

# RAy – Microwave link



## RAy3

- 1 Gbps / 24 GHz / 250 MHz
- 713 Mbps / 17 GHz, 24 GHz / 200 MHz
- 3.5 – 112 MHz channels
- Asymmetric channels
- AES 256, SyncEth, PTP
- 1x ETH, 1x SFP, 1x USB
- Solar ready - 22W
- Each unit tested -30 to +55°C
- Full outdoor, easy installation
- Interference tolerant
- Wifi management
- RAY Tools (Android, iOS)

**RAy** is a high-speed point-to-point microwave link, ideal for establishing robust links in the most challenging conditions.

This **Full Outdoor** Software Defined Radio with Linux OS, is designed for **high performance links** with **maximum reliability**, **exceptional system gain** and **resistance to disturbances**. All relevant state-of-the-art concepts have been carefully implemented without compromise.

RAy is well proven within the market since 2009 in thousands of installations in tens of countries from the poles to the equator.

It is used by Internet Service Providers as well as global Telco operators for both, backbone and last-mile microwave links.

**RAy3**, the 3rd generation of RAY, with possibility of **asymmetric channels** and **1 Gbps FDD** is the top equipment for license free bands.



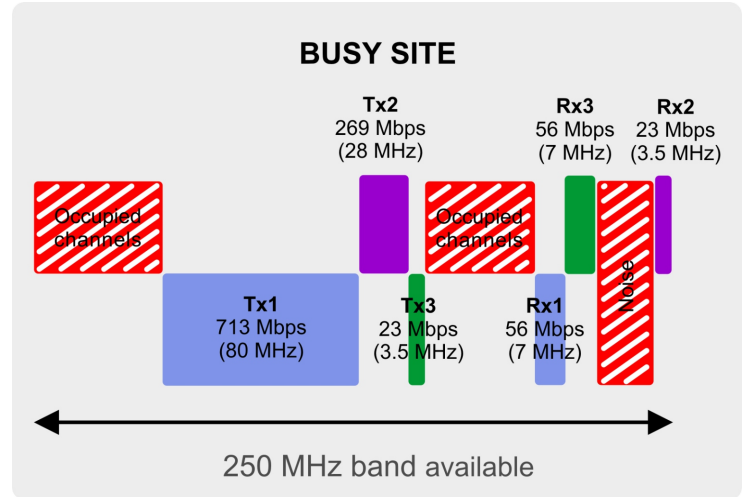
## RAy2

- 360 Mbps / 10, 11, 17, 18, 24 GHz
- 1.75 – 56 MHz channels
- 1x ETH, 1x SFP, 1x USB
- Solar ready - 22W
- Each unit tested -30 to +55°C
- Full outdoor, easy installation
- Maximum distance & reliability
- Interference tolerant
- Wifi management
- RAY Tools (Android, iOS)

## General overview

	RAy2	RAy3
<b>Max. Speed</b>	<b>360 Mbps</b> <b>256 QAM</b> <b>56 MHz</b>	<b>1 Gbps</b> <b>2048 QAM</b> <b>112 MHz</b>
Speed / 56MHz	360 Mbps 256QAM	540 Mbps 4096 QAM
Bands	10, 11, 17, 18, 24 GHz	17, 24 GHz
Asymmetric channels	No	Yes
Channel size	1.75 – 56 MHz	3.5 – 112 MHz
Modulations	QPSK 16 – 256 QAM	QPSK 16 – 4096 QAM
AES 256	No	Yes
Sync Eth, PTP	No	Yes
ESD	4 kV	8 kV
Surge immunity	1 kV	4 kV

Example: RAY3 asymmetric channels in 24 GHz band



## RAY Tools Mobile App

- **Wifi** connection between unit and mobile phone
- **Link calculation**
  - fade margin for given distance
- **Antenna Alignment**
  - RSS & SNR, displayed and acoustic notification
- **Link management**
  - responsive web interface

## Reliability

- Each unit **tested in a climatic chamber** and in real traffic
- **Robust** input **filter** with no adjustable components
- All our free band units meet licensed band standards
- Built-in **surge protections**
- **Heavy-duty industrial components**
- Industrial rugged die-cast aluminium case
- **- 30 to +55 °C**
- 3 year warranty

## Security & Integrity

- Licensed bands available (RAY2)
- **FEC**, interleaving, proprietary **data compression**
- **Proprietary protocol** on Radio channel
- Assigned peer unit permanently monitored
- **Management** - https, ssh,
- **Unique ssh key** for each unit
- **Role-based access control** (2 levels)
- AES256 encryption (RAY3)

## Long range & Data speed

- Exceptional **robustness** against **noise** and **interference**
- Hitless **ACM, ATPC**
- **Exceptional sensitivity**: up to -103 dBm
- **Narrow channels**: 3.5 – 112 MHz (RAY3)
- **Wide ranging modulation options**: QPSK – 4096 QAM (RAY3)
- **Asymmetric channels** (RAY3)
- **2+0** solution for double speed available (10, 11, 18 GHz)

## Easy to install and maintain

- **Full outdoor** unit with aluminum casing
- **Direct mounting** to parabolic antennas
- Simple signal polarization change through unit rotation
- Built-in **spectrum analyzer** for free channel search
- **RSS voltage output** for antenna alignment
- 17, 24 GHz - the same HW for both, L/U units
- HW button for factory and customers settings
- RAY2 and RAY3 are mechanically compatible

## Configuration & Diagnostic

- **Web interface** or CLI via SSH
- **Non-intrusive management** via USB using either ETH/USB adapter or WiFi/USB adapter with DHCP
- **SNMP** including Traps and Informs
- Automatic detection of unit polarization
- **Constellation diagram** of the received signal
- Temperature, Power voltage, RSS, MSE, BER, Data rate, Output power status and history avail. as text or charts

# RAy3 technical parameters

<b>Radio parameters</b>	<b>RAy3</b>		
Frequency range	17.10 – 17.30 GHz; 24.00 – 24.25 GHz		
Channel spacing	3.5, 5, 7, 10, 14, 20, 28, 40, 56, 80, 100, 112 MHz		
Channel duplex spacing	Flexible, min.18 MHz between channel edges		
Gross data rate	2.7 – 1002 Mbps		
FEC	LDPC, RS		
	<b>Speed / Sensitivity</b>		
<b>Modulation</b>	<b>3.5 MHz</b>	<b>56 MHz</b>	<b>112 MHz</b>
QPSK_S	2.7 Mbps / -99.0 dBm	48 Mbps / -88.0 dBm	97 Mbps / -85.0 dBm
QPSK	5.0 Mbps / -94.5 dBm	81 Mbps / -84.5 dBm	161 Mbps / -81.5 dBm
16 QAM	9.5 Mbps / -88.5 dBm	168 Mbps / -77.5 dBm	334 Mbps / -74.5 dBm
32 QAM	11 Mbps / -85.0 dBm	213 Mbps / -73.5 dBm	426 Mbps / -70.5 dBm
64 QAM	15 Mbps / -82.0 dBm	267 Mbps / -70.5 dBm	536 Mbps / -67.5 dBm
128 QAM	17 Mbps / -79.0 dBm	319 Mbps / -67.5 dBm	636 Mbps / -64.5 dBm
256 QAM	19 Mbps / -76.0 dBm	366 Mbps / -64.5 dBm	730 Mbps / -61.5 dBm
512 QAM	22 Mbps / -73.0 dBm	413 Mbps / -61.5 dBm	823 Mbps / -58.5 dBm
1024 QAM	23 Mbps / -69.5 dBm	459 Mbps / -58.5 dBm	918 Mbps / -55.5 dBm
2048 QAM (7 - 112 MHz)	-	501 Mbps / -55.5 dBm	1002 Mbps / -52.5 dBm
4096 QAM (14 - 56 MHz)	-	540 Mbps / -52.5 dBm	-
ACM	Hitless		
RF Output power	-30 to +10 dBm		
ATPC	Yes		
MTU	10240 B		
Latency (RFC 2544)	268 µs (64B/366 Mbps); 313 µs (1518 B/366 Mbps) 173 µs (64B/1002 Mbps); 198 µs (1518 B/1002 Mbps)		
Synchronization	Synchronous Ethernet; 1588v2 transparent clock		
<b>Electrical</b>			
Primary power	PoE active 37 – 60 VDC, IEEE 802.3at; PoE passive 20 – 60 VDC; DC 20 – 60 VDC; floating		
Power consumption	typ. 22.5 W (w/o SFP)		
<b>Interfaces</b>			
Ethernet	1× 10/100/1000 Base-T Auto MDI/MDIX / RJ45		
SFP	1× 10/100/1000 Base-T/1000Base-SX/1000Base-LX (power max. 1.25 W)		
USB	USB 2.0 / Host A		
RSS voltage	Two contact sockets		
Indication LED	SYS		
<b>Environmental</b>			
IP Code (Ingress Protection)	IP66		
MTBF (Mean Time Between Failure)	> 750.000 hours (> 85 years)		
Operating temperature	- 30 to + 55°C (ETSI EN 300019-1-4, class 4.1.)		
Operating humidity	5 to 95% non-condensing		
Surge immunity	4 kV acc. EN 61000-4-5		
ESD resistance	8 kV acc. EN 61000-4-2		
<b>Mechanical</b>			
Casing	Rugged die-cast aluminium		
Size	160 H x 245 W x 245 D mm (6.3 x 9.6 x 9.6 in)		
Weight	2.6 kg (5.7 lbs)		
Mounting	FOD, direct mounting to antenna		
<b>Diagnostic</b>			
Real time monitoring	RSS, MSE, BER		
Diagnostic tools	Spectrum analyzer, Pinger, Constellation diagram		
History charts	Temperature, Power voltage, RSS, MSE, BER, Data rate, RF Output power		
Statistics	RMON counters for all interfaces		
Antenna alignment	RSS voltage, RAY Tools, web		
SNMP	v2c including configurable TRAPS		
<b>Security</b>			
Management	HTTP, HTTPS, SSH, Telnet, RAYTools App		
Access accounts	3 levels (Guest, Admin, Super)		
Encryption	AES256, 192, 128		
<b>Standards</b>			
Approvals	17 GHz CE (RED), RoHS 24 GHz CE (RED), FCC, RoHS		

# RAy2 technical parameters

RAy2	10 GHz		11 GHz		17 GHz / 24 GHz <sup>(3)</sup>		18 GHz	
Radio parameters	Lower	Upper	Lower	Upper	The same HW for L/U		Lower	Upper
Sub-band A	10.300 – 10.420	10.476 – 10.588	10.695 – 10.970	11.185 – 11.460	no sub-bands		17.700 – 18.209	18.710 – 19.219
Sub-band B	10.125 – 10.325	10.475 – 10.675	10.935 – 11.195	11.425 – 11.695	17.1 - 17.3		18.167 – 18.690	19.177 – 19.700
Sub-band C	-	-	-	-	24.0 - 24.25		17.700 – 18.300	19.300 – 19.700
Channel spacing	1.75, 3.5, 7, 14, 20, 28/30, 56 MHz		1.75, 3.5, 7, 14, 28/30, 40, 56 MHz		3.5, 7, 14, 28, 40, 50, 56 MHz		1.75, 2.5, 3.5, 5, 7, 13.75, 27.5, 55 MHz	
Channel duplex spacing	min. 58 MHz		490, 530 MHz		min. 60 MHz		1008, 1010, 1560 MHz	
Gross data rate	1.4 – 360 Mbps		1.4 – 360 Mbps		4.9 – 360 Mbps		2.5 – 360 Mbps	
FEC	LDPC							
<b>Speed / Sensitivity</b>								
Modulation	1.75 MHz	56 MHz	1.75 MHz	56 MHz	3.5 MHz	56 MHz	1.75 MHz	55 MHz
QPSK_S <sup>(1)</sup>	1.4 Mbps / -103.0 dBm	-	1.4 Mbps / -102.0 dBm	-	-	-	-	-
QPSK	2.5 Mbps / -100.0 dBm	73 Mbps / -86.0 dBm	2.5 Mbps / -99.0 dBm	73 Mbps / -87.0 dBm	4.9 Mbps / -97.0 / -96.0 dBm	73 Mbps / -87.0 / -86.0 dBm	2.5 Mbps / -97.0 dBm	73 Mbps / -84.0 dBm
16 QAM	5.0 Mbps / -92.0 dBm	160 Mbps / -79.0 dBm	5.0 Mbps / -93.0 dBm	160 Mbps / -80.0 dBm	9.6 Mbps / -90.0 / -89.0 dBm	160 Mbps / -80.0 / -79.0 dBm	5.0 Mbps / -91.0 dBm	160 Mbps / -75.0 dBm
32 QAM	6.3 Mbps / -88.0 dBm	203 Mbps / -75.0 dBm	6.3 Mbps / -89.0 dBm	203 Mbps / -76.0 dBm	12 Mbps / -87.0 / -86.0 dBm	203 Mbps / -76.0 / -75.0 dBm	6.3 Mbps / -88.0 dBm	203 Mbps / -72.5 dBm
64 QAM	7.4 Mbps / -87.0 dBm	257 Mbps / -72.0 dBm	7.4 Mbps / -88.0 dBm	257 Mbps / -73.0 dBm	14 Mbps / -84.0 / -83.0 dBm	257 Mbps / -73.0 / -72.0 dBm	7.4 Mbps / -85.0 dBm	257 Mbps / -70.0 dBm
128 QAM	8.9 Mbps / -84.0 dBm	304 Mbps / -68.0 dBm	8.9 Mbps / -84.0 dBm	304 Mbps / -69.0 dBm	17 Mbps / -83.0 / -79.0 dBm	304 Mbps / -69.0 / -68.0 dBm	8.9 Mbps / -82.5 dBm	304 Mbps / -67.0 dBm
256 QAM	-	338 Mbps / -66.0 dBm	-	338 Mbps / -67.0 dBm	20 Mbps / -81.0 / -77.0 dBm	338 Mbps / -66.0 / -65.0 dBm	-	338 Mbps / -64.0 dBm
256 QAM_TO <sup>(2)</sup>	-	359 Mbps / -63.0 dBm	-	359 Mbps / -64.0 dBm	-	359 Mbps / -64.0 / -63.0 dBm	-	359 Mbps / -63.0 dBm
ACM	Hitless							
RF Output power	-10 to +13 dBm		-15 to +24 dBm		-25 to +5 dBm / -30 to +10 dBm		-10 to +24 dBm	
ATPC	Yes							
Latency (RFC 2544)	81 µs (64 B / 358 Mbps), 234 µs (1518 B / 358 Mbps)							
<b>Electrical</b>								
Primary power	PoE active 40 – 60 VDC, IEEE 802.3at; DC 20 – 60 VDC; floating							
Power consumption	21 W		21 – 29 W		21 / 23 W		21 – 28 W	
<b>Interfaces</b>								
Ethernet	1x 10/100/1000 Base-T Auto MDI/MDIX / RJ45							
SFP	1x 1000Base-SX / 1000Base-LX (power max. 1.25 W)							
USB	USB 2.0 / Host A							
RSS voltage	Two contact sockets							
Indication LED	AIR, SYS, ETH							
<b>Environmental</b>								
IP Code	IP66							
MTBF	> 750.000 hours (> 85 years)							
Operating temperature	- 30 to + 55°C (ETSI EN 300019-1-4, class 4.1.)							
Operating humidity	5 to 95% non-condensing							
Surge immunity	1 kV acc. EN 61000-4-5							
ESD resistance	4 kV acc. EN 61000-4-2							
<b>Mechanical</b>								
Casing	Rugged die-cast aluminium							
Size	157 H x 244 W x 244 D mm (6.2 x 9.6 x 9.6 in)							
Weight	2.8 kg (6.1 lbs)		2.8 kg (6.1 lbs)		2.5 kg (5.5 lbs)		2.7 kg (5.9 lbs)	
Mounting	FOD, direct mounting to antenna							
<b>Diagnostic</b>								
Real time monitoring	RSS, MSE, BER							
Diagnostic tools	Spectrum analyzer, Pinger, Constellation diagram							
History charts	Temperature, Power voltage, RSS, MSE, BER, Data rate, RF Output power							
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<b>Standards</b>								
Approvals	10 GHz CE (RED), RoHS 11 GHz CE (RED), RoHS, FCC 17 GHz CE (RED), RoHS 18 GHz CE (RED), RoHS, FCC 24 GHz CE (RED), RoHS, FCC							

<sup>(1)</sup> Stability optimized (stronger) FEC  
<sup>(2)</sup> Throughput optimized (weaker) FEC

<sup>(3)</sup> RAY2-17 and RAY2-24 were under production until III/2021

