- Up to 8 solenoids operate simultaneously
- 5000' to furthest valve (using #14/2 gauge wire)
- 7400' to furthest valve (using #12/2 gauge wire)
- (2) Two-Wire path outputs
- Ethernet ready
- Hand-held ready

- Operates AC-actuated solenoids
- 1, 2 & 4 station decoders

- 10,000' loop (using #14/2 gauge wire)
- 14,000' loop (using #12/2 gauge wire)
- Programmable decoder addresses
- Soil moisture sensing ready
- Grounding every 600'

Sentinel DC Two-Wire Features

- Operates up to 204 stations standard
- Toro or Irritrol valves come standard with AC or DC solenoids
- 1, 2 & 4 station decoders

- (4) Two-Wire path outputs standard; up to (8) available with additional daughter board
- Soil moisture sensing ready
- Grounding every 1000'

- Operates DC-latching solenoids
- Up to 16 stations operate simultaneously
- 15,000' to furthest valve (using #14/2 gauge wire)
- Ethernet ready
- Hand-held ready

Features common to all 2-wire models:

- 204-station count
- Remote and flow-sensor ready
- Soil moisture sensing ready
- Ethernet ready

Station Counts

Sentinel Two-Wire Decoder satellite controllers are all capable of operating up to 204 irrigation stations. If not connecting to all 204 stations via two-wire, the addition of a 900 MHz radio will operate additional wireless output board stations, up to 204. (See section on output board communication.)

Program Features

The Sentinel Two-Wire satellite controller can be programmed from the faceplate or Sentinel WMS software. The Sentinel software is accessible in the field using NSN Connect on a web-enabled device. The satellite controllers retain all program information and current time during extended power outages.

- 16 programs per field satellite
- 8 start times per program
- Repeats & soak time by program or station
- ET-based control by program
- Precipitation rates and plant factor adjustments by station
- Soil moisture control by program
- Up to 16 soil moisture sensors per satellite
- Rain Off from 0 to 250 days by controller, program or station, across the system.
- Percent Scale from 0–255% by controller, program or station, across the system.

See Specifications pages 37 and 38.

Two-Wire Field Controller Models

**Powder-coated
Wall Mount**

**Green Plastic
Pedestal Mount**

**Large Stainless Steel
Wall Mount**

**Stainless Steel
Pedestal Mount**

AC Sentinel 2-Wire and Parts	
Part Number	**Description**
SBAWS1U	AC powder-coated wall mount
SBAWS5U	AC large stainless steel wall mount
SBAPP1U	AC green plastic pedestal mount
SBAPS1U	AC stainless steel pedestal mount
SB-DAC-1	1-station decoder AC
SB-DAC-2	2-station decoder AC
SB-DAC-4	4-station decoder AC
SB-BLA	AC in-line surge protection

DC Sentinel 2-Wire and Parts	
Part Number	**Description**
SBDWS2U	DC powder-coated wall mount
SBDWS5U	DC large stainless steel wall mount
SBDPP1U	DC green plastic pedestal mount
SBDPS1U	DC stainless steel pedestal mount
SB-DDC-1	1-station decoder DC
SB-DDC-2	2-station decoder DC
SB-DDC-4	4-station decoder DC
SB-DEC-SG-Line	DC surge arrestor

Part Numbers explained:

SBA – AC station output
SBD – DC station output
WS1 – Powder-coated Wall Mount (Small)
WS5 – Stainless Steel Wall Mount (Large)

PS1 – Stainless Steel Pedestal Mount
PP1 – Plastic Pedestal Mount
U – UHF radio

Typical 2-Wire Spec:

SBAWS1U
- 204-station Sentinel Two-Wire AC Controller
- Faceplate
- Medium Powder-coated Steel Wall-Mount
- UHF Radio
- Ethernet ready
- Soil sensing ready

📝 See Specifications pages 37 and 38.

📝 If using a non-Toro DC-latching solenoid valve, verify compatibility with Toro: 951-785-3381.

📝 Sentinel 2-Wire valve part numbers are on page 30.

Two-Wire Field Controller
Wire and Grounding Recommendations

Wiring

Wiring should be polyethylene double-jacketed or UF-B UL PVC double-jacketed two-conductor solid core designed for direct burial with insulation 3/16 inch (.060") thick, high density, sunlight resistant incased in an outer jacket of Polyethylene or PVC conforming to ICEA S-GL-402 or NEMA WC5, having a minimum wall thickness of .045 inches.

✎   Single strand 14 Gauge PVC irrigation wire has NOT proven to be reliable. The PVC insulation isolation is soft and easily damaged. Any break or nick in the insulation, no matter how small, will eventually cause the wire to fail. All wire insulation shall be intact and free of nicks and cuts.

ALL wire connections need to be ABSOLUTELY water tight.
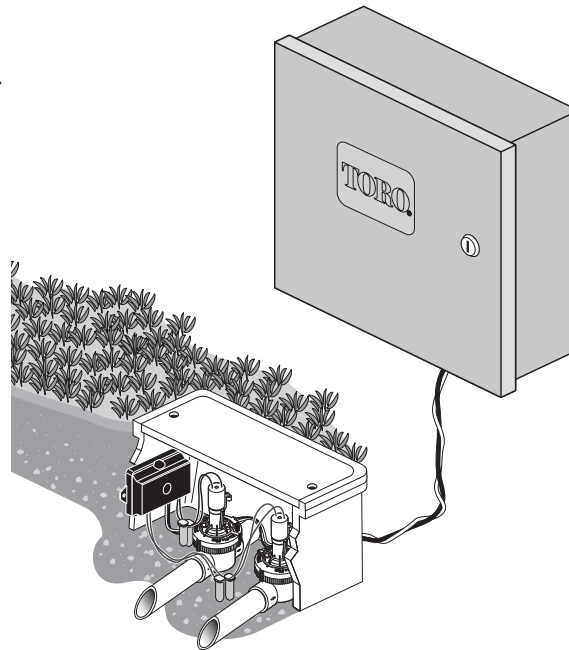
Wiring Sizes:

Standard wire lengths for straight-line installation; i.e., wire distance to the furthest device without any loop:

Wire Size (gauge):	#14	#12
Total Loop Wire Length (ft) – Distance to furthest AC valve	10,000	14,800
Total Straight Run Wire Length (ft) – Distance to furthest AC valve	5000	7,400
Total Straight Run Wire Length (ft) – Distance to furthest DC valve	15,000	

✎   Wire size chart is provided for reference only.
#14Ga wire or larger is always recommended as specified above.

Grounding

1. All grounding rods should be bare copper of 5/8" diameter or greater, and 8' length or greater.

2. All grounding plates should be 5 square feet, typically 4" by 96", as outlined in ASIC Earth Grounding Guideline 100-2002.

3. A measured resistance reading of no more than 25 ohms is necessary at each (Lightning Arrestor). ASIC Spec: Section 7.0 – Measuring resistance, item A.

Ground rods and plates should be located at a minimum distance to assure that the two-wire path is outside of the electrode sphere of influence for the grounding rod. For an 8' grounding rod, this means that the grounding rod must be connected at least 8' away from the two-wire path and at a right angle to the two-wire path. (Under no circumstance should a ground rod or ground plate be installed in or under a valve box, meter box or electrical box.)
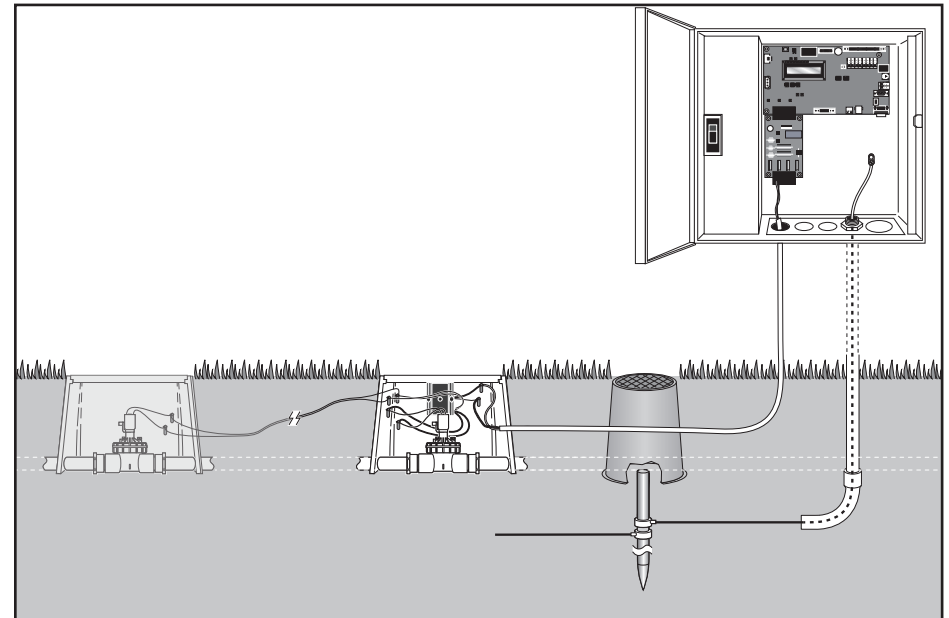
Sentinel 2-Wire controller showing wire paths, decoders, and grounding

Ethernet

Ethernet allows for remote connection from the central computer into a Communication Termination Module (CTM) or to any Sentinel satellite controller. Sentinel satellite controllers are equipped with a Cat5 Ethernet port configurable to a static IP address, subnet and gateway. Cellular data modems connect via the on-board Ethernet or serial port on the Sentinel satellite controller.

Cellular Technology

Data Modem (U.S.)

Cell Data Modems connect either direct to a Sentinel satellite controller or Communication Termination Module (CTM). This provides wireless internet connectivity to the Sentinel device. It is best to use the Cat5 Ethernet port on the cellular data modem to the Sentinel satellite controller or CTM. This provides for the fastest data transfer possible from the Sentinel WMS software to the device. Data service can be through Verizon, ATT or Sprint. Signal strength must be verified from the desired carrier prior to installation. The modems are obtained through your local authorized Toro Sentinel distributor.

Recommended Modem
Sierra Wireless LS300 Gateway Modem

Part Number	Description
SCT_TORO_LSE_ATT	LS300 modem with AT&T service
SCT_TORO_LSE_VZW	LS300 modem with Verizon service
SCT_TORO_LSE_SPCS	LS300 modem with Sprint / PCS service

UHF Radio

Sentinel UHF radios provide wireless communications over a contiguous site. The central computer either direct connects with a serial cable to the CTM (Communication Termination Module) or remotely via Ethernet or cell data modem to operate the base radio. Depending on the installation location of the CTM, the range of radio signal varies to the Sentinel satellite controller. A radio site survey is required to determine a frequency and signal strength. An FCC license is required to operate UHF radio. Sentinel satellite controllers can be specified with the UHF radio and antennas pre-installed.

✎ Contact your local authorized Toro Sentinel distributor for UHF radio site survey information.

Wi-Fi

Sentinel satellite controllers can operate using Wi-Fi network adapters. Within a Wi-Fi operating system, a Wi-Fi network adapter connected to the on-board Ethernet port on the Sentinel satellite controller provides communication. A static IP address is not required to operate with this device.

Recommended Modems
- Netgear WNCE2001
- Lantronix WiBox
- Lantronix PremierWave

900 MHz Spread Spectrum

A 900 Mhz spread spectrum radio (SB-RAD-XTND-SAM) direct connected via serial cable from the Sentinel central computer communicates to 900 Mhz spread spectrum Sentinel satellite controllers in the field. Range of distance and signal strength are determined by a 900 MHz spread spectrum radio site survey. Appropriate antennas are determined from the site survey. Contact your local authorized Toro Sentinel distributor for more information.

✎ Contact your local authorized Toro Sentinel distributor for spread spectrum radio site survey information.

Part Number	Description
SB-RAD-XTND-SAM	Long-range 900 MHz spread spectrum radio

Telephone (landline)

Analog phone communication allows for connection to a Communication Termination Module (CTM) or directly to a Sentinel satellite controller. An external Sentinel phone modem (SB-PM) is specified with the Sentinel device. Analog phone service must be available at the central computer and also at the Sentinel field device location. The phone modem connects directly to the Sentinel CTM or satellite controller via serial cable provided with the Sentinel phone modem.

Part Number	Description
SB-PM	Phone modem

Method of Communication

Ethernet to satellite

Cellular IP modem (USA) / GSM Modem (Europe)

CTM

Sentinel WMS software

WiFi network

Wi Fi

900 MHz modem

High Gain Yagi Antenna

Phone modem

Sentinel satellite controller
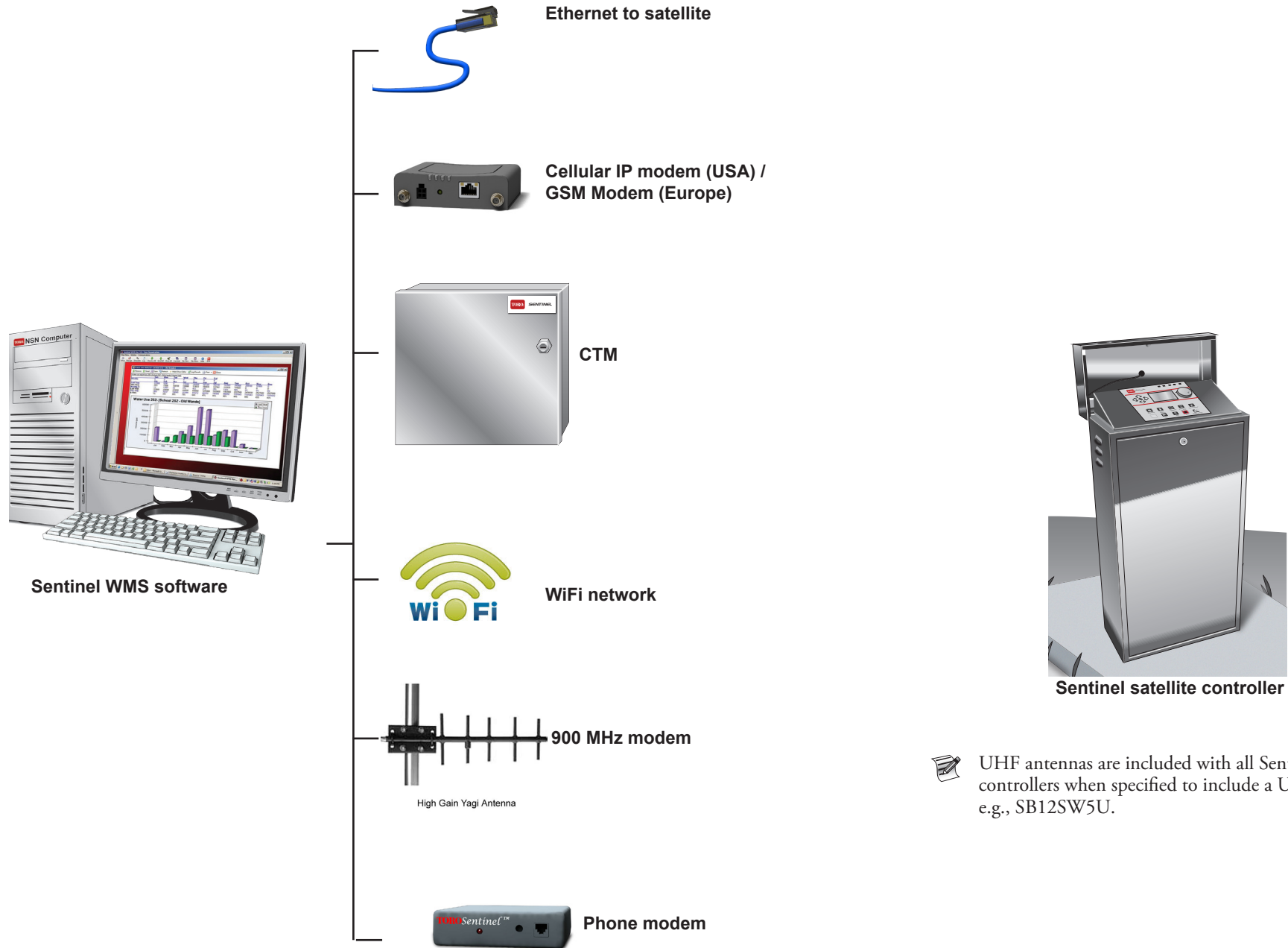
UHF antennas are included with all Sentinel controllers when specified to include a UHF radio; e.g., SB12SW5U.

Communication Termination Module (CTM)

The Communication Termination Module (CTM) provides a bridge between an initial communication of Ethernet Cat-5 or cellular data to UHF radio. The CTM is housed in an outdoor, stainless steel wall-mount cabinet and includes the connections for Ethernet Cat-5 and serial cables.

A
B
C
D

Small metal wall mount for CTM
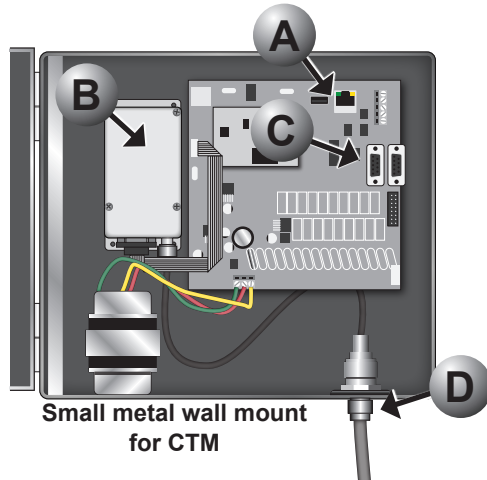
CTM Legend	
Letter	**Description**
A	ethernet port
B	UHF radio
C	serial connector
D	BNC connector

📝 See Specifications pages 37 and 38.

Sentinel controller

5 dB gain UHF omni-directional antenna

Serial cable

The CTM PN: SB-CTM-WS3

Ethernet

Central computer

Cellular data

50' coaxial antenna cable
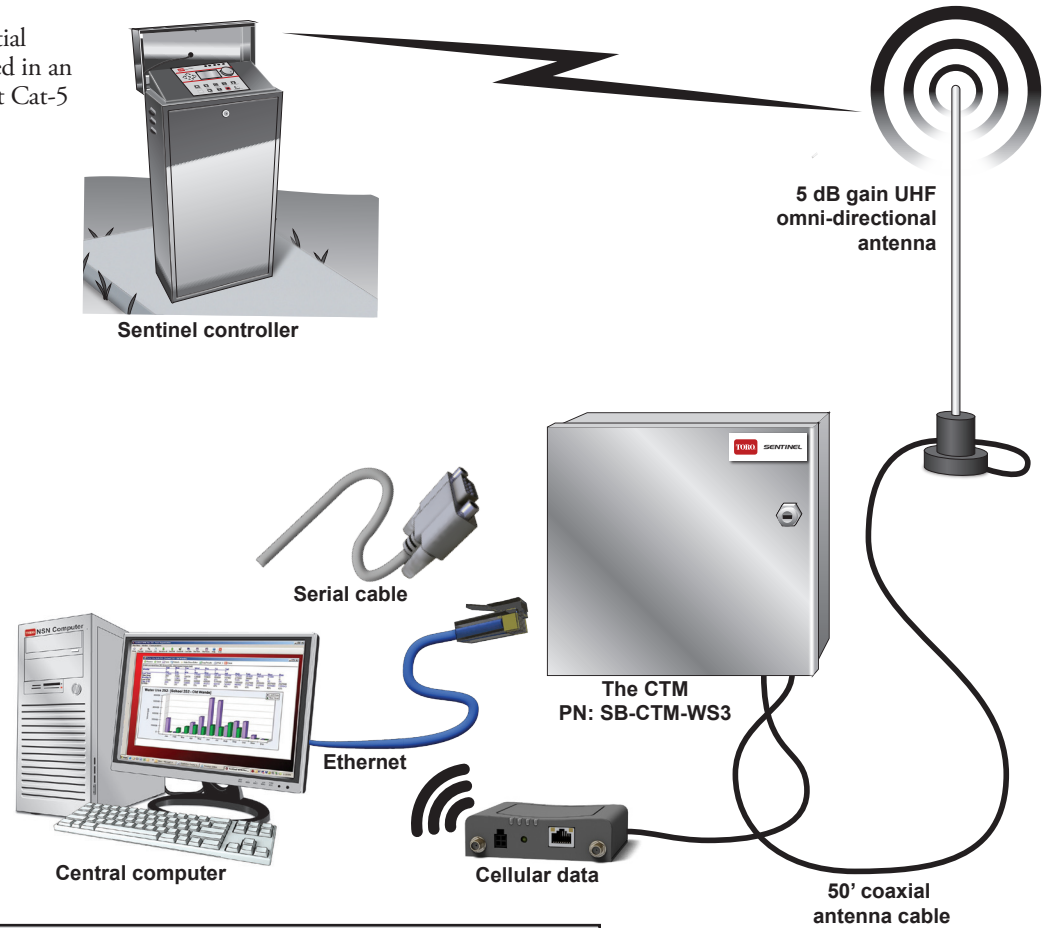
How a CTM Boosts Broadcast Range

1 Sentinel software communicates with CTM via ethernet or other method (see illustration top-right).

2 CTM communicates with all satellites.
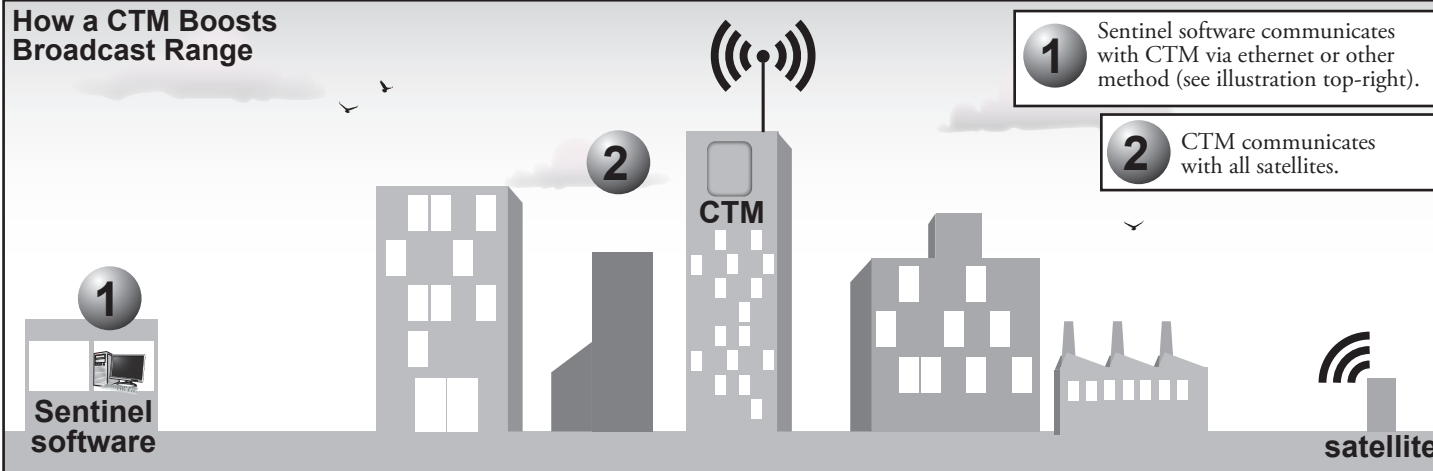
📝 Sentinel WMS software can communicate to an unlimited number of Communication Termination Modules (CTMs).

1 Sentinel software

2

CTM

satellite

16

Communication Devices to Sentinel Satellites

Communication between Sentinel software and satellite controllers can be any combination of these technologies.

Example: Software communicates to one controller via ethernet and another via UHF radio.

Ethernet

Cellular modem

Sentinel satellite controller

UHF radio

Sentinel WMS software

Ethernet

Cellular modem

Serial cable

Communication Termination Module (CTM)

Sentinel satellite controller

Sentinel satellite controller
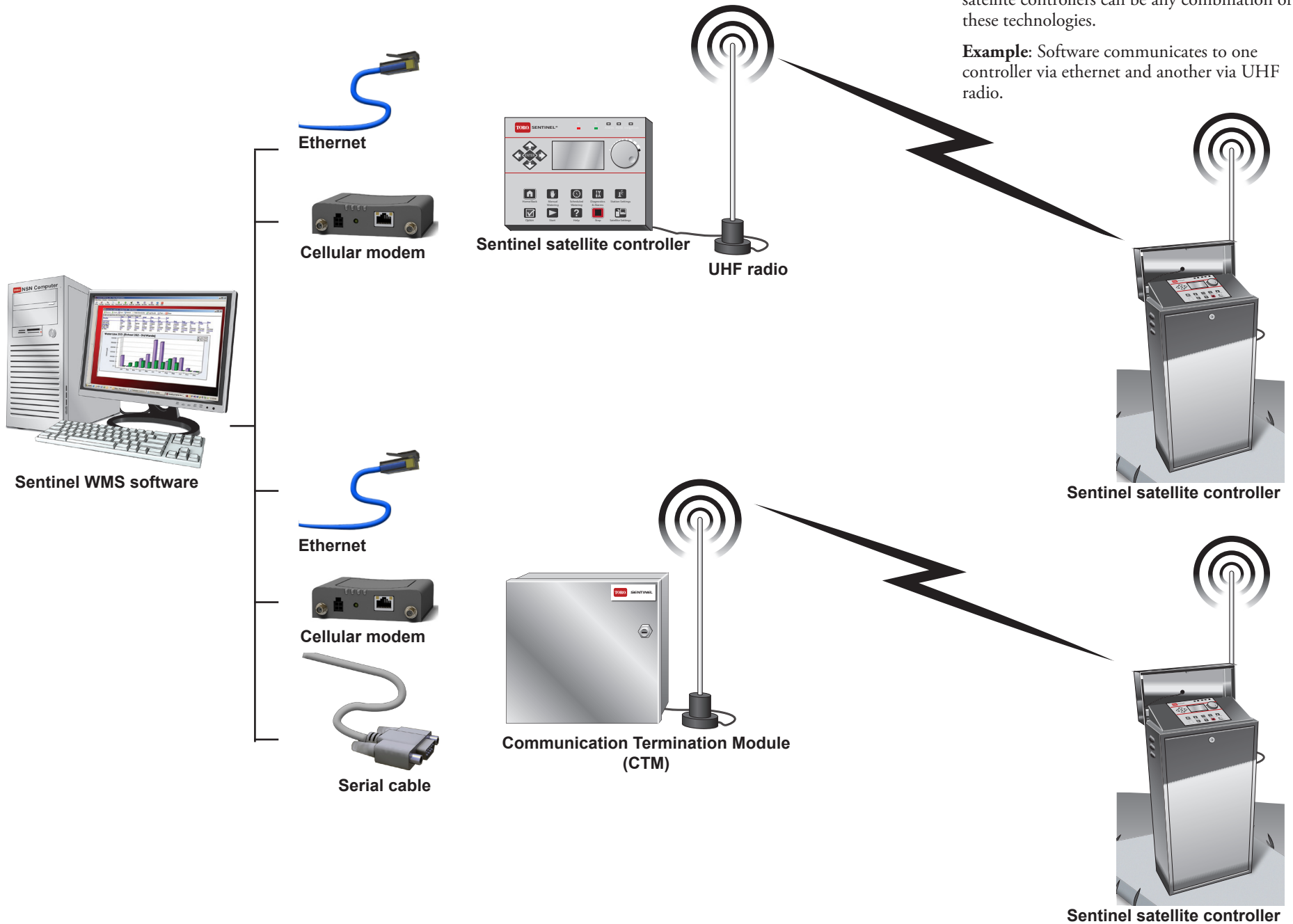
Antennas

ATX (Stubby) Antenna

Based on communication type, Toro ATX (Stubby) antennas can be UHF, Spread Spectrum or cellular data omnidirectional surface-mount antennas. ATX antennas come with their own cables, but can be extended with prior approval from Toro. Toro Sentinel satellites specified with either UHF or Spread Spectrum radios will come standard with the appropriate ATX antenna installed.

Part Number	Description
SB-ANT-ATX4	450 - 470 MHz high profile, omnidirectional UHF antenna
SB-ANT-ATX9	900 MHz high profile, omnidirectional antenna

VRA (Pancake) Antenna

Based on communication type, Toro VRA (Pancake) antennas can be UHF, Spread Sprectrum omnidirectional, low-profile transit antennas. VRA (Pancake) antennas are intended to be used with the cables included with the radio; however, they may be extended with prior approval from Toro. Toro Sentinel satellites specified with either UHF or Spread Spectrum radios will come standard with the appropriate VRA antenna installed.
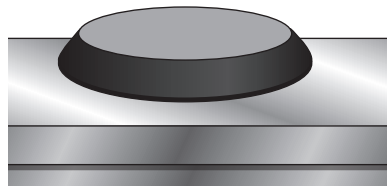
Part Number	Description
SB-ANT-VRA4	450 - 470 MHz low profile, omnidirectional UHF antenna
SB-ANT-VRA9	900 MHz low profile, omnidirectional antenna

Toro Sentinel controllers specified with UHF or Spread Spectrum radios come standard with an installed antenna on the cabinet.

Cabinet	Toro Installed Antenna
WS1 – Powder Coated Small Metal Wall-Mount Cabinet	UHF - ATX (Stubby) Antenna
WS2 –Powder Coated Medium Metal Wall-Mount Cabinet (2-wire)	UHF - ATX (Stubby) Antenna
WS5 –Stainless Steel Wall-Mount Cabinet	UHF - VRA (Pancake) Antenna
PP1 – Plastic Pedestal Cabinet	UHF - VRA (Pancake) Antenna
PS1 – Stainless Steel Cabinet	UHF - VRA (Pancake) Antenna

Mast Antenna

Toro Mast antennas are 5db gain UHF omnidirectional antennas and are used primarily to connect to the base radio (CTM). Toro offers two central software packages that include the Mast antenna with 50' of coaxial cable and appropriate connections to connect directly to a CTM. If it is necessary to locate the Mast antenna further than 50' from the CTM, then specify separately the LMR-400-DB cable. The maximum length of LMR-400-DB cable is 100'. Longer runs of coaxial cable and higher db gain antennas are available through the local authorized Sentinel distributor. Radio site surveys conducted by the authorized Sentinel distributor determine if a different Mast antenna is required.

Part Number	Description
SGIS-1-0	Sentinel WMS software NSN computer CTM 5db gain Mast antenna 50' coaxial cable and connections
SGIS-0-1	Sentinel WMS software CTM 5 db gain Mast antenna 50' coaxial cable and connections
SB-ANT-MAST	UHF 5db gain omnidirectional mast antenna
IS-50NX-C0-MA	Antenna surge protection

Sentinel Communications

📝 Based on an authorized Sentinel distributor radio site survey, some external antennas may be required to provide adequate communication from the CTM to Sentinel satellite controller or from a Sentinel satellite to a spread spectrum Sentinel controller.

📝 If required, **antenna surge protection** may be added to the hardware. Toro recommends a flange mounted, DC block, single transmitter coaxial lightning protection for 1.5 MHz to 700 MHz with N male surge side and N female protected side connectors.

Yagi Antenna
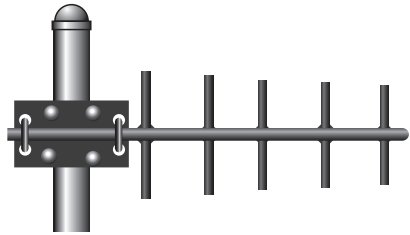
Toro Yagi antennas are aluminum directional antennas typically used to extend the communication range of a Sentinel satellite controller to a CTM (UHF), or to a Wireless Output Board (Spread Spectrum). A radio site survey conducted by the authorized Sentinel distributor will verify communications and recommend Sentinel satellite controllers that require Yagi directional antennas. Toro offers three different Yagi directional antennas depending on requirements of signal power. The 3 element Yagi antenna has a 5db gain, the 6 element is 9db gain and the 12 element is 12.25db gain.

Coaxial cable used from the Sentinel controller to the Yagi antenna is dependent on the length of run. Up to 50' in distance, Toro recommends a 3/8" cable SB-CAB-ANT-MAST-50-8. For distances between 50' and 200', LMR-400-5/8" cable is recommended.

Part Number	Description
SB-ANT-YAG3	3-element 450 - 470 yagi directional antenna
SB-ANT-YAG6	6-element 450 - 470 yagi directional antenna
SB-ANT-YAG12	12-element 450 - 470 yagi directional antenna

Controller to Yagi

The Central Computer and Software

Toro Sentinel WMS Software is a simple but powerful interface used to program controllers, obtain reports, download weather data, map irrigated sites and run irrigation. Sentinel WMS software is PC-based (Windows 7) and can operate locally on a non-dedicated computer. The Sentinel WMS software also operates on certain computer servers (Windows Server 2008, 2012). Through Sentinel software, the user communicates to Sentinel satellite controllers via Ethernet, UHF radio, 900 MHz, cell data modem, fiber optic, analog phone or any combination of these methods.

Toro National Support Network

All Toro Sentinel WMS Software packages come with 2 years of National Support Network. NSN is a 24/7/365 toll-free technical software support service based in Abilene, Texas. NSN provides phone and online Sentinel software support as well as hardware warranty and 24 hour replacement support on NSN provided computers. Extensions to the National Support Network service are in increments of 1 or 3 years.

NSN Connect

All Toro Sentinel WMS Software packages come with 2 years of NSN Connect service. NSN Connect is an internet-based application that allows for remote access to the user's host computer or server via secured user names and passwords. A free NSN Connect App is available for IPhone and Ipad devices. NSN Connect allows the user to control their entire irrigation system from a remote internet-enabled device. This includes programming individual controllers, operating irrigation stations or sending commands to entire systems. NSN Connect works on Windows 7.

Precision ET

All Toro Sentinel WMS Software packages come with 2 years of Precision ET service. Precision ET is a daily evapotranspiration service provided to the Sentinel WMS software via an internet connection. The Precision ET value is accurate to 1 square kilometer of the latitude and longitude values of the desired site.

Central Computer Options

Part Number	Description
SGIS-1-T	Includes Sentinel WMS software, 2 years of NSN support, 2 years of NSN Connect service and 2 years of Precision ET service. Purchaser supplies own computer.
SGIS-0-1	Includes Sentinel WMS software, Sentinel Communication Termination Module (CTM), 5db gain base antenna, 50' of antenna coaxial cable, 2 years of NSN support, 2 years of NSN Connect service and 2 years of Precision ET service. Purchaser supplies own computer.
SGIS-1-0	Includes Sentinel WMS software, NSN Desktop computer, 24" monitor, color printer, Sentinel Communication Termination Module (CTM), 5db gain base antenna, 50' of antenna coaxial cable, 2 years of NSN support, 2 years of NSN Connect service and 2 years of Precision ET service.

NSN Support Extension Plans

Part Number	Description
SSE-T-1	1 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-T or SGIS-0-1
SSE-T-3	3 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-T or SGIS-0-1
SSE-C-1	1 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-0 (includes computer warranty)
SSE-C-3	3 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-0 (includes computer warranty)

NSN Computer Specifications*

Component	Specification
Processor	Intel® Core i3 (3.50 GHz) Biostar BIB85-AHA ATX System Board LGA1150 socket 1333 MHz Bus
RAM	4 GB DDR3 dual channel
Audio	Realtek CODEC ALC892-VC, 5.1 channel (integrated) (Support Blu-ray Audio)
Network Interface	1 - INTEL 82579 (PHY). 10/100/1000 Mb/s auto negotiation, Half/Full duplex (integrated)
Motherboard Bus Type	(1) PCI-E x 16, (2) PCI-E x1, (1) PCI-E x 4, (2) PCI
Hard Drive	500 GB
Optical Drive	DVD-RW Dual Format LightScribe. Supports all formats including CD / CDR / CDRW / DVD / DVD-RW.
Case Type	Mid-Tower (5-Bay)
Video Card	3 - (1) Integrated VGA, (1) DVI, (1) HDMI. INTEL HD Graphics integrated. Supports dual independent displays (Extended mode)
Serial (COM) Ports	6 - (2) Integrated system board COM port, (4) Integrated RS-232 9 pin Single headers
USB Ports	6 - (2) in front, (4) integrated in back – (2) x 2.0, (2) x 3.0
Backup Device	320 GB Removable Hard Drive 8 GB USB 2.0 Mini Flash Drive Second Copy (License Only)
Mouse	Microsoft® Compatible Optical Wheel USB
Keyboard	Microsoft Compatible USB
Monitor	32" ViewSonic® Wide Screen Flat Panel
Speakers	Stereo – On Monitor
Battery Backup	EATON/Powerware Back-UPS 700 LCD
Printer	Canon PIXMA iP2702
Operating System	Windows® 7 Ultimate 64 bit
OS Recovery Device and Software	320 GB External Hard Disk, Symantec Ghost
Antivirus Software	AVAST Anti-Virus (5 year) (License only)
DVD Decoder Software	Windows Media Player (DVD Player CODEC)
CD/DVD Authoring Software	Windows® 7 Ultimate 64 bit
Accessories	See **.

*Computer specifications subject to change at any time without notice. Availability and specifications of NSN products and services may vary by international region. Please contact NSN or your TORO distributor for details.

**Accessory kit contains:1 – RS-232 in-line surge protection device, 1 - mouse pad, 1 -1USB printer cable, 1 – computer power cord, and any other necessary cables and/or software.

When using a non-NSN computer, verify computer specifications with Toro prior to installing Sentinel software: 951-785-3381.

Handheld remote

Rain sensor

Rain bucket

Cellular

Valves

Decoder

Flow sensor

Moisture sensor

Toro Sentinel satellite controllers come standard with the ability to read numerous sensor devices. Based on the sensor input, Sentinel satellites activate or shut down irrigation valves and switches.

Typical Sentinel satellite sensor inputs are wireless soil moisture sensors, flow sensors, rain buckets, wireless or wired rain sensors or any other contact sensor device. Control of individual stations and programs are based on the current condition or change of state from the sensor devices. An example would be an individual zone shutting down due to high flow detected on that station or entire programs operate or shut down due to soil moisture.

Sentinel controllers are manually activated in the field using a Sentinel UHF radio hand-held. If the Sentinel satellite controller is connected directly using Ethernet or cell modem, a web-enabled phone or tablet can operate the controller. When using NSN Connect, controllers can be programmed, or manually controlled via a web-enabled phone, tablet or computer.

Sentinel Device Features:
- 2 Flow sensors per controller
- Learn flow by station
- High, low & zero flow detection
- Leak detection
- Station shut-down or information alarms
- Graphing of flow
- 16 wireless soil moisture sensors per controller
- Soil moisture control by program
- Learn moisture by sensor
- Low & High moisture threshold settings
- Soil moisture with ET by program
- Graphing of soil moisture
- Rain collection via rain bucket
- Multiple rain buckets per site
- Site shutdown via individual rain bucket
- Graphing of rain
- UHF Radio hand-held ready (no receiver required)
- Phone & tablet accessible with Ethernet or cell data communications to controller
- Start or stop individual programs by contact switch change of state

Toro Sentinel satellite controllers are accessible from the field using several different control devices. With the exception of using NSN Connect, all communication devices communicate directly with the Sentinel satellite and not through software to satellite controller. If using UHF radio as communication to a Sentinel controller, a Sentinel UHF radio hand-held manually controls stations and programs. If the controller communicates via Ethernet or cell data modem, Smart phones, tablets and remote computers can also be used to access a Sentinel satellite controller.

Radio Hand-Held Control

The Sentinel UHF radio hand-held can communicate with any Sentinel satellite controller. A Sentinel satellite that incorporates a built-in UHF radio is "hand-held ready" for receiving commands without having to add any external hardware to the controller. The Sentinel radio hand-held uses proprietary firmware that allows the Sentinel controller to receive and audibly confirm simple DTMF commands for field operation.

Functions available with the Sentinel radio hand-held:

- Manual operation of stations
- Manual operation of stations with specific time
- Manual operation of programs
- Cancel individual stations and programs
- Cancel all stations
- Quick advance of stations
- Station rain hold
- Sequence stations with specific time
- Clear alarms
- Voice Communications

Part Number	Description
SHHR	Radio hand-held

See Specifications page 40.

Smart Phone & Tablet Control – Network Interface

Toro Sentinel satellite controllers use a built-in network interface that allows for control and diagnostics via Ethernet or cell data communications to the controller. Users access the controller from the designated IP address assigned. A login and password is required to gain access to the Sentinel satellite. Besides manual control of stations and programs, diagnostics are available for the controller through the network interface. No UHF radio or external hardware is required for smart phone or tablet control.

Functions available with Sentinel network interface:

- Manual operation of stations
- Manual operation of stations with specific time
- Manual operation of programs
- Cancel individual stations
- Cancel all stations and programs
- Quick advance of stations
- Review logs of all controller events and alarms
- View current soil moisture levels

NSN Connect

Sentinel WMS software comes with two years of NSN Connect service. NSN Connect provides simple access to the host computer or server operating Sentinel WMS software via apps on web-enabled smart phones and tablets. Once access is established, the user has full control of individual Sentinel controllers or entire system. NSN Connect allows programming of individual controllers, manual operation of stations and programs, full shutdown of the site, review of alarms and initiation of rain holds for individual controllers or the entire system. Additional NSN Connect plans can be specified with the Sentinel WMS software or renewed annually.

Functions available with NSN Connect:

- Password protected
- Manual operation of stations
- Manual operation of stations with specific time
- Manual operation of program
- Setup of programs
- Review alarms
- Clear alarms
- Rain hold stations, programs or entire controller
- Rain hold entire system
- Review log files

Part Number	Description
NSN Connect-LIC	1-year NSN Connect extension

The Toro Sentinel WMS software communicates with an unlimited number of weather stations, Toro Precision ET accounts, or rain buckets to adjust irrigation and perform automatic shutdowns of the system. All Sentinel satellite controllers come standard with the capability of operating using evapotranspiration data.

Key Features

- Unlimited number of weather devices per system
- Internet-based ET included with Sentinel WMS software (Precision ET)
- Unlimited rain buckets connect directly to satellites
- Rain shut downs from weather station or rain buckets
- ET checkbook calculations
- Data automatically exportable to customized Excel spreadsheet by controller or system

- Multiple brands and models of weather device
- One Precision ET value can download to unlimited number of controllers
- Selectable download time for ET to controllers
- Temperature shut downs from weather station
- Graphical display of ET & Rainfall
- Operates in conjunction with Toro Pro Series Moisture Sensors

Weather Sensors

Davis Instruments Vantage Pro 2 Plus

(select one model plus the data logger)

Davis Instruments Part Number	Description
6162	900MHz wireless
6162C	Cabled
7626	(AC powered repeater if necessary used with Model 6162)
7627	(Solar powered repeater if necessary used with Model 6162)
6510SER	Data logger and Davis Weatherlink software

For more information, please go to www.davisnet.com.

Campbell Scientific ET 106 & T Weather 107

Must have Sentinel firmware loaded into the data logger
(contact Campbell Scientific 435-227-9100)

For more information, please go to www.campbellsci.com.

Turf Weather

Model TTW232

www.campbellsci.com

Cellular data

ethernet   **serial**

Davis Vantage Pro2
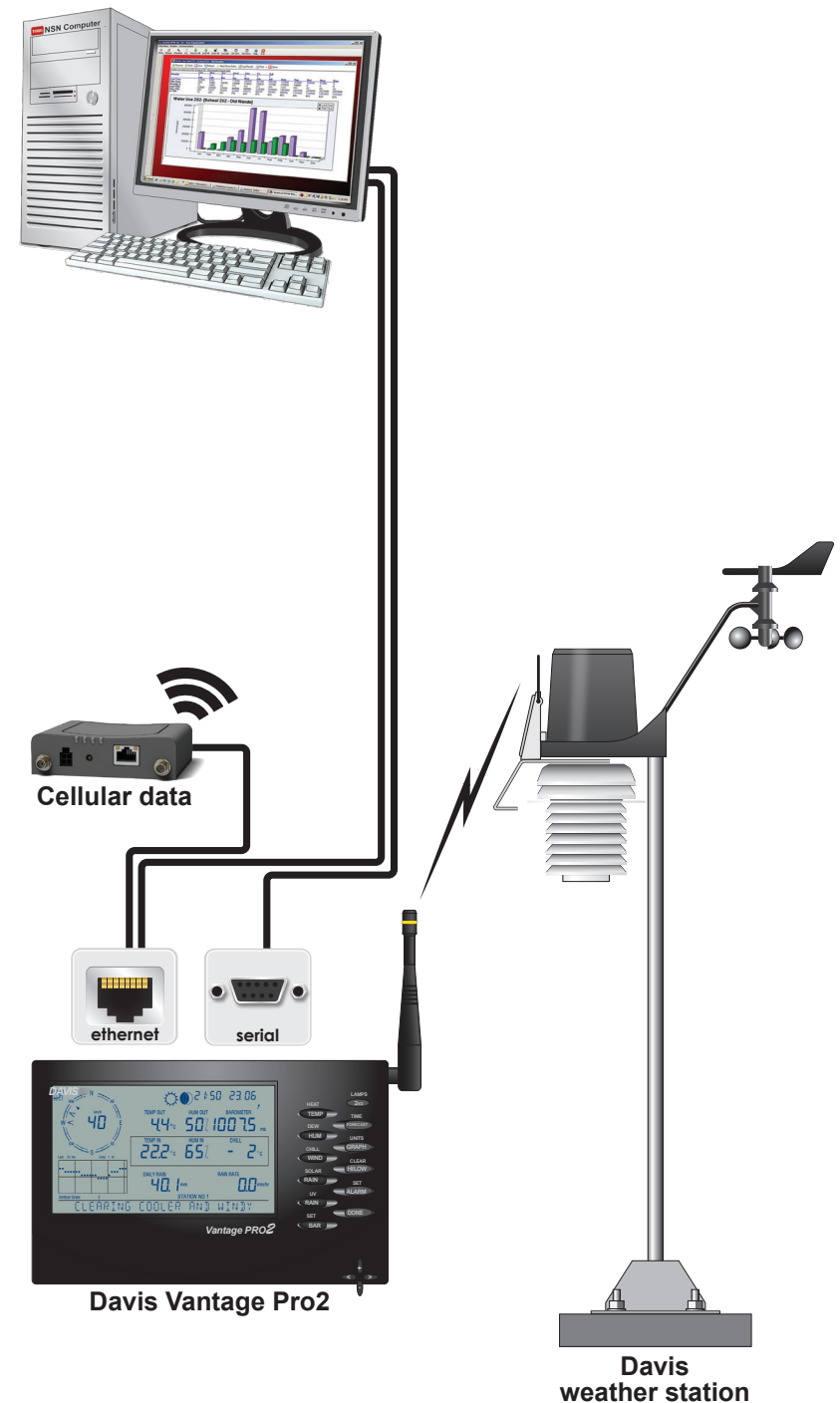
Davis weather station

Toro Precision™ ET

Toro Precision ET is an internet-based evapotranspiration value that calculates from thousands of weather stations across the United States. The ET value calculates according to the latitude and longitude of the selected site. Daily ET values can be shared across multiple controllers. The daily download time is selectable by the user. The host computer must have internet access in order to obtain Precision ET data. Toro Precision ET does not include rainfall quantities, therefore either rain sensors or onsite rain buckets are used to determine local amounts. Sentinel WMS software includes two years of Toro Precision ET and is renewable on a yearly basis.

Part Number	Description
T-PREC-ET	1-year Precision™ ET

Alarm Switch

Toro Sentinel satellite controllers use a specific alarm switch terminal to operate either normally open or normally closed rain sensors. Wired or wireless sensors are programmed via the Sentinel WMS software to react specifically to individual programs. Reaction can be to start, stop, or ignore the change of state of the alarm switch.

Recommended Rain Sensors

Part Number	Description
Toro TWRS	Wireless rain sensor
Toro TWRFS	Wireless rain/freeze sensor
Toro TRS	Wired rain sensor
Toro 53853	Wired rain/freeze sensor

See Specifications pages 40 and 41.

rain sensor

Sentinel controller connected to rain sensor

Rain Buckets

The Toro Sentinel WMS software can read rainfall quantities from a single or multiple rain buckets. Rain buckets share the flow sensor terminal of a Sentinel satellite controller and record rainfall amounts in .01" increments. Rain buckets can be setup to work in conjunction with Toro Precision ET to calculate daily values and are used to perform automatic rain shut downs from the Sentinel WMS software. Software must be operational in order to utilize rain bucket information within the system.

The following rain bucket is compatible with Sentinel satellite controllers:

Davis Instruments Part Number	Description
7857	Rain Bucket

See Specifications pages 40 and 41.

For more information, please go to www.davisnet.com.

Sentinel controller connected to rain bucket

Davis Instruments Rain Bucket

Toro Sentinel satellites have extensive flow retrieval, reaction and retention capabilities. Flow setup and reactions are executed within the Sentinel satellite. (Programming the Central Software is not required for many of the flow processes.)

Key Features
- Two flow sensors per standard controller
- Two flow sensors per wireless output board (up to 32 wireless output boards per Sentinel controller)
- Learn flow by station
- High flow detection by station or group of stations
- Low flow detection by station or group of stations
- Zero flow detection by station or group of stations
- Unexpected flow detection outside of scheduled watering
- Volumetric flow shutdown
- Actual flow graphing
- Projected flow graphing
- Daily, Weekly, Monthly and Yearly flow logging
- Exportable to customized Excel spreadsheets

Flow Data Retrieval

The Toro Sentinel satellite controller retrieves flow data via the Data Retrieval Port (flow sensor and switch closure inputs). Flow sensor terminal inputs support simultaneous connection of the flow sensor, rain bucket, or ET gauge. Once the Sentinel satellite controller begins to read flow data, it automatically learns individual station flow and stores this data.

Sentinel conventional-wired controllers, two-wire controllers, and wireless output boards have two flow sensor and one alarm inputs available. Each flow sensor terminal is independently programmable for K-Factor and Offset. Each wireless output board will transmit real-time flow while in operation back to the Sentinel satellite via 900 MHz radio (up to 32 wireless output boards per Sentinel satellite). The Sentinel satellite sums all flow input totals.

Flow Reaction

Toro Sentinel Satellites have the ability to react to flow anomalies. High Flow, Low Flow, Zero Flow and Unexpected Flow are detected using a flow sensor on a Sentinel controller. The reactions to flow conditions are selectable by the user and includes Stop, Informational, or Off/Ignore.

- Stop: The affected station is shut down and prohibited from operating until the station alarm is cleared by the user.
- Informational: Alarms flag the problem station but do not deactivate it from future operations.
- Off or Ignore: Bypasses any station regardless of flow condition. When a group of stations are operating, the Sentinel satellite controller will process the stations individually and identify the problem station within the group.

Water Use Records

Sentinel satellites record and store (2 years) of flow data at each individual controller. Flow records each day and can be stored in separate log files for permanent retention. Flow is displayed for the current week, month and year plus previous year by month for comparison. Flow retrieval is automatic or manually performed from the Sentinel software. Flow, ET and Rainfall export to a unique Excel spreadsheet file stored in the log file folder. This spreadsheet is customizable to display and compare data from the Sentinel satellite and entire system.

Standard Flow Sensors

The following flow sensors are compatible with the Sentinel satellite controllers:

- Toro Flow Sensors ½"–4" Model TFS-050 through TFS-400
- Irritrol Flow Sensors 1"–21/2" Brass tee, 11/2"–4" PVC, 3"–30" Insertion style
- Data Industrial (Standard Models) – 228PV Series, IR220B Series

Part Number	Size	Pressure Rating PSI (BAR)	Suggested Operating Range		
			gallons per minute	liters per second	cubic meters per hour
TFS-050	1/2" (1.3 cm)	150 (10.3)	1.2 - 12		
TFS-075	3/4" (1.9 cm)	150 (10.3)	2.7 - 28		
TFS-100	1" (2.54 cm)	150 (10.3)	5 - 50		
TFS-150	1.5" (3.8 cm)	100 (6.9)	5 - 100	.3 - 6.3	1.1 - 22.7
TFS-200	2" (5.1 cm)	100 (6.9)	10 - 200	.6 - 12.6	2.3 - 45.4
TFS-300	3" (7.6 cm)	100 (6.9)	20 - 300	1.3 - 18.9	4.5 - 68.1
TFS-400	4" (10.2 cm)	100 (6.9)	40 - 500	2.5 - 31.5	9.1 - 113.6

See Specifications page 40.

Flow Sensor Cable – A shielded 16 gauge cable in a polyethylene jacket is required for proper flow sensor signals. Cables can run up to 2000' from flow sensor location to a Sentinel satellite controller.

Installation Requirements – Size flow sensors based on range of typical flow of operation and not on mainline size. The upstream pipe of the flow sensor must have a straight run 10 times the diameter of the pipe and the downstream 5 times the diameter of the pipe.

Optional Flow Sensors
Non Standard and "Slow" Flow Meters for installations where straight run piping is not possible

Sentinel satellites also work with different flow sensors from Netafim, Bermad, Krohne, etc.

Netafim Hydrometer (Reed Switch (RS), 1 Pulse per Gallon) Normally "Closed" or "Open"

Bermad Hydrometer 910-series (Reed Switch (RS), 1 Pulse per Gallon) Normally "Closed" or "Open"

Netafim Hydrometer (Photo Diode High Frequency (PDH)) Normally "Closed" or "Open" (3-wires required for flow) High Frequency Registers may be preferable for the 6" & 8" meters when (Reed Switch (RS), 1 Pulse / 10 Gallons).

> Special Toro 3-wire flow meter cable (Model SB-NET/9PIN) is required.

Please go to www.netafimusa.com and/or www.bermad.com for more information on these flow sensors.

Master Valve

Toro Sentinel satellites allow the local master valve to be set as "Normally Closed" or "Normally Open". In a Normally Open setting, the master valve is not powered unless a main-line flow alarm is indicated in the Sentinel controller. When this occurs, the Sentinel satellite energizes the master valve and shuts the mainline down.

In addition to the local master valve, sixteen separate stations from the terminal board or decoders can be assigned as master valves along with one station as an auxiliary pump station. Master valves are assigned to mirror the controller master valve or operate specifically with specific groups of stations. The auxiliary pump station enables a specific terminal board or decoder station to operate with only specific programs.

Sentinel satellites are compatible with most manufacturers AC or DC-latching solenoids. Toro recommends Toro valves for "Normally Closed" applications and Irritrol 102P series for "Normally Open" or "Normally Closed".

> If using a non-Toro DC-latching solenoid valve, verify compatibility with Toro: 951-785-3381.

Toro P220 valve family

Part Number	Valve Description
P220-26-04	1" in-line, angle
P220-26-06	1½" in-line, angle
P220-26-08	2" in-line, angle
P220-26-00	3" in-line, angle
P220S-26-04	1" in-line, angle ACT™ (Active Cleansing Technology)
P220S-26-06	1½" in-line, angle ACT™
P220S-26-08	2" in-line, angle ACT™
P220S-26-00	3" in-line, angle ACT™
220-26-04	1" in-line, angle, brass
220-26-06	1½" in-line, angle, brass
220-26-08	2" in-line, angle, brass
220-26-00	3" in-line, angle, brass

Toro Sentinel satellites are capable of reading and reacting up to 16 Toro Pro Series Soil Moisture Sensors per controller. Toro Pro Series Soil Moisture Sensors can communicate several thousand feet away wirelessly to Sentinel satellites. The soil moisture sensors regulate when stations run and the operating time within a program. Moisture sensing is selectable by program and can operate in conjunction with evapotranspiration.

Key Features

- 16 wireless Toro Pro Series Soil Moisture Sensors per controller (no wiring required to a Sentinel satellite controller)

- Toro Pro Series Moisture Sensors include 3' of tethered cable for optimal placement at various root depths (see illustration, right).

- Compatible with dual-level Toro Pro Series wireless wireless moisture sensors

- Toro Pro Series Receiver provides wireless communication to Toro Pro Series Moisture Sensors from Sentinel satellites

- Toro Pro Series Moisture Sensors can be placed up to 500' from Toro Pro Series Receiver or Repeater

- Toro Pro Series wireless Repeaters extend range of communication up to 1500' from a Toro Pro Series Receiver

- Sentinel satellite controllers automatically record and store driest and wettest moisture readings for proper calibration

- Moisture values can be displayed in volumetric values (percent moisture to solid and air) or scaled values (0% to 100%)

- Graphing of moisture levels over time within Sentinel WMS Software

- Can operate in conjunction with evapotranspiration (start on low moisture, runtime by ET)

Toro Sentinel Moisture Sensing

Toro Pro Series Moisture Sensors (PN: TPS-SS) communicate wirelessly to Sentinel satellite controllers when an optional Pro Series Receiver (PN: TPS-RX) is specified with the controller. A Sentinel satellite controller communicates with up to 16 Pro Series Moisture Sensors. Sensors are associated with individual Sentinel programs. Programs only allow irrigation to occur when low moisture settings are reached. Irrigation operates in user-defined cycles until the high moisture setting is met.

After installation, a Sentinel satellite is set to "Learn" mode for the soil moisture. The controller records both the driest and wettest soil moisture readings over a user-defined length of time. After settings record, the Sentinel satellite is set to "Active" for each individual sensor. Users set a High and Low value associated for each program controlled by moisture.

A graph of moisture changes displays in the Sentinel WMS software. Moisture readings show changes to dry and wet values and indicate user-defined start and stop limits by individual programs.

Toro Pro Series Moisture Sensors

Toro Pro Series Moisture Sensors (PN: TPS-SS) communicate via 900 MHz signal. No communication license is required. Wireless communication allows for flexibility in placement of sensors on the site. Sensor may be direct buried (measurement of exact location is recommended) or installed inside a valve box. Pro Series Moisture Sensors have a 3' tethered cable to allow optimal location in the desired root zone of turf, shrubs or trees (see illustration).

Toro Pro Series Receivers

All Toro Sentinel satellite controllers come standard with a plug-in adapter to connect an optional Toro Pro Series Receiver (PN: TPS-RX). The Receiver provides 900 MHz communication to Toro Pro Series Moisture Sensors (PN: TPS-SS). Range of communication is 500' from receiver to moisture sensors. If the distance between receiver and sensor exceeds 500', then a Toro Pro Series wireless Repeater is used (PN: TG-R-EXT external mount, or TG-R-INT internal mount). Toro Pro Series wireless Repeaters extend the range of communication from the receiver 1500', then another 500' to the moisture sensor. When a Sentinel satellite is ordered with Moisture Sensing, the controller comes with the Pro Series Receiver and antenna built into the cabinet.

Part Number	Description
TPS-RX	Toro Pro Series receiver
TPS-SS	Toro Pro Series soil sensor
TG-R-EXT	External repeater
TG-R-INT	Internal repeater

See Specifications page 41.
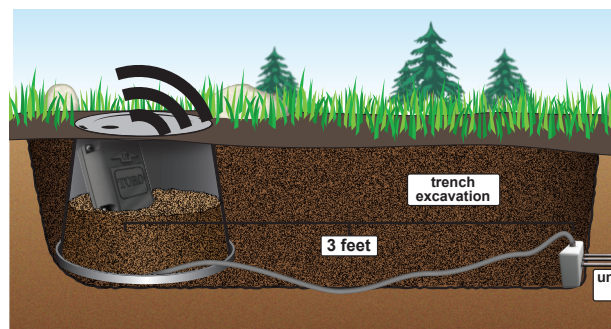
Conventional Wired with Faceplate
Powder-coated Wall Mount

- small painted wall-mount enclosure
- level three surge protection
- onboard network connection

- onboard Pro Series wireless connection
- ATX antenna

wired

Part Number	Station Count
SB12WS1U	12
SB24WS1U	24
SB36WS1U	36
SB48WS1U	48

wireless

Part Number	Station Count
SBW12WS1U	12
SBW24WS1U	24
SBW36WS1U	36
SBW48WS1U	48

Conventional Wired with Faceplate
Green Plastic Pedestal Mount

- green plastic pedestal mount enclosure
- level three surge protection
- onboard network connection

- onboard Pro Series wireless connection
- VRA antenna

wired

Part Number	Station Count
SB12PP1U	12
SB24PP1U	24
SB36PP1U	36
SB48PP1U	48

wireless

Part Number	Station Count
SBW12PP1U	12
SBW24PP1U	24
SBW36PP1U	36
SBW48PP1U	48

Conventional Wired with Faceplate
Stainless-steel Wall Mount

- large stainless steel enclosure
- level three surge protection
- onboard network connection

- onboard Pro Series wireless connection
- VRA antenna

wired

Part Number	Station Count
SB12WS5U	12
SB24WS5U	24
SB36WS5U	36
SB48WS5U	48

wireless

Part Number	Station Count
SBW12WS5U	12
SBW24WS5U	24
SBW36WS5U	36
SBW48WS5U	48

Conventional Wired with Faceplate
Stainless-steel Pedestal Mount

- large stainless steel enclosure
- level three surge protection
- onboard network connection

- onboard Pro Series wireless connection
- VRA antenna

wired

Part Number	Station Count
SB12PS1U	12
SB24PS1U	24
SB36PS1U	36
SB48PS1U	48

wireless

Part Number	Station Count
SBW12PS1U	12
SBW24PS1U	24
SBW36PS1U	36
SBW48PS1U	48

Conventional Wired No-Faceplate
Powder-coated Wall Mount

- small painted wall-mount enclosure
- level three surge protection
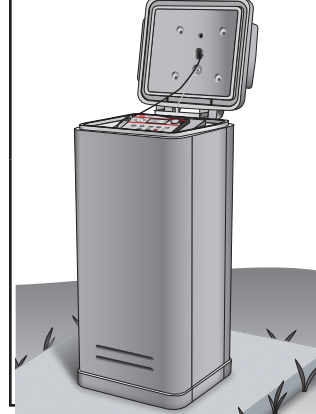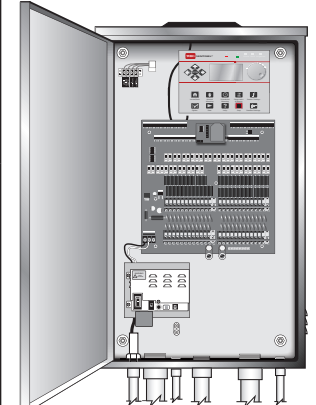- onboard network connection

- onboard Pro Series wireless soil sensing connection
- UHF radio and antenna

wired

Part Number	Station Count
SBN12WS1U	12
SBN24WS1U	24
SBN36WS1U	36
SBN48WS1U	48

wireless

Part Number	Station Count
SBWN12WS1U	12
SBWN24WS1U	24
SBWN36WS1U	36
SBWN48WS1U	48

Two-Wire Controller

- small painted wall-mount enclosure
- green plastic pedestal mount enclosure
- large stainless steel enclosure

- onboard network connection
- AC or DC solenoid activation
- onboard Pro Series wireless soil sensing connection
- UHF radio and antenna

AC Sentinel 2-Wire and Parts	
Part Number	Description
SBAWS1U	AC powder-coated wall mount
SBAWS5U	AC large stainless steel wall mount
SBAPP1U	AC green plastic pedestal mount
SBAPS1U	AC stainless steel pedestal mount
SB-DAC-1	1-station decoder AC
SB-DAC-2	2-station decoder AC
SB-DAC-4	4-station decoder AC
SB-BLA	AC in-line surge protection

Two-Wire Controller

DC Sentinel 2-Wire and Parts	
Part Number	Description
SBDWS2U	DC powder-coated wall mount
SBDWS5U	DC large stainless steel wall mount
SBDPP1U	DC green plastic pedestal mount
SBDPS1U	DC stainless steel pedestal mount
SB-DDC-1	1-station decoder DC
SB-DDC-2	2-station decoder DC
SB-DDC-4	4-station decoder DC
SB-DEC-SG-Line	DC surge arrestor

24 VAC Solenoids	
Part Number	Description
P220-26-04	1" in-line, angle
P220-26-06	1½" in-line, angle
P220-26-08	2" in-line, angle
P220-26-00	3" in-line, angle
P220S-26-04	1" in-line, angle ACT™
P220S-26-06	1½" in-line, angle ACT™
P220S-26-08	2" in-line, angle ACT™
P220S-26-00	3" in-line, angle ACT™
220-26-04	1" in-line, angle, brass
220-26-06	1½" in-line, angle, brass
220-26-08	2" in-line, angle, brass
220-26-00	3" in-line, angle, brass

DC-Latching Solenoids	
Part Number	Description
P220-26-94	1" in-line, angle
P220-26-96	1½" in-line, angle
P220-26-98	2" in-line, angle
P220-26-90	3" in-line, angle
P220S-26-94	1" in-line, angle ACT™
P220S-26-96	1½" in-line, angle ACT™
P220S-26-98	2" in-line, angle ACT™
P220S-26-90	3" in-line, angle ACT™
220-26-94	1" in-line, angle, brass
220-26-96	1½" in-line, angle, brass
220-26-98	2" in-line, angle, brass
220-26-90	3" in-line, angle, brass

Select one item from each part number table below for your long-range wireless output board controller.

Long-Range Wireless Output Board Controller

Board/Radio Kit

Part Number	Description
W121-XT	12-station wireless output board, level 3 surge protection with XTND spread spectrum radio.
W241-XT	24-station wireless output board, level 3 surge protection with XTND spread spectrum radio.
W361-XT	36-station wireless output board, level 3 surge protection with XTND spread spectrum radio.
W481-XT	48-station wireless output board, level 3 surge protection with XTND spread spectrum radio.

Enclosures

Part Number	Description
SBW-WS1	Wall-mount, powder-coated small metal cabinet
SBW-WS5	Stainless steel wall-mount
SBW-PP1	Plastic pedestal (green)
SBW-PS1	Stainless steel pedestal

Antenna

Part Number	Description
SB-ANT-ATX9	Spread spectrum, stubby antenna
SB-ANT-VRA9	Spread spectrum, pancake antenna

Sentinel Communications

Part Number	Description
SCT_TORO_LSE_ATT	LS300 modem with AT&T service
SCT_TORO_LSE_VZW	LS300 modem with Verizon service
SCT_TORO_LSE_SPCS	LS300 modem with Sprint / PCS service
SB-RAD-XTND-SAM	Long-range 900 MHz spread spectrum radio
SB-PM	Phone modem

LS300 modem

900 MHz spread spectrum radio

Sentinel Communications - optional

Part Number	Description
SB-ANT-YAG3	3-element 450 - 470 yagi directional antenna
SB-ANT-YAG6	6-element 450 - 470 yagi directional antenna
SB-ANT-YAG12	12-element 450 - 470 yagi directional antenna

Yagi antenna

Sentinel Central Computer Options

Part Number	Description
SGIS-1-T	Includes Sentinel WMS software, 2 years of NSN support, 2 years of NSN Connect service and 2 years of Precision ET service. Purchaser supplies own computer.
SGIS-0-1	Includes Sentinel WMS software, Sentinel Communication Termination Module (CMT), 5db gain base antenna, 50' of antenna coaxial cable, 2 years of NSN support, 2 years of NSN Connect service and 2 years of Precision ET service. Purchaser supplies own computer.
SGIS-1-0	Includes Sentinel WMS software, NSN Desktop computer, 24" monitor, color printer, Sentinel Communication Termination Module (CTM), 5db gain base antenna, 50' of antenna coaxial cable, 2 years of NSN support, 2 years of NSN Connect service and 2 years of Precision ET service.

NSN Support Extension Plans

Part Number	Description
SSE-T-1	1 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-T or SGIS-0-1
SSE-T-3	3 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-T or SGIS-0-1
SSE-C-1	1 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-0 (includes computer warranty)
SSE-C-3	3 Year NSN Support Extension, NSN Connect and Precision ET for SGIS-1-0 (includes computer warranty)

NSN Connect

Part Number	Description
NSN Connect-LIC	1-year NSN Connect extension

Sentinel Remote Control Devices

Part Number	Description
SHHR	Radio hand-held

Weather Stations

Davis Instruments Part Number	Description
6162	900MHz wireless
6162C	Cabled
7626	(AC powered repeater if necessary used with Model 6162)
7627	(Solar powered repeater if necessary used with Model 6162)
6510SER	Data logger and Davis Weatherlink software

Rain Buckets

Davis Instruments Part Number	Description
7857	Rain Bucket

Rain/Freeze Sensors

Part Number	Description
Toro TWRS	Wireless rain sensor
Toro TWRFS	Wireless rain/freeze sensor
Toro TRS	Wired rain sensor
Toro 53853	Wired rain/freeze sensor
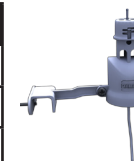
Flow Sensors - Standard

Part Number	Size	Pressure Rating PSI (BAR)	Suggested Operating Range		
			gallons per minute	liters per second	cubic meters per hour
TFS-050	1/2" (1.3 cm)	150 (10.3)	1.2 - 12		
TFS-075	3/4" (1.9 cm)	150 (10.3)	2.7 - 28		
TFS-100	1" (2.54 cm)	150 (10.3)	5 - 50		
TFS-150	1.5" (3.8 cm)	100 (6.9)	5 - 100	.3 - 6.3	1.1 - 22.7
TFS-200	2" (5.1 cm)	100 (6.9)	10 - 200	.6 - 12.6	2.3 - 45.4
TFS-300	3" (7.6 cm)	100 (6.9)	20 - 300	1.3 - 18.9	4.5 - 68.1
TFS-400	4" (10.2 cm)	100 (6.9)	40 - 500	2.5 - 31.5	9.1 - 113.6

Master Valve

Part Number	Valve Description
P220-26-04	1" in-line, angle
P220-26-06	1½" in-line, angle
P220-26-08	2" in-line, angle
P220-26-00	3" in-line, angle
P220S-26-04	1" in-line, angle (scrubber)
P220S-26-06	1½" in-line, angle (scrubber)
P220S-26-08	2" in-line, angle (scrubber)
P220S-26-00	3" in-line, angle (scrubber)
220-26-04	1" in-line, angle, brass
220-26-06	1½" in-line, angle, brass
220-26-08	2" in-line, angle, brass
220-26-00	3" in-line, angle, brass

Toro Pro Series™ Soil Moisture System

Part Number	Description
TPS-RX	Toro Pro Series receiver
TPS-SS	Toro Pro Series soil sensor
TG-R-EXT	External repeater
TG-R-INT	Internal repeater
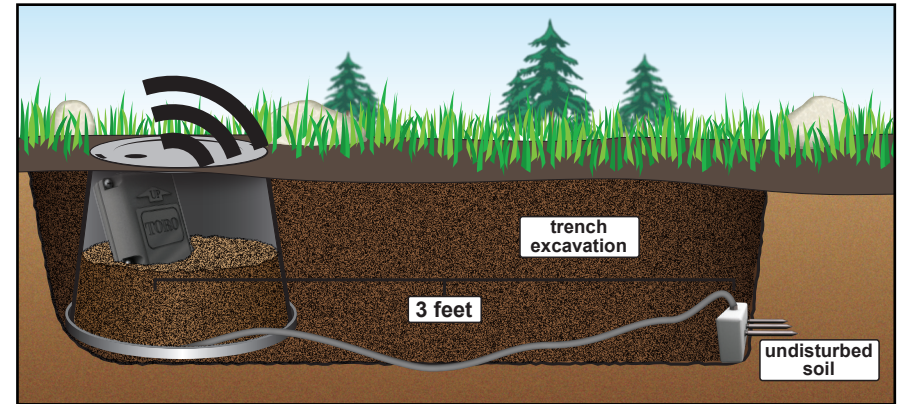
TPS-SS installed in a valve box for easy location

PART 1 - CENTRAL SOFTWARE

General Overview

A. The Water Management System shall be a Toro Sentinel Water Management System (WMS).

B. The System shall include the following general components:
   1. Sentinel WMS Software
   2. Sentinel Field Satellites with conventional wiring terminals, wireless output board terminals or two-wire (each satellite capable of up to 204-stations)
   3. Sentinel Communications Hardware
   4. Central Computer utilizing Windows 7® or Windows 8® Operating System

C. The system central computer may be furnished by the owner or purchased as part of the Water Management System package from Toro. The owner supplied computer must meet the minimum specifications as required by Central software.

Central Software

A. The central software shall have the following programming features:
   1. Access to the programming features of field satellites through PC-based Central software.
   2. Controls up to 999 field satellites.
   3. Group field satellites into "Systems" for system-wide adjustment of:
      a. Rain Shut Downs
      b. Percent Scale (Percent Adjust)
      c. ET adjustment from shared weather source
   4. Separate each field satellite into 16 unique programs. Each program shall have the following setup options:
      a. Specified start times (1-8)
      b. 6-week Active Water Days scheduling
      c. Hour/minute runtime format
      d. Percent Scale
      e. Cycle Delay
      f. Program Repeats
      g. Continuous Run (Continuous Program Repeat)
      h. Water Window
      i. Activate Auxiliary Pump.
      j. ET-based Run Time
      k. Soil Moisture based operation
      l. Percent Scale from 0–255% by field satellite, program or station, across the system

5. Separate each field satellite into 16 watering day schedules. Each schedule shall have the following:
   a. Rolling 6-week format
   b. Ability to overlay on current calendar
   c. Multiple standard Odd/Even or Interval options
6. Adjustment of station runtimes by:
   a. Manual runtime adjustment
   b. Manual percentage adjustments
   c. Automatic acquisition of evapotranspiration data
   d. Historical evapotranspiration
   e. Soil moisture sensor readings

B. The central software shall have the ability to import maps and have interactive symbols representing field locations of valves. Map shall include the following:
   1. Jpg or bmp formatted image
   2. Valve icons indicating
      a. Manually activated valves
      b. Automatically activated valves
      c. Master valve or pump operation

C. The central software shall have the ability to monitor up to (2) flow inputs directly connected to each field satellite. Central software shall have the ability to:
   1. Learn and record flow of individual stations
   2. Record flow on a daily, weekly, yearly basis
   3. Record station flow violations including:
      a. High flow
      b. Low flow
      c. Zero flow
      d. Mainline high flow
      e. Volumetric shutdowns

D. The central software shall be able to automatically schedule program start times based on flow of individual stations. Flow optimization shall include the following features:
   1. Create water sources with maximum flow
   2. Create flow zones associated to water sources with maximum flow
   3. Individually assign stations to water sources or flow zones
   4. Automatically run the Scheduler at a predetermined time
   5. Automatically run the Scheduler after retrieval and recalculation of ET runtimes
   6. Automatically send rescheduled start times to field satellites

E. The central software shall be able to monitor (1) alarm switch inputs, either normally open or normally closed. A pre-programmed action shall take place

that includes:
1. Start programs based on switch change of state
2. Stop and block programs based on switch change of state

F. The central software shall have the ability to monitor (16) wireless soil moisture sensors per field satellite (one per program). Each sensor shall be able to learn low and high moisture levels and control program starts and cycles based on moisture thresholds. Sensor readings will be in volumetric values and can be scaled from 0% to 100%.
1. Threshold settings shall allow for start on low moisture, stop on high
2. Start on low threshold and run pre-set time
3. Start when below high moisture and run to high threshold
4. Start on low threshold and run based on evapotranspiration calculated time

G. The central software shall have the ability to connect to an unlimited quantity of weather stations:
1. The weather stations will measure and store temperature, relative humidity, dew point, wind speed and direction, and solar radiation for use in the calculation of evapotranspiration.
2. The central shall automatically communicate ET data to field satellites for recalculation of watering times.

H. The central software shall be capable of monitoring rainfall at a weather station or rain collector and implement a rain delay based on user-defined inputs including:
1. Rain threshold amount
2. Sampling period
3. Saved rain off to activate when threshold reached
4. System to affect
5. Reset condition

I. The central software shall be capable of monitoring temperature from a weather station and implement a delay based on user-defined inputs including:
1. Temperature threshold amount
2. Sampling period
3. Saved shut downs activate when threshold reached
4. System to affect
5. Reset condition

J. The central software shall provide a Satellite Activity/Alarm Report. This report will display and print satellite alarm and warning events that show various field anomalies. Such events include:
1. Failed communications
2. Station high flow
3. Station low flow
4. Station zero flow

5. Main line overflow
6. Unscheduled flow
7. Electrical current violations
8. Open circuits
9. Max station violation
10. Power failures
11. Decoder communication failures
12. Stations in programs
13. Stations in rain hold
14. Station runtime since day change

K. The central software will be capable of automatically creating and storing reports in an RTF format with specific date stamps in a user-defined location and include:
1. Station alarms
2. Station runtime since last day change
3. Stations in programs
4. Downloaded ET and rainfall
5. Daily water use
6. Weekly water use
7. Monthly water use
8. Yearly water use

L. The central software will be capable of exporting the following satellite data to an Excel spreadsheet:
1. Monthly water usage
2. Monthly accumulated ET
3. Monthly accumulated rainfall

M. The central software will be capable of automatically sending Satellite and System Activity/Alarm reports to specific email addresses.

N. The central software shall come standard with the following support:
1. Central computers provided by the manufacture shall come with two years of software support, computer warranty, remote access and an internet-based ET service.

PART 2 - COMPUTER TO SATELLITE COMMUNICATIONS

A. The central computer shall be capable of multiple communication modes, and must allow for mixed modes within the same system.

B. Computer to satellite communications methods can be:
    1. Narrowband, UHF data radio
    2. Spread Spectrum radio
    3. Cellular Technology
    4. Ethernet
    5. WIFI
    6. Fiber Optics
    7. Serial Cable

C. All communications, regardless of mode, will be true two-way and will provide visual and/or audio confirmation of receipt.

D. The field satellite shall be capable of uninterrupted operation in the event that the central computer is not operational or communication failure with one or more satellites has occurred.

E. A field radio site survey shall be conducted when using UHF radio and/or Spread Spectrum radio.

F. The site survey shall be conducted by a factory-trained service representative.

G. The site survey shall include in writing, verification of communications from base radios to field satellite controllers, suitable UHF radio frequency for operations and locations of any external antennas.

H. When using UHF radio as the means of central computer to field satellite communications, an FCC license will be provided by the factory trained service representative conducting the site survey.

PART 3 - COMPUTER TO SATELLITE HARDWARE
(Communication Termination Module)

A. The central computer shall communicate to the field satellites via a Communication Termination Module (CTM).

B. The module will be housed in a locking stainless steel cabinet for indoor or outdoor mount.

C. The Communication Termination Module (CTM) will include (2) 9-pin serial ports and Ethernet port for communication.

D. The Communication Termination Module (CTM) shall include a 2-watt UHF radio with a BNC connector for external antenna connection.

E. The Communication Termination Module shall come with a 5-year hardware warranty.

PART 4 - FIELD SATELLITE HARDWARE
(Conventional Wired Field Satellites)

A. The field satellite shall use solid-state control technology and be capable of automatic, semi-automatic and manual operations.

B. The field satellite shall be programmable by the built-in keyboard and rotary dial with back-lit LCD. (*Remove this feature if using Sentinel Faceless field satellites.*)

C. The field satellite shall have built-in diagnostics indicating specific field satellite or field alarms, network settings and testing of field stations.

D. The field satellite shall be in a locking stainless steel or powder-coated metal wall mount, stainless steel pedestal or plastic pedestal cabinet.

E. Access to high voltage and 24-volt field wire shall be through a front door panel with a keyed lock.

F. The pedestal model shall bolt into a concrete footing that has mounting bolts embedded in the concrete pad. The concrete pad shall be sloped away from the pedestal to prevent water accumulation around the base of the cabinet.

G. The field satellite shall be capable of operating up to 204 stations.

H. The field satellite shall be capable of activating station output boards via attached ribbon cables or short-range and/or long-range spread spectrum radios.

I. The field satellite shall be capable of operating at 115 V a.c. (+/- 10%) 50/60Hz and be capable of withstanding an incoming surge or electrical spike or 4.5 kV on the input side.

J. Each 24-volt station output shall be capable of delivering 0.5 amperes at (12VA) at 24 V a.c.

K. The field satellite shall be capable of operating (6) multiple stations for a total output current of 2.0 amperes at 24 V a.c.

L. The field satellite shall have a built-in Ethernet port for optional network connectivity.

M. The field satellite shall have a built-in wireless soil moisture sensing port for optional Wireless Soil Sensing Base Station connection.

N. The field satellite shall have a built-in USB port for field firmware updates and program back-up.

O. The field satellite shall have (2) built-in nine pin serial ports.

P. The field satellite shall have status lights indicating alarms, current irrigation and rain holds. (*Remove this feature if using Sentinel Faceless field satellites.*)

Q. The field satellite shall have the ability to read (2) flow inputs connected directly to a data-retrieval terminal connection inside the field satellite cabinet and read, display and record real-time gallons per minute.

R. The field satellite shall have the ability to read an additional (14) flow inputs via optional wireless output remote modules.

S. The surge testing shall conform to the following standards: ICE 61000 Standard for Lighting Surge, 1089 Bellcore Testing, UL 1449.

T. The 24-volt output board with full surge shall be capable of withstanding field surges in excess of 20 KV.

U. The field satellite shall have manual activation switches and LEDs indicating station operation for each station.

V. The field satellite shall have the capability to activate (16) separate master valves via mirrored master valve designation.

W. The field satellite shall come standard with back-up battery for real-time clock retention in the event of a power failure. The field satellite shall maintain the time-of-day, day-of-week and user defined programs.

X. The field satellite control module components shall be enclosed in a weather resistant plastic case.

Y. The field satellite shall be grounded according to the ASIC 100-2002 Grounding Guidelines.

Z. The field satellite shall come with a 5-year hardware warranty.

PART 5 - FIELD SATELLITE HARDWARE
(Two Wire – DC Solenoids)

A. The field satellite shall use solid-state control technology and be capable of automatic, semi-automatic and manual operations.

B. The field satellite shall be programmable by the on-board keyboard with rotary dial with back-lit LCD.

C. The field satellite shall have built-in diagnostics indicating specific field satellite or field alarms, network settings and testing of field stations.

D. The field satellite shall be in a locking stainless steel, powder-coated metal wall mount, stainless steel pedestal or plastic pedestal.

E. Access to high voltage and field wire shall be through a front door panel with a keyed lock.

F. The pedestal model shall bolt into a concrete footing that has mounting bolts embedded in the concrete pad. The concrete pad shall be sloped away from the pedestal to prevent water accumulation around the base of the cabinet.

G. The field satellite shall be capable of operating up to 204 stations.

H. The field satellite shall be capable of connecting either a short-range and/or long-range spread spectrum radio for activation of wireless output remote modules.

I. The field satellite shall have a built-in Ethernet port for optional network connectivity

J. The field satellite shall have a built-in wireless soil moisture sensing port for optional Wireless Soil Moisture Sensing Base Station connection.

K. The field satellite shall have a built-in USB port for field firmware updates and program back-up.

L. The field satellite shall have (2) built-in nine pin serial ports.

M. The field satellite shall operate DC latching solenoids and be able to activate (16) decoders, and (32) individual valves simultaneously.

N. The field satellite shall have non-volatile memory and self-diagnostics to identify decoder communication and open circuits.

O. The field satellite shall be able to run all decoders on #14 AWG cable up to 15,000 feet in any direction from the field satellite.

P. The field satellite shall have the ability to read (2) flow inputs connected directly to a data-retrieval terminal connection inside the field satellite cabinet and read, display and record real-time gallons per minute.

Q. The field satellite shall have the ability to read an additional (14) flow inputs via optional wireless output remote modules.

R. The field satellite shall have the capability to activate (16) separate master valves via mirrored master valve designation.

S. The field satellite shall come standard with a backup battery for real-time clock retention in the event of a power failure. The field satellite shall maintain the time-of-day, day-of-week .

T. The field satellite control module components shall be enclosed in a weather resistant plastic case.

U. Valve Communications:
   1. Communication between field satellite and the decoders shall be accomplished by a twisted pair of #14 AWG decoder cables for direct burial within a red HDPE outer jacket.
   2. Decoders shall have 'Integrated Surge Protection' rated to 20 KV (20,000 volts) secondary surge.
   3. Decoders shall be pre-addressed with a five-digit address and not programmable.
   4. All splices shall be made in accordance with National Electrical Code® Articles 300.5 (Underground Installations) and 110.14 (Electrical Connections) using 3M DBYR-6 connectors, which are UL listed under "UL 486D-Direct Burial", for wet or damp locations, 600 volts.
   5. Decoder communication cable shall be installed in a separate trench a minimum of 12" per 100 volts away from any power cable.

V. Grounding
   1. Decoder communication cable shall connect a line surge-protector to

4"x 36" ground plate and communication cable no more than 500 feet from any decoder location along the two-wire path and be installed according to ASIC guidelines. Grounding of 20 ohms, or less, will be required.

2. The field satellite shall be grounded according to the ASIC 100-2002 Grounding Guidelines.

W. The field satellite shall come with a 5-year hardware warranty.

PART 6 - FIELD SATELLITE HARDWARE
(Two Wire – AC Solenoids)

A. The field satellite shall use solid-state control technology and be capable of automatic, semi-automatic and manual operations.

B. The field satellite shall be programmable by the on-board keyboard with rotary dial with back-lit LCD.

C. The field satellite shall have built-in diagnostics indicating specific field satellite or field alarms, network settings and testing of field stations.

D. The field satellite shall be in a locking stainless steel, powder-coated metal wall mount, stainless steel pedestal or plastic pedestal.

E. Access to high voltage and field wire shall be through a front door panel with a keyed lock.

F. The pedestal model shall bolt into a concrete footing that has mounting bolts embedded in the concrete pad. The concrete pad shall be sloped away from the pedestal to prevent water accumulation around the base of the cabinet.

G. The field satellite shall be capable of operating up to 204 stations.

H. The field satellite shall be capable of connecting either a short-range and/ or long-range spread spectrum radio for activation of wireless output remote modules.

I. The field satellite shall have a built-in Ethernet port for optional network connectivity

J. The field satellite shall have a built-in wireless soil moisture sensing port for optional Wireless Soil Moisture Sensing Base Station connection.

K. The field satellite shall have a built-in USB port for field firmware updates and program back-up.

L. The field satellite shall have (2) built-in nine pin serial ports.

M. The field satellite shall have the ability to communicate and control up to a total of 204 field decoders.

N. The field satellite shall operate 24VAC solenoids and be able to activate up to (8) decoders and up to (8) individual valves simultaneously depending on the solenoid, the length of the two-wire path, and the total number of decoders on the path. (Note: Sentinel AC two-wire decoders are incompatible with Toro SGS Spike Guard solenoids.)

O. The field satellite shall have non-volatile memory and self-diagnostics to identify decoder communication and open circuits.

P. The field satellite shall be able to run all decoders on #14 AWG cable up to 10,000' when wire is looped from the field satellite and 5000' in a straight run.

Q. The field satellite shall have the ability to read (2) flow inputs connected directly to a data-retrieval terminal connection inside the field satellite cabinet and read, display and record real-time gallons per minute.

R. The field satellite shall have the ability to read an additional (14) flow inputs via optional wireless output remote modules.

S. The field satellite shall have the capability to activate (16) separate master valves via mirrored master valve designation.

T. The field satellite shall come standard with a backup battery for real-time clock retention in the event of a power failure. The field satellite shall maintain the time-of-day, day-of-week .

U. The field satellite control module components shall be enclosed in a weather resistant plastic case.

V. Valve Communications:
1. Communication between field satellite(s) and the decoders shall be accomplished by a polyethylene double-jacketed or UF-B UL PVC double-jacketed two-conductor solid core for direct burial with insulation 3/16 inch (.060") thick, high density, sunlight resistant incased in an outer jacket of Polyethylene or PVC conforming to ICEA S-GL-402 or NEMA WC5, having a minimum wall thickness of .045 inches.
2. All splices shall be made in accordance with National Electrical Code® Articles 300.5 (Underground Installations) and 110.14 (Electrical Connections) using 3M DBYR-6 connectors, which are UL listed under "UL 486D-Direct Burial", for wet or damp locations, 600 volts.
3. Decoder communication cables shall be installed in a separate trench a minimum of 12" per 100 volts away from power cable.

W. Grounding
1. Decoder communication cable shall connect a line surge-protector to 4"x 36" ground plate and communication cable no more than 500 feet from any decoder location along the two-wire path and be installed according to ASIC guidelines. Grounding of 20 ohms, or less, will be required.
2. The field satellite shall be grounded according to the ASIC 100-2002 Grounding Guidelines.

X. The field satellite shall come with a 5-year hardware warranty.

PART 7 – FIELD SATELLITE HARDWARE
(Wireless Output Remote Modules)

A. The wireless output remote module shall use solid-state control technology and be capable of automatic, semi-automatic and manual operations.

B. The wireless output remote module shall be programmable by a separate field satellite with on-board keyboard with rotary dial with back-lit LCD.

C. The wireless output remote module shall be in a locking stainless steel, powder-coated metal wall mount, stainless steel pedestal or plastic pedestal.

D. Access to high voltage and field wire shall be through a front door panel with a keyed lock.

E. The pedestal model shall bolt into a concrete footing that has mounting bolts embedded in the concrete pad. The concrete pad shall be sloped away from the pedestal to prevent water accumulation around the base of the cabinet.

F. The wireless output remote module shall be capable of operating up to (48) stations via conventional wired valves.

G. The wireless output remote module shall operate 24VAC solenoids and be able to activate (6) individual valves simultaneously.

H. The wireless output remote module shall be capable of operating at 115 V a.c. (+/- 10%) 60Hz and be capable of withstanding an incoming surge or electrical spike or 4.5 kV on the input side.

I. The wireless output remote module shall have the ability to read (1) flow input connected directly to a data-retrieval terminal connection inside the wireless output remote module cabinet.

J. The wireless output remote module shall have the capability to operate (1) master valve from the on-board master valve terminal. The master valve shall be normally-closed.

K. The wireless output remote module shall come with a 5-year hardware.

PART 8 – FIELD SATELLITE PROGRAMMING CAPABILITIES

A. Time-of-day, day-of-week, expected flow, actual flow and operational status shall be shown in LCD display.

B. The field satellite shall have a real-time clock with adjustable day change hour.

C. The field satellite shall have (16) independent programs.

D. Each station shall be assigned independently to any or all of the 16 programs.

E. Each program shall be assigned to any of sixteen independent watering schedules.

F. Each program shall have (8) start times, (99) repeat cycles with a programmable delay between cycles from 0-255 minutes.

G. Each program shall have a programmable water window where watering will only take place between a start and end time.

H. The field satellite shall be capable of running any one or combination of programs simultaneously.

I. The field satellite shall have a program adjust feature that allows for independent percent-adjust feature that allows for independent percentage adjustment of each program from 10% to 250% in 1% increments.

J. The field satellite shall have the ability to monitor up to (16) wireless soil moisture sensors. Each sensor shall be able to learn low and high moisture levels and control program starts based on both moisture levels. Sensor readings will be in volumetric values and can be scaled from 0% to 100%.
   1. Threshold settings shall allow for start on low moisture, stop on high
   2. Start on low threshold and run pre-set time
   3. Start when below high moisture and run to high threshold
   4. Start on low threshold and run based on evapotranspiration calculated time

K. The field satellite shall be capable of running irrigation programs based on Evapo-Transpiration (ET) input. When the ET functions are activated, the field satellite automatically adjusts program run times according to the ET data.

L. The field satellite shall have a non-volatile memory that can maintain time and all programming functions.

M. When the field satellite is operating in either manual or automatic modes, the remaining run time shall be displayed.

N. The field satellite shall have the following additional standard features in a stand-alone mode:
   1. Alarm alerts
   2. Ability to create and store programs for future use
   3. Ability to read and react to low, high and zero flow
   4. Ability to store water usage by day, week, month and year
   5. Ability to view soil moisture readings
   6. Ability to read and react to current draw of all AC powered stations
   7. Ability to test decoders for communication
   8. Ability to set field satellite to static or dynamic IP address
   9. Ability to program decoder addresses
   10. Ability to test UHF radio with a bounce-back signal

PART 9 - HAND-HELD REMOTE

A. The field satellite shall have the ability to accept and execute commands from a portable UHF hand-held radio remote having an output power of 5 watts.

B. The hand-held remote radio shall not require the installation of a central computer or any radio receiver and shall have the ability to communicate directly to a field satellite in a stand-alone mode.

C. The remote shall have the ability to execute the following commands:
   1. On/Off of individual stations
   2. On/Off of individual programs
   3. Quick station advance
   4. Set stations in rain hold
   5. Run a station sequence

D. The handheld will provide the ability for two-way voice communications.

E. The field satellite when connected via Ethernet, cell data modem or WIFI shall have the ability to accept and execute commands from a web-enabled smart phone.

F. The web-enabled smart phone shall have the ability to execute the following commands:
   1. On/Off of individual stations
   2. On/Off of individual programs
   3. Quick station advance

PART 10 - ACCESSORY EQUIPMENT

Flow Sensors

A. The flow sensor shall be an in-line type with a non-magnetic, spinning impeller (paddle wheel) as the only moving part.

B. The electronics housing shall be glass-filled PPS.

C. The impeller shall be glass-filled nylon or Tefzel® with a UHMWPE or Tefzel sleeve bearing.

D. The shaft material shall be tungsten carbide.

E. The electronics housing shall have two ethylenepropylene O-Rings and shall be easily removed from the meter body. The sensor electronics will be potted in an epoxy compound designed for prolonged immersion.

F. Electrical connections shall be 2 single conductor 18 AWG leads 48 inches long. Insulation shall be direct burial "UF" type colored red for the positive lead and black for the negative lead.

G. The sensor shall operate in line pressures up to 100 psi and liquid temperatures up to 140° F, and operate in flows of 1⁄2 foot per second to 20 feet per second with linearity of ± 1% and repeatability of ± 1%.

H. The sensor body shall be fabricated from Schedule 80 PVC Tees, available in 1 1⁄2", 2", 3, and 4" with socket end connections.

I. The flow sensor shall come with a 2-year warranty.

Cable for Flow Sensors

A. Approved flow sensors may be located up to 2000' from the field satellite.

B. All data communications wire connecting flow sensors to the electronics that are buried below grade, with or without conduit, shall be constructed to direct burial specifications similar to Telecommunications Exchange Cable (REA PE-89).

C. The cable shall be constructed of 20 AWG, or larger, copper conductors twisted into pairs of varying lengths to prevent cross talk and include a drain wire for optional field grounding. Conductors shall be insulated with polyethylene or propylene with a suggested working voltage of 350 volts.

D. The cable shall feature an aluminum-polyester shield and be finished with a black high-density polyethylene jacket. Cable should be equivalent to AT&T PE-39 or PE-89.
   1. Communication cable shall be installed in a separate trench a minimum of 12" per 100 volts away from power cable and a minimum of 12" from any two-wire communication cable.

Splices for Flow Sensors

A. All wire connections shall be watertight with no leakage to ground or shorting from one conductor to another.

B. All splices shall be made in accordance with National Electrical Code® Articles 300.5 (Underground Installations) and 110.14 (Electrical Connections) using 3M DBY-6 or DBR-6 connectors, which are UL listed under "UL 486D-Direct Burial", for wet or damp locations, 600 volts.

Weather Stations and Rain Collectors

A. The weather station shall be located in an area "representing" the typical landscape to be irrigated.

B. The weather station shall be available in both wireless and cabled versions. The station shall include a sensor suite combining rain, temperature, humidity, solar radiation and anemometer in one package. A desktop console/data logger shall be included that provides "at a glance" weather information. The rain collector shall read rainfall amounts in 0.01" increments and accumulate up to 200" of annual rainfall. The anemometer shall be able to read wind speeds up to 150 mph. The temperature gauge shall be able to read outside temperature readings from -40 degrees to +150 degrees. The station shall record daily ET (Evapotranspiration) and log monthly and yearly amounts up to a total of 200" of ET.

C. The station shall provide software that runs locally on the same PC and OS

running the irrigation control equipment. The software shall provide screens for viewing current dynamic weather conditions from all weather sensors. The software shall allow for generation of reports in table or graph format. Graphing shall be in either line or bar graph formats.

D. The weather station shall connect to the central computer via direct cable, spread spectrum radio , Ethernet or cell data modem.

E. The weather stations shall be installed as per manufacturer's specifications.

Wired Rain Collector

A. Rain collector sensors shall be magnetic type tipping bucket with reed switch.

B. Rain collector housing shall be constructed of aluminum or high density UV resistant plastic.

C. Rain Collector sensors may be located up to 500' from the field satellite.

D. All data communications wire connecting rain collectors to the electronics that are buried below grade, with or without conduit, shall be constructed to direct burial specifications similar to Telecommunications Exchange Cable (REA PE-89).

E. The cable shall be constructed of 20 AWG, or larger, copper conductor twisted into pairs of varying lengths to prevent cross talk. Conductors shall be insulated with polyethylene or propylene with a suggested working voltage of 350 volts.

F. The cable shall feature an aluminum-polyester shield and be finished with a black high-density polyethylene jacket. Cable should be equivalent to AT&T PE-39 or PE-89.
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Splices for Rain Collector

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Soil Moisture Sensing

A. The soil moisture sensors shall be located in typical areas representing the controlled program. Sensors shall be installed by removing enough soil to insert the sensor body below grade before pressing the moisture sensor spikes into undisturbed soil.

B. Equipment:
   1. Wireless base station utilizing spread spectrum communications
   2. Wireless soil moisture sensors with built-in spread spectrum transmitter
   3. Wireless repeaters utilizing spread spectrum communications
   4. All sensors shall be waterproof and have a body dimension of 2" x 3" x 5" with three or six spikes at 2" x 3/16". Sensors shall have an operating temperature of 32° to 140°F.
   5. Sensors shall measure and transmit real time moisture minimum every 5 minutes and be displayed in central software.
   6. The transmitter shall have a line of sight range of up to 500 feet from the buried location, and shall operate at 902-928 MHz band (unlicensed in the United States).
   7. Sensors shall not exceed 500' from a wireless base station unless repeaters are added to the system.
   8. Repeaters shall be used in areas to increase wireless range. Repeaters shall be installed up to 1500' from a wireless base station and 500' from wireless soil moisture sensor.

Glossary of Terms

AC Decoder	A decoder that operates 24VAC activated solenoid valves
Base Radio	A UHF radio that communicates to a group of Sentinel controllers
Cellular Data Modem	A wireless media convertor that changes a wireless data signal to either a Ethernet or serial signal
CTM	Communication Termination Module; used to convert an Ethernet or cellular communication to UHF radio
Data Retrieval Port	A port on the Sentinel timing module used to receive signals from a flow sensor, rain collector or contact sensor
DC Decoder	A decoder that operates latching activated solenoid valves
Decoder	Electronic components sealed in a potted enclosure for direct burial in the field. Decoders attach to a two-wire path from the Sentinel two-wire controller and convert an electronic signal to open and close an irrigation valve.
Ethernet Modem	A media convertor that changes an electronic signal from an incoming Cat5 cable to a serial signal
Faceless Controllers	Sentinel field satellite controllers without a programmable keypad
Flow Sensor	A T-type inline sensor plumbed into the mainline of the irrigation system to read flow in gallons or liters. It requires a pair of wires back to the Sentinel field satellite controller for operation
Hand-Held	A portable UHF radio used to control irrigation stations remotely in the field. Control is from a code sequence programmed into the portable radio firmware.
Master Valve	An electrically activated solenoid valve plumbed in-line on the mainline and upstream of the individual irrigation station valves
Rain Collector	A device used to collect and measure accurate amounts of rainfall in .01 increments, it attaches directly to a Sentinel field satellite controller
Satellite	Sentinel field controller, up to 48 stations that communicates with the Sentinel WMS software
Serial Cable	A 9-pin communication cable that connects to a Sentinel timing module from a communication device or computer
Serial Port	A communication port on the Sentinel timing module
Soil Moisture Receiver	A spread spectrum radio that attaches to a Sentinel timing module and provides communication to a soil moisture sensor
Soil Moisture Repeater	A spread spectrum radio that increases signal distance between a soil moisture receiver and soil moisture sensor
Soil Moisture Sensor	A wireless in-ground sensor that transmits real-time moisture readings to a Sentinel field satellite controller
Spread Spectrum Radio	A two-way communication device that connects to a Sentinel timing module and antenna. Operates in 2.4GHz or 900MHz frequency range.
Stubby Antenna	Either a UHF or spread spectrum antenna that attaches to the bottom of a Sentinel wall-mount cabinet
Surge Arrestor	A component installed on a two-wire path that directs an electrical power surge to earth ground. Attaches to a ground rod or ground plate.
Timing Module	The part of a Sentinel field satellite controller that houses the main circuit boards, including communiation ports and radios, available with and without a keypad
Two-Wire Controller	Sentinel field satellite controller that operates up to 204 irrigation stations via a two-wire cable path. Decoders are attached on the two-wire path at each valve location.
UHF Radio	A two-way communication device that connects to a Sentinel timing module and antenna. Operates in the 450 to 470 frequency range.
VRA Antenna	Either a UHF or spread spectrum pancake antenna that attaches to the top of a Sentinel wall-mount or pedestal cabinet
Weather Station	A group of sensors that read current weather conditions and calculates evapotranspiration, this weather station communicates to the Sentinel WMS software
Wireless Output Boards	Station output boards with surge protection and station terminals that communicates to a Sentinel timing module using spread spectrum radios
WMS Software	Sentinel Water Management Software that communicates up to 999 Sentinel field satellite controllers
Yagi Antenna	A directional UHF or spread spectrum antenna that mounts externally from a Sentinel cabinet

Additional Resources

Thank you for reviewing Toro's Sentinel Design Guide. The purpose of this guide is to provide information to a consultant, distributor and/or end-user on the various Sentinel components and options to build and specify a Sentinel system that meets and even exceeds all customer requirements. For further design and application information please contact:

West –   Don Ghella 602-418-2295 (Don.Ghella@Toro.com)

East/Southeast –   Jim Laiche 804-334-2225 (Jim.Laiche@Toro.com)

Midwest/Northeast –   Bruce Funnell 616-450-6618 (Bruce.Funnell@Toro.com)

Riverside, CA -   Custom Build Services 951-785-3381

TORO SENTINEL SPECIFYING INFORMATION CONTACTS:

Don Ghella – don.ghella@toro.com – (602) 418-2295

Jim Laiche – jim.laiche@toro.com – (804) 334-2225

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