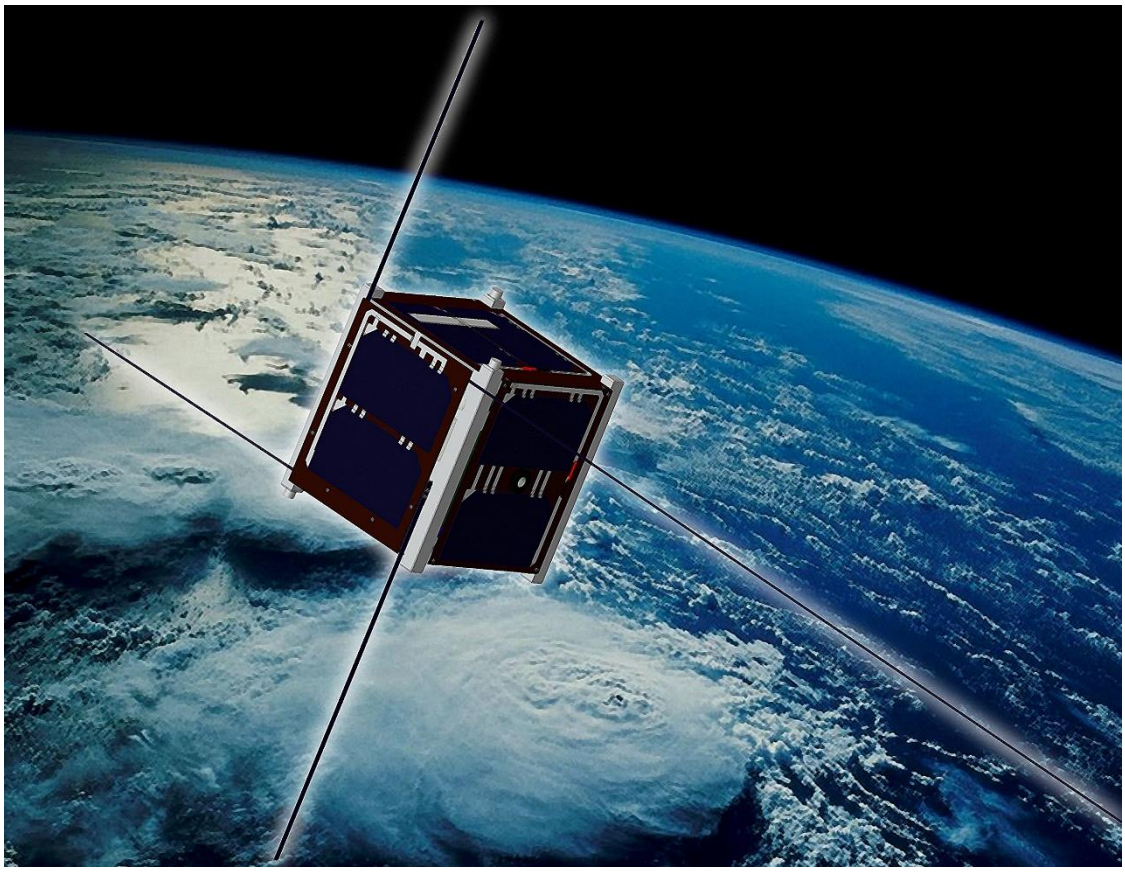
NEXUS Project Team



Amateur Communication Technology Demonstration Satellite NEXUS

「CW System Communication Format」

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Revision History

Version	Date	Revision	Autor	Approval
1.0	2018/10/10		ono	
1.1	2019/01/29		Fujii	

1. Summary of system

This system can translate CW beacon. This system has operation mode and change the mode to Normal Mode and Power Saving Mode by the satellite condition. The timing what changes the operation mode is transmitted by EPS (Electric Power Supply system), CW system changes the mode automatically. Furthermore, this system has Stopping Mode and Custom Mode. Custom mode can send data arbitrarily. Also, these modes can be operated by FMR (Flight Management Receiver).

2. Operation Mode

In this section, we explain the CW operation mode. Operation mode list is shown in follow.

Table 1 Operation mode list

Mode	details
Normal mode	Receive the sensing data from SG (Sensor Group), convert data to CW beacon and transmit these converted beacons. Transmission time is about 50sec, and interval is about 3sec. Details of sensing data are shown in next section.
Power saving mode	Detect EPS flag and transit to this mode, when the satellite's power condition is in danger. Transmitted data is same as Normal Mode however, interval is about 30 sec. Details of sensing data are shown in next section.
Custom mode	Receive the sensing data from SG (Sensor Group), convert data to CW beacon and transmit these converted beacons. These sending data are selected arbitrarily by FMR command. Transmission time is about 30 to 100sec, and interval is about 3sec. Details of sensing data are shown in next section.
Line Check Mode	In the first operation, we need to confirm whether operation is correct or not. we call this confirmation that Line Check. This confirmation is operated by FMR. This CW mode sends the result of line check 10 time. Transmission time is about 30sec, and interval is about 3sec. After the Line Check Mode, CW mode transit previous mode automatically.
Uplink Reply	When satellite receive the uplink command from Ground station, this mode is operated by FMR. This mode sends data 3 time. Interval is about 3sec. reply contents：UPLINK IS OK

3. Communication Format

3.1. Communication data from SG

Communication data from SG are shown as below.

Table 2 Communication data from SG

Contents	Data type	Data amount
Satellite time	int	4 bytes
Switch information	int	1 byte
Reset information	int	5 bytes
Battery Voltage	long	2 bytes
Battery Current	long	2 bytes
Battery temperature 1	long	2 bytes
Battery temperature 2	long	2 bytes
5V regulator temperature 1	long	2 bytes
5V regulator temperature 2	long	2 bytes
3.5V regulator temperature	long	2 bytes
Power amplifier temperature in transponder	long	2 bytes
QPSK transmitter temperature	long	2 bytes
FSK transmitter temperature	long	2 bytes
Gyro data (x,y,z)	long	6 bytes
Magnet data (x,y,z)	long	6 bytes
SUM		42 bytes

These data send as hex data. So, receive data should be convert to correct amount. Conversion formula is shown in follow.

3.1.1. Satellite time

Satellite time count binary every 0.5 sec. So, conversion formula is shown in follow.

$$\text{Time} = 0.5 \times \text{Satellite Time (dec)} \quad (1)$$

3.1.2. Switch information

Switch information doesn't need to convert. The meaning of this data is shown as follow.

7bit(MSB)	6bit	5bit	4bit	3bit	2bit	1bit	0bit(LSB)
Forced execution	Heater	3.5V regulator	CDH	CAM	QPSK	FSK	TPR

< caution >

Forced execution: Operate regardless of power condition.
Heater : Heater that warm up battery.
CDH : Command Data Handling system.
CAM : Camera system.
QPSK : QPSK transmitter.
FSK : FSK transmitter.
TPR : Transponder

If each bit shows 1, it means switch ON, and it shows 0, means switch Off.

3.1.3. Reset information

This data also doesn't need to convert. Each 1-byte count reset times. The meaning of each bytes are shown as blow.

reset info[0]	reset info[1]	reset info[2]	reset info[3]	reset info[4]
FMR	CDH	CW	EPS	SG

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FMR : Flight Management Receiver system.
CDH : Command Data Handling system.
CW : CW system.
EPS : Electric Power Supply system.
SG : Sensor Group system.

3.1.4. Battery Voltage

Battery voltage can be converted as follow.

$$\text{Battery Voltage [V]} = 0.001 \times \text{Battery Voltage(dec)} \quad (2)$$

3.1.5. Battery Current

Battery current can be converted as follow.

$$\text{Battery Current [A]} = 0.001 \times \text{Battery Current (dec)} \quad (3)$$

3.1.6. Temperature

Temperature data can be converted as follow. Temperature data is signed data. So, before convert data, calculation of 2's complement is needed.

$$\text{Temperature data (dec)} = \text{2's complement of Temperature data (hex)} \quad (4)$$

Obtain correct data by multiply 0.01 to signed data.

$$\text{Temperature data [deg]} = 0.01 \times \text{Temperature data (dec)} \quad (5)$$

3.1.7. Gyro data

Gyro data can be converted as follow. Gyro data is signed data. So, before convert data, calculation of 2's complement is needed.

$$\text{Gyro data (dec)} = \text{2's complement of Gyro data (hex)} \quad (6)$$

Obtain correct data by multiply 0.0125 to signed data.

$$\text{Gyro data [deg/sec]} = 0.0125 \times \text{Gyro data (dec)} \quad (7)$$

3.1.8. Magnet data

Magnet data can be converted as follow. Magnet data is signed data. So, before convert data, calculation of 2's complement is needed.

$$\text{Magnet data (dec)} = \text{2's complement of Magnet data (hex)} \quad (8)$$

Converted data shows physical amount. Unit is nano tesla nT.

3.2. Normal Mode
Send data of Normal Mode are shown as follow.

Call sign	Satellite name	CW mode	Satellite time	Switch information	Reset information	Battery Voltage
JS1YAV	NEXUS	2 words	8 words	2 words	10 words	4 words

Battery Current	Battery Temperature 1	Battery Temperature 2	5V Regulator Temperature 1	5V Regulator Temperature 2	SUM
4 words	4 words	4 words	4 words	4 words	57 words

Figure 1 Communication format in Normal Mode

These data are transmitted in about 50sec, and interval of these data is about 3sec.

3.3. Power Saving Mode
Power Saving Mode send same data as Normal Mode shown in section 3.2 however, interval of the sending data is about 30sec. this interval is same as 10 times of that in Normal Mode.

3.4. Custom Mode
This mode selects the sending data by 4 bytes data following command data. Sending data which can be selected are shown in Table 2. Communication format in this mode is shown as follow.

Call sign	Satellite name	CW mode	Satellite Time	Switch information	Reset information
JS1YAV	NEXUS	2 words	8 words	2 words	10 words

Sensing data	SUM
Variable (0 to 64) words	Variable (33 to 97) words

Figure 2 Communication format in Custom Mode

These data are transmitted in about 30 to 100sec, and interval of these data is about 3sec.

3.5. Line Check Mode
This mode sends the result of line check. So, we define the sending times as 10 times. Communication format of this mode is shown as follow.

Call sign	Satellite name	CW mode	Satellite Time	Switch information	Reset information	Lain check result	SUM
JS1YAV	NEXUS	2 words	8 words	2 words	10 words	2 words	35 words

Figure 3 Communication format in Line Check Mode

Interval is about 3sec.

3.6. Uplink Reply
When satellite received uplink from ground station, satellite must tell that to ground station. The reply contents are shown as below.

UPLINK IS OK

This reply sends 3 times. And interval is about 3sec.