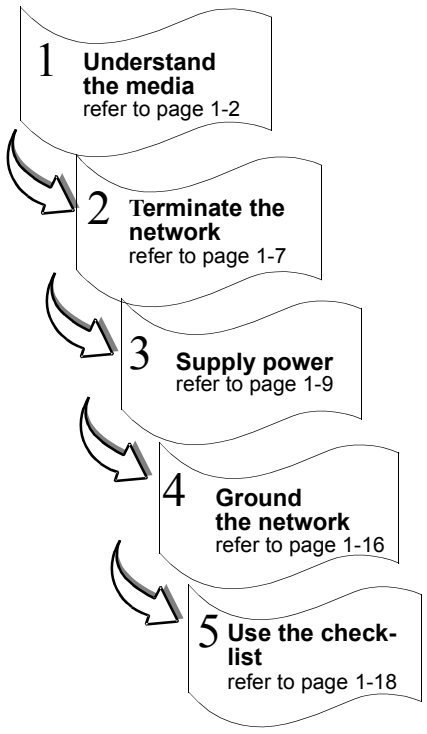
Get Started

What's in This Chapter?

This chapter introduces the DeviceNet cable system and provides a brief overview of how to set up a DeviceNet network efficiently. The steps in this chapter describe the basic tasks involved in setting up a network.

Set Up a DeviceNet Network

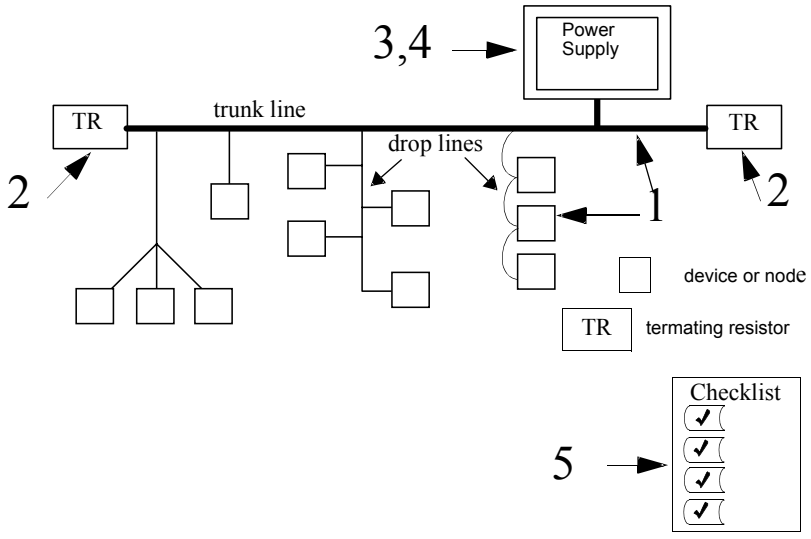
The following diagram illustrates the steps that you should follow to plan and install a DeviceNet network. The remainder of this chapter provides an overview and examples of each step, with references to other sections in this manual for more details.



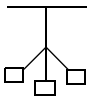
1 Understand the media	Refer to page 1-2
2 Terminate the network	Refer to page 1-7
3 Supply power	Refer to page 1-9
4 Ground the network	Refer to page 1-16
5 Use the checklist	Refer to page 1-18

Basic DeviceNet Network

This figure shows a basic DeviceNet network and calls out its basic components.



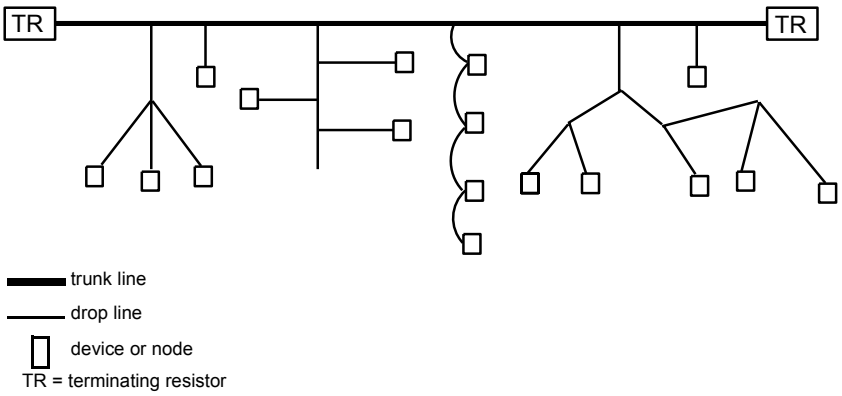
1 Understand the media



You must terminate the trunk line at both ends with 121 Ohms, 1%, 1/4W terminating resistors.

Understand the Topology

The DeviceNet cable system uses a trunk/drop line topology.



Use only DeviceNet media that meet or exceed ODVA specifications.

Understand the Cable Options

You can connect components using five cable options:

Use this cable	For
Round (thick)	The trunk line on the DeviceNet network with a nominal outside diameter of 12.2 mm (0.48 in.). You can also use this cable for drop lines.
Round (mid)	The trunk line on the Devicenet network where smaller cable diameters and smaller bend radii are required. Its outside diameter is specified by the vendor. This cable can also be used for drop lines.
Round (thin)	The drop line connecting devices to the main line with an outside diameter of 6.9 mm (0.27 in.). This cable has a smaller diameter and is more flexible than thick cable. You can also use this cable for the trunk line.
Flat	The trunk line on the DeviceNet network, with dimensions of 19.3 mm x 5.3 mm (0.76 in. x 0.21 in.). This cable has no predetermined cord lengths, and you are free to put connections wherever you need them.
Unshielded drop cable	This is a non-shielded, 4 conductor, drop cable for use only in flat cable systems, with an outside diameter specified by the vendor.

NOTE: These generic cable types are available in a variety of different offerings such as FLEX, HAZ-DUTY, CLASS I (600V), UV RESISTANT, etc.

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

- All DeviceNet Cabling components selected shall be suitable for the environment in which they are installed and in particular; corrosion resistance, IP rating and Ultra Violet stabilization.

  Note: DeviceNet cables are available in a variety of different types including; High flexibility, Hazardous duty, Class 1 - 600 Volt, UV resistant.

  Consideration must also be given to environmental protection of cable components when individual nodes are removed for maintenance and for testing.

- Excessive bending of DeviceNet cables can reduce their ability to meet the DeviceNet specification. Standard Thick cables shall have a bending radius of greater than 3" (75mm). Standard Thin cables shall have a bending radius of greater than 2" (50mm).

- Round shielded cable (thick, mid and thin) contains five wires: One twisted pair (red and black) for 24V dc power; one twisted pair (blue and white) for signal, and a drain wire (bare).

  Flat cable contains four wires: One pair (red and black) for 24 dc power; one pair (blue and white) for signal.

  Unshielded 4-wire drop cable is only designed for use with flat cable systems.

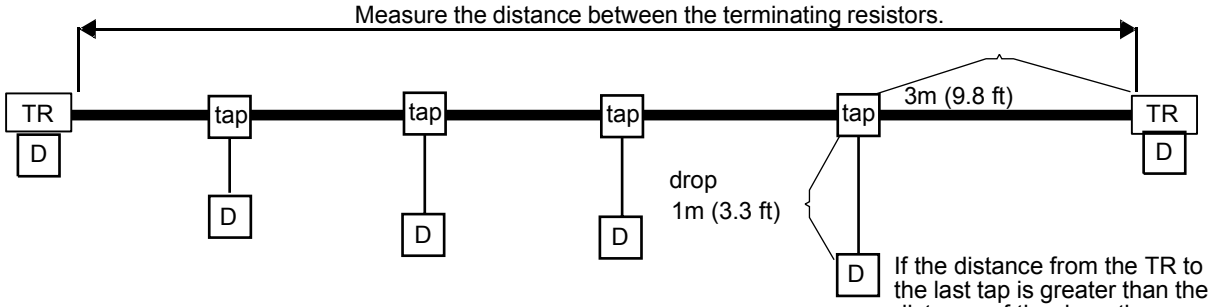
The maximum cable distance is not necessarily the trunk length only. It is the maximum distance between any two devices.

Determine the Maximum Trunk Line Distance

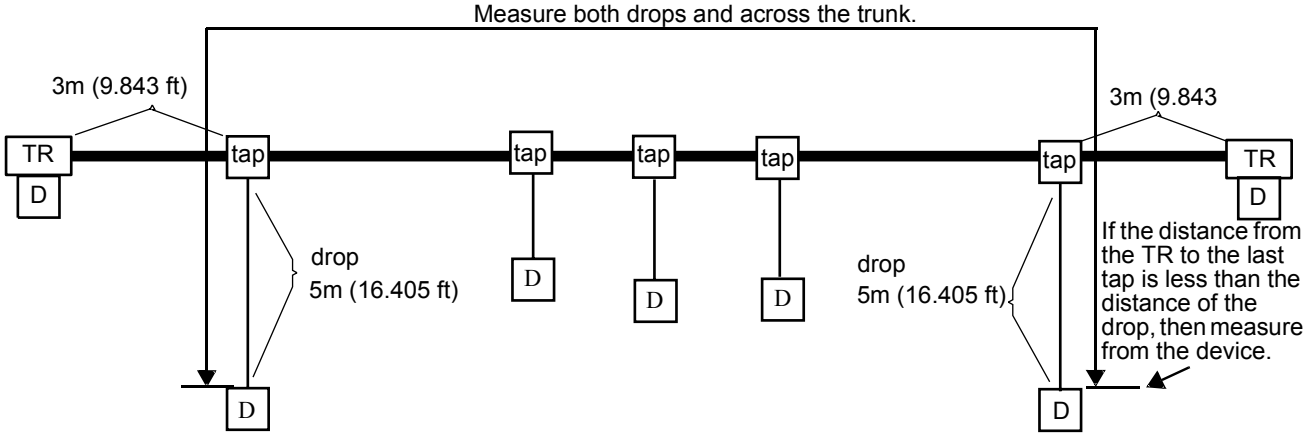
The diatnace between any two points must not exceed the maximum cable distance allowed for the data rate used.

Data rate	Maximum distance (flat cable)	Maximum distance (thick cable)	Maximum distance (mid cable)	Maximum distance (thin cable)
125k bit/s	420m (1378 ft)	500m (1640 ft)	300m (984 ft)	100m (328 ft)
250k bit/s	200m (656 ft)	250m (820 ft)	250m (820 ft)	100m (328 ft)
500k bit/s	75m (246 ft)	100m (328 ft)	100m (328 ft)	100m (328 ft)

For most cases, the maximum distance should be the measurement between terminating resistors. However, if the distance from a trunk line tap to the farthest device connected to the trunk line is greater than the distance from the tap to the nearest terminating resistor (TR), then you must include the drop line length as part of the cable length.



Always use the longest distance between any 2 nodes of the network.



Determine the Cumulative Drop Line Length

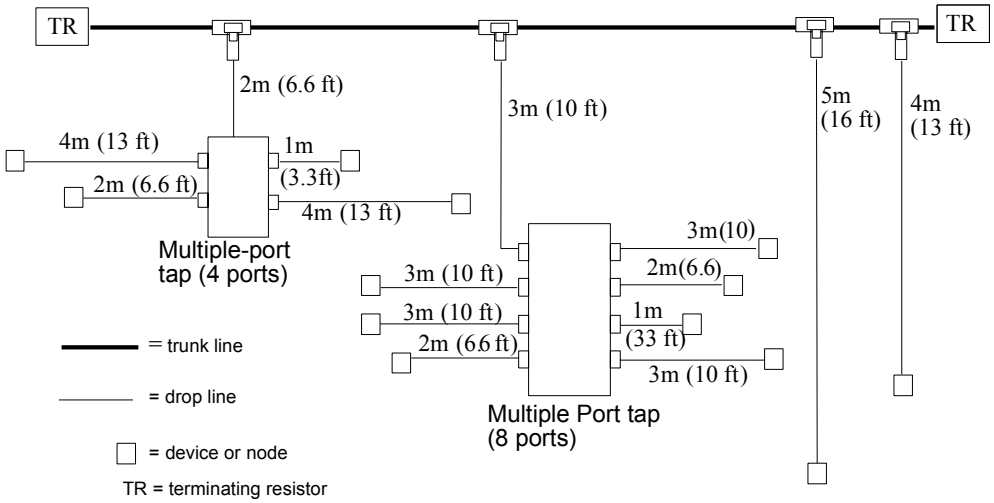
The data rate you choose determines the maximum trunk line and the cumulative drop line lengths.

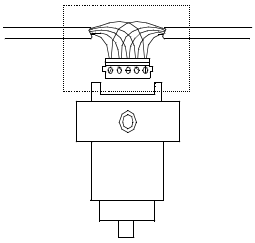
The cumulative drop line length refers to the sum of all drop lines, thick, thin, or mid cable, in the cable system. This sum cannot exceed the maximum cumulative length allowed for the data rate used.

Data rate	Cumulative drop line length
125k bit/s	156m (512 ft)
250k bit/s	78m (256 ft)
500k bit/s	39m (128 ft)

The maximum cable distance from any device on a branching drop line to the trunk line is 6m (20 ft).

The following example uses four T-Port (single-port) taps and two multi-port taps to attach 13 devices to the trunk line. The cumulative drop line length is 42m (139 ft) and no single node is more than 6m (20 ft) from the trunk line. This allows you to use a data rate of 250k bit/s or 125k bit/s. A data rate of 500k bit/s cannot be used in this example because the cumulative drop line length (42m) exceeds the total allowed (39m) for that data rate.



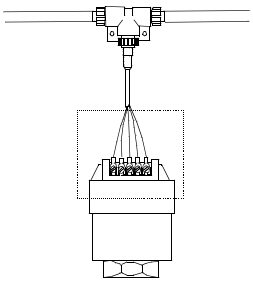


device with removable open-style connector

About the Direct Connection

Connect devices directly to the trunk line only if you can later remove the devices without disturbing communications on the cable system. This is called a “zero-length” drop, because it adds nothing (zero) when calculating cumulative drop line length.

Important: If a device provides only fixed-terminal blocks for its connection, you must connect it to the cable system by a drop line. Doing this allows you to remove the device at the tap without disturbing communications on the trunk line of the cable system.



device with fixed open-style connector

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

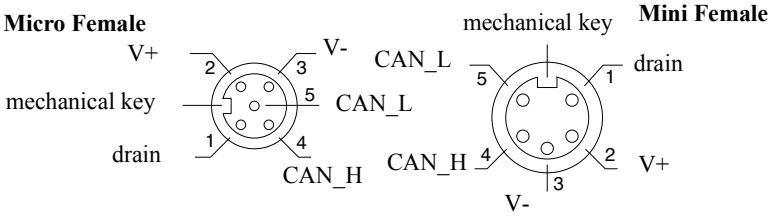
Using Connectors

Connectors attach cables to devices or other components of the DeviceNet cable system. Field-installable connections are made with either sealed or open connectors.

Connector	Description
Sealed	Mini-style: Attaches to taps and thick, thin, and mid cable. Micro-style: Attaches to thin cable only - has a reduced current rating.
Open	Plug-in: Cable wires attach to a removable connector. Fixed: Cable wires attach directly to non-removable screw terminals (or equivalent) on device.

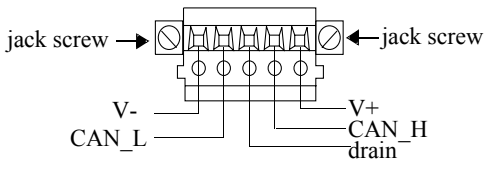
Micro/Mini field-installable quick-disconnect (sealed) connectors (round media only).

Screw terminals connect the cable to the connector.

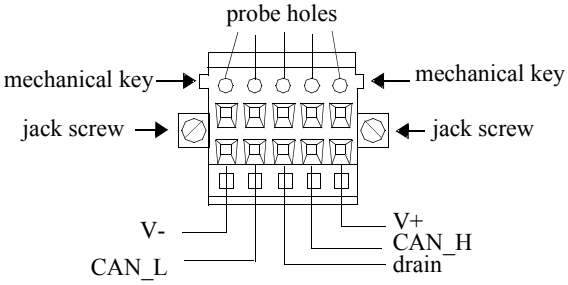


Plug-in field-installable (open) connectors

Most open-style devices ship with an open-style connector included.



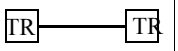
5-pin linear plug



10-pin linear plug

See Chapter 3 for information about making cable connections

2 Terminate the network



The terminating resistor reduces reflections of the communication signals on the network. Choose your resistor based on the type of cable (round or flat) and connector (open or sealed) you use:

- For round cable:
  - the resistor may be sealed when the end node uses a sealed T-port tap
  - the resistor may be open when the end node uses an open-style tap
- For flat cable:
  - the resistor is a snap-on cap for the flat cable connector base, available in sealed and unsealed versions

To verify the resistor connection, disconnect power and measure the resistance across the Can_H and Can_L lines (blue and white wires, respectively). This reading should be approximately 50-60 ohms.

Do not put a terminating resistor on a node with a non-removable connector. If you do so, you risk network failure if you remove the node. You must put the resistor at the end of the trunk line.

You must attach a terminating resistor equal to 121 ohms, 1%, 1/4W or greater wattage, to each end of the trunk cable. You must connect these resistors directly across the blue and white wires of the DeviceNet cable.

ATTENTION: If you do not use terminating resistors as described, the DeviceNet cable system will **not** operate properly.

The following terminating resistors provide connection to taps and the trunk line.

- sealed-style terminating resistors

Male or female connections attach to:

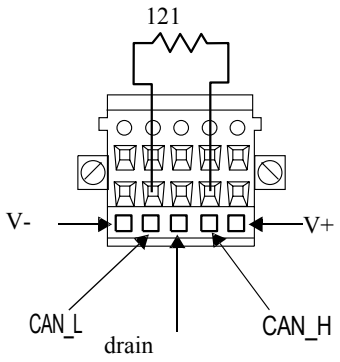
- trunk line ends
- T-Port taps

- open-style terminating resistors

121 ohms, 1%, 1/4W or greater wattage resistors connecting the white and blue conductors attach to:

- open-style T-Port taps
- trunk lines using terminator blocks

Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power



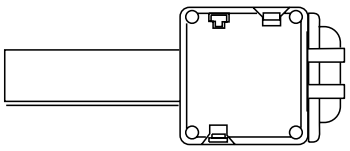
- Flat cable terminating resistors

The 121 ohm resistor is contained in the snap-on interface module:

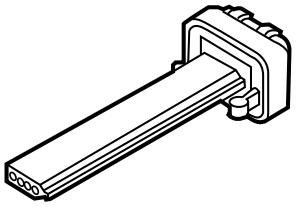
– sealed terminator with an Insulation Displacement Connector (IDC) base (NEMA 6P, 13; IP67)

– unsealed terminator with IDC base (no gaskets) (NEMA 1; IP60)

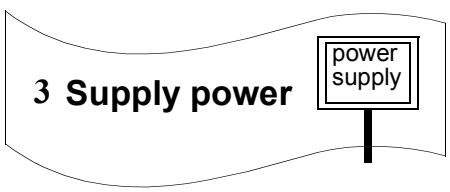
Network end caps should be included with each flat cable terminator; see Page 3-12 for complete installation instructions.



terminating resistor with end cap



end cap



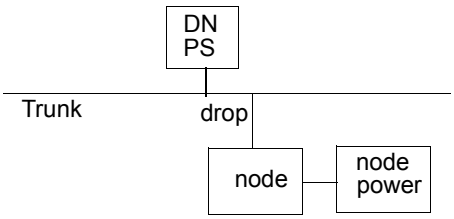
Guidelines for Supplying Power

The cable system requires the power supply to have a rise time of less than 250 milliseconds to within 5% of its rated output voltage. You should verify the following:

- the power supply has its own current limit protection
- fuse protection is provided for each segment of the cable system

  - any section leading away from a power supply must have protection
- the power supply is sized correctly to provide each device with its required power
- derate the supply for temperature using the manufacturer's guidelines

Use the power supply to power the DeviceNet cable system only. If a device requires a separate 24V power source other than the DeviceNet power source, you should use an additional 24V power source.



Important: For class 2 cables, your national and local codes may not permit the full use of the power system capacity when installed as building wire. For example, **in the United States and Canada, the power supplies that you use with class 2 cable must be Class 2 listed per the NEC and CECode.** The total current allowable in any section of class 2 cable must not exceed 4A (100VA). Assume that a cable is class 2 unless the vendor describes it as class 1.

Class 1 power supplies allow for an 8A system, and the use of Class 1 flat cable. See Appendix A for more information about national and local codes.

▶ Appendix B - Powering Output Devices provides valuable information to the installer.

Choosing a Power Supply

The total of all of the following factors must not exceed 3.25% of the nominal 24V needed for a DeviceNet cable system.

- initial power supply setting - 1.00%
- line regulation - 0.30%
- temperature drift - 0.60% (total)
- time drift - 1.05%
- load regulation - 0.30%

Use a power supply that has current limit protection as per national codes such as NEC, Article 725.

Important: The dc output of all supplies must be isolated from the ac side of the power supply and the power supply case.

If you use a single power supply, add the current requirements of all devices drawing power from the network. This is the minimum name-plate current rating that the power supply should have. For proper operation of your network, we recommend that you use a power supply that complies with the Open DeviceNet Vendor Association (ODVA) power supply specifications and NEC/CECode Class 2 characteristics (if applicable).

To determine the required power supply current:

1. Add the current requirements of all devices drawing power from the network.
   For example: 6.3A
2. Add an additional 10% to this total to allow for current surge.
   e.g. 6.3A x 10% = 6.93A
3. Make sure the total of 2 is less than the minimum name-plate current of the power supply you are using. e.g. 6.3A < 8A and NEC/CECode

About Power Ratings

Although the round thick cable and Class 1 flat cable are both rated to 8A, the cable system can support a total load of more than 8A. For example, a 16A power supply located somewhere in the middle of the cable system can supply 8A to both sides of the power tap. It can handle very large loads as long as no more than 8A is drawn through any single segment of the trunk line. However, cable resistance may limit your application to less than 8A.

Drop lines, thick, mid or thin, are rated to a maximum of 3A, depending on length. The maximum current decreases as the drop line length increases.

Drop line length	Allowable Current
1.5m (5 ft)	3A
2m (6.6 ft)	2A
3m (10 ft)	1.5A
4.5m (15 ft)	1A
6m (20 ft)	0.75A

You may also determine the maximum current in amps (I) by using:

I = 15/L, where L is the drop line length in feet

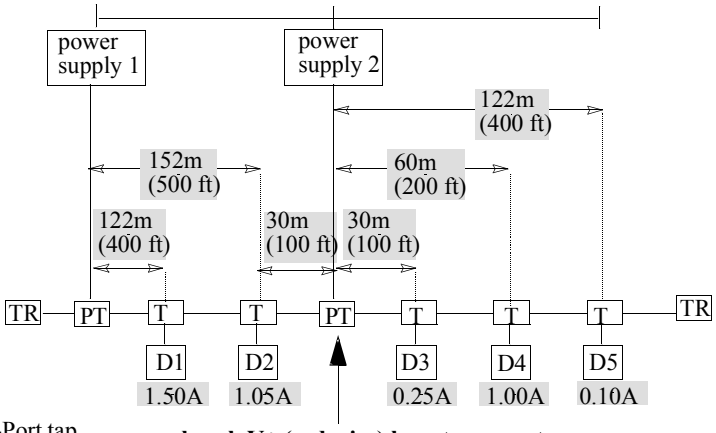
I = 4.57/L, where L is the drop line length in meters

The maximum allowable current applies to the sum of currents for all nodes on the drop line. As shown in the example on page Page 1-3, the drop line length refers to the maximum cable distance from any node to the trunk line, not the cumulative drop line length.

- The maximum allowable current may also be limited by high maximum common mode voltage drop on the V- and V+ conductors
  - the voltage difference between any two points on the V- conductor must not exceed the maximum common mode voltage of 4.65V
- voltage range between V- and V+ at each node within 11 to 25V

Sizing a Power Supply

Follow the example below to help determine the minimum continuous current rating of a power supply servicing a common section.



TR = terminating resistor T = T-Port tap
PT = power tap D = device

Power Supply 1

Add each device's (D1, D2) DeviceNet current draw together for power supply 1 (**1.50+1.05=2.55A**).

Results ⇨ 2.55A is the minimum name-plate current rating that power supply 1 should have. Remember to consider any temperature or environmental derating recommended by the manufacturer.

Important: This derating factor typically does not apply when you consider the maximum short circuit current allowed by the national and local codes.

Power Supply 2

Add each device's (D3, D4, D5) current together for power supply 2 (**0.25+1.00+0.10=1.35A**).

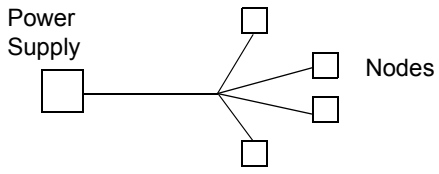
Results ⇨ 1.35A is the minimum name-plate current rating that power supply 2 should have. Remember to consider any temperature or environmental derating recommended by the manufacturer.

Placing the Power Supply

DeviceNet networks with long trunk lines or with devices on them that draw large currents at a long distance sometimes experience difficulty with common mode voltage. If the voltage on the black V- conductor differs by more than 4.65 volts within the trunk line from one point on the network to another, communication problems can occur. Note: There is 0.35 volts reserved for the drop line. Moreover, if the voltage between the black V- conductor and the red V+ conductor ever falls below 15 volts, then common mode voltage could adversely affect network communication. To work around these difficulties, add an additional power supply or move an existing power supply closer to the heavier current loads.

To determine if you have adequate power for the devices in your cable system, use the look-up method which we describe more fully in Chapter 4. See the following example and figure (other examples follow in Chapter 4). You have enough power if the total load does not exceed the value shown by the curve or the table.

In a worst-case scenario, all of the nodes are together at one end of the cable and the power supply is at the opposite end, so all current flows over the longest distance.

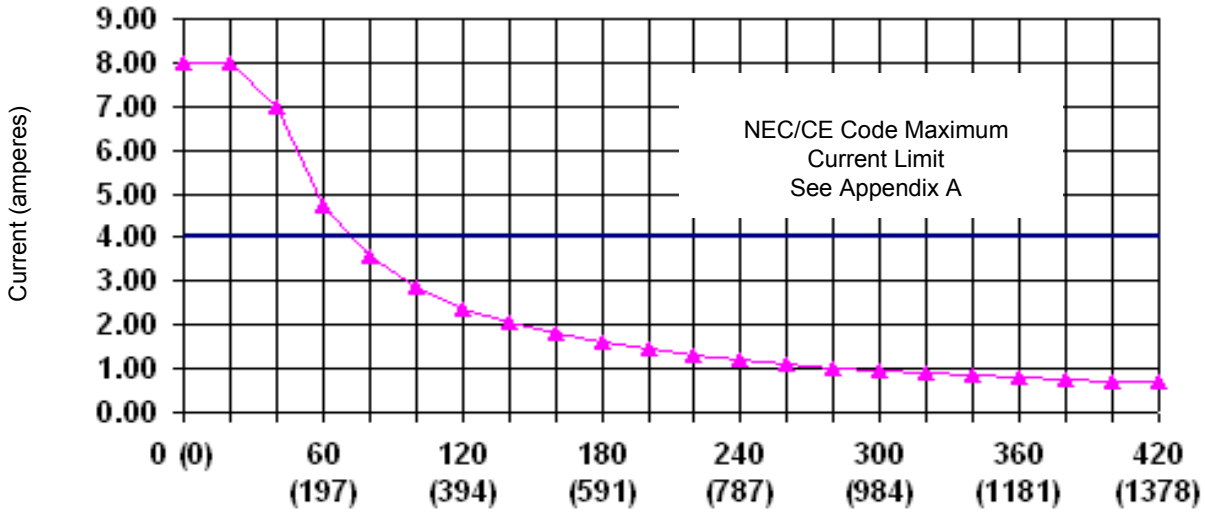


Important: This method may underestimate the capacity of your network by as much as 4 to 1. See Chapter 4 to use the full-calculation method if your supply does not fit under the curve.

A sample curve (reprinted from page 4-4) for a single, end-connected power supply is shown on the next page.

Figure 1.1 One Power Supply (End Segment) Flat Cable

Important: Assumes all nodes are at the opposite end of the cable from the power supply.

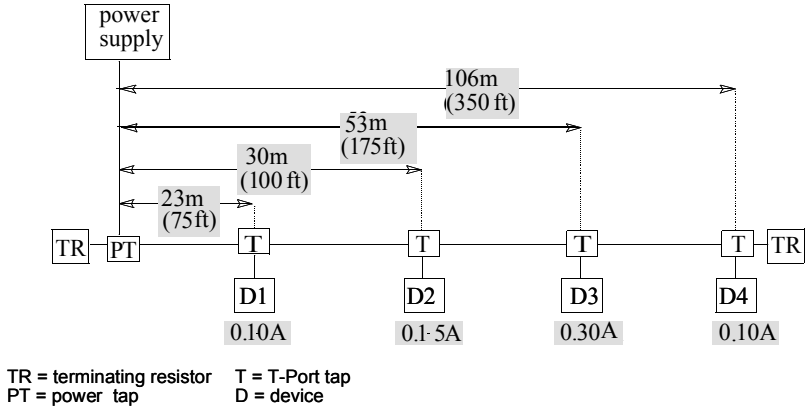


Network Length m (ft)	Maximum Current (A)
0 (0)	8.00*
20 (66)	8.00*
40 (131)	7.01*
60 (197)	4.72*
80 (262)	3.56
100 (328)	2.86
120 (394)	2.39
140 (459)	2.05
160 (525)	1.79
180 (591)	1.60
200 (656)	1.44

Network Length m (ft)	Maximum Current (A)
220 (722)	1.31
240 (787)	1.20
260 (853)	1.11
280 (919)	1.03
300 (984)	0.96
320 (1050)	0.90
340 (1115)	0.85
360 (1181)	0.80
380 (1247)	0.76
400 (1312)	0.72
420 (1378)	0.69

Exceeds NEC CL2/CECode 4A

The following example uses the look-up method to determine the configuration for one end-connected power supply. One end-connected power supply provides as much as 8A near the power supply.



1. Determine the total length of the network.

   – **106m**

2. Add each device's current together to find the total current consumption.

   – **0.10+0.15+0.30+0.10=0.65A**

Important: Make sure that the required power is less than the rating of the power supply. You may need to derate the supply if it is in an enclosure.

3. Find the next largest network length using the table on page 1-13 to determine the maximum current allowed for the system (approximately).

   – **120m (2.47A)**

Results ⇨ Since the total current does not exceed the maximum allowable current, the system will operate properly (0.65A is less than 2.47A).

Important: If your application doesn't fit "under the curve," you may either:

- Do the full-calculation method described in Chapter 4.
- Move the power supply to somewhere in the middle of the cable system and reevaluate per the previous section.

Connecting Power Supplies

To supply power you will need to install and ground the power supplies. To install a power supply:

Important: Make sure the ac power source remains off during installation.

1. Mount the power supply securely allowing for proper ventilation, connection to the ac power source, and protection from environmental conditions according to the specifications for the supply.

2. Connect the power supply using:

   – a cable that has one pair of 12 AWG (4 mm^2)* conductors or the equivalent or two pairs of 15 AWG (2.5mm^2) conductors

   – a maximum cable length of 3m (10 ft) to the power tap

   – the manufacturer's recommendations for connecting the cable to the supply

*** NOTE:** Metric wire sizes are for reference only - you should select a wire size big enough for the maximum possible current.

4 Ground the Network

You must ground the DeviceNet network at only one location. Follow the guidelines described below.

ATTENTION: To prevent ground loops,

- **For Shielded Round media** - Ground the V- conductor, shield, and drain wire at **only one** place.
- **For Flat media** - Ground the V- conductor at **only one** place.

Do this at the power supply connection that is closest to the physical center of the network to maximize the performance and minimize the effect of outside noise.

Make this grounding connection using a 1 in (25mm) copper braid or a #8 AWG (10mm^2) wire up to a maximum 3m (10 ft) in length. Where greater than 3M (10 ft) must be used due to installation constraints, adequate sized grounding cable shall be utilized to ensure effective grounding takes place and provides a low impedance path from the shield to ground for optimal shield performance.

If you use more than one power supply, the V- conductor of **only one** power supply should be attached to an earth ground.

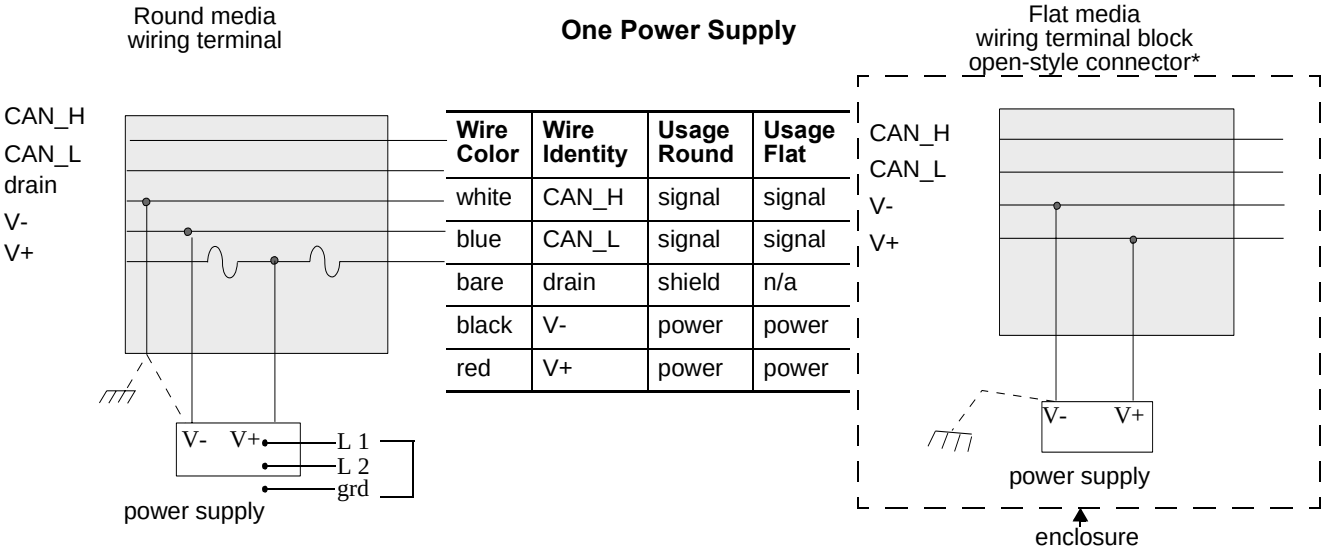
If you connect multiple power supplies, V+ should be broken between the power supplies. Each power supply's chassis should be connected to the common earth ground. Verify that V- is isolated from the Power supply chassis.

To ground the network:

- Connect the network shield and drain wire to an good earth or building ground (such as an 8 foot stake driven into the ground, attached to building iron or the cold water plumbing) using a 25 mm (1 in.) copper braid or a #8 AWG (10 mm^2) wire up to 3m (10 ft) maximum in length.
- Use the same ground for the V- conductor of the cable system and the chassis ground of the power supply. Do this at the power supply.

Important: For a non-isolated device, be certain that additional network grounding does not occur when you mount the device or make external connections to it. Check the device manufacturer's instructions carefully for grounding information.

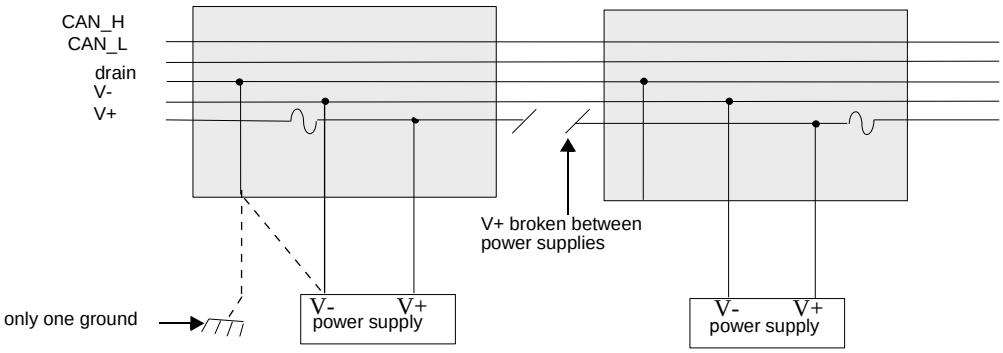
One Power Supply



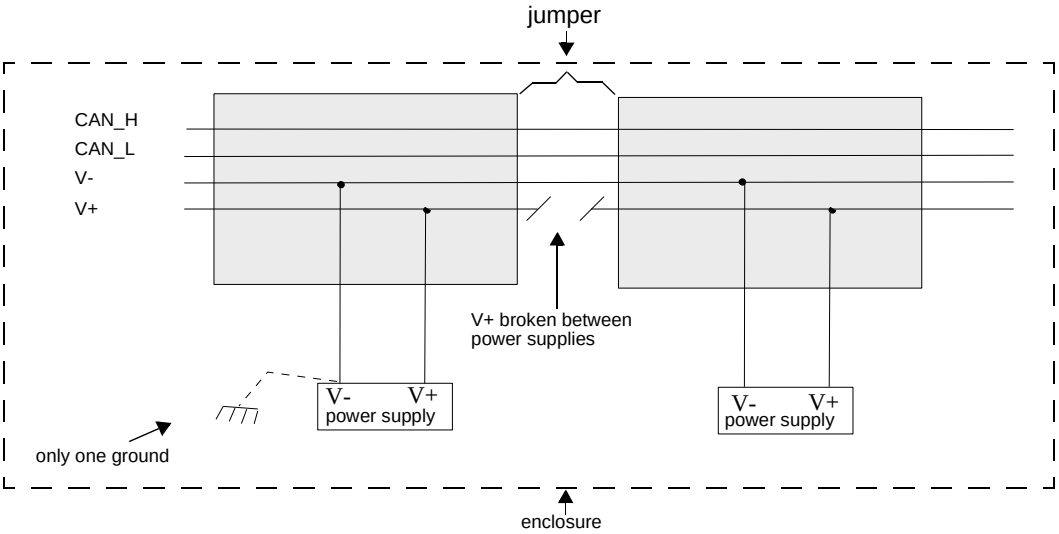
Wire Color	Wire Identity	Usage Round	Usage Flat
white	CAN_H	signal	signal
blue	CAN_L	signal	signal
bare	drain	shield	n/a
black	V-	power	power
red	V+	power	power

*A micro style connector may be used for power supply connections requiring less than 3A. Use a mini or open-style connectors for up to 8A.

Two or more Power Supplies for Round Media



Two or more Power Supplies for Flat Media



5 Use the checklist

Use this checklist when you install the DeviceNet network. You should complete this checklist prior to applying power to your network.

- ❑ Total device network current draw does not exceed power supply current limit.
- ❑ Common mode voltage drop does not exceed limit (as defined in Section 3, Chapter 1).
- ❑ Number of DeviceNet nodes does not exceed 64 on one network. The practical limit on DeviceNet nodes may be 61 slave nodes since you should allow one node each for the scanner, the computer interface module, and an open node at node 63.*
- ❑ No single drop over 6m (20 ft).
- ❑ Cumulative drop line budget does not exceed network baud rate limit.
- ❑ Total network trunk length does not exceed the maximum allowable per the network data rate and cable type.
- ❑ Terminating resistors are on each end of the trunk line and are proper.
- ❑ Ground, at only one location, preferably in the center of the network
  - – V- for flat media
  - – V- drain and shield for round media
- ❑ All connections are inspected for loose wires or coupling nuts.
- ❑ Check for opens and shorts.

Important: * Devices default to node 63. Leave node 63 open to avoid duplicate node addresses when adding devices. Change the default node address after installation.