CASCADE 2019
PRODUCT GUIDE

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DOCUMENT CONTROL

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www.codancomms.com/lmr/

NOTE

The user's authority to operate this equipment could be revoked through any changes or modifications not expressly approved by Codan Limited.

The design of this equipment is subject to change due to continuous development. This equipment may incorporate minor changes in detail from the information contained in this manual.

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

RF Exposure Warning

Exposure to radio frequency (RF) energy has been identified as a potential environmental factor that must be considered before a radio transmitter can be authorized or licensed. The FCC and IC have therefore developed maximum permissible exposure (MPE) limits for field strength and power density, listed in FCC 47 CFR § 1.1310 and IC RSS-102 Issue 5 Sect 4. The FCC has furthermore determined that determination of compliance with these exposure limits, and preparation of an Environmental Assessment (EA) if the limits are exceeded, is necessary only for facilities, operations and transmitters that fall into certain risk categories, listed in FCC 47 CFR § 1.1307 (b), Table 1. All other facilities, operations and transmitters are categorically excluded from making such studies or preparing an EA, except as indicated in FCC 47 CFR §§ 1.1307 (c) and (d).

KDB 447198 D01 General RF Exposure Guidance v06 and IC RSS-102 Issue 5 provide assistance in determining whether a proposed or existing transmitting facility, operation or device complies with RF exposure limits. In accordance with KDB 447198 , FCC 47 CFR § 1.1307 (b) and RSS-102 Issue 5 Sect 2.5, the Codan Communications transmitter manufactured in Canada is categorically excluded from routine evaluation or preparing an EA for RF emissions and this exclusion is sufficient basis for assuming compliance with FCC/IC MPE limits. This exclusion is subject to the limits specified in FCC 47 CFR §§ 1.1307 (b), 1.1310 and IC RSS-102 Issue 5 Sect 4. Codan Communications has no reason to believe that the excluded transmitter encompasses exceptional characteristics that could cause non-compliance.

Notes:

- The FCC and IC's exposure guidelines constitute exposure limits, not emission limits. They are relevant to locations that are accessible to workers or members of the public. Such access can be restricted or controlled by appropriate means (i.e., fences, warning signs and others).
- The FCC and IC's limits apply cumulatively to all sources of RF emissions affecting a given site. Sites exceeding these limits are subject to an EA and must provide test reports indicating compliance.

RF Safety Guidelines and Information

Base and Repeater radio transmitters are designed to generate and radiate RF energy by means of an external antenna, typically mounted at a significant height above ground to provide adequate signal coverage. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. The following antenna installation guidelines must be adhered to in order to ensure RF exposure compliance:

Non-building-mounted Antennas:

- Height above ground level to lowest point of antenna ≥ 10m
- Power ≤ 1000W ERP (1640W EIRP)

Building-mounted Antennas:

Power ≤ 1000W ERP (1640W EIRP)

The following RF Safety Guidelines should be observed when working in or around transmitter sites:

- Do not work on or around any transmitting antenna while RF power is applied.
- Before working on an antenna, disable the appropriate transmitter and ensure a "DO NOT USE" or similar sign is placed on or near the PTT or key-up control.
- Assume all antennas are active unless specifically indicated otherwise.
- Never operate a transmitter with the cover removed.
- Ensure all personnel entering a transmitter site have electromagnetic energy awareness training.

For more information on RF energy exposure and compliance, please refer to the following:

1. FCC Code of Regulations; 47 CFR §§ 1.1307 and 1.1310
2. KDB 447198 D01 General RF Exposure Guidance v06
3. https://www.fcc.gov/general/radio-frequency-safety-0
4. IC RSS-102 Issue 5, "Radio Frequency Exposure Compliance of Radio Communication Apparatus"

RF Maximum Permissible Exposure (MPE)

Exhibit Requirements for Installations in the United States of America

FCC Part 1, Section 1.1307 table 1- Transmitters, Facilities and Operations Subject to Routine Environmental Evaluation states the following for Part 90 Devices:

- Part 90 devices Non-building-mounted antennas: height above ground level to lowest point of antenna <10 m and power >1000 W ERP (1640 W EIRP). Building-mounted antennas: power >1000 W ERP (1640 W EIRP).

Another way of wording this is that Part 90 devices are not Subject to Routine Environmental Evaluation when the antenna is installed at 10Meters or higher and operating total power level of all channels is less than 1640 Watts EIRP.

As an example, a 100W transmitter with a 10dB gain antenna with a low loss cable would translate into 1,000 Watts EIRP in the envelope lobe. If it is mounted 10 Meters or higher above where people could be walking, you have a safe installation and do not have to perform MPE calculations for safe distance.

If the antenna is lower than 10 Meters then you need to verify that your installation is at a safe distance for Exposure to the General Population.

For United States installations, you must ensure that your installation complies with the Maximum Permissible Exposure (MPE) requirements for general population that are specified under FCC Part 1 Section 1.1310 Table 1.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	6
3.0-30	1842/f	4.89/f	*900/f^2	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f^2	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

For US Installations, the maximum power density resulting from the composite Effective Isotropic Radiated Power (EIRP) from the antenna connected to this equipment must be limited to the maximum permissible exposure as stated below:

- **Power density limit for the band 152 to 174MHz** = 0.2 mW/cm²

MPE and Safe Distance Calculations for USA Installations

This Power Density value is determined by the combination of RF output, cable loss, antenna gain, and distance from the antenna when energized.
The MPE calculation for US installations is expressed as follows:

- **Power Density Pd (mW/cm²) =** $\left(\frac{EIRP}{4*\pi*d^2}\right)$

Where

- **d** = distance from the antenna expressed in cm.
- **EIRP expressed in mW** = $10^{\left(\frac{[Tx\ pwr\ (dBm)+Ant\ Gain\ (dBi)-Cable\ Loss\ (dB)]}{10}\right)}$
- **Tx Power (dBm)** = 10*log[Tx Power (mW)]

As an example, with the transmitter running at 100 watts output into an antenna with a gain of 10 dBi using a short cable with 0dB loss, to verify if 650cm (6.5meters) is a safe distance from the antenna to ensure exposure compliance of 0.2mW/cm2:

1) 100 Watts Tx Power = 50dBm
2) EIRP (mW) = $10^{\left(\frac{[Tx\ pwr\ (50dBm)+Ant\ Gain\ (10dBi)-Cable\ Loss\ (0dB)]}{10}\right)} = 10^{\left(\frac{60}{10}\right)}$ = 1,000,000mW
3) Pd (mW/cm2) = $\left(\frac{EIRP}{4*\pi*d^2}\right) = \left(\frac{1,000,000}{4*\pi*650^2}\right) = \left(\frac{1,000,000}{5,309,291}\right)$=0.19 mW/cm^2

- 6.5 meters (21.125 Feet) is a safe distance for US installations when using a 10dBi Antenna

The minimum safe distance, from a radiating structure using different "Gain Antennas"

- For the Band 152 to 174MHz with 2dBi Gain Antenna: d (safe distance) = 2.6 m
- For the Band 152 to 174MHz with 6dBi Gain Antenna: d (safe distance) = 4.0 m
- For the Band 152 to 174MHz with 10dBi Gain Antenna: d (safe distance) = 6.5 m

RF Maximum Permissible Exposure (MPE)

Exhibit Requirements for Installations in Canada

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\,f^{0.3417}$	$0.008335\,f^{0.3417}$	$0.02619\,f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\,f^{0.5}$	$4.21 \times 10^{-4}\,f^{0.5}$	$6.67 \times 10^{-5}\,f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

MPE and Safe Distance Calculations for Canada Installations

For Canada installations, the maximum power density resulting from the composite Effective Isotropic Radiated Power (EIRP) from the antenna connected to this equipment must be limited to the maximum permissible exposure as stated below:

- **Power density limit for the band 152 to 174MHz** = 1.291 W/m²

The MPE calculation for US is expressed as follows:

- **Power Density Pd (W/m²)** = $\left(\frac{EIRP}{4 \cdot \pi \cdot d^2}\right)$

Where

- **d** = distance from the antenna expressed in meters (m)
- **EIRP expressed in Watts (W)** = $10^{\left(\frac{[Tx\ pwr\ (dBW) + Ant\ Gain\ (dBi) - Cable\ Loss\ (dB)]}{10}\right)}$
- **Tx Power (dBW)** = 10*log[Tx Power (W)]

As an example, with the transmitter running at 100 watts output into an antenna with a gain of 10 dBi using a short cable with 0dB loss, to verify if 7.5meters is a safe distance from the antenna to ensure exposure compliance of 1.21W/m2:

4) 100 Watts Tx Power = 20dB

5) EIRP (W) = $10^{\left(\frac{[Tx\ pwr\ (20dBW) + Ant\ Gain\ (10dBi) - Cable\ Loss\ (0dB)]}{10}\right)} = 10^{\left(\frac{20}{10}\right)}$ = 1,000W

6) Pd (W/m2) = Pd (W/m2) = $\left(\frac{EIRP}{4 \cdot \pi \cdot d^2}\right) = \left(\frac{1{,}000}{4 \cdot \pi \cdot 8.5^2}\right) = \left(\frac{1{,}000}{907.9}\right)$=1.11 W/m²

- 8.5 meters is a safe distance for Canada installations when using a 10dBi gain antenna.

When installing the antenna, the above relationship should be used to ensure the combination of power, antenna gain, and distance is such that the maximum permissible power density is not exceeded. Different combinations of output power and antenna gain will result in different minimum safe distances.

The minimum safe distance, from a radiating structure using different Gain Antennas"

- For the Band 152 to 174MHz with 2dBi Gain Antenna: d (safe distance) = 3.5 m
- For the Band 152 to 174MHz with 6dBi Gain Antenna: d (safe distance) = 5.5 m
- For the Band 152 to 174MHz with 10dBi Gain Antenna: d (safe distance) = 8.5 m

Contents

Safety Information 9
Important Safety Warnings 9
Subrack and Front Panel Safety 11
Front Panel Installed – User Access 11
Front Panel Assembly Removed – Qualified Personnel 11

Overview 13
Cascade LMR Base Station / Repeater Platform 13

General Information 15
Introduction 15
Key Features 16
Hardware Performance 16
Software Innovation 16
P25 Compliant 16
Support and Services 16
Remote Programming and Monitoring 16
Module Configurations 17
Cascade Web GUI 18

SAFETY INFORMATION

IMPORTANT SAFETY WARNINGS

To reduce the risk of personal injury and property damage, exercise caution and look for and comply with the safety symbols shown below.

STOP SIGN
When this symbol is shown, **DO NOT** continue until the safety items identified have been noted and addressed. Ignoring this reminder violates Codan standards of design for the product and will most likely result in severe personal injury or equipment damage.

CAUTION SIGN
When this symbol is shown, exercise caution and read the information carefully. If the corresponding procedure or information is not performed or applied correctly, the equipment may fail or performance may be compromised and personal safety could also be compromised.

NOTE:
When this symbol is shown, the selected information will add clarity to a procedure or provide additional information that will enhance the equipment performance.

- **Equipment Modification** – DO NOT modify any parts on this equipment. Contact Codan Radio Communications Service Department.
- **Radiation from Radio Frequency (RF)** – DO NOT touch the antenna when using the Transmitter. Always follow RF Safety Guidelines.
- **Exploding Hazard** – DO NOT operate the Cascade equipment if flammable gas or gas fumes are present.
- **RF Burn Hazard** – DO NOT touch the output connector in an open circuit condition while transmitting. The amplifier RF output connector may produce risk of RF burns if operated with the output connector in an open-circuit condition. The power amplifier should always be operated in the specified load and connector.
- **Personal Safety** – DO NOT operate or perform maintenance on the system without direct authority from Codan Radio Communications. Comply with all material handling regulations as many components are heavy and moving or lifting could cause physical injury.
  Some metal edges on the Cascade are sharp; wear gloves for protection.
- **Airflow Restriction** – DO NOT cover or restrict the cooling fans or vents; overheating can occur and cause serious damage.
- **Equipment Damage** – DO NOT lift the subrack by the front panel handles. The handles are not designed to bear the full weight of the subrack and fitted modules.
- **Hot Surface Hazard** – The Power Amplifier surface temperature may exceed safe touch temperatures when operated under high-power and/or high-ambient temperature conditions.
- **Shock Hazard** – Protect all Cascade equipment from the possibility of lightning strikes and contact from any unspecified external power source.

Assembled subrack and modules weigh over 45 pounds (~20 kilograms). A two-person lift may be required.

SUBRACK AND FRONT PANEL SAFETY

- A tool is required to access the area (removing the front panel)
- A qualified service person is required to access the front panel area, even without equipment energized
- An unqualified user should not remove the front panel as no access is required to this area for any routine operation of the system
- The Cascade subrack and modules should be well ventilated and free from moisture and excess dust and dirt

Front Panel Installed – User Access

Hazard	Description
Heat Hazard	• Recirculated air may be hot in some scenarios • Handles may remain hot after exposure to high ambient air temperature within specifications
Mechanical	Improperly secured front panel may fall on the operator
Noise	• Acoustic noise level may be hazardous, especially in multi-rack configurations • Wear protective hearing equipment when necessary

Front Panel Assembly Removed – Qualified Personnel

Hazard	Description
Energy Hazard	• All power supply +48V outputs and connected front interface board (FIB) circuits can source hazardous energy levels • PSU–PA power harness may remain energized at hazardous energy levels after disconnection from PSU side (PA input capacitor charge)
Heat Hazard	• Module enclosures may become hot under normal operation
Mechanical	• Rough edges are present on the subrack; lacerations are possible while adding or removing modules and connectors. • Operator may crush finger between rackframe and module handle when inserting leftmost or rightmost TRx module

OVERVIEW

CASCADE LMR BASE STATION / REPEATER PLATFORM

The Codan Cascade™ is a software-defined Base Station / Repeater platform that has been engineered from the ground up with a focus on IP-networked radio solutions with remote programming and diagnostics and built around high specification performance. The Codan Cascade has built-in diagnostics, alarms and logging capability; and allows for system parameters to be monitored, configured and upgraded remotely over IP. The Codan Cascade provides the extremely high performance expected from a Public Safety LMR system and is built around the requirements from FCC (Federal Communications Commission), TIA (Telecommunications Industry Association) and IC (Industry Canada). The Cascade is 100% RoHS compliant.

GENERAL INFORMATION

INTRODUCTION

The Cascade is built on a modular platform. Each module is durable, slides into the 19-inch, 4RU (rack unit) subrack and is secured in place with captive fasteners. This all-inclusive package features two analog / P25 repeaters with variable 100W RF power amplifiers, built-in network interface and integrated power supply.

The Cascade unit's Graphical User Interface (GUI) is browser-based, allowing the radio system administrator / user to remotely access, view and modify select unit software functions and settings without having to install any proprietary Codan software.

The unit's GUI supports the latest 32- and 64-bit Windows 10 versions of Chrome.

KEY FEATURES

- Rack space efficient – 2 x 100W only occupies 4RU
- Supports P25 digital, analog narrowband and mixed operating modes
- Built-in IP-based remote configuration and remote site monitoring
- Built-in logging and alarming, with user-definable automated failure mitigation behaviors
- Built-in testing and calibration functionality
- Supports open standard P25 CAI (Common Air Interface) and IP Protocols
- Meets or exceeds industry standard regulatory guidelines for performance in a Public Safety LMR system

Hardware Performance

The Codan Cascade is engineered to deliver the same exceptional performance that has become synonymous with the Codan LMR name.

Software Innovation

The software at the heart of the Codan Cascade has been developed by analyzing and addressing the fundamental challenges faced by today's Public Safety communications customers.

P25 Compliant

Codan's commitment to open standards and vendor neutrality is maintained with full support of P25 CAI and IP Protocols, allowing for interoperability with other Codan and Third Party equipment.

Support and Services

The Codan Cascade is supported by our comprehensive professional services and support programs. **For more information or to contact technical support, the Codan Communications website is located at: www.codancomms.com/lmr/**

Remote Programming and Monitoring

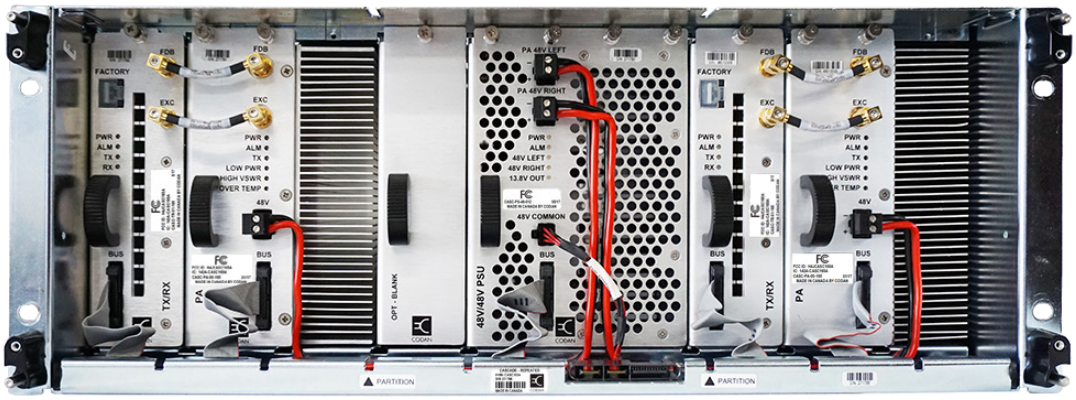
The Codan Cascade provides browser-based monitoring of equipment health and performance. Operators have the ability to remotely make system modifications or take critical action without visiting the site.

MODULE CONFIGURATIONS

The Cascade product is capable of acting as an RF repeater or base station with up to two “Simultaneous Receive Channels” and up to two 100W “Simultaneous Transmit Channels”.

The Cascade product is comprised of the following:

- A 19” Subrack which houses all of the Cascade components
- A DC Power Supply which supplies electrical power to all the modules
- Up to two RF Transceiver modules
- Up to two RF Power Amplifier modules
- A Front Panel which contains cooling fans and control circuitry
- A Front Interface Board which handles all the module to module communication



Dual System Subrack

CAUTION

DO NOT LIFT the system by these handles. The handles are designed to remove and install the front panel, not to bear weight.

Cascade Front Panel

CASCADE WEB GUI

CASCADE Web GUI is an innovative user interface for the CASCADE system. The GUI has many unique features including:

- Full remote access to the Cascade system – no need be preset at the radio site
- Remote access uses standard IT infrastructure – no need for adding communication infrastructure
- Most common Web browsers gives full access to the system – no need to install User Interface software.
- Access restrictions are implemented by using Login and Password protection
- Communication protocols are secure and encrypted
- Single User Interface let user manage multiple transceivers at one time
- Multiple features of the User Interface enables, but is not limited to:
  - Configuring receivers and transmitters
  - Managing users and passwords
  - Updating firmware and software
  - Saving and loading system configurations
  - Monitoring the system”s real time status
  - Performing basic PTT and BER tests