CIRCUIT OPERATION

Sensors

Engine Speed Sensor (X255)

The engine speed signal is crucial to the system, as the information from the sensor is used in virtually all of the strategies within the 'DDE' (Digital Diesel Electronics) and its Engine Control Module (ECM) (Z132). Through this sensor, the ECM (Z132) knows if the engine is turning, how fast it is turning and approximately where the engine is in its cycle. The sensor is of the 'Hall effect' type, which sends out a pulse to the ECM (Z132) every time a 'tooth' is sensed on the flywheel (the flywheel has six 'teeth'). If the sensor fails, then the warning lamp is activated and the ECM (Z132) enters a 'limp home' mode where the ECM (Z132) looks at the signal from the needle lift sensor in one of the injectors. The needle lift sensor gives one pulse per injection, i.e. one pulse per twelve engine speed sensor pulses. The response of the ECM (Z132) to changes in engine parameters will, therefore, be considerably slower, and a higher idle speed is initiated to try to compensate at low engine speeds.

Needle Lift Sensor (X318)

The engine has six diesel fuel injectors, one of which has a sensing element at the tip which informs the ECM (Z132) exactly when the injector fires (the 'beginning of injection' signal). The ECM (Z132) uses this to correct the injection timing and also to back up the engine speed signal in case that sensor fails. If this sensor fails, the warning lamp will switch on and the vehicle will enter 'limp home' mode with reduced engine power/performance and lack of throttle response (as there is a lack of feedback on the injection timing).

Engine Coolant Temperature Sensor (X126)

This sensor is a 'thermistor' (a temperature dependent resistor) where the voltage output varies in proportion to coolant temperature. The ECM (Z132) uses this information in many strategies, i.e. to correct the injected fuel quantity and timing (especially during cold starts), length of glow plug timing, etc. The sensor is located in the top of the engine block. In case of a failure, the warning lamp is not activated and the ECM (Z132) selects a substitute value of 50˚C for glow plug and ignition timing and uses the fuel temperature to correct the fuel quantity, glow plug timing will not be correct, possibly resulting in long crank times in cold weather as well as slight fuelling effects. These symptoms may not be noticeable.

Mass Air Flow Sensor (X105)

The Mass Air Flow Sensor (X105) is a hot film sensor which has a heated surface maintained by an electrical current at a constant temperature. With cool air flowing past the sensor, the volume of air drawn into the intake manifold is measured by the electrical current required to keep the temperature of the hot film sensor constant. This data is used to calculate the injected fuel volume and the rate of Exhaust Gas Recirculation (EGR).

The intake air temperature is measured by a thermistor with a negative temperature co–efficient and measures the actual temperature of the turbo booster air entering the engine. The ECM (Z132) uses this information, in conjunction with the manifold absolute pressure sensor, to determine the volume of air being drawn into the engine.

Boost Pressure Sensor

The boost pressure sensor signal is used in conjunction with the air temperature signal to calculate volume air flow into the engine. The sensor is located on the rear bulkhead, with the pressure tap just after the charge air cooler. If the sensor fails, a substitute value of 490 hPa is used by the ECM (Z132), producing a reduction in power due to a fuel quantity limiting to 21mg/stroke.

Throttle Position Sensor (X171)

The DDE system is a 'Drive by Wire' system i.e. the throttle pedal does not directly control a throttle disc or the amount of fuel injected into the engine, but accelerator movements or 'drivers request' are sensed and the information is passed to the ECM (Z132). The ECM (Z132) calculates the maximum allowable fuel quantity from the air flow into the engine, engine speed, temperature, etc. It also includes information from strategies such as smoke limitation, active surge damping, automatic gear change, fuel reduction, etc. to calculate the final figure. When driving, if the 'drivers request' signal is smaller than the maximum allowable quantity, then the requested quantity is injected. However, if the requested quantity is greater than the maximum allowable, then the latter quantity is injected rather than the driver's demand. Therefore the Throttle Position Sensor (X171) is very important to the system. It is located within the cab, close to the pedal assembly itself. The unit consists of a potentiometer and has three outputs:

1. Throttle Position – pin 37 ECM (Z132)

The sensor outputs the pedal position to the ECM (Z132), which uses the information as described above.

2. Idle Position Switch – pin 25 ECM (Z132).

The sensor has a separate idle position switch which informs the ECM (Z132) of the pedal status in the form of a simple on/off signal. This information is used by the ECM (Z132) to implement 'idle speed control' and other strategies i.e. 'overrun fuel shut–off'.

3. Kick Down Switch.

This switch is currently not used.

Fuel Temperature Sensor

A thermistor is also located inside the injection pump. The fuel temperature sensor signal is used to adjust the quantity of injected fuel, especially during temperature extremes. The signal is also used to back up the Engine Coolant Temperature Sensor (X126). If this sensor fails, the ECM (Z132) uses a substitute value of 60˚C and only slight effects on fuelling may possibly be noted.

Fuel Quantity Feedback Sensor

Located within the injection pump, this sensor sends the ECM (Z132) information regarding the actual quantity of fuel injected. Failure of the sensor or corrupted signals will illuminate the warning lamp and cause the engine to stall or not start. A second check, a plausibility check against the needle lift sensor, also takes place.

Fuel Quantity Actuator

Once again located within the injection pump, this is a moving magnet actuator, failure of which will cause the engine to stall or not start as the ECM (Z132) will activate the Fuel Shut–Off Solenoid (K111).

Injection Timing (Solenoid Valve Injection Timing Device (K229))

This is another actuator within the injection pump. The ECM (Z132) receives a signal from the needle lift sensor and attempts to correct the injection timing accordingly. If a change does not occur, then the ECM (Z132) assumes a fault exists, activates the warning lamp and reduces the quantity of injected fuel.

Fuel Shut–Off Solenoid (K111)

The Fuel Shut–Off Solenoid (K111) shuts the engine down if the ECM (Z132) detects a major fault. Failure of the valve itself does not activate the warning lamp, although if a short circuit occurs, the engine will shut down.

Cruise Control

Due to the DDE system being ‘drive by wire’, a cruise control feature is supplied in the ECM (Z132) itself. Activation is via the steering wheel switches to a converter box and on a single line to the ECM (Z132). Failure of the signal results in cruise control not working.

Brake Switches

The ECM (Z132) has two brake inputs, each of opposite polarity. Comparison of the polarity states provides the ECM (Z132) with a brake sense (i.e. if switch 1 high and switch 2 low going to switch 1 low and switch 2 high) and so cancels cruise control. If both switches are the same polarity, the ECM (Z132) senses a fault and does not allow cruise control.

Vehicle Speed Signal

The ECM (Z132) takes this signal from the Anti–Lock Brake System ECU (Z108) and uses the information for cruise control and ‘active surge damping’. Failure of the signal results in cruise disallowed and temporary lack of surge damping (i.e. hard acceleration will cause the vehicle to surge slightly). After 10 sec. a substitute value of 150 km/h is used. Surging will reduce so as to be hardly noticeable.

Theft Alarm

The ECM (Z132) has a simple on/off input regarding the theft alarm. The ECM (Z132) will not allow the engine to start once activated and will kill the engine if activated up to 300 RPM (programmable). Over 300 RPM, the engine is unaffected.

Relays

The DDE engine management system on the diesel vehicles uses four relays:

ECM (Z132) power supply (main relay), glow plug relay, starter motor relay and fuel pump relay. Two are located in the fuse box and two in the ECM (Z132) box behind the battery.

Main Relay

Located in the ECM (Z132) box, this relay supplies the power feed to the ECM (Z132). It is controlled via the Ignition Switch (X274) in position II.

Glow Plug Relay (Z135)

The Glow Plug Relay (Z135) takes a feed directly from the battery and, on initialisation via the ECM (Z132), supplies current to each of the six glow plugs (one per cylinder) to aid cold starting. The glow time is controlled via the ECM (Z132) which also monitors the relay and illuminates the glow plug indicator lamp for the duration of the glow time. This relay is relatively large and is located with the main relay next to the ECM (Z132).

Starter Motor Relay

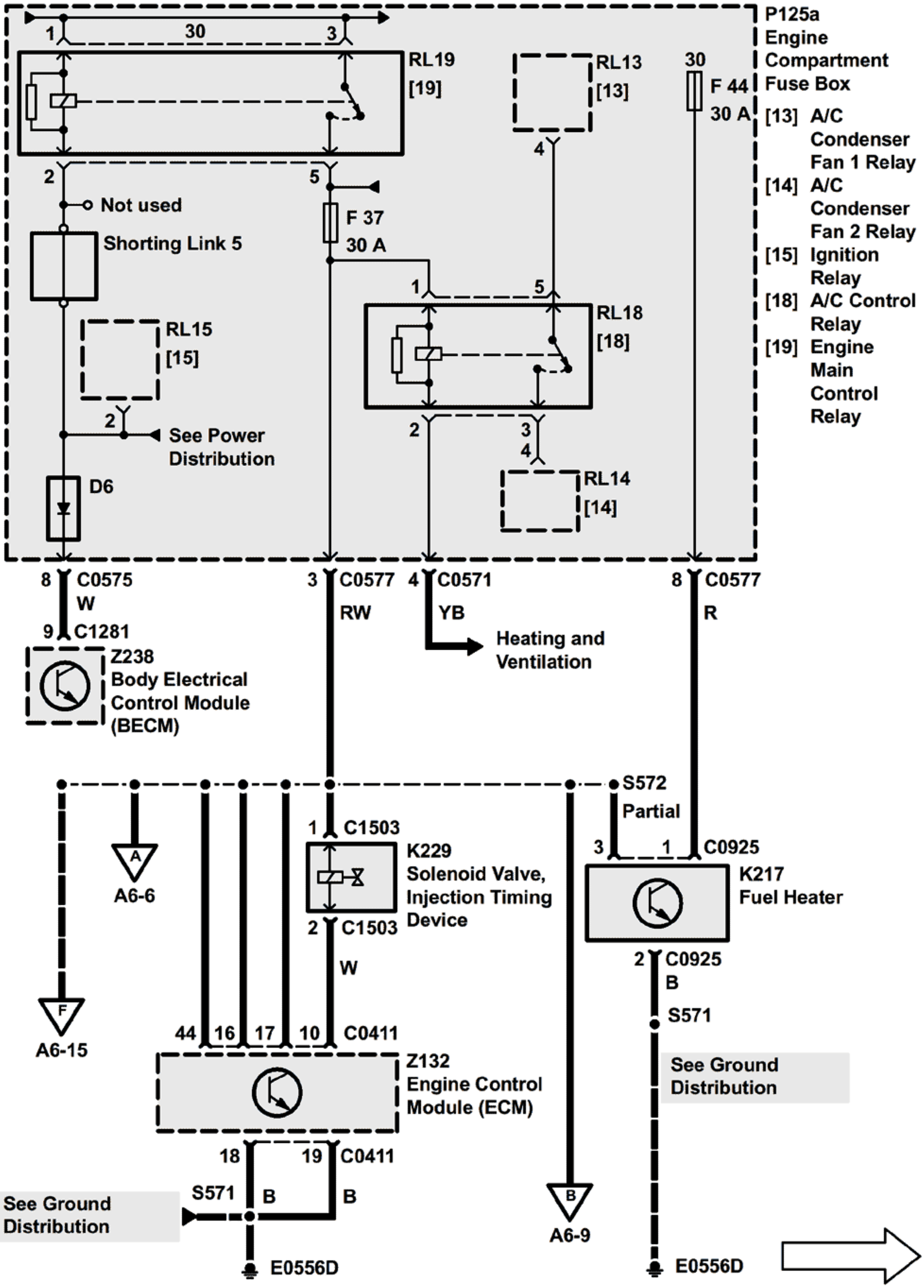
This relay is also ignition key controlled, activated with the key in the ignition III position only. Releasing the key after cranking cuts supply to the relay and switches off the starter motor.

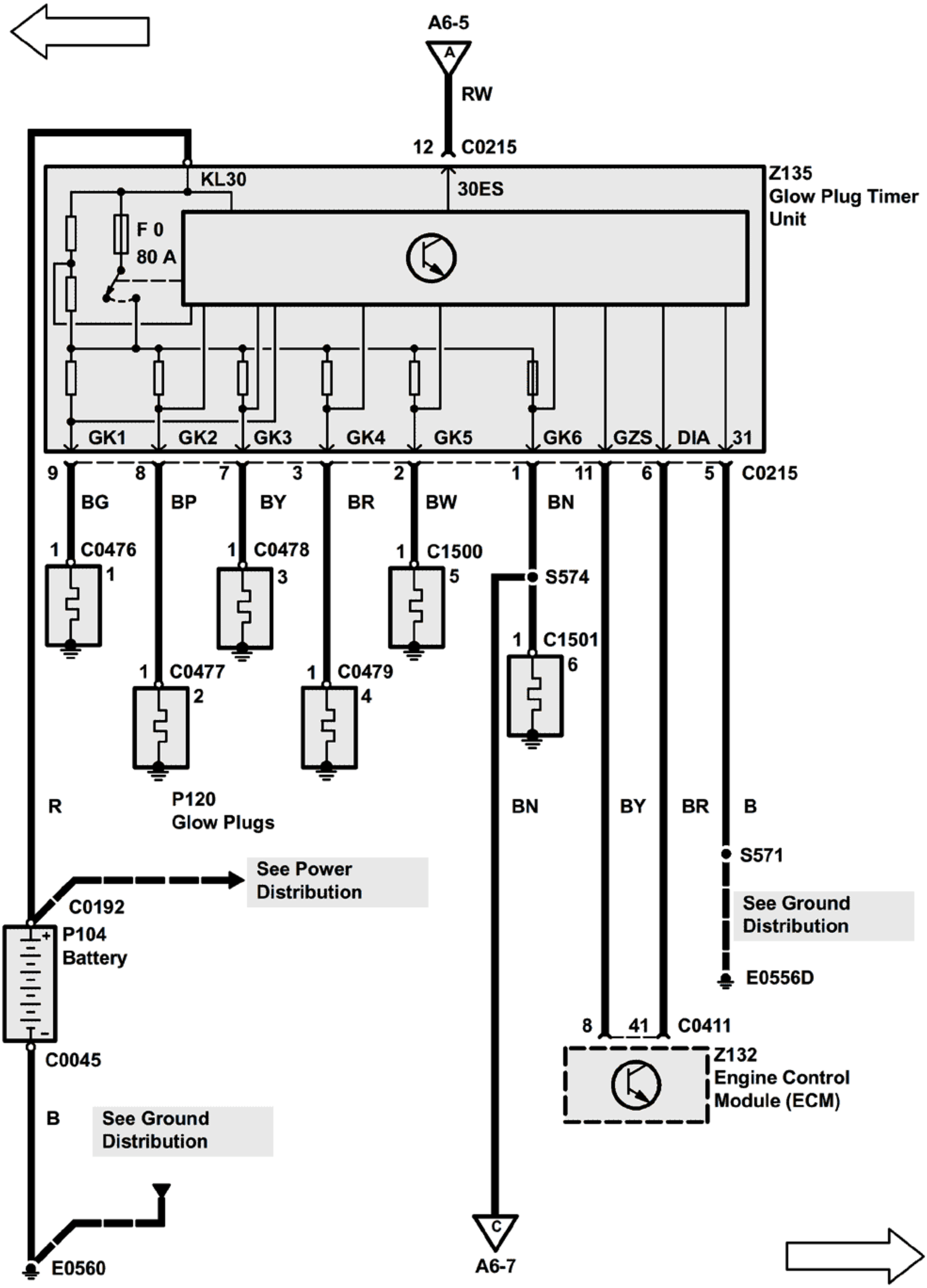
Fuel Pump Relay

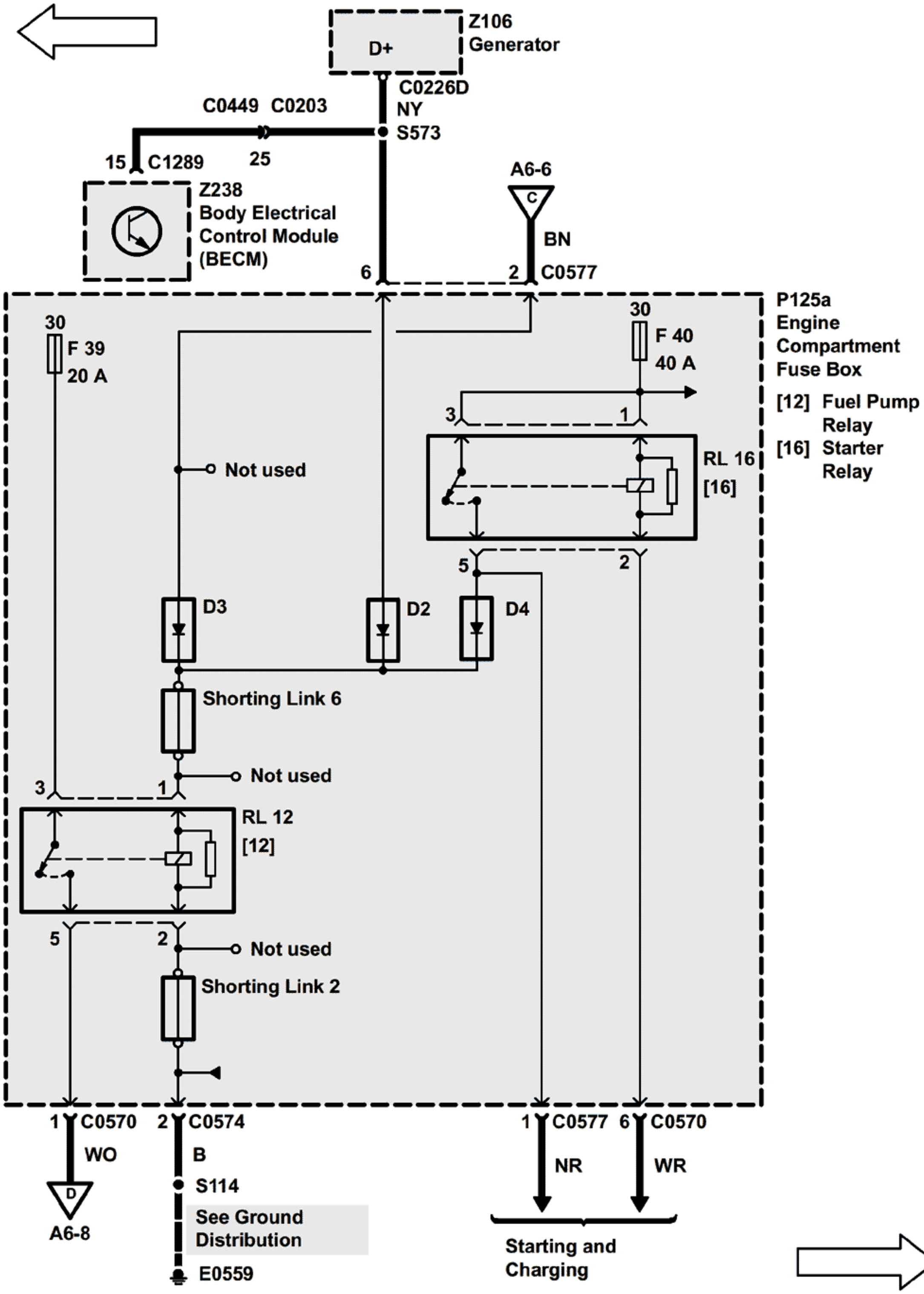
The fuel pump relay is pulled in when the starter motor is activated, the earth path provided by the alternator output. When the engine is running, the starter motor is deactivated, supplying an earth path while the generator supplies a feed i.e. a polarity reversal.

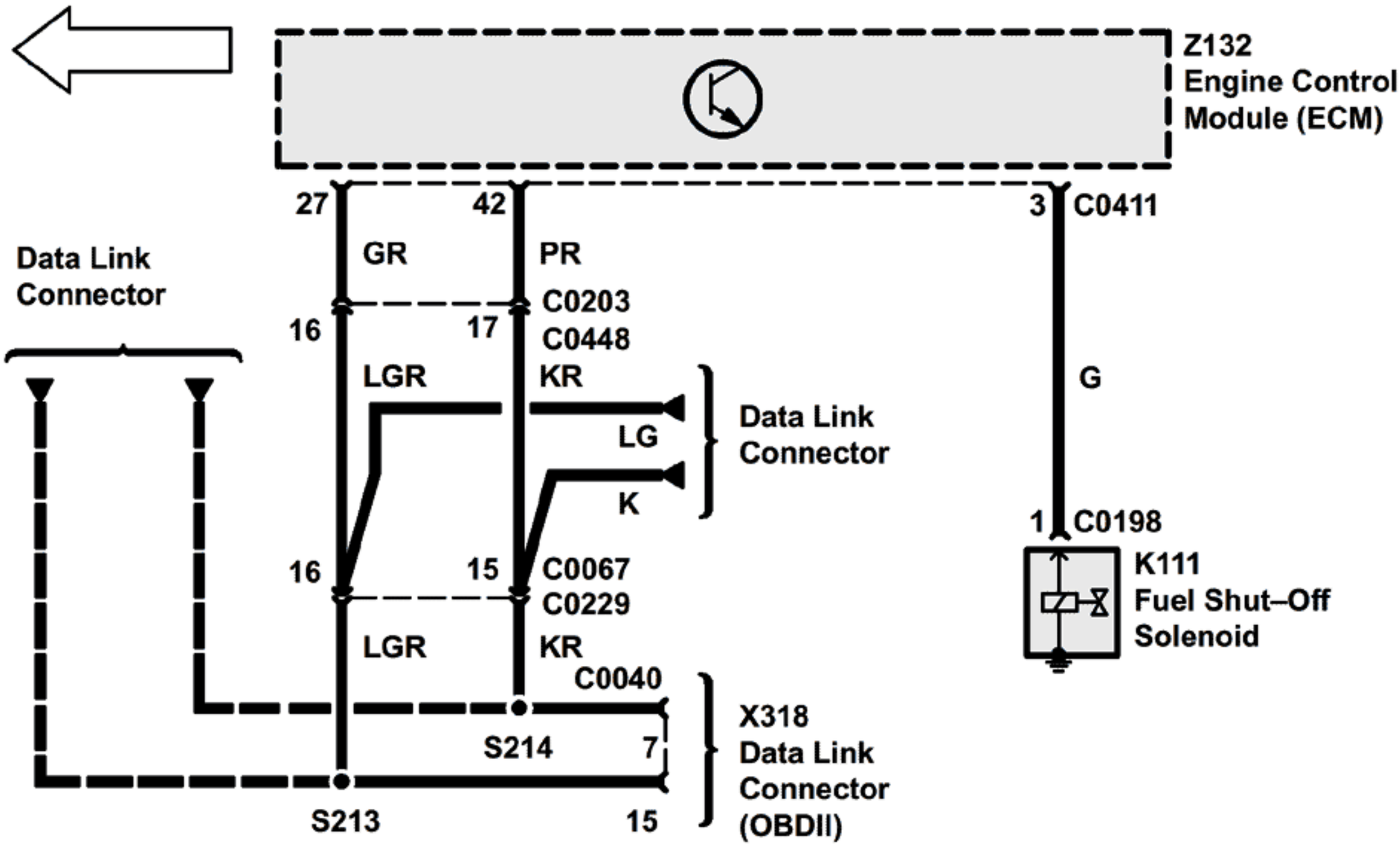
ECM (Z132)

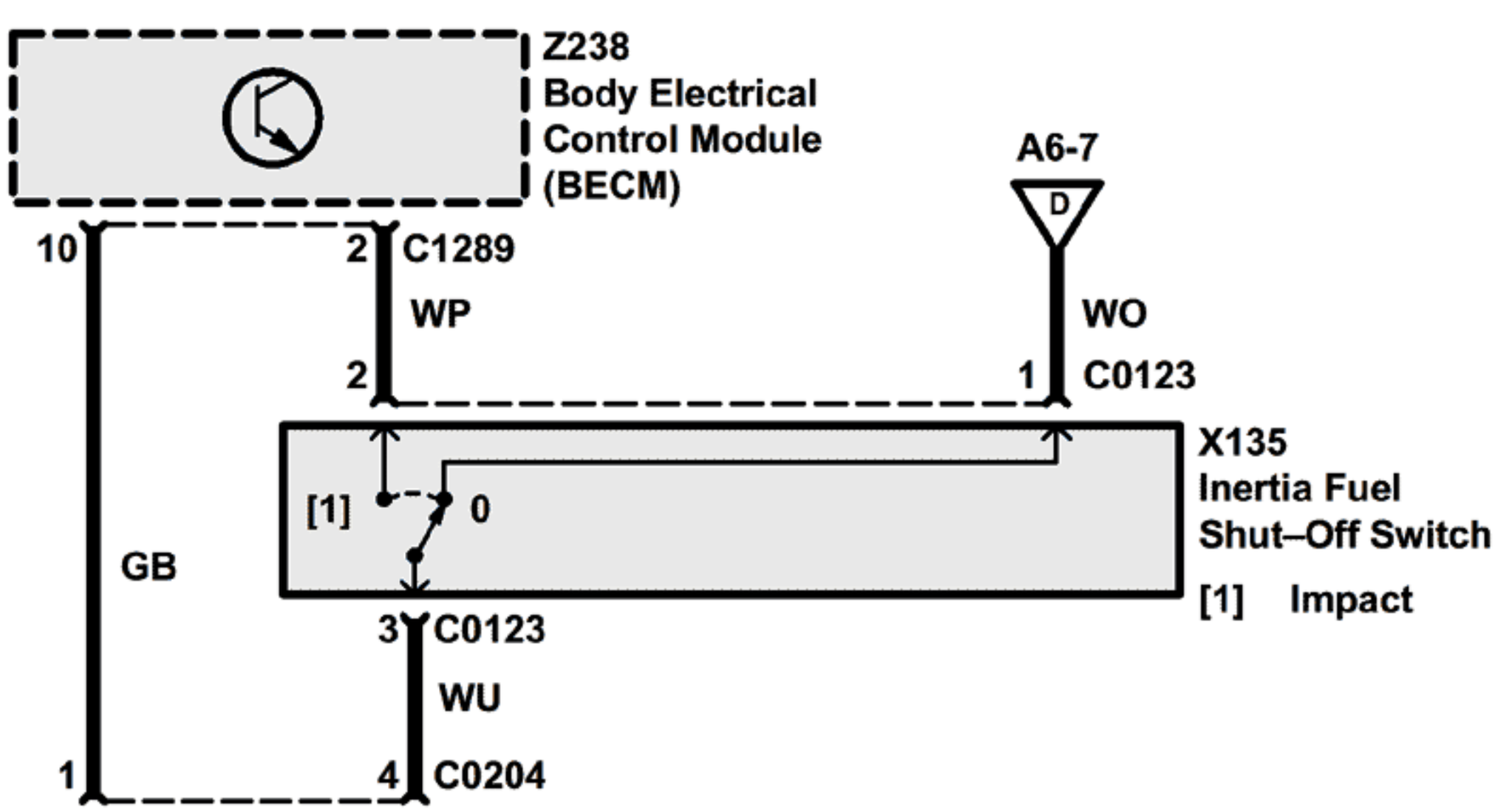
If the ECM (Z132) itself is not working, the entire engine management system will cease to operate, i.e. no fuel, tacho reading, etc.

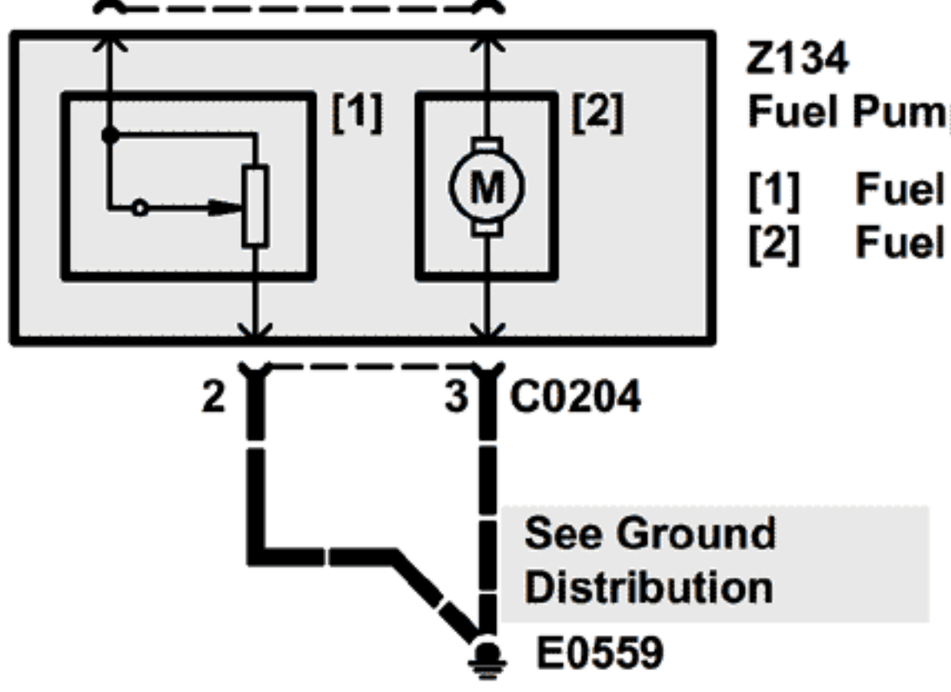

P125a
Engine
Compartment
Fuse Box
[13] A/C Condenser Fan 1 Relay
[14] A/C Condenser Fan 2 Relay
[15] Ignition Relay
[18] A/C Control Relay
[19] Engine Main Control Relay
RL19
[19]
RL13
[13]
30
F 44
30 A
RL15
[15]
RL18
[18]
RL14
[14]
F 37
30 A
Not used
Shorting Link 5
D6
See Power Distribution
Z238
Body Electrical Control Module (BECM)
Heating and Ventilation
Z132
Engine Control Module (ECM)
K229
Solenoid Valve, Injection Timing Device
K217
Fuel Heater
S572
Partial
S571
See Ground Distribution
A6-6
A6-15
A6-9
E0556D
8 C0575 W 9 C1281
3 C0577 RW
4 C0571 YB
8 C0577 R
1 C1503
2 C1503 W
3 C0925 1
2 C0925 B
44 16 17 10 C0411
18 19 C0411
S571 B B

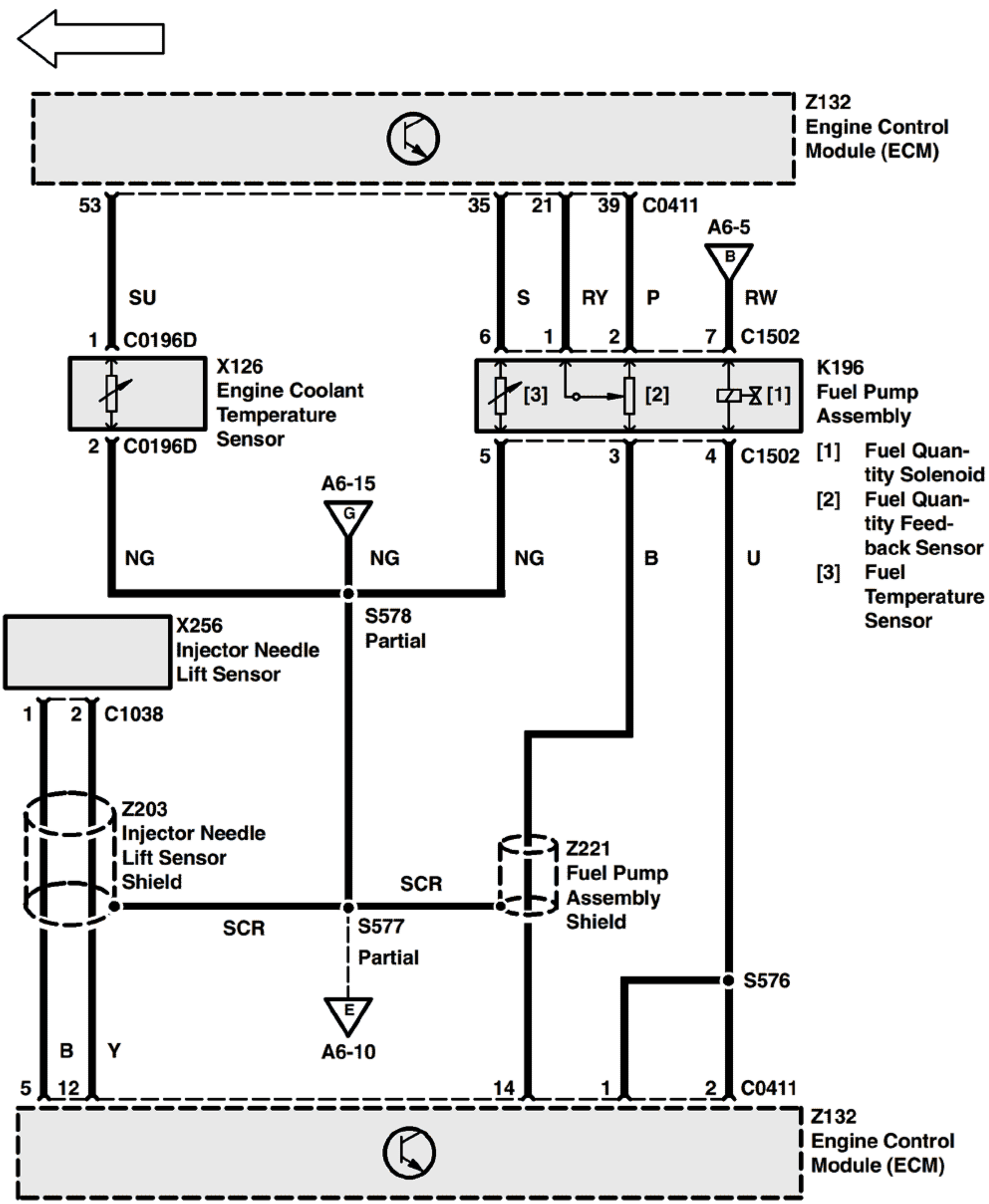

A6-5
A
RW
12 C0215
KL30
30ES
Z135
Glow Plug Timer
Unit
F 0
80 A
GK1 GK2 GK3 GK4 GK5 GK6 GZS DIA 31
9 8 7 3 2 1 11 6 5 C0215
BG BP BY BR BW BN
1 C0476 1
1 C0478 3
1 C1500 5
S574
1 C1501 6
1 C0477 2
1 C0479 4
P120
Glow Plugs
R
BN BY BR B
See Power
Distribution
C0192
P104
Battery
S571
See Ground
Distribution
E0556D
C0045
B
See Ground
Distribution
8 41 C0411
Z132
Engine Control
Module (ECM)
E0560
C
A6-7

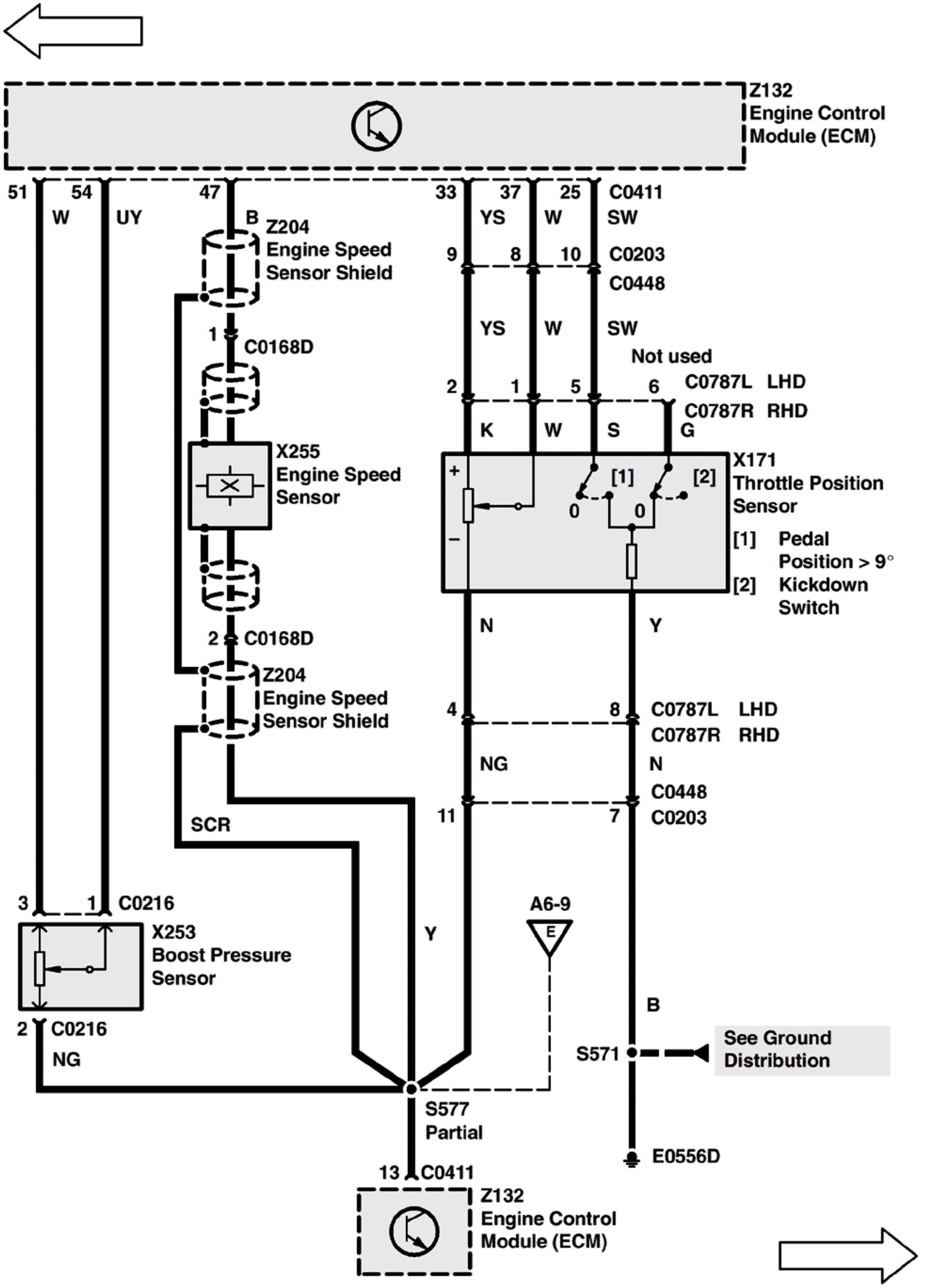

Z106
Generator
D+
C0226D
NY
S573
C0449
C0203
15
C1289
25
Z238
Body Electrical
Control Module
(BECM)
A6-6
C
BN
2
C0577
6
P125a
Engine
Compartment
Fuse Box
[12] Fuel Pump
Relay
[16] Starter
Relay
30
F 39
20 A
30
F 40
40 A
3
1
RL 16
[16]
Not used
5
2
D3
D2
D4
Shorting Link 6
Not used
3
1
RL 12
[12]
5
2
Not used
Shorting Link 2
1
C0570
WO
D
A6-8
2
C0574
B
S114
See Ground
Distribution
E0559
1
C0577
NR
6
C0570
WR
Starting and
Charging

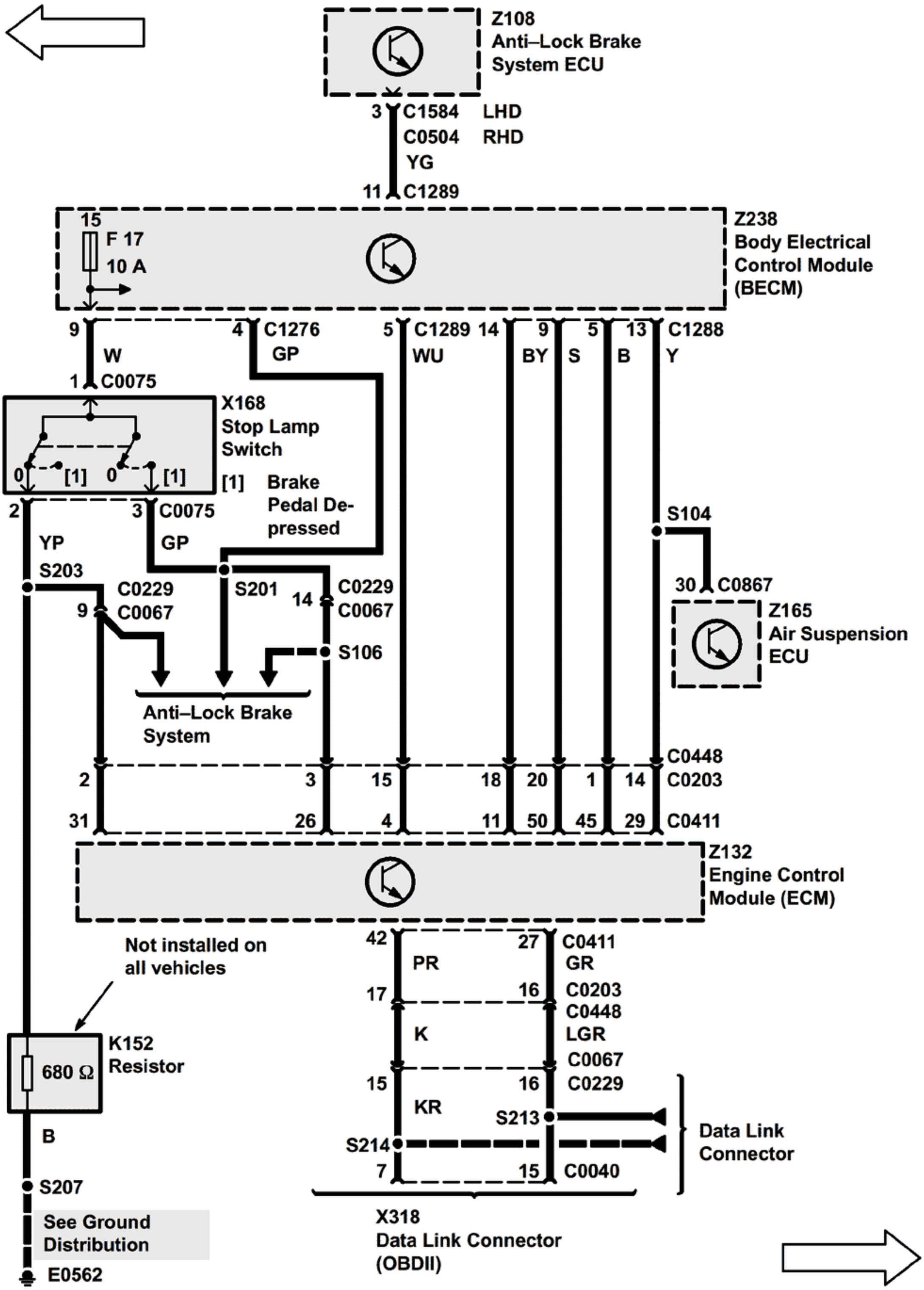

Z132
Engine Control
Module (ECM)
27
GR
42
PR
3
C0411
Data Link
Connector
C0203
16
17
C0448
LGR
KR
LG
K
Data Link
Connector
G
1
C0198
K111
Fuel Shut–Off
Solenoid
16
15
C0067
C0229
LGR
KR
C0040
S214
7
X318
Data Link
Connector
(OBDII)
S213
15

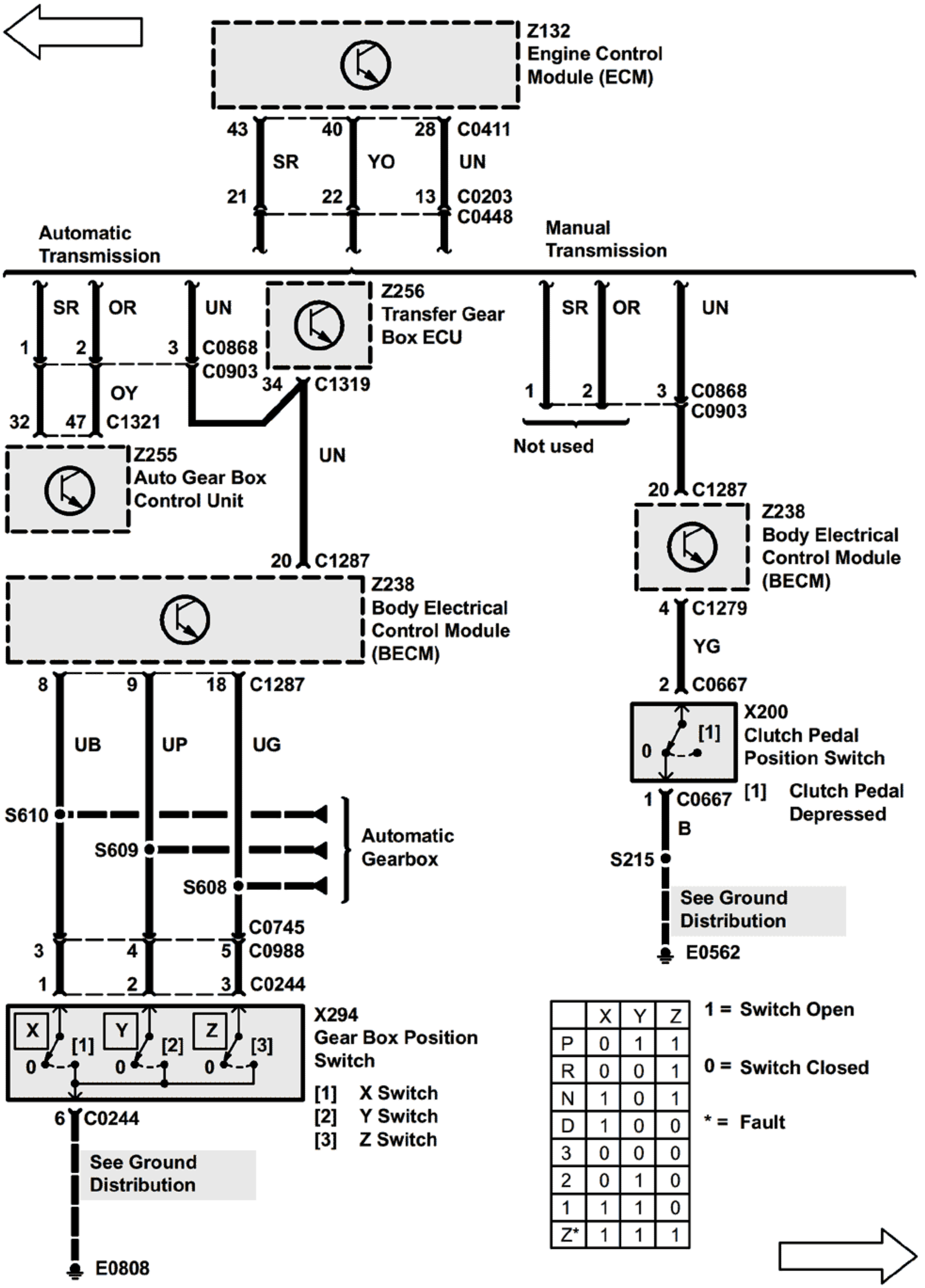

Z238
Body Electrical
Control Module
(BECM)
A6-7
D
10
2
C1289
WP
WO
2
1
C0123
X135
Inertia Fuel
Shut–Off Switch
[1]
0
[1] Impact
GB
3
C0123
WU
1
4
C0204


[1]
[2]
M
Z134
Fuel Pump Module
[1] Fuel Level Sensor
[2] Fuel Pump
2
3
C0204
See Ground
Distribution
E0559


Z132
Engine Control
Module (ECM)
53
35
21
39
C0411
A6-5
B
SU
S
RY
P
RW
1
C0196D
6
1
2
7
C1502
X126
Engine Coolant
Temperature
Sensor
[3]
[2]
[1]
K196
Fuel Pump
Assembly
2
C0196D
5
3
4
C1502
[1] Fuel Quantity Solenoid
[2] Fuel Quantity Feedback Sensor
[3] Fuel Temperature Sensor
A6-15
G
NG
NG
NG
B
U
S578
Partial
X256
Injector Needle
Lift Sensor
1
2
C1038
Z203
Injector Needle
Lift Sensor
Shield
SCR
SCR
S577
Partial
Z221
Fuel Pump
Assembly
Shield
S576
E
A6-10
B
Y
5
12
14
1
2
C0411
Z132
Engine Control
Module (ECM)


Z132
Engine Control
Module (ECM)
51
W
54
UY
47
B
Z204
Engine Speed
Sensor Shield
1
C0168D
X255
Engine Speed
Sensor
2
C0168D
Z204
Engine Speed
Sensor Shield
SCR
3
1
C0216
X253
Boost Pressure
Sensor
2
C0216
NG
33
YS
37
W
25
SW
C0411
9
8
10
C0203
C0448
YS
W
SW
Not used
2
1
5
6
C0787L LHD
C0787R RHD
K
W
S
G
X171
Throttle Position
Sensor
+
–
[1]
[2]
0
0
[1] Pedal
Position > 9°
[2] Kickdown
Switch
N
Y
4
8
C0787L LHD
C0787R RHD
NG
N
11
7
C0448
C0203
Y
A6-9
E
B
S571
See Ground
Distribution
E0556D
S577
Partial
13
C0411
Z132
Engine Control
Module (ECM)


Z108
Anti–Lock Brake System ECU
3 C1584 LHD
C0504 RHD
YG
11 C1289
15
F 17
10 A
Z238
Body Electrical Control Module (BECM)
9 W 1 C0075
4 C1276 GP
5 C1289 WU
14 9 BY 5 S 13 B C1288 Y
X168
Stop Lamp Switch
0 [1] 0 [1]
[1] Brake Pedal De-pressed
2 YP S203
3 C0075 GP
S201
S104
30 C0867
Z165
Air Suspension ECU
C0229 9 C0067
14 C0229 C0067
S106
Anti–Lock Brake System
C0448
2 3 15 18 20 1 14 C0203
31 26 4 11 50 45 29 C0411
Z132
Engine Control Module (ECM)
Not installed on all vehicles
42 PR 17
27 C0411 GR
16 C0203
C0448
K LGR
C0067
15 KR
16 C0229
S213
S214
7 15 C0040
Data Link Connector
K152
Resistor
680 Ω
B
S207
See Ground Distribution
E0562
X318
Data Link Connector (OBDII)

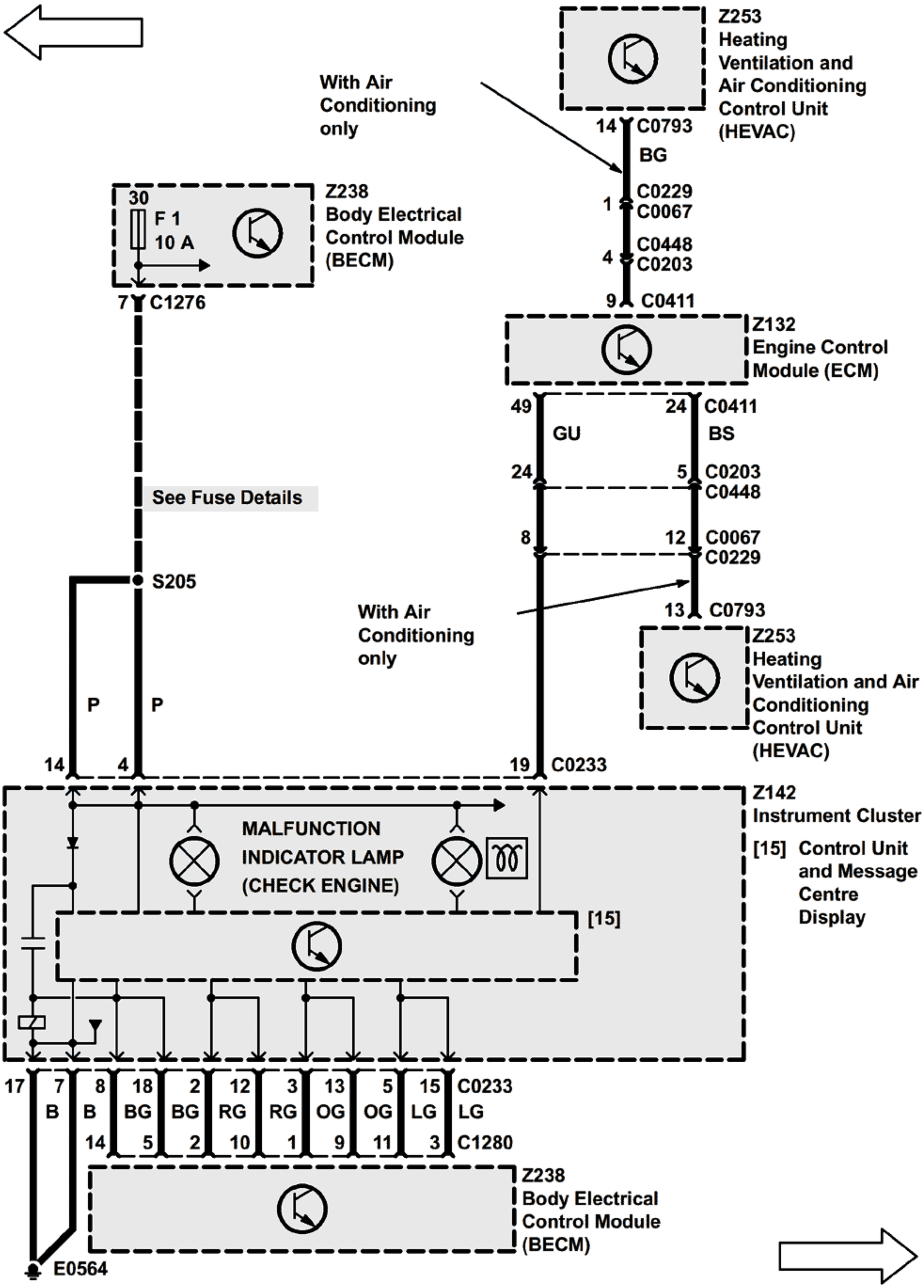


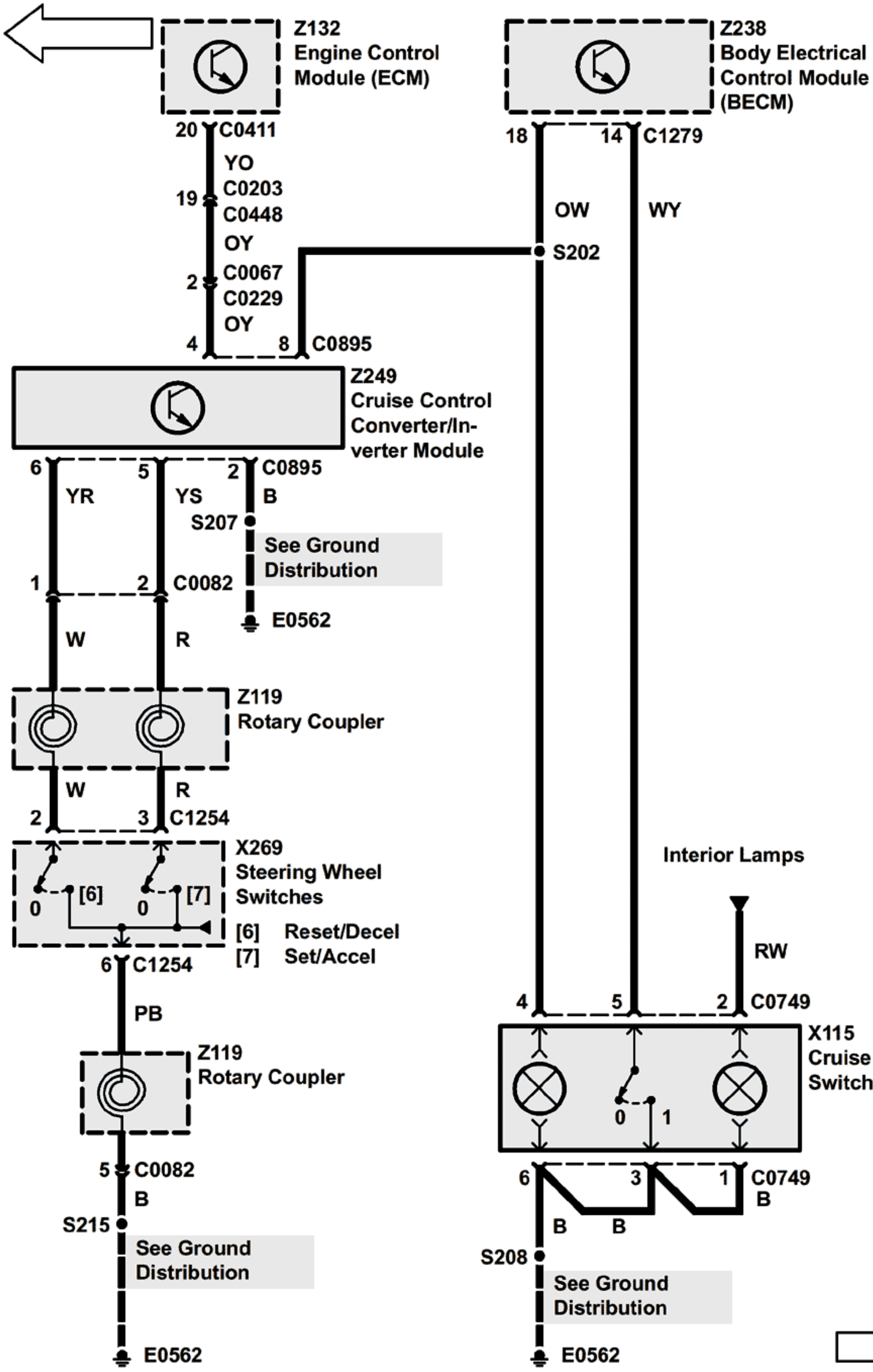
	X	Y	Z
P	0	1	1
R	0	0	1
N	1	0	1
D	1	0	0
3	0	0	0
2	0	1	0
1	1	1	0
Z*	1	1	1

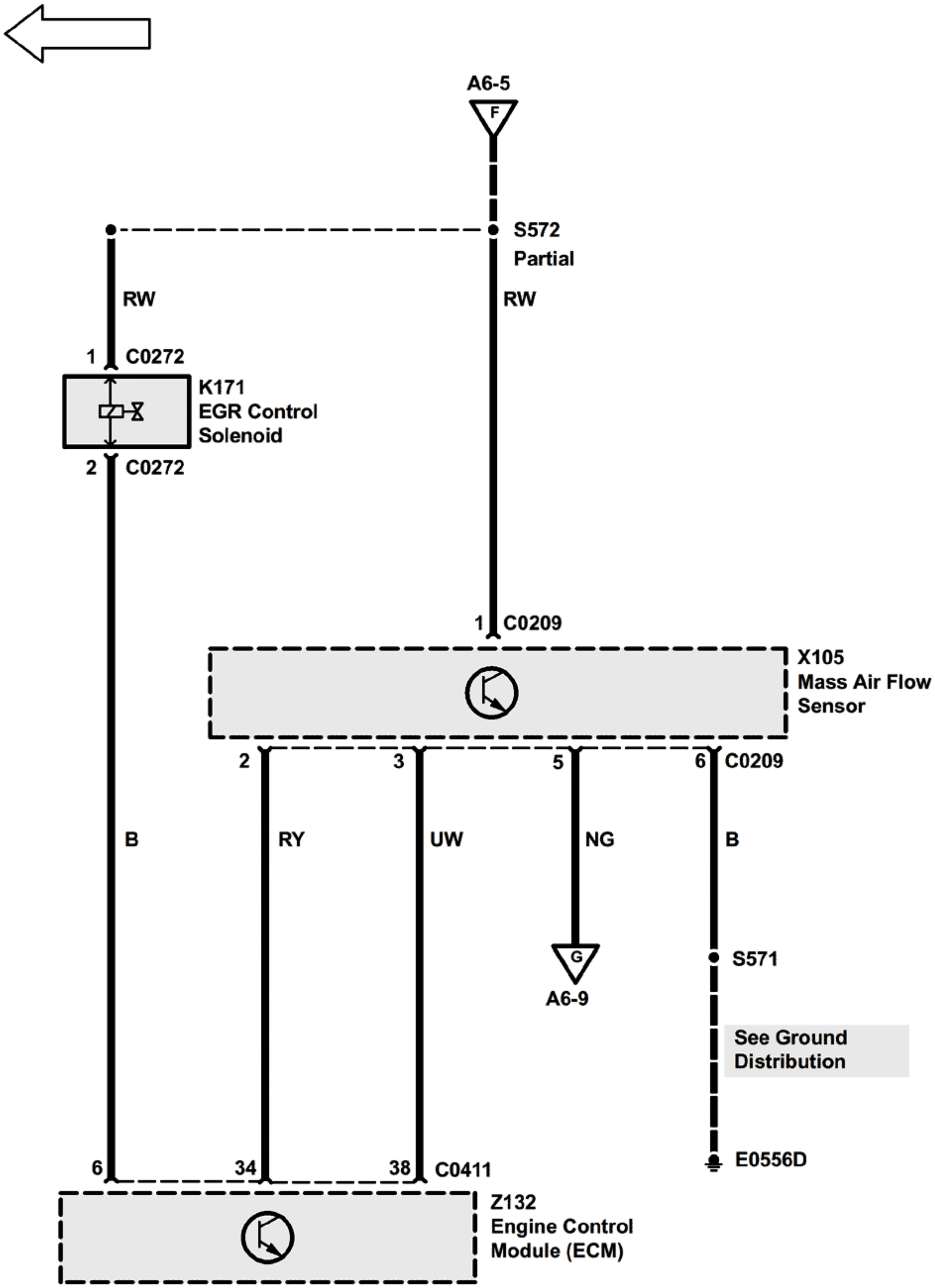
1 = Switch Open

0 = Switch Closed

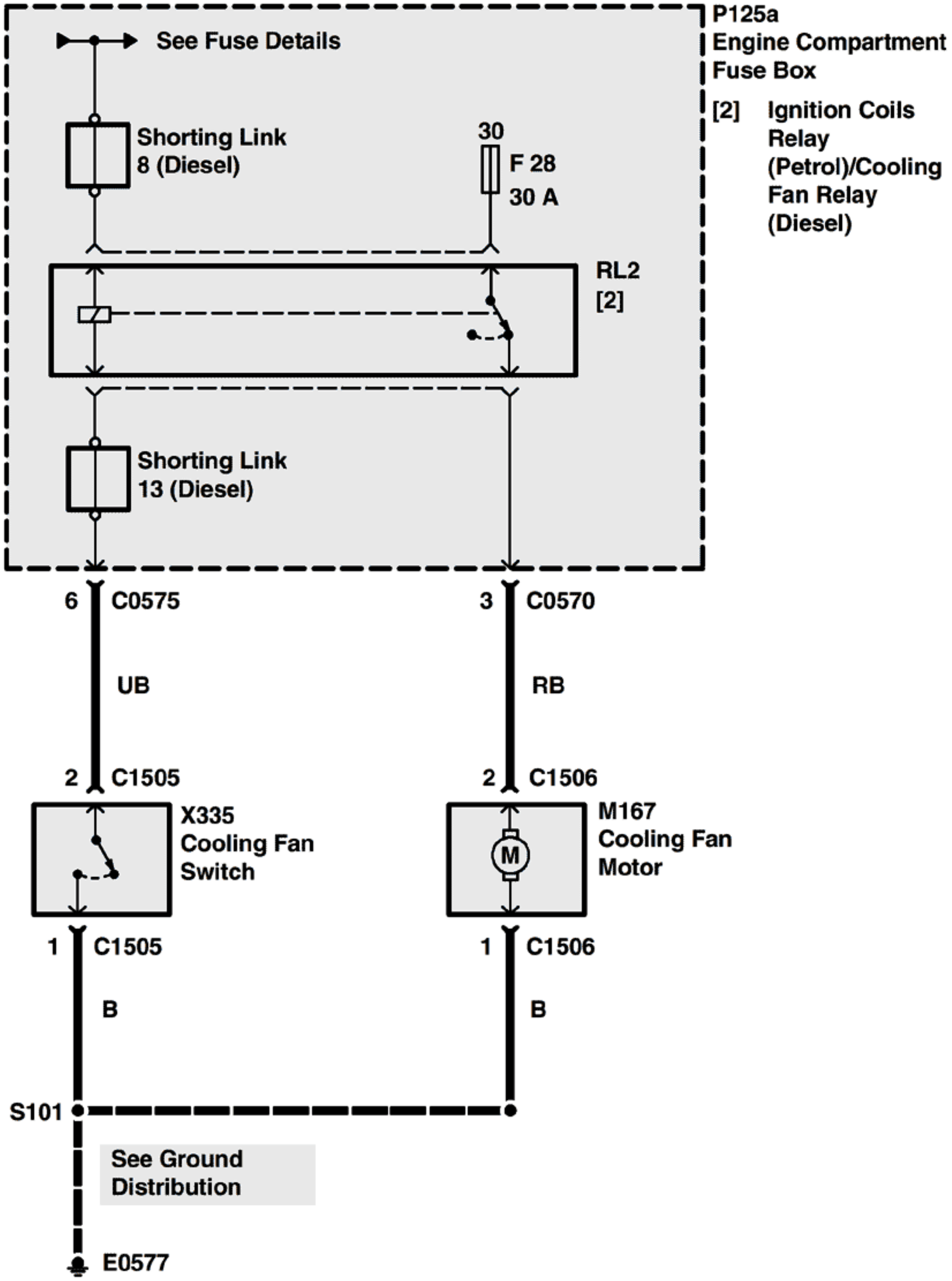
* = Fault


With Air Conditioning only
Z253 Heating Ventilation and Air Conditioning Control Unit (HEVAC)
14 C0793
BG
C0229
1 C0067
C0448
4 C0203
9 C0411
Z132 Engine Control Module (ECM)
49 GU 24 C0411 BS
24 5 C0203
C0448
8 12 C0067
C0229
13 C0793
With Air Conditioning only
Z253 Heating Ventilation and Air Conditioning Control Unit (HEVAC)
Z238 Body Electrical Control Module (BECM)
30
F 1
10 A
7 C1276
See Fuse Details
S205
P P
14 4
19 C0233
Z142 Instrument Cluster
[15] Control Unit and Message Centre Display
MALFUNCTION INDICATOR LAMP (CHECK ENGINE)
[15]
17 7 B
8 B 14
18 BG 5
2 BG 2
12 RG 10
3 RG 1
13 OG 9
5 OG 11
15 LG 3
C0233 LG
C1280
Z238 Body Electrical Control Module (BECM)
E0564


Z132
Engine Control
Module (ECM)
20 C0411
YO
19 C0203
C0448
OY
2 C0067
C0229
OY
4 8 C0895
Z249
Cruise Control
Converter/In-
verter Module
6 5 2 C0895
YR YS B
S207
See Ground
Distribution
1 2 C0082
E0562
W R
Z119
Rotary Coupler
W R
2 3 C1254
X269
Steering Wheel
Switches
0 [6] 0 [7]
[6] Reset/Decel
[7] Set/Accel
6 C1254
PB
Z119
Rotary Coupler
5 C0082
B
S215
See Ground
Distribution
E0562
Z238
Body Electrical
Control Module
(BECM)
18 14 C1279
OW WY
S202
Interior Lamps
RW
4 5 2 C0749
X115
Cruise Control
Switch
0 1
6 3 1 C0749
B
B B
S208
See Ground
Distribution
E0562


A6-5
F
S572
Partial
RW
1 C0272
K171
EGR Control
Solenoid
2 C0272
RW
1 C0209
X105
Mass Air Flow
Sensor
2 3 5 6 C0209
B
RY
UW
NG
B
G
A6-9
S571
See Ground
Distribution
E0556D
6 34 38 C0411
Z132
Engine Control
Module (ECM)

(MY 2000)


See Fuse Details
Shorting Link
8 (Diesel)
30
F 28
30 A
RL2
[2]
Shorting Link
13 (Diesel)
P125a
Engine Compartment
Fuse Box
[2] Ignition Coils
Relay
(Petrol)/Cooling
Fan Relay
(Diesel)
6 C0575
UB
2 C1505
X335
Cooling Fan
Switch
1 C1505
B
3 C0570
RB
2 C1506
M167
Cooling Fan
Motor
M
1 C1506
B
S101
See Ground
Distribution
E0577