SAMEER

Passion for performance

SAMEER

Society for Applied Microwave Electronics Engineering & Research

प्रौद्योगिकी सूक्ष्मतरंग इलेक्ट्रॉनिकी अभियांत्रिकी तथा अनुसंधान संस्था

Annual Report

2017-18

AUTONOMOUS SOCIETY OF

MeitY

MINISTRY OF ELECTRONICS & INFORMATION TECHNOLOGY

GOVERNMENT OF INDIA

GOVERNING COUNCIL OF SAMEER

Shri Ravi Shankar Prasad
Hon'ble Minister for Electronics & Information Technology, Government of India
Electronics Niketan, 6 CGO Complex,
New Delhi 110 003

Shri A.K.Balani
Group Coordinator (R&D in CC&BT)
Ministry of Electronics and Information Technology, Govt. of India, Electronics Niketan, 6 CGO Complex,
New Delhi 110 003

Shri K. J. Alphons
Hon'ble Minister of State
Ministry of Electronics & Information Technology, Govt. of India
Electronics Niketan, 6 CGO Complex,
New Delhi 110 003

Dr. Devang V. Khakhar
Director, Indian Institute of Technology - Bombay. Powai, Mumbai 400 076

Shri Ajay Prakash Sawhney, IAS
Secretary, Ministry of Electronics & Information Technology, Government of India,
Electronics Niketan, 6 CGO Complex,
New Delhi 110 003

Shri Tapan Mishra,
Director, Space Research Centre
Dept. of space ,
Ahmedabad

Shri Pankaj Kumar IAS
Additional Secretary
Ministry of Electronics and Information Technology, Govt. of India, Electronics Niketan, 6 CGO Complex,
New Delhi 110 003

Dr. Ajit Kalghati
Executive Director, R&D, Bharat Electronics Ltd., Corporate Office Outer Ring Road Nagavara, Bangalore 560 045

Smt. Anuradha Mitra IDAS
Additional Secretary & Financial Adviser
Ministry of Electronics and Information Technology, Govt. of India, Electronics Niketan 6 CGO Complex,
New Delhi 110 003

Shri Debashis Das
Chairman & Managing Director
Electronics Corporation of India
Hyderabad

Shri Rajiv Kumar IFS
Joint Secretary (Societies)
Ministry of Electronics and Information Technology, Govt. of India, Electronics Niketan6 CGO Complex,
New Delhi 110 003

Mrs. Sulabha Ranade
Director General, Society for Applied Microwave Electronics Engineering. & Research (SAMEER)
IIT Campus, Powai,
Mumbai 400 076

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 Electronics, 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 gives me great pleasure to present the technical activities pursued by SAMEER for the year 2017-18.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.

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

SAMEER under MeitY has grown to be a Premier R & D institute pursuing high end application oriented research in Linear Accelerators, Atmospheric and Radar based instrumentation, High power RF/ Microwave, Millimeter Wave technology, Communication, Antennas, Photonics, EMI/EMC etc. The expertise and knowledge base is continuously enhanced by way of executing core and sponsored projects in respective fields. The organization has proved its competence in technology areas of focus and contributed to various National level programs and missions by making products and equipments indigenously.

The new projects that were initiated this year in 2017-18 include

1. NAVIC

SAMEER is the nodal agency for design and development of the SPS Receiver ASIC chip for NAVIC. Satellite based navigational services address the emerging demands of the Civil Aviation along with the navigational requirements of users (like positioning & timing). Understanding the need for indigenous Satellite Navigation System, Indian Space Research Organization (ISRO), with an objective to provide Reliable Positioning, Navigation and Timing services to the users over India and its neighbourhood has established a network of 7 satellites in 'Geo Stationary Orbit (GEO)' and 'Geo Synchronous Orbit (GSO)'. This constellation of satellites is named as "NavIC" (Navigation Indian Constellation) . The ASIC chip for NAVIC would provide Reliable Positioning, Navigation and Timing services to the users over India

2. COAL SAR

With the expertise developed by undertaking core R&D activity of Synthetic Aperture Radar (SAR), SAMEER has, with the funding of Coal Ministry, undertaken an Indigenous development to design ground based FMCW-

SAR imaging radar to predict failures and slope instabilities in open cast (coal) mines by radar interferometry techniques. It will be a first of its kind Early Warning Radar to monitor instabilities of dump slopes in the country. The instrument is being developed for the Central Mine Planning and Design Institute (CMPDI), Ranchi, a subsidiary of Coal India Limited, a Maha-Ratna Company .

3. Linear Accelerator technology for Non Destructive Testing

   Linear Accelerator Technology for non destructive evaluation of big metal castings for strategic applications is being pursued and it contributes to the national level programmes and missions.

4. Design and Development of Switched beam array antenna for 5G Technologies at 60 GHz 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 taken up by SAMEER .

Among the various achievements for this year 2017-18 include

1. One 6 MeV Linac Machine has been commissioned at Amravati Cancer Foundation, Amravati and after AERB clearance, patient treatment started in June 2017.

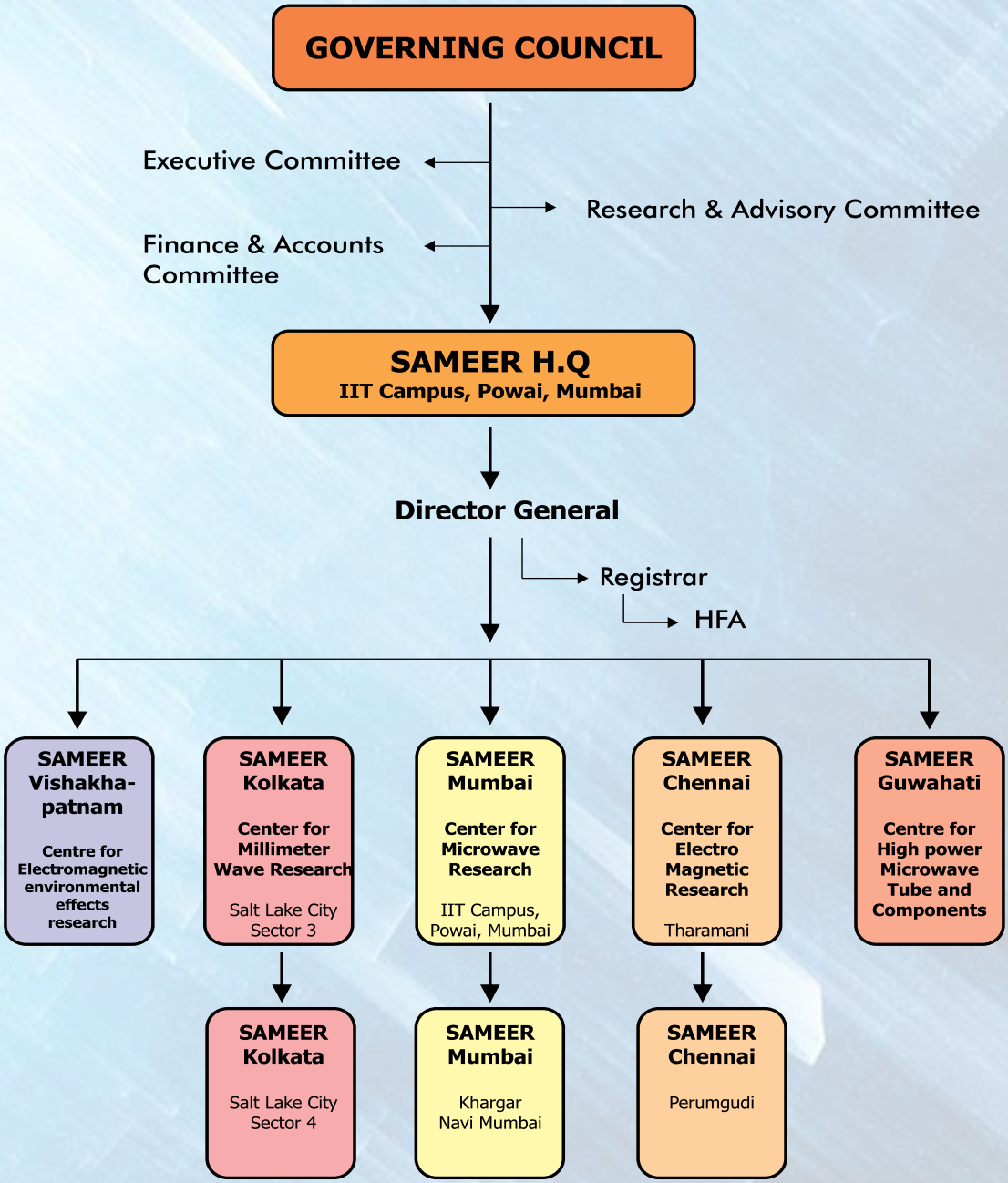
2. Two Microwave tea processing systems, each having 10 kW MW power output, were developed and handed over to the industry with an academic partner. One system was developed for Guwahati University and was installed at Bhergaon Tea Estate, Bhergaon, Assam. Another system was developed for Tezpur University and was installed at Chandraprabha Tea Factory, Golaghat, Assam.

3. A table top moisture meter system has been successfully developed, tested, validated and calibrated at IIFPT Thanjavur for moong dal, rice and wheat.

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

Sulabha Ranade
Director General

SAMEER
ORGANIZATIONAL CHART



SAMEER

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

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

SAMEER Mumbai
Centre for Microwave Research

One of the important work areas at this center is Linear accelerator technology which finds application in cancer radiation therapy. Another Major area of expertise in SAMEER is Atmospheric instrumentation. Atmospheric radars which are basically clear air Doppler radars were developed for probing the various layers of the atmosphere and collecting vital information on atmospheric dynamics. Apart from these two programmes, focus is also placed on development of RF / Microwave heating/drying applications, High Power components, meteorological instruments, Radio Altimeters etc. 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. The center has developed special infrastructure for integrated optics and photonics which enables us to develop certain key optoelectronics products and systems.

A modern NABL accredited EMI/EMC laboratory has been established at Kharghar , Navi Mumbai, the second R&D campus, for offering test measurement and consultancy services to the industries.

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 have also been established at this campus. Recently new infrastructure has been added at this campus for electrical products safety Lab for testing electronics products as per standards.

SAMEER Chennai
Centre for Electromagnetics

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. The Centre strengthened its lead position in area of EMI/EMC by establishment of dedicated MIL-STD test facilities and upgradation of in house EMI/EMC calibration Lab to National level lab catering to calibration needs of the EMI/EMC test lab in the country. The EMI/EMC calibration lab is NABL accredited.

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.

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).

SAMEER, Kolkata

Centre for Miliimeter Wave Technology

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. The centre has built strong design teams in antennas and millimeter wave technology. A number of core projects and sponsored projects of national importance are being carried out at this Centre. The Centre also provides test, measurement and design consultancy services to industries and government institutions in the areas of EMI/EMC, antennas and radomes.

SAMEER, Visakhapatnam

Centre for Electromagnetic Environment Effects (E^3)

Centre for Electromagnetic Environmental Effects (E^3), Visakhapatnam is being established at Gambheeram village, Visakhapatnam Dist, Andhra Pradesh in 13 acres of land allotted by Govt. of Andhra Pradesh. The E^3 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.

SAMEER Centre for E^3 has been pursuing its objective of doing Electromagnetic Environmental Effects (E^3) Research, Development, Test, and Evaluation. The E^3 facility specializes in a variety of capabilities, ranging from box level to complete system level testing

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.

This Centre consists of India's largest outdoor RS105 EMP facility as per MIL STD 461E/F for large objects and other Highly specialized facilities viz., HEMP Pulse Current Injection (PCI) Test System according to MIL-STD-188-125/1&2, Ultra Wide Band (UWB) Test system, 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 EMI/EMC modeling and Computational Lab consists of various 3D EM tools viz., ANSYS HFSS, CST, FEKO with advanced simulation methods and High End hardware equipment to solve the all the EMI/EMC problems of both civilian and defense products.

One of the major objectives of this centre is to develop pool of skilled manpower in the area of EMI/EMC through regular workshops, seminars and other educational & academic events. As a part of this training and academic activities, M.Tech students of local Colleges were allowed to carry out their project work under the guidance of SAMEER Scientists. Areas in which students are carrying out their project work includes fundamental of Electromagnetics to the Applied Electromagnetics in the EMI/ EMC domain viz. EMC antennas, Measuring devices, instrumentation, High Power Electromagnetics – radiators & pulse propagation study, etc.

SAMEER, Guwahati

Centre for High Power Microwave Tube and Component Technology

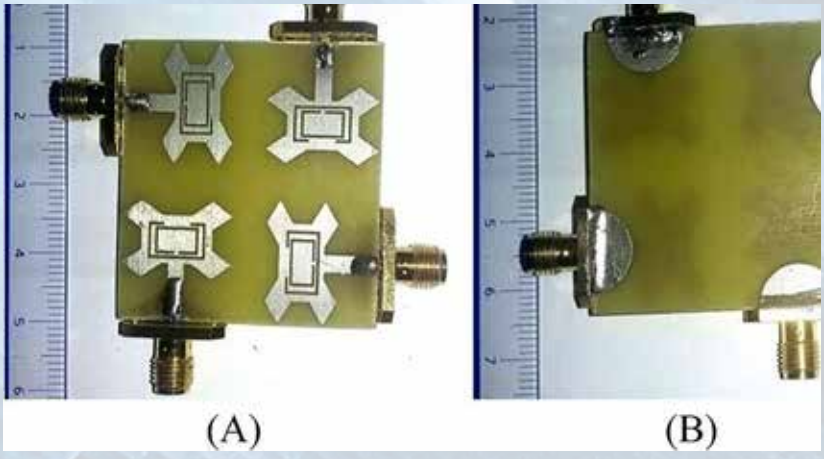
Centre for High Power Microwave Tubes and Components Technology is being established at the Campus of Indian Institute of Technology, Guwahati. This centre is dedicated for development of conventional high power microwave tubes/components as well as futuristic high power mm wave and THz sources. It will develop manpower working in the area of high power microwave tubes/components by proper training. The 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

ANTENNA AND ELECTROMAGNETIC DESIGN

SAMEER has developed design expertise to virtually design and develop any kind of antenna in VHF/UHF/ Microwave/ Millimeter wave frequencies. The antennas which have high importance include Multifunctional antennas, shared aperture antennas, conformal antennas with low RCS, multiband and UWB antenna, smart antennas, electronically steered array (ESA)/phased array, Multi-beam antennas, Wraparound antennas, communication antennas, waveguide slotted array antennas.

Compact 4 element SierpinskiKnopp fractal UWB MIMO antenna with dual band notch

A 4 element ultra-wide band (UWB) multiple-input multiple-output (MIMO) antenna is designed. A novel SierpinskiKnopp fractal geometry issued in the antenna radiator design to accomplish miniaturization. The antenna elements are placed orthogonal to each other. The spacing between any pair of elements is 0.11 λ (λ being the free space wavelength at 7.15 GHz).A CSRR shape like slot is etched on the radiating element to achieve dual band notch characteristics at WiMax 3.5 GHz and WLAN 5.4 GHz regions. The total size of the proposed antenna is 40 ×40 mm2and operates from 2.6 to 10.6 GHz,



Photographs of the fabricated antenna : A, front view; B, rear view
81×45mm (220×220 DPI)

A prototype of the proposed SAA configuration with five antenna elements: (a) the top view (b) an isometric view

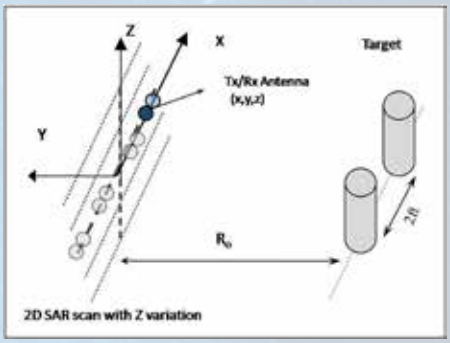
exhibiting a reflection coefficient S_{11}< -10 dB and an isolation better than 20 dB. The MIMO antenna does not require any additional structure to improve isolation. Envelope correlation coefficient (ECC) and capacity loss (CL) are calculated to evaluate the diversity performance of the proposed antenna. The measured values exhibit better match with the simulated results.

A Multiband, Multipolarization Shared Aperture Antenna

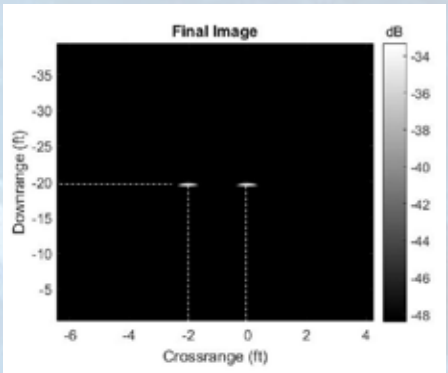
A compact, shared-aperture antenna (SAA) configuration consisting of various planar antennas embedded into a single footprint is realized. An L-probe-fed, suspended-plate, horizontally polarized antenna operating in an 900-MHz band; an aperture-coupled, vertically polarized, microstrip antenna operating at 4.2-GHz; a 2 × 2 microstrip patch array operating at the X band; a low-side-lobe level (SLL), corporate-fed, 8 × 4 microstrip planar array for synthetic aperture radar (SAR) in the X band; and a printed, single-arm, circularly polarized, tilted-beam spiral antenna operating at the C band are integrated into a single aperture for simultaneous operation. This antenna system could find potential application in many airborne and unmanned aircraft vehicle (UAV) technologies. While the design of these antennas is not that critical, their optimal placement in a compact configuration for simultaneous operation with minimal interference poses a significant challenge to the designer. The placement optimization was arrived at based on extensive numerical full-wave optimizations.

3-D Radar Imaging Using Extended 2-D Range Migration Technique

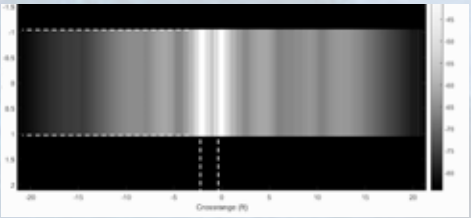
A three dimensional (3-D) imaging system is implemented by employing 2-D range migration algorithm (RMA) for frequency modulated continuous wave synthetic aperture radar (FMCW-SAR). The backscattered data of a 1-D synthetic aperture at specific altitudes are coherently integrated to form2-D images. These 2-D images at different altitudes are stitched vertically to form a 3-D image. Numerical simulations for near field scenario are also are carried out to validate the proposed algorithm.



Imaging geometry of experimental setup



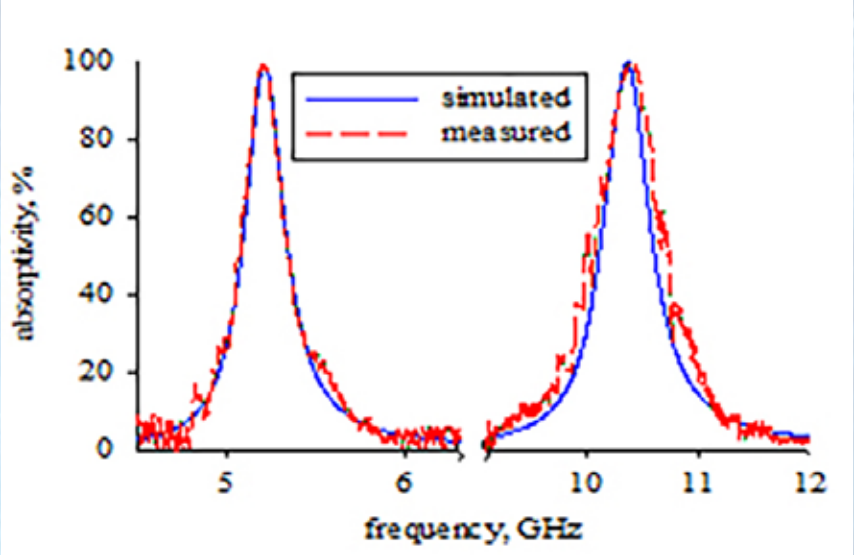
Vertically stitched image of two cylinders



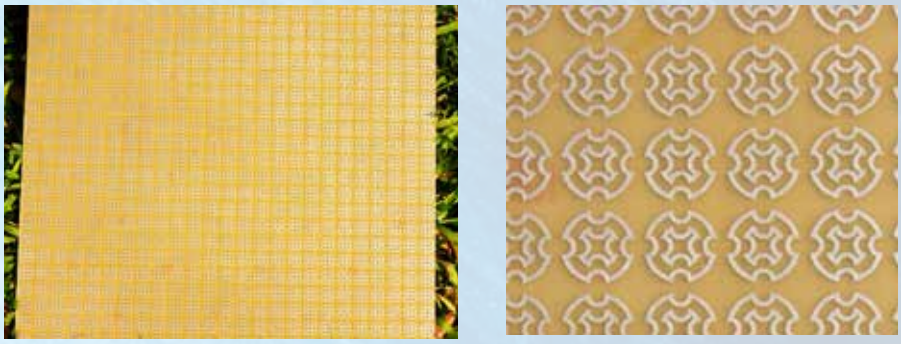
Cross-sectional image of the cylinders at a particular height.

Wide-angle and polarisation insensitive dual-band metamaterial absorber

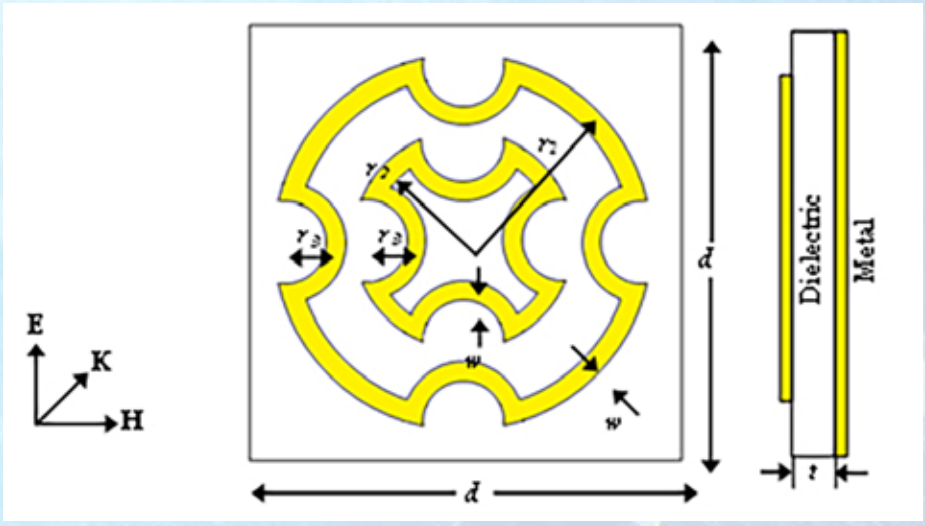
A single layer wide angle and polarization insensitive compact metamaterial absorber for dual-band (C- and X- bands) operation is designed, fabricated and analyzed. The unit cell of the proposed absorber is made up of two modified concentric circular rings printed on a grounded dielectric substrate. The surface power loss distribution on the unit cell confirms the dual band nature. A planar absorber fabricated with 25x25 unit cells is tested for its absorption characteristics and found to exhibit more than 99% absorptivity at both 5.2GHz and 10.4GHz frequency bands. The proposed dual band absorber maintains its absorptivity of the order of 99% for various polarization angles and wide angles of incidence.



Simulated and measured absorptivity under normal incidence.



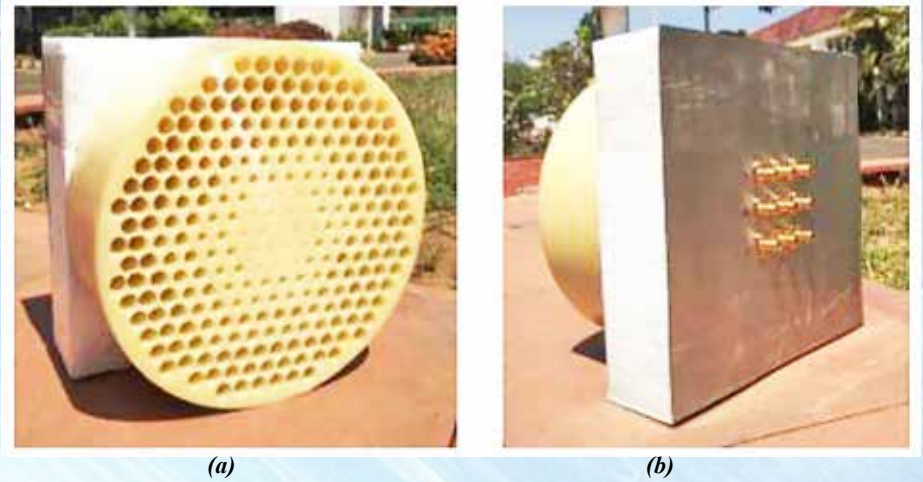
Photograph of the fabricated structure.



Unit cell geometry of proposed structure d=12, r1=5.3, r2=3.1, r3=1.45, w=0.6 and t=1(All dimensions are in mm) a Top view b Side view

Analysis of Dielectric Lens Loaded Antenna

A high gain antenna for 5G communication applications is designed and fabricated. High gain is achieved by incorporating the concept of dielectric lens loading on a rectangular microstrip antenna operating at 60 GHz. Two configurations of dielectric lenses (hyper hemispherical and synthesized elliptical) are analyzed. The hyper hemispherical lens loaded antenna exhibits again of 14.98 dB gain and the synthesized elliptical dielectric lens antenna provides 19.71 dB gain.

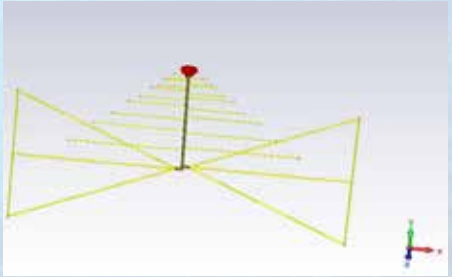


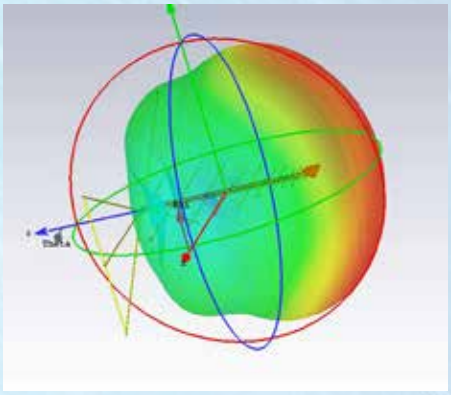
(a) (b)

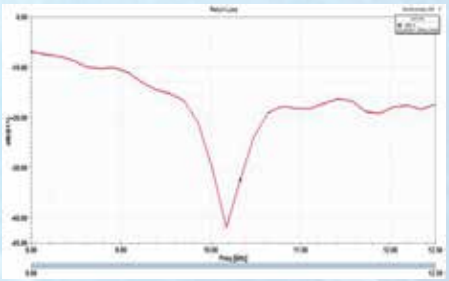
(a) Isometric front view and (b) Isometric back view of the fabricated perforated dielectric lens loaded antenna

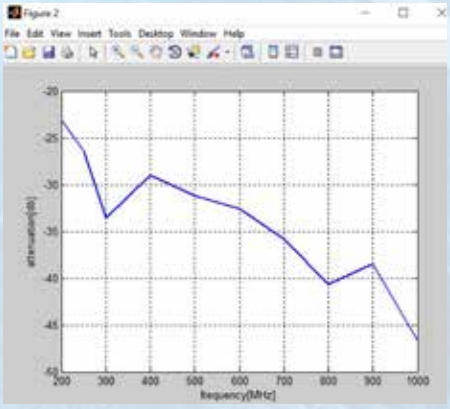
CAD modeling & Antenna Factor estimation of EMC antennas – Log-periodic, Bi-conical & Bi-ConiLog antennas

The broadband EMC antennas are designed as per the requirements of the CISPR & FCC standards for carrying out Radiated Emissions (RE) and Radiated Susceptibility (RS) tests. The antennas LPDA, Bi-conical & Bi-ConiLog are modelled using Computer Simulation Studio (CST) software tool and their S11, VSWR, gain and radiation patterns are studied. Further, an approach for estimating the Antenna Factor as per ANSI C63.5 standard for each antenna using CST is carried out. Good correlations between the simulated models and commercial models is observed.



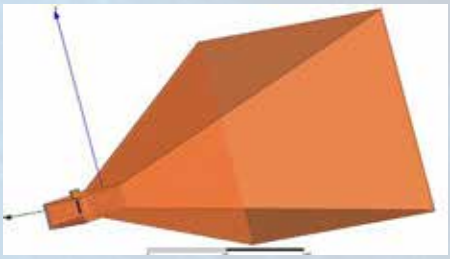


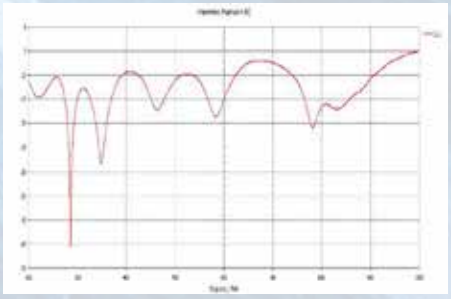




Modeling & simulation of Standard Gain Pyramidal Horn antennas from 1-18 GHz

The study on Standard gain Pyramidal Horn antennas used in calibration of standard & ridge antennas is carried out from 1 – 18 GHz frequency range. The design equations are considered from the standard text books and research articles. The propagation of EM waves along the respective waveguides is also studied for validation of feeding the horn antenna. Antenna Factor is estimated as per ANSI C63.5 standard and compared with the commercial horns available in the market. ANSYS HFSS software tool is used for modeling & simulation of X-band horn antenna. For further study & computation of Antenna Factor all the standard gain horns, Altair HyperWorks FEKO is used.



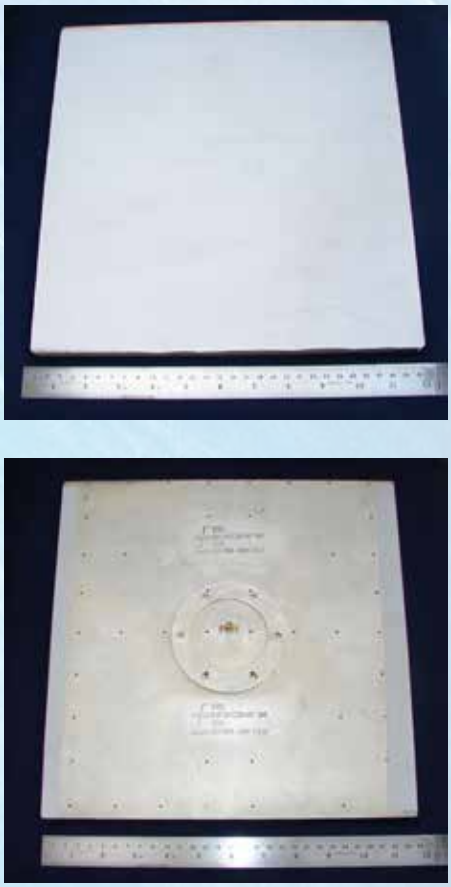


Design and Development of Data Link Antennas at X-band:

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 patch fed horn has been developed for Tx - application. It exhibits gain better than 9.0 dBi and 3dB beamwidth of 60^0 x 60^0. A radial horn with gain higher than 3.5 dBi and half-power beamwidth of 110^0 x 110^0 is developed for Rx purpose.

A left hand circularly polarized (LHCP) helical antenna and a cavity backed cross dipole antenna (RHCP) are also developed for Tx & Rx application respectively. The helical antenna produces gain superior than 10dBi (3dB beamwidth of 60^0 x 60^0). The cross dipole causes more than 5.0 dBi gain and half-power beamwidth of 110^0 x 110^0 LNA, Limiter & Filter have also been developed as associated components. Developed antennas along with circuit components have been successfully delivered to the end user.



Developed High Gain Slotted Waveguide Array Antenna: the top-view (left), and bottom-view (right)

Developed X-band data link antennas and associated circuit components.

Design and Development of High Gain Slotted Waveguide Array Antenna at X-band

The main objective of this project is to design and develop broadband high gain slotted waveguide array antenna for data link application at X-band. The broadband high gain slotted waveguide array antenna consists of three layers: (a) radiating slots on the top layer, (b) aperture coupled cavity in middle layer, and the corporate feed distribution in bottom layer. The two dimensional array structure shown in Fig. 2. The antenna is having 30dBi gain, wider than 1 GHz bandwidth and 30cm x 30cm x 2cm size. One number of this antenna has been fabricated, performance optimized and successfully delivered to the end user.

Multiband wrap around Antenna

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 omni-directional coverage (at -10dB level) in both azimuth and elevation plane in S-band and C-band. In Ka-band, apart from the omni-directional azimuth coverage, the antenna produces a squinted beam in the elevation plane. The multiband antenna finds application in the onboard system.

A 4-Quadrant wrap around antenna of 1m diameter has been fabricated using 2 layer RT Duroid substrate. It is covered with a Teflon radome of thickness 10mm. Cables and connectors based inter-quadrant connectiv-

ity has been realized. The overall antenna is mounted on a curved metallic base. A photograph of the developed prototype is shown in Fig. 3. The antenna yields half-power beamwidths of 85^{o} x 80^{o} at both S- and C-bands. The measured results are highly encouraging.

The fabricated 4-quadrant multiband wrap around antenna.

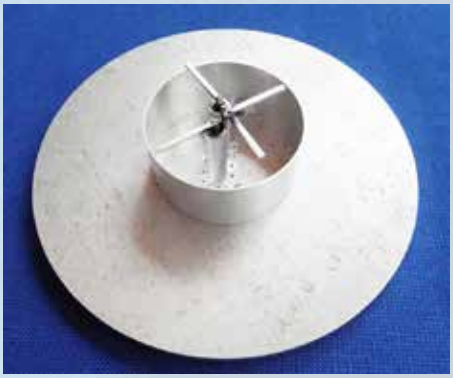
Ka-band squinted beam antenna

An independent Ka-band cavity backed squinted beam has been designed and developed. A 20mm thick teflon has been employed as radome which uses steps to resist radome movement during air-borne application. Beam squint of $\approx 52^{0}$ with a 6dB beamwidth $\approx 54^{o}$ has been demonstrated to the end user with gain ≈ 9 dBi. A photograph of the different parts of the antenna is shown below

Ka-band cavity backed squinted beam antenna.

S-band cross dipole antenna

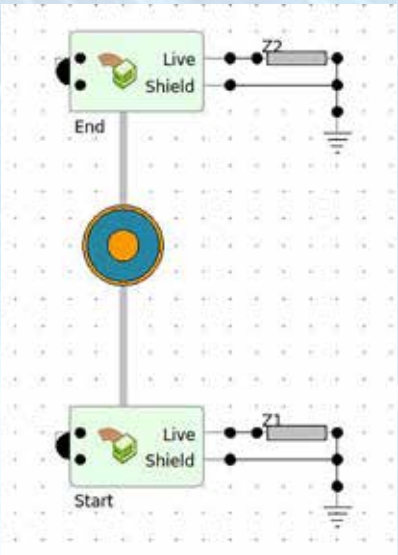
A dual linearly polarized cross dipole antenna has been designed and developed with improved beamwidth. It operates in both horizontal and vertical polarization over 2.15-2.45GHz. Two dedicated co-axial ports have been employed for the excitation / reception of horizontally and vertically polarized signal. It exhibits 3dB beamwidth of ≈ 135° and gain 5.5 dBi for each of the ports. A photograph of the antenna is shown below

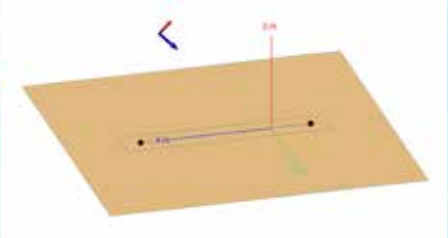


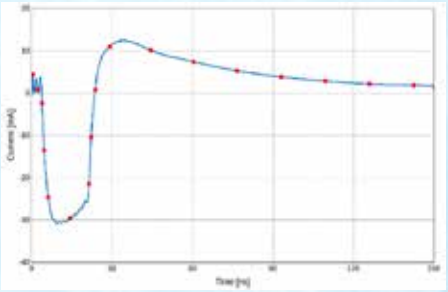
Simulation study on High-altitude Electromagnetic Pulse (HEMP) coupling to cables

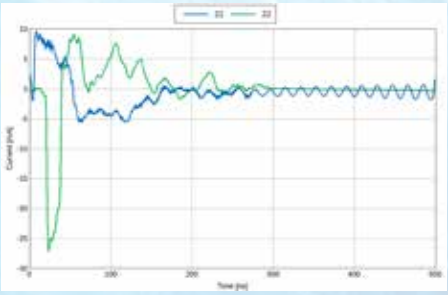
RG58C/U co-axial cable is considered to study the coupling effects of EMP into it. The cable is terminated at both ends with 50Ω impedance. The sample cable is placed at 1cm of height from the infinite ground plane. The EMP Pulse is modeled in POST-FEKO and launched at 45° axially above the cable. The coupled voltages and currents are computed and shown below. Further, the real-time EMP generated from RS105 test facility at SAMEER-CE3, Visakhapatnam is used in analyzing the coupling effect of it to the Shielded Co-axial cable. The real-time EMP pulse measured

using the free-field D-Dot sensor is shown below.

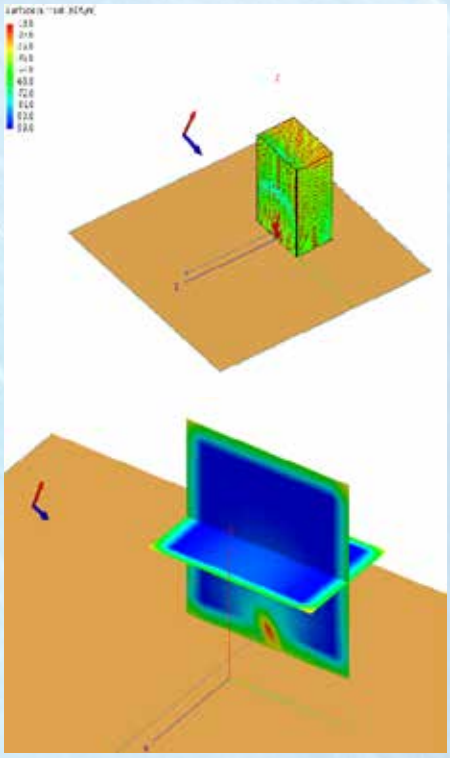






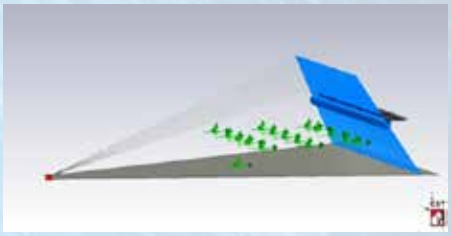


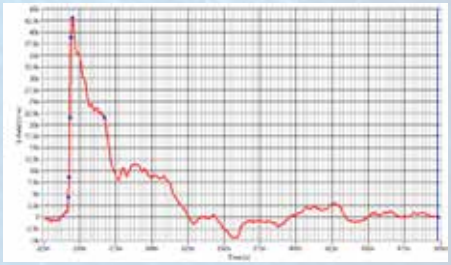
A study is carried out to analyze the surface currents generated and the fields produced inside a shielded shelter with dimensions of 3 x 2 x 3 m for a co-axial cable penetrated into a shielded shelter for EMP. The cable is placed at a height of 1cm from the infinite ground plane. The EMP is launched at angle of 45° and studied for the currents generated across the loads. Significant coupling of EMP energy into the shielded shelter is observed which can have a devastating affect on the electronics housed inside the chamber.

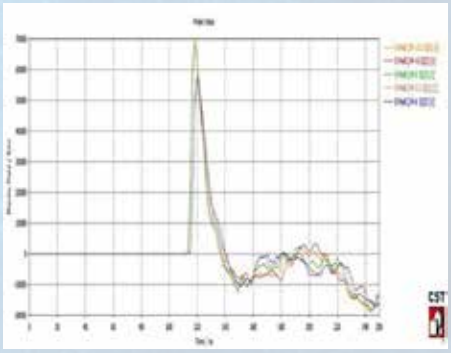


Modeling & simulation analysis of Bounded wave EMP Structure as per MIL STD 461F/G,RS105

Bounded wave EMP structure of TEM type model was developed using CST EM Modeling tool for analysis of Field uniformity of generated EMP pulse characteristics as per MIL STD 461 F/G, RS105. Simulated Filed uniformity results will have good concurrence with parasitical results. Further, the Developed EMP antenna model is used for assessing the shielding effectiveness of cabinets for EMP hardening.







Spherical Dipole Antenna (SDA)

The Spherical Dipole Antenna (SDA) was designed and fabricated as a developmental activity under core project. The antenna has been designed and fabricated over the frequency range of 50 kHz – 200 MHz – 3 GHz. The calibration of the fabricated antenna is underway and the simulation results are matching with those of measured ones. The antennas intended to be used for Shielding Effectiveness measurements of small enclosures.

Structure of an Ultra Wide Band Spherical Dipole Antenna

ATMOSPHERIC AND METEOROLOGICAL SYSTEMS

SAMEER has played a significant role in establishing atmospheric remote sensing technologies in the past three decades. The interactions of SMEER with atmospheric scientists during the course of initial developmental activities have led to a very specialized knowledge base and expertise. The radar instrumentation with its special reference to atmosphere has opened up a new sector of high power engineering, sophisticated signal processing techniques and sensitive receivers due to the very special nature of atmospheric targets whose behavior are controlled by statistical parameters. As a continuation of this, SAMEER has taken up many activities where the acquired knowledge base was utilized and further expanded in the areas of atmospheric instruments.

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. The development of Radiosonde Receiver ground system as well as balloon payload had been completed. SAMEER Completed the delivery of last Eight units of Radiosonde ground systems. These systems are being deployed in the field by IMD.

Lightning Detection Network

SAMEER, as part of MeitY's North East program, has developed indigenous Lightning Detection and Localization Network. Lightning is the single largest cause of fatalities due to natural disasters and it's envisioned that this system will alleviate this problem. The Five units Lightning Detection Nodes designed and fabricated and were handed over to Tripura University for field trials. The Lightning data processing software and Nodes integration is in progress. By December 2018 the system will be deployed for trials in NE region.

NavIC SPS Receiver ASIC

Satellite based navigational services address the emerging demands of the Civil Aviation along with the navigational requirements of users (like positioning & timing). Understanding the need for indigenous Satellite Navigation System, Indian Space Research Organization (ISRO), with an objective to provide Reliable Positioning, Navigation and Timing services to the users over India and its neighbourhood has established a network of 7 satellites in 'Geo Stationary Orbit (GEO)' and 'Geo Synchronous Orbit (GSO)'. This constellation of satellites is named as "NavIC" (Navigation Indian Constellation) on the occasion of successful launch of last satellite of NavIC.

With SAMEER as the nodal agency, the design and development of the NavIC Receiver will be carried out in collaboration with IIT Bombay, IIT Jodhpur, and IIST Thiruvananthapuram and IIT Madras. It is proposed to develop the NavIC receiver ASIC in two phases over a period of 30 months.

In the first phase, comprising a period of 12 months, a table top civilian grade (SPS) receiver will be delivered; using discrete and Commercial Off-the-Shelf (COTS) components, and a COTS FPGA. This receiver will be loaded with FPGA based baseband signal processing and PVT computation firmware to generate the receiver position data using NavIC signals. In second phase starting from second year, the same receiver will be developed in silicon, as combination of two ASICs (One RF ASIC and one Digital processing ASIC).

SAMEER has completed the design & simulation of the dual (S and L5) band RF Front End Receiver along with Antenna. The RF Front was fabricated and tested successfully using COTS RF components. The Customized FPGA Based DSP Board Procured required for the project was also fabricated and tested.

COMMUNICATION SYSTEMS

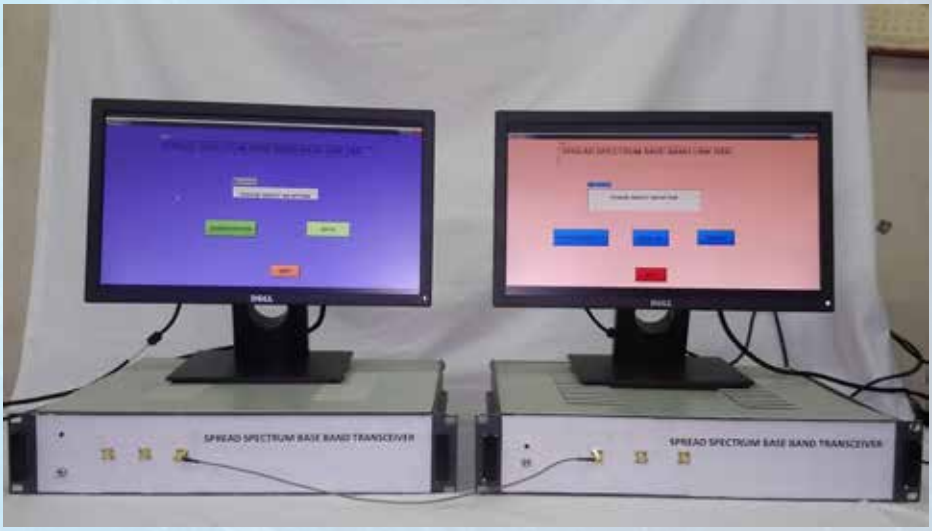
SAMEER has contributed in wireless communication technologies for industry through ambient noise survey, network planning and optimization for Radio paging and Cellular Communication Systems. With this experience, SAMEER continued to work in the communication and DSP hardware.

Special Achievements

Interceptor Missile experiment was carried out by DRDO at Dr Abdul Kalam Island, off the coast of Odisha on 28.12.2017. Interceptor missile scored a direct hit on incoming missile at an altitude of 15 km and destroyed it. The "Two RF Channel CDMA Receiver" designed and developed by SAMEER was used in the Interceptor, to establish the important data communication link. Ground based "Spread Spectrum Transmitter" was also designed and developed by SAMEER in this mission. The details about the incoming missile were transmitted by the Spread Spectrum Transmitter to the Interceptor through the Two RF Channel CDMA Receiver. Similar experiments have been carried out many times during the last few years.

Spread Spectrum Baseband Transceiver

DSP division has designed and developed the spread spectrum baseband data link which can be configured and used for future sponsored projects requiring jamming immunity and security. The transceiver supports two transmit (TX) and two Receive (RX) channels. In each TX/RX channels multiple data channels can be combined using CDMA. The configuration of the transceiver and data interface with the transceiver is done through RS232 interface using GUI based application in a host computer.



At present, the transceiver has been validated for single data channel using gold code having 21 dB processing gain. The transceiver has the capability to select any gold code from 90 gold code family sets. The transceiver is tuned for 10-6 BER and +/- 20 KHz Doppler tracking range. With two data channels multiplexed, it can support -10dB SNR for asynchronous CDMA received signals.

The transceiver has been validated for 2.5MHz bandwidth at 70 MHz IF frequency. It has tunable band pass filter in the analog front end hardware which can be tuned for different bandwidth requirements. The baseband modules can be retuned for different data rate and processing gain requirements.

Development of FCS-BDS Modules

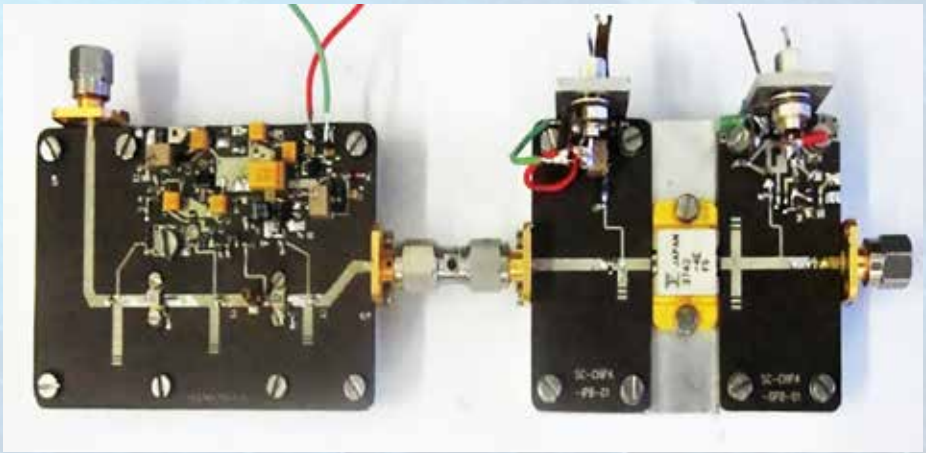
SAMEER has developed 3 variants (GRSE, MDL, FN) of Fire Control System (FCS) system as indigenous technology development. SAMEER has signed an MoU with BEL, Chennai for fabrication 5 FCS systems based on the requirement of end user. All 9 FCS systems are installed and trials

are completed for 3 systems. Based on the need, SAMEER has developed the BDS spare modules for all the three variants of FCS systems already supplied. The BDS modules are tested for their functional specifications and qualified for the ET and ESS standards.

Technology Development for Compact C-band Transmitter

Design & Development for indigenization of RF/Microwave circuits and modules was undertaken in context of ongoing core R&D project 'Technology Development for Compact C-band Transmitter'. The Transmitter design from the concept stage of component selection to circuit board realization and subsystem development is oriented and focused towards the design challenge of miniaturization and power efficient Transmitter realization. In accordance with these challenges of the core R&D project, the design and realization had specifically addressed in-house development of Dielectric Resonator based Oscillator operating in C-band, Direct Phase Modulation at the carrier frequency in C-band.

The above depicts the performance evaluation of cascaded PC boards of the C-band Transmitter namely C-band Source, C-band Frequency Divider divide-by-320, C-band Direct Phase Modulator. The C-band source provides the carrier for the in-house designed modulator; while also providing the C-band input for the Frequency Divider for phase lock loop. The main emphasis of the design is power efficient circuit function realisation with the power budget duly taken care.



Microwave Amplifier Chain of Transmitter

As part of the indianisation of the RF/Microwave circuits and modules and within the scope of the ongoing C-band Transmitter project design & development of the microwave amplifier chain to provide the specified power output of +35 dBm. The figure 2 below shows the design and fabrication of the amplifier chain for the specified output of +35 dBm operating from single power supply source of +8V. The Power Amplifier will amplify the modulator output C-band signal providing gain of 33 dB.

Re-Configurable Communication link

A Re-configurable communication link is designed and development is under progress. This compact data link can be configured for the following parameters i) Bandwidth ii) RF frequency iii) Number of TX/RX channels from 1 to 2 iv) RF output level up to 6dBm v) Few set of baseband modules like CDMA/OFDM/PSK modulation vi) TX/RX path gains vii) Decimation rates for RX path and interpolation rates for TX path etc. Power amplifier and LNA need to be added to this data link. The objective of this design is to make configurable hardware and firmware so that data link can be made ready for sponsored projects with reduced development time.

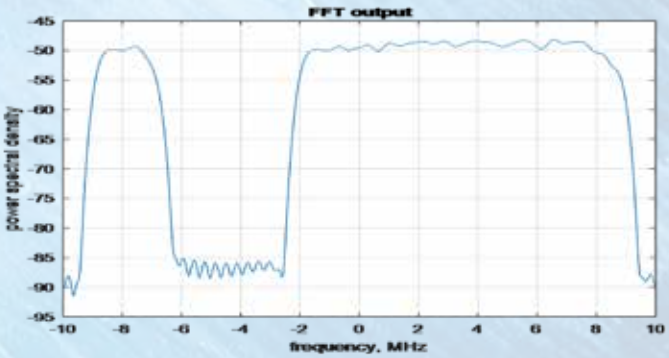
The data link can support different interfaces like USB, RS232, RS422, RS485, Ethernet and MIL1553B for

data interface and configuration requirements. It is planned to include many libraries of baseband modules. Some of the library modules are developed and some are under development. The hardware has options for general purpose I/O, optically isolated I/O, I2C bus expansion port for I2C device interfacing and on board memory. It is planned to add data link adaptation feature for maximum use of the data link based on channel conditions.

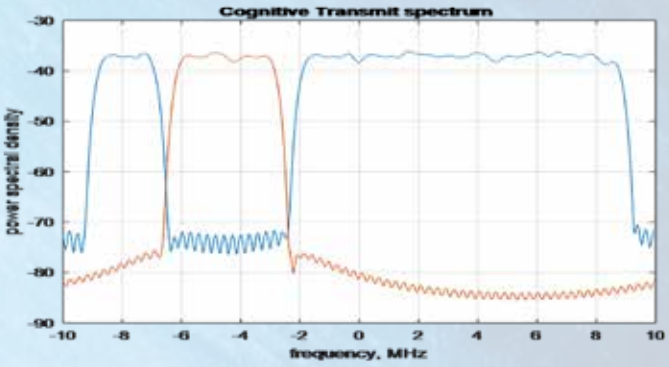
Re-Configurable Data link

Implementation of Non-Contiguous Orthogonal Frequency Division Multiplexing (NC-OFDM) on ZynQ7000 platform for Cognitive Radio (CR) Applications

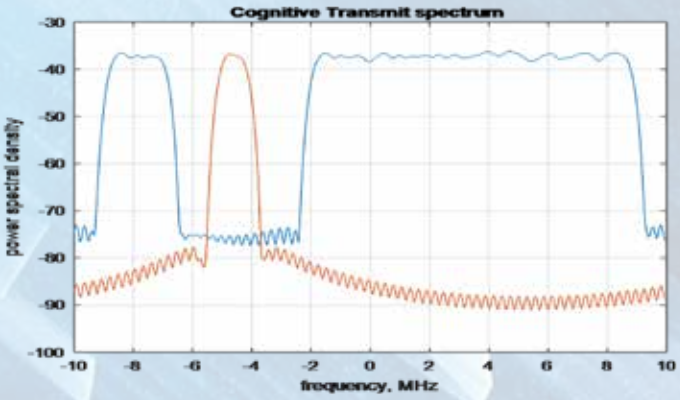
Cognitive Radio(CR) systems are proposed as a novel concept which uses dynamic spectrum access(DSA) as a method for the efficient spectrum utilization. A flexible Orthogonal Frequency Division Multiplexing(OFDM) technique called Non-Contiguous Orthogonal Frequency Division Multiplexing (NC-OFDM) is identified as a suitable candidate for the Cognitive Radio baseband processing where individual subcarriers can be made off/on, based on the frequencies occupied by the licensed User. NC-OFDM can also used for dynamically shaping the spectrum based on the channel impairments, interference and jamming threats. In this core work, we have simulated the NC-OFDM transceiver link which is compared with the conventional OFDM link in the MATLAB environment and implemented the same on ZynQ7000, all programmable System On Chip AD9361 Software Defined Radio Kit platform. The Transmitter output Spectrum, Spectrum after de-activating unwanted sub-carriers, the Spectrum shaping using Raised Cosine filtering, Spectrum sensing using correlation of known pattern and FFT based spectrum sensing were simulated in the MATLAB environment. The hardware implementation



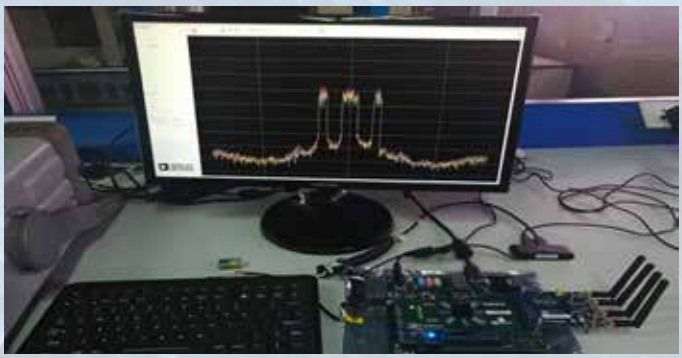
NC-T Spectrum (a) NC-OFDM Transmit spectrum



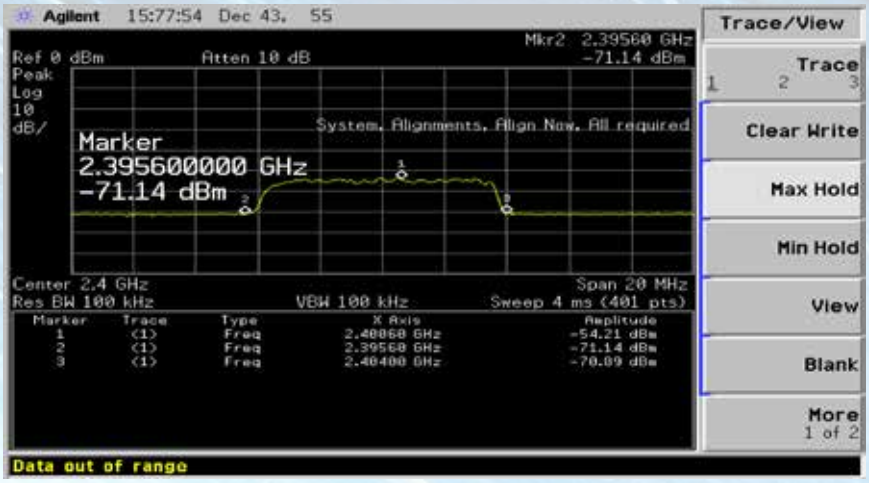
(b) FFT based sensing & Cognitive User spectrum
(b) NC-OFDM spectrum, PU signal



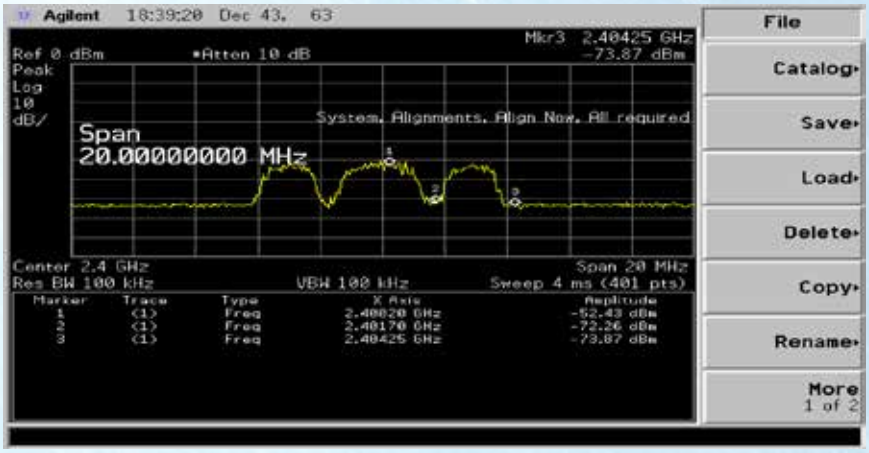
(c) FFT based sensing & Cognitive User-2 Transmit spectrum



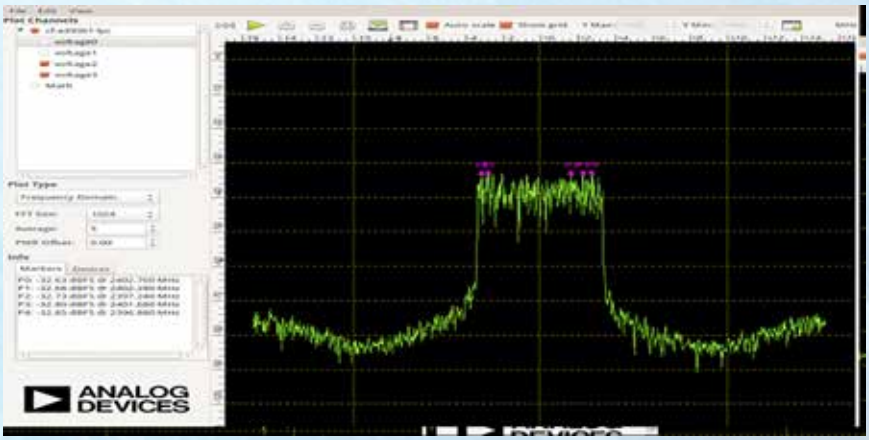
(d) Hardware Test setup



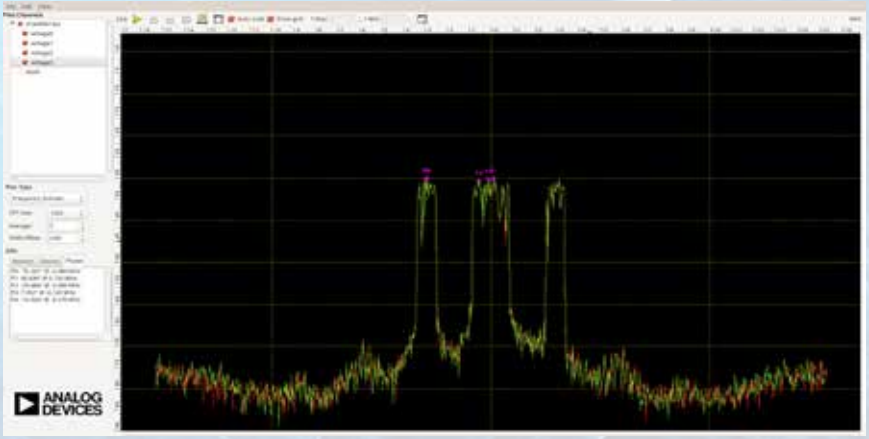
(e) OFDM Spectrum-Spectrum Analyser



(f) NC-OFDM Spectrum-Spectrum Analyser



g) OFDM Spectrum-ADI IIO Oscilloscope



h) NC-OFDM Spectrum- ADI IIO oscilloscope

results were compared with MATLAB simulation results. The implementation results are shown in the above picturs.

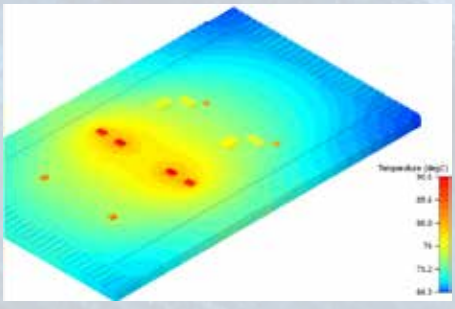
ELECTRONICS PACKAGING

Communication systems are being made up of different materials ranging from insulator to metals. The complex fragile structure of electronic systems with stringent environmental specification requires special attention to meet the expected reliability for which facilities will be set up. With experise developed over the last two decades in thermal areas,

Thermal Design of Remote Radio System

Thermal design of power amplifier board was carried out for remote radio head being developed by Indian Institute of Technology, Bombay. The board consists of driver stage and main stage power amplifier devices, FPGA, TRX and power supply modules. Total dissipation from the power amplifier board is about 200 Watts and the system is exposed to 40oC ambient condition.

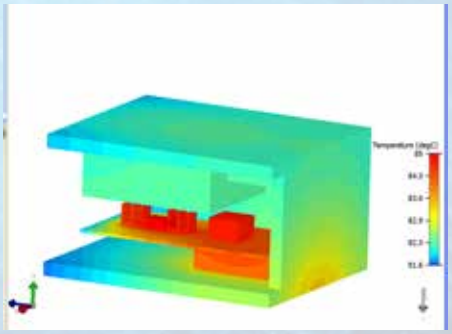
Thermal simulation of the system is completed using Computational Flow Dynamics software and designed appropriate heat sink for the system. Case temperature of each module and the air temperature in and around the hot spot components were predicted. Copper puck



is designed to increase the in-plane thermal conductance of the heat sink to obtain significant reduction in the case temperature. Thermal vias were incorporated on the PC board to increase the through plane thermal conductance of power amplifier to effectively conduct the heat from the device package to copper puck.

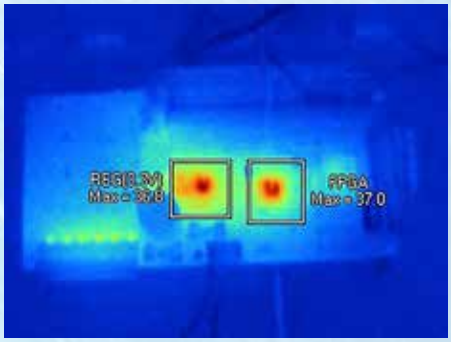
Design of Heatsink for Power MOSFET

SAMEER Chennai is developing RF communication system for strategic application. Power supply section consists of DC-DC convertor, power MOSFET, EMI filter etc. The total dissipation from the system is around 18 Watts and the MOSFET is the critical component. The system was qualified for 65oC working ambient. Suitable heatsink was designed for the MOSFET to spread the heat and fins were designed on the surfaces of the enclosure to dissipate heat from the enclosure to the ambient. Fin geometry and spacing between fins were optimized to maximize the heat transfer rate from the enclosure. Suitable surface finish was recommended to increase the radiation heat transfer from the enclosure. The thermal design optimization has considerably reduced the MOSFET case temperature.



Thermal mapping of power ICs

Thermal mapping of power ICs was done for a power control board for a private Industry. Non-contact temperature measurement of power ICs was carried out using infrared thermal imager and recommendations were given to reduce the case temperature.

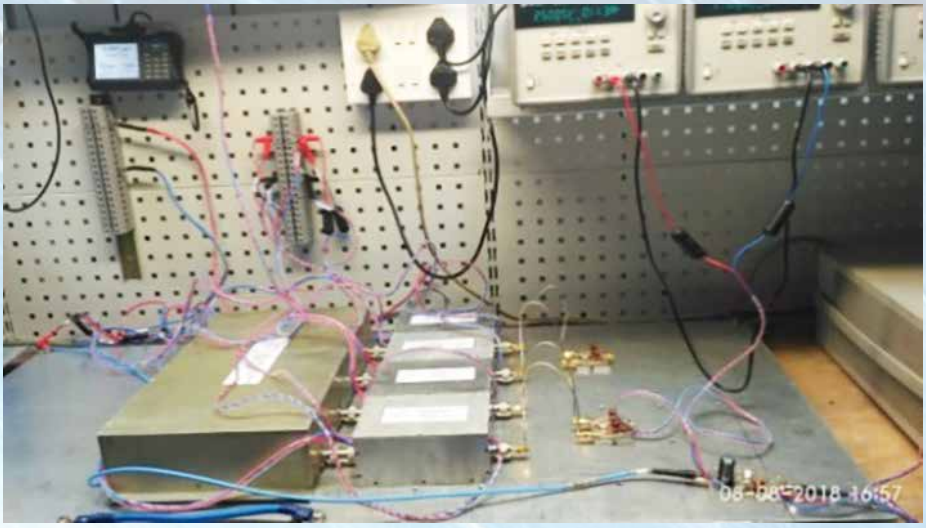


MEDICAL APPLICATIONS

SAMEER has done pioneering work in development of Linear accelerator technology for cancer therapy. Developments in the application of RF/Microwave and allied technology to the solution of medical problems, particularly the detection and treatment of cancer, have been very encouraging. Modern radiation therapy treatment planning deploys medical imaging along with microwave technology. Medical images are used to obtain information about internal body organs or the skeleton to determine a patient's physical state. An image may show damage to organs that cannot be externally visualized. Improved targeting through image guidance will be biggest breakthrough for Radiation therapy. It is inevitable that radiation therapy devices will have integral image guidance. Better imaging means enables to treat much smaller fields with much higher doses. Imaging ill tell us which part is already dead and which are still active or have metastatic potential. SAMEER continued its contribution for the development of various systems for medical applications.

Indigenous Magnetic Resonance Imaging system

National Mission Programme has been initiated on "Indigenous Development of Magnetic Resonance Imaging System" under Digital India Programme of Govt of India with an objective of to design, develop and conduct clinical trials of 1.5 Tesla MRI scanner by the Ministry of Electronics and Information Technology. SAMEER is the Nodal agency to execute this project with collaborating partners



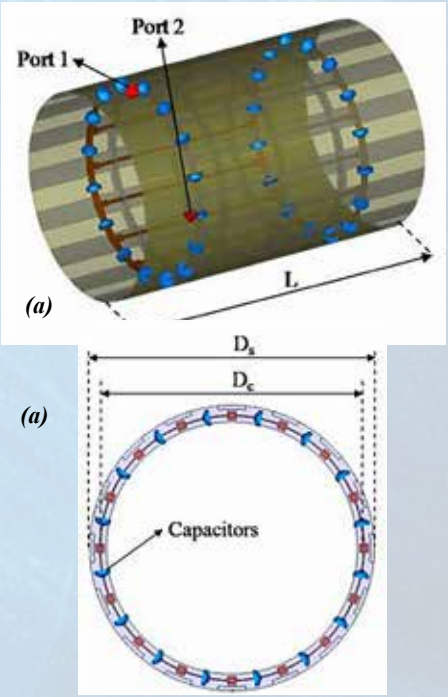
5 Kw Pulse Power Amplifier

Channel Spine Array Coil - Wired Structure

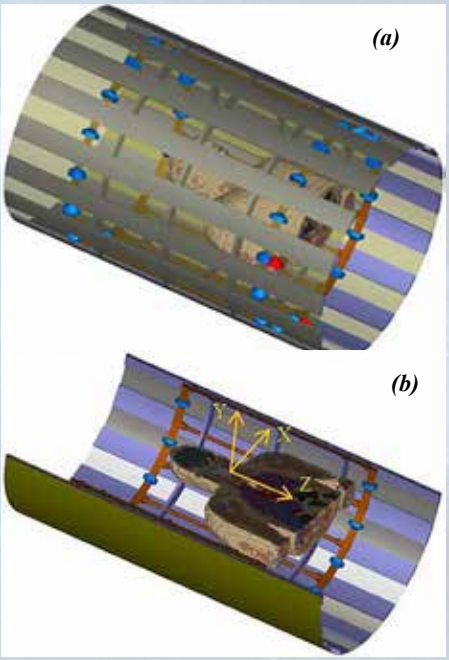
i.e. CDAC, IUAC & MIRC. Lot of progress has been made in designing various subsystems. Many MR Coils have been fabricated and tested such as tuning of Knee Birdcage coil, Head Bird Cage coils, Surface coils. GE Phantom loaded testing with Birdcage coils has been completed. Designing the Spine array coil supporting structure and Cardiac array coil supporting structure has been done. Testing (Tuning, Decoupling) of 10-Channel Neck-Spine Array Butterfly Quadrature Coil is accomplished. Development and packaging of two chains of 4.5 kW pulsed power RF system has been accomplished. The controls for coils and amplifier are on the verge of completion. A prototype for MRI patient table has been prepared and we are working on controls development for vertical motion. The first prototype of Monitoring and Diagnostic software is developed and the interface is frozen to be TCP/IP. Additionally, SAMEER has procured a 1.5 T refurbished GE magnet to test the in-house developed sub components like coils, amplifier with the magnet. The magnet is currently getting installed at SAMEER. Once the installation is complete testing of subcomponents with the magnet will be commenced.

Body Birdcage Coil using Cylindrical Rods

A high-pass Body Birdcage Coil using cylindrical rods is designed for a 1.5 T MRI system. The operating resonant mode is investigated for optimized magnetic field homogeneity. The shielded Body Birdcage Coil is energized in the circularly polarized feed configuration. The input ports of the Body Birdcage Coil are matched (S11 = S22 = -19.7 dB) and isolated (S21 = S12 = -26.4 dB) at 64.3 MHz . The same analysis has been extended for human model loaded Body Birdcage Coil. A slight shift in the resonant frequency from 64.3 MHz to 63.5 MHz is observed for unloaded and human model loaded Birdcage Coil. The B1+ field distributions of human model loaded and unloaded Body Birdcage Coils are analyzed for dominant mode.



Body Birdcage Coil using cylindrical rods (a) 3D view (a) Top view.



Body Birdcage Coil using cylindrical rods with human model (a) Full view (b) Sectional view.

6 MV Medical Linac-SID-DHARTH-IV

During the initial year of formation of SAMEER it has successfully developed 4 MeV Medical Linac (known as "Jeevan Jyoti"). The achievement was very well appreciated in medical and scientific community. Later on two more units were made to establish the technology after incorporating modification obtained from users after its two years of operation. Thereafter SAMEER has aggressively pursued the Medical Linear accelerator programme under National Jai Vigyan mission. In the first phase SAMEER has developed 2 6 MV Linac machine for cancer thereapy treatment which were installed at Cancer Institute of Chennai and Mahatma Gandhi Institute of Medical Sciences at Wardha. These machines have treated thousands of cancer patients by radiation exposure. In the second phase of the mission two more machines have been developed. One Linac Machine has been commissioned at Amravati Cancer Foundation, Amravati and after AERB clearance, patient treatment started in June 2017. The second machine has been installed at BKL Walawalkar Hospital, Dervan, Maharashtra. SAMEER continued to maintain existing Jai Vigyan Medical LINACs in working condition.

High Energy Linear Accelerator Technology for Medical and Other Applications

Technetium is one of the most widely used radioisotope in the nuclear medicine based diagnostic procedures world wise. The growing number of nuclear medicine centers in the country, the annual requirement of 99mTc is growing and the need for 99m Tc is rapidly increasing. At present, many hospitals in the country import 99Mo from abroad and elute 99mTc from it. Usually 99mTc is by product of reactors and efforts are pursued worldwide to look for linear accelerator based generation of 99mTc. SAMEER with its core expertise in linac systems has initiated research and development of 30 MeV, 8-10kW beam power Linear Accelerator for medical and other application with the funding from Ministry of Electronics & Information Technology (MeitY). The Phase-I of the project is under progress.

Multileaf Collimator (MLC) For Dual Energy LINAC System

A new, customized, small sized design of MLC for Dual Energy LINAC has been developed. The Multi-leaf collimator (MLC) is an important attachment to the LINAC. It is used to shape the LINAC beam to best match with the cancer tumour. SAMEER MLC has 80 movable leaves arranged in pairs, made of lead or tungsten, which can block fractions of the radiation beam. By moving and controlling a large number of narrow, closely abutting individual leaves, one can generate almost any desired field shape.

Some relevant features are :

- Use of linear motion guides &Tongue & Groove arrangement
- Single focused
- Multi-Threaded Spindles for high speed
- Auto Zero positioning system using homing scheme.
- Easy of servicing motor and leaf
- 0.1 mm accuracy in target position
- Precise beam delivery to reduce treatment margins
- Smart interlocks for protecting collision
- Use of lightweight materials for housing assembly.

Record & Verify System

The Record and Verify System is an Oncology Information System for facilitation of external beam radiotherapy workflow. We have developed a complete DICOM database for Treatment management, that serves the needs of radiotherapy starting from patient admission upto patient discharge, with facility for multi-fraction and multi-session treatment delivery. The development of interface with frontend systems namely Department Order Filler, Department Order Placer and Treatment Delivery Console are in progress. The treatment delivery console is developed and verification of the system performance using inhouse developed test benches emulating the role of Linac and MLC controllers vis-à-vis communication between the entities is in progress and testing using data intensive DYNAMIC type treatment are being carried out. A second database for archival of all the data generates during the RT workflow is under development.

MILLIMETER WAVE TECHNOLOGY

Millimeter Waves (MMW) offers several advantages compared to Microwaves. These are operating bandwidth higher spatial resolution, smaller size and lower probability of intercept or interference. These advantages are directly related to the reduction in wavelength at millimeter waves as frequency increases. Greater available bandwidth help in achieving higher resolution, significantly larger communication data capacity, higher speed and greater flexibility in design and operation. SAMEER has established millimeter wave design and development facility and has expertise in microwave and millimeter wave component developer over the past few years.

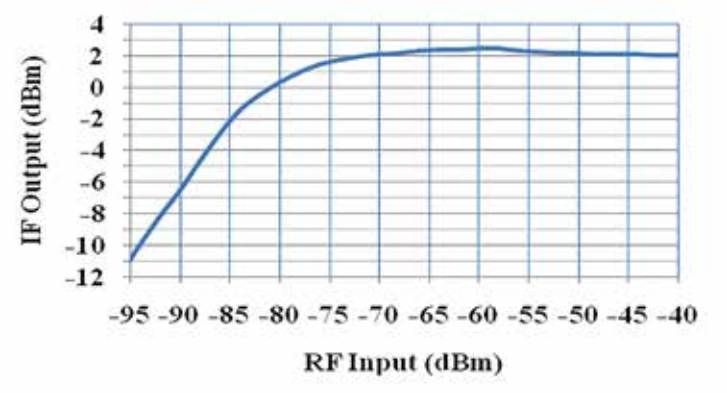
X-Band Transmitter & Receiver for on-board Data Link:

The aim of this project is the design, development, and delivery of 10 units of X-band transmitters and 10 units of receivers for on-board data link application. The data-Link system provides secured and anti-jam RF communication The transmitter modulates (BPSK) the incoming data and up-converts into X band signal with maximum output CW power of 20W. The output frequency is programmable in steps of 5MHz. The low noise receiver X-band receiver has a dynamic range of 55 dB with minimum detectable signal of -95 dBm. The super heterodyne receiver with automatic gain control down-converts the X-band signal to a 70 MHz IF signal. Two-stage down conversion has been adopted for better rejection of sidebands.

Detailed simulation of transmitter and receiver modules have been carried out to evaluate electrical performances such as noise figure (NF), 1dB compression point, spurious rejection of receiver and output power, spurious and harmonic rejection of transmitter. The simulations were also performed to check the system performances from -40 to +85degC. Thermal analysis of receiver has been performed with the association of SAMEER, Chennai and for the transmitter is under progress. Fabrication of mechanical housing and different types of PCBs (RF, IF and DC) have been carried out. Assem-

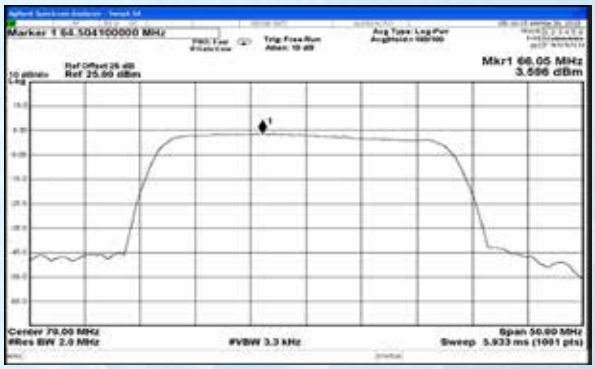
bled first prototype of the receiver and it's measured dynamic range is given below: The dynamic range is 55dB with minimum detectable signal (MDS) of -95dBm.

1st prototype of the X-band receiver.



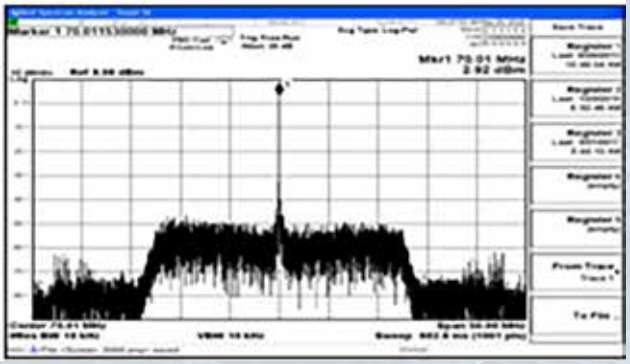
Dynamic range measurement result of X-band receiver.

The measured IF bandwidth of the receiver, which is 20MHz, as shown below.



Measured RF bandwidth of the receiver.

Spurious rejection at the IF output has been measured to be greater than 60 dB as shown below: The IF output power is within 2 ± 2 dBm.



The spurious rejection spectrum.

(1) Ka-band Telemetry Transmitter

The objective for this development is to simultaneously generate Ka-band signals in 4-channels. It has applications in an air-borne system. The transmitter consists of three sections, namely, the power supply section, the first stage up-converter and the second stage up-converter section. The power supply section operates with 28V DC and provides all necessary bias for the other sections. The first up-converter receives a 70MHz IF signal and converts it to an S-band signal. The second up- converter takes that S-band signal and converts it into a Ka-band signal and divides it into four ports through a pre-optimized 4x1 power divider. Co-axial cable based interconnectivity has been ensured.

4-channel transmitter.

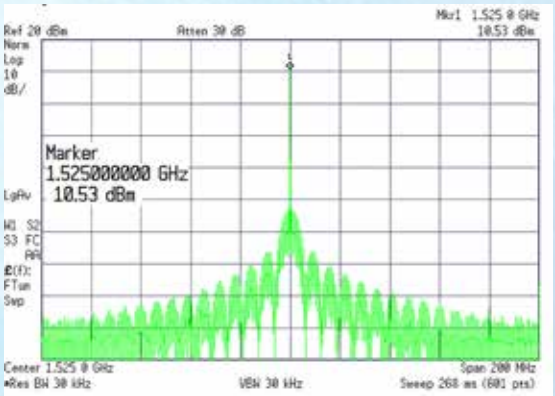
2-Channel W-band Coherent Transceiver Front-end:

The objective is to develop a W-band radar front-end system. It finds applications in the air-borne system.

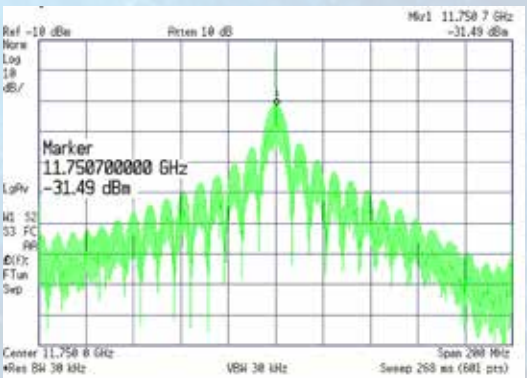
(a) Exciter module

An exciter module has been developed to generate low power signal at L-band and X-band signals. The exciter consists of a 100MHz master crystal oscillator, an L-band signal generation unit and an X-band signal generation unit. The L- and X-band units result in CW power considering the master oscillator as reference, the outputs of which are periodically chopped to produce pulsed outputs.

exciter module for W-band transceiver.

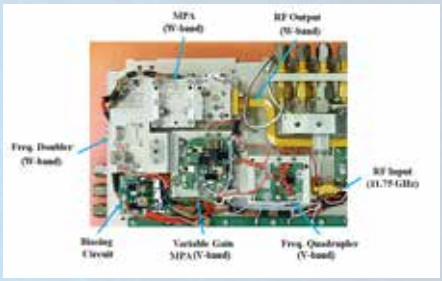


The measured output spectrum at L band (Above) and X-band (below).



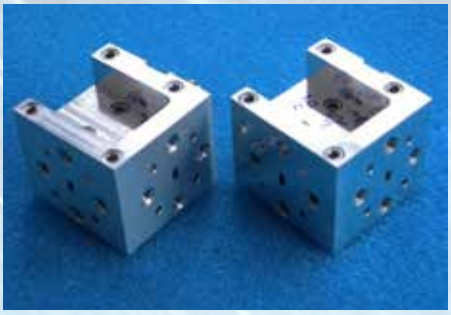
(b) Multiplier chain

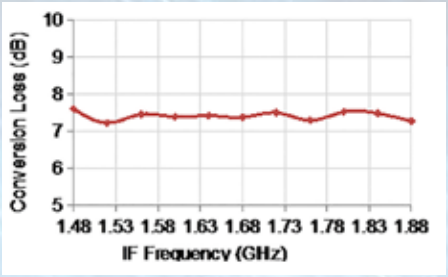
A cascaded frequency multiplier chain with output amplifier has been designed and developed considering the X-band exciter module as the input. It produces W-band output. The engineering prototype is shown in Fig. 13. This 12th order frequency multiplier provides a stable reference power for injection locking of a W-band oscillators in the transmitter section. It generates W-band output power in excess of 11dBm over the 250MHz bandwidth. The spurious rejection is better than 50dB.



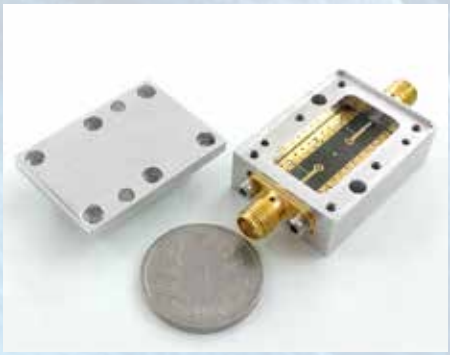
(c) W-band Mixer

The RF Mixer required at the front end of the receiver to generate an IF (1.6 GHz) from the incoming W-band signal. It is realized on a 5-mil microstrip substrates using mixer diode. A microstrip line based low-pass filter (LPF) is integrated at the IF output. Realization of the thin lines of the LPF and the narrow gaps for mounting the diode are the critical parts of the development. The measured conversion loss is lower than 8dB, which is another critical requirement of the development.

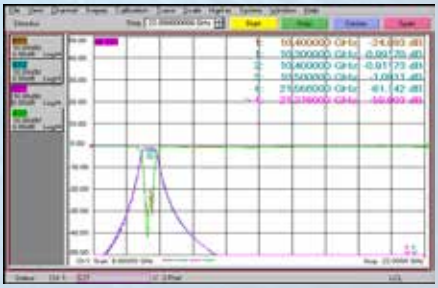




Measured conversion loss of the mixer.

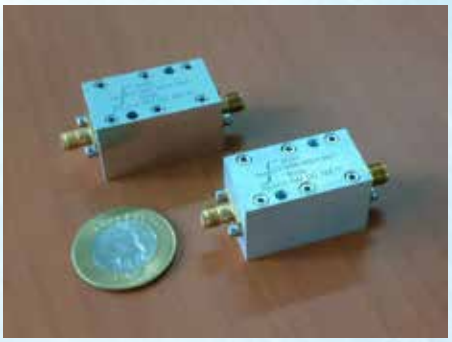


Developed prototype of the X-band filter (above), and its measured S-parameters (below).



(d) Narrow Pass-band Filter at X-band

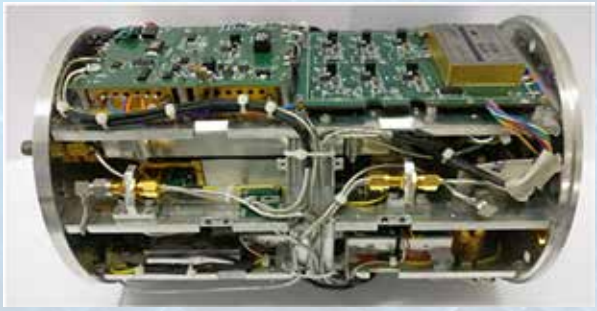
A very narrow band (2%) filter has been designed and developed at X-band. The design utilizes six co-axial cavity resonators which are coupled to each other by inductive windows. A critical achievement if this development is 2% pass-band with insertion loss lower than 1dB in the pass band. Rejection higher than 55dB at 300MHz offset from the centre frequency was the other significant success of this design and development.



Narrow band pass filter developed at X-band (left) and its measured S-parameters (right).

3-Channel W-band Coherent Transceiver Front-end :

The objective is to develop a W-band radar front-end system for air-borne system. One transceiver unit has been developed. The transmitter section generates pulsed output with a peak power of 50W. The receiver section down-converts the W band frequency to IF level at 75 MHz using two stages of down-conversion. The receiver has a noise figure (NF) of 10 dB and gain of 65 dB in each of the channels. The phase and amplitude balance among the channels can be controlled digitally. The receiver sensitivity is -98dBm with a dynamic range of 60 dB.



The 3-channel W-band coherent RF transceiver front-end unit.

Data link RF transceiver at X-band :

The objective is to develop X-band transceiver for on-board application. A unit has been developed and experimented. The transmitter section can deliver maximum CW power of 10W at X-band. The center frequency can be configured in 40 different frequencies within a bandwidth of 200 MHz. The receiver section down converts the X-band frequency to IF frequency at 70 MHz using two stages of down conversion. The receiver section has a dynamic range of 60 dB with constant output power of +4 dBm along with a low noise figure of 3 dB.

The developed X-band RF transceiver

A compact band pass filter with about 4% bandwidth has been designed and developed at X-band as an indispensible part. Microstrip line fed comb-line cavity filter configuration has been adopted. Rejection as high as 40dB at 1GHz offset has been achieved with an insertion loss lower than 1dB at the pass-band. The fabricated prototype and its measured performance are shown below.

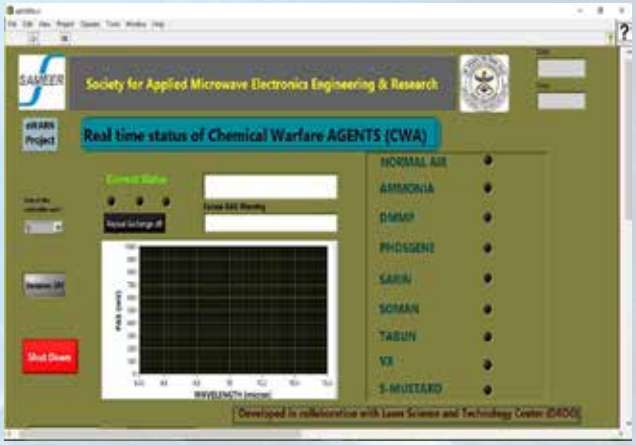
PHOTONICS TECHNOLOGY

The photonics programme was initiated in 1991. The main objective was to create a technological based in the country to fabricate planar light wave circuits (also called integrated optic devices) and grow quantum well structures. It was a challenging taks as no infrastructure existed at SAMEER to undertake photonics work at that time, the resources were limited and the manpower was new with very little exposure to this technology. However, in short span of five year, the technology base a created and few devices demonstrated. A number of project were undertaken to perfect the technology and deliver photonic components like power splitter, modulator, switch etc. A facility for Photonics device packaging was also established during 2002 to 2007 to serve the photonic device fabrication in India. SAMEER is one of the few R&D laboratories in the Country where such facilities are available.
Design & development of Trace multigas sensor system for the detection of Toxic chemicals

A trace multigas sensor system has been designed and developed, which can detect harmful chemical gases from the atmosphere at sub ppm level. This instrument uses a Tunable InfraRed Laser source, which absorbs the gas molecule inside a Gas cell. The detection is performed using MEMs device and signals were acquired with high speed electronics using Wavelength Modulation technique. The control software was designed and created to suit the user agency.

Developed Instrument

The instrument was tested and calibrated at specialized DRDO lab at Gwalior for almost all Chemical Warfare Agents (CWA). The detection limits were achieved to suit requirements for Security agenizes. The instrument was further integrated at the R&D (Engg) Pune site for real time measurements.



GUI of the sensor system

Achievement

A Trace Multigas sensor system was designed, developed, tested, calibrated at DRDO lab and successfully integrated at User's site before handing over to LASTEC, Delhi.

Development of a High-Speed, Compact OCT Imaging System

A proposal titled "Development of an Optical Coherence Tomography System and to increase the Data Acquisition Speed by placing FPGA based DAQ" has

been evolved by SAMEER along with VIT, Vellore and submitted to DST for approval.

OCT is a non-invasive imaging technique that enables visualization of tissue or other objects with resolution similar to that of some microscopes. There has been an increasing interest in OCT because it provides much greater resolution than other imaging techniques such as magnetic resonance imaging (MRI) or positron emission tomography (PET). OCT uses a low-power light source and the corresponding light reflections to create images, which is a method similar to the ultrasound that uses light instead of sound.

In the conventional system configuration, two devices are required – a digitizer for data acquisition and a D/A board to control the scanner. Additional cabling to synchronize the devices is another complexity. With the proposed, new platform, the acquisition and control I/O could be combined in a single module. This helps in synchronizing both the functions using the FPGA, so it is easier to build, cable, and configure the system. The absence of external wiring makes the system, very compact and portable. This portability opens the product up to new applications in a variety of spaces.With the conventional system, we are also limited to slower image display rates because of the computationally intensive processing required to create the image. Significant improvement in video display rates of more than 40 frames per second with the new FPGA-based system configuration, would facilitate several benefits like real-time measurement signal processing, which improve the display performance by eliminating the lag between measurement and display.

Design and development of MEMS based detectors and their real time testing as IR Laser based sensor system for environmental monitoring

The scope of this project is to design and develop MEMS based Gas cells to generate Photo-acoustic and Photo-thermal signals and detect them through Lock-in technique for sensing purpose.

The photo acoustic and photo thermal techniques will be compared and chosen for application specific sensitivity maximization. A MEMS platform will be demonstrated for two different applications. One measuring IR temperature for soil measurements and another acoustic signal through MEMS for detecting trace gases under sub ppm.

The project is submitted to Nano-Mission Program of DST New Delhi and waiting for final approval.

RF AND MICRO-WAVE SYSTEM

SAMEER has been working in the field of high power RF and microwave technology for more than three decades. Thus, one of the core competencies of SAMEER is in the field of designing high power RF and microwave generators, components and systems. Several projects in this field have been successfully executed by SAMEER for government departments and industries. SAMEER has now full-fledged expertise, infrastructure and facilities to design, develop and characterize/test high power RF and microwave systems.

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. In an Electromagnetic (EM)

First porotype of EM Disinfestation system

EM Disinfestation System

Disinfestation system, food grains are exposed to Electric field radiation in a closed system. It results in rapid killing of all the pests and larvae including the egg stage infestation. Because of this unique property of in-depth penetration of EM Fields in the core of food grain, the infestation is eliminated from the core and prevented from re-emerging.

Some relevant features are:

- Increase the shelf life of food grains upto 18-24 months.
- Retains nutrients
- Ensures 100% mortality of pests without use of hazardous chemicals.
- Capability of processing up to 5kg grain packed in bags using frequency controlling.
- Process time is adjustable as per load.
- Automatic impedance tuning with user friendly controls.
- Product Temperature Monitoring through Suitable Sensor.
- Maximum Process Temperature from 40 to 60 deg. C for disinfestation of grain.
- Digital Display of RF & temperature.

Application of Frontier EM & Electronics based TechnologY (S.A.F.E2.T.Y.):

MeitY has sanctioned a 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 Converised material handling system with RFID based tracking mechanism, 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, a centralized warehouse management. SAMEER is the nodal agency for the S.A.F.E2.T.Y project and SAMEER is responsible for design, development, system integration, testing , co-ordination with other participating agencies and deliverables from the project. During last year major technologies proposed for the project have been developed . A table top moisture meter system has been successfully developed, tested, validated and calibrated at IIFPT Thanjavur for moong dal, rice and wheat.

Conveyer system installed at FCI

Online moisture meter is successfully developed and is currently getting calibrated at IIFPT Thanjavur for various food grains. A conveyer system has been fabricated and is currently shipped to IIFPT Thanjavur for integrated testing with other sub systems like, weighing, online moisture meter. The entire conveyer system along with its sub modules was installed at FCI, Borivali and was tested on few gunny bags. SAMEER is also working on tagging each gunny bag with RF ID for unique identification and saving of the data.

Table top Moisture meter

Online moisture meter mounted on the conveyer

Microwave tea processing systems

Two Microwave tea processing systems, each having 10 kW MW power output, were developed by RFMS Division, SAMEER. One system was developed for Gauhati University and was installed at Bhergaon Tea Estate, Bhergaon, Assam. Another system was developed for Tezpur University and was installed at Chandraprabha Tea Factory, Golaghat, Assam. These projects were funded by Ministry of Electronics and Information Technology (MeitY).

Coal Slope Monitoring Radar (CSMR)

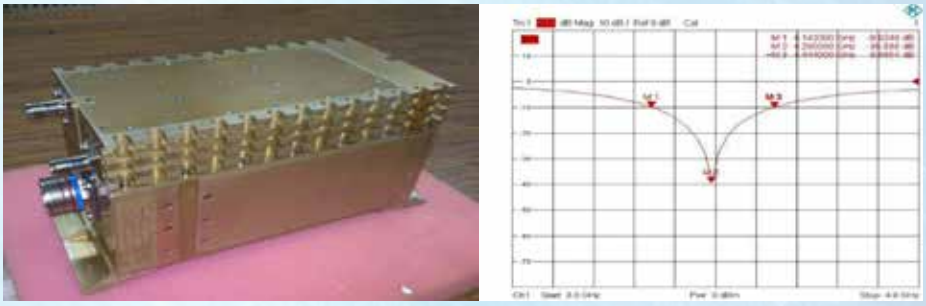
With the expertise developed by undertaking core R&D activity of Synthetic Aperture Radar (SAR), SAMEER has, with the funding of Coal Ministry, undertaken an Indigenous development to design ground based FMCW-SAR imaging radar to predict failures and slope instabilities in open cast (coal) mines by radar interferometry techniques. This recently initiated the design activity and the GB- SAR system will be a 1st of its kind Early Warning Radar to monitor instabilities of dump slopes in the country. The instrument is being developed for the Central Mine Planning and Design Institute (CMPDI), Ranchi, a subsidiary of Coal India Limited, a Maha-Ratna Company and the proposed site for installation and evaluation is National Coal Fields (NCL), Singrauli, M.P.

STRATEGIC APPLICATIONS

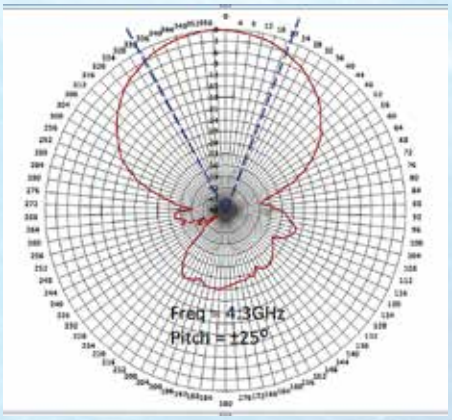
Core strength of SAMEER has been RF/Microwave engineering. This has helped to undertake and execute a number of strategic projects. These project activities have helped SAMEER to build up expertise in one hand and also to meet the requirement of strategic departments. Some of the activities undertaken are briefly reported below.

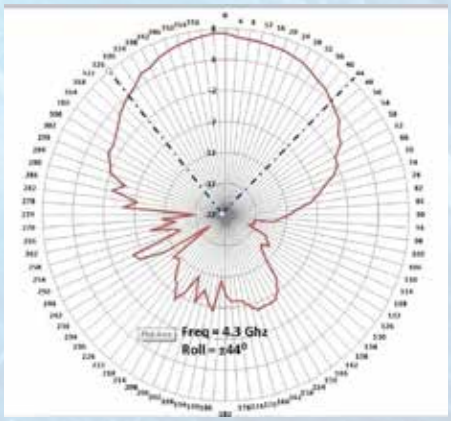
Indigenous development of Radar Altimeter for Rustom II UAV

Rustom-II is a Medium Altitude Long Endurance Unmanned Air Vehicle (MALE UAV) used for reconnaissance, surveillance, Artillery fire correction and Battlefield Damage Assessment. This is a FMCW System and has the capability of detection and estimation of altitude, i.e. height over ground level for a pitch and roll of ±25o and ±45o of the aircraft (UAV) specifications. The radar altimeter (R2RAM) is a critical system for the new generation of UAV's while automatic take off and landing.



Pitch and Roll Pattern of R2RAM Antenna





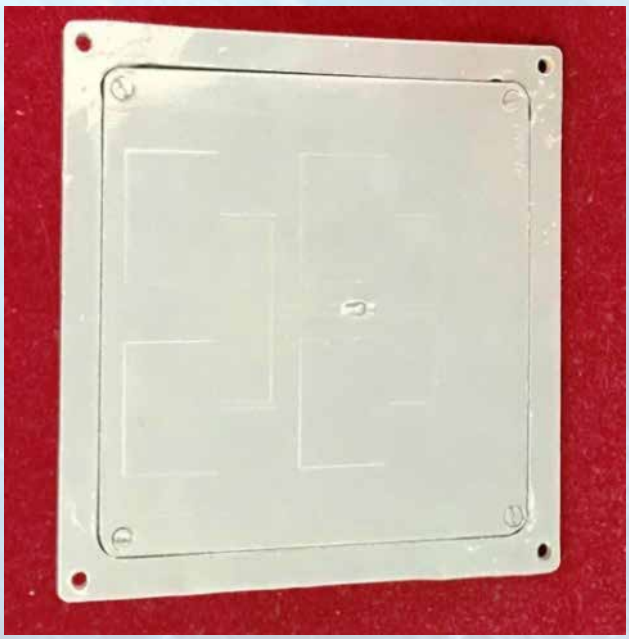
Proximity Sensor Systems

The **'Proximity Sensor Systems'** enables the measurement of altitude above the ground level. The proximity sensor will be integrated with the vehicle and is required to measure the altitude of the vehicle above the ground level irrespective of the fall angle. SAMEER has developed in 3 type variants of the Proximity Sensor. This is a low-cost, capable for operation in fast-moving platforms and having ease of mass production. SAMEER has also developed a Simulator to test and evaluate the Proximity Sensor in the laboratory as well as in the field. The Simulator also having the feature of setting the Fuze timer and the Height of Burst (HoB) of the Proximity Sensor before integration.

Proximity Sensor

Radar Level Probe

The Radar Level Probe (RLP) for hazardous liquid Level Measurement in tank is an indigenously developed sensor system for user agency and works on the FMCW radar principle for measuring the range (level). RLP is designed to function in harsh industrial environment and can be withstand temperature in excess of 200 degrees Celsius. The RLP hardware has a full digital RF transceiver and Spartan-6 FPGA device from Xilinx stable is used for the programmable logic and DSP. The level information is displayed as reading on LCD is expressed in standard 4-20 mAmp as output data for the operator. The RS-422 RX lines are available on external connector and can be run by specified cable to the control room for viewing the liquid level reading in the control room.



Antenna for R2RAM

SERVICES

ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

EMI can be a threat to individual as well as public safety as it can cause disruption to strategic infrastructure such as hospital, transportation, airports/military air base, etc. SAMEER with its expertise in EMI/EMC, continues to provide essential EMC compliance testing services to the industry in India. Electronic products from various manufacturing sectors including Industrial, Scientific and Medical Electronics products, control, communication, automotive and IT industrial produces have been tested for EMC compliance as per International standards. SAMEER also pursues Research in the field of Electromagnetic Interference and Compatibility and undertakes Core R&D programs in this area/. Research activities for development of EMC antenna sensors, High E field Generators and NEMP simulators have also been undertaken.

SAMEER has provided Electromagnetic Compatibility test and calibration services to large number of Indian electronic industries in compliance with ISO/IEC 17025:2005. SAMEER, Chennai continued to focus on EMC

testing, design consultancy, calibration and training activities with continual improvement. Efforts were made to automate a few testing and calibration setups for more consistent and time efficient test procedures. SAMEER continued with the accreditations of testing and calibration activities and also put efforts to include more tests in the scope of accreditations. Any challenge in meeting the EMC compliance was taken up by the design consultancy team to offer cost effective solutions in a time bound manner. Products having application in Space, Defense, transport and process and IT/consumer industry have been tested for its EMI compliance as per their respective international EMC standards such as IEC/CISPR, MIL-STD-461 E/F. Other than regular EMI / EMC testing, assignments like measurement of Shielding Effectiveness (S.E.) of cabin door for Naval ship, shielded enclosure built for the purpose of housing the indigenous MRI machine being developed by Technology Innovation Division were also undertaken. The division has also undertaken measurement of Radiated Emission of train for various projects like (i) Mumbai Monorail Phase - II (ii) Air conditioned suburban train manufactured by M/s. BHEL Bangalore and (iii) Kolkata Metro rail (all in moving condition).

EMI-projects/activities completed and ongoing

More than 792 testing and 185 calibration assignments were carried out and 426 industries were benefited.

Radiated emission testing of Kolkata Metro rail

NABL Desktop surveillance audit

As part of NABL accreditation, provided information as per the documents to maintain the accreditation status of the Division as an accredited Conformity Assessment Body(CAB) and to comply with the requirements of (CAB) ISO/IEC 17025: 2005 or ISO: 15189: 2012 or ISO/IEC 17043:2010 or ISO Guide 34:2009 (whichever is relevant) and NABL policies. The information provided was considered and evaluated at NABL secretariat to verify the continued compliance for maintaining accreditation. NABL has verified the continued compliance by conducting desktop surveillance for testing (Civilian and Military) and calibration facilities.

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 18 number of different external customers (EMI/EMC and others test-measurements). Some of the significant measurement services are mentioned below

Surge test carried out for a 220V/800A automatic float cum boost charger which could not be accommodated in designated laboratory set-up. The test set up was customized for this product. End user of the product is NTPC.

Fail safe validation test was carried out for LED signal lighting unit, which will be used in railway signaling. Basis of the validation was verification of safety integrity level 4 (SIL4) through mean time between failure (MTBF) calculation.

Customized surge test-up for the 220V/800A automatic float cum boost charger not accommodative to designated test set up.

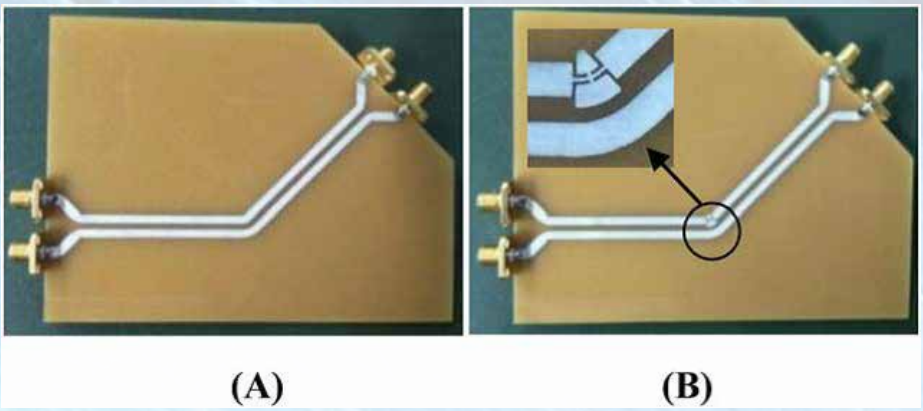
Design Consultancy

Design consultancy for radiated emission as per RE-102 for the power supply Unit was carried out for User agency. Better shielding techniques were offered, including cable shielding.

Conducted Proficiency Testing (PT) of inter laboratory comparison program for the year of 2017-2018 to identify the technical competence level of the test laboratories. The test laboratories such as M/s. Electronics & Quality Development Centre (EQDC), Gujarat, M/s. Honeywell, Bangalore, M/s. Wipro Ltd, Bangalore, M/s. Tata Power Sed, Bangalore, and M/s. HCL, Chennai have participated in the programme. This is done by circulating an artifact to the participating testing laboratories for the evaluation of radiated, conducted, harmonics, and flicker emission. Comb generator and harmonics & flicker generator, developed by York EMC, UK was used as the artifact for the proficiency testing programme. The performance of laboratories participated in ILC, was evaluated using Z score calculation.

Mitigation of common mode noise in bent differential transmission line using curved PBG unit cell.

A curved photonic band gap (PBG) unit cell loaded bent differential line is realized to suppress the differential-to common mode conversion noise. The PBG unit cell,loaded at the bend is designed and optimized to provide the required delay characteristic on the inner transmission line of a differential line. An LC equivalent circuit of curved PBG unit cell is fab-

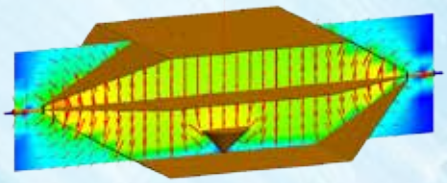


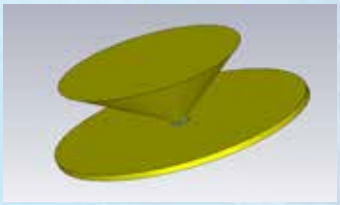
Fabricated differential lines (A) 45° bent (B) PBG loaded 45° bent.

ricated and realized the constituent lumped element parameters are calculated. The realized PBG loaded bent differential line exhibits a measured mode conversion noise below 220 dB from DC to 6 GHz demonstrating a common mode noise suppression of around 9 dB.

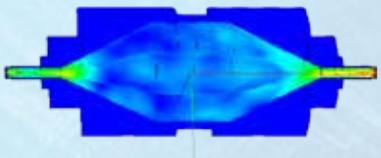
Modeling & simulation analysis of fast-rise time (nsec) sensor for Electromagnetic Pulse (EMP) study

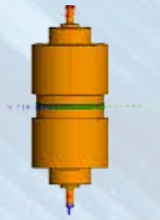
EMP Sensor CAD model is developed to study the interaction of the same with the nsec electromagnetic pulses. The model is developed using CST Studio Suite and the parameters, S11, Surface Currents, VSWR and Radiation Patterns are observed. Further, the sensor model is placed inside the TEM cell to investigate the highly-intensified Electric Field. Pulse analysis is also carried out to evaluate the sensor performance.

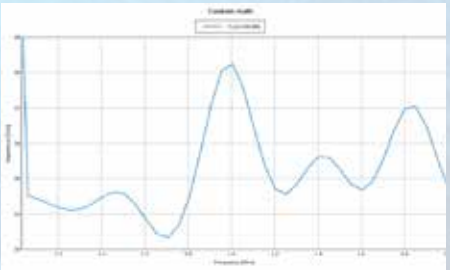


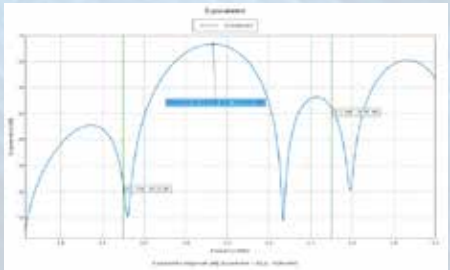


CAD modeling & simulation analysis for estimation of Shielding Effectiveness of Conductive fabrics as per ASTM D4935 standard









The study on Electromagnetic Shielding Effectiveness of conductive polymers / fabrics is carried out as per the requirements of ASTM D4935 standard. CAD models are developed using Altair HyperWorks FEKO Simulation tool. The S11, VSWR and Surface currents are evaluated to characterize the cell. Impedance analysis is carried out to validate the cell across the cross section. Further, the practical model is to be designed & developed to assess its performance.

Design and Development of Line Impedance Stabilization Network (LISN) as per CISPR 16 for EMC Measurements

Designed 5µH LISN as per CISPR 16 to provide stabilized impedance of 50 ohm over the frequency range 150 kHz to 100 MHz. LISN was designed using PSPICE tool. Done theoretical calculations on proposed schematic and same were verified with simulation results obtained in PSPICE. Conduction emissions from single phase DC motor using designed LISN was measured for both phase and neutral lines. Designed 5µH LISN will be utilized for measuring conducted emissions as per CISPR 25 for automotive applications.

Design and Development of Line Impedance Stabilization Network (LISN) as per CISPR 16 for EMC Measurements

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LISN Prototype Designs

Design and Development of Solar Radiometer and IOT based Solar Auto-Tracking system for radiometric applications

Solar radiation measurements are important for a wide range of applications in engineering, agriculture, health sector and in many fields of natural sciences. In order to measure the direct component of solar radiation, the sensor head must have very narrow Field of View of the sun.

The developed tracking system enables measurement of solar radiation in the precisely defined Field of View (< 1 degrees) with dual axis for Azimuth (0-360 deg) and Elevation (0-90 deg) for whole sky angular scanning. Stepper motors were used for controlled dual axis rotations. Optical encoder is used to maintain precise positioning. In automatic mode, a 'raindrop sensor' detects the precipitation and parks the instrument to protect the optics. The developed tracking system can be controlled remotely using a web based application.

Developed system will be interfaced to solar radiometers 'an instrument to measure direct solar radiation and to estimate atmospheric aerosols over the observation location'. The developed system not only avoids manual collection of readings in the hot sun, but also improves accuracy and temporal resolution of the data.

Radiometer Mechanical Optical housing

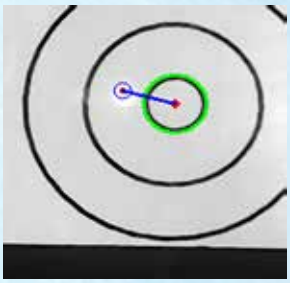
Radiometer Electronics

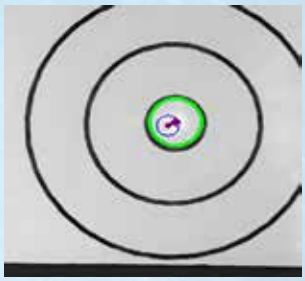
Auto Tracker Assembled unit

IOT feature of Auto Tracking unit

Design and Developed Image Based Pointing Error Detection/correction System for Hand Held and Auto-Tracking Radiometers

An image processing approach to minimize this pointing error in the Hand Held/Auto-tracking radiometers is attempted for the first time. The technique combines image processing and selective averaging of sampled readings. The proposed technique is capable of accounting for the pointing error in radiometers especially in a moving ship on rough seas. Customized Image processing algorithms were developed using Open CV Image processing tool and are applied onthe images captured by the system to find out the off-pointing of the sun-disc from the exact center on cross hair in terms of pixels.



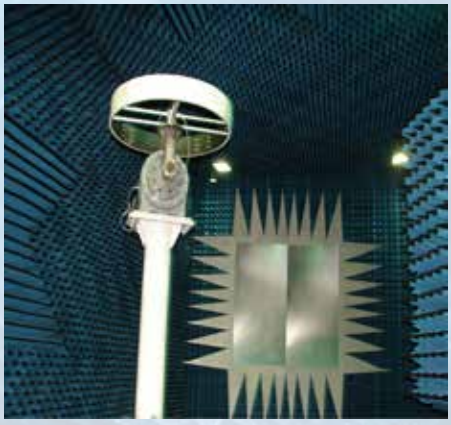


After correction

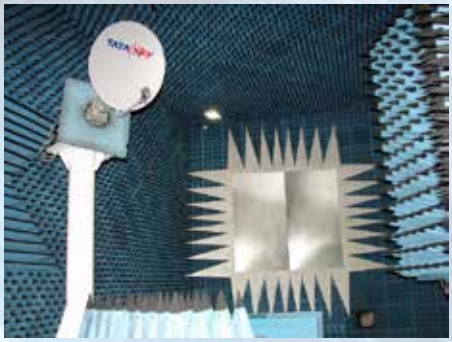
Facilities

COMPACT ANTENNA TEST RANGE (CATR) FACILITY

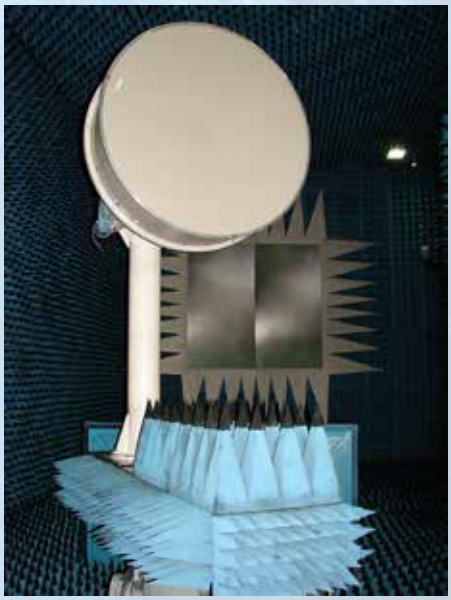
In a Compact Antenna Test Range (CATR), high gain microwave antenna radiation performance can be evaluated in a limited indoor space which is significantly lower compared to its open space far field range requirement. The CATR is a unique facility available for characterization of various antennas and radomes over the frequency range of 1-110GHz. It is also equipped for scattering performance evaluation in the frequency range of 1GHz-40GHz. The facility is being utilized by private industries and Govt. agencies for performance evaluation antennas and radomes for different military and civilian applications. CATR facility has been availed by 20 different users in the last financial year.



Photograph of the azimuth measurement set-up during radiation parameter measurement of the multiband wrap around antenna.



The radiation pattern measurement set-up of a DTH antenna.



Photograph of the measurement set-up during radiation performance evaluation of a microwave communication antenna.

RS105,TRANSIENT ELECTRO-MAGNETIC 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.

EMP PULSED CURRENT INJECTION (PCI) TEST SYSTEM ACCORDING TO MIL-STD-188-125/1&2:

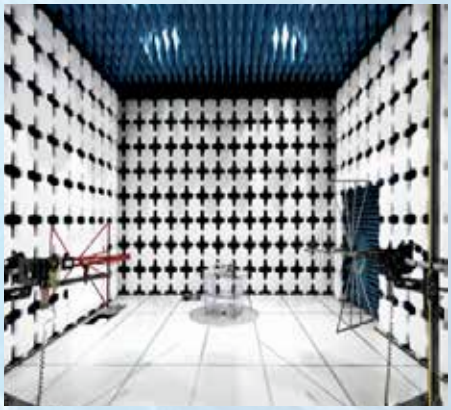
PCI is test method for measuring the performance of a Point of Entry (POE) protective device on a penetrating conductor. A HEMP/EMP threat-relatable transient is injected on the penetrating conductor at a point outside the electromagnetic barrier, and the residual internal transient stress is measured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

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: EMI/EMC MODELING AND COMPUTATIONAL LAB

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.

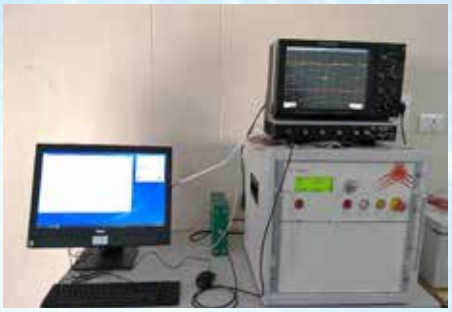


ESTABLISHMENT OF SPECIALIZED TEST FACILITIES

For the establishment of highly specialized facilities viz., Outdoor Nuclear Electromagnetic Pulse (NEMP) immunity test system as per MIL STD 461E/F, RS105 for large objects, HEMP 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, 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 and Two scientists were deputed to carry out Factory Acceptance Test (FAT) for Electromagnetic Pulse (EMP) immunity test system as per MIL STD 461E/F, RS105 for large objects.

Site acceptance testing (SAT) for PCI and UWB test systems were successfully completed at SAMEER CE3 Visakhapatnam Campus during 22-30 November 2017. Scientists stationed at SAMEER CE3 Visakhapatnam were given hands-on training on both UWB and PCI systems installation & Operation by M/s. Montena Technology SA, Switzerland.

Outdoor Nuclear Electromagnetic Pulse (NEMP) immunity test system Antenna and Generator as per MIL STD 461E/F, RS105 Installed at the Site.

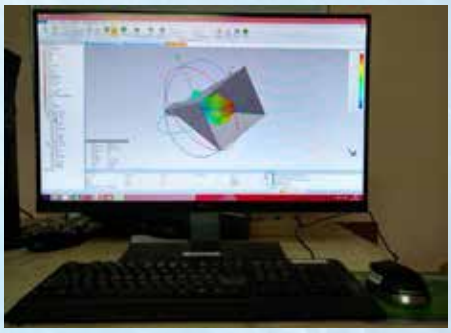


HEMP Pulse Current Injection (PCI) Test System As per MIL-STD-188-125/1&2 Installed at Site

Ultra Wide Band (UWB) Test system Antenna, Generator and Measurement System Installed at Site

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.



Mechanical engineering facility

The objective of this facility is to provide Mechanical design of the components and system hardware, Provide fabrication and assembly support to the different core and sponsored projects of the centre, System assembly and its simulation study for complying mechanical stability against environmental hazards such as vibration, shock etc and device new methods to meet fabrication and assembly challenges.

This facility 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. This facility has contributed some innovative mechanical design of system & sub-systems, and fabricated it in-house under different projects, which are as follows.

Structural design of W-band three channel transceiver system (ø168mm x 236mm long) has been optimized using commercially available structural analysis software, ANSYS workbench (R15.0). Analysis & optimized the structure as per the "QT" specifications of random vibration in all the three axes. The optimized results of directional deformation, equivalent stress and directional acceleration in longitudinal axis are shown in the following figures. Finally, all the parts of the W-band three channel transceiver have fabricated.

The typical fabrication process has been devised for realizing a wrap around antenna with thick radome (ø1022mm, thickness 10mm). It has been realized by means of 4-quadrants, which were suitably bent to form the conformal antenna. The difficulties in this are due to the bending of the structure along with its thick radome and retaining its curved shape. For this, initially the undercut has been generated at the two opposite edges of a 25 mm thick dielectric between which a thick aluminum

The fabricated four quadrant (left) and the complete conformal antenna.

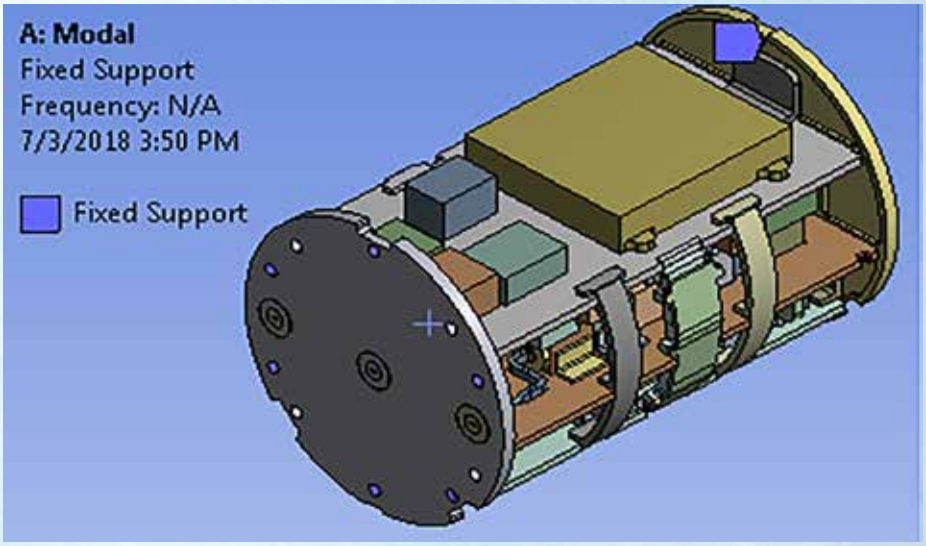
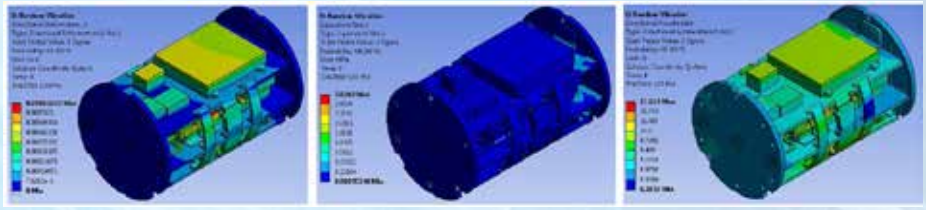
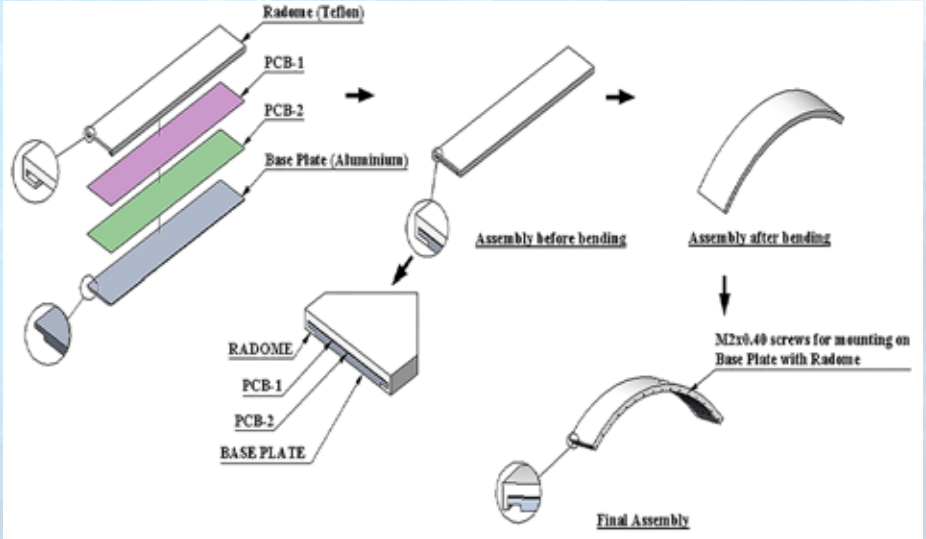


plate is inserted laterally. Finally, the whole structure was bent to the desired shape by which the curved shape of the dielectric is retained. A mounting structure is also fabricated for holding the four quadrants of conformal antenna and the overall antenna has been assembled.



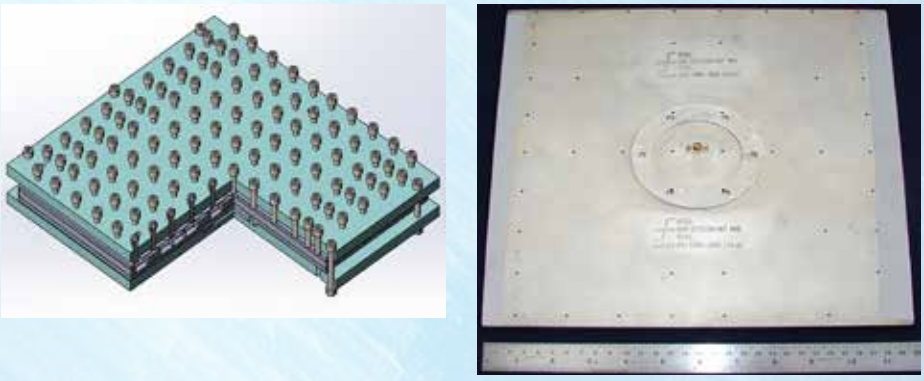


The Development process of the conformal antenna.

A slotted waveguide array antenna (298mm x 298mm x 18.6mm) with corporate feed has been designed from mechanical aspects. It is realized using multiple layers stacked one-a-top- another. Suitable fixtures for proper execution of flawless in-house fabrication are also developed. The different layers of the antenna are shown below :

Different parts of the fabricated antenna. From left: top part (rear side), middle part (rear side), middle part (top side), and bottom part (rear side).

One special fixture has been designed for joining all three main parts of the antenna. They have been joined using appropriate amount of silver paste between any two mating faces. The assembly was put on the fixture to generate moderate downward pressure between the parts. Finally, the fixture with antenna assembly was thermally cured at 120°C. The developed prototype is shown.



Different parts of the antenna assembled in a specially deviced fixture for thermal curing (left) and the developed antenna (right).

EVENTS/CONFERENCES/SEMINARS/ WORKSHOPS

Universal Moisture meter and two Microwave Tea Drying systems were launched at Advantage Assam Summit held on 3rd& 4thFebruary 2018 by Ravi Shankar Prasad Honorable Union Minister of Electronics and Information Technology.

A One-day workshop on 'EMC Standards and Measurements' was organized on 6th October, 2017. More than 100 participants attended the Workshop. Sanjay Baisakhiya, Scientist E delivered a lecture on Introduction to Electromagnetics Interference and Compatibility at EMC Workshop held at SAMEER, Chennai on 6th October 2017.G. Mahesh, Scientist-E delivered a lecture on Civilian EMI / EMC standards and Civilian EMI / EMC Measurements at EMC Workshop held at SAMEER, Chennai on 6th October 2017. G. Vincent Raj, Scientist D delivered a lecture on MIL EMC Standards and Measurements at EMC Workshop held at SAMEER, Chennai on 6th October 2017

Organized a one-day Training / workshop on "EMI/EMC testing and calibration of corresponding parameters" in respect of CISPR / IEC standards on 4th Jan 2018.

Sanjay Baisakhiya and G. Mahesh, Scientist-E delivered a lecture on Introduction to EMI and EMC Design /EMC and Civilian EMI / EMC standards, Measurements and EMC case Studies at one day EMC Workshop held at Maker Village, Kochi on 27th Feb 2018

A one day workshop on "Microwave Applications: Trends and Challenges" was held at SAMEER Kolkata Centre on 4th Nov, 2017. This was organized in association with IEEE AP/MTT Chapter of Kolkata section.

PARTICIPATION BY SAMEER

S. Vijayakumari CEM, Chennai attended a training programme on "Integrated Scientific Project Management for Women Scientists/ Technologists" at Centre for Organization Development, Hyderabad from 29.01.2018 to 02.02.2018.

Penilop P.S attended the one day MATLAB EXPO 2017 at Bangalore on 20th April 2017.

Penilop P.S attended one day seminar on "Embedded design with PetaLinux Tools at Bangalore on 31st August 2017.

Penilop P.S organized and attended one day seminar on Vivado Embedded Design and Zynq7000 SoC at SAMEER CEM, Chennai.

Penilop P.S Organized and attended a half day technical demo on Zed Board with AD9361 Interface at SAMEER CEM, Chennai.

Penilop P.S attended training programme on Integrated Scientific Project Management for Women scientists/Technologists at Centre for Organization Development, Hyderabad from January 29-February 2nd, 2018.

G Abdul Latheef, Sc F & P Chitra Sc D attended one day workshop on "EMC Standards & Measurements" organized by SAMEER-CEM on 6th October 2017 at Chennai.

K Naresh Kumar, Sc C attended seminar on 'Demystifying Indian EMC Regulation 2018' organized by Rohde & Schwarz on 5th March 2018 at Chennai.

G. Dhanushkodi and N. Palani attended workshop on "Exploring computational fluid dynamics" organized by Anna University, Chennai on 6th December 2017.

Deepak Kumar, CEM, Chennai attended and participated in 2-day "PTP/RMP Conclave" organised by NABL between 30th and 31st August 2017 at New Delhi.

Deepak Kumar, CEM, Chennai attended and participated in 4-day Training course on "Understanding General Requirements of Proficiency Testing as per ISO/IEC 17043:2010" organised by NABL between 02nd and 05th May 2017 at Chennai.

G. Mahesh and G.Vincent Raj attended a seminar on "Internet of Things" organized by M/s Keysight Technologies on 25th October 2017 at Chennai.

K. Naresh Kumar & Mahesh Chaluvadi Attended a one day seminar on "EMC Compliance and Automotive Test Symposium" conducted by Tektronix India on 23rd February 2018 at Chennai.

K. Naresh Kumar & Mahesh Chaluvadi Attended a one day seminar on "Demystifying Indian EMC Regulation 2018" conducted by Rohde & Schwarz India on 5th March 2018 at Chennai.

G. Mahesh attended a training course on "Testing of Telecom Equipment" organized by NABL during 16th to 18th November 2017 at Bangalore.

G. Mahesh, Scientist E audited EMC lab of M/s Wipro, Bangalore (TARANG) during 22-23 April 2017 to assess the compliance of lab to ISO/IEC 17025 requirements.

Mahesh Chaluvadi, K. Naresh Kumar, J. Thomas Vethamoni and P. Sudhakar attended one day workshop on EMC Standards & Measurements SAMEER, Chennai on 6th October 2017.

Dr. T Tiwari and Dr Sandeep Kumar Vyas attended Keysight hotspots seminar at Hotel Radisson Blu, Guwahati on 10th October 2017.

Dr. T Tiwari attended National Conference on Emerging Trends in Vacuum Electronic Devices & Applications - VEDA 2017 during 17th to 19th November 2017, Indian Institute for Technology Roorkee.

Manoj Phatangre and Narendra Shekhawat attended Mahendra Powerol seminar on 21st December 2017 at Hotel Radisson Blu, Guwahati.

Dr. Anuj Bhatnagar attended One day Theme meeting on biophotonics and photonics at Department of Atomic and Molecular Physics, Manipal University in November 2017 and spoke on "Photonic Devices: Indigenous Development", 27th November 2017.

Dr. Anuj Bhatnagar attended the First brain-storming meeting on Quantum science and Photonics at RRI Bangalore on 6th April 2017. He shared his views about integrated optic devices that can be fabricated for quantum applications.

DEPUTATIONS

Site acceptance testing (SAT) for PCI and UWB test systems were successfully completed at SAMEER CE3 Visakhapatnam Campus during 22-30 November 2017. Scientists stationed at SAMEER CE3 Visakhapatnam were given hands-on training on both UWB and PCI systems installation & Operation by M/s. Montena Technology SA, Switzerland.

Dr. B. Subbarao, Shri Gyanendra Verma, Shri M. Suresh Kumar and Shri P. Siva Kumar were deputed to carry out Factory Acceptance Test (FAT) for PCI&UWB test systems during 16 – 22 January 2017.

Dr. B. Subbarao and Shri B. Venkata Ramana, were deputed to carry out Factory Acceptance Test (FAT) for Electromagnetic Pulse (EMP) immunity test system as per MIL STD 461E/F, RS105 for large objects during 24 – 28 April, 2017 at M/s. Montena, Switzerland.

RESEARCH PAPERS / PUBLICATIONS

Arijit Majumder ; Soumyo Chatterjee ; Sayan Chatterjee ; Sheli Sinha Chaudhari ; Dipak Ranjan Poddar,"Optimization of Small-Signal Model of GaN HEMT by Using Evolutionary Algorithms", IEEE Microwave and Wireless Components Letters, Vol. 27, No. 04, pp. 362-364, April, 2017

G. Arun Kumar, and Bijit Biswas, " MMIC Resistive Mixer with Low Conversion Loss and Low LO Power", International Conference on Innovations in Electronics, Signal Processing and Communication (IESC-2017), 6-7th April, 2017, Shillong, Meghalaya.

Sumit Pratap Singh, Amitesh Kumar, Vivek Kumar Singh and Sagar , " A Broadband Wide-Beamwidth Circulary Polarized Microstrip Patch Antenna with Conformal Radome for High-Speed Airborne Communication", International Conference on Innovations in Electronics, Signal Processing and Communication (IESC-2017), 6-7th April, 2017, Shillong, Meghalaya.

Mousumi Sarkar, Paramita Banerjee, and Arijit Majumder, " Design of Broadband MMIC Low Noise Amplifier at W band using GaAs pHEMTs", International Conference on Innovations in Electronics, Signal Processing and Communication (IESC-2017), 6-7th April, 2017, Shillong, Meghalaya.

Tanuja Das and Vivek Kumar Singh, "Broadband Waveguide Monopulse Comparator at X-Band", International Conference on Innovations in Electronics, Signal Processing and Communication (IESC-2017), 6-7th April,2017,Shillong, Meghalaya.

Mahitosh Biswas, Roshan Lal Makkar, Anuj Bhatnagar, Subhananda Chakrabarti, "Annihilation of arsenic-nitrogen bonding defects in annealed InAs1xNx quantum dots grown through nitrogen background pressure controlled SS-MBE", Journal of Alloys and Compounds 722, pp. 287-292, online 9th June 2017.

Astha Singh, Geeta Sharma, Neeraj Ranjan, Kshitij Mothallia, Anuj Bhatnagar, B P Singh, Deepak Mathur, Parinda Vasa, "Laser writing of single-crystalline gold substrates for surface enhanced Raman spectroscopy" Applied Optics, 12th June 2017.

Sukhendu Bhanja, Mousumi Sarkar, Tanmay Ghoshal, Arijit Majumder "Stabilization of Pulsed IMPATT Oscillator at W Band Over Extended Ambient Temperature Range", International Conference on Communication Devices and Networking (ICCDN) 2017, 3 - 4th June, 2017 SMIT, Sikkim.

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Deepak Kumar, CEM, Chennai authored a technical paper titled "Inter Laboratory Comparison (ILC) of Conducted Emission Measurements" which has been reviewed, recommended and accepted by the Editorial team of IEEE EMC Magazine and scheduled for its publication in 3rd Quarter 2018 (Volume 7, Issue 3) of IEEE EMC Magazine .

Chief Guest

Mrs. Sulabha Ranade, Director General was the Chief Guest on All India Aviation seminar – A look into futuristic CNS/ATM Systems on 25th November 2017.

Examiner

Dr. Anuj Bhatnagar was external examiner for PhD. Student Ms. Ranjana Shourie from NITK Surathkal, taken viva-voce examination on 22nd September 2017.

Dr Alok J Verma was external examiner for MTech student Mr Siddesh Haldhankar, K J Somaiya Engg College, Mumbai, taken Viva examination on 7th October 2017

Interaction with industries

Co-ordination was undertaken for e-procurement registration for extending SAMEER, Chennai services for ISRO spacecrafts. Further item-wise empanelment was successfully done under the category "Specialized Work Execution" for under taking limited / proprietary tenders in the area of "Thermal Simulation of satellites and its Subsystems".

Interactions with the design executing industry was co-ordinated involving Indian Institute of Technology, Bombay scientists for providing the design know–how for the realization of the optimized heatsink.

INVITED TALKS

K. Sridhar, CEM, Chennai delivered a talk on 'Mobile Communication Systems' at Indian Institute of Information Technology, Tiruchirapalli on 23.02.2018.

K. Sridhar, CEM, Chennai delivered keynote address at International Conference on Smart Structures and Systems (ICSSS 2017) held on 28.03.2018 at Saveetha Engineering College, Chennai.

S. Vijayakumari, CEM, Chennai delivered a guest lecture at Vel Tech Engineering College, Chennai on 28.03.2018.

Penilop P.S delivered an invited lecture on "Spectrum shaping for Wireless Applications" in the workshop titled "Emerging &Relevant areas in RF& Wireless Communication" organized by Muthoot Institute of Technology & Science, Ernakulum on 13th February 2018.

K.Mourougayane was invited as Chief Guest and given a lecture on " Evolution of Self Adaptive Communication Systems and Cognitive Radio" on 10.3.2018 in a technical symposium "CHANNEL" conducted by Adhiparasakthi Engg. College, Melmaruvattur

K.Mourugayane was invited as Chief Guest and given a lecture on " Enabling Wireless Technologies and IoT for Smart Health Care Applications" on 2.5.2018, in a 3 days ICMR sponsored Workshop on "Major Challenges in Medical Imaging, Big data Analytics for Clinical and Medical Applications" at Vellammal Engg College, Chennai

G. Mahesh, Scientist-E delivered a lecture on Introduction to EMC at Tagore Engineering College, Chennai on 13th Nov 2017 as a part of their faculty development programme.

B.Subbarao Scientist-F gave an invited talk at Vignan College of Engineering (Woman) Duvvada, Visakhapatnam.

Mrs. Sulabha Ranade, Director General gave an invited talk on 1st workshop on Indigenization of Strate-

gic technologies : Govt stakeholder & Think Tank's Perspective (IIT Mumbai)

P. Siva kumar, Scientist-C, gave an invited guest lecture on 'Introduction to Electromagnetics' at NSRIT Engineering College, Visakhapatnam on 5th July, 2017.

B. Venkata Ramana, Scientist-C, gave an invited guest lecture was delivered on 'Electromagnetics Theory & Interference measurements' at JNTUK-university college of Engineering, Vizianagaram on 15th September, 2017.

Mrs. Sulabha Ranade, Director General gave an invited talk on Linear Accelerator for Cancer treatment at the Hyatt Regency, Kolkata on 10th March 2018

Discussions held with RWRDC division, Hindustan Aeronautics Limited (HAL), Bangalore for possibility of EMI/ EMC testing – Radiated Susceptibility (RS) 103 as per MIL STD 461E at SAMEER, Visakhapatnam for Advanced Light Helicopter (ALH) and Light Combat Helicopter (LCH) on 19th February 2018.

Discussions held with Gayatri Vidyaparishad college of Engineering (GVPCOE), Visakhapatnam regarding execution of collaborative DST sponsored projects with SAMEER CE3, in Electromagnetics domain on 17th February, 2018.

An interaction and lab visit to SAMEER, Vizag was arranged for NPO & design teams of ADA to have an overview of the facilities available at SAMEER Visakhapatnam for EMI/EMC studies & utilization of the same for LCA(Navy) program

Mrs. Sulabha Ranade, Director General delivered lecture at CDAC Noida on 'Activities of SAMEER' as part of their induction programme on 5th July 2017.

TRAINING AND EDUCATIONAL ACTIVITIES

One of the major initiatives of SAMEER is to develop pool of skilled manpower in the area of RF/Microwave, Millimeterwave and EMI/EMC through regular workshops, seminars and other educational & academic events. As a part of this training and academic activities, B.Tech/M. Tech students of local colleges were allowed to carry out their project work under the guidance of SAMEER Scientists. During the year SAMEER Scientists of various centres have imparted training/guided 48 B.Tech/M. Tech/Ph.D students in their project work.

SAMEER has imparted training to 86 Graduate/Diploma/ITI holders under the Apprentice Act 1961.

PROMINENT VISITORS

Dr. Anil Kakodkar, Former Chairman, Atomic Energy Commission visited SAMEER on 29th December 2017

Dr. B. V. S. Narayana Murthy, Director, RCI (DRDO), of visited SAMEER, Kolkata on January 2018.

Dr Surendra Pal, Vice Chancellor Defence Institute of Advanced Technology, Pune visited to SAMEER, Guwahati on 31st May 2017.

Dr. Rajiv Modi, Chairman, Board of Governors, IIT Guwahati visited to SAMEER Guwahati on 15th June 2017.

Air Vice Chief Marshal S V Deb visited to SAMEER Guwahati on 26th June 2017.

Dr. Lalit Kumar, Chairman, CEPTAM, DRDO, Delhi, visited to SAMEER Guwahati on 24th July 2017.

Shri Pradyumna Vyas, Director of NID, Ahmedabad visited SAMEER, Chennai on 25th April 2017.

DR.K.Hari Babu, M.P, Visakhapatnam, Shr. P.V.N.Madhav,M.L.C and Shri. O.Naresh Kumar,Member,PRSG visited SAMEER visakhapatnam on 25-01-2018 to monitior Project Progress

Shri. O.Naresh Kumar,Member,PRSG visited SAMEER visakhapatnam on 06-09-2017 to monitior Project Progress

Lt.Cdr Lawrence D'Cunha, Office Incharge, Navel EMC Unit,Visakhapatnam visited SAMEER Visakhapatnam on 06-09-2017 to discuss about mutual collaborative works in the field of EMI/EMC

DR.K.Hari Babu, M.P, Visakhapatnam, Shr. P.V.N.Madhav,M.L.C during their visit to SAMEER, Visakhapatnam

IMPLEMENTATION OF OFFICIAL LANGUAGE

SAMEER, Mumbai is 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 are being invited to delivered lectures in the Hindi workshops. Staff members are encouraged to writes notes and draft in Hindi and to comply with the Official language Acts and Rules. Due to our consistent 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 is steadily growing. The website of the society both Hindi and English version get updated simultaneously.

HINDI PAKHWADA CELEBRATION

Shri Rajiv Kumar, Joint Secretary, Ministry of Electronics & IT, Chief Guest on the occasion being welcomed by Smt. Sulabha Ranade, Director General

Hindi Pakhwada has become a very popular event in the organization. During year under review Hindi Pakhwada was organized from 1th September 2017 to 15th th September 2017. On this occasion, Hindi Kavita Path, Hindi Books Review, and Hindi Noting & Drafting Competitions were conducted. Main function including Prize distribution function was held on 14th September 2017. Shri Rajiv Kumar, Joint Secretary, Ministry of Electronics and Information Technology, Government of India graced the occasion as Chief Guest. Shri Vipul lakhanavi Scientist –G of BARC and editor of a scientific Hindi Magazine 'Vaigyanki' was the Guest of Hounour. An appeal was issued by the Director General on this occasion requesting the staff members to make maximum use of Hindi in their official work.

Hindi Pakhwada (14-29 September 2017) was celebrated between 25th and 26th September 2017 by SAMEER, Chennai. On this occasion, Hindi Competitions were organized by Raj Bhasha Implementation Committee (RIC) Staff members enthusiastically participated this year celebration, which was very interactive and a grand success. Kum. Shweta Verma, Hindi Pradhyapak from Dept. of OL, Ministry of Home Affairs, Chennai was the Judge for the said occasion. She emphasized on adapting Hindi in daily official work in her address to the participants on the occasion of closing ceremony of Hindi Pakhwada on 26th September 2018. Cash Awards were distributed to each of first six prize winners of two Hindi competitions on this occasion.

Kum. Shweta Verma, Hindi Pradhyapak,Dept. of OL, MHA, GoI, Chennai being felicitated by Shri V.Venkatesan, Programme Director, SAMEER Chennai

Participants during Hindi competitions organised on the occasion of Hindi Pakhwada on 25.09.2017

RIGHT TO INFORMATION ACT

SAMEER, is a public body as provided in Section 2 (h) of the RTI Act. Request for information under RTI Act can either be field at any of the locations of SAMEER or can be submitted online through the RTI module. Mandatory disclosures as per the guidelines of Sec 4(1) (b) have been published in the RTI module on SAMEER Website. The same is updated periodically.

All RTI applications received during the financial year 2017-18, were duly processed.

SWACHH BHARAT ABHIYAN

As a part of GREEN initiative, Installation and commissioning of Solar panels to generate 60KVA solar power was successfully completed.

Installed 60KW Solar Power on Building terrace at SAMEER, Visaklhapatnam

Swachh Bharat Pakhwada was organised in SAMEER during the year 2017-18, Several activities were organised in the observance of Swachh Bharat Pakhwada. All employees actively participated with in Swachhta Pakhwada that started with a pledge ceremony. A series of lectures on different topics related to sustainability of clean and green environment organised and was attended by employees of other centres through video conferencing. The cleaning and

Plantation of saplings at SAMEER Visakhapatnam Campus

beautification of office premises and its surroundings were undertaken by our employees. Old, obsolete and scrap items were identified and segregated for disposal in order to achieve aesthetic and neat look of Labs. Furthermore, tree plantation was oragnised for crating healthy and green environment.

Smt Sulabha Ranade, Director General, SAMEER inaugurated the "Bio-Waste Treatment Plant" at SAMEER, IIT Powai Campus on 9th Feb 2018. The plant is operational using wet waste from staff canteen and residential area.

Glimpse of Cheerful mood of Participants after Cleaning of Taramani Campus during Swachh Bharat Pakhwada from 1st to 15th August 2017

Cleaning and beautification of Perungudi Campus during Swachh Bharat Pakhwada from 1st to 15th February 2018

SOCIAL AND CULTURAL EVENTS

SAMEER Celebrated the Independence day and Republic Day with usual pomp and gaiety. Dr. A. Agarwal, Shri K.K.Radhakrishnan and Shri Ulhas V. Vard- have had the honour of hoisting the national flag on the above occasions. SAMEER Staff and their family members participated in the Celebrations.

Annual Day celebrations are always looked forward to by SAMEER staff members. This year, the annual day was celebrated by SAMEER on 29th December 2017. Dr. Anil Kakodkar, Former Chairman, Atomic Energy Commission was the chief Guest on the occasion. Prizes were presented to to children of staff members for their achievement in academics and sports. A variety of entertainment programmes were presented and the staff members, their families, guests and invitees enjoyed the programmes.

Cultural activities during Annual Day