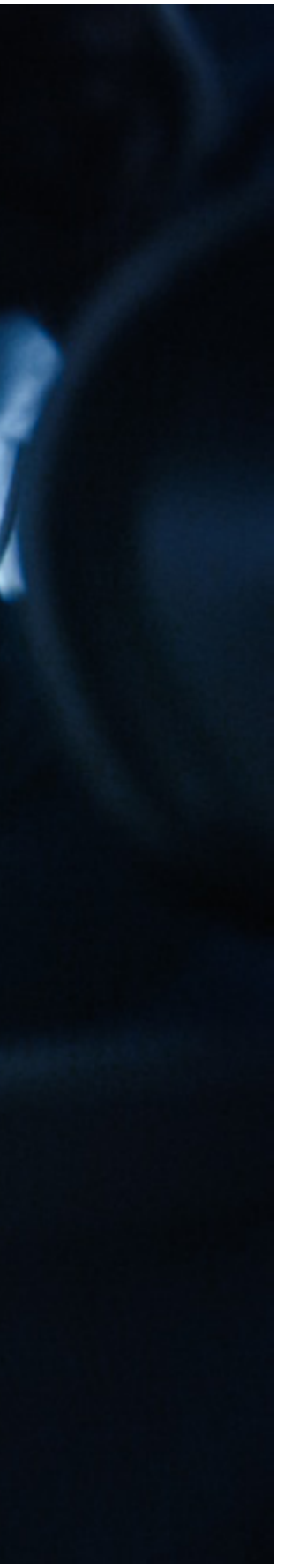
ANNUAL REPORT 2022 & 2021

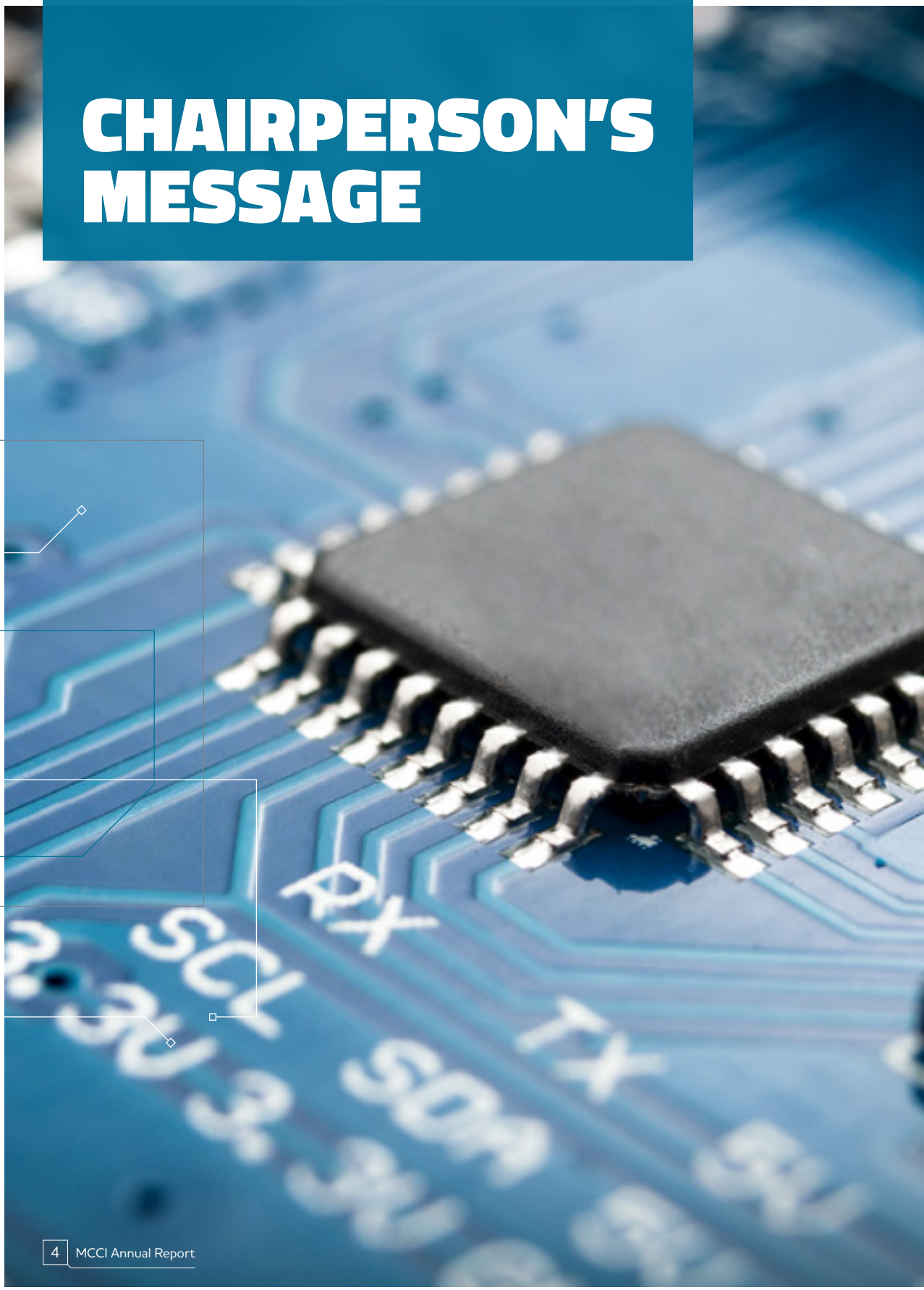
MCCI
SOLVE THE IMPOSSIBLE

TECHNOLOGY CENTRE
ENTERPRISE IRELAND
IDA IRELAND SUPPORTED

TABLE OF CONTENTS



CHAIRPERSON'S MESSAGE



CHAIRPERSON'S MESSAGE

I am honoured to welcome you to the combined Annual Reports for the Microelectronics Circuits Centre of Ireland (MCCI) for 2021 and 2022.

As we reflect upon the challenges and triumphs of the past two years, I am delighted to share with you the progress we have made in navigating the unprecedented circumstances brought about by the COVID-19 pandemic and how we emerged from its in shadow in 2022.

The Microelectronic Circuits Centre Ireland (MCCI) has a unique relationship with Tyndall National Institute, Enterprise Ireland and IDA Ireland. The on-going collaboration and specialist ecosystem that has been developed allows a team of world-class researchers and postgraduate students to deliver excellent application driven research. This has contributed to positioning Ireland as a global location for microelectronics companies, thereby contributing hugely to the vibrant microelectronics industry.

The Irish Government, through Enterprise Ireland and IDA Ireland, are investing significant funding and resources into the centre. There is evidence of this long term, strategic investment is paying dividends for the Irish economy. MCCI has built scale and expertise that can assist the worlds leading companies to conduct leading edge research, in a stable, secure environment, enabling the next generation of technology solutions.

It is recognised that MCCI gives existing indigenous companies a large competitive advantage as well as helping in the creation of new start-up companies.

Despite the obstacles presented by the global health crisis during 2020 and 2021, MCCI has remained steadfast in our commitment to excellence in microelectronics research and development. Throughout the last two years, we have witnessed the tireless efforts of our researchers and engineers as they continued to drive innovation and deliver cutting-edge solutions.

As we turn our focus towards the future, I am thrilled to announce the appointment of our new Executive Director, Mr. John Morrissey during 2021. With his wealth of over 30 years' experience in the microelectronics Industry, John brings a fresh perspective and a passion for driving MCCI's mission forward. His leadership will undoubtedly propel us to new heights of success and foster stronger collaborations within our industry.

I would like to thank our talented and hardworking operations and researchers for their dedication and support. Looking ahead, we are optimistic about the opportunities that lie before us. The world is witnessing a rapid acceleration in digital transformation, and microelectronics will continue to be a cornerstone of this revolution.

In conclusion, I invite you to delve into the pages of this Annual Report and discover the remarkable accomplishments of MCCI in 2022 and 2021. It is through our collective efforts that we continue to push the boundaries of microelectronics and shape the future of technology. Thank you for your ongoing support, and I look forward to the exciting journey that lies ahead.

Donal Sullivan
Chairman MCCI CSC Board

EXECUTIVE DIRECTOR MESSAGE

EXECUTIVE DIRECTOR MESSAGE

Dear Stakeholders,

In my first full year, as Executive Director, It's with great pleasure that I present to you the Annual Reports for the Microelectronics Circuit Centre of Ireland (MCCI) for the years 2021 and 2022. This report encapsulates the achievements, challenges, and remarkable progress made by MCCI in each year that will be remembered for its unprecedented disruptions caused by the global COVID-19 pandemic. Despite the adversity faced, MCCI has emerged stronger, in 2021 and 2022, and more committed than ever to advancing Ireland's position as a global leader in microelectronics research innovation. This report outlines our steadfast efforts to navigate the pandemic's challenges, and our achievements in research and development.

As we reflect upon the past two years, it is impossible to overlook the significant impact of the COVID-19 pandemic. The sudden onset of this global health crisis brought about unforeseen challenges, disrupting businesses, economies, and societies worldwide. MCCI, like many organisation, faced immense difficulties in adjusting to the new normal. The safety and well-being of our staff, researchers, and partners became our top priority, leading us to swiftly implement remote work arrangements and stringent health and safety protocols. While the pandemic compelled us to adapt our operations, it also served as a catalyst for innovation, resilience, and unity within our organisation.

Amidst these extraordinary circumstances, MCCI demonstrated remarkable resilience and determination in fulfilling its mission. Our team worked diligently to ensure the continuity of our research and development projects, leveraging digital platforms, virtual collaboration tools, and innovative methodologies to sustain our progress. The dedication and adaptability of our researchers, engineers, and support staff played a pivotal role in overcoming the hurdles presented by the pandemic.

Throughout 2021 and 2022, MCCI continued to spearhead ground-breaking research, development, and commercialization initiatives, reaffirming Ireland's position as a global hub for microelectronics innovation. We achieved significant milestones in various areas, including advanced integrated circuit design, intelligent sensing systems, wireless communications, and emerging semiconductor technologies. The collaborative efforts between our industry partners, academic institutions, and research teams have yielded breakthroughs that are driving transformative changes across diverse sectors, from healthcare to transportation, from agriculture to telecommunications.

MCCI enjoys a substantial advantage due to its affiliation with Tyndall National Institute. Hosted within Tyndall, MCCI is part of a much broader ecosystem focused on science and technology. This affiliation not only facilitates research within the field of microelectronics but also opens doors to interdisciplinary collaborations and innovative endeavours. MCCI works closely with numerous research groups at Tyndall, creating a powerful synergy that extends the competence of microelectronics into various science and technology innovations. Furthermore, this collaboration extends to industry partners, enhancing the practical application of research findings and significantly increasing their impact. In essence, being a part of Tyndall National Institute offers MCCI a rich and supportive environment, fostering cooperation, innovation, and the translation of research into real-world solutions in both academic and industrial domains.

Moreover, MCCI has consistently upheld its dedication to nurturing collaboration and facilitating the exchange of knowledge within the microelectronics ecosystem. This commitment extends not only to its presence at Tyndall National Institute and University College Dublin but also encompasses partnerships with various institutions, reaching across the globe, including key industry stakeholders.

Furthermore, MCCI has remained steadfast in its commitment to fostering collaboration and knowledge exchange within the microelectronics ecosystem. Despite the limitations imposed by the pandemic initially, we organized virtual conferences, seminars, and workshops that brought together industry

leaders, researchers, and policymakers to exchange ideas, share insights, and explore new avenues for collaboration. These initiatives have strengthened MCCI's network, fostered innovation, and empowered our stakeholders to leverage the immense potential of microelectronics for societal and economic benefit.

As we look ahead, we remain very optimistic about the future. The challenges posed by the pandemic have reaffirmed the importance of MCCI's role in driving technological advancements MCCI is poised to embark on a path of, growth, and continued success.

In conclusion, I extend my sincere gratitude to our dedicated staff, esteemed partners, and valued stakeholders for their unwavering support and commitment to MCCI's vision. Your trust, collaboration, and resilience have been instrumental in our ability to navigate through these challenging times. Together, we have laid a strong foundation for a brighter future, one where microelectronics innovation and breakthroughs will pave the way for a prosperous and sustainable society.

John Morrissey
Executive Director

ABOUT US

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The vision and mission statements articulate MCCI's aspirations and goals, emphasizing our commitment to advancing microelectronics technology, fostering collaboration, and driving economic growth.

Vision

Be a globally recognised leader in microelectronic IC design research.

Mission

Deliver world class technology innovation with industry collaboration that has real impact which offer benefits for the greater societal good and the planet.

To develop future technology leaders for the semiconductor industry.

Objectives

Our strategic objectives are focused on research excellence in microelectronics, cutting edge industry relevance, talent development and technology transfer.

Organisational Structure

An overview of MCCI's organisational structure and key departments is provided, highlighting the roles and responsibilities of various teams in supporting the centre operations and research initiatives.

Our research teams are based across six of Ireland's universities; Tyndall National Institute, University College Dublin, Munster Technological University, SETU Carlow, University of Limerick and Maynooth University and they work with many industry partners on technological advances for the growth of the semiconductor sector.

1 Tyndall National Institute Institiúid Náisiúnta

2 MTU Ollscoil Teicneolaíochta na Mumhan Munster Technological University

3 University of Limerick Ollscoil Luimnigh

4 SETU Ollscoil Teicneolaíochta an Oirdheiscirt South East Technological University

5 Maynooth University National University of Ireland Maynooth

6 University College Dublin Ireland's Global University

MCCI – Microelectronic Circuits Centre Ireland is a Technology centre that provides high impact microelectronic IC design research for the semiconductor industry. We are funded by a combination of core base funding from Enterprise Ireland as well as leveraged contribution funding from Industry. MCCI is hosted at Tyndall National Institute, Cork, Ireland. Our location in Tyndall is a fantastic advantage which allows us to plug into and leverage the ICT technology research ECO system at Tyndall and its many partners. We collaborate with many diverse research groups across Tyndall, each specialising in areas such as magnetics, photonics, nano materials, and quantum innovations. This leads to even higher levels of application impact that appeals to Industry. Examples of these are research technology demonstrator platforms already developed or being co-developed at Tyndall are targeting medical/biomedical, implantable Industrial IOT and power management/energy applications. We work with many of the global semiconductor companies located in Ireland and abroad. We work with them to enhance their microelectronic research for product innovations and developments for multi-application enhancements. Our research strategy is focused on analog, analog mixed-signal, RF, & millimetre wave circuit IC architecture and design, including the development of system level solution research demonstrators or prototypes.

An important measure of our success is the number of world class PhD students and researchers who collaborate with industry and then transition or transfer to the semiconductor companies based in Ireland having completed their PhDs. We strive to grow and train the talent pool to become the best microelectronic IC design engineers who can develop to become Industry technology leaders in their field as they advance through their careers.

Our high performing team work closely with industry and academic partners, to bridge the gap between Industry needs and academic research. The results of this close relationship is industry lead high impact research which result in many IEEE publications as well as other affiliative technology publication platforms. We support our academic partners, with state-of-the-art design infrastructure, CAD tools, design methodologies, including state of the art foundry wafer fabrication and package assembly technology access that are aligned with our industry partners plus full equipped design measurement laboratories for test and measurement validation of research test chips.

A very recent addition to our research strategy is the Cyrogenic lab measurement capability being installed at Tyndall, allowing test circuits to be tested and measured at Cryogenic temperature as low as 4 degree Kelvin for the first time at MCCI. The new Lab investment has now enabled a new Cryogenic -CMOS research activity in circuit design.

MCCI has a lead technical steering advisor panel, which consists of senior professors, researchers and Industry technologist who are world-renowned professors and principal investigators (PI's) and IC technologists who help steer, offer advice of direction and strategy to the centre.. A valued panel, that helps our principal investigators (PI's) staff develop world-leading technology research roadmaps for MCCI to pursue and fund.

Our research outcomes and IP can be used to generate and supports new start-up companies SME's across the tech sector, in areas such as wireless COMS, Industrial5.0, Biomedical Devices and implantable devices and IOT for Industry, home, food and agriculture applications.

KEY HIGHLIGHTS OF 2022

This section highlights the significant achievements of MCCI in 2022, including notable research breakthroughs, successful project outcomes, industry recognition, and awards received by the centre and its researchers.

Research Excellence Impact

MCCI researchers have achieved high research impact over the last 12 years, reaching over 100 papers published in IEEE Tier 1 journals and conferences. During 2022 alone, over 30 papers were published, following a fantastic year in 2021 with an impressive 47 publications.

With over 90 staff members connected to MCCI, which includes Professors PI's, Senior and junior researchers, PhD, Masters students and operations support staff, MCCI has achieved a critical mass of talent that are very focused on their research strategies and technical challenges. The team is keenly engaged with Industry members and close collaboration is the order of the day and this gives extra motivation and relevance to their work and talent and is well recognised by the many industry members MCCI engages with.

Industry members also see the added advantage of the longer term collaboration with MCCI. During 2022, MCCI reached a significant secondary milestone of the 100th research personnel transferred to industry over a 10-year period. These researchers are highly trained in circuit design skills, knowledge, and domain experts in using Industry standard IC CAD tools and wafer fab processes that MCCI provides them access to.

See list of publications in annex 1

FUTURE OUTLOOK AND STRATEGIC ROADMAP

This section outlines MCCI's future outlook and strategic priorities, emphasising its commitment to continuous innovation, industry collaboration, talent development, and technology commercialisation. It also highlights the key challenges and opportunities that lie ahead.

Research and Development Initiatives

An overview of MCCI's research and development initiatives in 2022 is presented, showcasing the centre's focus on cutting-edge technologies, advanced methodologies, and collaborative projects with industry partners.

RESEARCH PILLARS

RESEARCH PILLARS

Broadband & Low Power RF Transceivers

Our RF & mm wave research is focused on for next generation low power broadband , data-centres and cloud computing. RF for next generation wireless 5/6G communications, medical, environmental sensing, imaging and stimulation.

RF & mm wave

RF in this area research is focused on applications of microwave and millimetre wave RF front-end components, RF co-design methods for multi-functional RF components, filter synthesis techniques, broadband antenna arrays and low-cost integration methods for wireless, space and defence communication systems.

Power Management

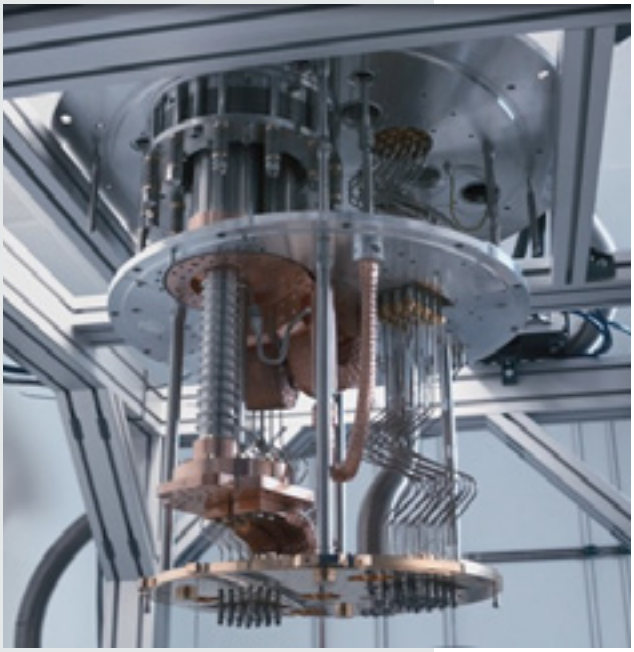
This strategy is focused on Ultra Low Power (ULP) and higher efficiency PMIC integrated systems, and energy harvesting solutions. Research is exploring highly integrated power supplies systems to address the need for smaller physical form factors and energy reduction while achieving higher energy efficiency challenges.

Precision Analog Circuits

Our Precision Analog Circuits research explores ultra-low power high dynamic range data converters, multi-sensor interfaces, analogue front ends for ultra-low power applications in Industrial 4.0 and Biomedical/Medical devices including implantables.

The Intelligent Edge & Digital

We are exploring new lower power efficient circuit architectures for data sensing, measurement & data conversion to digital and stored incorporating Machine learning (ML) and AI. Data Security is a growing concern globally and research investigations into how circuit design partitioning can help achieve a more secure data network.



Cryogenic CMOS

A new research pillar for the centre has been added in 2022 to examine and develop CMOS circuit designs that operate effectively at ultralow temperatures, i.e. down to 4 degree Kelvin. Part of the research is investigating how PCB testing materials and spice level models for circuit design behave at these temperatures and verify new methods and techniques for improved performance.

APPLICATION AREAS

BioMedical & Medtech

Power Management & Energy

Wireless Communications

Industrial, Instrumentation & IOT

Space Grade Electronics

MCCI INDUSTRY MEMBERS

Below are our active industry members we are collaborating with.

2022 HIGHLIGHTS

EU & INDUSTRY COLLABORATION

Dutch Medical start up - BCON Medical & NKI (Dutch Cancer Research Institute)

BCON Medical and NKI collaboration kick off meeting was held in Tyndall. After a very successful collaborative funding proposal to Health Holland, MCCI/Tyndall are going to work on an implantable wireless magnetic sensor probe to assist in organ or tumour physical location device during cancer medical surgery. This will be a 3 year long programme working with the two partners mentioned above.

- BCON Medical, NKI and MCCI/Tyndall staff at 1st Project kick off meeting at Tyndall Cork

EVENTS

APEC, Houston Texas, USA

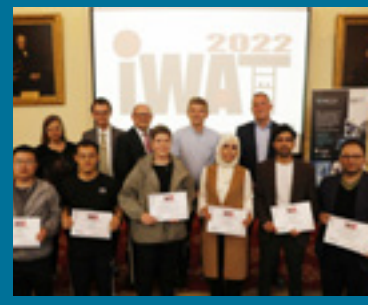
MCCI were delighted to attend the first in person (Post COVID-19) "Applied Power Electronics Conference and Exposition" (APEC) 2022 in USA to promote our MCCI and Tyndall Power Management & Energy research. The conference is an annual event that focuses on the practical and applied aspects of the power electronics business and has something of interest for anyone involved in the power electronics industry.

A number of technical papers from Tyndall and MCCI were presented at the conference. Great industry and academic networking discussions were achieved, the objective being broader Industry collaboration and hiring opportunities.

MCCI members on Booth Duty at APEC 2022

IIWAT 2022, DUBLIN IRELAND

MCCI attended IWAT 2022 – International Workshop on Antenna Technology in Trinity College Dublin Ireland. MCCI were proud sponsor of the best paper awards. One of the student category winners was Mr Nadeem Rather, from Tyndall National Institute for his Paper "Flexible and Semi-Transparent Chipless RFID Tag Based on PDMS-Conductive Fabric Composite"



Best paper award winners and sponsors at IWAT'22

2022 ANNUAL HIGHLIGHTS

Prestigious Industry Awards

MCCI PhD student, Mr Zhongzheng Wang, won the coveted Analog Devices (ADI) Outstanding Student IC Designer Award 2022 for EU region. The outstanding IC design early researcher award for EU region is presented annually to recognise early PhD researchers for excellence in analog, mixed-signal & RF, integrated circuit design.

Zhongzheng was nominated for his exceptional academic research achievements to date and potential to develop novel ways to interrogate electrochemical sensors. "We would like to commend and congratulate Zhongzheng on his prestigious award and his achievements to date since joining MCCI. Zhongzheng has had an impressive track record as an IC designer and his current PhD research is already delivering impact, in that he is currently designing a completely novel way to interrogate electrochemical sensors" John Morrissey, Executive Director MCCI, said. He joined our technology centre less than two years ago which makes this achievement even more impressive.

▲ Zhongzheng Wang being presented his ADI award from Mr Philip Quinlan Design Engineering Director at ADI.

His research focuses on new generation electrochemical sensor interface ICs, with an emphasis on low noise low offset techniques for operational amplifiers, low-leakage-current sampling switches and high precision ADC/DACs.

▲ Anthony Wall (left), receives the Wrixon Research Excellence Bursary in Tyndall.

MCCI Student wins Wrixon Research Excellence Bursary

Anthony Wall, PhD student with MCCI was one of the first winners of the Wrixon Research Excellence Bursary in Tyndall. The Wrixon Bursary recognises and promote postgraduate Research Excellence in Tyndall based on students accomplishments and achievements during their PhD and Master's research.

Anthony graduated from University College Cork with 1st Class Honors in the BE degree in Electrical & Electronic Engineering in 2018, and is currently pursuing the PhD degree with MCCI, University College Cork in the area of Mixed Signal Circuit Design.

MCCI researchers occupy 1st & 3rd spots of most popular papers downloaded from IEEE Solid-State Circuits Letters

MCCI researchers occupy 1st & 3rd spots of most popular papers downloaded from IEEE Solid- State Circuits Letters

- Delighted & very proud that two MCCI researchers occupy 1st & 3rd spots of most popular papers downloaded from IEEE Solid-State Circuits Letters during a 9 months period Congratulations to Subhash Chevella and Anthony Wall. "A Low-Power 1-V Supply Dynamic Comparator" by Subhash Chevella, Danny O'Hare & Ivan O'Connell @ MCCI "An Improved Linearity Ring Oscillator-Based Current-to-Digital Converter" by Anthony Wall

ASSOCIATED FUNDING HIGHLIGHTS

Very significant 5 year Research funding from SFI was awarded to Prof. Bogdan Staszewski after a successful 2nd phase proposal submission and a successful track record of results achieved over that last 5 years.

Talent Development Programs

MCCI's strives to ensure funded talent development programs are in place, including Masters graduate, PhD and postdoctoral research positions, collaborative industry-academia initiatives, and professional development opportunities, is provided, highlighting the centre's efforts to nurture the next generation of microelectronics professionals through it research activity.

Student Research and Internships

MCCI also engages with students from across the globe through research projects, internships, and industrial placements showcasing the center's commitment to fostering hands-on learning experiences and bridging the gap between academia and industry.

Continuous Professional Development

MCCI's initiatives to support continuous professional development for industry practitioners, including workshops, training programs, and industry-led seminars, webinars and demonstrating the center's role in upskilling and knowledge exchange.

KEY OUTREACH EVENTS

MTC 2022

MTC – MCCI's Technical Conference 2022 took place online, from June 28th to 30th with 153 attendees. The Virtual MTC consisted of 3, 3hr sessions over 3 days. MTC is a member's only event, where Industry guests get early pre-publication access to upcoming papers and direct access to our PhD researchers. 19 papers were presented which included 11 from Tyndall based MCCI team and 8 from MCCI UCD. The conference is of very high value to our Industry members as they will gain early access to our research work publications and research breakthroughs.

Hopefully in 2023, we will return to the in-person 1 full day event which has higher networking value for all attendees.

AACD 2022

31st Advances in Analog Circuit Design International Workshop

MCCI were proud to help fund, host and organise the "Advances in Analog Circuit Design" - AACD 2022. 2022 was the 31st anniversary of this international event and only the 2nd time it was held in Ireland over 30 year period.

This conference event is rather unique in that it brings research leaders of IC design in the world by invitation together with Industries advanced leaders in IC design technology. They present and discuss their advancements and challenges in the semiconductor world in a workshop style setting. It attracts a diverse combination of researchers and industry collaborative members together. AACD'22 attracted an international audience to Cork, Ireland for 3 days. It was a hugely successful event with over 130 attendees who heard 18 papers presented over the duration of the conference. Two of MCCI's researchers were invited to present at AACD'22. There were ample networking opportunities with a gala dinner and social events organised in Tyndall to showcase our research excellence to a wider audience.

MCCI organised the event and all costs were fully funded by very generously semiconductor Industry sponsorships.

▲ Mr Zhongzheng Wang presenting at AACD'22

▲ John Morrissey addressees the audience at AACD'22

FACILITIES AND INFRASTRUCTURE

Research Facilities, Equipment and Tools

MCCI's strives to have state-of-the-art research facilities, including laboratories, Industry standard IC design CAD tools and specialized equipment available for its researchers showcasing the center's cutting-edge infrastructure for advanced microelectronics research.

The example below is one of the new facilities and equipment and tools available at MCCI, supporting research and development activities across various domains, and fostering innovation and experimentation

New state of art Cryogenic CMOS laboratory added in 2022

To support our new research pillar for the centre in 2022, CRYOGENERIC CMOS, a New BLU FORS Cryogenic Cooler was purchased through a successful application to an Enterprise Ireland Capital call. A laboratory was created in Tyndall for Cryogenic measurements (down to 4 degrees Kelvin) for CMOS Design circuit validation testing and characterization. This will allow our researchers to examine and develop CMOS circuit designs that operate effectively at ultralow temperatures, i.e. down to 4 degree Kelvin. Part of the research is investigating how PCB testing materials and spice level models for circuit design behave at these temperatures and verify new methods and techniques for improved performance.

New BLU FORS Cryogenic Cooler installed in Tyndall which is dedicated to Cryogenic measurement lab for CMOS Design circuit validations.

Further MCCI and Tyndall investments are being made in 2022 to support further research in RF & mm Wave and High Voltage Power (GRID). Two new separate laboratories are to be created and developed for test and measurement in RF & mm wave and High Voltage Power. The new laboratories are being constructed should be ready for use in 2023.

New Design tool kit was purchased and installed in SETU Carlow to support undergrad and post grad research activities in IC circuit design.

ACKNOWLEDGMENTS

MCCI acknowledges the support and collaboration received from its Industry members, research partners, government agencies, and stakeholders, recognizing their contributions to the center's success and growth in the past and for the future.

Annex 1A

MCCI @ Tyndall Research Staff & Team

RESEARCHER PROFILES

OUR RESEARCH LEADERS


Dr. Ivan O'Connell


Dr. Brendan Mullane


Dr. Danny O'Hare


Prof. Dimitra Psychogiou


Dr. Gerardo Salgado


Prof. Peter Kennedy


Dr. John Buckley


Prof. Anding Zhu


Prof. R. Bogdan Staszewski


Dr. Elena Blokhina


Dr. Teerachot Siriburanon


Mr. Seamus O'Driscoll


Dr. Deepu John


Dr. Barry Cardiff


Dr. Pádraig Cantillon-Murphy


Dr. Darren Francis Kavanagh

MCCI & Tyndall National Institute

- Prof. Dimitra Psychogiou, Principle Investigator (RF & mm wave)
- Prof. Pádraig Cantillon-Murphy, Principle Investigator (BioMedical Imaging)
- Dr. John Buckley, Principle Investigator (RF Wireless Antenna & Systems)
- Dr. Ivan O'Connell, PI & Head of Group - Precision Circuits
- Dr. Daniel O'Hare, Principle Investigator (Sensor Interfaces & Precision Circuits)
- Mr Seamus O'Driscoll, PI of Power Management (ULP PMIC)
- Dr. Gerardo Salgado, Senior Researcher
- Dr. Luis Linares Senior Researcher
- Subhash Chevella Senior Researcher
- Anita Schuler, Senior Digital Design Engineer
- Gerry McGlinchey Snr Analog IC Design Consultant
- PhD Students

Anthony Wall, Zhongzheng Wang, Rachel Georgel, Minda Wen, Javier Higes Marquez, Brendan O Callaghan, Alessandro Ferro, Mikhail Gaidukov, Madhu Jacob, Rahul Jaiswal, Mohammed Nasser, Nidhya Mathew Brendan O'Sullivan, Ruaidhrí Murphy, Aleksandr Sidun, Manish Srivastava, Andrija Stankovic, Madhan Venkatesh, Daniel Woodward, Zixiao Zhang, an Pavlovic, Herman Alexander Jaeger, Dr. Kilian O'Donoghue, Manish Srivastava, Nadeem Rather, Cian O Donnell

MCCI @ University College Dublin (UCD) Research Team

- Prof. Peter Kennedy, Principle Investigator (RF PLL/Freq Generation)
- Prof. R. Bogdan Staszewski, PI, (RF Freq Gen & RF Transceivers)
- Prof. Anding Zhu, PI, (RF & mmw Transceivers)
- Dr. Teerachot Siriburanon, PI, (RF)
- Dr. Elena Blokhina, PI, (RF & mmw Transceivers)
- Dr. Deepu John, PI, (RF & mmw Transceivers)
- Dr. Barry Cardiff, (RF & mmw Transceivers)
- PhD Students

Armia Salib, Dawei Mai, Reza Nikandish, Amir Bozorg, Yizhe Hu, Hieu Minh Nguyen, Reza Nikandish, Amir Bozorg, Dr. Panagiotis Giounanlis, Viet Anh Nguyen, Hieu Minh Nguyen, Mohamed Shehata, Jianglin Du

Brian Keogh, Samaneh Sadeghi Maraht, Chenhao Chu, Li Xiaolinn

MCCI @ University of Limerick (UL) Research Team

- Dr Brendan Mullane, Principle Investigator (Digital Signal Processing (DSP) and CPU)
- PhD Students

Shantanu Mehta

MCCI @ SETU Carlow Research Team

- Dr Darren Francis Kavanagh, Principle Investigator (Analog Mixed-Signal Design)
- Dr Vincent O Brien, Principle Investigator (Analog Mixed-Signal Design)
- PhD Students
- Alumni and recently graduated PhD's in 2021

Jos Prakash, Muhammad Usman, Luca Avallone, Dermot, Annamarie FordymackaDobynn, Aidan Murphy, Yann Donnelly, Yang Xu, Suoping Hu, Meng Li,Spyros Kalogiros Meysam Khanghan, Ciaran Wilson

- Recently graduated PhD's in 2022

Purushothaman Anantha, Sivapalan Gawsalyan, Jianglin Du, Xiaoyu Wang, Madhu Jacob, Yue Li, Hao Zheng, Venkata Bhumireddy, Valerio Mazzaro, Andrija Stankovic, Madhan Venkatesh, Enis Kobal, Arelene John

PUBLICATIONS

1. Y. Kandeel, S. O'Driscoll, C. O'Mathuna, M. Duffy, "Optimum Phase Count in a 5.4-W Multiphase Buck Converter Based on Output Filter Component Energies", TPEL, Dec 2022
   - https://ieeexplore.ieee.org/document/9969915
   - DOI: 10.1109/TPEL.2022.3226708
2. C. Chu, J. Pang,... A. Zhu, "Broadband Sequential Load Modulated Balanced Amplifier With Extended Design Space Using Second Harmonic Manipulation", MTT, Dec 2022
   - https://ieeexplore.ieee.org/document/9982501
   - DOI: 10.1109/TMTT.2022.3226440
3. C. Chu, V. Tamrakar,... A. Zhu, "High-Efficiency Class-iF-1 Power Amplifier With Enhanced Linearity", MTT, Dec 2022
   - https://ieeexplore.ieee.org/document/9968067
   - DOI: 10.1109/TMTT.2022.3224132
4. R. B. Staszewski, A. Esmailiyan, H. Wang, E. Koskin, P. Giounanlis, X. Wu, A. Koziol, A. Sokolov, I. Bashir, M. Asker, D. Leipold, R. Nikandish, T. Siriburanon and E. Blokhina, "Cryogenic Controller for Electrostatically Controlled Quantum Dots in 22-nm Quantum SoC", OJ-SSCS, Oct. 2022.
   - https://ieeexplore.ieee.org/document/9915422
   - DOI: 10.1109/OJSSCS.2022.3213528
5. T. Kobal, A. Zhu, "Digital Predistortion of RF Power Amplifiers With Decomposed Vector Rotation-Based Recurrent Neural Networks", MTT, Oct 2022
   - https://ieeexplore.ieee.org/document/9913714
   - DOI: 10.1109/TMTT.2022.3209658
6. M. Saeed, O. Märtens, B. Larras, A. Frappé, D. John, B. Cardiff, "Event-Driven ECG Classification using Functional Approximation and Chebyshev Polynomials", BioCAS, Oct 2022
   - https://ieeexplore.ieee.org/document/9948612
   - DOI: 10.1109/BioCAS54905.2022.9948612
7. C. O'Mathúna, S. O'Driscoll, "Heterogeneous Integration of Power Conversion using Power Supply on Chip and Power Supply in Package", Focus Topic / Invited Lecture, EPE ECCE, Sep 2022
   - https://ieeexplore.ieee.org/document/9907236
8. Bozorg A, Staszewski R B, "A Charge-Sharing IIR Filter With Linear Interpolation and High Stopband Rejection", JSSC, May 2022
   - https://ieeexplore.ieee.org/document/9766434
   - DOI: 10.1109/JSSC.2022.3166960
9. A. Wall, P. Walsh, K. Sadeghipour, I. O'Connell, D. O'Hare, "An Improved Linearity Ring Oscillator-Based Current-to-Digital Converter", SSC-L, Aug 2022
   - https://ieeexplore.ieee.org/document/9854922
   - DOI: 10.1109/LSSC.2022.3198367
10. X. Chen, T. Siriburanon, Z. Wang, J. Du, Y. Hu, A. Zhu, R. B. Staszewski, "A Digital-to-Time Converter Based on Crystal Oscillator Waveform Achieving 86-fs Jitter in 22-nm FD-SOI CMOS", RFIC, June 2022
    - https://ieeexplore.ieee.org/document/9863080
    - DOI: 10.1109/RFIC54546.2022.9863080
11. A. Bozorg and R. B. Staszewski, "A Charge-Rotating IIR Filter with Linear Interpolation and High Stop-Band Rejection", JSSC, May 2022
    - https://ieeexplore.ieee.org/document/9766434
    - DOI: 10.1109/JSSC.2022.3166960
12. T. Kobal, Y. Li, X. Wang, A. Zhu, "Digital Predistortion of RF Power Amplifiers With Phase-Gated Recurrent Neural Networks", MTT, April 2022
    - https://ieeexplore.ieee.org/document/9750009
    - DOI: 10.1109/TMTT.2022.3161024

13. Mai D, Donnelly Y, Kennedy MP, Tulisi S, Breslin J, Griffin P, Connor M, Brookes S, Shelly B, Keaveney M, "Wandering Spur Suppression in a 4.9-GHz Fractional-N Frequency Synthesizer", JSSC, Apr 2022
    - https://ieeexplore.ieee.org/document/9758061
    - DOI: 10.1109/JSSC.2022.3163080
14. D. Mai, Y. Donnelly, M. P. Kennedy, S. Tulisi, J. Breslin, P. Griffin, M. Connor, S. Brookes, B. Shelly and M. Keaveney, "Experimental Verification of Wandering Spur Suppression Technique in a 4.9GHz Fractional-N Frequency Synthesizer", JSSC, April 2022
    - https://ieeexplore.ieee.org/document/9758061
    - DOI: 10.1109/JSSC.2022.3163080
15. X. Wang, Y. Li, A. Zhu, "Digital Predistortion Using Extended Magnitude-Selective Affine Functions for 5G Handset Power Amplifiers With Load Mismatch", MTT, Mar 2022
    - https://ieeexplore.ieee.org/document/9733181
    - DOI: 10.1109/TMTT.2022.3152766
16. J. Pang, C. Chu, J. Wu, Z. Dai, M. Li, S. He, A. Zhu, "Broadband GaN MMIC Doherty Power Amplifier Using Continuous-Mode Combining for 5G Sub-6 GHz Applications", JSSC, Feb 2022
    - https://ieeexplore.ieee.org/document/9701663
    - DOI: 10.1109/JSSC.2022.3145349
17. C. Chu,.... A. Zhu, "Waveform Engineered Sequential Load Modulated Balanced Amplifier With Continuous Class-F–1 and Class-J Operation", MTT, Feb 2022
    - https://ieeexplore.ieee.org/document/9612005
    - DOI: 10.1109/TMTT.2021.3123678
18. H. M. Nguyen, J. S. Walling, A. Zhu, R. B. Staszewski , "A mm-Wave Switched-Capacitor RFDAC", JSSC, Feb 2022
    - https://ieeexplore.ieee.org/document/9698835
    - DOI: 10.1109/JSSC.2022.3142718
19. G. Sivapalan, K. Nundy, S. Dev, B. Cardiff, D. John, "ANNet: A Lightweight Neural Network for ECG Anomaly Detection in IoT Edge Sensors", TBioCAS, Jan 2022
    - https://ieeexplore.ieee.org/document/9669005
    - DOI: 10.1109/TBCAS.2021.3137646
20. H. Shen, A. Blaq, D. John, B. Cardiff, "A Foreground Mismatch and Memory Harmonic Distortion Calibration Algorithm for TIADC", TCAS-I, Dec 2022
    - https://ieeexplore.ieee.org/document/9991970
    - DOI: 10.1109/TCSI.2022.3229208
21. D. Mai, M P Kennedy, "Optimized MASH-SR Divider Controller for Fractional-N Frequency Synthesizers", TCAS-I, Dec 2022
    - https://ieeexplore.ieee.org/document/9999158
    - DOI: 10.1109/TCSI.2022.3230634
22. V. Nguyen, F. Schembari, R. B. Staszewski, "Exploring Speed Maximization of Frequency-to-Digital Conversion for Ultra-Low-Voltage VCO-Based ADCs", TCAS-I, Nov 2022
    - https://ieeexplore.ieee.org/document/9964456
    - DOI: 10.1109/TCSI.2022.3223468
23. E. Kobal, T. Siriburanon, R. B. Staszewski, A. Zhu, "A Compact, Low-Power, Low-NF, Millimeter-Wave Cascode LNA With Magnetic Coupling Feedback in 22-nm FD-SOI CMOS for 5G Applications", TCAS-II, Nov 2022
    - https://ieeexplore.ieee.org/document/9961902
    - DOI: 10.1109/TCSII.2022.3224412

24. V. Mazzaro, M P Kennedy, "A Family of Δ Modulators With High Spur Immunity and Low Folded Nonlinearity Noise When Used in Fractional- Frequency Synthesizers", TCAS-I, Aug 2022

- https://ieeexplore.ieee.org/document/9854133
- DOI: 10.1109/TCSI.2022.3195659

25. H. Shen, D. John, B. Cardiff, "A Background Calibration for Joint Mismatch in the OFDM System With Time-Interleaved ADC", TCAS-II, June 2022

- https://ieeexplore.ieee.org/document/9793855
- DOI: 10.1109/TCSII.2022.3182235

26. E. Kobal, T. Siriburanon, X. Chen, H. M. Nguyen, R. B. Staszewski, A. Zhu, "A Gm-Boosting Technique for Millimeter-Wave Low-Noise Amplifiers in 28-nm Triple-Well Bulk CMOS Using Floating Resistor in Body Biasing", TCAS-I, Aug 2022

- https://ieeexplore.ieee.org/document/9868137
- DOI: 10.1109/TCSI.2022.3200161

27. M.P. Kennedy, V. Mazzaro and D. Mai, "Nonlinearity-Induced Spurs in Fractional-N Frequency Synthesizers", TCAS-II, Apr 2022

- https://ieeexplore.ieee.org/document/9761208
- DOI 10.1109/TCSII.2022.3169224

28. Y. Hu, T. Siriburanon, R. B. Staszewski, "Multirate Timestamp Modeling for Ultra-Low-Jitter Frequency Synthesis: A Tutorial", TCAS-II, Apr 2022

- https://ieeexplore.ieee.org/document/9765581
- DOI: 10.1109/TCSII.2022.3171498

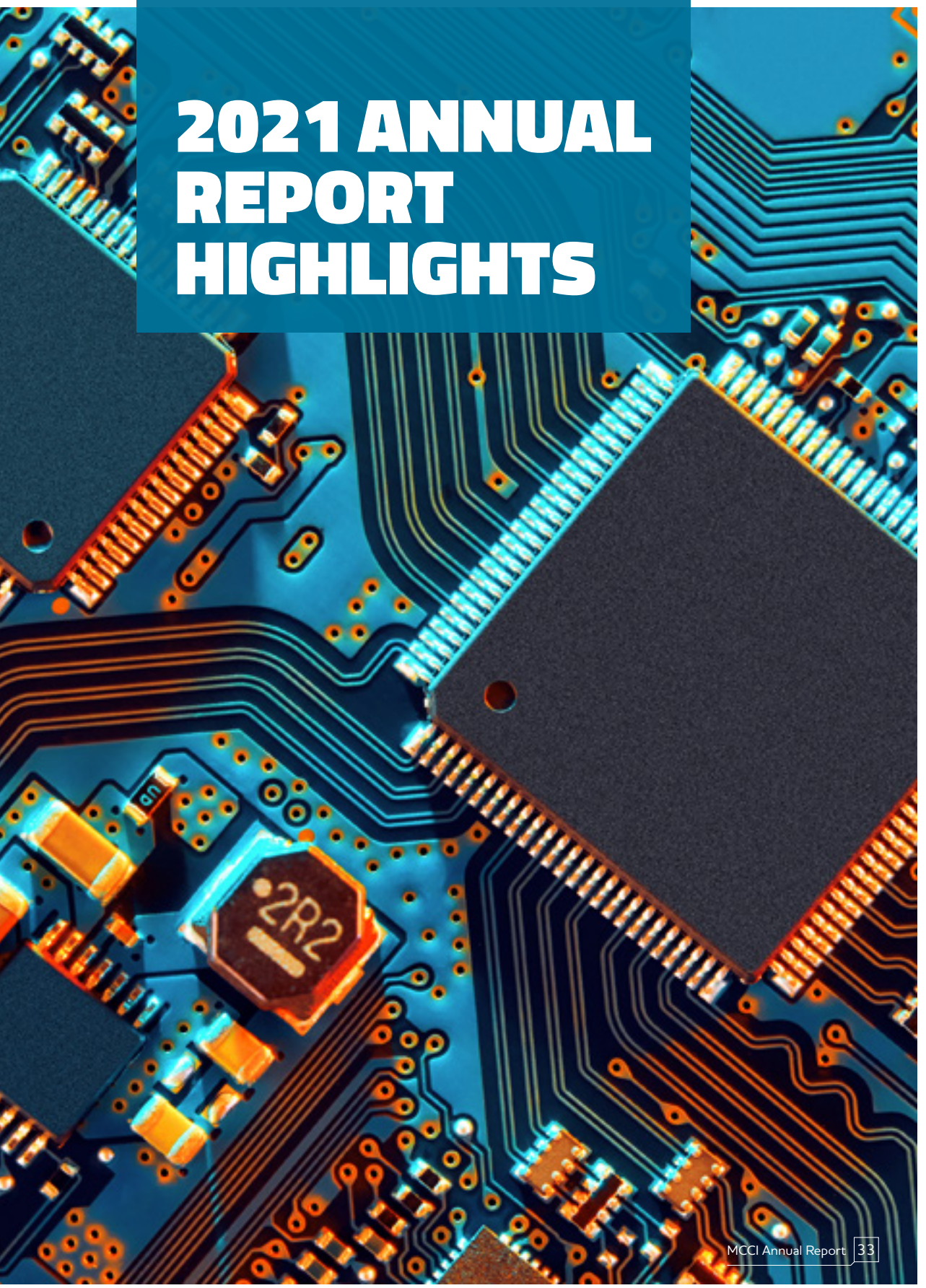
29. H. M. Nguyen, F. Zhang, I. O'Connell, R. B. Staszewski, J. S. Walling, "An Edge-Combining, Frequency Multiplying Class-D Power Amplifier", TCAS-II, Apr 2022

- https://ieeexplore.ieee.org/document/9765583
- DOI: 10.1109/TCSII.2022.3171495

30. Y. Kandeel, S. O'Driscoll, C. O'Mathuna, M. Duffy, "Multiphase 3-Level Buck Passives Analysis Including 2- Phase Coupled Inductors", APEC, Mar 2022

- https://ieeexplore.ieee.org/document/9773500
- DOI: 10.1109/APEC43599.2022.9773500

2021 ANNUAL REPORT HIGHLIGHTS



2021 ANNUAL REPORT HIGHLIGHTS

New Centre Executive Director John Morrissey Appointed to MCCI

John previously worked at Analog Devices as Product Line Director of a global product development BU based at the Limerick site.

John took up his Director of MCCI position on 14th June 2021.

He has over thirty years' experience in microelectronic product development working for Analog Devices. He has held several senior design engineering management, marketing/business executive roles in new product development at ADI.

John is a University of Limerick alumni, Bachelor of Engineering BEng degree and a graduate of an IMI MBA program. He is a member of IEEE and has presented at many international solid state circuit conferences and holder of one patent award.

Dear Members, Partners, and Stakeholders,

After my first 18 months as Executive Director, I am delighted to present the Annual Report for 2021, providing a comprehensive overview of the Microelectronic Circuit Centre of Ireland's (MCCI) accomplishments and contributions to the microelectronics industry during a challenging time when COVID- 19 restrictions were still the norm and face to face meeting and gatherings had to be managed carefully with mask wearing and social distancing was still the norm on health and safety grounds.

This report highlights our research and development initiatives, industry collaborations, education programs, and overall research performance.

In 2021, even in the grips of the global pandemic restrictions, MCCI continued to strengthen its position as a leading research centre in the field of microelectronics, driving innovation and technology advancements. We remained dedicated to supporting our Industry members and partners, fostering innovation and industry growth, while nurturing a talented workforce to meet the evolving demands of the sector.

There were many challenges that we attempted to overcome and drive on to scale up further across a broader areas of research in a semiconductor sector that is very buoyant and looking for even more collaboration across Research Centres and research Institutes across the globe.

John Morrissey
Executive Director

KEY HIGHLIGHTS 2021

MCCI PHASE 3 (2020 – 2025 RESEARCH CYCLE) SUCCESSFULLY FUNDED PROJECTS FROM ENTERPRISE IRELAND

Mr. Seamus O Driscoll

Our research will focus on the development of gate driver solutions for multi-level topologies which naturally reduce the size, cost and weight of the power passive components in systems by 4-9X. Our research will focus on the design and integration of a number of innovative intelligent gate driver features to enhance, switching speed, efficiency and performance. We will design and integrate a number of new techniques for achieving magnetic galvanic isolation between the switch driver signal and secondary side switch or bridge driver with industry's smallest transformer magnetic size. This will also enable us achieve industry's lowest gate driver output-to-input common-mode injection immunity (CMTI, CIO) from the high dV/dt switching node to the complex low voltage CMOS control system. We will research and design a novel gate driver secondary side powering system to enable the addition of new switch control and protection telemetry features for switches in multi-level architectures (automotive requires 10 ppb failure rates). Finally, we will research and design new gate-driver based control techniques which are required for GaN or emerging SiC MOSFET. For MCCI, this opens up the prospect of R&D partnerships with a new range of Irish based companies in power systems, automotive, energy and power semiconductor devices. The intent is that this proposal initially leverages ICERGi (Irish SME) base technology with very high performance system. The idea is that a subsequent collaboration will allow them create more highly integrated future generations of their technology.

Dr. Daniel O'Hare

We live in an Internet of Things (IoT) world where our environment and vital signs are monitored by hundreds of different sensors. Each iteration of the leading Smartphones incorporate more and more sensors. A traditional multi-sensor Analogue Frontend (AFE) consists of separate channels from each sensors. Each signal path is custom designed for a particular sensor and a mux connects the individual paths to a shared ADC. This implementation takes up a lot of chip area especially if the signals need large resistors and capacitors to filter out noise above 10kHz. Analogue to Digital converters have undergone a huge increase in performance in the 21st century. These improvements have meant that the power bottleneck in sensor systems is now the analogue interface not the ADC.

The circuit techniques developed in this research project will be applicable to most sensor interfaces. The project will also leverage Tyndall Sensor Technology and know-how to enable new applications in the areas such as environmental monitoring. This work is applicable to the MCCI themes of Smart Agriculture, Connected Health and Industrial.

Dr. Ivan O Connell

The group will focus on addressing the on-going research challenges associated with realising "Real-World" Precision Circuits, which address the end-application requirements. In addition, the group will also establish a research activity in the area of "Cryo-CMOS", which has 2 primary applications: Quantum Computing and Space/Satellite electronics. stage. The activity will be focused developing the precision CMOS circuits required to operate at those cryogenic temperatures. In the area of Quantum Computing, the goal of Quantum Supremacy will only be achieved by having 50 to 100 Qbits, the sensing, control and reading of these Qbits requires a significant amount of CMOS electronics which is not currently in place, especially at the necessary power levels and with the required precision. Similarly, with a growing number of satellites, it is no longer sustainable to heat all the on-board electronics to 300 Kelvin to ensure their successful operation. Instead a significant percentage of these electronics will be required to operate at the ambient space temperature which can vary significantly depending on far away it is from the various planets, the sun and stars. This will significantly reduce the cost of the satellites which is required to support the growth in this area of the coming years.The development of electrochemical sensor interfaces, will enable a raft of point of care diagnostic applications especially in the area of Smart-Agri and MedTech.

The Cyro-CMOS will enable a new generation of Satellites where the electronics operates at the ambient temperature eliminating the need for heaters and the associated solar cells to power them.

Dr. John Buckley

This proposal addresses several research challenges associated with the design of Wirelessly Powered Implantable Medical Devices (WPIMD). As shown in Fig. 1, WPIMD are miniaturized devices that can be implanted in the human body to enable continuous monitoring of physiological parameters such as blood glucose level, blood pressure and neural activity recording as well as neural stimulation and drug delivery. These devices use an external reader to provide RF power to the implant and also enable wireless transfer of data from the implant. The provision of Wireless powering removes the requirement for a battery but results in several key research challenges.

Dr. Deepu John & Dr. Barry Cardiff

Deep neural networks (DNNs), which are loosely modelled after the human brain, have been shown to be remarkably successful in recognising and interpreting patterns in many applications such as image and video processing. However, due to high computational complexity, power, and resource requirements, DNNs are not well explored for low power applications such as Internet of Things (IoT) sensors, wearable healthcare etc. IoT devices have stringent energy and resource constraints and, in many cases, deal with one-dimensional time series data.

This project will investigate novel techniques for time-series data and its hardware implementation. The project will address the challenges of implementing complex DNN models for energy efficient and performance driven IoT edge devices. The project aims to develop hardware architectures that are scalable, programmable, and easily adaptable to different DNN models and applications. The DNN architectures developed will be demonstrated in hardware for a wearable healthcare application such as heartbeat identification.

This project aims to develop energy efficient IoT sensors that can perform deep learning and pattern recognition at the edge of the network. The proposed research can potentially transform various industries, such as connected health, weather forecasting, autonomous manufacturing etc by providing improved turnaround times and lower costs, and thus will enhance the economic opportunities and competitiveness of these industries.

Prof. Peter Kennedy

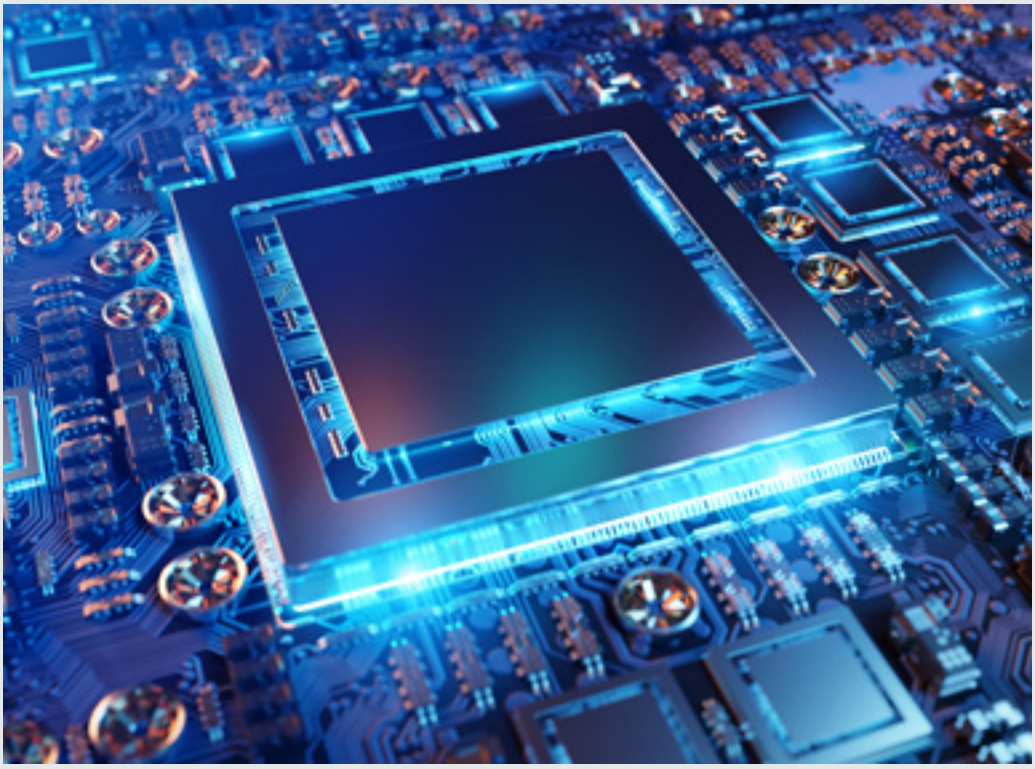
The aim of the project is to develop novel modulators which, when used in combination with quantization nonlinearities in bang-bang quantizers and DCOs, will yield better spur performance than is possible using conventional DDSMs.

The Big Idea is to exploit our understanding of the interaction between the statistics of modulators and loop nonlinearities that give rise to excess phase noise and spurs, our leadership in PMR, and our patent(s).

We will address two specific areas for improvement: designing (i) an alternative to a MASH to implement fractional-N division and (ii) a high-speed

Many MCCI companies have an interest in PLLs. Most are currently using CP-PLLs. It is important to keep abreast of rapid developments in BB-PLLs and, if possible, to gain a competitive advantage by exploiting PMR.

The project explores ideas at architectural level and will necessarily neglect many practical implementation issues. Assuming the expected improvements in performance are achieved, the next steps will be to move to circuit level simulations and then to implement integrated circuit demonstrators in partnership with MCCI companies.



Prof. Bogdan Staszewski

The migration from analogue to digital-intensive architectures is a trend in transmitter design, especially applicable for 5G networks. For years, researchers have tried to push the transceivers, not only at single GHz-bands but also at mmW frequencies, into fully digital domain for full integration into single chip devices. The transmitter for mmW 5G application has been developed for many years to obtain better performance and also, from the design perspective. In order to have an outstanding RFDAC that supports future 5G applications, our target is to continue optimizing a frequency-multiplied switched-capacitor RFDAC to obtain higher resolution for better EVM and ACPR. Simultaneously, applying the AI-assisted algorithm to improve AM-AM and AM-PM linearity performance. The outcome of this project will be a mmW RFDAC which can support wide bandwidths of up to 2GHz at 28GHz carrier frequency so that it can be deployed in the 5G mobile transmitters. This project will benefit the Irish IC industry involved in mmW 5G.

Dr. Yizhe Hu & Prof. Bogdan Staszewski

A ground-breaking fractional-N frequency synthesis technique at mmW (28 GHz), called charge-sharing locking (CSL), for sub-100fs jitter with less than 20 mW power consumption will be introduced. It naturally supports the fractional-N operation, low power consumption, and PVT robustness. The CSL technique can be also applied to 5G-IoT sub-mW fractional-N PLL based on ring oscillators, achieving < 300fs jitter. Further, it is able to be extendable to all applications based on ADPLLs (e.g. phase modulator, digital transmitter, FMCW radar...) with achieving an order-of-magnitude better performance in phase noise or power consumptions.

MCCI RESEARCHERS RECEIVE FUNDING IN ENTERPRISE IRELAND CAPITAL EQUIPMENT FUNDING CALL

Dr. Ivan O'Connell, Head of Precision Circuits and Dr. Darren F. Kavanagh Principal Investigator, were successful in the Enterprise Ireland Capital Equipment Funding Call. MCCI, is proud to be part of the Technology Centre Programme, a joint initiative between Enterprise Ireland and IDA Ireland. The technology Centres programme is resourced by highly qualified researchers who provide a unique ecosystem for collaboration in strategically important areas.

Commenting on the funding, John Morrissey, Executive Director, MCCI, said, "Congratulations to Dr. Kavanagh and Dr. O' Connell who have received funding for their highly innovative projects. Our research team work tirelessly to deliver on our research roadmap which is focused on leading edge innovations for broad range of leading edge applications. These range from future networks to communications; Internet of Things (IOT); medical device technologies; smart agri to neuromorphic and quantum computing. The funding will enable MCCI to purchase new leading-edge equipment, engage with our industry partners on emerging technologies that have a future need for industry and societal impact."

Dr Ivan O'Connell's project entitled "High End Vector Generator for Testing High Speed Analog Converters" will enable the testing of high performance analog converters and RF Chipsets. It will enable the testing and generation of Complex modulated signals up to 44 GHz, Supply for multiple modulation techniques,support for both I and Q paths and Ultra-low phase noise to enable best in class capability.

Dr Darren Francis Kavanagh's project "Electronics R&D Testbench Equipment" will focus on the creation of an extremely valuable Electronics R&D Test bench facility at the engCORE research lab at the Institute of Technology Carlow. The equipment will enable measurement, test and characterisation of electronic circuits and systems and prototypes.

PREMIER KNOWLEDGE TRANSFER EVENTS:

MTC – MCCI's first virtual technical conference took place from 15th to 17th June due to COVID-19 restrictions. A very successful virtual event was achieved using Zoom link dial-in. MTC is an exclusive member event, where guests will get pre-publication access to upcoming papers and direct access to our researchers.

The following sessions took place with 3 short 3 hr sessions over the course of 3 days with each session having an industry and academic chairperson to manage the sessions.

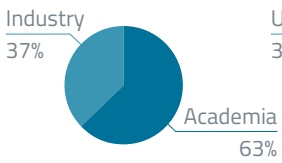
Session One – RF Circuits

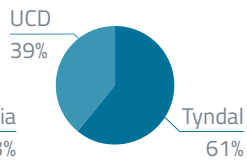
Session Two –PLLs and Oscillators

Session Three – ADCs and Sensors

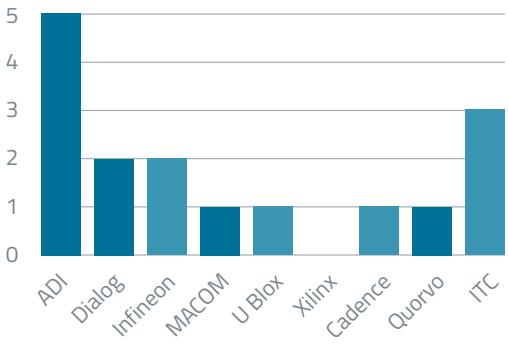
MTC'21 Attendance Statistics:

- 141 attendees
- 10 companies in attendance
- 122hrs of industry
- Engagement





Industry Audience



MCCI HOSTED AACD 2021 "ADVANCES IN ANALOG CIRCUIT DESIGN" VIRTUAL WORKSHOP

For the first time in AACD's history, this landmark conference is a fully virtual event boasting record registration figures more than 650 people. MCCI was the proud sponsor and organiser of AACD 2021 which was held over 6 days in March 2021. MCCI was due to host the event in Cork in 2020, but due to the COVID-19 pandemic, the team made the decision to host it online, thereby enabling a record attendance given everyone was now working from home very effectively.

AACD brings together experts from Industry and academia who are advancing the frontiers of analog circuit design to brainstorm on new future possibilities. The themes for the conference were:

Analog Circuits for Machine Learning

Current, Voltage and Temperature Sensors

High-Speed Communication

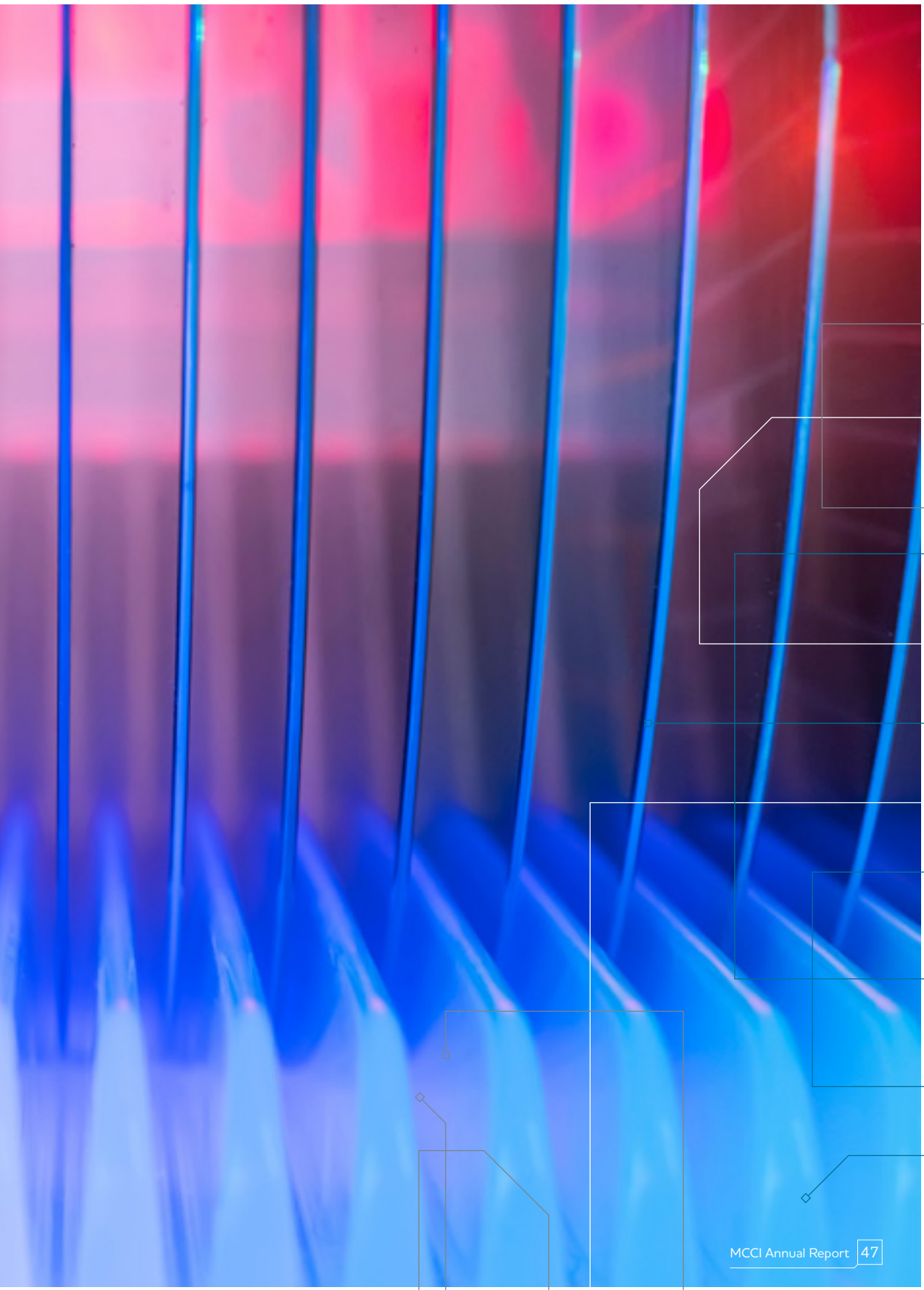
- 565hrs of industrt engagement
- Attendance by day

Day	Total Participants
Day 1	229
Day 2	170
Day 3	177
Day 4	130
Day 5	134
Day 6	109

MCCI RESEARCH PUBLICATIONS DURING 2021

An impressive 31 papers were published in IEEE tier1 journals from the research group during 2021. This was a record from the group and shows the level of maturity and scale of the funded projects from MCCI.

RESEARCH PUBLICATIONS



PUBLICATIONS

1. X. Wang, Y. Li, H. Yin, C. Yu, Z. Yu, W. Hong, A. Zhu, "Digital Predistortion of 5G Multiuser MIMO Transmitters Using Low-Dimensional Feature-Based Model Generation", MTT, Dec 2021
   - https://ieeexplore.ieee.org/document/9635696
   - DOI: 10.1109/TMTT.2021.3129777
2. Y. Li, X. Wang, A. Zhu, "Reducing Power Consumption of Digital Predistortion for RF Power Amplifiers Using Real-Time Model Switching", MTT, Dec 2021
   - https://ieeexplore.ieee.org/document/9653793
   - DOI: 10.1109/TMTT.2021.3132347
3. M. Saeed, Q. Wang,... B. Cardiff, D. John, "Evaluation of Level-Crossing ADCs for Event-Driven ECG Classification", TBioCAS, Dec 2021
   - https://ieeexplore.ieee.org/document/9655502
   - DOI: 10.1109/TBCAS.2021.3136206
4. A. John, K. Nundy, B. Cardiff, and D. John, "Multimodal Multiresolution Data Fusion Using Convolutional Neural Networks for IoT Wearable Sensing", TBioCAS, Dec 2021
   - https://ieeexplore.ieee.org/document/9645245
   - DOI: 10.1109/TBCAS.2021.3134043
5. Y. Chen, J. Gong, R. B. Staszewski and M. Babaie, "A Fractional-N Digitally Intensive PLL Achieving 428-fs Jitter and <-54 dBc Spurs Under 50-mVpp Supply Ripple," JSSC, Nov 2021
   - https://ieeexplore.ieee.org/document/9612718
   - DOI: 10.1109/JSSC.2021.3123386
6. S. Dartizio,... L. Avallone,... M. P. Kennedy,.. S. Levantino, "A 12.9-to-15.1GHz Digital PLL Based on a Bang-Bang Phase Detector with Adaptively Optimized Noise Shaping Achieving 107.6fs Integrated Jitter", JSSC, Oct 2021
   - https://ieeexplore.ieee.org/document/9566605
   - DOI: 10.1109/JSSC.2021.3116860
7. J. Du, T. Siriburanon, X. Chen, Y. Hu, V. Govindaraj, A. Zhu, R. B. Staszewski, "A Millimeter-Wave ADPLL With Reference Oversampling and Third-Harmonic Extraction Featuring High FoMjitter-N", SSC-L, Oct 2021
   - DOI: 10.1109/LSSC.2021.3124130
   - https://ieeexplore.ieee.org/document/9594074
8. V. Nguyen, F. Schembari, R. B. Staszewski, "A Deep-Subthreshold Variation-Aware 0.2-V Open-Loop VCO-Based ADC", JSSC, Oct 2021
   - DOI: 10.1109/JSSC.2021.3114006
   - https://ieeexplore.ieee.org/document/9568690
9. Li Y, Wang X, Pang J, Zhu A, "Boosted Model Tree-Based Behavioral Modeling for Digital Predistortion of RF Power Amplifiers", MTT, Sep 2021
   - DOI: 10.1109/TMTT.2021.3081096
   - https://ieeexplore.ieee.org/document/9443030
10. Y. Hu, X. Chen, T. Siriburanon, J. Du, V. Govindaraj, A. Zhu and R. B. Staszewski, "A Charge-Sharing Locking Technique With a General Phase Noise Theory of Injection Locking". JSSC, Sep 2021
    - DOI: 10.1109/JSSC.2021.3106237
    - https://ieeexplore.ieee.org/document/9530245
11. D. Mai, Y. Donnelly, M. P. Kennedy, S. Tulisi, J. Breslin, P. Griffin, M. Connor, S. Brookes, B. Shelly and M. Keaveney, "Experimental Verification of Wandering Spur Suppression Technique in a 4.9GHz Fractional-N Frequency Synthesizer", ESSCIRC, Sept 2021
    - https://ieeexplore.ieee.org/document/9567841
    - DOI: 10.1109/ESSCIRC53450.2021.9567841
12. A. Bozorg and R. B. Staszewski, "A Charge-Rotating IIR Filter with Linear Interpolation and High Stop-Band Rejection", ESSCIRC, Sept 2021
    - https://ieeexplore.ieee.org/document/9567811
    - DOI: 10.1109/ESSCIRC53450.2021.9567811

13. E. Kobal, T. Siriburanon, R. B. Staszewski and A. Zhu, "A 28 GHz Switched-Filter Phase Shifter with Fine Phase-Tuning Capability Using Back-Gate Biasing in 22 nm FD-SOI CMOS", ESSCIRC, Sept 2021
    - https://ieeexplore.ieee.org/document/9567845
    - DOI: 10.1109/ESSCIRC53450.2021.9567845
14. J. Du, T. Siriburanon, Y. Hu, V. Govindaraj and R. B. Staszewski, "A Reference-Waveform Oversampling Technique in a Fractional-N ADPLL," JSSC, Aug 2021
    - DOI: 10.1109/JSSC.2021.3101046
    - https://ieeexplore.ieee.org/document/9511426
15. J. Du, Y. Hu, T. Siriburanon, E. Kobal, P. Quinlan, A. Zhu and R. B. Staszewski, "A Compact 0.2–0.3-V Inverse-Class-F23 Oscillator for Low 1/f3 Noise over Wide Tuning Range," JSSC, Aug 2021
    - DOI: 10.1109/JSSC.2021.3098770
    - https://ieeexplore.ieee.org/document/9502919
16. Q. Luo, ...X. Wang, C. Chu, A. Zhu, " Linearization Angle Widened Digital Predistortion for 5G MIMO Beamforming Transmitters", MTT, July 2021
    - https://ieeexplore.ieee.org/document/9497659
    - DOI: 10.1109/TMTT.2021.3098600
17. A. Bozorg and R. B. Staszewski, "A clock-phase reuse technique for discrete-time band-pass filters," JSSC, June 2021
    - https://ieeexplore.ieee.org/document/9463914
    - DOI: 10.1109/JSSC.2021.3086621
18. J. Du, T. Siriburanon, X. Chen, Y. Hu, V. Govindaraj, A. Zhu and R. B. Staszewski , "A 24-31 GHz Reference Oversampling ADPLL Achieving FoMjitter-N of -269.3 dB", VLSI, June 2021
    - https://ieeexplore.ieee.org/abstract/document/9492340
    - DOI: 10.23919/VLSICircuits52068.2021.9492340
19. P. Chen, F. Zhang, S. Hu and R. B. Staszewski, "A Feedforward and Feedback Constant-Slope Digital-to-Time Converter in 28nm CMOS Achieving ≤ 0.12% INL/Range over >100mV Supply Range", VLSI, June 2021
20. H. M. Nguyen, J. S. Walling, A. Zhu, R. B. Staszewski , "A Ka-Band Switched-Capacitor RFDAC Using Edge-Combining in 22nm FD-SOI", VLSI, June 2021
    - https://ieeexplore.ieee.org/document/9492451
    - DOI: 10.23919/VLSICircuits52068.2021.9492451
21. R. B. Staszewski, "Quantum Computer on a Chip," Workshop (1-hr), WSE-8, "Cryogenic Electronics for Quantum Computing and Beyond: Applications, Devices, and Circuits", RFIC, June 2021
22. A. John, B. Cardiff, D. John, "A 1D-CNN Based Deep Learning Technique for Sleep Apnea Detection in IoT Sensors", ISCAS, May 2021 (conf sched)
    - https://ieeexplore.ieee.org/document/9401300
    - DOI: 10.1109/ISCAS51556.2021.9401300
23. M. Saeed, Q. Wang, O. Märtens, B. Larras, A. Frappé, B. Cardiff, D. John, "Event-Driven ECG Classification Using an Open-Source, LC-ADC Based Non-Uniformly Sampled Dataset", ISCAS, May 2021
    - https://ieeexplore.ieee.org/document/9401333
    - DOI: 10.1109/ISCAS51556.2021.9401333
24. C. Smyth, G. Wang, R. Panicker, A. Nag, B. Cardiff, D. John, "Continuous User Authentication Using IoT Wearable Sensors", ISCAS, May 2021
    - https://ieeexplore.ieee.org/document/9401741
    - DOI: 10.1109/ISCAS51556.2021.9401741
25. S. Hu, P. Chen, P. Quinlan and R. B. Staszewski, "A 0.7-V Sub-mW Type-II Phase-Tracking Bluetooth Low Energy Receiver in 28-nm CMOS," JSSC, April 2021
    - https://ieeexplore.ieee.org/document/9397874
    - DOI: 10.1109/TCSI.2021.3070782.

26. Li Y, Wang X, Zhu A, "Complexity-Reduced Model Adaptation for Digital Predistortion of RF Power Amplifiers with Pretraining-Based Feature Extraction", MTT, Mar 2021

- https://ieeexplore.ieee.org/document/9286857
- DOI: 10.1109/TMTT.2020.3039788

27. Y Xu, J Pang, X Wang, A Zhu, "Three-Stage Load Modulated Power Amplifier With Efficiency Enhancement at Power Back-Off", MTT, Mar 2021

- https://ieeexplore.ieee.org/document/9372838
- DOI: 10.1109/TMTT.2021.3061436

28. Yang Xu, Jingzhou Pang, Xiaoyu Wang, Anding Zhu, "Enhancing bandwidth and back-off range of Doherty power amplifier with modified load modulation network", MTT, Feb 2021

- https://ieeexplore.ieee.org/document/9354111
- DOI: 10.1109/TMTT.2021.3056402

29. M. Mercandelli,... L. Avallone,... M. P. Kennedy,.. S. Levantino, "A 12.9-to-15.1GHz Digital PLL Based on a Bang-Bang Phase Detector with Adaptively Optimized Noise Shaping Achieving 107.6fs Integrated Jitter", ISSCC, Feb 2021

- https://ieeexplore.ieee.org/document/9365768
- DOI: 10.1109/ISSCC42613.2021.9365768

30. A. Santicciolli,... L. Avallone,... M. P. Kennedy,.. S. Levantino, "A 98.4fs-Jitter 12.9-to-15.1GHz PLL-Based LO Phase-Shifting System with Digital Background Phase-Offset Correction for Integrated Phased Arrays", ISSCC, Feb 2021

- https://ieeexplore.ieee.org/document/9365972
- DOI: 10.1109/ISSCC42613.2021.9365972

31. A. Bozorg and R. B. Staszewski, "A 0.02–4.5 GHz LN(T)A in 28-nm CMOS for 5G exploiting noise reduction and current reuse," JSSC, Feb. 2021

- https://ieeexplore.ieee.org/document/9186793
- DOI: 10.1109/JSSC.2020.3018680

32. G. Nikandish, R. B. Staszewski and A. Zhu, "Unbalanced power amplifier: An architecture for broadband back-off efficiency enhancement," JSSC, Feb. 2021

- https://ieeexplore.ieee.org/document/9173563
- DOI: 10.1109/JSSC.2020.3014244

33. X. Chen, Y. Hu, T. Siriburanon, J. Du, R. B. Staszewski and A. Zhu, "Flicker Phase-Noise Reduction Using Gate–Drain Phase Shift in Transformer-Based Oscillators", TCAS-I, Dec 2021

- https://ieeexplore.ieee.org/document/9640618
- DOI: 10.1109/TCSI.2021.3131968

34. Mazzaro V, Kennedy MP, "Folded Noise Prediction in Nonlinear Fractional-N Frequency Synthesizers", TCAS-I, Aug 2021

- https://ieeexplore.ieee.org/document/9521548
- DOI: 10.1109/TCSI.2021.3104275

35. Avallone L, Mercandelli M, Santiccioli A, Kennedy MP, Levantino S, Samori C, "A Comprehensive Phase Noise Analysis of Bang-Bang Digital PLLs", TCAS-I, Jul 2021

- https://ieeexplore.ieee.org/document/9406179
- DOI: 10.1109/TCSI.2021.3072344

36. Donnelly Y, Kennedy MP, "An Algorithm for Implementing a Modulator Whose Output Is Spur-Free After Nonlinear Distortion", TCAS-I, July 2021

- https://ieeexplore.ieee.org/document/9499510
- DOI: 10.1109/TCSI.2021.3098901

37. A. Bozorg and R. B. Staszewski, "A 20 MHz – 2 GHz Inductorless Two-Fold Noise-Canceling Low-Noise Amplifier in 28-nm CMOS," TCAS-I, July 2021

- DOI: 10.1109/TCSI.2021.3092960
- https://ieeexplore.ieee.org/document/9493708

38. G. R. Nikandish, A. Nasri, A. Yousefi, A. Zhu and R. B. Staszewski, "A Broadband Fully Integrated Power Amplifier Using Waveform Shaping Multi-Resonance Harmonic Matching Network," TCAS-I, July 2021

- DOI: 10.1109/TCSI.2021.3095708
- https://ieeexplore.ieee.org/document/9484677

39. Mazzaro V, Kennedy MP, "Spur Immunity in MASH-Based Fractional-N CP-PLLs with Polynomial Nonlinearities", TCAS-I, Jun 2021

- https://ieeexplore.ieee.org/document/9374752
- DOI: 10.1109/TCSI.2021.3063206

40. S. Hu, P. Chen, P. Quinlan and R. B. Staszewski, "A 0.7-V Sub-mW Type-II Phase-Tracking Bluetooth Low Energy Receiver in 28-nm CMOS," TCAS-I, April. 2021

- https://ieeexplore.ieee.org/document/9397874
- DOI: 10.1109/TCSI.2021.3070782

41. R. Murphy, P. McCloskey, Z. Cao, C. Ó Mathúna, S. O'Driscoll, "High Frequency Magnetic Sheet Materials – Performance Factor Comparisons and Design of Toroidal Inductors Embedded in PCB", APEC, June 2021

- https://ieeexplore.ieee.org/document/9487131
- DOI: 10.1109/APEC42165.2021.9487131

42. A. John, S. J. Redmond, B. Cardiff, D. John, "A Multimodal Data Fusion Technique for Heartbeat Detection in Wearable IoT Sensors", JIOT, June 2021

- https://ieeexplore.ieee.org/abstract/document/9466940
- DOI: 10.1109/JIOT.2021.3093112

43. F. Zhang, P. Chen, J. S. Walling, A. Zhu, R.B. Staszewski, "An Active-under-Coil RFDAC with Analog Linear Interpolation in 28-nm CMOS", TCAS-I, Feb 2021

- https://ieeexplore.ieee.org/document/9361220
- DOI: 10.1109/TCSI.2021.3059368

44. Y. Hu, T. Siriburanon and R. B. Staszewski, "Oscillator Flicker Phase Noise: A tutorial," TCAS-II, Feb. 2021

- https://ieeexplore.ieee.org/document/9286468
- DOI: 10.1109/TCSII.2020.3043165

45. A. Esmailiyan, J. Du, T. Siriburanon, F. Schembari and R. B. Staszewski, "Dickson-charge-pump-based voltage-to-time conversion for time-based ADCs in 28nm CMOS," IEEE Open Journal of Circuits and Systems (OJ-CAS), Jan. 2021

- https://ieeexplore.ieee.org/document/9290350
- DOI: 10.1109/OJCAS.2020.3043094

46. G. Nikandish, R. B. Staszewski and A. Zhu, "A fully integrated GaN dual-channel power amplifier with crosstalk suppression for 5G massive MIMO transmitters," TCAS-II, Jan. 2021

- https://ieeexplore.ieee.org/document/9138457
- DOI: 10.1109/TCSII.2020.3008365

47. D. Mai, M. P. Kennedy, "MASH-Based Divider Controllers for Mitigation of Wandering Spurs in a Fractional-N Frequency Synthesizer", TCAS-I, Jan 2021

- https://ieeexplore.ieee.org/document/9264725
- DOI: 10.1109/TCSI.2020.3035538

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