SSS-ADEM3

The Smart Sensor Simulator (SSS) for the Caterpillar ADEM A3 and ADEM 2000 ECMs (collectively known as an ADEM III) enables investigators to download HVEDR data without risk of spoiling the data by overwriting Snapshot records associated with diagnostic trouble codes. Sometimes information related to the operation of a vehicle at the time of a traffic crash can be found in Caterpillar Snapshot records associated with diagnostic trouble codes. This article provides the operational warnings and technical information regarding the SSS use with the ADEM 3.
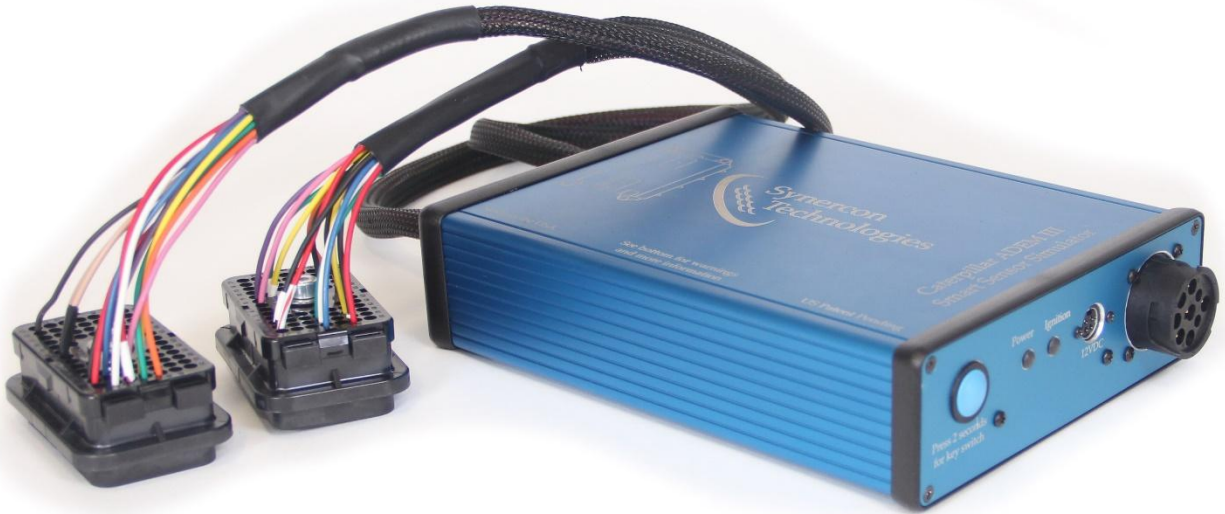

Figure 1: A photograph of the Synercon Technologies Smart Sensor Simulator with the 70 pin Caterpillar connectors.

Operational Notes and Warnings

The ADEM III units have large capacitors that may be discharged before being reconnected to power. The key-on signal operates the capacitor charging circuits which may result in an inrush of current. Since the inrush of current is sourced through the SSS, the SSS unit may experience a "brown-out" where the voltage drops in the SSS as the capacitors charge. This results in the SSS microprocessor resetting, which turns off the ignition relay. The symptom of this event is a brief illumination of the green led on the SSS and the cycling of the internal relay. There are 2 remedies for this situation:

1) Use a larger power supply, like a portable jump pack with the 12V cigarette lighter adapter.
2) Continue to cycle the ignition button until the capacitors charge and the relay stays engaged with the green light on. This process does not generate new fault codes.

The SSS-ADEM3 may not create a fault free environment for ECMs with a 7AS serial number prefixes. For other testing results see the Application Table below.

Some ECM programming and configurations are set to expect certain J1939 messages for information. While the SSS microprocessors generate many commonly used J1939 messages, there may be configurations of ECMs that are looking for J1939 messages that are not provided by the SSS. Some of these configurations can be set by the truck operator which means the factory defaults are not able to identify these changes.

See the TruckCRYPT support for Caterpillar to see what types of data are available from CAT ECMs.

Link to the service notice to add the extra resistors to simulate the sensor needed to measure injector pressure, which is needed for HEUI based engines.

Electronic Control Unit (ECU) Description

The SSS-ADEM III has 2 connectors that are each 70 pins. These connectors are keyed differently, so they cannot be connected incorrectly. The photograph shown below has CAT part numbers for the interfacing connectors.


Figure 2: Caterpillar ADEM III engine control module.

While many ECMs are painted yellow, others may be black or not painted at all. The ECM is located on the driver's side of the engine, about middle height and towards the rear of the engine compartment.
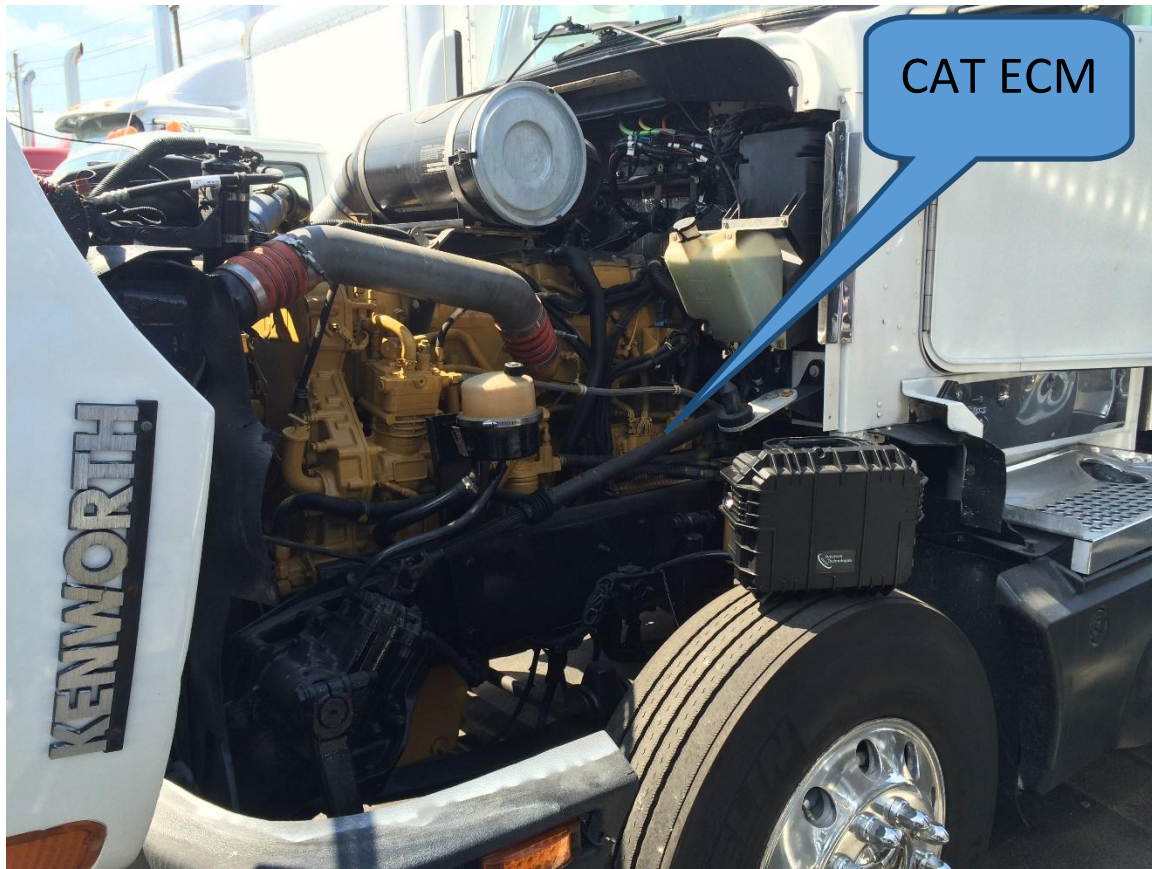
The Cat ADEM III communicate with service tools and the Forensic Link Adapter using the J1708/J1587 network. This is also known as the ATA protocol in Caterpillar circles. The SSS provides a direct wiring from the ECM to the 9-pin diagnostic connector. The photograph below shows a Smart Sensor Simulator connected to a Cat ADEM III. The diagnostic port has a tool connected. In this case, the tool is a Forensic Link Adapter; however, any diagnostic tool that can use the J1708 network can be used (e.g. Nexiq, Cat Comm Adapter, DPA5, Noregon DLA, etc.).
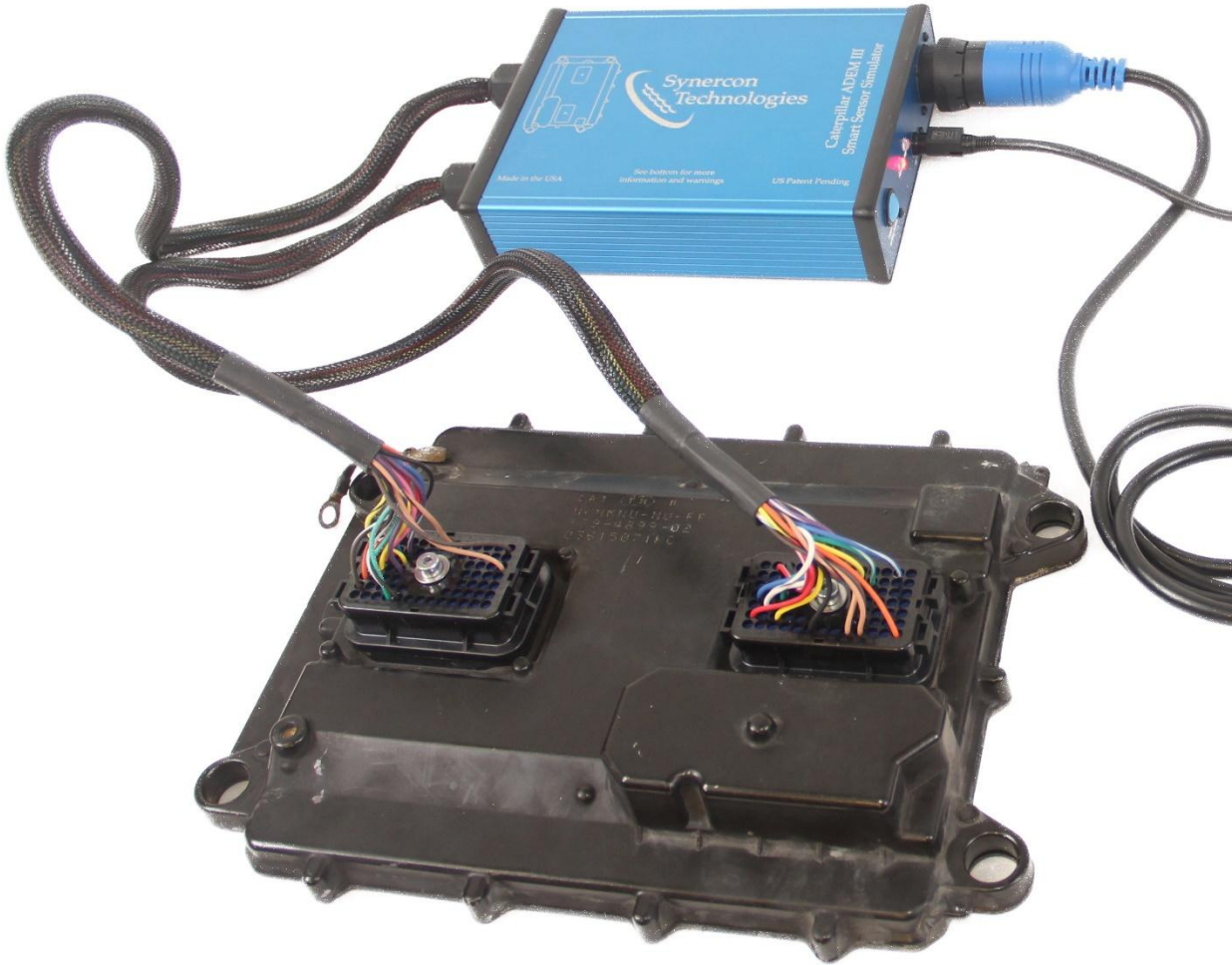
ECU Applications

A Caterpillar ADEM III form factor ECU is used on engines from 1998 to 2010. While the external shape of the ECM is similar from engine to engine, the internal programming and flash files can be different. Thus, the SSS may not produce the same results on all engines. As such, testing is encouraged to verify the expected operation of the SSS.

The following table shows the different engine configurations that use engine control modules with 70 pins on each connector. The years of production are approximate and are intended to be a guide to identify what engine to expect based on the model year of the truck. The table does not account for discrepancies in model years based on rebuilt engines and glider chassis kits.

Prefix	Engine	ECM	Description	Start Year	End Year	SSS Testing
7AS	3126B	ADEM 2000	HEUI	1998	1999	Warning - Faults Known to
8YL	3126B	ADEM 2000	HEUI	2000	2000	Untested
BES	3126B	ADEM 2000	HEUI	2000	2000	Untested
1MM	3406E	ADEM 2000	EUI	1999	1999	Untested
2WS	3406E	ADEM 2000	EUI	1999	1999	Untested
3CS	C-10	ADEM 2000	Clean Power-EUI	1999	2001	Untested
AKB	C-10	ADEM 2000	Remanufactured	2000	2000	Untested

2KS	C-12	ADEM 2000	Clean Power-EUI	1999	2001	Untested
ALS	C-12	ADEM 2000	Remanufactured	2000	2000	Untested
6NZ	C-15	ADEM 2000	Clean Power-EUI	2000	2001	Fault Free
7CZ	C-16	ADEM 2000	Clean Power-EUI	2000	2001	Untested
9SZ	3126B	ADEM 2000	HEUI	2001	2001	Untested
CKM	3126E	ADEM 2000	HEUI	2001	2001	Fault Free with June 2015 Mod
HEP	3126E	ADEM III	Bridge-HEUI	2002	2002	Untested
MBJ	C-10	ADEM III	Bridge-EUI	2002	2002	Untested
MBL	C-12	ADEM III	Bridge-EUI	2002	2002	Fault Free
MBN	C-15	ADEM III	Bridge-EUI	2002	2002	Untested
KAL	C7	ADEM III	ACERT-HEUI	2003	2004	Untested
SAP	C7	ADEM III	ACERT-HEUI	2005	2005	Untested
WAX	C7	ADEM III	ACERT-HEUI	2005	2006	Untested
9DG	C9	ADEM III	ACERT-HEUI	2003	2006	Untested
KCA	C11	ADEM III	ACERT	2003	2006	Untested
KCB	C13	ADEM III	ACERT	2003	2006	Fault Free
BXS	C15	ADEM III	ACERT	2003	2004	Fault Free

Note: The ADEM III and ADEM 2000 appear the same on the outside. Each have 70 pin connectors.

If faults exist, please contact Synercon Technologies for more information and strategies.

See http://www.synercontechnologies.com/files/SSS-ADEM3-June-2015-Mods.pdf for the modification needed for the CKM engine

If you have an ECM that is not tested, please contact us to discuss some options to verify the expected operation. Many engines are electrically the same, but differ in displacement. For example, an MBL engine was tested to be fault free. The MBJ and the MBN engines are likely similar in build and electronics.

Smart Sensor Simulator Design and Programming

The SSS-ADEM 3 uses a Generation 1 printed circuit board that is exclusively licensed from the University of Tulsa. This board uses voltage regulators, resistor networks, digital to analog (DAC) converters, pulse width modulated signals, and J1939 messages to simulate the sensor outputs a truck would provide the engine.

The SSS can accommodate both 2-wire and 4 wire coolant sensors at the same time.

The Accelerator Pedal Position is simulated by sending a 5 volt, 50% duty cycle pulse width modulated signal at approximately 490 Hz. This will register a throttle position of about 51%.

Many vehicles and ECMs expect to see J1939 network traffic. The following messages are generated by the SSS to simulate functions of the truck. The following messages are generated by the CAN channel in the SSS.

PGN	Parameter Group Label	Period (sec)	Source Address	CAN ID (Hex)	Data
65265	Electronic Brake Controller 1	0.100	11- Brake System Controller	0x18F0010B	00 00 00 00 00 00 00 00

65265	Cruise Control/Vehicle Speed	0.100	23 – Instrument Cluster	0x18FEF117	00 00 00 00 00 00 00 00
65265	Cruise Control/Vehicle Speed	0.100	33 – Body Controller	0x18FEF121	00 00 00 00 00 00 00 00
65265	Cruise Control/Vehicle Speed	0.100	40 - Cab Display	0x18FEF128	00 00 00 00 00 00 00 00
65265	Cruise Control/Vehicle Speed	0.100	49 – Cab Controller	0x18FEF131	00 00 00 00 00 00 00 00
57344	Cab Message 1	1.0	23 – Instrument Cluster	0x18E00017	00 00 00 00 00 00 00 00
57344	Cab Message 1	1.0	33 – Body Controller	0x18E00021	00 00 00 00 00 00 00 00
57344	Cab Message 1	1.0	40 - Cab Display	0x18E00028	00 00 00 00 00 00 00 00
57344	Cab Message 1	1.0	49 – Cab Controller	0x18E00031	00 00 00 00 00 00 00 00
65264	Power Takeoff Information	0.100	23 – Instrument Cluster	0x18FEF017	00 00 00 00 00 00 00 00
65264	Power Takeoff Information	0.100	33 – Body Controller	0x18FEF021	00 00 00 00 00 00 00 00
65264	Power Takeoff Information	0.100	40 - Cab Display	0x18FEF028	00 00 00 00 00 00 00 00
65264	Power Takeoff Information	0.100	49 – Cab Controller	0x18FEF031	00 00 00 00 00 00 00 00

The J1939 messages are sent from 5 source addresses. Four of the sources send duplicate information, which ensures that the ECM sees the messages relaying information in the J1939 messages. The truck operator can change the source address for different messages using CAT ET. Therefore the SSS broadcasts messages from all source addresses, providing the most complete truck simulation environment. For example, the Diesel Particulate Filter regeneration switch status is broadcast on the Cab Message (PGN 57344), but depending on the implementation, the message could come from the Instrument Cluster, Body Controller, Cab Display, or Cab Controller. By broadcasting these messages from all four source addresses, the ECM will be satisfied, regardless of its configuration.

Smart Sensor Simulator Wiring Harness

Matching the programming running on the circuit board to the ADEM A3 ECM requires building a cable interface. The cable is defined by specifying each end of the wires. These signals and circuits are specified in the following table.

CAT Vehicle Connector P1 (P/N: 160-7689)				
Vehicle connector	Wire Application	Color	PCB Designator	Mini-Fit Jr Rev 7c
P1-2	+5V supply	Red/White	5V Veh Supp	J18:18
P1-3	Sensor Return	Black/White	Vehicle Sens Ret	J18:8
P1-8	J1708 +	Pink	J1708 +	J18:14
P1-9	J1708 -	Purple	J1708 -	J18:15

P1-10	Output #2	Purple/White	Free	Free
P1-11	Output #5	Tan/Black	Free	Free
P1-12	Output #3	Blue/White	Free	Free
P1-13	Output #4	White/Black	Free	Free
P1-19	Output # 6	Yellow/Black	Vout E	J18:6
P1-20	Output # 7	Green/White	Vout F	J18:7
P1-26	Coolant level Norm	Brown/White	Vout G	J18:2
P1-32	VSS +	Blue	VSS +	J18:4
P1-33	VSS -	White	VSS -	J18:5
P1-34	CAN Low	Green	J1939 -	J18:17
P1-48	ECM power	Red	Safe 12V	J18:1
P1-50	CAN Hi	Yellow	J1939 +	J18:16
P1-54	Coolant level Low	Brown	V2WS 1	J18:12
P1-63	ECM Ground	Black	GND	J18:9
P1-66	Throttle position	Tan	PWM 3	J18:11
P1-70	Ignition	Orange	Ignition	J18:10

CAT Engine Connector P2 (P/N: 160-7690)				
Engine connector	Wire Application	Color	PCB Designator	Mini-Fit Jr Rev 7c
P2-2	+5V supply	Red	5V Eng Supply	J24:13
P2-3	Return	Black	Eng Sens Ret	J24:12
P2-8	Coolant Solenoid	Tan/Black	E2WS 1	J24:5
P2-13	Air inlet shutoff	Brown	VR0	J24:15
P2-14	Barometric Pressure	White	PWM 2	J24:24
P2-16	Fuel Pressure 1	Blue	VR2	J24:10
P2-17	Fuel pressure 2	Purple/White	VR1	J24:9
P2-24	Oil Pressure	Red/White	Vout C	J24:21
P2-25	Intake Act Press	Pink	VR0	J24:14
P2-31	Intake Valve Press	Tan	E2WS 2	J24:6
P2-32	Engine Coolant Temp	Green	Vout D	J24:22
P2-33	Fuel Temp	Yellow	Vout A	J24:19
P2-35	Intake Man Air Temp	Purple	Vout B	J24:20
P2-40	Boost Press	Orange	PWM 1	J24:23
P2-48	Engine speed +	Brown/White	Free	Free
P2-49	Engine speed -	Green/White	Free	Free
P2-58	Engine Speed 2+	Yellow/Black	Vout H	J18:3
P2-59	Engine Speed 2-	Black/White	Free	Free

Free wires are run to enable future use and are not connected internally in the SSS.

All SSS-ADEM3 units shipped after June 28, 2015 also have a wiring modification that enables a circuit to simulate the injector actuation pressure sensor. [Instructions for the June 2015 modification](#) are printed as a PDF file.

Acronyms

ACERT   Advanced Combustion Emissions Reduction Technology

ADEM   Advanced Digital Engine Management

CGI   Clean Gas Induction

CRS   Cat Regeneration System

EUI   Electronic Unit Injection

HEUI   Hydraulically actuated and Electronically controlled Unit Injectors

ECM   Electronic Control Module or Engine Control Module

IAPCV   Injection Actuation Pressure Control Valve on HEUI engines only

PGN – J1939 Parameter Group Number