

Accsense Direct Data Stream Interface Document

Introduction

This document describes the protocol used by the Accsense gateway in Accsense Direct Data Stream (ADDS) mode to communicate to a customer's host computer via a direct TCP socket.

Intended Audience

This document is intended to be used as a guide for writing software that resides on a host computer that interfaces to the Accsense B01-02 Gateway. Typically, the host computer software intercepts, formats, displays and stores the data from the Accsense gateway.

Readers of this document should have a basic understanding of TCP sockets.

System Overview

The system is comprised of a wireless mesh/gateway and a host computer. The wireless mesh consists of wireless sensor pods. These pods transmit information to the gateway, primarily sensor data. The gateway collects data from the wireless sensor pods within its wireless mesh, formats this data as an ASCII string and forwards it to the host computer using an Ethernet connection. Status information (for example, error messages) is also sent to the host computer in a similar fashion.

Gateway Requests

The gateway initiates all requests to the host computer by sending an ASCII string to the destination IP address via a TCP socket. A gateway request consists of several parameter/value pairs that are terminated by a ASCII NUL character (ASCII 0). Each parameter consists of a parameter name followed by an '=' character and then the parameter value. Each parameter string is terminated by the '\n' (ASCII 0x0a) character. The meaning of each parameter string is usually dependent on a particular parameter with the name "OP".

Example Gateway Requests

The following examples illustrate the gateway-generated query strings. The '\n' character has been replaced by carriage returns for readability and the terminating NUL has been replaced by '\0'.

Init Request

This request is sent by the gateway whenever it determines it needs its local timestamp and/or its measurement interval to be refreshed.

```
PLUGIN-NAME=LRSA-ADDS  
INIT  
\0
```

This request is sent when either of the following conditions occurs:

1. The gateway has reset

- The host computer connection has been shut down. It is therefore recommended that the TCP connection to the gateway is left open as long as possible so the data stream is not interrupted.

Upon receipt of this message, the host computer software must send a response before the gateway will start sending pod data. This response must look similar to:

```
MEASUREMENT_PERIOD_MS=5000
TIME=1150322627
\0
```

Hello Request Example (OP=40)

The hello request is generated whenever a gateway has experienced a reset condition.

```
OP=40
GWMAC=0014a0000abc
GWHW=1
GFW=0.5.3.0-P.211
GWRADIOFW=00.03.02.03
GWRESET=42
\0
```

Heartbeat Request Example (OP=30)

This message allows the host computer to ascertain that a gateway is still operational even though sensor pod data updates have not been sent.

Gateway Firmware Versions below 0.7.3.0-P2.14: The heartbeat request is generated by the gateway during idle periods. In other words, if the gateway has not generated any other messages to the host computer in a certain time period, the heartbeat message is generated.

```
OP=30
GWMAC=0014a0000abc
\0
```

Gateway Firmware Versions at or above 0.7.3.0-P2.14: The heartbeat request is generated by the gateway every 30 seconds.

```
OP=30
GWMAC=0014a0000abc
PODABSENTLIST=0014A0000000AABB,0014A0000000CCDD,0014A0000000EEFF
\0
```

Data Request Example (OP=10)

The data request is generated whenever the gateway receives sensor data transmitted by a wireless sensor pod. The amount and type of data contained in this message (comma delimited) is dependent on the type of pod that transmitted the data message.

```
OP=10
GWMAC=0014a0000abc
PODEUI=0014A0000000ABCD
PODDATA=0000,0000,0000,0273,03D9
DATATS=1150323290
PODLQI=00f0
PODBATT=1
\0
```

Pod Configuration (OP=20)

The pod configuration message is generated by the gateway whenever a pod is first associated (introduced) to the gateway's wireless mesh or upon reset or power-up of a given pod that has already been associated in the wireless network.

```
OP=20
GWMAC=0014a0000abc
PODEUI=0014A0000000ABCD
PODTYPE=0204
PODHW=0.0.0.0
PODFW=0.5.3.0
\0
```

Error String (OP=50)

If the gateway encounters an error, it will generate a message with this opcode.

```
OP=50
GWMAC=0014a0000abc
GWFW=0.4.7.3
GWERRTS=1150323750
GWERRTS=ERROR...WSM msg is NULL
\0
```

Data Acquisition Block (OP=70)

If the pod has Data Acquisition (DAQ) capability and it was triggered according to its configuration, it will generate a message with this opcode:

```
OP=70
GWMAC=0014a0000abc
PODEUI=0014A0000000ABCD
PODBLOCKID=0
PODBLOCKNUM=0,1
PODBLOCK=0000,00010,00012,0011,0009,0020,0032,004A
\0
```

Request Query String Format

The gateway relays information to the host computer in the form of an ASCII string that usually consists of parameter name/value pairs over a TCP socket. The query string variable format is detailed below:

GWMAC

This parameter is contained in every gateway-generated request and identifies the source of the request.

OP

This parameter details the operation for the query string and is contained in every gateway-generated request. The values for this field include:

- **10**: Request is a pod data message. The following sub-parameters are contained in a data request:
 - **PODEUI** – This 16 digit hexadecimal number identifies the sensor pod that is reporting data
 - **PODDATA** – This parameter contains a list of comma delimited, 4 digit hexadecimal (16 bit) numbers. These numbers represent the raw A/D values that are captured in the sensor pod. The coefficients necessary to convert this raw data into meaningful data must be applied by the host computer software.

The order and number of parameters is determined by the Pod Configuration message.

- **DATATS** – This parameter represents the time, in Unix epoch seconds, that the sensor data was captured.
- **PODLQI** – The Link Quality Indication (LQI) of the pod's radio receiver. This parameter can be used to indicate the relative strength of the radio signal at the pod. This number has a range from 0000 to 00FF hex, where 00FF represents the best signal strength.
- **PODBATT** – This parameter contains a value of 1 when the sensor pod is on battery power, 0 if it is line-powered.

Optionally, depending on the version of gateway software that is running, the following extra parameters may also be sent:

- **PODTYPE** – This parameter indicates the pod type. The host computer should make an association between the pod EUJ and the pod type.
 - **PODHW** – Indicates the hardware version of the pod
 - **PODFW** – Indicates the firmware version of the pod
- **20:** Request is a pod configuration message. Each pod reports its configuration whenever it is associated with a wireless mesh or upon reset. The following sub-parameters are contained in a pod configuration request:
 - **PODEUI** – This 16 digit hexadecimal number identifies the sensor pod that is reporting data
 - **PODTYPE** – This parameter indicates the pod type. The host computer should make an association between the pod EUJ and the pod type.
 - **PODHW** – Indicates the hardware version of the pod
 - **PODFW** – Indicates the firmware version of the pod
 - **30:** Request is a gateway heartbeat. For gateway firmware versions below 0.7.3.0-P2.14, this message is generated only when the gateway has not sent other messages (e.g. data) for 30 seconds. However, for firmware version 0.7.3.0-P2.14 and above, this message is generated every 30 seconds regardless of other message activity.
 - **PODABSENTLIST** – This parameter is optionally sent if the gateway detects that one or more pods that are members of the mesh network have not reported within a pre-defined time interval. This parameter is only sent for gateway firmware versions at or above 0.7.3.0-P2.14. The time interval is determined by the following formula:

Where m_i = measurement interval and p_{avi} = pod absentee validation interval

If $m_i \geq 30$ seconds and $m_i \leq 10$ minutes, then $p_{avi} = 2 \times m_i$

If $m_i < 30$ seconds, then $p_{avi} = 60$ seconds

If $m_i > 10$ minutes, then $p_{avi} = 10$ minutes

- **40:** Request is a gateway hello. This request is generated each time the gateway resets.
 - **GWHW** – Indicates the gateway hardware version
 - **GWFW** – Indicates the gateway firmware version
 - **GWRADIOFW** – Indicates the firmware version of the gateway radio
 - **GWRESET** – Indicates the reason that the gateway reset. Possible values include:
 - 42: Reset Button
 - 44: Power Up
 - 46: Software crash

- 50: Brownout
- 52: Clock failure
- 54: Software reset
- **50:** Request is an error/status string. This request is generated whenever an important system event has occurred (e.g. suspected radio control failure or memory allocation problems). The following sub-parameters are contained in an error/status request:
 - **GWFW** – The firmware version of the gateway
 - **GWERRTS** – The approximate time that the error occurred
 - **GWERRSTR** – An ASCII string which contains a description of the error/status
- **70:** Request is a pod data block. This request is only generated by pods that have Data Acquisition (DAQ) capability. Once the pod has been configured, armed and triggered, it will send this opcode with the following sub-parameters:
 - **PODEUI:** The 16 digit pod identifier.
 - **PODBLOCKID:** The logical device id on the pod that has triggered.
 - **PODBLOCKNUM:** This parameter contains the current block number followed by the total number of blocks delimited by a comma. Example:
PODBLOCKNUM=0,32 means that the current block number is zero out of a total of 32.
 - **PODBLOCK:** This parameter represents the data in the data block, delimited by commas.

Host Computer Responses

The host computer only required to directly respond to the Gateway ADDS Init Request message (see section **Init Request**). Otherwise, the MEASUREMENT_PERIOD_MS or TIME fields may be sent independently and asynchronously. As detailed previously for gateway requests, the ASCII string from the host computer must be terminated with an ASCII NUL (ASCII 0) character and parameter name/value pairs must be ended with the '\n' character.

It is recommended that a message containing the TIME parameter be sent to the gateway periodically in order to keep its timestamp synchronized with the host computer. A good rule of thumb for the generation of this message is around once per hour.

Also, please note that changes to the MEASUREMENT_PERIOD_MS parameter may take up to 30 seconds to 5 minutes, depending on the previous measurement interval that was configured, to take effect.

DELETE_POD Response

This response is sent whenever the host side needs to remove a pod from a gateway's mesh. This element contains the EUI of an individual pod to delete from the mesh. After the pod is removed from the mesh, the gateway will prevent messages from that pod from reaching the host computer. However, please note that the pod will continue to attempt to send its messages to the gateway, so it is recommended that the pod be powered off after this XML element has been sent to the gateway.

For example, when the gateway receives the following response, it will delete the pod with EUI=0014a0000001123e from the mesh:

DELETE_POD=0014a0000001123e

DISCRETE_CFG Response

This response contains the configuration for discrete I/O. It is only applicable to pods which support configurable discrete I/O (A1-08 through A1-12). Discrete I/O configuration consists of two 16 bit masks, expressed as ASCII hexadecimal numbers:

1. Input/output mask. If a bit is set to 0, the corresponding I/O is configured as an input bit. Otherwise, it is configured as an output.
2. Output value mask. If a discrete I/O is configured as an output in the Input/Output mask, this value indicates the value that should be output on the corresponding output pin. A '1' value will output a high level whereas a '0' value will output a low level.

Note, for example, the following host response:

```
DISCRETE_CFG=0014a0000001123e 0002 0000  
DISCRETE_CFG=0014a00000011255 0003 0002
```

This XML object configures the discrete I/O of two separate pods. The first pod with serial number **0014a0000001123e** is configured with pin 1 as an input and pin 2 as an output with a low level. Pod **0014a00000011255** is configured with both pins as output: Pin 1 is configured with a low level and pin 2 is configured with a high level.

NOTE: Each DISCRETE_CFG statement describes only one pod I/O configuration.

NOTE: Discrete I/O configurations are persistent per gateway/pod power cycle. Therefore, it is recommended that the host application refresh these states upon reception of gateway/pod reset or power cycle requests (OP code 40 or 20).

Pod Sensor Board Power Configuration Responses

Normally, Accsense sensor pods cut power to their sensor boards after data collection in order to lower power requirements and, therefore, increase battery life. However, some sensors have an unusually large "warm up" time requirement. In this case, it is necessary to leave power enabled on the sensor board. Pod firmware versions later than or equal to 0.7.3.0 and gateway firmware versions greater than or equal to 0.8.3.0-P2.15 support the configuration of the pod sensor board power mode. The host can send a **DISABLE_POD_BD_PWRDWN** response to disable the normal power down cycle (power cut after data collection) or **ENABLE_POD_BD_PWRDWN** to re-enable the normal cycle. The EUI should be supplied as a parameter to this command. For example, to disable the normal power cycle for a pod in the mesh with eui 0014a0000001123e, the following response would be sent to the gateway:

```
DISABLE_POD_BD_PWRDWN=0014a0000001123e
```

In order to re-enable normal sensor pod power, the following response would be sent to the gateway:

```
ENABLE_POD_BD_PWRDWN=0014a0000001123e
```

NOTE: Each pod board power configuration statement describes only one pod power down configuration.

NOTE: Pod board power configurations are persistent per gateway/pod power cycle. Therefore, it is recommended that the host application refresh these states upon reception of gateway/pod reset or power cycle requests (OP code 40 or 20).

Data Acquisition (DAQ) Responses

Some pod models (model TBD) will have the capability of performing high-speed data acquisition. Three DAQ response messages exist for configuration of the DAQ, starting (arming) the DAQ, and stopping (disarming) the DAQ.

DAQ Configuration Response

The DAQ is configured with the following command sequence:

```
DAQ_CFG=[eui] [dev] [sm] [sr] [tl] [pt] [ns] [te]
```

The parameters of the configuration command are:

- **eui**: The eui of the pod to configure.
- **dev**: The logical DAQ device number to configure. This parameter is only relevant for pods that have more than one DAQ and should be set to zero for pods that only have one DAQ.
- **sr**: The sample rate for acquisition, in milliseconds.
- **sm**: The sample mode of the DAQ operation. The valid DAQ modes are:
 - AUTO (value = 0): The DAQ waits for the trigger to occur, then collects up to the total number of samples (ns). After the total number of samples has been collected, the pod sends a series of OP=70 requests.
 - CONTINUOUS (value = 1): The DAQ continuously collects data at the specified sample rate (sr). The trigger level (tl), number of pre-trigger trigger samples (pt), total number of samples (ns) and the trigger edge (te) are ignored in this mode.
- **tl**: The trigger level for the DAQ operation. This parameter, in conjunction with the trigger edge, specifies when the DAQ will complete its acquisition.
- **pt**: The number of pre-trigger samples to collect. When armed, the DAQ will continue to collect samples until the trigger criteria is met. After the trigger is hit, the DAQ will collect the total number of samples minus the number of pre-trigger samples (ns – pt).
- **ns**: The total number of samples to collect.
- **te**: The trigger edge. This parameter shall have a 0 for rising edge and a 1 for a falling edge.

For example, if the pod with eui=0014a00000000abc has one DAQ unit and it is desired to configure it with sample mode=AUTO, sample rate=10ms, trigger level=100, number of pre-trigger samples= 40, total number of samples=1024 and trigger edge=rising, the following configuration request should be issued:

```
DAQ_CFG=0014a00000000abc 0 0 10 100 40 1024 0
```

DAQ Arm Response

Once the DAQ is configured it can be armed (started) with the following sequence:

```
DAQ_ARM=[eui] [dev] [options]
```

The parameters for this command are:

- **eui**: The eui of the pod to arm.
- **dev**: The logical DAQ device number to arm.
- **options**: The arming options mask. This parameter is pod-specific and is a 16-bit hexadecimal ASCII number.

DAQ Disarm Response

Once the DAQ has been configured and armed, it can be disarmed (stopped) with the following sequence:

DAQ_DISARM=[eui] [dev]

This command will immediately stop any ongoing Data Acquisitions in progress. APPENDIX A: Recommended Pod Configuration

Pod Measurement Period vs. Power Supply

If the configured measurement period is less than 30 seconds, it is recommended that the pods in the mesh be AC powered due to battery life and pod wakeup latency considerations.

Number of Pods in the Mesh

Due to the limitations of the wireless mesh bandwidth, there is a strong dependency between the measurement period and the maximum number of pods that the mesh can reliably support. This dependency is summarized in the following table:

# of Pods	20	15	10	5	2
16	100%	99%	95%	95%	75%
12	100%	99%	95%	95%	94%
8	100%	99%	96%	96%	96%
4	100%	99.5%	99%	99%	99%
2	100%	100%	99%	99%	99%
1	100%	100%	100%	100%	100%

Sensor Coefficients

A1-01					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
4-20ma		0	0.020345	0	0 mA
0-5V		0	0.0048828	0	0 Volts
Digital 1		0	1	0	0
Digital 2		0	1	0	0
Event Counter LSW ⁱ		0	1	0	0
Event Counter MSW ⁱ		0	1	0	0
Temperature		-39.6	0.01	0	0 °C
Humidity		-4	0.0405	-0.0000028	0 %RH
Vibration		100	-0.097752	0	0 Gs)
Acoustic		100	-0.097752	0	0 %
Supply Voltage		0	0.0048828	0	0 Volts
Light		0	0.097752	0	0 %

A1-02					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
RTD	-244.806034	0.714371	8.28744E-05	1.63706E-08	°C
Thermistor	113.719	-0.33	0.000438	-2.573E-07	°C
Ambient Temp	158.36	-0.20743	0	0	°C
Thermocouple	1240.74	-1.61559	0.000663263	-4.50566E-07	°C
0-5V	0	0.0048828	0	0	Volts
Supply Voltage	0	0.0048828	0	0	Volts
Digital	0	1	0	0	

A1-03					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
Temperature	-39.6	0.01	0	0	°C
Humidity	-4	0.0405	-0.0000028	0	%RH
Vibration	100	-0.097752	0	0	%(of 6 Gs)
Acoustic	100	-0.097752	0	0	%
Supply Voltage	0	0.0048828	0	0	Volts
Light	0	0.097752	0	0	%

A1-04					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
4-20ma	0	0.020345	0	0	mA
0-5V	0	0.0048828	0	0	Volts
Digital 1	0	1	0	0	
Digital 2	0	1	0	0	
Event Counter LSW ⁱ	0	1	0	0	
Event Counter MSW ⁱ	0	1	0	0	
Ambient Temp	158.36	-0.20743	0	0	°C
Supply Voltage	0	0.0048828	0	0	Volts

A1-05					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
Temperature	-39.6	0.01	0	0	°C
Humidity	-4	0.0405	-0.0000028	0	%RH
Supply Voltage	0	0.0048828	0	0	Volts

A1-06					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
RTD	-244.806034	0.714371	8.28744E-05	1.63706E-08	°C
Ambient Temp	158.36	-0.20743	0	0	°C
Supply Voltage	0	0.0048828	0	0	°C
Digital	0	1	0	0	

A1-07						
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units	
Digital 1	0		1	0	0	
Digital 2		0	1	0	0	
Event Counter LSW ⁱ		0	1	0	0	
Event Counter MSW ⁱ		0	1	0	0	
Ambient Temp	158.36		-0.20743	0	0 °C	
Supply Voltage	0		0.0048828	0	0 Volts	

A1-01a					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
4-20ma	0	0.020345	0	0	0 mA
0-5V	0	0.0048828	0	0	0 Volts
Digital 1	0	1	0	0	0
Digital 2	0	1	0	0	0
Event Counter LSW ⁱ	0	1	0	0	0
Event Counter MSW ⁱ	0	1	0	0	0
Temperature	-39.6	0.01	0	0	0 °C
Humidity	-4	0.0405	-0.0000028	0	0 %RH
Vibration	100	-0.097752	0	0	0 %(of 6 Gs)
Acoustic	100	-0.097752	0	0	0 %
Light ⁱⁱ	0	0.00468106	0	0	0 Lux
Supply Voltage	0	0.00732422	0	0	0 Volts
Digital Open Time, milliseconds (LSW) ⁱ	0	0.001	0	0	0 Milliseconds
Digital Open Time, milliseconds (MSW) ⁱ	0	0.001	0	0	0 Milliseconds
Digital Event Count	0	1	0	0	0

A1-02a					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
RTD	-105.424981	0.083071	1.083563E-06	1.619583E-11	°C
Thermistor	113.719	-0.33	0.000438	-2.573E-07	°C
Ambient Temp	158.36	-0.20743	0	0	°C
Thermocouple	1233.765	-0.3906623	3.142981E-05	-5.094074E-09	°C
0-5V	0	0.0048828	0	0	0 Volts
Supply Voltage	0	0.00732422	0	0	0 Volts
Digital	0	1	0	0	0
Digital Open Time, milliseconds (LSW) ⁱ	0	0.001	0	0	0 Milliseconds
Digital Open Time, milliseconds (MSW) ⁱ	0	0.001	0	0	0 Milliseconds
Digital Event Count	0	1	0	0	0

A1-03a					
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units
Temperature	-39.6	0.01	0	0	0 °C
Humidity	-4	0.0405	-0.0000028	0	0 %RH
Vibration	100	-0.097752	0	0	0 %(of 6 Gs)
Acoustic	100	-0.097752	0	0	0 %
Supply Voltage	0	0.00732422	0	0	0 Volts
Light ⁱⁱ	0	0.00468106	0	0	0 Lux

A1-04a						
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units	
4-20ma	0	0.020345	0	0	0	mA
0-5V	0	0.0048828	0	0	0	Volts
Digital 1	0	1	0	0	0	
Digital 2	0	1	0	0	0	
Event Counter LSW ⁱ	0	1	0	0	0	
Event Counter MSW ⁱ	0	1	0	0	0	
Ambient Temp	158.36	-0.20743	0	0	0	°C
Supply Voltage	0	0.00732422	0	0	0	Volts
Digital Open Time, milliseconds (LSW) ⁱ	0	0.001	0	0	0	Milliseconds
Digital Open Time, milliseconds (MSW) ⁱ	0	0.001	0	0	0	Milliseconds
Digital Event Count	0	1	0	0	0	

A1-05a						
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units	
Temperature	-39.6	0.01	0	0	0	°C
Humidity	-4	0.0405	-0.0000028	0	0	%RH
Supply Voltage	0	0.00732422	0	0	0	Volts

A1-06a						
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units	
RTD	-105.424981	0.083071	1.083563E-06	1.619583E-11	0	°C
Ambient Temp	158.36	-0.20743	0	0	0	°C
Supply Voltage	0	0.00732422	0	0	0	°C
Digital	0	1	0	0	0	
Digital Open Time, milliseconds (LSW) ⁱ	0	0.001	0	0	0	Milliseconds
Digital Open Time, milliseconds (MSW) ⁱ	0	0.001	0	0	0	Milliseconds
Digital Event Count	0	1	0	0	0	

A1-07a						
Sensor	Coeff 1	Coeff 2	Coeff 3	Coeff 4	Units	
Digital 1	0	1	0	0	0	
Digital 2	0	1	0	0	0	
Event Counter LSW ⁱ	0	1	0	0	0	
Event Counter MSW ⁱ	0	1	0	0	0	
Ambient Temp	158.36	-0.20743	0	0	0	°C
Supply Voltage	0	0.00732422	0	0	0	Volts
Digital Open Time, milliseconds (LSW) ⁱ	0	0.001	0	0	0	Milliseconds
Digital Open Time, milliseconds (MSW) ⁱ	0	0.001	0	0	0	Milliseconds
Digital Event Count	0	1	0	0	0	

The pod reports a single, 4-digit hex value. In order to convert that value into a standard measurement, you must first convert it to decimal, and then use the following equation:

$$\text{Value} = \text{Coeff1} + \text{Coeff2} * [\text{ReportedValue}] + \text{Coeff3} * [\text{ReportedValue}]^2 + \text{Coeff4} * [\text{ReportedValue}]^3$$

If you have any questions about how to apply these coefficients, please contact us at:
support@accsense.com

ⁱ This value is part of a 32 bit value which is formed from the 16 bit LSW and MSW components:
Value = MSW*65536 + LSW.

ⁱⁱ This value is calculated differently than the standard method. The Coefficients are used in an exponentiation: Exponent = Coeff1 + Coeff2*[Reported Value] + Coeff3*[Reported Value]^2 + Coeff4*[Reported Value]^3, Value = 10^Exponent.