CW Beacon Decode Method

TK2-SYS-E-25-0052

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Executive summary

This document provides a comprehensive guide on decoding the CW beacon transmitted by the Ten0Koh2 satellite. Detailed explanations, including the necessary calculations and conversion formulas, are outlined to ensure clarity and ease of understanding for future references.

Content

About the CW Beacon of Tenkoh2

The Tenkoh2 satellite continuously transmits its status using a CW beacon. There are two modes for this transmission: during nominal operation and during the JAMSAT mission operation, each with distinct content. Our callsign is "JS1YKI:". It's important to note that after our callsign, there is a colon. The number of characters following the "JS1YKI:" is 25 for Nominal Mode and 37 for JAMSAT Mode. By converting the string that follows this callsign, one can discern the status of the satellite.

During the JAMSAT operation, in addition to some of the items from the Nominal Mode, the status of the JAMSAT equipment is also added.

Here are the items you can decode from each mode:

Nominal Mode

1	2			3			4			5			6	7			8			9			10
2	8	A	A	B	C	C	C	V	V	V	T	T	T	E	S	S	S	W	W	W	M	M	M	O

No.	Item
1	Check GPIO expander
2	Power Line status
3	Battery Current (A)
4	Battery Voltage (V)
5	Battery Temperature (°C)
6	EPS Controller Status
7	Subsystem Interface Status
8	WDU Temperature (°C)
9	MCU Temperature (°C)
10	Operation mode

JAMSAT Mode

1	2			3			4			5			6	7		
2	8	A	A	B	C	C	C	V	V	V	T	T	T	E	S	S	S

8				9		10			11			12			13			14
T	T	T	T	J	J	B	B	B	I	I	I	U	U	U	C	C	C	O

No.	Item
1	Check GPIO expander
2	Power Line status
3	Battery Current (A)
4	Battery Voltage (V)
5	Battery Temperature (°C)
6	EPS Controller Status
7	Subsystem Interface Status
8	Mode Timer
9	JAMSAT Status
10	ADC Voltage (mV)
11	Input (dBm)
12	UHFout (dBm)
13	58Gout (dBm)
14	Operation mode

Item Descriptions and Conversion Formulas

Nominal Satellite Status

This section provides information on the standard operational state of the satellite. When in JAMSAT mode, the satellite's status is determined by combining the information from both the nominal and JAMSAT-specific status fields. Below, we detail the conversion methods and provide a brief description for each status item related to the satellite's nominal operation.

Check GPIO expander

The GPIO (General Purpose Input/Output) is used to determine whether the satellite's GPIO pins are functioning correctly.

- A value of 28 indicates that the pins are operating without any issues.

Power Line Status Evaluation

The Power Line status provides insights into the operation of multiple components on the satellite.

- Each line item, such as '5V_CAM', '5V_PL', '5V_NUM', etc., corresponds to a specific bit in the binary representation. Reference the table below for details.
- The given three-character hexadecimal value is converted to its binary equivalent to determine the status of these items.
- In this binary format, a '0' indicates that the component is operational (ON), while a '1' denotes that it's not functioning (OFF).

By translating and interpreting these values, the operational status of various satellite components can be ascertained.

Bit Description: In this representation, the bit order starts from the leftmost position as Bit0. The naming convention used for the description follows the format: [Voltage]_[System Name].

No.	Bit Description
Bit11(MSB)	5V_CAM
Bit10	5V_PL
Bit9	5V_NUM
Bit8	3V3_JASMAT
Bit7	3V3_ADCS
Bit6	5V_OBC
Bit5	5V_ADCS
Bit4	5V_COM
Bit3	-
Bit2	-
Bit1	12V_ADCS
Bit0(LSB)	12V_LIU

Battery Current (A) Evaluation

The battery current represents the flow of electric charge in the battery unit on the satellite.

1. Start by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To find the battery current in volts, use the formula:
   B.current(volt) = adc(dec) * (5 / 4096)
3. Then, convert the voltage to current with the following formula:
   B.current = (B.current(volt) - 2.5) / (200 * 0.001)

By following these steps, you can ascertain the flow of electric charge in the battery unit.

Note:

- If the result is greater than 0, it indicates Discharge.
- If the result is less than 0, it indicates Charge.

Battery Voltage (V) Evaluation

The battery voltage represents the current voltage level of the battery unit on the satellite.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the battery voltage, use the formula:
   B.volt = adc(dec) * (5 / 4096)

By following these calculations, you can ascertain the current voltage level of the battery unit.

Battery Temperature (°C) Evaluation

Battery temperature represents the current operating temperature of the battery unit on the satellite.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the battery voltage temperature, use:
   B.temp(volt) = (adc(dec) / 4096) * 5
3. To find the actual temperature in Celsius, apply:
   B.temp = (B.temp(volt) * 147.06) - 273.15

By following these calculations, you can ascertain the operational temperature of the battery unit.

EPS Controller Status Evaluation

This indicates the status of the EPS controller onboard the satellite. The values represent the following modes:

- If the value is **2**, it denotes Nominal Mode.
- If the value is **3**, it represents Mission Mode.
- If the value is **4**, it indicates Emergency Mode.

Subsystem Interface Status Evaluation

The Subsystem Interface status provides a comprehensive view of the communication interface's operational state for various satellite components.

- Each line item, such as 'I2C_RTC', 'I2C_MEM', 'I2C_EPSC', etc., corresponds to a specific bit in the binary representation. For further clarity, refer to the table provided.
- Convert the provided three-character hexadecimal value into its binary equivalent to determine the status of these items.
- In this binary representation, '0' suggests an error in the communication of that particular component, whereas '1' indicates it is functioning properly.

By decoding and interpreting these binary values, one can deduce the functioning state of different satellite communication interfaces.

Bit Description: In this representation, the bit order starts from the leftmost position as Bit0. The naming convention adopted for the description follows the pattern: [Communication Method]_[System Name]. Here, 'I2C' stands for "Inter-Integrated Circuit" and 'UART' represents "Universal Asynchronous Receiver-Transmitter".

No.	Bit Description
Bit11(MSB)	-
Bit10	UART_JAMSAT
Bit9	I2C_NU
Bit8	I2C_MATLIU
Bit7	I2C_CAM
Bit6	I2C_ADCS
Bit5	I2C_IFPV
Bit4	I2C_ANT
Bit3	I2C_COM
Bit2	I2C_EPSC
Bit1	I2C_MEM
Bit0(LSB)	I2C_RTC

WDU Temperature (°C) Evaluation

The WDU temperature represents the current operating temperature of the Watch Dog Unit on the satellite.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the temperature voltage, use:
   WDU.temp(volt)=(adc(dec)/1024)*4.97
3. To find the actual temperature in Celsius, apply:
   WDU.temp=(WDU.temp(volt)*147.06)-273.15

By following these calculations, you can ascertain the operational temperature of the Watch Dog Unit.

MCU Temperature (°C) Evaluation

The MCU temperature represents the current operating temperature of the Micro Controller Unit on the satellite.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the temperature voltage, use:
   WDU.temp(volt)=(adc(dec)/1024)*4.97
3. To find the actual temperature in Celsius, apply:
   WDU.temp=(WDU.temp(volt)*147.06)-273.15

By following these calculations, you can ascertain the operational temperature of the Micro Controller Unit.

Operation mode Evaluation

Value	Mode
0	Nominal Mode
1	Real Time Mode
2	ADCS Mode
3	Mission Mode
4	JAMSAT Mission Mode
5	Telemetry Download Mode
6	Payload Download Mode
7	Direct Subsystem CMD Mode
8	Emergency Mode

JAMSAT (N3TRP) Status

In the following sections, we will examine items that are unique to the JAMSAT mission. We will outline the formulas used to convert their values and provide brief descriptions to illuminate the status they indicate, separate from the mission's broader context.

Mode Timer (min) Evaluation

In the following sections, we will discuss the Timer function within N3TRP, a piece of equipment used in the JAMSAT mission. The JAMSAT mission operates two separate missions within specific time frames. If the current time falls within these specified ranges, it indicates that the corresponding mission is active.

Here, we outline the Timer function during these mission modes:

1. Convert the 4-character hexadecimal string to its decimal equivalent.
2. If the value falls within the range of 0 to 1339, then the Transponder mode is active. If the value is within the range of 1440 to 2880, then the 58G Beacon is transmitting.

JAMSAT Status Evaluation

The JAMSAT Status provides a comprehensive view of the operational state of electronic components within the N3TRP equipment.

- Each line item, such as 'VC1 LOCK', 'VC2 LOCK', '7021 LOCK', etc., corresponds to a specific bit in the binary representation. For further clarity, refer to the table provided.
- Convert the provided three-character hexadecimal value into its binary equivalent to determine the status of these items.
- In this binary representation, '0' suggests that the component is active, whereas '1' indicates it is inactive.

By decoding and interpreting these binary values, one can deduce the operational state of different electronic components within the N3TRP.

Bit Description: In this representation, the bit order starts from the leftmost position as Bit0. The naming convention adopted for the description follows the pattern: [Component Name]_[Function].

No.	Bit Description
Bit7(MSB)	UHFCW ON
Bit6	58G ON
Bit5	AMP EN
Bit4	VC2 ON
Bit3	58G LOCK
Bit2	7021 LOCK
Bit1	VC2 LOCK

Bit0(LSB)	VC1 LOCK

ADC Voltage (mV) Evaluation

The ADC Voltage was originally intended to monitor the status of the battery. However, in the flight model, this circuit was not connected, and as a result, the value displayed will always be 0. This does not indicate an error or malfunction; it simply reflects the absence of a connection in the current configuration.

Input (dBm) Evaluation

The Input field represents the strength of the radio waves input into the transponder, returning the highest value.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the strength of the input signal, use the formula:
   Input = 0.0772 * adc (dec) - 153.23

By following these calculations, you can ascertain the strength of the radio waves input into the transponder.

UHFout (dBm) Evaluation

The UHFout field represents the highest value of the output signal from the transponder in the Ultra High Frequency (UHF) range.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the strength of the output signal, use the formula:
   Uout = 0.0154 * adc (dec) + 16.841

Note that if the adc value is 1 or less, it indicates that the transponder mode is not active.

By following these calculations, you can ascertain the highest value of the output signal from the transponder in the UHF range.

58Gout (dBm) Evaluation

The 58Gout field represents the output value of the CW Beacon being transmitted at 58G.

1. Begin by converting the provided 3-character hexadecimal string to its decimal equivalent.
2. To determine the strength of the output signal, use the formula:
   58Gout = 0.009 * adc (dec) + 4.499 + 5.5

Note that if the adc value is 19 or less, it indicates that the 58G mode is not active.
By following these calculations, you can ascertain the output value of the CW Beacon being transmitted at 58G.