

## Executive Summary

This document walks through a manual decoding of some Radio Bridge RBS305-ATH-US temp/humidity sensor payloads received in the Helium Console Debugger.

The manual analysis involved converting the base 64 encoded payload into binary form, then using the information in 2 Radio Bridge reference manuals to interpret the bytes.

It's not clear what was causing the decoder function to return an error status. The payload seemed valid independent of the Decoder status.

Payload	Decoder Status	Port	Reported at	Interpretation
Hw0FkIA8AA==	error	2	Sunday, September 13, 2020 12:42:36 PM <a href="#">GMT-04:00</a> DST	<ul style="list-style-type: none"> <li>Humidity has risen above upper threshold</li> <li>Temp = -16.1C</li> <li>Humidity = 60.0%</li> </ul>
Hg0CCZAKEA==	success	2	Sunday, September 13, 2020 12:42:36 PM <a href="#">GMT-04:00</a> DST	<ul style="list-style-type: none"> <li>Temperature has fallen below lower threshold</li> <li>Temp = 9.9C</li> <li>Humidity = 10.1%</li> </ul>
HQ0GFVAJkA==	error	2	Sunday, September 13, 2020 11:58:22 AM <a href="#">GMT-04:00</a> DST	<ul style="list-style-type: none"> <li>Humidity has fallen below lower threshold</li> <li>Temp = 21.5C</li> <li>Humidity = 9.9%</li> </ul>
FQ0CCgAMMA==	error	2	Wednesday, September 16, 2020 5:32:35 AM <a href="#">GMT-04:00</a> DST	Trigger – put the device in the freezer <ul style="list-style-type: none"> <li>Temperature has fallen below lower threshold</li> <li>Temp = 10.0C</li> <li>Humidity = 12.3%</li> </ul>
HgEZODAXEDhAAAA=	Success	2	Saturday, September 19, 2020 12:15:57 PM <a href="#">GMT-04:00</a> DST	Supervisory Event – triggered by putting the magnet beside the device <ul style="list-style-type: none"> <li>Tamper detected since last event</li> <li>Current tamper State = Yes</li> <li>No error with last downlink</li> <li>Battery is not low</li> <li>Radio Comm error occurred and device reset</li> <li>Battery Voltage = 3.0</li> </ul>
Hg0AFkAzIA==	Success	2	Monday, September 21, 2020 3:39:52 PM <a href="#">GMT-04:00</a> DST	<ul style="list-style-type: none"> <li>Periodic Report</li> <li>Temp = 22.4C</li> <li>Humidity = 51.2%</li> </ul>

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## References

ID	Reference	Description
1	<a href="https://radiobridge.com/products/wireless-air-temperature-and-humidity-sensor">https://radiobridge.com/products/wireless-air-temperature-and-humidity-sensor</a>	Radio Bridge document repository
2	Common Sensor Messages.pdf	Document that describes the messages common to all Radio Bridge wireless sensors.
3	Wireless Air Temp and Humidity Sensor User Guide.pdf	Reference Manual for Radio Bridge temperature and humidity sensors, including uplink and download message protocols.
4	<a href="https://github.com/RadioBridge/Packet-Decoder/blob/master/radio_bridge_packet_decoder.js">https://github.com/RadioBridge/Packet-Decoder/blob/master/radio_bridge_packet_decoder.js</a>	Radio Bridge decoder source code
5	<a href="https://www.epochconverter.com/">https://www.epochconverter.com/</a>	Unix time converter
6	<a href="https://base64.guru/converter/decode/hex">https://base64.guru/converter/decode/hex</a>	Base64 to Hex converter
7	<a href="https://www.rapidtables.com/convert/number/index.html">https://www.rapidtables.com/convert/number/index.html</a>	Binary/Octal/Decimal/Hex converter
8	<a href="https://www.rapidtables.com/convert/number/binary-to-decimal.html">https://www.rapidtables.com/convert/number/binary-to-decimal.html</a>	Binary to Decimal converter

## Helium Debugger Payloads to Analyze

### *Function error*

```
"decoded": {
  "error": "function_crashed",
```

```

    "status": "error"
    "name": "RBS305-ATH-US",
    "payload": "Hw0FkIA8AA==",
    "port": 2,
    "reported_at": 1600015356
    "download_url": "https://console.helium.com/api/v1/down/048e72bb-958f-4039-b2d8-858fe9cb59ef/xEtUOKyJzWNYL6cwOzjfzSsgT592pa9D/bde5ed20-8dbe-4018-95f6-ef9a43f71337",
    "fcnt": 10,
    "id": "1a7502ed-3264-472c-8878-67c0860c9cd9",
    "payload": "Hw0FkIA8AA==",
    "payload_size": 7,
    "port": 2

```

"reported\_at": 1600015356 = **Your time zone:** Sunday, September 13, 2020 12:42:36 PM [GMT-04:00](#) DST

**Use the Base64-to-hex converter in Reference 6 to convert "Hw0FkIA8AA==" to "1f0d0590803c00"**

1f0d0590803c00

1f 0d 05 90 80 3c 00

00011111 00001101 00000101 10010000 10000000 00111100 00000000

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
<b>Hex</b>	1f	0d	07	90	80	3c	00
<b>Binary</b>	0001 1111	0000 1101	0000 0101	1001 0000	1000 0000	0011 1100	0000 0000
<b>Decode</b>	Protocol = 1 Seq# = 15	Temp event	Humidity has risen above upper threshold	-16C	.1C	60% humidity	.0% humidity

Byte	Field	Reading (Hex)	Reading (binary)	Payload Key	Interpretation
0		1f	0001 1111	Protocol Version   Packet Count 0001 1111	Protocol Version = 1 Sequence # = 15
1	Message Type	0d	0000 1101	Uplink Message: Temperature Event	A temperature event occurred
2	Temperature/Humidity Event Payload	05	0000 0101	See table 7 in Ref #3	Humidity has risen above upper threshold
3	Current temperature in degrees Celsius with sign bit	90	1001 0000	<ul style="list-style-type: none"> <li>Negative value</li> <li>0x10</li> </ul>	-16C
4	First decimal of current temperature (0-9) in the most significant 4-bits.	80	1000 0000		.1 Temp = -16.1C
5	Humidity in % relative humidity (0-100%)	3C	0011 1100		Humidity = 60%

6	First decimal of relative humidity (0-9) in the most significant 4-bits.	00	0000 0000		0 Humidity = 60.0%

## Success

```

    "decoded": {
      "payload": {
        "Message": "Event: Air Temperature/Humidity, ATH Event: Temperature has
Fallen Below Lower Threshold, Temperature: 9.9, Humidity: 10.1, Packet Counter: 14,
Protocol Version: 1"
      },
      "status": "success"
    },

```

```

"downlink_url": "https://console.helium.com/api/v1/down/048e72bb-958f-4039-b2d8-
858fe9cb59ef/xEtUOKyJzWNyL6cwOzjfzSgT592pa9D/bde5ed20-8dbe-4018-95f6-ef9a43f71337",
"fcnt": 9,

```

```

"name": "RBS305-ATH-US",
"payload": "Hg0CCZAKEA==",
"port": 2,
"reported_at": 1600012856

```

"reported\_at": 1600015356 = **Your time zone:** Sunday, September 13, 2020 12:00:56 PM [GMT-04:00](#) DST

### Use the Base64-to-hex converter in Reference 6

Payload in hex: 1e0d0209900a10

1e 0d 02 09 90 0a 10

00011110 00001101 00000010 00001001 10010000 00001010 00010000

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
<b>Hex</b>	1e	0d	02	09	90	0a	10
<b>Binary</b>	0001 1110	0000 1101	0000 0010	0000 1001	1001 0000	0000 1010	0001 0000
<b>Decode</b>	Protocol = 1 Seq# = 14	Temp event	Temp fallen below lower threshold	9C	.1C	10% humidity	.1% humidity

Byte	Field	Reading (Hex)	Reading (binary)	Payload Key	Interpretation
0		1e	0001 1110	Protocol Version   Packet Count	Protocol Version = 1

				0001 1110	Sequence # = 14
1	Message Type	0d	0000 1101	Uplink Message: Temperature Event	A temperature event occurred
2	Temperature/Humidity Event Payload	02	0000 0010	See table 7 in Ref #3	Temperature has fallen below lower threshold
3	Current temperature in degrees Celsius with sign bit	09	0000 1001	<ul style="list-style-type: none"> <li>positive value</li> <li>0x09</li> </ul> See table 6 in Ref #3	9C
4	First decimal of current temperature (0-9) in the most significant 4-bits.	90	1001 0000	See table 6 in Ref #3	.9 Temp = 9.9C
5	Humidity in % relative humidity (0-100%)	0a	0000 1010	See table 6 in Ref #3	Humidity = 10%
6	First decimal of relative humidity (0-9) in the most significant 4-bits.	10	0001 0000	See table 6 in Ref #3	1 Humidity = 10.1%

### Another Function Error

```
{
  "debug": {
    "req": {
      "body": {
        "app_eui": "0101010101010101",
        "dc": {
          "balance": 991614,
          "nonce": 1
        },
        "decoded": {
          "error": "function_crashed",
          "status": "error"
        }
      }
    }
  }
}
```

```
"name": "RBS305-ATH-US",
  "payload": "HQ0GFVAJkA==",
  "port": 2,
  "reported_at": 1600012702
```

"reported\_at": 1600012702 = **Your time zone:** Sunday, September 13, 2020 11:58:22 AM [GMT-04:00](#) DST

#### Use the Base64-to-hex converter in Reference 6

Payload in hex: 1d0d0615500990  
1d 0d 06 15 50 09 90

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Hex	1d	0d	06	15	50	09	90
Binary	0001 1101	0000 1101	0000 0110	0001 0101	0101 0000	0000 1001	1001 0000
Decode	Protocol = 1 Seq# = 13	Temp event	Humidity has fallen below lower threshold	21C	.5C	9% humidity	.9% humidity

## Another Function Error

```
{
  "id": "no_integration_id",
  "name": "Console Debug Integration",
  "description": "console debug",
  "status": "success"
}
{
  "body": {
    "app_eui": "0101010101010101",
    "dc": {
      "balance": 990581,
      "nonce": 1
    },
    "decoded": {
      "error": "function_crashed",
      "status": "error"
    }
  },
```

```
"name": "RBS305-ATH-US",
"payload": "FQ0CCgAMMA==",
"port": 2,
"reported_at": 1600248755
"reported_at": 1600248755 = Your time zone: Wednesday, September 16, 2020 5:32:35 AM GMT-04:00 DST
```

### Use the Base64-to-hex converter in Reference 6

Payload in hex: 150d020a000c30  
15 0d 02 0a 00 0c 30

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Hex	15	0d	02	0a	00	0c	30
Binary	0001 0101	0000 1101	0000 0010	0000 1010	0000 0000	0000 1100	0011 0000
Decode	Protocol = 1 Seq# = 5	Temp event	Temp fallen below lower threshold	10C	.0C	12% humidity	.3% humidity

## Supervisory Event

```
"name": "RBS305-ATH-US",
```

Version 1.0

RBS305-ATH-US\_payloadAnalysis

"payload": "HgEZODAXEDhAAAA=",  
"port": 2,  
"reported\_at": 1600532157

"reported\_at": 1600532157 = **Your time zone:** Saturday, September 19, 2020 12:15:57 PM [GMT-04:00](#) DST

HgEZODAXEDhAAAA=

Payload in Hex: 1e01193830171038400000

1e 01 19 38 30 17 10 38 40 00 00

Byte	Field	Reading (Hex)	Reading (binary)	Payload Key	Interpretation
0		1e	0001 1110	Protocol Version   Packet Count 0001                      1110	Protocol Version = 1 Sequence # = 14
1		01	0000 0001	Message type 0x00 = Device has reset 0x01 = Daily Supervisory Message 0x02 = Tamper event has occurred	Message type = Supervisory Message
2		19	0001 1001	Supervisory error codes Bits 7:5 not used 4 Tamper detected since last reset 3 Current tamper State 2 Error with last downlink 1 Battery Low (under 2.8V) 0 Radio Comm Error	Tamper detected since last event Current tamper State = Yes No error with last downlink Battery is not low Radio Comm error occurred and device reset
3		38	0011 1000	Current Sensor State	??
4		30	0011 0000	Battery Level - two-digit battery voltage	Battery Voltage = 3.0
5		17	0001 0111	Extended Sensor State	??
6		10	0001 0000	Extended Sensor State	??
8		38	0011 1000	Extended Sensor State	??
9		40	0100 0000	Extended Sensor State	??

The message below is what the decoder function provided. Note that it does not decode the Current Sensor State or the Extended Sensor State values.

**"Message": "Event: Supervisory, Battery Voltage: 3.0V, Accumulation Count: 0, Tamper Since Last Reset: 1, Current Tamper State: 1, Error With Last Downlink: 0, Battery Low: 0, Radio Comm Error: 1, Packet Counter: 14, Protocol Version: 1"**

I could not find information on how to decode the Current Sensor State or the Extended Sensor State values. I sent a question to Radio Bridge asking for help. If I get the answer, I'll add it here.

The current sensor state (byte 1 of the supervisory message) is defined by the individual data sheets.

The battery level (byte 2 of the supervisory message) is a two-digit battery voltage. For example, if the battery voltage is 2.9V, byte 2 would be 0x29.

The extended sensor state is a 4-byte field added in firmware version 2.0. This allows sensors that have higher precision or multiple values to be reported during a supervisory event.

Applying a magnet to a sensor that has test message capability will force a supervisory message to allow the user to query the current state, battery level, etc. This feature is available in firmware v2.0 and beyond.

The event accumulation count in bytes 7-8 represent the number of sensor events since the last supervisory message. This can be used in conjunction with the “disable all sensor events” setting so that only an event total is reported during a supervisory message, but the individual events themselves are not reported as they occur which can serve to greatly improve battery life. This feature is available in firmware v2.0 and beyond.

(above) Section 3.12 from the Common Message manual (as referenced by my support ticket response) – unfortunately, while the extended sensor state 4-byte field is mentioned, it doesn’t say anything about how to decode the information in the fields.

## Downlink Ack

File: 20200921\_DownLinkACK-invalid-event-debug-3.json

```
"name": "RBS305-ATH-US",
"payload": "HP8B",
"port": 2,
"reported_at": 1600685651
decoded": {
  "payload": {
    "Message": "Event: Downlink Acknowledge, Downlink: Message Invalid, Packet Counter: 12, Protocol Version:
1"
```

Monday, September 21, 2020 6:54:11 AM [GMT-04:00](#) DST

HP8B

Payload in Hex: 1cff01

1c ff 01

Byte	Field	Reading (Hex)	Reading (binary)	Payload Key	Interpretation
0		1c	0001 1100	Protocol Version   Packet Count 0001                      1100	Protocol Version = 1 Sequence # = 12
1		ff	1111 1111	Downlink Ack message type	



2		01	0000 0001	0x00 = Not used 0x01 = Message was invalid or undefined 0x02 = Message was valid	Invalid or undefined message
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## ATH Event: Periodic Report

File: 20200922\_Temp-HumidityPeriodicReport-valid-event-debug-3.json

```
"name": "RBS305-ATH-US",
"payload": "Hg0AFkAzIA==",
"port": 2,
"reported_at": 1600717192
```

```
"decoded": {
  "payload": { "Message": "Event: Air Temperature/Humidity, ATH Event: Periodic Report, Temperature: 22.4, Humidity: 51.2, Packet Counter: 14, Protocol Version: 1"},
  "status": "success"
```

"reported\_at": 1600015356 = **Your time zone:** Monday, September 21, 2020 3:39:52 PM [GMT-04:00](#) DST

Payload in hex: 1e0d0016403320

1e 0d 00 16 40 33 20

00011110 00001101 00000000 00010110 01000000 00110011 00100000

	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
<b>Hex</b>	1e	0d	00	16	40	33	20
<b>Binary</b>	0001 1110	0000 1101	0000 0000	0001 0110	0100 0000	0011 0011	0010 0000
<b>Decode</b>	Protocol = 1 Seq# = 14	Temp event	Periodic Report	22C	.4C	51% humidity	.2% humidity

## Decoder Function

Radio Bridge provides a generic decoder function (i.e. a decoder that supports multiple sensors) at the following GitHub repository: [https://github.com/RadioBridge/Packet-Decoder/blob/master/radio\\_bridge\\_packet\\_decoder.js](https://github.com/RadioBridge/Packet-Decoder/blob/master/radio_bridge_packet_decoder.js)

That is what I am using in the Helium Console after I did the decode exercises for this document.