

# HIGH VOLTAGE POWER TRANSMISSION USING X-BAND MAGNETRON AND RECEPTION WITH PHASED ARRAY RECTENNA

<sup>1</sup>ERRABELLY ANUDEEP

<sup>1</sup>student

<sup>1</sup>electronics and communication engineering

<sup>1</sup>Sreenidhi institute of science and technology, Hyderabad, India

**Abstract :** This paper mainly speaks about dispatching of microwaves through the X -band magnetron whose operating frequency lies in the range of 7.0-13.0GHZ with its input power of 6KV and can produce output power of 25KV which is then connected via coaxial cable to the circulator with proper impedance matching between the microwave source and transmit antenna of multiple input multiple output planar array with REV technique (retro directive) embedded into it to produce a microwave beam with VSWR (1.2). B.W.MAX of 25% and minimized phase error of 0.01% to enhance maximum transmission efficiency and lower the phase error at the RECTENNA after the pre processing of the received beam completed by amplitude mono pulse receiver method which can power the locomotive engine possessing universal motor of 1500 volt DC by down conversion of 25 KV - 1500V DC. There by the old conventional method of high tension power cable and pantograph collectors can be eliminated saving power losses and havocs to human life.

This paper provides all the technical details of WPT(wireless power transmission technique by phased array to empower the future locomotives electrical run vehicles smart phones To overcome the power theft ,electrocution ,mechanical laying of overhead lines for locomotives and its maintenance

**Index Terms-** Rev, amplitude mono pulse, phased arrays Rectenna

## I. INTRODUCTION

old pantograph collectors is to be replaced with the new microwave technologies using ISM Band frequencies and x-ray magnetron to provide high voltage to power the locomotive engines there by this paper provides a typical solution to evade the conventional high tension power supplies needs to be replaced with HPTMW(high power transmission through microwaves) by using x-band magnetron[1] which takes input of 6kv and producing output voltage of 25kw is sent through the OFC(optical fiber cable) to circulator and finally to antenna[2] which is procured by the Rectenna array using half wave dipole and schottky barrier diode to produce regulated dc voltage of 1500v to run the universal synchronous motor of locomotive without causing any havoc to human lives providing great reliability and flexibility. But continuous beam transmission creates wastage of input power and damage to cathode of magnetron. Fig[0.1] exhibits the x-ray magnetron and Rectenna array..



fig[ 0.1] x-ray magnetron source

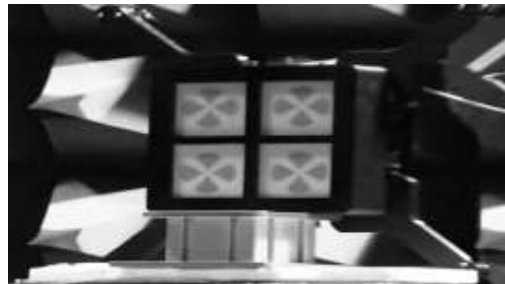


fig [0.2] planar array

## II. RECTENNA(HIGH POWER RECEPTION SYSTEM)

Rectenna is simply the rectification antenna created with half wave  $\lambda/2$  dipole array with schotky barrier diode in series to have switching speeds and low forward voltage drop there by preventing the heat loss. high efficiency gallium

arsenide diodes are to be used .about 1000-2000 dipoles can be employed depending on the desired power required by the load to run .by the experimentations conducted by nasa in collaboration with the raytheon lab produced a rectenna of 6 sub arrays with 4500 dipoles used to power pair of 300 lamps of 200 watts each wirelessly over 1.6 miles from the microwave transmit antenna about 82.5% of microwave energy had got converted completely to power far off distant bulbs. many research oriented companies like mitsubishi in collaboration with jaxa japan aerospace agencies had performed a testimonial at mitsubishi electric facility in hyogo prefecture and successfully transmitted the ,micro wave power to 500mts with a transmit frequency of 5.8 GHZ.



fig[ 0.3] locomotive receiver with-phased array antennas

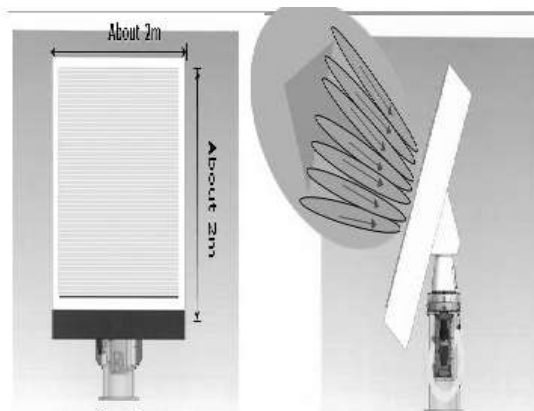
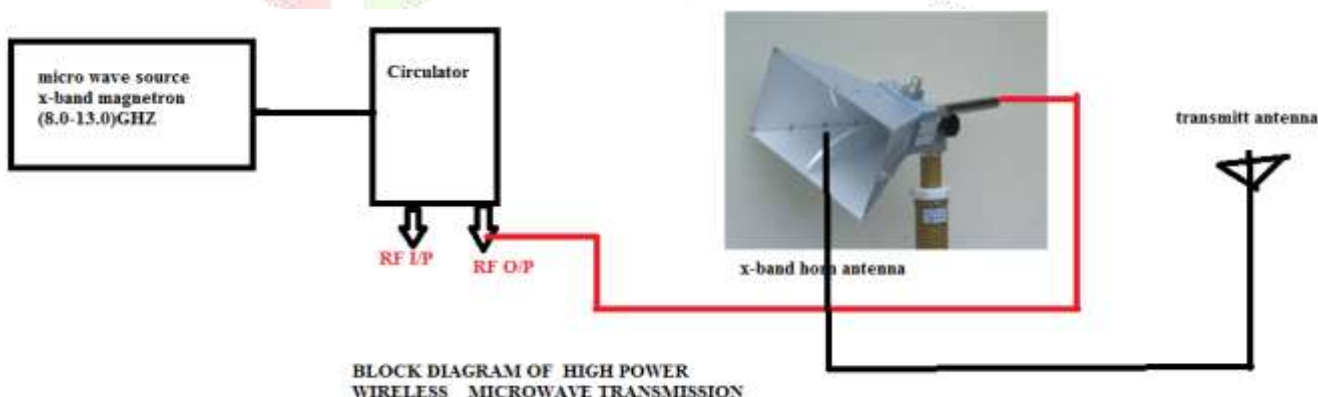


fig [0.4] transmitter with retro directive microwave beam

### III. IMPLEMENTATION OF CIRCULATORS AND ISOLATOR

Since the bandwidth of the optical fibre is in THZ. The microwave source is connected through the optical fibre to the circulator fig 1.4 of n number ports in our case it is four port circulator in which the input is applied at port no 1 and output is collected from the port no 4 . circulator is implemented to keep away backward reflections and to provide VSWR exactly equal to zero but practically its 0.5 to 0.6 may be in the limit between 0 to 1 . ratio of forward reflection coefficient to backward reflection coefficient must be equal to obtain a perfect standing wave without reflections. the ideal VSWR range is from zero to infinity.

Instead this can also be implemented using the isolator fig 1.112 which has two ports and unidirectional transmission possible a secondary solution to prevent the reflections back and provide perfect impedance equalization between the microwave source and the transmitting Pyramid Sectoral horn .the used x ray magnetron provides Insertion Loss: 0.45 dB ,Isolation: 20 dB, VSWR: 1.22:1.



### IV. IMPLEMENTATION OF X-BAND REPEATER

one of the peculiar accretion of this x band repeater fig[1.4 ]is that it can retransmit any signal on its existing authentic frequency allowing common 10 GHz simplest equipment used generally for mountain-top contesting can be implemented

between source and receiver. for high voltage microwave beam retransmission repeater can be constructed using slightly slotted waveguide omni directional radiator operating at frequency of ten gigahertz. and promoting isolation of about 90 db. series of power amplifiers and LC filters with bandwidth of 10MHZ. repeaters have matched screws built in to prevent reflections and promote high gain before transmit. signal received from the receive antenna is fed into the 3 Ga As (FET) lower noise amplifier with about noise figure of 1 db and 30 dB gains respectively. signal then directed to inter-digital LC filtering circuit to increase the power gain of received signal si is passed into the voltage controlled variable attenuation circuitry which has a productive range of 40 dB. The signal gets amplified by the power amplifier unit which has a gain about 30 db and 1 watt maximum output, filtered and transmitted through then, second waveguide antenna. A SCHOTKY diode power detector and dc amplifier provide an indication of power output level. previously existing 10.36832 MHz beacon is collimated with the repeater at the same line of sight. beacon is an ebonized crystal based reference unit which provides a CW recognition at least once each 60 seconds by keying a carrier frequency to switch on and off with the help of Morse message "DE WB6IGP/B" at about 8 wpm . This beacon gets amplified and transmitted by its own repeater unit.

## V. MICROWAVE HIGH DIRECTIVE BEAM CONTROL

The microwave beam generated at the source is directed to the receiving antenna after it gets acknowledged through the pilot beacon from the receiving antenna to maintain phase angle accuracy to 0.01% ,there by mitigating the power of side lobes in field pattern to maximize the energy of the beam ,power to achieve maximum power transmission efficiency. we require couple of phased array antenna coupled with the same phase, equal amplitude feed from the dipole or yagi uda antenna to move the beam at transmitter to receive pilot signal and microwave beam transmission simultaneously thereby hindering the delay of the rectification at rectenna and to have a robust continuously running locomotive we can implement any number of microwave source modules about (say) 1000 which in turn requires 19000 sub arrays for beam controlling purpose and power generation.

It requires 100w high power amplifier modules to produce a output power of 25 KW using retro directive system which can determine the AZIMUTHAL usable beam widths. coming to the amplitude mono pulse receiver it calculates ratio of difference and sum from intermediate IF frequencies sum and difference received from a transmitter and converts the relevant phase details of received microwave frequency signal..The mono pulse receivers receive the sum and difference from space pointed array of antenna and the control signal is utilised for rejection of side lobes. Therefore we need to check the radiation efficiency of phased array which can interpolate result of dc to RF conversion accuracy means to say that the aperture of TX antenna and RX antenna should have maximum cooperation with one another to mitigate beam tracking and phase errors to be hindered. we require a minimum of 1000 patch antenna installed in each and every sub array .HPA-MDL dividing circuit divides the base of patch antenna from other RF components. chosen MW frequency signal lying in X band needs to be amplified at the high power amplifier stage The concept of retro directive systems is the receiver sends a pilot signal say 2.4GHZ ism band test frequency in real time it differs with various circumstances. the transmitter at different offset frequency irrespective of physical damages it delivers highly directive with minimized phase error to receiver

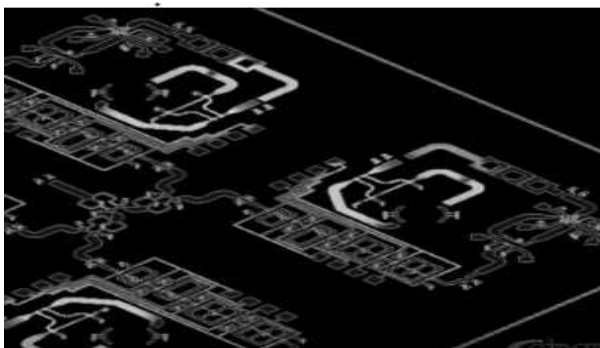


fig [0.5] simulated patch antenna as an sub array inside-phased array

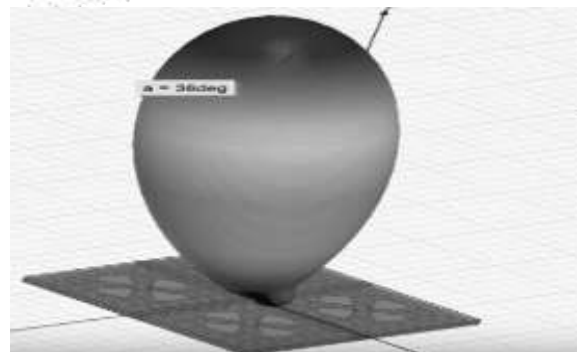


fig [0.6] beam alignment 360 degrees

## VI. TECHNICAL PROVOCATIONS

- To further improve the accuracy of steering microwave beam
- To increase the efficiency of conversion from microwaves to DC power at receiver
- To reduce the size and weight of the electronic modules used in RECTENNA
- HOW can we encrypt the microwave beam ,design of protocols is yet to be found in research

## VII. ADVANTAGES

- over head lines in railways can be eliminated
- No problem of wear and tear ,friction between centenary and over head line
- electrocution and havoc to human life can be achieved
- maintenance is quite tolerable

## VIII. DISADVANTAGES

- humans cannot tolerate the RF radiation
- AS per the study the electrical resistivity of men and women is different
- RF exposure may be harmful if used more than threshold limit set by ITU
- it depends on the type of skin whether dry or wet since skin epidermis layer would act as a capacitor

## IX. FUTURE SCOPE & CONCLUSION

IN future we can see the existence of microwave powered railway locomotives and smart phones covering the gaps of the primitive technologies and making enhancements with IIOT(industrial IOT).

## X. RESULTS AND DISCUSSION

TABLE 1 MEASURED HPA MDLS DATA PROCURED FROM ANALYSING ARRAY

Item	Measured Data (304 HPA-MDLs)
Frequency	5.803GHz +/- 85MHz
Output power	Averagely 8.9W
PAE (HPA) module info	70.003%
PAE (HPA-MDL) modules in sub array	61.0032%
Phase Error practical value	1.056 degrees in RMS
Spurious level of noise attenuations	-55.98 DBC
Weight in grams	1024g

## XI. ACKNOWLEDGMENT

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