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◆Research Keyword

CubeSat, NEXUS, Amateur Radio Communication, π/4 shift QPSK

◆Research

Communication Evaluation of CubeSat "NEXUS"

Background

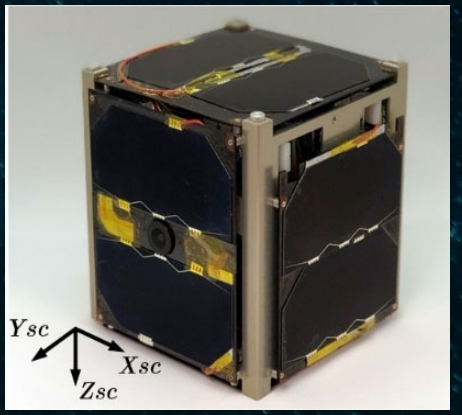
In recent years, the development of satellites, especially CubeSats, has become active. Along with that, missions have become more sophisticated and diversified. Therefore, development of transceivers capable of high-speed and accurate communication and improvement of satellite communication technology have been desired.

In addition, so many CubeSats use the amateur radio band because of its reasonable equipment, much information related to communication technology, and ease of getting reception cooperation.

About CubeSat "NEXUS"

The amateur communication technology demonstration satellite "NEXUS" is 1U size (10cm cubic) CubeSat. The purpose of NEXUS is demonstration of high-speed transceivers and the camera system having high versatility. NEXUS is equipped with four mission devices: π/4 shift QPSK transmitter, FSK transmitter, linear transponder, and the small camera system "N-CAM". And it has seven missions in table below. NEXUS was adopted by JAXA's "Innovative Satellite Technology Demonstration Program" and launched by Epsilon-4 on January 18, 2019.

For further information, please visit "NEXUS" homepage.



Minimum Success	(1) Demonstration of π/4 shift QPSK transmitter
	(2) Demonstration of FSK transmitter
Full Success	(3) Practical demonstration of π/4 shift QPSK transmitter
	(4) Practical demonstration of FSK transmitter
	(5) Demonstration of linear transponder
	(6) Practical demonstration of N-CAM
Extra Success	(7) Mapping field intensity of 145 MHz band at orbital altitude of 500km

◆Research

Communication Evaluation

The purpose of this research is two points below.

- Show that π/4 shift QPSK transmitter and FSK transmitter installed in NEXUS can communicate at higher speed than before.
- Provide data which can contribute to improve amateur communication technology.

Therefore, I compare each transmitter in table on the right and evaluate the communication when the packet length or the preamble length is changed. In addition, a lot of satellites communicate with circularly polarized waves, but NEXUS introduced polarization diversity method in which horizontal and vertical polarized waves are demodulated in separate systems and the data is complemented. Therefore, I also evaluate the difference of polarization. For these evaluations, the effective throughput is used.

	Modulation Method	Data Rate[bps]
Traditional transceiver	GMSK	9600
	AFSK	1200
π/4 shift QPSK transmitter	π/4 shift QPSK	38400
FSK transmitter	FSK	1200, 2400, 4800, 9600, 14400, 19800

Comparison of conventional transceiver (GMSK9600bps) and FSK transmitter (9600bps) has completed.

From this result, the effective throughput of FSK transmitter is higher than that of conventional transceiver. Compared with polarization, polarization diversity is an effective. In the future, I'll evaluate FSK transmitters other than 9600bps and π/4 shift QPSK transmitters. Eventually, the developed transmitter and demodulator, and the data evaluated for their performance, will be released together for future satellite development projects.

	Effective Throughput[bps]		
	Horizontal	Vertical	Circularly
GMSK	1634	1935	1013
FSK	2863	2743	1498

Development of π/4 shift QPSK Decoder

To develop the π/4 shift QPSK decoder, I use Matlab-Simulink and GNU Radio. With Simulink, signals with less noise can be make as shown in Figure. Currently, I'm developing decoder using GNU Radio for comparison of processing speed. The π/4 shift QPSK transmitter uses CCSDS-compliant Reed-Solomon code, so Reed-Solomon decoder is also under development.