Study and Development of a Microwave Wireless Power Supplying System for ZigBee Devices

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A wireless sensor network is a communication network system which consists of some sensor devices. The sensor network is adaptable to a wide variety of applications, for example, building automation and agricultural production management. Battery problems of a wireless sensor device including its lifetime and exchange cost are serious obstacles to constructing the wireless sensor network. The objective of the present thesis is to develop a ZigBee sensor network powered by external microwave, in order to realize a battery-less or wirelessly-charged wireless sensor network (Fig.1). We adopt the 2.4 GHz ISM band as a power transmission microwave frequency band. We first examined compatibility between microwave power transmission and ZigBee communication. We conducted ZigBee communication experiments while the ZigBee device was irradiated with external microwave. From the experimental results, we confirmed that the ZigBee devices can communicate in the external microwave at a frequency of 2.46 GHz. Therefore, we used 2.46 GHz as the power transmission microwave frequency. The external microwave power density which interrupts the ZigBee communications depended on received signal strength indicator (RSSI) of the ZigBee communication. Next, we developed a rectification circuit, and obtained a conversion efficiency of 65 %. Then, we developed a rectenna by connecting the rectification circuit to a power receiving patch antenna whose antenna gain was 6.35 dBi. We conducted power transmission experiments with the developed rectennas. When we used 4 rectennas, we obtained a conversion efficiency of 65 % and an output power of 64 mW, and confirmed that these rectennas could output enough voltage to operate the ZigBee device. Finally, we conducted ZigBee device operation experiments by microwave power transmission. The ZigBee device could be operated by microwave power, and could communicate with another ZigBee device. Using secondary batteries, we succeeded to operate a ZigBee device and charge the batteries at the same time (Fig.2).

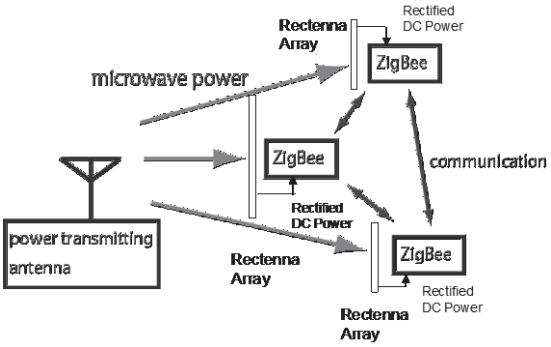

Fig.1 ZigBee sensor network with microwave power transmission.

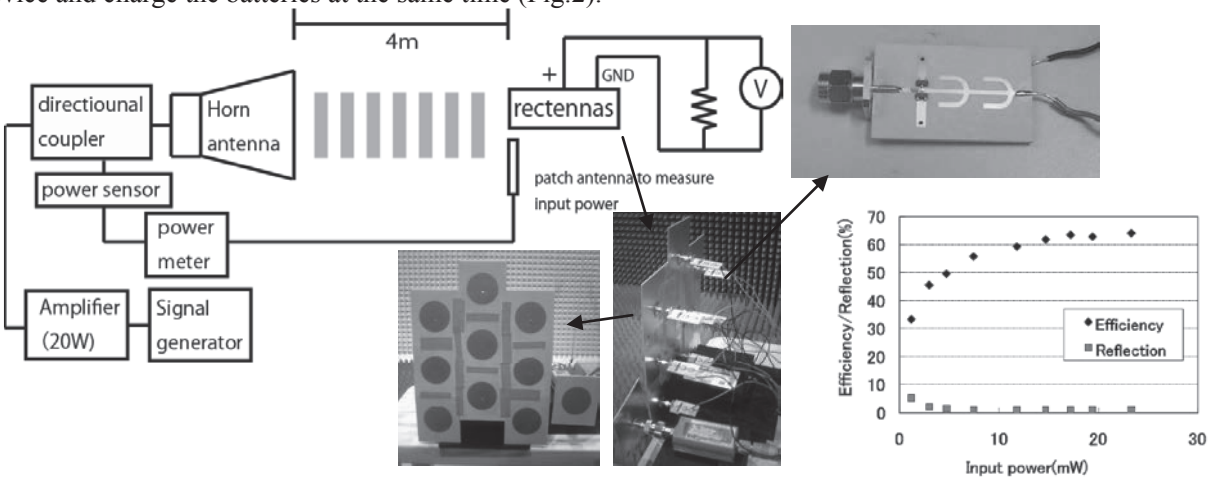

Fig.2 Experimental setup of ZigBee sensor network with microwave power transmission and RF-DC conversion efficiency of developed rectenna.