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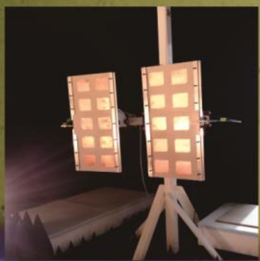
# Abstracts of

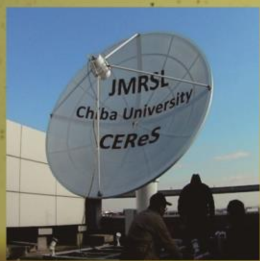
# The 7th Indonesia Japan Joint Scientific Symposium

## The 24th CEReS International Symposium

## The 4th Symposium on Microsatellite for Remote Sensing (SOMIRES 2016)

## The 1st Symposium on Innovative Microwave Remote Sensing






## November 21-24, 2016
## Keyaki Convention Hall, Chiba University

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IJJSS 2016

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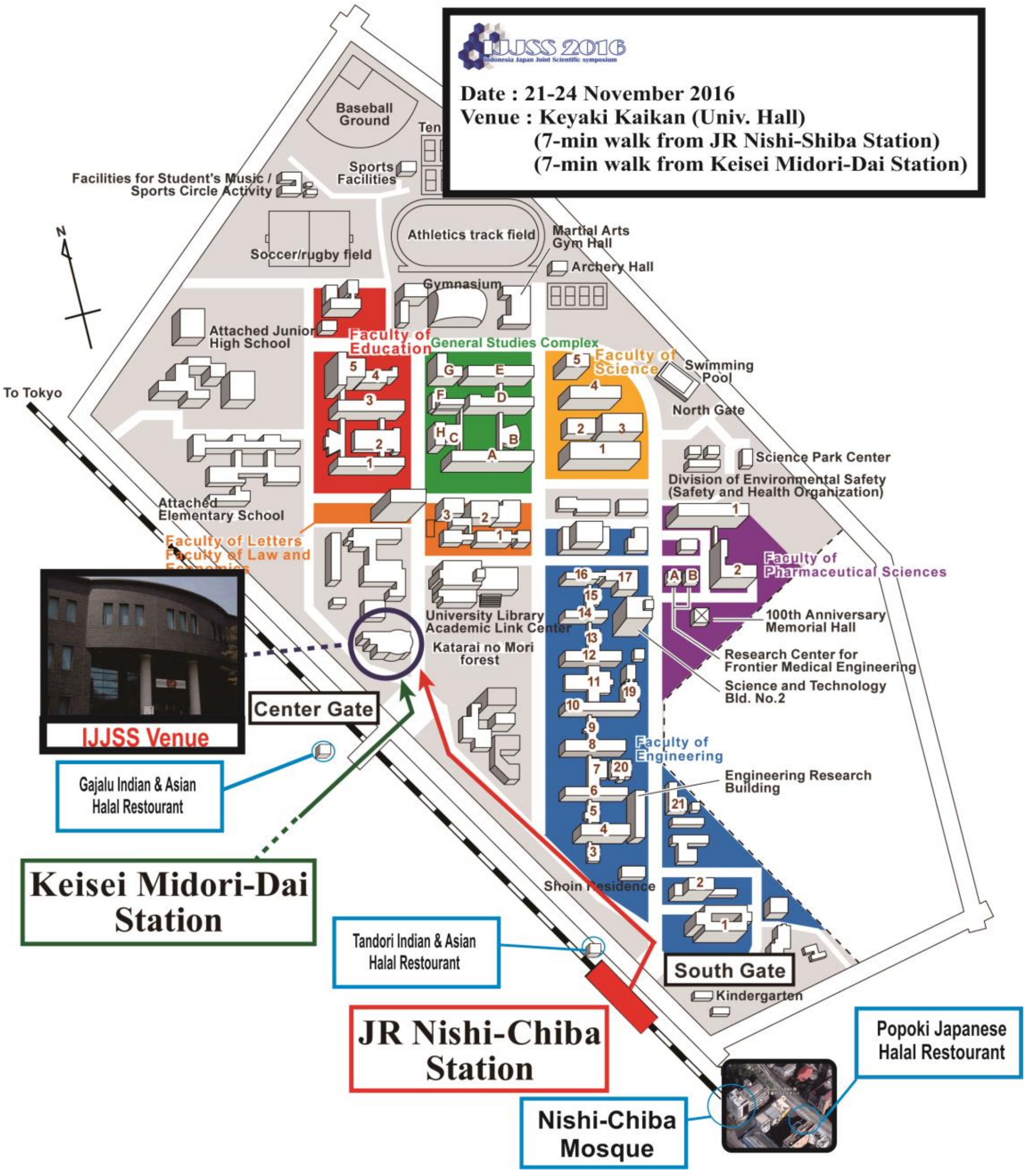
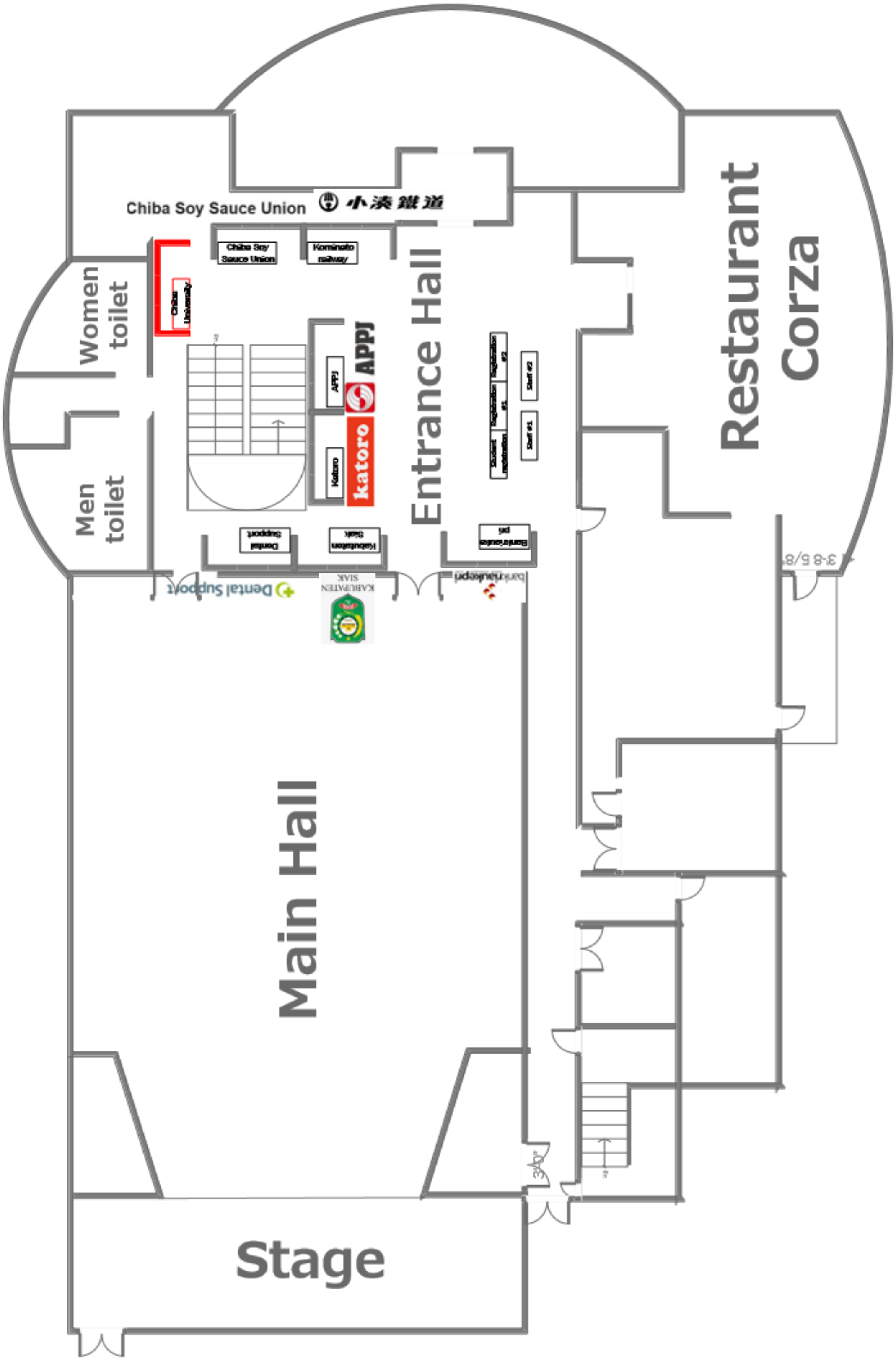
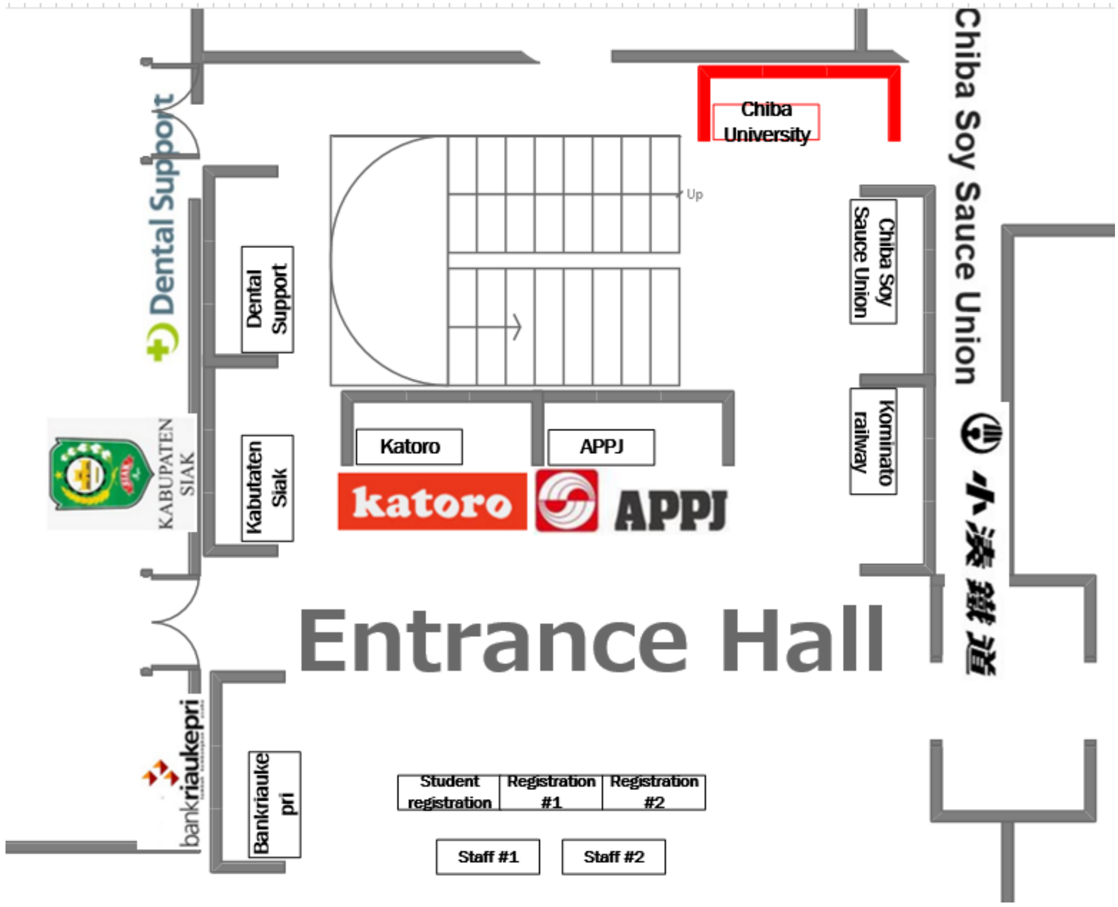


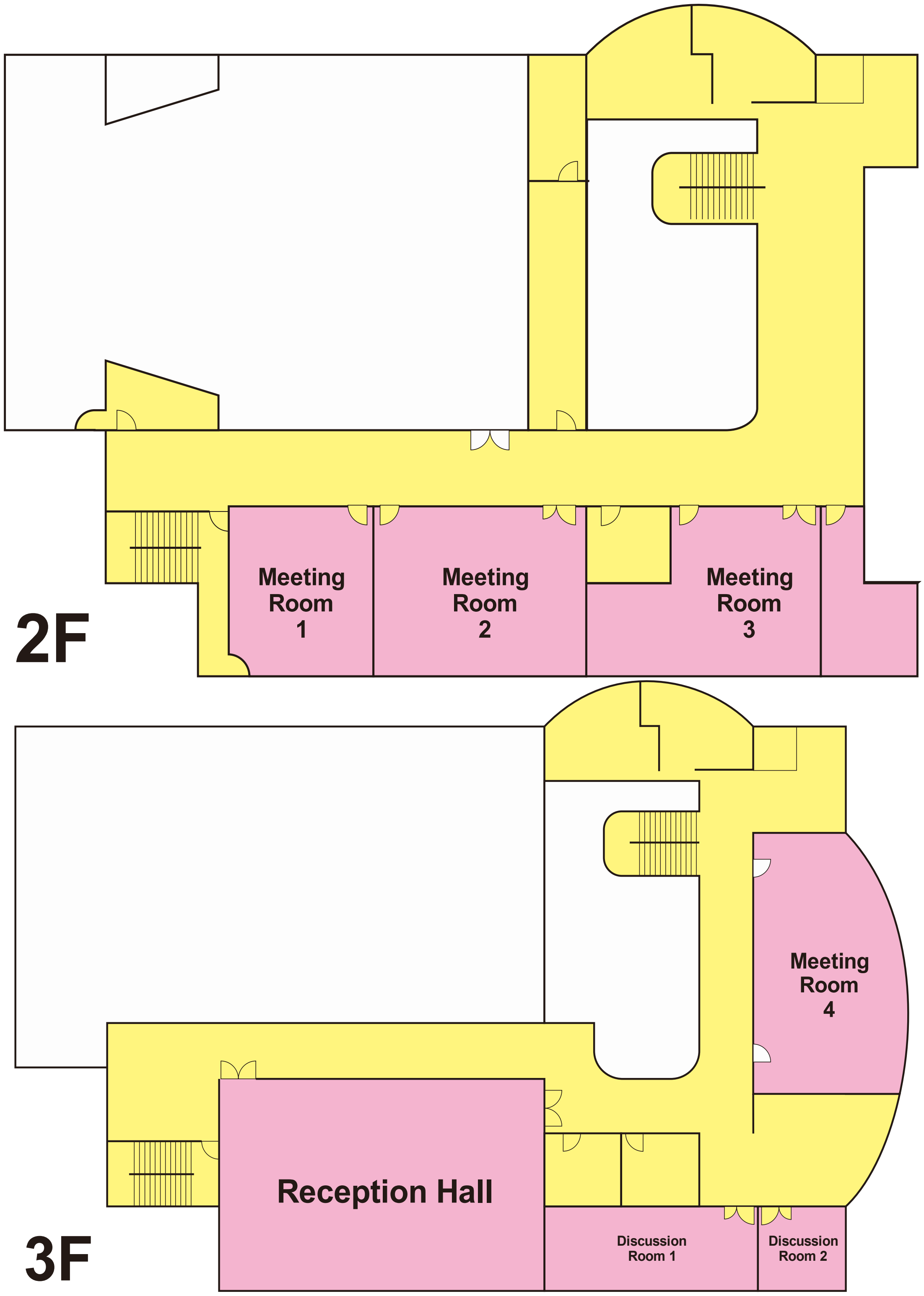

Chiba University and IJJSS Venue Map




1st floor of Keyaki Convention Hall




Layout of Sponsorship and Registration Booth
at 1st floor of Keyaki Convention Hall




2nd and 3rd floor of Keyaki Convention Hall

# The 7th Indonesia–Japan Joint Scientific Symposium
# The 24th CEReS International Symposium
# The 4th Symposium on Microsatellites for Remote Sensing
# The Symposium on Innovative Microwave Remote Sensing
# at a Glance

November 21-24, 2016
Keyaki Convention Hall, Chiba University

| Monday, November 21 | |
|---|---|
| 09:30-12:00 | Opening Ceremony<br>(Moderator : Dr Takenobu Aoki and Meidesta Pitria) |
| | Opening Remark :<br>General Chairman Prof Hiroaki Kuze |
| | Opening Speech :<br>Rector of Chiba University – Prof Takeshi Tokuhisa |
| | Opening Speech :<br>Vice President of University of Indonesia – Prof Bambang Wibawarta |
| | Inauguration Ceremony of New Sister University :<br>Universitas Islam Riau (UIR) – Chiba University |
| | Inauguration Ceremony of International Collaboration :<br>Regency of Siak – Center for Environmental Remote Sensing |
| | **Keynote Speech (1)** – Prof Yoshifumi Yasuoka<br>**Keynote Speech (2)** – Prof Eko Tjipto Rahardjo<br>**Keynote Speech (3)** – Drs. H. Syamsuar, M.Si |
| 11:45-12:00 | Symposium Memorial Photograph |
| 12:00-13:30 | Lunch |
| 13:30-17:00 | Laboratory / Research center visiting<br>Prof Hiroaki Kuze – Lidar Facility<br>Prof Josaphat Tetuko Sri Sumantyo – Microwave Remote Sensing Facility<br>Prof Hitoshi Irie – Atmospheric Research Facility<br>Prof Atsushi Higuchi – Himawari-8 Facility (Dr Koichi Toyoshima)<br>Prof Naoko Saito – GOSAT Facility<br>Prof Katsumi Hattori – Geohazard Research<br>Prof Shogo Shimazu – Chemistry Research Facility<br>Prof Hiroshi Asanuma – Mechanical Engineering<br>Prof Motoi Machida – Chemistry Research Facility (22 November 2016 08:00 to 15:30) |
| 13:30-15:00 | Alumni Meeting – 3F Reception Hall (Prof Ryoko Niikura)<br>Opening speech<br>– Rector of Chiba University : Prof Takeshi Tokuhisa |

| Monday, November 21 | |
|---|---|
| 15:00-17:00 | Business Forum - Keyaki Kaikan Hall (Prof. Kenichi Sakakibara)<br>– Bank Riau Kepri<br>– Kabupaten Siak<br>– Kantodensi<br>– APPJ<br>– Dental Support (Prof. Takeshi UCHIDA, R.Ph., Ph.D)<br>*"The Challenge of Medical and Care Supporting System in Japanese Hyper Aging Society"* – BF001 |
| 17:00-19:00 | Welcome party – 3F Reception Hall<br>Opening speech :<br>– Rector of Chiba University : Prof Takeshi Tokuhisa<br>– General Chairman : Prof Hiroaki Kuze<br>– Kanpai (Opening toast) : Prof Ryutaro Tateishi<br>Japanese traditional dance :<br>– Fuuryuu Funazoroi – Fujima Kanhiroyuki<br>Indonesian traditional dance :<br>– Gunung Sari – Siina Takanobu<br>Introduction of delegations |

| Tuesday, November 22 | |
|---|---|
| 09:30-16:00 | Parallel Oral Presentation Session |
| 16:00-17:00 | Poster session |
| 17:00-19:00 | Banquet – 3F Reception Hall<br>Opening speech : Prof Motoi Machida<br>– Kanpai (Opening toast) : Prof Kenichi Sakakibara<br>Free talk for future exchange and collaboration<br>– Prof Katsumi Hattori<br>– Prof Kenichi Sakakibara<br>– Prof Hiroshi Asanuma |

| Wednesday, November 23 | |
|---|---|
| 09:30-15:00 | Parallel Oral Presentation Session |
| 15:30 | Closing and Awards Ceremony<br>– Best Paper Awards<br>– Best Presenter Awards<br>– Best Poster Awards<br>– Best Student Awards |

# Keynote Speech

Monday, November 21
10:15-11:45

| *10:15-11:45*<br>*Mon, Nov 21* | 7th Indonesia Japan Joint Scientific Symposium | Chair : Takenobu Aoki<br>1F Main hall |
|---|---|---|
| *10:15-10:45*<br>*KS001* |  | Prof Yoshifumi Yasuoka<br>Chiba University<br><br>*Social Implementation of Remote Sensing; how can remote sensing contribute to tackling climate change* |
| *10:45-11:15*<br>*KS002* |  | Prof Eko Tjipto Rahardjo<br>Universitas Indonesia (UI)<br><br>*Environmental impact of electromagnetic fields and waves* |
| *11:15-11:45*<br>*KS003* |  | Drs. H. Syamsuar, M.Si<br>Mayor/Regent of Regency of Siak, Riau Province, Indonesia<br><br>*The success steps of Regency of Siak in tackling environmental issues; resolving the problem of forest fires in Siak District, Riau Province; Achievement of the National Environment Award 2015 and 2016* |

| 13:00-14:00<br>Wed, Nov 23 | 7th Indonesia Japan Joint Scientific Symposium #13 | Chair : Eko T Rahardjo<br>3F Reception Hall |
|---|---|---|
| 13:00 - 13:20<br>P155 | Eko T Rahardjo<br>*Radiation Performance of X-Band Array Antenna Implemented Using Unequal Power Divider Feeding System* | |
| 13:20 - 13:40<br>P116 | Fitri Yuli Zulkifli<br>*Differential-Fed Circular Patch Antenna with High Impedance Surface Substrate* | |
| 13:40 - 14:00<br>P060 | Evizal Abdul Kadir<br>*MIMO Antenna System for Microsatellite Communications* | |
| 14:00 - 14:20<br>P056 | M Fauzan Edy Purnomo<br>Development L-Band Antena With Low Power For Circularly Polarized-Synthetic Aperture Radar (Cp-Sar) Application On Unmanned Aerial Vehicle (UAV) | |
| 14:20 - 14:40<br>P043 | Cahya Edi Santosa<br>*Circularly Polarized Microstrip Antenna with Eye-slot for X-band Synthetic Aperture Radar Application* | |

| 13:00-15:00<br>Wed, Nov 23 | 7th Indonesia Japan Joint Scientific Symposium #14 | Chair : Kenji Kuriyama<br>3F Meeting Room 4 |
|---|---|---|
| 13:00 - 13:20<br>P090 | Kenji Kuriyama<br>*Ground-based Spectral Measurements of Chlorophyll Fluorescence from Vegetation Canopies* | |
| 13:20 - 13:40<br>P115 | Muhammad Kamal<br>*The effect of field spectrometer measurement distance to the identification of Rhizophora stylosa mangrove from remote sensing imagery* | |
| 13:40 - 14:00<br>P113 | Pramaditya Wicaksono<br>*Preliminary assessment of Sentinel-2A Multispectral Image and UAV for mapping and validation of benthic habitats composition* | |
| 14:00 - 14:20<br>P026 | Derick Christopher AM<br>The Use of Hyperspectral Data to Analyze Climate Change According to Carbon Stocks and Southeast Sulawesi Biodiversity | |
| 14:20 - 14:40<br>P050 | Yuta izumi<br>*Polarimetric analysis of long term paddy rice observation using ground-based SAR (GB-SAR) system* | |
| 14:40 -15:00<br>P078 | Akhmad Arifin Hadi<br>*Exploring Attractive Landscape Elements and Sceneries in Bukit Kucing Forest Tanjungpinang by using Visitors-Employed Photography Method* | |

The 7th Indonesia Japan
Joint Scientific Symposium
(IJJSS 2016)
Chiba, 20-24 November 2016

# MIMO Antenna System for Microsatellite Communications

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Husnul Kausarian[d]

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## Abstract

A MIMO antenna system is proposed to improve data throughput limitations in multiple input multiple output for microsatellite and wireless communication systems in this investigation. The 4×4 MIMO antenna is designed to operate in the 2.4 and 2.6 GHz for Microsatellite Communication and Long Term Evolution (LTE) applications. The system's radiation pattern re-configurability is realized by using the microcontroller-driven PIN diode switching concept. Simulations and measurements exhibited good agreements for both of configuration on the 2×2 MIMO and 4×4 MIMO. The antenna is operational between 2.387 to 2.628 GHz, while the simulated and measured reflection coefficients are at least -24.3 dB. All configurations produced a narrow beam forward radiation pattern and suitable for microsatellite communication as well as LTE communication.

## Keywords

Antennas, Multiple-Input-Multiple-Output (MIMO), Microsatellite Communication, Long Term Evolution (LTE)

## 1. Introduction

Implementing reconfigurable antenna system onto wireless communication front end has significantly contributed to the improvement of wireless communication systems (WCS). Frequency, polarization, radiation pattern or their combination can be diversified to enable better WCS service delivery. Signal strength and data throughput of WCS can further be enhanced by implementing a reconfigurable system using multiple-input multiple-output (MIMO) antenna for WCS front end in such a way that antennas radiation characteristics are dynamically changed in accordance with the user's behavior such as mobility, data usage and method used to access the WCS. Hence, the introduction of the MIMO antenna system based reconfigurable front end will significantly improve the data capacity and directivity of WCSs. Researches on MIMO antenna based on frequency configurability for mobile devices are investigated in (Haitao, 2013), (Kulkarni, 2013), (Jin, 2012), (Karimian, 2012). Previous research is done on frequency re-configurability to control or steer radiation patterns for MIMO antenna designed, furthermore in these proposed frequency configurable antenna designed is mostly to switch the antenna beam. MIMO antennas which are

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reconfigurable in terms of polarization and radiation are proposed in (Pei-Yuan, 2012), (Zhengyi, 2009), (Sarrazin, 2009), (Yan, 2013) is based on antenna design such as used slot, array antenna design or butler matric to control radiation pattern and polarization. In these designs, it is only the receiver side that controls the radiation pattern of the antenna beam. The use of dielectric resonators as MIMO antennas for LTE band is presented in (Cui, 2011). However, the design covers single frequency band at 700 MHz. A compact, ultra wideband MIMO antenna for mobile device proposed in (Jae-Min, 2005). The design is achieved using a printed folded monopole antenna coupled with a parasitic inverted-L element. However, similar to the previous only for receiver side for devices, although cover wideband frequency but not in 2.6 GHz spectrum.

## 2. Reconfigurable MIMO Antenna Design

In this proposed design, individual antennas are cascaded to form the MIMO antenna system. The antenna is implemented using a low-cost FR-4 board with a relative permittivity of εr = 4.7, height, h = 1.6 mm and loss tangent, tan δ = 0.019. The single element and 2x2 MIMO antenna is designed based on the procedure described in (Balanis, 2005), (Evizal, 2014) resulting in optimized structure illustrated in Figure 1. The 2x2 array yielded a narrowband, directional antenna with high gain, and hence, slots are introduced onto the antenna to widen its 10 dB impedance bandwidth.

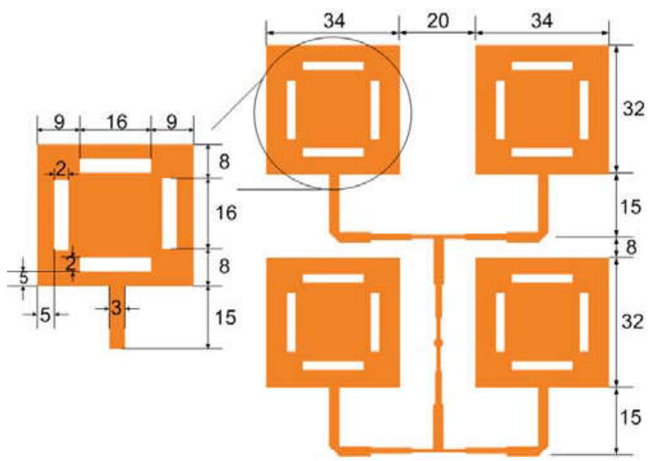
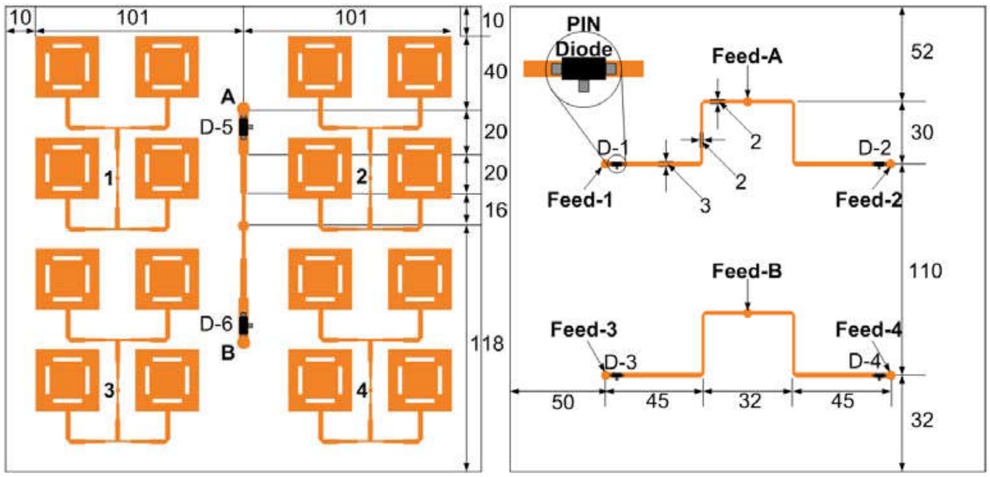



**Figure 1. Design of the single MIMO antenna (all dimensions in mm)**

The antenna elements are arranged and fed using a corporate feeding scheme. PIN diodes are used to connect the desired antenna feed to the main transmission line as shows in Figure 2, every set element of MIMO antenna has transmission line to connect or disconnect to others element in order to making array element. The locations of the radiating elements (labelled as element 1, 2, 3 and 4) and diodes on the top layer is shown in Figure 2(a), while the bottom layer antenna layer comprising transmission lines is shown in Figure 2(b). A total of 6 PIN diodes are used to connect/disconnect these lines by activating/deactivating the DC power towards each PIN diode using a microcontroller unit.




(a) (b)

**Figure 2. Design of the 4x4 MIMO antenna (a) top view (b) bottom view.**

This antenna can be switched using the PIN diode configurations listed in Table 1 to operate between three configurations:

i. Single (aggregate) mode: all elements of the antenna are set to operate as a single 4x4 array with high gain. The two 2x2 arrays are connected using a single feed centered on top of the substrate. For this configuration, all six PIN diodes are activated.
ii. Two 2x2 MIMO: Antennas 1 and 2 are connected to a transmission line to form array A. Similarly, antennas 3 and 4 are connected to the transmission line to form array B. The combination of arrays A and B produces the 2×2 MIMO antenna configuration. PIN diodes D-1 and D-2 are activated to feed power into Port A, while diodes D-3 and D-4 are activated to feed power into Port B.
iii. A 4x4 MIMO: In order to configure antenna become 4x4 MIMO with low gain because every set of MIMO antenna are working independently then antenna ports 1, 2, 3 and 4 are activated simultaneously. This configuration occurs when all the PIN diode is deactivating.

**Table 1. PIN diode settings for the three antenna configurations.**

| CONFIGURATION | DIODE | | | | | |
|---|---|---|---|---|---|---|
| | D-1 | D-2 | D-3 | D-4 | D-5 | D-6 |
| MIMO 4x4 | Off | Off | Off | Off | Off | Off |
| MIMO 2x2 | On | On | On | On | Off | Off |
| Single Antenna | On | On | On | On | On | On |

## 3. Antenna Performance Evaluation

The MIMO antenna system is fabricated and integrated with a microcontroller unit to enable its reconfigurable feature. Its prototype is shown in Figure 3. The antenna performance is first evaluated using a vector network analyzer and radiation pattern measurement system in an anechoic chamber. Experimental evaluation of the overall system is then performed in the Wireless Communication Centre (WCC) UTM, to validate its accuracy and limitation.

### 3.1 Evaluation of the MIMO Antenna

To properly evaluate the antenna reflection coefficient, radiation pattern and antenna gain, each ports are evaluated individually while the rest are terminated. Since there are four single antennas, the reflection coefficient for each port is labelled $S_{11}$, $S_{22}$, $S_{33}$ and $S_{44}$. The isolations between the antenna ports are denoted as $S_{mn}$. Meanwhile, the ports for the 2x2 MIMO are indicated as ports A and B. Their reflection coefficients are designated as SAA and SAB, while the isolations between ports are labelled as SAB and SBA. Port A is measured when only diodes D-1 and D-2 are activated, while port B when D-3 and D-4 are activated.

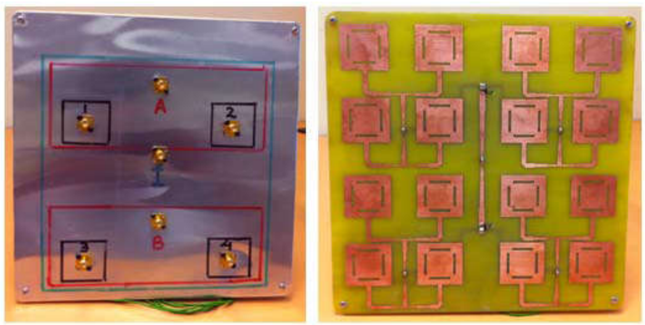



**Figure 3. The prototype of the MIMO antenna system top and bottom views.**

### 3.2 Testing

The proposed MIMO system is then implemented as an access point for Wireless Local Area Network (WLAN). User types (whether it is a laptop, smart phone, etc) accessing the internet is determined before their data throughput and radio unit is assessed. The use of the WLAN architecture in this section simplifies the assessment procedure due to its availability compared to when LTE devices are used. Figure 4 shows the WLAN access point using the developed MIMO antenna system, consisting of 3 set of Mikrotik R52 radio units and Mikrotik Router Board 133. A microcontroller model Microchip PIC16F877 is used to control the activation of PIN diodes for the MIMO system. The seven MIMO antenna ports are connected to the radio unit via coaxial cables and standard SMA connector.

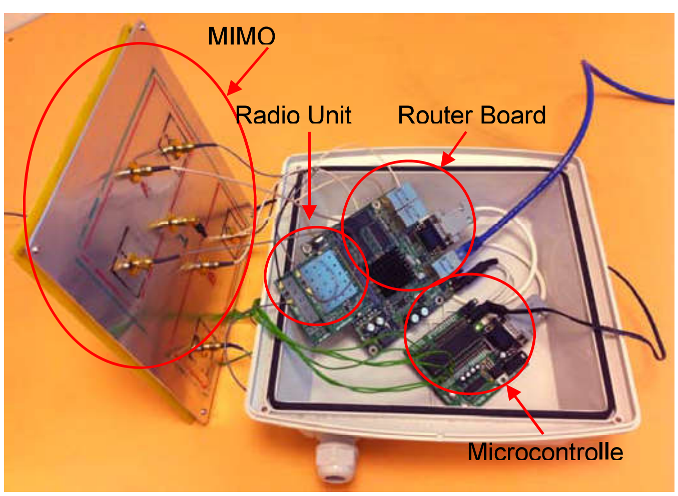



**Figure 4.Configuration of MIMO antenna system in the WLAN access point.**

## 4. Results and Discussion

The single MIMO antenna evaluated indicated a satisfactory agreement between simulation and measurement. Its measured reflection coefficient indicated operation from 2.387 to 2.628 GHz for WLAN and LTE bands see Figure 5. Simulations produced a minimum S11 of -27.8 dB at 2.45 GHz whereas the optimal measured S11 of -24.3 dB at a slightly higher frequency of 2.5 GHz.

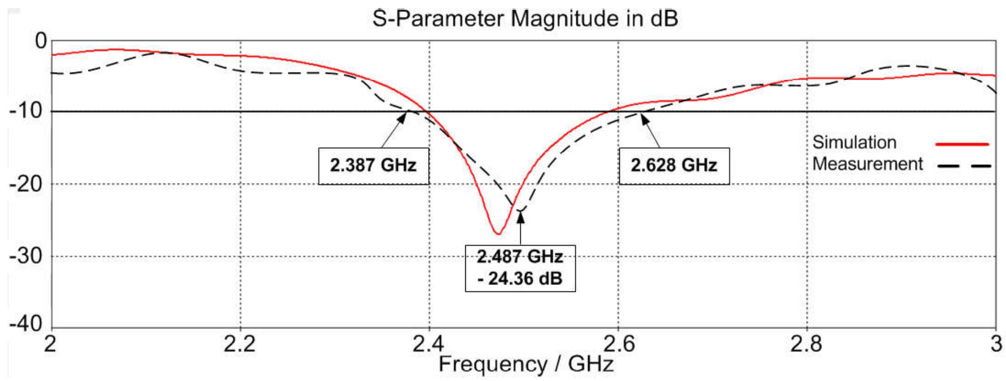



**Figure 5. Simulated and measured reflection coefficient of the single MIMO antenna.**

Isolation between the antenna ports for this antenna is also assessed and summarized in Figure 6, indicating the maximum isolation of at least 15 dB.

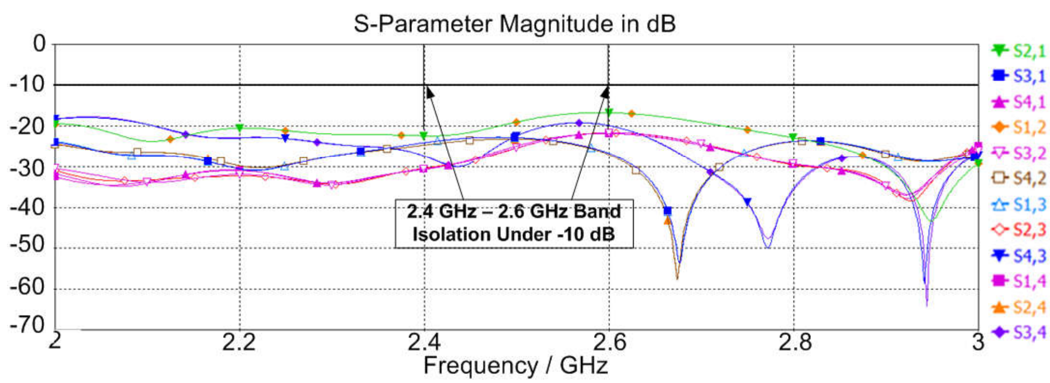
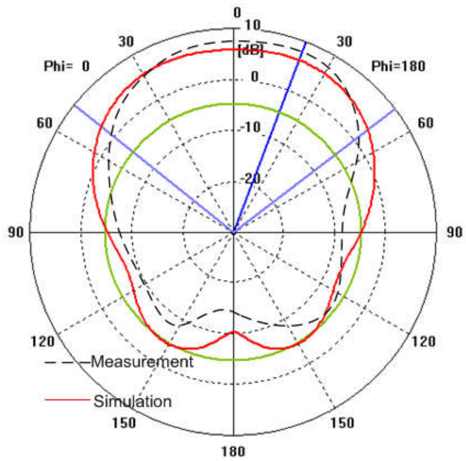
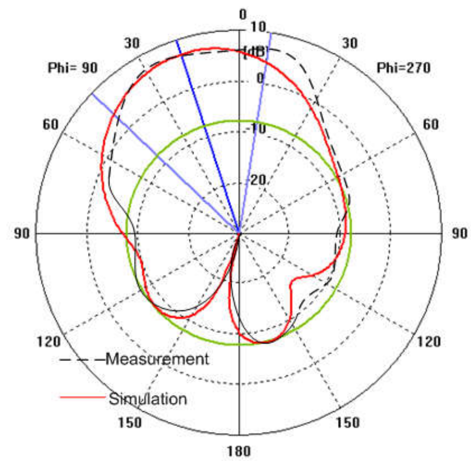



**Figure 6. Isolation between different ports of the MIMO antenna.**

The radiation pattern of the first configuration, the 4×4 MIMO antenna are simulated and measured at 2.5 GHz, as shown in Figure 7 indicating a good agreement. A directional forward beam is generated for the E- and H-planes with minimal side lobes.



(a)



(b)

**Figure 7. Radiation pattern of a single antenna (a) E-field (b) H-field.**

Next, the 2x2 MIMO antennas are evaluated by activating PIN diodes 1, 2, 3 and 4. MIMO antennas 1 and 2 connected to Port A, and 3 and 4 connected to Port B are also evaluated separately in terms of reflection coefficient and inter-port isolation, see Figure 8. Isolation between ports A and B are at least 10 dB.

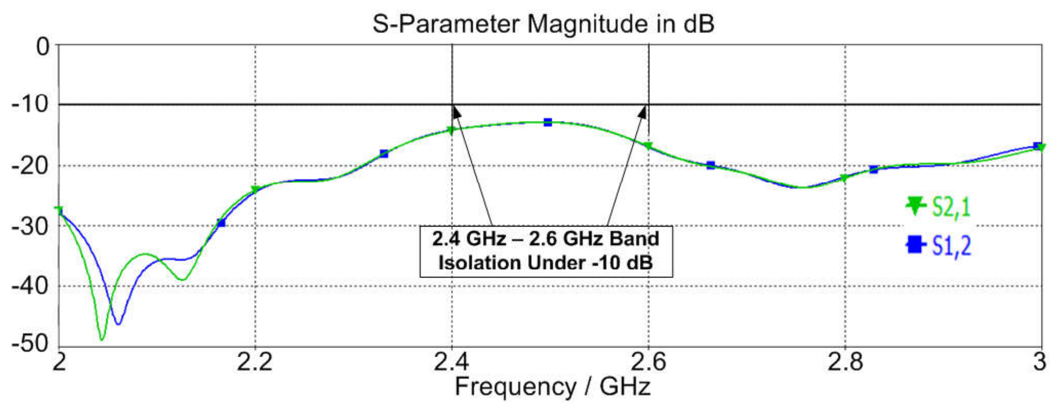
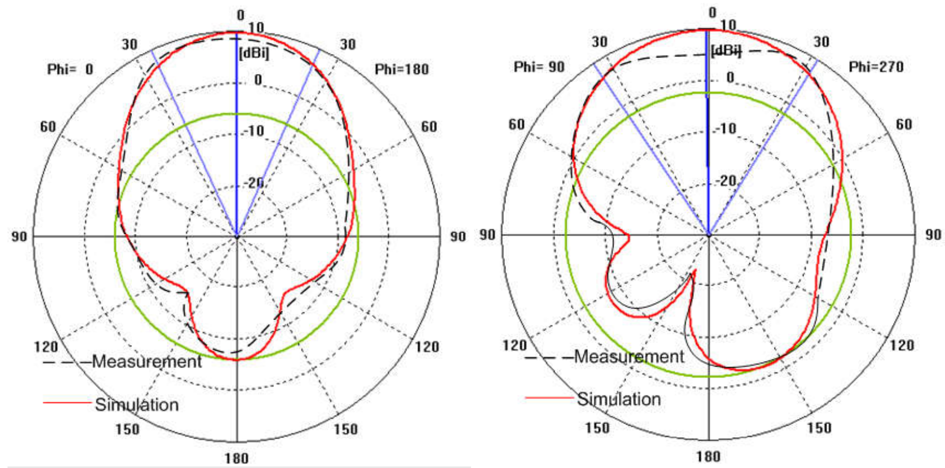



**Figure 8. Inter-port isolation of the 2x2MIMO antenna.**

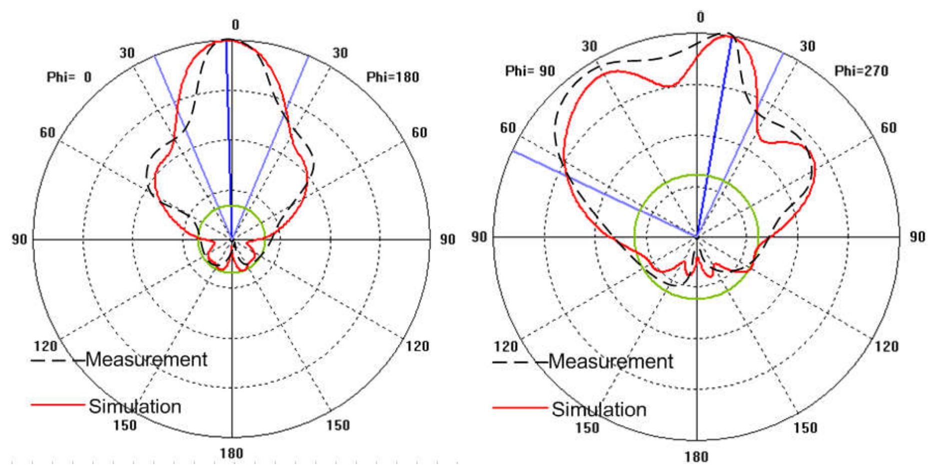
Similar to the previous structure, the radiation pattern of 2x2 MIMO are performed separately at 2.5 GHz and summarized in Figure 9. Note that the same forward radiation is exhibited with a narrower beamwidth compared to the previous single antenna due to the additional array elements. Simulated and measured results agreed with slight minor lobe disagreements.




(a) (b)

**Figure 9. Radiation pattern of dual MIMO antenna (a) E-field (b) H-field.**

The third antenna operation as a single, high gain 4x4 array is evaluated by activating all PIN diodes to enable each element's connection to the transmission line.. Its radiation pattern is measured at 2.5 GHz, similar to previous evaluations, and shown in Figure 10. Notice that the beam direction is narrower compared to the previous single and dual MIMO antenna.




(a) (b)

**Figure 10. Radiation pattern of single MIMO antenna (a) E-field (b) H-field**

## 5. Conclusion

A reconfigurable MIMO antenna system for WLAN and LTE standards has been proposed, consisting of rectangular slotted microstrip antenna elements. They form an array antenna which can either be configured as a 2x2 or 4x4 MIMO antenna system, or can also be used as a conventional high gain directional array. Pattern configurability is achieved via the switching of six PIN diodes located on the microstrip transmission line. Measurements confirmed that the antenna is operational from 2.387 to 2.628 GHz, agreeing well with simulationswith optimal reflection coefficients of -27.8 dB at 2.4 GHz and -24.3 dB at 2.6 GHz, respectively. The proposed system is then integrated within a WLAN access point and further evaluated in a practical environment. Both 2x2 and 4×4

MIMO antenna configurations produced narrow beam forward radiation patterns in both E- and H-planes, and met the ECC requirement of below 0.5 and diversity gain of between 9 and 10 dBi.

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