

DR400 Series Repeaters

Installation Guide



Designed in the United Kingdom

DR400 Series Repeaters

Installation Guide

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Thank you for purchasing an Entel DR400 Series DMR & Analogue Repeater. For the safe and optimum performance of this product, please read this manual carefully before use.

1. DISCLAIMER

Entel has prepared this manual with care but provides no warranty regarding its accuracy or reliability. While the information herein is believed to be reliable, Entel cannot assume responsibility for inaccuracies, often arising because Entel reserves the right to make changes without notice to any product herein to improve reliability, function, or design.

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2. SAFETY INFORMATION

WARNING: Risk of Serious Injury, Death, or Equipment Damage

- Read and strictly follow all safety precautions in this manual and related documents before installing, operating, or maintaining this Entel DR400 Series repeater.
- Installation, maintenance, and service must only be performed by trained and qualified engineers in accordance with all applicable local safety codes, standards, and regulations.

2.1. Symbols used in this Guide



Caution – Risk of damage to the repeater



Warning – Risk of injury, death or property damage

2.2 Symbols used on the Repeater

The following table lists and describes the safety and informational symbols marked on the repeater.

Symbol	Description	IEC 60417 Reference
	Power ON: Indicates the ON position for the AC mains power switch.	5007
	Power OFF: Indicates the OFF position for the AC mains power switch.	5008
	Protective Earth (Ground): Identifies the terminal intended for connection to an external conductor for protection against electric shock in case of a fault.	5019
	Direct Current (DC): Identifies on the equipment label the direct current voltage range that the repeater is compatible with, alongside the maximum current draw.	5031
	Alternating Current (AC): Identifies on the equipment label the alternating current voltage range at the repeater is compatible with, alongside the maximum current draw.	5032

2.3. Who Should Read This?

Anyone installing, maintaining, or working near this repeater and its antenna system must read and understand these safety instructions.

2.4. Key Safety Risks



Repeaters pose significant safety risks

Follow the guidelines below to minimize potential hazards:

- Electrical Shock:** Hazardous AC/DC voltages.
- RF Burns:** High Radio Frequency energy exposure.
- Thermal Burns:** High operating temperatures.

2.4.1. Electrical Safety



Hazardous Voltages

- Ensure an easily-accessible power source is available to power the repeater.
- If powered via an AC supply, only use a mains supply with RCD (Residual Current Device) protection.
- Disconnect all power sources before installation or maintenance.
- Ensure the repeater is properly grounded according to local electrical codes and manufacturer instructions.
- Ground all antenna cable shields per the cable manufacturer's recommendations.

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- If using an outdoor antenna, fit and properly ground an appropriate surge protection (correct RF bandwidth and power rating).
- Use only power cords and connectors supplied or specified by Entel.
- Do not open the repeater casing or insert objects into ventilation openings.

2.4.2. RF Exposure Safety



Hazardous Radio Frequency Energy

- This equipment generates a significant amount of Radio Frequency (RF) energy. Its antenna is intended to be installed in a location where users are not ordinarily exposed to high levels of energy close to the antenna.
- Installers and users are responsible for ensuring compliance with all local and international regulations regarding human exposure to ElectroMagnetic Fields (EMF). Consult your national frequency regulator for details.
- Install antennas in locations that ensure minimum safe separation distances are maintained according to applicable RF exposure regulations. In the absence of such regulations, maintain a minimum distance of 5 metres (preferably 10 metres) from a transmitting antenna to minimise RF exposure.
- Never operate the repeater without a correctly connected antenna or dummy load.
- The primary RF burn risk comes from touching or being within 2-3 cm of the antenna during transmission, which can cause RF burns.
- Disconnect repeater power before connecting or disconnecting antennas to prevent equipment damage and reduce injury risk.
- UK Specific Guidance:
 - o HSE: <https://www.hse.gov.uk/pubns/books/hsg281.htm>
 - o Ofcom: <https://www.ofcom.org.uk/spectrum/electromagnetic-fields/compliance-and-enforcement-guidance>

2.4.3. Thermal Safety



Hot Surfaces & Airflow Requirements

- Components can become very hot during operation:

- o Exercise caution when near the operating repeater.
- o Allow the unit to cool down sufficiently before performing maintenance.
- o Never store combustible materials near the repeater.
- Ensure adequate clearance around the unit for airflow.
- Do not block or cover ventilation openings, as proper airflow is essential for cooling.
- Periodically clean the optional repeater dust filter if fitted due to the repeater operating in a dusty environment. The frequency of cleaning will depend on how dusty the repeater's operating environment is.
- Operate the repeater only within its specified environmental limits (see section 3.6 below).

3. PRODUCT OVERVIEW

3.1. Description

The DR400 series comprises professional radio repeaters designed for communication systems operating in the VHF or UHF frequency bands. The series includes the DR42x (VHF) and DR48x (UHF) models, which supports DMR Tier II digital, analogue, and mixed-mode operation, and the DR42x/A (VHF) and DR48x/A (UHF), dedicated analogue-only models. All models are engineered for continuous duty cycle operation and function as reliable standalone units.

3.2. Model Variants

The DR400 Series includes several models tailored for specific frequency bands and modes of operation. Use the table below to identify the frequency band and mode(s) supported by your specific repeater model:

Model	Frequency Band	Mode Capabilities
DR422	VHF (136–174 MHz)	▪ DMR Tier II Digital ▪ Analogue Conventional ▪ Mixed Mode
DR422/A	VHF (136–174 MHz)	Analogue Conventional Only
DR482	UHF (400–470 MHz)	▪ DMR Tier II Digital ▪ Analogue Conventional ▪ Mixed Mode
DR482/A	UHF (400–470 MHz)	Analogue Conventional Only

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3.3. Front Panel LED Indicators and Engineering Socket

The front panel provides LED status indicators for repeater operation as per Figure 1 below:



Figure 1

1. Power LED
2. TX DMR Slot 1 / Analogue LED
3. RX DMR Slot 1 / Analogue LED
4. TX DMR Slot 2 LED*
5. RX DMR Slot 2 LED*
6. USB engineering socket

* Not operational on Analogue-only models

- All extinguished No power applied / switched off
- All **Amber** Switched On & booting up
- **Power LED:** Indicates power status.
 - o Solid **Green** Operational using primary power (AC or DC)
 - o Flashing **Green** Operational using DC revert power (i.e. AC mains failed)
 - o Alternating **Amber / Red** Bootloader mode
 - o Alternating **Green / Red** Programming mode
 - o Flashing **Red** Repeater disabled
 - o Solid **Red** Major alarm
 - o Solid **Amber** Minor Alarm
- **TXA LED:** Indicates transmission on Timeslot 1 (DMR) or analogue channel.
 - o Extinguished Idle
 - o Steady **Red** Transmitting normally
 - o Flashing **Red** Transmitting in 'limp mode' (Tx power=1W)
- **RXA LED:** Indicates reception on Timeslot 1 (DMR) or analogue channel.
 - o Extinguished Idle
 - o Steady **Green** Receiving normally

- o Steady **Amber** Receiving invalid signal (interference)
- **TXB LED:** Indicates transmission on Timeslot 2 (DMR). (Not operational on Analogue-only models)
 - o Extinguished Idle
 - o Steady **Red** Transmitting normally
 - o Flashing **Red** Transmitting in 'limp mode' (Tx power=1W)
- **RXB LED:** Indicates reception on Timeslot 2 (DMR). (Not operational on Analogue-only models)
 - o Extinguished Idle
 - o Steady **Green** Receiving normally
 - o Steady **Amber** Receiving invalid signal (interference)

The front panel also houses a USB engineering socket for factory use only.

3.4. Rear Panel Connection Ports

Note: The repeater depicted in Figure 2 below has the optional dust filter fitted.

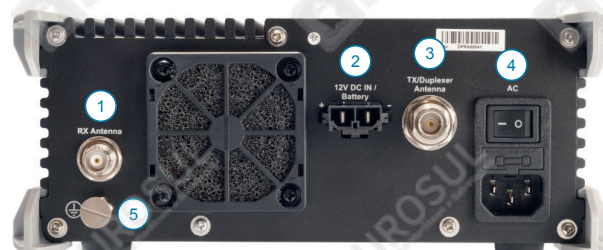


Figure 2

1. Receiver input (dual antenna port configuration only / not present when the optional internal duplexer has been fitted).
2. DC Power / Backup Battery Connector.
3. Transmitter output (dual antenna port configuration / TX & RX connector when the optional internal duplexer has been fitted).
4. AC Mains input / Mains On/Off switch / Fuse holder. Replacement fuse part number:
230VAC model: [Littlefuse 021301.6](#)
110VAC model: [Littlefuse 023903.2](#)
5. Grounding stud



Mains switch ON



Mains switch OFF

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The rear panel houses all the connection ports for power and RF.

- **AC Power Connector:** For AC mains power input:
 - **UK/Euro Version:** 230 VAC $\pm 10\%$, 50Hz
Fuse: **1.6A** Slo-Blo (5x20mm)
([Littlefuse P/N 021301.6_](#))
 - **American Version:** 110 VAC $\pm 10\%$, 60Hz
Fuse: **3.2A** Slo-Blo (5x20mm)
([Littlefuse P/N 023903.2_](#))

Your repeater's AC power configuration is indicated on the rear label.

- **DC Power Connector:** For DC power input or battery backup connection (12.0–15.0 VDC).
- **Ground Screw:** For connection to the site's earth ground.
- **Tx Antenna Connector:** N-Type female connector for the transmit antenna or duplexer output (if the optional internal duplexer has been fitted).
- **Rx Antenna Connector:** BNC female connector for the receive antenna (absent if the optional internal duplexer has been fitted).

The rear panel also houses the repeater's optional dust filter, which must be fitted if the repeater is being installed in a dusty environment. In such a case, this filter must be cleaned periodically at a frequency determined by how dusty the repeater's operating environment is.

3.5. Power Supply Options

The repeater is designed for flexible operation and can be configured in one of three ways. The appropriate configuration should be selected based on the installation site, available power, and operational reliability requirements.

3.5.1. AC Main Power

This configuration is intended for permanent installations with a reliable AC power source, such as the electric grid or a site protected by a UPS, inverter, or generator.

The repeater's internal power supply is compatible with either 110V AC (60Hz) or 230V AC (50Hz). In this mode, the AC input is converted to the stable, low-voltage DC required for all repeater components.



Risk of Equipment Damage

Before connecting power, check the label on the rear of the repeater to confirm its AC voltage configuration. If this needs to be changed, then please contact your dealer or Entel technical support.

3.5.2. AC Power with DC Backup (DC Revert)

For critical applications demanding maximum uptime, the repeater should be powered by an AC source with a battery connected for automatic backup.

In this arrangement, the repeater runs on AC mains power as its primary source. A compatible external backup battery is connected to the DC input, where it is managed by the repeater's intelligent charging system. If the AC mains supply fails, the system instantly and seamlessly switches to the DC battery, ensuring uninterrupted operation.

Operation During DC Revert:

- **RF Power:** To maximize battery life during a power outage, the repeater will automatically operate at the pre-configured **"low" RF power level**, even if the channel is set to "high" power. It is crucial to set the "low" power level appropriately for your needs.
- **Limp Mode:** If the battery voltage drops to **11.8V**, the repeater will enter a power-saving "limp mode," restricting RF power to 1W.
- **Shutdown:** The repeater will automatically disable if the battery voltage reaches **11.5V**.

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Battery Charging:

Once AC power is restored, the integrated multi-stage charger will recharge the battery as per Figure 3 below. Charging is automatically suspended during repeater transmissions.

- **Recovery Charge:** If battery voltage is below 11.5V, it receives a 1A constant current charge whilst the repeater is NOT transmitting.
- **Bulk Charge:** Between 11.5V and 13.8V, the battery receives a 3A constant current charge whilst the repeater is NOT transmitting.
- **Float Charge:** At 13.8V, the charger transitions to a constant-voltage float charge whilst the repeater is NOT transmitting, with the current tapering from 3A towards 0A to keep the battery fully charged without damage.

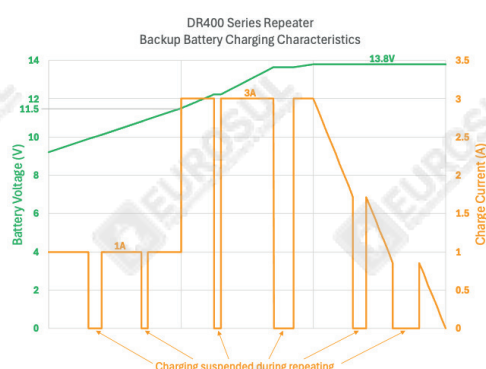


Figure 3

Battery Requirements:

- Use only backup batteries compatible with the specified charging profile (typically lead-acid types).
- Given the 3A maximum bulk charge current, a battery with a capacity between **12Ah and 30Ah** is recommended.



Risk of Equipment Damage

- When operating from an AC supply, NEVER connect an external DC power supply to the DC input connector. Doing so will create a voltage conflict between the internal and external supplies, which will likely cause permanent damage to the repeater. The DC input is only for a compatible backup battery when using AC power.
- Ensure the correct polarity when connecting the battery.

3.5.3. DC Power Only

This configuration is ideal for mobile, remote, or off-grid applications where only a DC source is available.

The repeater requires a nominal input voltage between **12.0V DC and 15.0V DC**. This allows it to be powered by various sources, such as a vehicle's electrical system, a solar power installation, or a shared battery bank with an external charger.

Operation on DC Power:

- **Limp Mode:** If the supply voltage drops to **11.8V**, the repeater will enter "limp mode," restricting RF power to 1W. Normal power is restored when the voltage rises back to at least 12.0V.
- **Shutdown:** The repeater will automatically switch off if the supply voltage reaches **11.5V**.



Incompatible Voltages

Ensure your DC source is stable and remains within the 12.0V to 15.0V range. If the source voltage is incompatible or fluctuates outside this range, a DC-to-DC converter should be installed.



Risk of Equipment Damage

Ensure the correct polarity when connecting the DC power supply.

3.5.4. DC-Only vs DC-Revert

It is critical to understand how the repeater behaves differently depending on its power mode, as this affects the RF output power.

- **Mains Fail – DC Revert Mode:** The repeater operates at the "low" RF power setting.
- **DC-Only Mode:** The repeater operates at the **RF power level configured for the current channel** (either "low" or "high").

The repeater determines its power mode upon startup. If it detects that AC power has been present at any point since it was last booted, it will operate in **DC Revert Mode** when running on battery. If it has never seen AC power during the current boot cycle, it will operate in **DC-Only Mode**.

Therefore, if a repeater in DC Revert mode is rebooted while AC power remains absent, it will start up in DC-Only mode, its LED pattern will indicate that it is operating in DC-Only mode, and transmit at high power. This may provide a stronger signal, which may drain the backup battery faster.

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3.6. Specifications

Note: Specifications are subject to change and based on TIA603D and ETSI standards where applicable.

Physical		
Size (H x W x D):	95 x 220 x 375 mm (main body only)	
Weight:	4.15 kg	
Temperature Range:	Operational:	-30°C to +60°C (fan unrestricted)
		-30°C to +55°C (fan dust filter fitted)
	Storage:	-40°C to +70°C
Relative Humidity:	Up to 95% (non-condensing) at 50°C	
Antenna Connectors:	Two Antenna Working:	Tx: N-Type female Rx: BNC female
	With Optional Duplexer:	Tx/Rx: N-Type female
Power Connectors:	AC:	Fused IEC C14 (fits IEC C13 cable)
	DC:	Molex Mini-Fit Sr. 2-Circuit Plug

RF General	
Mode of Operation:	Full-Duplex Repeater
Number of Channels:	1
Frequency Range:	400-470 MHz
Channel Bandwidth:	12.5 kHz or 25 kHz
Supported Modes of Operation: (Auto-switches between modes)	Analogue FM Conventional
	DMR Tier II (TS 102 361-1 and -2)*

Transmitter		
Rated Output Power:	1-25W (adjustable)	
Transmitter Duty Cycle:	Continuous Duty	
Frequency Stability:	<0.5 ppm	
Intermodulation Attenuation:	>40 dB	
Adjacent Channel Power: (ETSI & TIA603E)	12.5kHz	>60 dB
	25kHz	>70 dB
FSK Modulation Fidelity (DMR)*:	Frequency:	<3%
	Magnitude:	<1%
Max Freq Deviation / Modulation Limiting: (Analogue FM)	12.5kHz	±2.5 kHz
	25kHz	±5.0 kHz
Spurs & Harmonics (Conducted and Radiated):	<1GHz	<-36 dBm
	>1GHz	<-30 dBm
FM Hum & Noise:	12.5kHz	<-45 dB
	25kHz	<-50 dB

Power Supply			
Power Supply Type:		Switching	
Input Power Modes:		AC only	
		AC with DC-revert upon AC-failure	
		DC only	
Input Voltage:	AC:	UK/Euro:	230 VAC ±10%, 47-53 Hz
		Americas:	110 VAC ±10%, 57-63 Hz
	DC:	12.0-15.0 VDC	
Typical Input Power: (25°C, VSWR<1.5 and backup battery fully charged or absent)	AC:	Standby:	18 VA
		25W Tx:	130 VA
		1W Tx:	40 VA
	DC:	Standby:	3 W
		25W Tx:	70 W
		1W Tx:	20 W
Backup Battery Compatibility:	Charge Scheduling:	Batt Charging during Standby	
		Charging suspended during Tx	
	Charge Current:	1A @ $V_{batt} < 11.5VDC$	
		3A @ $11.5VDC < V_{batt} < 13.8VDC$	
Up to 3A @ $V_{batt} = 13.8VDC$			

Receiver			
Frequency Stability:		<0.5 ppm	
Sensitivity:	Analogue	12dB SINAD	<0.2 μV
	DMR*	5% BER	<0.2 μV
Adjacent Channel Selectivity:	ETSI	12.5kHz	>60 dB
		25kHz	>70 dB
	TIA603E	12.5kHz	>65 dB
		25kHz	>75 dB
Blocking / Desensitisation:	ETSI	>84 dB	
	TIA603E	>84 dB	
Intermodulation Response Rejection:	ETSI	>70 dB	
	TIA603E	>75 dB	
Spurious Response Rejection:	ETSI	>70 dB	
	TIA603E	>75 dB	
Spurious Emissions (Conducted and Radiated):	<1GHz	<-57 dBm	
	>1GHz	<-47 dBm	

* Not applicable to analogue-only models

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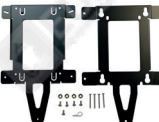
Conformance				
	UK & Europe (Land)	UK & Europe (Marine)	USA (Land)	Canada
Radio:	EN 300 086 EN 300 113	EN 300 720	CFR Title 47 Part 90	RSS-119
Safety:	EN 62368-1			
EMC:	EN 301 489-1 and -5	EN 60945	CFR Title 47 Part 15	ICES-003
Labelling:	UKCA marked CE marked		FCC ID: RV6DRUHFLE	ISED IC ID: 34924-DRUHFLE
Emission Designators				
Bandwidth	Modulation	Channelisation	Information Carried	Applicable Designator
12.5 kHz	Analogue FM	1x Analogue Channel	Voice	11K0F3E
25 kHz	Analogue FM	1x Analogue Channel	Voice	16K0F3E
12.5 kHz	Digital 4FSK	DMR 2-Timeslot TDMA	Data	7K60FXD*
12.5 kHz	Digital 4FSK	DMR 2-Timeslot TDMA	Voice	7K60FXE*
12.5 kHz	Digital 4FSK	DMR 2-Timeslot TDMA	Voice & Data	7K60FXW*

All specifications shown are typical unless otherwise stated and are subject to change without notice to improve reliability, function, or design.

* Not applicable to analogue-only models

3.7. Optional Items

The following optional items are available for the repeater:

#	Item Part Number(s)	Image	Contents
1	DC Power Lead Entel P/N: DR/DCL		- DC power cable (3m length) with one end terminated in a DC power connector and a fuse holder fitted to the repeater end. - Fuse 15A (Littlefuse P/N 0287015_)
2	Internal Duplexer Kit Entel P/Ns: DUP/380-450MHz/5-7MHz 380-450MHz (5-7MHz Tx/Rx separation) DUP/380-450MHz/7-12MHz 380-450MHz (7-12MHz Tx/Rx separation) DUP/380-450MHz/12-20MHz 380-450MHz (12-20MHz Tx/Rx separation) DUP/450-520MHz/5-7MHz 450-520MHz (5-7MHz Tx/Rx separation) DUP/450-520MHz/7-12MHz 450-520MHz (7-12MHz Tx/Rx separation) DUP/450-520MHz/12-20MHz 450-520MHz (12-20MHz Tx/Rx separation)		- Duplexer. - Set of Coaxial Cables (qty:3). - Mounting Hardware (Screws & Rx Port Blocking Plug) NOTE: Repeater frequency pair is required at time of ordering to tune the duplexer
3	Dust Filter Entel P/N: DR/DF		- Dust filter foam. - Mounting Frame. NOTE: Use of the dust filter reduces the repeater's maximum operating temperature to +55 °C due to airflow restrictions
4	Wall Mount Kit Entel P/N: DR/WMK		- Wall bracket. - Repeater bracket. - Mounting Hardware (screws and bushings) NOTE: Appropriate wall fixings to be supplied by the installer
5	AC Mains Filter for Ship Installations Entel P/N: DR/ACFILTER		Inline AC Mains Filter NOTE: Marine EMC standards are only met when this filter is installed

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3.8. Spare Parts

Refer to the dealer portal for a list of DR Series repeater spares.

4. PROGRAMMING AND TUNING

Refer to Entel's DR400 Series Repeater Programming Guide for detailed programming guidance.

This guide is downloadable from the dealer portal at <https://www.entel.co.uk/support/dealer-portal/>

4.1. Programming

The repeater's operational parameters are configured using the Entel Dealer Programmer (EDP) software. This includes:

- **Channel Frequencies:** Setting Tx and Rx frequencies.
- **Channel Type:** Setting channel type to Analogue, Digital DMR, or Mixed Mode (auto-switched Analogue/DMR). NOTE: DR4xx/A models only support Analogue operation.
- **Analogue Channel Bandwidth:** Setting the channel bandwidth to 12.5kHz or 25kHz.
- **Power Levels:** Configuring whether the channel should use the High or Low transmit power levels. Note that a repeater operating in "AC Power with DC Backup (DC Revert)" mode will automatically switch to the Low transmit power level during DC-Revert conditions to preserve battery life – even if the repeater has been configured to operate at a High transmit power level.
- **Subtones/Codes:** Assigning CTCSS/DCS tones to the analogue channel, and/or Colour Codes to the DMR channel. Note that assignment of a CTCSS/DCS tone to analogue channels (and the analogue portion of mixed mode channels) is compulsory. Analogue carrier squelch operation is not supported. Also note that DR4xx/A models only support Analogue operation.
- **Squelch:** Setting the squelch level (Normal, Tight, or Custom) for analogue and mixed-mode channels.

4.2. Tuning

Factory-calibrated TX power levels are pre-set to:

- High transmit power level: 25W
- Low transmit power level: 5W

Dealer-adjustable TX power levels can be configured via the Entel Detail Programmer to fine-tune the High and Low power settings to the requirements of your specific installation.

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5. PHYSICAL INSTALLATION

5.1. Unboxing

Unpack the repeater carefully and check that you have received the following standard items. If any item is missing or damaged, contact your dealer.

- DR400 Series Repeater
- AC Power Cord:
 - o **UK** Version: UK AC power cable OR
 - o **Euro** Version: Euro AC power cable OR
 - o **American** Version: US AC Power cable
- Repeater Quick Start Guide
- USB Programming Cable

5.2. Installing Hardware Options

5.2.1. Duplexer

If you ordered the optional duplexer from Entel alongside your repeater, then the repeater will be delivered with the duplexer installed.

Entel supplied duplexers include connecting cables and hardware kits.

The optional duplexer can be field-installed by following the instructions included with the duplexer kit. These instructions can also be downloaded from the dealer portal.

5.2.2. Front handles

Certain install locations, such as installation onto a tray inside a 10" or 19" cabinet, may require the front handles to be removed. This is accomplished as follows:



- a. Power off the repeater and disconnect all cables. Place on a protective surface to prevent scratching.
- b. Use a 3mm Hex Key to remove the eight screws that retain the front handles as per the red arrows in Figure 4 below.



Figure 4

- c. Use a PH1 screwdriver to remove six screws from the front panel as per the red arrows in Figure 5 below.

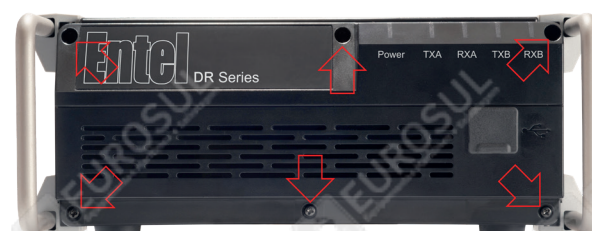


Figure 5

- d. Slide the front handles off the repeater body and store safely in case of future reuse.

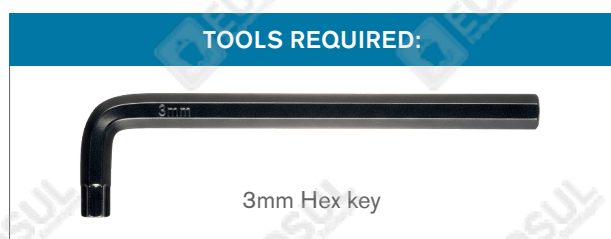
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- e. Follow step c above in reverse order to reattach the repeater front panel.
- f. Follow step b above in reverse order to reinstall the eight screws into the empty screw holes.

Follow the steps above in reverse to reattach the front handles.

5.2.3. Rear bumpers

Certain install locations, such as installation onto a tray inside a 10" or 19" cabinet, may require the rear bumpers to be removed. This is accomplished as follows:



- a. Power off the repeater and disconnect all cables. Place upside down on a protective surface to prevent scratching.
- b. Use a 3mm Hex Key to remove the eight screws that retain the rear bumpers as per the red arrows in Figure 6 below.



Figure 6

- c. Remove the rear bumpers and store safely in case of future reuse.
- d. Follow step b above in reverse order to reinstall the eight screws into the empty screw holes.

Follow the steps above in reverse to reattach the rear bumpers.

5.3. Pre-Installation Considerations

Proper installation ensures the best possible performance and reliability. Consider the following when determining an appropriate installation location:

- **Location:** Install the repeater in a dry, clean, and well-ventilated location that meets the specified environmental conditions.
- **Ventilation:** The repeater is cooled by forced convection. Ensure at least 15 cm (6 inches) of open space around all ventilation openings to allow for adequate airflow. Do not operate the unit in a sealed cabinet.
- **Security:** To prevent unauthorized access, it is recommended to install the repeater in a secure, lockable vented cabinet or secure (access-controlled) room.
- **Power Source:** Select a location with easy access via a secure cable run to the repeater's intended power source. Consider the reliability of this power source, the vulnerability of the cable run, as well as other equipment that will share power via the same breaker and/or fuse when selecting the power source.
- **Antenna Run:** Select a location with access via a coaxial cable run to the repeater's intended antenna location.

5.4. Mechanical Installation

The DR400 repeater is designed for desk mounting, mounting in a standard 10-inch or 19-inch equipment rack, or wall mounting (using the optional wall mounting kit).

5.4.1. Wall Mounting

Entel recommends the optional wall mount kit is used to securely mount the repeater against a wall. Instructions in this regard are included with the wall mount kit. These instructions can also be downloaded from the dealer portal.

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5.4.2. 10" or 19" Rack Mounting

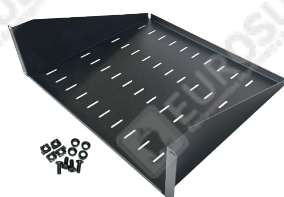
The repeater (95mm high with front handles and rear bumpers removed) fits into a 3U high rack space (133mm high), with some of this additional space needed to accommodate the rack tray, support rails and mounting hardware.

A 10" rack measures 222mm between vertical rails, which is wide enough for a single repeater with front handles and rear bumpers removed (220mm wide with a 1mm gap either side).

A 19" rack measures 450mm between vertical rails, which is wide enough for two repeaters with front handles and rear bumpers removed side by side (2x220mm wide with a 3mm either side and a 4mm gap in the centre).

Install the repeater into a 10" or 19" rack as follows:

EQUIPMENT REQUIRED:



Rack shelf and mounting hardware as appropriate for your rack type



Rack support rails and mounting hardware as appropriate for your rack type

TOOLS REQUIRED:



PZ3 screwdriver



PH2 screwdriver

- Note that airflow to cool the repeater is drawn in through the fan at the back of the repeater and expelled out via the vents on the repeater front panel at a rate of up to 30 cubic foot per minute (CFM). Prepare your rack to accommodate this volume and direction of repeater airflow, which may require blanking panels, venting panels, heat baffles, rack fans and/or similar airflow management hardware to be fitted.
- Use the PH2 screwdriver to fit the repeater onto the rack shelf. The repeater comes equipped with the required four screws to attach it to the rack shelf as per the red arrows in Figure 7 below. Fitment may require corresponding holes to be drilled in the rack shelf.

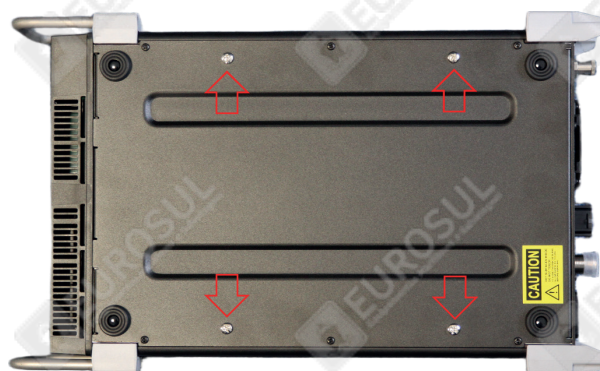


Figure 7

- Use the PZ3 screwdriver and mounting hardware to install the rack support rails at the appropriate height in the rack in accordance with the manufacturer's recommendations.
- Install the repeater shelf into the rack in accordance with the manufacturer's recommendations.

5.5. Electrical Installation

Proper electrical installation is critical for the safety, reliability, and performance of the repeater. The installation procedure varies depending on the intended power source. Follow the steps for the configuration that matches your operational requirements.



Warning: Ensure all power sources are disconnected before making any connections.

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5.5.1. Initial Step for All Configurations: Grounding

Proper grounding is the foundation of a safe installation and provides protection against lightning and electrical faults.

Connect the Earth Ground: Secure a heavy-gauge ground wire from the site's main grounding point (e.g., from the equipment cabinet or a dedicated earth stake) to the ground screw on the repeater's rear panel. Ensure the connection is clean, tight, and secure.

5.5.2. Configuration 1: AC Power Only Installation

This configuration is for standard installations where a reliable AC mains supply is available.

1. **Verify AC Voltage:** Before connecting power, check the label on the rear of the repeater to confirm its AC voltage configuration (e.g., 230V AC or 110V AC). Ensure this matches the mains supply at the installation site. If the voltage needs to be changed, then please contact your dealer or Entel technical support.
2. **Connect AC Power Cord:** Ensure the power switch on the repeater rear panel is switched off before connecting the supplied AC power cord to the AC inlet. Plug the other end into a grounded, RCD-protected mains outlet. Do not yet switch AC power on.
3. **Do NOT connect DC Power:** The DC input connector on the rear panel should be left disconnected in this configuration.

5.5.3. Configuration 2: AC Power with DC Battery Revert Installation

This configuration provides maximum uptime for critical applications by using a backup battery that automatically engages if the AC mains supply fails.

1. **Install AC Power:** Follow steps 1 and 2 from the "AC Power Only Installation" section above.
2. **Connect the Backup Battery:**
 - a. **Battery Requirements:** Use a 12V backup battery type that is compatible with the repeater's 13.8V float charge voltage, such as a lead-acid type. A battery with a capacity between 12Ah and 30Ah is recommended to align with the 3A maximum bulk charge current capacity of the internal battery charger.

- b. **Connection:** Use the optional Entel DC Power Lead (P/N: DR/DCLE) or a suitable custom cable with a 15A in-line fuse at the repeater-end for protection. Secure this cable in a suitable conduit or raceway to protect the cable against mechanical damage. If the cable cannot be installed in a raceway or conduit, or if the cable is lengthened beyond 3m, then a second 15A fuse (supplied by the installer) must be fitted at the battery-side of the DC power lead. Remove the DC fuse(s) before connecting the lead to the DC input connector on the repeater's rear panel to prevent the repeater power up during the installation. Do not yet replace the DC fuse(s) when done.

- c. **Polarity:** Ensure the correct polarity when connecting to the battery terminals. Reversing the polarity may damage the repeater or the battery.
- d. **Battery Connection Only:** The DC input is only for connecting a compatible backup battery when using AC power.



Warning: NEVER connect an external DC power supply or a separate battery charger to the battery connected to the DC input connector when the repeater is powered by AC mains, as this will likely cause permanent damage to the repeater's internal power supply.

5.5.4. Configuration 3: DC Power Only Installation

This configuration is ideal for mobile, remote, or off-grid applications where only a DC source is available.

1. **Verify the DC Source:**
 - a. **Voltage Range:** Ensure your DC power source is stable and provides a nominal voltage between 12.0V DC and 15.0V DC. If the DC power system comprises an external battery charger and battery bank, then this requires an examination of the DC supply voltage range extremes. Maximum DC supply voltage is typically the absorption charge voltage level (battery capacity between 80% and 98%, but not yet fully charged). Minimum voltage is typically the battery voltage at its minimum useable capacity level with the DC battery charger inoperative or switched off.

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- b. **Voltage Conversion:** If the source voltage is incompatible (e.g., a 24V system) or fluctuates outside the required nominal range, a suitable DC-to-DC converter must be installed between the source and the repeater.

2. Connect DC Power Lead:

- a. **Connection:** Use the optional Entel DC Power Lead (P/N: RP/DCL) or a suitable custom cable with a 15A in-line fuse fitted at the external DC power supply end of the cable run for protection. If you are using the Entel DC Power Lead, then secure this cable in a suitable conduit or raceway to protect the cable against mechanical damage. If the cable cannot be installed in a raceway or conduit, or if the cable is lengthened beyond 3m, then a second 15A fuse (supplied by the installer) must be fitted at the battery or DC power supply end of the DC power lead. Remove the DC fuse(s) before connecting the lead to the DC input connector on the repeater's rear panel. Do not yet replace the DC fuse(s) when done.
- b. **Polarity:** Ensure the correct polarity when connecting to the DC power source.
3. **Do NOT connect AC Power:** The AC power inlet on the rear panel MUST be left disconnected in this configuration.



Warning: NEVER connect AC mains to the AC input connector when the repeater is powered by DC power, as this will likely cause permanent damage to the repeater's internal power supply.

5.6. RF Installation

A professional and meticulous RF installation is essential for achieving the best possible performance and reliability from your DR400 repeater. This section provides guidance on selecting components and installing the antenna system correctly for either dual-antenna or single-antenna (duplexer) configurations.



Warning: This repeater generates significant Radio Frequency (RF) energy which can cause burns. Ensure the repeater is powered off before connecting or disconnecting any RF cables.

5.6.1. Installation Scenarios

Follow the guidance that matches your system's configuration.

1. Dual-Antenna Installation

This configuration uses two separate antennas: one connected to the repeater's Transmit (Tx) port and one to the Receive (Rx) port.

- a. **Antenna Separation (Isolation):** To prevent the powerful transmit signal from overwhelming the sensitive receiver (two conditions known as "desensitisation" and "transmitter noise"), the two antennas must be vertically separated. Consult your radio system engineer to recommend the vertical separation distance specific to your channel frequencies, Tx/Rx separation, antenna types, antenna gains, other co-sited & near-sited repeaters and site RF noise level.
- b. **Required Connections:** The transmit antenna cable connects to the N-Type female Tx connector and the receive antenna cable to the BNC female Rx connector on the repeater rear panel.

2. Single-Antenna Installation (with Internal Duplexer)

This configuration uses a single antenna for both transmit and receive, requiring an internal duplexer to filter and route the signals.

- a. **Duplexer Compatibility:** The duplexer is a precision-tuned device. You must verify that it is suitable for and has been tuned to your repeater's programmed channel frequencies:
- i. **Frequency Separation:** The repeater's channel separation (the difference between its Tx and Rx frequency) must fall within the range specified for the duplexer model (e.g., the DUP/380-450MHz/5-7MHz is for channels with a 5-7 MHz Tx/Rx frequency split).
- ii. **Tuning:** A duplexer must be precisely tuned to your specific Tx and Rx frequencies by the supplier at the time of ordering. Using a duplexer tuned for a different channel pair will result in extremely poor performance or complete system failure.
- b. **Required Connections:** The antenna cable connects to the N-Type female Antenna connector on the repeater rear panel.

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3. Connecting to an Antenna Combining System:

At shared repeater sites, it's common to use an antenna combining system to allow multiple repeaters to use a single transmit antenna and a single receive antenna. These antennas along with their coaxial cable runs and surge arrestors are typically supplied by the site manager, frequency coordinator or another 3rd party.

a. **Coordination is Crucial:** Before starting, you must have the specific frequency and power level assignments from the site manager or frequency coordinator, who would have verified the compatibility of your frequencies (interference and intermodulations) with other co-sited repeaters, and who would have assigned and configured antenna combiner ports for your equipment. It is therefore important that the repeater is programmed to these exact specifications, and connected only to the assigned ports that would have been pre-tuned to your exact frequencies.

b. Transmit (Tx) Connection:

- i. Locate the transmit combiner, which is the device that combines multiple transmitter outputs.
- ii. Identify the specific input port on the combiner that has been tuned for your repeater's assigned transmit frequency. These ports are typically clearly labelled.
- iii. Using a high-quality 50-Ohm jumper cable, to connect the repeater's N-Type female Tx connector to the correct combiner port.
- iv. Ensure the repeater's transmit power is set to the level specified by the site manager, as the combiner port will have a maximum power rating.



Warning: Connecting to the wrong port will result in a severe impedance mismatch (high VSWR), which will prevent the repeater from transmitting correctly and may damage its power amplifier.

c. Receive (Rx) Connection:

- i. Locate the receiver multicoupler (or preselector), which distributes the signal from the shared receive antenna to multiple receivers.

- ii. Identify the specific output port on the multicoupler assigned to your repeater's receive frequency.
- iii. Using a high-quality 50-Ohm jumper cable, connect the repeater's BNC female Rx connector to the correct multicoupler port. This connection provides the repeater with a filtered signal, protecting it from interference from other on-site transmitters.

5.6.2. Component Selection

The quality of your antenna system components directly impacts coverage and reliability.

1. Antenna Selection:

- a. **Type and Pattern:** Choose an antenna with a radiation pattern appropriate for your coverage needs. Omni-directional antennas provide 360-degree coverage, ideal for a central site serving a wide area. Directional antennas focus RF energy in a specific direction, which is useful for linking to a particular area or overcoming interference.
- b. **Gain and Power Rating:** The antenna's gain and power rating must be suitable for the repeater channel Tx and Rx frequencies and output power. Higher gain antennas can increase effective range but have a more compressed radiation pattern.
- c. **Antenna Installation Location:** Install the antenna(s) in accordance with the manufacturer's recommendations, and as high and as clear of surrounding obstructions as possible using mounting brackets. A roof, mast, or tower is an ideal location. Avoid mounting the antenna(s) very close to other metallic structures, which can block, reflect, or distort the radio signals. A pre-installation site survey is recommended to identify the optimal location and the antenna mounting hardware or standoffs required.
- d. **EMF Exposure Perspective:** To comply with safety regulations and prevent human exposure to high levels of RF energy, the transmit antenna must be installed in a location where it is inaccessible to the general public or untrained personnel. As detailed in section 2.4.2 above, a minimum separation distance of 5 metres, and preferably 10 metres, must be maintained between the transmitting antenna and any person.

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2. Coaxial Cable Selection:

- a. All cabling must be high-quality, 50-Ohm impedance coaxial cable, installed in accordance with the manufacturer's recommendations.
- b. The choice of cable involves a trade-off between signal loss, cost, and flexibility. For long cable runs where preserving signal strength is critical, use low-loss "thicknet" cables (e.g., LMR-400 or larger). For shorter, more complex runs, a more flexible cable (e.g., RG-213) may be sufficient. Always calculate the total signal loss to ensure the antenna system meets your system coverage design requirements.

3. Lightning Surge Protection:

- a. If using an outdoor antenna, it is a critical safety requirement to install a suitable lightning surge arrester in accordance with the manufacturer's recommendations.
- b. The arrester must be rated for the correct frequency band and power level. It is typically installed where the coaxial cable enters the building and connected with a heavy-gauge wire to the site's primary earth ground point.

5.6.3. Cable Installation and Weatherproofing

Careful finishing protects the system from the elements and ensures long-term reliability.

1. Grounding and Securing:

- a. The outer shield of the coaxial cable must be grounded in accordance with the manufacturer's recommendations – typically at the building entry, at the bottom of the tower or mast, at the top of the tower or mast, and at a stated interval in between for particularly long cable runs.
- b. Mechanically secure the cable along its entire length in accordance with the manufacturer's recommendations – typically by using suitable ties or clips that are rated for prolonged exposure to ultraviolet light. Do not allow the cable to hang unsupported, and respect the manufacturer's specified minimum bend radius to avoid internal damage.

2. Weatherproofing:

- a. **External Connections:** All external RF connections, such as at the antenna or surge arrester, must be made fully waterproof. Use a wrap of self-amalgamating rubber tape, applied and wrapped in accordance with the coaxial connector manufacturer's recommendations.
- b. **Cable Entry:** Seal the point where the cable enters the building using a suitable cable gland or silicone sealant to prevent water ingress.

6. COMMISSIONING

After the physical, electrical, and RF installations are complete, the repeater is ready for commissioning. This final stage involves safely applying power and verifying that the entire system is operating correctly.

6.1. Antenna System Commissioning

Antenna system commissioning is beyond the scope of this guide. The below is offered as broad guidance only. Consult an antenna system specialist for detailed commissioning guidance specific to your antenna system and installation.

6.1.1. Antenna System Sweep Test

Before connecting the antenna cable to the repeater, it is recommended to test it with an antenna analyser. A sweep test measures the Voltage Standing Wave Ratio (VSWR) across your operating frequencies. A high VSWR (above 2:1) can cause poor performance and trigger major alarms by reflecting power back into the repeater. A healthy antenna system should have a VSWR below 1.5:1 at the operational Tx and Rx frequencies.

In case of a high VSWR reading, performing a Distance to Fault (DTF) test will pinpoint the physical location of any high-loss points, such as bad connections or cable damage.

6.1.2. Cable Losses

Before connecting the coaxial cable to the antenna, it is recommended to use a calibrated RF power meter to measure both the forward power delivered to and the reflected power from the antenna at the actual Tx frequency.

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6.2. Applying Power

Before applying power, perform these final safety checks:

1. Verify that all electrical grounding, power, and RF connections are secure and correctly installed.
2. Ensure a suitable antenna or a 50-Ohm dummy load with the correct power rating is connected to the Tx antenna port. Never apply power to the repeater without a load connected.
3. Confirm that the polarity of DC cable connections are correct.



Risk of Equipment Damage

Reversing DC polarity may cause damage to the repeater.

Follow the procedure that matches your specific power configuration:

6.2.1. For AC Power Only Installations:

1. Turn on the circuit breaker for the AC mains outlet that supplies the repeater.
2. Switch the repeater's rear panel AC power switch to the 'ON' position.

6.2.2. For AC with DC Revert Installations:

1. Ensure the backup battery is securely connected.
2. Disconnect the DC power cable from the repeater rear panel, reinstall the 15A fuse(s) removed in section 5.5.3 step 2.b above, and reconnect the DC power cable.
3. Turn on the circuit breaker for the AC mains outlet that supplies the repeater.
4. Switch the repeater's rear panel AC power switch to the 'ON' position.

6.2.3. For DC Power Only Installations:

1. Ensure the DC power source is enabled and stable.

2. Disconnect the DC power cable from the repeater rear panel, reinstall the 15A fuse(s) removed in section 5.5.4 step 2.a above, and reconnect the DC power cable.

6.3. Verifying Proper Operation

- **Boot-up Sequence:** Upon power-up, all LEDs will illuminate steady **Amber** during boot. The Power LED will turn solid **Green** and the other LEDs extinguish once the boot process is complete.

1. Repeater Function Check:

- o Using a properly programmed two-way radio terminals, transmit on the repeater's receive frequency.
- o Observe the repeater's front panel. The RXA (or RXB for DMR Slot 2 transmissions) LED should illuminate steady **Green**, indicating valid signal reception. Note that for Analogue-only (DR4xx/A) models, testing is limited to the RXA and TXA (Analogue) indicators.
- o The repeater should then transmit. The TXA (or TXB) LED should illuminate steady **Red**.
- o Confirm that a second radio receives the repeated transmission clearly.

2. DC Revert Functionality Test: (For AC-Mains with DC Battery Backup installations only)

This test verifies the automatic backup system.

- o With the repeater operating normally on AC power (solid **Green** Power LED), simulate a power failure by turning off the AC circuit breaker supplying the repeater.
- o The repeater should switch seamlessly to battery power, and the Power LED should begin flashing **Green**.
- o Perform another Repeater Function Check (item 1 above). The repeater should operate correctly, but will now transmit at its pre-configured "low" RF power level to conserve battery life.
- o Restore AC power by turning the circuit breaker back on. The repeater should switch back to AC power, and the Power LED should return to solid **Green**.

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6.4. Troubleshooting

The front panel LEDs provide a clear, at-a-glance diagnosis of the repeater's operational status. If the repeater is not functioning correctly, or if any LED is showing an alarm state (**Red** or **Amber**), refer to the indicators below. Always disconnect power from the repeater before inspecting connections or replacing components.

- Power LED flashing **Red**, repeater is disabled, check the:
 - DC power supply voltage is between 12V and 15V.
 - Repeater is within its operating temperature range (-30°C to +60°C).
- Power LED solid **Red**, major alarm, check:
 - The antenna VSWR is below 3:1.
 - If the receiver is blocked by a persistent interfering signal, investigate and correct the source of interference.
- Power LED solid **Amber**, minor alarm, check:
 - The repeater is within its operating temperature range (-30°C to +60°C).
 - The Fan for proper operation, and if needed clean the airways or arrange for its repair.
 - The antenna VSWR is below 2:1.
- TXA or TXB flashing **Red**, repeater is in limp mode (transmit power level = 1W), check the:
 - The antenna VSWR is below 2:1.
 - DC Voltage is above 11.8V
 - Repeater is within its operating temperature range (-30°C to +60°C).
- RXA or RXB steady **Amber**, repeater is detecting an interfering signal.
 - For interference at weak levels, increase the squelch level if the resultant reduction in coverage is not operationally significant
 - For interference at higher levels (which is usually accompanied by the Power LED illuminating solid **Red**), investigate and correct the source of the interference.

7. WARRANTY, SERVICE AND TECHNICAL SUPPORT

Entel offers long-term support for its products, including repair and spare parts support. For all warranty, service, and technical support enquiries, please contact your authorized Entel dealer or Entel directly. Have the repeater's model and serial number ready when you call.

- **Website, Technical Support Desk & live chat:**
www.entel.co.uk
- **Email:** technical@entelsales.co.uk
- **Telephone:** +44 (0)20 8236 0032

Contact

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