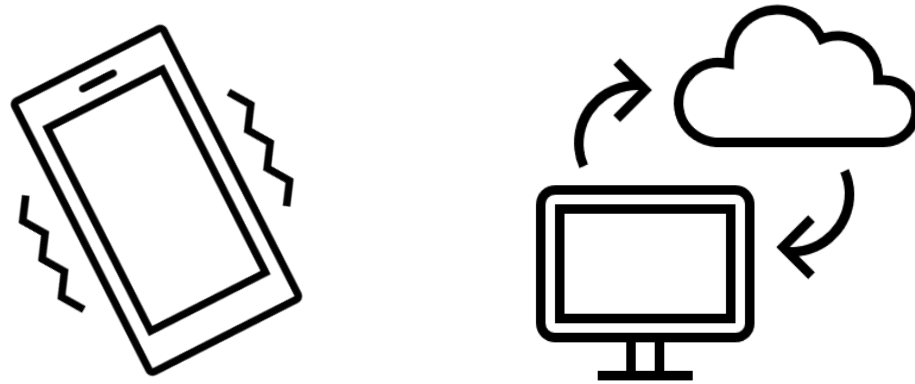


SMALL TO LARGE SCALE IRRIGATION AUTOMATION



1. Background
2. Automation
 - a. What is it?
 - b. Why should I use it?
3. Remote Control – Traditional Irrigation timers
4. System Integrators -Today's Platforms
 - a. So many options
 - b. Communication methods
 - c. Systems integration
5. Toro Tempus
 - a. System architecture
 - b. Simple and Reliable
 - c. User Interface
 1. App
 2. Web Platform
 - Canopy
 - Cluster
 - Automations
 - e. Updates for 2023
7. Treetoscope Sensor

The TORO logo is a red square with the word "TORO" in white, bold, sans-serif capital letters.

About Me

Toro Ag - *Technical Sales Manager*

Support sales team, dealer network, and end users with technical issues and specification

Ernst Irrigation - *Irrigation Design and Sales*

St. Paul, OR

Hardware store established 1910

➔ Irrigation sales – 1960's

- Designed drip, sprinkler, micro-sprinkler, traveling gun, linear & pivot systems.
- Pump specification - End-suction centrifugal, electric submersible turbine, and line-shaft turbine pumps
- Field service support - Filtration troubleshooting and service; Automation programming and troubleshooting

Primary Crops – Hops, Hazelnuts, Blueberries, Cane berries, Strawberries, Nursery: Bare root, can-yard, pot-in-pot, Greenhouse; Hort production, Grass seed, Kiwi



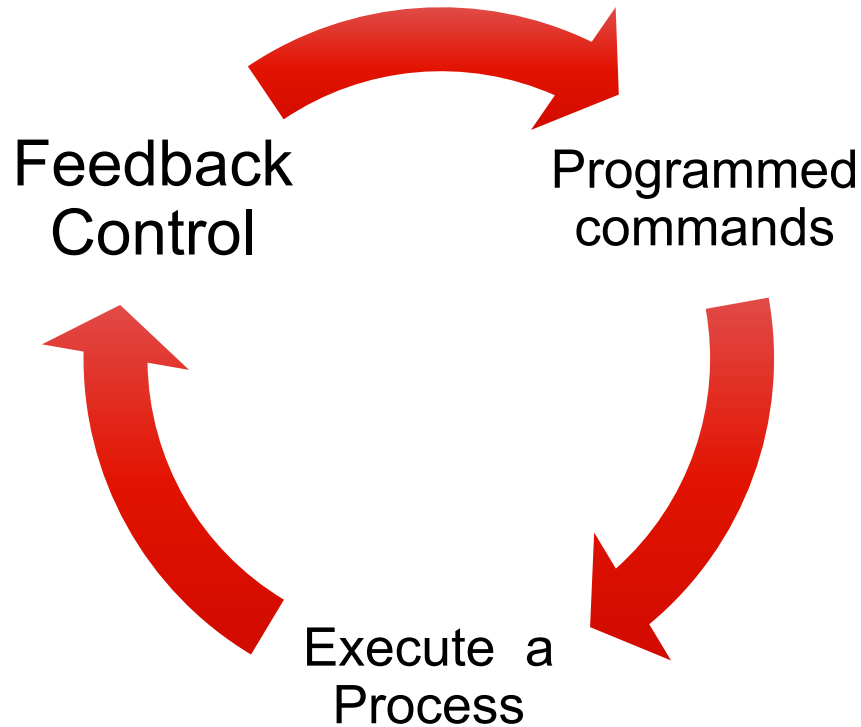
History of Toro Ag

- Originally built by Reed Irrigation Systems in 1972
- Acquired by James Hardie in 1978
- Acquired by Toro in 1995
- Acquisition of Drip-In specifically to bolster the drip line product offering, 1997
- Key products
 - Aqua-Traxx Azul & FlowControl Tape
 - Blueline hose
 - Greenhouse products
 - Controllers
- The Toro Company celebrated it's 100-year centennial in 2014
- Toro Micro Irrigation changed name to Toro Ag in 2017



What is Automation?

- *Automation*- a technology concerned with performing a process by means of programmed commands, combined with automatic feedback control to ensure proper execution of the instruction



	1	2	3	4	5	6	7	8	9	0	On	S	A	C	E	a	o	e	g	EB	SB	Ch	Sy	U	Sh	Hk	Br	Rm
2	2	4	1	3	E	15	Oh	IS	B	D	F	b	d	f	h					SY	X	Fp	Cn	R	X	Al	Cg	Kg
3	0	0	0	0	W	20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A	1	1	1	1	0	25	A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
B	2	2	2	2	5	30	B	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
C	3	3	3	3	0	3	C	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
D	4	4	4	4	1	4	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	
E	5	5	5	5	2	C	E	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
F	6	6	6	6	A	D	F	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	
G	7	7	7	7	B	E	Q	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	
H	8	8	8	8	a	F	H	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	
I	9	9	9	9	b	c	I	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	

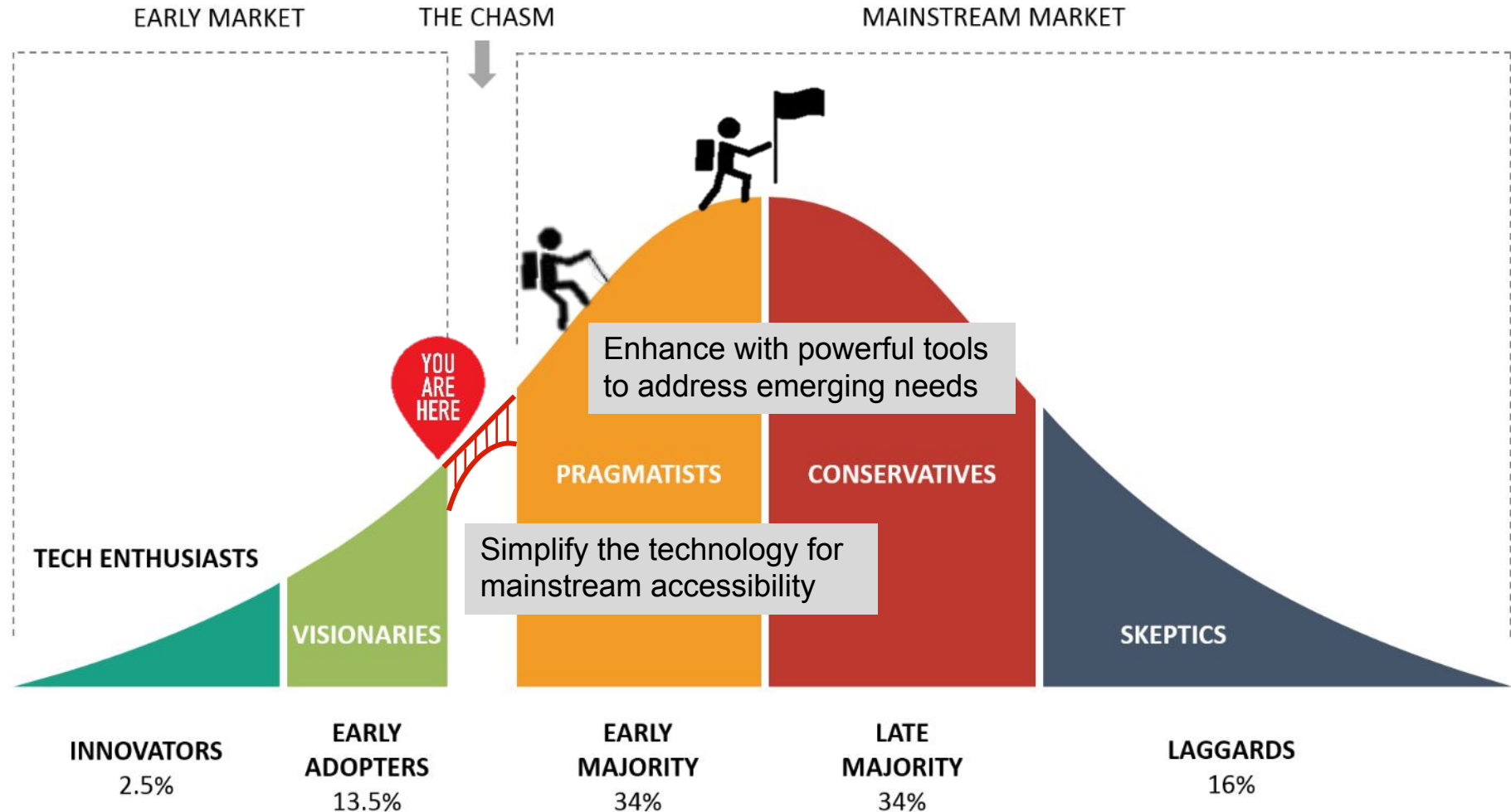
Hollerith Tabulating machine – 1890 Census

2 Major Features

- *Remote control*
 - Execution of programmed commands
 - Wired, wireless, or direct acting
 - Valve control, motor control, switch relays
 - An event that leads to change in state
 - Vents opens, shades close, fans turn on
- *System integration* - The differentiator
 - Feedback Control
 - All components and systems must “talk” to each other
 - Communications must contain useful information
 - Weather stations, pressure transducers, flowmeters,
 - Injection systems should be accessible from a single platform

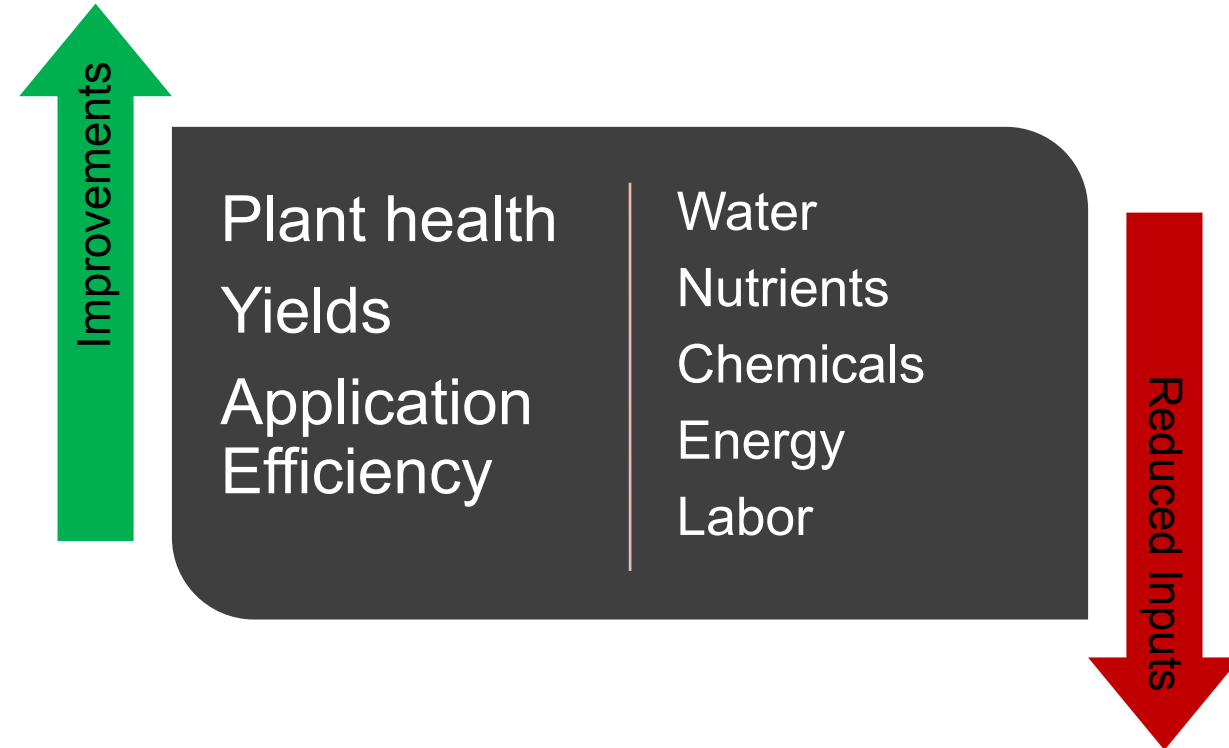
Automation Market Overview

Automation market expected to double over the next 5 years

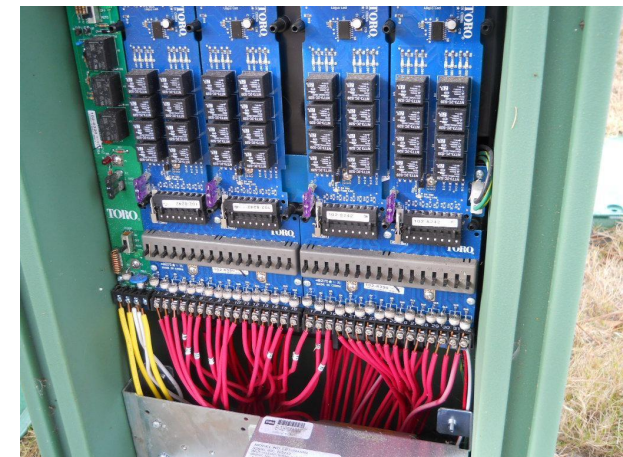


Automation in Irrigation – Why should I use it?

- Automated controls allow users to realize the full benefits of the irrigation system...
 - Water delivery
 - Nutrient delivery
 - Climate control
- Provides a central point to execute management decisions
- When leveraged correctly.....



Remote Control - Early Irrigation Controllers



Remote Control – AC Controllers



Wurtlin's Wall of Confusion



Customer build – Siemens HMI & smart relay
 — Abandoned PLC for manual switching



Vision II Timer

- Linkable controllers
- Rain sensor input
- Station run times adjusted by individual dials

Remote Control - AC Controllers

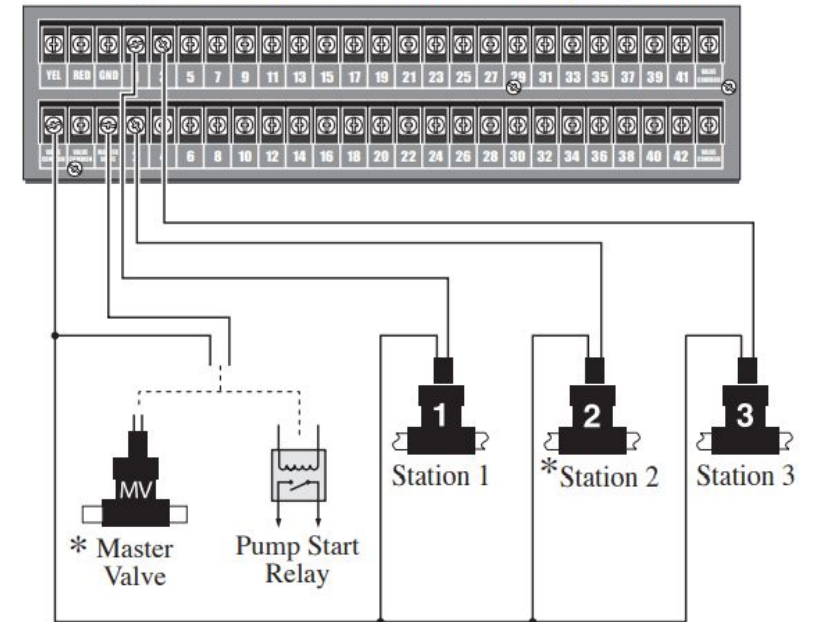


Irritrol Rain Dial

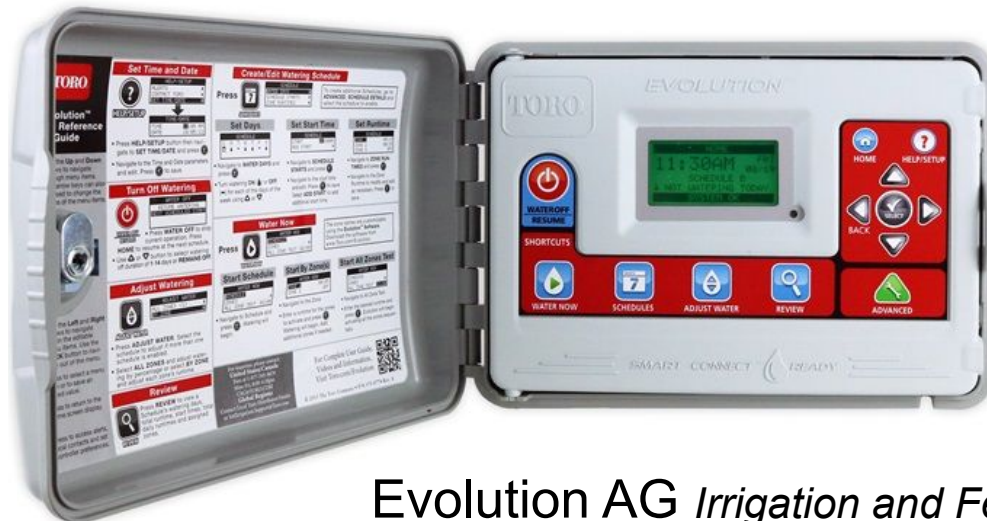
Electrical Specifications

- Transformer input: 120 VAC, 60 Hz
- Transformer output: 24 VAC, 1.25 amps
- Maximum output per station: 24 VAC, .5 amp
- Maximum total output to valves: 24 VAC, 1.0 amp (including master valve)
- Battery backup: 9-volt alkaline battery (not included)

Wiring for standard (non-flow sensing) system



- Program valve runtime from 1 second to 24 hours
- Operate up to 4 valves at one time
- Manage 2 Fertilizer pumps
- Wireless Valve Remote Control with 1,000 ft. range



Evolution AG Irrigation and Fertigation Controller

Wire Sizing

Data Needed

- Maximum current draw of the electrical unit (valve or controller) in amperes (I)
- Distance in feet (one way) to the electrical unit (F)
- The allowable voltage drop in the wire without affecting functions of the electrical unit (Vd)

Maximum One-way Distance (ft.) Between Controller and Valve (standard 24 VAC solenoid) †

Valve Wire Sizing							
Ground Wire	Control Wire						
	18	16	14	12	10	8	6
18	1020	1260	1470	1640	1770	1860	1930
16	1260	1630	2000	2330	2610	2810	2960
14	1470	2000	2590	3180	3710	4150	4480
12	1640	2330	3180	4120	5050	5900	6590
10	1770	2610	3710	5050	6540	8030	9380
8	1860	2810	4150	5900	8030	10400	12770
6	1930	2960	4480	6590	9380	12770	16540

† Solenoid Model: 24 V ac Pressure: 150 psi Voltage Drop: 4 V Min. Op. Voltage: 20 V Amperage (peak): 0.3A

Chart 1
Minimum Solenoid Operating Voltage
Under Various Line Pressure

Line Pressure	Voltage (Internal Bleed Configurations)	Voltage (External Bleed Configurations)
200 psi (13,8 Bar)	21.1	
175 psi (12,1 Bar)	20.2	
150 psi (10,3 Bar)	19.1	20.0
125 psi (8,6 Bar)	18.2	19.1
100 psi (6,9 Bar)	17.1	18.2
75 psi (5,2 Bar)	16.1	17.3
50 psi (3,4 Bar)	16.0	16.4

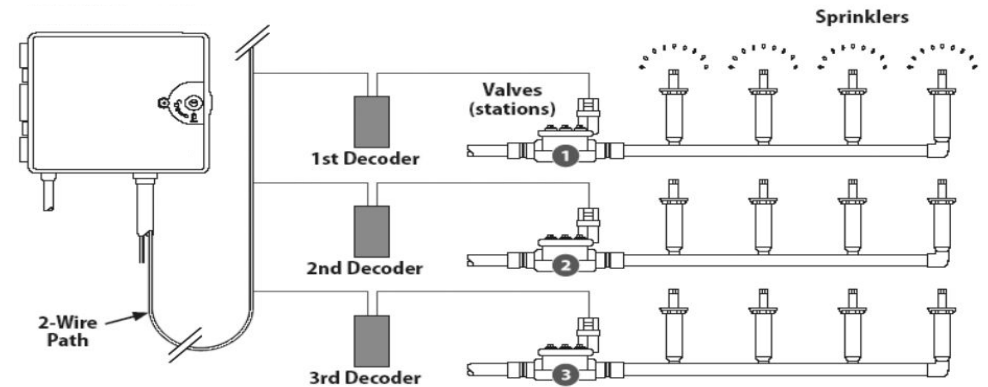
**Copper Wire Resistance
of Various Sizes**

Sizes AWG	Resistance at 20°C Ohms per 1000 ft.
4	.25
6	.40
8	.64
10	1.02
12	1.62
14	2.57
16	4.10
18	6.51

- Electricity, like water in pipes, loses some of its potential (*VOLTAGE*) as it travels along a wire run.
- Proper wire gauge helps to minimize such losses.
- Applies for AC and DC

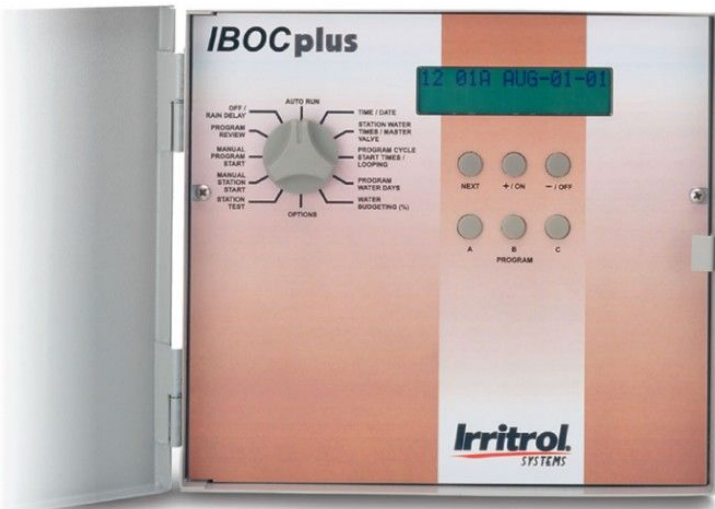
2-wire Decoder systems

- Common 2-wire path connects each valve to controller
- Each valve tied to wire path via *decoder*
- *Decoder* receives a digital signal from controller
 - Signal is specific to a decoder or decoder station in the case of multi-valve decoders
- Typically used with many valves or large areas
 - 2-wire controllers can usually operate 90+ decoders
 - Operates devices miles away



Typical Decoder and Valve Operation

Remote Control - DC Controllers



Irritrol *IBOC* plus Controller

- Powered by one six-volt alkaline battery or one A-SPC-2 (solar-powered converter)
- Output: 24 VDC latching

Controllers to Valves

Wire size (Awg)	20	18	16	14	12
Distance (ft.)	400	600	1000	1600	2400



DDC WP Controller

- Accepts Toro TRS Wired RainSensor™, Wired Rain/Freeze and other normally-closed sensors
- Low-battery indicator visible on LCD screen
- Three independent programs and three start times per program
- Three scheduling choices by program:
 - Seven-day calendar
 - 1 to 7-day interval
 - Odd/even with 365-day calendar and 31st day exclusion
- Station run times from one minute to four hours in one-minute increments

- 2-station
- 4-station
- 6-station
- 8-station



Multi-strand Wire	Distance (Ft.)
18 AWG	197
16 AWG	305
14 AWG	493
12 AWG	820

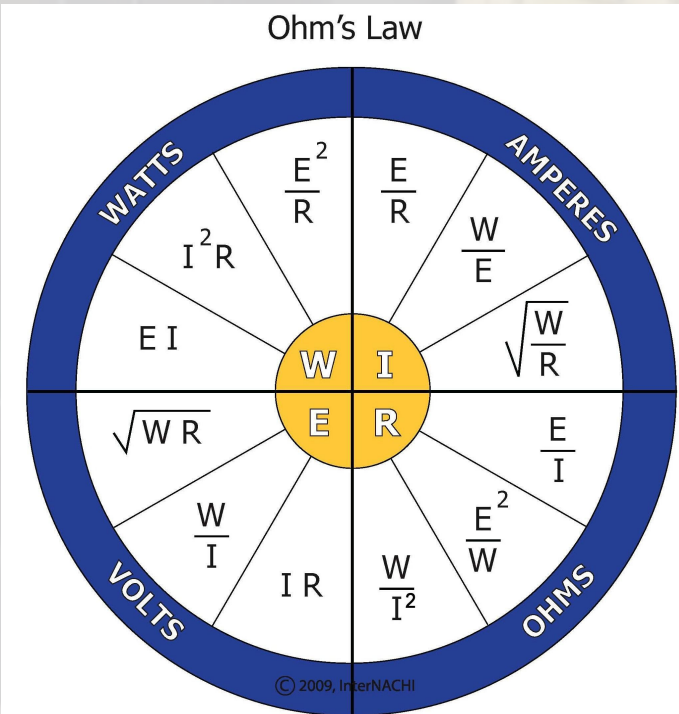
Things Will Go Wrong

- After verifying irrigation components are in proper working order, the control system must be diagnosed
- Troubleshooting & servicing controllers requires a basic understanding how the system is configured.
 - Location of valves
 - Controller type
 - Auxiliary sensors
 - Programming objectives
- Using a multimeter or specific test equipment, operators need to properly identify shorts, loads, resistances.
- With the results derived from testing, user must identify issue and solution

PROGRAMMING WATERING SCHEDULE				
WATERING TIMES				
Valve Station	A Program	B Program	C Program	Valve / Station Description
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

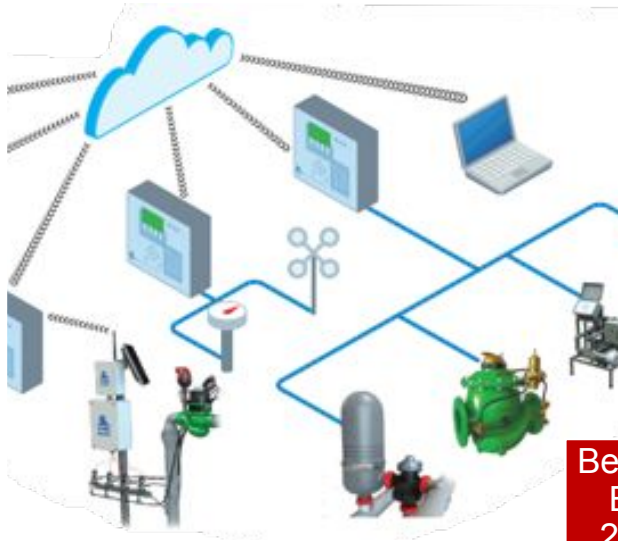
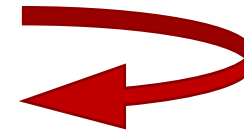
Start Times			Watering Days
1st	2nd	3rd	

Irritrol SYSTEMS See www.RainDialDoctor.com for more information 1052301 Rev. B

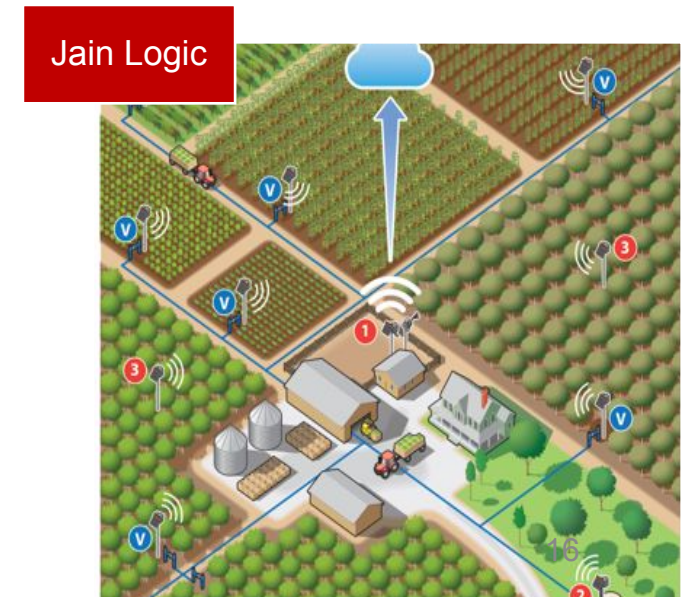
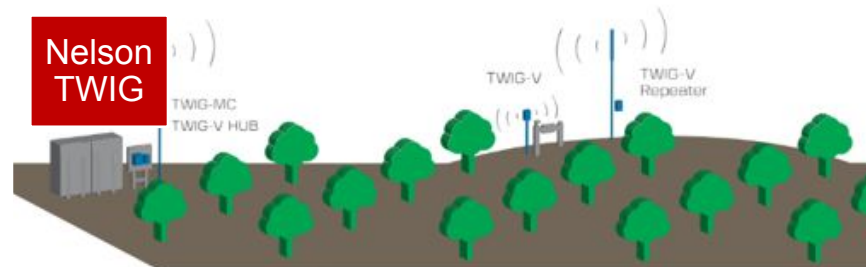
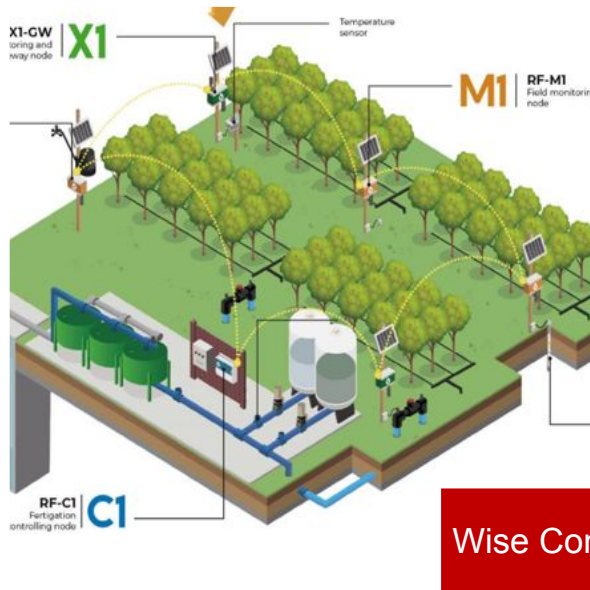


Today's Platforms

Remote Controls System Integrators



- Slow march towards comprehensive automation platforms
- Existing platforms come in a range of complexities, allow varying levels of access and integration



Might feel like a crowded market

- Numerous Brands and platforms available.
 - Whose products should we use?
 - Established vendor or independent brand?
- Fear of commitment
 - Does my platform have staying power?
 - Is my dealer committed?













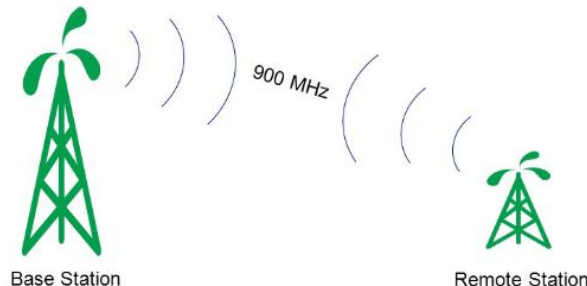






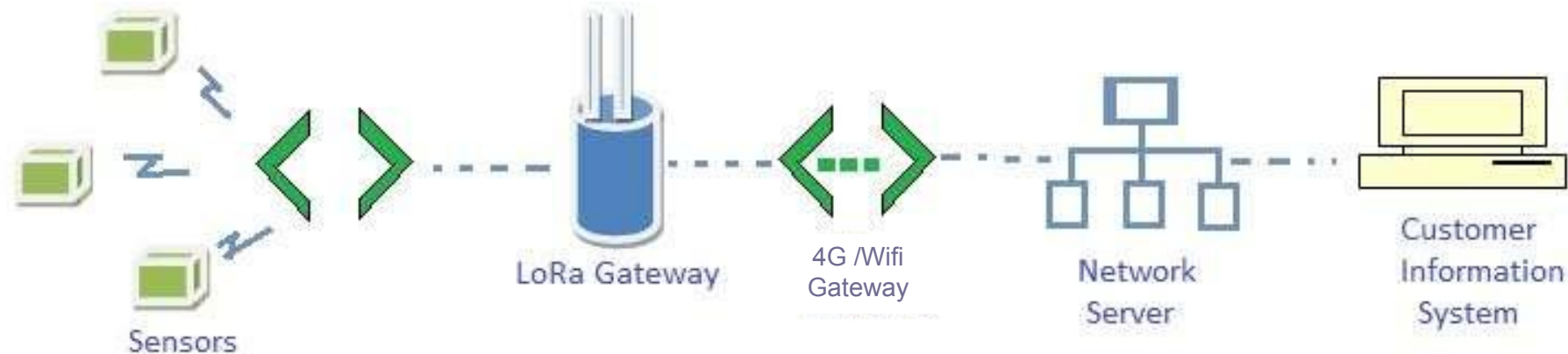
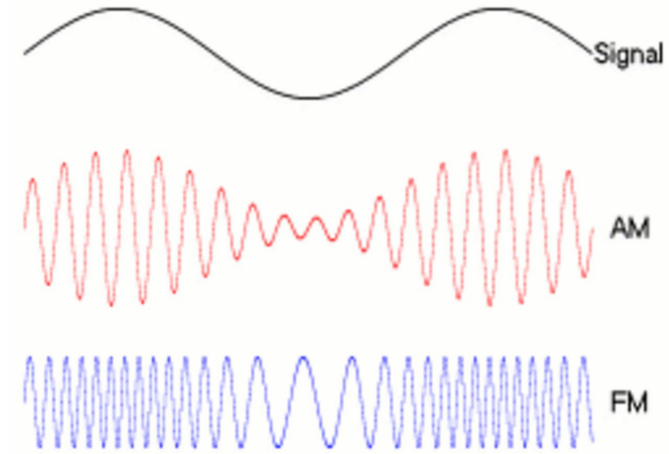
Common Components and Communication Methods

- Industry wide move toward “wireless” communication
 - In-field hardware is hard-wired to a radio-equipped device in close proximity (typ. <100ft)
 - Common names: RTU, Node, Module...
 - In-field devices accessed remotely through an internet connected gateway
- Combination of radio and cellular communication
- Device communication - Mesh network, direct-to-base station, or radio repeater
 - Common frequencies - 27MHz, 400-500MHz, 900MHz, 2.4GHz & 5 GHz



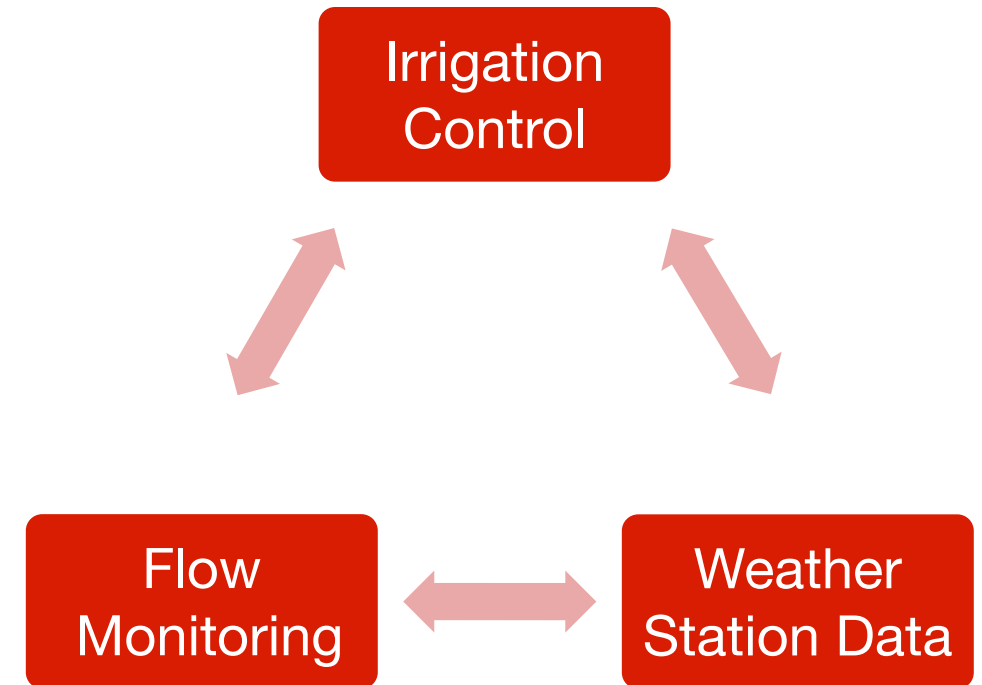
LoRa – Long Range Radio

- Spread spectrum modulation type used which uses wide-band linear FM pulses. The frequency increase or frequency decrease over certain period is used to encode data information to be transmitted.
- Low energy consumption
- 915 MHz in US
- Transmits small data packets, over long distances
- Unlicensed nodes available, LoRaWAN licensed protocol available too
- Allows for firmware over-the-air updates



- Feedback Control

- Sensors are rapidly becoming more reliable, simple, robust, & inexpensive.
- Some platform sensors are proprietary, other platforms are “sensor agnostic”
- Access via one entry portal or multiple apps & platforms
- Presents an opportunity to set thresholds, recommendations, & alerts
- Historically, growers have jumped between individual platforms to make irrigation decisions.



Key Features

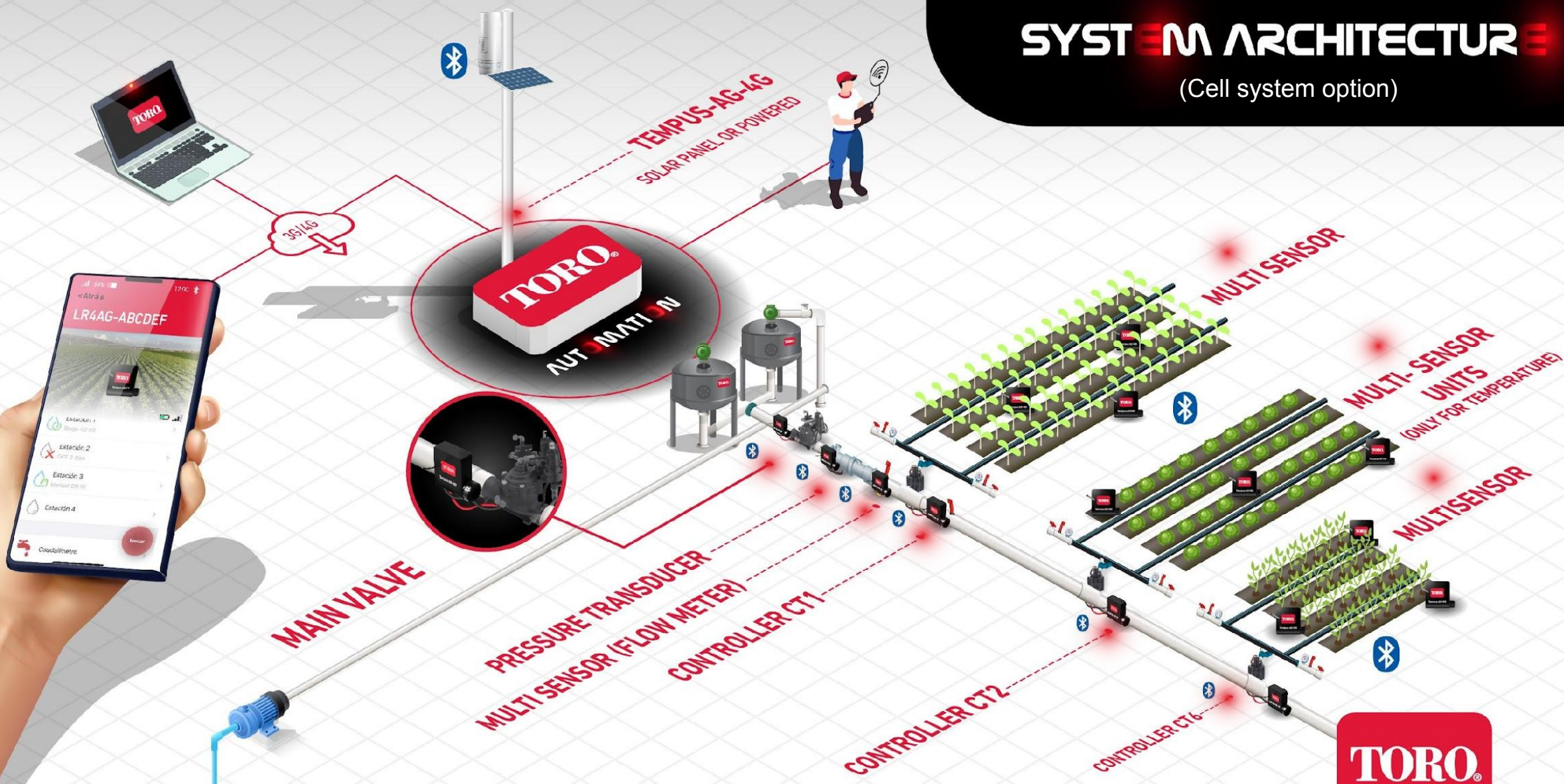
- Automation SYSTEM, not individual controller/components
- Hassle-free installation
 - minimal hardware
 - easy mounting options - no solar panel, no long cable runs
 - setup with mobile device – no forms to send!
- Simple, intuitive mobile interface for easy schedule programming – plan & adjust in real-time
- Confirm irrigations happened as planned
- Know if something went wrong with user-defined alerts
- Verify or adjust valve operation on-site via local Bluetooth connection
- Strong support network – Dealer, NSN, dedicated support





SYSTEM ARCHITECTURE

(Cell system option)



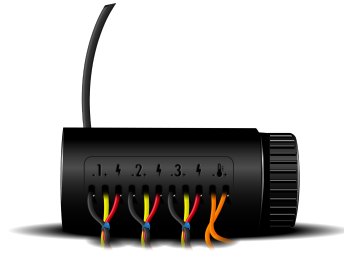
TORO



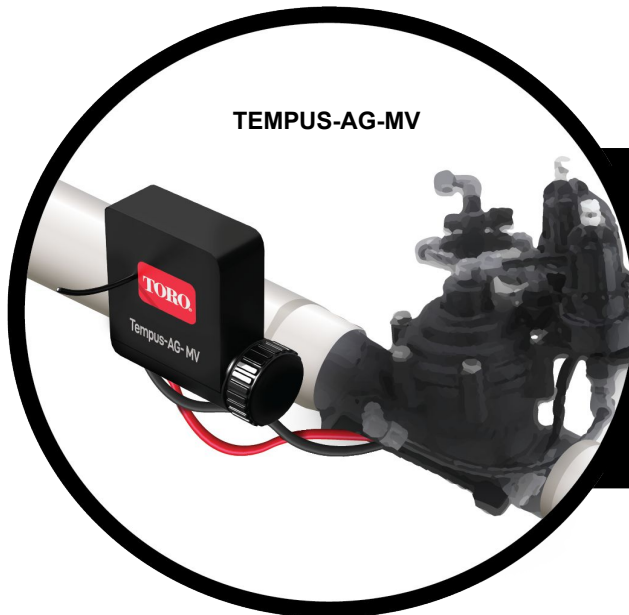
TEMPUS-AG-CT



TEMPUS-AG-PR



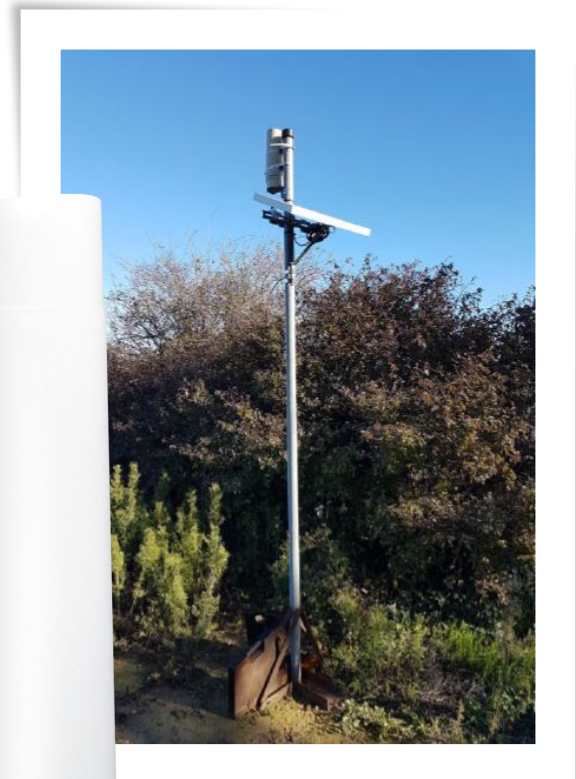
TEMPUS-AG-MS



TEMPUS-AG-MV

□ EASY HARDWARE
INSTALLATION

- No pedestal needed
- 9V battery facilitates installation
- Weather/waterproof unit



TEMPUS-AG-4G

TEMPUS-AG-4G

- 20W solar panel (Optional for power challenged installations)
- Powerful lithium battery for up to 5 days of battery life
- Multi operator SIM card included
- Installation brackets included



A solar powered (or wall connected) base station that connects all controllers and devices to the cloud.

POWER
SUPPLY



ASSOCIATE
DEVICES

up to **25**
AG-CT • AG-MV • AG-PR • AG-MS

RANGE (Radius)

800m or **2,600ft**


MANAGED VIA



CONNECTION



RESISTANT

Waterproof housing 

TORO

AUTOMATION

TEMPUS-AG-WF



• Optional 5m or 10m cable

A Wi-Fi base station that connects all controllers and devices to the cloud.

POWER
SUPPLY



ASSOCIATE
DEVICES

up to **30**
AG-CT • AG-MV • AG-PR • AG-MS

RANGE
(Radius)

800m or **2,600ft**
Extended antenna as an option

MANAGED VIA



CONNECTION



AUTOMATION

TEMPUS-AG-CT



A waterproof battery-powered wireless irrigation controller capable of operating up to 6 latching solenoids.

DATA ACQUISITION

1, 2 or 6 stations

SENSOR CAPABILITY

Pressure Switch, Flow Meter and Rain Sensor

4 irrigation schedule p/station



Continuous irrigation or cycle and soak



Time in seconds



Irrigation by time or volume



Fertigation capability

RANGE (Radius)

800m or 2,600ft


MANAGED VIA



CONNECTION



RESISTANT

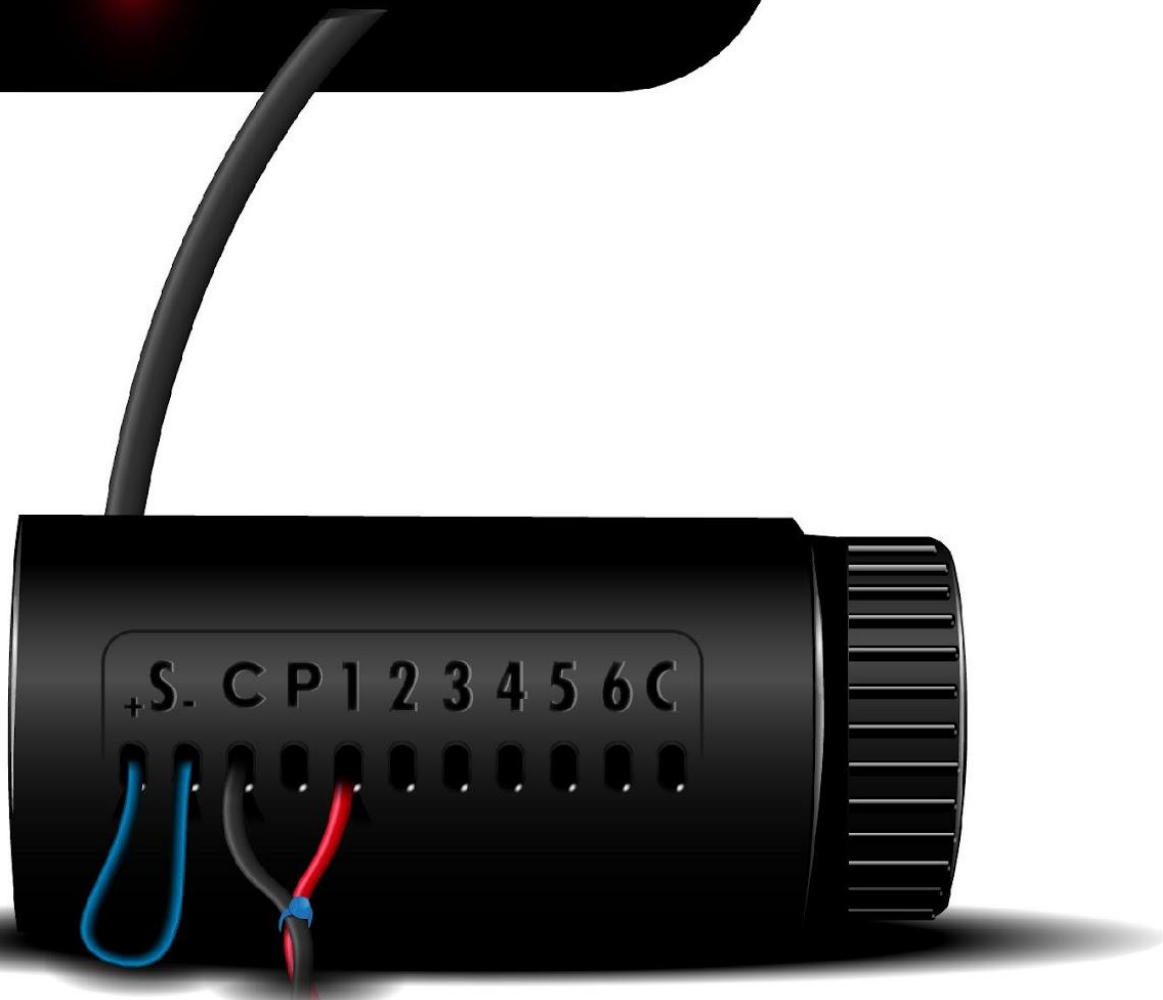
Waterproof (IP-68) 

POWER SUPPLY







AUTOMATION

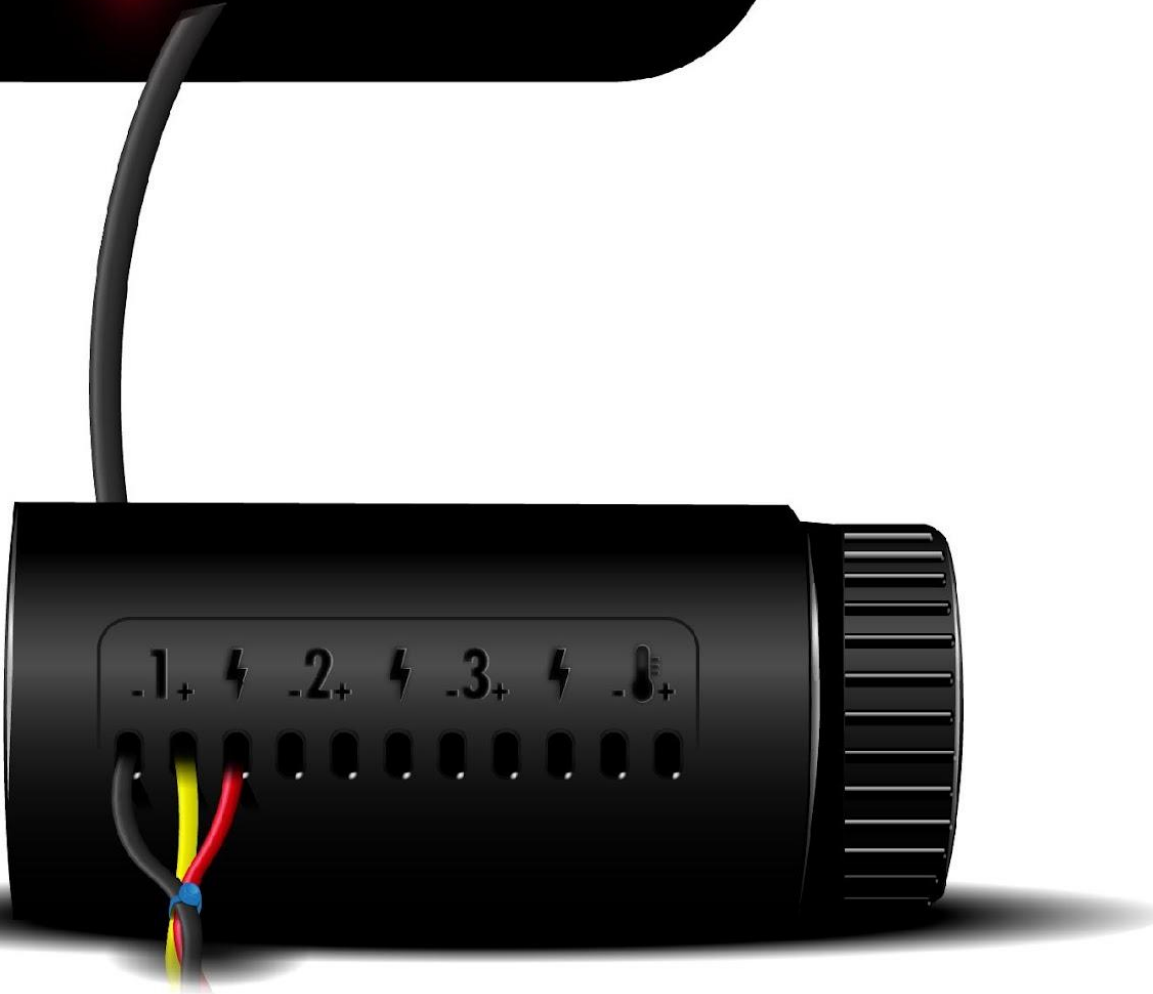
TEMPUS-AG-MV



A waterproof battery-powered wireless irrigation controller capable of storing 200 start times from different AG-CT's. Ideal to control main valve.

INPUTS	1 main valve station
SENSOR CAPABILITY	Pressure Switch, Flow Meter
RANGE (Radius)	800_m or 2,600_{ft}
MANAGED VIA	
CONNECTION	LoRa 
RESISTANT	Waterproof (IP-68) 
POWER SUPPLY	 9V

TEMPUS-AG-MS 1



A waterproof battery-powered wireless irrigation data acquisition device for a variety of sensors.

DATA ACQUISITION

1 sensor

SENSOR CAPABILITY

Flowmeter, Rain sensor, Moisture sensor, Anemometer, Pluviometer, Air humidity sensor, Tensiometer

RANGE (Radius)

800m or **2,600ft**


MANAGED VIA



CONNECTION



RESISTANT

Waterproof (IP-68) 

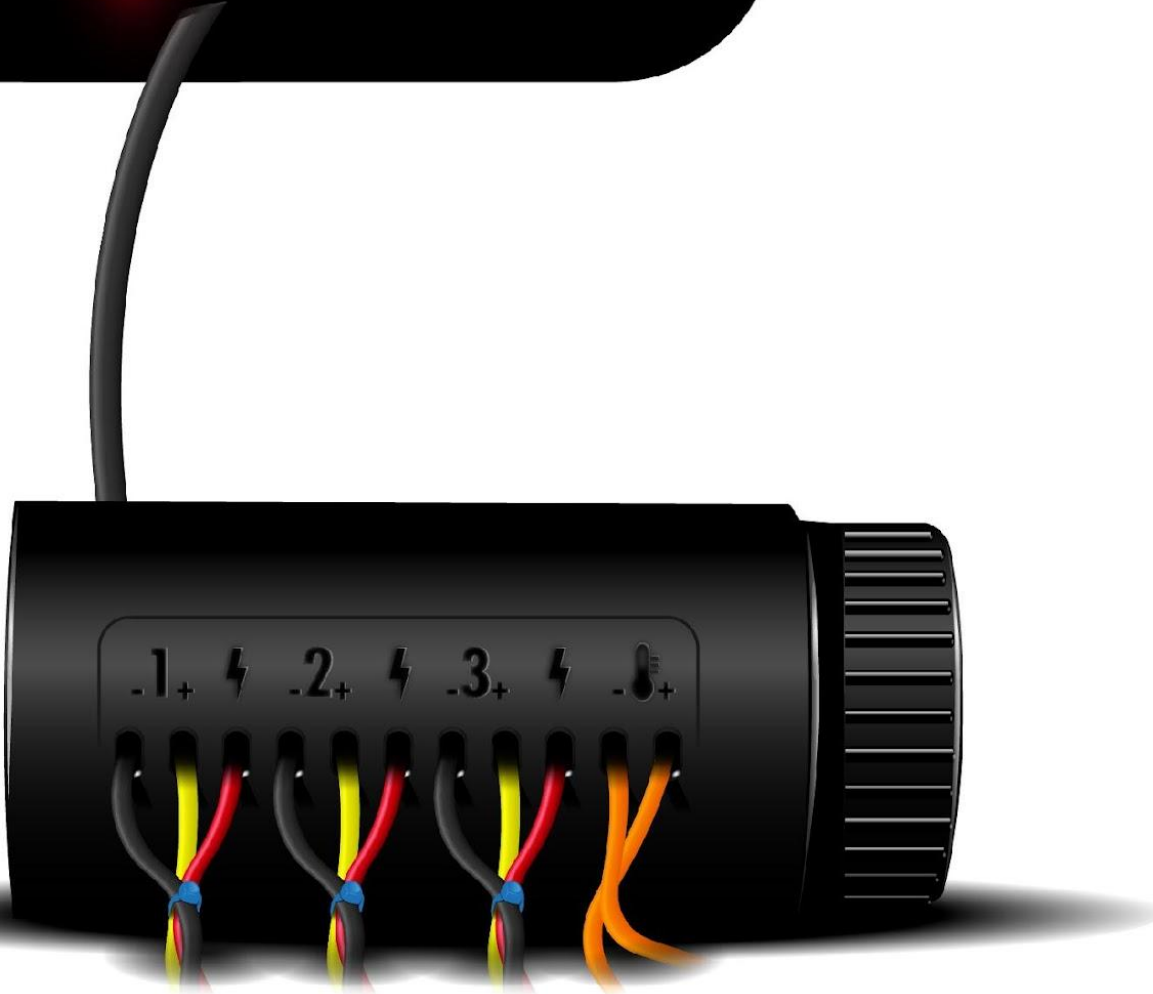
POWER SUPPLY



Note: Depending on sensor 2 or 3 wires used – explained in the App during installation



TEMPUS-AG-MS 4



A waterproof battery-powered wireless irrigation data acquisition device for a variety of sensors.

DATA ACQUISITION

3 sensors plus temperature

SENSOR CAPABILITY

Flowmeter, Rain sensor, Moisture sensor, Anemometer, Pluviometer, Air humidity sensor, Tensiometer, Temperature

RANGE (Radius)

800m or **2,600ft**


MANAGED VIA



CONNECTION



RESISTANT

Waterproof (IP-68) 

POWER SUPPLY



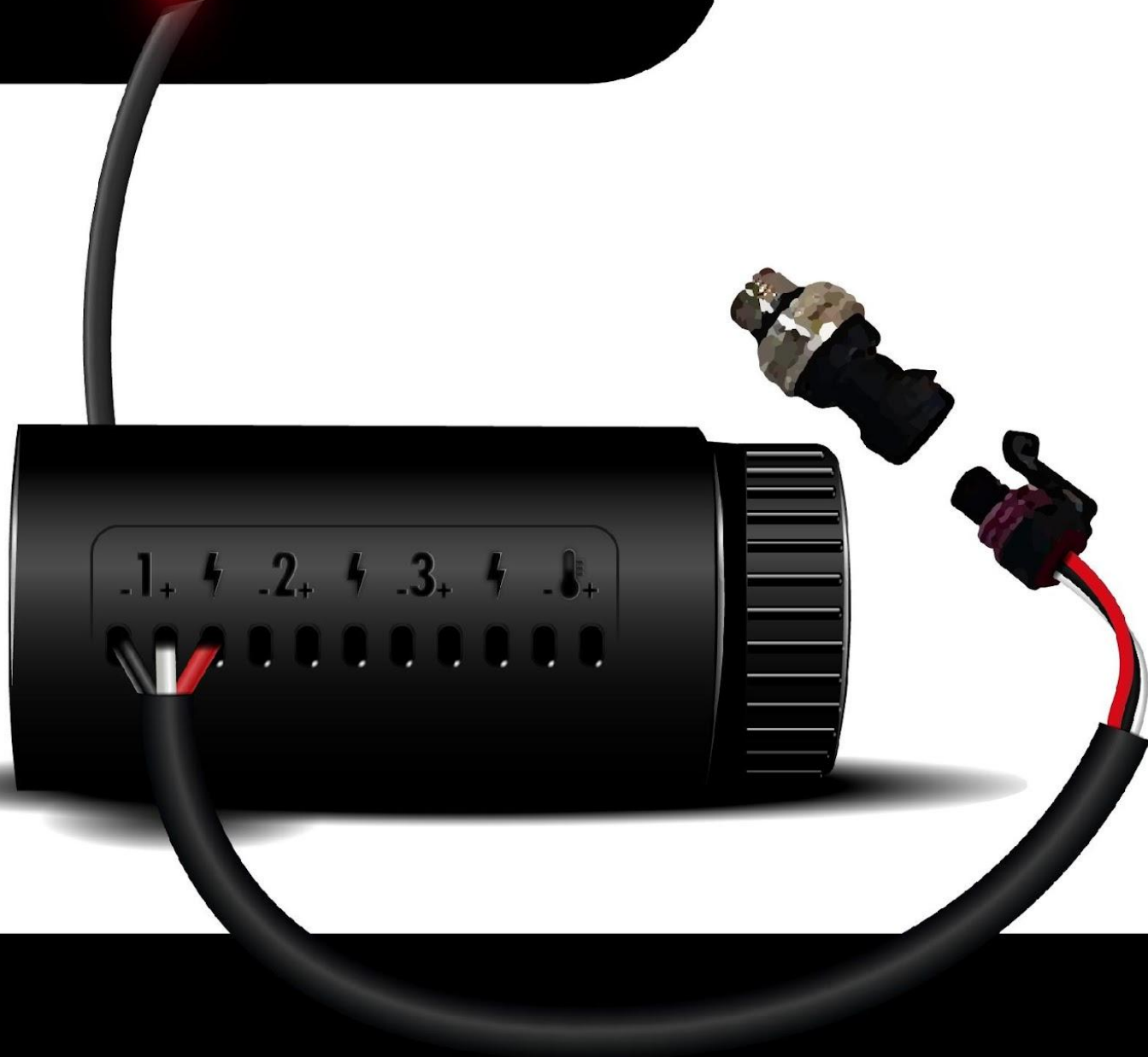
AUTOMATION



MS module accepts

- Pulse
 - Flowmeter, wind sensor
- Dry Contact
 - Pressure switch, rain sensor
- Analog (0- 3.5V)
 - Humidity sensor, moisture sensor, soil tensiometer

TEMPUS-AG-PR



A waterproof battery-powered wireless irrigation device for pressure measurement.

DATA ACQUISITION

Pressure values

SENSOR CAPABILITY

Pressure up to 232 psi

RANGE (Radius)

800m or **2,600ft**


MANAGED VIA



CONNECTION



RESISTANT

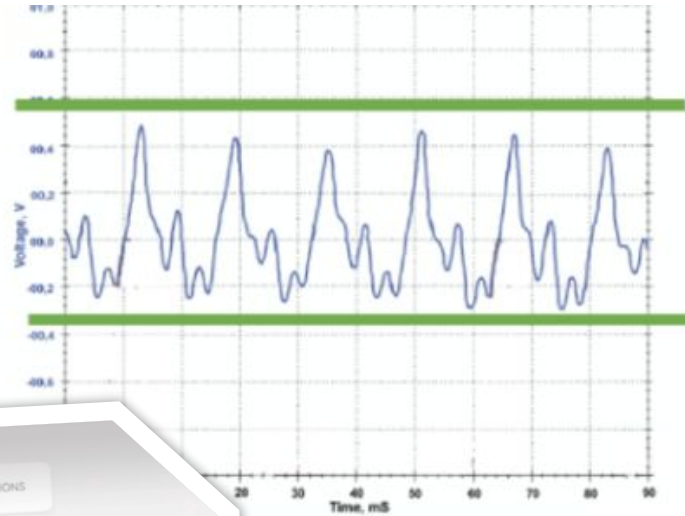
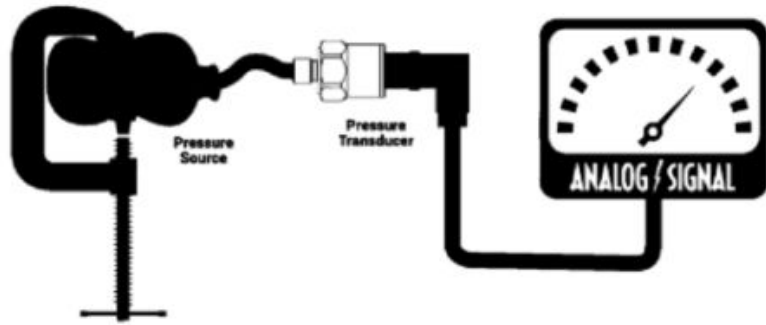
Waterproof (IP-68) 

POWER SUPPLY

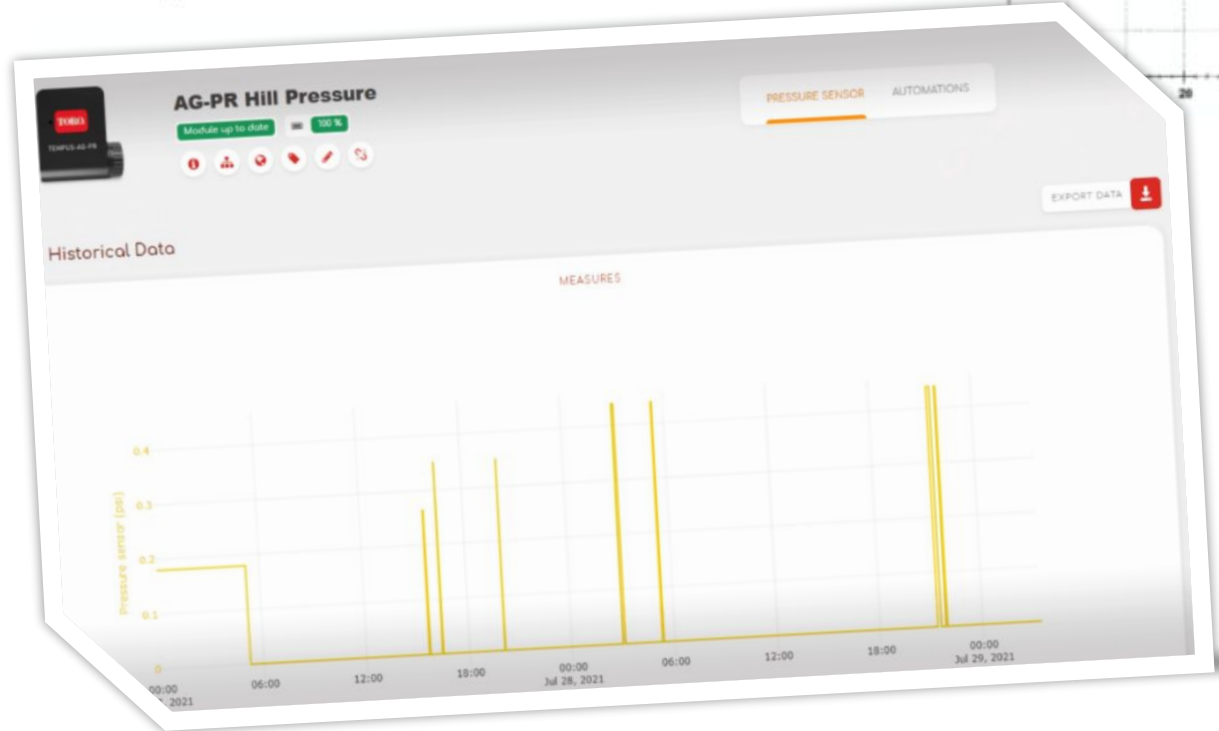


AUTOMATION

Tempus Ag - PR



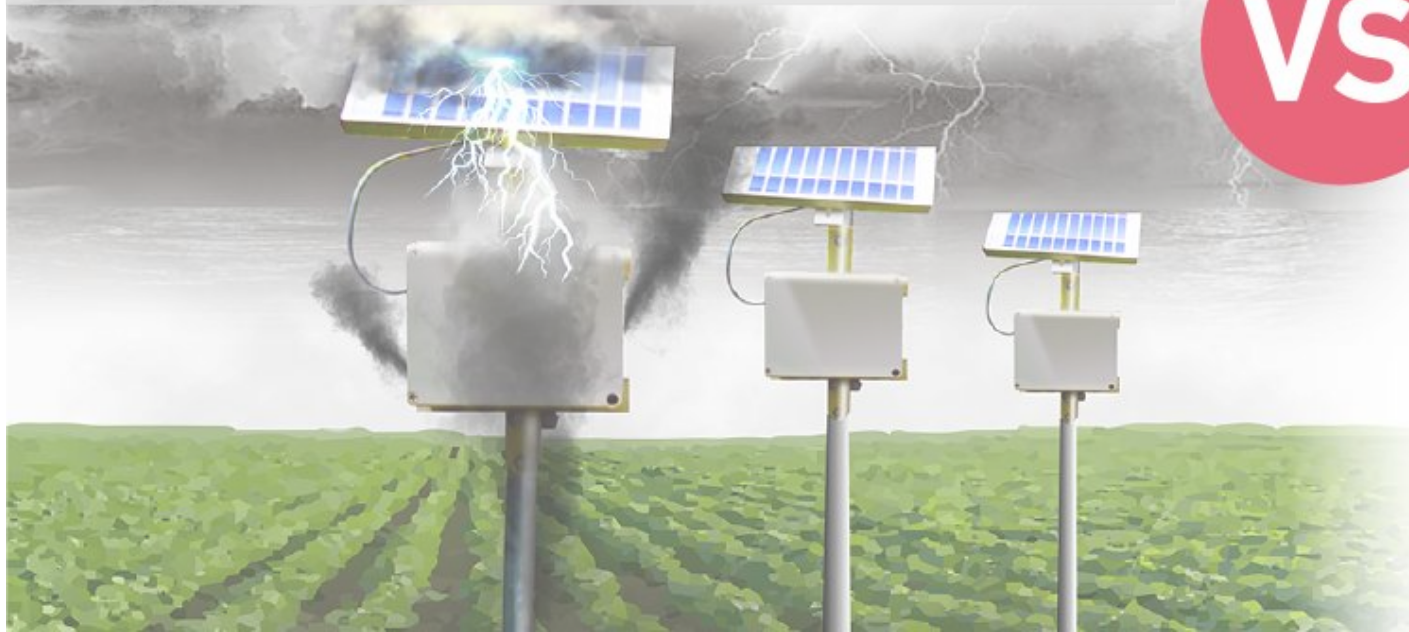
Your
“Digital Pressure
Gauge”



- Pre-wired with included transducer; rated for 0-232 PSI
- Factory calibrated -> Plug & play installation
- Set high & low thresholds for alerts, notifications, and logic operations

NO MORE "THE STORM BURNED MY SYSTEM"

- No long wire runs to controllers
 - Less conductors = less lightning damage
- Programs are stored locally on field devices
- Loss of internet or power at base station does not interrupt programs



VS.



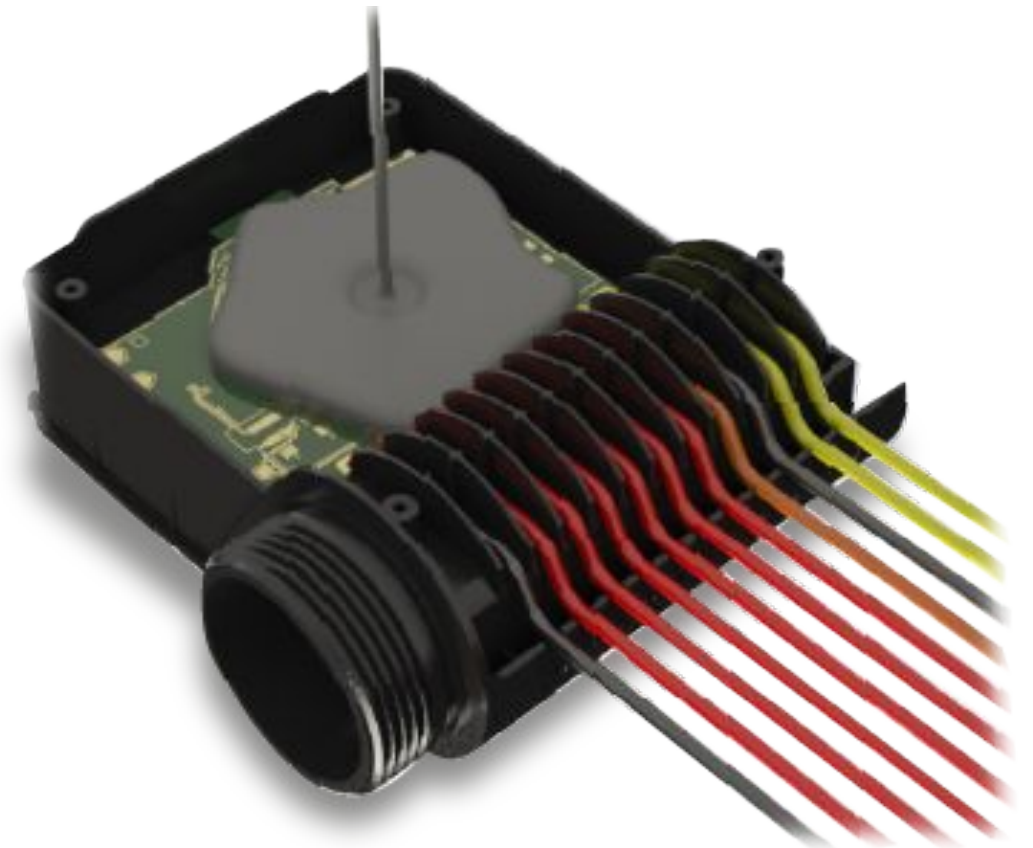
POTTING VS. CONFORMAL COATING

IP68 Rating eliminates intrusion of...

- Dust
- Insects
- Moisture/Humidity

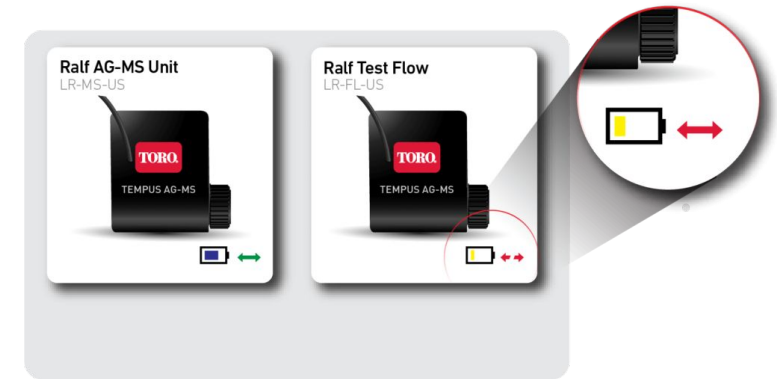
Simplifies servicing

Allows for double warranty coverage compared to main competitors



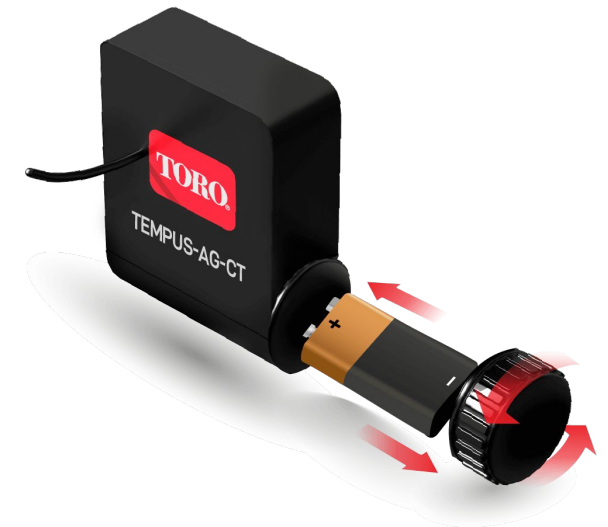
Installation & Maintenance

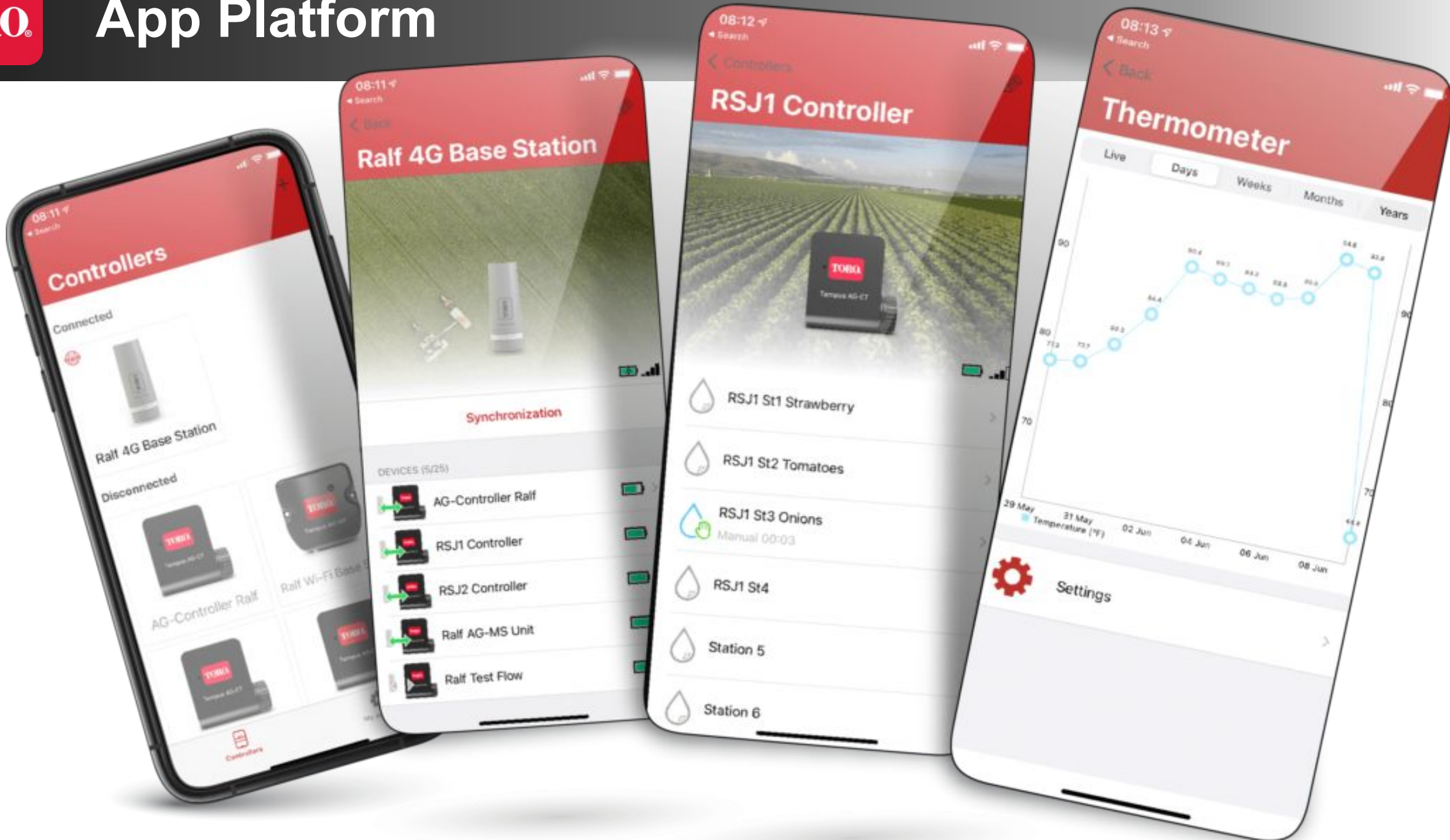
- One person installation; no need for a crew
- Devices are commissioned via Bluetooth and associated with a gateway at user's discretion
 - Modules can operate independently



Expected battery life guidance

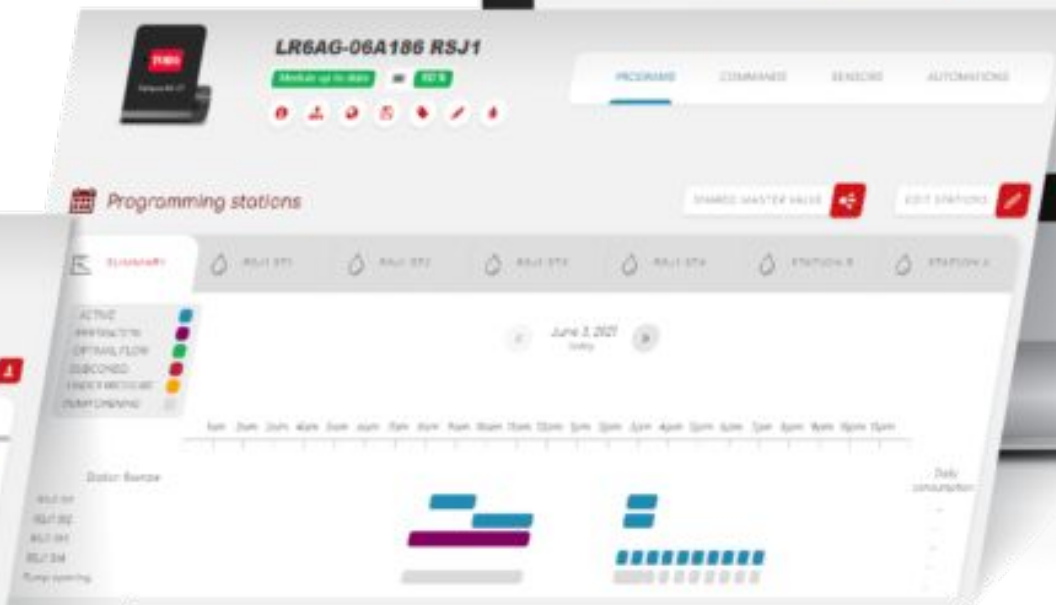
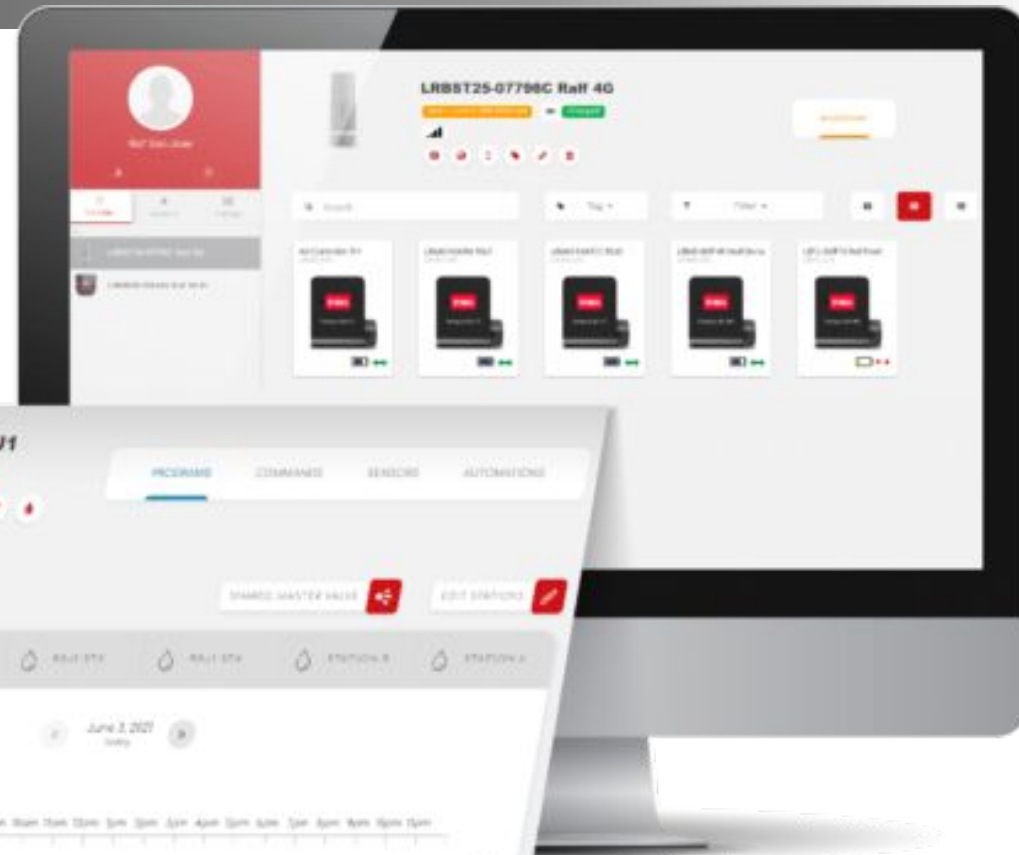
- AG-CT-1 station with 6 start times/days → ~10.5 month
- AG-CT-1 station with 12 start times/days → ~9.7 month
- AG-CT-6 stations with 6 start times/days → ~7.8 month





Web platform offers access to additional tools

- Programming summaries
- User preferences
- Customer/User lists
- Cluster
- Canopy
- Automations



Tempus AG - Canopy

- Geofencing tool
- User dashboard – access to all devices, system status, & alerts/alarms

The dashboard provides a comprehensive overview of the irrigation system's status. Key features include:

- Site List:** A sidebar on the left lists managed sites: Hollis Hill Tree Farm, Jolly Pecan Farms Base Station 1, Tosselli CT6, and Tosselli Demos.
- Map:** A central map shows the geographical location of the sites in the Dummerston area.
- Dashboard Metrics:**
 - Connected relay:** 1/1
 - Connected modules:** 4/4
 - Daily consumption:** 0 gal
 - Thresholds exceeded:** 30
 - Very low battery:** 0
 - Water leak:** 0
- Device Table:** A table below the metrics lists individual devices with their communication status, battery levels, watering status, and notification counts.

PRODUCT	NAME	COMMUNICATION	BATTERY	WATERING STATUS	PRESSURE SWITCH	NOTIFICATIONS	ACTIONS
TEMPUS-AG-CT	A Tosselli CT2 09F78E	●	100 %			0	See
TEMPUS-AG-MS	A Tosselli MS 08D472	●	100 %			0	See
TEMPUS-AG-PR	TPSAG-PR-0947CB	●	80 %			0	See
TEMPUS-AG-CT	A Tosselli CT6 097610	●	100 %			30	See

Tempus AG – Cluster

- Summary view with each station in Cluster
- Facilitates simpler programming
- Programming less prone to human error
- Main valve stores all scheduled starts

The screenshot displays the Toro Tempus AG Cluster control interface. The top left shows a cluster of stations for 'Well 7' with 4 stations. The main interface is divided into several sections:

- Summary View (Left):** Shows the status of various components: ZONE 1 OFF, ZONE 2 OFF, FERT PUMP OFF, and EMPTY OFF. A legend on the left identifies colors for WATERING (blue), FERTIGATION (purple), PUMP OPENING (grey), OPTIMAL FLOW (green), OVER PRESSURE (red), and UNDER PRESSURE (yellow). A 'Station flowrate' chart shows watering events for Zone 1 (8am-10am) and Zone 2 (10am-12pm) on December 12, 2022.
- Control Panel (Top Right):** Includes 'ANNUAL CONTROLS' with a play button, 'STATUS ON', and a 'LOOPING MODE' toggle switch.
- Navigation (Middle):** Features tabs for 'PROGRAMS', 'FLOWMETER', 'AUTOMATIONS', and 'COMMANDS'. Below these are 'LOOPING MODE' and 'ADD MODULE' buttons, along with a search bar for stations.
- Scheduling View (Right):** A detailed Gantt-style chart for 'December 12, 2022 Monday' showing watering events from 6am to 4pm. Blue bars represent watering durations for different zones, with a 'Daily total u' bar at the bottom.

- User defined alerts; email and/or push notifications
- Define actions when threshold are exceeded
- Automated is not Autonomous

Alerts for exceeding thresholds

Enter thresholds to be notified when extreme values are reached.

Low threshold 17 psi High threshold 84.9 psi

Save

Linked modules

Modules

Link to your TEMPUS-AG-PR the modules which will be controlled by the next actions.
Modules belonging to a cluster must be linked with core, they are marked with an icon

Add modules

+ Add

Action

All the modules linked to the TEMPUS-AG-PR will be affected.

Low threshold not reached

No action

High threshold exceeded

No action

Back between thres

No action

Daily volume alert

Enter thresholds to be notified when extreme values are reached.

Low threshold High threshold gal

Settling time

Delay during which the flow is not monitored following a start.

min

Leak detection alert

Max volume(gallons) allowed before alert

gal

Stations flow

Once you have entered the flow

Enter the nominal flow rate of

These flow values must be entered

A-SCION WOOD

Fert Pump

Fill at least one station's flow rate

Maximum flow alert

Minimum flow alert

Stations flow

Once you have entered the flow rate of your installation, you can set threshold alerts to protect

Enter the nominal flow rate of your different stations in order to control it. You will be able to det

These flow values must be entered in the program management page of the programmer, in the

A-SCION WOOD gal/min

Fert Pump gal/min

Fill at least one station's flow rate to access following features

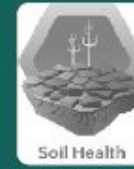
Maximum flow alert

Minimum flow alert

- Toro Tempus - New feature set for Spring '23 release
 - Historical summary view
 - Summary view - Day/week/month options
 - Enhanced data export features
 - Improved unit selection; Ac-ft, Ac-in
 - Sensor chart view with summary screen
 - Valve groups for loop programming
 - Soil Moisture Tool Kit
 - Mobile Dashboard

**IRRIGATION IS THE
MOST CRUCIAL
FACTOR IN
FARMING**

WHEN AND HOW MUCH TO IRRIGATE?

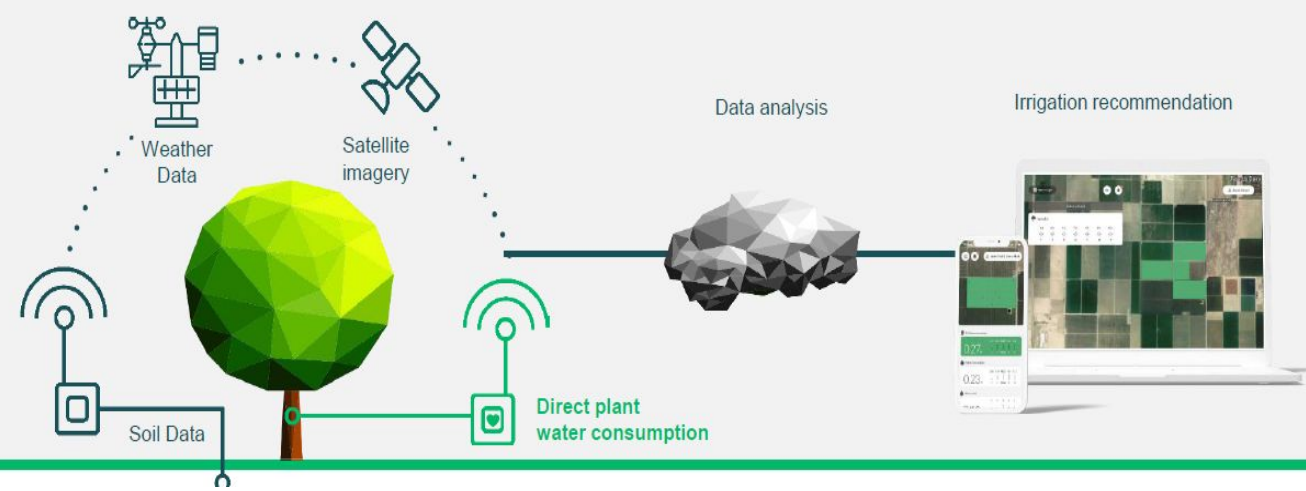




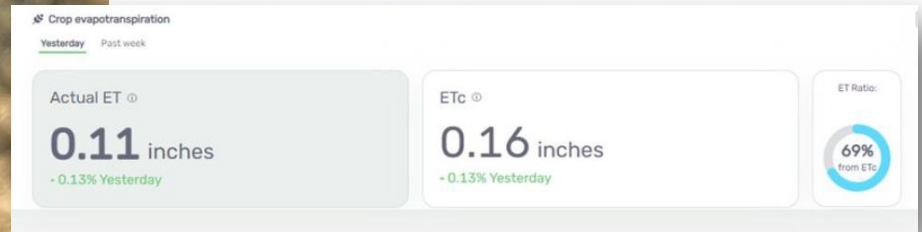
- Irrigation recommendations
- Stress level management
- Weather history and forecast
- Plot-level insights
- Alerts and notifications 24/7

The world's first plant-based irrigation decision support SaaS platform, Based on Direct Plant-Sensing

Direct water consumption data is translated to the block level using remote sensing to deliver accurate irrigation recommendations



The rate of sap (or water) moving from the roots of plants, through the stem, and to the leaves is strongly coupled to **rate of transpiration and photosynthesis**.



treetoscope THE DIFFERENTIATION

- Plug & play
- Scalable
- Low maintenance
- Affordable
- Direct, Quantitative Data
- Real time
- High value



Ag

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