SAMEER

Passion for performance

SAMEER

Society for Applied Microwave Electronics Engineering & Research

प्रौद्योगिकी सूक्ष्मतरंग इलेक्ट्रॉनिकी अभियांत्रिकी तथा अनुसंधान संस्था

ANNUAL REPORT 2016-17

AUTONOMOUS SOCIETY OF

MeitY

MINISTRY OF ELECTRONICS & INFORMATION TECHNOLOGY

GOVERNMENT OF INDIA

GOVERNING COUNCIL

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VISION, MISSION AND OBJECTIVES

Vision
To be a Premier R&D Institution of International repute in RF/ Microwave and Millimeter wave technology.

Mission
To achieve excellence in application-oriented research in the areas of RF/Microwave/ Millimeter wave Technology and Electromagnetics.

OBJECTIVES

- To contribute to the growth of science and technology of microwave electronics and allied areas through intensive research, design, development, training of manpower and setting up of facilities for national progress.
- To encourage and promote the development of microwave electronics in the country in order to achieve self reliance.
- To encourage advancement of microwave electronics through scientific research, development, education and to promote industrial applications and wider utilization of microwave technology and products.
- To develop the technology in national interest as a sponsored or grants-in-aid project for developing technology demonstration models and batch production of successful products if required. The projects are taken up (1) that are state-of-the-art technology (2) that serve as import substitution leading to reduction of undesirable foreign dependence (3) for which intensive R&D capability is needed (4) which are needed in small quantity and are not commercially available readily (5) which are in initial stages of development and usage before large scale usage builds up (6) for which the know-how from other R&D units can be taken and extended from their specific applications to broad range of applications (7) which are in the nature of spares of important systems ceased to be available in the market due to multiple reasons including obsolescence .
- To co-operate and collaborate with national and international institutions, research laboratories and other professional organizations.
- To organize study programmes, lectures, symposia, conferences, exhibitions and similar promotional activities.
- To build up library of books, periodicals and papers, films and other video aids.
- To undertake, aid and promote publications on RF and microwave electronics and allied subjects.
- To set up national facilities, regional centers and other units in selected fields of specialization for carrying out specialized experiments or for dissemination of knowledge.
- To set up, as appropriate, joint programmes to develop and share knowledge, expertise and experience with educational, research and other professional organizations in India and abroad particularly in the developing countries.
- To do all such other lawful acts, deeds or things which are cognate to the objectives of the society or conducive to the attainment of all or any of the above objectives

Overview by Director General

It is my proud privilege to present the Annual Report of SAMEER for the year 2016-17. The report provides an account of various activities, initiatives, products developed or deployed and recognitions given by various agencies, along with Financial Statements and information with regard to the society during the period.

The primary objective for SAMEER is to promote self reliance of the country in microwave electronics which is a very high tech area of work. The work encompasses both civilian sector with societal applications as well as strategic sector. Thus SAMEER's role is well defined for betterment of general public and the country.

The objective is being achieved by engaging in core research for advancement of microwave and allied technology and also undertaking projects from user agencies who are serving the countries needs in National Missions.

By undertaking challenging high technology microwave electronics designs for national missions SAMEER serves the nation for growth of science and technology and also keeps country in the international scenario for economic competitiveness and addresses the social needs of the country.

Some of the ongoing major R&D activities with support of our Ministry which are being pursued include

1. High Energy Linear Accelerator (30 MeV) for medical isotope generation is progressing with design of phase 1 being in advanced stage of completion
2. Magnetic Resonance Imaging (MRI) which is an indigenous development is a powerful diagnostic tool to visualize internal structures of the body in detail is being designed and has made significant progress in design and fabrication.
3. Another important project funded by the ministry is Smart warehouses with Application of Frontier EM & Electronics based Technology "with the objective of having an indigenous programme for ensuring food safety. The objective will be achieved by developing online moisture measurement based on Dielectric properties of the material, E-Vision system for quality characterization of rice, high power RF system for thermal disinfestations and controlling moisture, temperature relative humidity sensors, and a centralized warehouse management.

SAMEER has also made significant R&D contributions in the following activities :-

- **Fire control systems**
- **Radar Altimeters**
- **Airborne antennas**
- **Secure communication systems**

etc which have been delivered to the user agency and deployed.

SAMEER has also made significant contribution in atmospheric instrumentation area where many of its projects are nearing completion.

SAMEER has unique expertise in antenna design and development of various types of array antennas for communications applications. This is of immense importance and immediate interest for the upcoming 5G technology developments.

The design and development of millimeter wave components is an exclusive knowhow which has enhanced the capabilities of SAMEER in the strategic sector.

SAMEER continues to provide state of the art services in area of EMI/EMC test measurement and consultancy. SAMEER facilities are also accredited to many national and international bodies.

I am thankful to our parent ministry for its continued support and encouragement in all our R&D programmes.

Sulabha Ranade
Director General

PREAMBLE

Society for Applied Microwave Electronics Engineering & Research (SAMEER) is an autonomous R&D institution under the Ministry of Electronics and Information Technology, Govt. of India. SAMEER is an offshoot of the Microwave Engineering Group of Tata Institute of Fundamental Research (TIFR), Mumbai. SAMEER was formed in 1984 as a R&D Laboratory of the then Department of Electronics, Government of India and moved to its present location at Indian Institute of Technology, Mumbai in 1988. SAMEER has five centres located at Mumbai, Chennai, Kolkata, Visakhapatnam and Guwahati. The headquarters of SAMEER is located at IIT campus, Powai, Mumbai

Mumbai Centre – Centre for Microwave Research (CMR) specialises in the areas of Medical Electronics, Radar Instrumentation, Atmospheric Instrumentation, Signal Processing, High Power Radio frequency and Microwave Components and Systems, and Photonics. Under various core and sponsored research programmes, it has done pioneering work in these areas. It undertakes and executes sponsored projects for various Government agencies, Public Sector Undertakings and Industries. NABL accredited EMC test and measurement facilities have been established at Kharghar, Navi Mumbai, the second R&D Campus of SAMEER, Mumbai. Under the Linear Accelerator Infrastructure development project sponsored by the MietY, a state-of-the-art laboratory with Linear Accelerator tube development and Radiation shielded test and assembly facilities has also been established at this campus.

Chennai Centre – Centre for Electromagnetics (CEM) specializes in the areas of Antennas, Communications and Electromagnetic Interference /Compatibility (EMI/EMC). It offers comprehensive test, consultancy, training, engineering and research services to national agencies and electronics industries in India. It is also involved in research and development in the areas of RF & Microwave communication, Digital Signal Processing, antennas and electronics packaging. NABL accredited EMC calibration laboratory has been established at this centre. As a new initiative, second campus of SAMEER-CEM at Perungudi, Chennai has been built to establish Electronics Design Centre (EDC) for realizing System on Package (SOP) has been set up in.

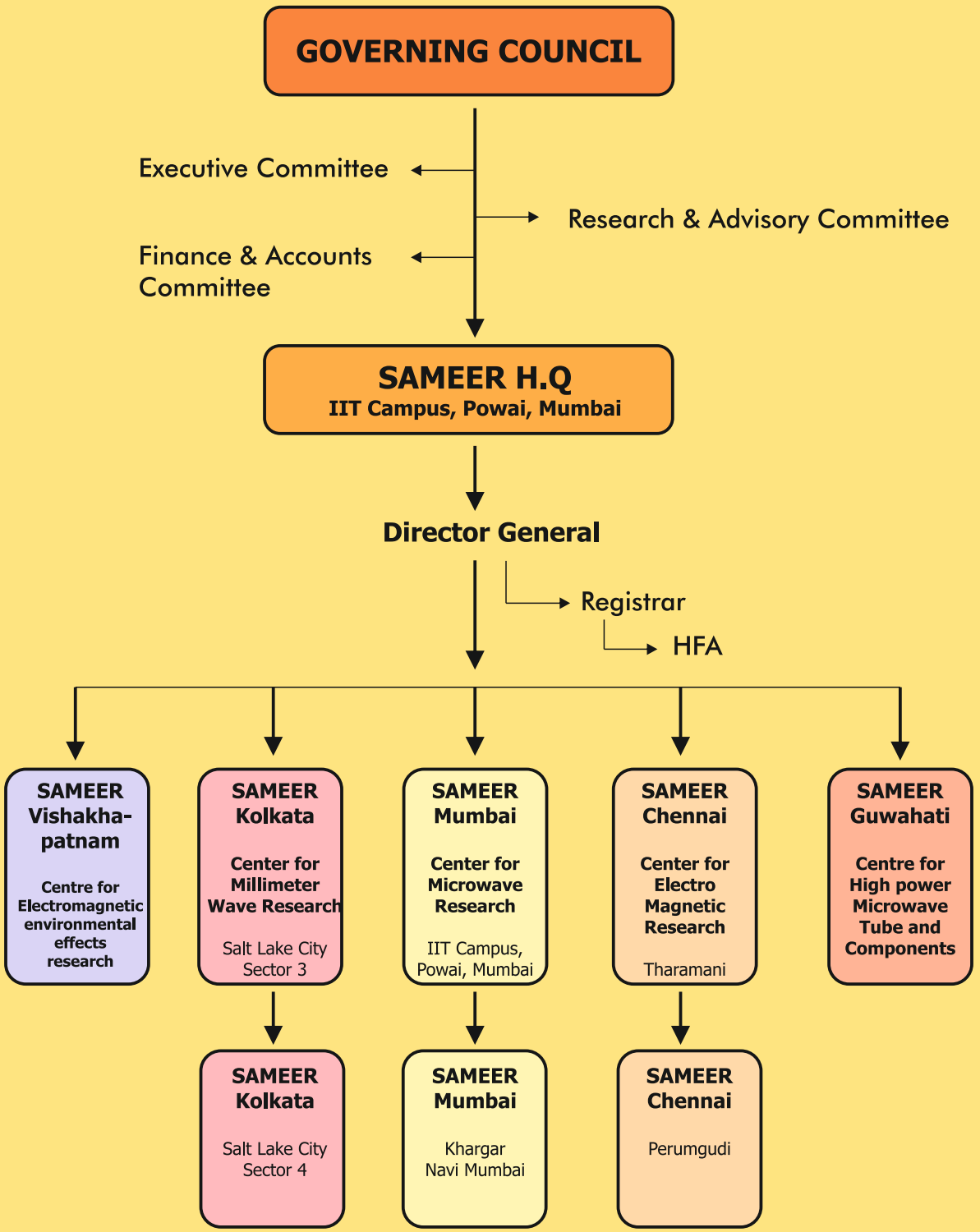
The Centre at Kolkata – Centre for Millimeter wave Technology specializes in the areas of Antenna and Millimeter wave technology. It is involved in the development of RF, Microwave and Millimeter-wave (MMW) components, sub-systems and systems for various users in the country. It has NABL accredited EMI/EMC test and measurement laboratory for evaluation of electronic products and services to industries. The centre has established a state-of-the-art millimeter wave laboratory with test, measurement, simulation, fabrication and assembly facilities and a Compact Antenna Test Range (CATR) facility for evaluation of antennas, radomes and scattering study with support of the MeitY at its second Campus of SAMEER, at Salt Lake, Kolkata.

Centre for Electromagnetic Environmental Effects (E3), Visakhapatnam is being established at Gambheeram village, Visakhapatnam Dist, Andhra Pradesh in 13 acres of land allotted by Govt. of Andhra Pradesh. The E3 facility specializes in a variety of capabilities, ranging from box level to complete system level testing to cater to the increasing requirement from the strategic sectors.

Centre for High Power Microwave Tubes and Components Technology is also being established at the Campus of Indian Institute of Technology, Guwahati. The objective of the Centre is to establish facilities required for development of high power microwave tubes/components as well as research and development activity for design and development of magnetrons and circulators at GHz.

SAMEER

ORGANIZATIONAL CHART



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Society for Applied Microwave Electronics Engineering & Research

MUMBAI

- Linear accelerator technology based systems
- Atmospheric Instrumentation
- RF & microwave high power systems
- Radar and strategic systems
- Antennas
- Photonics
- EMI/EMC

B) Facilities

- Mechanical design and fabrication facility
- Computer & IT cell
- Technical Information Centre

CHENNAI

- EMI/EMC test measurements & consultancy Electromagnetics & Antennas
- Communication systems
- Electronics packaging and thermal design
- Digital Signal processing

B) Facilities

- CE accredited EMC facility
- NABL accredited EMC equipment calibration facility
- Mechanical fabrication facility
- Technical Information Centre

KOLKATA

- Millimeter wave and microwave components, subsystems and systems
- Antennas
- EMI/EMC
- MMIC

B) Facilities

- Compact Antenna Test Range
- Mechanical design and precision fabrication
- MIC and assembly
- Technical Information Centre

NAVI MUMBAI

- EMI/EMC Test Measurement and design consultancy
- NABL accredited EMI/EMC facility
- Linear Accelerator processing laboratory
- Radiation shielded test facility

VISAKHAPATANAM

- Electromagnetics and Environmental effects
- Highly specialized Electromagnetic Pulse (EMP) and pulse current injection

GUWAHATI

- Design and development of high power microwave tubes and components

SAMEER MUMBAI

Centre for Microwave Wave Research

SAMEER, Mumbai has been pursuing research and development activities in the field of Medical electronics, RF and Microwave based radar Instrumentation, Photonics, RF/Microwave heating/drying applications, High Power components, meteorological instruments, Radio Altimeters. In addition to this, EMI/EMC services are offered to various industries. Its second campus at Navi Mumbai has facility for batch fabrication of LINAC tubes and also houses the EMI/EMC test facilities. Recently new infrastructure has been added at this campus for electrical products safety Lab for testing electronics products as per standards.

The major R&D programmes pursued here are in the field of Linear accelerator technology which finds application in radiotherapy treatment for cancer and Atmospheric instructions where specific expertise was developed to make radar based instruction for probing the various layers of the atmosphere and collect vital information on atmospheric dynamics. Apart from these two programmes, focus is also placed on development of high power RF and Microwave components and systems. The centre has also built special infrastructure for integrated optics and photonics. There are also interdisciplinary research initiatives in the areas like Digital Signal Processing, Navigational aids, Radar Instrumentation. The research activities are initiated through core research programmes which further lead to product development.

ATMOSPHERIC RADAR & INSTRUMENTATION (ARI) DIVISION

SAMEER with its wide and unique experience in technologies related to atmospheric instrumentation is identified as one of the prime R&D institutes for developing high technology instrumentation required in the field of atmospheric studies. The atmospheric Instrumentation has evolved as a major thrust area of the last two decades. This is rapidly growing field all around the world and finds numerous applications in the field of Operational meteorology, studies related to tropical dynamics, boundary layer research, aviation, air quality measurements and environmental monitoring. SAMEER is mainly pursuing activities related to development of RF and acoustic remote sensing applications for probing the atmosphere. This technology finds many applications not only in the field of meteorology but also in aviation, environmental/air pollution monitoring and wind energy potential assessment.

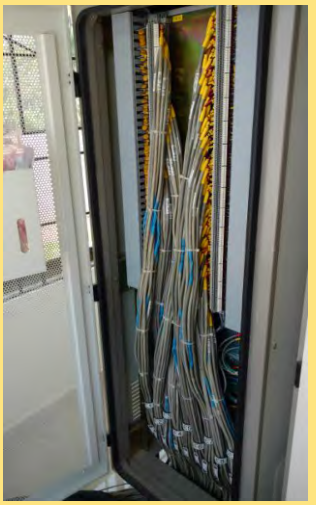
The division has executed following programmes during the year.

Design, Development and installation of Stratosphere Troposphere (ST) Radar at Guwahati University for North-East Region

The project envisions design, development and installation of ST Radar national facility at Gauhati University for north east states with emphasis on cost effective indigenisation of this sophisticated technology. SAMEER, with its proven capability in similar field, aims to execute this state of the art technology based project and to take lead in this field at national level. This is active aperture radar operating around 212 MHz frequency. The radar will have an array of 576 Yagi-Uda antennas arranged in a circular configuration. To enable the use of electronic scanning of the main beam, each antenna will be fed by an independent transmit/receive module. There are 576 T/R modules used for the 576 antennas. Each T/R module generates RF power output up to 400 Watt peak. The combined output power of 576 T/R modules will be 230 kWatt peak. The T/R module operates in the pulse mode with a duty up to 10% and the pulse width can be varied from 0.5 µS to 64 µS. Complete Antenna support structure with all the 576 antennas and balun boxes, TR modules, cable trays and power divider boxes has been installed at ST Radar site. Cable laying for Power cables, sync cables, CAN cables and RF cables has been completed. The field measurements for the entire Radar will be commencing soon.

Closer View of antenna array along with TR modules

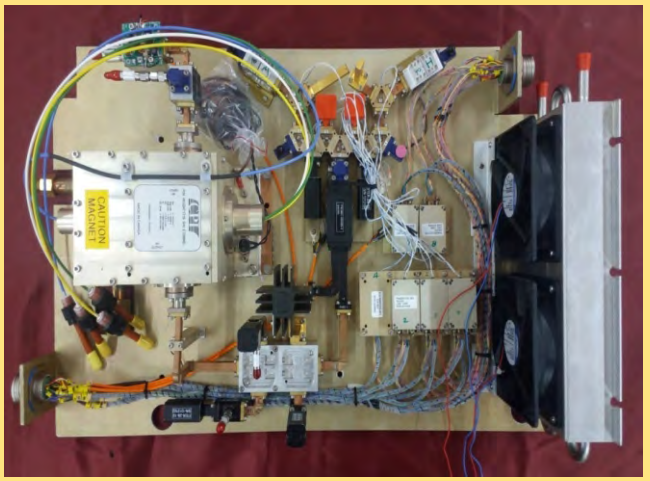
Fitment of 1:16 way power



power supply connection for divider/combiner (white boxes) 144 TR modules

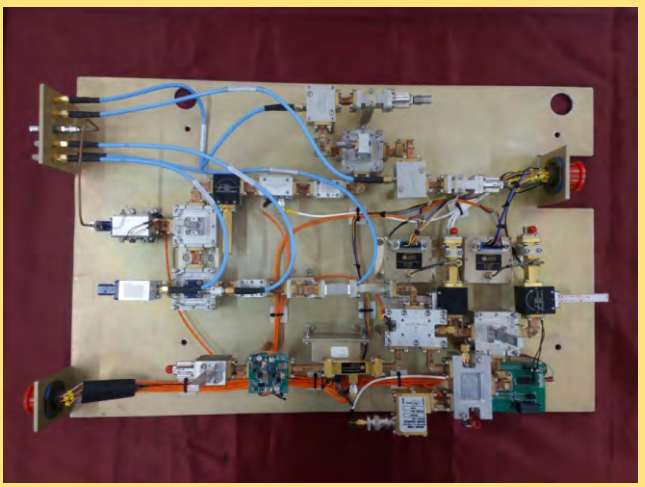
Development of Ka Band Polarimetric Doppler Radar for Cloud Profiling :

This project is funded by Ministry of Earth Sciences (MOES) with an outlay Rs 941.71 lakhs. Clouds play a critical role in earth's climate through the reflection, absorption and emission of radiation, the vertical transport of heat and moisture and the generation of precipitation and its associated latent heat release and evaporation. In order to adequately understand the role of clouds and improve their parameterization in numerical model; fundamental studies important to clouds formation, evolution and dissipation are required. These studies are possible with the help of Ka Band Polarimetric Doppler Radar. Radar consists of 1.8 m dia Cassegrain antenna mounted on a trailer and has scanning capability in azimuth and elevation for hemispherical coverage of clouds. System has many state-of-the-art features. Most of the sub-systems have been tested and the system level integration is being done. Major work like ka-band front end assembly unit, development of controller and monitoring unit for EIKA, testing of EIKA has been completed during this calendar.



Ka-band front-end Assembly Unit: EIKA Side

Ka-band front end Assembly unit unit consists of ka-band components at transmit and receive end. Sub systems on this plate which are integrated together are EIKA transmitter, up-converter, LO distribution network, internal calibration and microwave receiver. All above subsystems include nearly 50 modules which were to be inter-connected with the help of wave guide links. The placement of all these modules was a tough task. Therefore for this type of placement, 3D drawing of each module was created in software. After creating 3D drawing of each module, placement work was modeled using Inventer 3D modeling software. After many iterations above configuration was finalized. Based upon above modeling actual drawings of the waveguide links were created. There are total seven types of links required. For each type of link, fabrication jig was created and then all 50 links were made. These



Ka-band front-end Assembly Unit: Local Oscillator side

Testing of EIKA using our own make Controller & Monitoring Unit (CMP)

links are having excellent results with S11 better than 30 dB and S21 minimum 0.14 for link with 3 bends. The Integration of Microwave plate is completed and installed in Rack along with Modulator. On the software front, Radar Controller software consists of data processing, display, communication; system health monitoring and antenna scan control modules. Many codes for Communication, Display, System health monitoring and data processing modules have been developed and tested individually. It is to be integrated and tested in its entirety. As part of the Cloud Radar algorithm development, basic algorithms for Drop Size Distribution and velocity de-aliasing using the spectral data from the vertical looking cloud radar has been developed. The integrated online signal and data processing programs along with cloud radar user interface programs are in the final stage of development using python language in Linux environment.

Assembly of Radar electronics in an Electronic Enclosure

Development of Conformal Antennas

Multi-arm multimode conformal antennas have been developed for broadband omni-directional coverage. A

2 element array of multi-arm multimode conformal antennas has been fabricated and tested by exciting in various phase differences for beam tilting. The radiation pattern has been measured. RCS has been measured for different spiral mode excitations. The project has been reviewed and recommended for closure.

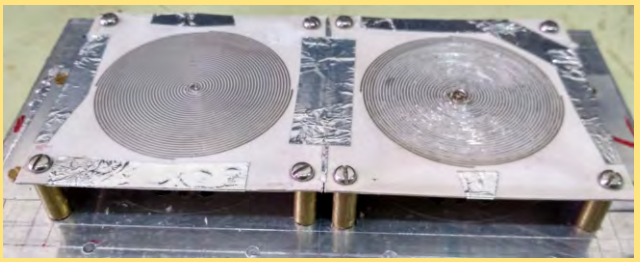


Photo of Spiral Antenna array

Phased Array SODAR Activities

The Mobile Sodar, fitted on a Eicher make mini truck and powered by solar panel, developed by SAMEER is deployed at IMD, Airport Observatory Premises, Kolkata in March 2017.

The smooth functioning of SAMEER Phased Array Sodar Systems at NPCIL Kaiga, S.K University Anantapur, NESAC, Umiam, Shillong, NPCIL Kakrapar and SPL, VSSC, Trivandrum are supported through AMC and spare parts supply.

INDUSTRIAL METEOROLOGICAL SYSTEMS DIVISION

The division is involved in design and development of meteorological systems and radars for collecting and processing of ground and upper air weather data.

403 MHz Radiosonde System

SAMEER is executing a sponsored project to develop and fabricate 403 MHz Radiosonde Ground system and balloon-borne device with sensor package to measure the atmospheric pressure, temperature and humidity and transmitter, for India Meteorological Department (IMD).

Ground System

The development of Radiosonde Receiver ground system as well as balloon payload had been completed. Eight units of Radiosonde ground systems were already delivered and the remaining seven units are ready and expected to be delivered in two months' time. These systems shall be deployed in the field by IMD.

Ground System

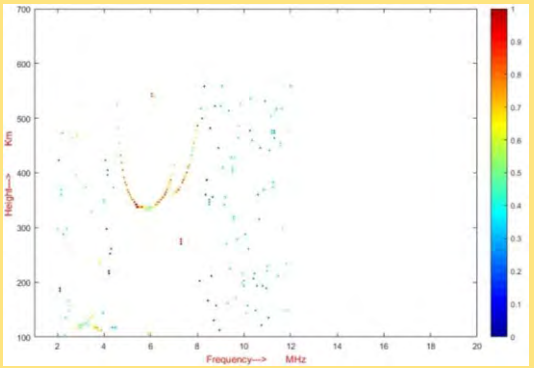
Design & development of Digital Ionosonde

The indigenous Digital Ionosonde project; executed under the auspices of MEITY's North East programme was installed successfully, with the fabrication, erection and installation of the bespoke, Delta Antenna for transmitting Ionosonde signals. The performance of the system was verified by development collaborators (and end users) at Dibrugarh University, Assam. Preliminary scientific validation of the Ionogram data has been carried out satisfactorily. Work on the acquisition of Skymap and Drift data, and its scientific validation is on-going. Our collaborators at Dibrugarh University are of the opinion that the "system has lot of potential and has performed well for its age"

This system can be potentially used in various scientific researches like space climate studies, magneto-

Delta Antenna

ionospheric studies etc. This instrument can be used in Earthquake Prediction, by monitoring the changes in the Ionosphere that precede these powerful events.



Ionograms showing the F1 layer

Lightning Detection Network

As a part of MeitY's North East programme, is developing an indigenous Lightning Detection and Localization Network. Lightning is the single largest cause of fatalities due to natural disasters, & it's envisioned that this system will alleviate this problem. The Lightning Detection Node has been designed and five units of Node are in fabrication. The Lightning data processing software is in the advanced stage of development. By the end of the year the system will be deployed for field trials in NE region.

RF & MICROWAVE SYSTEMS DIVISION

SAMEER has core expertise in design and development of high power RF/microwave systems. It has been working in the field of high power RF and Microwave technology for more than three decades and over the years has generated technical expertise and experience to design various high power RF and microwave sources and related hardware. Generation of high power is very critical for various scientific, industrial and strategic applications such radar transmitters, subsystem for generating ionizing radiation, heating etc. Each of these applications will require a unique design and optimization and requires deep knowledge and expertise to design such subsystems/systems.

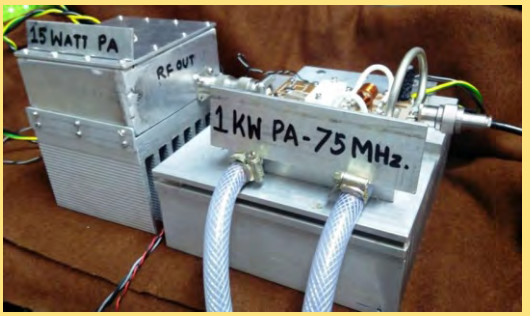
Microwave Technology Based Tea processing system for NE States

Microwave heating systems for the application of drying of tea powder are being developed for Gauhati University and Tezpur University. The system comprises of a 10 kW, 2.45 GHz microwave source with conveyorised applicator. Individual system with applicator, stabilizer and chiller unit will be commissioned, one each at Gauhati University and Tezpur University. The system is capable of generating 2kW to 10kW of microwave power at a nominal frequency of 2.45GHz which falls in ISM band. This system mainly comprises of two microwave generators MS5. Each generator MS5 generates 1kW to 5kW microwave power. The output of these generators is connected to the conveyorised applicator through waveguide plumbing and horn antennas. Both the generators are exactly identical and use same components. The applicators are also similar. Two Units have been transported to respective user site and commissioned. One unit is being delivered.

Development of Solid State HP Amplifier

75 MHz, 800 Watt Solid State Amplifier

The 800 Watt, 75 MHz power amplifier has been

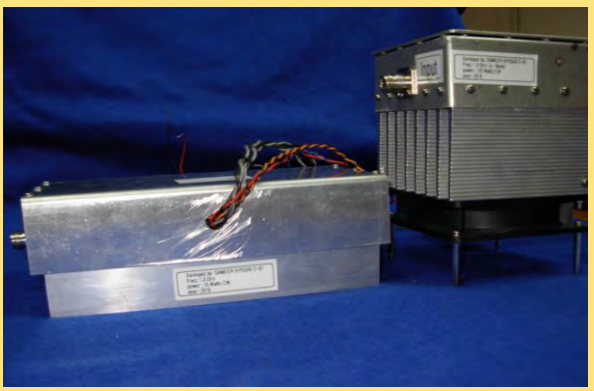


75 MHz 800W 3 stage SSHPA module

developed using 3 stages amplification. The pre-driver and driver stages are housed in one chassis module. Both these cascaded stages deliver the output power of maximum 53.4dBm and this will drive the final power amplifier. After development, fabrication and various optimizations in the matching networks and bias conditions, the maximum power of 59 dBm (800 Watts) CW is achieved. The overall gain is more than 80 dB and bandwidth is ± 1.5MHz. The present design has forced air cooling system. But it is recommended to use water cooling system for sustainable operation over extended period. Hence water cooled heatsink is also developed.

1.3 GHz, 185W CW Power SSPA

The power amplifier is designed, developed and tested at L-band frequency 1.3GHz with an output power of 185 Watt CW using 3 stage of amplification. By implementing various impedance matching techniques in the present design and optimizing the component values, 185 Watts of CW Power has been obtained. The overall gain of the amplifier chain is 50dB and the bandwidth is ±30 MHz. The amplifier modules are forced air cooled with compact axial fans to maintain the heatsink temperature below 60°C. Two such power amplifiers have been developed and tested. To achieve a higher output of, say, 400 Watts, it is possible to combine a number of identical high power amplifiers with high power combiner which has been designed and tested for optimum performance. The L band HPSSPA is shown in the picture below.



L band 185W HPSSPA

TECHNOLOGY INNOVATION DIVISION

Technology Innovation division undertakes projects which utilizes the expertise in RF & microwave and innovates to specific applications.

Indigenous Magnetic Resonance Imaging system:

Department has sanctioned project titled "Indigenous Development of MRI scanner" under Digital India Programme of Govt of India with an objective of to design, develop & conduct clinical trials of 1.5 Tesla MRI scanner. Viewing the importance of the project Hon'ble MCIT on "Good Governance Day" i.e. 25th Dec, 2014 handed over the Sanction Order of the project during an event organized by the Department of Electronics and Information Technology. SAMEER is the Nodal agency to execute this project with collaborating partners i.e. CDAC, IUAC & MIRC. During last one year, lot of progress has been made in designing various subsystems. Many MR coils have been fabricated & successfully tested. The Head Birdcage Coil and its supporting circuitry has been developed and tested. The Flat Spine Array both 4-Channel and 8-Channel are developed.Phased Array Coils Circular ring structured and Rectangular Ring Structured 8-Channel Cardiac Array is developed and tested with phantom. The 2KW of Power is generated successfully with the combined chain of Driver amplifier, combiner and high-power amplifier, with amplifier setup gain of 46dB. The signal generation and receiver is on the verge of completion.1st integration with other collaborating agencies were conducted in November 2016 where an image was given as input to the partially developed system and same image was obtained as output.

Pretreatment Dose Verification for IMRT using Monte Carlo Method

In Radiation Therapy, independent MU calculations is rather very important for verification of complex

treatments, especially in the presence of small, irregular and concave fields and due to heterogeneities introduced by materials such as lung, bone, air and non-biological implants. With Dynamic Treatments like IMRT and IMAT, there may be large deviations in the intended volume dose distributions and the actual delivered doses, reducing Tumor Control Probabilities and at the mean time increasing the probability of radiation induced secondary cancers due to possible overdose to the Organs At Risk. This calls for independent pre-treatment dose verification for complex treatments.

Monte-Carlo methods have proven to be very promising in terms of accuracy and provide more realistic results. These methods allow simulating the transport of ionizing radiation in complex configurations such as Linacs, Detectors, Phantoms etc., of millions of particles viz., photons, electrons and positrons. We propose to develop the system in two stages; (1) Creation of the phase space of the Linac and (2) Evaluation of the dose distribution in the patient, for which we estimate, the object representation of the patient from the Computed Tomography (CT) images.

Multileaf Collimator (MLC) For Dual Energy LINAC System:

A new, customized, small sized design of MLC for Dual Energy LINAC is taken up. The available dimensions are 725 X 725 X 120 mm in which FPGA based controller is installed. There are 40 X 2 high density tungsten leaves. Every leaf has independent motor. The achieved leaf speed is 20mm/second with motion accuracy 0.1 mm. User interface is developed using Lab-View software.

Some relevant features are :

- Software for Drag and pull leaf position.
- The MLC software system can now directly take any hand drawn template by user (with some generic rules).
- Smart database logging of patient treatment using MLC.
- Incorporation of camera based template verification.

Record & Verify System

We envisage to develop a complete radiotherapy information management system, compliant to the DICOM standard, with capabilities to interface with imaging systems, treatment planning systems and treatment delivery systems. The system is intended to provide image, RT objects and reports storage capabilities, so that it can potentially function as an integral link between imaging, diagnosis, planning, treatment delivery and record keeping, thus serving complete RT workflow. In addition it shall provide scheduling capabilities for the treatment delivery system and create records for billing.

The basic RVS with the capabilities for treatment delivery and record keeping is in the final stages of development, incorporating completely in-house developed DICOM implementation. The code is developed in C++ using design patterns rendering it maintainable and suitable for incorporating future developments and changes to the DICOM standard.

Application of EM Wave Based Technology for Disinfection of Grains, Pulse and Seeds for Safe Storage

Indian Council of Agriculture Research has sponsored project titled "Application of EM Wave Based Technology for Disinfection of Grains, Pulse and Seeds for Safe Storage "with the objective of developing an Innovative electronics and electromagnetic based disinfestations for safe management of grains, pulses and seeds. The grains will be exposed to high power Electromagnetic radiations in an RF based disinfestation system. The thermal gradient between the pests and the grains ensures destruction of pests while keeping the grains intact. Such a system will limit the food wastage to a great extent. During last one year substantial progress has been in the project. The parallel plate applicator model has been design and

simulated. The electrical characteristics of simulated model have been measured. The test model of parallel plate applicator for RF dis-infestation has also been designed and developed. The system is tested upto 200W RF power in open loop for high power.

Smart warehouses with Application of Frontier EM & Electronics based Technology (S.A.F.E2.T.Y.):

Department has sanctioned project titled "Smart warehouses with Application of Frontier EM & Electronics based Technology "with the objective of having an indigenous programme for ensuring food safety. The objective will be achieved by developing online moisture measurement based on Dielectric properties of the material, E-Vision system for quality characterization of rice, high power RF system for thermal disinfestation and controlling moisture, temperature relative humidity sensors, and a centralized warehouse management. SAMEER is the nodal agency for the S.A.F.E2.T.Y project and it is not only responsible for design, development, system integration and testing but also for the overall technical and financial progress, co-ordination with other participating agencies and deliverables from the project. During last one year a lot of progress has been made in the project. Sensors for online moisture measurement, offline test structure for prototype measurement and 5.81 GHz transceiver has been developed successfully. For RF disinfestations system, design and development of high power parallel plate applicator and 1KW RF amplifier @27.15 MHz is completed successfully. Also, successful integration of disinfestation system (DDS + Amplifier + Applicator) is done.

high power parallel plate applicator

Design & development of Vacuum Assisted Radio Frequency Dryer System:

At present, different conventional dryers are available to the industry. In such dryers, once the product is exposed to the heat, it is very difficult to keep a control on the inside temperature of the product. Most of the times, it is observed that the temperature goes beyond the required temperature. Some primary concerns regarding increasing the Temperature are that it damages the product (overheating, discoloring, modifying the particle characteristics, skinning, cracking).It also results in increasing the heat losses of the system. Vacuum drying systems are new in the industry and can play a major role in the drying process of various products.

SAMEER has indigenously developed a conveyorized, vacuum assisted radio frequency dryer system specially to achieve higher efficiency at low temperature in heating / curing of the agro products.

System Applications:

The system can be widely used in the following industries:

- Agro Industry
- Pharma Industry
- Chemical Industry

PHOTONICS DIVISION

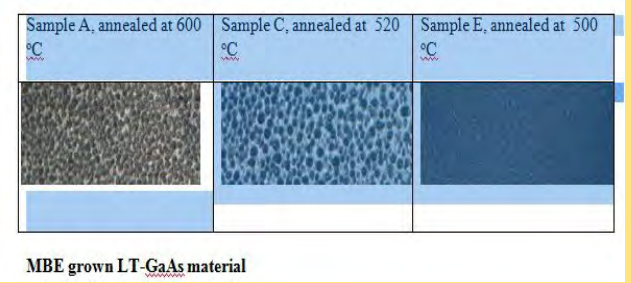
Photonics division specializes in the area of development of terahertz technology for spectroscopy and imaging, broadband wireless communication system, trace gas sensors to detect the harmful gases from the atmosphere at sub ppm level and High Resolution Imaging System using Spectral Domain-Optical Coherence Tomography (SD-OCT).The division also has core expertise in direct writing of wave guide devises using femto second laser ,Modeling and Design of THz waveguide and Growth of LT-GaAs based THz emitter material using Molecular Beam Epitaxy (MBE).

Development of broadband wireless communication system using terahertz Technology , DeitY (Ongoing)

Work on THz waveguide simulation carried out. The waveguides were fabricated and tested up to 150 GHz. Optical directional coupler fabricated using femto second laser writing technique for THz application. MBE used for growth of LT-GaAs material.

Growth of LT-GaAs based THz emitter material using MBE (completed)

The MBE equipment installed at SAMEER is used for growth of LT-GaAs material. The material is required for fabrication of THz emitters and receivers. The LT-GaAs based emitters are commonly used in THz generation, as reported in the literature. This material is not easily available in market. The objective of this work is to develop this material so that the same can be converted into THz emitter and receiver. The LT-GaAs material has been grown at 240, 250 and 260 degree C followed by rapid annealing at 600 degree C. Rapid thermal annealing system was programmed for user defined annealing parameters. The crucible and effusion cell have been procured for MBE to carry out growth in the presence of aluminum.



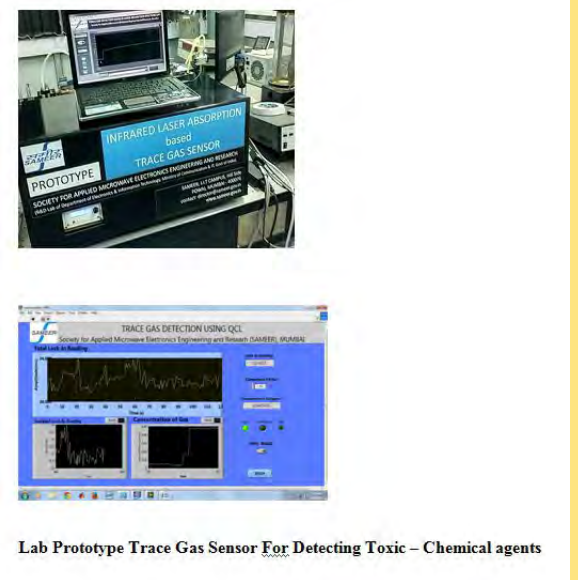
MBE grown LT-GaAs material

Design & Development of Quantum Cascade Laser (QCL) absorption based toxic – chemical detector for Homeland Security

SAMEER has developed a lab prototype trace gas sensor for detecting toxic – chemical agents for homeland security applications. This will be utilized to detect harmful chemicals present in the air. These instruments are required to be fit-in near HVAC of VIP buildings.

Photo-acoustic spectroscopy based gas sensor prototype has been developed. MEMS sensor has been used for acoustic wave detection generated by modulated Laser light from MIR wavelength QCL source.

Multi-gas sensing has been established by tuning QC laser in the wide wavelength range. The scanning speed has been optimized to suit user's requirement for early detection of toxic chemicals. The minimum detection limits for Ammonia and SF6 gases have been achieved at part per trillion (pptv) levels.



Lab Prototype Trace Gas Sensor For Detecting Toxic – Chemical agents

MEDICAL ELECTRONICS DIVISION

Microwaves and RF play an important role in high end medical devices both for diagnostics and treatment. SAMEER has pioneered the technology for linear accelerator based cancer therapy machine which is cleaner alternative to Cobalt-60. LINAC uses diversity of technologies such as ultra high clean vacuum, joining technology, high power microwave engineering, high voltage pulsed electrical engineering, precision mechanical engineering, medical physics, control electronics, precision bulk optics and system engineering.

Based on its core expertise in the standing wave linear accelerators developed at TIFR, SAMEER has aggressively pursued the Medical Linear accelerator program under National Jai Vigyan mission. In the first phase SAMEER has developed two 6 MV Linac machines for cancer therapy treatment which are installed at Cancer institute Chennai and Mahatma Gandhi Institute of Medical Sciences at Wardha. These machines have treated thousands of cancer patients by radiation exposure. The second phase of the mission is being implemented.

Diagnostic Medical imaging is one of fastest growing areas in India. Advanced cutting-edge technologies are being used to understand disease prognosis, thereby strengthening the sophistication level of the participants in the sector. SAMEER with its core expertise in high technology areas have embarked on two programmes of radioisotopes for nuclear imaging and magnetic resonance imaging (MRI) scanner with a mission to diagnostic tests not only need to be "available", but they also need to be "affordable" and "accessible" in order to be able to make a real impact.

Medical Electronics Division-I is actively involved in the linac based applications. The division has undertaken following linac activities

Research and Development of High Energy Electron Linear Accelerator Technology for Medical and Other Applications:

Radio-isotopes are widely used in industry and medicine. Around 140 radio-isotopes are used worldwide in medical applications such as diagnostic, therapeutic and preventive purpose. Medical isotopes are used in non–invasive nuclear diagnostic imaging techniques to identify illnesses such as heart disease and cancer at an early stage. The most widely used medical radioisotope is 99mTc (Technetium) and an estimated 70,000 medical imaging procedures take place daily around the world. As large majority of 99mTc is produced from nuclear reactors which are ageing and slowly shut down due to environmental considerations, there is a shortage of 99Mo and 99mTc. High Energy Linac offers clean alternative production methods.

With SAMEER having a core expertise in linac systems submitted a feasibility report to Ministry which was approved by working group and sanctioned with INMAS DRDO as a co participating agency.

The phase 1 of the project is under progress where the design of major subsystems has been completed. The accelerating structure and electron gun has been finalized. Radiation lab layout has also been finalized.

Some of the technological challenges being addressed are:

- The linac will be two-stage system which is being done for first time at SAMEER
- The average power of Klystron is very high and hence the thermal design of entire system including convertor target is very essential and critical
- The modulator will be high repetition rate and SAMEER will be handling such modulator for the first time

- The radioactivity near the convertor region will be very high and shielding design is critical
- The neutron generation will be high and proper shielding for neutrons is needed

MEDICAL ELECTRONICS DIVISION-II

6 MV Medical linac "Siddharth":

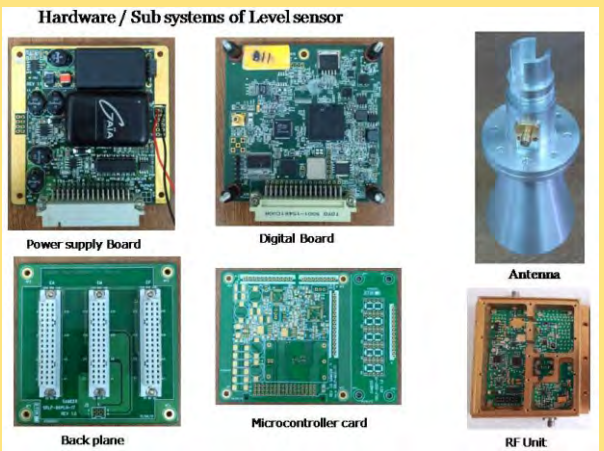
The second machine under phase II of jai-Vigyan national mission at of MeitY was installed and commissioned at Cancer foundation hospital at Amravati, Maharashtra.

RADAR DIVISION

Radar Division has the core expertise in development of compact custom built radars for range measurements. With frequency modulated continuous wave (FMCW) technology having matured provides very low cost low complexity solutions as an alternative to pulsed technology.

Liquid level probe

Measurement of levels of liquids especially in harsh industrial environment poses a significant challenge. FMCW radar in X-band is being developed to accurately measure the level of corrosive liquid in a storage tank at very high temperature stored in a tank with accuracy of few millimeters. The probe needs to be designed to withstand temperature in excess of 200 degrees Celsius.



ARINC based Radar Altimeter :

FMCW technology based Altimeter was flight evaluated from a few meters to excess of 2 km and delivered to the user.

Ground based Synthetic Aperture Radar

A number of fatalities have occurred in the recent past due to sudden collapse of benches/or high walls in open cast mines. Although considerable efforts have been made in the past to understand the mechanism of these failures, no pre-warning systems/devices have as yet been developed indigenously for prior indications for such failures.

The major drawback of these conventional techniques is:-

(i) Installation of devices on the monitored surface which are mostly inaccessible

(ii) Laser based techniques though the issue of accessibility is overcome, these and other similar methods, essentially represent fixed point measurement (i.e. surface displacement points can only be observed one at a time)

(iii) Covering large observational areas requires large number of instruments, leading to higher costs, or scanning with a smaller number of devices at the expense of temporal resolution.

Radar based instrumentation has some advantages over other methods in its ability to cover large surface

areas for true two-dimensional monitoring day and night in almost any weather condition; atmospheric dust or haze have little effect. Radar's active transmit/receive mode of operation provides an advantage over passive optical methods that depend on solar or other illumination. Given the advantages of imaging radar, such radar based slope stability monitoring systems are being developed for such markets. SAMEER in collaboration with IIT Bombay and DRDO has submitted to coal ministry a S&T proposal for "Indigenously developed slope stability radar".

Multi-comport converter

A rugged fully configurable multi port converter was realized using FPGA technology for use in multiple communication ports such as RS232, RS422, MIL 1553 4-20mA etc was designed which operates on single power supply. The GUI was developed which can be used during evaluation of many platforms which use different protocols such as Altimeters etc.

EMI/EMC DIVISION

EMI/EMC division provides EMI/EMC compliance testing and consultancy services to industry from its SAMEER, Navi Mumbai campus. Products having diverse application in space/defense and various industry sectors like Medical, IT, automation & control, Power were tested as per international standards like MIL-STD-461, CISPR 11, 14, 15, 22 and IEC 61000-4-X, IEC 60601-1-2, IEC 61326 etc.. The division has also assisted in finalizing the proposed RADAR site by carrying out Noise survey at Solapur on request by M/s. Indian Institute of Tropical Meteorology (IITM). Also, the measurement of Shielding Effectiveness test for MRI shielded room and fire class cabin door for Naval ship was undertaken for TIC-I division, SAMEER and M/s. Godrej Ltd., Mumbai respectively. The design consultancy service for compliance testing as per Civilian standard was offered to industry. The division has also undertaken the radiated emission measurement of moving train of the first train manufactured by M/s. Medha drives, Hyderabad under 'make in India' scheme. More of such proposals of Radiated Emission measurement for locomotives like first Air Conditioned suburban train being manufactured by M/s. BHEL, Bangalore and Monorail Phase-II are in pipeline

During past FY as many as 77 customers availed EMC test services for their 108 products. In total 293 tests were conducted by the division contributing to the growth of Indian industries thus helping in realizing the vision of our honorable prime minister of 'make in India'.

The division has established in-house EMC calibration laboratory offering calibration services for instruments required for EMC test and measurement. The EMC calibration laboratory is also accredited as per ISO/IEC 17025: 2005. In addition to fulfilling our calibration requirements, the division has also offered calibration services to 9 other EMC test laboratories across the country from Government and private sectors during the same period.

The division has necessary expertise for the design & development of High Power Microwave sources and antennas for EMC and HEPM applications.

Services

1. EMC test, measurement and consultancy services as per various standards
2. Services were offered for calibration of EMC test instrumentsas well as Electro Static Discharge generator and RF components
3. Consultancy was offered to M/s. IRD, Mumbai for complying to Radiated Susceptibility test as per IEC 61000-4-3 for their product to be installed at Nuclear Power Plant
4. A workshop on EMI/EMC requirements and requisite standard was offered to M/s. Aker solutions, Navi Mumbai

Newly established Laboratories and facilities

Electronic safety and environmental test laboratory for testing products pertaining to IT, Audio/Video and Household equipment has already been established. It houses state-of-art test equipment required for carrying out the electrical and environmental safety tests. The said test facility was formally inaugurated by Smt.Sulabha Ranade, Director General, SAMEER and thrown open for Indian Industries. It is proposed to include safety test requirements for Medical equipment as well. Currently, the division is in the process of acquiring accreditation from NABL as per ISO/IEC 17025:2005. Subsequently approval will be sought from BIS for carrying out the electronic safety tests on equipment falling in category of IT, audio/video, household and medical applications.

Accreditations and listing

1. A desktop surveillance audit for EMC test laboratories was conducted by NABL and granted continuation of accreditation for the EMC test facility
2. A surveillance audit was conducted by external auditors deputed by NABL as per ISO/IEC 17025: 2005 for EMC calibration facility. A continuation of accreditation status for the laboratory was granted.
3. The division is listed on website of Federal Communication Commission (FCC) for Conducted and Radiated Emission testing as per FCC Part 15

As a part of core R&D in the EMI/EMC domain following activities were undertaken

1. Development of 200 kV Marx generator is completed. The packaging of prototype unit is underway.
2. The theoretical design & development of Half Impulse Radiating Antenna (HIRA) is completed. The simulation results have been obtained. The fabrication of the antenna is underway. It will be

Inauguration of Safety Lab

used along with above mentioned Marx generator for radiating UWB High Voltage Impulse required for HEPM testing.

3. The theoretical design & development of Spherical Dipole Antenna (SDA) is completed. The simulation results have been obtained. The fabrications of the antennas (for two bands) are underway. They will be used for Shielding Effectiveness measurement of instrument racks as per requisite standard.

SAMEER CHENNAI

Centre for Electromagnetics

SAMEER Chennai centre specializes in the areas of EMI/EMC, advanced communication systems, Digital Signal processing, Antennas and thermal engineering. The Centre's thermal design facility is unique. It can model, simulate and evaluate the thermal design requirements of electronic hardware from component level through PCB to rack level. It also has core expertise in areas of communications using RF and microwave technologies. The centre has provided unique test, measurement, calibration and consultancy services in EMI/EMC, antennas and thermal engineering to Industries and Govt. departments. The Centre has two campuses-main campus is in CIT Campus, Taramani and the second campus is located in Perungudi. An electronic design Centre has been established in the perungudi campus for realizing system on package. A brief description of activities pertaining to the centre is given below.

ELECTROMAGNETICS AND ANTENNA ACTIVITIES

Design and Development of Switched beam array antenna for 5G Technologies at 60GHz

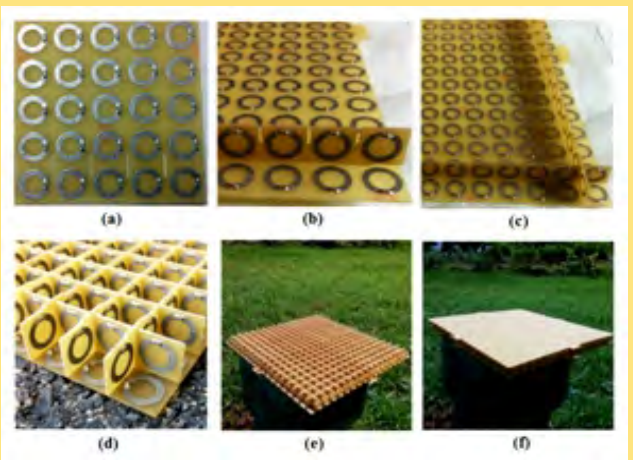
Design and Development of various types of array antennas for communications applications, is of immense importance and immediate interest for the upcoming 5G technology developments. Especially novel antennas that can provide, switched beam from the base station, to the mobile user with small foot print will be the most desired for the project requirements. The requirements of sub-millisecond latency and bandwidth limitation in traditional wireless spectrum have driven the cellular networks, to break the Base Station (BS)

Metamaterial Based Flat Lens for MRI Applications

centric paradigm and thus enabling the future 5G technologies. These 5G technology demands, large beam forming antennas with high gain characteristics in order to extend the coverage, while reducing interference and improving link quality at the cell edges. In the proposed approach, a periodic arrangement of electrically small unit cells (antenna element), are implemented for the specified application of beam switching. Beam switching will be accomplished by varying the phases between the antenna ports. Proposed antenna configuration uses multiple ports integrated into a single device, which is capable of steering the radiation pattern to a desired predefined direction. The radiation pattern with switching options exhibits wide elevation plane beam width and the small narrow azimuth plane beam width.

Metamaterial Based Flat Lens for MRI Applications

A cuboid meta-material unit cell with μ = -1 is realized. A periodic configuration consisting of the proposed 3D unit cell is realized for magnetic field focusing application. The unit cell of subwavelength consists of capacitor loaded planar printed rings on each face of cuboid of dimension 15x15x16mm3. The unit cell is designed by considering the effect of capacitor's tolerance on the resonant frequency. A flat lens of 270x270x16mm3 made of 18x18x1 periodic array of proposed unit cells is fabricated and tested. The fabricated flat lens exhibits magnetic field focusing at 64MHz with an improvement of 10dB when compared to the power without the flat lens. The measured results are in good agreement with simulated results.



Fabrication steps of metamaterial based flat lens

Metamaterial based flat lens at 65MHz (Unit cell size /500)

Development of end-to-end 5GTest bed

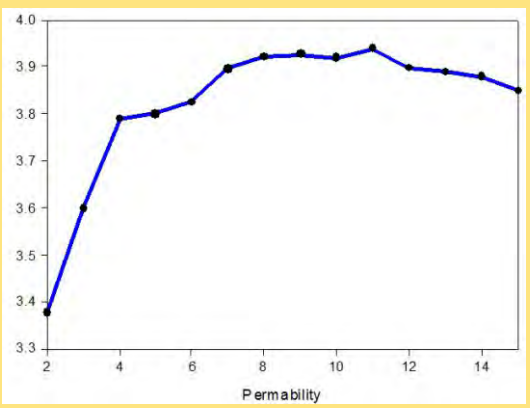
A multi institute initiative for the development of end-to-end test bed is proposed by collaborating with various academic institutions.

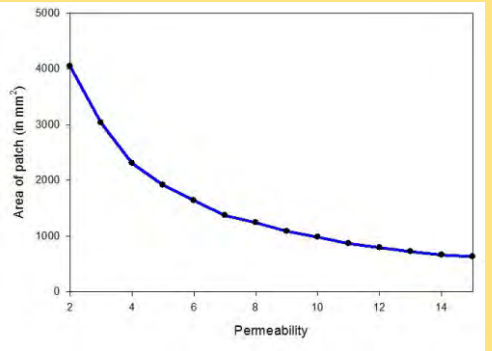
In order to leverage the various research activities going on in the country and to develop a next generation technology base which can facilitate creation of products and solutions using 5G technologies, it is essential to develop and provide an extensive test bed covering all the areas of a 5G network solution to the R&D community in India. With this background, it is proposed to develop an end to end test bed as a joint effort between Academia, Industry, Indian Operators, and Telecom vendors (including Indian startups, SMEs and MNCs). This Test Bed will be built Bottom Up, particularly with regard to all the new 5G technologies, and not assembled by procuring systems from elsewhere.

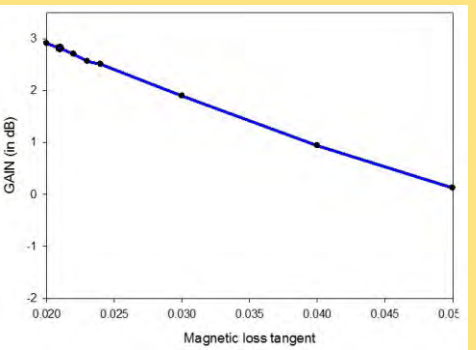
The project is proposed as a multi-institute collaborative project with participation from eight institutes – IIT Bombay, IIT Delhi, IIT Hyderabad, IIT Madras, IIT Kanpur, IISc Bangalore, CEWiT and SAMEER. Each one will be contributing to the test bed in a complementary manner based on the expertise and interest of each institute. The expertise spans from antenna design on one end to the service layer architecting and designing on the other. Care has been taken to avoid overlaps in various subsystem developments. While the hardware development are confined to a fewer institutes, the algorithms and software will be developed in several institutes using common platforms and integrated in one place. The participating institutes have already worked on developing similar technology test bed subsystems in the past. Several components of the 5G test bed are also under development in these institutes.

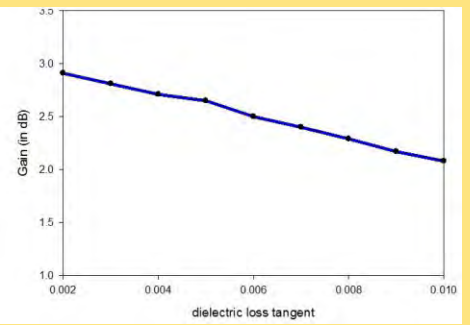
Magneto – dielectric substrates for miniaturized antenna application

Magneto – dielectric substrate for miniaturized antenna applications is a collaborative project of SAMEER-CEM, Chennai and Centre for Materials for Electronics Technology (CMET). The objective of the project is to use the Magneto-Dielectric (MD) material that is provided by CMET and miniaturize the microstrip patch antenna at low frequencies (in the order of hundreds of MHz). Designing of miniaturized RF components in the VHF-UHF band is becoming highly desirable these days. Use of high permittivity substrates leads to highly concentration of fields around the high permittivity region, which results in the low efficiency and narrow band characteristics.





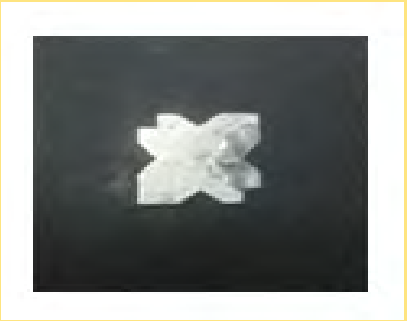


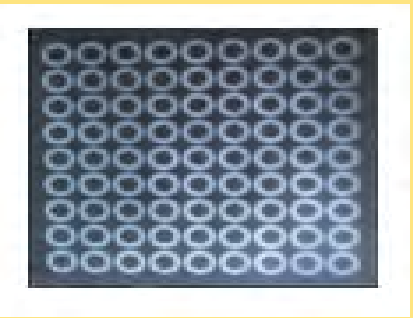


Gain variation for different dielectric loss/ magnetic loss tangents These problems with high permittivity substrates usage paved a way for magneto dielectric substrates. Magneto dielectric (MD) materials have permittivity (εr) and permeability (μr) values greater than unity. Magneto dielectric materials can also miniaturize the antenna by the same factor (η= √(ε_r μ_r)) as that of the high permittivity substrates with moderate values of permittivityand permeability without depreciating the antenna performance. To analyze the antenna performance with MD material, a comparison has been made with the similar antenna on high permittivity dielectric substrate like FR4 (εr= 4.4). The antenna loaded on MD material achieved good miniaturization and better bandwidth and efficiency compared to that of antenna on FR4 substrate.

Design and Development of Reconfigurable Circularly Polarized Fabry- Perot Antenna

Modern communication systems and Space-borne radars demand for high gain, wideband and conformal antennas. Periodic structures can be implemented in linear and planar array configurations for high gain antenna applications. Conventionally planar antenna arrays, with high gain and beam steering capability are designed using corporate feeding network, resulting in So to avoid these losses space fed arrays, reflect arrays and Fabry-Perot Resonator (FPR) antennas are employed for high gain conformal antenna applications. FPR antenna consists of single radiating element backed by a ground plane with a Partial Reflecting Surface (PRS) placed at λ0/2 distance. Circularly Polarized Fabry-Perot Resonator (CP-FPR) is designed and fabricated with diagonal slit Koch fractal square patch as primary radiator and 9x9 array of circular rings as PRS.





CP Feed antennaPeriodic partial reflecting surface CP-FPR Antenna

Polarization reconfigurable CP-FPR antenna is developed with diagonal slit Koch fractal square patch as primary radiator which exhibits an impedance bandwidth of 8.125 % for S11 < -10dB and a realized gain of 16.05 dB with axial ratio of 1.2625dB for Probe 1 excitation and 16.05 dB gain with axial ratio of 1.2552 dB for probe 2 excitation at resonant frequency of 9.6GHz.

EMC ACTIVITIES:

EMC Division of SAMEER-CEM, Chennai is a leading laboratory in the country, providing Electromagnetic Compatibility test and calibration services to large number of Indian electronic industries in compliance with ISO/IEC 17025:2005. EMC Division continued to focus on EMC testing, design consultancy, calibration and training activities with continual improvement. The Division strived to increase the number of testing, calibration and design assignments with its state-of-the art infrastructure, complemented by the team of experienced and dedicated engineers.

EMC Division offers comprehensive test and design solutions, consultancy, calibration and research services to its customers, backed by consistent and time efficient test procedures.

More than 330 testing and 146 calibration assignments were carried out and 264 industries were benefited.

NABL Reassessment Audit

National Accreditation Board for Testing and Calibration Laboratories (NABL) conducted reassessment of EMI/EMC Testing and calibration laboratory of SAMEER-CEM, Chennai during 25-26th October, 2016. NABL awarded certificate for testing and calibration with a validity upto 3/11/2018 and 22/12/2018 respectively.

Design Consultancy

System level EMC hardening was carried out for 3+1 Zone TCU with heater and Heat Exchanger to achieve EMC compliance as per IEC/CISPR std. for M/s Dynetic Product Pvt Ltd. Chennai. As a part of

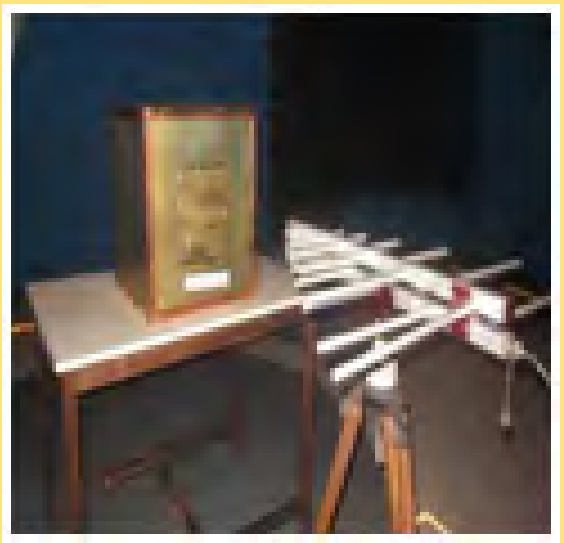
hardening, placement of the subsystem, cable routing, filtering and grounding schemes were reviewed and modified to achieve the compliance.

EMC Design consultancy C-Arm X-ray machine (Dream Series) manufactured by M/s Cura Healthcare Pvt. Ltd to achieve compliance to IEC 60601-1-2 standard. Common mode noise was identified on the interconnecting cables and suppression was achieved using the port and cable level filtering. Filtering was also done on DC-DC converters on the control cards to bring down common mode noise contribution from them.

Shielding effective evaluation was carried out for following items manufactured by M/s Coatex Industries, Pune.

- Conductive Gasket
- Honeycomb Mesh
- Transparent shielding material

A jig was fabricated to evaluate above items. These items were assesses for frequency range of 10 KHz-18 GHz.



Alternative Energy Generation Testing

Onsite EMI evaluation was carried out for 2MW turbine generator at Dharapuram, Coimbatore. The machine is 2MW turbine generator that converts kinetic energy into electric power to 760V AC output (generator voltage) and grid voltage of 620V. The height of the turbine tower is of 95 meters and individual blade length is 58 meters and the total diameter of the blade is 116 meters. Rotor can rotate to a Max. speed of 14 RPM. Based on the wind speed the rotor speed may go upto max. 14 RPM from which turbine will generate 2MW of active power. Measured data contained the contribution from various other sources also, analysis was carried out to identify the contribution from the wind turbine.

Conducted Emission, Radiated Emission and Harmonics & Flicker Emission measurements using relevant Artifact for each respective measurement were carried out in NABL Accredited 5 EMC Labs at different locations of India under our ILC Program.

DIGITAL SIGNAL PROCESSING DIVISION

Indigenous Development of Fire Control System (FCS)

FCS-FNII (2016-17):

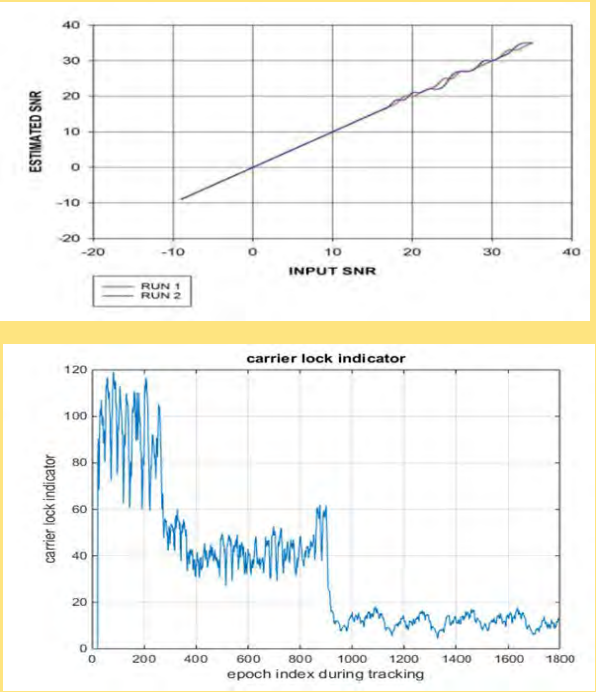
The division has designed and developed another variant of Fire Control System (FCS) based on the specifications provided by the end user. The system is tested for the functional requirements and qualified for the Environmental Tests (ET), Environmental Stress Screening (ESS) tests, 168 hours of Endurance Test and Electromagnetic Compatibility (EMC) qualification as per MIL STD 461C. The project is successfully completed and the system is delivered in April 2016. The Factory Acceptance Tests (FAT) are completed in February 2017.

Development of FCS-OBS Modules

SAMEER has developed 3 variants (GRSE, MDL, FN) of FCS system. These systems are installed and being used now. Based on the requirements, SAMEER has developed the on-board spare modules for all the three variants of the FCS systems already supplied. The OBS modules are tested for their functional specifications and qualified for the ET and ESS standards.

Adaptive Algorithms for Performance Optimization of Spread Spectrum Transceivers

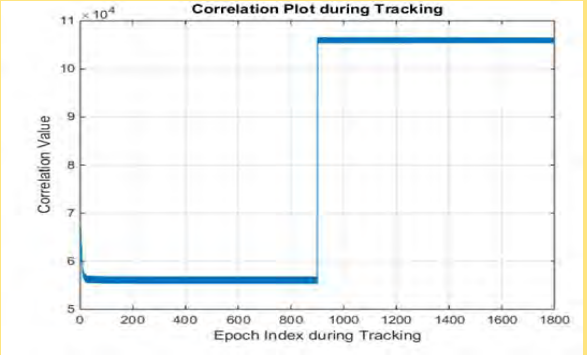
Compared to the fixed communication systems, adaptive systems offer improved throughput and effective utilization of the data link based on the channel conditions. In Spread Spectrum (SS) based systems, the user can select between security aspects (jamming resistance) and throughput based on the channel conditions, if the data link is built-in with adaptive capability. Considering the added advantages offered by the adaptive systems,



SNR estimation Carrier lock indication

simulation based implementation is done on adaptive transceiver algorithms for SS systems with hardware implementation feasibility. In order to implement the adaptive features in SS systems, SNR estimation algorithm, interference suppression algorithm are developed and link distance calibration is done.

During hardware implementation, the code length and data rate can be made adaptive for selection between security and throughput as per the user requirements. With Software Defined Radio (SDR) based hardware, the data link adaptation can be done with more flexibility to meet the user requirements. SNR estimation algorithm is able to



Correlation output during Tracking

Data Link parameter adaptation

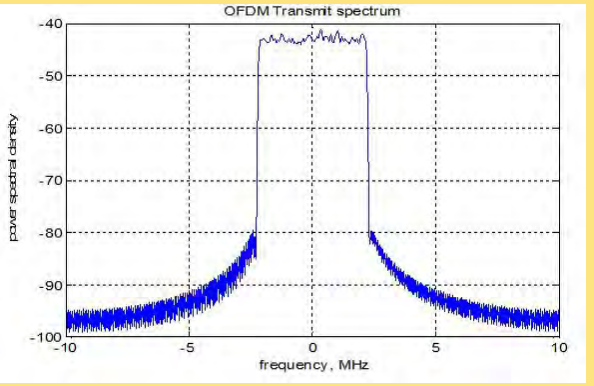
Data rate	code length	Processing gain	Board Clock Frequency	BW (MHz)	Adapting for given specification
9600	127	21	45,516,800	2.5	High security
19200	63	17.9	45,158,400	2.5	Medium of both
38400	31	14.9	47,616,000	2.3	High throughput

Adaptation of system parameters

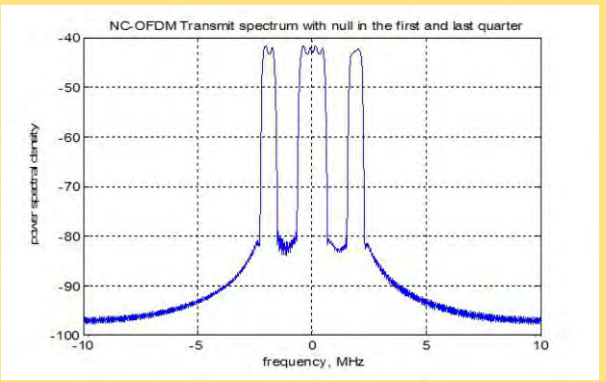
give +/-1 dB accuracy. Interference suppression algorithm gives very good SNR improvementover different interferences like single tone jamming, pulse jamming, AWGN and multiple access interference.

Spectrum Shaping using Non-Contiguous Orthogonal Frequency Division Multiplexing (NC-OFDM) for Cognitive Radio (CR) Applications

Cognitive Radio (CR) is an innovative technology that supports dynamic spectrum access (DSA) to utilize the spectrum more efficiently in an opportunistic manner without causing interference to the licensed users.Multi Carrier Modulation (MCM) technique such as Orthogonal Frequency Division Multiplexing (OFDM) is identified as one of the suitable candidate for the design of CR systems. To provide high data rates while avoiding interference with licensed users, a variant of OFDM called Non - Contiguous Orthogonal Frequency.

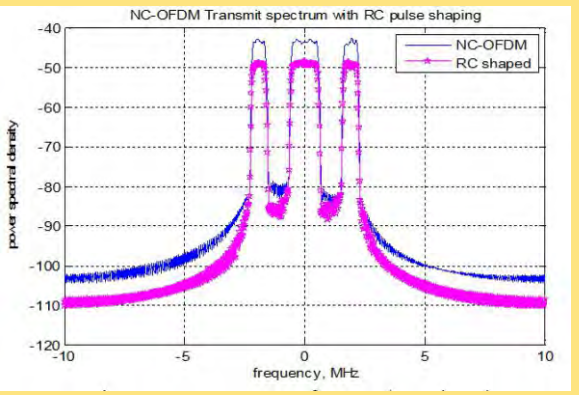


OFDM Spectrum



Spectrum with de-activated sub-carriers

Division Multiplexing (NC OFDM) is used in CR. NC-OFDM will be useful to dynamically shape the spectrum based on the channel impairments, interference and jamming threats. In this core R&D work, the NC-OFDM transceiver link is simulated in MATLAB environment towards hardware implementation. The transmitter output spectrum, spectrum after de-activating unwanted sub-carriers, spectrum shaping using Raised Cosine filtering, Spectrum sensing using correlation of known pattern and FFT based spectrum sensing were simulated.



Spectrum after pulse shaping

COMMUNICATION SYSTEMS DIVISION

The division undertakes applied research in strategic communication systesm using Rf& microwave technology.

Two RF channel CDMA receiver

Coded Division Multiple Access receiver has been designed and developed for an important telecommunication data link requirement. Present design is third generation one after successful deployment of Mk-I and Mk-II versions. Mk-I version had single RF channel with lower data rate. It was upgraded to two RF channels and each RF channel catering for two data channels with higher data rate. In Mk-III version, further optimization has taken place with reference to weight and dimensions. The data link is highly secured type due to the direct sequence spread spectrum technology adopted in the design and development. Four numbers have been completed and delivered to the user agency.

Spread Spectrum Transmitter

Spread Spectrum Transmitter supports a secured data link by modulating the input signal with direct sequence spread spectrum coding and up-converting to the radio frequency as required by the user department. This system serves as a simulator for the purpose of test and evaluation of the receiver as well as a driver source for the power amplifier to transmit the required power for the data link. Two numbers of the Spread Spectrum Transmitter have been developed and another six numbers are in progress.

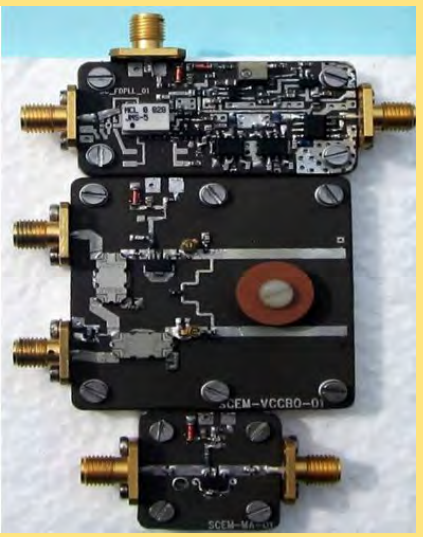
Secured Two way Communication system

Secured two way communication system is being designed and developed for a data communication requirement. This system will have separate frequency allocation for the transmitter and receiver. The data being transmitted in one direction will be very critical in nature and this data modulation will be based on direct sequence spread spectrum technique. The data transmission in the other direction will be encrypted. The receiver system consists of multiple numbers of channels for simultaneous operation. The system will undergo very stringent environmental test and evaluation.

User agency successfully conducted flight trials of Two RF Channel CDMA receiver in actual deployment conditions

Technology Development for Compact C-band Transmitter

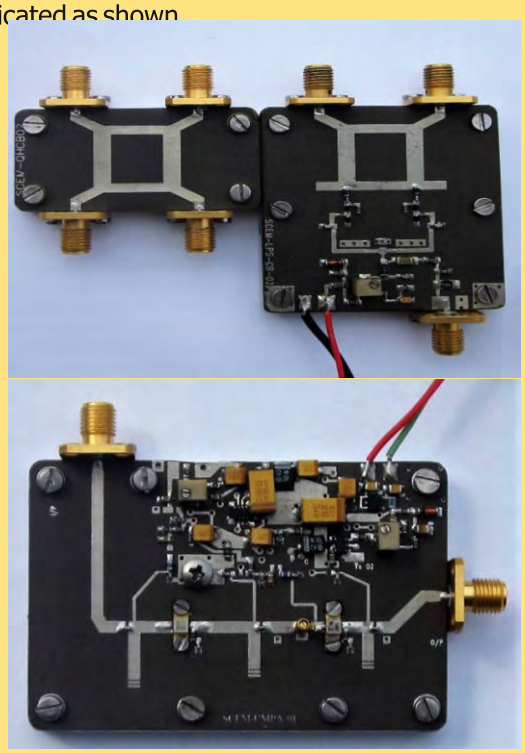
A new core R&D project has been undertaken for technology development of 'Compact C-band Transmitter' for possible applications in various microwave communication systems. The design challenges being addressed in the transmitter development includes miniaturization, power efficiency and compliance of environmental specifications. In-house development of stable microwave source is taken up. In this context microwave circuits like C-band Dielectric resonator oscillator, C-band monolithic amplifier, C-band frequency divider and phase locked loop have been designed and fabricated.



In addition, circuit level developments were undertaken for direct modulation at transmitter frequency. A C-band direct phase modulator was designed configured around in-house designed microstripline quadrature hybrid as shown in Circuits development for Stabl Microwave Source

The direct phase modulator has been tested to meet the project requirements. Medium power GaAs FET amplifier operating at C-band has also

been designed with appropriate bias derived for single power supply operation and the same has been fabricated as shown



C-band Direct Phase Modulator Circuits C-band Medium Power Amplifier

As depicted all the aforesaid microwave circuit developments are based on standardized carrier plate assemblies. This methodology has been devised to reduce development time cycle with the added advantages of uniform physical size, assembly alignment, precision connectorising and cascadable microwave interconnections with testability options.

Development of S -Band Direct Phase Modulator & S-Band Phase Locked Dielectric Resonator Oscillator

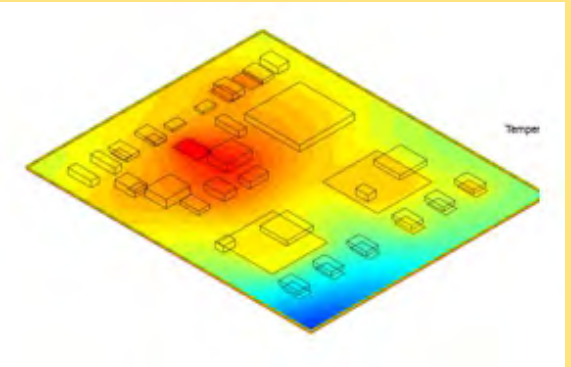
As a part of execution of core R&D projects, Design and Development of S-band Direct Phase Modulator and S-band Phase Locked Dielectric Resonator Oscillator have been completed. These product developments will find various applications in microwave communication systems for space, defence and other systems. A wide application potential with commercialization of the R&D effort by transfer of technology to industry is foreseen - Thereby SAMEER can contribute to 'Make in India' vision of Government of India.

ELECTRONICS PACKAGING DIVISION

Thermal Simulation of Multilayer Printed Circuit Board

Thermal design of a multilayer layer printed circuit board was carried out for onboard satellite application. The board consists of several Integrated Circuits and Components mounted both on its top side and bottom side and is specified to work in 20oC vacuum environment.

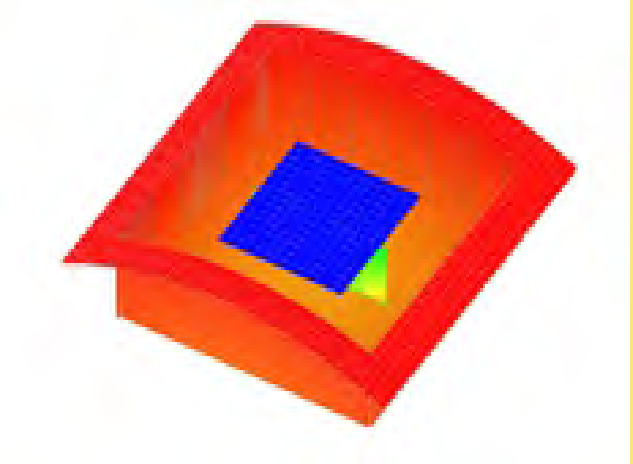
The Thermal design work had addressed modeling of all critical components with their respective heat flux. Each layer of the board was modeled with corresponding copper traces. Heating due to current flow through copper traces (Joule heating) is also considered for the thermal analysis. As there is no convection, the temperature of components had increased. As a solution, suitable thermal vias are incorporated underneath the critical components to spread the heat across the PCB thickness. With the optimization using **FloTHERM** simulations the temperature of critical components has been reduced.



Thermal design of Power supply enclosure

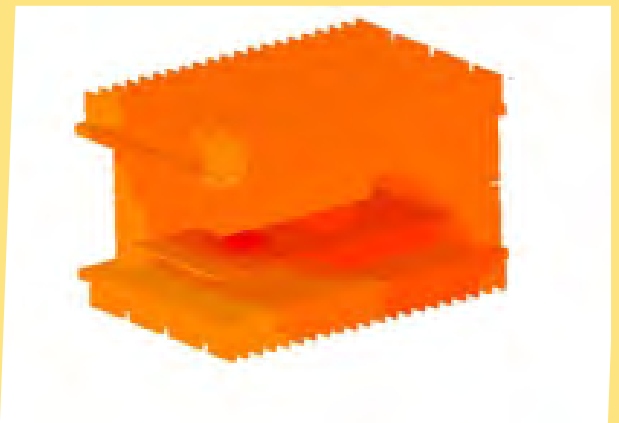
Thermal design of Power supply cum power divider enclosure for airborne application is completed. Total dissipation from the system is around 20 Watts. As the circuit boards are housed inside a sealed enclosure the heat transfer by convection is low and the temperature rise of critical components was high. As a solution heat transfer path has been designed to effectively conduct the heat from electronics devices such as DC-DC

convertor, MOSFET, power divider etc. to the outer surfaces of the enclosure. Heat sink is designed and realized on the surfaces of the enclosure to dissipate heat to the ambient. Parametric study was done to optimize the fin thickness, fin spacing and fin height to maintain the rise of case temperature of critical components within 20oC with respect to specified ambient temperature.



Thermal design of Airborne Patch Antenna

Thermal design of Patch antenna for application in airborne communication system has been carried out considering the kinetic heating due to air friction. Kinetic heating takes place on the outer surface of the radome while the vehicle is moving at very high speed. Heat generated due to kinetic heating is a major concern in design of antennas for airborne systems. Temperature distribution across the thickness of the radome is predicted. Computational fluid dynamics analysis was undertaken to predict heat transfer from the radome to the patch antenna considering the operating time period. Thickness of the radome, heat transfer from radome to patch antenna etc. have been optimized for improved thermal performance in order to maintain the patch antenna under safe operating temperature limit.



SAMEER Kolkata

Centre for Millimeter Wave Technology

SAMEER Kolkata Centre, pursuing active researches and developments in the field of antennas, microwave, and millimeter wave technology. The centre is executing sponsored as well as core projects in the field of antenna and millimeter wave circuits & systems. For the competence development, some core developments are carried out on anticipated requirements. The centre also provides test and measurement services to the private industries and Govt. agencies in the areas of EMI/EMC, antennas, radome and RCS. Design consultancy services are provided in EMI/EMC. The centre has established a state-of-the-art antenna radiation performance evaluation facility, called Compact Antenna Test Range (CATR).

ANTENA DIVISON

Antenna Division specializes in Design and developments of microwave and millimeter wave antennas for strategic and civilian applications. The division undertakes core research and developments which can find practical applications. It also provides antenna radiation parameter measurement to the Govt. agencies and private industries utilizing the CATR facility installed at the centre.

S/Ka band tracking antenna

This project was sponsored by a Govt. R&D lab. The objective of the assignment was to indigenously design and develop a telemetry tracking antenna system which will operate at both S-band and Ka-band using same radiating aperture. It finds application for airborne tracking in a ground station. Cassegrain configuration has been used at Ka-band while at S-band prime focus configuration has been adopted. For the present application, a frequency selective sub-reflector has been developed which allows S-band signal to pass through it with low insertion loss and reflects the Ka-band signal. The antenna is dual circularly polarized (LHCP and RHCP both) at Ka-band and dual linearly polarized at S-band (HP and VP both).

The fabricated overall antenna is shown in Fig.1. It yields gain over 53.2 dBi for both LHCP and RHCP reception at Ka-band with a 3dB beamwidth of 0.43° x 0.44°. At S-band, it exhibits half-power beamwidth of 6.3° x 5.3° with gain better than 31.6 dBi for both vertical and horizontal polarizations. All the S- and

Ka-band nulls of the antenna have been aligned within 0.1° which was a critical requirement of the project. The antenna has been delivered to the end user.

Fabricated overall antenna for S- and Ka-band tracking.

1. Multiband wrap around Antenna

This is a sponsored project from a Govt. R&D lab. The objective of this assignment is the design and development of multiband microstrip wrap around antenna for C-band, S-band, and Ka-band communication. An important requirement of the development is to ensure omnidirectional coverage (at -10dB level) in both azimuth and elevation plane in S-band and C-band. In Ka-band, apart from the omnidirectional azimuth coverage, the antenna produces a squinted beam in the elevation plane. The multiband antenna finds application in the onboard system.

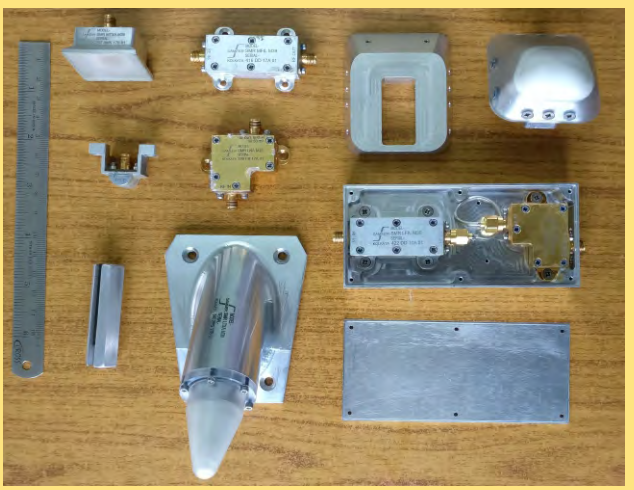
A photograph of the fabricated single quadrant antenna is shown in Fig. 2. It is covered with a Teflon radome of thickness 10mm. The antenna yields half-power beamwidths of 85° x 80° at both S- and C-bands.

Fabricated 1-quadrant of the multiband wrap around antenna.

Design and Development of Data Link Antennas at X-band

This is a sponsored project from a Govt. R & D Lab. The objective of this project is to design and develop a transmitting and receiving antenna subsystem at X-band for onboard data link application. These antenna subsystems will be fitted in an airborne platform. The receiving antenna needs to be integrated with LNA for achieving the desired gain. Both high gain and broad beamwidth are achieved by a specially designed antenna.

A linearly polarized microstrip patch fed horn has been developed as the Tx antenna. It has gain better than 9.0 dBi with 3dB beamwidths of 60° x 60°. A radial horn antenna, having gain better than 3.5 dBi with half power beamwidth of 110° x 110° is also developed. A left-handed circularly polarized Helical antenna (LHCP) & a right-handed circularly polarized cavity backed cross dipole antenna (RHCP) are also developed for use at the Tx and RX end. The Helical antenna yields gain better than 10 dBi (3dB beamwidth 60° x 60° while the cross dipole shows gain better than 5.0 dBiC (3dB beamwidth 110° x 110°). LNA, Limiter & Filter have also been developed as associated components. The limiter with LNA section offers a gain of 18.5 + 0.5 dB with noise figure lower than 2.5 dB over the desired frequency range. Narrow band filters with about 5% bandwidth have been developed for the transmission and reception band. It shows more than 36dB rejection at about 600MHz offset from centre frequencies and an insertion loss lower than 1dB.



Data Link Antennas, LNA, Limiter & Filter.

Design and Development of Data Link Antennas at C-band

This project is sponsored by a Govt. R & D Lab. The objective of this assignment project is to design and develop a C-band transmitting and receiving antenna subsystem for data link application. The data link RF transceiver operates in full duplex mode. It bears two different units, one fitted on a ground-based platform and the other in an airborne system. The transceiver mounted on airborne system contains two transmitting antennas in switching mode and two active receiving antennas with LNA to cover a very wide area. Waveguide-based antennas are being used for the onboard system. Achieved gain is better than 5.0 dBi with 3dB beamwidths of 140° x 60°. The total 16 nos. of these antenna has been developed, tested and delivered to the end user.

Data Link Tx- & Rx- Antennas at C-band

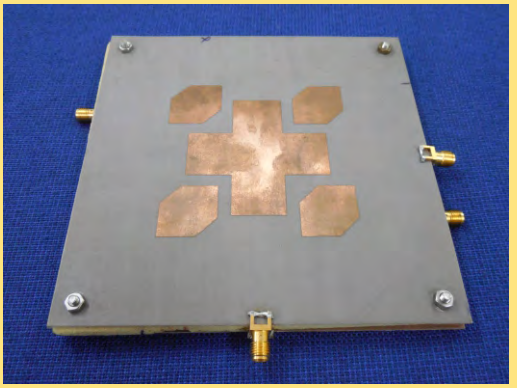
Design and Development of Radio Proximity Fuse Antenna at Ku-band

This is a sponsored project from a Govt. R & D Lab. The main objective of this project is to design and develop RPF Transmitting and Receiving Antennas at Ku-band. Waveguide-based traveling wave series slotted array antenna has been used. The slotted array is loaded with 0.5mm thick Teflon Radome to protect it from environmental hazards. The 3dB beam width of an element in the azimuth plane is approximately 123° at a squint angle of 50°, implying the requirement of three antennas for 360 ° coverage.Hence total 6 antennas are required for a Tx-Rx system. The element gain is 5dBi for squint angle 25° to 70° and the SLL is better than 17dB. Six numbers of these antenna were delivered to the end user.

RPF Rx-Antenna (left) and Tx-Antenna (right).

Dual-Band (S/C-band) Dual-Polarized Microstrip Antenna

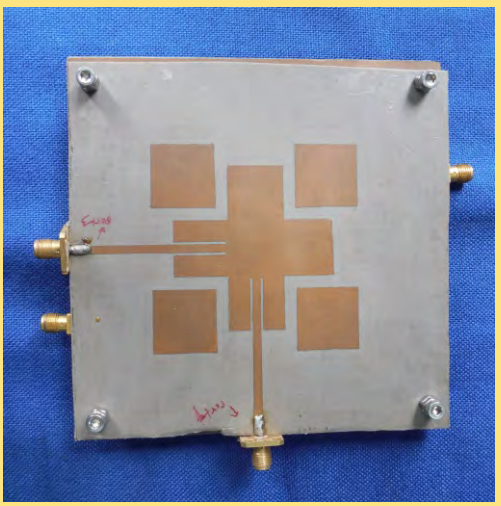
A shared aperture microstrip antenna has been developed for S- and C-band operation. The antenna is dual feed dual linearly polarized (LP) at S-band and dual feed dual circularly polarized (CP) at C-band. Each of the composite feed at C-band results in LHCP or RHCP radiation exclusively. The antenna yields impedance bandwidths of higher 3.5% at S-band with an isolation better than 22dB. It also exhibits more than 20.9% impedance bandwidth at C-band and AR-bandwidth of ≈ 10.2% at both the C-band ports.



S- and C-Band dual polarized microstrip antenna.

Dual Band (S/C-band) Dual Linearly Polarized Microstrip Antenna

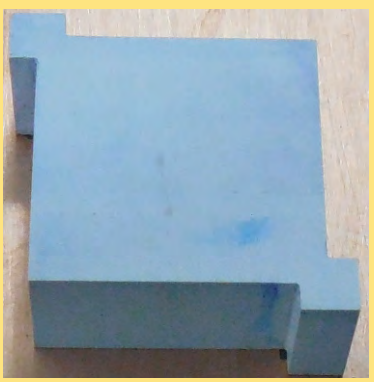
Shared aperture configuration has been employed to develop this microstrip antenna for S- and C-band communication. The antenna is dual feed dual linearly polarized at both S- and C-band. The impedance bandwidth is 23 % at C-band with an inter-port isolation better than 32dB. At S-band it yields 4.5% matching bandwidth.



S- and C-Band dual linearly polarized microstrip antenna.

Dual Linearly Polarized Dielectric Resonator Antenna

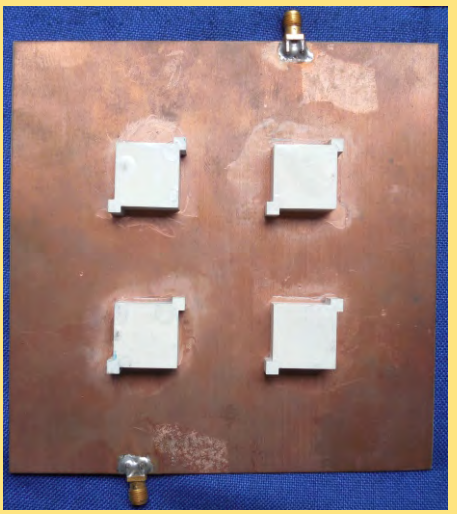
A dual linearly polarized dielectric resonator antenna (DRA) has been developed. Aperture coupled technology has been adopted. The antenna employs two orthogonal microstrip feed lines for exciting orthogonal polarizations. The prototype is realized using a DRA material with permittivity ε = 10. The antenna yields 13% impedance bandwidth (3.37-3.85GHz) with an isolation better than 39dB and gain 6.5dBi.



Dual polarized dielectric resonator antenna with improved isolation.

Dual Linearly Polarized Dielectric Resonator Antenna

A 2x2 array of dual linearly polarized dielectric resonator antenna (DRA) has been developed, employing aperture coupled technology. A photograph of the fabricated array is shown in the adjoining figure. The antenna yields 14% impedance bandwidth (3.37-3.88GHz) with an isolation better than 24dB and gain 11dBi.



2x2 array of dual polarized dielectric resonator antenna.

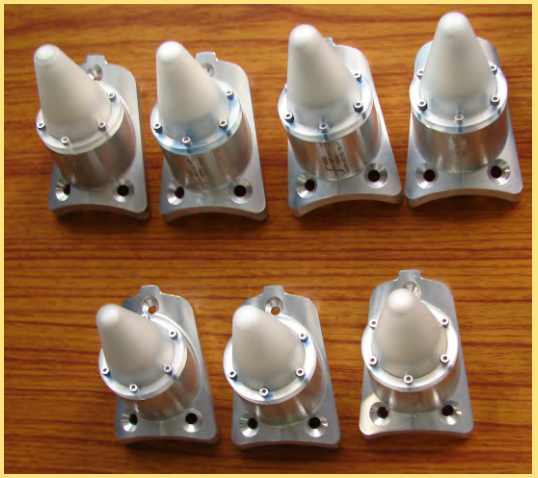
Monopole Antenna at X-band

An X-band monopole antenna has been designed and developed having an omnidirectional coverage in the azimuth plane with gain better than 2.0 dBi. A Teflon Radome of size 12.7 mm x12.7 mm x 18.5mm (L x W x H) is used to protect the antenna from the environmental hazard. Total ten nos. of antennas have been developed.

Monopole antennas.

Helical antenna at X-band

Cavity backed helical antennas have been designed and developed at X-band. The antenna exhibits a gain of 10 dBiC gain with 3dB beamwidth 60° in both the planes. Six nos. of antennas have been developed.



Cavity backed Helical antennas at X-band.

Design and Development of Printed Dipole Antenna at C-band

A printed dipole antenna fed with an integrated Balun excited has been developed at C-band. The antenna is sandwiched in Rexolite material for environmental protection. A reflector is used to enhance the on body radiation performance of the antenna. The antenna produces sector coverage of 140° x 60° with a gain of better than 5 dBi.

Printed Dipole Antenna

CIRCUITS AND SYSTEMS DIVISION

The division specializes indesign and development of microwave and millimeter wave based systems and sub-systems for military and civilian applications.

Ka/S-band Telemetry Receiver :

This project was sponsored by a Govt. R&D Lab. The aim of this project was design, development, and delivery of 4 units of Ka/S-Band RF receiver for telemetry application. The developed receiver can operate in two modes: Ka-band mode and S-band mode. The user can select the desired mode of operation. In Ka-band operation, the received Ka-band signal is down-converted to 70 MHz IF while in S-Band operation, it is down-converted from S-band to 70 MHz IF. The receiver has provision for changing the S-band LO signal at 500kHz step using frequency selection push button switches mounted on the front panel. But the received RF signal is down-converted to 70MHz fixed IF signal. The LO signal frequency selection switches and corresponding seven segment displays are interfaced with the S-band PLL with the help of PIC microcontroller. There is also a provision for selecting the 10MHz reference signal from internal or external sources. A bar LED indicator on the front panel indicates the received signal strength.

The low noise receiver has a dynamic range of 40 dB (-90 dBm to -50 dBm) with a noise figure less than 2.7 dB for S-band and less than 4 dB for Ka-band operation. The IF bandwidth is user selectable between 2MHz, 4 MHz, and 10 MHz. LO phase noises at S-band are -86dBc/Hz @ 1kHz, -81dBc/Hz @ 10kHz, -102dBc/Hz @ 100kHz and -127dBc/Hz @ 1MHz. At 14.12GHz the measured LO phase noises are -84dBc/Hz @ 1kHz, -78dBc/Hz @ 10kHz, -83dBc/Hz @ 100kHz and -111dBc/Hz @ 1MHz respectively. Four units of the receiver are successfully designed, developed, tested and finally delivered to the end user. The following associated modules have been developed.

- **Ka-band Sub-harmonic Mixer**

  The Ka-band sub-harmonic mixer down-converts the Ka-band RF signals to S-band signals. This is an X2 harmonic mixer. The LO frequency is 14.1 to 14.2 GHz and the LO power required is -5 dBm. The measured conversion loss for the mixer is less than 11 dB and port to port isolations are better than 30 dB.

- **Ka-band Band Pass Filter**

  Ka-band bandpass filter is developed to reject LO and Image frequencies. The 3rd order filter is used after the LNA in the receiver. The

insertion loss and return loss for the filter are less than 1 dB and better than 15 dB respectively. The rejection at the LO and image frequencies are better than 60 dB. The bandwidth of the filter is 550 MHz.

- **S-band Synthesizer Module**

  S-band synthesizer is used as LO for S-band mixer which converts S-band input signal to 70 MHz IF signal. The frequency range of the synthesizer is 2.13 to 2.23 GHz with 500 kHz step. It provides 2 dBm output power. Phase noise of the synthesizer are -86 dBc/Hz@1KHz, -83 dBc/Hz@10kHz and -100dBc/Hz@100kHz.

- **Ku-band Synthesizer Module**

  PLL based Ku-band frequency synthesizer module is developed with output freq 14.12GHz and output power of 2.9dBm. Phase noises of the synthesizer are -84 dBc/Hz@1KHz, -78 dBc/Hz@10kHz and -83dBc/Hz@100kHz.

- **Automatic Gain Control unit**

  An automatic gain control unit is employed in the receiver to produce a constant output signal at the receiver output when the amplitude of an incoming signal varies over a wide dynamic range of 40 dB. The output amplitude is set Vset = 0.6 V.

- **70 MHz Switchable filter-Amplifier**

  Switchable filter amplifier is used to amplify the signal and also to provide the user an option to select the bandwidth of the IF output (70 MHz). Three options of bandwidth selection are provided at the output and these can be selected using a control signal. The output IF bandwidths options are 2 MHz, 4 MHz, and 10 MHZ

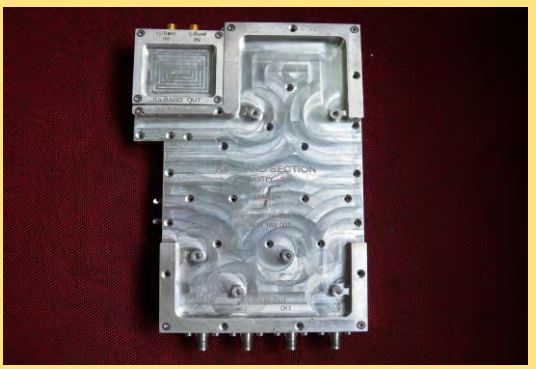
S/Ka-band Telemetry RF Receiver

Design and Development of Ka-band Transmitter

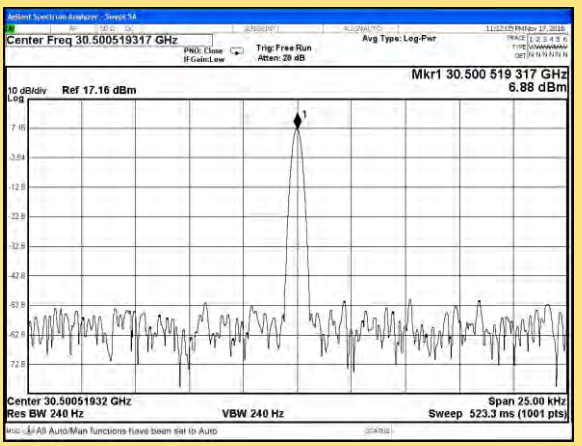
This is a sponsored project from a Govt. R&D lab. The objective of this assignment is the design and development of a 4-channel Ka-band transmitter base unit and four numbers of Ka-band amplifier units. These find application in airborne system.

a. 4-channel Ka-Band transmitter base unit

The module has been developed to generate Ka-band signal in 4 co-axial channels simultaneously. This consists of a Ka-band mixer, a BPF, a 4-way power divider, and digital phase shifter with biasing circuit. the module receives an IF signal at S-band and an LO signal at Ku-band. A frequency up-converter has been employed to up-convert the S-band IF to Ka-band RF signal. The up-converter contains an integrated doubler at the LO port. The up-converted Ka-band signal is filtered out through a BPF and gets divided into 4-channels. Phase balance within ± 5.5° has been realized among the output signals. The output power of each of the channels is 6 dBm.



4-channel Ka-band transmitter base unit



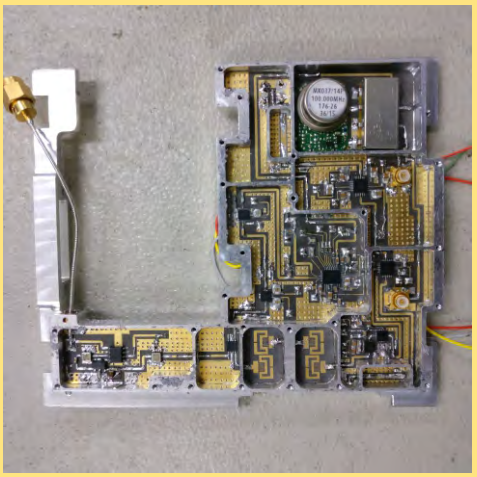
the measured output of a channel

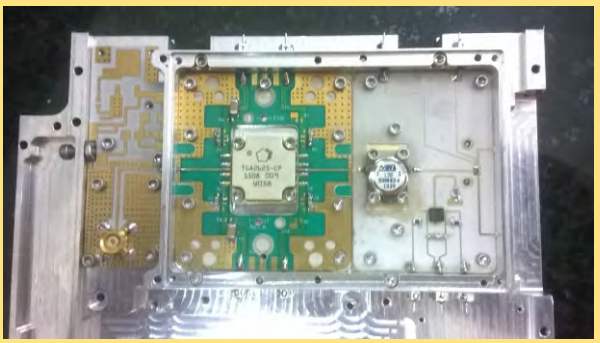
Data Link RF Transceiver at X-band

This is a sponsored project from a Govt. R&D lab. The objective of this assignment is to develop a data link RF transceiver at X-band for 2-way communication application.

a. Data Link Transmitter

The X-band transmitter unit is developed for up-link communication. It takes a 70MHz RF signal with 20 MHz bandwidth as input. The signal is up-converted to X-band using two stage up-converter. The output frequency is programmable in steps of 5 MHz. The up-converted output is amplified using a power amplifier to get CW power of 10.5W. The amplifier exhibits a small signal gain of ≈35±0.5dB over the required frequency band.

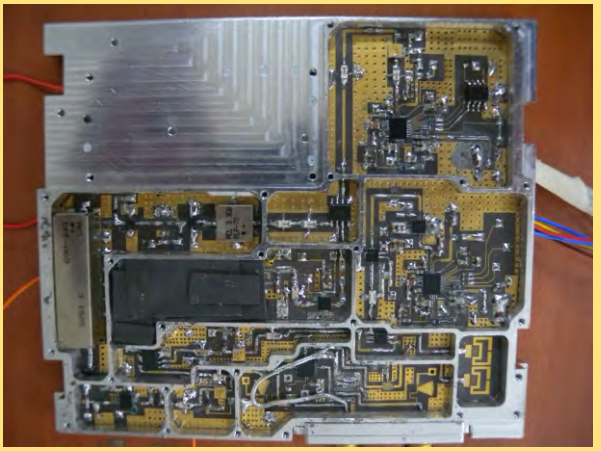




Fabricated prototype power amplifier of the exciter

b. Data Link Receiver

The X-band receiver unit is developed for downlink communication. The X-band input signal of 20 MHz bandwidth is down-converted to a fixed IF at 70 MHz using two stage down-converter. The output power level is about 4 dBm. The input frequency is programmable in steps of 5 MHz. Receiver sensitivity of -95 dBm is demonstrated with a dynamic range of 60 dB. Achieved noise figure is lower than 4.5 dB for the complete chain. The complete receiver is realized in a single module of dimensions 120mm x 105mm x 10.2mm.



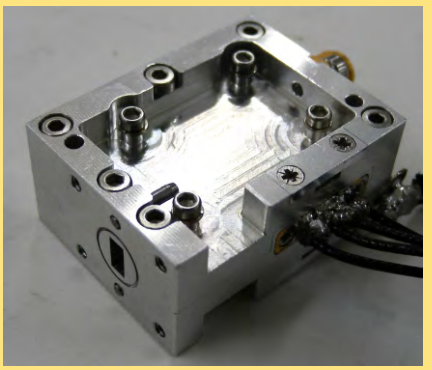
X-band Datalink Receiver.

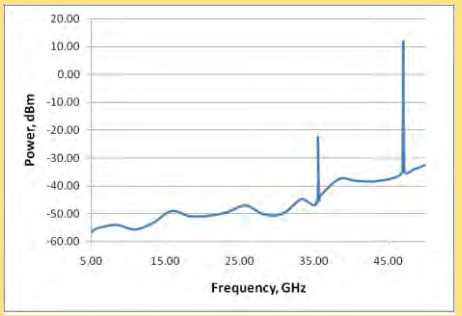
W-band Coherent Transmitter-Receiver

This project has been sponsored by a Govt. R&D Lab. A 47 GHz frequency quadrupler and a 47 GHz medium power amplifier with driver circuit have been designed, developed and tested.

a. U-band Frequency Quadrupler

A 47 GHz frequency quadrupler has been designed,





frequency quadrupler module and measured output spectrum

developed and tested. Measured results have exhibited more than 12 dBm of output power at 47 GHz for 3-5 dBm of input power at 11.75 GHz. Spurious and other harmonic rejection achieved is in excess of 30 dBc.

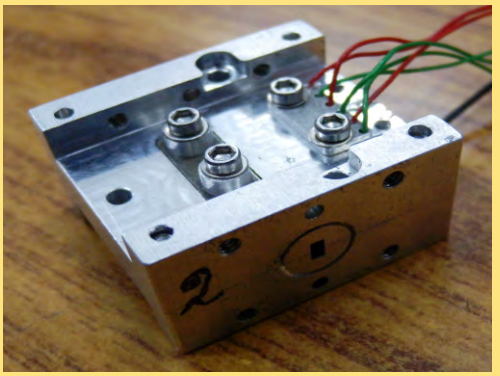
b. U-band Medium Power Amplifier

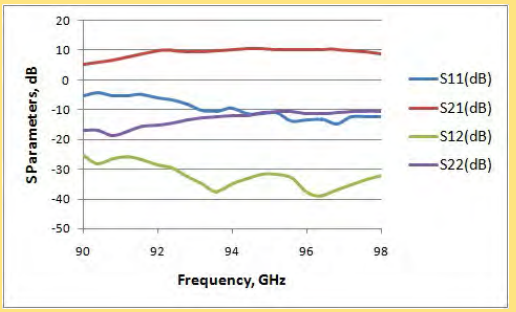
A 47 GHz medium power amplifier with driver circuit has been designed, developed and tested. Procured MMIC chip has been packaged in a microstrip-based hybrid MIC with waveguide interface at input and output ports through low loss microstrip to waveguide transition. More than 10 dB of small signal gain and 18 dBm of output power have been achieved at 47 GHz.

U-band medium amplifier module and its measured frequency response

c. W-band Medium Power Amplifier

A W-band medium power amplifier with driver circuit has been designed, developed and performance measured. MMIC chip has been packaged in a microstrip-based hybrid MIC with waveguide interface at input and output ports through low loss microstrip to waveguide transitions. More than 10 dB of small signal gain and 16 dBm of output power have been achieved at W-band.

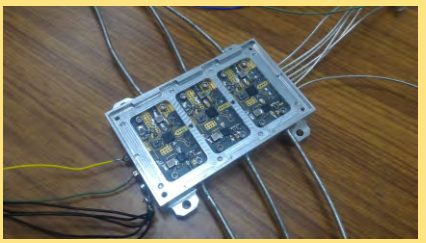




W-band amplifier module and its measured S-parameters

d. IF Module

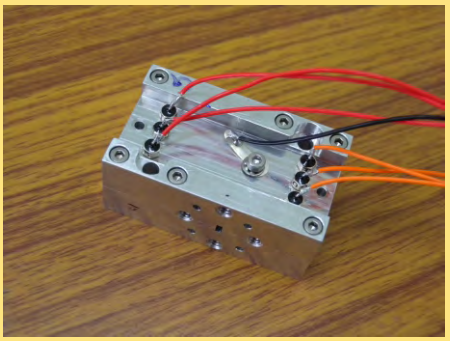
The IF Module is used in the receiver. The output of the mixer is a 1.6 GHz signal which is fed to the IF Module. The module comprises of a band pass filter, a digital bit attenuator, and an amplifier. 3 parallel IF Sections have been incorporated in a single module for the 3 channels of the receiver. Each of the channels provides a gain of 24.5 dB and a 3 dB bandwidth of 30 MHz. The channel to channel isolation is better than 25 dB.



3-channel IF section at 1.6GHz and its measured frequency response

e. W-band Low Noise Amplifier

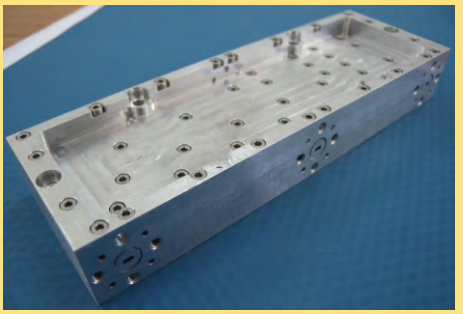
The W-band low noise amplifier (LNA) has been developed for the receiver front end of the 3-channel transceiver. An MMIC based LNA has been employed and assembled in a mounting cavity along with biasing arrangements. Microstrip to waveguide transition have been used at the input and output interface. The LNA yields a gain of 18.1 dB with input and output return losses better than 10dB. Its noise figure is 4.65 dB ± 0.1 dB over 1GHz bandwidth.

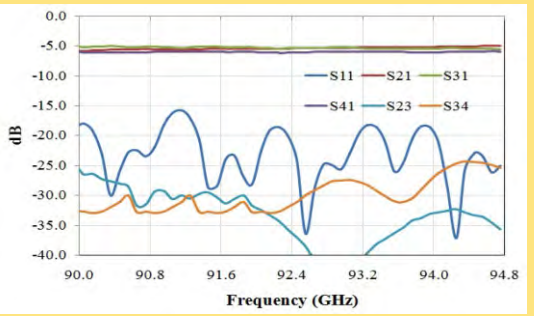


w-band LNA, measured gain and reflection coefficients and its Noise Figure

f. W-band 3-way conventional power divider

The three-way power divider is developed for LO power division in the receiver section of the W-band coherent Tx-Rx system. The measured insertion loss of the power divider is less than 1.5 dB, return loss is better than 15 dB and isolation is better than 25 dB. The amplitude imbalance is less than ± 0.25 dB. The dimensions of the hybrid are 137mm x 45mm x 20mm.

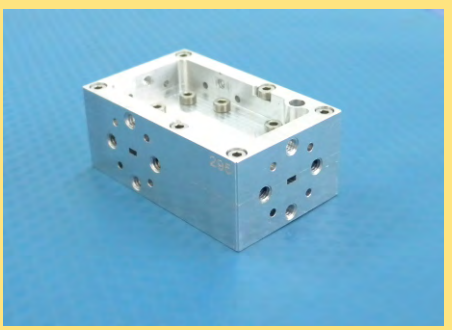




W-band 3-way power divider and its measured S-parameters

g. Compact W-band 3-way power divider

The compact 3-way power divider has advantages of size and performance compared to the conventional 3-way power divider. It is based on a Riblet type hybrid and the power division among the three ports is done using a single coupling region as compared to two coupling regions in the conventional coupler. The measured insertion loss of the power divider is less than 0.5 dB, return loss and isolation are better than 20 dB. The amplitude and phase imbalances are less than ± 0.25 dB and ± 1.75° respectively. It's dimensions are 45mm x 28mm x 20mm.



prototype of the compact 3-way power divider

h. W-band choke flange

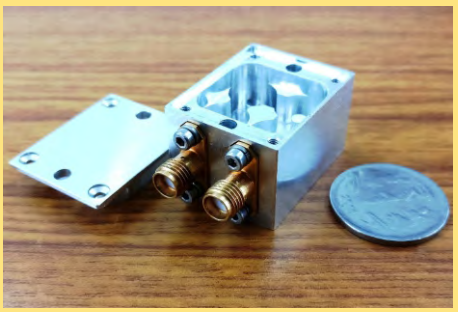
A choke flange has been designed and developed to prevent the leakage from waveguide junction. This

is required due to the close placement of the transmitter and receiver. The measured leakage at the waveguide junction with normal flange was - 32 dBm and with the choke flange, it is -78 dBm. The choke flange has reduced the leakage at the junction by 46 dB.

W-band straight section with choke flange

h. Narrow band filter at X-band

A band pass filter (BPF) with very narrow pass band has been developed at X-band. Coupled coaxial cavity configuration has been adopted. It exhibits about 2% bandwidth with about 35dB rejection at 200MHz offset from the centre frequency. An insertion loss of 1dB or lower is realized.



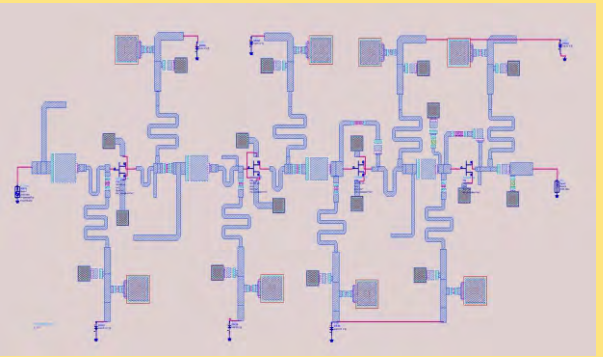
BPF at X-band

The following core activities were undertaken

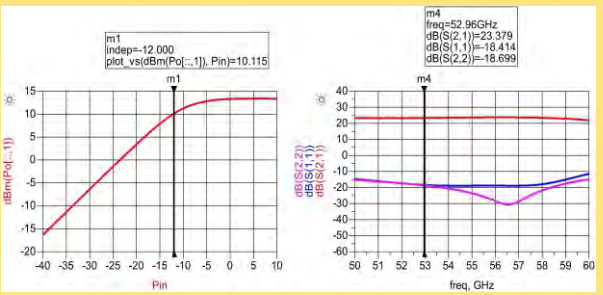
1. Design and Development of V band MMIC Amplifier

An MMIC based V-Band amplifier has been designed. The execution is motivated due to the fact that 60-GHz band offers a wide license-free bandwidth of around 57 to 65 GHz usable for many high data rate applications. It will be highly compact in size and therefore suitable for application in the receiver front end of 60 GHz systems.

The topology employs a 4-stage cascaded amplifier with optimum matching for high gain and low noise figure. The MMIC has been designed using PH-10 design kit of United Monolithic Semiconductor (UMS). The simulated gain is 23.5 $\pm$ 0.5 dB with a noise figure lower than 3.2 dB over a frequency range of 50 to 60 GHz. The last stage is optimized for obtaining 1dB output compression at +10 dBm.



MMIC Design Layout of the V-Band amplifier

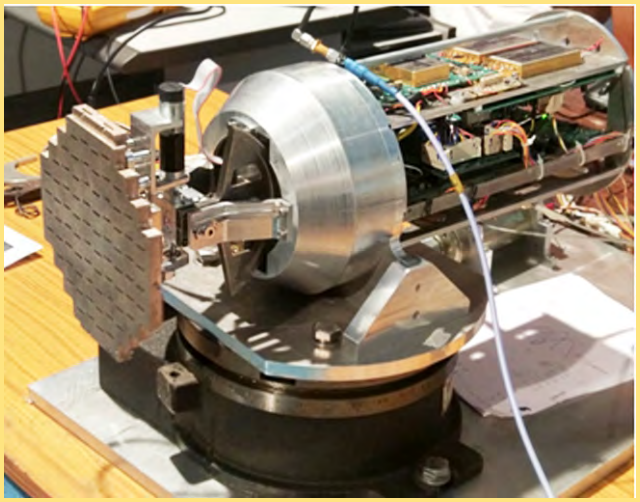


simulated P1 dB gain and impedance matching of the amplifier with frequency

2. Design and Development of Two axes Stabilization system

This two-axis stabilization system development at Ku-band was undertaken with an objective to track targets within a specified range and angle at a millimeter-wave frequency. The system accepts command from the user via serial interface and orient the antenna towards the target within a predetermined time using servo control mechanism. This active multi-frequency pulse Doppler monopulse tracking system operates with range channel gating. The system continuously tracks the target in azimuth and elevation plane,

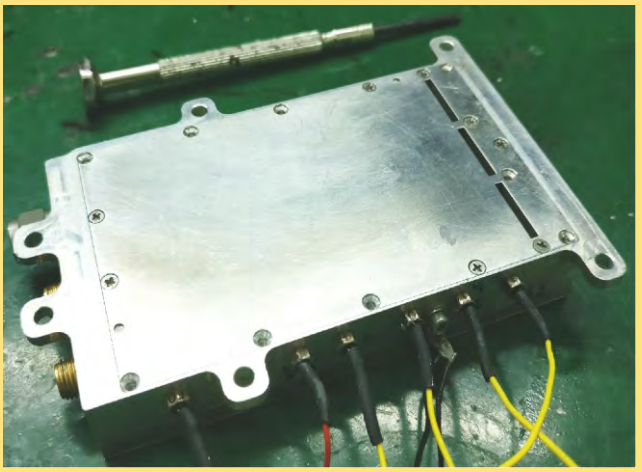
and generates the errors signal necessary for tracking. The antenna receives RF signal from target direction and the subsequent system analyzes the received signal to determine the target position. All associated devices and sub-systems like slotted waveguide array antenna, comparator, exciter, RF and IF receivers have been designed and developed.



A prototype of the two axes gimbaled RF tracker

Ku-band 3-channel receiver

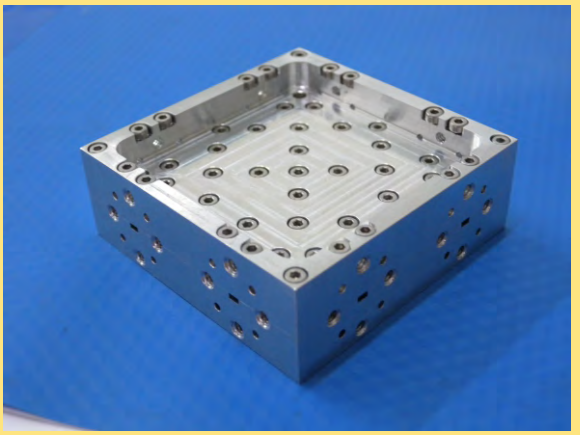
A three channel MMIC based Ku-band RF front end receiver has been developed. It down converts a 17GHz RF signal into a 200MHz IF signal. The down conversion has been realized using a single stage converter, which is an important achievement. The three channels have been realized in a single module, which has made it compact which is a critical requirement of the project in view of the stringent dimensions and weight.



Ku-band 3-channel receiver

W-band six-port receiver

The objective of this assignment is to measure the reflection coefficient and phase of an unknown device under test. The six-port receiver consists of a hybrid along with VCO and 4 detectors. The six-port hybrid has been designed and developed as a major constituent. It is designed using power divider and 3 short slot hybrids. It operates over 91GHz to 97 GHz. The measured insertion loss for the hybrid is less than 1.5 dB; return loss and isolation are better than 20 dB. The amplitude and phase imbalances are less than $\pm$ 0.5dB and $\pm$ 2.5° respectively. The dimensions of the hybrid are 60mm x 60mm x 22mm.

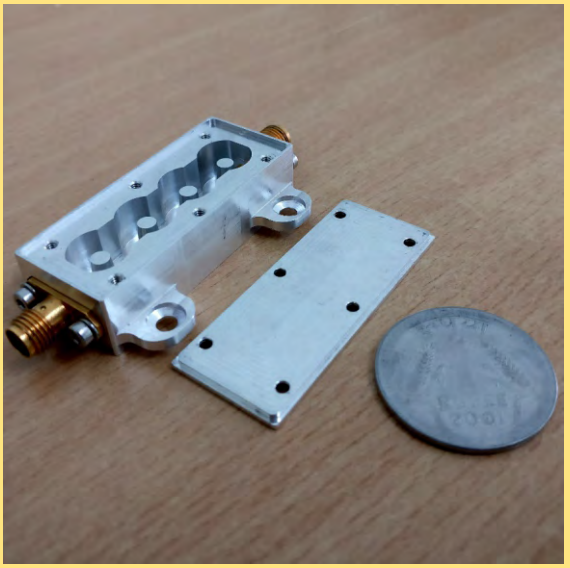


W-band six-port hybrid

Other Components Developed

2. Narrow band filter at X-band

A band pass filter with about 5% bandwidth has been designed and developed at X-band. Coupled coaxial cavity configuration has been adopted to achieve high rejection. Each of the individual coaxial cavities is resonant and inductively coupled to the adjacent cavities by means of a narrow slot in the cavity wall. A photograph of the realized prototype is shown in the adjoining figure. Rejection as high as 36dB at 600MHz offset has been demonstrated with an insertion loss lower than 1dB. This filter is about 50% compact compared to a conventional waveguide iris filter.



prototype of the X-band filter

EMI/EMC Division

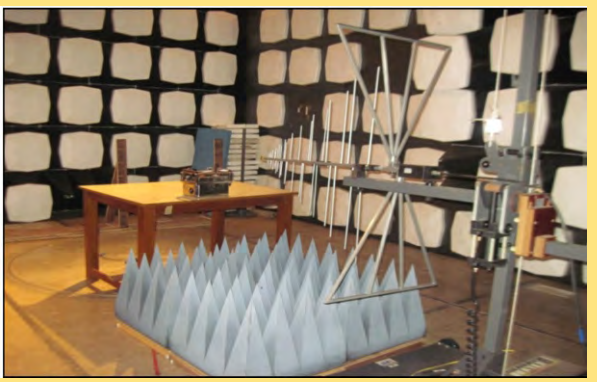
Objectives of the division is to provide test/measurement and consultancy services to industries and Govt. agencies for evaluation of their electronics and electrical products for electromagnetic compatibility. The division also takes up core and sponsored R&D project relevant to the application in the area of EMI/EMC.

1. Test, Measurement and Consultancy services

Test, measurement, and consultancy services have been provided to the external industries and Govt. agencies for evaluation of their electronics and electrical products. Electromagnetic compliances of customer's products have been evaluated as per different national and international standards. In this year, test/measurement supports have been provided to 24 number of different external customers (EMI/EMC and others test-measurements).

Survey of isolation among various antennas mounted on ship SG Barracuda and electromagnetic compatibility performance evaluation at its various control / instrumentation rooms. The ship has been exported to Mauritius by GRSE, Kolkata, India.

ESD test set-up for Site Monitor of M/s. AQ ElteknikABAlsikegatan, Uppsala, Sweden.



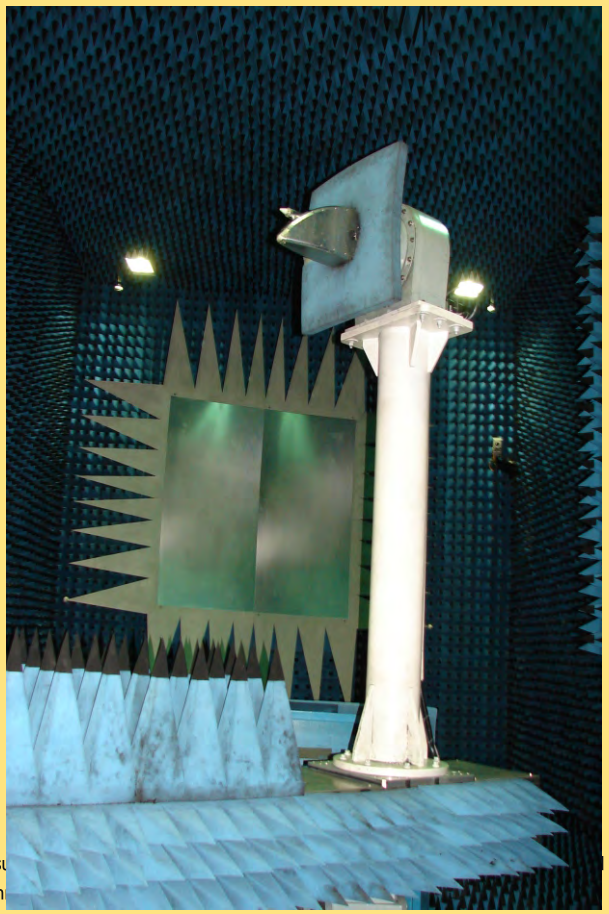
Radiated Power Measurement set-up for Radio Remote Control Transmitter for M/s Changzhou Lianli Automation Technology Co. Ltd, China.

functional performance measurement of 10kw power conditioning unit of Statcon Power Controls Ltd., Noida at Customers premises. The performance of anti-islanding operation was also evaluated.

Compact Antenna Test Range (CATR) Facility

Objectives of the division are to provide antenna radiation parameter measurement, radome, and RCS measurement support to the industries and Govt. agencies from all over the country.

CATR is a unique facility available for characterization of different antennas in the frequency range of 1-100GHz for different military and civilian applications. The facility is also equipped for radome performance evaluation in the frequency range of 1GHz-40GHz. The facility is being utilized by private industries and Govt. agencies for performance evaluation of their antennas and radomes. CATR facility has been availed by 20 different users in the last financial year.



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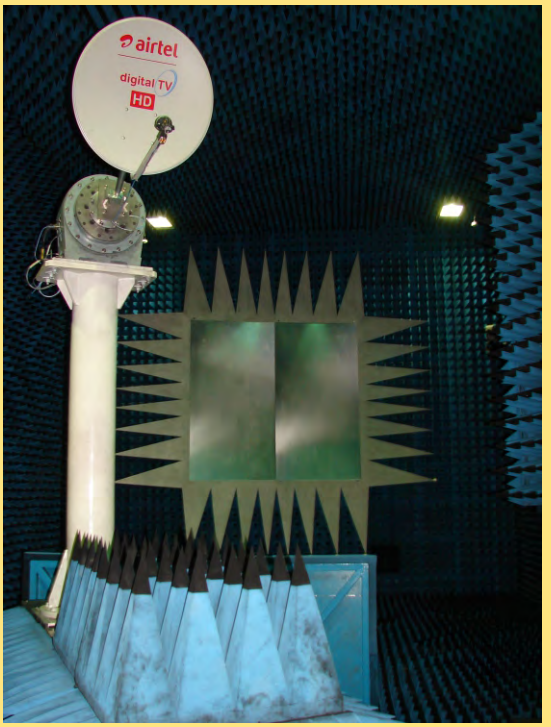
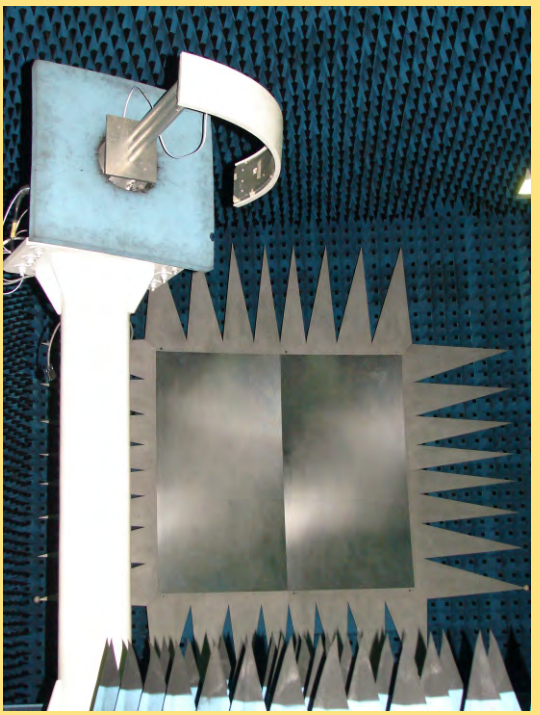


measurement set-up during radiation parameter measurement of a DTH antenna.



measurement set-up during radiation performance evaluation of a conformal multi-band antenna.

MECHANICAL FACILITY DIVISION:

The division caters to mechanical design of the components and system hardware and provide fabrication and assembly support to the different core and sponsored projects of the centre.

It also supports system assembly and its simulation study for complying mechanical stability against environmental hazards such as vibration, shock etc.

The division is equipped with state-of-the-art CNC machines like VMC, Wire-cut, EDM, laser welding etc. The CAD tools have enabled the team to generate mechanical design, models and drawings proficiently in short time. Using mechanical simulation software, proper structural design and analysis for complying mechanical stability against environmental hazards (such as vibration, shock etc.) are performed. With these facilities, the division is meeting the project needs and their delivery schedule.

During this financial year, the Mechanical Division has contributed some innovative mechanical design of system & sub-systems, and fabricated it in-house under different projects, which are as follows.

1. Structural design of the S/Ka band tracking antenna (ø1990mm x 985mm height) has been optimized using structural analysis software, ANSYS workbench (R15.0). It is capable to withstand wind load of 60Km/Hr. All the parts of S/Ka band tracking antenna (except main reflector) have been fabricated in-house.
2. A mechanical structure has been developed for fitment in the nose cone of an airborne system. The structure consists of an antenna covered with radome. The rexollite made radome has replaced the metallic nose cone profile of the actual airborne unit. The mechanical arrangement between the antenna and the air-borne unit has been designed accordingly.

Fabricated parts of the antenna and section of the air-borne unit.

SAMEER
VISAKHAPATNAM

CENTRE FOR ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3),

Centre at Visakhapatnam has been started in June, 2014 with objective of establishing highly specialized test facilities in the country in the field of E3 as per MIL STD 461F/G, 464 and MIL STD 188-125-1&2. In order setting up of an Extension Centre at Visakhapatnam with proposed specialized test facilities to cater the increasing requirement from the strategic sectors, Government of Andhra Pradesh has allotted 13 Acres of Land on lease basis for a period of 33 years to SAMEER at APIIC IT-Layout, Gambheeram village, Anandapuram Mandal, Visakhapatnam District, Andhra Pradesh state.

SAMEER with its vast experience in the areas of EMI/EMC, EMP (Electromagnetic Pulse) can put the expertise to the benefit of Defense services, academic Institutions, public and private industries. The Centre can provide world class EMI/EMC evaluation infrastructure for the benefit of Indian Industry. The Centre also aims in developing pool of skilled manpower in the area through regular workshops, seminars and other events.

SAMEER Centre for E3 has been pursuing its objective of doing Electromagnetic Environmental Effects (E3) Research, Development, Test, and Evaluation. The E3 facility specializes in a variety of capabilities, ranging from box level to complete system level testing.

The primary activities of the Centre are in the areas of

- Electromagnetic Environmental Effects (E3) Research & Development
- EMC Compliance Testing
- Scientific publications, evolving standards & test specifications
- E3 Prediction, Analysis, Design consultancy and Hardening services
- Training and Education
- EM Modeling and Analysis

A. Proposed specialized test facilities being established -

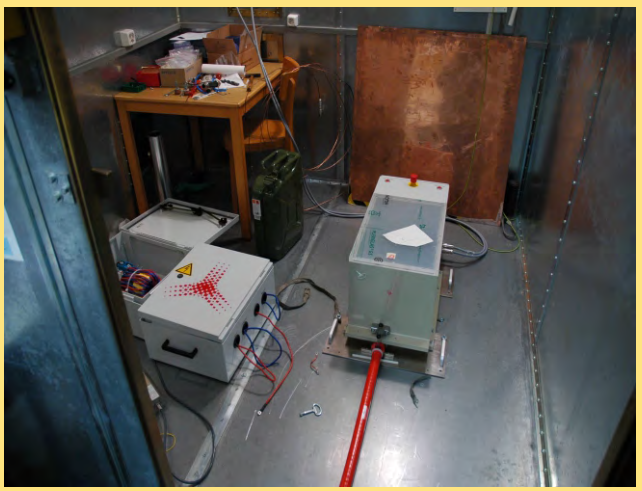
1. **RS105, Transient Electromagnetic Pulse Test Facility as per the MIL STD 461F/G and 464 for large objects:**

   Electromagnetic pulse (EMP) is a high amplitude, short duration, broad band pulse of electromagnetic energy which can have devastating effects on unprotected electronic

equipment and system. EMP facility as per MIL-STD-461, RS105 is a welcome step in the country for the systems, which have not been tested as of now and waivers are accorded to vendors due to non-availability of the EMP TEST FACILITY in the Country.

2. **EMP Pulsed Current Injection (PCI) Test System according to MIL-STD-188-125/1&2:**

PCI is test method for measuring the performance of a Point of Entry (POE) protective device on a penetrating conductor. A HEMP/EMP threat-relatable transient is injected on the penetrating conductor at a point outside the electromagnetic barrier, and the residual internal transient stress is measured inside the barrier.

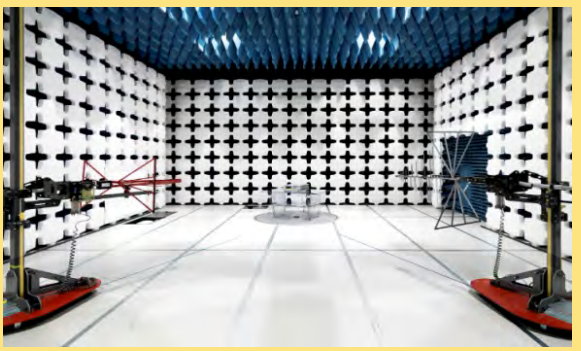


3. **Ultra-Wide Band (UWB) Test System.**

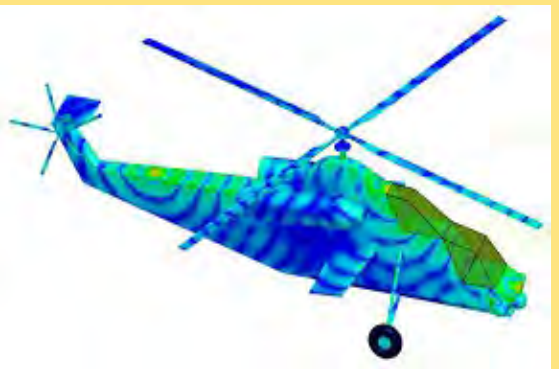
Ultra-Wide band (UWB) is a short duration, Pulsed RF technology that achieves the highest possible bandwidth at the lowest possible center frequency. The technology can be used for communications, radar and ranging & location applications.

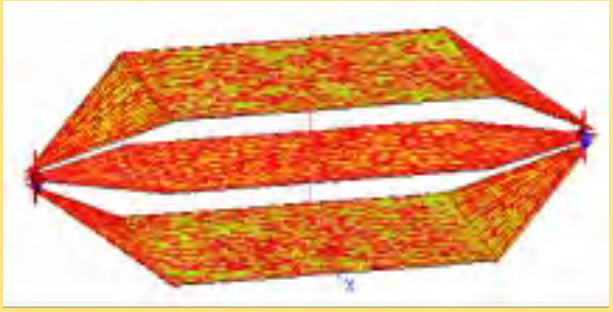
MIL Test facility as per MIL STD 461F/G: Establishing the necessary test facilities to carry out Radiated Emission (RE), Radiated Susceptibility (RS), Conducted Emissions (CE) and Conducted susceptibility (CS) tests as per MIL STD 461F/G & 464.

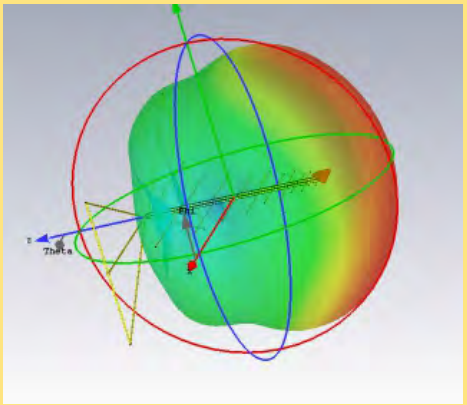
EMI/EMC Modeling and computational Lab



Mobile EMC test facility for carrying in-situ measurement:







Mobile EMC test facility for carrying in-situ measurement:

Civil Works Progress of the centre:

Considerable progress was made in civil works of the centre. Compound wall construction along the site boundary is completed by CPWD and it is handed over to SAMEER. Civil works of Administration and utility buildings completed 90% and works of other buildings viz., laboratory, Security and canteen and guest house Buildings completed 65% including Electrical and Mechanical services.

Construction of Laboratory and Administrative buildings is in progress

Establishment of Specialized Test facilities :

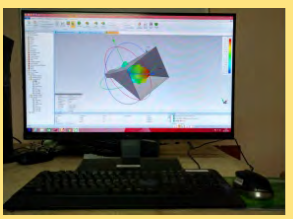
For the establishment of highly specialized facilities viz., Outdoor Electromagnetic Pulse (EMP) immunity test system as per MIL STD 461E/F, RS105 for large objects, EMP Pulse Current Injection (PCI) Test System according to MIL-STD-188-125/1&2, Ultra Wide Band (UWB) Test system, Installation and commissioning of RF shielded Anechoic Chamber including RF Shielded Control Room, RF shielded CS lab, MIL EMI/EMC Test facilities as per MIL STD 461F/G, the tendering process (Pre-bid, Technical Evaluation, Commercial Bid evaluation) is completed.

Preliminary Design and Critical Design Review meetings were held to understand the intricate details of the design for EMP, PCI and UWB test Systems. Four scientists were deputed by Competent Authority to carry out Factory Acceptance Test (FAT) for PCI & UWB test systems during January 2017 at M/S Montena Switzerland.

PDR, CDR Meeting for PCI, UWB and EMP

EM Modeling and Analysis laboratory

EM Modeling laboratory is established with High-End Workstation PCs and 3D Electromagnetic Simulation software with state-of-the-art numerical methods for solving wide range of electromagnetic problems encountered in various industries. The softwares are suitable for solving geometrically complex models to electrically large structures and can address the failure aspects of the product during product design phase itself. The EMI/EMC modeling and Computational Lab consists of various 3D EM tools with advanced simulation methods and hardware equipment to solve the all the EMI/EMC problems of both civilian and defense products. Installation and training on the specialized softwares viz., ANSYS HFSS, CST, FEKO is completed.



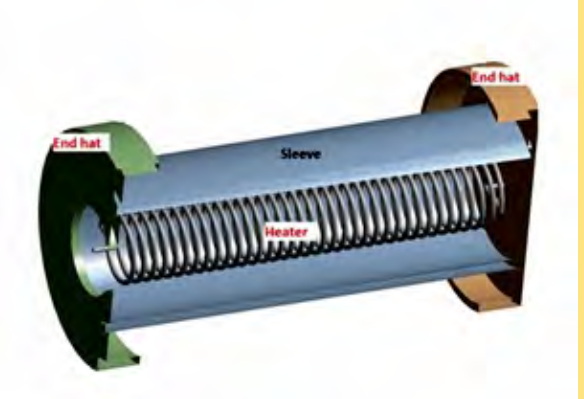
SAMEER,
IIT GUWAHATI

CENTRE OF HIGH POWER MICROWAVE TUBE AND COMPONENT TECHNOLOGY,

SAMEER has established a centre named "Centre for High Power Microwave Tube and Component Technology" at IIT Guwahati, Assam working in the area of high power microwave tube and component technology as per nation's requirement.This centre is dedicated for development of conventional high power microwave tubes/components as well as futuristic high power mm wave and THz sources. It will develop manpower working in the area of high power microwave tubes/components by proper training. The centre is an R&D laboratory in which scientists of the centre along with M. Tech. / Ph.D. students and faculty members of IITG is carrying out R&D in the area of high power microwave tubes /components, including conventional as well as futuristic microwave tubes. The centre is developing various facilities required for development of high power microwave tube and components which are given below:

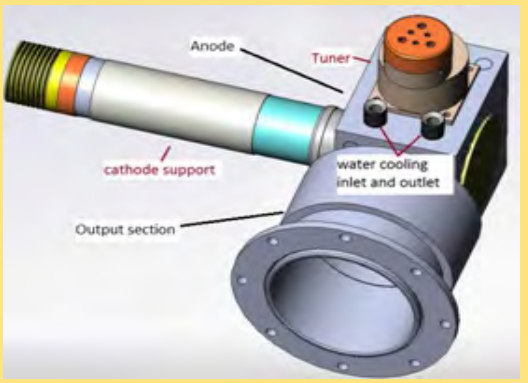
Development of facilities:

- High power microwave tubes/components CAD design facility
- Clean room facility for microwave tubes/components processing
- Low and high power microwave measurement facility
- Furnace brazing facility
- High precision mechanical fabrication and inspection facility
- Chemical laboratory facility
- High voltage test facility



3D model of cathode

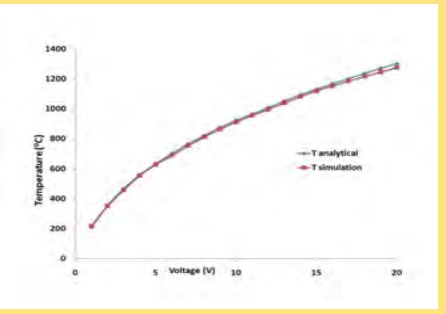
In the mean time, the centre is involved in R & D activities which are given below :



3D model of Magnetron

R&D Activities:

- Design and development of pulsed magnetron capable of delivering peak and average powers of 3.1 MW and 4 kW, respectively at frequency 2998 ± 10 MHz
- Design and development of three port circulator capable of handling peak and average powers of 3.1 MW and 4 kW, respectively at frequency 2998 ± 10 MHz
- Design and development of RF load capable of handling average power of 10 kW at frequency 2998 ± 10 MHz



Analytical and simulation results of magnetron heater

Handing over MoU signed by SAMEER with Andhra Pradesh MedTech Zone Ltd, (AMTZ)

MEIS 2016

SAMEER was the knowledge partner of Medical Electronics Innovation Summit organized by Ministry of Electronics & Information Technology (MeitY), Government of India, during 22-23 September 2016 at VMCC, IIT Bombay, Mumbai. During the summit an MoU was signed by SAMEER with Andhra Pradesh MedTech Zone Ltd, (AMTZ) to foster healthcare infusion of indigenous technology and promotion of medical devices manufacturing industry in India.

Honourable Minister for Electronics & Information Technology, Shri Ravi Shankar Prasad, Minister of State for Electronics & Information Technology Shri P.P.Choudhury and Secretary to Govt. of India, Ministry of Electronics & Information Technology, Mrs. Aruna Sunderarajan IAS in MEIS exhibition stall

2ND INTERNATIONAL CONFERENCE ON MAGNETIC RESONANCE IMAGING.

Inaugurating the Conference on Recent Advances in MRI and MRS

Conference on Recent Advances in MRI and MRS @ INSA: 21st to 23rd March, 2017

Narrowing down the objective of the 1st International conference on "Health Tech Innovations 2015" organized at the Victoria Menezes Convention Center, IIT Powai, Mumbai, the 2nd International Conference on MRI was organized by SAMEER on 2nd and 3rd March 2017, the focus of this conference was on Magnetic Resonance Imaging Technology. This conference dealt with sub-aspects of the vast field of MRI. Professionals involved in the design and development of MRI subsystems are submitted their Abstracts in the area of the work being carried out. The speakers of the expert talks of the workshop chaired the Expert Panel during various sessions. The best papers was recognized and awarded in each session. The conference provided an excellent opportunity for students and professionals working in the area of MRI Technology to showcase their work in front of experts. It has provided an opportunity to interact with the experienced, eminent professionals and

academicians working in the field of MRI. Scientists researching in any area of MRI, physicists working in the radiological sector, Doctors and Radiologists, professionals working in allied sectors of medical imaging, entrepreneurs and MRI instrument manufacturers from India participated in this conference.

PARTICIPATION IN CONFERENCE / WORKSHOP / SEMINAR

PARTICIPATION BY SAMEER

Shri Dipankar Dan and Shri SatyajitChakrabartiattended a seminar on "Uncertainty in Measurement" at Kolkata organized by Indian Chamber of Commerce on 26th May 2016.

Shri Amitesh Kumar, Scientist-C, SAMEER Kolkata attended a one day seminar on "Keysight HOTSPOTS" held in Kolkata.

Shri Amitesh Kumar, Scientist-C, SAMEER Kolkata attended half-day seminar on "COMSOL Multiphysics& Application Builder Workshop" at Salt Lake, Kolkata.

Dr. G. Arun Kumar and Shri. Bijit Biswas attended the GIAN course on "Terahertz Technology and Its Applications" held during 1st - 5th August, 2016 at National Institute of Technology, Patna.

Shri Bijit Biswas attended IEEE International Microwave and RF Conference (IMaRC), Dec 16, New Delhi, India.

Shri Rajesh Harsh and DharmeshVerma SAMEER, Mumbai made a presentation on "Magnetic Resonance Imaging" before a forum of Professors of IIT's and NIT's

Shri Dharmesh Verma, SAMEER, Mumbaimade a presentationon "FPGA based Transmitter, Gradient and Receiver system of MRI".beforea forum of Professors of IIT's and NIT's

Invited Talks/Lectures

Dr. AlokVerma, Scientist-D delivered an invited Lecture on "Development of Optical sensor for Homeland Security at SAMEER", at Two day course on "Technologies for Nuclear, Biological and Chemical protection", R&DE (Engg), Pune, November, 2016

Dr. Alok Verma, Scientist-D gave an invited Lecture on "Development of Optical sensor for Homeland Security at SAMEER", at Two day course on "Technologies for Nuclear, Biological and Chemical protection", R&DE (Engg), Pune, November, 2016.

Shri Satyajit Chakrabarti, Scientist-D, SAMEER Kolkata delivered an invited lecture on "Multifunction Antenna" in the Indian Antenna Week 2016 at Madurai.

Shri Satyajit Chakrabarti, Scientist-D, SAMEER Kolkata delivered an invited lecture on "Multi-function Antenna" in the MCKV Engineering College, Belur (near Kolkata) on 24th Sep 2016.

Training programs attended or conducted

1. A one day training on usage of HDL coder in Matlab for VHDL was conducted on 11thJan 2017 at SAMEER Mumbai. Scientist from SAMEER Mumbai attended the training. Hands on was also provided in the training.
2. Shri Sagar, Research Scientist, SAMEER Kolkata Centre attended Short Term Course on Analysis & Implementation of Dielectric Resonator Antennas during 21st-26th Nov, 2016 organized by Department of EECE, IIT Kharagpur

Deputation of persons in India/Abroad

3. DrAlokVerma was selected as Technical Chair for IEEE sponsored International conference on Photonics at Thakur college of Engineering, Mumbai.

4. DrAlokVerma was deputed to attend DRDO review meetings held at LASTECH, Delhi, DRDE, Gwalior and R&D E, Pune. This includes Project monitoring review meeting, Executive Board Meeting, Testing & calibration integration meetings on quarterly basis in 2016.

Talks / Lectures Delivered

5. Shri Rajesh Harsh, Scientist-F SAMEER, Mumbai delivered a talk on 'National mission on development of an indigenous MRI: A status report'. The workshop was organized by Department of NMR & MRI Facility, AIIMS, New Delhi.

6. Shri Amitesh Kumar, Scientist-C, SAMEER Kolkata attended an IEEE lecture on the topic "A New Class of Printed Leaky Wave Antennas and Microwave Guiding Structures" delivered by Prof. Y. M. M. Antar.

7. Shri Vivek Kumar Singh, Scientist-D, SAMEER Kolkata delivered a lecture on "Basics of Antenna & Antenna measurement" at NIT Rourkela, Odhisa.

8. Shri Dipankar Dan, Scientist-D, SAMEER Kolkata delivered a lecture on "Electromagnetic waves and its various applications", at National Institute of Technical Teacher Training & Research, Kolkata.

9. Shri ArijitMajumderdelivered a lecture on "Millimeter wave Seeker Frontends" at DLRL, Hyderabad on 16th December 2016 as part of CEP course for DRDO personnel.

10. Shri ArijitMajumderdelivered three lectures in a short term course on "Recent Advancements in Short Range Wireless Communication" at IIT Kharagpur on 15thJuly , 2016.

11. Shri ArijitMajumderdelivered a lecture on "Monopulse RADAR principles" at RCCIIT Kolkata, on 11th July as part of faculty development program on "High Frequency application in Nano Electronics and Photonic Devices"

Publications

- Kirtika Dubey, KrishnatPawar, Sangeeta Kulkarni, Rajesh Harsh, "Design and Development of Automatic Level Control For Indigenous MRI," 6th International Conference on Communication and Signal Processing, April 2017
- KishoriPatil, SanketYavalkar, Dr.S.D.Ruikar, Rajesh Harsh, "Communication between Different Sub-Systems of MRI," 6th International Conference on Communication and Signal Processing, April 2017

o K. Mittholiya, P.K. Anshad, A.K. Mallik, S. Bhardwaj, A. Hegde, A. Bhatnagar, R. Bernard, J.A. Dharmadhikari, D. Mathur, A.K. Dharmadhikari, "Inscription of waveguides and power splitters in borosilicate glass using ultrashort laser pulses" Journal of optics, Published online link.springer.com in Sept 2016, Print version to appear.

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o P. Motale1, R. Patil2, N. Sreevalsen2, V. Rathore2, M. S. Panse1, and Alok J. Verma2 "Design of a virtual wavelength meter using LabView for Quantum Cascade Laser", International Conference on Communication and Signal Processing (ICCSP), 2016, IEEE Xplore Digital Library, DOI: 10.1109/ICCSP.2016.7754095, INSPEC Accession Number: 16498004

o Alok J. Verma , N. Sreevalsen, Vinod Rathore, "Nitric oxide sensor based on Photo-acoustic spectroscopy using DFB-CW Quantum Cascade Laser (QCL) for Breath Analyzer" The International Conference on Fiber Optics and Photonics 2016 © OSA 2016

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Automation, Control and Information Engineering, WASET, Vol-10, No-4, 2016.

- SubalKar, Madhuja Ghosh,Amitesh Kumar and A. Majumder;" Complementary Split Ring Resonator-Loaded Microstrip Patch Antenna Useful for Microwave Communication," International Journal of Computer, Electrical, Automation, Control and Information Engineering, WASET, Vol-10, No-10, 2016.
- Sayan Chatterjee, Jayanta Das and ArijitMajumder, "Circularly polarized offset center cross slotted array antenna at Ka band", IEEE MTT-S International Conference on Numerical Electromagnetic and Multiphysics Modeling and Optimization (NEMO), 2016, pp. 1-4.
- Rangana Banerjee Chaudhuri, Abhirup Das Barman, SukhenduBhanja, ArijitMajumder and SubalKar, "Low phase noise Frequency Tripled Microwave Signal Generation using external Optical Modulation", Microwave and Optical Technology Letters, vol. 58, issue. 5, pp. 1082-1085, May 2016.
- G. Arun Kumar, Bijit Biswas and D. R. Poddar, "A Compact Broadband Riblet-Type Three-Way Power Divider in Rectangular Waveguide", IEEE Microwave and Wireless Components Letters, vol. 27, no. 02, pp. 141-143, February, 2017.

  G. Arun Kumar and D. R. Poddar, "Broadband Rectangular Waveguide to Suspended Stripline Transition Using Dendritic Structure", IEEE Microwave and Wireless Components Letters, vol. 26, no. 11, pp. 900-903, November, 2016.
- D. Dan " Measurement and Analysis of Electromagnetic Compatibility on Ship" accepted in 3rd URSI Regional Conference on Radio Science-2017, March, 1-4, Tirupati, Andhra Pradesh, India.
- M.S.S.K Bhargav, B. VenkataRamana, Dr. K.C.B. Rao, P. Siva Kumar, "Prediction and Analysis of Electromagnetic Interference in Radio Frequency Propagation for Transmitter - Receiver pair using LabVIEW" in INCEMIC 2016, held during 08-09 December, 2016 at Bangalore.
- P. Raghunadha Reddy, P. Siva Kumar, Dr. K.C.B. Rao "Design & validation of Low-cost RF Current probe to estimate the Surface Transfer Impedance (STI) of Co-axial cable under test using LabVIEW software" in INCEMIC 2016, held during 08-09 December, 2016 at Bangalore.
- M.S.S.K Bhargav, B. VenkataRamana, Dr. K.C.B. Rao, P. Siva Kumar 'Prediction and Analysis of Electromagnetic Interference in Radio Frequency Propagation 'in International Journals Radio Frequency Design in July, 2016.
- P. Raghunadha Reddy, P. Siva Kumar, Dr. K.C.B. Rao 'An easy approach for measurement of Surface Transfer Impedance of co-axial cables as per MIL STD 1377 for EMC qualification' in International Journal of Microwave Engineering & Technology in June, 2016.
- Makarand G. Kulkarni, A. N. Cheeran, K. P. Ray and S. S. Kakatkar, "Design Of A Novel CPW Filter Using Asymmetric DGS," Antennas and Propagation Symposium (APSYM 2016), Cochin University of Science and Technology (CUSAT), Cochin, India, December 15-17, 2016.
- SuyogChoudhari, Prachi Bhatia, Anjana Rodrigues, MukeshPatil and Roshan Makkar,"Modelling for Spectral Domain Optical Coherence Tomography (SD-OCT) System" ,3rd International Conference on Opto-Electronics and Applied Optics,2016 (OPTRONIX-2016) University of Engineering and Management, Kolkata, India, 18-20 August, 2016 (Acceptedto be published in Springer)

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- Pooja Motale1, M. S. Panse1, Sreevalsen N.2, V Rahore2 and Alok J. Verma, "Automated system using LabVIEW for Wavelength tuning of QCL for Multiple Trace Gas Sensing",International Journal for Research in Emerging Science and Technology, I J R E S T,Volume-3,Issue-6,Jun, 2016
- M. Biswas ; A. Balgarkashi ; S. Singh ; N. Shinde ; R.L.Makkar ; A.Bhatnagar ; SubhanandChakrabarti, "A low-temperature photoluminescence study of GaAs1-xNx/GaAs multiple quantum-wells", Proc. SPIE 10111, Quantum Sensing and Nano Electronics and Photonics XIV, 1011139 (January 27,2017);doi:10.1117/12.2251981.
- Balgarkashi, M. Biswas, S. Singh, D. Das, N. Shinde, R. L. Makkar, A. Bhatnagar, S. Chakrabarti, "Low-temperature photoluminescence studies in epitaxially-grown GaAsN/InAs/GaAsN quantum-dot-in-well structures emitting at 1.31 μm ", Proc. SPIE 10114, Quantum Dots and Nanostructures: Growth, Characterization, and Modeling XIV, 101140Q (February 20, 2017); doi:10.1117/12.2250527
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- Umesh K. Deshmukh; Yogesh K Choukikar; S BhaskaraNaik , " Design of CPW fed Bow-Tie Slot Antenna for Ground Penetrating Radar Application", 2016 IEEE Xplore, May, 20-21, DoP: 09 January 2017
- Savita Mahajan; Anand Mane; S BhaskaraNaik, "Effect of coupling media on sleeve Monopole antenna for breast imaging application", 2016 IEEE Xplore, May, 25-27,DoP: 26 January 2017.
- Mahesh D. Sawarbandhe ; S BhaskaraNaik ; V. R. Satpute ; Saugata Sinha, "Coaxial antenna for microwave ablation", 2017 IEEE Xplore, , Aug, 13-14, DoP: 05 January 2017.
- Narkhede, A. Gandhi, BhaskaraNaik S and J. Prajapati "Annular antenna system for Microwave Imaging for Breast Cancer Detection", 2016 IEEE Indian Antenna Week (IAW 2016), Madurai, India, 2016, pp. 21-24. doi:10.1109/IndianAW.2016.7883589 Date of Publication:23 March 2017
- Bijit Biswas, and G. Arun Kumar, " A V-band High Performance Single-Stage MMIC Frequency Quadrupler," 2016 IEEE International Microwave and RF Conference (IMaRC), December, 5-9, New Delhi, India.
- Arun Kumar, "Compact Integrated Antenna-Mixer Design Using Microstrip Circular Patch at 2.4 GHz" Accepted in 2016 IEEE International Microwave and RF Conference (IMaRC), December, 5-9, New Delhi, India.
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- Arvind Agarwal, JS Pillai, K Aurobindo, GS Isola, JD Abyankar, Purnima Shrivastava and Abhishek Kodilkar, "Monsoon Cloud Observations Using A Low Power Vertical Looking Ka Band Cloud Radar " IEEE International GeoScience and Remote Sensing Symposium (IGARSS2016), Bejing China 10-15 July, 2016, paper FR2.08.4 IEEE IGARSS 2016, China.
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- SM Rathod, P Jadhav, RN Awale, KP Ray, SS Kakatkar, " Low profile hexagonal ring patch antenna for biomedical application," International Conference on Computing Communication Control and automation (ICCUBEA), August 2016
- Vijay Sarode, K.P.Ray&Shoba Krishnan, "Design, Development And Simulation Of Microwave High Power Waveguide Dual Directional Coupler", International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE), ISSN (Online): 2394-6849, Volume-3, Issue-12, December 2016, pp. 62-67.
- AboobackkarSidhique, Mahesh Chaluvadi, P. H. Rao, 'Analysis of 3D Metamaterial with μ = -1 for Magnetic Field Focusing'IEEE-Asia-Pacific Microwave Conference, New Delhi, December 2016.
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- S M Rathod, A Achugatla, R N Awale, K P Ray, S SKakatkar, "Analysis of Directivity Enhance Circular Microstrip Antenna with Shorting Post, "International Union of Radio Science- 3rd Regional Conference on Radio Science 2017 NARL-Gadanki, March 2017 Conference
- K. Kabilan and M. Saketh , " Implementation of SERPENT cryptographic algorithm for secured communication data transmission," , 4th International Conference onInnovations in Information, Embedded and Communication systems (ICIIECS-17), March 2017

- Mr. Wreek Dutta, M. Tech student of MCKV Institute of technology, MAKUT, has under gone project training on "Dual Circularly Polarized Microstrip Patch Antennas for S-band Communication" under the guidance of Shri SatyajitChakrabarti.
- Shri Prateek Mandal, B.Tech student, NIT Patna, has undergone six-month training on "Design and Development of High gain, Broad beamwidthQuadrifilar helix antenna at C-band for ground based airborne application" under the guidance of Shri Vivek Kumar Singh.
- Two B.Tech students, SoumikDey and PinakiNaskar of Calcutta University completed their B.Tech project on Metamaterial phase shifters under the guidance of Mr. Amitesh Kumar.

- Shri A. Basil, B. Tech. Student, Heritage Institute of Technology, Kolkata has undergone 6 months training on "Design and Development of Horn antenna at Ka-band" under the guidance of Shri Dipankar Dan.
- Shri Bijit Biswas has supervised Vocational Training Program for a B. Tech student from SDET Brainware Group of Institutions, West Bengal.
- Ms. PayelBasu, M. Tech. Student, BIT Mesra, Kolkata Campus has undergone 6 months training on " Design of a MMIC Based Power Amplifier at X-band" under the guidance of Smt. Paramita Banerjee.
- Ms. Nikita Das, B. Tech. Student, Sikkim Manipal Institute of Technology, Sikkim has undergone 6 months training on "Design and implementation of a compact multi-band filter" under the guidance of Dr. G. Arun Kumar.
- Dr. G. Arun Kumar is presently supervising a Ph.D. candidate Mr. Souma GuhaMallick registered under Jadavpur University on "Design of passive SIW components for microwave and millimeterwave applications".

Mrs. Sulabha Ranade, Director General addressing the gathering during Hindi Pakhwada

Hindi Implementation

Though SAMEER is a technical organization, it has made sincere efforts to implement Hindi in its official work. The Official Language Implementation Committee of the organization monitored the progress of Hindi implementation. Its meetings were presided by the Director General. During the year under review, meetings of the committee were held regularly.

During the year SAMEER, Mumbai Centre was notified under rule 10(4) of the Official Languages Rules 1976. Hindi workshops were organized in every quarter of the year to encourage the staff members to prepare notes and drafts in Hindi. Senior Officers of the Official Language Department of the Government of India were invited to deliver lectures in the Hindi workshops. The participants of Hindi workshop were given exposure to the Official Language Acts and Rules and their responsibilities to comply with them. Consequent to our efforts of Hindi implementation, significant progress is seen in use of Hindi in writing of notes and drafts by the staff members. Notices and Circulars are being issued both in Hindi and English. Communications in Hindi are steadily growing.

Celebration of Hindi Pakhwada has become a very popular event in the organization. Hindi Pakhwada was organized from 14th September 2016 to 29th September 2017. On this occasion, Hindi Kavita Path, Hindi Essay Writing, and Hindi Noting and Drafting Competitions were conducted. Prize distribution function was held on 28th September 2017. Dr. Ashok Tewary, a well known person in Hindi literary world was Chief Guest on this occasion. Director General, Registrar, and Hindi Officer addressed the gathering.

SWACHH BHARAT ABHIYAN

Government of India launched the Swachh Bharat Abhiyan on October 2, 2014 and asked people from all walks of life to help in successful implementation of this mission. The mission seeks to achieve the goal of Clean India in next five years so that the 150th birth anniversary of Mahatma Gandhi can be celebrated as an accomplishment of this duty. As part of Swachh Bharat Abhiyan, cleanliness drive was organised by SAMEER in various buildings and surrounding areas during the year. Posters and banners were displayed prominently in and around SAMEER for wide publicity.

Important Visitors

Shri P.P. Choudhury, Hon'ble Minister of State for Electronics & IT and Law & Justice visited SAMEER on 23rd September 2016 and reviewed the activities of SAMEER. He tooka round of the laboratories and facilities. He appreciated the good work being carried out by SAMEER.

Hon'ble Minister of State for Electronics & Information Technology and Law & Justice with senior Officers of SAMEER

Dr. S. Christofer, Chairman DRDO and Secretary Department of Defencevisited SAMEER centre at Kolkata on 27th August, 2016. He was taken to the laboratories and facilities at SAMEER, Kolkata. He appreciated the work being carried out by SAMEER, Kolkata,

Felicitation

Prof. R.V.S.Sitaram, first Director, SAMEER was felicitated on 21st December 2016 on his completion of 90 years. Prof. B.V.Sreekantan, former Director, TIFR and Chairman, SAMEER participated through video conferencing. Dr. S.R.Gowarikar, former Director, CSIO was the Chief Guest on the occasion. A brief presentation was made by Mrs. SulabhaRanade, Director General on the progammes of SAMEER from its inception. Many former employees also participated.

Prof. R.V.S.Sitaram being welcomed by Mrs. SulabhaRanade, Director General. Dr. Gowarikar is also seen

Photo taken along with Prof. Sitaram during his felicitation

SOCIAL AND CULTURAL EVENTS

Dr. B.M.Baveja, Chief Guest inaugurating the Annual Day 2016

Audience enjoying the cultural programmes

SAMEER ANNUAL DAY CELEBRATION

SAMEER Mumbai celebrated its Annual Day on 29th December 2016. Shri B.M.Baveja, Group Coordinator (R&D in CC&BT), MeitY was the Chief Guest on the occasion. Staff and their families participated in various sports and cultural programmes organized on the occasion. Employees who had completed 25 years of service were felicitated on the occasion. Shri B.M.Baveja gave away prizes to the winners of sports participants. Mrs. SulabhaRanade, Director General honoured the participants of various cultural activities by presenting them with mementos.

Cultural Programms

Cultural programmes

Annual Day was celebrated by SAMEER Kolkata Centre on 9th July 2016 at RabindraTirtha near Salt Lake City, Sec-V, Kolkata. Various cultural programmes by employees and families of SAMEER Kolkata wereorganisedon the occasion.August 2015.

Photograph during the inaugural session of the cultural program.

Photograph during the prize distribution of the sports day.

Staff members of the centre celebrated sports day on 13th Jan 2017 at Sec III, Salt Lake city, Kolkata. A picnic of staff members and their familieswas organised on 4th Feb 2017 at Bamunmoro,Barasat, near Kolkata.

Group photo of SAMEER Kolkata employees with their family members in picnic 2017.