

SAFE-COM Wireless

Public Safety Distributed Antenna System

Product Line Series
SAFE-1000

Off-Air **Class A Channelized Booster System**

User Manual

Safe-Com Wireless
Holmdel, NJ 07733
www.safe-comwireless.com

WARNING. This is **NOT** a **CONSUMER** device. It is designed for installation by **FCC LICENSEES** and **QUALIFIED INSTALLERS**. You **MUST** have an FCC LICENSE or express consent of an FCC Licensee to **operate this device. You MUST** register Class A signal boosters (as defined in 47 CFR 90.219) online at **"<http://www.fcc.gov/signal-boosters/registration>" www.fcc.gov/signal-boosters/registration.**

Unauthorized use may result in significant forfeiture penalties, including penalties in excess of \$100,000 for each continuing violation."

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- This device complies with part 15 of the FCC Rules.
Operation is subject to the following two conditions:
1. This device may not cause harmful interference, and
 2. This device must accept any interference received, including interference that may cause undesired operation.

Liability Disclaimer

The information contained in this document is assumed to be correct and current. The manufacturer is not responsible for errors or omissions and reserves the right to change specifications at any time without notice. Safe-Com Wireless assumes no responsibility for its use nor for any indirect, incidental damage or loss resulting from its use.

Under Industry Canada regulations, this radio frequency power amplifier may only be used with the transmitter with which the amplifier has been certified by Industry Canada. The certification number for the transmitter with which this amplifier is permitted to operate is IC:22303

Conformément à la réglementation d'Industrie Canada, le présent amplificateur de puissance radiofréquence peut être utilisé seulement avec un émetteur avec lequel il a été certifié par Industrie Canada. Le numéro d'identification d'Industrie Canada pour l'émetteur avec lequel l'amplificateur est autorisé à fonctionner est IC : 22303

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This radio transmitter (identify the device by certification number, or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (identify the device by certification number, or model number if Category II) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Introduction

Safe-Coms DASAssure™ is a patent-pending fiber Distributed Antenna Systems utilizing a new architecture that addresses the challenges of designing, deploying and maintaining a Public Safety DAS over its life-time. This innovative approach utilizes channel processing that assures the lowest interference and spurious radio communications coverage enhancement available. This modular hot-swap card system permits single channel expansion on ANY frequency adding only the power and resources required. Yet the design is the most compact fiber DAS available – easily fitting 4 bands into a 18x18x6inch NEMA 4 unit. Safe-Com's high quality manufacturing system and superior applications support assures your success and the public's safety.

This User Manual is specifically written for the SAFE-1000 Series:

SAFE-1020 Off-Air Head-End, Class A

SAFE-1015 Fiber Remote Unit, Class A

And the

SAFE-1030 Bidirectional Amplifier, Class A

FCC Antenna Requirements

The user must assure that the installation meets FCC RF exposure limits. Minimum distance between any person and the operating antenna must be 24 inches or 60 cm. The antenna must be mounted on a stable, permanent structure.

Maximum ERP is 5 watts per FCC regulations per rule part 90.219(e)(1). The FCC licensed and qualified installer user must calculate the total transmitted power, taking into account the losses of the cables and splitters etc, plus the gain of the antenna to assure compliance with the maximum exposure regulation.

Lightening protection is required on all antennas as loss or damage as a result of lightening is not covered by the warranty. Antennas must be connected prior to turning up power to the unit.

Frequency Bands of Operation and RF output power control

The authorized bands of use include:

- > 763-775 – 793-805 MHz
- > 758 -768 – 788-798 MHz
- > 806-824 – 851-869 MHz
- > 450-512 MHz
- > 150-174 MHz
- > 896-941 MHz

The plug-in cards determine the frequency transmitted. The manufacturer factory-sets the operating bands for each plug-in card. Each card can accommodate frequencies across the entire band or more. The operating bands can not be modified by the user. Consult the manufacturers data sheet and this operating manual to confirm proper operation. RF Output is controlled automatically by an ALC (automatic level control) circuit within the cards. The user can not set the output power to exceed the FCC limits. The user can set the output power lower than the designed maximum using the software supplied by the manufacture.

Startup

The SAFE-1000 series Products operate on 120/220 VAC 50-60 Hz.

Alternate power sources which can be specified include

- > -48 VDC
- > +9VDC
- > +12 VDC

The system must be hardwired to the above power options.

Connect the system to the appropriate power source (120/220VAC or -48 VDC or +9 or +12 VDC).

An AC power source requires 3 connections: Line, Neutral and Ground.

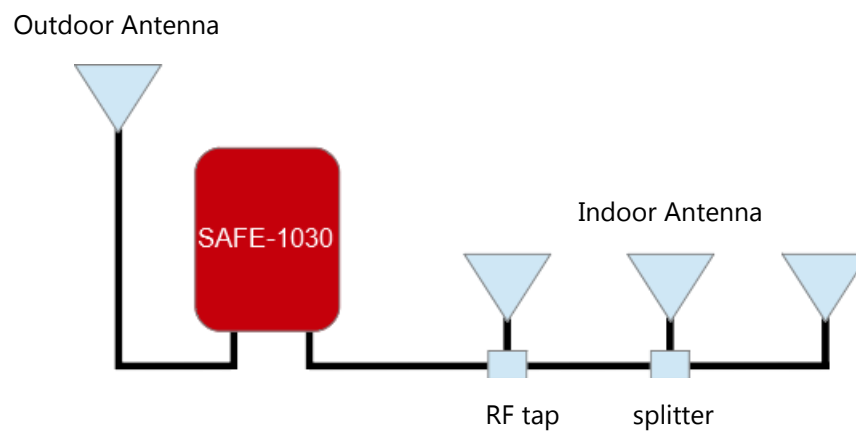
Earth grounding the NEMA case is required.

Connections inside the Head-end and Remote units are provided to connect the power source to the Unit.

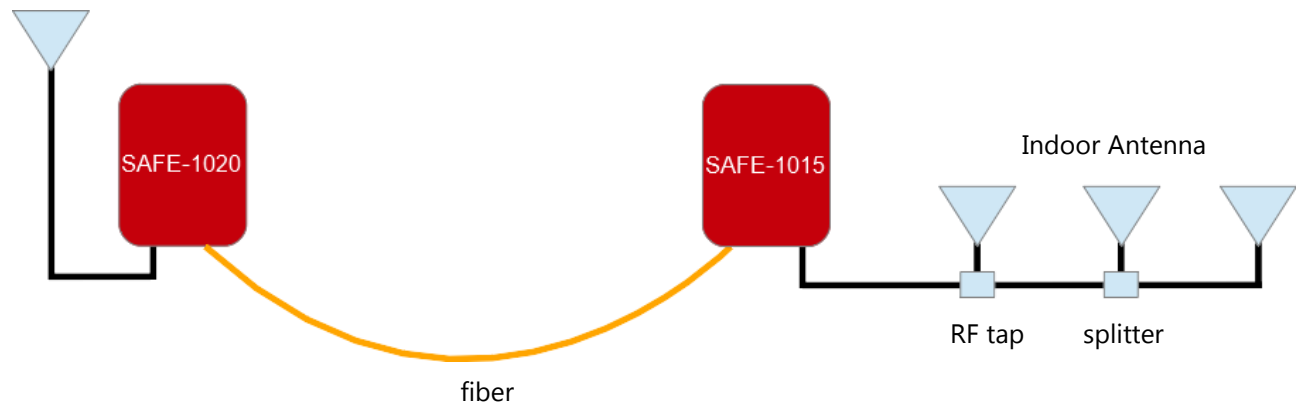
The NEMA Unit is grounded to the case ground terminal internally. The user must assure that the earth ground connection is properly connected to the external earth ground.

Quick System Application Overview

Bidirectional Amplifier: Model 1030



Fiber DAS Option: Model SAFE-1020 & SAFE-1015



Connect all units with power. Single-mode Fiber Connections are required for the fiber DAS option. Power up the Head-End Unit and confirm the frequencies are set properly. See below. The frequencies should have been programmed at the factory, but the installer must always confirm the correct settings once the equipment is in the field. In a fiber DAS, power up and connect the Remotes.

Setting up the Head-End Off-Air Unit

The SAFE-1000 Head-end sets up the same way regardless if it is a BDA or fiber DAS.

The first step is to assure the individual channel frequencies are programmed properly.

Plug **Head-End Off-Air Channelizer** units USB into a PC.

Start Terminal Program

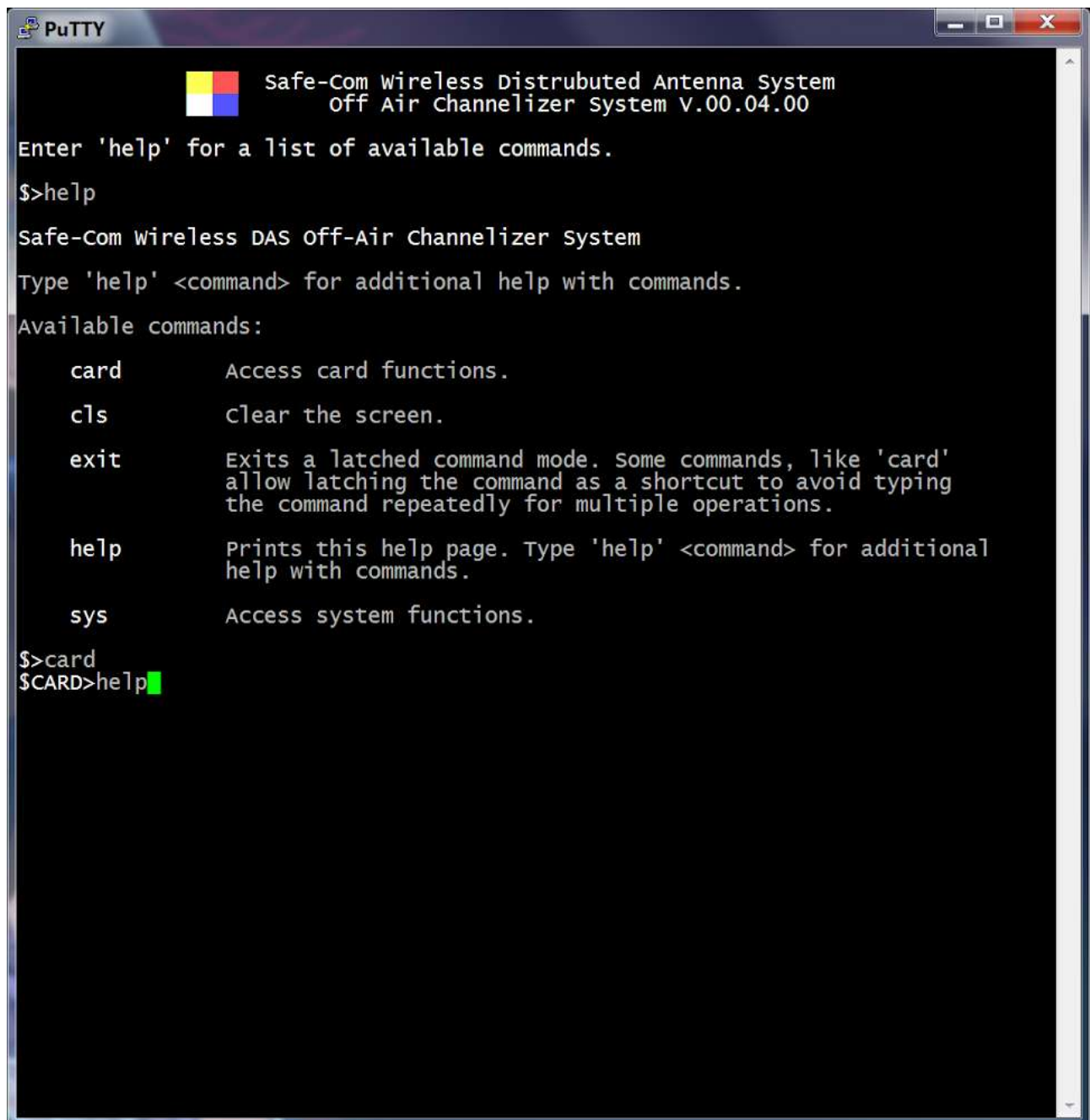
(Putty is used in this example)

Set proper COM port. See Device Manager.

Port Settings: 115200 baud, 8 bits, 1 stop bit,
no parity, no flow control



The Safe-Com logo and title will appear once proper COM port is selected and configured.
Enter “help” at prompt (\$>) to display terminal commands.



```
PuTTY

Safe-Com Wireless Distributed Antenna System
Off Air Channelizer System V.00.04.00

Enter 'help' for a list of available commands.

$>help

Safe-Com Wireless DAS Off-Air Channelizer System
Type 'help' <command> for additional help with commands.
Available commands:

    card      Access card functions.
    cls       Clear the screen.
    exit      Exits a latched command mode. Some commands, like 'card'
              allow latching the command as a shortcut to avoid typing
              the command repeatedly for multiple operations.
    help      Prints this help page. Type 'help' <command> for additional
              help with commands.
    sys       Access system functions.

$>card
$CARD>help
```

As shown above, enter “card” at the \$> prompt to display card control commands. Shown below.


```

$>card
$CARD>help

Safe-Com Wireless DAS Off-Air Channelizer System

Usage: card [operation] [<arguments>]

Operations:

    exit          Exits 'card' latched command mode, clearing any active card
                   selection.

    scan          Scans the backplane bus for available cards.

    sel, select [<address>]
                   Selects a card to modify. This becomes the 'active' card.
                   Valid address are in the range ?-?. Addresses may be
                   entered in the following formats:

                           nnn      Decimal notation (e.g. 59)
                           0xhh     Hexidecimal notation (e.g. 0x3B)
                           Onnn     Octal notation (e.g. 073)

    set [option] [<value>]
                   Sets card configuration options.

                   Available options:

                   freq [<value>]
                           Enter the desired RF output center frequency.
                           Value is in MHz.

                   atten [<value>]
                           Sets a base RF input attenuation of 6dBm, 12dBm, or
                           18dBm. 100-B cards only. Value is in dBm.

                   squelch [<value>]
                           Enter the ACG2 RSSI threshold that will engage the output
                           amplification. Value is in mV.

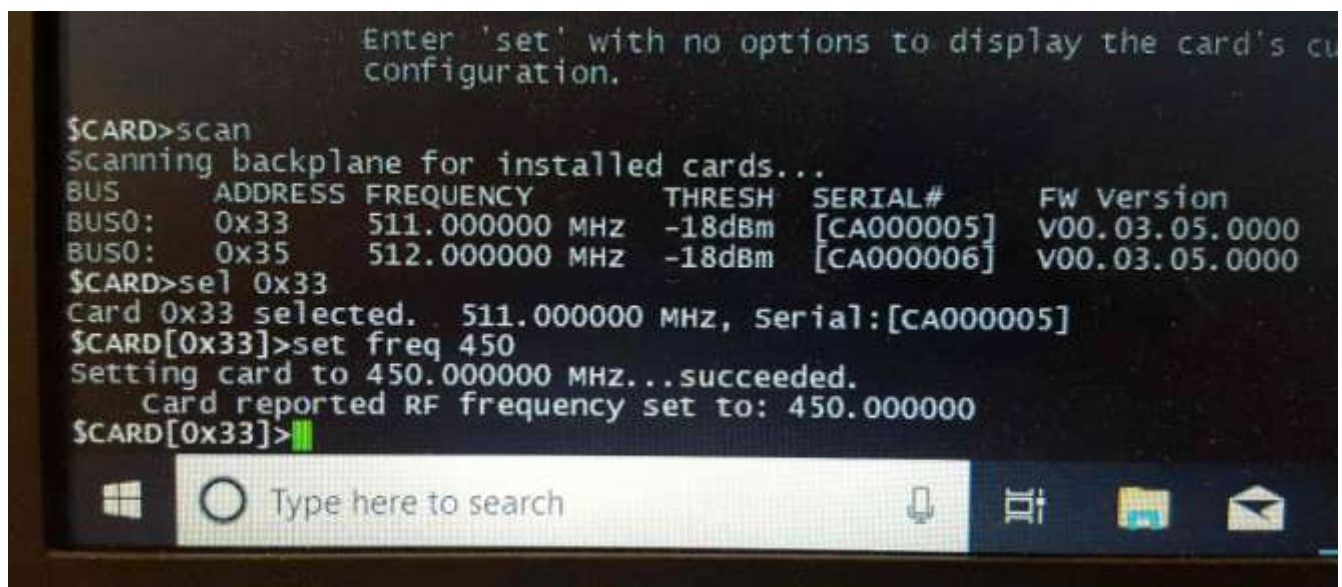
                   threshold [<value>]
                           Enter the RF threshold that will engage the input
                           attenuator. 100-B cards only. Value is in dBm.

                   Enter 'set' with no options to display the card's current
                   configuration.

$CARD>

```

AT "\$CARD>" prompt enter "scan" to display the connected cards and their address as shown below.



Follow above entries to set the frequency of each card.

- Select card ("sel 0x33")
- Set the frequency of that card ("set freq 450")
- See confirming response from system

The channel card is now programmed to pass 450.0000 MHz.

Proceed to program each card in the subrack.

Note: All the cards should have been programmed to the proper frequencies per order at the factory. Nonetheless, the installer must confirm the proper settings.

The Head-End "Off-Air" Unit receives an input from its Off-Air antenna which is pointing to the donor base-station site - or from other radio signal source.

Each Channel Card plug-in card of the SAFE-1010 Head-End Unit accepts a broadband signal from the Off-Air Receiver Card and filters everything out except the single desired frequency. That frequency is set via the terminal program shown above.

The acceptable RF input power range per card = -100dBm to -10 dBm. Internal Automatic Level control will amplify (or attenuate) the signal so that it is at the appropriate level to drive the next stage. The next stage is a power amplifier (in the BDA case) or a fiber optic transmitter (in the Fiber DAS case).

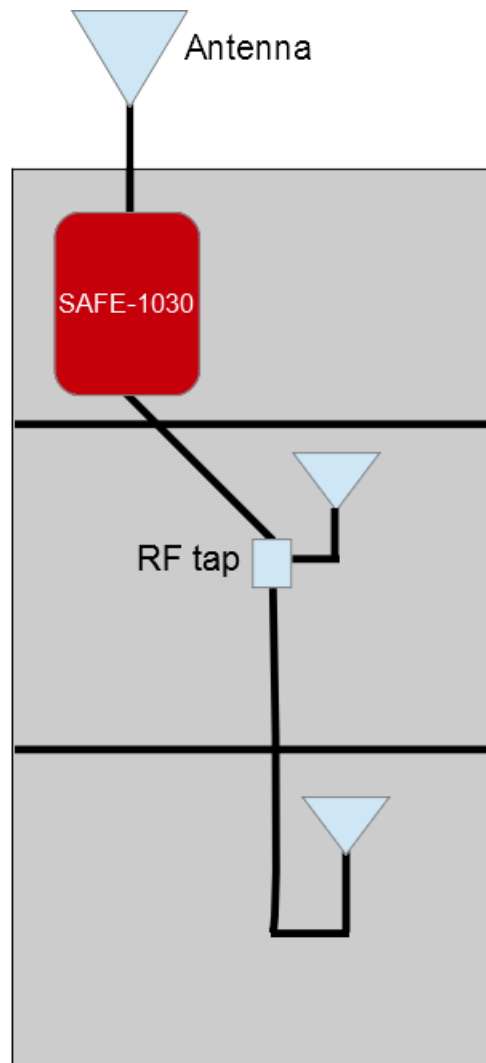


Figure 1

Safe-COM Off-Air Channelized
Distributed Antenna System installed
in a building needing RF coverage

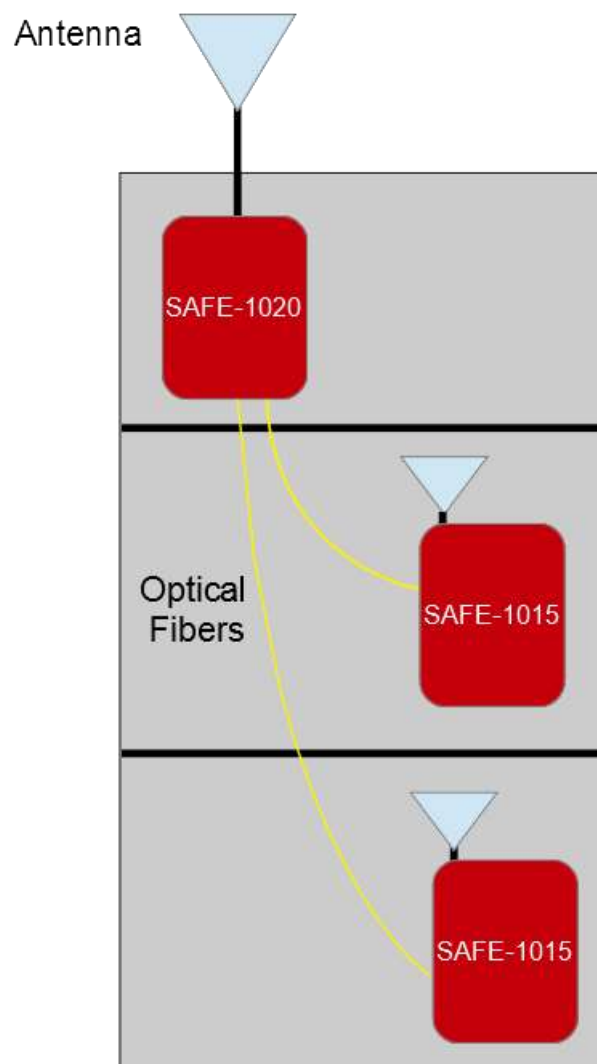


Figure 2
Safe-COM Off-Air Channelized
Distributed Antenna System
with Fiber Option

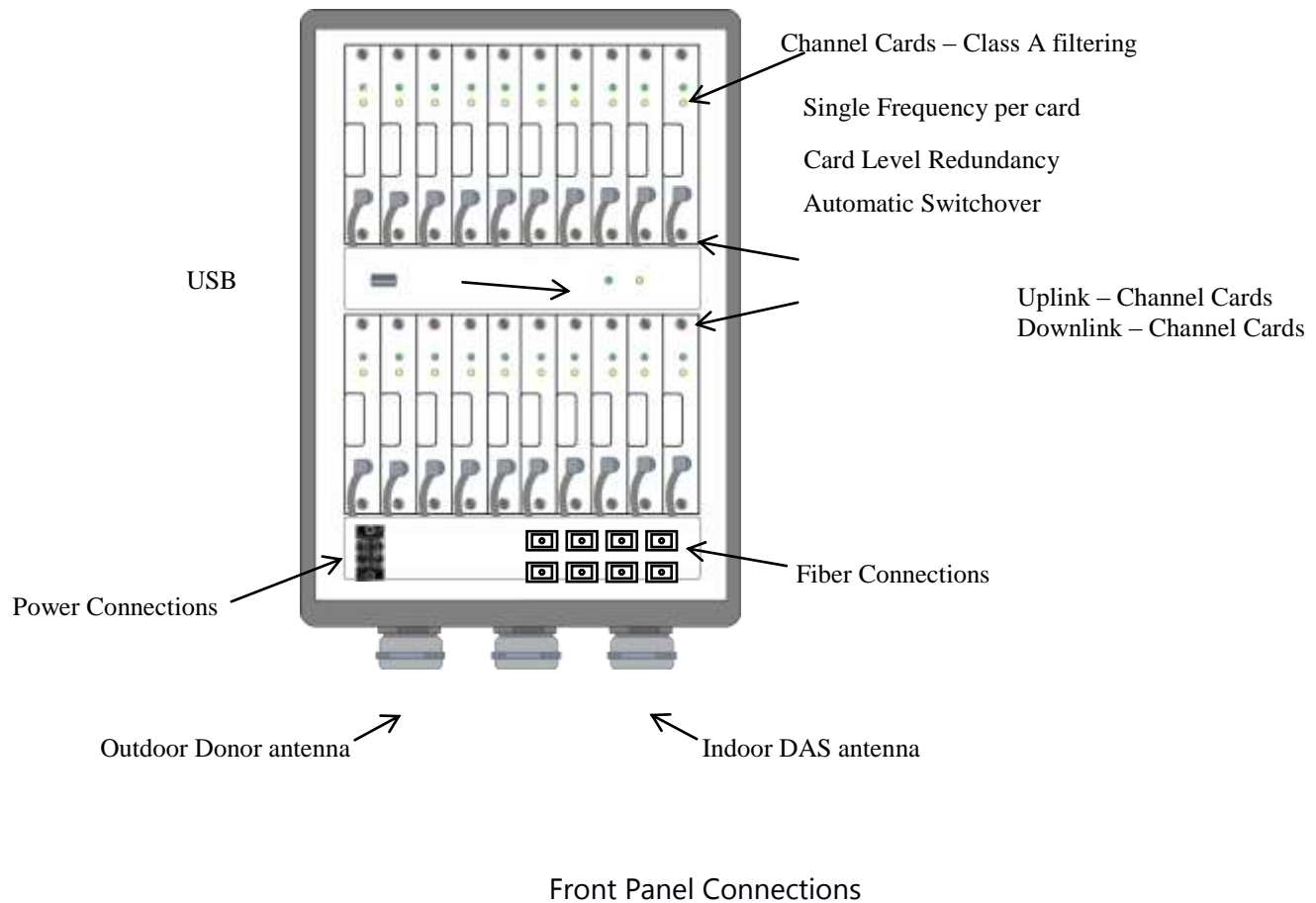
RF Input Levels

Typical input range into the SAFE-1020 and SAFE-1030 Channelized Head-end unit is -95 to -10dBm

Within this range the Safe-Com Head-end will automatically compensate and adjust the level for optimal drive into the fiber distribution system.

A signal injected into the Head-end unit below -95dBm will not drive the fiber DAS properly causing low CNR. The system will automatically squelch signal below -95dBm.

A signal much above -10dBm will generate distortion and at very high power levels, > 0 dBm, may damage the equipment.



Card System

The Safe-Com DAS is a “Opto-channelized” system. This means the individual RF carriers are transported independently, on a dedicated RF and optical path, minimizing the opportunity to generate intermodulation. Each plug-in card on the down-link carries a single RF channel.

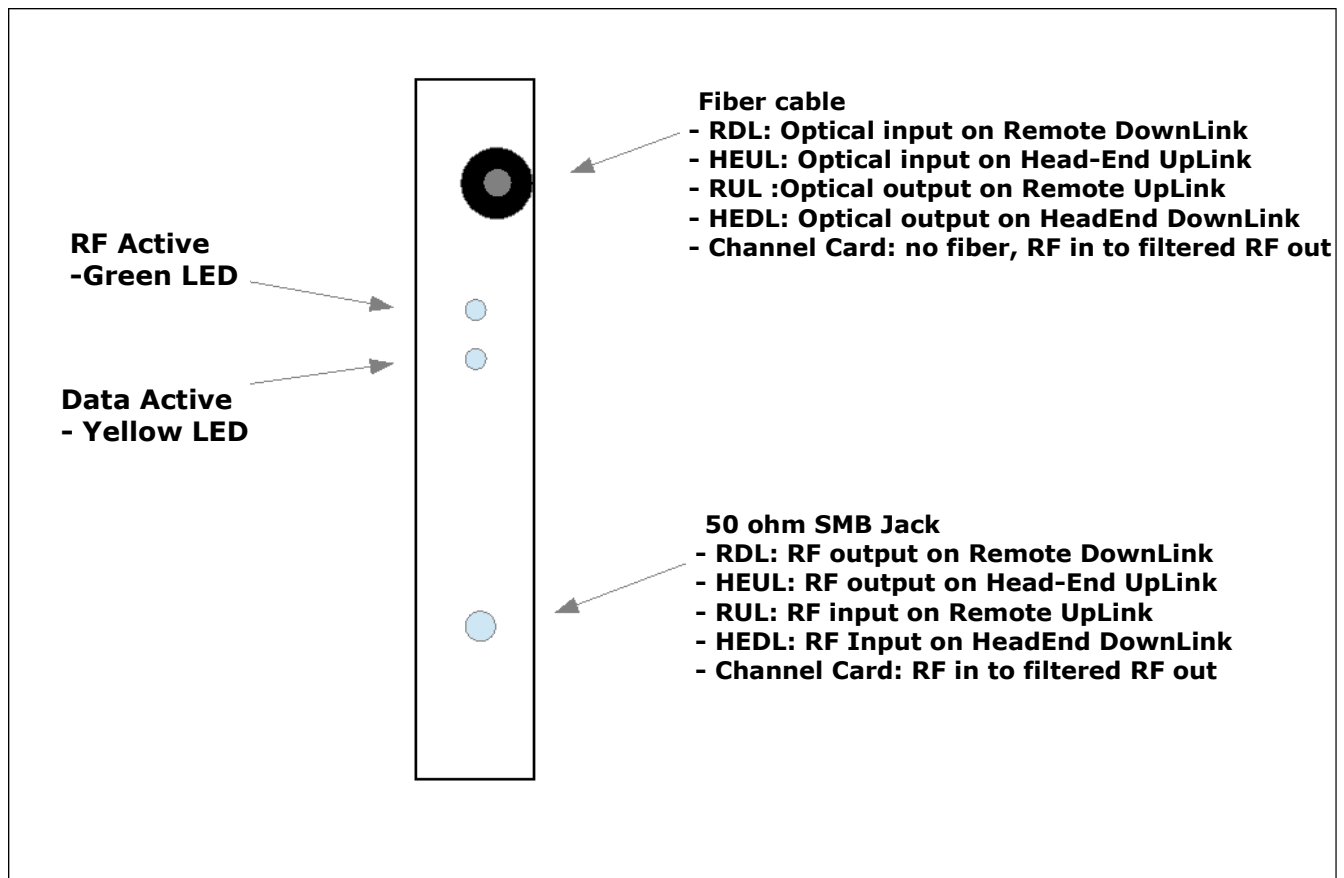
There are four types of cards:

- > Downlink Cards – these cards carry the signal from the base station to the remote units (and towards the mobile radio user) . Two types: HEDL: Head-End Downlink and RDL: Remote Downlink.

- > Uplink Cards – these cards carry the signal transmitted by the users mobile radio, received at the remote unit and transported by fiber to the head-end and its connected base-station. Two types: RUL: Remote UpLink and HEUL: Head-End UpLink

A short pigtail with an SC/APC connector on the plug-in cards provides the optical interface.

A 50 ohm SMB jack provides the RF interface. It is located on the front panel of each individual plug-in card.



Typical plug-in card



Warning: Laser output from fiber (RUL & HEDL Cards).
Laser output from the SC/APC Tray
Do not stare into fiber connectors.

The RUL (Remote UpLink) and HEDL (Head-End DownLink) Cards have an optical output from the fiber pigtail attached to the plug-in card.

The HEUL (Head-End Up link) and the RDL (Remote DownLink) Cards have an optical output from the SC/APC tray at the top of the unit.

Connecting the fiber

The SAFE-1000 uses standard singlemode fiber to connect the head-end with the remote Units.
Up to four remote units can be used with each Head-end.
Multiple Head-ends can be added to expand the System.

SC/APC are the standard connectors used. They use an 8 degree polish angle.

The number of fibers required for each remote depends on the Fiber Configuration of your system.
The number of fiber connections inside the Head-end Unit depends on the Topology of your system.

Inside the Head-end unit one will find up to eight green SC/APC adapter ports.

Topology – Star: Each Remote requires a dedicated home run connection directly back to the Head-end
Star is the default topology.

Fiber Configuration – Dual: Each Remote uses 2 fibers. One for uplink and one for downlink

Number of fiber connectors at Head-End: Eight (8)

Number of fiber connectors at Remote: Two (2)

Topology - Star: Each Remote requires a Home run connection directly back to the Head-end
Fiber Configuration - Single: Each Remote uses 1 fiber. Uplink and Downlink are optically multiplexed onto the same fiber strand.

Number of fiber connectors at Head-End: Four (4)

Number of fiber connectors at Remote: One (1)

Topology - Linear: The fiber hops from Head-end to each Remote in a linear daisy chain. No need to run each Remote to the Head-end.

Fiber Configuration - Dual: Each Remote uses 2 fibers. One for uplink and one for downlink same fiber strand.

Number of fiber connectors at Head-End: Two (2)

Number of fiber connectors at Remote: Four (4) except the last Remote which has one (2)

Topology - Linear: The fiber hops from Head-end to each Remote in a linear daisy chain. No need to run each Remote to the Head-end.

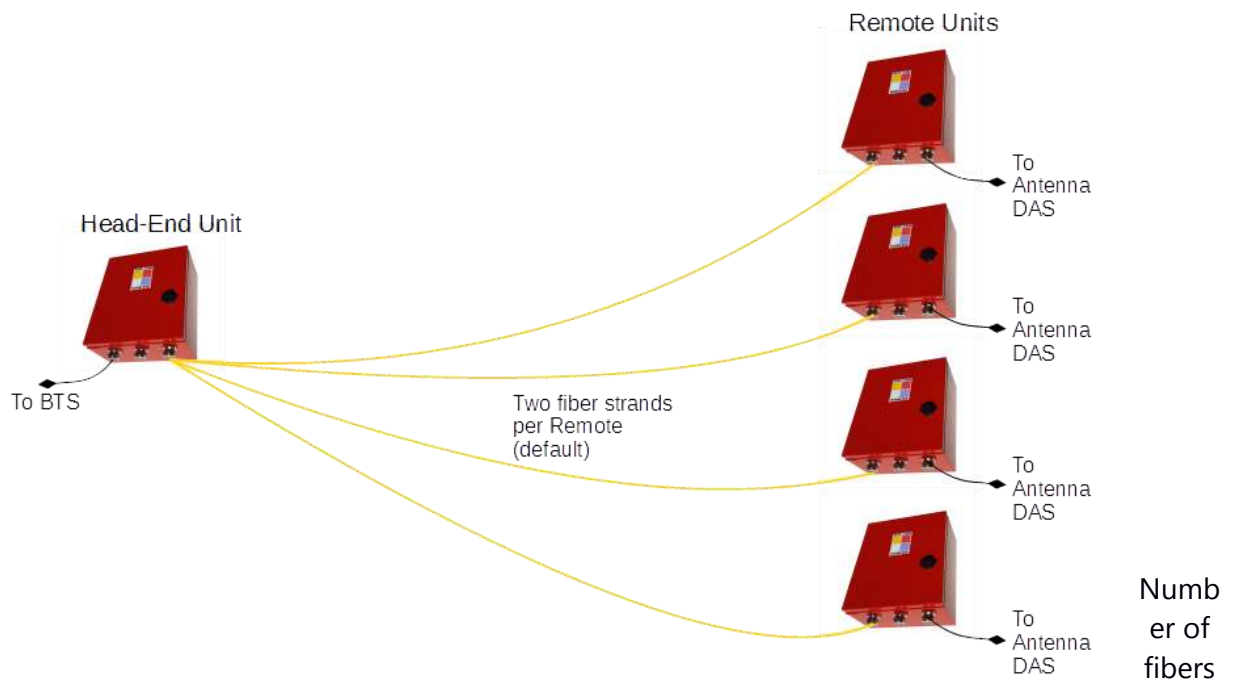
Fiber Configuration - Single: Each Remote uses 1 fiber. Uplink and Downlink are optically multiplexed onto the same fiber strand.

Number of fiber connectors at Head-End: One (1)

Number of fiber connectors at Remote: Two (2) except the last Remote which has one (1)

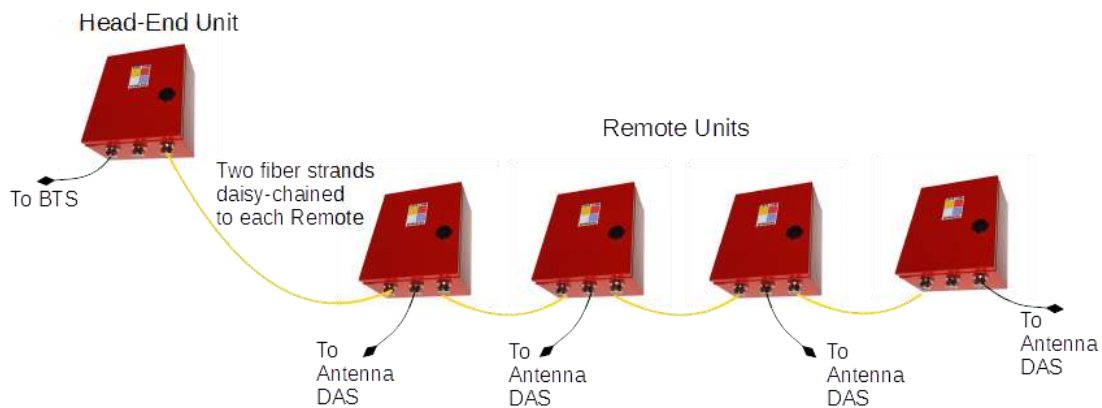
Maximum Optical Loss: The System can easily handle up to 5dBo of optical loss between Head-end and any Remote. Beyond 5dBo, the System CNR may degrade.

Star Topology



to each remote depends on "Fiber Configuration" described above.
A combination of Star and Linear are available. Consult factory.

Linear Topology



Setting up the Remote Unit

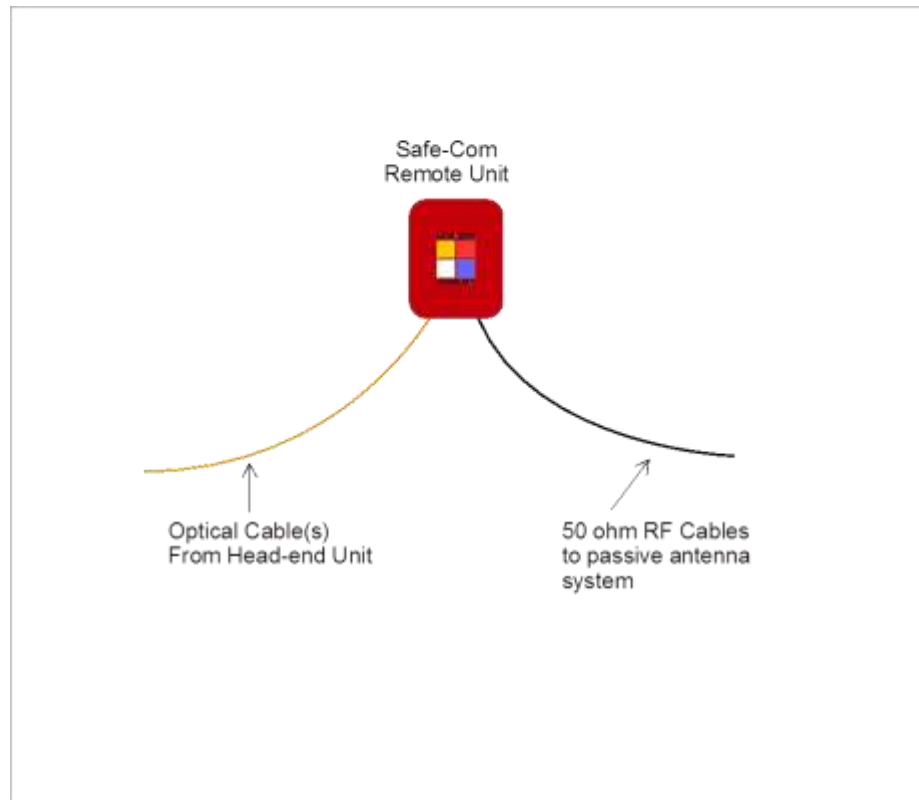
The Remote Unit accepts bidirectional optical signals via single mode fibers from the Head-End Unit.

It converts the optical signals to RF – radio frequency.

The RF port is connected to a distributed antenna system consisting of antennas, splitters and taps.

The Remote Unit monitors the incoming signal and assures proper levels so as to guarantee the radiated emissions downlink do not exceed FCC limits.

The uplink path provides a fixed gain back-haul to the Head-end. The system monitors the incoming RF signal (from the antenna) and attenuates when excessive signal is detected at the uplink input port. This is to prevent damage to the internal circuitry. Excessive RF input (above -10dBm) can damage the unit so care should be taken not to key up radios or cellphone near the unit, especially during installation process. Radios including cellphones should not be used in close proximity to the units.



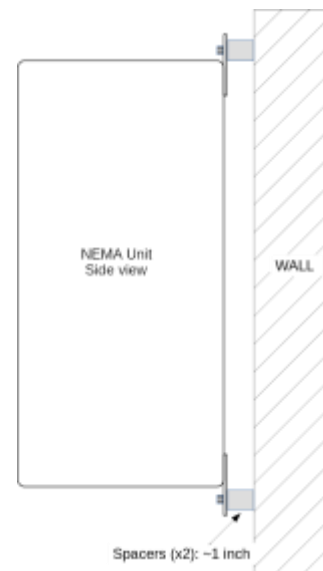
Installation

Installation - Wall-Mounting:

When mounting the Remote on the wall, it is critical to provide spacers between the unit and the wall. A one inch space is appropriate to allow for air flow.

Power is hardwired into the unit. The power applied is based on model number ordered. Consult the order number and the company data sheet to confirm power type. Options include 120VAC, 12VDC, -48VDC.

RF cable selection is based on the RF connector requested. Default type is a panel mounted 50ohm SMA female. Therefore RF cable required will be 50ohm SMA Male.



Antenna and Power Exposure

Maximum Public Exposure to RF (MPE) CFR 1.1310 (e) & RSS-102, clause 4

The maximum exposure level to the public from the EUT shall not exceed a power density, **S**, per the table below.

NOTE: The calculation performed for this EUT were performed for antenna with a maximum gain of 6 dBi, to determine the minimum distance required in order to remain compliant with the permissible exposure levels. If different antenna gain or distance is to be used, the permissible exposure levels of Table 1 below must be respected.

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)
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

Contact information, i.e., licensee for Class A/B devices, if available; and the FCC at (<https://signalboosters.fcc.gov/signal-boosters/>) for Class B devices.

Setting up the Downlink on the Remote

The SAFE-1000 has automatic Level control features which controls the downlink radiated RF output power at the Remote and assures the maximum FCC limits are never exceeded under normal operating conditions.

The System will tolerate a direct fiber connection (i.e. a short 1 meter fiber) between the Safe-Com Head-end and the Safe-Com Remote Unit without exceeding RF output levels. Although a minimum of 2 dB optical fiber loss is advisable.

Note: Never connect another manufacturers DAS or BDA equipment to the Safe-Com System. Performance is unpredictable, it can damage the equipment and it will exceed FCC operating limits causing interference to other public safety or commercial system operations.

Power up the unit with the appropriate power source (110 / 220VAC 50/60HZ, +9VDC, +12VDC, - 48VDC)

Connect the SC/APC connectors to the Remote unit. The number of connectors will depend on the Topology and Fiber Configuration of your System. Use normal good practices in handling fiber and fiber connectors. Clean the fiber tips before connecting.

The individual RDL (Remote Down Link) Card RF downlink outputs are combined into a single multi-channel output.

An optional duplexer, if included, combines uplink and downlink channels.

If a duplexer is not included, two antennas will be used: one for uplink and the second for downlink. (The default configuration includes an internal duplexer)

Antenna separation of 30 feet minimum is required between uplink and downlink antenna when a duplexer is not used This separation assures the downlink signal will not overload the uplink input. But the user will need to verify this distance with field testing.

There are three Remote DownLink (RDL) card types available. Each Card is designated as to the specific range of frequencies it can accept:

<u>RDL Card Type</u>	<u>Number of simultaneous RF frequencies per Card</u>	<u>Input range</u>
"VHF Card"	one	150 – 174 MHz
"UHF Card"	one	450 – 512 MHz
"7-8-9 Card"	one	763 – 941 MHz

Refer to product labels and factory test data to confirm the plug-in cards band of operation.

Although a Downlink card can accept a wide range of frequencies, it is designed to operate with only one modulated RF carrier per card. Inputting 2 or more carriers per card can lead to damage and the performance will not meet specifications and cause interference with other operating bands.

Network Management System (NMS)

The system is delivered with an executable NMS program as a download from the website. Copy the program on your PC and click to start. A USB cable will connect between your PC and each Unit. The proper COM port needs to be selected in your Device Manager.

GUI layout subject to change



OverView TAB

The Overview TAB shows status and alarm summaries of the entire System. The System is defined as the Head-End unit and all connected Remote Units (up to 4). A label is located at the center of the screen where the name of the System can be entered. Additional labels are provided next to each Unit. There the user can enter a description of each unit such as location or function.

The "Status" label indicates the overall condition of the Unit: All Good = Green; Alarm = Red. If a unit shows a Red alarm, click on the Detail TAB (e.g: "Head-End" or "Remote 1") above associated with that unit to display a dedicated page showing all settings and specific alarms for that Unit.

Detail TAB

Each unit in the system (up to five units per System: One Head-End and 4 Remotes) has a dedicated Detail TAB showing its specific settings and alarms as seen below.

Refer to the “**Safe-Com Wireless NMS User Manual**” for details in downloading, installing and using the Network Management System.

Parameter	Value
Output Power, 1 watt nominal (Note 2) 2 watt nominal (Note 3)	UHF,7,8,9 : 20dBm at 8 channels, 18dBm min. VHF : 20dBm at 4 channels, 18 dBm min. 2 watt version: 3dB higher per channel
Input Power maximum UL / DL	-10dBm max input (off-air port) 2 watts max downlink (direct connect)
Gain UL / DL	100 to 80 dB (off-air version)
Noise Figure	9 dB
Spurious	FCC Compliant – typically -60dBc
Rejection	-50 dBc at 50kHz typical (Class A Unit)
Gain Control (Note 4)	30dB
Optical Loss (SMF SC/APC)	5dBo
Power	40 watts avg. at 10 channels, 60 watts peak (Note 4)
Size	11.8 x 10.8 x 6.5 inches - 20lbs Head-end / Remote / Battery backup
Temperature	-10 to +50 deg C

System Specifications

Attenuation range shared with ALC circuit.

Power / Mechanical

Power Supply	85-240 VAC or 12 VDC or -48 VDC
Power Consumption	100 watts maximum depending on channel count
Size	460 x 460mm wall footprint, 165mm deep
Weight	< 35lbs
Enclosure	NEMA 4, IP65

Additional Details of the front panels are shown in the Head-End and Remote Quick Reference.
The Quick Reference is shown here and is attached to the inside door of each unit.

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