Quality of Satellite Communication Signals Related to Problems in RF Components as Hardware

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***Abstract*—As the generation of mobile communication develops as is slated to be hooked up to satellite communication, the importance of digital or software is highlighted more and more as a fad that the notion of SDR will work things out. Communication is a product of impartially integrating the fields of software and hardware. In order to stop the waste of time in finding causes of failure in communication by scrutinizing the software of a system, this paper as a problem diagnosis report shares an idea that problems in the hardware of the system end up with malfunctions in satellite communication. Since the portals of the satellite wireless payload are taken up by the antenna and the filter, which account for forming the wireless link, the consequences of problematic RF components are investigated. Physical errors in the components are brought up to demonstrate a functional degradation like weakened signals.**

I. INTRODUCTION

Mobile communication was differentiated from satellite communication just now. But, the former is approaching the latter, which is expected to happen in the 6th generation of mobile communication. Vertical connection is said to be added to wireless networks on the ground. This will be possibly applied to monitoring and controlling driverless automobiles and conveying massive data between distant points with lower latency[1,2]. It pushes the field of software to a higher level such as adaptive configuration in heterogeneous networks and on-board processor(OBP) in a satellite. Will the quality of satellite-combined mobile service be subject only to the digital and software block of the system? No wonder that the analog and hardware block is another indispensable element.

The hardware commonly essential to a satellite and a mobile base-station is represented by the antenna and the RF filter[3,4]. They are placed in the portals of each and every wireless communication system. An RF filter passes desirable frequencies and blocks the signals from other frequency bands. Channel selectivity comes from it. The passed signal is guided to the antenna which radiates it propagating to the counterpart in the wireless link. Although the new software technology is introduced for a new era, as long as both the filter and the antenna may not work as wanted, the communication service cannot be realized. Before demodulation and after modulation in the RX and TX signal chains, respectively, the data carried by the high frequency will be secured or lost, dependent on the performances of the antenna and the filter.

Most of the times, though the antenna is located right adjacent to the filter, their designs are separated and the two components are electrically cascaded, which once in a while winds up with growth in size and loss. The work in this paper will bring the design combining the filter with the antenna electromagnetically, which is reckoned as something requiring a high-level skill but helpful to hindering the hardware block from physically growing, and enables us to quickly check the frequency-to-strength of the radiated signal. On the contrary to the proposed benefits, others have treated realization of the antenna apart from that of the filter. I. Hunter et al assembled waveguide cavities through coupling screens to form the passband and adjusted the number of cavities to satisfy the required level of noise suppression in the stopband[5]. M. Morelli et al adopted stepped impedance resonators to extend the stopband of their filter to a higher frequency[6]. These are just filters which feed the antenna through the RF cable as electrical connection. This is practiced a lot with the horn antenna[7]. The antenna is combined electromagnetically with the filter[8]. M. Barbuto et al located a filter next to the antenna, but it is just a notch filter not a bandpass filter.

This paper takes an approach that a bandpass filter and an antenna are designed simultaneously as one structure meeting the requirements on the X-band satellite communication. Realization of a filter is done with matching the impedances between the different electromagnetic blocks. Moreover, the quality of RF signals is investigated from the standpoint of the strength of the radiated power as well as the electric field guided in case the mechanical distortion should be given to the geometry of the assembly of the filter and the antenna as the hardware in a satellite undergoes vibration and thermal stress

II. DESIGN OF THE DEVICES AND EXAMINATION OF THE PERFORMANCES INFLUENCING WIRELESS COMM. SERVICE

Combination will hold the two element devices, say the antenna and the filter. Aimed at the X-band satellite communication, the rectangular waveguide of WR 112(28.5-by-12.6 mm^2) is transformed to a filtering structure and the section to the antenna

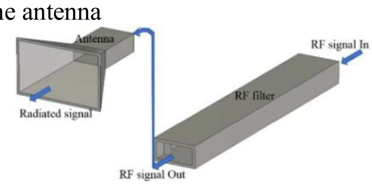
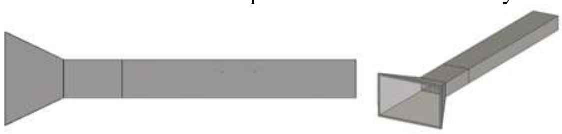
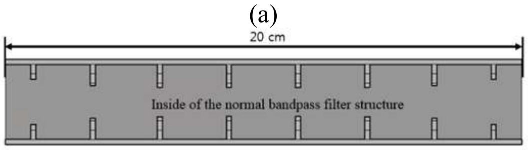


Figure 1. The antenna and the filer as separate components for Sat-Comm.

The 3D views of the devices are shown in Figure 1. There is a flow of the signal starting at the input of the filter(BPF) and arriving at that of the antenna. These elements are combined as follows despite the level of difficulty in design



(a)



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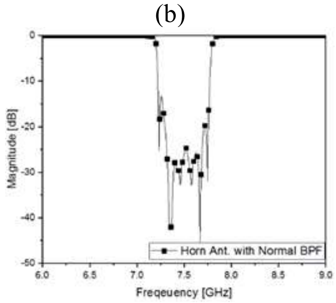

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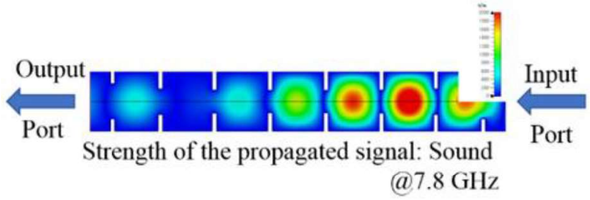

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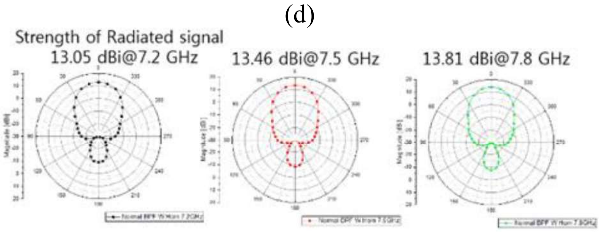
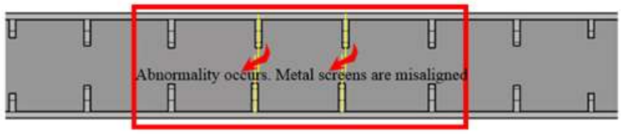


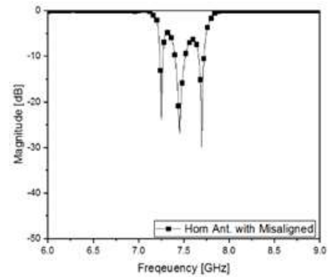
(e)

Figure 2. Combining the antenna and the filer (a)Total structure (b)Inside the filter (c)S_{11} (d)E-filed behavior (e)Radiated field patterns in the passband

The filter is connected as part of the feed for the antenna without separation as in Figure 2(a). The filter of Figure 2(b) is made to have the passband from 7.1 GHz to 7.9 GHz with S_{11} below -15 dB as in Figure 2(c). The E-filed guided smoothly reaching the output port leads to the radiation as in Figures 2(d) and (e) each What if abnormality happens to the hardware?



(a)



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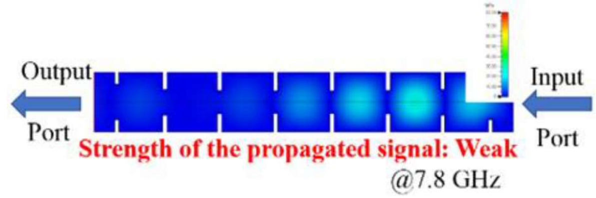
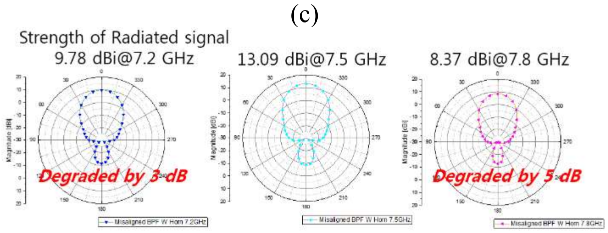


(c)



(d)

Figure 3. Mechanical errors occur and their effecs(a)Misalignment of the screens in the filter (b)S_{11} (c)E-filed behavior (d)Radiated field patterns

2 pairs of metal screens are misaligned in BPF as in Figure 3(a). S_{11} becomes very poor near the band-edges and the E-field is significantly blocked as in Figures 2(c)~(d). This ends up with decrease in radiated power or signal by over 3 dB

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