

Electronic Control Module Field Guide

Caterpillar - Cummins - Detroit - Mack - Mercedes
Identification Guide to Engines with Recoverable Data

January 2010 Edition



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Field Guide

Information



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Acknowledgements

This Field Guide has been prepared by the Wisconsin State Patrol and Messerschmidt Safety Consulting based on training and testing completed as of January, 2010. Because of the dynamic nature of the research in this field, the authors reserve the right to make updates as additional data become available. Questions or comments about the information contained in this Field Guide should be directed to:

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Research for this Field Guide was completed in partnership with Fox Valley Technical College in Appleton, Wisconsin. Special acknowledgements are given to Program Director Robert Behnke and Diesel Technician Instructor Mike Farrell from the school's J. J. Keller Transportation Center. The advancement of education in this field is only possible with the help of institutions such as Fox Valley Technical College that are dedicated to the pursuit of academic research.



Recognition must also be given to the following individuals who provided insight, corrections, and ideas for this Guide. Their dedication to the field of ECM technology is commendable.

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Engine Coverage / Identification

At the present time, five engine manufacturers use Electronic Control Modules (ECMs) that record data of interest to collision investigators. In many cases, this information concerns sudden deceleration data for given time periods both before and after the event. Table 1 lists these engines and the years for which coverage is presently available. It should be noted that not all engines manufactured for the years listed below are accessible. Furthermore, some engines manufactured during these model years will only provide ECM configuration data. For detailed coverage information, it is necessary to review the manufacturer pages presented later in this Field Guide. Of the engines listed in Table 1, Mack only allows public access to general programming parameters and fault code information. Mack crash information, if available, is only recoverable by individuals specified by the manufacturer.

Engine Manufacturer	Configuration Data	Incident Data
Caterpillar	1994 – 2010	1994 ¹ – 2010
Cummins	1994 – 2010	2002 ² – 2010
Detroit Diesel	1993 – 2010	1998 – 2010
Mack	1998 – 2010	1998 – 2010
Mercedes Benz	2000 – 2010	2000 ³ – 2010

¹ Only ECMS with software revisions after late 1995 have the ability to store incident information.
² Only the ISM and ISX engine models with software revisions after late 2004 have the ability to store incident information. As of 2008 (EPA 07), all I-Series engines may document this data.
³ Only ECMS having software version 12.09 or higher are accessible.

Table 1 - Engines Using ECMS Capable of Storing Collision Data

When examining an engine for possible data extraction, it is important to note the engine model and year of manufacture. This information is found on the identification tag, which can be an actual metal plate or a decal. In most cases, this tag is affixed to either the top of the valve cover or to the left side of the engine. In Figure 1, the engine identification tag from a Cummins engine is shown with leader arrows showing the model (ISB) and build date (1998).

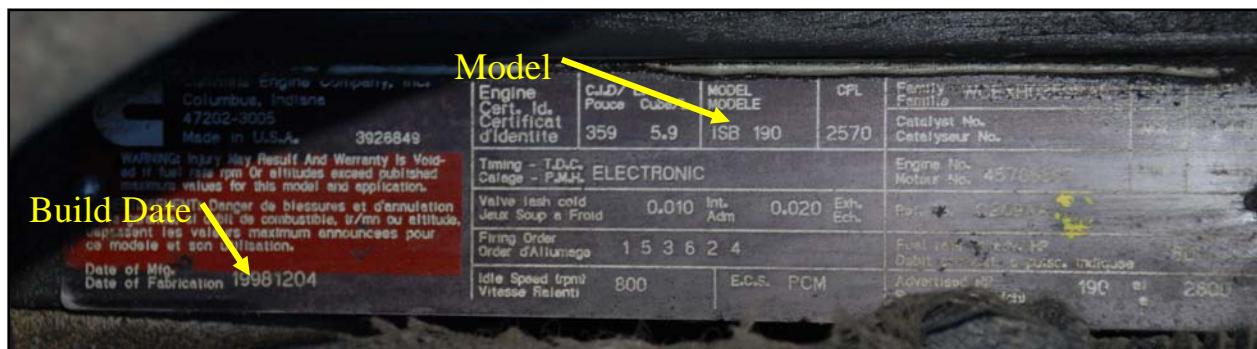


Figure 1 – Sample Engine Identification Tag

Documentation

Transmission Information

When calculating speed, the ECM uses the rear axle ratio as part of its programming. Therefore, it is necessary to verify this number. In most cases, this can be done by examining the transmission identification tag located on the differential housing. Any legible information, including the ratio and serial number, should be documented and photographed. A sample identification tag is shown below in Figure 2.



Figure 2 – Sample Spicer Transmission Identification Tag

Rolling Radius

In addition to the rear axle ratio, the ECM also considers the size of the drive tires when determining the vehicle's speed. Therefore, tire data such as manufacturer, model, and size should be recorded. In addition, the rolling radius of the drive wheels must be measured. This measurement should be taken on a flat surface with the vehicle in the same weighted configuration it was in when the incident occurred.

To measure the rolling radius, use a level to project the center of the axle hub beyond the rim and tire. Then, using a ruler or tape measure, document the distance from the hub to the ground as shown in Figure 3.



Figure 3 – Measuring Rolling Radius

Preserving Data

After determining that an engine and ECM are supported by available software as indicated in this Field Guide, steps should be taken to preserve any information contained in the ECM.

Responding officers should:

- Turn off the truck's ignition and secure the vehicle keys. This should be done immediately upon arriving at the incident scene.
- Determine if the ECM should be downloaded at the scene, or if the truck will be towed to a secondary location. This decision should be based on anticipated roadway closure time, availability of a technician that is trained to perform the forensic data extraction, and the need to obtain consent or search warrant authorization.
- If the vehicle must be moved, ensure that the key is in the "off" position, and disconnect the vehicle's battery as a precaution. *The battery should not be disconnected if the ECM is a Detroit Diesel DDEC III, or if the engine is a 1994 – 1995 Caterpillar 3176 or 3406.*
- If there is a danger of power being lost on a Detroit DDEC III or a 1994 – 1995 Caterpillar 3176 or 3406 engine, ensure that a supplemental 12-Volt system is applied to the batteries.
- Calibration data should always be obtained in addition to incident data. This helps to verify the accuracy of recorded speeds and incident timings.



Caterpillar

1994 - 2010



About Caterpillar

Using the software program *Electronic Technician* (Cat ET), calibration information, trip data, fault information, and diagnostic code snapshots can be recovered from Caterpillar ECMS. When a diagnostic code such as low engine coolant or low oil pressure is detected, the ECM will document data surrounding the event. In addition, the driver can trigger a snapshot by toggling the cruise control set/resume switch in a specified manner. Snapshots are only available with ECMS having software installed or upgraded after November of 1995.



Figure 4 - Caterpillar test run completed at Fox Valley Technical College in Appleton, Wisconsin

In addition to diagnostic codes, a quick stop snapshot can be created when the wheel speed slows at a user specified rate. If the rate is set at zero, the feature will not be activated. In most cases, the quick stop parameter was generally not enabled unless specifically requested by the customer. Beginning in 2007, the parameter was automatically set to 10 mph/sec at the factory. When a quick stop is triggered, the ECM will document up to 44 seconds prior to the deceleration threshold being met, and 15 seconds after.

Supported Engines

Most Caterpillar heavy and medium duty engines manufactured since 1994 using Advanced Diesel Engine Management (ADEM) systems are capable of storing snapshot data. These include the numerical C-Series, as well as electronic 3176, 3126, and 3406 models. Other engines are limited to storing ECM configuration data.

Engine Identification

All Caterpillar engines will likely be yellow in color, regardless of the size or model. The best method to identify the particular product is to look at the identification tag located on top of the valve cover. This label will show the model and year of manufacture. Figure 5 shows a 1994 Caterpillar 3176 engine identification tag with the year and model entries noted. Figure 6 shows a sample Caterpillar engine with the ECM location noted.

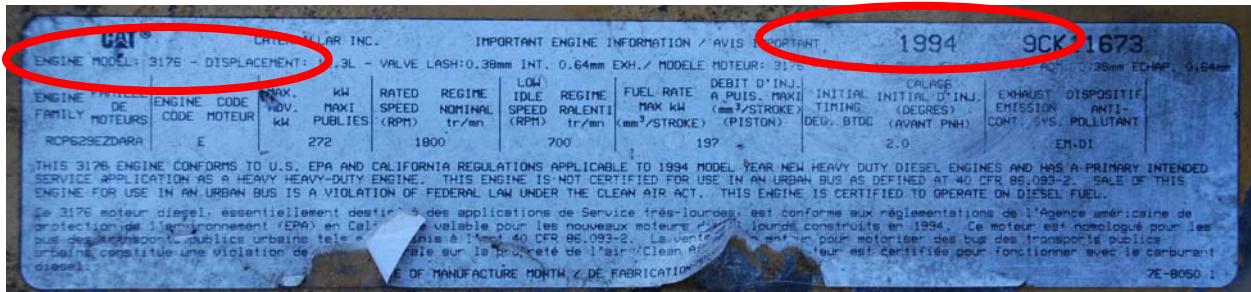


Figure 5 – 1994 Caterpillar 3176 Engine Identification Tag

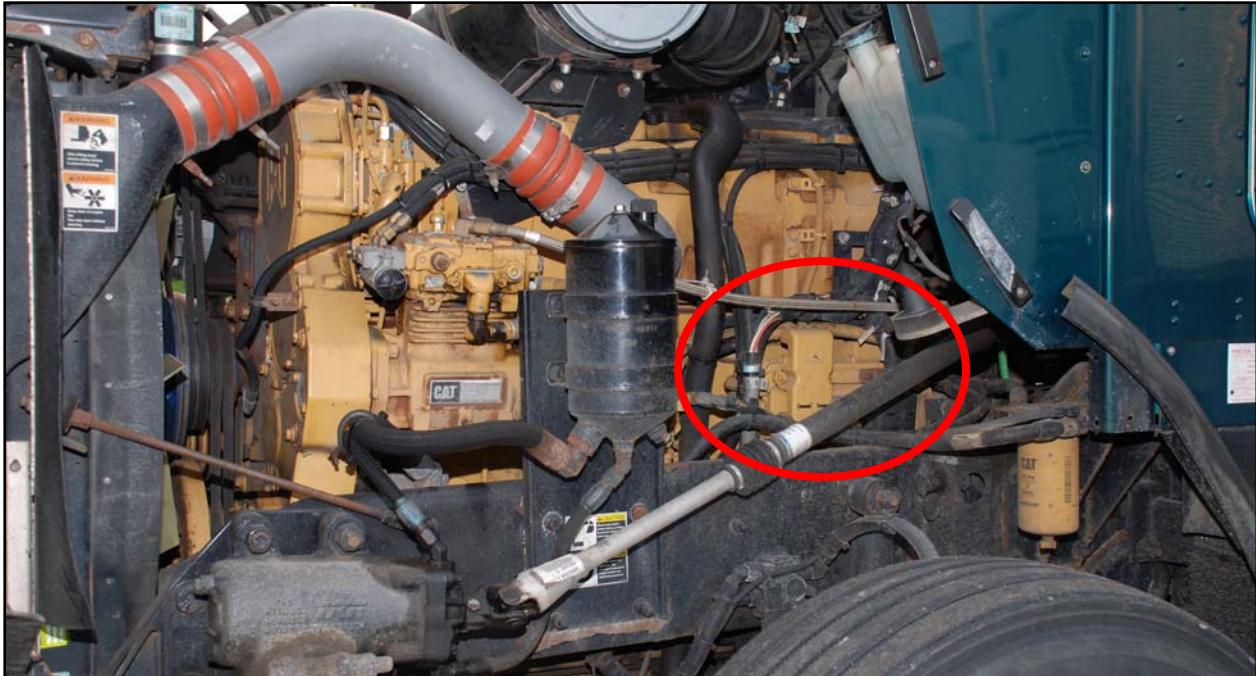


Figure 6 – Sample Caterpillar ECM Location

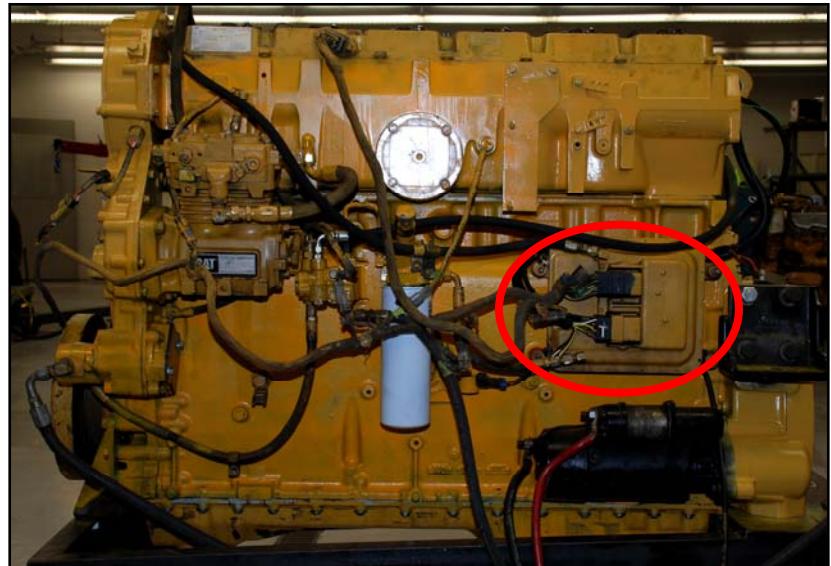
Potential Data Loss

The ECMS installed on 1994 – 1995 engines do not have an internal battery. If power is lost or not maintained to these engines, snapshot data may be erased. Beginning in 1996, the ECMS have an internal battery, and data will not be lost if power is removed from it. Affected engine models and serial numbers are shown in Table 2, and the ECM location on a Caterpillar 3176 is shown in Figure 7.

Engine Model	Affected Serial Numbers
3176	9CK00001 through 9CK27878
3406	5EK00001 through 5EK66039

Table 2 – 1994 and 1995 Caterpillar Engine Models Without Internal Batteries

Figure 7 – Caterpillar 3176 Engine and ECM Location





About Cummins

Two separate software programs are used to access Cummins ECUs. The first of these programs, *Insite*, is used by technicians to program the modules, retrieve trip data, and to read fault code information. With respect to faults, the ECUs document snapshots at the first and last times a fault code is triggered. Codes that occur in between are overwritten and therefore not stored. Fault code snapshots are for a single moment in time, and surrounding information is not captured.

PowerSpec, the second Cummins software program, also recovers configuration, trip, and fault code data. In addition, *Powerspec* extracts sudden deceleration information from the ECU for 59 seconds prior to the event and 15 seconds after the event. With Cummins, a sudden deceleration is defined as a wheel speed change of 9 mph/sec. The ability to save such information was not programmed until late 2004, and the sudden deceleration data will only be available in specific ECUs with initial programming or software updates since that time.

Supported Engines

All Cummins heavy and medium duty on-highway engines built in 1994 or later will contain configuration and fault code data. However, only the 2002 and newer ISM and ISX engines have the ability to store sudden deceleration information. As of 2008 (EPA 07), all I-Series engines may record this information. Celect engines are only accessible using *Insite* and are thus limited in their data storage ability. Data can be extracted from Celect Plus engines using *Powerspec*; however these data are limited to trip, configuration, and fault information.

Some Cummins engines may use a secondary Road Relay recording system. This device is located in the cab, within view of the driver. A Road Relay module has the ability to store sudden deceleration information, even if the ECU does not. The Road Relay is accessible using *PowerSpec* software.

Engine Identification

Cummins engines will likely be black or red in color, regardless of the size or model. For "I" Series engines (ISB, ISC, ISL, ISM, ISX), the best method of identifying the motor is to look at the identification tag located either on top of the valve cover or on the left side of the engine. This tag will show the model and year of manufacture. Figure 8 shows a 2001 Cummins ISX engine identification tag with the year and model entries noted. Figure 9 identifies a sample Cummins ISX engine with the ECM location noted.



Figure 8 – 2001 Cummins ISX Identification Tag

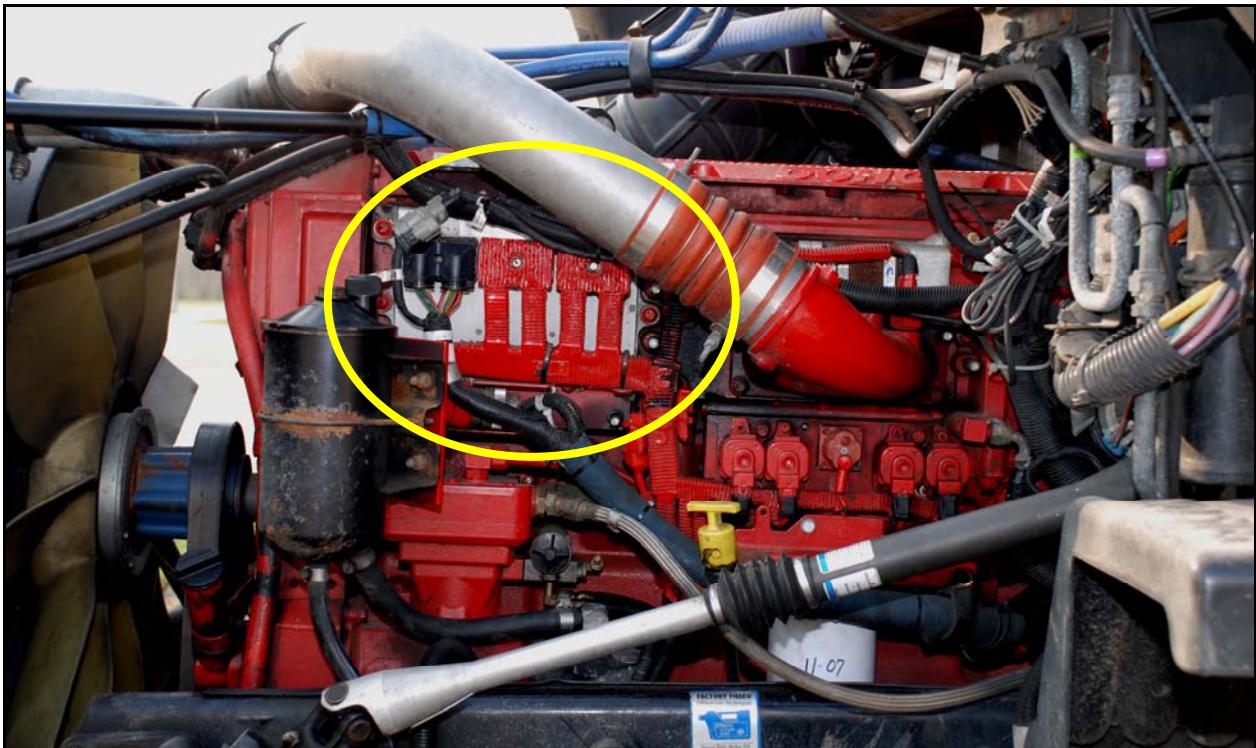


Figure 9 – ECM Location on Cummins ISX Engine

If the engine is not an "I" Series motor, it will be necessary to look at the ECM itself to determine which type of module it is. Located on the left side, the Celect and Celect Plus ECMS will generally be black in color and have the model name printed on the face. Figure 10 shows the typical location of a Celect ECM.



Figure 10 – Celect ECM on 1994 Cummins M11 Engine



Detroit Diesel

1993 - 2010



About Detroit Diesel

Two separate software programs are used to access Detroit Diesel ECUs. The first of these programs, *Detroit Diesel Electronic Controls Reports*, also known as *DDEC Reports*, recovers data concerning engine operation for the previous three months. This includes trip information such as daily miles traveled, time of operation, average speed, and fuel economy. In addition, data surrounding the last three fault codes are shown. Referred to as *Diagnostic Records*, this information contains 55 seconds of data concerning vehicle operation and engine performance.

In addition to trip data and fault code information, Detroit Diesel ECUs also document the last two hard brake events, as well as the last time the vehicle came to a stop. With Detroit Diesel engines, a hard brake is defined as a wheel speed change of 7 mph/sec. Data stored in these event files include vehicle speed and engine speed, as well as brake, throttle, and cruise control usage for up to 104 seconds before the event, and 15 seconds after the event. The second program used to access Detroit ECUs is *Detroit Diesel Diagnostic Link* (DDDL). DDDL retrieves calibration data and additional fault code data.

Supported Engines

Engines with Detroit Diesel Electronic Controls (DDEC) III or higher ECUs will contain information. The DDEC III will only store trip and configuration data, while the subsequent models will store the last stop, hard brake, and diagnostic records. In addition, some Detroit Diesel engines may use a secondary ProDriver recording system. A ProDriver module has the ability to store hard brake information, even if the ECU does not. Beginning with the DDEC VI system, diagnostic records are no longer available. Table 3 shows the applicable DDEC models and installation years.

DDEC Series	Years Installed
DDEC III	1993 - 1997
DDEC IV	1998 - 2003
DDEC V	2004 - 2006
DDEC VI	2007 - 2010

Table 3 – DDEC Models

Engine Identification

Detroit engines are typically green in color, with the identification decal located on the top left side of the engine. This will show the year, engine model, and serial number. Figure 11 shows a typical Series 60 engine identification decal.

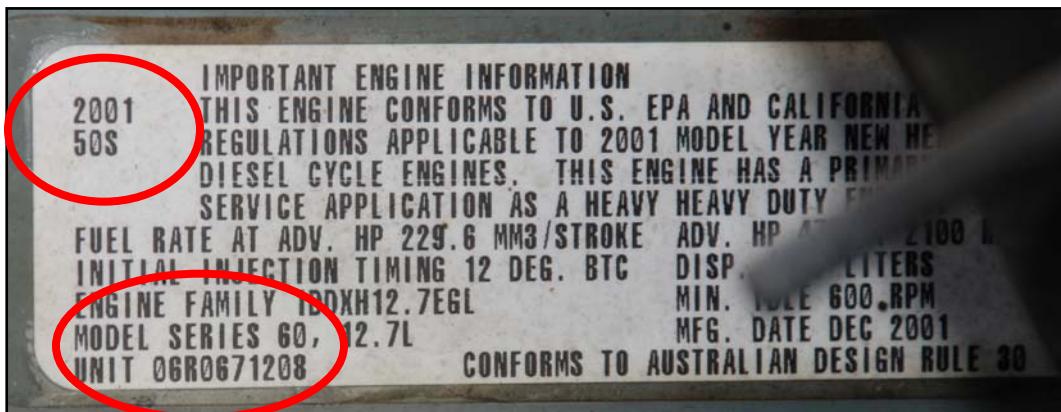


Figure 11 – 2001 Detroit Diesel Series 60 Engine Identification Decal

After noting the engine year, the ECM itself should be identified. All Detroit ECMS are located on the left side of the motor. The DDEC III and DDEC IV systems are similar in appearance, with a label on the top surface identifying the exact unit. Figure 12 shows the DDEC III / IV location and identification label.

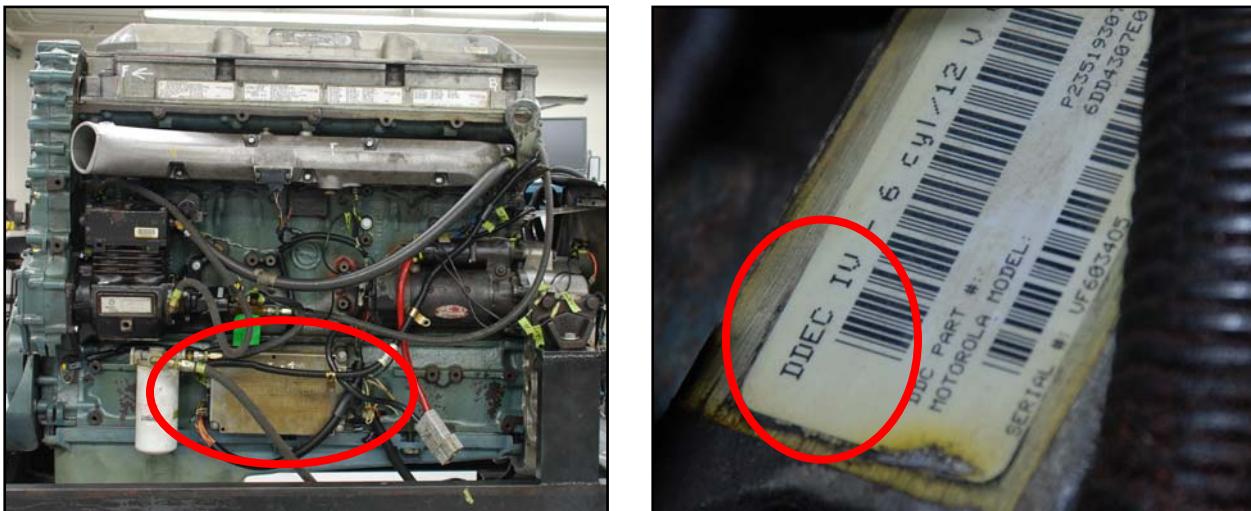


Figure 12 – Detroit Diesel DDEC III and IV Location and Identification Label

The DDEC V exterior was redesigned from its predecessors and has two large plugs on its face. This ECM will likely also have an identification label affixed to its surface. Figure 13 shows the DDEC V location and identification label.

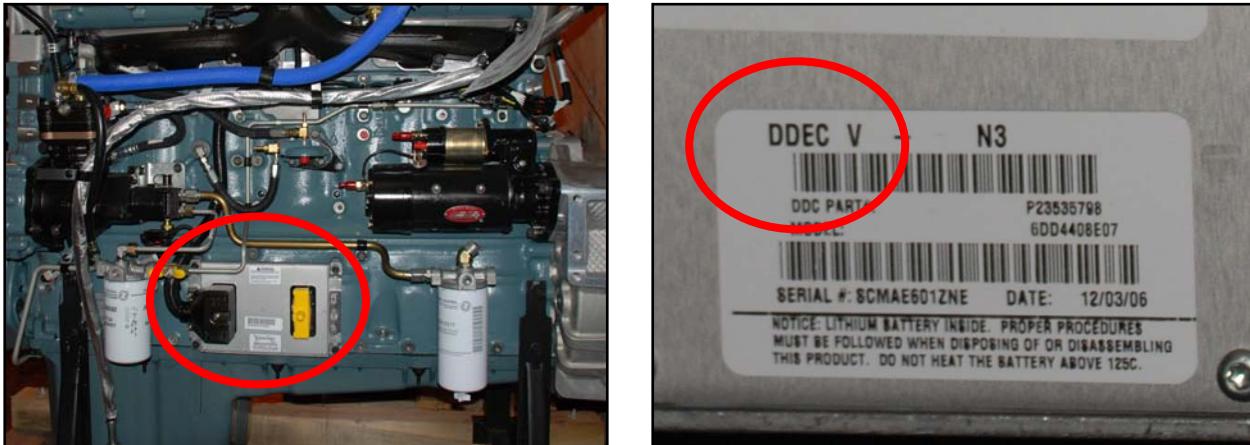


Figure 13 – DDEC V Location and Identification Label

The DDEC VI ECM consists of two components, the Motor Control Mount (MCM) on the engine and the Common Powertrain Controller (CPC) located in the cab. These components are shown in Figure 14. If the ECM system must be removed from the vehicle for data extraction, both the MCM and the CPC should be secured. The CPC is commonly located under the dash or behind the “B” pillar, while the MCM is located on the left side of the engine.



Figure 14 – DDEC VI Motor Control Mount (MCM) and Common Powertrain Controller (CPC)

Potential Data Loss

The DDEC III ECM does not have an internal battery. If power is interrupted or not maintained to these engines, data may be lost. After identifying a unit as a DDEC III, precautions should be taken to ensure that the vehicle's battery system is maintained. Figure 15 shows the decal, which is typically affixed to the top of the unit, identifying it as a DDEC III.



Figure 15 – Sample DDEC III Identification



Mack

1998 - 2010



About Mack

The ECM used by Mack is known as the Vehicle Management Control System (V-MAC). In 1998, the V-MAC III began documenting quick stop events in addition to fault codes. In addition, as of 2006, the V-Mac IV also recorded last stop information. Although configuration and fault code information is retrievable by the public, quick stop and last stop events are not. Rather, this information is only accessible by individuals specifically designated by Mack. When an extraction is performed to recover incident information, up to 75 seconds may be documented. Available data may include wheel speed, engine speed, clutch use, and cruise control status.

Publicly available software, which is known as *Vehicle Computer Aided Diagnostic Software* (VCADS), will allow the user to retrieve general programming information. Fault code snapshots are for a single moment in time, and surrounding information is not captured. Therefore, given the limitations of VCADS, it is recommended that precautions be taken to preserve the ECM data for preparation to ship the module(s) directly to Mack's designee.

Additional information about obtaining a Mack download may be obtained by visiting www.hvedr.com or by contacting Mr. Timothy Cheek of Delta[v] Forensic Engineering in North Carolina at (704) 525-5700 or Mr. John Steiner of KEVA Engineering in California at (805) 388-6016. These individuals have been designated by Mack for forensic ECM data extractions.

Supported Engines

Mack engines built in 1998 and later that use V-MAC III and V-MAC IV ECUs have the ability to store event information (Table 4). It is possible that some 1997 engines that were sold in the latter portion of 1997 may use the V-MAC III and thus may also contain accessible data.

Table 4 – VMAC Models Installed Between 1998 and 2010

Covered VMAC Series	Years Installed
V-MAC III	1998 – 2006
V-MAC IV	2006 – 2010

Engine Identification

Mack engines are typically grey or red in color. The identification tag is generally found on the top left side of the engine. This will show the year and engine model. Figure 16 shows a sample identification tag from a 2000 Mack E7 engine. In this example, the tag was affixed to the top of the valve cover.



Figure 16 - Sample 2000 Mack E7 Identification Tag

Mack ECUs consist of two components, the Engine Electronic Control Unit (EECU) on the motor and the Vehicle Electronic Control Unit (VECU) located in the cab. A sample VECU is shown in Figure 17. When forwarding the Mack components to the manufacturer for data extraction, it is necessary to remove both units from the vehicle. VECUs installed prior to 2004 are located behind the kick panel on the right (passenger) side. Beginning in 2006, the VECU was mounted near the center of the dashboard, behind other electronic components. These newer modules are somewhat difficult to remove due to their position. Prior to disconnecting any components, it is recommended that the Mack designees listed on the previous page be contacted.



Figure 17 - Mack Vehicle Electronic Control Unit (VECU)





About Mercedes-Benz

The Mercedes-Benz engine (MBE) uses Detroit Diesel ECM software. For data extraction, two separate programs are required. The first of these programs, *Detroit Diesel Electronic Controls Reports*, also known as *DDEC Reports*, recovers data concerning engine operation for the previous three months. This includes trip information such as daily miles traveled, time of operation, average speed, and fuel economy. In addition, data surrounding the last three fault codes are shown. Referred to as *Diagnostic Records*, this information contains approximately 55 seconds of data concerning vehicle operation and engine performance. The second program used to access Mercedes-Benz ECMS is *Detroit Diesel Diagnostic Link* (DDDL). DDDL retrieves calibration data and additional fault code data.

In addition to trip data and fault code information, Mercedes-Benz ECMS will also document the last two hard brake events, as well as the last time the vehicle came to a stop. In these engines, a hard brake is defined as a wheel speed change of 7 mph/sec. Data stored in these event files include vehicle speed and engine speed, as well as brake, throttle, and cruise control usage for up to 104 seconds before the event, and 15 seconds after the event.

Supported Engines

Data can be extracted from all 2000 and newer 900 Series and 4000 Series Mercedes-Benz engines, provided that the ECM is using software version 12.09 or higher. Because the internal software version cannot be determined without actually accessing the ECM, it is recommended that the presence of internal information be assumed to exist and that steps be taken toward its preservation. Beginning with the use of DDEC VI controls in 2007, diagnostic records are no longer available.

Engine Identification

Mercedes-Benz engines are typically silver in color, with the identification decal located on the top left side of the engine. This decal includes the year, make, and engine model. Figure 18 shows a typical engine identification decal. In this example, a 2004 MBE 4000 engine is shown.

Pre-2007 Mercedes-Benz ECUs consist of two components, the Pumpe Liene Dusse (PLD) on the engine and the Vehicle Control Unit (VCU) located in the cab. If the ECU system must be removed from the vehicle for data extraction, it is recommended that both the PLD and the VCU be secured. Figure 19 shows a VCU located under the dashboard, just below the ignition key switch. For 2007 and newer engines, the similar two-component DDEC VI system is used. Please see the DDEC VI information in the Detroit Diesel section of this Field Guide for more information on these newer engines.



Figure 18 – Sample MBE Engine Identification Decal



Figure 19 – Sample Mercedes-Benz Vehicle Control Unit (VCU)



Data Reference Table

Engine Manufacturer	Engine or ECM Model	Year Introduced	Configuration Data	Quick Stop Data	Last Stop Data	Diagnostic Record
Caterpillar	ADEM II	1994	Yes	See Note 1	No	See Note 1
Caterpillar	ADEM III	1999	Yes	Yes	No	Yes
Caterpillar	ADEM IV	See Note 2	Yes	Yes	No	Yes
Cummins	Celect	1994	Yes	No	No	No
Cummins	Celect Plus	1996	Yes	No	No	No
Cummins	ISB	1998	Yes	See Note 3	No	No
Cummins	ISC	1998	Yes	See Note 3	No	No
Cummins	ISL	1998	Yes	See Note 3	No	No
Cummins	ISM	1998	Yes	See Note 4	No	No
Cummins	ISX	1998	Yes	See Note 4	No	No
Detroit	DDEC III	1993	Yes	No	No	No
Detroit	DDEC IV	1998	Yes	Yes	Yes	Yes
Detroit	DDEC V	2004	Yes	Yes	Yes	Yes
Detroit	DDEC VI	2007	Yes	Yes	Yes	No
Mack	V-Mac III	1998	Yes	Yes	No	No
Mack	V-Mac IV	2006	Yes	Yes	Yes	Yes
Mercedes	900 and 4000	2000	Yes	See Note 5	See Note 5	See Note 5
Mercedes	900 and 4000	2007	Yes	Yes	Yes	No

Note 1 - ECM Must Have Software Revision After November 1995

Note 2 - The ADEM IV was Introduced in 2005 with the C-15 Engine and in 2007 on All Other Models

Note 3 - Sudden Deceleration Data is Available Starting in 2008 (EPA 07)

Note 4 - Sudden Deceleration Data is Available Starting in 2002, with ECM Software Revisions from Late 2004

Note 5 - Data is available with ECM Software Revisions 12.09 or Higher

