Design of C Band Transmitter of TLR

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Abstract:

This paper presents the design issue & challenges in realization of C-Band transmitter for Troop Level Radar (TLR). The design goal was to develop compact and reliable all weather C band transmitter. Design aim was to to ensure compactness and light-weight. It should have easy accessibility for all components.

Key Words: Transmitter, TLR, TWT,FDM

I. INTRODUCTION

The C Band transmitter of Troop Level Radar (TLR) employees travelling wave tube (TWT) as a final power amplifier. TWT is powered by Inverter & Floating deck modulator (FDM). To generate waves from TWT it needs high voltage potential difference. This voltage potential difference is generated with the help of many high voltage components like Inverter, FDM, Bleeder, Cathode & collector Probe Tray and isolation transformer. FDM can reach voltage difference of 37 KV. In this process C band transmitter generates heat which needs to be dissipated in order to maintain correct functioning of the system.

C Band Transmitter of TLR weigh around 1 Ton. Units like inverter, Transformers, Cathode & collector probe tray ,Capacitor etc constitute half weight of transmitter. These items should be fixed firmly using correct material in order to meet system vibration specifications. In addition to this, TLR racks where designed for rack depth of 800mm to meet system requirement of minimum volume container. Since all items are mounted upto depth of 800mm so it should be designed with considering for ease of maintenance and all items should be easily accessible.

Waveguide chain of any transmitter use to be very critical factor on deciding its overall size. Also Wave guide length adds loss of waves, so number of wave guide chain in a transmitter should be optimized. There should be some provision in system to accommodate small deviation caused by manufacturing or assembly procedure.

II. Design

To design optimum size transmitter, its modules should be placed accordingly. To ensure this all modules should be placed adjacent to its connecting module. Inverter in TLR is assembly of 4 sub assemblies. These assemblies are mounted on milled plates for better rigidness and aesthetic look of system. These sub assemblies are self locating and can be accessed from either from top,bottom,side or rear of inverter without disturbing adjacent items. In order to maintain cables coming from other sub modules in inverter we used cable manager which has pre defined bending radius and save cables from damages. Inverter is mounted on slide to ensure easy accessibility for its all components for maintenance. To remove heat generated by IGBT's cold plate is designed with précised accuracy. It consist of few PCB's and 2 transformers, these items generate considerable amount of heat while operation. This heat generated need to be taken out in order to maintain system temperature with safe working limit. It was optimized by using blowers with defined flow path.

Capacitor & Transformer assembly

Capacitor & transformer assembly is used in transmitter to support other sub assemblies to generate high voltage difference. It consist of 2 capacitors, 2 Transformers & 1 CLR, these all items should be placed on single platform to provide fixed cable routing and easy maintenance of system. Overall weight of this assembly was around 240Kg. Selecting material like steel can be very good in this condition but it will also increase overall system weight, hence aluminum plate is used to locate all items on single platform. This plate is optimized for maximum strength to minimum weight to ensure structural stability of assembly. In addition to this,

all items mounted on this tray are self locating pinning at rear and locking from front on Teflon strips for ease of placing in system. Whole assembly is supported by slide for better accessibility of all individuals and connector panel in front to disengage full assembly at once from front.

Floating Deck Modulator (FDM) of C Band Transmitter floats at 37KV. To mount this extra care to be taken like keeping it away from metal or sharp objects by at least 150mm. It has been observed in past that if any blowholes or gap is there between FDM and mounting platform there is chances that it will generate spark. Addition to this FDM can reach up to temperature of 100 degree Celsius which quite high. As per mechanical property of Nylon it can be used as mounting platform but it cannot sustain this high voltage difference so there was need of material which is having high die electric constant. This was achieved by selecting Homopolymer, its mechanical property is same as Nylon but Die electric constant is better than that.

Traveling Wave Tube (TWT) is used to generate waves in transmitter when high voltage difference is applied. Since it works on high voltage its gun get heated up which need to be cooled. It generate spark when it come in contact of any metal or if any sharp metal piece is near to this by distance of approx 120mm. In order to avoid this we used nylon piece with non metallic fasteners near gun in place of metal base to avoid spark & to withstand high temperature.

Total heat load of transmitter is around 23KW, which need to be taken out of system in continuously. Main contributor for this heat load is TWT & Inverter cold plate, to cool these units we use Heat Exchanger which will cool these units. Flow rate and pressure is maintained in this system using sensors attached with heat exchanger, which will give fault signal in case of flow rate or pressure drop and shut down the system for safe keeping. Since C Band Transmitter is placed in closed container and its other sub assemblies generate considerable amount of heat which omits use of cooled air from air conditioner and it should reach every point of transmitter to maintain working temperature using air duct in rack with assembly of blowers to maintain air flow path in rack.

Waveguides are used to C Band Transmitter to give direction and path for wave generated in TWT without disruption and losses. Design of waveguide should be optimized to maintain rack overall size. These waveguides are supported in C Band transmitter by clamps to withstand system vibration level. Height adjustment provision is provided in clamps used for arresting wave guides for trouble free operation. Addition to this, to accommodate dimensional variation in other two directions adjustment is provided in TWT. Since Transmitter of TLR is subjected to EMI/EMC test, wave guide chain going to Microwave rack to Rotary joint should be properly sealed. It was achieved by designing a adopter which seals the rack outlet and it can adjusted 2 directions in case of any mismatch with proper sealing. Since TWT, 4 port circulator and wave guides are placed on single platform for ensuring easy maintenance of all interconnecting modules and permanent routing of High voltage cables & cooling hoses coming from heat exchanger, the whole tray mounted on single tray with proper sliding mechanism.

IV. CONCLUSION

Transmitter has been realized & tested for full operation its meeting all functional requirements. The weight & size of transmitter can be reduced by selection of compact modules or multi tasking modules.

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