

## Appendix B – Application Note

### Interfacing J1939 Engines and/or Gensets to an NMEA 2000® Network Using Maretron's J1939 to NMEA 2000® Gateway (J2K100)

**Warning:** *Improper installation of the Maretron J2K100 may prevent existing engine accessories (i.e., engine gauge displays, key switches, throttle and shift controls, etc.) from working properly. You must have an understanding of J1939 data networks before attempting to install the J2K100. Maretron strongly recommends that you understand SAE documents J1939-11 and J1939-15 (see Section 3.1 of this appendix) before attempting to install the J2K100 and that you consult the engine/genset manufacturer for their recommendations before connecting anything to the J1939 network.*

## **Table of Contents**

|     |  |     |
|-----|--|-----|
| 1   | Introduction .....   | B3  |
| 2   | NMEA 2000® Network Basics .....                              | B3  |
| 3   | J1939 Network Basics.....                                    | B4  |
| 3.1 | SAE J1939 Recommended Cabling and Connectors.....            | B5  |
| 4   | Determining J1939 Network Type .....                         | B5  |
| 4.1 | Single Engine/Genset, No J1939 Network Installation .....    | B5  |
| 4.2 | Single Engine/Genset, Single J1939 Network Installation..... | B7  |
| 4.3 | Two Engines/Gensets, No J1939 Network Installation.....      | B8  |
| 4.4 | Two Engines/Gensets, Single J1939 Network Installation ..... | B9  |
| 4.5 | Two Engines/Gensets, Dual J1939 Networks Installation .....  | B10 |

## **Table of Figures**

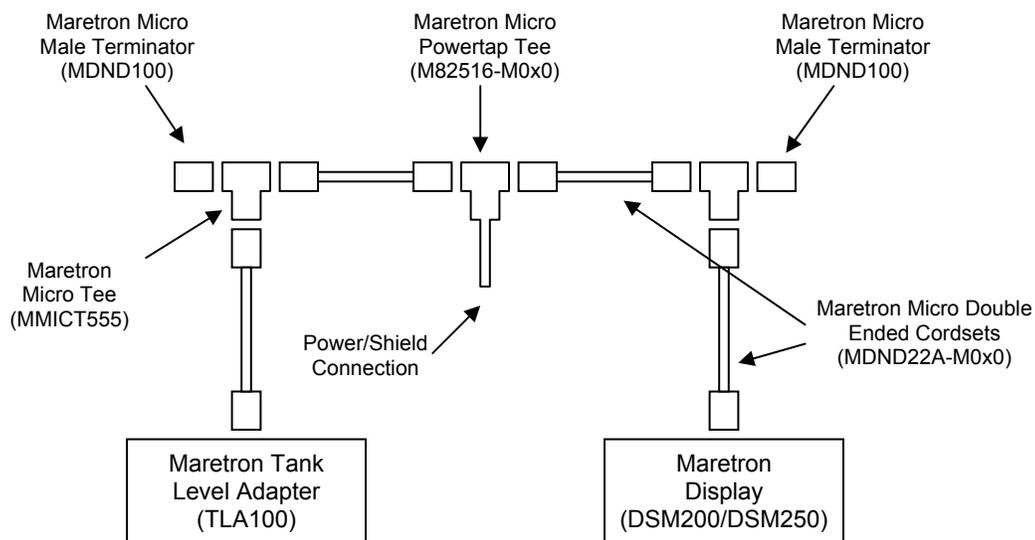
|          |  |     |
|----------|--|-----|
| Figure 1 | – Typical NMEA 2000® Network .....                                     | B3  |
| Figure 2 | – Typical Single Engine J1939 Network .....                            | B4  |
| Figure 3 | – Two Engine, Single J1939 Network.....                                | B4  |
| Figure 4 | – Two Engine, Dual J1939 Networks.....                                 | B5  |
| Figure 5 | – Single Engine/Genset, No J1939 Network Installation Diagram .....    | B6  |
| Figure 6 | – Single Engine/Genset, Single J1939 Network Installation Diagram..... | B7  |
| Figure 7 | – Two Engines/Gensets, No J1939 Network Installation Diagram.....      | B8  |
| Figure 8 | – Two Engines/Gensets, Single J1939 Network Installation Diagram ..... | B9  |
| Figure 9 | – Two Engines/Gensets, Dual J1939 Network Installation Diagram.....    | B10 |

## 1 Introduction

The Society of Automotive Engineers (SAE) has developed an electronic communication networking standard for the automotive industry called J1939, which is used on many larger diesels and some gasoline engines. Likewise, the National Marine Electronics Association (NMEA) has developed an electronic communication networking standard for the marine industry called NMEA 2000®, which is used for navigation information as well as other vessel data such as engine information. These two networks are now beginning to coincide more and more on vessels and Maretron has developed a gateway for bridging the two networks together via its J1939/NMEA 2000® gateway (J2K100). This application note provides a basic overview of the two networks and how the J2K100 is used to bridge engine and genset information from the J1939 network to an NMEA 2000® network.

## 2 NMEA 2000 Network Basics

An NMEA 2000® network consists of two or more nodes (electronic boxes) interconnected together using NMEA 2000® approved cable and connectors. A typical NMEA 2000® network is shown in Figure 1.

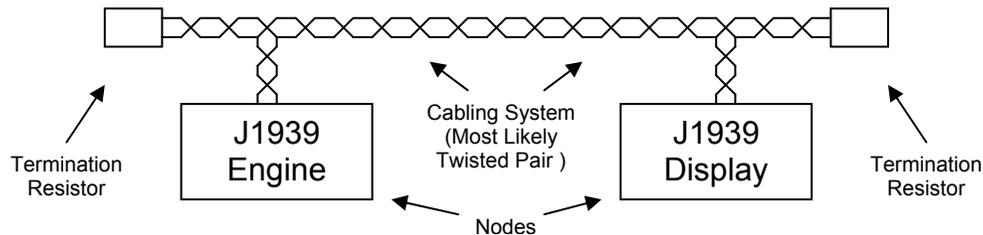


**Figure 1 – Typical NMEA 2000® Network**

The “trunk” or “backbone” (horizontal cable and connectors shown in Figure 1) usually runs stem to stern throughout the vessel with individual components connected as “drops” or “stubs” (vertical cable and connectors shown in Figure 1). NMEA 2000® networks can have as many as 50 drops throughout the vessel containing virtually any vessel information (engines, batteries, AC systems, tanks, rudder position, compass, GPS, depth, AIS data, etc.). Each end of the trunk or backbone is connected to a termination resistor (121Ω), which is used to terminate the line in its characteristic impedance to prevent reflections or ringing on the network. NMEA 2000® cables and connectors contain 5 conductors, two for power and ground (12Volts), two for data, and one for shielding.

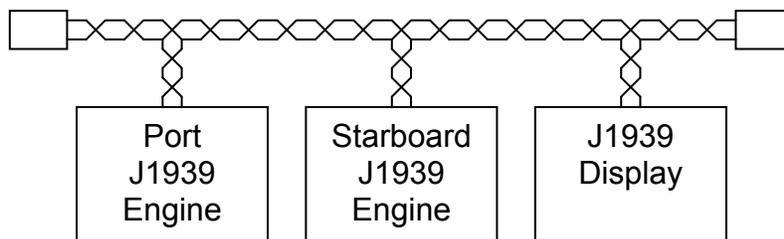
### **3 J1939 Network Basics**

Like an NMEA 2000<sup>®</sup> network, a J1939 network is based on Controller Area Network (CAN) technology. A CAN network consists of two or more nodes, and for J1939 networks, they usually include one or more engines and the corresponding engine displays. In addition to the nodes or electronic boxes, a CAN network consists of the cabling system, which is used to interconnect the nodes. At both ends of the network are terminating resistors (121Ω) that are used to terminate the line in its characteristic impedance to prevent reflections or ringing on the network. J1939 is typically wired using twisted pair for the two data lines. Figure 2 shows a typical J1939 network with a single engine and a single display.



**Figure 2 - Typical Single Engine J1939 Network**

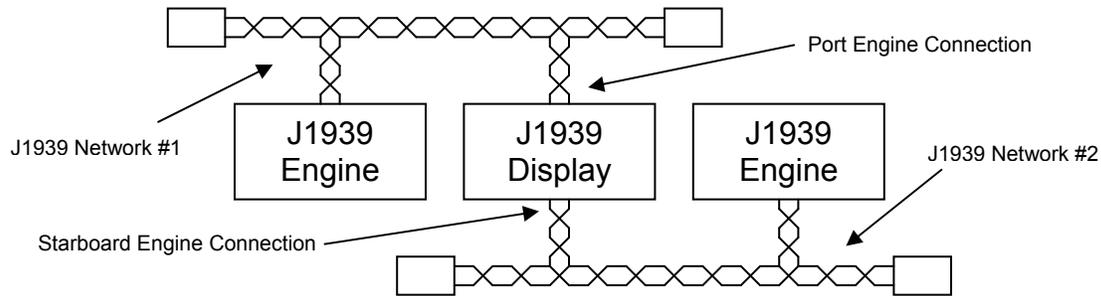
Another example showing a two engine, single J1939 network is given below in Figure 3.



**Figure 3 – Two Engine, Single J1939 Network**

The two engine, single J1939 network shown in Figure 3 requires the individual engines to use different source addresses so that the display can distinguish which data packets or messages are associated with which engine (J1939 and NMEA 2000<sup>®</sup> refer to the messages as Parameter Group Numbers or PGNs). Usually, but not always, the port engine is assigned to address 0 while the starboard engine is assigned to address 1 by the engine manufacturer.

Another example showing two engines with, dual J1939 networks is given below in Figure 4.



**Figure 4 – Two Engines, Dual J1939 Networks**

Unlike the single J1939 network shown in Figure 3, the dual J1939 network scheme shown in Figure 4 does not require the engines to have unique J1939 addresses. This is because the display can determine which messages or PGNs are from which engine by the physical connection on the display unit. In this scheme, each engine usually uses a source address of zero (0).

### 3.1 SAE J1939 Recommended Cabling and Connectors

Maretron highly recommends that you purchase and understand two documents published by SAE, which describe the recommended cables and connectors used for J1939 networks (approximately \$100). These documents (J1939-11 and J1939-15) provide important information for cabling and connectors used to interconnect the J2K100 with the J1939 network. You can find these documents at the following web page:

<http://www.sae.org/standardsdev/groundvehicle/j1939a.htm>

Deutsch Industrial Products Division is a supplier of J1939 connectors; their catalog can be found at the following link:

<http://www.deutschipd.com/cans.pdf>

## 4 Determining J1939 Network Type

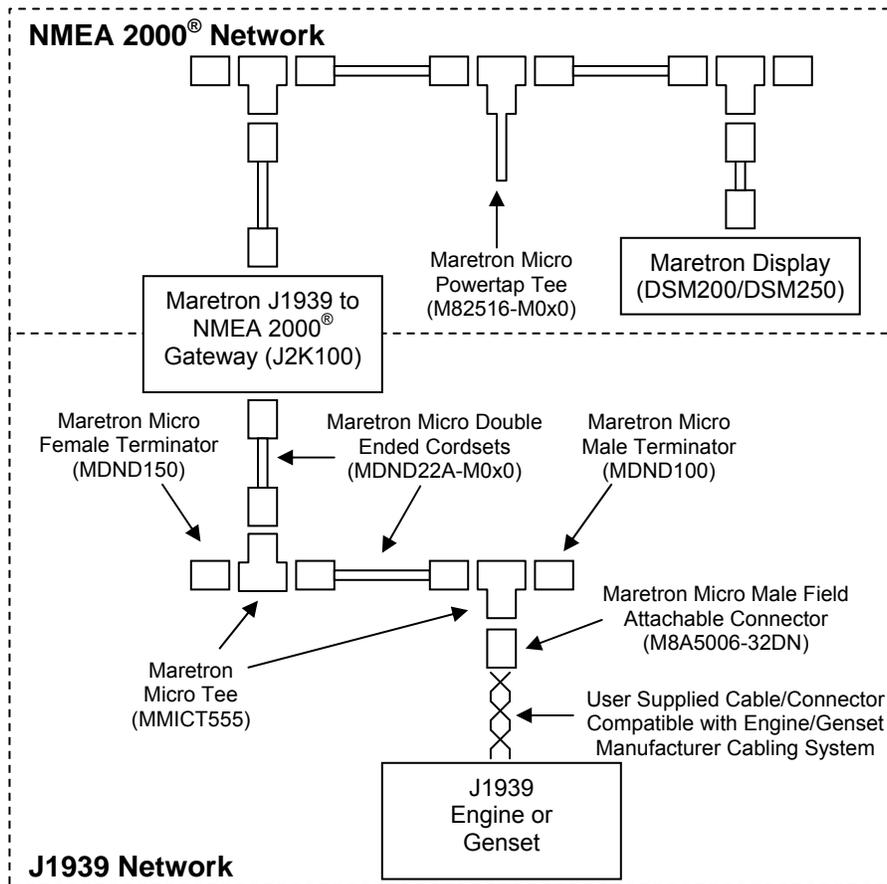
Before installing Maretron's J2K100, it is imperative to understand the type of J1939 network you are dealing with, which may be one of the following:

1. Single Engine/Genset, No Existing J1939 Network
2. Single Engine/Genset, Single J1939 Network (Figure 2)
3. Two Engines/Gensets, No Existing J1939 Network
4. Two Engines/Gensets, Single J1939 Network (Figure 3)
5. Two Engines/Gensets, Dual J1939 Networks (Figure 4)

### 4.1 Single Engine/Genset, No Existing J1939 Network Installation

Although an engine or genset may have a J1939 interface, a particular installation may not have an existing J1939 network because no other device is connected. In this case, it will be necessary to build a J1939 network to interconnect the engine/genset with the Maretron

J2K100 gateway, which can be done using NMEA 2000<sup>®</sup> cable and connectors. Figure 5 shows how to build a J1939 network using Maretron NMEA 2000<sup>®</sup> cable and connectors.



**Figure 5 – Single Engine/Genset, No J1939 Network Installation Diagram**

Although not required, this example mostly uses NMEA 2000<sup>®</sup> cable and connectors for the J1939 network. This is convenient because the network components are readily available and easily plugged together. Notice that there is no powertap in the J1939 network and this is because the J1939 engine/genset and J2K100 receive their power independent of the J1939 network. An alternative to building the J1939 network with NMEA 2000<sup>®</sup> approved cabling is to use SAE recommended cabling and connectors (see Section 3.1).

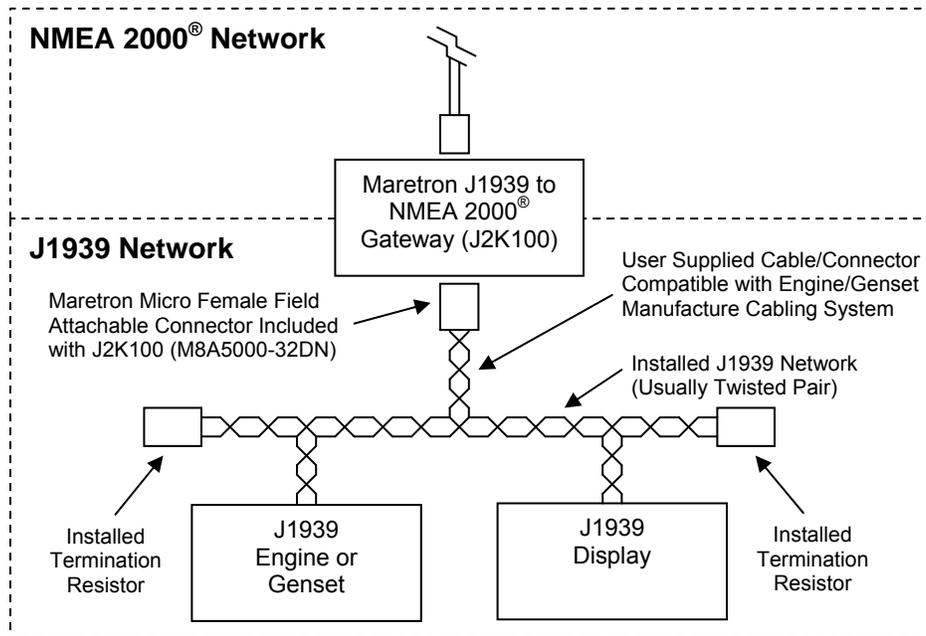
For illustration purposes, the J1939 network in Figure 5 shows the engine drop or stub (i.e., connection between engine/genset and the Maretron tee) as a two wire or twisted pair cable. The network wiring actually requires three wires: two CAN bus signals (usually designated CAN-H and CAN-L, usually yellow and green respectively), and a ground used as a reference (usually designated as CAN-SHLD). Refer to SAE J1939-11 and J1939-15 for recommended practices in connecting CAN-H, CAN-L, and CAN-SHLD.

After completing the physical connections, you will need to configure the J2K100 so it responds to the appropriate J1939 address. Most single engine installs have the J1939 address set to 0, but not always, so check with the engine manufacturer and use a Maretron NMEA 2000<sup>®</sup> display (DSM200/DSM250) to program the J2K100 with the corresponding

J1939 address. On the NMEA 2000® side, most single engine displays are looking for the NMEA 2000® instance to be set to 0. Again, you can use a Maretron display to program the appropriate NMEA 2000® instance. Refer to the *J2K100 User's Manual* (Section 2.5) for a description of configuring a J2K100.

## 4.2 Single Engine/Genset, Single J1939 Network Installation

Figure 6 shows a single engine/genset, single J1939 network installation diagram. This type of system already has a working J1939 network so there is no need to build the entire J1939 network as described in Section 4.1.



**Figure 6 – Single Engine/Genset, Single J1939 Network Installation Diagram**

This configuration requires an additional drop or stub from the J1939 trunk or backbone to the Maretron J2K100. You should follow the engine/genset manufacturer's instructions for adding the drop, which are generally specified to be 1 meter or less in length.

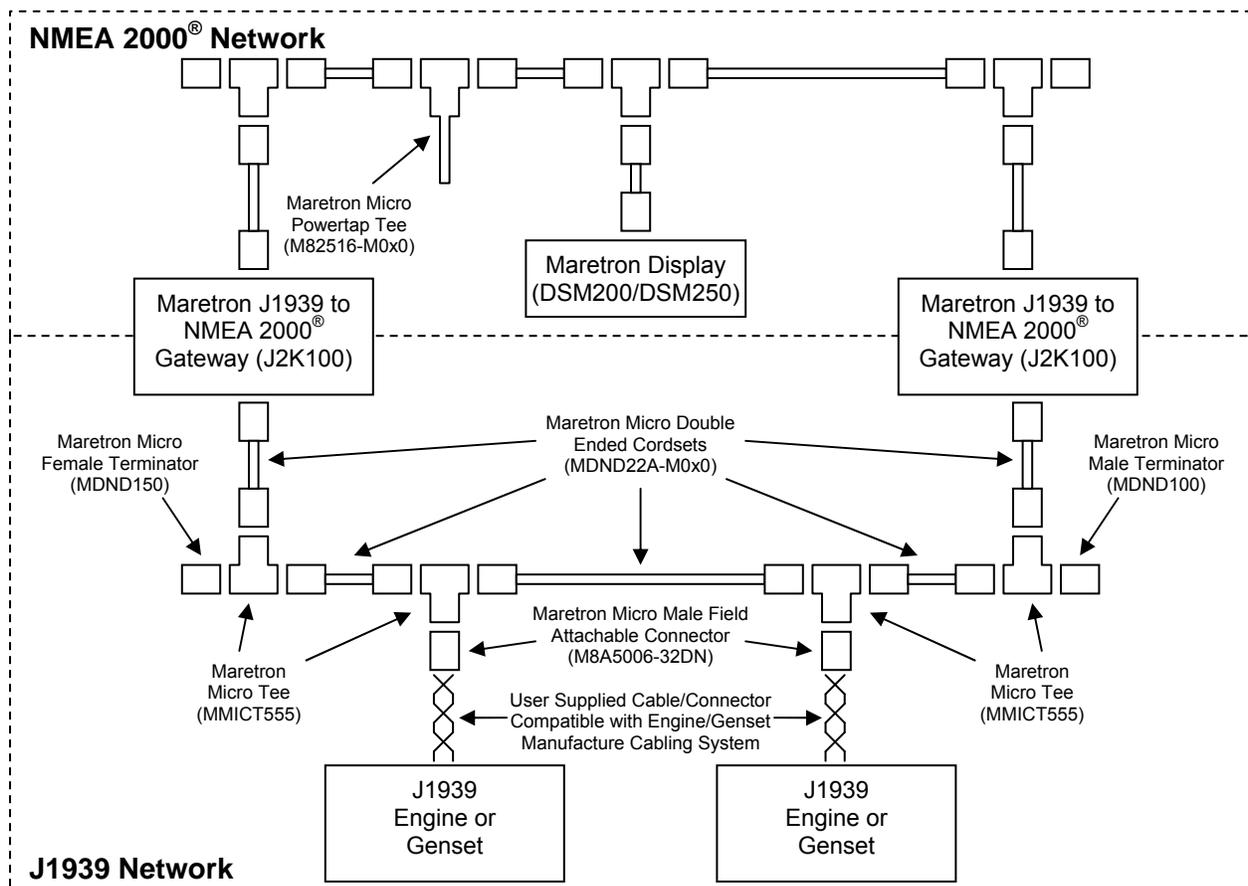
For illustration purposes, the J1939 network in Figure 6 shows the J2K100 drop or stub (i.e., connection between J1939 network and Maretron J2K100) as a two wire or twisted pair cable. The network wiring actually requires three wires: two CAN bus signals (usually designated CAN-H and CAN-L, usually yellow and green respectively), and a ground used as a reference (usually designated as CAN-SHLD). Refer to SAE J1939-11 and J1939-15 for recommended practices in connecting CAN-H, CAN-L, and CAN-SHLD.

After completing the physical connections, you will need to configure the J2K100 so it responds to the appropriate J1939 address. Most single engine installs have the J1939 address set to 0, but not always, so check with the engine manufacturer and use a Maretron NMEA 2000® display (DSM200/DSM250) to program the J2K100 with the corresponding J1939 address. On the NMEA 2000® side, most single engine displays are looking for the

NMEA 2000® instance to be set to 0. Again, you can use a Maretron display to program the appropriate NMEA 2000® instance. Refer to the *J2K100 User's Manual* (Section 2.5) for a detailed of configuring a J2K100.

## 4.3 Two Engines/Gensets, No Existing J1939 Network Installation

Although an engine or genset may have a J1939 interface, a particular installation may not have a J1939 network because no other device is connected. In this case, it will be necessary to build a J1939 network to interconnect the engine/genset with the Maretron J2K100 gateway, which can be done using NMEA 2000® cable and connectors. Figure 7 shows how to build a J1939 network using Maretron NMEA 2000® cable and connectors.



**Figure 7 – Two Engines/Gensets, No J1939 Network Installation Diagram**

Although not required, this example mostly uses NMEA 2000® cable and connectors for the J1939 network. This is convenient because the network components are readily available and easily plugged together. Notice that there is no powertap in the J1939 network and this is because the J1939 engine/genset and J2K100 receive their power independent of the J1939 network. An alternative to building the J1939 network with NMEA 2000® approved cabling is to use SAE recommended cabling and connectors (see Section 3.1).

For illustration purposes, the J1939 network in Figure 5 shows the engine drops or stubs (i.e., connections between engines/gensets and the Maretron tees) as a two wire or twisted pair

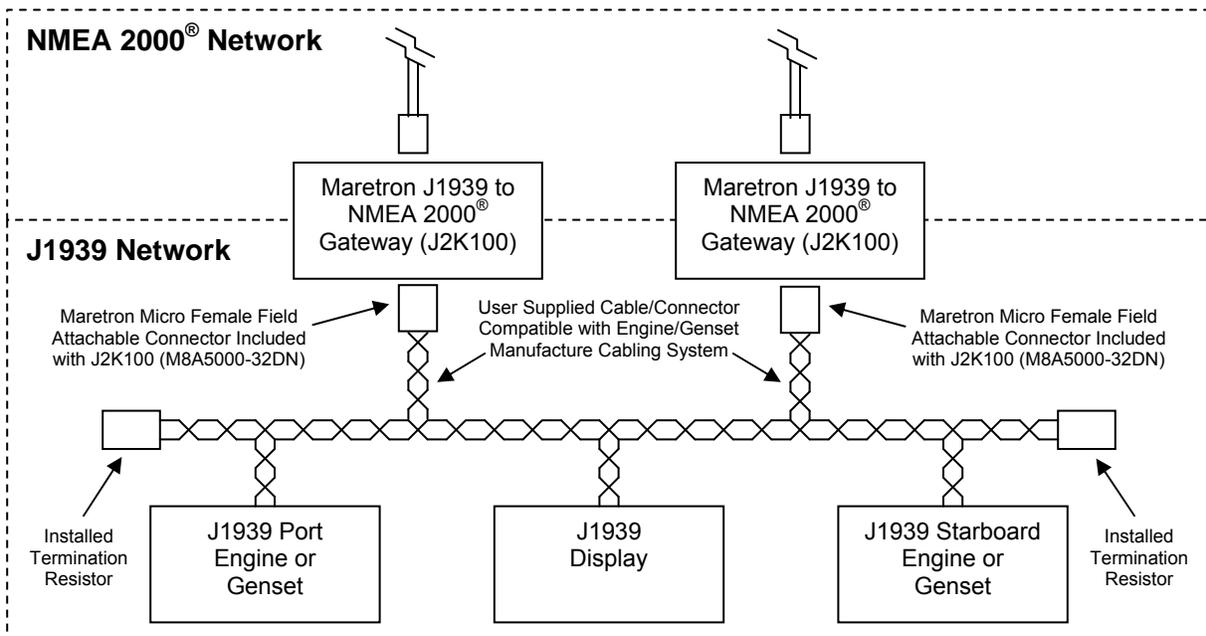
cable. The network wiring actually requires three wires, two CAN bus signals (usually designated CAN-H and CAN-L, usually yellow and green respectively) and a ground used as a reference (usually designated as CAN-SHLD). Refer to SAE J1939-11 and J1939-15 for recommended practices in connecting CAN-H, CAN-L, and CAN-SHLD.

The diagram in Figure 7 requires that the J1939 engines/gensets have unique J1939 addresses, otherwise the J2K100s won't be able to distinguish which messages or PGNs are from which engine. Check with the engine manufacturer to be sure that the J1939 interfaces on the engines/gensets have been set to different addresses. If the engines/gensets have the same address and the engine manufacturer is unable program unique addresses, you will need to build two separate J1939 networks similar to the diagram shown in Figure 9.

After completing the physical connections, you will need to configure the J2K100's so they respond to the appropriate J1939 engines/gensets. Most dual engine installs have the port engine J1939 address set to 0 and the starboard engine J1939 address set to 1, but not always, so check with the engine manufacturer and use a Maretron NMEA 2000® display (DSM200/DSM250) to program the J2K100s with the corresponding J1939 address. On the NMEA 2000® side, most dual engine displays are looking for the NMEA 2000® instance to be set to 0 for the port engine and the NMEA 2000 instance set to 1 for the starboard engine. Again, you can use a Maretron display to program the appropriate NMEA 2000® instances. Refer to the *J2K100 User's Manual* (Section 2.5) for a description of configuring a J2K100.

## 4.4 Two Engines/Gensets, Single J1939 Network Installation

Figure 8 shows a two engines/gensets, single J1939 network installation diagram.



**Figure 8 – Two Engines/Gensets, Single J1939 Network Installation Diagram**

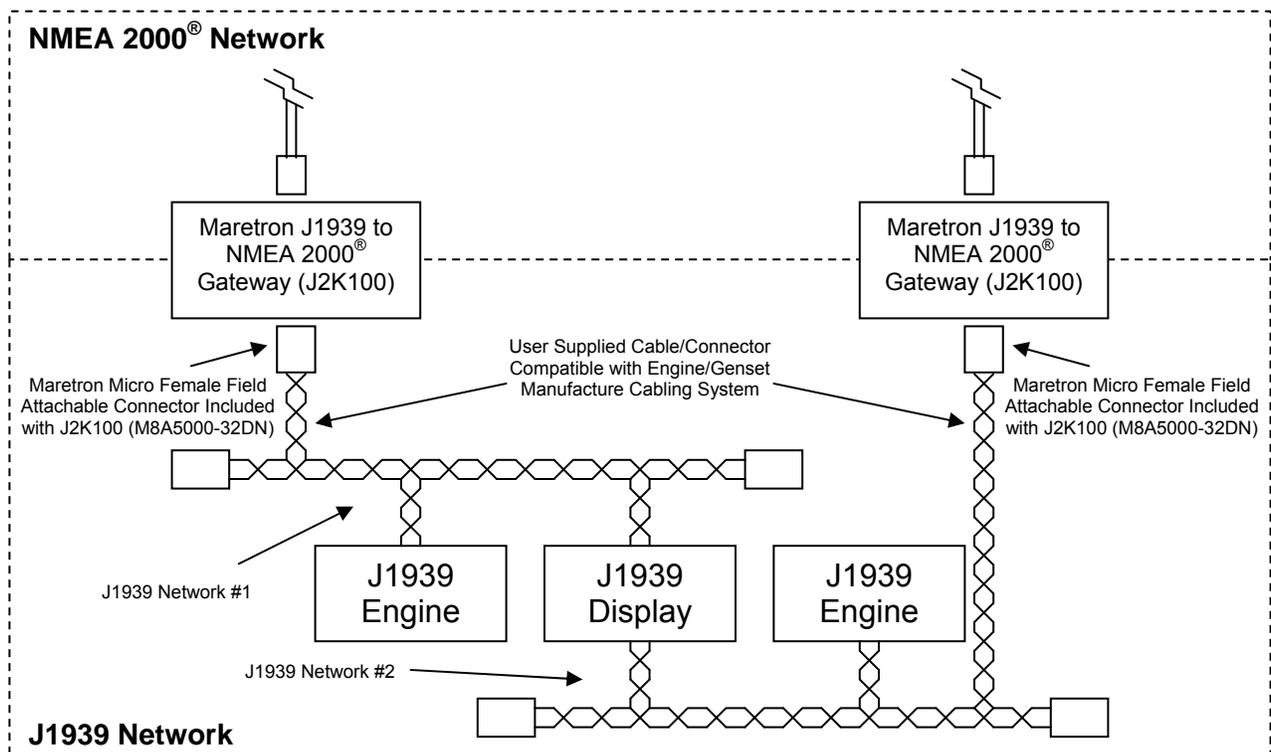
This configuration requires two additional drops or stubs from the J1939 trunk or backbone to the Maretron J2K100s. You should follow the engine/genset manufacturer's instructions for adding the drop, which are generally specified to be 1 meter or less in length.

For illustration purposes, the J1939 network in Figure 8 shows the J2K100 drops or stubs (i.e., connection between J1939 network and Maretron J2K100s) as a two wire or twisted pair cable. The network wiring actually requires three wires, two CAN bus signals (usually designated CAN-H and CAN-L, usually yellow and green respectively) and a ground used as a reference (usually designated as CAN-SHLD). Refer to SAE J1939-11 and J1939-15 for recommended practices in connecting CAN-H, CAN-L, and CAN-SHLD.

After completing the physical connections, you will need to configure the J2K100's so they respond to the appropriate J1939 engines/gensets. Most dual engine installs have the port engine J1939 address set to 0 and the starboard engine J1939 address set to 1, but not always, so check with the engine manufacturer and use a Maretron NMEA 2000<sup>®</sup> display (DSM200/DSM250) to program the J2K100s with the corresponding J1939 address. On the NMEA 2000<sup>®</sup> side, most dual engine displays are looking for the NMEA 2000<sup>®</sup> instance to be set to 0 for the port engine and the NMEA 2000 instance set to 1 for the starboard engine. Again, you can use a Maretron display to program the appropriate NMEA 2000<sup>®</sup> instances. Refer to the *J2K100 User's Manual* (Section 2.5) for a description of configuring a J2K100.

## 4.5 Two Engines/Gensets, Dual J1939 Network Installation

Figure 9 shows a two engines/gensets, dual J1939 network installation diagram.



**Figure 9 – Two Engines/Gensets, Dual J1939 Network Installation Diagram**

This configuration requires two additional drops or stubs from the J1939 trunk or backbone to the Maretron J2K100s. You should follow the engine/genset manufacturer's instructions for adding the drop, which are generally specified to be 1 meter or less in length.

For illustration purposes, the J1939 network in Figure 8 shows the J2K100 drops or stubs (i.e., connection between J1939 network and Maretron J2K100s) as a two wire or twisted pair cable. The network wiring actually requires three wires: two CAN bus signals (usually designated CAN-H and CAN-L, usually yellow and green respectively), and a ground used as a reference (usually designated as CAN-SHLD). Refer to SAE J1939-11 and J1939-15 for recommended practices in connecting CAN-H, CAN-L, and CAN-SHLD.

After completing the physical connections, you will need to configure the J2K100's so they respond to the appropriate J1939 engines/gensets. Most dual engine installs have the port engine J1939 address set to 0 and the starboard engine J1939 address set to 1, but not always, so check with the engine manufacturer and use a Maretron NMEA 2000® display (DSM200/DSM250) to program the J2K100s with the corresponding J1939 address. On the NMEA 2000® side, most dual engine displays are looking for the NMEA 2000® instance to be set to 0 for the port engine and the NMEA 2000 instance set to 1 for the starboard engine. Again, you can use a Maretron display to program the appropriate NMEA 2000® instances. Refer to the *J2K100 User's Manual* (Section 2.5) for a description of configuring a J2K100.