Tonick Watering Ltd

Operating instructions and
MODBUS Protocol Specification for
IRRInet-ACE 2Wire

ModBus commanded, dual 2wire decoder Signalling module

Version # 6.1

Date 07/02/2018

Revision History:-

1 First cut. Now obsolete

2 Revised control strategy

3.0 Remove use of coils, use holding registers. 2 lines on 1 interface

3.1 Add LEDs register, AA55H register, clarify Signaling in Process bit operation. Slave address selection, 1 or 2. Fun. 17 content brought in line with Modicon.

3.2 Add Line 1 & 2 AC present into status register 40-001

3.3 Add 'Can't Implement Signaling', separate flags for line 1 and 2 in bits 14, 15 of register 40-001

3.4 Modbus serial spec changed from 1 stop bit to 2

3.5 Fn 17, CRC byte order swap & on/off byte changed. Fn 11 explained in more detail. Comms 0V connection redefined.

3.6 removal of 1.5 character periods timeout in Modbus spec. 3.5 character periods increased to 4.

4.0 Merge with Tonick decoder data

4.1 company address change

5.0 Incorporation of Senders. Reboot on no comms. Signalling WM now double commands. Revised turn off, if fail turn on. Software and decoder version reported in Fn. 17 Provision for DIAS-C Decoder In A solenoid. 16 valves active, each line.

5.1 Register 40-006 now reports software version x 10 in top byte, decoder type in bottom byte. Forced reboot if 40-006 is written to $0B77. Bug fix to enable operation with only AC feed to one line. Loss of AC to one line discussed. Software now V2.1

6.0 MK3 Signalling introduced. Customer numbers embedded in the protocol. When used, only MK3 decoders and DIAS with the same customer number will respond to on/off commands. 40-006 now embeds the customer number in its data

6.1 Minor typos corrected. Refers to Tonick decoders throughout

GENERAL

This document draws on information contained in the following Modicon Documents: -

- *MODBUS over Serial Line – Specification and Implementation Guide V1.02 Dec 20 2006*
- *Modicon Modbus Protocol Reference Guide* ***PI-MBUS-300 Rev.J***

The master controller is an IRRInet-ACE. The interface card fits into the ACE rack. Up to 2 interface cards with slave addresses 1 and 2 may be used in one ACE. Communication will be RS485 MODBUS RTU binary.

ModBus is a protocol developed for use on PLCs, and much of the terminology in the Modicon documents assumes a certain understanding of PLCs.

HARDWARE

The communication hardware specification for IRRINET-ACE 2WIRE is fixed at RS485 9600 Baud 1 Start, 8 Data, No parity, 2 Stop bits. The port is isolated to 3000V from the 2 wire paths and is +-80V fault tolerant on A and B. It will also withstand up to 15kV discharge from both direct and human body models. The isolation is intended to resolve lightning strike issues on the 2 wire paths, so protecting the IRRINET-ACE.

IRRINET-ACE 2WIRE resolves a query complete by 4 character periods, or 750uS (whichever is the greater for the baud rate) of line idle. IRRINET-ACE 2WIRE does NOT respond to any message that times-out. A break of 4 characters / 750uS initiates the interpretation of the query received. The ACE therefore needs to be sure that commands are sent as single bursts of characters with no significant inter-character breaks or delays.

IRRINET-ACE 2WIRE supports a maximum of 127 Tonick 2 wire TW/2W decoders, MK3 decoders and Decoder In A solenoid (DIAS) on each of its 2 wire path lines. This is a total of 254 decoder stations per interface.

IRRINET-ACE 2WIRE supports a maximum of 15 sensor decoders on each of its 2 wire path lines. These can be a mix of soil moisture, flow, pressure and digital inputs.

IRRINET-ACE 2WIRE hardware will drop the relevant line if a current greater than approx 1 .6A is detected for more that 5 seconds. This event sets error codes in the 16 bit Signalling status register 001 accessed with function code 3. An algorithm in the firmware attempts to make a decision about whether a line current fault can be attributed to a particular decoder. If it can, an error will be recorded for that decoder. Note: A short-circuit detection may not be triggered if there is significant line resistance between the controller and the short-circuit.

The Earth Stake terminal (EST) MUST be connected to a properly bedded earth stake or plate via a $4mm^2$ (#11 AWG) or larger earth wire. This earth system is not to be regarded as an electrical safety earth. Connection of the EST to a building and/or an electrical earth is NOT permitted. If it was, a lightning strike on the field cable would be conducted into the building and/or its electrical installation.

Wiring

IRRINET-ACE 2WIRE should be wired as follows for each of its 2 lines.

AC1 and **AC1** terminals should be wired to its transformer or inverter supply. Please note a separate transformer or inverter for each line can be supplied with the interface.
FL1 is the Field Cable 1 'Live' terminal (referred to as the 'line')
FN1 is the Field Cable 1 'Neutral' terminal

EST1 (Earth Stake Terminal) must be connected to the earth stake (see above for recommendations) EST1 and EST2 can be connected together to just 1 earth stake or plate

AC2 and **AC2** terminals should be wired to its transformer or inverter supply.
FL2 is the Field Cable 2 'Live' terminal (referred to as the 'line')
FN2 is the Field Cable 2 'Neutral' terminal
EST2 (Earth Stake Terminal) must be connected to the earth stake (see above for recommendations) EST1 and EST2 can be connected together to just 1 earth stake or plate

Modbus Terminals

A (D0), B (D1) are half duplex RS485 signals. **B** is more positive than **A** during line idle conditions

COM is the ground of the RS485 circuitry, and must be connected to the RS485 0V of the ACE. The 0V of the interface's comms is within +/- 1.5V of the 0V of the Irrinet ACE PSU Auxiliary Output 1B

13.8VDC (ACE Supplied) Power

Auxiliary Output 1B. This supplies the IRRINET-ACE 2WIRE CPU and RS485. Max 250mA taken.

SOFTWARE

The IRRINET-ACE 2WIRE MODBUS protocol is implemented using RTU transmission mode (Binary). Message framing is achieved by line idle duration as described above. Please refer to the Modicon documents mentioned above if a fuller understanding of ModBus and its implementation on serial lines is required.

The IRRINET-ACE 2WIRE MODBUS implementation embraces the MODBUS function numbers such that decoder stations are accessed as bits in holding registers 8-23 called DESIRED and corresponding STATUS (Actual) in the same bits in holding registers 24-39, whilst data values (such as line sensitivity) are accessed in holding registers 1-7.

In general, slave specific Comms counts and errors counts are recorded, but IRRINET-ACE 2WIRE does not record successful message counts for the bus as a whole. Available counts are available on FUN 11; these counts are reset to zero at power-up.

ModBus standard decrees that register number 1 is transmitted within a ModBus messages as address 0000. The addresses discussed below are the addresses that would appear in the master program. The numbers that are transmitted within messages will be one less.

Each decoder address/station is controlled by a DESIRED bit in a holding register and a STATUS bit in another holding register. An error flag can be generated by software in the ACE, if after a Signalling has finished, the DESIRED and STATUS differ.

B Read- fn 03. Preset- fn 16 C Read- fn 03. Preset- fn 16

address	Desired	address	Status (Actual)
40-008	outputs 1-16 line1	40-024	Status 1-16 line 1
40-009	outputs 17-32 line 1	40-025	Status 17-32 line 1
40-010	outputs 33-48 line 1	40-026	Status 33-48 line 1
40-011	outputs 49-64 line 1	40-027	Status 49-64 line 1
40-012	outputs 65-80 line 1	40-028	Status 65-80 line 1
40-013	outputs 81-96 line 1	40-029	Status 81-96 line 1
40-014	outputs 97-112 line 1	40-030	Status 97-112 line 1
40-015	outputs 113-127 line 1	40-031	Status 113-127 line 1
40-016	outputs 1-16 line 2	40-032	Status 1-16 line 2
40-017	outputs 17-32 line 2	40-033	Status 17-32 line 2
40-018	outputs 33-48 line 2	40-034	Status 33-48 line 2
40-019	outputs 49-64 line 2	40-035	Status 49-64 line 2
40-020	outputs 65-80 line 2	40-036	Status 65-80 line 2
40-021	outputs 81-96 line 2	40-037	Status 81-96 line 2
40-022	outputs 97-112 line 2	40-038	Status 97-112 line 2
40-023	outputs 113-127 line 2	40-039	Status 113-127 line 2

For example: Turn on decoder 10 in line 2
Set bit #9 in 'desired' holding register 40-016 (decoder 1 is in bit #0)
Wait about 1 second
Poll Holding Register 40-001. Test bit 0. If zero, Signalling is finished.
OR…Poll using Fn 11. When status is 0000, Signalling is finished, otherwise it is HEX FFFF
Test bit #9 in 'status' Holding Register 40-032
Desired & Status (actual) should be the same; if not, a failure.

A	Read- fn 03. Preset- fn 16	(40-001)	Interface Status
address	**description**	**bit#**	**description**
		0	1 = Signalling in process
40-001	Interface Status	1	Line 1 has high current
40-002	Switching current change threshold lower (50mA)	2	Line 2 has high current
40-003	Switching current change threshold upper (600mA)	3	Line 1 fuse has tripped (resettable)
40-004	Total 2 wire line 1 current (mA, resolution +/-5mA)	4	Line 2 fuse has tripped (resettable)
40-005	Total 2 wire line 2 current (mA, resolution +/-5mA)	5	Line 1 on (1), line off (0)
40-006	Top byte= software ver. X 10, bottom = decoder type & Customer number code	6	Line 2 on (1), line off (0)
40-007	Front panel LED values	7	
		8	Line 1 AC present
D	**SENDER DECODERS. Flow/Pressure/Moisture**	9	Line 2 AC present
40-040	Sender address (1-15) for line 1	10	
40-041	Sender data for line 1	11	
40-042	Sender address (1-15) for line 2	12	
40-043	Sender data for line 2	13	
		14	Can't Implement Signaling, Line 1
		15	Can't Implement Signaling, Line 2

To switch up to 3-4 conventional decoders per interface....or up to 16 DIAS-C 2-way or 10 DIAS-C 3way Write multiple holding registers 008-023, Bank B, with function 16 with bits set accordingly (up to 8 changes per line at one time)

- Poll register 001, bit 0, Bank A, with function 3 until bit 0 is zero, i.e. Signalling finished. Allow about 1 second per decoder operation. Attempts to re-write while Signalling in process will be blocked and a MODBUS exception response 06 returned.
- OR… poll using Fn 11. When status is 0000, Signalling is finished, otherwise it is HEX FFFF
- Make sure line has not overloaded by checking bits 1-4 in register 40-001
- Read multiple holding registers 024-039 with function 3. Compare like bits in Banks B & C. If different, an error has occurred
    - Output 1, status 0... fail to turn on
    - Output 0, status 0...fail to turn off (but interface has done it using an emergency off). 'Can't implement Signalling' bit set
    - Output 1, status 1...successful on
    - Output 0, status 0...successful off
- Reading status registers whilst Signaling in Process is set, may give erroneous results, but will not generate a MODBUS exception code.
- If fail to turn off, 'Can't Implement Signaling' will be set on the relevant line
- If fail to turn on, reset its DESIRED (output) bit back to 0 with function 16 to clear the fault indication

The relevant line (2 wire path) will be turned on automatically with the first decoder on and left on until manually turned off by writing the relevant bit 5 or 6 of register 001 to zero.

Line 1 can be turned on in the absence of any on decoders by writing bit 5 of register 001 to one. Line 2 can be turned on in the absence of any on decoders by writing bit 6 of register 001 to one. Either of these operations will need a read/modify/write to avoid changing other bits.

Turning the line on without operating any decoders is very helpful for doing faultfinding on the relevant 2 wire path.

Turning the relevant line off will reset all its associated bits in Banks B & C to zero.

To maintain compatibility with future developments of IRRINET-ACE 2WIRE, the user should NOT read or write to locations that are not currently implemented.

Remember that ‘Signaling in Process’ must be polled (and seen to be clear) before examining the corresponding STATUS (Actual) bit.

IRRINET-ACE 2WIRE automatically turns the relevant line on if decoders are desired on and left on until manually turned off by writing bit 5 or 6 of register 001 to zero. Set/reset of Bit 5 in Holding Register 001 will force the line 1 on and off, or set/reset of Bit 6 in Holding Register 001 will force the line 2 on and off, but only until the reception of the next message that alters the DESIRED bits (even if nothing is changed).

Decoders are switched one at a time in roughly 1 second intervals. Decoders will be switched on in the order biggest address…smallest address. e.g. Decoders 1, 3, 5, 99, will be turned on:- 99, then 5, then 3 then 1. If both lines are commanded simultaneously, line 1 will switch all first, then line 2.

Successful operation of a decoder station is determined by the measured change in line current as a result of the attempt at switching. The values for determining a correct change in current can be inspected and set in registers 002 and 003, accessed through functions 03 and 16. As shipped, the unit expects a minimum change of 50mA and a maximum change of 600mA. These values are adequate for normal decoder applications. For DIAS-C 2-Way solenoids, this must be set by the ACE to 20mA.

IRRINET-ACE 2WIRE continuously monitors line current, and will turn off the relevant line, if a current above the maximum of 1.6A is measured for more than about 5 seconds. The capability of IRRINET-ACE 2WIRE to supply current is determined by an external transformer or AC inverter. The transformer recommended is 26VAC, 34VA and the inverter 32VAC 60Hz. Each line must be powered by its own power supply. There is no galvanic connection between lines 1 and 2, apart from sharing the same earth stake which shunts lightning currents to ground

Note. Short Circuits on the line that are many ohms (cable length) away from IRRINET-ACE 2WIRE may not trigger this action, and in the event of extreme field cable lengths, may not even trigger an overload. The overload event can be polled via the status register, and also sets the ‘Line Faults’ red LED.

Failed Stations
The LED (D9) will flash blue then red, if the last station attempted is a fail. If a cluster of stations is operated using Fn. 07, write register, a failed within the cluster may not illuminate the red LED. However the bit pattern in the DESIRED register will differ from its corresponding in ACTUAL.

Normal On and off Commands:

Measure line current
Send on or off command
Measure line current again
Subtract the difference in currents
If difference is greater than low threshold, in register 001, signal a successful on or off

Only one 'on' try will be attempted before a 'fail turn on’ is returned. HOWEVER an 'off 'command will be automatically sent to the failed decoder in case it did actually turn on, but the increase in current was insufficient.

Decoder Off strategy:

1. Send a normal ‘off’ command
2. If no response, measure current on line and save value. Send a 3 cycle gap which will turn off all listening decoders. Then turn back on any remaining decoders in the group. Again measure current on line. If 1 decoder less current, mark it as a successful ‘off’
3. If not 1 decoder less current. Turn off line power for 3 seconds, re-energise line, wait 3 seconds, turn on any remaining decoders in the group. Flag a ‘fail off’ for that decoder.

THE IRRINET WILL NEVER LEAVE A DECODER RUNNING even if it logs a 'fail-turn-off.

Sensor Decoders
There can be up to 15 sensor decoders in addition to the 127 valve decoders. These are separately addressed as 1-15, but do not interfere with decoders 1-15

There are currently 9 types.

1. Volumetric soil Moisture Content (VMC), returning 0-55% in 1% increments
2. Contact closure counting. Measuring up to 5 closures/second from volt-free contacts. Counting into 7 bits in a byte 0x00-0x7F, wrapping around. The top bit is the contact position. 1=closed, 0=open.
3. 8 digital inputs. Measuring 12-30V AC or DC on each input with respect to a common. A voltage present returns a 1 in the byte. Inputs are isolated up to 1KV from the 2wire path.
4. Gauge pressure, 0-10BAR using an IP68 custom sensor, G1/4 male thread
5. Gauge pressure -1Bar to +6Bar using an IP68 custom sensor, G1/4 male thread
6. Tank level 0-3m water
7. Well level, 0-30m
8. Differential pressure +/- 1Bar
9. Combo decoder Master Valve, Pressure, Flow

More details on these sensors are in the brochure 'Tonick Watering Sensor Decoders'

Accessing the Sensors
The interface to the sensor decoders is by two 16 bit holding registers for each line
40-040 Sensor address line 1
40-041 Sensor Trigger/results line 1
40-042 Sensor address line 2
40-043 Sensor Trigger/results line 2

To trigger a sensor read, Using command 16-write multiple holding registers

- Load Sensor address with a number between 1 and 15
- And load the trigger/results register with -1, 0xFFFF
- Wait up to 4 seconds
- The Modbus reply from the command 16 will be delayed by up to 2 +/- ½ seconds whilst the sensor decoder is actually being read. At the end of this time (or earlier if the read is finished) the Modbus reply will come back from the command 16. ENSURE THE CONTROLLER MODBUS TIMEOUT DELAY IS SET TO A SUITABLY LONG FIGURE. 4 seconds is suggested.
- Using command 03- read multiple holding registers: Read 40-041 or 043 for the result.
- As an alternative to polling 40-001, 40-024 and 40-025 may be read using 03- read multiple holding registers. When the data is ready, the register 40-025 will no longer contain -1 0xFFFF.

If a there is a response from the sensor decoder, the bottom 8 bits of 40-041 or 043 will be the sensor value returned and the top 8 bits will be set to 0x01 i.e. 0x01ss, where ss is 8 bits of sensor data.
If no response from the sensor decoder, all 16 bits will be 0x0000

The Modbus reply to command 16 will be delayed by up to 2-3seconds whilst the sensor decoder is actually being read. At the end of this time (or earlier if the read is finished) the Modbus reply will come back from command 16. ENSURE THE CONTROLLER MODUS TIMEOUT DELAY IS SET TO A SUITABLY LONG FIGURE

Do not try to write to the ModBus with any further command until the reply comes back from the sender.

Reboot on Comms Failure

Register 006 in Bank A contains BUILD-DATA This is put there at boot time.
Top byte holds the software version number x 10. E.g. Version 3.0 is held as 30 decimal = $1E in hex
Bottom byte holds the decoder type in the lower nibble and the customer number in the higher nibble

- 0 Underhill Landscape decoder, TK-DEC-1
- 1 Waterrmation Signalling-type decoder, TW/2W
- 2 Netafim AquativeAC+, motorized valve
- 3 DIAS, Decoder In A Solenoid (both 2-way and 3 way types)
- 4 MK3 decoder signalling. Applies to DIAS and MK3 hardware

e.g Customer $2 (MEAC), decoder type MK3&DIAS, software version 3.1
40-006 = $1F24

As long as BUILD-DATA is left alone in 40-006, the interface will continue to function without the communications being active.

Should the host controller change register 006 from BUILD-DATA, it will be necessary to keep the RS485 active within a 15 second interval. If no characters are received (whether addressed to the slave or not), the Irrinet Interface will reboot. This will clear down any active decoders and go back to listening for valid comms commands to that slave. During reboot, BUILD-DATA will again be written to register 006. Thus the reboot on comms failure will be disabled until the ACE again alters 006 to a value other than BUILD-DATA

Please note: this is not foolproof. Older RS485 transmitter ICs may load down the A/B lines when powered off, such that B will no longer be more positive than A. In this case, the interface will think it is receiving a continuous stream of 00H bytes and will not reboot. More modern RS485 ICs do not load down the A/B bus when un-powered. The user is urged to try this out to see what happens before relying on a reboot to protect other equipment. The interface has a small biasing network built-in, to keep B more positive than A by about 1/4V when not loaded down by anything else, or unconnected.

Reboot on Comms Command

If 40-006 is written by the host controller to the value $0B77 (hex), the interface will reboot within 2 seconds.
This will clear down any active decoders and go back to listening for valid comms commands to that slave. During reboot, BUILD-DATA will again be written to register 006. Thus the reboot on comms failure will be disabled until the ACE again alters 006 to a value other than BUILD-DATA. BUILD-DATA can never be compiled to the value $0B77

Loss of AC Power

The Interface will function with only one line powered up with an AC feed. Decoders demanded on an unpowered line will be ignored. Their values in DESIRED will not be actioned.

If both lines are powered up and power feed is lost to one line, the interface will stop communicating for 1-2 minutes, then reboot under watchdog action. If 40-006 had been set to another value than BUILD-DATA, the reboot will happen sooner, in about 16-20 seconds.

If AC power feed to one line is lost for a few seconds, the comms will halt, then re-start as soon as the AC power is restored. There will not be a re-boot and decoders on the powered line will be unchanged. Decoders on the line that lost its power will be off. It is up to the host controller to recover the previous decoder state.

With AC power feed absent from both lines, the Modbus will communicate and the Status register can be interrogated. Bits 8 and 9 will read zero, The green OK LED will be flashing, instead of steady. Normal operation will commence when one or both AC feeds become present.

LEDS:

The LEDs register 40-007 holds the following data which is mimicked on the front panel LEDS. 1 = LED on, 0 = LED off.

- Bit 0: DC Power OK — Green
- Bit 1: MODBUS frame being received — Yellow
- Bit 2: MODBUS frame being sent — Yellow
- Bit 3: MODBUS comms error — Red
- Bit 4: Line 1 AC present — Orange
- Bit 5: Line 1 decoder Signalling — Blue)
- Bit 6: Line 1 energized — Green) Tri-colour LED
- Bit 7: Line 1 Faults — Red)
- Bit 8: Line 2 AC present — Orange
- Bit 9: Line 2 decoder Signalling — Blue)
- Bit 10: Line 2 energised — Green) Tri-colour LED
- Bit 11: Line 2 Faults — Red)

Bits 6 & 7 or 10 & 11 may be on simultaneously. Bits 5 or 9 are only on during the transmission of a decoder on/off command.

Slave Address Selection:

A jumper link is used to select MODBUS slave 1 or 2. Fitting the link (marked J11 on the main PCB) will configure the interface to MODBUS address 1, removing it, to address 2. When using two interfaces in the same crate (basket), make sure each is set to a different MODBUS address.

Jumper link pairs J5 and J8 alter the polarity of decoder Signalling waveform on lines 1 and 2 respectively. Consult factory if these need to be changed.

Modbus Commands implemented on IRRINET-ACE 2WIRE are:-

01 Read Coil Status - not implemented.
02 Read i/p Status - not implemented
03 Read multiple (holding) Registers.
04 n/u
05 Force Single Coil - not implemented
06 n/u
07 n/u
08 Diagnostics (loopback)
09 n/u
10 n/u
11 Fetch Comms Event Counter – Returns busy status and a count of successful comms implementations
12 n/u
13 n/u
14 n/u
15 Force multiple coils – not implemented
16 Preset multiple (holding) registers.
17 Report Slave ID – Returns the decoder type and software Version number.
18 n/u
19 n/u
20 n/u
21 n/u

Functions outside of the range quoted above are not allowed.

Note:

Fun 17. Returns IRRINET-ACE 2WIRE information – slave ID, on/off, Serial Number, Decoder type, S/W Version.

Information is returned as: -
<ADD> <FUN> <COUNT> <Slave ID> <On/off> <Ser# Hi> <Ser# Lo> <Dec. type> <S/W Ver> <CRC Hi> <CRC Lo>
Where <slave ID> = 01, <On/off> = HEX FF = (always) on;

- Slave ID The slave address of the interface
- On/off. 0xFF if one or more lines are energised, 0x00 if both are off
- Serial# Hi & Lo. Not used
- Decoder type; 0=Landscape (UI), 1=TW/2W, 2=Aquative+AC, 3=DIAS-C, 4=MK3 signalling, DIAS or MK3 Hardware
- Software Version: times 10. E.g Version 3.0 will be reported as 30, 0x1E ($1E)

Fun. 11. Returns a status of $FFFF (hex) if the Signaling in Process bit is set.

Please refer to *Modicon Modbus Protocol Reference Guide* ***PI-MB US-300 Rev.J*** for details of these commands.

Specification. (This is a preliminary document, all specifications subject to possible change)

Supply Voltage 24 ~ 32 Vrms AC 50 or 60Hz. Transformer supplied: 26VAC 34VA 1300mA, either (a) 230VAC 50Hz input OR (b) 115VAC 60Hz input. Specified at ordering time. Alternatively the 32V AC 60Hz inverter may be used for DIAS-C
Supply Current Up to 1 .3A

Output Voltage 23 ~ 31 Vrms AC
Output Current up to 1 .2A max

Note: Full Line output voltage will be continuously applied to the solenoids connected to 'on' decoders in the Tonick TW/2W, MK3 and UI TK-DEC-1 families. Attention must be given to the specifications of these solenoids. DIAS-C 2-Way will hold at 30mA, DIAS-C 3-way will hold at 60mA

Line Signaling For each of the two lines: Up to 127 Tonick 2 Wire TW/2W or DIAS-C. Up to 16 active DIAS-C 2-way, 10 DIAS-C 3-way or 3-4 TW/2W or TK-DEC-1I decoders (Subject to total solenoid loads)

Approvals CE (European) marked and compliant
RoHS (European) compliant & lead free WEEE (European) Compliant (Exempt)

CPU 8 bit RISC. 8MIPs . 64K flash / 4K RAM / 4K EEPROM.

Firmware Re-writable application in general flash space. Uses Kanda Keyfob programmer.

Communications RS485 ModBus RTU mode. (+-80V fault, 15kV discharge) 9600 Baud, N,8,2 (Other formats on request)
Slave address 1.

Connections

IRRINET-ACE 2WIRE should be wired as follows for each line.

AC1 and **AC1** terminals should be wired to the transformer supply. Please note the transformer for each line is supplied with the interface.
FL1 is the Field Cable 1 'Live' terminal (referred to as the 'line')
FN1 is the Field Cable 1 'Neutral' terminal
EST1 (Earth Stake Terminal) must be connected to the earth stake (see above for recommendations) EST1 and EST2 can be connected together to just 1 earth stake or plate

AC2 and **AC2** terminals should be wired to the transformer or inverter supply.
FL2 is the Field Cable 2 'Live' terminal (referred to as the 'line')
FN2 is the Field Cable 2 'Neutral' terminal
EST2 (Earth Stake Terminal) must be connected to the earth stake (see above for recommendations) EST1 and EST2 can be connected together to just 1 earth stake or plate

Modbus Terminals
A (D0), B (D1) are half duplex RS485 signals. **B** is +ve and **A** is –ve during line idle conditions
COM is the ground of the RS485 circuitry, and must be connected to the RS485 0V of the ACE. The 0V of the interface's comms is within +/- 1.5V of the 0V of the Auxiliary Output 1B, (connected through a diode bridge)

13.8VDC (ACE Supplied) Power
Auxiliary Output 1B. This supplies the IRRINET-ACE 2WIRE CPU and RS485 circuits.
FL1, FN1, FL2, FN2 are optically isolated to 3KV from Auxiliary Output 1B

Environmental General

Storage 0 to 70 Degrees Centigrade
0% to 90 % humidity (non -condensing)

Operation +3 to +50 degrees centigrade
20 to 80 % humidity (non –condensing)

DATA ON THE TONICK DECODERS

TW/2W-1, TW/2W-2, TW/2W-3, TW/2W-4

Body Colour: White, red end caps, embossed “Tonick Watering”
Power Consumption: Typically 3mA at 26V RMS
Input Voltage Range: 19V RMS to 32V RMS, 50 or 60Hz, Sinusoidal. Other frequencies not allowed.
Solenoid Output: Full AC input voltage less 1V is continuously applied to the solenoid for the duration of the on-time. No DC or solenoid current reduction is used.
Max. Output: 500mA RMS steady-state per output. (Typically powers 2 solenoids).
1.2A max for all outputs combined (TW/2W-2/3/4)
Temperature Range: Operating: +5degC to +50degC at 500mA output. Max +60degC at 250mA output.
Storage: -10degC to +70degC
Signaling System: Modulation of AC waveform at AC zero crossing.
Input Power Distortion: Pure Sinewave. Avoid any distortion of waveform slope or perturbations at the AC zero crossing point or within +/- ¼ cycle from that point.
Decoder Address Range: 1 – 127 (Use a Tonick ‘Watermation/2W’ programmer)
Outputs in multiple decoders may be programmed to the same address, but will switch simultaneously.
Outputs in multiple decoders may be programmed to unrelated addresses.

Decoder-In-A-Solenoid (DIAS™)

Advanced Technology *(Patent Applied For)*

2Wire Decoder built-into a valve solenoid

Special Features

- **Combines a 2Wire Decoder and Solenoid into one product.**
- **Reduces number of field wire connections by 50%**
- **Multi-colored LED provides feedback — reduces troubleshooting time.**
- **Screws into most valves. (adapters for Hunter, Toro, Irritrol, Bermad & Rain Bird).**
- **Compatible with all Aquamonix & Tonick 2Wire Controllers and Converters.**
- **Superior distance and number of concurrent active stations.**
- **No grounding necessary along the 2Wire path.**
- **Built-in powerful protection from Lightning surges.**
- **Can re-use old wiring. Earth leakage on 2Wire well tolerated.**
- **‘Out of the box’, works as a normal 24VAC solenoid with ultra low current.**
- **Works with the Tonick Sensor decoder range; soil moisture, flow and pressure.**

DIAS Electrical Specifications:

- **19-32 VAC, 60 Hz preferred. (Low cost inverters available for 50Hz regions)**
- **In normal 24VAC solenoid mode, works equally with 50Hz and 60Hz.**
- **In-Rush Current – 300mA-350mA**
- **Holding Current - 30mA (2-way solenoid), - 60mA (3-way solenoid), both relatively independen t of applied AC voltage.**
- **Idle Current (typical) — 4.5mA**
- **Maximum Active Valves per 2Wire path:**
  - **2-way 16 (spread relatively equally along the path)**
  - **3-way 10 (spread relatively equally along the path)**
- **Valves Clustered together: (Low water pressure: ~3Bar)**
  - **2-Way**
    - **1000m 16**
    - **1500m 12**
    - **2000m 8**
  - **3-way**
    - **1000m 8**
    - **1500m 7**
    - **2000m 6**
- **Maximum operating distance 2-way: (Low water pressure: ~3Bar)**
  - **2.5mm^2 conductors 11,000m 35,750 feet (1 valve active)**
  - **AWG14 conductors 10,000m 32,500 feet (1 valve active)**
  - **4mm^2 conductors 22,000m 71,500 feet (1 valve active)**
- **Solenoid thread size:**
  - **¾" UNF20, front thread**
  - **1/8" BSP Female, 3-way back water port thread**
- **Adaptor for ¾" UNF20 to Hunter thread**
- **Adaptor for ¾" UNF20 to Rain Bird thread**

Test conditions for the above data:

- Plunger stroke 1.8mm
- Bottom port orifice size 1.8mm diameter
- 32VAC at 60Hz from the controller
- Distances need to be derated at higher water pressures
- Cluster numbers need to be derated at higher water pressures
- Each idle DIAS draws approximately 4.5mA. Large numbers of valves on the same 2-way path will lower the cluster limits and maximum distance of the furthest valve.
- DIAS will not reliably operate below 19VAC. Use Ohm's Law with long cable lengths;

Tonick Watering

Advanced Features:

- **The DIAS can be programmed from a low cost Portable Programmer.**
- **Program the corresponding station number into DIAS as part of initial controller setup and installatio n. Addresses 1-127.**
- **Connects to a 2Wire path with a single pair of wires directly to the solenoid.**
- **Ultra-low holding current allows more stations to be operated at one time.**
- **Program decoder's address to 0 to turn into a normal 24VAC solenoid.**
- **The DIAS comes standard with co-molded LED providing visual feedback:-**
    - **Green Colour — Decoder is "Ready" as a decoder**
    - **Orange Colour (Red & Green together) - Solenoid is "ON" as a decoder**
    - **Red Colour —Solenoid is "ON" as a normal 24VAC solenoid**
    - **No Colour— No Power, broken wire.**

3-Way Solenoid
(In decoder mode, standby. Green)

2-Way Solenoid
(In conventional solenoid mode, on. Red)

Tonick Watering

Further Information:

The DIAS will respond to both 1 - 63 and 1 - 127 addresses. Address 0 (out of the box), it will behave as a normal 24V AC solenoid. (See notes)

DIAS comes in two versions; a normal 2-way water port solenoid or a 3-way with a back water port for use in large val ves, as in Agriculture.

There is a radical improvement in performance over a conventional Tonick TW/2W or Underhill TK-DEC-1. With DIAS, ty pically 8 - 10 3-way solenoids can be active on one 2.5mm^2/14 AWG cable, or up to 16 2-way. Distances of many Km are possible.

Uses the same proven Tonick lightning protection that does not need earth stakes along the 2Wire path.

As with existing Tonick controllers, the system is tolerant of significant 2Wire cable leakage to earth. This means old ca bles may be re-used, or new ones can be of significantly lower cost. For instance, two individual PVC insulated, direct-b ury conductors may be laid side by side. Correspondingly, expensive wire joiners are unnecessary. Grease-filled wire n uts are quite adequate.

Due to careful design and miniaturization, the size of the DIAS is almost the same as many conventional solenoids.

DIAS may be used with the **Tonick Sensor decoder range** of soil moisture, flow, pressure and digital input.

To use DIAS, a valve should be purchased without a solenoid, or the existing solenoid removed and re-used in other pr ojects. Thread adaptors are available for Rain Bird, Toro, Irritrol and Hunter valves. The DIAS has a 3/4" UNF thread w hich fits almost all other valves. The DIAS just screws in like a normal solenoid. Gone are the two other waterproof co nnections from decoder to solenoid, together with the concern of DC electrolytic destruction of the wires if the joints are not perfect.

Software upgrades are available for the Tonick Programmer/Tester (TW-2W-P/T), the BT2 (OEM decoder interface) in al l its variants, the TW-3, Sapien, RM-2 Internet based controller and NOVO multi-wire to 2Wire converter.

Tonick Watering

Notes:

- It is not possible to mix conventional Tonick TW/2W or Underhill TK-DEC-1 decoders with DIAS; it must be all one or the other.
- MK3 decoders may be mixed with DIAS
- Sensor decoder range may be mixed with DIAS
- DIAS is best run at 60Hz to achieve full performance.
- A useful range of low cost inverters are available for 50Hz areas. One of these would replace the transformer that normally accompanies the controller. Versions of inverters include 12VDC input, 24VDC input and Universal line power input 90-265VAC.
- Use of an inverter will remove the occasional instance of poor controller performance on site, due to noisy and distorted incoming 115V/230V line power.
- It is not possible to combine a DIAS electronic circuit with a 3rd party solenoid.
- De-rating the BT2 at ambient temperatures greater then +50degC will be less likely required, as currents with typically 8 DIAS on together are well within its +70degC range
- When working as a normal 24VAC solenoid (address 0), the DIAS cannot be used with many 3rd party irrigation decoders. In this mode the DIAS is designed to work with multi-wire systems that feed 24VAC to irrigation solenoids.

Connecting To Solenoids That Are Commoned.

The Tonick TW/2W-1, single output decoder has a pair of yellow wires for the solenoid output. When installed adjacent to the solenoid, each wire of the decoder output is connected to each wire of the solenoid; the polarity is unimportant.

However, if two or more solenoids are connected through multi-core cable, where one side of each solenoid is connected to a common return, then the polarity of the decoder connection to the multi-core is very important.

In each Tonick decoder, there is an electronic switch in just one solenoid output lead, whilst the other solenoid lead is connected directly to the red wire of the decoder's power leads. This solenoid output MUST be connected to the solenoid common in the multi-core cable.

To identify the common in the decoder, use one or other of the following methods:

For a single output decoder, TW/2W-1, place one side of a multi-meter on the red the decoder power lead. Using the Ohms range, look for a low resistance (2 Ohms or less) between this and first one, then the other of the decoder's yellow solenoid outputs. The solenoid output lead with the low resistance connection is the 'common'.

The common solenoid lead, so identified, should be marked and wired to the multi-core wire that is connected to the solenoid commons. Usual practice is to tie a knot in the wire.

The multiple output decoders TW/2W-2, TW/2W-3, TW/2W-4, have a brown common wire, which is connected internally to the red lead. When connecting to solenoids, connect one side of each solenoid to the brown lead and the other to the coloured output wire.

Any unused decoder output leads must be protected from contact with water or the ground and may NOT be connected together.

Decoder Datecodes.

Tonick decoders are date-coded with one capital letter and one or two numbers. This is engraved into the plastic case near one end cap. It can be interpreted as follows.
A stands for January, February or March.
B stands for April, May or June.
C stands for July, August or September.
D stands for October, November or December.

The number in the date-code pair is the last number of the year.
e.g. **A11** was made in January, February or March 2011

Lightning Warranty.

Tonick provides an exchange replacement decoder in the event that any are destroyed by lightning during the warranty period. (At the time of writing, the warranty period is 5 years). This warranty is confined to the exchange of like-for-like and does not include removal and refitting of the replacement.

To avoid unnecessary delay in receiving replacements, Tonick will send out new decoders before receipt of the damaged ones. However, when reporting the loss, a Returns Authorisation Number (R.A.N.) must be obtained from Tonick Sales (+44 1346 531193). The damaged decoders then should be returned, clearly identified with that R.A.N., before 60 days have elapsed. If not, after that time, an invoice will be raised for the full value of the decoders and their carriage.

Tonick reserves the right to refuse returned decoders that do not have a valid R.A.N.

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