ICT INTERNATIONAL

IoT Catalogue 2018

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ICT International

Enabling better global research outcomes in soil, plant & environmental monitoring.

Introduction

ICT International's unique family of digital sensors, IoT nodes and dataloggers have been designed to measure key plant and environmental parameters for a range of applications, including advancement of plant and soils research, studies of water availability, climate change, evaluation of plant genetics, breeding programs and transpiration measurement; as well as a variety of environmental measurement. They have been installed to measure water level, water quality, ambient and microclimate conditions (weather stations), plant water use (sap flow), plant water potential (psychrometer), soil moisture and soil water potential in a range of locations across the world including; the Brazilian rainforests, the world's tallest trees in California, mine site rehabilitation in Australia and Peru, greenhouse tomato production in Australia, subarctic permafrosts in Alaska, and equatorial rainforests.

Contents

Gateways

ICT Universal Telemetry Hub

Product Description

The ICT International Telemetry Hub is a powerful, modular and flexible electronic platform that operates remotely in any climate, forming the foundation for specialised scientific and industrial monitoring systems. Configured as a telemetry gateway to transmit data from ICT International data loggers, instruments and LoRa Nodes, it is supported by an extensive software suite that can be customised to suit a wide range of IoT monitoring and control applications. The Telemetry Hub can be optioned to communicate via Satellite (using the Iridium Short Burst Data service), Penta-band GSM, CAT-M1, Wi-Fi, 2.4GHz proprietary wireless networking, Bluetooth, RS485, RS232, Ethernet, LoRa/LoRaWAN, USB and SDI-12. It can also be optioned to provide analogue and digital outputs and inputs. Powered by a replaceable, solar charged, internal Lithium Ion battery, with a built in solar charge regulator.
The Telemetry Hub has a multiprocessor architecture. The main CPU is a 32 bit, three-stage, pipelined ARM Cortex M3 processor with a nested vectored interrupt controller and a high-performance DMA controller.

Features

- 2-channel LoRa Gateway
- LoRa ultra-long range spread spectrum radio - Certified for 868 and 915 MHz ISM spectrum in most geographical regions of the world.
- LoRa RF sensitivity -148dBm and max TX power of 20dBm
- SDI-12 logging
- Ethernet/3G/CAT-M1/Iridium/Wi-Fi backhaul
- Dual switched power outputs of 4.2/4A OR up to 15V/1A
- Auxiliary RS485/RS232 port, Analogue I/O port and I^2C / SPI port
- Power management to external sensors
- Auto battery charge rate adjustment based on available sunlight
- Optional still image camera, GPS, LCD touchscreen, 24 bit auto-ranging analogue input, 16-bit analogue output
- User customisable schedules - data collection, cloud upload and file synchronisation
- Local CSV file storage on SD card
- Mesh networking of up to 20 hubs
- Alerts and email notifications

System

ARM Cortex M3 processor
Nested vectored interrupt controller
DMA controller
16 GB MicroSD storage

Enclosure

IP67 rated, extruded aluminium - hard anodised body. Moulded UV, moisture and impact resistant endcaps.
All fasteners 316 stainless steel.
Sealed service hatch provides easy access to switches, SD and SIM cards and non-waterproof connection
5 x IP67 weatherproof interfaces

Electrical data

4.9Ah wide temperature range, lithium-ion
Self-managed, solar powered

Environmental data, quality & reliability

Operating range –20°C to 60°C
RoHS compliant (lead-free)

Security

RF communications - end to end packet encryption
GSM - optional SSL connection to cloud

Gateways

Model	Region			Radios					Access		Interfaces			Features					Enclosure	
	AU915, AS923 (Australia / Asia)	US915 (United States)	EU868 (Europe)	2 x LoRa	3G	2.4GHz proprietary wireless	WiFi	Iridium Satellite	GUI-Based Configuration	USB Serial Console	USB Host	Dual CAN ports	RS-485/RS232	MicroSD Storage	Secure cryptographic storage	Dual switched power outputs	Mobile network time synchronisation	Solar charger	IP67 rated, extruded aluminium	IP67 weatherproof interfaces
C-NODE-2-G-LORA	○	○	○	●	●	●	○	○	●	●	●	●	●	16GB	●	●	●	●	●	●
C-NODE-2-G-LORA-S20	○	○	○	●	●	●	○	○	●	●	●	●	●	16GB	●	●	●	●	●	●

● = Hardware ready, software available. ○ = Product variants

Gateways

NEXUS 8: 8-channel LoRaWAN™ IoT Edge Gateway

Product Description

The NEXUS 8 range of LoRaWAN™ gateways combine a high-performance LoRaWAN™ radio with multiple back-haul technologies, simplifying deployment of Internet of Things networks in urban and rural areas. The 8-channel low-power long-range LoRa® ISM-band radio is suitable for coordinating thousands of IoT devices within a radius of up to 25 km. Multiple gateways can be effectively co-located to create gateway installations of 16 or more channels. Rural or difficult urban deployment is straight-forward using solar and LTE, and can provide Internet connectivity to other devices via Ethernet. The built-in multi-constellation GNSS can accurately locate the gateway and assists with gateway time synchronisation and radio transmit frequency calibration.
The Embedded Linux operating system which powers the gateway is fully open to the user, enabling custom configuration and application installation. Out-of-the-box support for multiple major LoRaWAN™ networks makes setup a breeze, and secure cryptographic storage means nobody can infiltrate your network even if they gain physical control. The LoRa® radio is fully configurable and supports the creation of custom LoRa® and FSK protocols or running a local closed-loop LoRaWAN™ server without Internet connectivity required.

Features

- LoRaWAN™ 8-channel LoRaWAN™ Gateway
- RSSI geo-location capable
- Packet forwarders for major networks
- LoRa®/FSK ISM band low-power long-range radio
- RX: 8 x 125kHz LoRa®, 1 x 500kHz LoRa®, 1x FSK
- TX: 1 x LoRa®/FSK (half-duplex)
- RX Sensitivity –137 dBm
- Maximum TX power 20 dBm EIRP
- GNSS Concurrent multi-constellation GNSS (3)
- GPS, Galileo, GLONASS, and BeiDou support
- GPS time synchronisation –167 dBm navigation sensitivity
- CAN Dual CAN ports with dedicated ground and power access

System

OS: Definium Linux 4.x Kernel (Arch Linux derivative)
Software pre-installed for managing all features
Hardware: 1 GHz ARM A8 with 512 MB RAM
16 GB MicroSD storage (OS installed on card)
Display: HDMI with up to 2048 x 2048 resolution
LTE/3G: Up to 10 Mbps down / 5 Mbps up
FDD LTE Bands: 1, 3, 5, 7, 28

Enclosure

Powder-coated 183 x 138 x 35 mm, 300 g
IP66+ TBA

Electrical data

Power supply 12 V nominal, range 10 V to 24 V DC
Power-over-Ethernet, range 44 V to 57 V
Consumption 5 W average, 7 W peak

Environmental data, quality & reliability

Operating range –20°C to 60°C
RoHS compliant (lead-free)

Security

Secure cryptographic storage of keys and certificates
Hardware random number generator

Certifications and approvals

AS/NZS 60950.1:2011, AS/NZS 4268:2012, IEC 60950–1, CENELEC EN, 60950–1, 47 CFR 15.247, 47 CFR 15.207, 47 CFR 15.247, 47 CFR 15.215, IDA TS SRD

Gateways

Model	Region	Radios	Access	Interfaces	Features	Enclosure
	AU915, AS923 (Australia / Asia) US915 (United States) EU868 (Europe)	LoRa, LoRaWAN, FSK LTE (RX diversity, 3G fall-back) Multi-constellation GNSS WiFi Iridium Satellite	Display (HDMI) with USB USB Serial Console	CAN / CANOpen Ports USB Host GPIO Expansion	LoRaWAN™ Packet Forwarder MicroSD for OS & Storage Embedded Linux OS RSSI geo-location capable Secure cryptographic storage Power over ethernet Solar charger	Power-coated and transparent IP66+ (with outdoor antennas)
Nexus 8	○ ○ ○	● ● ● ○ ○	● ●	2 1 20	● 16GB 4.x ● ● ●	●
Nexus 8 Outback	○ ○ ○	● ● ● ○ ○	● ●	2 1 20	● 16GB 4.x ● ● ●	●
Nexus 8 Solar	○ ○ ○	● ● ● ○ ○	● ●	2 1 20	● 16GB 4.x ● ● ● ●	●

● = Hardware ready, software available. ○ = Product variants

Nodes

MFR-NODE/ MF-NODE
Multifunction Research Node

- LoRaWAN™ low-power, long-range connectivity
- 8GB SD Card for data storage (MFR-NODE)
- Supporting SDI-12, 2 x 32-bit dry-contact counting digital inputs.
- Optional 24-bit ADC for 2x differential / 4x single ended sensor.
- Optional CAT-M1
- Solar rechargeable Lithium-ion, Single use LiSOCl2, or external 12V power options
- Optional Multi-constellation GNSS

Product Description

The MFR-NODE and MF-NODE have been designed to provide flexible communication, sensor and power options. The MFR-NODE supports SDI-12 and 2 x dry contact digital inputs as well as optionally 2x differential / 4x single ended analogue inputs. The MFR-NODE and MF-NODE support sensors with higher power requirements, a solar panel can charge either the internal lithium-ion battery or both the node and sensor can be powered by an external 12V system (e.g. battery or mains source). Optional CAT-M1 provide an option for remote installation in areas outside the range existing LoRaWAN networks. The optional multiconstellation GNSS ensures you won't lose track of your device. The MFR-NODE has an onboard 8GB SD Card to provide data logging capabilities and full data redundancy in the event of temporary loss of communications or dropped packets - ideal for research applications.

S-NODE

SDI-12 Node for environmental monitoring

- LoRaWAN™ low-power, long-range connectivity
- Supporting SDI-12, 2 x 32-bit dry-contact counting digital inputs.
- Optional CAT-M1
- Solar rechargeable Lithium-ion, Single use LiSOCl2, or external 12V power options
- Optional Multi-constellation GNSS

Product Description

The S-NODE has been designed to support the broad suite of SDI-12 based environmental sensors, with an optional 2 x 32-bit dry-contact counting digital input just for the those wishing to add a tipping bucket rain gauge. The S-NODE can support those sensors with higher power requirements, like the MFR-NODE a solar panel can charge either the internal lithium-ion battery or both the node and sensor can be powered by an external 12V system (e.g. battery or mains source).

Nodes

V-NODE

High resolution analogue sensors

- LoRaWAN™ low-power long-range connectivity
- Supporting 2x differential / 4x single ended sensor.
- 24-bit ADC with stable 3V or 10V excitation voltages
- Optional 2 x 32-bit dry-contact counting digital inputs.
- Solar rechargeable Lithium-ion, Single use LiSOCl2, or external 12V power options
- Optional Multi-constellation GNSS

Product Description

The V-NODE supports two differential or four single ended sensors. With a 24-bit ADC and stable 3V or 10V excitation voltages, the V-NODE is designed for those requiring precision in their analogue measurements. Use a SAFT Lithium-ion battery for low powered sensors or scale up the power system with a rechargeable Lithium-ion battery and external solar panel.

P-NODE

32-bit Pulse Counter Node

- LoRaWAN™ low-power long-range connectivity
- Four 32-bit dry-contact counting digital inputs
- Up to 1 kHz simultaneous counting (4 kHz total)
- Battery life up to 10 years with daily reporting
- Keep track of sensors with multi-constellation GNSS
- Fully reconfigurable via LoRaWAN™ downlinks

Product Description

The P-NODE 4-input pulse counter with LoRaWAN™ is a drop-in solution for monitoring pulses, such as those produced by common water, gas, electricity meters or agricultural and environmental sensors. Automatically collect accurate counting data periodically without the cost and burden of manually visiting premises. Designed battery life of up to 10 years with daily reporting, each dry-contact digital input is capable of simultaneously measuring up to 1 kHz with periodic reporting.

The optional multiconstellation GNSS ensures you won't lose track of your device. Each input is made available via an IP-rated standard connector (depending on variant, see below). Both connector halves are provided and optionally can be terminated to bare wires. Each sensor comes pre-configured with unique LoRaWAN™ ids and encryption keys, so configuration is optional. Settings on the device can be altered remotely via LoRaWAN™ or locally via USB.

Incoming data can be integrated directly into existing SCADA or other systems, replacing manual data-entry processes with up-to-date information automatically. Daily usage patterns (or more frequent, if configured) provide a valuable source of data for advanced analysis, helping to inform business decisions.

Nodes

TRK-NODE

Animal Tracking Node

- LoRaWAN low-power long-range connectivity
- Fully reconfigurable via USB or LoRaWAN downlink
- 400 Hz 3-Axis Accelerometer
- Multi-constellation GNSS (GPS, GLONASS, BeiDou, Galileo)

Product Description

The TRK-NODE is a customisable LoRaWAN™ solution designed for resource and animal tracking, featuring a multiconstellation GNSS and 400 Hz 3-Axis accelerometer. The TRK-NODE features ultra-low-power operational modes that allow advanced power saving and smart sleep-to-wakeup functions. Power and mounting systems are adapted to suit specific tracking requirements.

LVL-NODE

Ultrasonic Water Level Monitoring

- LoRaWAN low-power long-range connectivity
- Up to 10 metres ±1 cm precision, 5 metres with ±1mm precision
- Up to 15 years battery life with multiple reports per day
- Fully reconfigurable via USB or LoRaWAN downlink
- Level alarm mode with periodic sampling
- Multi-constellation GNSS (GPS, GLONASS, BeiDou, Galileo)

Product Description

A low-maintenance ultrasonic level sensor with LoRaWAN is a drop-in solution for monitoring all types of fluid levels. Automatic threshold-based alarms for low or high-level conditions are reported in seconds, reducing response time. Backed by long-range low-power LoRa radio, each sensor has a designed battery life of up to 15 years with daily reporting. The ultrasonic sensor is designed to be mounted above the target fluid to be monitored and automatically filters out echoes from minor obstructions (different filtering available on request). A ruggedised version with IP67-rated connectors and corrosion-resistant sensors is available. Integrating incoming data into existing systems is as easy as connecting to a LoRaWAN server and receiving data within seconds of it being sent.

Nodes

Model	Region			Inputs			Radios			Interfaces			Features						Power			Enclosure		
	AU915, AS923 (Australia / Asia)	US915 (United States)	EU868 (Europe)	SDI-12	Analogue (2x differential / 4x single ended)	Dry contact digital inputs (2)	LoRa, LoRaWAN, FSK	Multi-constellation GNSS	CAT-M1	USB Serial Console	LoRaWAN Downlink Config	Bluetooth	Periodic Reporting	Threshold-based Alarm	Thermal Condensation Cleaning	SD Card (Data Storage)	Off-the shelf integrated sensors	3-Axis Accelerometer	Non-Rechargeable Lithium	Researchable Lithium	External 12V Solar Input	IP65 Polycarbonate	IP67 Polycarbonate	Custom
MFR-NODE	○	○	○	●	○	●	●	○	○	●	●	●	●	●	●	●	○			●	●	●	○	
MF-NODE	○	○	○	●	○	●	●	○	○	●	●	●	●	●	●		○			●	●	●	○	
S-NODE	○	○	○	●		○	●	○	○	●	●	●	●	●	●	○	○		●	○	○	●	○	
V-NODE	○	○	○		●	○	●	○	○	●	●	●	●	●	●	○	○		●	○	○	●	○	
P-NODE	○	○	○		●		●	●	○	●	●	●	●	●	●		○		●	○	○	●	○	
TRK-NODE	○	○	○				●	●		●	●	●	●		●		●	●	●	○	○			●
LVL-NODE	○	○	○				●	●	○	●	●	●	●	●	●		●		●			●	○	○

● = Hardware ready, software available. ○ = Product variants

Sensors: Environmental Monitoring

Weather Stations and Microclimate

AIO 2 Weather Station with tipping bucket rain gauge

The AIO 2 Sonic Weather Sensor is a complete, high performance weather sensor. This technology provides industry grade accuracy without moving parts and includes a built-in compass used for automatic magnetic north alignment of the wind sensor.
The temperature and humidity elements are integrated into an IP65 sealed module with a quick disconnect for ease of calibration in the field. The pressure element is precisely calibrated, and temperature compensated. The AIO 2 will accept data from a tipping bucket rain gauge (0.25mm resolution) and a compatible pyranometer (Apogee SP-212).

Measures: RH (%), Temperature (°C), Barometric Pressure (kPa), Wind Speed (m/s), Wind Direction (°), Solar (W/m2) [Optional], Rainfall (mm) [Optional]
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11, 905 Tripod

MSO Weather Station with tipping bucket rain gauge

The MSO is an integrated 5-parameter Weather Station. Wind Speed and Wind Direction are measured using conventional cup and vane techniques. All other measurements are housed in a multi-plate naturally aspirated radiation shield to reduce solar radiation heating errors. The temperature sensor is a platinum RTD. Relative humidity is a based on our accurate solid-state sensor designed for continuous exposure to adverse climates. The barometric pressure sensor is a robust piezo-resistive device featuring high accuracy and long-term stability. An external tipping bucket rain gauge connects simply and allows for correct installation and siting per industry guidelines.

Measures: RH (%) / Temperature (°C) / Barometric Pressure (kPa) / Wind Speed (m/s) / Wind Direction (°), Rainfall (mm) [Optional]
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11, 905 Tripod

Sensors: Environmental Monitoring

Weather Stations and Microclimate

ATMOS-41 Is an all in one agricultural / research grade weather station.

Measures: RH (%), Temperature (°C), Vapour Pressure (kPa), Barometric Pressure (kPa), Wind Speed (m/s), Wind Gust Speed (m/s) Wind Direction (°), Solar (W/m²), Rainfall (mm), Lightning Strike (count) and Lightning Distance (km)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7, 905 Tripod

ATMOS-22

The ATMOS 22 (previously DS-2) is a rugged, research-grade two-dimensional sonic anemometer built specifically for agricultural, forestry, and environmental research applications. A lower wind speed threshold of 0 m/s makes the ATMOS 22 especially well-suited for measuring wind within plant canopies, where wind speeds are often below the threshold of a cup anemometer.

Measures: Wind Speed (m/s), Wind Direction (°), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

ATMOS-14

The ATMOS 14 (previously VP-4) is a small, simple integrated sensor built specifically for microclimate measurements.
This low-maintenance sensor will rapidly and reliably measure air temperature, relative humidity, barometric pressure and vapor pressure.

Measures: RH (%), Temperature (°C), Barometric Pressure (kPa), Vapour Pressure (kPa)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

Sensors: Environmental Monitoring

Rainfall

PRG02
The PRG02 is low cost high precision (0.2mm resolution) rain gauge constructed of high quality plastic materials for a very long durability (10-20 years).

Measures: Rainfall (mm)
Compatible Node: MFL-NODE, MF-NODE, S-NODE, P-NODE
Accessories: PRG02PMB

SRG0
The SRG0 is a research grade stainless-steel rain gauge with 0.2mm tips and high accuracy during intense rainfall events.

Measures: Rainfall (mm)
Compatible Node: MFL-NODE, MF-NODE, S-NODE, P-NODE

360RG
The 360 series of rain gauges are industry grade anodized aluminium and stainless-steel construction, with options for 0.1mm, 0.2mm and 0.25mm resolutions.

Measures: Rainfall (mm)
Compatible Node: MFL-NODE, MF-NODE, S-NODE, P-NODE
Accessories: 360-PMB

PRG1
The PRG1 is a low cost (1mm resolution) rain gauge constructed of high quality plastic materials for a very long durability (10-20 years), ideal for applications requiring high spatial resolution.

Measures: Rainfall (mm)
Compatible Node: MFL-NODE, MF-NODE, S-NODE, P-NODE
Accessories: PRG1PMB

Sensors: Environmental Monitoring

Solar Radiation

SN-500

The SN-500 measures net radiation with comparable accuracy to industry-leading competition in long-term field testing. Featuring an upward-looking and downward-looking pyranometer, and an upward-looking and downward-looking pyrgeometer the SN-500 provides separate measurements of the four components of net radiation as well as net shortwave, net longwave values.

Measures: Net Radiation (W/m^2), Net Shortwave Radiation (W/m^2), Net Longwave Radiation (W/m^2), Incoming Shortwave (W/m^2), Reflected Shortwave (W/m^2), Incoming Longwave (W/m^2), Reflected Longwave (W/m^2)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7, AM-500 Mounting Bracket

SP-212

The SP-212 is a low cost yet highly accurate pyranometer used for measurement of global solar radiation; a fully potted silicon cell photodiode and domed-shaped head makes the sensor fully weatherproof and self-cleaning.

Measures: Solar Radiation (W/m^2)
Compatible Node: V-NODE
Accessories: AL-120 Mounting Bracket and levelling Plate.

SU-202

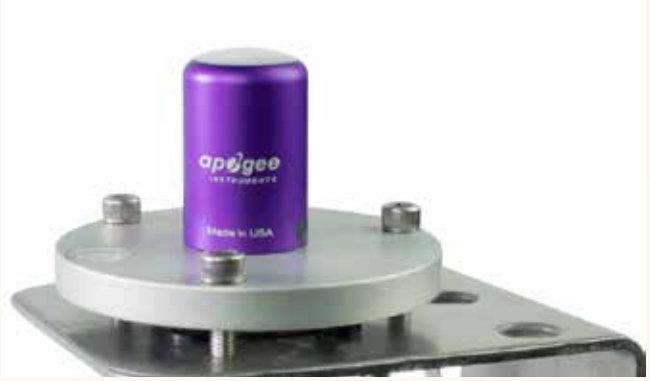
Apogee's new UV-A radiometers offer a low-cost option for continuously measuring UV-A radiation in outdoor environments, laboratory settings, and monitoring the filtering ability and stability of various materials.

Measures: UV-A (W/m^2)
Compatible Node: V-NODE
Accessories: AL-120 Mounting Bracket and levelling Plate.

SE-200

Apogee photometric radiometers use a photodetector with a spectral response that closely matches the sensitivity of the human eye to light; sensors include a diffuser to properly weight light incident from any angle. Apogee photometric radiometers provide highly accurate illuminance measurements (lux or footcandles) at an affordable price.

Measures: Illuminance (Lux)
Compatible Node: V-NODE
Accessories: AL-120 Mounting Bracket and levelling Plate.



Sensors: Plant Monitoring

Dendrometry

DPS40

The DPS40 is an SDI-12 Pivot Stem Dendrometer designed for the measurement of the diameter of small stems or branches between 5mm and 40mm. Sensor output is calibrated directly in millimetres of stem diameter. Each sensor is individually calibrated in 100 points over the whole range for excellent sensor linearity.

Measures: Stem diameter (mm), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE

DBS60

The DBS60 is an SDI-12 Band Dendrometer designed to measure short- and long-term changes in stem circumference at high resolution of 1µm (0.001mm). The DBS60 is non-invasive and attaches to the stem with an inextensible stainless-steel band.
The band has a linear thermal co-efficient of 17.3x 10^{-6} per °C, meaning that thermal variations caused by daily or seasonal changes in temperature have no measurable impact on the operation of the DBS60. The DBS60 is IP65 rated and is designed to be installed on stems greater than 80mm in diameter.

Measures: Change in Tree Circumference (mm), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE

Sensors: Plant Monitoring

Dendrometry

DEN5

The DEN5 radial dendrometer inserts into the tree along a single axis, allowing shrinking and swelling of plant tissues to be observed with high precision (±1µm). The radial dendrometer creates a point of reference by locking itself in at the centre of the tree, or at a depth that encompasses the active outer radius of the tree, then uses dual displacement transducers to measure diameter fluctuations in both xylem and phloem tissue which indicate tissue fluid pressures, thus providing information about sugar and water transport and status.

Measures: DI (BDHOB) mm, Xylem (mm)
Compatible Node: V-NODE

ZN11-T-IP

The ZN11-T-IP point dendrometer consists of a sealed electronic displacement transducer on a carbon fibre (CFK) frame. The combination of weatherproof materials and a solid anchorage in the stem make it possible to precisely detect changes in the stem radius with a resolution of less than 1µm. Applicable for tree stems greater than 70mm in diameter. The frame can be optionally upgraded to support two displacement transducers, allowing measurement of stem radius changes over bark and on xylem in parallel.

Measures: Stem Diameter (mm), Xylem Diameter (mm) [Optional]
Compatible Node: V-NODE

ZN11-O-WP

The ZN11-O-WP is a point dendrometer with a ring-shaped frame offered in different sizes to optimally fit small stems, roots and branches 1-8 cm in diameter (available diameter frames: 100 mm, 80 mm, 60 mm). The weather proof linear motion potentiometer provides <1µm resolution, allowing for analysis of diurnal stem radius fluctuations.
The frame can be optionally equipped with two displacement transducers, allowing measurement of stem radius changes over bark and on xylem in parallel.

Measures: Stem Diameter (mm), Xylem Diameter (mm) [Optional]
Compatible Node: V-Node

Sensors: Plant Monitoring

LINPAR

The LINPAR Linear PAR Sensor is designed for long term monitoring of canopy light interception. LINPAR consists of 33 individual PAR sensors along a 1m length wand. PAR readings are averaged across all 33 sensors to give a single output value.

Measures: PAR (µmol m^{-2} s^{-1})
Compatible Node: V-NODE
Accessories: AM-220 Mounting Bracket

SQ-110

The SQ-110 is a self-powered quantum sensor that measures photosynthetically active radiation (400 to 700 nanometres) and is calibrated for use in sunlight. Gardeners, greenhouse managers, growth chamber users and salt-water aquarists measure PAR to ensure optimal radiation conditions for plant growth.

Measures: PAR (µmol m^{-2} s^{-1})
Compatible Node: V-NODE
Accessories: AL-120 Mounting Bracket and levelling Plate.

SQ-500

The SQ-500 measures photosynthetically active radiation with a research grade, full spectral response sensor. Housed within a self-cleaning, cosine-corrected head that is fully-potted for a waterproof design.

Measures: PAR (µmol m^{-2} s^{-1})
Compatible Node: V-NODE
Accessories: AL-120 Mounting Bracket and levelling Plate.

SRS NDVI

The SRS NDVI (paired SRS-Ni and SRS-Nr sensors) matchbox-sized, multiband radiometer sensors used to measure Normalised Difference Vegetation Index (NDVI) at a plant or plot scale. (NDVI bands are centred at 630 nm and 800 nm with 50 nm and 40 nm full width half maximum (FWHM), respectively). NDVI provides a measure of canopy chlorophyll content and leaf area and is often used to monitor green-up in the spring and senescence in the fall.

Measures: NDVI
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

SRS PRI

The SRS PRI (paired SRS-Pi and SRS-Pr sensors) matchbox-sized, multiband radiometer sensors used to measure Photochemical Reflectance Index (PRI) at a plant or plot scale. PRI bands are centred at 532 nm and 570 nm with 10 nm FWHM. They are designed to continuously measure reflectance for calculation of PRI of plant canopies. PRI is related to canopy light use efficiency and is often used in studies of canopy photosynthesis and response to stress.

Measures: PRI
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

Sensors: Plant Monitoring

Leaf temperature and Wetness

SI-400 Series

The Apogee SI-411 is a highly accurate (±0.2% from -30°C to 65°C) infrared temperature sensor used for non-contact measurement of the temperatures of road surfaces, plant canopies, and soil, snow and water surfaces. Four field of view options available: standard (22°); narrow (18°); ultra-narrow (14°); and, horizontal (13° x 32°).

Measures: Target Temperature (°C), Sensor Body Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: AM-220 Mounting Bracket

Enviro-Therm™

The Enviro-Therm™ is a fixed-mounted infrared temperature sensor that is optimised for measuring plant-foliage surface temperature. The Enviro-Therm™ features the patented SKY-SPY™ systems which automatically corrects for errors caused by radiation to the sky, and measures surface temperatures from -10°C to 100°C, with ±0.3°C accuracy from -10°C to 50°C.

Measures: Target Temperature (°C)
Compatible Node: V-NODE
Accessories: AM-220 Mounting Bracket, Bernoullian Baffle

THERM-MICRO

The THERM-MICRO is a very small thermistor that can be adhered to a leaf surface for the measurement of absolute temperature of the leaf surface. Rapid Time Response (200 milliseconds), ±0.2°C Tolerance from 0°C to +70°C.

Measures: Leaf Temperature (°C)
Compatible Node: V-Node

SF-421

The SF-421 leaf and bud temperature sensor (formerly called the radiation frost detector) is an innovative temperature sensor designed to mimic leaves and flower/fruit buds, which can sometimes drop well below the ambient air temperature due to long-wave radiation loss on clear, calm nights.

Measures: Bud Temperature (°C), Leaf Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: AM-220 Mounting Bracket

PHYTOS-31

The PHYTOS 31 provides a measurement of both the onset and duration of wetness on a simulated leaf, and can be used to predict conditions favourable to plant diseases or infections may occur.

Measures: Leaf Temperature (°C)
Compatible Node: V-NODE

Sensors: Soil Monitoring

Soil Moisture

MP306/406

MP406 uses the standing wave principle to measure soil moisture with high accuracy and independent of variations in soil temperature or salinity. The MP406 has a reinforced body and stainless-steel needles making it ideal for use in extreme environments such as mine sites, landfills and saline soils as well as standard agricultural soils. The quality manufacture of the MP406 leaves it with a lifespan of 20+ years in the most extreme environmental conditions.

Measures: Soil Moisture (VWC%)
Compatible Node: V-NODE
Accessories: 11W Solar Panel, SPLM11

TDR-315L

The TDR-315L is a true waveform digitising Time Domain Reflectometer that derives soil permittivity and water content from the propagation time of an electromagnetic impulse conveyed along its waveguide. Because it is a true time domain device its readings are not derived from current and voltage magnitudes and relationships and hence are not impacted by soil electrical conductivity and compaction or texture.

Measures: Soil Moisture (VWC%), EC (dS/m), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11

TEROS-12

The TEROS 12 capacitance sensor measures soil moisture, conductivity and temperature. Commonly used in greenhouses applications for soilless growth media (rockwool, perlite), the robust form factor has been optimized for use in harsh field environments.

Measures: Soil Moisture (VWC%), EC (dS/m), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

Sensors: Soil Monitoring

Soil Moisture

EC5

The EC5 capacitance sensor is 5cm in length and measures a small volume of soil, ideal for use in both greenhouse and field applications.

Measures: Soil Moisture (VWC%)
Compatible Node: V-NODE

10HS

The 10HS capacitance probe is 10cm in length and measures water content where a large volume of influence is needed, typically in a field situation.

Measures: Soil Moisture (VWC%)
Compatible Node: V-NODE

EnviroPro EP100GL

The EnviroPro® multi-depth soil moisture probe has been carefully engineered to be accurate, long-life, maintenance-free instruments suitable for all soil types. Applications include turf, trees, flowers, vegetables, vines, cane fields, grains and dry-land crops, and many other plantations. Available in 40cm, 80cm, 100cm and 120cm lengths.

Measures: Soil Moisture (VWC%), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11

Sensors: Soil Monitoring

Soil Tension

TEROS-21

The TEROS 21 (previously MPS-6) is a matric water potential sensor that provides long term, maintenance-free soil water potential and temperature readings at any depth without sensitivity to salts. The range of the TEROS 21 goes from field capacity to as dry as permanent wilting point.

Measures: Soil Water Potential (kPa), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE

Jet Fill Tensiometer with ICT GT3-15 Transducer

A tensiometer measures the force with which water is held in the soil by the soil particles. This force, referred to as soil suction, soil tension, or soil water potential, indicates how tightly the water is bound in the soil, and how much energy must be exerted by plant roots to remove and use the water. The response to changes in soil water potential is immediate and so can measure very accurately small changes immediately. The vacuum inside the tensiometer is measured by a pressure transducer, which gives a continuous analogue output signal. A resolution of 0.1 kPa can be attained for the GT3 Tensiometer Transducer, across a range of 0 - 70 kPa of soil suction

Measures: Soil Water Potential (kPa)
Compatible Node: V-NODE
Accessories: 11W Solar Panel, SPLM11

Soil Oxygen

ICTO2 Soil Oxygen Sensor

The ICTO2 Soil Oxygen Sensor performs measurements based on a Galvanic cell principle. It is a passive sensor and does not require voltage input. The sensor has an automatic temperature compensation via an in-built thermocouple compensation circuit. The sensors are Teflon coated and made from long lasting plastics. Life expectancy in the field is five years. Typically used in vegetable or orchard crops for irrigation management, mining and landfill applications and laboratory based soil column studies.

Measures: Soil Oxygen (%)
Compatible Node: V-NODE

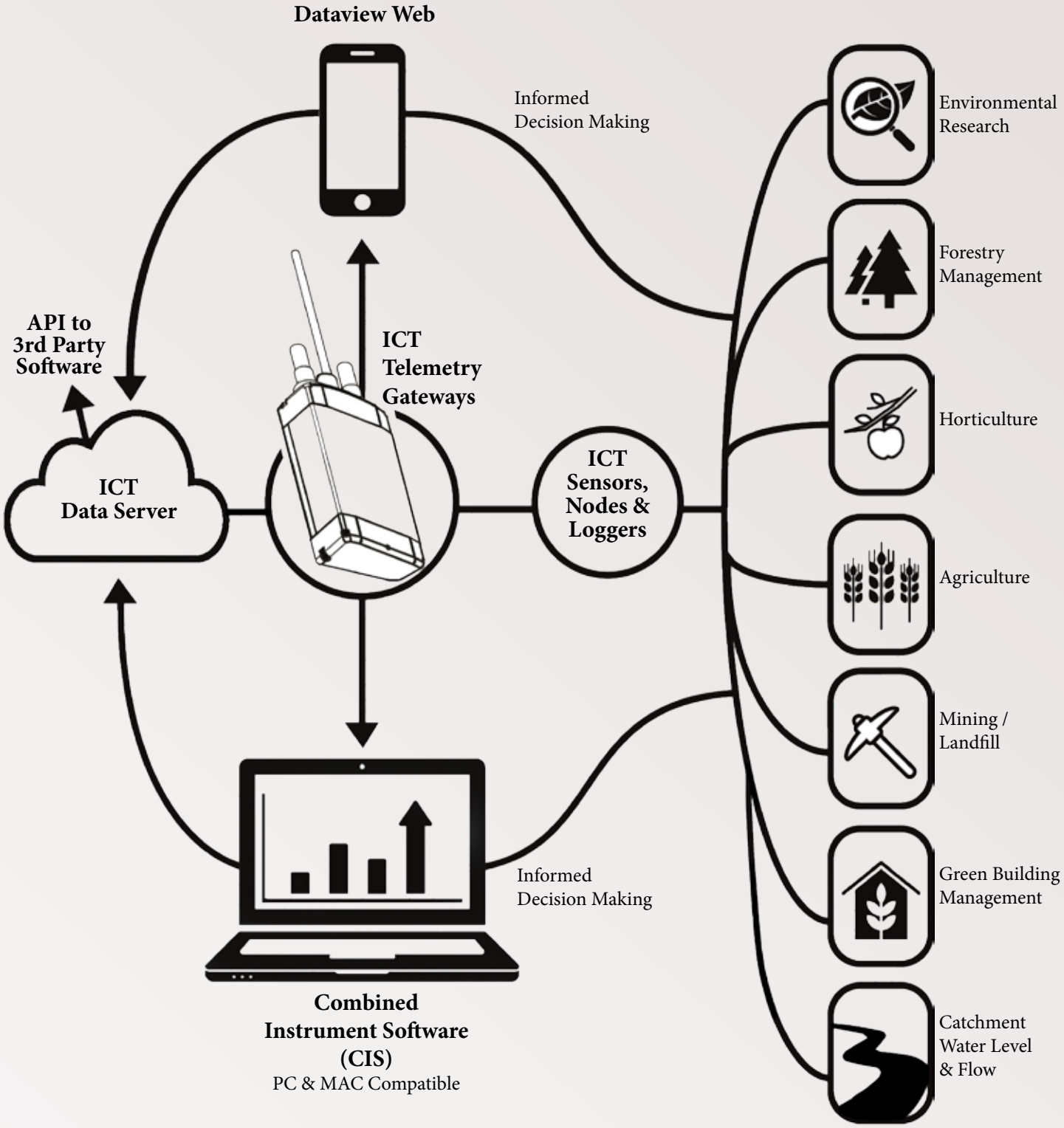
Soil Temperature

THERM-SS

The stainless steel temperature sensors (THERM-SS) are high quality, low cost sensors for measurement of soil, air or liquid temperature. The sensor consists of a thermistor embedded in a protective stainless steel body. THERM-SS sensors can be used in a wide range of applications from soil monitoring and climate control to concrete monitoring and explosive testing. THERM-SS has a measurement range between -40°C and +100°C. Standard cable lengths are 5m, 30m and 50m however custom length cables are available.

Measures: Soil Temperature (°C)
Compatible Node: V-Node

ICT International Data Management Solutions



Sensors: Water Monitoring

Water Level

Smart-PT

The Smart PT is a ceramic membrane pressure and temperature sensor that delivers accurate results for a wide range of fluid level measurement applications and is available with a vented or absolute pressure sensing module. The vent tube provides an atmospheric reference which compensates for variations in barometric pressure. Corrosion-resistant stainless-steel housing and potted electronics make Smart PT extremely durable and long lasting for submersible water applications.

Measures: Water Level (mm), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

6541 Shaft Encoder

The 6541 Shaft Encoder is a high accuracy float and pulley water level instrument which can achieve operating accuracy and resolution of 0.2mm. The 6541 has the range to monitor surface and underground waters (standard 0 – 8m) and the precision to monitor evaporation.

Measures: Water Level (mm)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
System Extension: 6529 Evaporation Monitoring System

HYDROS 21

HYDROS 21 sensor is an accurate tool for monitoring of water level, electrical conductivity, and temperature in both ground water and surface water. The sensor utilises a vented pressure transducer to obtain accurate water level measurements from 0 to 10m while removing the effects of barometric pressure. With a range of 0 to 120 dS/m, the HYDROS 21 sensor can make accurate electrical conductivity measurements in a broad range of applications.

Measures: Water Level (mm), EC (dS/m), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 7W Solar Panel, SPLM7

Sensors: Water Monitoring

Water Level

MaxSonar Ultrasonic

MaxSonar-WR range of ultrasonic proximity sensors provide object detection (including water surface) from 20cm to 765cm with 1cm resolution or 30cm to 500cm with 1mm resolution.

Measures: Distance to object (mm)
Node: LVL-NODE

RFS30 Float Switch

The RF30 is a side mounting switch consisting of a reed switch and pivoted actuator magnet encapsulated in a waterproof housing. Can be used for 'normally open' or 'normally closed' operation for measuring water level state within water troughs.

Measures: Water level state (open/closed)
Node: P-NODE

Sensors: Water Monitoring

Water Quality

ES-2

The ES-2 Electrical Conductivity Sensor is designed to measure the electrical conductivity of water in a pipe or tank.

Measures: EC (dS/m), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE

pHEHT

The pHEHT sensor has been designed for in-situ applications in some of the most difficult situations for a pH/ORP sensors in terms of sensor resistance, quick response, minimal flow dependence. The pHEHT sensor features long-life Plastogel® reference technology, increasing the lifetime of the probe and reducing the need to refill.

Measures: pH (pH), Redox (mV), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11

OPTOD

The OPTOD (Optical Dissolved Oxygen technology) is based on luminescent optical technology. The OPTOD sensor is in compliance with the ASTM International Method D888-05. OPTOD does not require calibration, and is suited to long term installation in all situations, especially in very low oxygen concentrations.

Measures: Dissolved Oxygen (mg/L, ppm or %), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11

Sensors: Water Monitoring

Water Quality

C4E

The C4E provides reliable Conductivity, Salinity and Temperature measurements.
The multi-range sensor allows the same sensor to be employed in a wide variety of applications, the monitoring system being set up to provide the optimum accuracy and resolution for the intended application. The C4E Conductivity / Salinity Sensor utilises four-electrode technology to ensure your required readings are accurate and reliable.

Measures: Salinity (µS/cm), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11

Nephelometric Turbidity

The PONSEL Turbidity sensor features an ISO 7027 compliant optical sensor with 0-4000 NTU range and is designed for long-term monitoring applications. The digital sensor stores calibration history in the sensor for plug-and-play connection without the need to recalibrate.

Measures: Turbidity (NTU), Temperature (°C)
Compatible Node: MFL-NODE, MF-NODE, S-NODE
Accessories: 11W Solar Panel, SPLM11

System Accessories

Power

7W Solar Panel
Monocrystalline 7W solar panel, Imp: 0.4A, Vmp: 17.3V, Voc: 21.16V,
Dimensions 285mm x 235mm x 15mm.

SPLM7
Integrated mounting system for 7W solar panel and LoRaWAN node to suit a mast or pipe with an outer diameter of 33mm - 53mm, a wall, or a tree with a diameter of greater than 15cm.

11W Solar Panel
Polycrystalline 11W solar panel, Imp: 0.61A, Vmp: 18V, Voc: 21.6V, Dimensions 340mm x 290mm x 22mm.

SPLM11
Integrated mounting system for 11W solar panel and IP67 enclosure housing 12V solar rechargeable power system (battery size scalable to 7Ah) and LoRaWAN node to suit a mast or pipe with an outer diameter of 33mm - 53mm, a wall, or a tree with a diameter of greater than 15cm.

20W Solar Panel
Monocrystalline 20W solar panel, Imp: 1.12A, Vmp: 17.8V, Voc: 22.3V,
Dimensions 285mm x 235mm x 25mm.

SPLM20
Integrated mounting system for 20W solar panel and IP67 enclosure housing 12V solar rechargeable power system (battery size scalable to 12Ah) and LoRaWAN node to suit a mast or pipe with an outer diameter of 33mm - 53mm, a wall, or a tree with a diameter of greater than 15cm.

System Accessories

Sensor Mounting

PRG02-PMB
Standard pole mounting bracket for the PRG02 rain gauge

PRG1-PMB
Standard pole mounting bracket for the PRG1 rain gauge

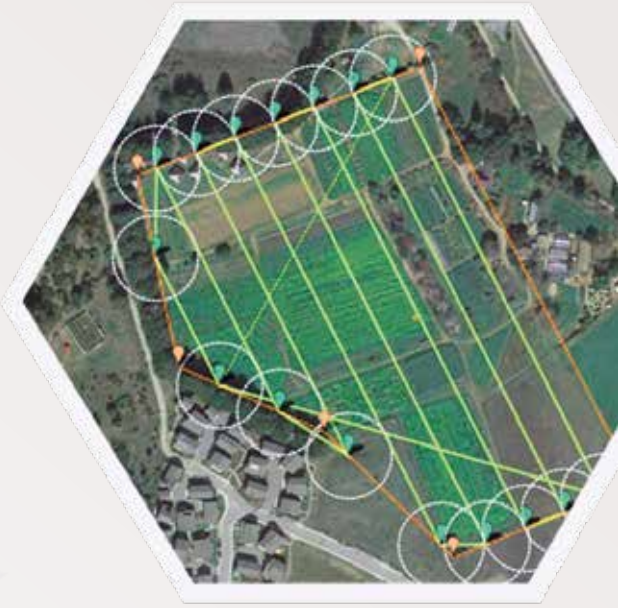
AM-500 Mounting Bracket
The AM-500 mounting bracket accommodates Apogee's net radiometer, and was designed to fit the mounting rod that comes with the net radiometer. The mounting bracket can be mounted to a mast or pipe.

AL-120 Mounting Bracket and levelling Plate.
The AL-120 Solar Mounting Bracket with leveling plate is designed to mount solar sensors SP, SQ, and SU series models to a mast or pipe with an outer diameter of 33mm - 53mm. The bracket has a leveling plate with an integrated bubble-level to make leveling simple and accurate for proper sensor installation.

AM-220 Mounting Bracket
The AM-220 Angle Mounting Bracket is designed to mount infrared radiometer (SI series) or radiation frost detector (SF series) to a mast or pipe with an outer diameter of 33mm - 53mm. The bracket is designed to orient the infrared radiometer at varying angles to satisfy all applications.

306-PMB
Standard pole mounting bracket for the 360-series rain gauge

905 Tripod
The 905 Tripod is a light weight collapsible tripod designed for rapid deployment and retrieval. It can be easily transported and erected by a single person. It is intended to support a complement of weather or atmospheric instrumentation weighing up to 7kg in winds up to 150km/h, when correctly anchored.



System Extension

6529 Evaporation Monitoring System

The 6529-3 operates an evaporation pan and records evaporation and rainfall data.
The instrument is normally supplied as a complete package with a US Class A evaporation pan and all installation fittings, but it can be connected to any other type of pan.

G3 Drain Gauge

The Smart Field Lysimeter is the complete package for measuring the water balance, allowing us to measuring deep drainage, evapotranspiration, and storage. The one-and-a-half meter tall Drain Gauge is buried directly in the ground to measure flow rate in unsaturated soils and collect soil water samples for chemical analysis. Water samples can be collected easily through a surface port to analyse for chemicals, fertilisers, and other contaminants.

ICT SFM1

The SFM1 Sap Flow Meter is a self-contained, stand-alone instrument for the measurement of sap flow or transpiration in plants. The SFM1 is a complete package containing sap flow sensors, data logger, interface software and internal battery which can be charged with an external solar panel. Utilising the Heat Ratio Method (HRM) principle the SFM1 Sap Flow Meter is able to measure high, low and reverse flow rates in both small woody stems & roots as well as large trees.

Like the Heat Field Deformation (HFD) principle, the HRM Sap Flow Meter is the only instrument that can measure zero flow and reverse sap flow rates. The SFM1 Sap Flow Meter is the most powerful and flexible instrument for the direct measurement of plant water use. Utilising 2.4GHz wireless communications, the SFM1 can be integrated into networks utilising the ICT Universal Telemetry Hub.

Enabling better global research outcomes in soil, plant & environmental monitoring.

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