DESCRIPTION ON THE CONSTITUTION OF RF TEST SET FOR SOC 13M ANTENNA

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ABSTRACT: The contents of RF test set which can be used for checking the function and performance of 13m antenna installed in KARI site are described in this paper. For the purpose of considering RF test set as the transceiver in COMS, it is designed to re-transmit the LRIT and HRIT in L-Band after receiving them in S-Band from 13m antenna. Additionally, this set has a function to turnaround raging tone used for the measurement of distance between satellite and 13m antenna. The required all equipments of RF test set are summarized with configuration. Measurements of several equipments which have already been delivered are described in this paper. The assembled RF test set will be used for the verification of 13m antenna

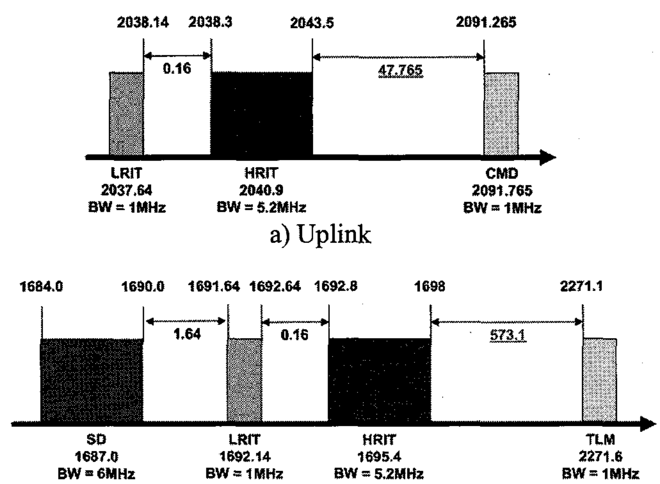
KEY WORDS: COMS, SOC, ANTENNA, RF

1. INTRODUCTION

COMS, to be launched in 2008, has three major missions like meteorological service, ocean monitoring, and Ka-Band satellite communication. Ground segments for COMS primary missions consists of four centers, namely SOC (Satellite Operation Center), MSC (Meteorological Satellite Center), KOSC (Korea Ocean Satellite Center) and CTES (Communication Test Earth Station). Among four centers, SOC performs backup operation of IDACS (Image Data Acquisition and Control System) in MSC and KOSC besides its primary functions for mission operation and satellite control. The backup operation of IDACS is MI/GOCI data pre-processing and processed data transmission even under MSC and KOSC are normally working. SOC will be located within the existing KARI (Korea Aerospace Research Institute) ground station and operated by KARI. User's meteorological data is transmitted to satellite as a format of LRIT (Low Rate Information Transmission) and HRIT (High Rate Information Transmission). LRIT/HRIT are international dissemination formats recommended by CGMS (Coordination Group for Meteorological Satellite) to increase the interoperability between member nations. Up to now, the number of antenna to be implemented in SOC site is only one. Thus, to cope with multi-mission mentioned above, antenna has a capability of receiving signal in S-Band and L-Band with suitable performance, G/T and transmitting signal in S-Band with enough EIRP (Equivalent Isotropic Radiated Power). From the link analysis [1], the needed size of antenna is finalized as 13m. Basically, ETRI (Electronic and Telecommunication Research Institute) is responsible for the development and delivery of antenna. New antenna building with base plate for this antenna is under construction by KARI. In this paper, the constitution of RF test set for checking the function and performance of 13m antenna is described. Indeed, the function and performance of 13m antenna can be verified by other satellite on operating before the launch of COMS. However, there are several constraints such as transmission is not permissible. RF test set installed temporarily in bore-sight has not any constraint to measure all needed characteristics of 13m antenna if it has similar capability to simulate L-/S-Band communication part in COMS. Firstly, considered frequency of signal handled by 13m antenna is shown in this paper. Secondary, required functions and configuration of RF test set are explained. Finally, drawing and measured results of several equipments which have already been delivered are described in this paper.

2. COMS FREQUIENCY

Figure 1 illustrates the considered COMS frequency plan released by KARI on January 26, 2006.



a) Uplink

b) Downlink

Figure 1 COMS Frequency

From the view point of interference, the review of COMS frequency is accomplished with considering 3rd harmonic elements generated between two signals. Especially, the narrow gap between LRIT and HRIT was examined and it does not influence the performance of user's receiver. [2] Command data is modulated by means of sub-carrier in CMD shown above figure. Besides command data, ranging tone for measuring the distance between satellite and ground cneter is also modulated with the same method. But command and ranging tone are not transmitted, simultaneously. The type of polarization is RHCP (Right Hand Circular Polarization) is adopted to transmit command data without LRIT/HRIT. In the case of downlink signal, SD (Sensor Data), LRIT and HRIT are linear polarized whereas telemetry data in TLM is the same type of command data.

3. CONFIGURATION OF RF TEST SET

To examine 13m antenna in SOC site, RF test set needs to provide following functions.

- LRIT/HRIT reception in 2037.64MHz and 2040.9MHz, respectively.
- Ranging tone reception in 2091.765MHz ± 100kHz, 20kHz and 16kHz
- SD transmission in 1687MHz
- LRIT/HRIT transmission in 1692.14MHz and 1695.4MHz, respectively.
- Turnaround ranging tone transmission in 2271.6MHz ± 100kHz, 20kHz and 16kHz.

Figure 2 shows the configuration of RF test set.

Received LRIT and HRIT by S-Band antenna are routed to duplexer. S-Band antenna also receives ranging tone and transmits turnaround ranging tone. This antenna can change the type of circular polarization easily by means of changing the setting of input of 90-degree hybrid coupler. Duplexer has one common port and two separated ports according to pass bandwidth. The frequency of LRIT and HRIT is then changed by frequency translator (2040.9 → 1965.4MHz). The translator is working as that in MODCS (Meteorological and Ocean Data Communication Subsystem) implemented in satellite. Next to frequency translation, LRIT and HRIT in L-Band are combined with SD (Sensor Data) in L-Band by combiner through variable attenuator which is needed to control the strength of signal in L-Band.

This element makes RF test set have an advantage of measuring G/T of 13m antenna. As mentioned above, the polarization of signal in L-Band is linear polarization and it can be accomplished by L-Band antenna. The frequency of SD generated by MODEM/BB is converted to L-Band by frequency translator (70 → 1687MHz). Meanwhile, the frequency of ranging tone is converted to S-Band like downlink frequency by frequency translator (2091.765 → 2271.6MHz). In the figure 2, color box means equipments which have already been delivered. Turnaround raging tone returns to 13m antenna with changing its strength by variable attenuator.

4. CHARACTERISTIC OF EQUIPMENTS

Figure 3 shows the drawings of S-Band antenna with its tripod mast.

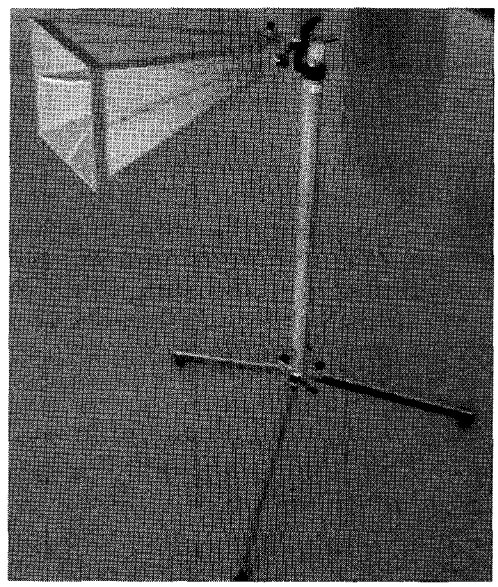


Figure 3 S-Band Antenna

Two input ports displayed as red cap in figure 3 are connected to 90-degree hybrid coupler's output port for

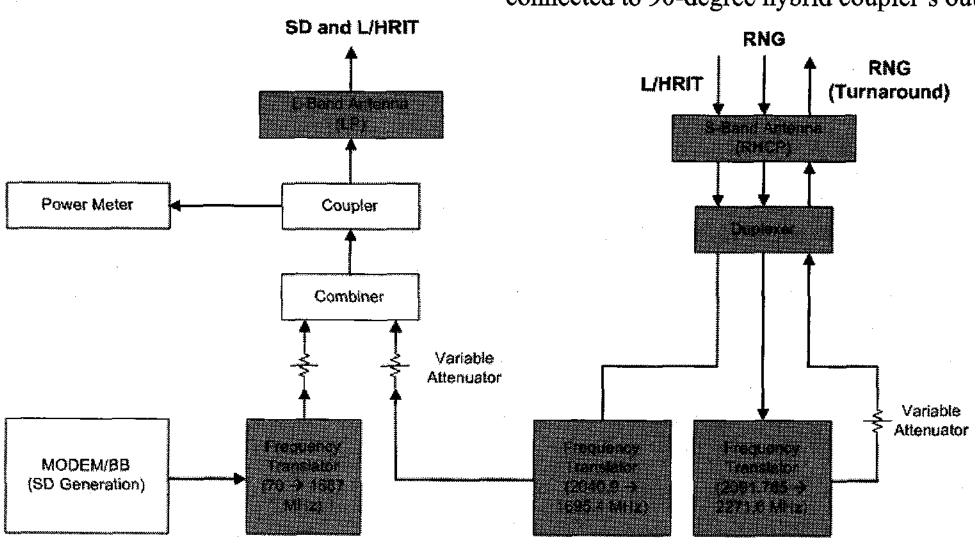


Figure 2 Configuration of RF Test Set

circular polarization. Figure 4 illustrates the radiation pattern at 2040.9, 2091, and 2271MHz.

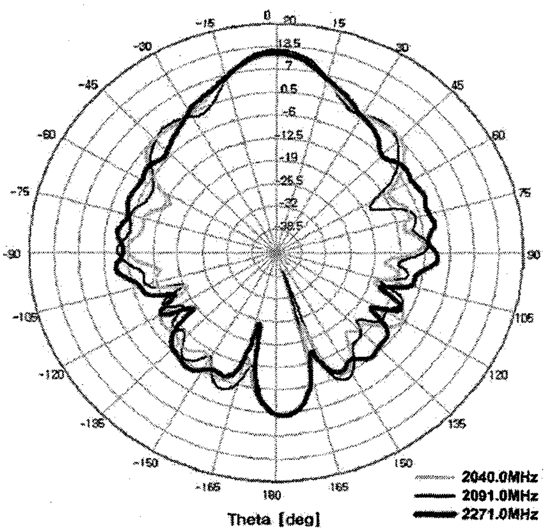


Figure 4 Radiation Pattern of S-Band Antenna

The directivity what is called as gain is 11, 12.3, and 11.72 [dBi] at 2040.9, 2091, and 2271MHz, respectively. The former two values will be used to estimate receiving performance, G/T, whereas the later will be used to calculate transmitting performance, EIRP. Figure 5 shows the radiation pattern of L-Band linear polarized antenna at 1687 and 1695MHz.

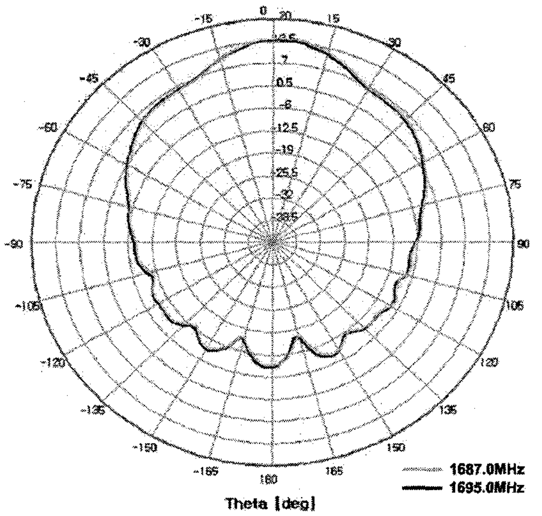


Figure 5 Radiation Pattern of L-Band Antenna

Its gain is measured as 13.93, 13.84 [dBi] at 1687 and 1695MHz, respectively. Due to act as only transmitting antenna, the gain is used to estimate EIRP. As mentioned above, this EIRP will be controlled by using attenuator between antenna and frequency translator. Figure 6 shows the channel characteristic of S-Band duplexer.

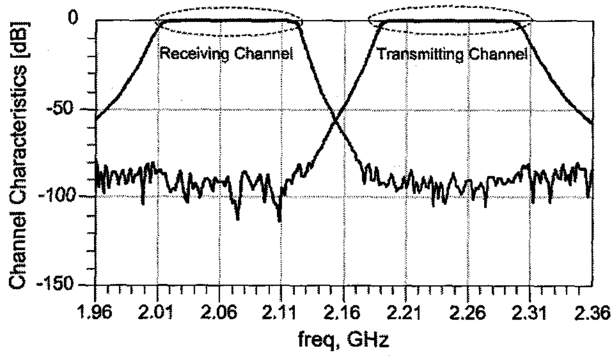
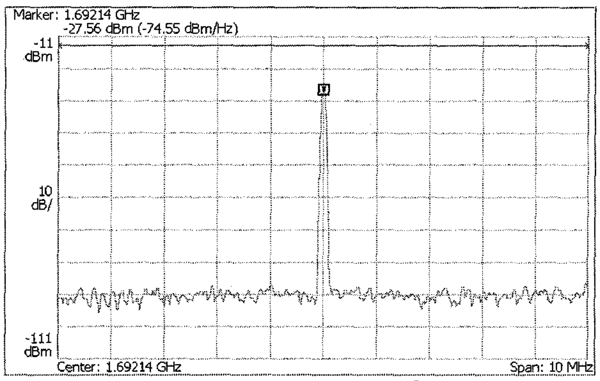
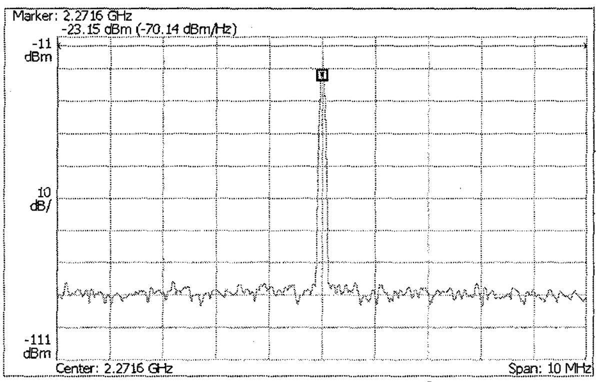


Figure 6 Channel Characteristic of Duplexer

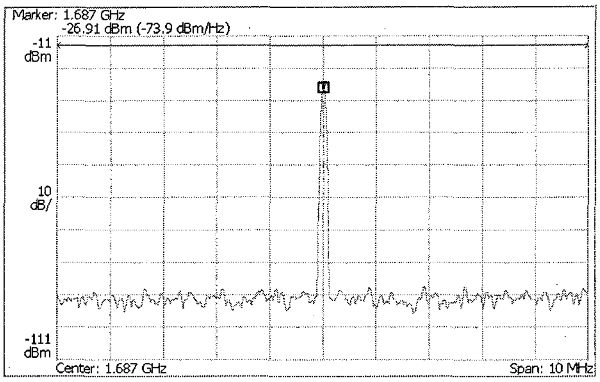
Duplexer has two frequency channels as shown in figure 6, one is for receiving L/HRIT and ranging tone whereas the other is for transmitting turnaround ranging tone. Thus, the common port routed to S-Band antenna is what is called as path for transmission and reception, simultaneously. Figure 7 illustrates the output signal spectrum of three different frequency translator when each signal with same frequency in figure 1 is fed into input port of them.



b) Frequency Translator (2040.9 → 1695.4MHz)



c) Frequency Translator (2091.765 → 2271.6MHz)



d) Frequency Translator (70 → 1687MHz)
Figure 2 Output Signal of Each Frequency Translator

Due to the setting of input signal strength as -50 [dBm] and 3 [dB] of cable loss, the conversion gain of translator is estimated as about 25 [dB] for a), C) and 28 [dB] for b) in figure 7. The reason why real modulate signal was not used is to check any spurious element generated in the process of frequency converting. As shown above figure, there is not any element to be an interference of wanted signal.

5. CONCLUSION

This paper describes the constitution of RF test set which can be used for checking the functional and performance characteristics of 13m antenna in SOC site. To measure the receiving performance, namely G/T of 13m antenna, the EIRP of RF test set can be controlled by using attenuator. For the purpose of checking the multi-function of 13m antenna, RF test set has two different antennas, one is for circular polarized S-Band antenna and the other is for linear polarized L-Band antenna. Three frequency translators are also needed to convert frequency of signal for test set to act as MODCS and TTC in COMS. Verification on this cost-effective set will be accomplished with sun or existing 13m antenna in KARI.

6. REFERENCE

[1] Park, D. J, et. al, 2005, Overall analysis on the link budgets of HRIT and LRIT in COMS, *Proc. ISRS 2005 Conference, JEJU*, pp. 98-100.

[2] Park, D. J, et. al, 2006, Analysis on spectrum for COMS user data, *Proc. KSRS'2006 Spring Conference*, Deajeon, pp. 377-380.