13M ANTENNA UPGRADE PLAN FOR FUTURE MISSION

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ABSTRACT: Future sub-meter resolution LEO missions require simultaneous dual-polarization downlink and/or multiple channel downlinks in single polarization. Especially, dual-polarization is needed to cope with bandwidth limitation due to high speed data transmission. Current KARI 13m X-Band antenna system needs to be upgraded to cope with such downlink schemes. This paper describes brief discussions on engineering work regarding how to meet the new requirements with minimum impact on current system as well as C&M (Control and Monitoring) software.

KEY WORDS: KOMPSAT, Antenna System, Dual-Polarization

1. INTRODUCTION

Current 13m antenna system in KARI site serves for receiving X-Band image data of KOMPSAT-1 (KOrea Muti-Purpose SATellite) and KOMPSAT-2. In addition, this 13m antenna system has a capability of supporting satellite operation with exchanging command and telemetry in S-Band with cited satellite.

For dual-Band application, the type of X-Band feed is cassegrain while that of S-Band feed is prime focus. Definitely, sub-reflector placed at the front of S-Band feed is designed as frequency selective surface, meaning that X-Band signal is reflected while S-Band signal is transferred.

In the case of LEO (Low Earth Orbit), the amount of data to be transmitted is proportional increasing with the resolution of X-Band image data. That is why high data rate is needed when Satellite equips with high-resolution optical camera. However, since the available frequency bandwidth which is proportional relation with data rate is limited for other service or application. Therefore, dual-polarization scheme has been proposed for the X-Band image data with high data rate [1]. The scheme is using two orthogonal polarizations which can act as two independent transmitting channels. The benefit of dual-polarization scheme is that the data rate is decreasing as a half. Due to the benefits, it is currently considered that dual-polarization scheme is applied to the communication of X-Band image data in the future sub-meter resolution mission. In that case, 13m antenna system should be upgraded for dual-polarization with considering minimum impact on current system.

In the other hand, dual-polarization scheme in S-Band is also considered for the stable satellite operation. When two S-Band antennas are mounted on satellite as a zenith direction and nadir direction, it is commonly considered that polarization of two S-Band antennas should be orthogonal such as RHCP for nadir direction and LHCP for zenith direction. If two isotropic antennas have the same polarization, acquisition loss can be occurred when the phase difference of two signals is 180 degree. Regarding the attitude of satellite, there is a possibility of changing the polarization when SOH (Status Of Health) telemetry is received by 13m antenna system.

Therefore, 13m antenna system should have a capability of changing the polarization of S-Band feed, agilely. However, it is current situation that manual changing of the polarization is only available at 13m antenna system.

To switch the polarization automatically, it is not evitable to upgrade the existed Ground Station Control (GSC) implemented by manufacturer. Instead of upgrading the existed GSC, it has been considered to improve the function of internally developed CAM-NT (Control And Monitoring-NT) software which is currently conducting the monitoring and control of antenna system excepting DEU (Digital Electronic Unit) related with antenna tracking function. This paper presents the upgrade plan of 13m antenna system from the viewpoint of two different frequency ranges, X-Band and S-Band.

2. X-BAND UPGRADE PLAN

Figure 1 shows the simplified configuration of X-Band feed assembly.

After passing the hybrid polarizer, X-Band image data is likely to be received with two orthogonal circular polarizations, RHCP (Right-Hand Circular Polarization) and LHCP (Left-Hand Circular Polarization). However, one of two polarizations is selected by a switch placed at the output of LNA and delivered into the DATA port.

On the other hand, the non-selected polarization is directed to LOAD, meaning that signal is terminated.

That is why polarization of data channel in current 13m antenna system is called as selectable RHCP and LHCP. Similarly, TRACK port is routed with coupler where tracking signal is coupled with a signal which has a selected polarization, meaning that tracking channel is also cited as selectable RHCP and LHCP.

Prior to making a plan for X-Band upgrade, it was very important that impact on the current system should be minimized.

range of receiver, meaning that no additional down-

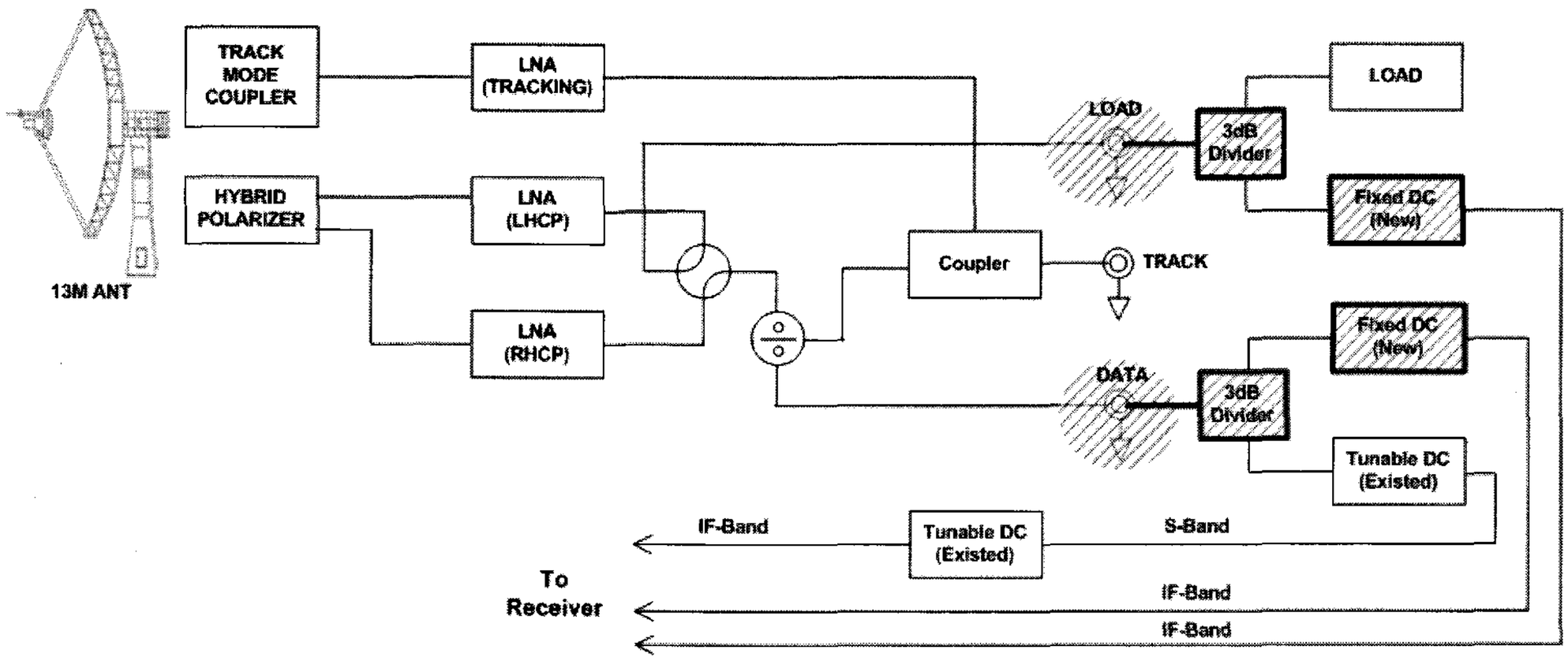

Figure 1 Configuration of X-Band feed assembly including new devices for dual-polarization scheme (Diagonal line-filled parts are supposed to be changed based on X-Band upgrade plan)

Eventually, it is determined that termination load at LOAD port is replaced with new fixed Down-Converter (DC) which conducts frequency conversion of X-Band image data into 720MHz-Band. The meaning of fixed down-converter is that single frequency is available at the local oscillator of down-converter. Thanks to fixed down-converter, there is no additional interface with current system to set the frequency of down-converter. On the other hand, it is decided that DATA port is routed with additional 3-dB divider. After that, one of two output ports of divider is connected with new fixed down-converter while the other port of divider is connected with existed down-converter. Therefore, there is no change of current link between DATA port and existed down-converter, meaning that there is no impact on current system. Figure 2 and Table 1 shows the picture and major specifications of candidate equipment for the new fixed down-converter.

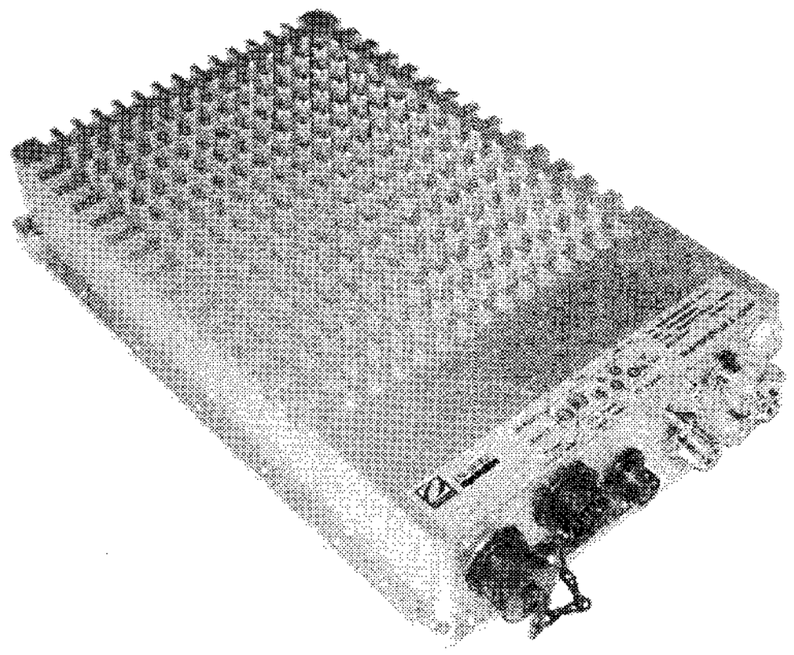

Figure 2 Picture of candidate fixed down-converter (SM01003240A manufactured by IN-SNEC)

Depending on the specification in Table 1, the IF output frequency is matched with the input frequency

Table 1 Major specifications of the fixed down-converter

Item	Specifications
RF input frequency	8020 – 8420MHz
IF output frequency	720MHz ± 200MHz
LO (Local Oscillator) type	Fixed frequency LO
LO frequency	7500MHz
Gain	30dB
External 10MHz input	Available
DC power supplied through IF cable	Available

For the purpose of better frequency stability, 10MHz reference signal generated by GPS (Global Position Satellite) receiver can be applied into external 10MHz input. Most of all, the tedious issue related with electric power supply is settled simply by using IF cable. When bias Tee is prepared, it is able to input the electric power into IF signal without any degradation on receiver.

3. S-BAND UPGRADE PLAN

In X-Band upgrade plan, it is described that selectable RHCP and LHCP scheme can be simply changed as simultaneous RHCP and LHCP by using new fixed down-converter. Differently from the polarization scheme of X-Band feed, it needs a large efforts and costs to change the polarization scheme of S-Band feed as simultaneous RHCP and LHCP. That is why CAM-NT should conduct a switching of polarization, agilely. Since the moment of changing the polarization is depending on the attitude of satellite, there are two possibilities of wrong setting of polarization at 13m antenna system, one is AOS (Acquisition Of Satellite) time and the other is passing time. If setting of polarization is wrong at AOS

time, signal level displayed on MODEM/BB could be lower than expected value. Similarly, suddenly level degradation is displayed on MODEM/BB during passing time when dominant polarization is changed due to satellite attitude. Regarding the criteria on the switching of polarization at 13m antenna system, CAM-NT should perform the continuous monitoring of signal level displayed on MODEM/BB. If the displayed level is lower than pre-defined limitation, CAM-NT conducts the switching of polarization and keeps the monitoring of MODEM/BB whether or not displayed level returns to expected value. If the displayed level is still remain as lower than pre-defined limitation despite of changes of polarization, CAM-NT switches to original polarization and performs an investigation whether or not RF equipment has a malfunction. Figure 3 shows the simplified configuration on the control and monitoring of 13m antenna system. Currently, GSC conducts the control and monitoring of 13m antenna system excepting baseband equipment such as receiver for X-Band image data and MODEM/BB for S-Band satellite operation. On the other hand, CAM-NT developed by KARI engineer performs control and monitoring of RF equipment and baseband equipment. Unless the DEU is not fully controlled and monitored by CAM-NT, it is impossible for CAM-NT to change the tracking polarization even though polarization is determined from the signal level displayed on MODEM/BB.

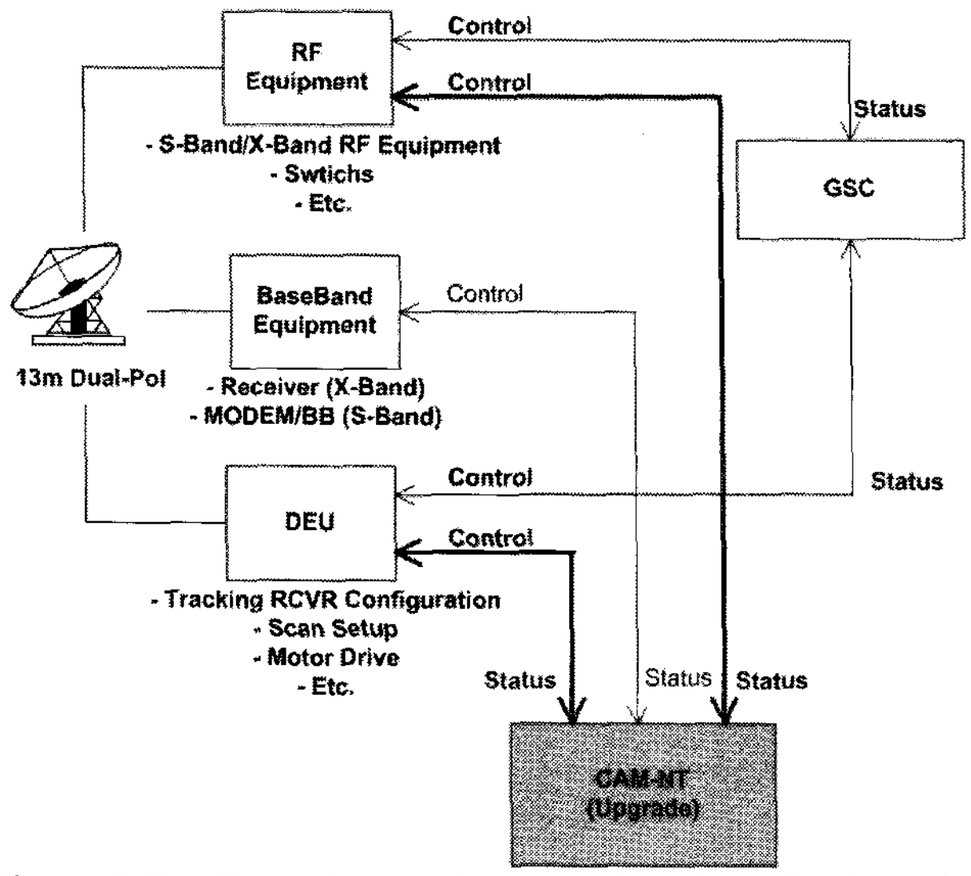

Figure 3 Configuration on the control and monitoring of 13m antenna system

Up to now, the message format and contents exchanged between GSC software and DEU are not clear. However, the required information, message format and contents, can be monitored by using COTS software such as Advanced Serial Port Monitor™ by AGG software co. Once, message format and contents are fully acknowledged, CAM-NT is modified to including for the communication with DEU.

4. CONCLUSION

To deal with the request on the dual polarization in future mission, it is determined that current 13m antenna system in KARI should be upgraded. The antenna system is primary to communicate with KOMPSAT-1 and KOMPSAT-2. That is why the impact on current system should be minimized. Based on the X-Band upgrade plan, current selectable RHCP and LHCP scheme is easily upgraded as simultaneous RHCP and LHCP by using new fixed down-converter. Regarding the S-Band upgrade, it is decided that the function of CAM-NT software needs to be improved to perform the control and monitoring of DEU which is related with only GSC.

5. REFERENCE

[1] Warren L. Stutzman, 1993. *Polarization in Electromagnetic Systems*. Artech House, Norwood, pp. 149-150.