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# EML IIIs

**Model: E38 - M73 Engine**
**E31 - M73 Engine**

**Production Date: E38 1995 - Present**
**E31 1996 - End of Production**

**Manufacturer: Siemens**

**Pin Connector: 88 Pins**

## Objectives of the Module

After completing this module, you will be able to:

- Name the Components that are Contained in the DK motors
- Explain the Stepper Motor Functions that are Monitored
- List the Inputs Required for EML Operation
- Decribe How the Throttle Valves are Synchronized
- List What Control Modules Require a Throttle Input Signal
- Understand What Type of Signal is Generated by the PWG

# EML IIIs

## Purpose of the System

The EML IIIs is an electronic throttle control system for the M73 V-12 engine. The EML IIIs was designed and developed by Siemens to BMW specifications.

The EML IIIs system uses two throttle valves and one pedal position sensor (PWG). The EML IIIs control module regulates the position of the throttle valves based on the input from the pedal position sensor.

**In addition to throttle control, the main functions of the EML IIIs include:**

- Idle stabilization by regulating the throttle openings at idle.
- Throttle valve positioning for optimum starting.
- Synchronization of the cylinder banks.
- Air volume control for ASC/DSC operation.
- Cruise control regulation (the EML IIIs control module contains the GR II logic introduced on the E38 740).
- Maximum road speed limiting

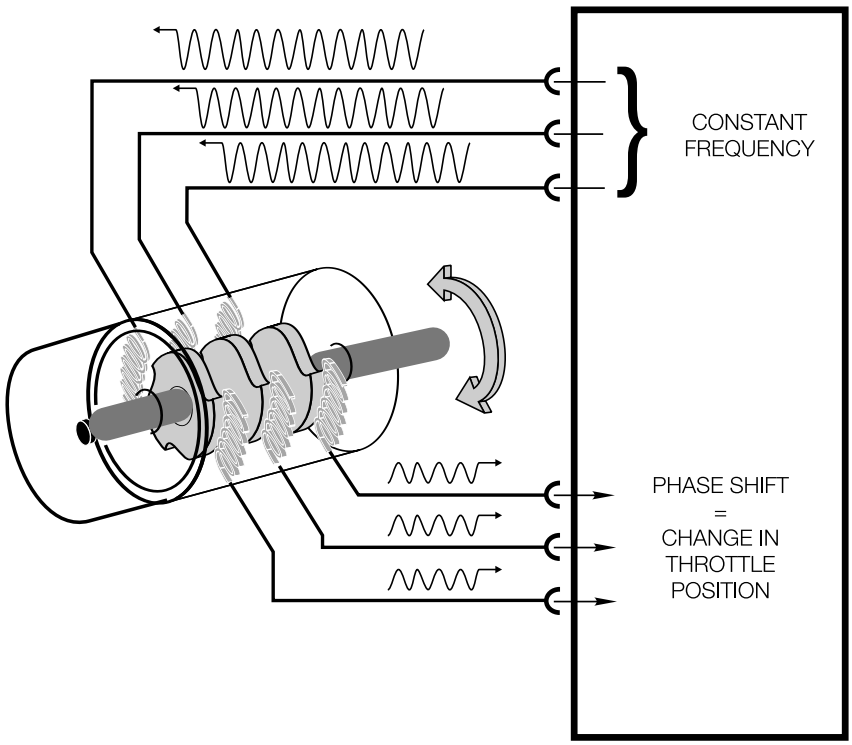
The operation of the EML IIIs is enhanced with additional backup (redundancy) features. This helps ensure reliable operation while maintaining a high level of operational safety.

The fault memory of the EML IIIs control module is stored in an **EEPROM** so that disconnection of the battery will not erase any stored faults.

The EML IIIs system is incorporated into the driving management system and is connected to the CAN line for signal interfacing with the ECM, ASC+T and AGS control modules.

**The EML III system includes:**

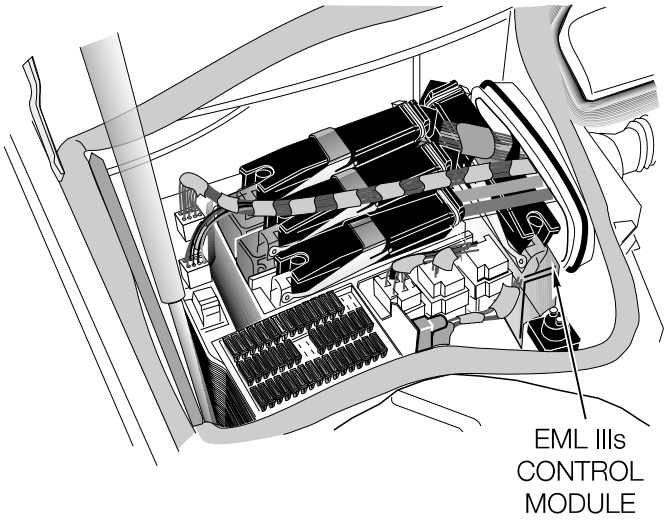
- The EML IIIs control module contains two separate processors for redundant checking of inputs and output controls.
- Each throttle valve is controlled by two separate stepper motors driving one rotor
- The external safety path.
- E38 EML fault indication is handled by the Check Control Module, through the instrument cluster matrix display.
- The hall sensor brake pedal switch is used for the brake pedal input.
- Logic monitoring of pedal/throttle valve operation



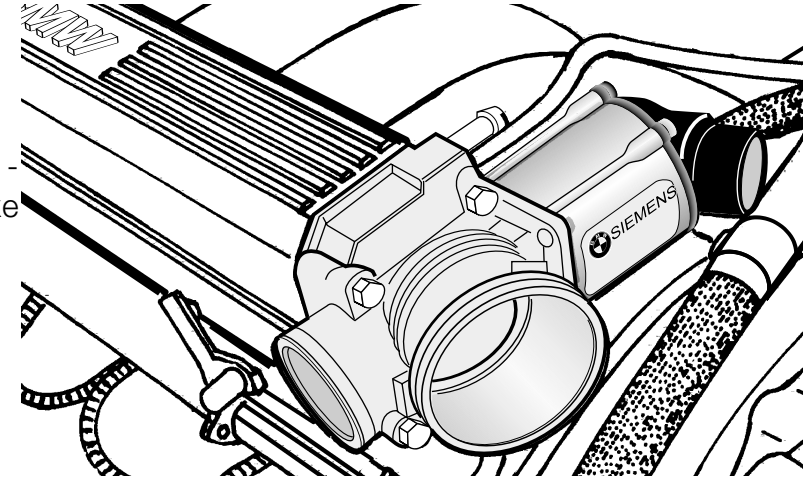
## COMPONENTS

The main components of the EML IIIs system include:

- The EML IIIs control module - located in the E-box.

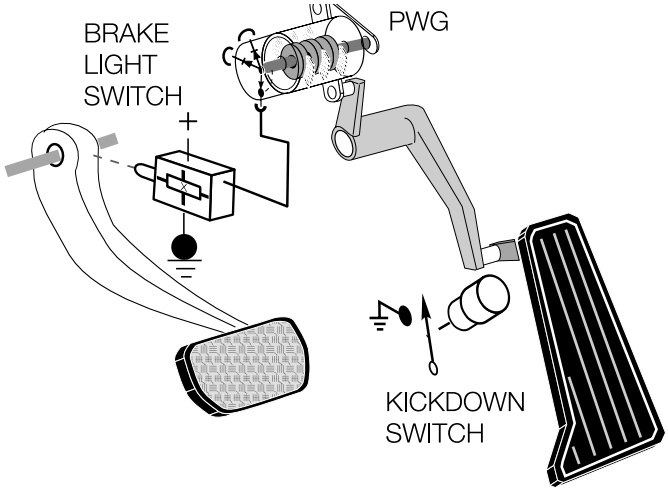



- Two throttle (DK) assemblies - mounted on each intake manifold.

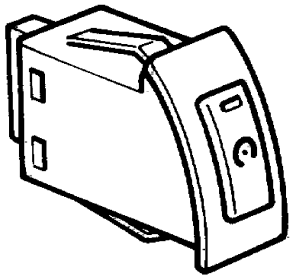



- One pedal position sensor (PWG) - connected to the accelerator pedal (with a separate kick-down switch).

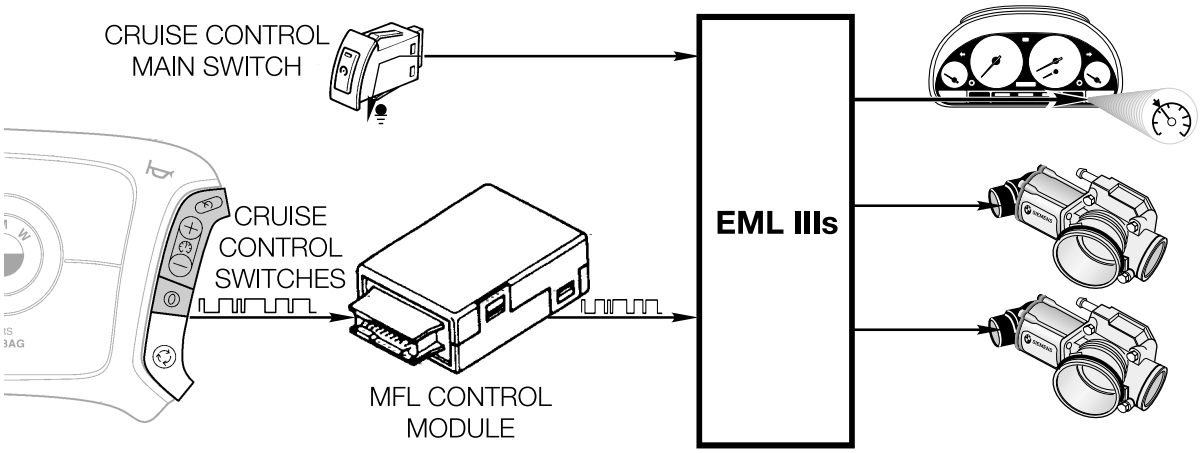
- Electronic brake light switch.



• Cruise control main switch - mounted on the instrument panel. Provides a switched ground input to the EML control module (Early E38 only, incorporated in the steering wheel control switch on later models).

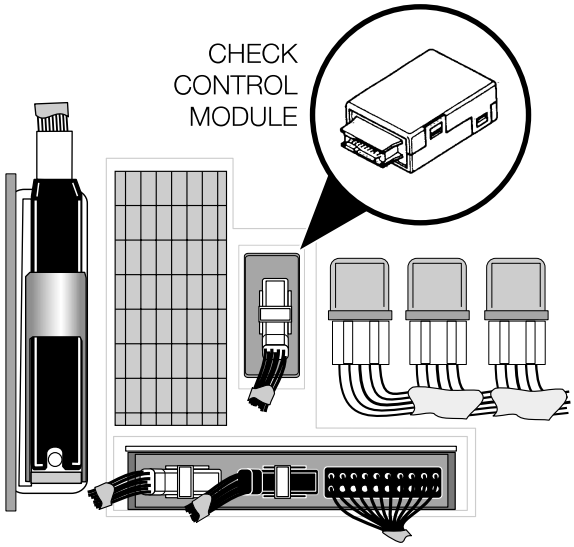


• Multi-Function Steering Wheel - cruise control switch pad and the MFL control module.




(E38 only)

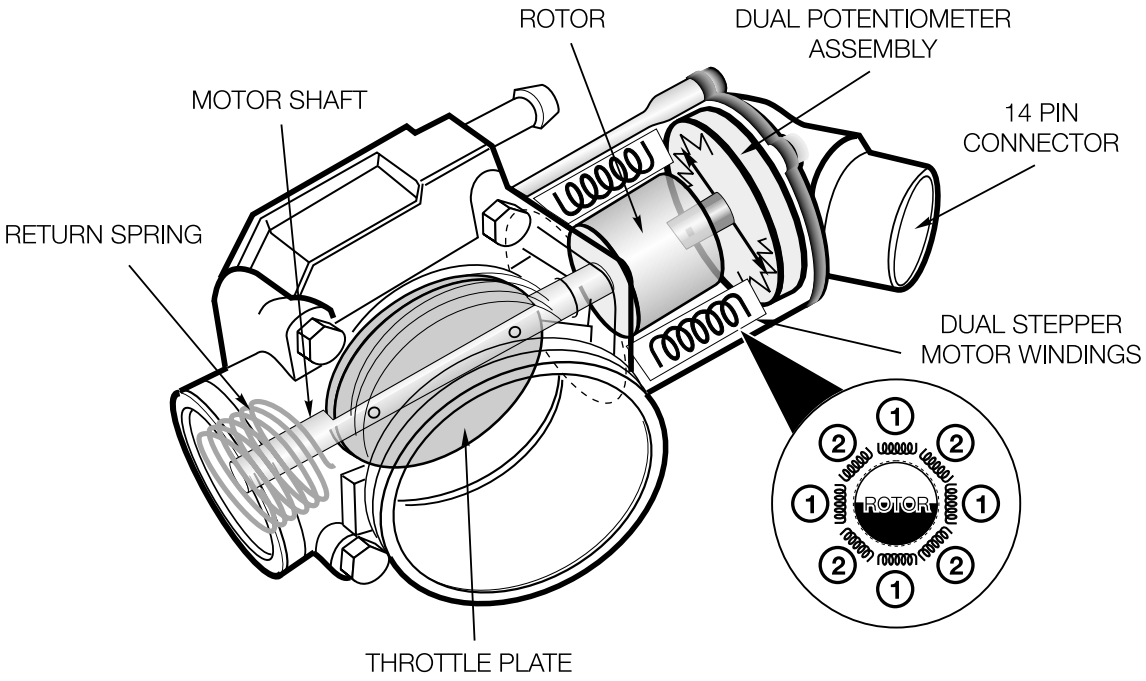
• Check control module - for activation of the fault warning display.



## THROTTLE VALVE (DK) MOTORS

The throttle valve assembly consists of the DK housing with the throttle valve plate, return spring, drive motor and feedback potentiometers. The EML IIIs throttle valve plate is driven directly by the motor shaft which allows for a precise control of the throttle plate positioning.

A dual stepper motor configuration is used to drive the throttle plate. Both stepper motors are controlled through separate final stages in the EML control module and operate on the one armature. The final stages for one stepper motor windings are controlled by one micro processor while the second motor windings are controlled by the second processor. The control of the stepper motors takes place simultaneously by each processor.




The dual feedback potentiometers signal the movement and position of the throttle plate to each processor. The two potentiometers have separate power and ground circuits to ensure the reliability of their operation.

This dual redundancy system allows the EML IIIs to continue operation, without driver inconvenience, if one stepper motor or control circuit malfunctions. If the self diagnosis of the EML IIIs detects a fault with one of the stepper motor controls, it will switch off the affected circuit and continue operation from one motor control circuit. The fault will be logged and the EML fault warning will be displayed in the cluster matrix.

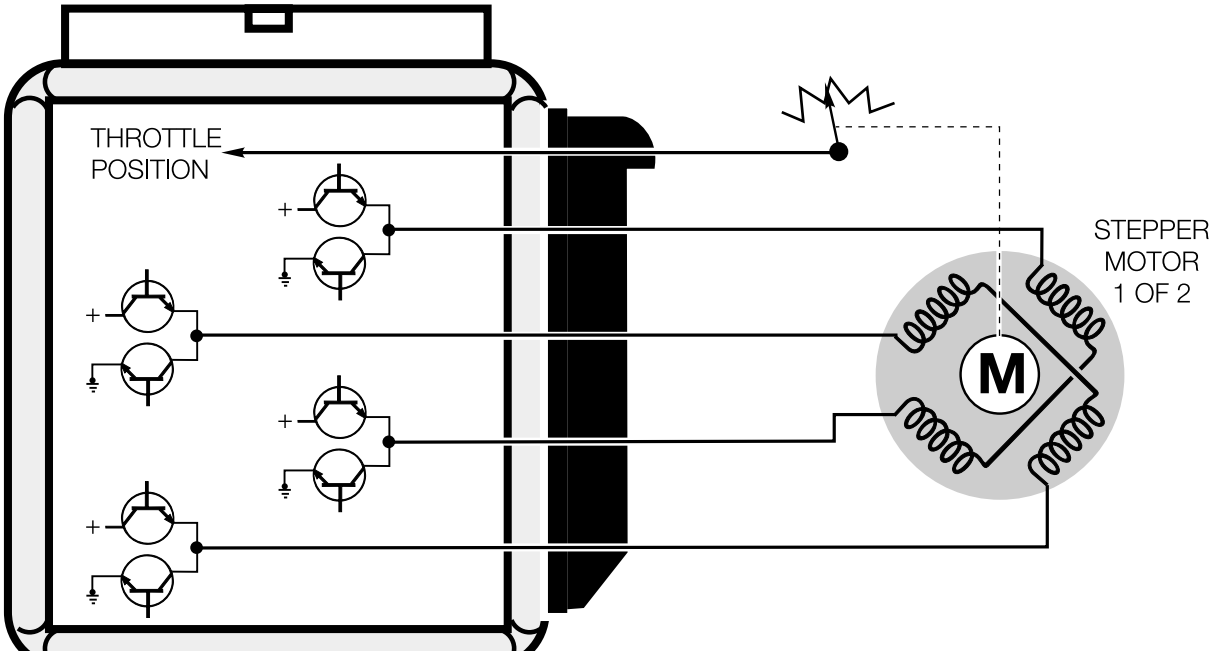
If a fault occurs that cannot allow continued operation of the throttle valve, the control for that bank of cylinders will be switched off.

## Stepper Motor Control

A digital square wave signal is used to drive the stepper motor of the DK assembly. The duty cycle of the frequency and trigger of the signal are changed to produce the magnetic field required to move the stepper motor rotor.

Each set of stepper motor windings are controlled by four final stages. Each final stage has the ability to switch between power and ground to reverse the direction of current flow through the windings (trigger). This switching allows the magnetic field of the coils to be reversed allowing the rotor to be driven in either direction to position the throttle plate at the precise setting called for by the PWG input request.

The final stage control varies the duty cycle to control the speed of movement and position of the throttle plate.




**Self Diagnosis:** The scope of EML self diagnosis for stepper motor operation includes:

- Checking
  - Both throttle valves are checked dynamically prior to engine starting (part of pre-start check with KL 15 on).
  - All eight final stage controls per stepper motor when KL 15 is switched on.

- Monitoring
  - The supply voltages for all potentiometers.
  - Throttle valve set position with the feedback potentiometers position.
  - Comparing the two potentiometer signals.
  - Comparing the set points calculated by each individual processor.
  - The throttle valve operation for OBD II checking requirements.

## CONDITIONS OF STEPPER MOTOR CONTROL

**Starting:** The EML IIIs control module will position the throttle valves to the optimum opening for engine start when it receives the KL 50 input over the CAN line.

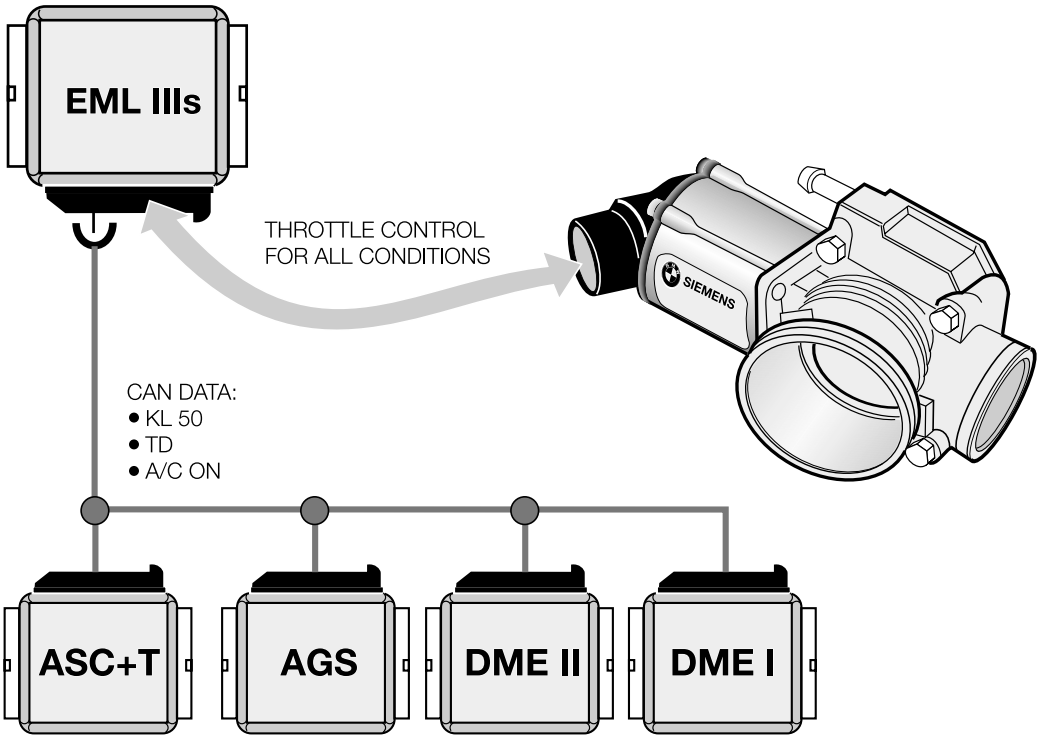
**Idle:** The EML IIIs programming will maintain a stable idle by adjusting the opening of the throttle valves when the vehicle is at a standstill. The EML receives the engine RPM signal from the ECM over the CAN line.

The idle will be stabilized for A/C compressor activation to compensate for the load of the compressor.

The EML receives TD and AC on signals over the can line.

**Decel Fuel Cutoff:** Decel fuel cutoff is activated based on the input from the pedal position sensor and the engine RPM signals. A high signal is supplied from the EML control module to the ECM control modules for the purpose of activating decel fuel cut off.

These input signals to the ECM control modules are separate hard wire lines that are also used for the “safety fuel cut off” feature of the EML control.



## THROTTLE POSITION SENSOR (PWG)

The throttle position sensor uses an inductive coil “oscillator” principle for accelerator position recognition input. The PWG consists of:

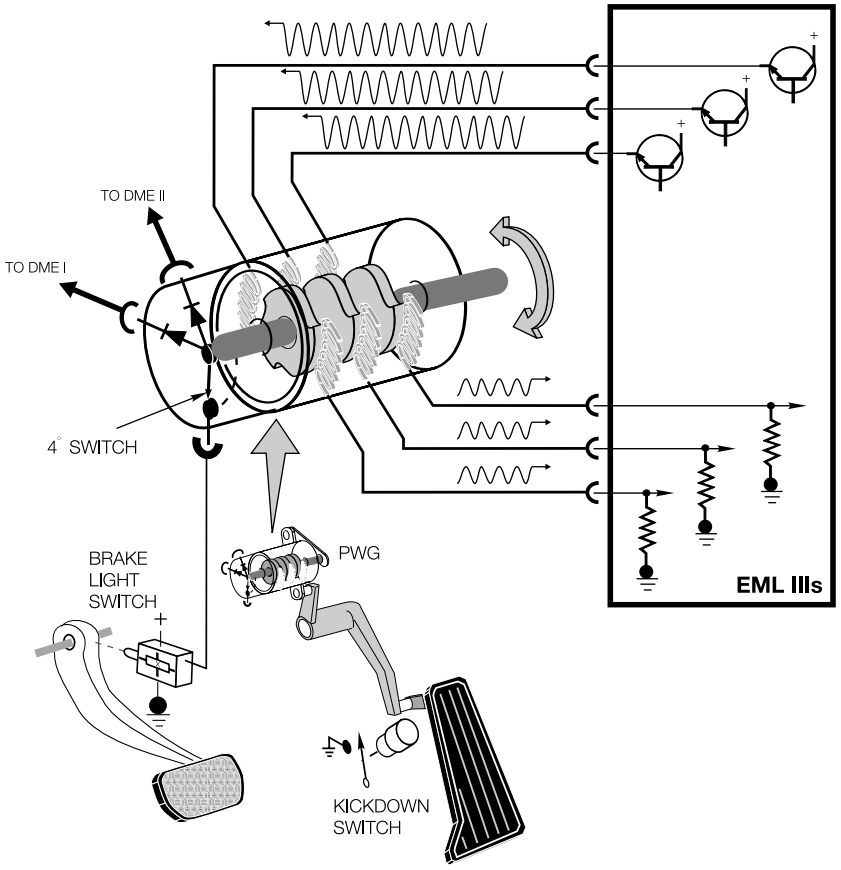
- Three separate inductive coils.

- One soft iron core eccentric, attached to the accelerator pedal through the PWG shaft.

- One 4° switch, for the external safety path function.

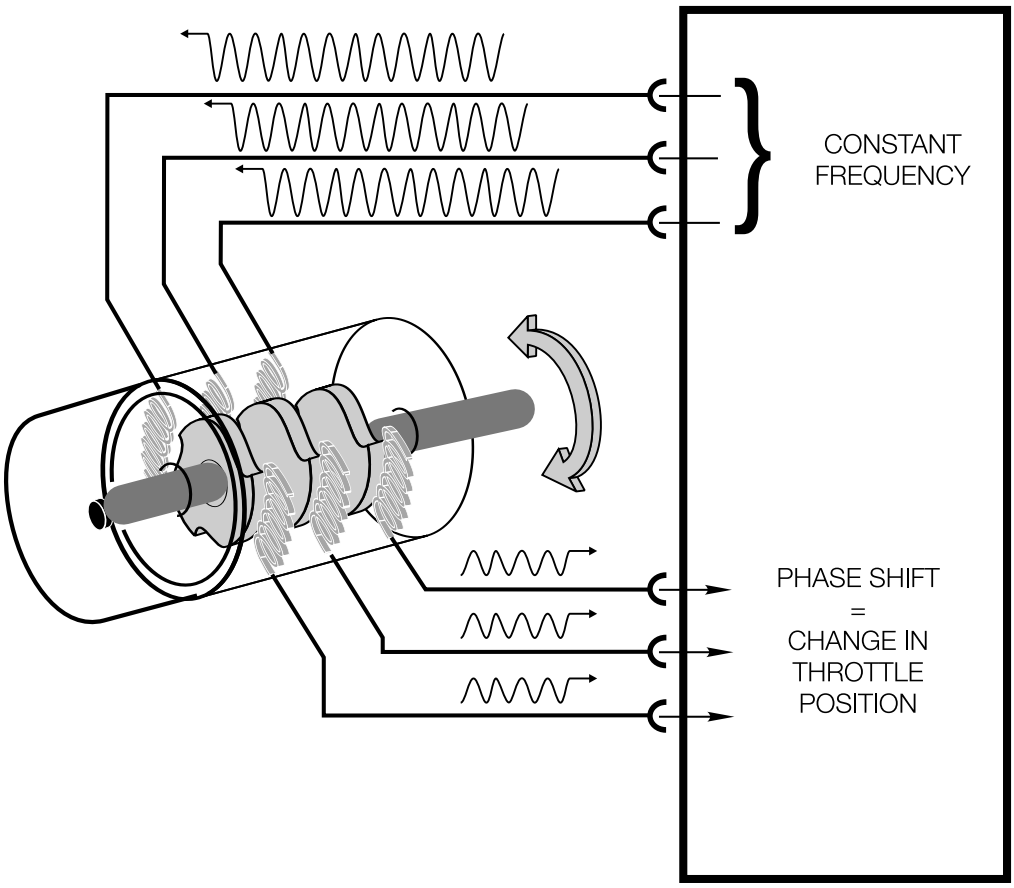
Each coil is supplied with an AC voltage signal, at a specific frequency, from the EML IIIs control module. As the pedal is moved, the eccentric shape of the iron core moves closer to the PWG coils.

This causes the inductance of the coils to increase due to the concentration of the magnetic field. The increasing inductance in the coil causes the amplitude of the AC frequency to be reduced.



The amplitude is decreased as the pedal is pressed down.

The EML control module monitors and processes the changing amplitude as the input request for throttle opening/closing.




The changing amplitude value is a measure of accelerator pedal movement. The EML control module is programmed to recognize pedal movement from 0° (idle) to 99° (WOT) based on the changing voltage signal.

The three inductive coils are used for redundancy purposes. All three signals from the PWG are input and evaluated by both processors of the EML IIIs control module.

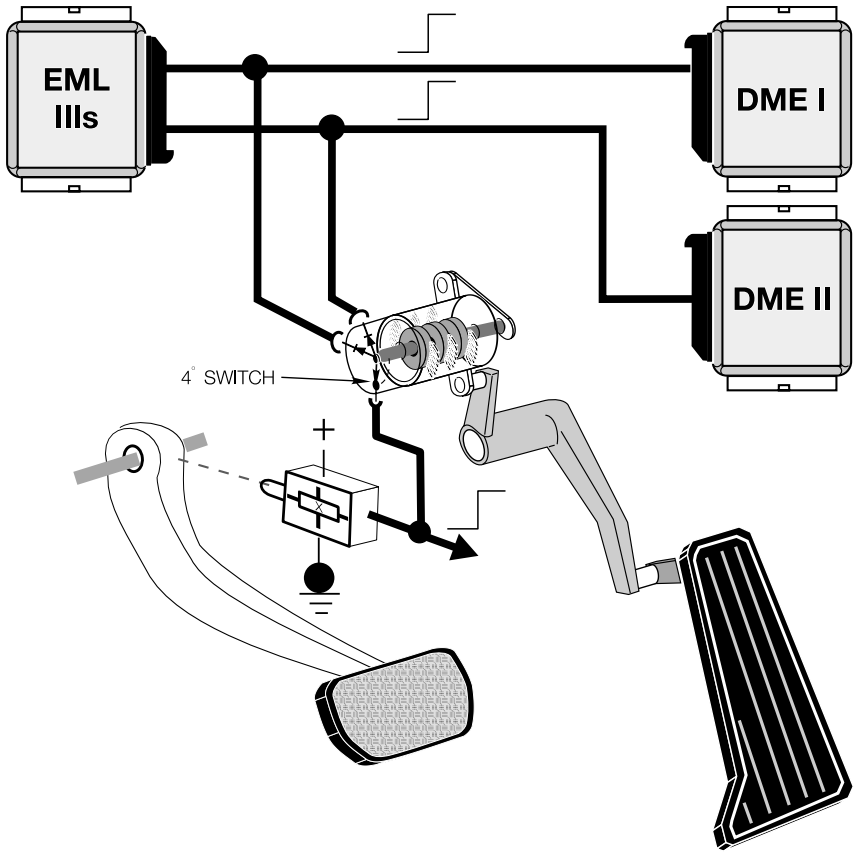
If one signal were to fail, the operation of the EML system, from the driver's perspective, would not be affected. The EML IIIs control module would continue to function from the remaining two signals. The fault will be recognized and stored in the fault memory and a failure warning message would be posted in the display matrix. If a second signal were to fail, the system would go into the failsafe operation and the EML IIIs control module would stop responding to the throttle input. The engine will start but not run above idle. This second fault would also be stored in the fault memory.

## EXTERNAL SAFETY PATH

The external safety path circuit is maintained to ensure that the decel fuel cutoff is activated if a fault occurs with the output control of the throttle motors causing the engine not to return to idle.

The external safety path exists from the electronic brake light switch, through the 4° switch, to the decel fuel cutoff inputs of the ECM control modules.

With the accelerator pedal released (4° switch closed) and the brake pedal pressed, a high signal is supplied (bypassing the EML control module) to the DME control modules to activate decel fuel cutoff.




A special tool is not required to test the safety path circuit for proper operation. A procedure is listed in the diagnostic pages for this purpose.

It requires stepping on the accelerator < 4° but far enough to display an off idle condition. With this displayed on the DIS/MoDIC screen, stepping on the brake pedal will display the decel fuel cut off request to the ECM.

## BASIC ADAPTION OF THE PWG

The PWG adaption allows the EML control module to learn the idle and wide open throttle limit positions. This adaption procedure must be carried out in the following instances:

- The EML control module is replaced
- The pedal position sensor is replaced
- The PWG is disconnected with the ignition “ON”
- A new variant code is installed in the EML control module
- The DIS/MoDIC diagnostic procedures request an adaption be carried out as part of the troubleshooting

**NOTE**: The engine will start but the throttle control system will not respond to inputs from the PWG until this basic adaption has been completed. The procedure for the basic adaption is listed in the “SPECIAL FUNCTIONS” section of the DIS/MoDIC - EML test pages.

The adaption procedure is carried out with KL 15 switched “ON” and the engine “OFF”. Driving the vehicle is not required for pedal adaption.

## EML III S CONTROL MODULE

The EML IIIs control module is located in the E-Box. All control and safety monitoring functions of the EML are backed up by redundant processing. Each pair of the output control final stages of the DK motors is controlled by a separate processor. The EML control module communicates with the ECM, ASC+T and EGS control modules over the CAN line for the following inputs/outputs:

### ECM Control Modules

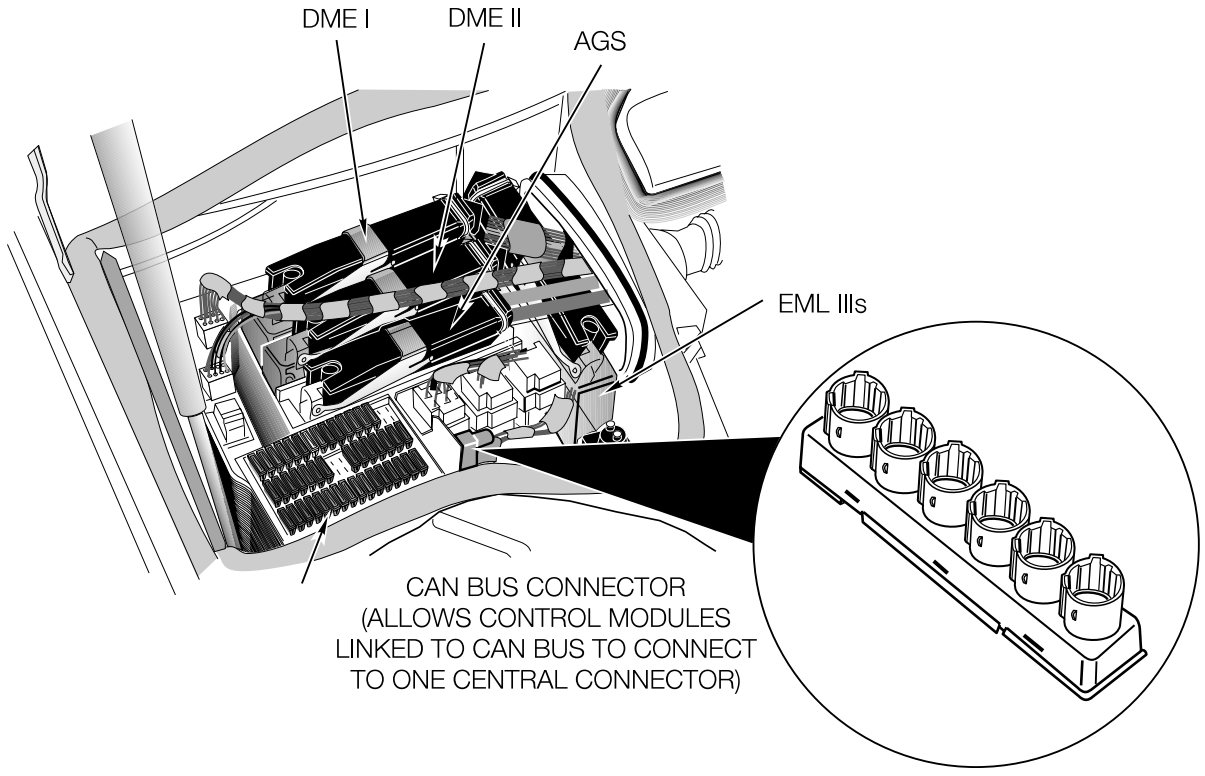
- Engine coolant temperature
- Throttle position
- A/C status (ON/OFF)
- Load signal (ti) for each DME
- Engine speed (TD)

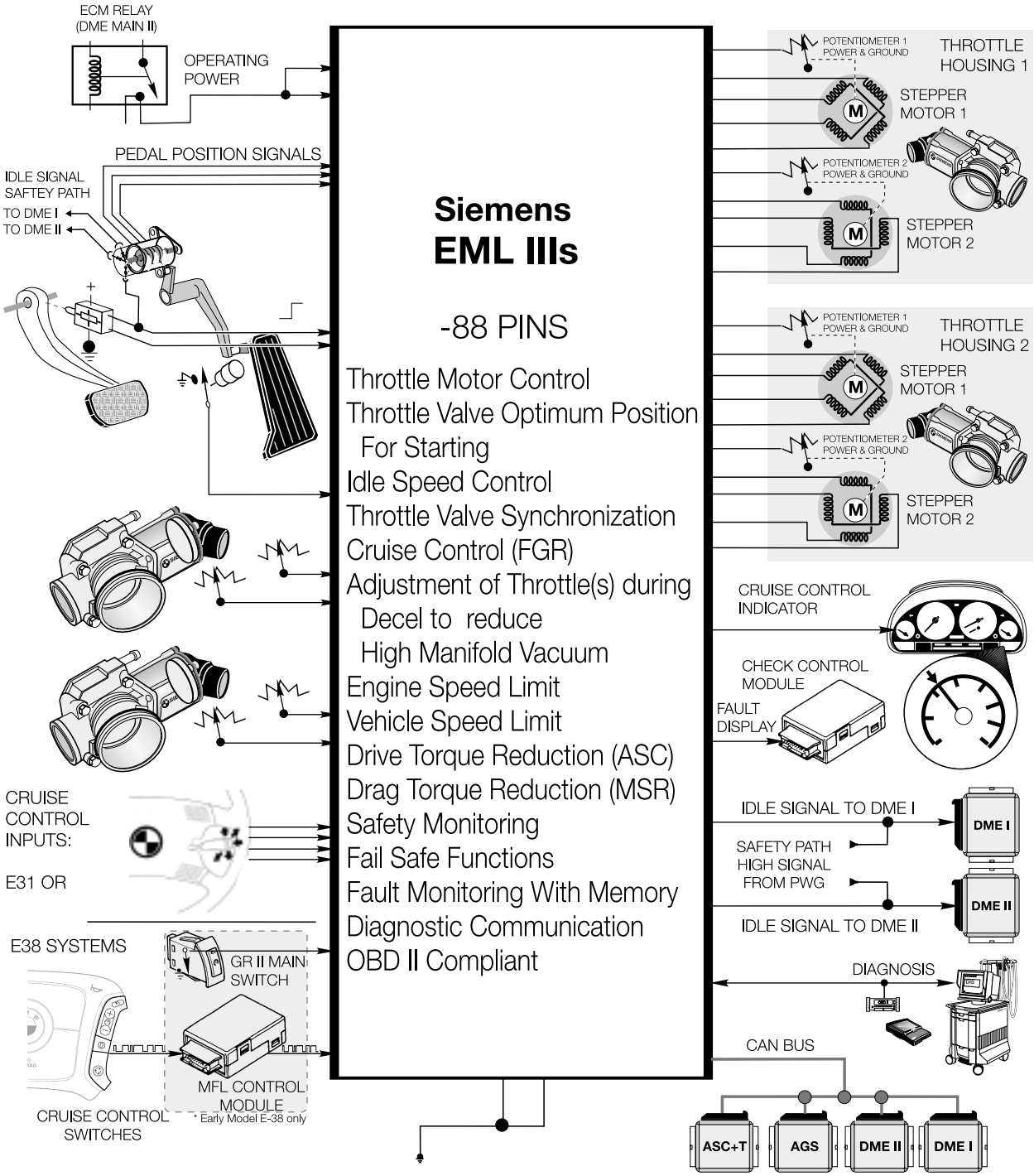
### AGS Control Module

- Kickdown
- Transmission range/program
- Shift Characteristics

### ASC+T Control Module

- Throttle valve angle
- Throttle valve increase
- Throttle valve decrease
- Vehicle speed

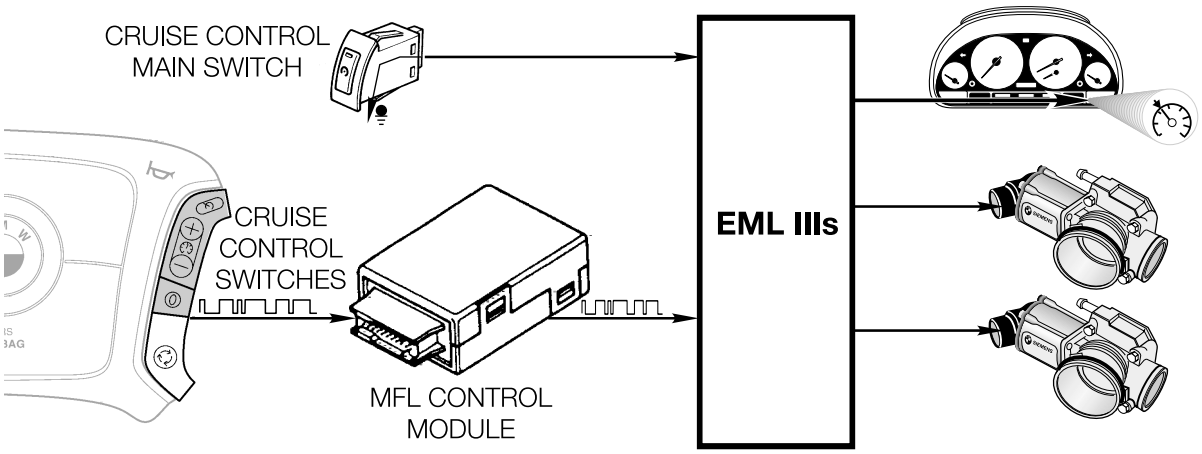



ECM RELAY
(DME MAIN II)
OPERATING
POWER
PEDAL POSITION SIGNALS
IDLE SIGNAL
SAFTEY PATH
TO DME I
TO DME II
CRUISE
CONTROL
INPUTS:
E31 OR
E38 SYSTEMS
GR II MAIN
SWITCH
MFL CONTROL
MODULE
* Early Model E-38 only
CRUISE CONTROL
SWITCHES
Siemens
EML IIIs
-88 PINS
Throttle Motor Control
Throttle Valve Optimum Position
For Starting
Idle Speed Control
Throttle Valve Synchronization
Cruise Control (FGR)
Adjustment of Throttle(s) during
Decel to reduce
High Manifold Vacuum
Engine Speed Limit
Vehicle Speed Limit
Drive Torque Reduction (ASC)
Drag Torque Reduction (MSR)
Safety Monitoring
Fail Safe Functions
Fault Monitoring With Memory
Diagnostic Communication
OBD II Compliant
POTENTIOMETER 1
POWER & GROUND
THROTTLE
HOUSING 1
STEPPER
MOTOR 1
POTENTIOMETER 2
POWER & GROUND
STEPPER
MOTOR 2
POTENTIOMETER 1
POWER & GROUND
THROTTLE
HOUSING 2
STEPPER
MOTOR 1
POTENTIOMETER 2
POWER & GROUND
STEPPER
MOTOR 2
CRUISE CONTROL
INDICATOR
CHECK CONTROL
MODULE
FAULT
DISPLAY
IDLE SIGNAL TO DME I
DME I
SAFETY PATH
HIGH SIGNAL
FROM PWG
DME II
IDLE SIGNAL TO DME II
DIAGNOSIS
CAN BUS
ASC+T
AGS
DME II
DME I

## CRUISE CONTROL OPERATION

All functions of the cruise control system are incorporated in the EML IIIs control module. The cruise control main switch is wired directly to the EML IIIs control module. The multi-function steering wheel inputs are direct to the EML through a separate serial data bus.

The EML control module regulates the operation of the cruise control by regulating the position of the throttle valves as it did in the past. The new cruise control logic adopted with the GR II E38 740I are incorporated in the EML control logic.




The EML controls the cruise control indicator lamp in the instrument cluster. When the main switch is pressed, the indicator lamp is illuminated.

The switching “OFF” priorities for cruise operation are carried over from the GR II system. The commands for cruise control operation are carried out according to the highest priority as follows:

| | |
|---|---|
| 5 - brake light switch - | directly from EML control module |
| 4 - transmission in neutral - | from AGS control module over CAN |
| 3 - “OFF” request - | from MFL steering wheel |
| 2 - Set/Accelerate - | from MFL steering wheel |
| 1 - Resume - | from MFL steering wheel |

The new logic incorporated into the cruise control include:

- Smoother acceleration under the Resume feature.

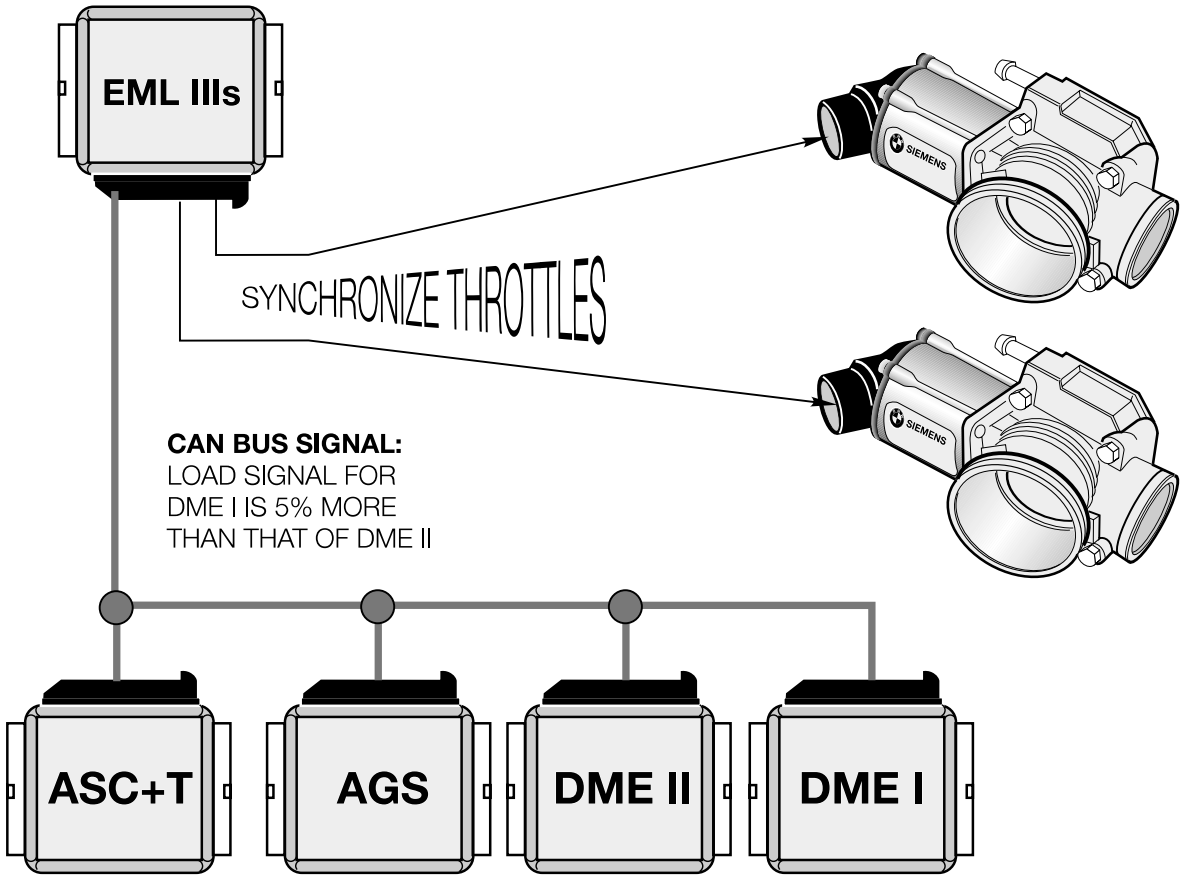
- Downshift on decel (down hill) to provide engine braking effect.

## CYLINDER BANK SYNCHRONIZATION

The throttle valves are synchronized automatically on the EML IIIs system. This ensures that both cylinder banks receive the same air charge and creates a smooth running engine. The synchronization takes place at an idle during the purge system shut off time. The synchronization process last approx. 100 seconds.

The total conditions for synchronization to take place are:

- Idling
- Engine speed between 560 - 720 RPM
- Throttle valve stops recognized (DK idle position)
- Load difference side-to-side no more than .04 to 10 %
- No faults in DME/EML control modules
- Purge system shut down




The EML control module processes the load signals from the two DME control modules. If a difference exists, the EML will adjust the DK motors to achieve equal air throughput on both banks. If the load difference is greater than 10%, the synchronization will not take place and a fault is stored in the memory.

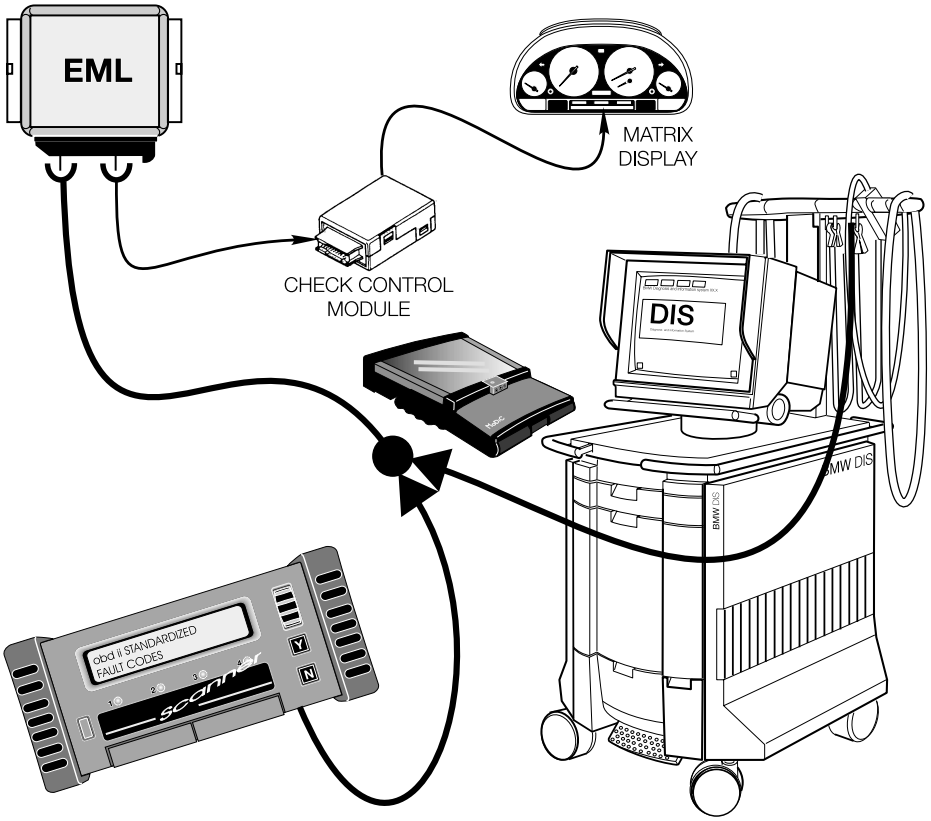
## FAULT RECOGNITION/DIAGNOSIS

The OBD II regulations require that any fault with the EML IIIs system that can affect emissions must turn on the “Check Engine Lamp” and be accessible through the OBD II read out connector. These faults will also be stored in the fault memory of the EML IIIs control module for access through the DIS test programs.

The failure warning of the EML IIIs system is through the check control system (CCM) of the E38. A fault message  from the EML control module is sent to the CCM and the message will be posted in the matrix display of the instrument cluster.

The diagnosis program of the DIS includes the “Fault Symptom” troubleshooting paths as well as the Test Modules, Service Functions and Expert Modes introduced with the E38 740i.

Diagnosis and troubleshooting should always begin with the fault symptom troubleshooting mode. Follow the test modules and diagnostic path provided by the DIS Tester.



## BASIC TROUBLESHOOTING

- Always personally verify the customer complaint.
- Perform a Quick Test to determine if the vehicle systems have logged fault codes.
- Call up the faulted system or appropriate test schedule to verify the correct control module is installed in the car.
- Follow the DIS/MoDIC on screen instructions and perform all tests as specified.
- Use the DIS and fault symptom diagnostic procedures as trained.
- Follow the appropriate test module procedures for systems that malfunction but fail to set faults in memory.
- System problems which elude diagnostic procedures must be brought to the attention of BMW of North America, Inc.
- **BMW Technical Assistance Hotline 1-800-472-7222**

## Review Questions

1. Why are faults not erased when the battery is not disconnected?_____
   _____

2. What components are contained in the DK motors?
   _____ _____ _____ _____
   _____ _____ _____

3. What Stepper Motor Functions are Monitored? _____
   _____
   _____
   _____
   _____

4. What happens to the AC frequency when the accelerator pedal is depressed? _____
   _____
   _____

5. If the engine does not respond after the PWG is replaced, what should you do?
   _____
   _____
   _____

6. How are the throttle valves synchronized? _____
   _____
   _____
   _____

7. What control modules require a throttle input signal? _____
   _____ _____ _____

8. How many final stage transistors are required to control one stepper motor?_____