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Forward the Future & the World with Comotech

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COMOTECH CORPORATION

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Microwave / mmW / Sub-THz
Sub-systems / modules / components
Wireless Fronthaul / Backhaul / Bridge

COMOTECH CORPORATION

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Forward the Future & the World with Comotech

Comotech has been a leading R&D millimeter-wave company in South Korea since 1999, producing 60GHz, 70/80GHz, 90GHz, 110GHz wireless transceivers as well as terahertz (THz), radar, microwave subsystems and devices for 5G wireless Fronthaul / Backhaul and next generation 6G terahertz networks.

Wireline based and wireless communication systems have gone through dramatic performance improvements over last 30 years. And many new advanced technologies are being opened up for the hyper-connected 5G mobile communication service, including AI, VR, AR, autonomous vehicle, finance, medicine, block chain, holographic applications, etc. For these key services and besides high bandwidth ultra-low latency is becoming a very pressing requirement.

For more than a decade Comotech has heavily invested in millimeter-wave R&D technologies. Since 2004 Comotech has been a leading millimeter-wave broadband wireless bridge and solutions provider achieving several patented technology milestones along the way. By now, and as a result of more than 20 years of experience in the millimeter-wave R&D technology sector, our product portfolio includes advanced high speed premium class wireless bridges with speeds up to 20 Gbps. With transmission bandwidth of these advanced millimeter-wave wireless bridges now reaching speed of ground based fiber optic lines, these products or now opening applications in mobile Fronthaul / Backhaul network, and military secure communication networks previously only supported by fiber optic transmission lines.

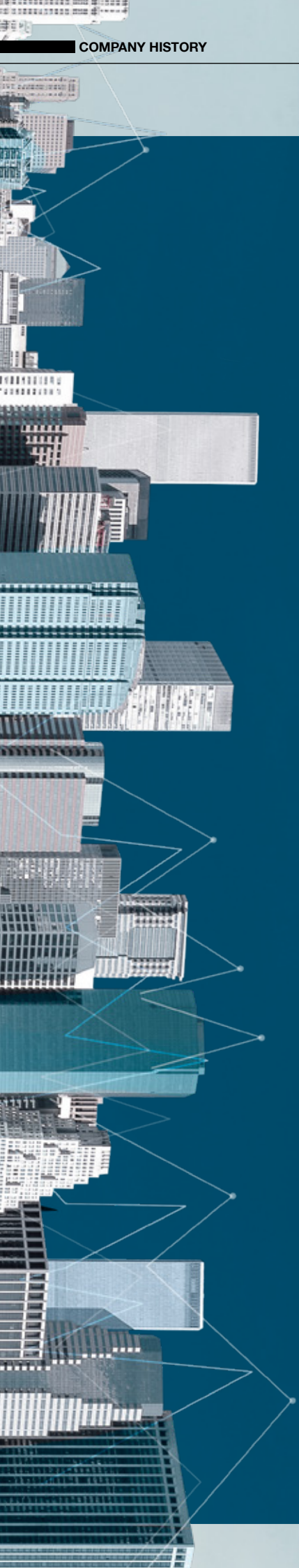
For financial network including high frequency trading (HFT) as well as in many medical operational networks, low latency data transmission is a very important requirement. Comotech produces world-class leading ultra-low latency (ULL) radio sub systems and full featured outdoor rated radio solutions with a radio latency of less than 10 ns per radio. These ULL products are leading edge and world record holding systems in terms of network latency that are used by world leading trade organizations like the Chicago Board of Trade (CBOT) and stock exchanges around the world, like New York and London Stock Exchange.

The Comotech team is committed to serve customers with high quality and highest performance products and services. We are continuing our quest as a leading and world class R&D team to explore new and advanced technology solutions that will benefit our valuable customers now and in the future.
Sincerely,

Youngsu Kim

CEO&President

Contents



HISTORY

2023	Headquarters / R&D Center moved to Seoul
2022	Development & Operation 204GHz Rain attenuation measurement system
2022	Technology Transfer Contract of 5G Dual Polarization Horn Antenna (RRA)
2021	Development & Operation 153GHz Rain attenuation measurement system
2020	Selected Country Representative Innovation Company 1000
2020	Develop Low Latency 92-95GHz W-band radiolink
2019	Release 71~76/81~86GHz E-band 20Gbps 256QAM radiolink & 92-95GHz W-band radiolink
2018	Release 71~76/81~86GHz E-band 10Gbps 256QAM radiolink & 64~71GHz New V-band radiolink
2017	Release 71~76/81~86GHz E-band 2.6Gbps 256QAM radiolink
2016	Develop E-band mmW Wireless Bridge for 5G Fronthaul/Backhaul
2015	Release QPSK/64QAM new 71~76/81~86GHz, 57~64GHz radiolink
2013	Certified product acquisition of 2.4576Gbps CPRI radiolink (SK Telecom)
2013	Release 71~76/81~86GHz 2.5Gbps 5Gbps (2.5G-Dual) GbE radiolink
2010	Develop 60GHz ITS Radar Sensor Module
2009	Develop E-Band(71~76/81~86GHz) RF Transceiver(NTE1G)
2008	Develop 24GHz Up/Down Converter & Synthesizer Module
2007	Acquirement of FCC for V-band & E-band transceiver, MIC KOREA certificate for V-band Transceiver
2006	Exhibited on CTIA Wireless Show in Las Vegas, USA
2005	Appointed as a Inno-Biz Company by the Small and Medium Business Administration
2005	Develop AirLight™ E-band Transceiver
2004	Develop 77GHz Automotive Anti-collision System RF Transceiver
2004	Acquirement of TELEC JAPAN certificate for ME100/MC650
2004	Develop AirLight™ V-band Transceiver
2003	Acquirement of ISO 9001 Certificate
2003	Develop 60GHz Up/Down Converter & AM Transceiver Module
2002	Develop 38GHz Transceiver Module for LMDS
2001	Appointed as a Venture Company by the Small and Medium Business Administration
2000	R&D Center approved by the Korea Industrial Technology Promotion Association
1999	NRD Corp. was established

PATENTS(KOREA)

Waveguide antenna accommodating a single-layer power feeding structure using a dielectric
10-2220423-0000 / February 19th, 2021

Dual Polarization Waveguide Antenna with Adjustment Unit Designed in Asymmetric Structure
10-2146465-0000 / August 13th, 2020

Waveguide Antenna for Efficient Distribution of Dual Polarization
10-2146464-0000 / August 13th, 2020

Dual Polarization Waveguide Antenna
10-1995356-0000 / June 26th, 2019

Non-Radiative Dielectric Waveguide Modulator Having a Waveguide Type Hybrid Coupler
10-0578353-0000 / May 3rd, 2006

Waveguide Type Terminator And Attenuator
10-0578355-0000 / May 3rd, 2006

Non-Radiative Dielectric Waveguide Mixer Using a Ringhybrid Coupler
10-0471049-0000 / February 1st, 2005

Circulator Using a Non-Radiative Dielectric Waveguide
10-0494569-0000 / June 1st, 2005

Method for Coupling an NRD Waveguide with a Rect. Waveguide Directly and NRD Waveguide Thereof
10-0502981-0000 / July 13th, 2005

Hybrid Type Ask Transceiver Using Non-Radiative Dielectric Waveguide And Rectangular Waveguide
10-0530503-0000 / November 16th, 2005

Metal Window Filter Assembly Using Non-Radiative Dielectric Waveguide
10-0399041-0000 / September 8th, 2003

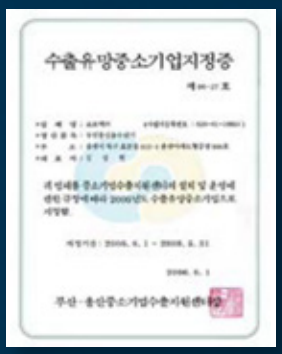
Metal Post Filter Assembly Using Non-Radiative Dielectric Waveguide
10-0399040-0000 / September 8th, 2003

Certifications for the system

ISO9001 : 2000

INNO-BIZ

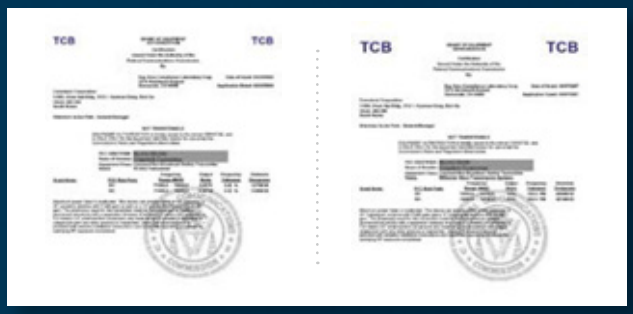
Certification for Venture



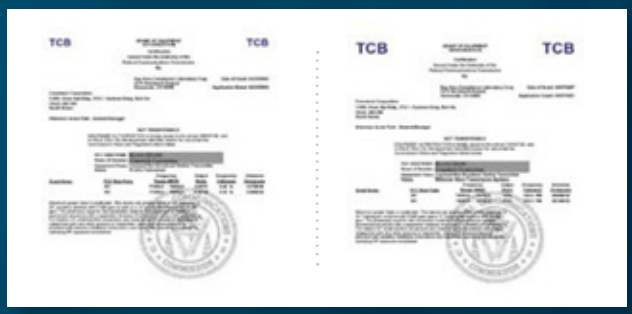
Small and medium Business administration

Certifications for the Products

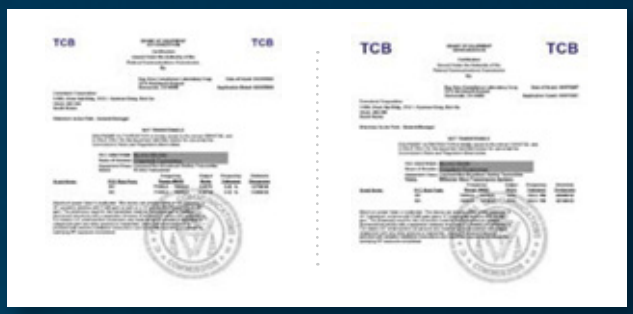
USA : FCC(71~76/81~86GHz, NTE1GQ)



USA : FCC(71~76/81~86GHz, NTE1G)



KOREA : MIC(57~64GHz, ME1G)



JAPAN : TELEC(59~66GHz, ME1G)

PATENTS(USA)

Waveguide Type Terminator and Attenuator
US 7,038,556 B2 / May 2nd, 2006

Non-Radiative Dielectric Waveguide Modulator Having a Waveguide Type Hybrid Coupler
US 6,987,434 B2 / January 17th, 2006

Non-Radiative Dielectric Waveguide Mixer Using a Ring Hybrid Coupler
US 6,871,056 B2 / March 22nd, 2005

Metal Window Filter Assembly Using Non-Radiative Dielectric Waveguide
US 6,600,392 B2 / July 29th, 2003

Local Oscillator Using Non-Radiative Dielectric Waveguide
US 6,545,552 B2 / April 8th, 2003

Metal Post Filter Assembly Using Non-Radiative Dielectric Waveguide
US 6,486,753 B1 / November 26th, 2002

Introduction

Comotech Corporation, founded in 1999, is a global provider of 5G wireless Fronthaul / Backhaul and next generation 6G Terahertz solution with 10Gbps, 20Gbps wireless link, millimeter-wave transceiver and components. Comotech can offer the most cost-effective products worldwide utilizing its long-term accumulated unique design skills and development infrastructures with high technology. The unique RF system of Comotech, AirLight™ series, provides point-to-point wireless system with a wide range of network applications. It guarantees the high efficient network system. AirLight™ series are challenging current wire network system to build RF infrastructure that supports the multiple network demands being placed on various industries.

R&D Equipment and Facilities

- Measurement Equipment - VNA, SNA, SA, Power Meter, Noise Figure Meter, Signal Generator and Antenna Measurement System (All possible measurement up to 500GHz), etc.
- Quality Assurance Equipment - Video Measuring System, Constant Temperature & Humidity Chamber, etc.
- Assembly Facilities - Clean Room (Class 10,000~100,000), Die Attach Machine, Wire Bonder, Ribbon Bonder, etc.

Design

To manufacture accurate components, Comotech utilizes a precise 2D/3D modeling software such as AutoCAD, and analyzes it using the latest electromagnetic field simulator, CST, HFSS, ADS as well. With these strong technical and mechanical backgrounds, Comotech can produce a cost effective and reliable products.

Development

Comotech produces both new concepts and products by simulating component performance against calculated expectations. By modeling the electrical performance within the mechanical constraints, components can be manufactured with extremely high accuracy.

Assembly

The company manufactures all components with a durable housing, an external jacket to add strength and protection. Active MMIC modules of LNA and HPA are bonded and assembled using wire bonder, wedge bonder in clean chamber. The whole assembled modules are tested for mechanical and electrical performance upon our extremely severe test conditions.

Section A – Microwave / mmW Fronthaul / Backhaul / Bridge

AirLight™ series Wireless Bridge systems are point-to-point ultra wideband links using 57~64GHz (*64~71GHz New V-band), 71~76/81~86GHz and 92~95GHz millimeter-wave frequency bands.

ME series is for 57~64GHz(64~71GHz) V-band unlicensed band. NTE series is for both 71~76/81~86GHz E-band licensed band and 92~95GHz newly opened W-band band. Up to 20Gbps is available in E-band system especially in North America and elsewhere of Europe recently, and it can be base technology for 6G Terahertz solution.

According to the oxygen absorption of all wireless bridges, those different bands have somewhat different propagation characteristics, thus E-band and W-band models have longer operational distance than V-band system.

These atmospheric characteristics of millimeter wave propagation are not necessarily disadvantageous. Millimeter waves can permit more densely packed communication links, thus it provides very efficient spectrum utilization, and they can increase spectrum efficiency of communication transmissions within restricted frequency band.

Characteristics

Specifications

User Interface

Applications

Installation Sites

mmW Fronthaul / Backhaul / Bridge

AirLight™ is the fastest wireless solutions for point-to-point wireless in 5G/6G backhaul, fronthaul, midhaul solutions. The interconnection between two endpoints apart from last mile can be easily deployed and installed. Current solutions including voice, leased line or optical fibers are too expensive to configure, and it's very difficult or impossible to transmit when high datarate is required. So, the performances of the links are usually limited. The AirLight™ can be deployed with full-duplex security systems, and it can be used for wireless link between buildings in downtown or campus area where higher speed is required. Backup link for optical fiber is easily installed when a system is needed to replaced. Therefore, your services can continue seamlessly even though any problems are on the link path.

◆ Low Cost Managements

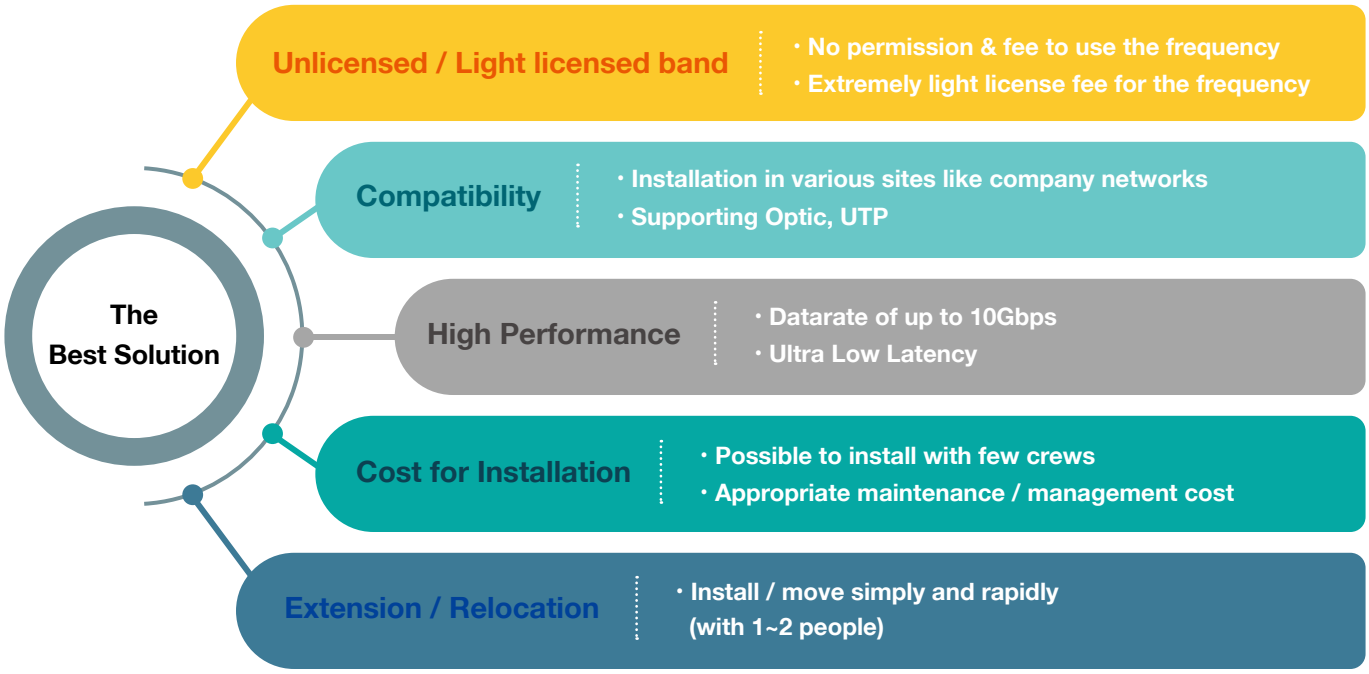
AirLight™ is more cost-effective than fiber optic because the initial expense is cheaper than the case of fiber optic, so you can save your budget. In spite of radio link, high security will be guaranteed by means of pencil-beam patterns in millimeter wave inherently. By using our AirLight™ units, the backup link will be doing well during system repairs of the fiber optic link when it has some problems on the path. And also, the unit can support as emergency hot-link within extremely short time, but for optic network, it will take longer recovery time to repair it.

◆ High Data Throughput

In today's communication markets, higher datarate is required more and more. And these situations will be continued and the necessity of high capacity of transmission path will be increased in near future. In optic networks connected each other so much complexly in urban, the extension of capacity is very difficult to reconfigure than wireless. Thus, the AirLight™ series will be the best choice when the ultra high data throughput and high-speed radio link between short ranges are needed especially in downtown.

◆ Flexible Configurations

When you need additional data link between buildings, or unexpected increase of node to connect, our AirLight™ series will be helpful. The quick installation even in an hour may be possible to deploy the units. The deployment of AirLight™ is extremely simple compared with the case of digging in optic solution.



mmW Fronthaul / Backhaul / Bridge

◆ Specifications

Comotech's AirLight™ Series wireless systems provide the ultimate Gigabit Fronthaul / Backhaul links for most demanding applications for carriers and enterprises. The products will operate either in 71~76/81~86GHz licensed bands or 57~64GHz(64~71GHz) unlicensed bands and have different antenna options for various link distance requirements.
The AirLight™ Series represents a breakthrough in long range gigabit links by extending the maximum link distance to 20 km.

Features

- E-band - 71 ~76/81 ~86GHz
- V-band - 57~64GHz (64~71GHz)
- Full duplex Up to 10Gbps
- Long Distance - Up to 25 km (15.6 miles)
- Ultra Low Latency – 20ns
- Reliability - Up to 99.999%
- Easy ant/ODU assembly at field
- Easy polarization deployment
- Easy azimuth/elevation alignment
- IP66 ODU enclosure
- All weather conditions

Applications

- Low Latency financial network
- 4G LTE/5G/IP Fronthaul / Backhaul
- CPRI/OBSAI wireless link
- Small cell network – No interference
- Hospital/campus application
- Last mile access – Extend high speed services
- Surveillance/security

Wireless Bridge (Fronthaul / Backhaul)

Wireless Bridge (Ultra Low Latency)

mmW ULL

▶ Specifications

mmW 1.25Gbps/2.5Gbps ULL (Ultra Low Latency)

Parameters		E-band	V-band
Frequency		71 ~ 76GHz, 81 ~ 86GHz	57 ~ 64GHz, 81 ~ 86GHz
Output Power		+25dBm / +28dBm / +33dBm	+10 dBm(+17 dBm)
Topology		FDD	
Data Rate		1.25 Gbps, Full-Duplex	
Bandwidth		1800 MHz	
Modulation		ASK	
Latency		< 20 ns	
Management		SNMP	
Input Power		DC 48V	
Interface		SFP MMF/SMF	
Antenna Gain		51dBi @ 2ft, 45dBi @ 1ft	48 dBi @ 2ft, 43dBi @ 1ft
Antenna Beam width		0.5° @ 2ft, 0.9° @ 1ft	0.6° @ 2ft, 1.2° @ 1ft
Operating Temperature		-45 ~ +60℃	
Size	Radio Only	300 × 230 × 130mm	
	with antenna	620 × 620 × 490mm @ 2ft, 340 × 340 × 220mm @ 1ft	
Weight	Radio Only	4.0 kg (8.8 lbs)	
	with antenna	6.7 kg (14.7 lbs) @ 2ft, 3.6 kg (7.9 lbs) @ 1ft	
	Pole Mount Kit	3.2 kg (7.0 lbs)	
Weather		IP67 / All Weather	
Vibration		Standard: IEC 60721-3-4, Duration: 30min/axis, random 4M3	
Wind Load		Survival: 235km/h (65m/s), Operation: 180km/h (50m/s)	

* Above specifications are subject to change without notice for better performance

mmW High Capacity

▶ Specifications

mmw 256QAM/QPSK systems

Parameters		NTE3GQ	NTE10GQ
Frequency Band		71 ~ 76GHz, 81 ~ 86GHz	
RF Bandwidth		500MHz	2,000MHz
Modulation Scheme		QPSK, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM Hitless ACM (Adaptive Coding and Modulation)	
Interfaces		10G SFP+, 1G SFP, RJ-45	
Capacity		2.6Gbps, 5.2Gbps(2+0) Full-Duplex	10Gbps, 20Gbps(2+0) Full-Duplex
Configuration		1+0, 2+0	
Networking		IEEE1588v2 Precision Time Protocol (PTP) Synchronous Ethernet (SyncE)	
Latency		< 48us	
Management Access		In-band, Web based GUI, SNMP V2, Telnet	
Antenna		1ft (30cm, 45dBi, 0.9°), 2ft (60cm, 51dBi, 0.5°)	
Power Supply		PoE or DC 48V	DC 48V
Power Consumption		55W	83W
Size	Radio only	300 x 230 x 130mm	
	With Antenna	620 x 620 x 490mm@2ft, 340 x 340 x 220mm@1ft	
Weight	Radio only	4.0kg (8.8lbs)	
	With Antenna	6.7kg (14.7lbs)@2ft, 3.6kg (7.9lbs)@1ft	
	Pole Mount Kit	3.2kg (7lbs)	
Operating Temperature		-40 ~ +65oC	
Environment	Weather	IP67 / All weather	
	Vibration	Standard: IEC 60721-3-4, Duration: 30min/axis, random 4M3	
	Wind Load	Survival: 235km/h (65m/s), Operation: 180km/h (50m/s)	

* Above specifications are subject to change without notice for better performance

Microwave Fronthaul / Backhaul / Bridge

◆ Technical Summary

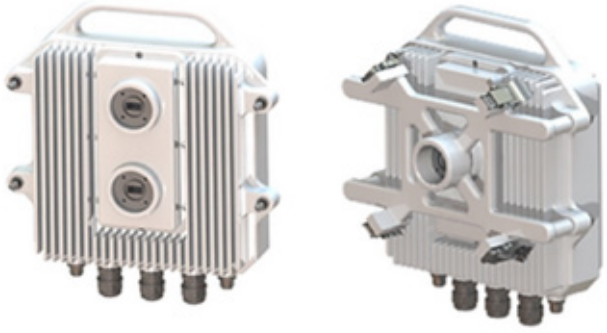
- Frequency Bands: 6 — 38 GHz
- Channel BW
  30 to 160 MHz (FCC)
  14 to 112 MHz (ETSI)
- Tx Power: 16 to 30 dBm
- Interface Options:
  2.5Gbe SFP or 10Gbe SFP+
  1Gbe SFP and RJ-45 (POE)
  HDMI for radio interconnection
- Modulation: up to 4096 QAM
- Temp Range: -40 to 55 C
- Power Consumption: 80W, typical.

◆ Applications

- Carrier data Fronthaul / Backhaul
- Fronthaul / Backhaul for video surveillance monitoring
- Government inter-building networks
- Connection of industrial sites for voice and data

◆ Feature Summary

- Up to 5.5 Gbps full duplex capacity per radio terminal
- Single or dual radio carrier per terminal — same or different freq band
- 4096QAM, up to 160MHz (ANSI) and 112MHz (ETSI) BW support
- Flex Platform — Customer exchangeable diplexers
- Configurations — 1+0, 1+1/2+2 HSB, 2+0/4+0 up to 6Gbps
- ACM, ATPC, XPIC, and 256AES encryption support
- 2x2 and 4x4 MIMO for enhanced link budgets
- Packet header and payload compression
- A dual sub-channel capability for 2x capacity per transceiver
- Digital pre-distortion for keeping high Tx power at Hign order QAM
- 4 modem cores per radio terminal for expandability
- 2.5G SFP or 10G SFP+ interfaces, plus RJ-45 POE
- Load balancing in 2+0 and 4+0 configurations
- A single radio SKU per frequency band — no low/high band radios
- Simplifies local stocking and sparing at customer sites.



Microwave Fronthaul / Backhaul / Bridgeradio terminal — shown with dual carrier option

◆ Product Description

Comotech's Microwave Fronthaul / Backhaul / Bridge represents best-in-class microwave radios available in the market today. The radio operates up to 4096QAM modulation and extended channel bandwidth up to 160MHz (ANSI) / 112MHz (ETSI) in a sing or dual transceivers per radio terminal. A dual sub-channel operation allows two data streams per transceiver. The resulting capacity is 2.75Gbps for single-transceiver radio link or 5.5Gbps for a dual-transceiver radio link. Header and payload compression can be used to increase the capacity even higher than these data rates.

The Microwave radio's unique architecture allows field replacement of diplexers. There is only one radio type for each frequency band and no distinction between the low and high band radios. This allows great simplification of part numbers for easy inventory stocking and sparing at customer sites.

10Gbe SFP+ or 2.5Gbe SFP slots are available to connect to your Ethernet networks. RJ-45 1Gbe interface comes standard for POE connection as well as a separate DC power input for power redundancy.

Built-in load balancing algorithm allows the radio combinations to carry traffic loads in a controlled manner. The user can use this feature to go longer distances or reduce antenna sizes for a given capacity requirement.

Dual carrier radio platform can be deployed with two radio signals in different frequency band (e.g. 6 and 11GHz) for diversity or repeater applications.

The Microwave Fronthaul / Backhaul / Bridge accessories include adapter plates in case the user needs to keep the existing antenna with a different antenna-radio interface.

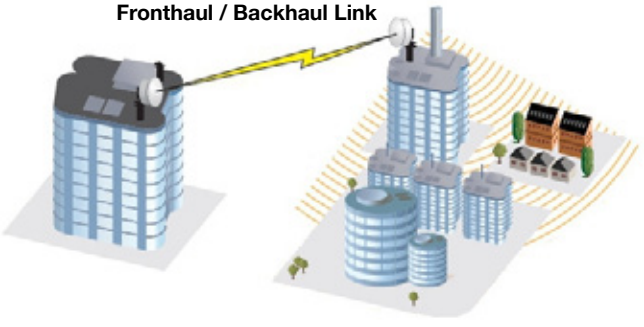
	6 GHz	7 GHz	8 GHz	11 GHz	13 GHz	15 GHz	18 GHz	23 GHz	32 GHz	38 GHz
Freq.	5.9 ~ 7.12	7.1 ~ 7.9	7.7 ~ 8.5	10.7 ~ 11.7	12.7 ~ 13.3	14.4 ~ 15.4	17.7 ~ 19.7	21.2 ~ 23.6	31.8 ~ 33.4	37.0 ~ 40.0
TR Spacing (MHz)	150, 160, 170, 240, 252, 340	154, 160, 161, 168, 190, 254	119, 126, 151, 208, 266, 311	490, 500, 530	266	315, 322, 420, 475, 490, 640	1008, 1010, 1560	1008, 1200, 1232	812	700, 1260

System	
Frequency Bands	FDD / Full-Duplex
Modulation Mode	Up to 4096 QAM
Channel Bandwidth	
CEPT/ETSI	7, 14, 28, 56, and 112 MHz
ANSI/FCC	30, 40, 50, 60, 80, and 160 MHz
Data Rate	2.75Gbps max per single radio link w/ dual sub-channel per TXVR 4 modem cores for 6Gbps expansion
Tx Power	Up to 30 dBm, Digital Pre-Distortion for high Tx power
Radio modes	Single or dual transceivers per radio ter (same or different frequency band) 1+0. 1+1/2+2 HSB, 2+0/4+0 2x2 or 4x4 MIMO
Compression	Header and payload compression
Protocol Support	Adaptive coding and modulation (ACM) Automatic Tx Power Control (ATPC) Radio link aggregation (RLA) - load balancing, SyncE or IEEE1588v2 PTP
Management	Web interface, SNMP, Solectek EMS
Latency	200 µsec, typical Ethernet config/traffic dependent
Power Consumption	80W Typical, config dependent
Power Supply	-38.4 V to –60V DC (ODU powered by RF cable from IDU)
MTBF	30 years
Compliance	FCC part 101, ETSI EN302 217-2-2
Physical interfaces	10Gbe SFP+ or 2.5G SFP, 1Gbe SFP, RJ -45 Gbe (POE), HDMI for radio interconnec, BNC (RSSI port), DC power input

Mechanical	
Antenna interface	Direct Mount to Antenna, OMT for dual carrier or dual radio config
Radio Size	11 in (28 cm) diameter 5.5 in (14 cm) height
Weight	9.5 lbs (4.3 kg))
Temperature	-40 to 55C
Material	Corro-Coat PE 71-190Z (powder coat) Gloss White
POE unit	Options for outdoor DC injector, Indoor DC injector, indoor POE/AC adapter

Microwave Fronthaul / Backhaul / Bridge physical interfaces — 10Gbe SFP+ or 2.5Gbe SFP, 1Gbe SFP, RJ-45, HDMI for radio connect, DC input (redundant)

Microwave Fronthaul / Backhaul / Bridge
Fronthaul / Backhaul Link



User Interface

◆ mmW GUI

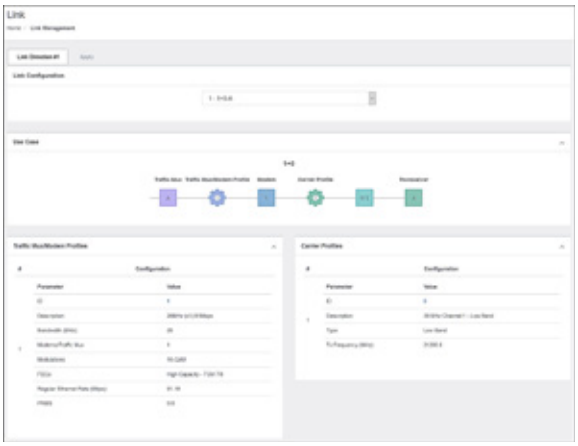
The user interface is the management equipment to check the AirLight™ system information and operational status. This indicates not only the basic system information, but also link status, such as Modulation type, Tx power, RSSI, in-system temperature, and so forth. Also, this system provides remote connection function to check the AirLight™ system information and operation status.

- **SNMP Configuration**
- **SNMP Contact Information**
- **SNMP System Name**
- **SNMP Service Information**
- **SNMP IP address**
- **Host IP address**
- **Community**
- **Permission**
- **SNMP Trap IP address**
- **SNMP Trap IP address**
- **Trap Community**
- **SNMP Version**

◆ Microwave GUI

The general user interface is provided in an application program that the user can install on any PC running Windows XP. Available information include the status of RF signals, connection to networks and internal temperature.

The user interface program provides management and monitoring of important system parameters via serial connection to the outdoor radio unit. The list of such parameters is as follows :



Monitoring of major parameters

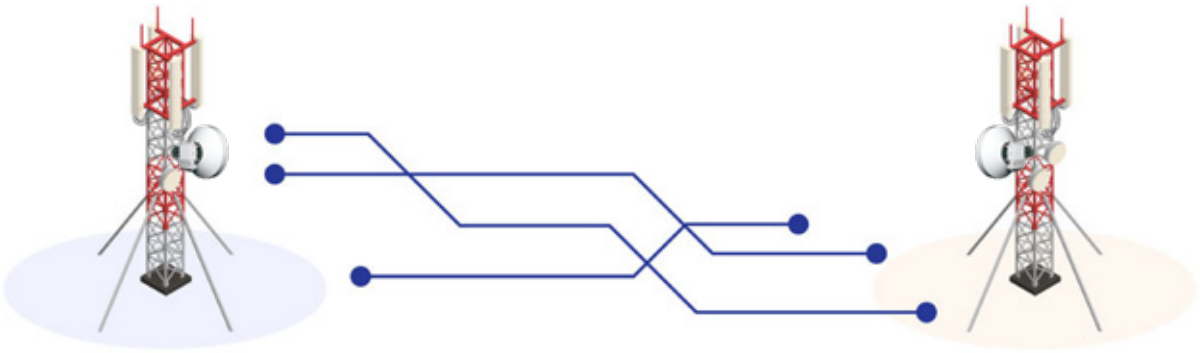
- SNMP Contact Information
- SNMP System Name
- SNMP Service Information

Additional Functions

- Alarm and warning functions
- Management of multiple units (up to 9)
- Function to output status parameters
- Function to record status parameters

Applications

AirLight™ can be used as P2P link including 5G E-band backhaul, fronthaul, midhaul solutions up to 20Gbps capacity with 2+0 configuration of 10Gbps E-band mmW radio, and establishing high-speed Fronthaul / Backhaul networks including financial networks with extremely low latency. AirLight™ is also used for emergency data recovery and surveillance purposes.



FWA(Fixed Wireless Access)
- P2P Wireless LAN
- 10Gbps, 2.6Gbps, 1.25Gbps

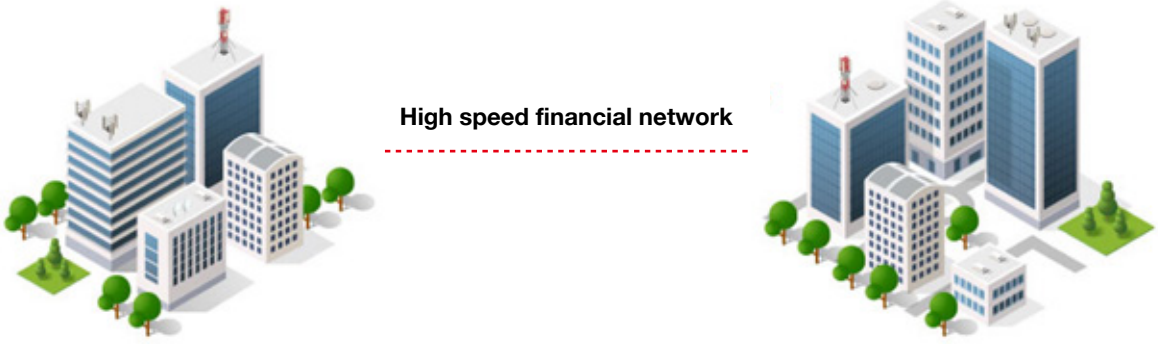
Gigabit Ethernet Network
- 100% throughput 300Mbps-10Gbps

Mobile Station Fronthaul/Backhaul
- 3G/4G LTE, 5G/6G Fronthaul/Backhaul
- CPRI Link, 10Gbps/2.4576Gbps

Time-Sensitive, Financial, Surveillance
- Low Latency : 20ns
- CCTV, Securiry Wireless

◆ Low Latency Financial network

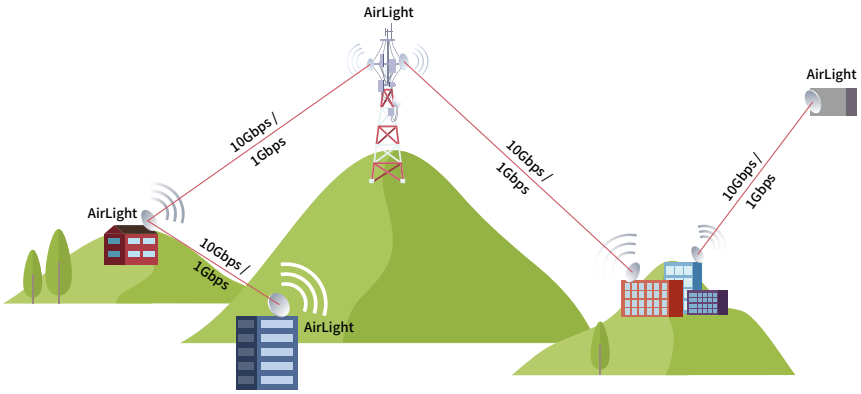
Financial networks require very high reliability and very low propagation delay for real time trading process.
AirLight™ series are proven in the field for a long time, and provide extremely low latency solution with only about 20 ns or less for this time-sensitive industry.



Applications

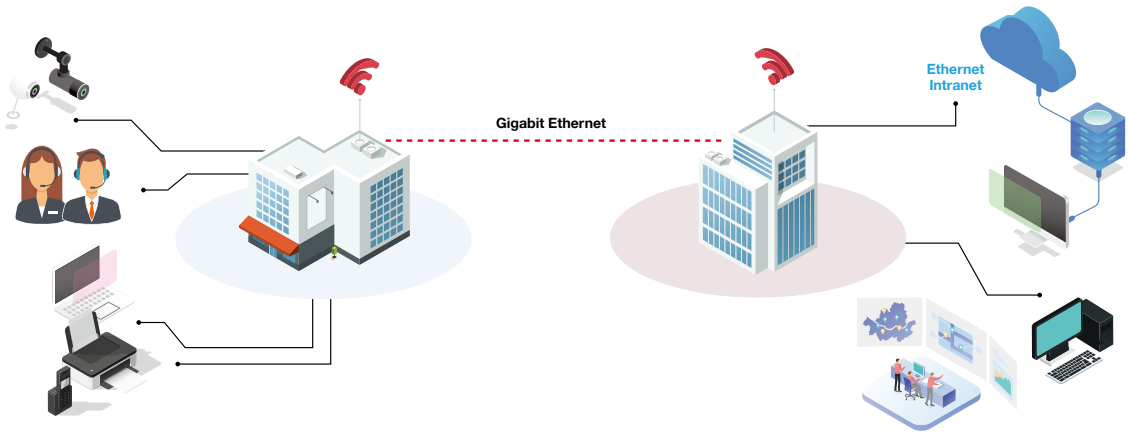
◆ Microwave / mmW Fronthaul / Backhaul / Bridge

- CPRI/OBSAI radiolink, Point-to-point, up to 20Gbps, E-band radiolink for 5G Fronthaul / Backhaul as well as 6G solution
- Faster, easier and simple E-band Fronthaul / Backhaul solution among DU, RU, RRH, CU etc.
- Reliability over all weather conditions with 256QAM Smart Adaptive Algorithm
- Efficient in dense urban area where fiber optic connection is not available
- 99.999% availability without interference with adjacent
- Easy plugin with 10GE SFP+ interface compatible to 10GE switch



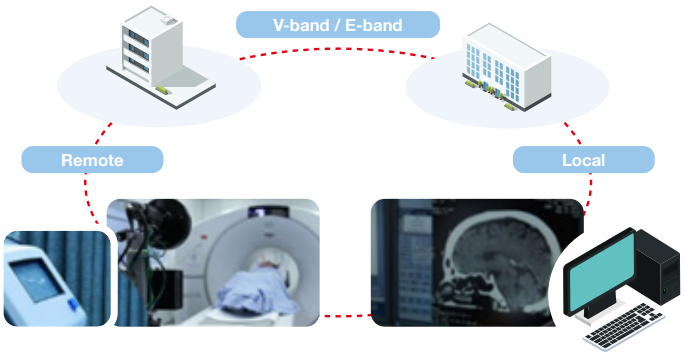
◆ FWA (Fixed Wireless Access)

Scalability of up to 20Gbps wireless bridge for FWA. Sharing various communication systems, which are separated from each network, through AirLight™ is available. A network which consists of telephones, cameras, PC's can be connected to another network through AirLight™. Therefore, the two networks can construct a separate private network.



◆ Hospital/Campus Network

Financial networks require very high reliability and very low propagation delay for real time trading process. AirLight™ series are proven in the field for a long time, and provide extremely low latency solution with only about 20 ns or less for this time-sensitive industry.



Installation Sites


E-band 2.6Gbps for Smart Factory

South Korea

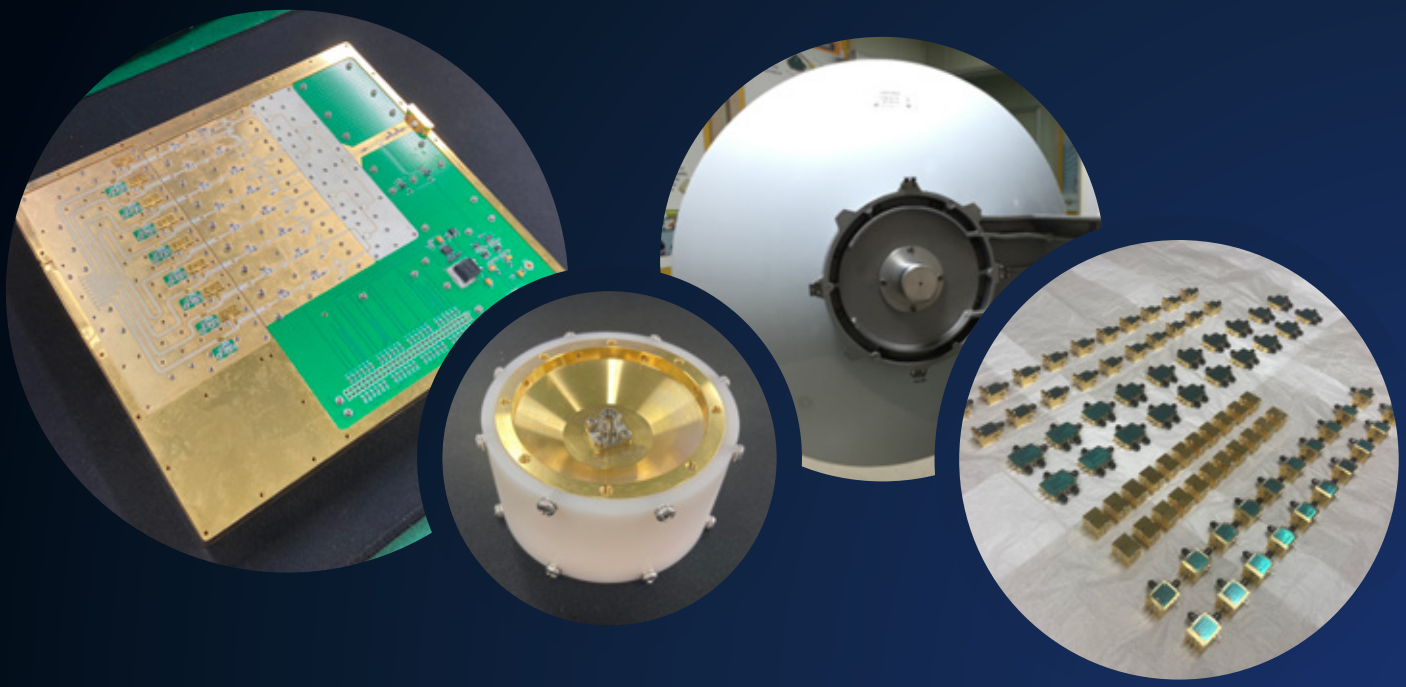

153GHz / 204GHz Rainfall Measurement System

South Korea


E-band 2Gbps (2+0), 1Gbps for Enterprise

Japan

Section B – Sub-systems, Modules & Components



Comotech's advanced mmW transceiver module has the best quality and superior performance to transmit ultra high speed digital data in millimeter wave. The maximum data rate of 10Gbps is possible.

Comotech develops several kinds of millimeter-wave up/down converters in 24GHz, 57~64GHz and 71~76/81~86GHz bands, as well as 140GHz Image Sensor module. These modules have superior RF performance so that the whole systems equipped with the module can operate more stable.

Comotech's RF components have high reliability and stability. We can develop millimeter-wave components above 18GHz K-band to 500GHz Y-band upon customer's request with the world best price.

Microwave / mmW Sub-systems

- TR80UD5K
- TR70AK2K
- TR60AK2K

Radar Sensor Modules

- RD24FM500
- RD77FM960
- RD60PCM100
- Antenna

Antennas

Microwave / mmW Components

- Diplexer
- Filter
- Power Amplifier
- Low Noise Amplifier
- Phase Locked Oscillator(PLO)
- Mixer
- Attenuator
- Transition
- Coupler
- Multiplier
- OMT / Polarizer
- X-band Rotary Joint
- Power Divider / Combiner
- Adaptor
- Others

Appendix

Microwave / mmW Sub-systems

◆ mmW Transceiver / UDC Modules

Features

- Frequency band 71~76/81~86GHz, 57~64GHz
- Low cost, High-Speed data link wireless solution
- Data rate 1.25Gbps

Applications

- Point-to-point wireless link for Gigabit Ethernet
- LAN-to-LAN interconnection
- Fronthaul / Backhaul networks
- Secure communications
- Mobile base station network

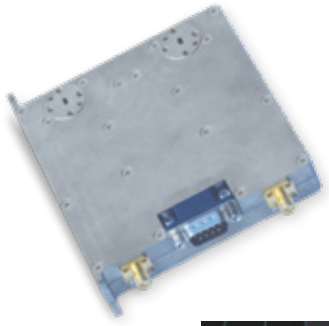
Specifications

Parameter	Typical Specification		
	TR38UD1K	TR60AK2K	TR70AK2K
RF Frequency [GHz]	6 ~ 38	57~64 / 64~71	71~76 / 81~86
Bandwidth [MHz]	150/500/1260	2,000	2,000
Output Power [dBm]	30	10	28
Noise Figure [dB]	5	8	10
Port & Control Interface	WR28 / SMA(f)	WR15 / SMA(f)	WR12 / SMA(f)
Bias Voltage / Current	12V / 5A	5V / 1.5A	5V / 3.2A
Size (L x W x H) [mm]	150 x 120 x 40	130 x 100 x 26	130 x 100 x 26

• Customer's specifications available

Radar Sensor Modules

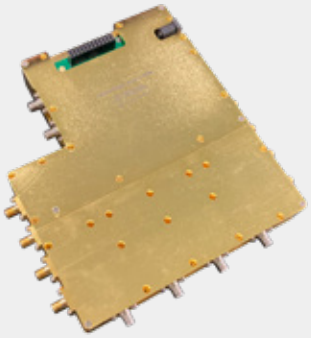
◆ Radar Sensor Modules



ITS Vehicle Detection System

Level guage

Car Collision Avoidance



Features

- Frequency: 24GHz, 60GHz, 77GHz, 79GHz, 140GHz
- Precise detection / Excellent detecting accuracy
- Small and light weight radar sensor

Applications

- Vehicle detection sensor / Intelligent Traffic System
- Airport obstacle detection / Industrial level gauge
- Replacement of visual detection

Specifications

- **Customer's specifications available**

Parameter	Typical Specification			
	RD24FM500	RD60PCM100	RD77FM960	RD140FM1K
RF Frequency Range	24 ~ 26GHz	57 ~ 64GHz	76 ~ 77GHz	140GHz
IF Frequency Range	DC to 250MHz	DC to 100MHz	DC to 10MHz	DC to 500MHz
Tx Output Power	20dBm	10dBm	12dBm	10dBm
Conversion Gain	30dB	30dB	20dB	20dB
Noise Figure	8dB	10dB	8dB	6dB
Maximum Rx Input Power	-30dBm	-20dBm	-17dBm	-15dBm
RF/IF Port	WR-34, SMA(f)	WR-15, SMA(f)	WR-12, SMA(f)	WR-6.5, SMA(f)

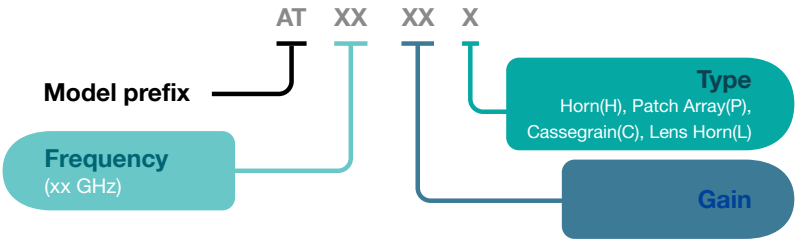
Antenna

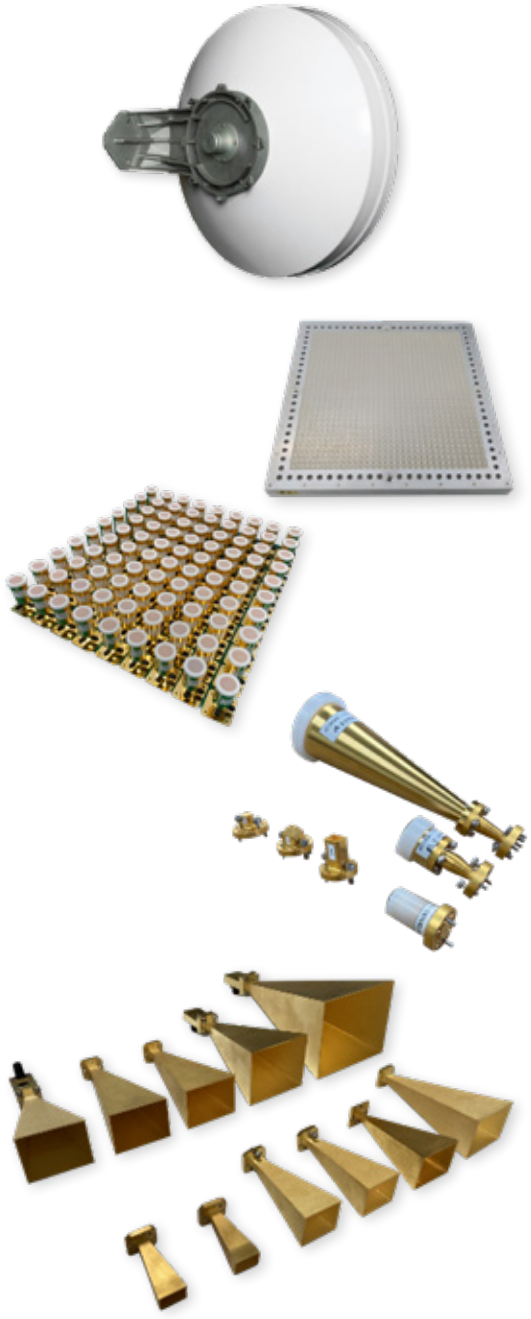
◆ Antenna

Features

- High performance and compact size
- Large Directivity for outdoor installation
- Customer's specifications available
- Frequency up to 500GHz

Ordering Information





• **Cassegrain Antenna**

Type	Band	Frequency [GHz]	Gain [dBi]	VSWR	Port
Cassegrain	V-band	50~75	43~48	2:01	WR15
	E-band	60~90	45~51	2:01	WR12
	W-band	75~110	45~51	2:01	WR10
Patch Array / Waveguide Slot Array	K-band	18~26.5	10~20	2:01	WR42 / K(f)
	V-band	50~75	43~48	2:01	WR15
	E-band	60~90	30~43	2:01	WR12
	W-band	75~110	30~43	2:01	WR10
Waveguide Probe	K-band	18~26.5	7	2:01	WR42 / K(f)
	Ka-band	26.5~40	7	2:01	WR28 / K(f)
	V-band	50~75	7	2:01	WR15
	W-band	75~110	7	2:01	WR10
Lens Horn	Ka-band	26.5~40	30~45	2:01	WR28 / K(f)
	D-band	110~170	30~45	2:01	WR6
	G-band	140~220	30~45	2:01	WR5
	Y-band	220~500	30~45	2:01	WR3 / WR2
Omni Directional	Ka-band	26.5~40	3	2:01	K(f)
	D-band	110~170	3	2:01	WR6
	Y-band	220~500	3	2:01	WR3 / WR2
Pyramidal Horn	K-band	18~26.5	10~25	2:01	WR42 / K(f)
	V-band	50~75	10~25	2:01	WR15
	E-band	60~90	10~25	2:01	WR12
	W-band	75~110	10~25	2:01	WR10
	D-band	110~170	10~25	2:01	WR6
	G-band	140~220	10~25	2:01	WR5
	Y-band	220~325	10~25	2:01	WR3
		325~500	10~25	2:01	WR2

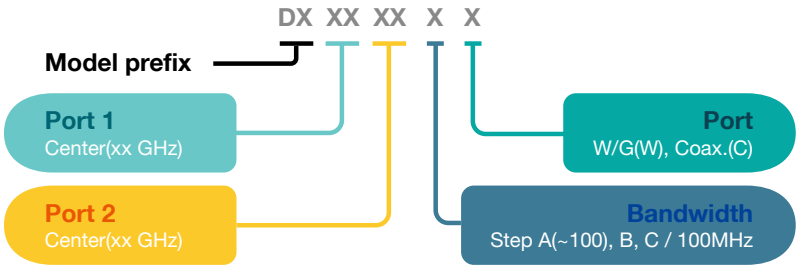
Microwave / mmW Components

◆ Diplexer

Features

- Waveguide cavity filter with high Q
- High power handling capabilities
- Frequency up to 325GHz
- Compact size and low cost

Ordering Information



- **Customer's specifications available**

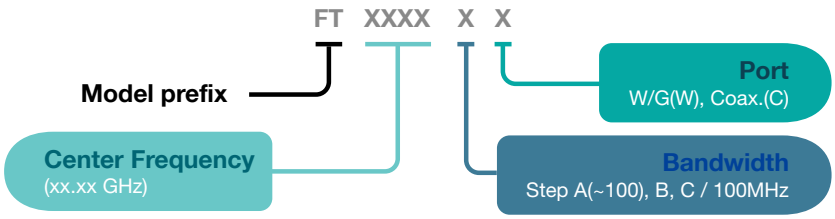
Model	Pass Band Range[GHz]		Insertion Loss [dB]	VSWR	Rejection [dBc/GHz]	Port
	Lower Band	Upper Band				
DX1718E	17.70~17.97	18.45~18.72	1.5	2.0:1	60	WR-42
DX2426D	24.05~24.45	26.05~26.45	1.5	2.0:1	60	WR-42
DX3840D	38.60~38.95	39.30~39.65	1.6	2.0:1	50	WR-28
DX6264J	62.00~63.00	63.85~64.85	2	2.0:1	70	WR-15
DX7383T	72.50~74.50	82.50~84.50	2	2.0:1	60	WR-12
DX9294D	91.80~92.20	93.80~94.20	2	2.0:1	60	WR-10
DX140160Z	140.0~145.0	160.0~165.0	2	2:01	45	WR6
DX200230Z	200.0~210.0	230.0~240.0	2	2:01	40	WR4

◆ Filter

Features

- Waveguide cavity filter with high Q and high power
- Frequency up to 325GHz
- Compact size and low cost

Ordering Information



- **Customer's specifications available**

Model	Pass Band Range [GHz]	Insertion Loss [dB]	VSWR	Rejection [dBc/GHz]	Port
FT2450C	24.35~24.65	1.5	2.0:1	65	WR-42
FT2850D	28.30~28.70	1.5	2.0:1	65	WR-42
FT3880D	38.60~39.00	1.5	2.0:1	65	WR-28
FT6250F	62.20~62.80	1.5	2.0:1	65	WR-15
FT7650T	75.50~77.50	1.5	2.0:1	60	WR-12
FT8350T	82.50~84.50	1.5	2.0:1	65	WR-12
FT9400D	93.80~94.20	1.5	2.0:1	60	WR-10
FT14000Z	140.0~145.0	2	2:01	45	WR6
FT20000Z	200.0~210.0	2	2:01	40	WR4

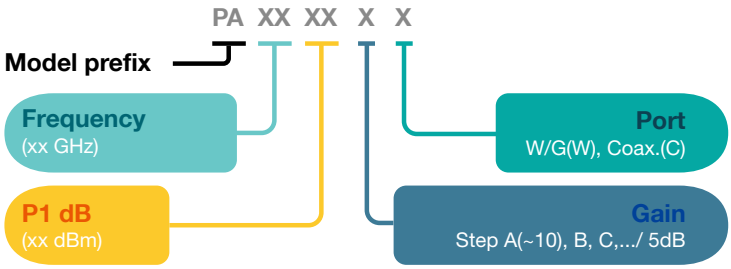
Microwave / mmW Components

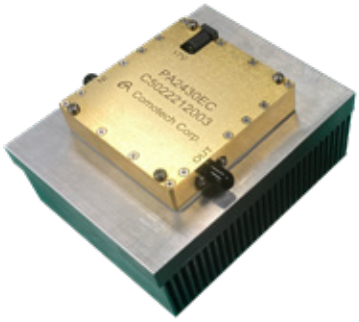
◆ Power Amplifier

Features

- Optimized by using driver amplifier units
- Equipped with voltage regulation circuits and over current
- protection function
- Unconditionally stable design
- Ka-band and V-band applications
- Compact size and low cost

Ordering Information





• **Customer's specifications available**

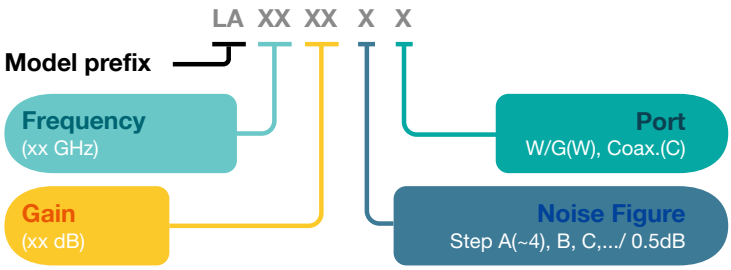
Model	Frequency [GHz]	P1dB [dBm]	Gain [dBi]	VSWR	Bias [V/mA]	Port
PA1817CW	15~22	16	16	2.0:1	9/110	WR-42
PA2425CW	20~26	24	20	2.0:1	9/400	WR-42
PA3024CW	26~35	23	17	2.0:1	9/230	WR-28
PA3825DW	36~40	24	24	2.0:1	9/600	WR-28
PA6014EW	57~64	12	27	2.0:1	5/210	WR-15
PA7321BW	71~76	20	13	2.0:1	5/300	WR-12
PA9421DW	92~96	20	23	2.0:1	5/300	WR-10

◆ Low Noise Amplifier

Features

- Low Noise Figure below 5dB typical
- Equipped with voltage regulation circuits and over
- current protection function
- Unconditionally stable design
- Ka-band and V-band applications
- Compact size and low cost

Ordering Information



• **Customer's specifications available**

Model	Frequency [GHz]	Noise Figure[dB]	Gain [dBi]	VSWR	Bias [V/mA]	Port
LA1826BW	17~22	4.5	25	2.0:1	5/90	WR-42
LA2415BW	20~26	4.5	14	2.0:1	5/50	WR-42
LA3827CW	36~40	5	26	2.0:1	5/90	WR-28
LA6038BW	57~64	4.5	36	2.0:1	5/140	WR-15
LA7314BW	71~76	5	13	2.0:1	5/50	WR-12
LA9421DW	92~96	5	17	2.0:1	5/70	WR-10

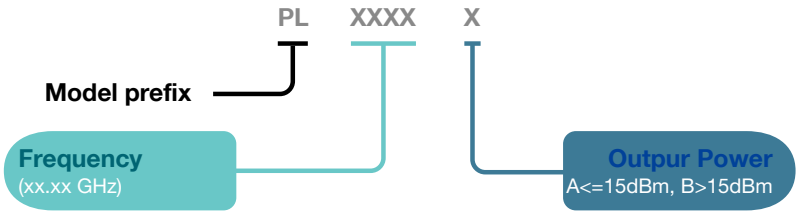
Microwave / mmW Components

◆ Phase Locked Oscillator

Features

- Low phase noise and microphonics
- Internal reference
- Contain voltage regulation circuits and over current protection function
- High stability and low cost

Ordering Information



• **Customer's specifications available**

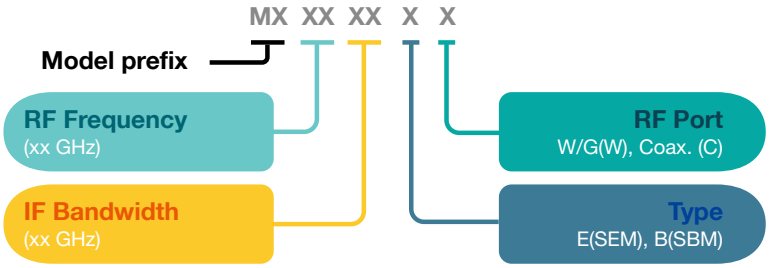
Model	Frequency [GHz]	Pout [dBm]	Phase Noise [dBc/Hz] @100kHz	Bias [V/mA]	Port
PL1815A	18.15	12	90	5/700	WR-42
PL2400A	24	15	90	5/1000	WR-42
PL3825B	38.25	15	90	5/1000	WR-28
PL6250A	62.5	12	95	5/700	WR-15
PL7350A	73.5	12	95	5/700	WR-12
PL8350A	83.5	12	95	5/700	WR-12
PL9280A	92.8	12	95	5/700	WR-10

◆ Mixer

Features

- Low conversion loss with wide IF bandwidth
- Single Ended Mixer(SEM) and Single Balanced Mixer(SBM)
- Ka-band and V-band applications
- Compact size and low cost

Ordering Information



• **Customer's specifications available**

Model	Frequency [GHz]		Conv. Loss [dB]	VSWR		RF to LO Isolation [dB]	Bias [V/mA]	Port	
	RF/LO	IF		RF/LO	IF			RF/LO	IF
MX1802BW	18~22	0~2	10	2.0:1	1.5:1	13	5/20	WR-42	SMA(f)
MX2401EW	23~25	0~1	10	2.0:1	1.5:1	13	5/20	WR-42	SMA(f)
MX3802BW	36~40	2~4	10	2.0:1	1.5:1	13	5/20	WR-28	SMA(f)
MX6102BW	57~64	0~2	10	2.0:1	1.5:1	13	5/20	WR-15	SMA(f)
MX7302BW	71~76	0~2	10	2.0:1	1.5:1	13	5/20	WR-12	SMA(f)
MX9402BW	92~96	0~2	10	2.0:1	1.5:1	13	5/20	WR-10	SMA(f)

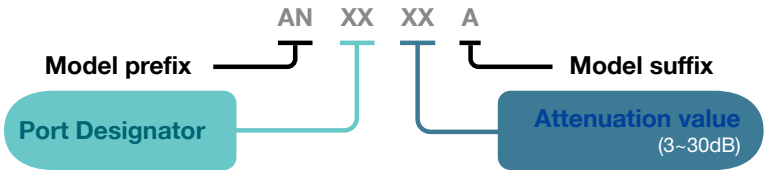
Microwave / mmW Components

◆ Attenuator

Features

- Precision, Fixed Attenuation
- Excellent VSWR characteristic
- Compact size and low cost

Ordering Information



• **Customer's specifications available**

Frequency Band	K	Ka	Q	U	V	E	W	F	G	Y
Frequency [GHz]	18 ~26.5	26.5~40	33~50	40~60	50~75	60~90	75~110	90~140	140~220	220~325
Port	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-8	WR-5	WR-3
Attenuation	03, 06, 10, 15, 20, 25, 30 or customer specific attenuation value									
VSWR	1.2 : 1									

◆ Transition

Features

- Low VSWR characteristic
- Variety RF band applications
- Low cost

Ordering Information

• **Customer's specifications available**

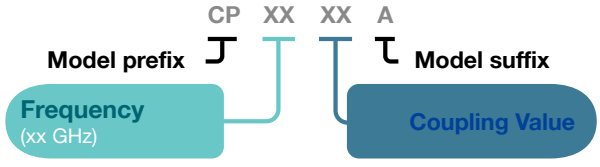
Model	Transition		Insertion Loss[dB]	VSWR
TS4228A	WR-42	WR-28	< 0.3	1.2:1
TS2822A	WR-28	WR-22	< 0.3	1.2:1
TS2215A	WR-22	WR-15	< 0.3	1.2:1
TS1512A	WR-15	WR-12	< 0.3	1.2:1
TS1210A	WR-12	WR-10	< 0.3	1.2:1
TS1008A	WR10	WR-8	< 0.3	1.2:1
TS0805A	WR-8	WR-5	< 0.3	1.2:1
TS0503A	WR-5	WR-3	< 0.3	1.2:1

◆ Coupler

Features

- Low loss with Broadband design
- High performance for Power Combiner/Divider.
- These couplers have a good directivity while retaining the minimal frequency sensitivity associated with higher quality units.
- The standard coupling values are 3, 6, 10, 20dB.
- Custom specifications are available for various applications.

Ordering Information



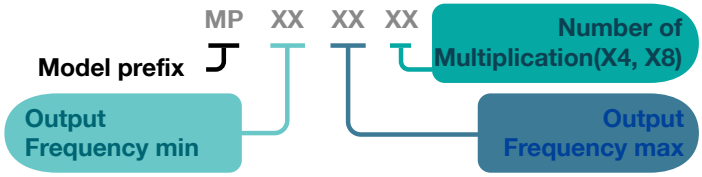
Microwave / mmW Components

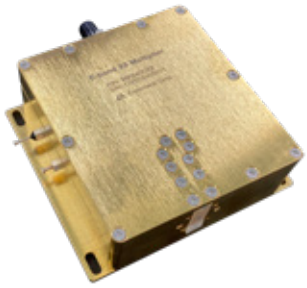
◆ Multiplier

Features

- Variety of RF band applications
- Compact size and low cost

Ordering Information





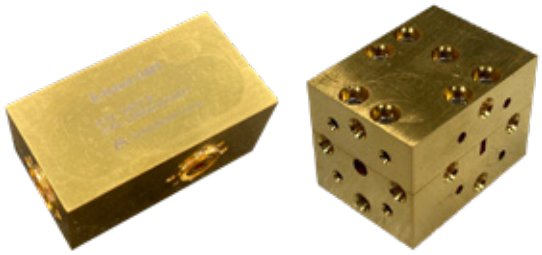
- **Customer's specifications available**

Model	Frequency [GHz]		Output Power [dBm]	Spurious [dBc]	Bias [V/mA]	Port	
	Input	Output				Input	Output
MP7080X4	17.5~20.0	70~80	+8	-60	7/250	SMA(f)	WR12
MP7677X6	12.67~12.83	76~77	+13	-60	5/250	SMA(f)	WR10
MP7688X8	9.5~11.0	76~77	+14	-60	7/600	SMA(f)	WR10
MP8092X8	10.0~11.5	80~94	+10	-60	7/200	SMA(f)	WR10
MP81110X8	10.12~13.75	81~110	+10	-60	7/200	SMA(f)	WR12

◆ OMT / Polarizer

Features

- E-band Frequency Orthomode Transducer / Polarizer
- Extend 1+1, 2+0 with single antenna



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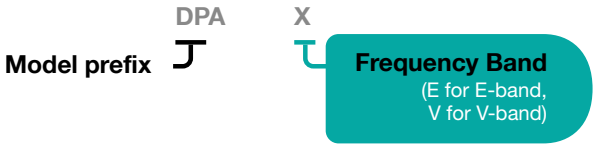


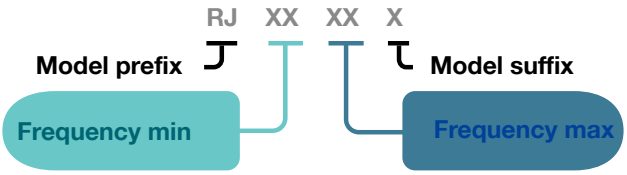
Model	Frequency [GHz]	Insertion Loss [dB]	Isolation [dBc]
OMT-E	71~86	2	35
POL79WR10	77~81	2	20

◆ X-band Rotary Joint

Features

- 8-12GHz X-band Waveguide Rotary Joint
- Extremely Low Insertion Loss(<0.25 dB) and VSWR(<1.2:1)

Ordering Information



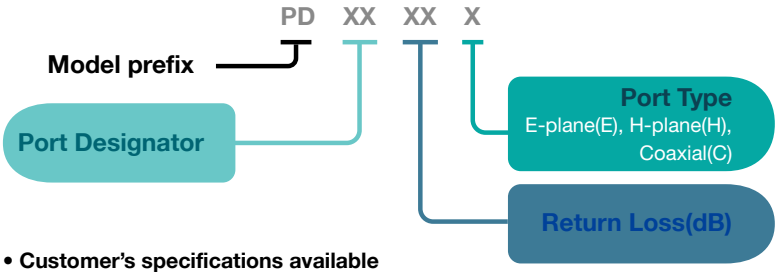
Microwave / mmW Components

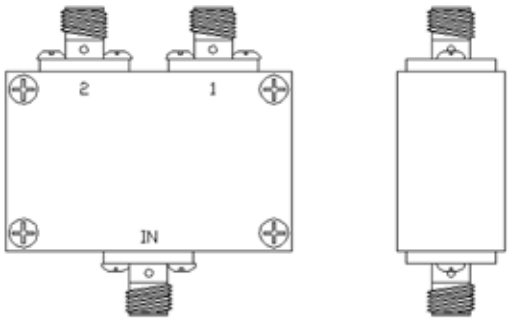
◆ Power Dividers/Combiner

Features

- Low VSWR characteristic
- Variety RF band applications
- Low cost

Ordering Information





• **Customer's specifications available**

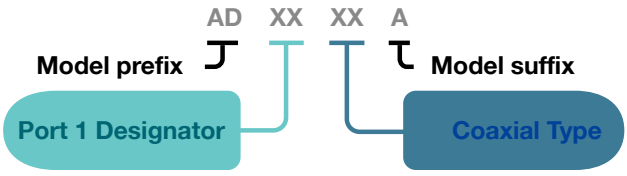
Model		Frequency Range[GHz]	Port	VSWR
E-plane	H-plane			
PD4220E	PD4220H	18~26.5	WR-42	1.3:1
PD2820E	PD2820H	26.5~40	WR-28	1.3:1
PD2220E	PD2220H	33~50	WR-22	1.3:1
PD1520E	PD1520H	50~75	WR-15	1.3:1
PD1220E	PD1220H	60~90	WR-12	1.3:1
PD1020E	PD1020H	75~110	WR-10	1.3:1

◆ Adaptor

Features

- Waveguide to Coax Adaptors feature an improved mechanical design offering greater durability and reliability.
- The Adaptors are fitted with K and V coaxial connectors which are suitable for operation over full waveguide bands up to 65GHz.
- The Adaptors fitted with female or male connectors are available.

Ordering Information



◆ About Other RF Components

There are many RF experts in Comotech's R&D Center. And we can produce most of all items which always satisfies on your demand at above 18GHz up to 110GHz millimeter-wave frequency band. Please contact to us for more information, we will respond as soon as possible for your requirement.

If minor dimensional changes have been incorporated, please contact our sales office for further information.

Appendix

▶ VSWR & Return Loss

VSWR	RETURN LOSS [dB]	TRANSMISSION LOSS [dB]	REFLECTION COEFFICIENT
1.00	∞	0.000	0.00
1.02	40.1	0.000	0.01
1.04	34.2	0.002	0.02
1.06	30.7	0.004	0.03
1.08	28.3	0.006	0.04
1.10	26.4	0.010	0.05
1.12	24.9	0.014	0.06
1.14	23.7	0.019	0.07
1.16	22.6	0.024	0.07
1.18	21.7	0.030	0.08
1.20	20.8	0.036	0.09
1.22	20.1	0.043	0.10
1.24	19.4	0.050	0.11
1.26	18.8	0.058	0.12
1.28	18.2	0.066	0.12
1.30	17.7	0.075	0.13
1.32	17.2	0.083	0.14
1.34	16.8	0.093	0.15
1.36	16.3	0.102	0.15
1.38	15.9	0.112	0.16
1.40	15.6	0.122	0.17
1.42	15.2	0.133	0.17
1.44	14.9	0.144	0.18
1.46	14.6	0.155	0.19
1.48	14.3	0.166	0.19
1.50	14.0	0.177	0.20
1.52	13.7	0.189	0.21
1.54	13.4	0.201	0.21
1.56	13.2	0.213	0.22
1.58	13.0	0.225	0.22
1.60	12.7	0.238	0.23
1.62	12.5	0.250	0.24
1.64	12.3	0.263	0.24
1.66	12.1	0.276	0.25
1.68	11.9	0.289	0.25
1.70	11.7	0.302	0.26
1.72	11.5	0.315	0.26
1.74	11.4	0.329	0.27
1.76	11.2	0.342	0.28
1.78	11.0	0.356	0.28
1.80	10.9	0.370	0.29
1.82	10.7	0.384	0.29
1.84	10.6	0.398	0.30
1.86	10.4	0.412	0.30
1.88	10.3	0.426	0.31
1.90	10.2	0.440	0.31
1.92	10.0	0.454	0.32
1.94	9.9	0.468	0.32
1.96	9.8	0.483	0.32
1.98	9.7	0.497	0.33
2.00	9.5	0.512	0.33
2.50	7.4	0.881	0.43
3.00	6.0	1.249	0.50
3.50	5.1	1.603	0.56
4.00	4.4	1.938	0.60

▶ Standard Rectangular Waveguide

Bands (USA)	EIA	Inner Size [mm]	Freq. Range [GHz]	Cut-Off Freq. (TE_{10}) [GHz]
L	WR-650	165.1 × 82.55	1.12 ~ 1.7	0.909
W	WR-510	129.54 × 64.77	1.45 ~ 2.2	1.158
R	WR-430	109.22 × 54.61	1.7 ~ 2.6	1.373
S	WR-284	72.14 × 34.04	2.6 ~ 3.95	2.079
C	WR-229	58.17 × 29.08	3.22 ~ 4.9	2.579
	WR-159	40.39 × 20.19	4.64 ~ 7.05	3.714
	WR-112	28.5 × 12.62	7.05 ~ 10	5.263
X	WR-90	22.86 × 10.16	8.2 ~ 12.4	6.562
Ku	WR-62	15.8 × 7.9	12.4 ~ 18	9.494
K	WR-42	10.7 × 4.3	18 ~ 26.5	14.058
Ka	WR-28	7.11 × 3.56	26.5 ~ 40	21.097
U	WR-19	4.8 × 2.4	40 ~ 60	31.381
V	WR-15	3.8 × 1.9	50 ~ 75	39.894
E	WR-12	3.1 × 1.5	60 ~ 90	48.387
W	WR-10	2.54 × 1.27	75 ~ 110	59.055
F	WR-8.0	2.032 × 1.016	90 ~ 140	73.8
D	WR-6.5	1.651 × 0.826	110 ~ 170	90.8
G	WR-5.1	1.295 × 0.648	140 ~ 220	116
H	WR-4.3	1.092 × 0.546	170 ~ 260	137
J	WR-3.4	0.864 × 0.432	220 ~ 330	174
Y	WR-2.8	0.711 × 0.356	260 ~ 400	211
	WR-2.2	0.559 × 0.279	330 ~ 500	268
	WR-1.9	0.483 × 0.241	400 ~ 600	311
	WR-1.5	0.381 × 0.191	500 ~ 750	393
	WR-1.2	0.305 × 0.152	600 ~ 900	492
	WR-1.0	0.254 × 0.127	750 ~ 1100	590

▶ Standard Circular Waveguide

Bands	EIA	Inner Diameter [mm]	Freq. Range [GHz]	Cut-Off Freq. [GHz]
C	WC-175	44.45	4.54 ~ 6.23	3.955
	WC-150	38.10	5.3 ~ 7.27	4.614
	WC-128	32.54	6.21 ~ 8.51	5.402
	WC-109	27.79	7.27 ~ 9.97	6.326
X	WC-94	23.83	8.49 ~ 11.6	7.377
	WC-80	20.24	9.97 ~ 13.7	8.685
Ku	WC-69	17.48	11.6 ~ 15.9	10.057
	WC-59	15.09	13.4 ~ 18.4	11.649
	WC-50	12.70	15.9 ~ 21.8	13.842
K	WC-44	11.13	18.2 ~ 24.9	15.794
	WC-38	9.53	21.2 ~ 29.1	18.446
Ka	WC-33	8.33	24.3 ~ 33.2	21.103
	WC-28	7.14	28.3 ~ 38.8	24.620
	WC-25	6.35	31.8 ~ 43.6	27.683
Q	WC-22	5.56	36.4 ~ 49.8	31.617
U	WC-19	4.78	42.4 ~ 58.1	36.776
V	WC-17	4.37	46.3 ~ 63.5	40.227
E	WC-14	3.58	56.6 ~ 77.5	49.103
W	WC-13	3.18	63.5 ~ 87.2	55.280
F	WC-11	2.77	72.7 ~ 99.7	63.462
D	WC-9	2.39	84.8 ~ 116	73.552

▶ dBm & Watt

dBm	Po	V
53	200 W	100 V
50	100 W	70.7 V
49	80 W	64.0 V
48	64 W	58.0 V
47	50 W	50.0 V
46	40 W	44.5 V
45	32 W	40.0 V
44	25 W	32.5 V
43	20 W	32.0 V
42	16 W	28.0 V
41	12.5 W	26.2 V
40	10 W	22.5 V
39	8.0 W	20.0 V
38	6.4 W	18.0 V
37	5.0 W	16.0 V
36	4.0 W	14.1 V
35	3.2 W	12.5 V
34	2.5 W	11.5 V
33	2.0 W	10.0 V
32	1.6 W	9.0 V
31	1.25 W	8.0 V
30	1.0 W	7.10 V
29	800 mW	6.40 V
28	640 mW	5.80 V
27	500 mW	5.00 V
26	400 mW	4.45 V
25	320 mW	4.00 V
24	250 mW	3.55 V
23	200 mW	3.20 V
22	160 mW	2.80 V
21	125 mW	2.52 V
20	100 mW	2.25 V
19	80 mW	2.00 V
18	64 mW	1.80 V
17	50 mW	1.60 V
16	40 mW	1.41 V
15	32 mW	1.25 V
14	25 mW	1.15 V
13	20 mW	1.00 V
12	16 mW	900 mV
11	12.5 mW	800 mV
10	10 mW	710 mV
9	8.0 mW	640 mV
8	6.4 mW	580 mV
7	5.0 mW	500 mV
6	4.0 mW	445 mV
5	3.2 mW	400 mV
4	2.5 mW	355 mV
3	2.0 mW	320 mV
2	1.6 mW	280 mV
1	1.25 mW	252 mV

dBm	Po	V
0	1.0 mW	225 mV
-1	800 uW	200 mV
-2	640 uW	180 mV
-3	500 uW	160 mV
-4	400 uW	141 mV
-5	320 uW	125 mV
-6	250 uW	115 mV
-7	200 uW	100 mV
-8	160 uW	90.0 mV
-9	125 uW	80.0 mV
-10	100 uW	71.0 mV
-11	80 uW	64.0 mV
-12	64 uW	58.0 mV
-13	50 uW	50.0 mV
-14	40 uW	45.0 mV
-15	32 uW	40.0 mV
-16	25 uW	35.5 mV
-17	20 uW	31.5 mV
-18	16 uW	28.5 mV
-19	12.5 uW	25.1 mV
-20	10 uW	22.5 mV
-21	8.0 uW	20.0 mV
-22	6.4 uW	17.9 mV
-23	5.0 uW	15.9 mV
-24	4.0 uW	14.1 mV
-25	3.2 uW	12.8 mV
-26	2.5 uW	11.5 mV
-27	2.0 uW	10.0 mV
-28	1.6 uW	8.9 mV
-29	1.25 uW	8.0 mV
-30	1.0 uW	7.1 mV
-31	800 nW	6.25 mV
-32	640 nW	5.8 mV
-33	500 nW	5.0 mV
-34	400 nW	4.5 mV
-35	320 nW	4.0 mV
-36	250 nW	3.5 mV
-37	200 nW	3.2 mV
-38	160 nW	2.85 mV
-39	125 nW	2.5 mV
-40	100 nW	2.25 mV
-41	80 nW	2.0 mV
-42	64 nW	1.8 mV
-43	50 nW	1.6 mV
-44	40 nW	1.4 mV
-45	32 nW	1.25 mV
-46	25 nW	1.18 mV
-47	20 nW	1.0 mV
-48	16 nW	900 uV
-49	12.5 nW	800 uV
-50	10 nW	710 uV

dBm	Po	V
-51	8.0 nW	640 uV
-52	6.4 nW	570 uV
-53	5.0 nW	500 uV
-54	4.0 nW	445 uV
-55	3.2 nW	400 uV
-56	2.5 nW	351 uV
-57	2.0 nW	320 uV
-58	1.6 nW	286 uV
-59	1.25 nW	251 uV
-60	1.0 nW	225 uV
-61	800 pW	200 uV
-62	640 pW	180 uV
-63	500 pW	160 uV
-64	400 pW	141 uV
-65	320 pW	128 uV
-66	250 pW	115 uV
-67	200 pW	100 uV
-68	160 pW	90.0 uV
-69	125 pW	80.0 uV
-70	100 pW	71.0 uV
-71	80 pW	64.0 uV
-72	64 pW	58.0 uV
-73	50 pW	50.0 uV
-74	40 pW	45.0 uV
-75	32 pW	40.0 uV
-76	25 pW	35.5 uV
-77	20 pW	31.5 uV
-78	16 pW	28.5 uV
-79	12.5 pW	25.1 uV
-80	10 pW	22.5 uV
-81	8.0 pW	20.0 uV
-82	6.4 pW	17.9 uV
-83	5.0 pW	15.9 uV
-84	4.0 pW	14.1 uV
-85	3.2 pW	12.8 uV
-86	2.5 pW	11.5 uV
-87	2.0 pW	10.0 uV
-88	1.6 pW	8.9 uV
-89	1.25 pW	8.0 uV
-90	1.0 pW	7.1 uV
-91	0.8 pW	6.1 uV
-92	0.64 pW	5.75 uV
-93	0.5 pW	5.0 uV
-94	0.4 pW	4.5 uV
-95	0.32 pW	4.0 uV
-96	0.25 pW	3.51 uV
-97	0.2 pW	3.2 uV
-98	0.16 pW	2.9 uV
-99	0.125 pW	2.51 uV
-100	0.1 pW	2.25 uV

NOTE

NOTE