EFI Connections™
Today's Technician's Link to Marine EFI Systems

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Sterndrive and Inboard Direct Fuel Injection Debuts

As technological advances in sterndrive and inboard engine technology continue at an ever increasing pace this year will prove to be an important year with the introduction of direct fuel injection. Volvo Penta as well as several other inboard engine manufacturers are prepping their direct injected engine offerings for this year's boating season.

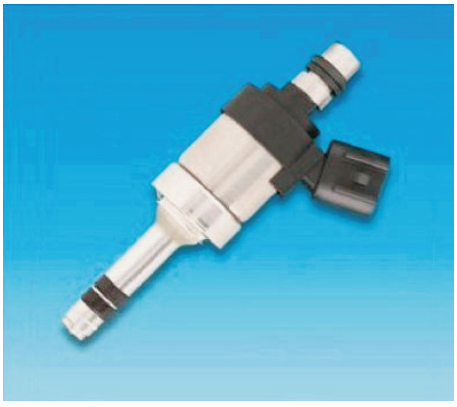
Marine technicians have been facing an ever increasing headwind of new technologies over the past several years. Emission controls, which were mandated on sterndrive and inboard engines sold in California in 2008 and nationally in 2010, presented the first big change since marine fuel injection was introduced in the early 1990s. This brought catalytic converters, oxygen sensors, misfire detection and a new fault code system into the marine service environment. Shortly afterward super-charging and variable valve timing became commonplace. When you combine this technology with other developments such as Electronic Throttle Control, CAN networks and GPS cruise control systems, its quite astounding how marine engines have advanced in a relatively short period of time.

2200 PSI Fuel Delivery To 65 Volt Injectors

Direct fuel injection presents the latest technology that marine technicians must become familiar with. While used by some outboard manufacturers for many years it had been absent in the sterndrive and inboard market. It's introduction this year on select marine engines is linked to General Motor's "Next Gen" engine initiative. This initiative, which GM states consumed millions of man-hours of engineering resources, resulted in a complete redesign of many of their engines. The new "Gen 5" 4.3L V6 for example incorporates not only direct injection but also variable valve timing and a light weight aluminum block. Volvo Penta will be offering a 240HP version of this engine.

Direct injection (DI) offers many benefits and also presents some service challenges. By injecting fuel directly into the cylinder DI places the point of fuel delivery very close to the point of ignition. This enables better fuel atomization, combustion efficiency and allows a leaner fuel mixture to be used compared to port fuel injection (PFI) for equivalent horsepower output.

Marine technicians familiar with port fuel injection will note some major differences



Delphi Multec Direct Fuel Injector
(photo courtesy of Delphi Corp)

on the new DI engines. First and foremost is the increase in fuel rail pressure. While typical PFI engines had fuel rail pressures in the 40 to 60 psi range, direct injected engines can have pressures of 2200 psi or

Continued on page 3...

From the TOP

Spring is upon us as we gear up for another boating season. As marine engine manufacturers release their latest products to the industry we take a look at some of the brand new technology being incorporated into these engines. This year's big news in the sterndrive and inboard market is Direct Fuel Injection. Volvo Penta and Pleasurecraft Engine Group are both slated to relase one or more engine models incorporating direct injection. We take a look at the technological changes and challenges presented on direct injected engines and provide a preview of what you can expect to see on these new engine models.

Another major development is the reappearnce of Ford in the marine industry. Indmar teamed up with Ford to produce three marinized versions of their Raptor series 6.2L V8 engines. We take a brief look at their new powerplants.

With CAN networking becoming more prevalent, our Tech Tips article on page 4 provides technicians with a basic introduction to CAN technology as used by the marine industry. Finally we are proud to announce the debut of our TechMate Pro diagnostic tool along with its new expanded support for the latest Mercury engines.

ed@rinda.com

2018 Mercury Support Released for TechMate Pro

The TechMate Pro scan tool's diagnostic capabilities have now been expanded to include support for late model Mercury, MerCruiser and Mercury Racing engines.

MerCruiser engine diagnostics include significantly enhanced functionality for 2008 and newer MerCruiser ECT catalyst equipped and non-ECT engines. Export models of these engines are also covered along with the new 4.5L V6.

Mercury outboard support has been expanded to include 2010-Up 40 thru 60 HP, 2012-Up 150 HP and 2014-Up 75 thru 115 HP four stroke engines. Verado, Optimax and other late model EFI equipped engines are also supported in the new software release.

Mercury Racing sterndrive engine coverage now includes 520, 540, 565, 1350, 1650 and 1750 HP models.

A new diagnostic adapter, #94032 shown in the photo below, is required for the aforementioned engine models. Adapter #94032 converts the 6-pin OBD-M connection found on Rinda Technologies CAN network adapter #94029 to Mercury's 10-pin CAN diagnostic port. Note you must have adapter #94029 to use #94032.

This enhanced software update is being offered to existing TechMate Pro owners free of charge. Adapter #94032 is available for $59.00 + shipping.

For additional information please contact Rinda Technologies at (773) 736-6633.

#94032 6-pin to 10-pin CAN converter

Indmar Raptor Engines Reunite Ford with Boating

Indmar's introduction of three all-new "Raptor Series" engines brings Ford Motor Company back into the boating industry. Ford has been absent from the marine engine market since their decision to exit the industry back in the mid-1990s. Indmar's new Ford-based inboards bring new capabilities and engine technology into the boating world.

Based on the 6.2L SOHC 16-Valve V8 engine that powers F-150 SVT Raptor and F-Series Super Duty Trucks, Indmar offers three variations of the engine which it states are purpose built for modern towboats and watersports applications. Featuring a 4th generation engine control module, overhead cam valve train, dual spark plugs, closed cooling and a Rousch supercharger on one engine model, marine technicians will need to acquaint themselves with Ford engine technology as well as new Indmar service and troubleshooting procedures.

A Diacom software update is available to support Indmar's Raptor Series engines, please contact Rinda Technologies at (773) 736-6633 for details.

...continued from page 1

Direct Injection (continued)

higher. On GMs Gen-5 DI engines typical fuel rail pressures hover around 2175 psi.

Unlike PFI systems the direct injectors themselves are quite different and require a much higher voltage to operate. A direct injector such as the Delphi Multec shown on the cover of this newsletter has an operational voltage range of 50 to 65 vdc. The increased voltage is supplied by special voltage booster and injector driver circuitry located in the Engine Control Module (ECM). This circuitry drives both terminals of the direct injector therefore each injector requires two connections to the ECM as opposed to one connection for older 12 volt port fuel injectors. The incorporation of additional voltage boosting electronics into the ECM also results in a module that is significantly larger than previous generation (non-DI) ECM modules as shown in Figure 1 below.

A major benefit of direct injection is that it allows very precise fuel delivery timing. The injectors typically deliver fuel into the combustion chamber after the exhaust valve has closed (to avoid raw fuel spraying out the exhaust port) and before the spark plug fires. This window of time represents just over 300 degrees of crankshaft rotation. By contrast, injectors on PFI engines could flow fuel for almost the entire 720 degree rotation of the crankshaft. The narrower fuel delivery timing window on DI engines requires very high pressures to inject fuel quickly and also to overcome cylinder pressure. In some situations, such as cold starting, the DI injectors may open and close multiple times during one combustion cycle to deliver an adequate fuel charge.

Fig 1. Volvo Penta DI Engine Control Module

Volvo Penta's 4.3L Direct Injected V6-240
(photo courtesy of Volvo Penta)

It is noteworthy to point out that a DI engine's intake ports only need to provide air rather than an air-fuel mixture. Eliminating the fuel increases airflow past the intake valves and into the cylinder. This boosts efficiency and horsepower compared to PFI engines. Directly injecting the fuel also helps cool the piston and cylinder walls making higher compression ratios possible.

Delivering a constant source of fuel at 2200 psi is no trivial task. The fuel systems on GM based DI engines are substantially beefed up and more complex compared to PFI fuel systems. Dual fuel pumps (a low pressure primary pump and high pressure secondary pump) are necessary to provide the volume and pressure required. The low pressure pump is electric and similar to pumps used on PFI systems. The high pressure pump on GM Gen-5 DI engines is typically mounted in the valley between cylinder heads and driven by a dedicated lobe on the camshaft. This pump feeds specially engineered stainless steel fuel rails that deliver the high pressure fuel to the direct injectors. The fuel system is returnless so fuel dead-heads at the rails.

Fuel pressure regulation is accomplished electronically via a pressure sensor mounted on the fuel rail assembly and a solenoid operated "spill valve" mounted on the high pressure pump. The spill valve is controlled by the engine control module to regulate and maintain proper fuel rail pressure. A diagnostic tool is required to monitor fuel pressure since there is no provision on the rail assembly to monitor the high pressure with a gauge.

Servicing the fuel system on a DI engine requires new procedures and safety precautions. It is important to follow the engine manufacturer's guidelines related to depressurizing the high pressure fuel system prior to service and also purging air from the system when repairs are completed.

Software updates for Rinda Technologies service tools related to diagnosing and servicing DI engines are available. Please contact us for details or visit our website at www.rinda.com.

Fig 2. DI Pump and Fuel Rail Assembly
(photo courtesy of Delphi Corp)

Tech Tip

CAN Bus Basics

Since the introduction of the Marine On-Board Diagnostics standard (OBD-M) in 2008, CAN communication capabilities have been a requirement on all sterndrive and inboard EFI engine control systems. While CAN communication is required for diagnostic purposes on all OBD-M compliant engines its capabilities extend well beyond just providing diagnostic data to marine technicians.

Expanding Network

From the onset of OBD-M marine engine manufacturers realized CAN's potential and its communication capabilities quickly spread throughout the vessel. CAN technology is now used for not only diagnostics but also to connect a variety of other peripheral marine systems together via an in-vessel network. Systems such as electronic throttle controls, helm displays, gauges, GPS receivers and a host of other devices are now commonly linked together via CAN. Mercury took an early lead in using this technology with the debut of their "Smartcraft" version of CAN in 2001.

CANs Beginning

CAN is an acronym for Controller Area Network and it was introduced by Robert Bosch Corp. in 1986. CAN is intended to facilitate the exchange of short real-time messages between intelligent modules in a vehicle. CAN is fault tolerant, resistant to electrical noise and much faster than prior generation technology. Mercedes Benz was the first automaker to use CAN technology in a vehicle in 1992.

A CAN network uses two wires to transmit (or receive) data. The wires are referred to as CAN High (CAN+) and CAN Low (CAN-). Data is transmitted over both wires simultaneously and the electrical signals on each wire are mirror images of each other as shown in Fig.1. This "mirroring" of signals allows CAN to be highly immune to electrical noise and also allows CAN to exchange information between devices that do not share a common ground connection. Typical signal levels found on a CAN network are 2.5vdc to 3.5vdc for CAN High and 1.5vdc to 2.5vdc for CAN Low.

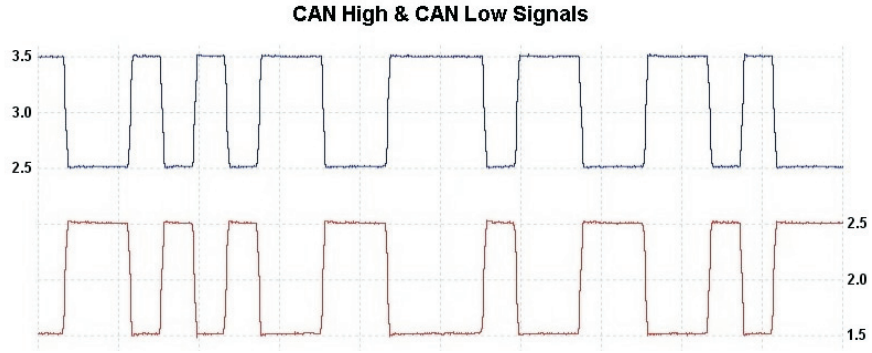


Fig 1 - CAN Electrical Signals

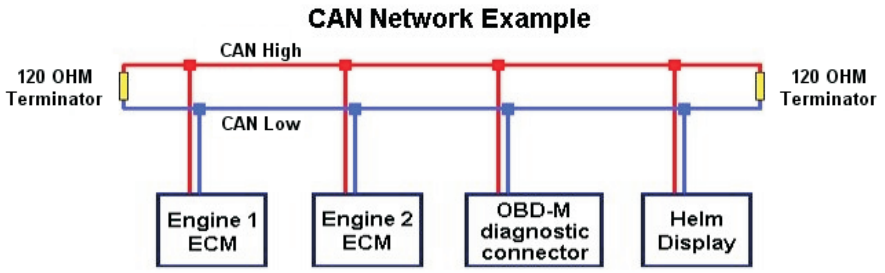


Fig 2 - CAN Network With Terminators

Basics Defined

The CAN standard created by Bosch defines the electrical aspects and basic transmission of data sent over a CAN network. For example, signal voltages, data packet requirements and error correction are specified. The standard does not define what type of data is sent over the network or how the data is to be interpreted. A good analogy would be a telephone system. A phone system defines how telephones are electrically connected but does not define what language is spoken in the phone conversation.

What's a Protocol?

In order to send meaningful information on a CAN network a "protocol" must be used. Protocols can be thought of as the language being spoken on the CAN network. A protocol defines how data is organized, exchanged and interpreted by devices connected to the network. Even though marine CAN networks conform to Bosch's standard it does not make them compatible with each other since they may use different protocols. Popular CAN protocols currently being used in the marine industry include:

- SAE J1939 (OBD-M)
- NMEA 2000
- Smartcraft

Making the Connection

Another notable aspect of the CAN standard is that it does not define what type of wire or connectors to be used to construct the network. For example, even though Smartcraft and NMEA 2000 are both CAN networks they use different connectors and cable types. The CAN standard leaves physical attributes like inter-connects up to designers of the network so they may tailor it to the environment in which it is going to be used.

Termination

CAN networks require their most distant ends to be "terminated" as shown in Fig 2. A CAN terminator is simply a resistor that is attached between the CAN+ and CAN- signal wires and are required at both ends of the network (bus). The two terminators in a typical CAN network are 120 ohms each and are required to maintain proper voltage levels on the bus. Since CAN is a relatively high speed network the terminators also help reduce electrical signal phenomenon called "reflections" on the network. In most cases if a CAN network is void of terminators it simply will not function at all.

Information Backbone

CANs use in the boating industry has grown dramatically over the past decade so it is important to have a good understanding of this technology. Be certain to attend engine manufacturer's training seminars and closely follow recommended service procedures. CAN networks have become an integral part of many modern pleasure boats and they often form the backbone of vessel operation. ■

Introducing…

TechMate Pro™

Setting a New Standard in Marine Diagnostics

The Professionals Choice for Marine Service

Built Tough with Advanced Features, Extensive Engine Support, Expandability and Affordability for Today's Demanding Marine Service Applications.

Supports MerCruiser, Mercury Outboards, Mercury Racing, Volvo Penta, Indmar, Crusader, Pleasurecraft Marine, Ilmor, Marine Power, Kodiak, Seven Marine, Panther Air Boats, Flagship Marine, GM RamJet Crate Engines and more…

A New Generation

Built upon the success of our original TechMate scan tool, TechMate Pro represents a new generation in marine diagnostics. With over 25 years of experience in designing and manufacturing marine diagnostic equipment we designed the TechMate Pro from the ground up with marine service technicians in mind.

Advanced Technology

Self contained and easy to use, the TechMate Pro uses the latest flash based microprocessor technology. New features include USB connectivity for easy updates, a high visibility multi-line graphic LCD display viewable in direct sunlight, SD card slot for system expansion, ergonomic soft-touch / anti-slip exterior for assured handling in marine environments, a water resistant key pad along with a host of other features.

Comprehensive Support and Features

The TechMate Pro has the widest marine engine support in the industry. Covering over two decades of marine EFI engines the tool displays complete engine control system information, faults and provides a variety of engine test and configuration features. TechMate Pro is the professional's choice for marine service.

TechMate Pro deluxe kit with carrying case and adapters

System support

- See next page for detailed engine support list

Basic Kit Contents *(additional kits shown on page 6)*

- TechMate Pro Scan Tool, stern drive / inboard instruction manual, outboard instruction manual and 1992 - Up GM MEFI adapter #94005

Optional Adapters

- **94006 MerCruiser PCM-555 / ECM-555 adapter**
  for 2001-Up MerCruiser EFI engines and and late model Mercury outboards.
- **94024 Volvo Penta 2006-07 EGC adapter**
  for all 2006-07 Volvo Penta gasoline EFI engines.
- **94026 PCM / Crusader ECM-07 adapter**
  for 2007-08 PCM/Crusader non-catalyst engines.
- **94028 Mercury 2-pin outboard adapter**
  fits a variety of mid-90s and newer Mercury / Mariner outboards
- **94029 CAN Network Adapter**
  for all catalyst equipped engines, also used on many manufacturers 2008-Up engines
- **94032 Mercury CAN converter**
  Used with adapter 94029 to allow connection to 2008-Up Mercury 10-pin CAN networks
- **94038 Mercury 3-pin outboard adapter**
  fits a variety of 2001-Up Mercury 4-stroke outboards equipped with Yamaha powerheads.
- **94011 Mercury 4-pin outboard adapter**
  fits a variety of mid-90s and newer Mercury / Mariner outboards.
- **94037 Mercury outboard in-line power adapter**
  Used along with adapter 94011 on many 1998-2008 25hp thru 60hp 4-stroke outboards.
- **94039 Mercury 18-pin outboard adapter**
  Used on 2006-Up 25 / 30hp 4-stroke outboards.
- **94013 Mercury Racing 2.5L adapter**
  for 1995-98 Mercury Racing 2.5L outboards.
- **94014 MerCruiser 2.8L / 4.2L diesel adapter**
- **94021 MerCruiser 7.3L diesel adapter**

Rinda Technologies Inc.

TechMate Pro Scan Tool
2018 Engine Support List

Mercury Outboards

- **2006 - Up Verado engines:**
  135hp, 150hp, 175hp, 200hp, 225hp, 250hp, 275hp, 300hp, 350hp
- **2002 - Up 4-stroke EFI engines:**
  25hp, 30hp, 40hp, 50hp, 60hp, 75hp, 90hp, 115hp, 150hp
- **1998 - Up 4-stroke Carbureted engines:**
  25hp, 30hp, 40hp, 50hp, 60hp
- **2001 - Up Optimax engines:**
  All models.
- **1998 - 2000 DFI engines:**
  All models
- **1994 - Up 2-stroke EFI engines:**
  150hp, 175hp, 200hp, 225hp, 225hp(3.0L)
- **1994 - 1999 2-stroke Carbureted engines:**
  225hp/(3.0L)
- **1995-Up Racing 2-stroke EFI engines:**
  150hp, 200hp, 225hp, 2.5L, 280hp, 300hp, Optimax XS series

MerCruiser

- **1992 - Up EFI engines:**
  All models
- **1996-up Carbureted engines with Thunderbolt V ignition:**
  All models

MerCruiser D-Tronic Diesels

- **1997 - 2007**
  2.8L 4-cylinder, 4.2L 6-cylinder
- **1997 - 2005**
  7.3L V8

Mercury Racing (sterndrives)

- **1998 - Up EFI engines:**
  All models

Volvo Penta

- **1992 - Up EFI engines:**
  All models

Crusader

- **1992 - Up EFI engines:**
  All models

Flagship Marine

- **1992 - Up GM EFI engines:**
  All Models

Ilmor Marine Engines

- **2009 - Up V10 engines:**
  MV-650, MV-725
- **2010 V8 engines:**
  All models

Indmar

- **1992 - Up GM EFI engines:**
  All models
- **2014 - Up Ford EFI engines:**
  All models

Kodiak Marine

- **1992 - Up GM EFI engines:**
  All Models

Marine Power

- **1992 - Up GM EFI engines:**
  All models

Panther Air Boats

- **2000 - Up GM EFI engines:**
  All Models

Pleasurecraft Marine

- **1992 - Up EFI engines:**
  All models (excludes 1990s Ford engines)

Seven Marine

- **2012 - Up Outboard EFI engines**
  All Models

GM RamJet Crate Engines

- **2000 - Up EFI engines:**
  RamJet 350, RamJet 502

TurnKey Engines

- **2001 - Up MEFI Engines**
  Engines equipped with MEFI 1 thru 5 EFI systems

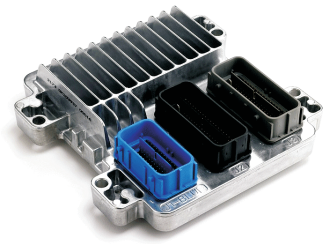
TechMate Scan Tool kit configurations

94070	**Basic scan tool kit** includes 94005 adapter	**$499.00**
94070c	**Scan tool kit with CAN interface** includes 94005 and 94029 adapters	**$599.00**
94070m	**Mercury / MerCruiser CAN kit** includes 94029 and 94032 adapters	**$599.00**
94070s	**Sterndrive / inboard scan tool kit** includes 94005, 94006, 94024, 94026, 94032 and 94029 adapters	**$749.00**
94070t	**Outboard scan tool kit** includes 94006, 94011, 94028, 94029, 94032, 94037, 94038 and 94039 adapters	**$819.00**
94070d	**Deluxe scan tool kit** for Sterndrives / Inboards / Outboards includes 94005, 94006, 94011, 94024, 94026, 94028, 94029, 94032, 94037, 94038 and 94039 adapters. **Includes deluxe carrying case.**	**$899.00**
94015	**Deluxe Carrying case**	**$79.00**

Specifications subject to change without notice. Engine support current as of spring 2018. Please call us or visit us on-line for the latest details. Tel: (773) 736-6633 www.rinda.com

EFI Toolbox

Products for Marine Service Technicians



NEW

TechMate Pro™ - Scan Tool

TechMate Pro represents a new generation in marine diagnostics. Industry leading coverage supporting over two decades of marine EFI engines. Self contained and easy to use TechMate Pro uses the latest flash based microprocessor technology. Features include USB connectivity for easy updates, a high visibility multi-line graphic LCD display viewable in direct sunlight, SD card slot for system expansion, ergonomic soft-touch and anti-slip exterior for assured handling in marine environments, a water resistant key pad along with a host of other features.

#94070 (basic kit) **$499.00**
includes 94005 adapter

Additional kits at: ***www.rinda.com/techmatepro/***

NEW ***Version 3.0***

Diacom® Marine - PC software

The undisputed workhorse of the marine service industry. Used by thousands of marine dealerships worldwide Diacom Marine harnesses the power of your Windows based PC or tablet to form a sophisticated EFI diagnostic system. Diacom Marine allows a technician to quickly view engine performance data to zero in on system malfunctions. Easily record and graph data from all accessible EFI system sensors and controls to capture elusive intermittent problems. Diacom Marine includes an extensive set of diagnostic features and has the broadest engine support in the marine industry. The software is compatible with Windows 10, 8, 7, Vista and XP.

#94010 (standard kit) **$579.00**
includes 94005 and 94006 adapters

#94030 (CAN kit) **$699.00**
includes 94005, 94006 and 94029 adapters

#94030d (deluxe kit) **$1149.00**
includes 94005, 94006, 94011, 94024, 94026, 94028, 94029, 94032, 94037, 94038, 94039 adapters and deluxe carrying case.

Additional details at: ***www.rinda.com/marine/***

EFI Diagnostic Adapters

#94005	GM-Delphi MEFI 1 - MEFI 4b	**$49.00**
#94006	MerCruiser PCM / ECM 555	**$49.00**
#94014	MerCruiser 2.8L / 4.2L D-tronic diesel	**$49.00**
#94021	MerCruiser 7.3L D-tronic diesel	**$59.00**
#94023	Diacom Marine CAN adapter (gen 1) (required for USB cable type 94074)	**$249.00**
#94024	2006-07 Volvo Penta EGC	**$49.00**
#94026	2007-08 PCM / Crusader ECM-07	**$49.00**
#94027	Merc / TechMate scan tool CAN adapter	**$169.00**
#94029	Diacom / TechMate Pro CAN adapter	**$249.00**
#94011	Mercury outboard 4-pin adapter	**$49.00**
#94013	Mercury Racing 2.5L outboard	**$39.00**
#94028	Mercury outboard 2-pin adapter	**$59.00**
#94032	Mercury 6-pin to 10-pin CAN converter	**$59.00**
#94037	In-line power adapter	**$59.00**
#94038	Mercury outboard 3-pin adapter	**$49.00**

Have questions or need technical assistance?

Please visit us online at www.rinda.com or call us at 773-736-6633 Mon-Fri, 9am to 5pm CST

EFI Connections™

Today's Technician's Link to Marine EFI Systems

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plus more…

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