Irrigation Network Controller

User Guide

Irrigation Network Controller

Water-Insight Irrigation Management System

Revision 3.0





WATER-INSIGHT

Contents

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Revision Details

1.0	08.12.14	RH	Original Format
1.1	11.06.15	RH	Modifications for version 2.xx INC firmware
1.2	10.08.15	RH	Reworded firmware upgrade procedure
1.3	27.08.15	RH	Added Activity Monitor screen
1.4	09.10.15	SC	Added operational notes
1.5	13.10.15	RH	Corrected operation notes on background task operation and incremented version.
1.6	24.11.15	RH	Updated INC screen shots. Edited device naming conventions. Corrected various typos.
1.7	25.02.16	RH	Added details to the System Summary description section.
1.8	22.06.16	RH	Updated Coms screenshot, and added Disk Not Inserted Alarm.
1.9	06.07.16	RH	Updated Background Comms Task Comms Activity Screenshot.
1.11	16.09.16	RH	Updated for major firmware release v3.00.
1.12	30.05.17	GP	Aligned to firmware V3.03, removed firmware version from doc to avoid unnecessary changes to the guide.
2.0	27.04.18	GP	Updated to add FarmID and V5.00 firmware additions, updated format, added installation guide and technical specs.
3.0	01.08.19	GP	Modified support for repeaters. Requires V5.05 firmware or later.

Introduction

About This User Guide

This document provides assistance with the installation and operation of the Water-Insight Irrigation Network Controller (INC) including the user interface and configuration of system functions for the operation of Irrigation Point Controller (IPC) devices for fixed-set water sprinkler systems. The INC is a component of the Water-Insight Irrigation Management System (IMS).

Other documents that should be read in conjunction with this document include:

- EP3 User Guide
- IPC Manager User Guide.
- QIMS User Guide
- Additional application notes which provide specific operational assistance.

Additional help can be found at www.qtech.co.nz, where application notes can be obtained to provide guidance for specific configuration scenarios, detailing the configuration workflow steps.

This guide assumes that you have been trained on and are familiar with Water-Insight Irrigation Management System (IMS) suite of products and software, their configuration and their terminology. Please refer to other Water-Insight resources for introductory training material or specific Owners Manual's for detailed descriptions of each product.

This version of the guide incorporates feature additions made to the product to support version 5.00 of the INC firmware.

Product Overview

The Water-Insight Irrigation Management System (QIMS) is a suite of hardware and software products used to configure, control, and monitor Water-Insight Irrigation Point Controllers (IPC). The primary aim of the irrigation solution is to manage water application at defined flow rates over a wide area promote pasture growth.

The QIMS system design utilises a low-cost controller (IPC) at each irrigation point. The IPC is self-contained device operating from solar power with on-board battery storage. The IPC operates a low power latching solenoid to control an irrigation sprinkler valve. The IPCs communicate via a 900 MHz mesh radio network, allowing watering schedules to be centrally managed.

- **Irrigation Point Controller (IPC).** These devices are used to control the solenoid valve at each irrigation point. They operate autonomously and are connected via a mesh radio network for configuration and monitoring of the IPC plus additional control.
- **IPC Repeater (IPC-R)**. This is a permanently powered version of the IPC with a high gain antenna used for complex radio communications in difficult terrain.
- **EP3**. This is a hand-held device used to configure and test IPCs.
- **Irrigation Network Controller (INC).** This is a permanently installed and powered device that is used to monitor and record the state of each IPC in a system. It can also configure and test IPCs. The device connects to the radio mesh network and to back end systems such as the IMS.
- **IMS Software System**. Application Server and User Interface for overall operations configuration management monitoring and control, used in larger networks.
- **IPC Manager**. This is a software application that is used to create the files used for configuring the INC, EP3, and IPCs.

Figure 1: Irrigation Network Controller

Features

- 900 MHz Short range radio up to approximately 1 km for mesh network communications to IPCs.
- General purpose rf. antenna fitting for application specific antenna connection.
- Onboard touch screen User Interface for IPC status reporting, configuration and control.
- Real Time Operating System and processor for scheduled status polling and site time management.
- Memory Card interface (SD Card) for site configuration file import.
- Industry standard Modbus protocol Interface for remote INC and IPC configuration connected to IMS equipment via USB.
- Basic IPC network health statistics.
- Digital Inputs and outputs for equipment control (when used in conjunction with IMS software).

Hardware Overview

The INC is housed in a metal enclosure with detachable top cover and it provides a number of connector interfaces for various purposes. Four mounting hole positions are provided on side flanges to fit M3 fixtures.

The front panel touch screen can be used with a finger or stylus provided with the product. Care should be taken to avoid using the touch screen with sharp objects or pens that may leave ink or abrasion marks.

The product is supplied with phoenix style plugs with screw fit terminal blocks for wire connection to digital inputs, outputs and power.

The product is fitted with a 900 MHz foldable whip antenna but this can be replaced with cabled connections to antennas using the SMA connector interface. The recommended maximum cable length is 6m. The package is also supplied with a mains adaptor power supply.

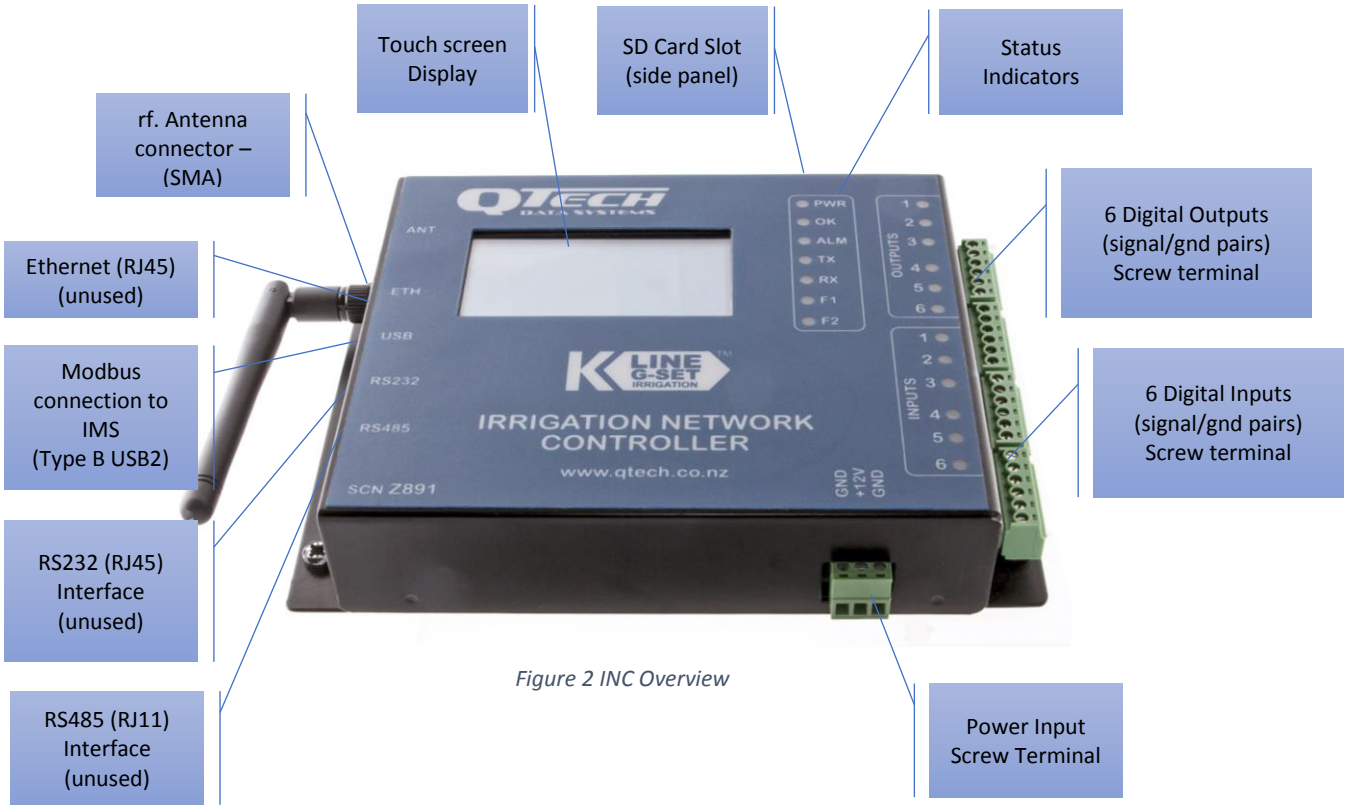


Figure 2 INC Overview

IMS Operation

A typical system consists of one or more (usually many) IPCs mounted on posts or in pods each connected to a sprinkler valve via a solenoid. Each IPC runs a scheduled watering plan according to a real time clock in the device. An EP3 or INC is used to send the time and schedule information to the IPC. Each IPC is defined in a human readable configuration file with a name and serial number and radio address. The configuration file is loaded into an EP3 or INC for distribution.

Schedules are also defined in a human readable configuration file. Schedules are distributed one by one with an EP3 but in an INC the scheduling process is automated and each schedule is sent to its associated IPC in sequence. Schedules (and configuration files) are stored on a memory card (SD card) and loaded into an EP3 or INC memory from the card. Once loaded on the INC or EP3 they remain in the device memory.

Schedule and configuration files hand be created and modified using a text editor on a workstation running Microsoft Windows. Alternatively, scheduling software such as IPC Manager from Water-Insightor Pod Scheduler from RX Plastics, can be used to generate the required files.

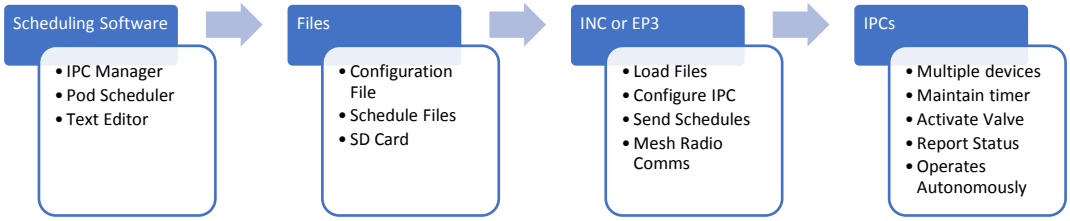


Figure 3: IPC Management Overview

Systems Overview

All systems are provisioned with an EP3. Medium sized systems can be run with an INC and larger systems augment the INC with the IMS software and hardware products.

Accessory products such as flow and level meters or specialised pump control wireless communications products are also available.

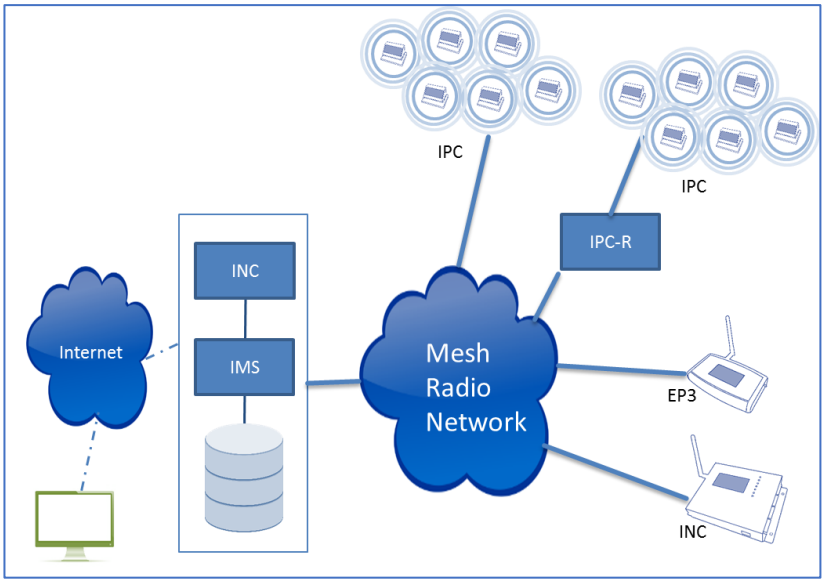


Figure 4: Typical IMS System options

Getting started

This section describes recommendations for installers and procedures for establishing the INC is operational. The INC can be supplied as a stand-alone item or fitted in an environmental enclosure. Specific hardware installation instructions are supplied with the product.

System and Equipment Requirements

The following tools and equipment should be carried by the installer when maintaining an INC and IPCs:

- EP3 handheld programmer
- SD Card to transfer IPC configuration and schedules to the unit.
- Stylus for touch screen operations
- Magnet for IPC programming
- Spare lithium ion batteries for the EP3
- Tools and fixtures for mounting the INC and managing cables.
- Tools and fixtures for mounting and running the INC antenna and cable.
- Mains adaptor power board with surge protection (minimum requirement).

Installation

Mounting placement

The INC can be mounted on a wall or on a table surface. It should be mounted in areas with low dust and water. If a suitable location cannot be found then it is recommended that the INC be mounted in an environmental enclosure, IP 54 or better.

Enclosure Water-Insight supply options

Environmental enclosures if supplied by Water-Insight use an ABS, Hinged, transparent cover, include wall mounting brackets. The enclosure measures: 465 x 350 x 160 mm. (Specifications may change from time to time). If wall mounting the INC it is recommended that clearance for these dimensions is provided on the wall space or table.

Wire gauges

The recommended wire gauge for I/O connections to screw terminals on the Inc is AWG Min: 28AWG, Max: 16AWG.

Power supply

The Irrigation Network Controller (INC) is powered from an external 12V DC power supply. Connection is via three pin screw terminals (Water-Insight supplied). Connection wiring is illustrated on the INC front panel.

Power supply protection

The INC is susceptible to electromagnetic interference including power surges and spikes. When operating the unit in plant rooms containing motors and motor speed controllers it is recommended that the INC power supply is protected by a surge protector rated at least 500 Joules and UL 1449 rating at 330V or similar.

For locations that include heavy electrical equipment or generating significant commutator noise use of an uninterruptable power supply (UPS) is recommended.

Routine maintenance (screen)

The INC screen should be kept free from dust and moisture using a dry cloth. The Water-Insight supplied stylus should be used when interacting with the screen or an un-gloved finger. Avoid using writing equipment and sharp objects that may leave marks and abrasions on the screen.

Antenna Placement.

The default supplied INC antenna is a whip style with a mounting bracket. The bracket should be affixed outside on the roof of the building housing the INC in an elevated position in free space clear of nearby objects such as walls.
Take care to avoid cable runs that exceed the recommended length for the coaxial cable specified (see specification section).

Ensure all cables are secured and tied back.

Initial configuration

Steps:

1. Mount the INC and connect the Antenna.
2. For standard INC installations there are no digital i/o connections so do not affix wires to the i/o connectors.
3. Check all wiring
4. Connect the power supply to the mains and plug the power connector into the INC.

When the INC is powered up and running the CPU OK LED will blink and the screen display the **Main Menu** as shown below. The Main Menu screen displays the current time value maintained in the INC.

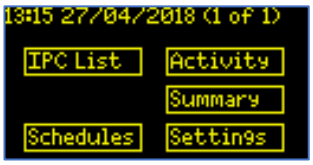
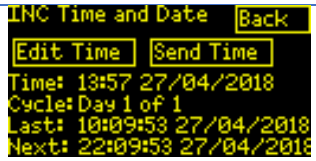
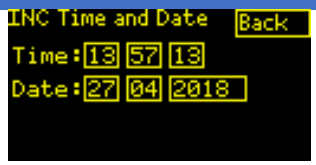
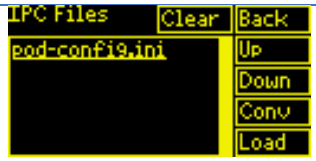


Figure 5: Main Menu

Now configure the INC basic settings:

Instruction	Display
1. On the main menu tap the ***settings*** button	 *Figure 6*
2. Set the time on the INC. tap the ***time*** button then tap ***edit time***	 *Figure 7*

Instruction	Display
3. Adjust each value by tapping on it and using the keypad to the correct date and time. More information is in the section – User Interface. Tap ***back*** a few times to return to the main menu when done.	 *Figure 8*
4. Other INC ***comms*** settings can be left as their factory defaults for now.	
5. If there are problems when tapping screen items and the INC does not seem to respond then the screen may need calibrating. See section: Touch screen calibration (***screen***). Make sure you have a stylus on hand.	 *Figure 9*
6. If the site has an IPC network in place load the IPC configuration file: Insert the SD card containing the configuration file, tap ***settings*** then ***IPC files*** then tap ***load*** after selecting the desired configuration file using the ***up*** and ***down*** buttons. (see section: loading the IPC list). Tap ***ok*** then ***back*** to return to the main menu.	 *Figure 10*
7. For basic functional tests it is not necessary to load the schedule files at this time.	
8. Now ready to verify operation.	

When the INC first powers on, the Background Communications Task will not immediately begin communicating with the IPCs, rather it will wait for the Status Interval to expire before beginning to poll the IPCs. This delay allows some time to test the system using manual communications without the Background Task interrupting.

Verifying Operation

The final steps to basic installation include communicating with an IPC

Instruction	Display
1. On the main menu tap the ***IPC List*** button. This brings up a list of the IPCs as defined in the IPC configuration file (aka pod list). Use the ***up*** and ***down*** buttons to select a post (IPC name or pod) that is known to be nearby the INC and operational. Then tap the ***view*** button	 *Figure 11*
2. Tap the checkbox next to ***status request*** to select it then tap ***send*** to initiate communications.	 *Figure 12*

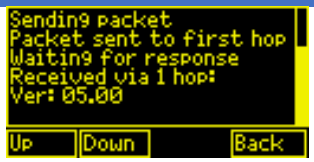
Instruction	Display
3. The IPC will respond with its status information. If it does not try another IPC.	

Figure 13

If there is still no communication verify that the IPC configuration file includes the correct radio channel and FarmID. (see section Managing IPCs). Refer to the EP3 manual for programming FarmID and Radio Channel on an IPC if necessary.

Next Steps

Once operation is verified the installer should proceed to:

a) Fine tune INC comms settings
b) Set the date/time on the site,
c) Load and distribute schedule files

The INC will then automatically poll each IPC for status

If the site does not have defined Schedules or IPC configurations, then the installer must first create them using either a text editor or using scheduling software such as IPC Manager from Water-Insight or Pod Scheduler from RX Plastics. Contact Water-Insight for support. See also section: Configuration Filer formats below.

User Interface

Touch Screen

Operation of the INC is provided primarily via a touch screen user interface. Using the stylus provided with the product or a finger, the user can tap on defined “button” areas of the screen to navigate various menu screens and adjust parameter values.

Warning. Avoid using sharp items and ink pens or pencils on the touch screen to prevent marks and abrasions.

Warning. Water contact with the Touch Screen should be avoided.

General Navigation

Where text entry is required a keypad is displayed. To cancel the editing operation, tap **cancel**. To delete a character tap **delete**. To accept a value tap **enter**.

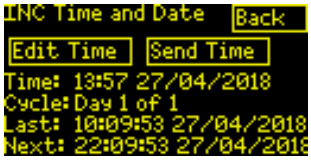


Figure 14

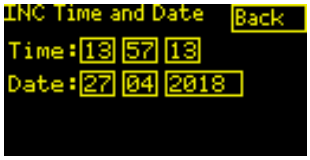


Figure 15

Figure 16

Some screens provide special buttons for navigation:

- **Back** returns the user to the previous screen
- **Next** takes the user to the next screen or the next item in a list
- **Prev** takes the user to the previous item in a list
- **Up** scrolls the current screen up to display more data or advances up a list of items
- **Down** scrolls the current screen down to display more data or advances down a list of items

Display values can also be adjusted by editing the schedule and configuration files on the SD Card.

Screen Calibration

An inherent aspect to touch screens is that they may drift out of calibration over time. The result of an un-calibrated touch screen is that position where the stylus is taped will not register correctly with the pixel position on the screen making it difficult to navigate screen easily.

To recalibrate the screen:

1. Tap ***Settings*** then tap the ***screen*** button.
2. A confirmation screen will appear asking if you want to calibrate the screen. Tap ***OK*** to proceed**.**
3. The screen will show a series of three small crosses (reference points), carefully tap each ‘**+**’ with a stylus.
4. Once completed the device will re-calculate the screen calibration factors then reset to show the main menu screen.

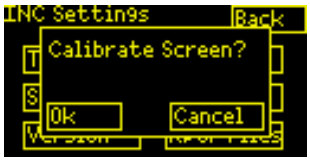


Figure 17

Note: These settings cannot be reverted to the previous settings so please ensure you are careful when re-calibrating.

Status Indicators

The INC has 7 led status indicators to display general activity of the device

- PWR – Power indicator – solid on indicates that power has been connected to the device.
- OK – heartbeat indicator - periodic flash (on/off) indicates INC processor operating OK
- ALM – Alarm indicator- short period flash indicates no SD Card inserted in memory card slot
- TX – intermittent flash Indicates INC radio is transmitting over the mesh radio network
- RX – intermittent flash indicates INC receiver has detected valid radio activity over the mesh radio network intended for the INC.
- F1 – general indicator, not used
- F2 – short intermittent flash indicates the SD card memory is being accessed by the INC processor. Do not remove the SD card whilst it is being accessed.

I/O Indicators

The INC has 6 digital inputs and 6 digital outputs. These can be used to monitor and control plant and equipment such as pumps and level sensors. The inputs and outputs are arranged in pairs, one for the signal and one for a ground or common level.

Each input has an associated indicator which is illuminated if the input is asserted. By default, shorting an input pair will assert the input.

Asserting an output will illuminate its associated indicator.

Inputs and Outputs are mapped to and controlled via the Modbus interface connected to IMS software systems.

Inputs and Outputs cannot currently be configured or controlled via the user interface.

The user should contact Water-Insight if there is a requirement to control plant and equipment for specific application purposes.

System Configuration

Configuration of INC operating parameters is performed via the User Interface. Site configuration of IPCs is managed through configuration and schedule files imported (loaded) into the INC via a SD memory card.

When setting an INC to work the process typically involves the following steps:

1. Load a IPC configuration (often called a pod list or IPC list)
2. Load the IPC schedule files
3. Set the Site time and broadcasting it to IPCs in the network
4. Modify INC operating parameters
5. Send each IPC its schedule

Thereafter individual IPCs can be interrogated for their status and IPC devices regularly polled for status information. The INC holds some basic statistics including for example: the number of IPCs that responded to the last communication request, the battery level of IPCs and checks to see that an IPC is operating its correct schedule.

Loading the IPC List

To configure a system on the INC first load a correctly formatted IPC list file. Insert a memory card with the file in the SD card slot in the INC. To select and load the IPC configuration file, go to the ***INC Settings*** screen and tap the ***IPC Files*** button.

Figure 18

The INC will display a list of all the files with the "**.ini**" extension present in the /pods folder. Use the ***Up*** and ***Down*** buttons to select the desired IPC configuration file and tap the ***Load*** button.

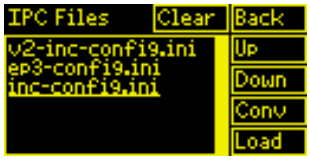


Figure 19

The INC will then copy the information from the file into its memory. This can take some time to complete so please be patient. Once the IPC list has been loaded, the INC should display a message indicating that it has been loaded ok.

Note. Typically, only one file will be listed pod-config.ini if Water-Insight IPC Manager is used to generate the configuration files.

Loading Schedule Files

The next step is to specify which directory on the SD card contains the schedule set to use. This is a subfolder of the /schedules folder. The purpose of the subfolder is to enable several sets of schedules to be kept on the SD card at a time. Each set must contain one schedule file for each IPC,

but the timing information in the files can be different. For example, one folder could contain schedules for use in spring, and another could contain schedules for use in summer.

Note. Many configurations typically only use one folder named default.

The INC needs to be configured to tell it which subfolder contains the schedules to use. To select the folder, go to the ***Main Menu*** and tap the ***Schedules*** button. The INC will display the **Schedules Settings** screen. Next tap the ***Folder*** button.

Figure 20

The INC will display the **Folder Selection** screen. Use the ***Up*** and ***Down*** buttons to select the folder and tap the ***Load*** button. This will save the selected folder and load the schedules in that folder into the INCs internal memory.

A progress gauge will be shown along the top of the screen. This process can take a few minutes to complete.

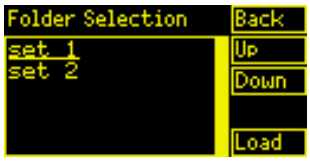


Figure 21

The schedule folder name and schedules are stored in non-volatile memory so does not have to be re-selected when the INC power is cycled. The schedule folder name is arbitrary, but must be consistent with the FAT32 file system conventions, and must not be longer than 8 characters long.

Adjusting INC Operating Parameters

When a site is commissioned, several system parameters may require adjusting to suit the environment and desired performance of the radio network including for example:

- How often IPC status messages are made from the INC to the IPC network
- Frequency of broadcast messages to the site to synchronise the site time.
- System behaviour in terrain with radio communication challenges
- Threshold levels for reporting low battery levels or IPC clock time drift problems

These parameters not changed often once the site behaviour has been characterised but may be adjusted from time to time to manage battery power consumption on IPCs; radio communications can consume battery capacity in IPC devices if the system is operating with high levels of radio communications from the INC.

Setting the INC Clock Time and Cycle Information

The INC has an accurate on-board Real Time Clock (RTC) that it uses to ensure all IPCs in the system have the same time on their RTCs. The INC time values can be altered as needed by tapping the appropriate number box that you want to edit

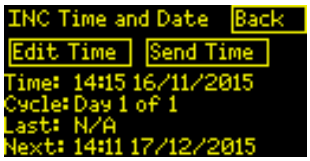


Figure 22

From the main menu, tap ***Settings*** then ***time*** to display the current time and day of the cycle, when the IPC network was last polled for status information and when the next poll is due.

Tap ***Edit Time*** to adjust the current time. Use the numeric keypad to adjust each value.

Tap ***Send Time*** to manually broadcast a time synchronisation message to the network.

This message is not guaranteed to reach all IPCs in the network but the message will propagate over the network for a few minutes. Individual IPCs can be polled for status to provide confidence that the time has propagated. Time issues on individual IPCs can be identified from periodic status polls of the entire network.

Note that the INC (nor an IPC) does not automatically adjustment for Daylight Savings.

The Day and Period values define the duration of the scheduling cycle, with Day being the current day of the cycle, and Period being the cycle length in days. IPCs repeat their watering plans periodically according to the period value.

The cycle period information is defined in the schedule file for each IPC. The current day of the cycle is automatically calculated by each IPC and report back to the INC it is status message. The INC also keeps track of the day of the cycle itself.

Note: In systems prior to version 5 (IPC and INC firmware) the cycle length and current day of the cycle are part of the Timeset message sent out to the IPCs and are adjusted in the INC. If there are system changes to schedules that have a multi-day operation, or complete reconfiguration of the INC with IPCs already operating, sending a Timeset from the INC will ensure that all schedules will activate correctly on the next working cycle. Alternatively resending the schedules will trigger the IPC to recalculate the event times over a multi-day cycle. The IPC recalculates its timer information on receipt of a schedule or at midnight on the last day of a cycle. In version 5 of the system this requirement to set the period and day in the INC was removed.

Setting the Time Synchronisation period

The INC will periodically broadcast its time in order to compensate for time drift of the real time clocks in each IPC. The synchronisation period is specified in hours and commonly is set to between 1 week and 1 month, although it can be set to as little as every hour. Setting the value to zero (0) will disable the time synchronisation message.

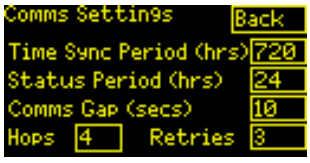


Figure 23

From the main menu tap ***settings*** then tap ***comms***. Tap the **Time Sync Period** value to adjust the period (in hours).

Each time this setting is changed, the next Timeset will be rescheduled relative to the time when the setting was changed.

Recommended value for sites that are being commissioned is 24 Hrs. Recommended value for sites that operational is 168-720 Hrs.

System Status Polling

The INC will periodically poll each IPC for its status information including for example: its time, its battery level, its schedule correctness. Metrics for setting the polling period are set in the **comms** settings. (see Figure 23.).

The values should be adjusted as follows:

Status Period: The INC periodically requests the status of each IPC in a round-robin polling scheme, from the first IPC through to the last through to the last in the IPC list. This value defines the time duration (in hours) between polling loops being triggered to start. If the polling loop took longer to complete than the Status Period, then the INC will simply begin the next polling loop immediately after the previous polling loop completes.

Setting the polling period to low (often) will impact battery consumption in the IPCs. Setting the value to high (infrequent) will mean that information displayed on the INC may not be current.

For systems that are being commissioned or are not operating as expected it is recommended that polling occurs daily (24 hrs). For systems that are operating well periodic polling every few days up to a week is recommended (e.g. 144 Hrs). For systems that are winterised and not operating polling every few weeks is sufficient (720 Hrs).

Setting the polling period to zero (0) will disable all status requests.

Status Gap: This value, in seconds, defines how long the INC will wait after each communications transaction finishes before starting the next one with the next IPC in the list. This setting also applies during schedule distribution. Recommended value is 10 for most systems but those that have long propagation times for messages across the mesh (usually due to terrain) network longer gap times can be configured. Compact sites may use a lower value in the range 1-5 seconds.

Hops: A Time-To-Live (TLL) parameter is included in the mesh route request messages and is used to limit how many hops the route request message will propagate through the network. When a Route Request process is started, the INC will initially use a small TLL value to reduce network congestion, and then increase the value as needed. The Hops value defines the maximum value that the TTL will be increased to, and therefore defines the maximum number of hops used to communicate with the IPCs.

This metric is typically set to 4, 8 or 16 for small medium or large sites.

Retries: During the Route Request phase, the INC will reattempt sending route request messages until it receives a route found message from the target IPC. The Retries value defines how many times the INC will retry for each TLL value.

Three (3) retries is typical, difficult sites may use 5 retries but anything larger is unlikely to elicit a response. The larger the value the more potential impact on IPC battery consumption.

Distributing Schedules

The INC can distribute schedules to all IPCs in the IPC list sequentially. This process is triggered manually by activating the send schedule function. The INC will then attempt to contact each IPC in

turn at send its schedule. If an IPC does not receive its schedule it will remain in a queue in the INC for retransmission at a later date.
Once an IPC receives its schedule it responds with its status including a signature checksum value which can be compared to the checksum held by the INC to verify that it has the correct schedule information. This is also used to detect IPCs that have not received an updated schedule.

The checksum is also used to detect if an IPC does not have a schedule at all or if it is inhibited (all scheduled watering deliberately suspended).

Note: Starting the schedule distribution process will bring any inhibited IPCs out of the inhibited state when they receive their schedule file.

When a site is commissioned the final step in the deployment is to issue the schedules. Thereafter IPCs should be polled for status information.

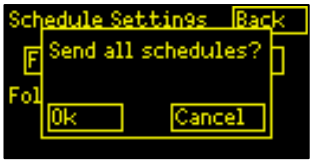


Figure 24

To trigger schedule distribution from the main menu, tap ***schedules*** then tap the ***Send All*** button in the ***Schedule Settings*** screen.

Systems that Use a Repeater

IPC networks can be configured to use a repeater. This is a device very similar to an IPC but normally permanently powered and utilising a high gain antenna. It is typically mounted within radio range of the INC and in a high position likely to maximise the probability of successful communications with IPCs in the block.

Repeaters are only used in systems where severe radio conditions hamper effective communications, possibly due to difficult terrain or when the INC antenna is a long way from the IPC network block.

For any IPC that uses hybrid communications mode (as defined in the configuration entry in the IPC list) the INC will direct messages to the IPC via the repeater.

Repeater configuration information is stored in the IPC configuration file (pod config). Repeater information is loaded into the INC when the IPC configuration file is loaded.

The configuration file will have an entry identifying the repeater and then for every IPC that uses the repeater, the pod entry for the IPC will use hybrid communications mode plus it will reference the repeater index to be used. In this way multiple repeaters are supported and groups of IPCs can each use an associated repeater.

For example, sample repeater entry in a pod config file is shown below (typically placed as the last entry in the file hence the [podxxx] entry in this example).

```
[pod123]
name=RPTR1
serial=6452
address=00:1E:C0:98:EF:B1
channel=24
mode=local
type=repeater
farmid=01:15
```


Corresponding IPCs using the repeater will use a pod entry as follows:

```
[pod2]
name=IPC02
serial=6800
address=00:1E:C0:98:D2:06
schedule=2
channel=24
mode=Hybrid
repeater=1
sublateral=2
farmid=01:15
```

Note. The repeater=1 entry must be present if the IPC uses hybrid (repeater) communications. The number refers to the ordinal number that the repeater entry appears in the pod config; repeater=1 refers to first incidence of a repeater definition in a config, 2 refers to the second incidence and so on. In this manner multiple repeaters can be defined in a config file with communications IPCs units directed to the associated repeater.

Contact Water-Insightfor additional assistance with system design and generation of configuration files for repeater-based systems.

Managing IPCs

The INC maintains configuration and status information for each IPC in the IPC list. Each IPC can be interrogated over the radio network to obtain the status.

IPC Communications

INC communications to an IPC are generally carried out using a mesh radio communications protocol. This is called **mesh mode** and allows communications that permit message transfer from one IPC to another in a series of hops from source (INC) to the destination IPC.

IPCs located nearby to the INC can be configured to operate in **local mode** wherein an attempt is made to contact the destination IPC directly without allowing other IPCs to participate in finding a route.

A combination of approached is used with **Hybrid mode** repeater systems (see above).

Radio communications occurs on a fixed radio channel that must be programmed into each IPC using an EP3.

What is FarmID?

In version 5 of the IMS system components. Each IPC is also programmed with a FarmID which constrains radio communications not just to the radio channel but to devices of the same FarmID.

If an IPC (running version 5) status returns the value of none in a status response for the FarmID then the value has not been programmed and normal communications is not facilitated. If the IPC returns the value of 01:01 this FarmID is reserved for temporary use in configuring systems and must be replaced by a valid FarmID.

> **Warning**: when configuring new sites ensure that the Radio channel and Water-Insightsupplied FarmID have been programmed into each IPC.

The FarmID is a unique number assigned, issued and managed by QTech. It uniquely identifies sets of IPCs deployed in a specified area of land (block) and it is issued to the farmer when new IPCs are deployed to the block. When IPCs are deployed to a site they are configured with several parameters:

1. A radio channel for communications to an EP3 or INC
2. A name which usually is a post or pod reference to assist the farmer in finding an IPC
3. A schedule to define watering times
4. A FarmID to restrict communications to the block

In version 5 of the system, once upgraded, IPCs without a FarmID configured will not communicate to an EP3 or INC, so part of the deployment process will include applying to Water-Insight for an ID. Water-Insight will maintain a database of IDs and where they are used. Water-Insight can programme the ID on behalf of the farmer for new production or issue the ID to farmers or installer,

so that units on their site can be configured. Currently, farmers (or agents and installers) will apply for an ID by contacting QTech. In future the ID will be issued using a self-service web site.

You cannot mix FarmIDs (use more than 1) within a block because this will degrade the effectiveness of the mesh radio communications system that Water-Insight employ to route radio traffic over wide-ranging terrain and IPC topography.

IPC List View

Once an IPC list has been loaded into the INCs memory, information about each IPC can be accessed individually from the IPC List screen. Tapping the ***IPC List*** button from the Main Menu will display a list of all the IPCs in the INC memory. The IPCs are listed in the order they appear in the configuration file.

Figure 25

IPC Information View

To access a specific IPC select it by using the ***Up*** and ***Down*** buttons and tap the ***View*** button. The INC will then display the **IPC Information** page for the selected IPC.

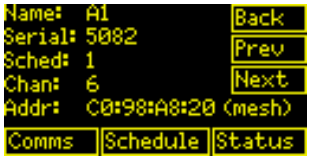


Figure 26

This page shows information about how the IPC has been configured, as defined in the IPC configuration file. It also has buttons that can be used to access more details about the selected IPC. The ***Comms*** button opens an interface that can be used to manually trigger the INC to communicate with the selected IPC. The ***Schedule*** button will make the INC display the schedule that has been loaded for the selected IPC. The ***Status*** button will make the INC display the current status values of the selected IPC.

Manually Initiated Communications

This screen can be used to manually trigger the INC to communicate with a specific IPC. It has buttons that can be used to select the type of communication message that the INC will send to the IPC.

Figure 27

Schedule Send: The INC will load the schedule of the selected IPC into memory and then send it to the IPC. Tap ***send schedule*** then tap ***send***.

Valve Control: The INC will send a message to the selected IPC, instructing it to open or close the solenoid valve connected to that IPC (which will turn the sprinkler on or off). Tap ***on*** or ***off*** and select the ***valve control*** checkbox before tapping ***send***.

Status Request: The INC will send a message to the selected IPC requesting its status information, and then wait for it to reply with a status response message. Tap ***status request*** then tap ***send***.

Inhibit: The INC will send a command to the selected IPC to prevent it from running its schedule, or to enable the schedule. Tap ***on*** or ***off*** and select the ***inhibit*** checkbox before tapping ***send***.

Once the type of message has been selected, tap the ***Send*** button. The INC will then display a screen which shows the progress of the communication transaction as it happens.

Figure 28

The process will generally start with a route discovery, with as many attempts as needed until a mesh route has been established to the IPC. The INC will then send the actual message to the IPC. The INC will then wait for a response from the IPC which contains the current status information. The screen will scroll as the information is displayed.

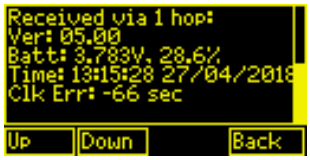


Figure 29

Figure 30

Figure 31

Note In version 5 of the INC and IPC firmware additional information including the IPC FarmID and the expected state of the IPC valve is also displayed (valve on meaning the valve is open and water should be flowing). Older firmware versions will not show this information.

If there is currently a background comms task in progress and the user attempts to do some manually initiated comms, then the INC will display "**Comms Busy**". The background comms transaction will normally complete within a few minutes (depending on various factors) and the manual comms can be reattempted later.

The INC can be configured to communicate with IPCs using one of three different communication methods for the manually initiated comms, and background comms tasks. The options are local, mesh, or hybrid. Each of these communications methods are detailed elsewhere.

The information displayed in a status response includes:

- Number of hops required to communicate to IPC (an indicator of how easy it is to send radio messages)
- Firmware version number of the IPC
- Current time on the IPC real time clock
- The variance in seconds between the IPC clock and the INC clock (maximum value shown is +/- 32767)
- The IPC schedule signature (CRC) which can be compared to the schedule information in the INC to determine if the IPC has the desired schedule.
- The current day of the cycle period expected by the IPC (in the form day x of y)
- The expected state of the valve (on/off meaning open/closed) (IPC Version 5 firmware or later)
- The FarmID programmed into the IPC (version 5 INC and IPC firmware or later).

View IPC Current Status

Each time that the INC receives a status message from an INC, it will update the "**current status**" of that IPC with the status values contained in the message. The current status of an IPC can be viewed by taping the ***Status*** button on the **IPC Information** page of that IPC.

Figure 32

The current status page displays the following information.

Polled: How long ago the INC requested (polled for) the status of the IPC, and whether or not the status request was acknowledged by the IPC.

Status: How long ago the last status message from the IPC was received by the INC.

Charge: The state of the IPCs battery at the time it sent the status message, represented as a percentage between 0% and 100%.

Clock Error: The difference in seconds between the time according to the IPC and that according to the INC. Note that the value will generally be larger with an increasing number of hops used to send the message.

Schedule: Whether or not the schedule stored in the IPC matches that specified in the INC.

If the INC has never attempted to communicate with the selected IPC then it will display that as shown below.

Figure 33

This screen will be displayed if the IPC list has been recently loaded, because the current status of each IPC is cleared when the IPC list is loaded from the SD Card.

IPC Schedule Viewer

The schedule of the selected IPC can be viewed by taping the ***Schedule*** button in the IPC Information page. The displayed schedule is what the INC has been configured to use for that IPC. Please note that the IPC may actually have a different schedule loaded, depending on whether or not the current schedule has been sent out to that IPC.

Figure 34

Note. In version 5 of the firmware (INC and IPC) the cycle period is defined in the schedule file and is shown as the **cycle length** value. Older firmware versions use the Timeset facility to set the cycle length.

If the INC cannot locate the schedule in its memory for the selected IPC it will display the following.

Figure 35

This might happen if the schedules haven't been loaded to the INCs internal memory, or if the schedules folder doesn't contain a schedule file corresponding to that particular IPC.
Background Communications

The INC maintains a **Background Communications Task** that is responsible for periodically communicating with the IPCs. The current state of the task can be viewed in the Activity screen. When the task is Idle that means it isn't currently communicating with any IPCs. When it is active the screen shows which IPC it is communicating with, the type of communications, and the progress though the IPC list before it goes back to Idle.

Figure 36

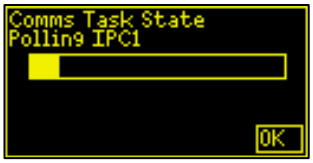


Figure 37

Advanced IPC operations

Site Timeset

The time on the IPCs in the site can be synchronised to the INC time using the broadcast Timeset. Refer to section: Setting the INC Clock Time and Cycle Information.

Sending a broadcast Timeset does not guarantee that each IPC will receive the Timeset.

Site Valve Control

To turn off every IPC on the site from watering the INC has a broadcast command feature. This function is used especially when commissioning a site and can be used if (one or more) valves appear to be stuck on (open). It is also used to temporarily suspend operations whilst other farm operations are undertaken.

Resumption of IPC operations will occur on the next scheduled valve on operation in each IPC. For example, on sites where all IPCs are running on a 30-minute operating schedule then this provides up to a 30-minute window before normal operation resumes.

Sending a broadcast valve off does not guarantee that each IPC will receive the message.

This function is available in version 5 or later.

Figure 38

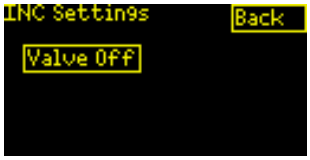


Figure 39

From the main menu tap ***settings*** then tap ***next*** to display advanced INC functions. Tap ***valve off*** to send a broadcast message to each IPC. Tap ***back*** to return to the INC settings screen.

IPC Network Status

The INC maintains basic statistical information about the current state of the system. It does not log or retain historical information. For historical data logging the IMS software system is required.

Current Status List

The INC maintains a record of the current state of each IPC in the system. Several aspects about each IPC are recorded, including:

- The IPC battery voltage.
- Whether or not the INC could communicate with the IPC.
- The status of the clock time maintained in the IPC.
- Which schedule the IPC has loaded and is currently active.

The current state of each IPC is marked as "**status unknown**" when the IPC list is first loaded from the SD Card, because at that point the INC will not have attempted to communicate with the IPCs so does not know what state they are in. The current status list is stored in non-volatile RAM, meaning that the state information is retained through cycling the power to the INC.

Status Messages

Each time that the INC receives a status message from an IPC it will update the current status entry of that IPC. If the INC attempts to communicate with an IPC, but the IPC doesn't respond then it will mark that IPC as being "**in comms fail**".

The INC also appends the status information to a Comma Separated Variable (CSV) log file on SD card. The INC creates one file for each IPC and creates a new file each month to prevent them becoming too large. This information is not visible on the display but can be retrieved by copying the files form the SD Card to a PC. The files can be imported into a spread sheet application such as Microsoft Excel.

System Summary

The INC has a System Summery screen that can be viewed by taping the ***Summary*** button from the **Main Menu** screen. The System Summary screen provides an overview of the system state. The meaning of each category is listed below.

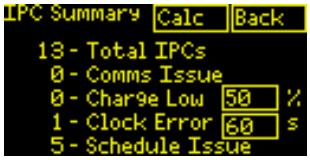


Figure 40

Comms Issue: The last time the INC polled the IPC the INC didn't receive a response.

Charge Low: The IPC battery voltage was less than 50 percent of capacity. This value can be changed.

Clock Error: The time difference between the IPC clock and the INC clock was greater than one minute (60s). This value can be changed.

Schedule Issue: The IPC has a different schedule from the one in the INC Schedule List, or the INC has no schedule loaded for that IPC.

The values listed in the System Summary can be refreshed by taping the ***Calc*** button. Also, the thresholds for the Charge and Clock error calculation can be edited as required.

Comms issues do not necessarily indicate a fault, only that the last requested status poll of the device did not succeed, which could occur for a variety of reasons including weather, communications interference or that the IPC has an underlying issue such as low battery and has gone into hibernation.

The Water-Insight IMS software system records successive polls of each IPC device and if the device consistently fails to respond it could also mean that the radio network is failing to make contact with the device due to a routing issue. This may be due to the location of the IPC relative to the INC including the network topology and terrain. Consult Water-Insight for a review of the radio network operation.

If the system is running Water-Insight IMS software then analysis can reveal how often each device tends to respond. An IPC device that communicates at least 75% of the time when polled (1 in 4 attempts) is considered to be in regular contact.

Devices that respond less than 25% of the time are defined as occasional contact. This is considered acceptable for monitoring functions but may require attention for on demand control operations

If a device does not respond for 30 days it is considered to be out of contact and attention is required by visiting the device with an EP3.

IPC List Filtering

Normally the IPC list will show all the IPCs in the system (as defined by the IPC configuration file generated by the IPC Scheduling software). This list can be filtered to show only a defined subset of the IPCs. An example of why this might be useful would be to list all of the IPCs that have low battery voltage.

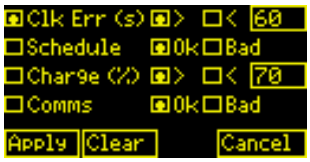


Figure 41

The filter can operate using any one of the following aspects of the current status list.

Clock Error: The number of seconds difference between the clock in the INC and that in the IPC (at the time the last status message was received). The recommended value for clock error threshold is 60s.

Schedule: Whether or not the schedule in the IPC matches that specified in the INC (Ok or Bad respectively).

Charge: The IPC battery voltage is greater or less than the specified charge as a percentage. The recommended value for battery level low threshold is less than 50%.

Comms: Whether or not the last attempt at communications failed or succeeded (Ok or Bad respectively).

Advanced INC Management

Application Firmware Self-Upgrade

The INC application firmware can be upgraded without needing any additional software or hardware devices. This is achieved by placing the firmware file onto the SD Card and plugging it into the INC. The file must be named **INC-App.bin** and located in the **/firmware** directory.

Once the card has been inserted navigate to the **INC Settings** screen and tap the ***Version*** button. The current firmware version that is running on the INC will be displayed. Next tap the ***Upgrade*** button then ***OK***. This will make the INC reprogram its firmware and restart. Now to check that the upgrade has worked correctly, navigate back to the Version screen, and you should see that the version number has changed.

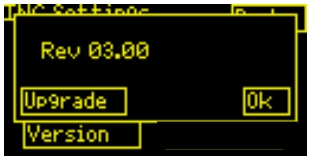


Figure 42

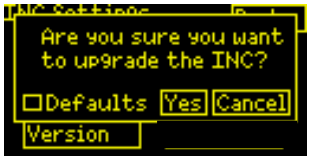


Figure 43

If the INC does not restart properly, and you can see that the RED and Green LEDs are alternately flashing, then you should remove the SD Card and re-insert it.

If you tick the ***Defaults*** checkbox, then the INC will reconfigure itself with the factory default settings. This includes erasing the touchscreen calibration factors, so you will need to use a stylus to recalibrate the screen when it restarts. You will also need to reload the IPC List, and the Schedules, and you will need to reconfigure the Comms Settings values if you have changed them from the default values. Setting the defaults is required when upgrading to version 3.00 from a previous version of firmware.

Steps:

1. Verify the firmware binary is called INC-App.bin
2. Copy it to the SD card to the /firmware folder
3. Insert the SD card into the INC (the SD card reader slot is located on the top side)
4. Commence the update from the INC user interface (GUI):
    a. Go to the main menu
    b. Tap onto the **Settings** button (bottom right button)
    c. Tap onto the **Version** button (bottom left button in the **INC Settings** screen)
    d. A dialog box will pop up with the current firmware's version number; tap onto the **Upgrade** button (bottom left of the dialog box)
    e. Tap the **Yes** button

f. At this point 3 lines of text appear briefly on the screen and the **ALM** and **OK** led lights will flash, then 2 more lines will be printed and finally the INC will reboot and show the main screen again (6 buttons view)

If the INC upgrade process appears to stall after displaying the first 3 text lines:

g. eject the SD card (manually push it, hear the click, then release it)
h. put the SD card back in (ensuring it clicks into place)
i. At this point two more lines will be printed and finally the INC will reboot and show the main screen again (6 buttons view)

If the INC upgrade process continues to remain stalled do these additional steps:

j. de-power the INC (carefully remove the green plug on the bottom holding the plug, not the wires)
k. re-power the INC by reinserting the power plug
l. Commence the FW upgrade procedure again (step 4a.)

INC Bootloader upgrade

From time to time the software used to upgrade the INC application (called the bootloader) needs to be upgraded.

Refer to Water-Insight Document: QIMS INC Firmware Installation Guide.

Configuration File Formats

The SD card which is used for transferring configuration files from the PC to the INC. The SD card must contain the following folders:

Folder	Description
Firmware	This contains the IPC firmware files used when upgrading IPC firmware or the EP3 firmware itself.
Schedules	This contains the schedule sets that were created by the IPC Scheduler application. The schedules are held in a named folder
Pods	This contains the IPC list usually created by IPC Scheduler Software.

Configuration files and schedules are stored on the memory card in a specific file and folder format:

```
pods\
      pod-config.ini
schedules\
      default\
            schedule-1.ini
            schedule-2.ini
            ...
      summer\
            schedule-1.ini
            schedule-2.ini
            ...
```

These files should then be copied to the SD card using Windows File Explorer. It is important that the file/folder layout matches that shown above.

Note. The folder names **pods** and **schedules** are explicitly required in the root folder. Schedule subfolder names may vary. Filenames must terminate with the .ini suffix. IPC list filenames may vary. Schedule files must follow the syntax used above.

The schedule folder name and schedules are stored in non-volatile memory so does not have to be re-selected when the INC power is cycled. The schedule folder name is arbitrary, but must be consistent with the FAT32 file system conventions, and must not be longer than 8 characters long.

IPC List

The IPC List contains information about each IPC, such as its radio address and which schedule it uses. The INC cannot communicate with an IPC until that information has been loaded into its internal memory. IPC Scheduling Software is commonly used to generate this configuration, and it outputs it in a file named "**pod-config.ini**". However, any filename with the .ini suffix can be used. In this way a memory card can hold multiple IPC lists. Files are human readable and can be manually edited with a text editor. A typical entry in an IPC list file looks like:

```
[pod1]
name=IPC01
serial=11552
address=00:1E:C0:9E:D0:27
schedule=1
channel=1
x-coordinate=0
y-coordinate=0
mode=Mesh
sublateral=1
farmid=01:01
```

The format descriptors are as follows:

Pod-Config Entry	Description
[pod1]	Record identifier, one for every IPC in the file
name=BK01	IPC friendly name, listed in the IPC list in an EP3 or INC, limited to 5 alphanumeric characters
serial=7054	Unique manufacturing serial number for the IPC printed on a label inside the IPC and visible, listed in the EP3 IPC list next to the IPC name.
address=00:1E:C0:98:C7:C1	Radio MAC address in EUI-48 format, all configurations must include this value and an IPC name. Extracted from the Water-Insightmanufacturing database for each IPC. This database can be interrogated from outside the organisation to produce a complete list of all IPCs by serial number and MAC address. Useful for third party software developers.
schedule=950	Identity of the schedule file in the schedules folder for the schedule associated with this IPC.
channel=1	Radio channel the IPC operates on. Generally, the same for each IPC on the farm. Assigned to the IPC by the manufacturer during production but can be reassigned by an agent if required.
x-coordinate=1588590.58532962	Post location (X) coordinate created by IPC manager from the GPS location of the post. Used by QIMS software for map views of the system. Can be left blank
y-coordinate=5268693.73952957	Post location (Y) coordinate created by IPC manager from the GPS location of the post. Used by QIMS software for map views of the system. Can be left blank.
mode=Mesh	Operating mode of the radio one of three options: a) mesh – for non- line of site operation over a farm b) local – for short range direct line of site operation c) hybrid – for use with a repeater system on the site. Forces all communications to the specified IPC to be forwarded to specified repeater (see repeater field below) for transmission to the destination IPC.
Repeater=1	This entry is only present when Hybrid (repeater) mode of operation is used for communicating to IPCs. It signifies the identity of the repeater (indicated by a number) through which the EP3 or INC will route all radio communications to a given IPC. More than one repeater can be used on a site according to the radio network design.
Type=repeater	Specifies the type of equipment. Valid values include **IPC** and **repeater**. This field must be present in the definition of a repeater. If not present in a pod entry the equipment is assumed to be of type IPC.
sublateral=1	This identifies the zone or group to which the IPC belongs. Multiple IPCs can

Pod-Config Entry	Description
	belong to a sublateral but typically only one IPC is scheduled to water at a time in that zone, as part of the system hydraulic design.
farmid=01:34	New feature added for IPC firmware revisions V5.00 and above. If this entry is present then the EP3 or INC (also running version 5.00 firmware or later) will transmit this value with all radio communications. Only IPCs programmed with a matching farm identifier will participate in radio communications. This enables radio communications to be restricted to a single IPC network when other networks on the same radio channel are nearby.

Schedule Files

Scheduling software is also commonly used to generate a schedule file for each IPC, which contains the timing information for the IPCs. The schedules are organised as a set of "**schedule-x.ini**" files with one file for each IPC.

Each entry in a schedule file follows this format:

Schedule file Entry	Description
[header]	Record identifier, used to identify the start of the schedule record
id=950	Schedule identifier used to associate a schedule with an IPC (see above)
cycle_length=2	Schedules are cyclic, this number represents the modulo number of days in each cycle
n_times=2	Defines the count of schedule operations in this schedule. A total of n_times (2) schedule operation time entries will be defined. Up to 16 operations can be defined.
CRC=261E	The file uses a calculated CRC which can be checked against the CRC of the schedule currently programmed in an IPC. Used to detect if an IPC has its correct schedule programmed. If the CRC values do not match then the schedule times programmed in the IPC is not the same as the expected schedule loaded in the INC or Ep3. Usually the schedules are resent to the IPC in this circumstance.
[time1]	Header identifier for the (first) of n_times (2) operations the IPC will perform
day=1	Day (1) of the modulo cycle_length (2) that the IPC turns on its valve
start=22:36	Start time of the day that the IPC turns on its valve
duration=28	Duration the valve stays on, when the duration is complete the valve turns off.
[time2]	Header identifier for the (second) of n_times (2) operations the IPC will perform
day=2	Day (2) of the modulo cycle_length (2) that the IPC turns on its valve
start=10:39	Start time of the day that the IPC turns on its valve
duration=27	Duration the valve stays on, when the duration is complete the valve turns off.

Technical Specifications

Note. Specifications are subject to change without notice.

INC Specification

Item	Parameter	Specification
General		
	Dimensions	Approx. 170 x 120 x 30 mm including side flanges 4 mounting holes to fit M3 fixture
	Weight	650 gms
	Temperature	Operating: 0-65 degrees C Storage 0-65 degrees C
	Humidity	0 – 90% non-condensing
	Ingress Protection	IP20 Water contact with screen should be avoided.
	Power	Input voltage: 12V +/- 15% Current: 0.25A Max.
	Device Management	Front panel touch screen Via Modbus interface
I/O		
	Digital Inputs	6 x signal/gnd pairs, switched to gnd Input voltage: 4V max. Input Current: 4 mA gnd inputs are internally tied to power ground
	Digital Outputs	6 x isolated relay output pairs Output voltage: 32V max. Output Current: 2A max.
Radio	Regulatory	ISM Band, AS/NZS 4268
	Antenna	Detachable, SMA connector Max. Cable length 6m (low loss RG57)
	Operating Frequency	915 – 928 MHz
	Output power	18 dBm +/- 2 dBm
	Receiver Sensitivity	-121 dBm
	Modulation	GFSK
Communications		
	IMS Interface	USB 2.00 Type B Modbus (RTU Slave) Interface
	Ethernet	IEEE 802.3 (connector fitted, for factory use only)
	RS232	RJ45 (connector fitted, for factory use only)
	RS485	RJ11 (connector fitted, for factory use only)
Storage		
	SD Memory Card	Secure Digital SDA 2.0

SD Card Specification

The INC uses an SD card interface for file transfer. The memory card should be formatted as FAT32. Typical memory device specifications are:

- Capacity: 8GB/16GB
- Standard: SDA 2.0
- Dimensions: 24 x 32 x 2.1mm (W x H x D)
- Weight: 2g
- Voltage: 2.7~3.6V
- Performance: Approximate Speed (read): 10~14 (MB/s), (write): 4~5 (MB/s)
- Speed Class: Class 10

Other card specifications may work but the user should verify that the EP3 can read the memory card correctly.

Warning. Performance of SD cards from some manufacturers may vary. If problems occur loading files then try using a class 4 SD card instead.

Warranty

The hardware and software referenced in this document is covered by Water-Insight Limited Warranty Agreement and software End User License Agreement, respectively.

Please refer to the Water-Insight Limited Product Warranty Agreement, which may be downloaded from the Water-Insight website: www.waterinsight.co.nz

Water-Insight Limited does not warrant the suitability of this product for any particular application as the conditions in which it is used are beyond our control. This is not withstanding warranty of merchantability.

Additional Information and Support

If you have problems try the following:

- Visit the Water-Insight web site for application notes and guides
- Refer to the troubleshooting section if one is present in this document
- Contact the support desk at support@waterinsight.co.nz
- Phone the support desk, contact details at beginning of this document