
 Cambium Networks™ 450m (Medusa) 3 GHz, 5 GHz and DC-LPU power wiring	Document Number	cam-10189
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1 Introduction

This document is a brief introductory guide to the cable connections and polarities for the DC power cable to 450m (Medusa) 3 GHz. A supplementary section discusses how this cabling might be applied to 450m 5 GHz.

The user guides describe in detail cable preparation and the use of EMC cable glands; to avoid repetition this is not included herein.

The 450m 3 GHz product user guide will contain a fuller description and takes precedence in the case of any discrepancy.

1.1 Background note

Many radios in Cambium Network's portfolio use power-over-Ethernet (PoE), supplied by a PoE injector (sometimes known as a midspan) over CAT5e cabling. This system cannot provide the higher power needed for the 450m 3 GHz radio. To support this increased power need, a higher power mains adapter plus a 4-wire (2-pair) cable of heavier gauge is used, together with appropriate connectors.

1.2 Revisions

Significant changes are marked by a bar in the left margin, or a double-border in tables.

2 Components


Parts for the power wiring are listed below. Note that additional parts and equipment will be required for LPU (lightning protection unit) surge protection.

Cambium part no.	Description	Manufacturer	Notes
N000000L115A	Cable, 4-conductor 0.75 mm ² 100m	Lapp 1032126	
N000000L117A	Cable, 4-conductor 0.75 mm ² 300m	Lapp 1032126	
N000000L116A	Cable, 4-conductor 1.0 mm ² 100m	Lapp 1032131	Use thicker cable for long cable runs. See section 2.1.
N000000L118A	Cable, 4-conductor 1.0 mm ² 300m	Lapp 1032131	
N000000L123A	DC power connector kit, 18 AWG, 10 pcs (4-pin plugs plus crimp terminals)	Molex 39-03-9042 Molex 39-00-0428	Spares kit. Sufficient parts are included in the radio and LPU kits. For 0.75mm ² cables.
N000000L124A	DC power connector kit, 16 AWG, 10 pcs (4-pin plugs plus crimp terminals)	Molex 39-03-9042 Molex 39-00-0089	Spares kit. Sufficient parts are included in the radio and LPU kits. For 1.0 mm ² cables.
N000000T001A	Crimp tool	Molex 63819-0900	
N000000T002A	Crimp removal tool	Molex 11-03-0044	To rework connector errors
n/a	Terminal block, crimp connectors or similar	Installer choice	To connect the 4-wire cable to the DC power supply (section 3.2).
N000000L054B	mains power supply, 54 V, 240 W	Meanwell HLG-240H-54A	

Note: the recommended connector kits contain gold-plated contacts for best reliability. Tin-plated contacts are commonly available *but should not be used*.

2.1 Cable choice

Installers are recommended to use the cables listed above. Other cables may be used, but installers should note particular features offered by the listed cables:

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Feature	Advantage
4 wires arranged as two twisted pairs	Optimum signal propagation that may be required by future feature enhancements. Non-twisted pair cables are suitable for power-only applications.
Wires have individual colours	Easy wire identification. Cables with wires of the same colour will increase the likelihood of wiring errors.
Braided shield	Enhanced protection from lightning-induced surges. Cables with only a foil shield are not recommended.
Wide temperature range, -40°C/-50°C to +90°C	Resists cracking at low temperatures.
UV resistant outer sheath	Resists degradation in sunlight.

Two cable types are recommended, 0.75 mm² and 1.0 mm² cross-sectional area. The following table gives guidance on which to choose. *It assumes that the recommended power supply is used, trimmed up to 57 V as described in section 3.3.*

Auxiliary port PoE load (note 1)	Maximum cable length 0.75 mm ² cable	Maximum cable length 1.0 mm ² cable
No Auxiliary port PoE load	130 m	170 m
With Auxiliary port PoE load	110 m	150 m

Note 1: this refers to a device wired to the 450m Auxiliary port that uses Power-over-Ethernet (PoE), such as a camera or WiFi access point.

Note 2: installers wishing to calculate the maximum cable length for other cables or cases may use the guidance in appendix 5.1.

Note 3: The 4-core cable is wired with 2 cores positive and 2 cores negative. 2-core cables *must not* be used. Whilst it might seem attractive, and sometimes cheaper, to use just one positive and one negative core, the power input circuit in 450m 3 GHz requires the power to be evenly distributed across all 4 cores. The guidance in appendix 5.1 may however permit thinner gauge cables to be used for short cable runs, if a more economic installation is required.

2.2 Power supplies and fusing


The recommended AC mains power supply includes current limiting.

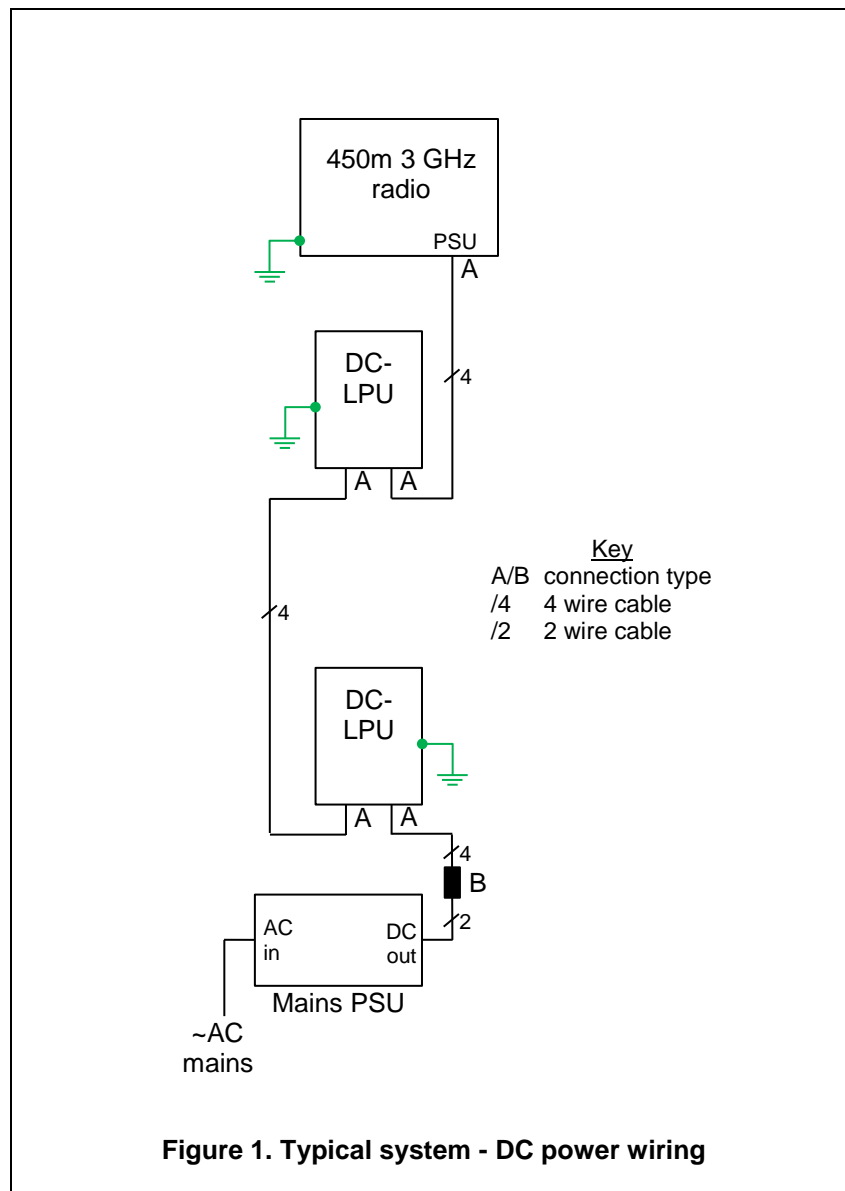
If a positive-ground DC supply is used – for example a -48 V DC telecom supply – then ensure that the negative rail has a fuse or circuit breaker rated at 6 A. The 450m DC input is wired to the Auxiliary PoE port: the positive wire has a direct connection, the negative wire is switched. *Switches or circuit breakers in the positive input rail are ineffective if two radios are linked by their Aux ports: the direct connection effectively bypasses the circuit breaker.*

See the warning in appendix 5.2 about ground-referred supplies and surge currents.

3 Connections

A typical installation will include a mains power supply, DC-LPUs (lightning protection units) and the radio. This is shown for illustration in Figure 1 below. *Note that data cables are not shown. This document is not a substitute for the LPU installation guide; significant installation and grounding details are omitted for clarity.*

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In Figure 1 there are two types of connection:

- Type A – At the 450m 3 GHz radio and at the DC-LPUs: 4-wire cable to 4-pin plug.
- Type B – At the PSU: 4-wire cable to 2-wire cable.

These two types are described and illustrated in the following sections.

3.1 450m 3 GHz radio and DC-LPU connections (type A)

The recommended cable is connected as shown in Figure 2, using the parts in the 4-pin connector kits N000000L123A and N000000L124A. The plug body shown is for illustration, and may be either black or white in practice.

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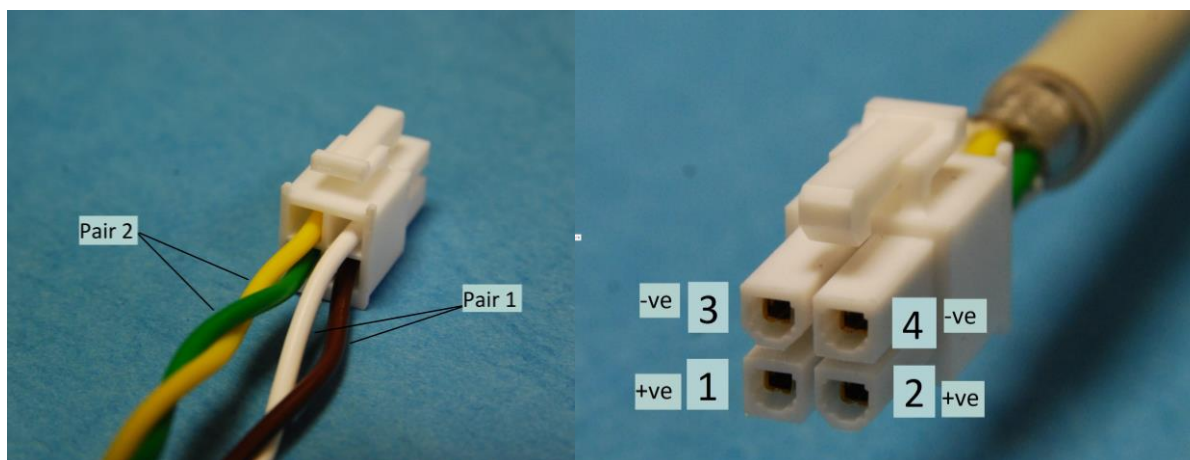


Figure 2. Cable to 450m/LPU wiring

Note the pin numbers, wire colours (when using the recommended cable) and power supply polarities that these represent:

Pin no.	Wire colour	DC polarity	Notes
1	Brown	Positive (+ve)	Negative pins are closest to the plug latch.
2	Green	Positive (+ve)	
3	White	Negative (-ve)	
4	Yellow	Negative (-ve)	

3.2 Power supply connection (type B)

Please review section 3.4 regarding cable testing before making the connections to the power supply.

The connection between the 4 wires of the drop cable and the 2 wires of the power supply are made as shown in Figure 3. Two examples are shown, using a terminal block and using crimps. Cambium Networks do not supply this connector, the installer should use any similar suitable means that fits the site installation practice.

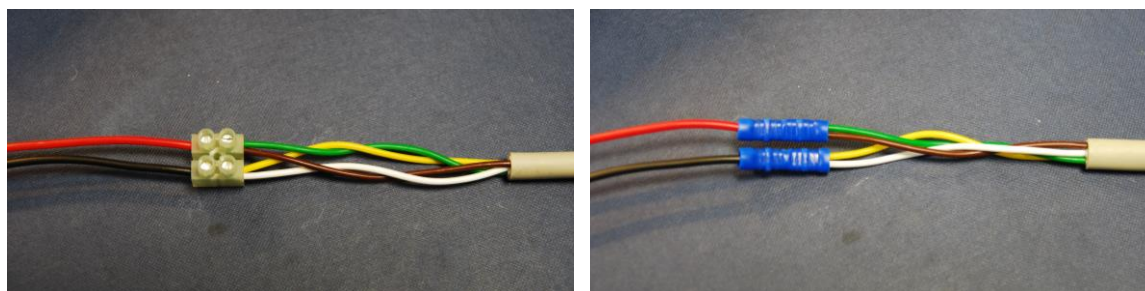



Figure 3. Cable to PSU wiring, terminal block (left), crimps (right)

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The wire colours (when using the recommended cable) and power supply polarities that these represent are:

450m wire colour	PSU wire colour	DC polarity	Notes
Brown	Red	Positive (+ve)	
Green		Positive (+ve)	
White	Black	Negative (-ve)	Negative wires are closest to the 450m plug latch.
Yellow		Negative (-ve)	

Important notes:

1. If the power supply wire strands have been consolidated with solder, then snip the soldered part off. Soldered strands *must not* be used in screwed or crimped connections.
2. When using a screw-terminal connector such as that shown on the left of Figure 3, make sure that the wire strands are protected from the terminal screw. Use a terminal block with wire protectors such as leaf springs, or a “rising cage” type, or fit crimp sleeves to the conductor strands.

3.3 Power supply

The recommended power supply from Meanwell has a default output voltage of about 54 V. It can be adjusted over a limited range using the trimmer under the black sealing bung labelled “Vo ADJ” on the top face. It is recommended, particularly for longer cable runs, or for installations with an Auxiliary port PoE load, to trim the output voltage up to between 57 V and 58 V. Gently prise the bung out, use a small screwdriver with a DMM (meter) to set the voltage, and replace the bung before use.


If a different power supply is used, it must be fitted with fold-back current limiting means such as a “hiccup” mode or fuse.

3.4 Testing

It is recommended that the wiring to the LPUs and radio is tested before making the connections to the power supply. Use a meter, ideally a DMM (digital multi-multimeter) with a diode test range, to check the following measurements. The LPUs and the radio must be connected, the power supply *must not* be connected.

Test no.	Meter positive	Meter negative	Approximate value	Notes
1	Brown (pin 1)	Green (pin 2)	0.6 ohms per 10 m cable 8 ohms maximum	Proportionate to cable length
2	White (pin 3)	Yellow (pin 4)		
3	Brown+Green (pins 1+2)	White+Yellow (pins 3+4)	10 K (kohms) minimum or 2 V minimum	Ohms test range or Diode test range
4	White (pin 3)	Brown (pin 1)	0.7 V typical	Diode test range (note)
5	Yellow (pin 4)	Green (pin 2)		
6	White+Yellow (pins 3+4)	Brown+Green (pins 1+2)		

Note: the 450m 3 GHz radio includes a reverse-polarity protection diode wired across the supply. Tests 4, 5 & 6 sense this diode and help to confirm the correct wiring.


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4 Direct DC power to 450m 5 GHz

The 450m 5 GHz radio is normally supplied by a PoE (Power over Ethernet) interface, using a power injector such as Cambium Networks AC+DC Enhanced Power Injector (EPI – C000065L002C) or the CMM5 (C000000L556B).

In certain circumstances it may be desirable to supply DC power to the 450m 5 GHz radio from a DC power supply (i.e. without a power injector), or over a longer cable with thicker conductors; this of course means that the PoE port becomes DC power only and Ethernet data must be wired to another interface, such as the SFP (Fibre) port.

To support this, the port should be wired as shown in Figure 4.

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(b) 4-core power cable, DC LPUs

This scheme permits a longer cable length because of the thicker, lower resistance wires in the 4-core power cable compared with CAT5e cable. At the top of the mast, use a short CAT5e cable wired to a 4-pin power connector as described for scheme (c) below, with a DC-LPU acting as a transition point between the 8-core and 4-core cables:

(c) DC LPUs, transition between 8-core CAT5e and 4-core power cables

This scheme is useful where the CMM5 is used to provide power and GPS synchronization, but a longer cable run is wanted. The usual CAT5e cable is replaced with a 4-core power cable, and DC-LPUs are once again used as transition points, this time at both the top and the bottom of the mast. Each wire pair in the 8-core CAT5e leads is terminated in one crimp terminal in the 4-pin power connector:

Wire pair	Ethernet pins	DC connector pin	Polarity
Orange	1, 2	3	Negative
Green	3, 6	2	Positive
Blue	4, 5	1	Positive
Brown	7, 8	4	Negative

It will be understood that the gain in cable length is maximized when the CAT5e “tail” at the bottom of the mast is as short as possible. The top “tail” *must* be short – 0.6 m maximum – for best lightning surge protection.

Example approximate maximum cable lengths for schemes (a), (b) and (c) are calculated in the table below. The cable length is determined by the minimum voltage at the radio (40 V) or the power supply rated current, whichever limit is met first.

Note: these figures are calculated for a 450m 5 GHz load of 80 W. Certain operating and test conditions may cause the power draw to exceed this for short periods. Prudent installation practice would allow for some margin by means of shorter cable lengths than those quoted below.

PSU	450m 5 GHz load	Cable resistance Ohms/100 m	PSU voltage	PSU current actual (max) *4	Cable length (total)
Scheme (a), CAT5e cable					
EPI	80 W	6.25	57 V *1	1.7 A (1.7 A)	93 m
as 450m 3 GHz	80 W	6.25	57 V *2	2.0 A (4.2 A)	136 m
CMM5 *5	80 W	6.25	54 V *3	1.73 A (1.73 A)	71 m
Scheme (b), 0.75 mm² 4-core cable					
EPI	80 W	3.1	57 V *1	1.7 A (1.7 A)	188 m
as 450m 3 GHz	80 W	3.1	57 V *2	2.0 A (4.2 A)	274 m
Scheme (c), 0.75 mm² 4-core cable					
CMM5	80 W	3.1	54 V *3	1.73 A (1.73 A)	144 m


Note 1: the EPI is rated at 58 V, 1.7 A (100 W). The output voltage may be slightly lower at full load.

Note 2: for a DC power supply adjusted up to 57 V per section 3.3

Note 3: for the CMM5, rated 55 V, 1.73 A (95 W), but typically 54 V on load.

Note 4: this is the current drawn from the power supply, with its rating included in parenthesis for comparison.

Note 5: this line provided for comparison, wired with CAT5e and RJ45 plugs throughout.

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5 Appendices

5.1 Cable calculations

Installers wishing to calculate cable lengths for other cables and situations may use the following guidance.

Minimum voltage at DC PSU	56 V
Minimum voltage at 450m 3 GHz radio	40 V
Peak current draw of 450m 3 GHz radio	4.0 A
Additional current required by Auxiliary PoE load	0.6 A
Maximum cable resistance, no PoE	$(56\text{ V} - 40\text{ V})/4.0\text{ A} = 4.0\text{ ohms}$
Maximum cable resistance, with PoE	$(56\text{ V} - 40\text{ V})/4.6\text{ A} = 3.5\text{ ohms}$

When calculating the cable length, remember:

- (i) Cable manufacturer's specifications normally quote the resistance at 20°C. You should allow for up to 16% increase in resistance at higher temperatures (0.4% per °C). The cable lengths in section 2.1 include this allowance, plus a margin for cable and radio variations to ensure reliable operation.
- (ii) The resistances are quoted per core. Use the same figure for the 4-wire loop resistance, because there are 2 cables in parallel for each polarity (half the resistance), and the loop has a "go" and a "return" path (double the resistance): the halving and doubling cancel each other out.


Thus for example, the recommended cables from Lapp are specified and calculated as below:

Cable	Manufacturer's specification	Add 16% for temperature	Add margin – use this figure
Lapp 1032126, 0.75 mm ²	2.60 ohms/100 m at 20°C	3.02 ohms/100 m at 60°C	3.10 ohms/100 m
Lapp 1032131, 1.00 mm ²	1.95 ohms/100 m at 20°C	2.26 ohms/100 m at 60°C	2.32 ohms/100 m

5.2 Power supplies and isolation

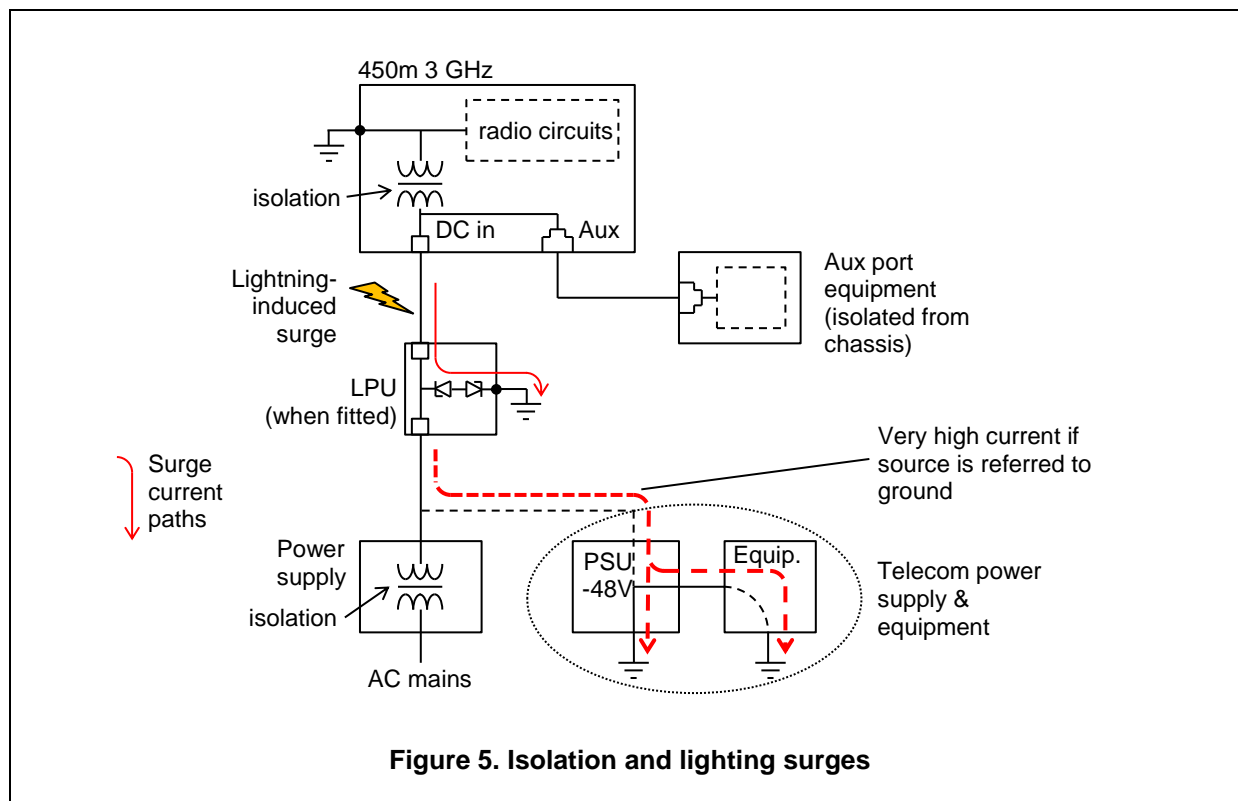
The power input to 450m 3 GHz and 5 GHz and the recommended AC mains power supply are isolated from their chassis. This means that in many cases, moderate voltage surges on the DC cable from lightning (for example) have no path to ground, and no harmful current can flow. There are however precautions to consider:

1. High voltage surges can exceed the breakdown voltage of the 450m and the AC mains power supply. Lightning protection units (LPU or 1000SS) are recommended: these will shunt high voltage surges to ground, whilst the isolated circuits continue to prevent harmful current flow in the radio and power supply.
2. If a ground-referenced DC supply is wired directly to the DC cable – for example, a telecom -48 V DC supply – then the installer must be aware that surge currents in the cable will flow into the supply ground. The power system and other components connected to it must be specified for and tolerant of such surges. Note that lightning protection units are of only partial help in this case, since surge currents will preferentially take the easiest path to earth, and the earthed DC supply is likely to be of a lower impedance than the LPU.
3. The 450m Auxiliary port has a PoE (Power over Ethernet) output that is part of the same power domain as the radio's DC input and is wired directly to it. Thus surge currents on the DC input cable will be conducted directly to any equipment connected to the Aux port (and vice-versa). Devices that conform to the IEEE 802.3 Ethernet standards have isolation

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between their wired ports and chassis, so moderate surge voltages appearing at the Aux port will then have no path to ground.

The architecture is illustrated in Figure 5, and shows the isolation barriers and potential surge current paths.



Document Revision History

Revision	Author	Change
000v001	Alex Kidger	First draft
000v002	Alex Kidger	Further information added; revised cable calculations; added section 4 and appendix 5.2.