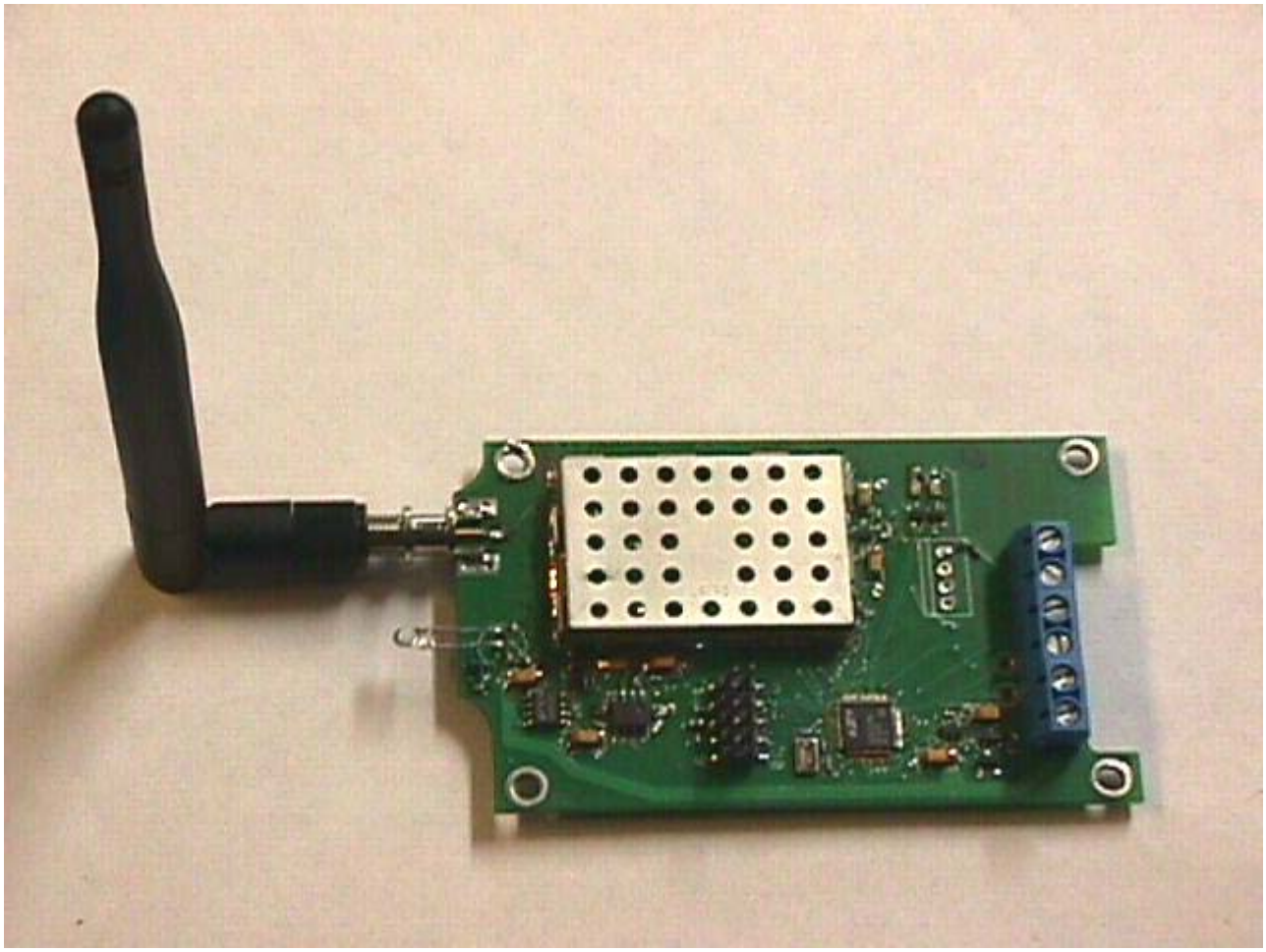
ATTACHMENT E (MANUAL)

Operations Manual

Wireless Data Acquisition Network
Wireless Data Acquisition Module
prTOS® Operating System



1 REVISION 1.0

2 JULY 31, 2006

IWS
Integrated Wireless Solutions

Preface

This document describes the operation of Integrated Wireless Solutions' (IWS) Wireless Data Acquisition Network (WDAN) using IWS's 2.4 ghz. Wireless Data Acquisition Modules (WDAM) and the proprietary prTOS® real-time OS, a pre-emptive, round-robin, multi-tasking operating system.

WDAN is a wireless, synchronous/asynchronous, self-healing, configurable, scaleable, point-to-multipoint RS-232 SCADA solution.

Wireless
: 2.4 ghz. radio communication between nodes using WDAP wireless data protocol.

Synchronous/Asynchronous
: Scheduled synchronous communication between drain and nodes with asynchronous alarm notification.

Self-healing
: Dropped/interrupted links dynamically establish new communication channels where possible.

Configurable
: Dynamic configurability for node-drain links, node identification, sleep and alarm intervals and setpoints.

Scaleable
: Cell support for 1 to 65535 nodes with no performance impact.

Point-to-multipoint
: A centralized drain module functions as a gateway between Wireless Data Acquisition Modules (nodes) and a Network Operations Control center (NOC). Any node that can be reached by a centralized "drain" module belongs to a cell. A Drain "harvest's" data from a cell.

Integrated Wireless Solutions (IWS) is committed to providing prompt and courteous technical support. If you cannot find the answer to your problem in this Operations Manual, our technical support staff is glad to assist you.

Describe your question or problem in detail. If you have a problem with the firmware, report what you did (the steps or procedures you followed) leading up to the problem. Also report your hardware configuration and the exact error message, if one appeared.

Send your question or problem to one of the following:

2.1.1.1.1 E-mail:
proper@cs.byu.edu
pbunker@qwest.net

2.1.1.1.2 Fax:

Introduction

The IWS Wireless Data Acquisition Module (WDAM) is a wireless datagram transport device designed for harvesting data from a Wireless Data Acquisition Network (WDAN) cell on a configurable, periodic basis. In addition, alarm set points may also trigger a pre-mature communication from a sensor node.

Each node participating in a WDAN cell is uniquely addressable and configurable. A Wireless Data Acquisition Protocol (WDAP) encapsulates WDAN datagrams for communication between product radios.

- Each node within a WDAN cell has a 16-bit unique address.
- Cell entry and exit points are via WDAM node RS232 UART.
- Individual WDAP Packet datagram payloads of up to 63 bytes.
- Redundant communication transmission frequencies are used for packet transport.
- Self-healing algorithms allow a WDAM to recover from "dropped" node to drain communication.
- Error recovery involves timeouts and packet sequence numbering. Data integrity is preserved by the use of cyclic redundancy checks (CRC), redundancy, and acknowledgement protocols.
- Rugged construction and ability to withstand extremes of temperature and humidity – waterproof and corrosion resistant.
- Secure, self-contained power supply - up and working 24/7.
- Nonvolatile memory (NVRAM) for storing software and/or firmware. NVRAM retains data even when power is lost. New firmware can be wirelessly downloaded to NVRAM storage, so you can keep capabilities up to date without excessive site visits.
- Intelligent control built in – sophisticated SCADA remotes can control local systems by themselves according to programmed responses to sensor inputs.
- Real-time clock for accurate date/time stamping of reports.
- Watchdog timer to ensure restarts after a power disturbance.
- Support for 256 node, industry standard MODBUS protocol plus advanced configuration and command communication with 65000 cell nodes using IWS's proprietary interface protocol.
- Ample capacity to support the equipment at your site … but not more capacity than you actually will use while supporting your expected growth over a reasonable period of time.

System Overview

A WDAN cell consists of one drain and up to 65535 WDAM nodes. The drain module is continually polling all the nodes in the cell in a cyclic, cardinal manner, one every 200 ms. Thus, an attempt is made by the drain to contact every possible node in a cell within a maximum time of every four hours (65535 nodes * 200 ms * (1 sec/1000 ms) * (1 min/60 sec) * (1 hr/ 60 min) = 3.6 hrs). Should a node require immediate attention, the drain multi-casts an any-node response every two seconds.

Figure 1 is an example SCADA water monitoring installation using IWS's WDAN technology.

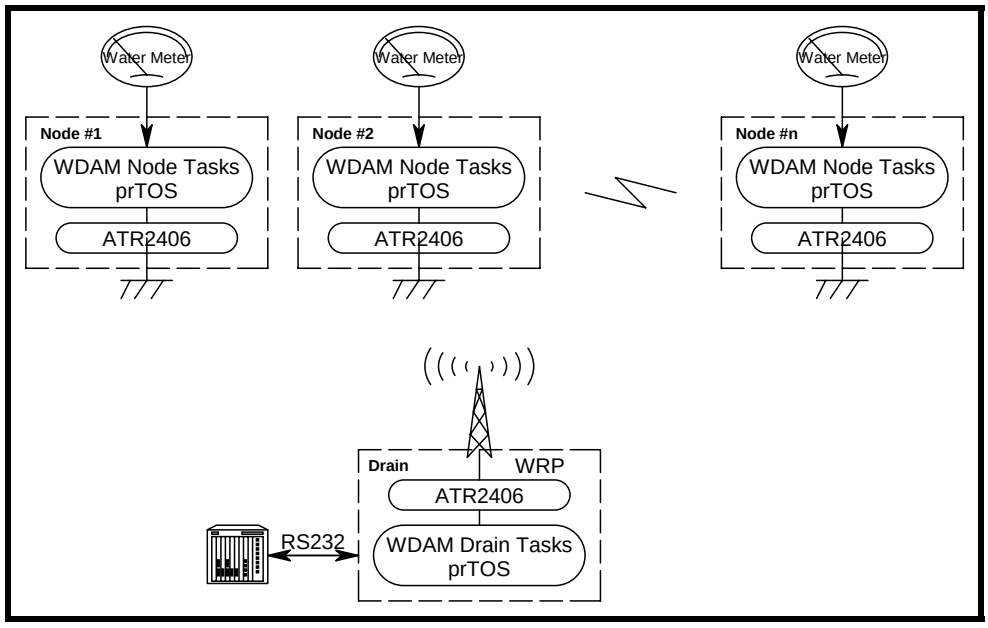


Figure 1. Example IWS WDAN Cell.

Each node in the IWS Wireless Data Acquisition Network consists of a 8051F340 based Wireless Data Acquisition Module (WDAM), an RS232 UART interface (optional), two level-triggered sensor inputs, a battery, and a radio antenna. A WDAM node receives datagrams from a centralized WDAN drain on a configurable, periodic basis and responds when interrogated for the requested information.

A WDAN drain module continuously attempts to contact all nodes in its cell in a cyclic, cardinal (ordered) manner. A WDAM node communicates with a drain module during it's time interval (as determined by the destination field of a WDAN packet). When the drain receives a response from a node, the information is communicated back to a NOC facility via its RS232 interface using Serial Data Acquisition Protocol (SDSP) or Mod-bus protocol. Any pro-active communication from the NOC, such as data alarm set-points, is included in the periodic communication with a node.

All nodes in a WDAN cell begin operating in a "roving listen" mode within a frequency band. When a discernable communication from a drain is received, the node will use that frequency for further communications. If the communication link is dropped, for whatever reason, the node reverts to the "roving listen" mode.

After a communication link has been established between a drain and a node, the node "goes to sleep" for a preset period (from 1 to 65535 minutes or 45.5 days - usually set at 24 hours). In this deep sleep mode, the WDAM node disables the radio and all power consuming devices as well as slows the internal processor clock to its lowest power consumption mode. External inputs from the attached sensor devices are still processed.

When the deep sleep mode period expires (or a set-point alarm occurs), the WDAM node comes awake by powering up the radio and the processor. The WDAM node listens for any communication from the drain. The drain is continually attempting to contact all nodes in a cardinal manner and as such, a nodes waits for its turn to communicate with the drain or uses the any-node poll in an alarm situation. (Using this knowledge, the node may decide to power down again for a short period and come back awake just before the drain's anticipated attempt to contact the node.)

When the node receives its intended communication from the drain, the encapsulated information is processed and a reply message is created. The received information could include just a request for its sensor data or other information such as alarm set-points or an adjusted sleep period. In any event, the drain listens after every attempt to communication with a node and thus the node has time to send its requested information back to the drain. After the transmission is complete, the node again enters a deep sleep period.

Drain Module Interface Protocol

NOC Command	NOC Response	Description	Drain tx →	← Node Reply
A[1]	**A0**=<*value*> **A1**=<*value*> **A2**=<*value*> **A3**=<*value*>	Alarm data port 0 Alarm data port 1 Alarm data port 2 Alarm data port 3		← **A0**=<*value*> ← **A1**=<*value*> ← **A2**=<*value*> ← **A3**=<*value*>
B<*node*> **B**<*node*>=<*value*>		Start BERT Set BERT period (ds)	**B**<*data*> →	← **B**<*data*>
C=<*interval*>	**C**<*interval*>	Sync sleep period (ds)	**C**<*interval*> →	← **C**<*interval*>
D{=<*level*>}		Set debug level		
E<*node*>**;0** **E**<*node*>**;1**	**E0**=<*value*> **E1**=<*value*>	Read node crc errors Read node TO errors	**E0** → **E1** →	← **E0**=<*value*> ← **E1**=<*value*>
F{=<*0-9*>}	***F**=<*0-9*>[3]	Set Drain frequency (0-9)		
G{=<*node*>}	***G**=<*node*>[3]	Set end poll address		
H		Help		
I<*node*>**;0**=<*interval*> **I**<*node*>**;1**=<*interval*> **I**<*node*>**;2**=<*interval*> **I**<*node*>**;3**=<*interval*>	***I0**=<*interval*>[3] ***I1**=<*interval*>[3] ***I2**=<*interval*>[3] ***I3**=<*interval*>[3]	Set dp0 alarm interval (s) Set dp1 alarm interval (s) Set dp2 alarm interval (s) Set dp3 alarm interval (s)	**I0**=<*interval*>→ **I1**=<*interval*>→ **I2**=<*interval*>→ **I3**=<*interval*>→	← **I0** ← **I1** ← **I2** ← **I3**
J0 **J1**{=<*1-15*>} **J2**{=<*retries*>} **J3**{=<*interval*>} **J4**{=<*interval*>}	***J0**={TBD}[3] ***J1**=<*1-15*>[3] ***J2**=<*retries*>[3] ***J3**=<*interval*>[3] ***J4**=<*interval*>[3]	Read Drain parameters Read/Set poll data port enable Read/Set Tx retries Read/Set "new node" interval Read/Set "911" interval		
K{=<*node*>}	***K**=<*node*>	Read/Set next node address	**K**<*node*> →	← **K**
L<*node*>**;0**=<*limit*> **L**<*node*>**;1**=<*limit*> **L**<*node*>**;2**=<*limit*> **L**<*node*>**;3**=<*limit*>	***L0**=<*limit*>[3] ***L1**=<*limit*>[3] ***L2**=<*limit*>[3] ***L3**=<*limit*>[3]	Set dp0 alarm limit Set dp1 alarm limit Set dp2 alarm limit Set dp3 alarm limit	**L0**=<*limit*>→ **L1**=<*limit*>→ **L2**=<*limit*>→ **L3**=<*limit*>→	← **L0** ← **L1** ← **L2** ← **L3**
M{=<*mode*>}	***M**=<*mode*>	Read/Set Drain mode		
N<*node*>**;0**=<*interval*> **N**<*node*>**;1**=<*interval*> **N**<*node*>**;2**=<*interval*>	***N0**=<*interval*>[3] ***N1**=<*interval*>[3] ***N2**=<*interval*>[3]	Set sleep interval (ds) Set alarm sleep interval (ds) Set acquire sleep interval (ds)	**N0**=<*interval*> → **N1**=<*interval*> → **N2**=<*interval*> →	← **N0** ← **N1** ← **N2**
O[1]		Suspend sleep 1 cycle	**O** →	← **O**
P<*node*>**;0**[1] **P**<*node*>**;1**[1] **P**<*node*>**;2**[1] **P**<*node*>**;3**[1] **P**<*node*>**;0**=<*value*> **P**<*node*>**;1**=<*value*> **P**<*node*>**;2**=<*value*>	**P0**=<*value*> **P1**=<*value*> **P2**=<*value*> **P3**=<*value*>	Read data port 0 Read data port 1 Read data port 2 Read data port 3 Set data port 0 Set data port 1 Set data port 2 Set data port 3	**P0** → **P1** → **P2** → **P3** → **P0**=<*value*> → **P1**=<*value*> → **P2**=<*value*> →	← **P0**=<*value*> ← **P1**=<*value*> ← **P2**=<*value*> ← **P3**=<*value*> ← **P0** ← **P1** ← **P2**

P<*node*>**;3=**<*value*>			**P3=**<*value*> →	← **P3**
Q[1]			**Q** →	← **Q**
	R0=<*serial#*>		**R0** →	←
	R1=<*version*>		**R1** →	**R0=**<*serial#*>
R<*node*>**;0**		Read node serial number		←
R<*node*>**;1**		Read node firmware version		**R1=**<*version*>

[1]Not a valid command from the NOC, [2]Not included in Rev 1.1, [3]Debug level greater than 0 or read.

Figure 2. WDAN 1.0 Drain/NOC interface protocol.

A - Node Alarm

Description: Reported to NOC during normal cycle or multi-cast "911" query. Indicates that the data port value accumulated during the alarm interval has exceeded the alarm limit.

NOC Command: Not available
NOC Response: **A0=**<*value*>
A1=<*value*>
A2=<*value*>
A3=<*value*>
Drain tx: Not available
Node Reply: ← **A0=**<*value*>
← **A1=**<*value*>
← **A2=**<*value*>
← **A3=**<*value*>

B – Bit-Error-Rate-Test (BERT)

Description: Bit error rate test.

NOC Command: **B**<*node*>
B<*node*>**=**<*value*>
NOC Response:
Drain tx: **B**<*data*> →
Node Reply: ← **B**<*data*>

C – Sync Sleep Period

Description: Synchronize cell sleep periods. Evaluated in deci-seconds.

NOC Command: **C=**<*interval*>
NOC Response: **C**<*interval*>
Drain tx: **C**<*interval*> →
Node Reply: ← **C**<*interval*>

D – Set Debug Level

Description: Set debug level.

NOC Command: **D**{=<*level*>}
NOC Response: None.
Drain tx: None.
Node Reply: None.

E – Read Node Errors

Description: Read node errors.

NOC Command: **E**<*node*>**;0**
E<*node*>**;1**
NOC Response: **E0=**<*value*>
E1=<*value*>
Drain tx: **E0** →
E1 →
Node Reply: ← **E0=**<*value*>
← **E1=**<*value*>

F – Set Drain Frequency

Description: Set drain frequency (0-9).

NOC Command: **F**{=<*0-9*>}
NOC Response: ***F=**<*0-9*>[3]
Drain tx: None.
Node Reply: None.

G – Set End Poll Address

Description: Set end poll address.

NOC Command: **G**{=<*node*>}
NOC Response: ***G=**<*node*>[3]
Drain tx: None.
Node Reply: None.

H – Help

Description: Help.

NOC Command: **H**
NOC Response: <*help info*>
Drain tx: None.

Node Reply: None.

I – Set Port Alarm Interval

Description: Set port alarm interval (in seconds).

NOC Command: **I**<*node*>**;0=**<*interval*>
I<*node*>**;1=**<*interval*>
I<*node*>**;2=**<*interval*>
I<*node*>**;3=**<*interval*>

NOC Response: ***I0=**<*interval*>[3]
***I1=**<*interval*>[3]
***I2=**<*interval*>[3]
***I3=**<*interval*>[3]

Drain tx: **I0=**<*interval*>→
I1=<*interval*>→
I2=<*interval*>→
I3=<*interval*>→

Node Reply: ← **I0**
← **I1**
← **I2**
← **I3**

J – Read/Set Drain Parameters

Description: Read/Set Drain parameters.

NOC Command:	**J0**	Read Drain parameters
	J1{=<*1-15*>}	Read/Set poll data port enable
	J2{=<*retries*>}	Read/Set Tx retries
	J3{=<*interval*>}	Read/Set "new node" interval
	J4{=<*interval*>}	Read/Set "911" interval
NOC Response:	***J0=**{TBD}[3]	
	***J1=**<*1-15*>[3]	
	***J2=**<*retries*>[3]	
	***J3=**<*interval*>[3]	
	***J4=**<*interval*>[3]	
Drain tx:	None.	
Node Reply:	None.	

K – Read/Set Next Node Address

Description: Read/Set next node address.

NOC Command: **K{=**<*node*>**}**
NOC Response: ***K=**<*node*>
Drain tx: **K**<*node*> →
Node Reply: ← **K**

L – Set Node Port Alarm Limits

Description: Set node port alarm limit.

NOC Command:	**L**<*node*>**;0=**<*limit*>	Set dp0 alarm limit
	L<*node*>**;1=**<*limit*>	Set dp1 alarm limit
	L<*node*>**;2=**<*limit*>	Set dp2 alarm limit
	L<*node*>**;3=**<*limit*>	Set dp3 alarm limit
NOC Response:	***L0=**<*limit*>[3]	
	***L1=**<*limit*>[3]	
	***L2=**<*limit*>[3]	
	***L3=**<*limit*>[3]	
Drain tx:	**L0=**<*limit*>→	
	L1=<*limit*>→	
	L2=<*limit*>→	
	L3=<*limit*>→	
Node Reply:	← **L0**	
	← **L1**	
	← **L2**	
	← **L3**	

M – Read/Set Node Drain Mode

Description: Read/Set Drain mode.

NOC Command: **M{=**<*mode*>**}**
NOC Response: ***M=**<*mode*>
Drain tx: None.
Node Reply: None.

N – Set Node Intervals

Description: Set node intervals in deci-seconds.

NOC Command:	**N**<*node*>**;0=**<*interval*>	Set sleep interval (ds)
	N<*node*>**;1=**<*interval*>	Set alarm sleep interval (ds)
	N<*node*>**;2=**<*interval*>	Set acquire sleep interval (ds)
NOC Response:	***N0=**<*interval*>[3]	
	***N1=**<*interval*>[3]	
	***N2=**<*interval*>[3]	

Drain tx: **N0=**<*interval*> →
N1=<*interval*> →
N2=<*interval*> →
Node Reply: ← **N0**
← **N1**
← **N2**

O – Suspend Node Sleep Cycle

Description: Suspend sleep 1 cycle.

NOC Command: **O**[1]
NOC Response: None.
Drain tx: **O** →
Node Reply: ← **O**

P – Read/Set Node Port Value

Description: Read/set node port value. (Ports 1-3).

NOC Command:	**P**<*node*>**;0**[1]	Read data port 0
	P<*node*>**;1**[1]	Read data port 1
	P<*node*>**;2**[1]	Read data port 2
	P<*node*>**;3**[1]	Read data port 3
	P<*node*>**;0=**<*value*>	Set data port 0
	P<*node*>**;1=**<*value*>	Set data port 1
	P<*node*>**;2=**<*value*>	Set data port 2
	P<*node*>**;3=**<*value*>	Set data port 3

NOC Response: **P0=**<*value*>
P1=<*value*>
P2=<*value*>
P3=<*value*>
Drain tx: **P0** →
P1 →
P2 →
P3 →
P0=<*value*> →
P1=<*value*> →
P2=<*value*> →
P3=<*value*> →
Node Reply: ← **P0=**<*value*>
← **P1=**<*value*>
← **P2=**<*value*>
← **P3=**<*value*>
← **P0**
← **P1**
← **P2**

← **P3**

Q –

Description: Undefined.

NOC Command: **Q**
NOC Response: **Q**
Drain tx: **Q** →
Node Reply: ← **Q**

R – Read Node Configuration

Description: Read node configuration.

NOC Command:	**R**<*node*>**;0**	Read node serial number
	R<*node*>**;1**	Read node firmware version
NOC Response:	**R0=**<*serial#*>	
	R1=<*version*>	
Drain tx:	**R0** →	
	R1 →	
Node Reply:	← **R0=**<*serial#*>	
	← **R1=**<*version*>	

<***node***>	= U16 (1 – 65,535)	2^{16} seconds = 18.2 hours
<***interval***>	= U32 (0 – 4,294,967,296)	2^{16} minutes = 1092 hours
<***value***>	= U32 (0 – 4,294,967,296)	2^{32} deci-seconds = 13.6 years

4-Unit Demonstration

The following is a description is of a 4-unit demonstration hardware package consisting of 2 Drains and 2 Nodes. Steps 1 through 3 can be used to demonstrate the Drain/Node operations, including Drain acquisition and self-healing algorithms, without interfacing the Drain with a RS232 terminal. Step 4 demonstrates data harvestings (water counts from Port 0), alarms, and various Drain and Node control settings.

A WDAN node interfaces with a host system via a RS-232 cable.

NOC		**Drain**	**Node**
		LED's:	LED's:
		Green – pw	Yellow – tx
		Red – tx	
		Yellow – rx	Hookup:
			Purple – +6 v dc
RS232	←→	RS232 – standard	Blue – ground
		GND	Yellow – water meter
		Tx	
		Rx	
		CTS	
		RTS	

Step 1. Power all 4 units; observe normal operation with both Nodes on Drain #1:

Drains: Tasking LEDs begin toggling once per second.
Defaults to WDAN 1.0 Drain/NOC interface protocol after 2 seconds.
Polling begins with rapidly blinking Tx LED (toggles 10 times/second).
Communication with node indicated by Rx LED blink.

Nodes: Search for Drain indicated by Rx LED rapidly blinking for each received packet.
Acquires Drain when 20 packets in 3 seconds are correctly received.
Repeat:
Node awakens and looks for Drain packet (Rx LED blinks).
Node determines time before its packet will be transmitted by Drain.
If power can be conserved, Node will sleep for a short period.
Node awakens and listens for expected packet from Drain (Rx LED blinks).
Node communicates requested information back to Drain
Node sleeps for extended period.

Note: Drain and Node Rx LED blinks when communication occurs.
Both Nodes probably will acquire Drain #1.
Drain #1's Rx LED should blink twice per cycle.

Step 2. Power down Drain #1; observe Nodes acquiring Drain #2.

Nodes: After loss of communication with Drain, Nodes search all frequencies for a Drain.
Rx LED rapidly blinks when valid packets are received from a Drain.
Acquires Drain when 20 packets in 3 seconds are correctly received.
Node begins communication cycle.

Note: Drain #2 should pick up both nodes.

Step 3. Power up Drain #1, cycle power on Node #1; observe a node on each Drain:

Node #1: After loss of communication with Drain, Node searchs all frequencies for a Drain.
Rx LED rapidly blinks when valid packets are received from a Drain.
Acquires Drain when 20 packets in 3 seconds are correctly received.
Node #1 begins communication cycle.

Note: Each Drain's Rx LED should blink once per cycle.

Step 4. Connect RS232 monitor to Drain; observe communication and configurability of system:

4a. Observe Port 0 values being harvested (water counts)

N4(161)6:P0=322

N4 = Node 4
(161) = Sequence # (0-255)
6: = 6 characters in Node payload
P0=322 = Port 0 value (water count)

Note: Node 4 automatically increments Port 0 value by 2 each time it is polled.
Node 13's Port 0 value is incremented by the external push button.

4b. Observe alarms

N4(163)6:A0=326

N4 = Node 4
(163) = Sequence # (0-255)
6: = 4 characters in Node payload
A=322 = Port 0 value exceeded setpoint for alarm interval (water count)

Note: Since Node 4's Port 0 value automatically increments, an alarm will regularly appear. Node 13's alarm will occur if more than 4 counts are entered (via the push button) in 15 seconds.

4c. Adjust alarm interval and count.

Commands to a Drain (or Node) via the RS232 interface are case insensitive and not echoed. They are indicated below by italics and underline.

*I4;0=5*N4(164)8:I0P0=328 Change Node 4's alarm interval to 5 seconds
'I0' indicates command received

*L4;0=10*N13(135)4:P0=5 Change Node 4's alarm value to 10 counts

N4(165)8:L0P0=330	Again, ‘L0’ indicates command received

4d. Adjust sleep period.

The Node sleep period can be set from 1 to 4,294,967,295 seconds (49.7 days).

*N4;0=86400*N13(136)4:P0=5	Change Node 4’s sleep period to 24 hours
N4(166)8:N0P0=332	Node 4 acknowledges change
N13(137)4:P0=5	
N13(138)4:P0=5	
...	Node 4 sleeps for 24 hours

4e. Interrogate/Set Node parameters.

*R4;0*N4(161)14:P0=322R0=12345	Get Node 4’s serial number
*R4;1*N4(162)11:P0=324R1=11	Get Node 4’s firmware version
...	

4f. Interrogate/Set Drain parameters.

*J2=5*N4(163)6:A0=326	Set Drain’s retry count (no response from node)
*K2*N4(163)6:P0=328	Change Drain’s frequency
N4(164)6:P0=330	
...	

4g. Toggle Drain output.

The ‘D’ command cycles through no, intermediate, and full debug output modes.

*D*N4(163)6:A0=326
...

Appendix A: Agency Certifications

FCC (United States) Certification

The Integrated Wireless Solutions (IWS) Wireless Data Acquisition Module complies with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required. In order to operate under IWS's FCC Certification, OEMs/integrators must comply with the following regulations:

1. The OEM/integrator must ensure that the text provided with this device [Figure A-01] is placed on the outside of the final product and within the final product operation manual.
2. The Wireless Data Acquisition Module may only be used with antennas that have been tested and approved for use with this modem [refer to 'FCC-approved Antennas' section].

Labeling Requirements

WARNING: The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product enclosure that displays the text shown in the figure below.

Contains FCC ID: UERwide2480
The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

Figure A1. Required FCC Label for OEM products containing the IWS Wireless Data Acquisition Module.

FCC Notices

IMPORTANT: The Integrated Wireless Solutions (IWS) Wireless Data Acquisition Module has been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Modifications not expressly approved by Integrated Wireless Solutions could void the user's authority to operate the equipment.

IMPORTANT: OEMs must test final product to comply with unintentional radiators (FCC section 15.107 & 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

IMPORTANT: The Wireless Data Acquisition Module has been certified for remote and base radio applications. If the module will be used for portable applications, the device must undergo SAR testing.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the inter-ference by one or more of the following measures: (*i.*) Re-orient or relocate the receiving antenna, (*ii.*) Increase the separation between the equipment and receiver, (*iii.*)Connect equipment and receiver to outlets on different circuits, or (*iv.*) Consult the dealer or an experienced radio/TV tech-nician for help.

Limited Modular Approval

Power output is conducted at the antenna terminal and can be adjusted from 1 mill-watt to 1 Watt at the OEM level. This is an RF modem approved for Limited Modular use operating as a mobile transmitting device with respect to section 2.1091 and is limited to OEM installation for Mobile and Fixed applications only. During final installation, end-users are prohibited from access to any programming parameters. Professional installation adjustment is required for setting module power and antenna gain to meet EIRP compliance for high gain antenna(s). Final antenna installation and operating configurations of this transmitter including antenna gain and cable loss must not exceed the EIRP of the configuration used for calculating MPE. Grantee (IWS) must coordinate with OEM integrators to ensure the end-users and installers of prod-ucts operating with the modem are provided with operating instructions to satisfy RF exposure requirements. The FCC grant is valid only when the device is sold to OEM integrators. Integrators are instructed to ensure the end-user has no manual instructions to remove, adjust or install the device.

FCC-approved Antennas

WARNING: This device has been tested with Reverse Polarity SMA connectors with the antenna listed below. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed below must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).

Fixed Base Station and Mobile Applications

IWS Wireless Data Acquisition Modules are pre-FCC approved for use in fixed base station and mobile applications. When the antenna is mounted at least 20cm (8") from nearby persons, the application is considered a mobile application.

Portable Applications and SAR Testing

When the antenna is mounted closer than 20cm to nearby persons, then the application is considered "portable" and requires an additional test be performed on the final product. This test is called Specific Absorption Rate (SAR) testing and measures the emissions from the modem and how they affect the person.

RF Exposure

This statement must be included as a CAUTION statement in OEM product manuals.

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 30 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTE: The separation distance indicated in the above is 30 cm, but any distance greater than or equal to 23 cm can be used (per MPE evaluation).

Part Number	Type	Connector	Gain	Application
A09-HSM-7	Straight half-wave	RPSMA	3.0 dBi	Fixed/Mobile

Table A1. Half-wave antennas (approved when operating at 1-watt power output or lower).

Appendix B. Electrical Characteristics

Analog Peripherals	• 10-Bit ADC - Up to 200 ksps - Built-in analog multiplexer with single-ended and differential mode - VREF from external pin, internal reference, or VDD - Built-in temperature sensor - External conversion start input option • Two comparators • Internal voltage reference • Brown-out detector and POR Circuitry
USB Function Controller	• USB specification 2.0 compliant • Full speed (12 Mbps) or low speed (1.5 Mbps) operation • Integrated clock recovery; no external crystal required for full speed or low speed • Supports eight flexible endpoints • 1 kB USB buffer memory • Integrated transceiver; no external resistors required
Voltage Supply Input	• 6 V
Power consumption	
High Speed 8051 µC Core	• Pipelined instruction architecture; Executes 70% of Instructions in 1 or 2 system clocks • 48 MIPS (typical 13.382 mhz).
Memory	• Expanded interrupt handler • 4352 Bytes RAM • 64 kB Flash; (In-system programmable in 512-byte sectors)
Digital Peripherals	• 40/25 Port I/O; All 5 V tolerant with high sink current • Hardware enhanced SPI™ • SMBus™ • Two enhanced UART serial ports • Four general purpose 16-bit counter/timers • 16-bit programmable counter array (PCA) with five capture / compare modules • External Memory Interface (EMIF)
Clock Sources	• Internal Oscillator: 0.25% accuracy with clock recovery enabled. (Supports all USB and UART modes) • External Oscillator: Crystal, RC, C, or clock (1 or 2 Pin modes) • Low Frequency (80 kHz) Internal Oscillator • Can switch between clock sources on-the-fly
Temperature Range	• –40 to +85 °C

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Supply voltage	• 3.2 to 4.6 V
Temperature ambient	• –10 to +60 °C

Appendix C. Glossary

bit-error-rate	[BER] is the ratio of received bits on an interface that contain errors. A bit error rate test is used to check the BER. The percentage of bits that have errors relative to the total number of bits received in a transmission, usually expressed as ten to a negative power. For example, a transmission might have a BER of 10 to the minus 6, meaning that, out of 1,000,000 bits transmitted, one bit was in error.
cell	A set of connected (reachable) nodes by a drain in a Wireless Data Acquisition Network (WDAN) is referred to as a cell. Any node that can be reached by a centralized “drain” module belongs to that cell.
CRC	CRC stands for "Cyclic Redundancy Code" and usually is reserved for algorithms that are based on the "polynomial" division. The essential mathematical operation in the calculation of a CRC is binary division, and the remainder from the division determines the CRC.
datagram	A sequence of up to 31 bytes preceded by a length byte is referred to as a datagram.
disparity	The difference between the number of 1's and 0's in a transmission character. A transmitted character with more 1's than 0's is said to have positive running disparity. A transmitted character with more 0's than 1's is said to have negative running disparity. And a transmission character with an equal number of 1's and 0's is said to have neutral disparity.
drain	A centralized WDAM module which functions as a gateway between Wireless Data Acquisition Modules and a Network Operations Control center (NOC). A Drain “harvest’s” node data from a cell.
node	A Wireless Data Acquisition Module participating in a Wireless Data Acquisition Network cell is referred to as a node. All nodes within a WDAN cell are assigned a unique 16-bit address.
packet	A packet is the data unity passed between nodes in a Wireless Data Acquisition Network using WDAP.
SCADA	An acronym for Supervisory Control And Data Acquisition. Its basic purpose is to remotely monitor various processes, gather real-time data and then analyze it.
source routing	The property of including the path of a packet within the packet itself.
sync word	A unique pattern used to sync a bit stream to a byte aligned datagram packet.

3 SPECIFICATIONS

Power Source	6 VDC at 600mA
Current Consumption	Receive: 60mA Transmit: 600mA
Sleep Modes	100 microAmp
RF Output Power	+ 28 dbM
Operating Temperature	–40 to +85 °C
Humidity	10-90% (non-condensing)
Antenna Impedance	50 Ohms unbalanced (nominal)
Antenna Connector	Pads for SMA female (plus ability for integrated antenna solution)
Operation Mode	Broadband single frequency
Frequency Control	PLL Synthesizer,
Operating Band	ISM 2.4Ghz band
Channel Spacing	1MHz
Modulation System	FSK
Number of Channels	10
RF Data Rate	72 kbps
Receiver Type	Single Conversion Superheterdyne
Receiver Sensitivity	-92 dbM @10Kbps
Range	Up to 15 miles with lower power and high gain antennas
Data Interface	Asynchronous Serial – RS232 (with interface board) or TTL
Data Interface Rate	9600bps
Data Rate	9600bps
Data Protocol	8,N,1, transparent transport protocol (no error correction or resend)
GPS Interface	Lassen SQ GPS Receiver will be accommodated on board. Antenna interface and connection to be specified by Navigational Sciences.
Packet Error	1e-3 @ -92 dbM (96 bit packets, with CRC)
Size	Approx. 1.75” x 2.47” x 0.375”
FCC Compliance	Part 15
Board Size	2.3”X3.5”