INTEGRATED COMMUNICATION SPECIFICATION

for the

REDUCED SHIPS-CREW BY VIRTUAL PRESENCE (RSVP)
ADVANCED TECHNOLOGY DEMONSTRATION (ATD)

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INTEGRATED COMMUNICATION SPECIFICATION

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ADVANCED TECHNOLOGY DEMONSTRATION (ATD)

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# Acknowledgment

The following individuals and organizations were the principal contributors to specific topics covered by this document.

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<td></td>
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1 Introduction

This document describes data communication throughout the Reduced Ships-Crew by Virtual Presence (RSVP) system. A system diagram highlighting the communication interfaces is given in Figure 1. There are four classes of communication in the RSVP system.

• Access Point internal
• Remote station internal
• Wired network
• Wireless network

These four topics are discussed in turn in Section 2. Section numbers noted in Figure 1 refer to the figures in this document.

2 RSVP Interfaces

2.1 Access Point Internal

2.1.1 Access Point Control Processor to Access Point Controller Microprocessor Radio

2.1.1.1 APCP to APCM Radio Mechanical Interface

The APCP and APCM Radio are contained in separate housings that are connected by two electrical cables, one carrying signals, and the other supplying power from the APCP to the APCM.

The cable carrying signals connect to a standard DB9 null modem interface, L-COM part number DMA060MF. The cable is a fully populated straight-through cable, L-COM part number CS2N9MF-x. (“x” specifies the length in meters and is TBD.) The female end of the cable is attached at the APCP. The male end is attached at the APCM.

The cable carrying electrical power supplies +5 VDC to the APCM Radio, drawing on the APCP power supply. Cable specifications are TBD.

2.1.1.2 APCP to APCM Radio Electrical Interface

Pin assignments in the cable between APCP and APCM are given in Table 1.

APCP to APCM Radio messages consist of a string of up to 4096 bytes (including those added for “byte stuffing,” as described below, each encoded as 11 bits transmitted in the following order:

• Start bit
• 8 data bits, least significant first
• Parity bit
- Stop bit

**Table 1. Pin assignments in APCM to APCP cable**

<table>
<thead>
<tr>
<th>Female Connector</th>
<th>Male Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal</td>
<td>Pin</td>
</tr>
<tr>
<td>DCD</td>
<td>1</td>
</tr>
<tr>
<td>RD</td>
<td>2</td>
</tr>
<tr>
<td>TD</td>
<td>3</td>
</tr>
<tr>
<td>DTR</td>
<td>4</td>
</tr>
<tr>
<td>DTR</td>
<td>4</td>
</tr>
<tr>
<td>SG</td>
<td>5</td>
</tr>
<tr>
<td>DSR</td>
<td>6</td>
</tr>
<tr>
<td>RTS</td>
<td>7</td>
</tr>
<tr>
<td>CTS</td>
<td>8</td>
</tr>
<tr>
<td>No connection</td>
<td>9</td>
</tr>
<tr>
<td>Ground</td>
<td>Shield</td>
</tr>
</tbody>
</table>

All messages begin with two bytes whose content is the hexadecimal value 80FF and end with two bytes whose content is the hexadecimal value 80FE. Messages do not have an intrinsic length. A receiver locates the end of a message by scanning for the message trailer.

"Byte stuffing" is used to prevent a receiver from interpreting data in the message that happens to have the value 80FE as a message trailer. A sender adds a byte containing 80 immediately following every data byte whose value happens to be 80. A receiver removes a byte containing 80 whenever there are two consecutive 80s (N bytes when there are 2N consecutive 80s). If there are an odd number of consecutive 80s, either the last 80 is part of the trailer or an error has occurred. Table 2 gives examples of how a receiver interprets various inputs.

**Table 2. Examples of Receiver Interpretation of Byte-Stuffed Inputs**

<table>
<thead>
<tr>
<th>Bytes received</th>
<th>Interpretation by receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 80 80 80 FE</td>
<td>Data: 80 80 FE</td>
</tr>
<tr>
<td>80 80 80 80 80 FE</td>
<td>Data: 80 80; Trailer</td>
</tr>
<tr>
<td>80 80 80 80 80 XX (other than FE)</td>
<td>Error</td>
</tr>
</tbody>
</table>
2.1.1.3 APCP to APCM Radio Sequencing

APCP to APCM Radio comprises four elements, which are described in turn in the following subsections.

- Autonomy
- Initialization
- Sensor data acquisition
- Network management

2.1.1.3.1 Autonomy

An APCP will operate normally in the event that the APCM Radio is disconnected at either end of the cable, or loses power. An APCM Radio will maintain itself in an inactive state in the event that it is disconnected at either end of the cable.

2.1.1.3.2 Initialization

APCP to APCM Radio sequencing for initialization is illustrated in Figure 2.

The AP and the APCM will be powered up at the same time. The AP will use wall power and will provide power to the APCM.

Both processors begin to boot at power up. The states of the AP and APCM processors are independent and each must be aware of the others’ state. One will boot faster than the other will, and operator, software signal, or error may reset the processors.

The following sequences define the various events/actions that take place from power on through cyclic communications.

1. Establish Communication

   Since the AP has no knowledge of the APCM’s state, it will try to establish communications by issuing a “HELLO” message every TBD seconds. When the APCM detects this message it responds.

   If no response is received within TBD transmittals, the AP will issue an “APCM timeout” alert, indicating that the APCM is not functioning. The APCP remains in this state until a response is received.

   The APCM commands the APCM radio not to transmit or receive while Establish Communication is taking place.

2. APCM Reset

   Following the successful establishment of communications, the APCP commands a reset to the APCM. Upon receipt, the APCM executes built-in test (BIT), clears RAM, and reloads all ROM data values. The APCP responds with the BIT results.

   If no response is received within TBD seconds, the APCP issues an APCP Communications Timeout Alert and will attempt to re-establish communications.
If a non-zero status is received, the APCP determines the TBD sequence, based upon the value.

The APCM commands the APCM radio not to transmit or receive while APCM Reset is taking place.

3. Parameter Download

Following a successful APCM reset, the APCP sends the “Initiate Parameter Download” message. Following this command, required as well as optional parameter blocks can be sent. Examples are the Operational Parameters, Valid Sensor IDs, and Data Package Descriptions. The APCM acknowledges each package.

If no response is received within TBD seconds, the APCP issues an “APCP Communications Timeout” alert and attempts to re-establish communications.

If a non-zero status is received, the APCP determines the TBD sequence, based upon the value.

The Parameter Load sequence is terminated by the “End Parameter Load” message. The APCM responds with a zero status to indicate that all the required parameters have been loaded.

If the response is nonzero, indicating that the APCM has not received all the required parameters, a TBD Alert is posted and no further sequencing occurs.

The APCM commands the APCM radio not to transmit or receive while Parameter Download is taking place.

4. Begin Radio XMIT/RCV

After Establish Communication, APCM Reset, and Parameter Download have been performed, both processors are ready to communicate with external sensors. The APCP issues the “Begin Radio XMIT/RCV” command to the APCM and the APCM responds with the state of the radio, following a TBD radio startup sequence.

2.1.1.3.3 Sensor Data Acquisition

APCP to APCM Radio sequencing for sensor data acquisition is illustrated in Figure 3. The logic is TBD.

2.1.1.3.4 Network Management

APCP to APCM Radio sequencing for network management is illustrated in Figure 4. The logic is TBD.
Figure 1. RSVP Communication System Architecture
Figure 2. APCP to APCM Radio Initialization Sequencing
Figure 3. APCP to APCM Radio Sensor Data Acquisition Sequencing
### 2.1.1.4 APCP to APCM Radio Message Description

Table 3 summarizes the messages at the APCP to APCM Radio interface. The content of these messages is defined in individual tables in Appendix A.

<table>
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<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
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<td>Hello</td>
<td>APCP</td>
<td>APCM</td>
<td>Command to transmit status</td>
<td>APCP determination</td>
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<td>Hello Acknowledge</td>
<td>APCM</td>
<td>APCP</td>
<td>Hello message received; no failure or request for service</td>
<td>Receipt of message</td>
<td>Table 26</td>
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<tr>
<td>Trouble</td>
<td>APCM</td>
<td>APCP</td>
<td>Hello command received; APCM has failed or requests service</td>
<td>Receipt of message</td>
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<td>Reset</td>
<td>APCP</td>
<td>APCM</td>
<td>Command to clear all data</td>
<td>Startup, reboot, power fail</td>
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<td>APCM</td>
<td>APCP</td>
<td>Reset command received</td>
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<td>Source</td>
<td>Destination</td>
<td>Function</td>
<td>Trigger</td>
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<td>APCM</td>
<td>APCP</td>
<td>Frequency Setting message received, but will not be honored due to APCM not being reset</td>
<td>Receipt of message</td>
<td>Table 35</td>
</tr>
<tr>
<td>Downlink</td>
<td>APCP</td>
<td>APCM</td>
<td>Command to send data to SC or PSM</td>
<td>Operator input at watchstation</td>
<td>Table 36</td>
</tr>
<tr>
<td>Downlink Acknowledge</td>
<td>APCM</td>
<td>APCP</td>
<td>Downlink message received, will be honored</td>
<td>Receipt of message</td>
<td>Table 37</td>
</tr>
<tr>
<td>Downlink Unknown</td>
<td>APCM</td>
<td>APCP</td>
<td>Downlink message received, but will not be honored because SC or PSM unknown</td>
<td>Receipt of message</td>
<td>Table 38</td>
</tr>
<tr>
<td>Downlink Size Error</td>
<td>APCM</td>
<td>APCP</td>
<td>Downlink message received, but will not be honored because message too large to fit in network management header</td>
<td>Receipt of message</td>
<td>Table 39</td>
</tr>
<tr>
<td>APCM Assignments</td>
<td>APCP</td>
<td>APCM</td>
<td>Identifies channels used by other APs in compartment</td>
<td>Subsequent to reset</td>
<td>Table 40</td>
</tr>
<tr>
<td>APCM Assignments Acknowledge</td>
<td>APCM</td>
<td>APCP</td>
<td>APCM Assignments message received, will be put into effect upon receipt of Frequency Setting message</td>
<td>Receipt of message</td>
<td>Table 41</td>
</tr>
<tr>
<td>Get Routing Table</td>
<td>APCP</td>
<td>APCP</td>
<td>Request for APCM routing table</td>
<td>APCP determination</td>
<td>Table 42</td>
</tr>
<tr>
<td>Routing Table</td>
<td>APCM</td>
<td>APCP</td>
<td>Data requested by Get Routing Table message</td>
<td>Receipt of message</td>
<td>Table 43</td>
</tr>
<tr>
<td>Message</td>
<td>Source</td>
<td>Destination</td>
<td>Function</td>
<td>Trigger</td>
<td>Content</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------</td>
<td>-------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Set Aging Threshold</td>
<td>APCP</td>
<td>APCM</td>
<td>Number of network management messages before a silent SC is considered</td>
<td>Following reset</td>
<td>Table 44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>dead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aging Threshold Acknowl</td>
<td>APCM</td>
<td>APCP</td>
<td>Set Aging Threshold message received, will be honored immediately</td>
<td>Receipt of</td>
<td>Table 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>message</td>
<td>message</td>
<td></td>
</tr>
<tr>
<td>Set RSSI Threshold</td>
<td>APCP</td>
<td>APCM</td>
<td>Minimum RSSI that SC not already in network must meet to be admitted to</td>
<td>Following reset</td>
<td>Table 46</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSSI Threshold Acknowl</td>
<td>APCM</td>
<td>APCP</td>
<td>Set RSSI Threshold message received, will be honored immediately</td>
<td>Receipt of</td>
<td>Table 47</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>message</td>
<td>message</td>
<td></td>
</tr>
<tr>
<td>Routing Addition</td>
<td>APCM</td>
<td>APCP</td>
<td>Specified SC has been admitted to network</td>
<td>Event</td>
<td>Table 48</td>
</tr>
<tr>
<td>Routing Deletion</td>
<td>APCM</td>
<td>APCP</td>
<td>Specified SC has been deleted from network</td>
<td>Event</td>
<td>Table 49</td>
</tr>
<tr>
<td>Uplink</td>
<td>APCM</td>
<td>APCP</td>
<td>Data received from SC or PSM</td>
<td>Event</td>
<td>Table 50</td>
</tr>
</tbody>
</table>

### 2.1.2 Access Point Control Processor to System Health Monitor Radio

#### 2.1.2.1 APCP to SHM Radio Mechanical Interface

The SHM Radio will be connected to the APCP via a PCI board. The mechanical interface will conform to the PCI Local Bus Standard\(^1\).

#### 2.1.2.2 APCP to SHM Radio Electrical Interface

The SHM Radio will be connected to the APCP via a PCI board. The electrical interface will conform to the PCI Local Bus Standard\(^1\).
2.1.2.3 APCP to SHM Radio Sequencing

An APCP will operate normally in the absence of an SHM Radio board. An APCM Radio will maintain itself in an inactive state in the absence of an SHM board.

2.1.2.4 APCP to SHM Radio Message Description

Table 4 summarizes the messages at the APCP to SHM Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 4. Messages at the APCP to SHM Radio Interface

<table>
<thead>
<tr>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.1.3 Access Point Control Processor to Video

The video unit has two parts – One is the actual video camera and the other is a PC-card video controller. Both units are made by Videum and have been tested in FY99 demonstrations.

2.1.3.1 APCP to Video Mechanical Interface

The Camera unit is 8” x 6” x 6” and has connections for an external power supply, an SVID interface and an RCA plug for a twisted pair interface.

The video controller card is a PCI bus card, which is installed into the AP’s backplane. It has external connections for both an RCA connector and an SVID connector.

2.1.3.2 APCP to Video Electrical Interface

The camera requires an external power source giving 13.5 VDC and 1 A. The camera is shipped with the power supply, which requires AC power. The camera has two interfaces to the controller:

- Twisted pair cable having RCA adapters at each end. This cable can be 100 feet long. Video data from the camera to the PC controller card is transferred over this interface, but not pan and tilt commands to the camera.
- SVID interface that provides video as well as commands to the camera.

The video controller interfaces to the processor’s PCI bus and conforms to the PCI bus electrical standard.

2.1.3.3 APCP to Video Sequencing

The Camera and the APCP are independent devices. Either may be powered on at any time without the other being powered on. The AP software is able to detect the state of the camera by software resident on the controller card.
2.1.3.4 APCP to Video Message Description

The communications from APCP applications software to the interface controller is through a COTS API, which is made by Videum.

2.1.4 APCP to Other I/O

In a fully implemented system based on RSVP principles, the APCP could have interfaces to devices not included in the demonstrations. These might include

- Sensors wired directly to the AP
- Interface to wired networks, such as automotive or industrial buses

2.2 Remote Station Internal

2.2.1 Environment Sensor Cluster Microcontroller to Environment Sensor Cluster Radio

2.2.1.1 ESC MCU to ESC Radio Mechanical Interface

TBD

2.2.1.2 ESC MCU to ESC Radio Electrical Interface

The Environment Sensor Cluster MCU and Environment Sensor Cluster Radio both operate at 3.3V nominal, +/-10%. Radio power is controlled by the MCU. For digital signals, logic 0 is 0 V, and logic 1 is 3.3 V. Signals in the Sensor Cluster MCU/Radio interface are described in Table 5.
Table 5. Signals in Sensor Cluster MCU to Sensor Cluster Radio Interface

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Description</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFDATAOUT</td>
<td>serial data</td>
<td>Radio</td>
<td>MCU</td>
</tr>
<tr>
<td>RSSI</td>
<td>Analog RF level</td>
<td>Radio</td>
<td>MCU</td>
</tr>
<tr>
<td>RFDATAIN</td>
<td>serial data</td>
<td>MCU</td>
<td>Radio</td>
</tr>
<tr>
<td>RF_SYN_CLK</td>
<td>clock to strobe input to radio synthesizer</td>
<td>MCU</td>
<td>Radio</td>
</tr>
<tr>
<td>RF_SYN_DATA</td>
<td>serial data input to radio synthesizer</td>
<td>MCU</td>
<td>Radio</td>
</tr>
<tr>
<td>RF_SYN_STB</td>
<td>counter load strobe to radio synthesizer</td>
<td>MCU</td>
<td>Radio</td>
</tr>
<tr>
<td>RF_RCV_ON</td>
<td>Receiver enable (logic 1 enables)</td>
<td>MCU</td>
<td>Radio</td>
</tr>
<tr>
<td>RF_XMIT_ON</td>
<td>Transmitter enable (logic 1 enables)</td>
<td>MCU</td>
<td>Radio</td>
</tr>
<tr>
<td>RF_ON</td>
<td>Radio enable (logic 1 enables)</td>
<td>MCU</td>
<td>Radio</td>
</tr>
</tbody>
</table>

2.2.1.3 ESC MCU to ESC Radio Sequencing

2.2.1.3.1 Initialization

The following is the sequence of events for RF transmission.

- Assert RF_RCV_ON and RF_ON
- Transfer 22 bits to synthesizer in radio to program it to operate at desired frequency
  - Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  - Assert RF_SYN_STB
  - Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  - Assert RF_SYN_STB
- Wait for oscillator to stabilize and lock to loop (5 ms maximum)
- De-assert RF_RCV_ON and assert RF_XMIT_ON
- Wait for transient to die out (100 μs maximum)
- Transfer serial data via RFDATAIN
- De-assert RF_ON and RF_XMIT_ON

The following is the sequence of events for RF reception.
• Assert RF_RCV_ON and RF_ON
• Wait for 100 μs
• Transfer 22 bits to synthesizer in radio to program it to operate at desired frequency
  – Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  – Assert RF_SYN_STB
  – Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  – Assert RF_SYN_STB
• Wait for oscillator to stabilize and lock to loop (5 ms maximum)
• Clear UART buffer of erroneous characters, if any (performed automatically by radio)
• Wait for transient to die out (100 μs maximum)
• Transfer serial data via RFDATAOUT
• De-assert RF_ON and RF_RCV_ON

2.2.1.3.2 Data Timing

Following initialization, the data transfer rate is 57,600 baud. Total message time must fit within 8 ms.

2.2.1.3.3 State Diagrams

Figure 5 through Figure 9 present state diagrams that define Sensor Cluster operation.
Figure 5. Sensor Cluster State Diagram, 1 of 5
Figure 6. Sensor Cluster State Diagram, 2 of 5
Figure 7. Sensor Cluster State Diagram, 3 of 5
Figure 8. Sensor Cluster State Diagram, 4 of 5
2.2.1.4 ESC MCU to ESC Radio Message Description

ESC MCU to ESC Radio messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity bit
- Stop bit

The interpretation of individual bytes is the same as for Access Point to Sensor Cluster communication, as described in section 2.4.1.4. The ESC Radio serves as a conduit between AP and ESC MCU.

2.2.1.4.1 Conversion of transmitted data to engineering units

Equation 1 is used to convert the transmitted value of RSSI to engineering units.

Equation 1

\[
\text{RSSI (dB)} = (\text{Transmitted value} \times (3.3 \text{ V} / 256) - 0.3 \text{ V}) \times (1 \text{ dB} / 0.01625 \text{ V})
\]
Equation 2 is used to convert the transmitted value from a linear temperature sensor to degrees Celsius.

Equation 2

\[ T(°C) = 28 \text{ mV} \times 25 °C / ((\text{Transmitted value} \times 3.3 \text{ V} / 256) - 0.25\text{V}) \]

Equation 3 is used to convert the transmitted value from a thermistor to degrees Kelvin.

Equation 3

\[ T(°K) = 1 / ((1/T_0) - (\ln(R_0/(3.3 \text{ V} \times R / \text{Transmitted value}) - R) / \beta)) \]

where

- \( T_0 \) (temperature at which \( R_0 \) is measured) = 298° K
- \( R_0 \) (nominal resistance) = 100,000 Ω
- \( \beta \) (Beta) = 3750
- \( R \) (for habitation-range thermistors) = 49,900 Ω
- \( R \) (for wide-range thermistor) = 10,000 Ω

Equation 4 is used to convert the transmitted value for a threshold set point to degrees Kelvin.

Equation 4

\[ T(°K) = 3.3 \text{ V} \times R / (R_0/((10^{\beta(1/T_0 - 1/\text{Transmitted value})}) + R)) \]

where

- \( T_0 \) (temperature at which \( R_0 \) is measured) = 298° K
- \( R_0 \) (nominal resistance) = 100,000 Ω
- \( \beta \) (Beta) = 3750
- \( R \) (for habitation-range thermostors) = 49,900 Ω
- \( R \) (for wide-range thermistor) = 10,000 Ω

Equation 5 is used to convert the transmitted value from a pressure sensor to pounds per square inch atmospheric (PSIA).
Equation 5

\[ P(\text{PSIA}) = \text{Transmitted value} \times \left( \frac{3.3 \text{ V}}{256} \right) \times \left( \frac{1 \text{ PSIA}}{0.06\text{V}} \right) \]

Sound is measured with respect to ambient noise. Adjustable gain allows interrupt level to change dynamically with environment. Equation 6 is used to convert the transmitted value for microphone gain to actual gain. (A small gain represents a large volume over ambient, and vice versa.) Equation 7 is used to convert gain to dB.

Equation 6

\[ \text{Gain} = 0.1 \times 2^{\text{Transmitted value}} \]

Equation 7

TBD

Equation 8 is used to convert the transmitted value from an oxygen sensor to \( \text{O}_2 \) concentration in percent.

Equation 8

\[ \text{O}_2(\%) = \text{Transmitted value} \times 20.9\% / \text{Calibration Value at 20.9\%} \]

Equation 9 is used to convert the transmitted value from a carbon monoxide sensor to \( \text{CO} \) concentration in parts per million.

Equation 9

\[ \text{CO(PPM)} = \text{Transmitted Value} / \left( 2.16 \text{ mV} / \text{PPM} \right) \]

Equation 10 is used to convert the transmitted value from an ionization smoke detector to TBD (engineering units).

Equation 10

TBD

Equation 11 is used to convert the transmitted data from a photoelectric smoke detector to TBD (engineering units).

Equation 11

TBD
Equation 12 is used to convert the transmitted value from a voltage sensor to Volts. It is used for battery and reference voltages.

Equation 12

\[ V = \text{Transmitted value} \times \frac{3.3\, \text{V}}{256} \]

Equation 13 is used to convert the transmitted value from a humidity sensor to percent relative humidity.

Equation 13

TBD

2.2.2 Structure Sensor Cluster Microcontroller to Structure Sensor Cluster Radio

2.2.2.1 SSC MCU to SSC Radio Mechanical Interface

TBD

2.2.2.2 SSC MCU to SSC Radio Electrical Interface

The Structure Sensor Cluster MCU and Structure Sensor Cluster Radio both operate at 3.3V nominal, +/-10%. Radio power is controlled by the MCU. For digital signals, logic 0 is 0 V, and logic 1 is 3.3 V. Signals in the Sensor Cluster MCU/Radio interface are described in Table 5.

2.2.2.3 SSC MCU to SSC Radio Sequencing

SSC MCU to SSC Radio sequencing is the same as ESC MCU to ESC Radio sequencing, as described in section 2.2.1.3.

2.2.2.4 SSC MCU to SSC Radio Message Description

SSC MCU to SSC Radio messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity bit
- Stop bit

The interpretation of individual bytes is the same as for Access Point to Sensor Cluster communication, as described in section 2.4.1.4. The SSC Radio serves as a conduit between AP and SSC MCU.
2.2.4.1 Conversion of transmitted data to engineering units

Equation 1 (section 2.2.1.4.1) is used to convert the transmitted value of RSSI to engineering units.

Equation 14 is used to convert the transmitted value from a strain sensor to TBD (engineering units).

\[ \text{Equation 14} \]

TBD

Equation 15 is used to convert the transmitted data from a high-g accelerometer to TBD (engineering units).

\[ \text{Equation 15} \]

TBD

Equation 16 is used to convert the transmitted value a low-g accelerometer to TBD (engineering units).

\[ \text{Equation 16} \]

TBD

2.2.3 Personnel Status Monitor Microcontroller to Personnel Status Monitor Radio

The Personnel Status Monitor comprises an Integrated Sensor Unit (ISU) worn on the torso and a Communication Interface Unit worn on the belt. Communication between these units is inherent to the Sarcos-supplied devices, and is outside the scope of RSVP.

Figure 10 depicts the PSM CIU (or “beltpack”), which comprises the PSM microcontroller and the PSM Radio.

2.2.3.1 PSM MCU to PSM Radio Mechanical Interface

TBD

2.2.3.2 PSM MCU to PSM Radio Electrical Interface

The PSM MCU and PSM Radio both operate at 3.3V nominal, +/-10%. Radio power is controlled by the MCU. All signals are digital. Logic 0 is 0 V, logic 1 is 3.3 V. Signals in the PSM MCU/PSM Radio interface are described in Table 6.
### Table 6. Signals in PSM MCU to PSM Radio Interface

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Description</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
</table>
| PREQ        | 0 to 1: interrupt MCU to waken if in Sleep mode  
             | 1: transfer bytes to MCU over RDO, under control of PGNT  
             | 1 to 0: transfer complete | Radio | MCU |
| PGNT        | 1: allow bytes to be transferred over RDO  
             | 0: suspend transfer (used to accomplish flow control) | MCU | Radio |
| RDO         | serial data | Radio | MCU |
| RREQ        | 0 to 1: interrupt Radio to waken if in Sleep mode  
             | 1: transfer bytes to Radio over PDO, under control of RGNT  
             | 1 to 0: transfer complete | MCU | Radio |
| RGNT        | 1: allow bytes to be transferred over PDO  
             | 0: suspend transfer (used to accomplish flow control) | Radio | MCU |
| PDO         | serial data | MCU | Radio |
| MCLK        | 28.8 kHz master clock | Radio | PSM |

### 2.2.3.3 PSM MCU to PSM Radio Sequencing

Figure 11 illustrates the PSM Radio to PSM MCU and PSM MCU to PSM Radio communications sequences.
Figure 11. Personal Status Monitor to PSM Radio Communications Sequencing
2.2.3.4 PSM MCU to PSM Radio Message Description

PSM MCU to PSM Radio Messages consist of a string of up to TBD bytes, each encoded as 8 data bits (no start, stop, or parity bits) transmitted MSB first.

Messages are not acknowledged.

Table 7 summarizes the messages at the PSM MCU to PSM Radio interface. The content of these messages is defined in individual tables in Appendix A.

<table>
<thead>
<tr>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter Normal Operation</td>
<td>PSM Radio</td>
<td>PSM MCU</td>
<td>Command to leave Sleep mode</td>
<td>Receipt of Exit Standby message from APCM</td>
<td>Table 51</td>
<td></td>
</tr>
<tr>
<td>Enter Standby</td>
<td>PSM Radio</td>
<td>PSM MCU</td>
<td>Command to enter Sleep mode</td>
<td>Receipt of Enter Standby message from APCM</td>
<td>Table 52</td>
<td></td>
</tr>
<tr>
<td>Downlink Data</td>
<td>PSM Radio</td>
<td>PSM MCU</td>
<td>Packet of downlink data</td>
<td>Event</td>
<td>Table 53</td>
<td></td>
</tr>
<tr>
<td>Physiological Data</td>
<td>PSM MCU</td>
<td>PSM Radio</td>
<td>Packet of physiological data</td>
<td>Time or PSM decision based on data fusion</td>
<td>Table 54</td>
<td></td>
</tr>
<tr>
<td>Low Voltage Shutdown</td>
<td>PSM MCU</td>
<td>PSM Radio</td>
<td>Battery needs to be recharged or replaced</td>
<td>Low voltage detected</td>
<td>Table 57</td>
<td></td>
</tr>
</tbody>
</table>
2.3 Wired Network

2.3.1 Access Point to Access Point

2.3.1.1 AP to AP Mechanical Interface

Access Points are connected to the wired network by means of RJ45 connectors and Category 5 Cable.

2.3.1.2 AP to AP Electrical Interface

The electrical interface to the wired network consists of a COTS 10/100Base-T network interface card.

2.3.1.3 AP to AP Sequencing

There is no restriction on the order in which APs come on line and go off line.

The minimum number of APs per compartment required for the AP(s) in the compartment to function properly is one. The maximum number of AP per compartment is TBD (for large spaces such as Main Engine Rooms, approximately 10; for other ship spaces, approximately 4). The minimum number of compartments for which APs must be active is zero (that is, any AP can be the first to come on line; the system supports APs coming online again after all APs have gone off line).

2.3.1.4 AP to AP Message Description

Table 8 summarizes the messages at the AP to AP interface. The content of these messages is defined in subsequent tables.
Table 8. AP to AP Messages

<table>
<thead>
<tr>
<th>Message Name</th>
<th>Trigger</th>
<th>Publisher</th>
<th>Subscriber</th>
<th>Server</th>
<th>Client</th>
<th>Message Description</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Data</td>
<td>data</td>
<td>AP</td>
<td>AP</td>
<td></td>
<td></td>
<td>Shared intracompartment data</td>
<td>Table 9</td>
</tr>
<tr>
<td>Data Fusion</td>
<td>time</td>
<td>AP</td>
<td>AP</td>
<td></td>
<td></td>
<td>Aggregated data set used for fusion</td>
<td>Table 10</td>
</tr>
<tr>
<td>Package</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9. Content of Sensor Data Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>&lt;specialized by sensor&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Content of Data Fusion Package Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Vector&lt;vector&lt;specialized by sensor&gt;&gt;</td>
<td></td>
<td>Most recent readings from all sensors</td>
</tr>
</tbody>
</table>
2.3.2 Access Point to Watchstation

2.3.2.1 AP to Watchstation Mechanical Interface

Access Points and watchstations are connected to the wired network by means of RJ45 connectors and Category 5 Cable.

2.3.2.2 AP to Watchstation Electrical Interface

The electrical interface to the wired network consists of a COTS 10/100Base-T network interface card.

2.3.2.3 AP to Watchstation Sequencing

There is no restriction on the order in which APs and watchstations come on line and go off line. Watchstations can come on line and go off line at any time without causing APs to operate incorrectly. APs can come on line and go off line at any time without causing watchstations to operate incorrectly.

The minimum number of watchstations required for APs to function properly is zero.

The minimum number of APs required for watchstations to function properly is zero.

The maximum number of watchstations RSVP can support is TBD (for the demonstrations, approximately 3; for a full implementation on a destroyer, approximately 20; for a full implementation on a carrier approximately 100).

The maximum number of AP per compartment that RSVP watchstations can support is TBD (for large spaces such as Main Engine Rooms, approximately 10; for other ship spaces, approximately 4).

Video transmission from an AP to a watchstation is initiated by command from the watchstation, and is terminated by a command from the watchstation or the observation by the AP that the watchstation is no longer connected.

Transmission of recorded video from an AP to a watchstation is performed upon command from the watchstation.

2.3.2.4 AP to Watchstation Message Description

Table 11 summarizes the messages at the AP to Watchstation interface. The content of these messages is defined in subsequent tables.
Table 11. AP to Watchstation Messages

<table>
<thead>
<tr>
<th>Message Name</th>
<th>Trigger</th>
<th>Publisher</th>
<th>Subscriber</th>
<th>Source</th>
<th>Target</th>
<th>Message Description</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm</td>
<td>Data fusion</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>Data fusion detected alarm condition</td>
<td>Table 12</td>
</tr>
<tr>
<td>Video</td>
<td>GUI</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>Video frames</td>
<td>Table 13</td>
</tr>
<tr>
<td>Sensor Data</td>
<td>New data</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>Continuous data update</td>
<td>Table 14</td>
</tr>
<tr>
<td>Time Synchronization</td>
<td>Time</td>
<td>AP</td>
<td>AP,WS</td>
<td></td>
<td></td>
<td>Eliminate old data problems</td>
<td>Table 15</td>
</tr>
<tr>
<td>Request Compartment Occupancy</td>
<td>GUI</td>
<td></td>
<td>WS</td>
<td></td>
<td>AP</td>
<td>Number and status of sailors</td>
<td>Table 16</td>
</tr>
<tr>
<td>Compartment Occupancy</td>
<td>Request</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>Quantity and Ids and status</td>
<td>Table 17</td>
</tr>
<tr>
<td>Request Sensor Data</td>
<td>GUI</td>
<td></td>
<td>WS</td>
<td></td>
<td>AP</td>
<td>Request one set of data or continuous update</td>
<td>Table 18</td>
</tr>
<tr>
<td>Sensor Data Reply</td>
<td>Request</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>Or could be in data base at WS</td>
<td>TBD</td>
</tr>
<tr>
<td>Request Sensor ID</td>
<td>GUI</td>
<td></td>
<td>WS</td>
<td></td>
<td>AP</td>
<td>Or could be in data base at WS</td>
<td>TBD</td>
</tr>
<tr>
<td>Sensor ID</td>
<td>Request</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>Or could be in data base at WS</td>
<td>TBD</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>GUI</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td>AP</td>
<td>What wrong with RSVP</td>
<td>TBD</td>
</tr>
<tr>
<td>Data Fusion Script</td>
<td>GUI</td>
<td></td>
<td>WS</td>
<td></td>
<td>AP</td>
<td>What wrong with RSVP</td>
<td>TBD</td>
</tr>
<tr>
<td>Request Recorded Video</td>
<td>GUI</td>
<td></td>
<td>WS</td>
<td></td>
<td>AP</td>
<td>What wrong with RSVP</td>
<td>TBD</td>
</tr>
<tr>
<td>Recorded Video</td>
<td>Request</td>
<td>AP</td>
<td>WS</td>
<td></td>
<td></td>
<td>What wrong with RSVP</td>
<td>TBD</td>
</tr>
<tr>
<td>Downlink</td>
<td>TBD</td>
<td></td>
<td></td>
<td>AP</td>
<td>WS</td>
<td>What wrong with RSVP</td>
<td>TBD</td>
</tr>
</tbody>
</table>
### Table 12. Content of Alarm Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>char[128]</td>
<td></td>
<td>AP generated message about the alarm</td>
</tr>
<tr>
<td>PubAP</td>
<td>int</td>
<td></td>
<td>ID of AP publishing alarm</td>
</tr>
<tr>
<td>Severity</td>
<td>enumSeverity</td>
<td>ALERT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ALARM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>FIRE_OUT</td>
<td></td>
</tr>
<tr>
<td>Sensor Cluster’s</td>
<td>vector&lt;int&gt;</td>
<td></td>
<td>Ids of sensors associated with alarm</td>
</tr>
<tr>
<td>Sensor ID</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 13. Content of Video Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>2.3.2.4.1.1 Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>int</td>
<td></td>
<td>Length of data stream</td>
</tr>
<tr>
<td>Data</td>
<td>UCHAR</td>
<td></td>
<td>Video data byte stream</td>
</tr>
</tbody>
</table>

### Table 14. Content of Sensor Data Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SensorData</td>
<td>&lt;specialized by sensor&gt;</td>
<td></td>
<td>Sensor data subscription</td>
</tr>
</tbody>
</table>
Table 15. Content of Time Synchronization Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Time</td>
<td></td>
<td>time</td>
</tr>
</tbody>
</table>

Table 16. Content of Request Compartment Occupancy Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBD</td>
<td>TBD</td>
<td></td>
<td>TBD</td>
</tr>
<tr>
<td>TBD</td>
<td>TBD</td>
<td></td>
<td>TBD</td>
</tr>
</tbody>
</table>

Table 17. Content of Compartment Occupancy Reply Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>int</td>
<td>0:N</td>
<td>Number of individuals in compartments</td>
</tr>
<tr>
<td>SailorIDs</td>
<td>vector&lt;int&gt;</td>
<td></td>
<td>Ids of sailors in compartment</td>
</tr>
<tr>
<td>Sailor status</td>
<td>TBD</td>
<td>11 = R(ed)</td>
<td>Status of individual sailor in compartment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 = Y(ellow)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>01 = U(nknown)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>00 = G(reen)</td>
<td></td>
</tr>
</tbody>
</table>
### Table 18. Content of Request Sensor Data Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ReplyOrSub</td>
<td>enumReplyOrSub</td>
<td>REPLY</td>
<td>Respond with data in reply message</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PUBLICATION</td>
<td>Create publication for continuous update</td>
</tr>
<tr>
<td>StartTime</td>
<td>time</td>
<td>DEFAULT time</td>
<td>1 hour ago</td>
</tr>
<tr>
<td>EndTime</td>
<td>time</td>
<td>DEFAULT time</td>
<td>Now</td>
</tr>
<tr>
<td>Interval</td>
<td>time</td>
<td>DEFAULT time</td>
<td>5 minutes</td>
</tr>
</tbody>
</table>

### Table 19. Content of Request Sensor Reply Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Values</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>enumRequestStatus</td>
<td>PUBLICATION_CREATED</td>
<td>Number of individuals in compartments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PUBLICATION_FAILURE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>REPLY_ENCLOSED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>REPLY_FAILRE</td>
<td></td>
</tr>
<tr>
<td>vSensorData</td>
<td>vector&lt;specialized by sensor&gt;</td>
<td></td>
<td>Sensor data reply</td>
</tr>
</tbody>
</table>
2.4 Wireless Network

The RSVP concept comprises three wireless network concepts.

1. Aloha. This network is employed for communication where low data rates are acceptable and the availability of electric power is limited. It is employed where the remote station is mobile. Care must be taken to keep the loading on this network as low as possible, because message reliability decreases sharply as loading increases. The Aloha network will be available in all ship spaces participating in an RSVP demonstration, and in a fully implemented system, it would be available in all ship spaces. The Aloha network is used for all AP-to-PSM communication. It is used by APs to transmit the IDs of the channels to which they are tuned. In the event that RSVP is modified to support ordinance monitoring, ordinance-to-AP messages would be carried over the Aloha network. Owing to the unavailability of a commercial radio with suitable low-power characteristics, the radios for this network are being designed and fabricated by the Draper Laboratory.

2. Reservation. This network is used for communication where low data rates are acceptable, the availability of electric power is limited, and message traffic is predictable. The reservation network will be available in all ship spaces participating in an RSVP demonstration, and in a fully implemented system, it would be available in all ship spaces. The reservation network is used for all AP-to-SC communication except the transmission of AP channel ID. Owing to the unavailability of a commercial radio with suitable low-power characteristics, the radios for this network are being designed and fabricated by the Draper Laboratory.

3. Commercial standard. This network is used for communication where high data rates are required and where the electric power draw is not an issue. The only identified user of this network is AP to SHM communication; consequently, only compartments that contain machinery need a commercial standard network. IEEE 802.11 is the selected technology.

Messages transmitted over the air interface employ 16-bit Cyclic Redundancy Check (CRC) for error detection. The generator polynomial is \( X^{16} + X^{15} + X^2 + 1 \).

Certain messages transmitted over the air interface include a byte containing Relative Signal Strength Indicator (RSSI). The units of RSSI are Volts per dBm, where dBm means power referenced to a 1-mW reference.

2.4.1 Access Point to Sensor Cluster

2.4.1.1 APCM to SC Radio Mechanical Interface

Access Points are not mechanically connected to Sensor Clusters.

In principle, to operate in the 2.4 GHz band, an SC needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship’s compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.
2.4.1.2 APCM to SC Radio Electrical Interface

The APCM and SC transfer messages across the air interface. Messages consist of a string of bytes in standard asynchronous serial format, using one start bit, one stop bit, and a trailing parity bit. The sense of the parity bit is odd during a message preamble, and even otherwise. The basic data rate is 57.6 kbps, which is compatible with other elements of the RSVP system. Radiated RF power is under 1 mw. Frequency-shift-keyed FM is employed.

2.4.1.3 APCM to SC Radio Sequencing

2.4.1.3.1 Aloha channel

A single channel is used throughout the ship as the Aloha channel. The ID of the Aloha channel is provided to the Access Point as part of the initialization procedure. The choice of channel is programmable, in case unforeseen circumstances cause the channel to become unusable. Remote stations that use the Aloha channel are preprogrammed with the IDs of two possible channels, a primary and an alternate.

Each Access Point transmits a message containing the ID of the channel it employs on the reservation network. There is no acknowledgement or retransmission of a failed message. This message is transmitted at a nominal rate of 1Hz. The exact transmission frequency is randomized to reduce the probability of collisions recurring. Access Points receive on the Aloha channel from time to time for the purpose of judging the health of the channel.

Sensor Clusters do not transmit on the Aloha channel. The Sensor Cluster channel acquisition procedure includes the Sensor Cluster receiving on the Aloha channel to obtain AP messages that identify which channels are assigned to which APs.

2.4.1.3.2 Reservation Channel

Each Access Point is assigned a particular reservation channel on which it transmits and receives. The channel assignment is programmable, in case difficulty communicating on a particular channel is encountered. A Sensor Cluster becomes “connected” to an AP via an exchange of messages called the acquisition process. The acquisition process includes the AP giving the SC a “slot” ID that defines the interval that is reserved (hence the term “reservation channel”) for SC transmission. The acquisition process is initiated by the Sensor Cluster that wants to be acquired. An Access Point may decline to accept a Sensor Cluster that wishes to be acquired, but a Sensor Cluster that has been denied may reapply with an “urgent” priority, which the Access Point will honor. Grounds for an AP declining to accept an SC include:

- The SC is not in the same compartment as the AP
- The SC would put the number of SCs “connected” to the AP over a threshold, TBD (approximately 50)
- The RSSI as detected by the AP is much less than that detected by the SC
An Access Point determines that a Sensor Cluster has failed by observing the absence of messages in the SC's reserved slot. The AP responds to the failure by recording it for purposes of assessing the health of the RSVP system, and by making the failed SC's reserved slot available for assignment to another SC. No other action is necessary.

A Sensor Cluster determines that an Access Point has failed by observing the absence of messages at the time the AP is expected to transmit. The Sensor Cluster responds to the failure by performing the acquisition process to “connect” with another AP. No other action is necessary.

An Access Point transmits a message for Sensor Clusters once per second ±100 µs, regardless of whether it actually has information to convey, and regardless of whether any Sensor Clusters are connected to the Access Point. Each Access Point listens for messages from Sensor Clusters on the AP’s channel.

Each Sensor Cluster connected to the AP has been assigned a fixed time at which the SC is allowed to transmit a message. The AP receiver is enabled at this time, but the SC may or may not transmit. Whether the SC transmits or not is determined by the SC based on the time that has elapsed since its last transmission and the SC’s assessment of whether the sensor data is “interesting.” When the sensor data is “uninteresting” the SC transmits a message (in its reserved slot) periodically (approximately every 10th second). When the sensor data is “interesting” the SC transmits messages more often (but always in its reserved slot).

2.4.1.4 APCM to SC Radio Message Description

APCM to SC Radio Messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity
- Stop bit

Bytes in uplink messages (SC Radio to APCM) have odd parity. Bytes in downlink messages (APCM to SC Radio) have even parity.

The first three bytes of every message constitute a header. The hexadecimal value of these bytes is FF00FF. Care is taken in the layout of subsequent bytes of the message to ensure that the sequence FF00FF cannot occur elsewhere in the message. If necessary, the range of an analog value is restricted to 1-254 instead of the usual 0-255.

Table 20 summarizes the messages at the AP to SC Radio interface. The content of these messages is defined in individual tables in Appendix A.
Table 20. APCM to SC Radio Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Management Data Frame</td>
<td>APCM</td>
<td>SC</td>
<td>Synchronization; identify start of frame</td>
<td>Time (periodic @ 1 Hz)</td>
<td>Table 58</td>
</tr>
<tr>
<td>AP Slot Assignment</td>
<td>APCM</td>
<td>SC</td>
<td>Identifies slot reserved for SC</td>
<td>Sensor Cluster Request message</td>
<td>Table 59</td>
</tr>
<tr>
<td>Downlink Data</td>
<td>APCM</td>
<td>SC</td>
<td>Data packet</td>
<td>Event</td>
<td>Table 60</td>
</tr>
<tr>
<td>Sensor Cluster Request</td>
<td>SC</td>
<td>APCM</td>
<td>Request “connection” to AP</td>
<td>SC decision (occurs rarely)</td>
<td>Table 61</td>
</tr>
<tr>
<td>Sensor Cluster Emergency Request</td>
<td>SC</td>
<td>APCM</td>
<td>Request “connection” to AP after being unsuccessful</td>
<td>SC decision (occurs rarely)</td>
<td>Table 62</td>
</tr>
<tr>
<td>Environment Sensor Cluster Analog Uplink</td>
<td>SC</td>
<td>APCM</td>
<td>Data packet</td>
<td>SC decision based on time &amp; interest criteria (period is 1-10 s)</td>
<td>Table 63</td>
</tr>
<tr>
<td>Environment Sensor Cluster Sound Uplink</td>
<td>SC</td>
<td>APCM</td>
<td>Data packet</td>
<td>SC decision based on time &amp; interest criteria (period is 1-10 s)</td>
<td>Table 64</td>
</tr>
<tr>
<td>Structure Sensor Cluster Uplink</td>
<td>SC</td>
<td>APCM</td>
<td>Data packet</td>
<td>SC decision based on time &amp; interest criteria (period is 1-10 s)</td>
<td>Table 65</td>
</tr>
</tbody>
</table>

2.4.2 Access Point Communication Module to Personnel Status Monitor

2.4.2.1 APCM to PSM Radio Mechanical Interface

Access Points are not mechanically connected to Personnel Status Monitors.

In principle, to operate in the 2.4 GHz band, a PSM needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship’s compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.
2.4.2.2 APCM to PSM Radio Electrical Interface

The APCM and PSM Radio transfer messages across the air interface. Messages consist of a string of bytes in standard asynchronous serial format, using one start bit, one stop bit, and a trailing parity bit. The sense of the parity bit is odd during a message preamble, and even otherwise. The basic data rate is 57.6 kbps, which is compatible with other elements of the RSVP system. Radiated RF power is under 1 mw. Frequency-shift-keyed FM is employed.

2.4.2.3 APCM to PSM Radio Sequencing

APCM to PSM Radio communication is carried out over the Aloha channel. A PSM may transmit a message at any time, which will in general be received by multiple APs, possibly located in multiple compartments. A PSM is expected to transmit messages containing vital signs at a rate of once every 60 seconds in routine situations, and at a rate of once every 15 seconds when the wearer is under severe physiological distress (as determined by the PSM). In the event that the PSM determines that it is undergoing rapid motion, it will transmit a message at 1 Hz to aid the location algorithm. The division of responsibilities between PSM MCU and PSM Radio to accomplish this is given in Table 21. The PSM adds a random component to transmission periods to reduce the probability of recurring collisions.

Access Points determine that a PSM has failed by observing that messages are not being received. Such determination must be coordinated with other APs, since the absence of message can be caused by the PSM’s wearer being in a location where it cannot be heard by particular APs, or by the wearer moving to a different compartment.

2.4.2.4 APCM to PSM Radio Message Description

AP to PSM Radio Messages consist of a string of up to TBD bytes, each transmitted as 11 bits in the following order:

- Start bit
- 8 data bits, least significant first
- Parity
- Stop bit

Bytes in uplink messages (PSM Radio to APCM) have odd parity. Bytes in downlink messages (APCM to PSM Radio) have even parity.

The first three bytes of every message constitute a header. The hexadecimal value of these bytes is FF00FF. Care is taken in the layout of subsequent bytes of the message to ensure that the sequence FF00FF cannot occur elsewhere in the message. If necessary, the range of an analog value is restricted to 1-254 instead of the usual 0-255.

Table 22 summarizes the messages at the AP to PSM Radio interface. The content of these messages is defined in individual tables in Appendix A.
Table 21. PSM Radio and PSM MCU Responsibilities for Physiological Data and Positioning Messages

<table>
<thead>
<tr>
<th>Condition</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PSM MCU</td>
</tr>
<tr>
<td>Rapid Motion</td>
<td>Physiological Distress</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 22. APCM to PSM Radio Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Management Data Frame</td>
<td>APCM</td>
<td>PSM Radio</td>
<td>Synchronization</td>
<td>Time (@ 1 Hz in the absence of a message directed to a specific PSM)</td>
<td>Table 66</td>
</tr>
<tr>
<td>Enter Standby</td>
<td>APCM</td>
<td>PSM Radio</td>
<td>Command all PSMs or specific PSM to enter Standby mode; transmitted @ 1 Hz for 60 s</td>
<td>Event</td>
<td>Table 67</td>
</tr>
<tr>
<td>Exit Standby</td>
<td>APCM</td>
<td>PSM Radio</td>
<td>Command all PSMs or specific PSM to exit Standby mode; transmitted @ 1 Hz for 60 s. This message is used to activate all PSMs when ship goes to General Quarters</td>
<td>Event</td>
<td>Table 68</td>
</tr>
<tr>
<td>Downlink Data</td>
<td>APCM</td>
<td>PSM Radio</td>
<td>Data packet</td>
<td>Event</td>
<td>Table 69</td>
</tr>
<tr>
<td>Physiological Data</td>
<td>PSM Radio</td>
<td>APCM</td>
<td>Corresponds to PSM MCU to PSM Radio physiological data packets</td>
<td>Event – message received from PSM MCU</td>
<td>Table 70</td>
</tr>
<tr>
<td>Positioning</td>
<td>PSM Radio</td>
<td>APCM</td>
<td>Short message used by tracking algorithm</td>
<td>Transmitted @ 1 Hz when wearer moving rapidly</td>
<td>Table 71</td>
</tr>
<tr>
<td>Low Power Shutdown</td>
<td>PSM Radio</td>
<td>APCM</td>
<td>PSM is about to shut down; battery needs to be replaced or recharged</td>
<td>Event – message received from PSM MCU</td>
<td>Table 72</td>
</tr>
</tbody>
</table>
2.4.3 Access Point Communication Module to System Health Monitor

2.4.3.1 APCM to SHM Mechanical Interface

Access Points are not mechanically connected to System Health Monitors.

In principle, to operate in the 2.4 GHz band, an SHM needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship’s compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.

2.4.3.2 APCM to SHM Radio Electrical Interface

The APCM and SHM Radio transfer messages across the air interface. Messages consist of a string of serial bytes in conformance with IEEE standard 802.11.

2.4.3.3 APCM to SHM Radio Sequencing

TBD

2.4.3.4 APCM to SHM Radio Message Description

Table 23 summarizes the messages at the APCM to SHM Radio interface. The content of these messages is defined in individual tables in Appendix A.

<table>
<thead>
<tr>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICHM Calibration</td>
<td>APCM</td>
<td>SHM</td>
<td>TBD</td>
<td>TBD</td>
<td>Table 73</td>
</tr>
<tr>
<td>ICHM Data</td>
<td>SHM</td>
<td>APCM</td>
<td>TBD</td>
<td>TBD</td>
<td>Table 74</td>
</tr>
<tr>
<td>ICHM Alert</td>
<td>SHM</td>
<td>APCM</td>
<td>TBD</td>
<td>TBD</td>
<td>Table 75</td>
</tr>
<tr>
<td>SHM System Status</td>
<td>SHM</td>
<td>APCM</td>
<td>TBD</td>
<td>TBD</td>
<td>Table 76</td>
</tr>
<tr>
<td>Configuration Data</td>
<td>SHM</td>
<td>APCM</td>
<td>TBD</td>
<td>TBD</td>
<td>Table 77</td>
</tr>
</tbody>
</table>

2.4.4 Access Point Communications Module to Ordinance Tracking Monitor

This section describes how an Ordinance Tracking Monitor (OTM) system might be integrated with RSVP. It is included for planning purposes only.

Communication between the OTM and RSVP relies upon residual capacity in the Aloha physical layer, which was designed to support an advanced Personnel Status Monitor (PSM). The OTM is envisioned as a transmit-only device, thereby allowing it to exploit the ultra low-power transmitter architecture used elsewhere in the RSVP system. Each OTM sends messages to the RSVP system approximately every 30 minutes.
reception, this data is logged to a system database from which it may be queried via the watchstation.

Each OTM is controlled by a low-power microprocessor such as the Microchip PIC16 or Motorola HC05. Every TBD minutes (approximately 30) the microprocessor wakes and samples the ambient temperature using an integral temperature sensor. Multiple sensors may be employed as required to ensure a given level of reliability. Other phenomena may be sensed. The sensed data measurements are relayed to the RSVP system, using the co-located 2.4 GHz radio transmitter. The measurements are also stored to local nonvolatile memory, in which is kept the entire profile acquired over the life of the tag. The microprocessor also provides an external serial interface. Using this interface, an external device may retrieve the measurement profile and ordnance serial number, as well as perform diagnostics on the tag operation.

2.4.4.1 Access Point Communication Module to Ordinance Tracking Monitor Mechanical Interface

Access Points are not mechanically connected to Ordinance Tracking Monitors.

In principle, to operate in the 2.4 GHz band, an OTM needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship’s compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.

2.4.4.2 Access Point Communication Module to Ordinance Tracking Monitor Electrical Interface

The OTM and APCM transfer messages across the air interface. Messages consist of a string of bytes in standard asynchronous serial format, using one start bit, one stop bit, and a trailing parity bit. The sense of the parity bit is odd during a message preamble, and even otherwise. The basic data rate is 57.6 kbps, which is compatible with other elements of the RSVP system. Radiated RF power is under 1 mw. Frequency-shift-keyed FM is employed.

2.4.4.3 Access Point Communication Module to Ordinance Tracking Monitor Sequencing

There are no restrictions on Ordinance Tracking Monitors coming on line, going off line, or moving in or out of range of any APCM. The minimum number of APs required for OTMs to perform correctly is zero. The minimum number of OTMs required for APs to perform correctly is zero. The maximum number of OTMs is TBD.

2.4.4.4 Access Point Communication Module to Ordinance Tracking Monitor Message Description

APCM to OTM Radio Messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:
Bytes in uplink messages (OTM to APCM) have odd parity. Bytes in downlink messages (APCM to OTM) have even parity.

The first three bytes of every message constitute a header. The hexadecimal value of these bytes is FF00FF. Care is taken in the layout of subsequent bytes of the message to ensure that the sequence FF00FF cannot occur elsewhere in the message. If necessary, the range of an analog value is restricted to 1-254 instead of the usual 0-255.

Table 24 summarizes the messages at the APCM to SHM Radio interface. The content of these messages is defined in a table in Appendix A.

Table 24. APCM to SHM Radio Message Summary

<table>
<thead>
<tr>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
<th>Function</th>
<th>Trigger</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTM Uplink</td>
<td>OTM</td>
<td>APCM</td>
<td>Periodic data transfer</td>
<td>Time</td>
<td>Table 78</td>
</tr>
</tbody>
</table>
3 References and Bibliography

3.1 References

3.2 Bibliography
4 Abbreviations and Acronyms

A  Ampere
AC  Alternating Current
ACK  Acknowledgement
A/D  Analog/Digital
ADC  Analog- to- Digital Converter
AP  Access Point
APCP  Access Point Control Processor
APCM  Access Point Communication Module
ARL  Advanced Research Laboratory
BIT  Built-In Test
BPM  Beats per Minute
C  Centigrade
CIC  Combat Information Center
CO  Carbon Monoxide
COTS  Commercial-off-the-Shelf
CRC  Cyclic Redundancy Check
CIU  Communication Interface Unit (component of PSM)
CW  Continuous Wave
dB  Decibel
DSSS  Direct Sequence Spread Spectrum
ESC  Environment Sensor Cluster
FFT  Fast Fourier Transform
FM  Frequency Modulation
FSK  Frequency-Shift-Keyed
GHz  Gigahertz
GMT  Greenwich Mean Time
GTE  General Telephone and Electronics
GUI  Graphical User Interface
Hz  Hertz
I/O  Input/Output
ICHM  Intelligent Component Health Monitor
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Identifier (or Identification)</td>
</tr>
<tr>
<td>ISM</td>
<td>Industrial, Scientific, and Medical</td>
</tr>
<tr>
<td>ISU</td>
<td>Integrated Sensor Unit (component of PSM)</td>
</tr>
<tr>
<td>K</td>
<td>Kelvin</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LSB</td>
<td>Least Significant Bit</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
</tr>
<tr>
<td>MCU</td>
<td>Microcontroller Unit</td>
</tr>
<tr>
<td>ms</td>
<td>Millisecond</td>
</tr>
<tr>
<td>MSB</td>
<td>Most Significant Bit</td>
</tr>
<tr>
<td>mw</td>
<td>Milli watt</td>
</tr>
<tr>
<td>NIC</td>
<td>Network Interface Card</td>
</tr>
<tr>
<td>O₂</td>
<td>Oxygen</td>
</tr>
<tr>
<td>PCI</td>
<td>Peripheral Component Interface</td>
</tr>
<tr>
<td>PPM</td>
<td>Parts per Million</td>
</tr>
<tr>
<td>PSIA</td>
<td>Pounds per Square Inch Atmospheric</td>
</tr>
<tr>
<td>PSM</td>
<td>Personnel Status Monitor</td>
</tr>
<tr>
<td>PSU</td>
<td>Pennsylvania State University</td>
</tr>
<tr>
<td>PUB</td>
<td>Publish(er)</td>
</tr>
<tr>
<td>RAM</td>
<td>Random-Access Memory</td>
</tr>
<tr>
<td>RCA</td>
<td>Radio Corporation of America</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>ROM</td>
<td>Read-Only Memory</td>
</tr>
<tr>
<td>RSSI</td>
<td>Relative Signal Strength Indicator</td>
</tr>
<tr>
<td>RSVP</td>
<td>Reduced Ship-Crew by Virtual Presence</td>
</tr>
<tr>
<td>s</td>
<td>Second</td>
</tr>
<tr>
<td>SC</td>
<td>Sensor Cluster</td>
</tr>
<tr>
<td>SHM</td>
<td>System Health Monitor</td>
</tr>
<tr>
<td>SSC</td>
<td>Structure Sensor Cluster</td>
</tr>
<tr>
<td>SUB</td>
<td>Subscribe(er)</td>
</tr>
<tr>
<td>SVID</td>
<td>System V Interface Definition</td>
</tr>
<tr>
<td>TBD</td>
<td>To be determined</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol/Internet Protocol</td>
</tr>
<tr>
<td>TDMA</td>
<td>Time-Division Multiple Access</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver Transmitter</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
<tr>
<td>VDC</td>
<td>Volts Direct Current</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
</tr>
<tr>
<td>WS</td>
<td>Watchstation</td>
</tr>
</tbody>
</table>
5 Appendix A: Message Content

5.1 APCP to APCM Radio Message Content

Table 25 through Table 50 define the content of the messages at the APCP to APCM Radio interface.

Table 25. Content of Hello Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>01</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 26. Content of Hello Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>81</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 27. Content of Trouble Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
### Table 28. Content of Reset Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>02</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 29. Content of Reset Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>82</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

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### Table 30. Content of Authorized SCs Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>82</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of first SC being enabled</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of first SC being enabled</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of first SC being enabled</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of first SC being enabled</td>
</tr>
</tbody>
</table>

...  

<table>
<thead>
<tr>
<th>4N + 4</th>
<th>XX</th>
<th>First byte of serial number of last (Nth) SC being enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>4N + 5</td>
<td>XX</td>
<td>Second byte of serial number of last (Nth) SC being enabled</td>
</tr>
<tr>
<td>4N + 6</td>
<td>XX</td>
<td>Third byte of serial number of last (Nth) SC being enabled</td>
</tr>
<tr>
<td>4N + 7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of last (Nth) SC being enabled</td>
</tr>
<tr>
<td>4N + 8</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>4N + 9</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 31. Content of Authorized SCs Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>85</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
Table 32. Content of Error Full Routing Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>TBD</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 33. Content of Frequency Setting Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>06</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>Reservation channel ID</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Aloha channel ID</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>7</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 34. Content of Frequency Setting Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>86</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
### Table 35. Content of Error – APCM Not Reset Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>TBD</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 36. Content of Downlink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>07</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Number (N) of data bytes</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>First data byte</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N + 8</td>
<td>XX</td>
<td>Last (Nth) data byte</td>
</tr>
<tr>
<td>N + 9</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>N + 10</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
### Table 37. Content of Downlink Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>82</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>9</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 38. Content of Downlink Unknown Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>TBD</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Number (N) of data bytes</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>First data byte</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N + 8</td>
<td>XX</td>
<td>Last (Nth) data byte</td>
</tr>
<tr>
<td>N + 9</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>N + 10</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
Table 39. Content of Downlink Size Error Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>TBD</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC or PSM to receive data</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Number (N) of data bytes</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>First data byte</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N + 8</td>
<td>XX</td>
<td>Last (Nth) data byte</td>
</tr>
<tr>
<td>N + 9</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>N + 10</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 40. Content of APCM Assignments Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>08</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>Number (N) of APs in compartment except this one</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Channel ID of first AP in compartment</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N + 5</td>
<td>XX</td>
<td>Channel ID of last (Nth) AP in compartment</td>
</tr>
<tr>
<td>N + 6</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>N + 7</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
Table 41. Content of APCM Assignments Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>88</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 42. Content of Get Routing Table Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>09</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

Table 43. Content of Routing Table Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>89</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>Number (N) of bytes in routing table</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of routing table</td>
</tr>
</tbody>
</table>

...  
N + 4 | XX | Last (Nth) byte of routing table  
N + 5 | 80 | First byte of trailer  
N + 6 | FE | Second byte of trailer
### Table 44. Content of Set Aging Threshold Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>0A</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of aging threshold</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of aging threshold</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>7</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 45. Content of Aging Threshold Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>8A</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 46. Content of Set RSSI Threshold Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>0B</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of RSSI threshold</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of RSSI threshold</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>7</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
### Table 47. Content of RSSI Threshold Acknowledge Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>8B</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>5</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 48. Content of Routing Addition Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>41</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC being added to routing table</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC being added to routing table</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC being added to routing table</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC being added to routing table</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>9</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
### Table 49. Content of Routing Deletion Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>42</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC being deleted from routing table</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC deleted from routing table</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC deleted from routing table</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC deleted from routing table</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>9</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>

### Table 50. Content of Uplink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>First byte of header</td>
</tr>
<tr>
<td>2</td>
<td>FF</td>
<td>Second byte of header</td>
</tr>
<tr>
<td>3</td>
<td>44</td>
<td>Message type</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>First byte of serial number of SC or PSM sending data</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Second byte of serial number of SC or PSM sending data</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Third byte of serial number of SC or PSM sending data</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Fourth (last) byte of serial number of SC or PSM sending data</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Number (N) of data bytes</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>First data byte</td>
</tr>
</tbody>
</table>

...  

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N + 8</td>
<td>XX</td>
<td>Last (Nth) data byte</td>
</tr>
<tr>
<td>N + 9</td>
<td>80</td>
<td>First byte of trailer</td>
</tr>
<tr>
<td>N + 10</td>
<td>FE</td>
<td>Second byte of trailer</td>
</tr>
</tbody>
</table>
5.2 PSM MCU to PSM Radio Message Content

Table 51 through Table 57 define the content of the messages at the Personnel Status Monitor MCU to Personnel Status Monitor Radio interface.

Table 51. Content of Enter Normal Operation Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>02</td>
<td>Number of bytes in this message</td>
</tr>
<tr>
<td>2</td>
<td>81</td>
<td>Message type</td>
</tr>
</tbody>
</table>

Table 52. Content of Enter Standby Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>02</td>
<td>Number of bytes in this message</td>
</tr>
<tr>
<td>2</td>
<td>82</td>
<td>Message type</td>
</tr>
</tbody>
</table>

Table 53. Content of PSM Downlink Data Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>Number of bytes in this message</td>
</tr>
<tr>
<td>2</td>
<td>83</td>
<td>Message type</td>
</tr>
<tr>
<td>3,4</td>
<td>XXXX</td>
<td>Compartment ID (12 bits), AP ID (4 bits)</td>
</tr>
<tr>
<td>5,6</td>
<td>XXXX</td>
<td>Ship ID</td>
</tr>
<tr>
<td>N - 6</td>
<td>XX</td>
<td>First (of N - 6) data byte</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>XX</td>
<td>Last (of N - 6) data byte</td>
</tr>
</tbody>
</table>
Table 54. Content of Physiological Data Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>09</td>
<td>Number of bytes in this message</td>
</tr>
<tr>
<td>2</td>
<td>01</td>
<td>Message type</td>
</tr>
<tr>
<td>3</td>
<td>see Table 55</td>
<td>Status byte 1</td>
</tr>
<tr>
<td>4</td>
<td>XX</td>
<td>Heart rate, BPM</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Axillary temperature, °C</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Environmental temperature, °C</td>
</tr>
<tr>
<td>7</td>
<td>see Table 56</td>
<td>Status byte 2</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>CIU battery voltage, Volts</td>
</tr>
<tr>
<td>9</td>
<td>FF</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Table 55. Content of PSM Physiological Data Message Status Byte 1

<table>
<thead>
<tr>
<th>Bit Number</th>
<th>Function</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (MSB)</td>
<td>Rapid Motion Flag</td>
<td>1 = rapid motion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = no rapid motion</td>
</tr>
<tr>
<td>6,5,4</td>
<td>Orientation</td>
<td>Tbd</td>
</tr>
<tr>
<td>3,2</td>
<td>Sailor Status</td>
<td>11 = R(ed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 = Y(ellow)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>01 = U(nknown)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>00 = G(reen)</td>
</tr>
<tr>
<td>1</td>
<td>ISU Battery Status</td>
<td>1 = battery low; 0 = battery ok</td>
</tr>
<tr>
<td>0 (LSB)</td>
<td>CIU Battery Status</td>
<td>1 = battery low; 0 = battery ok</td>
</tr>
</tbody>
</table>
### Table 56. Content of PSM Physiological Data Message Status Byte 2

<table>
<thead>
<tr>
<th>Bit Number</th>
<th>Function</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (MSB)</td>
<td>Shivering Flag</td>
<td>1 = shivering detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = no shivering</td>
</tr>
<tr>
<td>6</td>
<td>Electrode Contact Quality</td>
<td>1 = electrode contact fail</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = electrode contact ok</td>
</tr>
<tr>
<td>5</td>
<td>Panic Button Flag</td>
<td>1 = panic button depressed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = no panic button</td>
</tr>
<tr>
<td>4</td>
<td>Memory Full</td>
<td>1 = memory full</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = memory ok</td>
</tr>
<tr>
<td>3,2</td>
<td>Motion Status</td>
<td>11 = tbd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 = tbd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>01 = tbd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>00 = tbd</td>
</tr>
<tr>
<td>1,0</td>
<td>Unused</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Table 57. Content of Low Voltage Shutdown Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>02</td>
<td>Number of bytes in this message</td>
</tr>
<tr>
<td>2</td>
<td>62</td>
<td>Message type</td>
</tr>
</tbody>
</table>
5.3 **APCM to SC Radio Message Content**

Table 58 through Table 65 define the content of the messages at the APCM to Sensor Cluster Radio interface.

**Table 58. Content of SC Network Management Data Frame Message**

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Frame time</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Flags</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Second byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Third byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Fourth byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Fifth byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>Sixth byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>Seventh byte of this AP's reservation channel frequency</td>
</tr>
<tr>
<td>14</td>
<td>XX</td>
<td>Eighth (last) byte of this AP's reservation channel frequency</td>
</tr>
</tbody>
</table>
Table 59. Content of AP Slot Assignment Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Frame time</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Flags</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Third byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Fourth byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Fifth byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>Sixth byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>Seventh byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>14</td>
<td>XX</td>
<td>Eighth (last) byte of this AP’s reservation channel frequency</td>
</tr>
<tr>
<td>15</td>
<td>XX</td>
<td>First byte of SC’s ID</td>
</tr>
<tr>
<td>16</td>
<td>XX</td>
<td>Second byte of SC’s ID</td>
</tr>
<tr>
<td>17</td>
<td>XX</td>
<td>Third byte of SC’s ID</td>
</tr>
<tr>
<td>18</td>
<td>XX</td>
<td>Fourth (last) byte of SC’s ID</td>
</tr>
<tr>
<td>19</td>
<td>XX</td>
<td>Slot number</td>
</tr>
</tbody>
</table>
### Table 60. Content of SC Downlink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of SC’s ID (if bytes 5-8 are all zero, message applies to all SCs)</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of SC’s ID</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of SC’s ID</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth (last) byte of SC’s ID</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Bytes (N) remaining in this message</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>First data byte</td>
</tr>
<tr>
<td>...</td>
<td>XX</td>
<td>Last (Nth) data byte</td>
</tr>
</tbody>
</table>

### Table 61. Content of Sensor Cluster Request Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of SC’s ID</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of SC’s ID</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of SC’s ID</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth (last) byte of SC’s ID</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>RSSI as measured by SC</td>
</tr>
</tbody>
</table>
Table 62. Content of Sensor Cluster Emergency Request Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of SC’s ID</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of SC’s ID</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of SC’s ID</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth (last) byte of SC’s ID</td>
</tr>
</tbody>
</table>
### Table 63. Content of Environment Sensor Cluster Analog Uplink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>3X</td>
<td>Message type (X = 2 – F)</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Least significant byte of SC’s ID</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Time until sync</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>First byte of status</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Second (last) byte of status</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Humidity</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Narrow-range temperature</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Ionization smoke detector reading</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>Photo-electric smoke detector reading</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>Carbon monoxide reading</td>
</tr>
<tr>
<td>14</td>
<td>XX</td>
<td>Wide-range temperature</td>
</tr>
<tr>
<td>15</td>
<td>XX</td>
<td>3.3-V power level</td>
</tr>
<tr>
<td>16</td>
<td>XX</td>
<td>9-V power level</td>
</tr>
<tr>
<td>17</td>
<td>XX</td>
<td>Oxygen reading</td>
</tr>
<tr>
<td>18</td>
<td>XX</td>
<td>RSSI</td>
</tr>
<tr>
<td>19</td>
<td>XX</td>
<td>Differential pressure</td>
</tr>
<tr>
<td>20</td>
<td>XX</td>
<td>Absolute pressure</td>
</tr>
<tr>
<td>21</td>
<td>XX</td>
<td>Hatch closure switches (1 = hatch closed; 0 = not closed)</td>
</tr>
<tr>
<td>22</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>23</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
Table 64. Content of Environment Sensor Cluster Sound Uplink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>3X</td>
<td>Message type (X = 2 – F)</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Least significant byte of SC’s ID</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Time until sync</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>First byte of status</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Second (last) byte of status</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Sound voltage, peak-to-peak</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Sound voltage, average</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>FFT bin # containing highest amplitude</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>Amplitude of FFT bin containing highest amplitude</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>FFT bin # containing 2nd highest amplitude</td>
</tr>
<tr>
<td>14</td>
<td>XX</td>
<td>Amplitude of FFT bin containing 2nd highest amplitude</td>
</tr>
<tr>
<td>15</td>
<td>XX</td>
<td>Gain</td>
</tr>
<tr>
<td>16</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>17</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
Table 65. Content of Structure Sensor Cluster Uplink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>3X</td>
<td>Message type (X = 2 – F)</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>Least significant byte of SC’s ID</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Time until sync</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>First byte of status</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Second (last) byte of status</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Stress</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Acceleration measured by low-g accelerometer</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Acceleration measured by high-g accelerometer</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>

5.4 APCM to PSM Radio Message Content

Table 66 through Table 72 define the content of the messages at the APCM to Personnel Status Monitor Radio interface.

Table 66. Content of PSM Network Management Data Frame Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>ID of AP’s reservation channel</td>
</tr>
<tr>
<td>6</td>
<td>00</td>
<td>Bytes remaining in this message</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
Table 67. Content of Enter Standby Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>ID of AP's reservation channel</td>
</tr>
<tr>
<td>6</td>
<td>05</td>
<td>Bytes remaining in this message</td>
</tr>
<tr>
<td>7</td>
<td>01</td>
<td>Identifies Standby message</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>First byte of PSM serial number (if bytes 8-11 are all zero, message applies to all PSMs)</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Second byte of PSM serial number</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Third byte of PSM serial number</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Fourth (last) byte of PSM serial number</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
### Table 68. Content of Exit Standby Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>ID of AP's reservation channel</td>
</tr>
<tr>
<td>6</td>
<td>05</td>
<td>Bytes remaining in this message</td>
</tr>
<tr>
<td>7</td>
<td>02</td>
<td>Identifies Exit Standby message</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>First byte of PSM serial number (if bytes 8-11 are all zero, message applies to all PSMs)</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Second byte of PSM serial number</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Third byte of PSM serial number</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Fourth (last) byte of PSM serial number</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
## Table 69. Content of PSM Downlink Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of APCM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of APCM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of APCM header</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>ID of AP's reservation channel</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Bytes (N) remaining in this message</td>
</tr>
<tr>
<td>7</td>
<td>03</td>
<td>Identifies Downlink message</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>First byte of PSM serial number (if bytes 8-11 are all zero, message applies to all PSMs)</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Second byte of PSM serial number</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Third byte of PSM serial number</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Fourth (last) byte of PSM serial number</td>
</tr>
<tr>
<td>12,13</td>
<td>XXXX</td>
<td>Compartment ID (12 bits), AP ID (4 bits)</td>
</tr>
<tr>
<td>14,15</td>
<td>XXXX</td>
<td>Ship ID</td>
</tr>
<tr>
<td>16</td>
<td>XX</td>
<td>First (of N – 11) data byte (if there are no data bytes: N = 11, byte 16 is the first byte of CRC, and byte 17 is the last byte of CRC)</td>
</tr>
<tr>
<td>N + 4</td>
<td>XX</td>
<td>Last (of N – 11) data byte</td>
</tr>
<tr>
<td>N + 5</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>N + 6</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
Table 70. Content of Physiological Data Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of PSM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of PSM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of PSM header</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of PSM serial number</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of PSM serial number</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of PSM serial number</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth (last) byte of PSM serial number</td>
</tr>
<tr>
<td>9</td>
<td>see Table 55</td>
<td>Status byte 1</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Heart rate, BPM</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Axillary temperature, °C</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>Environmental temperature, °C</td>
</tr>
<tr>
<td>13</td>
<td>see Table 56</td>
<td>Status byte 2</td>
</tr>
<tr>
<td>14</td>
<td>XX</td>
<td>CIU battery voltage, Volts</td>
</tr>
<tr>
<td>15</td>
<td>FF</td>
<td>Reserved</td>
</tr>
<tr>
<td>16</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>17</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
Table 71. Content of Positioning Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of PSM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of PSM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of PSM Header</td>
</tr>
<tr>
<td>4</td>
<td>61</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of PSM serial number</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of PSM serial number</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of PSM serial number</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth byte of PSM serial number</td>
</tr>
<tr>
<td>9</td>
<td>see Table 55</td>
<td>Status byte 1</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>

Table 72. Content of Low Power Shutdown Message

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of PSM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of PSM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of PSM header</td>
</tr>
<tr>
<td>4</td>
<td>62</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of PSM serial number</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of PSM serial number</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of PSM serial number</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth (last) byte of PSM serial number</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>
### 5.5 APCM to SHM Message Content

Table 73 through Table 77 define the content of messages at the APCM to System Health Monitor interface.

#### Table 73. Content of ICHM Calibration Message

<table>
<thead>
<tr>
<th>Offset</th>
<th>Type</th>
<th>Name</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ulong</td>
<td>GMT_Time</td>
<td>time in GMT for ICHM sensor calibration</td>
</tr>
<tr>
<td>4</td>
<td>Ulong</td>
<td>GMT_Date</td>
<td>Date in GMT for ICHM calibration</td>
</tr>
<tr>
<td>10</td>
<td>Short</td>
<td>ID</td>
<td>ID number for this cal structure</td>
</tr>
<tr>
<td>12</td>
<td>Short</td>
<td>Num_Chan</td>
<td>number of channels (sensors) in cal structure</td>
</tr>
<tr>
<td>14</td>
<td>Short</td>
<td>Cal_Type[Num_Chan]</td>
<td>1 - m/s², 2 - pressure, 3 - volts, 4 - magnetic, 5 - m/s, 6 - m/s, etc.</td>
</tr>
<tr>
<td></td>
<td>Short</td>
<td>Status[Num_Chan]</td>
<td>0 - factory cal, 1 - ICHM validated, 2 - self check ok, 3 - out of spec, 4 - inoper</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>Time_Cal</td>
<td>cal constant for time domain integer data (multiply ADC int value by)</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>TC_Freq</td>
<td>frequency where time cal was actually measured</td>
</tr>
<tr>
<td></td>
<td>Short</td>
<td>Num_Freq</td>
<td>number of frequencies in the cal structure - 1 for single constant</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>f[1]</td>
<td>frequency data in Hz for 1st point, channel 1</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>mag[1][1]</td>
<td>magnitude data (multiply int by to calibrate) for 1st point, channel 1</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>phz[1][1]</td>
<td>phase data (multiply int by to calibrate into radians) for 1st point, channel 1</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>mag[2][1]</td>
<td>magnitude data (multiply int by to calibrate) for 1st point, channel 2</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>phz[2][1]</td>
<td>phase data (multiply int by to calibrate into radians) for 1st point, channel 2</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>f[n]</td>
<td>frequency data in Hz for nth point, channel 1</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>mag[1][n]</td>
<td>magnitude data (multiply int by to calibrate) for nth point, channel 1</td>
</tr>
<tr>
<td></td>
<td>Float</td>
<td>phz[1][n]</td>
<td>phase data (multiply int by to calibrate into radians) for nth point, channel 1</td>
</tr>
</tbody>
</table>
### Table 74. Content of ICHM Data Message

<table>
<thead>
<tr>
<th>Offset</th>
<th>Type</th>
<th>Name</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>256 Char</td>
<td>Comment String</td>
<td>String that describes the run/sensors</td>
</tr>
<tr>
<td>256</td>
<td>Ulong</td>
<td>GMT_time</td>
<td>Time in GMT for beginning of record (seconds since 00:00:00 GMT)</td>
</tr>
<tr>
<td>260</td>
<td>Ulong</td>
<td>Prec_nsec</td>
<td>decimal part of the precise time in nanoseconds</td>
</tr>
<tr>
<td>264</td>
<td>Ulong</td>
<td>GMT_date</td>
<td>GMT date (days since 1 Jan. 1970)</td>
</tr>
<tr>
<td>268</td>
<td>Ulong</td>
<td>Record Length</td>
<td># samples in this record</td>
</tr>
<tr>
<td>272</td>
<td>Short</td>
<td>Data Type</td>
<td>1-time, 2-spatial(image), 3-frequency(magnitude), 4-req(magnitude/phase), 5-frequency(real/imaginary)</td>
</tr>
<tr>
<td>274</td>
<td>Short</td>
<td>Sample Size</td>
<td>Number of bytes/sample: 1:char, 2:short, 4:int, -4:float</td>
</tr>
<tr>
<td>276</td>
<td>Short</td>
<td>Num_CHAN</td>
<td>Number of sensor channels</td>
</tr>
<tr>
<td>278</td>
<td>Short</td>
<td>Resolution</td>
<td># A/D bits</td>
</tr>
<tr>
<td>280</td>
<td>Short</td>
<td>Calibration</td>
<td>0 = none</td>
</tr>
<tr>
<td>280+c chan#* 2</td>
<td>Float</td>
<td>Reserved</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>282+c chan#* 2</td>
<td>Float</td>
<td>Sampling Rate</td>
<td>(Fs, Pixels/Line, frequency step)</td>
</tr>
<tr>
<td>286+c chan#* 2</td>
<td>float</td>
<td>Chan1[1]</td>
<td>Channel 1 sample 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chan2[1]</td>
<td>Channel 2 sample 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ChanN[1]</td>
<td>Channel N sample 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chan1[2]</td>
<td>Channel 1 sample 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chan2[2]</td>
<td>Channel 2 sample 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>:</td>
<td></td>
</tr>
</tbody>
</table>


Table 75. Content of ICHM Alert Message

<table>
<thead>
<tr>
<th>Offset</th>
<th>Type</th>
<th>Name</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>unsigned long</td>
<td>GMT_Time</td>
<td>Time in GMT for last alert calculation update</td>
</tr>
<tr>
<td>4</td>
<td>unsigned long</td>
<td>GMT_Date</td>
<td>Date in GMT for last alert calculation update</td>
</tr>
<tr>
<td>8</td>
<td>int</td>
<td>Alert_Type</td>
<td>ID number for alert or feature algorithm on ICHM</td>
</tr>
<tr>
<td>10</td>
<td>int</td>
<td>Alert_ON</td>
<td>1 - alert exceedence condition is met, 0 - else</td>
</tr>
<tr>
<td>12</td>
<td>float</td>
<td>Prob_Thresh</td>
<td>Probability threshold (0.00 - 1.00) for alert condition</td>
</tr>
<tr>
<td>16</td>
<td>float</td>
<td>Time_Thresh</td>
<td>Time threshold in hours to failure for alert condition</td>
</tr>
<tr>
<td>20</td>
<td>int</td>
<td>Thresh_Update</td>
<td>Set to 1 by SHM for new thresholds, set to 0 by ICHM</td>
</tr>
<tr>
<td>22</td>
<td>int</td>
<td>Num_Prob</td>
<td>Number of probability samples in Prob vs time curve</td>
</tr>
<tr>
<td>24</td>
<td>float</td>
<td>Time_Step[1]</td>
<td>Time in hours for 1st probability calculation</td>
</tr>
<tr>
<td>28</td>
<td>float</td>
<td>Prob_Fail[1]</td>
<td>Estimated probability of failure at Time_Step[1]</td>
</tr>
<tr>
<td>32</td>
<td>float</td>
<td>Time_Step[2]</td>
<td>Time in hours for 2nd probability calculation</td>
</tr>
<tr>
<td>36</td>
<td>float</td>
<td>Prob_Fail[2]</td>
<td>Estimated probability of failure at Time_Step[2], etc.</td>
</tr>
</tbody>
</table>
### Table 76. Content of SHM System Status Message

<table>
<thead>
<tr>
<th>Offset</th>
<th>Type</th>
<th>Name</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ulong</td>
<td>GMT_Time</td>
<td>Time in GMT for last status update</td>
</tr>
<tr>
<td>4</td>
<td>ulong</td>
<td>GMT_Date</td>
<td>Date in GMT for last status update</td>
</tr>
<tr>
<td>8</td>
<td>short</td>
<td>SHM_ID</td>
<td>SHM ID number</td>
</tr>
<tr>
<td>10</td>
<td>short</td>
<td>SHM_Status</td>
<td>Overall SHM Status: 0 - offline, 1 - nominal, 2 - failure alert, 3 - servicing alert</td>
</tr>
<tr>
<td>12</td>
<td>char[12]</td>
<td>SC_File</td>
<td>Overall SHM configuration filename</td>
</tr>
<tr>
<td>24</td>
<td>char[12]</td>
<td>SP_File</td>
<td>Overall SHM prognostic filename</td>
</tr>
<tr>
<td>36</td>
<td>short</td>
<td>SHM_Subs</td>
<td>Number of Health Subsystems</td>
</tr>
<tr>
<td>?</td>
<td>short</td>
<td>Num_ICHM</td>
<td>Number of ICHMs</td>
</tr>
</tbody>
</table>

### Table 77. Content of Configuration Data Message

<table>
<thead>
<tr>
<th>Offset</th>
<th>Type</th>
<th>Name</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>unsigned long</td>
<td>GMT_Date</td>
<td>Date in GMT for configuration</td>
</tr>
<tr>
<td>4</td>
<td>short</td>
<td>Type</td>
<td>Configuration type: 0 - component, 1 - sensor, 2 - ICHM, 3 - SHM</td>
</tr>
<tr>
<td>6</td>
<td>short</td>
<td>Num_Elem</td>
<td>Number of elements (1 if Type = 0 or 1)</td>
</tr>
<tr>
<td>32</td>
<td>char[12]</td>
<td>Config_El[1]</td>
<td>Further configuration filename (NULL if Type = 0, 1)</td>
</tr>
</tbody>
</table>
### 5.6 APCM to OTM Message Content

Table 78 defines the content of the message at the AP to Ordinance Tracking Monitor interface.

**Table 78. Content of OTM Uplink Message**

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Value (Hex)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FF</td>
<td>First byte of OTM header</td>
</tr>
<tr>
<td>2</td>
<td>00</td>
<td>Second byte of OTM header</td>
</tr>
<tr>
<td>3</td>
<td>FF</td>
<td>Third byte of OTM header</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>Message type</td>
</tr>
<tr>
<td>5</td>
<td>XX</td>
<td>First byte of OTM serial number</td>
</tr>
<tr>
<td>6</td>
<td>XX</td>
<td>Second byte of OTM serial number</td>
</tr>
<tr>
<td>7</td>
<td>XX</td>
<td>Third byte of OTM serial number</td>
</tr>
<tr>
<td>8</td>
<td>XX</td>
<td>Fourth (last) byte of OTM serial number</td>
</tr>
<tr>
<td>9</td>
<td>XX</td>
<td>Current temperature, °C</td>
</tr>
<tr>
<td>10</td>
<td>XX</td>
<td>First byte of number of stored temperature values</td>
</tr>
<tr>
<td>11</td>
<td>XX</td>
<td>Second byte of number of stored temperature values</td>
</tr>
<tr>
<td>12</td>
<td>XX</td>
<td>Battery level, volts</td>
</tr>
<tr>
<td>13</td>
<td>XX</td>
<td>First byte of CRC</td>
</tr>
<tr>
<td>14</td>
<td>XX</td>
<td>Second (last) byte of CRC</td>
</tr>
</tbody>
</table>