1 General Information

The cooling system for the V6 Alloytec engine has been re-designed to accommodate this engine's unique configuration and engine cooling performance requirements. The following list is a summary of new and modified components:

- Revised radiator assembly (new tanks incorporating integral a drain tap and coolant air bleed facility).
- New plumbing including radiator hoses, inlet pipe, heater pipes, heater hoses and heater water valve.
- New rear mount thermostat assembly and thermostat housing.
- New coolant outlet incorporating a 'screw on' pressure cap.
- New coolant specification (common with GEN III V8 vehicles).
- New side chutes and radiator shroud (common with GEN III V8 vehicles).
- New fan mounting shroud (common with GEN III V8 vehicles).
- Modified cooling fan operating strategy (both cooling fans are controlled by the Engine Control Module).

Depending on the model, a standard or high-power cooling fan system may be fitted to the vehicle. However, all models use a two stage, cooling fan operating strategy.

- On the standard cooling fan system, two, single-speed electric cooling fans are fitted When operating on Stage 1, only the right (larger diameter) fan motor is enabled. When Stage 2 is required, the left (smaller diameter) fan is also activated. For Stage 1, only one fan motor is operational and for Stage 2, both fan motors are operational.
- On the high power cooling fan system each fan motor is dual-speed and has a different power rating. Both fan motors fitted operate either on low-speed (Stage 1) or high-speed (Stage 2).

The cooling fan diameters are the same on all models. Regardless of the system fitted, operation of the cooling fans is dependent on engine coolant temperature, vehicle speed, A/C request (where fitted) and A/C system pressure. Refer to Section 6C1-1 Engine Management – V6 – General Information for further information.

The air conditioning system condenser is mounted to the front of the radiator and is located and supported by four clips moulded into the front of the plastic radiator tanks. The lower clips lock the condenser in place and can be released by hand to facilitate condenser removal.

The condenser, filter drier receiver, radiator and the fan motors/blades/shroud assembly can be removed and installed individually from the vehicle. For removal and installation procedures relating to air conditioning components, refer to Section 2C HVAC Climate Control (Manual A/C) – Removal and Installation.

2 General Description

2.1 Radiator Assembly

When the vehicle is built, the condenser, filter drier receiver, cooling fans, fan shroud and radiator are installed into the engine bay as an assembled unit. This unit is described as the radiator assembly or as the Condenser, Radiator and Fan Module (CRFM).

The radiator has an aluminium core and is of the cross-flow design. Plastic side tanks are attached to the core by clinch tabs. The clinch tabs are formed as part of the core assembly.

Pegs are attached to the lower frame and the upper area of each side tank. These pegs are used to support the radiator in four rubber mounts. The assembly is held in position by two spring clips at the upper mounting locations.

A high temperature rubber seal is used to seal the mating surface between the core and each side tank. The seal(s) must be replaced any time the side tank is removed from the core.

NOTE

The radiator core side tanks or transmission oil cooler cannot be replaced separately. If there is a fault with any of these components, the radiator assembly must be replaced. Small core repairs may be made using an aluminised silicon based liquid repair agent. Refer to 3.16 Radiator – Radiator Repair Procedure in this Section.

For vehicles with automatic transmission, a transmission oil cooler is located in the right-hand side radiator tank. The cooler pipes from and to the transmission are connected to the oil cooler flexible hoses by means of quick connect fittings.

When air conditioning is fitted, the air conditioning condenser is mounted to the front of the radiator and is located and supported by four clips moulded into the front of the plastic radiator tanks. The lower clips lock the condenser in place and can be released by hand to facilitate condenser removal. The air conditioning receiver drier also forms a part of the complete CRFM assembly.

Each of the cooling fan motors are attached by three screws to the one-piece plastic fan shroud. In turn, the fan shroud is mounted to the rear of the radiator and is located and supported by four clips moulded into the rear of the plastic radiator tanks. The upper clips lock the fan shroud in place and can be released by hand to facilitate fan shroud removal. The shroud must be removed to allow fan motor and blade assembly removal.

Two harness connectors are mounted to the upper section of the fan shroud allowing the fan motor and blade assemblies to be removed individually from the shroud. The fan motor and blade is balanced as an assembly. These two components are serviced only as a unit and are not to be separated.

Two types of CRFM are fitted to Alloytec V6 models – ‘standard’ and ‘high power’ systems. Alloytec V6 cooling fan motors and operating strategies differ according to market and / or model application. All components other than the fan motors are common to both types of Alloytec V6 CRFM. For a comprehensive description of the different operating strategies and electrical wiring for the ‘standard’ and ‘high power’ systems,
refer to 2.2 Cooling Fans – Standard Specification and 2.3 Cooling Fans – High Power Specification in this Section.

The shroud, fan assemblies and transmission cooler hoses can be removed and installed individually from the vehicle. For removal and installation procedures, refer to 3.14 Cooling Fan and Shroud Assembly,
3.15 Flexible Transmission Cooler Hose and 3.16 Radiator in this Section. For removal and installation procedures relating to the air conditioning components of the CRFM, refer to Section 2C HVAC Climate Control (Manual A/C).

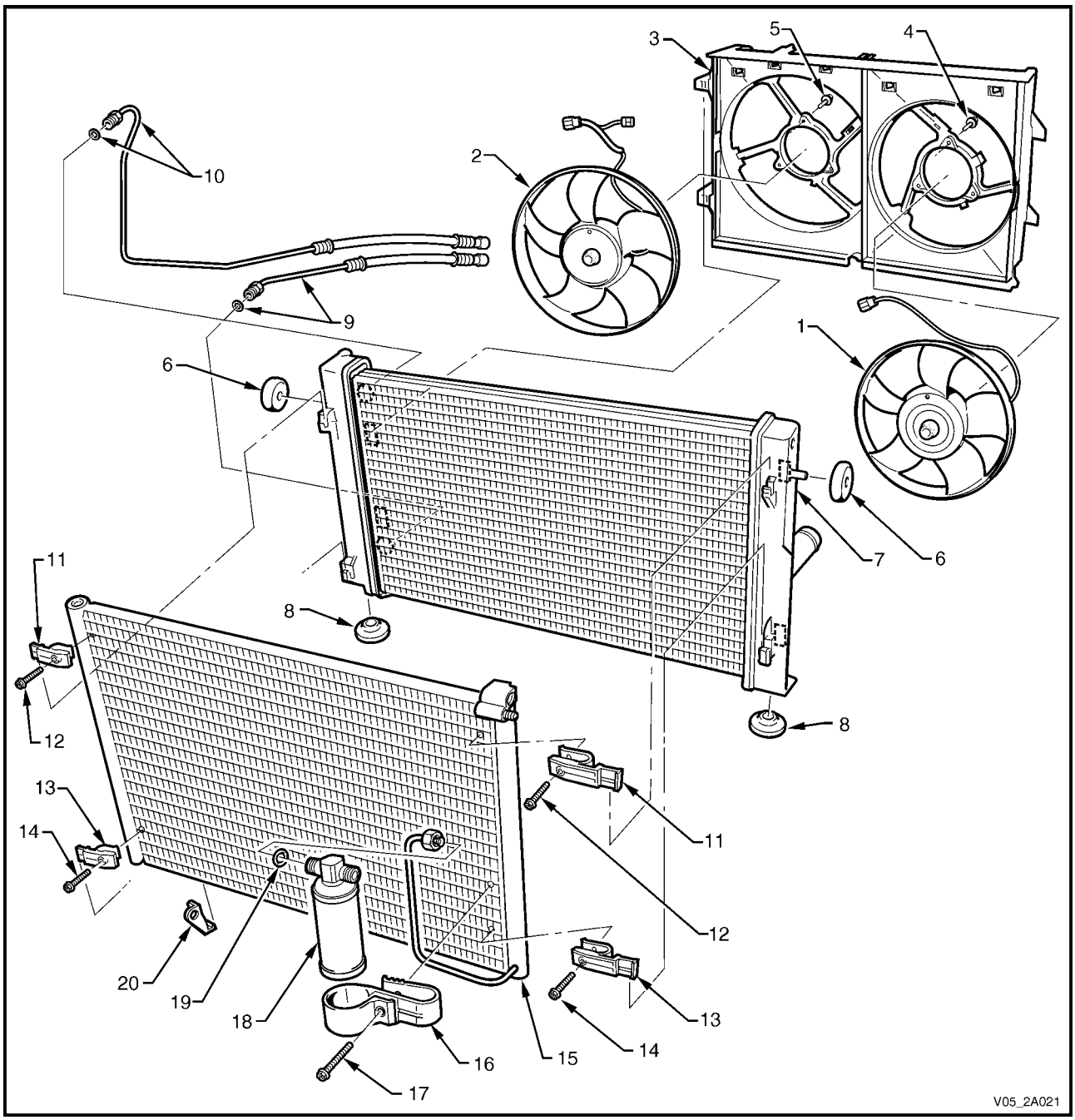

Figure 6B1 – 1

Legend

1	LHS (Small) Fan and Motor Assembly	11	Upper Condenser Mounting Clips (2 places)
2	RHS (Large) Fan and Motor Assembly	12	Upper Condenser Mounting Clip Screws (2 places)
3	Fan Shroud	13	Lower Condenser Mounting Clips (2 places)
4	LHS Fan Retaining Screw (3 places)	14	Lower Condenser Mounting Clip Screws (2 places)
5	RHS Fan Retaining Screw (3 places)	15	Condenser
6	Upper Radiator Insulators (2 places)	16	Filter Drier Receiver Mounting Bracket
7	Radiator	17	Filter Drier Receiver Mounting Bracket Screw
8	Lower Radiator Insulators (2 places)	18	Filter Drier Receiver
9	Lower Transmission Cooling Line and Seal	19	Filter Drier Receiver O-ring
10	Upper Transmission Cooling Line and Seal	20	Ambient Air Temperature Sensor Mounting Bracket (OCC A/C only)

2.2 Cooling Fans – Standard Specification

Overview

All MY 2005 VZ Series Alloytec V6 RHD sedan, wagon and utility models are fitted with a standard cooling fan system (280 Watt), which consists of two single-speed fans. This cooling fan system operates as follows:

- Stage 1 – large diameter fan operates at maximum speed.
- Stage 2 – small and large diameter fans both operate at maximum speed.

The smaller low-speed fan on the left is 293 mm in diameter with a motor rated at 120 Watts, while the larger high-speed fan on the right is 354 mm in diameter with a motor power rating of 160 Watts.

The following outlines the operation of the cooling system, at block level, also showing what inputs the Engine Control Module (ECM) requires.

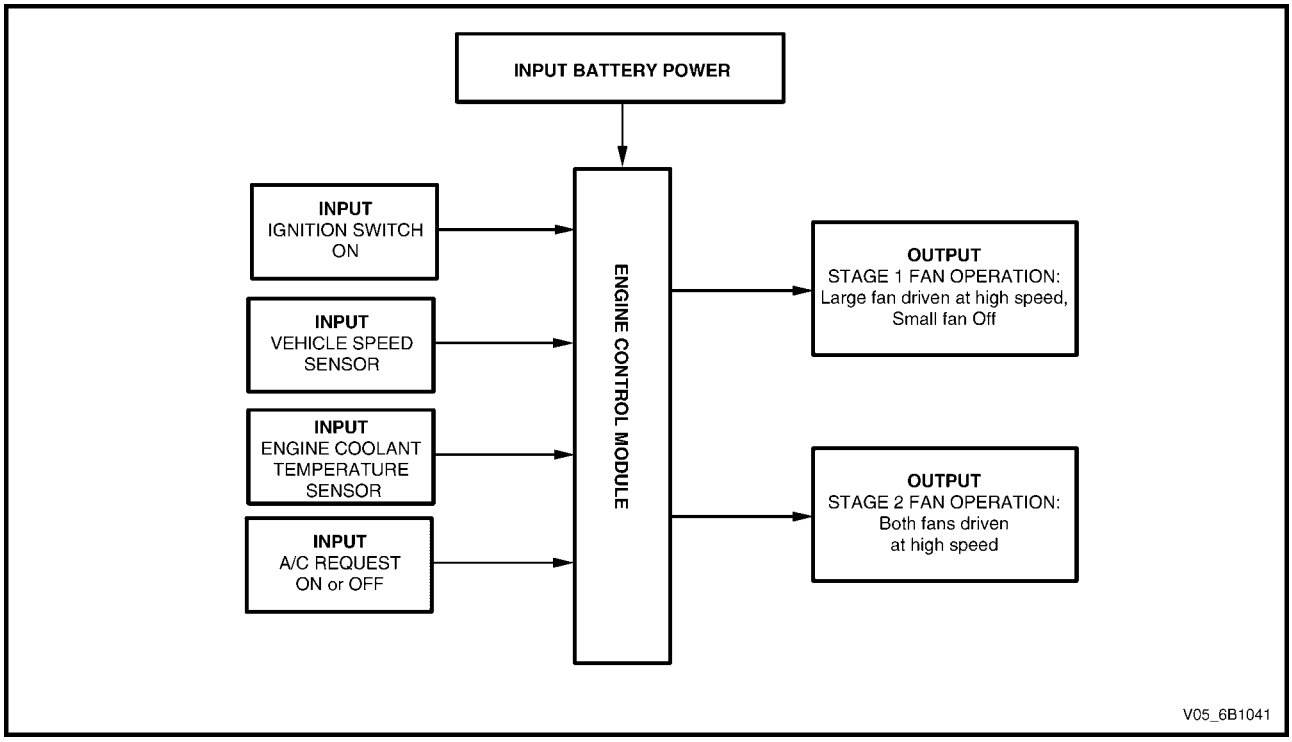

Figure 6B1 – 2

With 12 volts applied and the fans mounted to the radiator with a condenser fitted, the operating speeds are:

	Stage 1	Stage 2
Large Fan	2,250 ± 150 rpm	2,250 ± 150 rpm
Small Fan	Inoperative	2,050 ± 150 rpm

Relays

The engine cooling fan relays are located in the fuse and relay compartment under the hood.

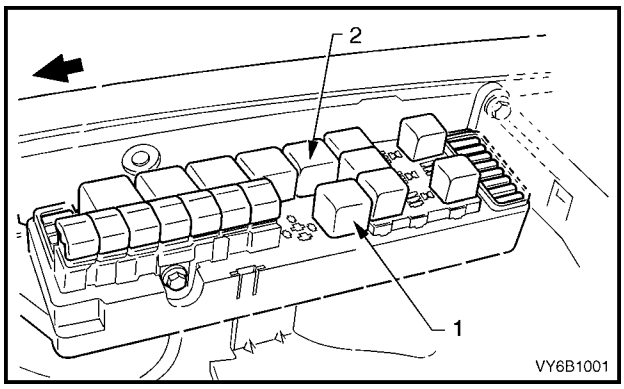

Figure 6B1 – 3

Legend

1 Cooling Fan Relay 1 for large fan operation.
2 Cooling Fan Relay 2 for small fan operation.

Cooling Fans and Shroud Assembly

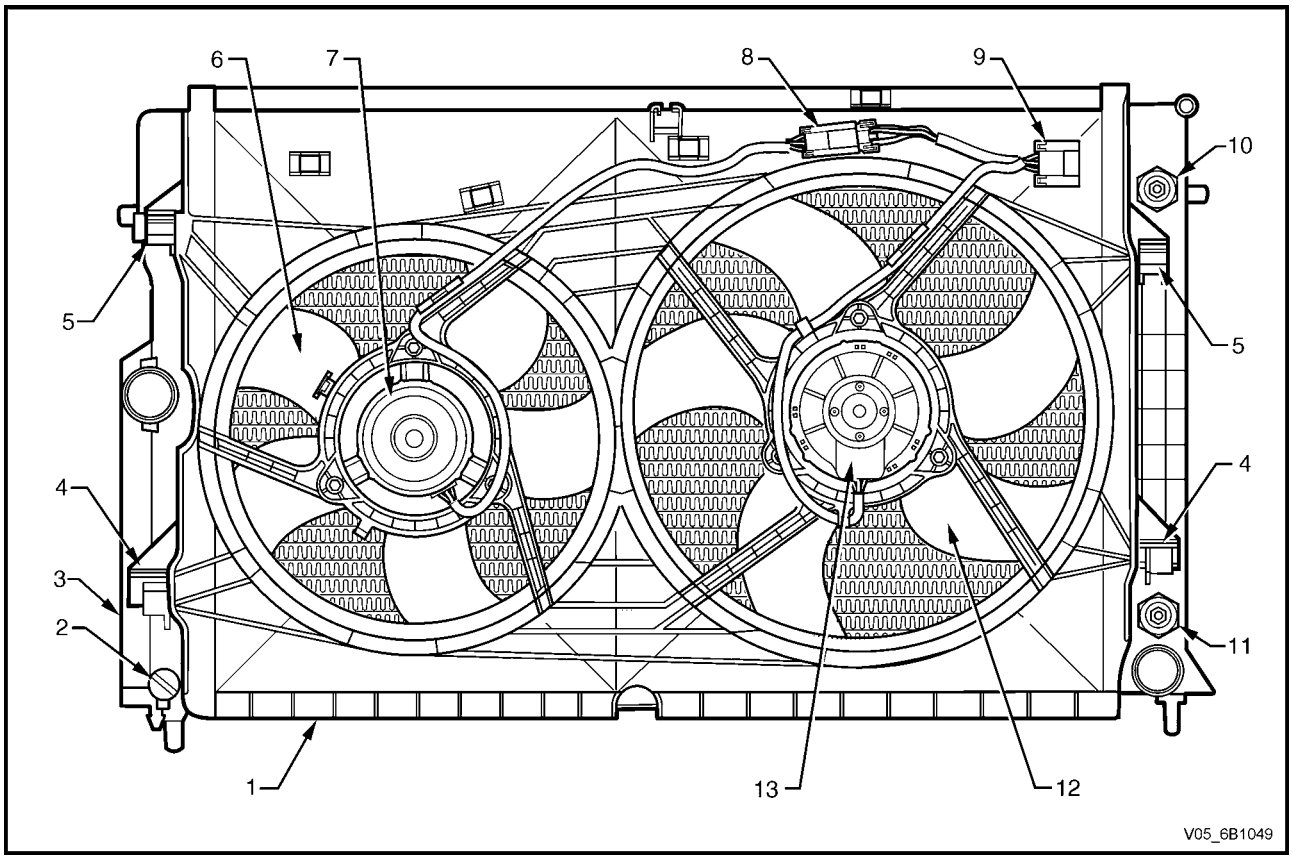

Figure 6B1 – 4

Legend

1 Fan Shroud
2 Radiator Drain Tap
3 Radiator
4 Fan Shroud Lower Support
5 Fan Shroud Upper Support / Locking Retainer
6 Small, Left Fan – 5 Blade, 293 mm Diameter
7 Small, Left Fan Motor – 120 Watt, Single-speed
8 Left Fan Motor Harness Connector (2 terminal)
9 Left and Right Fan Motor Harness Connector (4 terminal)
10 Oil Cooler, Upper Line Connection (Auto. Trans. only)
11 Oil Cooler, Lower Line Connection (Auto. Trans. only)
12 Large, Right Fan – 5 Blade, 354 mm Diameter
13 Large, Right Fan Motor – 160 Watt, Single-speed

Fan Motors

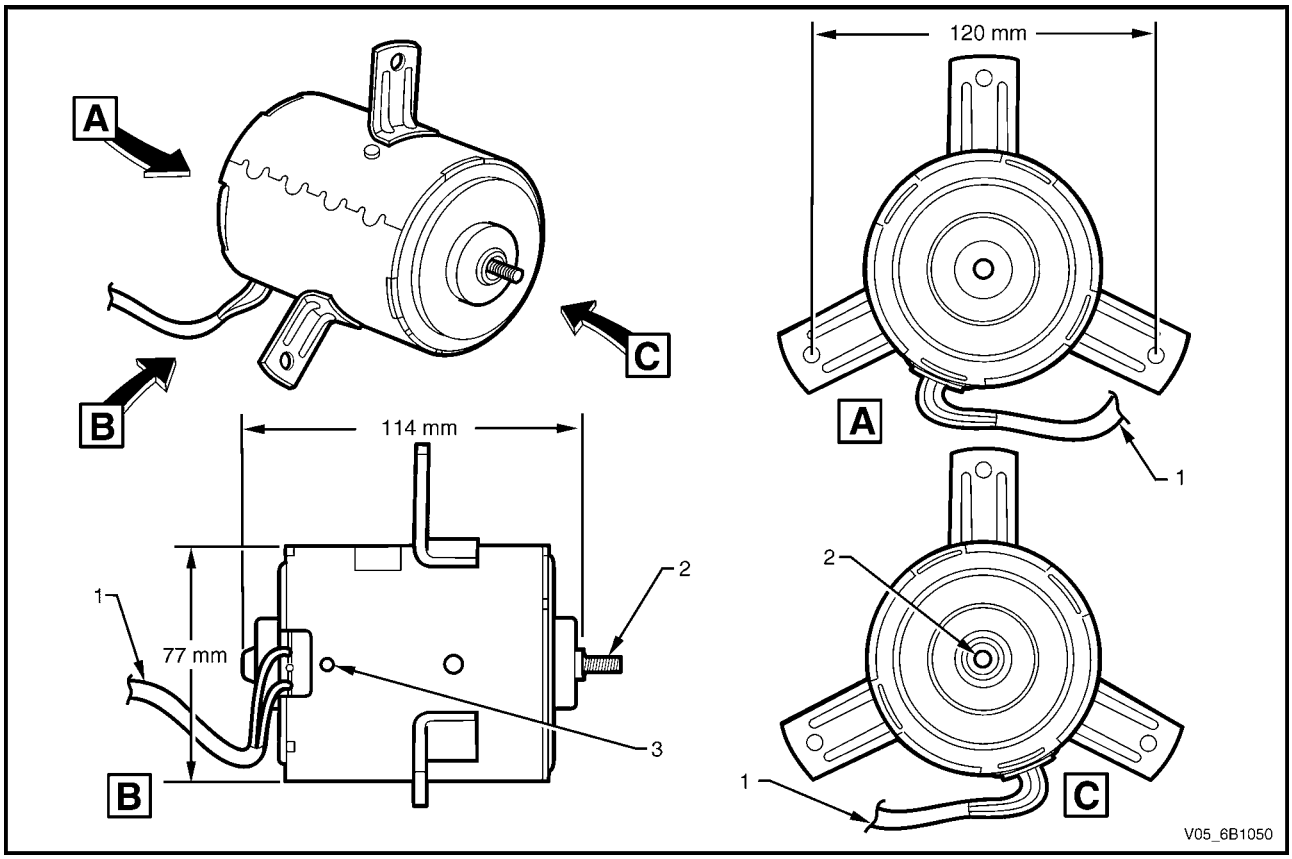

Figure 6B1 – 5

Legend

1	Two-wire Harness	2	Armature Shaft	3	Drain Hole

When the Standard Cooling Fan System is fitted to an Alloytec V6 engine, the fan motors are 12 Volt and single-speed. The internal construction of the fan motor consists of two brushes and two permanent magnets. A two-wire pigtail harness is permanently connected to both motors and is attached to the polypropylene fan shroud at two locations by integral clips moulded as part of the fan shroud.

The RHS motor harness is directly connected to the engine harness through a 6-pin connector. It also carries an additional 2-pin connector, which attaches to the LHS motor harness and enables individual removal of the LHS and RHS fan and motor assemblies when necessary, refer to Figure 6B1 – 4. The two associated electrical connectors are attached to the shroud by way of slide lock clips. The motor is attached to the fan shroud by three bolts at threaded mounting flanges spot-welded symmetrically around the fan housing, refer to Figure 6B1 – 5.

The enclosed fan motor housing is constructed of yellow zinc coated steel. A drain hole is located in the bottom of the housing to allow for breathing and draining of any moisture ingress.

Both fan motors rotate in an anticlockwise direction when viewed from the fan motor side.

The RHS motor is rated at 160 Watts and drives the larger diameter (354 mm) fan blade at approximately 2,250 ± 150 rpm.

The LHS motor is rated at 120 Watts and drives the smaller diameter (293 mm) fan blade at approximately 2,050 ± 150 rpm.

Both LHS and RHS fan and motor are balanced as a unit and fan blades must not be separated from their respective motors. Fan motors and blades are serviced only as an assembled unit. However, it should be noted that the central nut attaching the fan blade to the motor shaft has a left-hand thread.

There are also suppression capacitors incorporated into the fan motor, located on the brush holders. These suppression capacitors help eliminate fan motor noise through the radio speakers. As these capacitors are not serviced separately, should a problem occur with either capacitor, the motor assembly must be replaced.

Operation

On MY 2005 VZ Series vehicles with Alloytec V6 engines and standard specification fan motors, each of the engine cooling fan motors has two terminals; one positive and one negative. The positive terminals are permanently connected to battery voltage, via fusible links F101 (large fan) and F107 (small fan).

Stage 1 Fan Operation

The large cooling fan operation is enabled when the ECM via circuit 335 energises the Engine Cooling Fan Relay 1 (R7). When the negative terminal is connected to ground through Engine Cooling Fan Relay 1 (R7), the large cooling fan (right) operates.

The ECM determines when to enable the Engine Cooling Fan Relay 1 (R7), based on inputs from the A/C request signal, Engine Coolant Temperature (ECT) sensor and the Vehicle Speed Sensor (VSS).

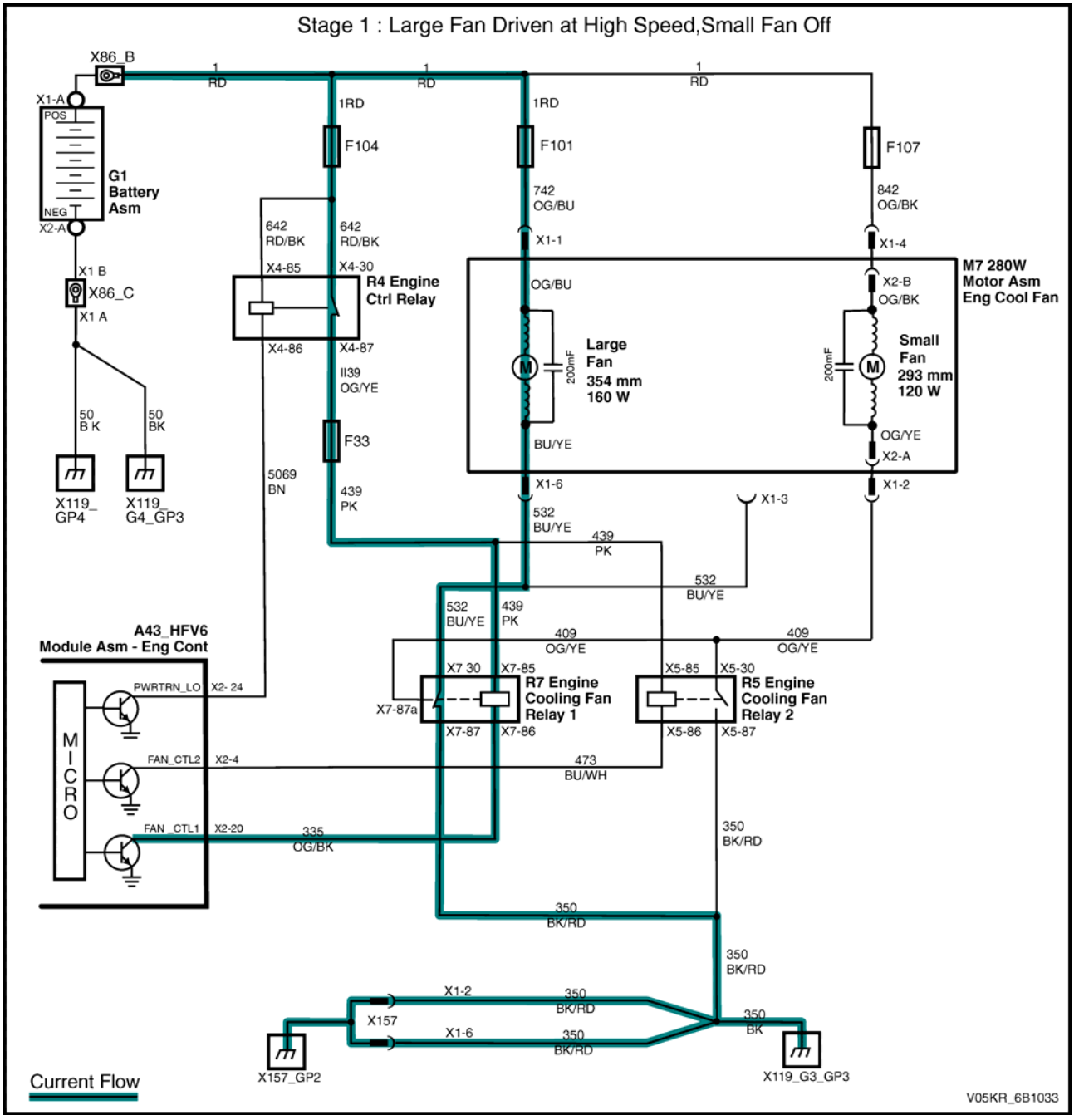

Figure 6B1 – 6

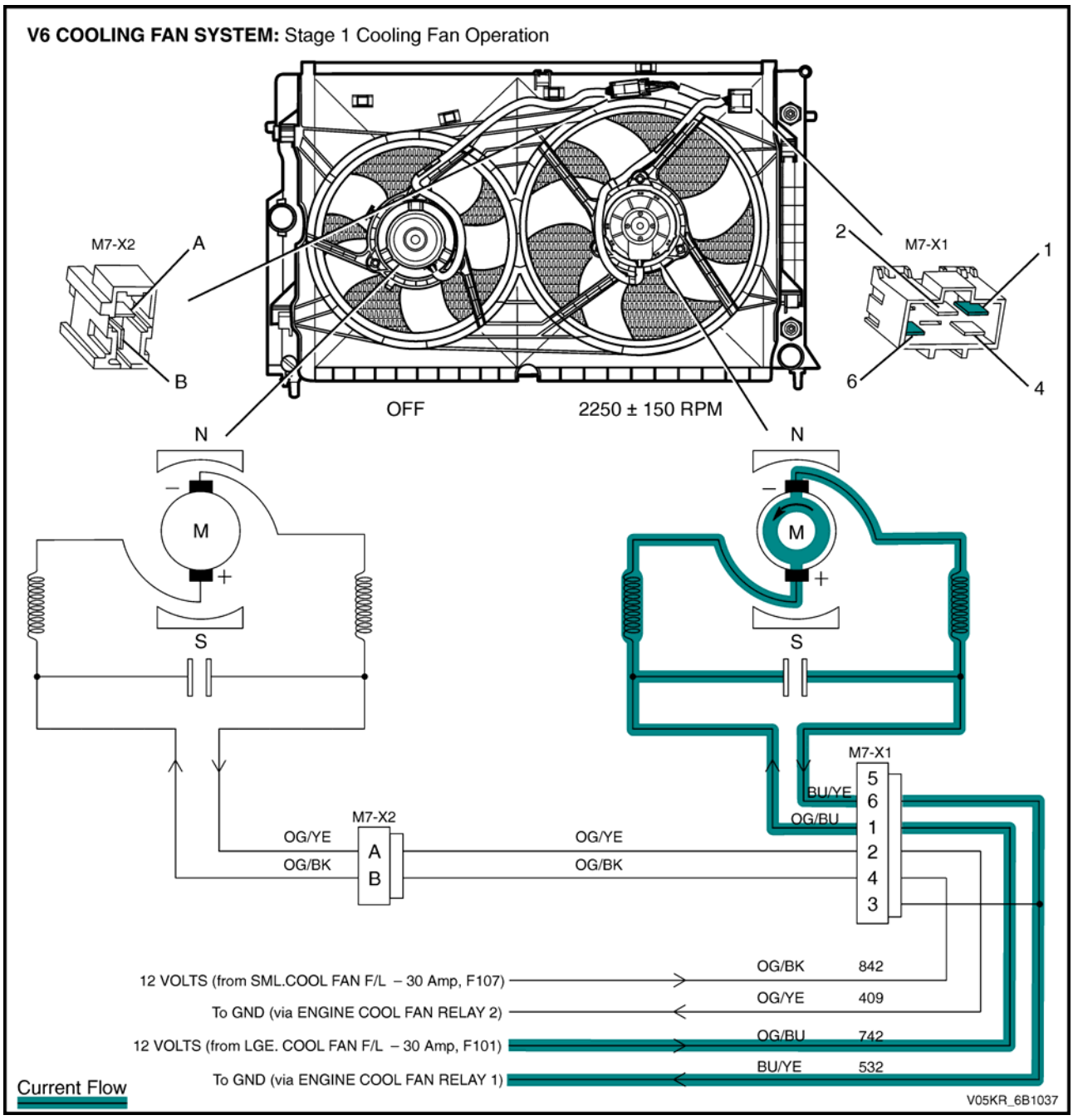

Figure 6B1 – 7

Conditions for Stage 1 Fan Operation

1 The ECM turns Engine Cooling Fan Relay 1 (R7) ON when:

- Air conditioning request indicated (YES) and the vehicle speed is less than 30 km/h;
- Air conditioning pressure is greater than 1,500 kPa;
- Coolant temperature is greater than 104° C; or
- An ECT sensor failure is detected by the ECM.
  Refer to Section 6C1-2 Engine Management – V6 – Diagnostics in this Service Information for additional information; or
- When the ignition switch is turned from ON to OFF and the engine coolant temperature is above 117° C, the ECM will continue to energise the Engine Cooling Fan Relay 1 (R7) for approximately four minutes.

2 The ECM turns Engine Cooling Fan Relay 1 (R7) OFF when the following conditions have been met:

- Air conditioning request not indicated (NO) and the coolant temperature is less than 99° C; or
- Air conditioning request indicated (YES) with pressure less than 1,170 kPa, vehicle speed greater than 50 km/h and coolant temperature less than 99° C.

Stage 2 Fan Operation

The small (left) cooling fan operation is enabled when the ECM via circuit 473 energises the Engine Cooling Fan Relay 2 (R5). When the negative terminal is connected to earth via the Engine Cooling Fan Relay 2 (R5), the small cooling fan operates. Both cooling fans are now operational, the large fan via Engine Cooling Fan Relay 1 (R7) and the small cooling fan via Engine Cooling Fan Relay 2 (R5).

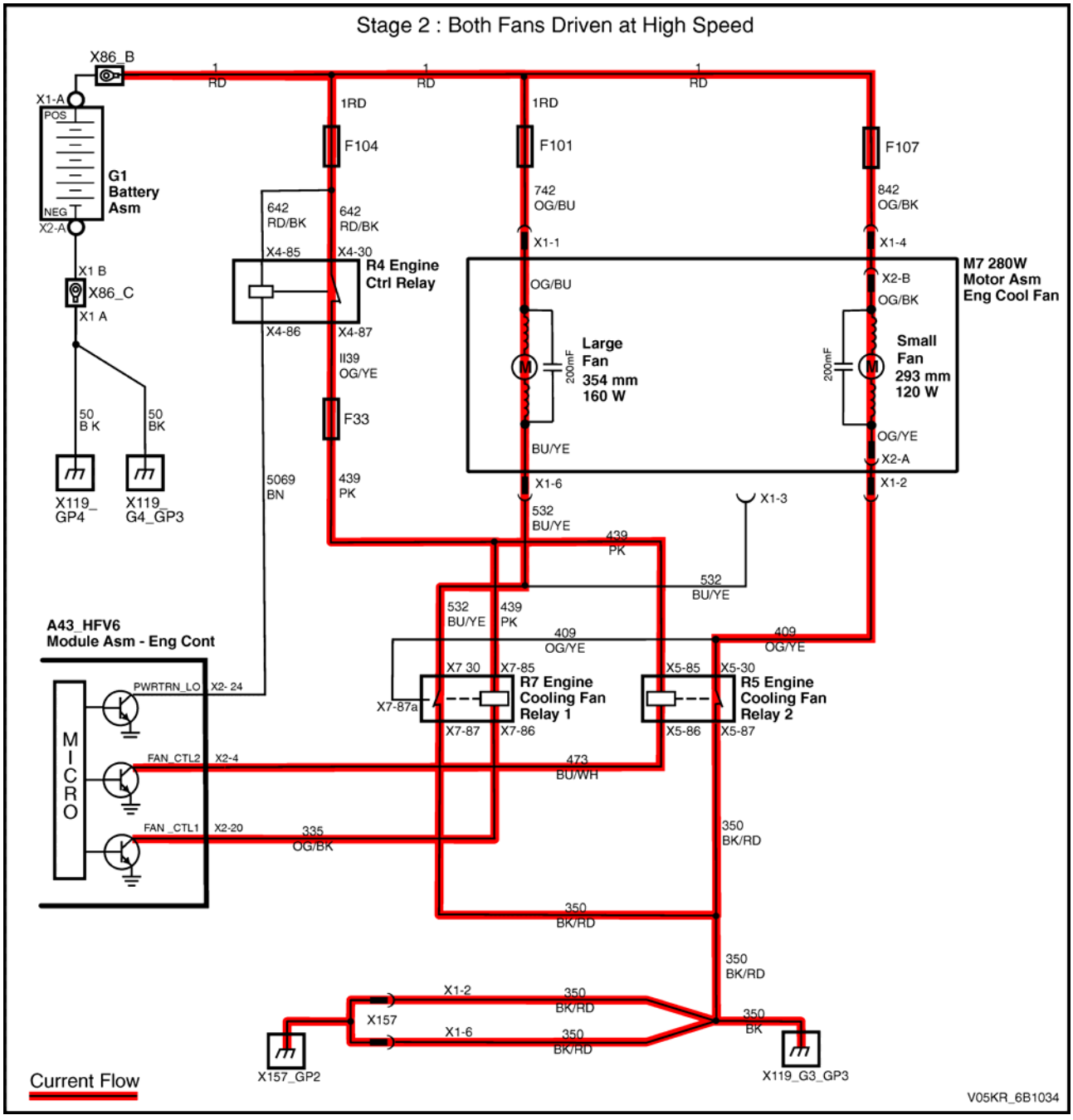

Figure 6B1 – 8

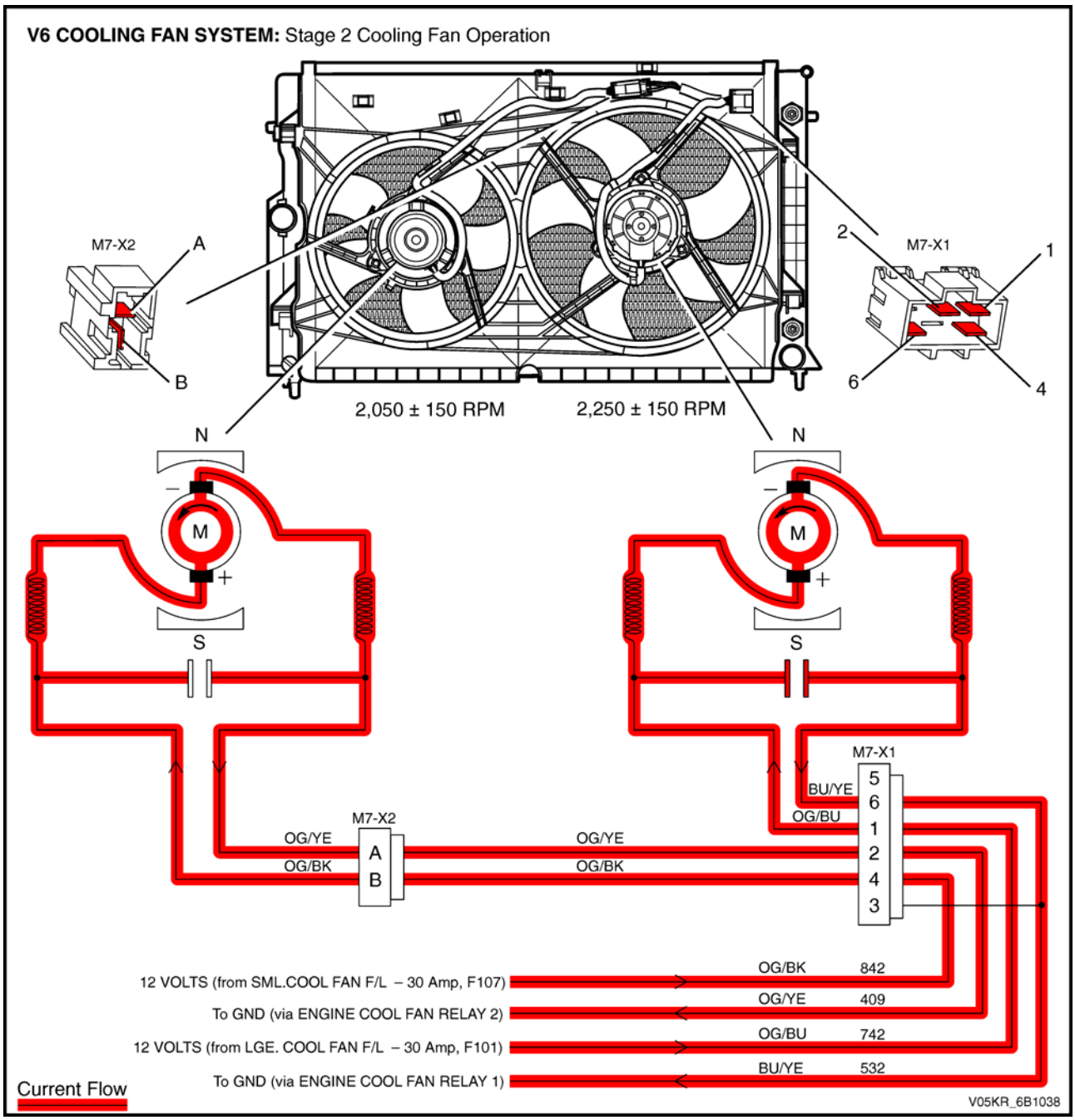
V6 COOLING FAN SYSTEM: Stage 2 Cooling Fan Operation
M7-X2
A
B
M7-X1
1
2
4
6
2,050 ± 150 RPM
2,250 ± 150 RPM
N
N
M
M
S
S
M7-X1
5
6
1
2
4
3
BU/YE
OG/BU
M7-X2
A
B
OG/YE
OG/BK
OG/YE
OG/BK
12 VOLTS (from SML.COOL FAN F/L – 30 Amp, F107)
To GND (via ENGINE COOL FAN RELAY 2)
12 VOLTS (from LGE. COOL FAN F/L – 30 Amp, F101)
To GND (via ENGINE COOL FAN RELAY 1)
OG/BK 842
OG/YE 409
OG/BU 742
BU/YE 532
Current Flow
V05KR_6B1038

Figure 6B1 – 9

Conditions for Stage 2 Fan Operation

The ECM determines when to enable the Engine Cooling Fan Relay 2 (R5), based on inputs from the ECT sensor.

1 The ECM turns Engine Cooling Fan Relay 2 (R5) ON if the Engine Cooling Fan Relay 1 (R7) has been energised for one second and the following conditions have been met:

- If there is a ECM message response fault, setting a DTC P1258;
- The ECM detects an ECT sensor failure. Refer to Section 6C1-2 Engine Management – V6 – Diagnostics in this Service Information for additional information;
- Engine coolant temperature is above 108° C; or
- Air conditioning pressure is greater than 2000 kPa.

NOTE

If the large engine-cooling fan is off when the criteria for turning the small engine-cooling fan on are first met, the small engine-cooling fan will turn on 5 seconds after the large engine-cooling fan is switched on.

2 If both the large and small cooling fans are enabled, the ECM turns the small engine-cooling fan OFF (via Engine Cooling Fan Relay 2) when:

- The engine coolant temperature is less than 103° C; and
- Air conditioning request is not indicated (NO); or
- Air conditioning request is indicated (YES) and the pressure is less than 1500 kPa.

2.3 Cooling Fans – High Power Specification

Overview

All MY 2005 VZ Series Alloytec V6 LHD models, Alloytec V6 RHD cab chassis (2WD and AWD) and Alloytec V6 RHD AWD wagon models are fitted with a high power cooling fan system (400 Watt), which consists of two dual-speed fans. This cooling fan system operates as follows:

- Stage 1 – both fans operate at low-speed.
- Stage 2 – both fans operate at high-speed.

The smaller fan on the left is 293 mm in diameter with a motor rated at 180 Watts, while the larger fan on the right is 354 mm in diameter with a motor power rating of 220 Watts.

While both the standard and high power assemblies have the same diameter fans, the power rating of the electric motors, changes and can be seen visually by the larger diameter motor for the high power assemblies.

The following block diagram outlines the operation of the cooling system that also shows the inputs the Engine Control Module (ECM) requires.

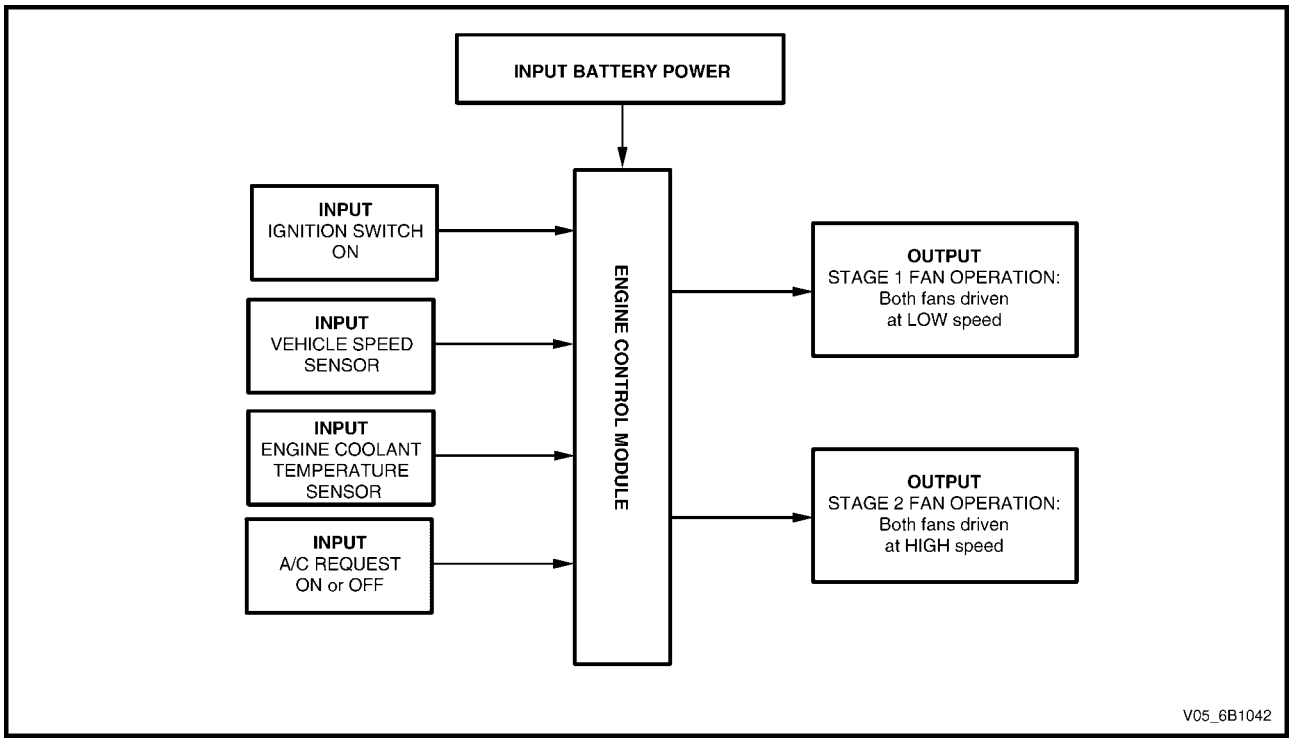

Figure 6B1 – 10

With 12 volts applied and the fans mounted to the radiator with a condenser fitted, the operating speeds are:

	Stage 1	Stage 2
Large Fan	2,350 ± 150 rpm	2,750 ± 150 rpm
Small Fan	2,050 ± 150 rpm	2,300 ± 150 rpm

Relays

The engine cooling fan relays are located in the fuse and relay compartment under the hood.

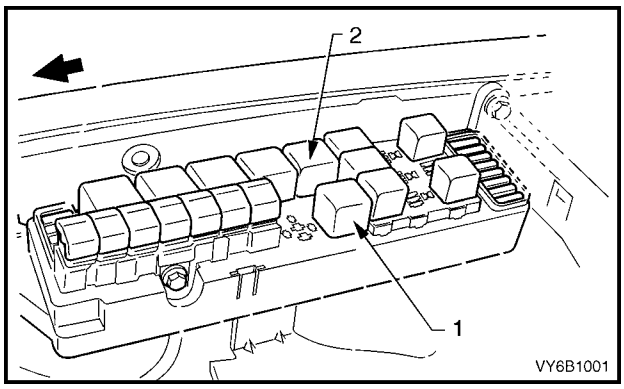

Figure 6B1 – 11

Legend

1 Cooling Fan Relay 1 for low-speed fan operation.

2 Cooling Fan Relay 2 (in conjunction with Cooling Fan Relay 1) for high-speed fan operation.

Cooling Fans and Shroud Assembly

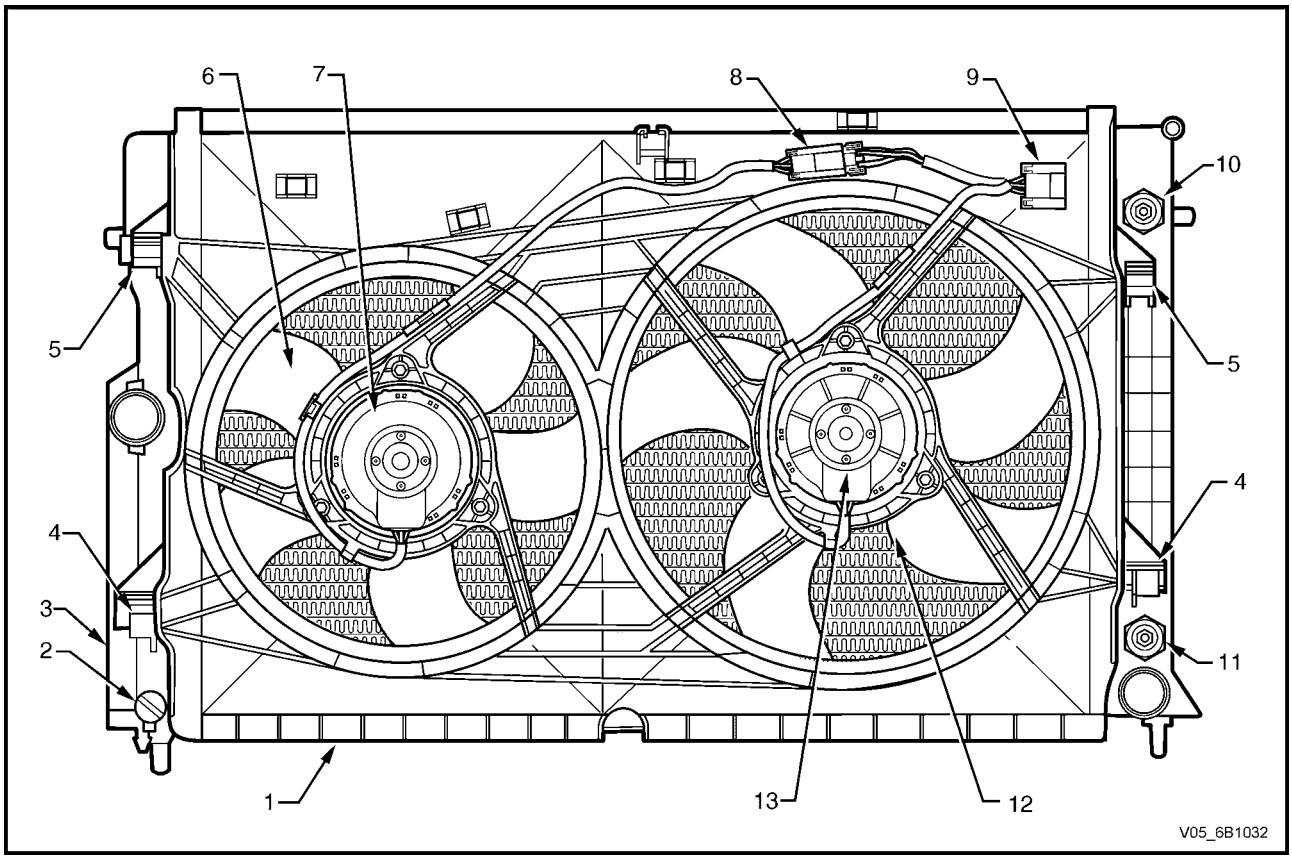

Figure 6B1 – 12

Legend

1 Fan Shroud
2 Radiator Drain Tap
3 Radiator
4 Fan Shroud Lower Support
5 Fan Shroud Upper Support / Locking Retainer
6 Small, Left Fan – 5 Blade, 293 mm Diameter
7 Small, Left Fan Motor – 180 Watt, Dual-speed
8 Left Fan Motor Harness Connector (3 terminal)
9 Left and Right Fan Motor Harness Connector (5 terminal)
10 Oil Cooler, Upper Line Connection (Auto. Trans. only)
11 Oil Cooler, Lower Line Connection (Auto. Trans. only)
12 Large, Right Fan – 5 Blade, 354 mm Diameter
13 Large, Right Fan Motor – 220 Watt, Dual-speed

Fan Motors

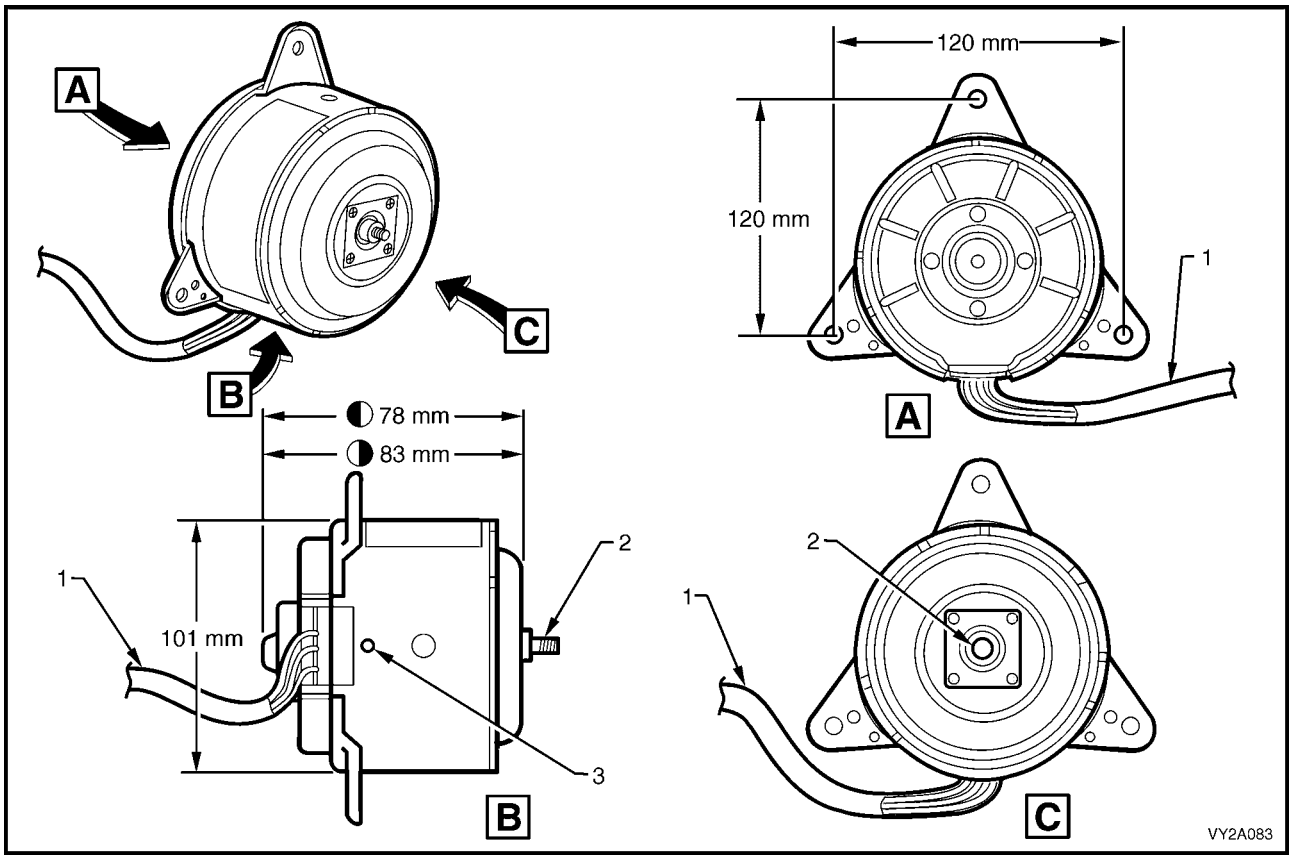

Figure 6B1 – 13

Legend

1	Three-wire Harness	2	Armature Shaft	3	Drain Hole
◐	Dimension applicable to small diameter fan blade	◑	Dimension applicable to large diameter fan blade		

Whenever a High Power Cooling Fan System is fitted, the fan motors are 12 Volt and dual-speed. Accordingly, the internal construction of the fan motor consists of four brushes and four permanent magnets. A three-wire pigtail harness is permanently attached to both motors and is attached to the polypropylene fan shroud at two locations by integral clips moulded as part of the shroud. The RHS motor harness is connected directly to the engine harness through a 6-pin connector. It also carries an additional 4-pin connector that attaches to the LHS motor harness and enables individual removal of the LHS and RHS fan and motor assemblies when necessary, refer to Figure 6B1 – 12. The two associated electrical connectors are attached to the shroud by way of slide lock clips. The motor is attached to the polypropylene fan shroud by three bolts installed at the threaded mounting flanges, which protrude symmetrically from the rear of the fan motor housing, refer to Figure 6B1 – 13.

The enclosed fan motor housing is constructed of yellow zinc coated steel. A drain hole is located in the bottom of the housing to allow for breathing and draining of any moisture ingress.

Both fan motors rotate in an anticlockwise direction when viewed from the fan motor side.

The LHS motor is rated at 180 Watts and drives the smaller diameter (293 mm) fan blade. During Stage 1 operation, the fan is driven at 2,050 ± 150 rpm. During Stage 2 operation, the fan is driven at 2,300 ± 150 rpm.

The RHS motor is rated at 220 Watts and drives the larger diameter (354 mm) fan blade. During Stage 1 operation, the fan is driven at approximately 2,350 ± 150 rpm. During Stage 2 operation, the fan is driven at 2,750 ± 150 rpm.

Both LHS and RHS fan and motor are balanced as a unit and fan blades must not be separated from their respective motors. Fan motors and blades are serviced only as an assembled unit. However, it should be noted that the central nut attaching the fan blade to the motor shaft has a left-hand thread.

There are also suppression capacitors incorporated into the fan motor, located on the brush holders. These suppression capacitors help eliminate fan motor noise through the radio speakers. As these capacitors are not serviced separately, should a problem occur with either capacitor, and then the motor assembly must be replaced.

Operation

The electrical circuitry for the high power specification cooling fans is different to that used for the standard specification system. Each high power fan motor has three terminals; one positive and two negative (one for low-speed operation and one for high-speed operation). The positive terminals are permanently connected to battery voltage, via fusible links F101 (large fan) and F107 (small fan).

The fan motors are also connected electrically, as follows:

- The low-speed negative wires from each motor go through the radiator fan connector separately and are spliced together in the main wiring harness before reaching Engine Cooling Fan Relay 1.
- The high-speed wires from each motor are spliced together before the radiator fan connector and go through the connector as one circuit, to Engine Cooling Fan Relay 2.

Stage 1 Fan Operation

When the low-speed negative terminal from each motor is connected to ground via Engine Cooling Fan Relay 1 (R7), both cooling fans will operate at Stage 1 (Large fan at 2,350 ± 150 rpm, Small fan at 2,050 ± 150 rpm). With Engine Cooling Fan Relay 1 still activated, when the high-speed negative terminal from each motor is connected to ground via Engine Cooling Fan Relay 2 (R5), both fans operate at Stage 2 (Large fan at 2,750 rpm ± 150 rpm, Small fan at 2,300 ± 150 rpm).

Stage 1 cooling fan operation is enabled when the ECM via circuit 335 energises the Engine Cooling Fan Relay 1.

The ECM determines when to enable Stage 1, based on inputs from the A/C request signal, Engine Coolant Temperature (ECT) sensor and the Vehicle Speed Sensor (VSS).

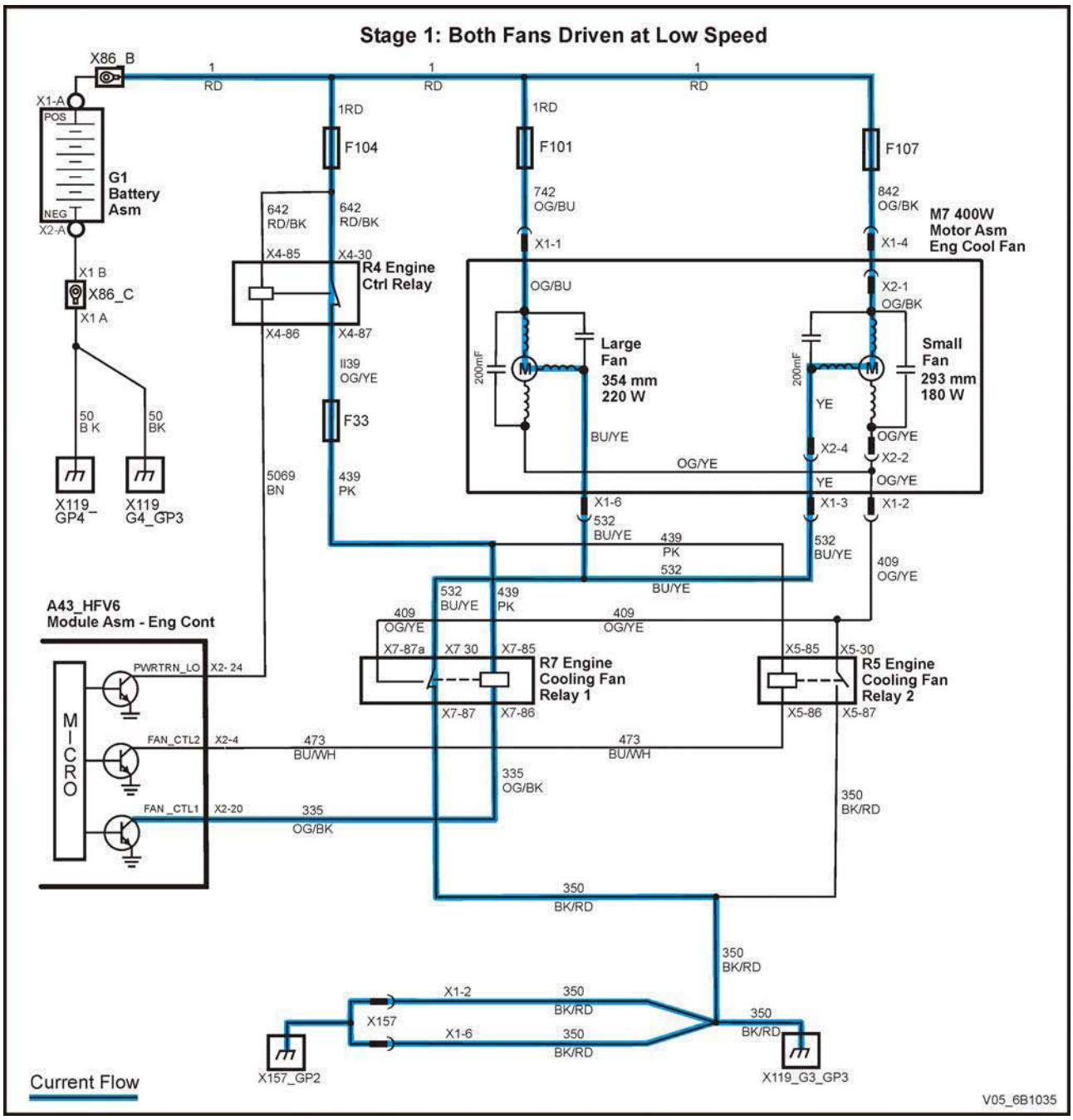

Figure 6B1 – 14

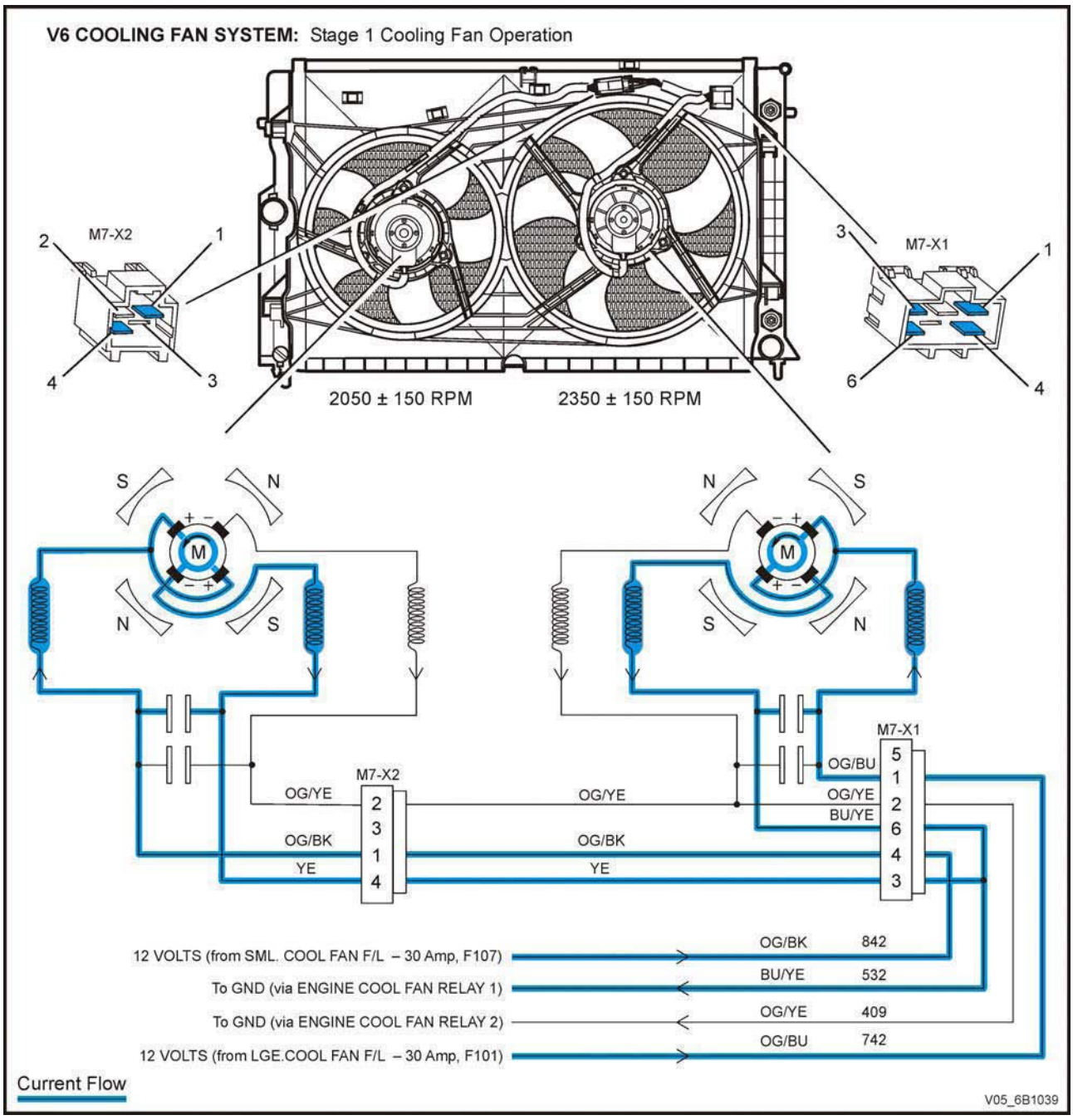

Figure 6B1 – 15

Conditions for Stage 1 Fan Operation

1 The Engine Cooling Fan Relay 1 is turned ON when:

- Air conditioning request indicated (YES) and the vehicle speed is less than 30 km/h;
- Air conditioning pressure is greater than 1,500 kPa;
- Coolant temperature is greater than 104° C; or
- An engine coolant temperature sensor failure is detected by the PCM.
  Refer to Section 6C1-2 Engine Management – V6 – Diagnostics for additional information; or
- When the ignition switch is turned from ON to OFF and the engine coolant temperature is above 117° C, the ECM will continue to energise the Engine Cooling Fan Relay 1 (R7) for approximately four minutes.

2 The ECM switches OFF Engine Cooling Fan Relay 1 when the following conditions have been met:

- Air conditioning request not indicated (NO) and the coolant temperature is less than 99° C, or
- Air conditioning request indicated (YES) with pressure less than 1,170 kPa, vehicle speed greater than 50 km/h and coolant temperature less than 99° C.

Stage 2 Fan Operation

Stage 2 cooling fan operation is enabled when the ECM via circuit 473 energises the Engine Cooling Fan Relay 2.

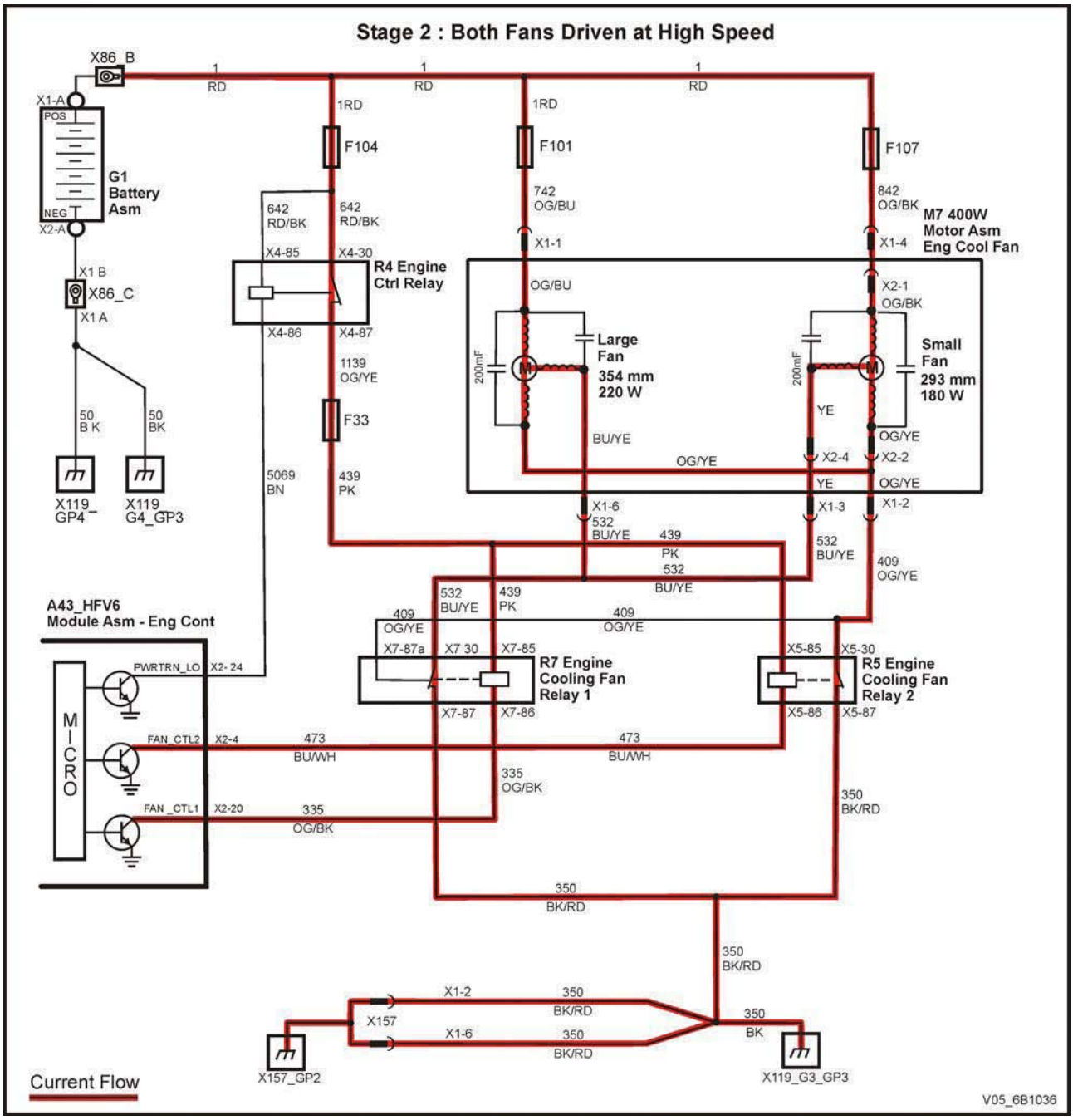

Figure 6B1 – 16

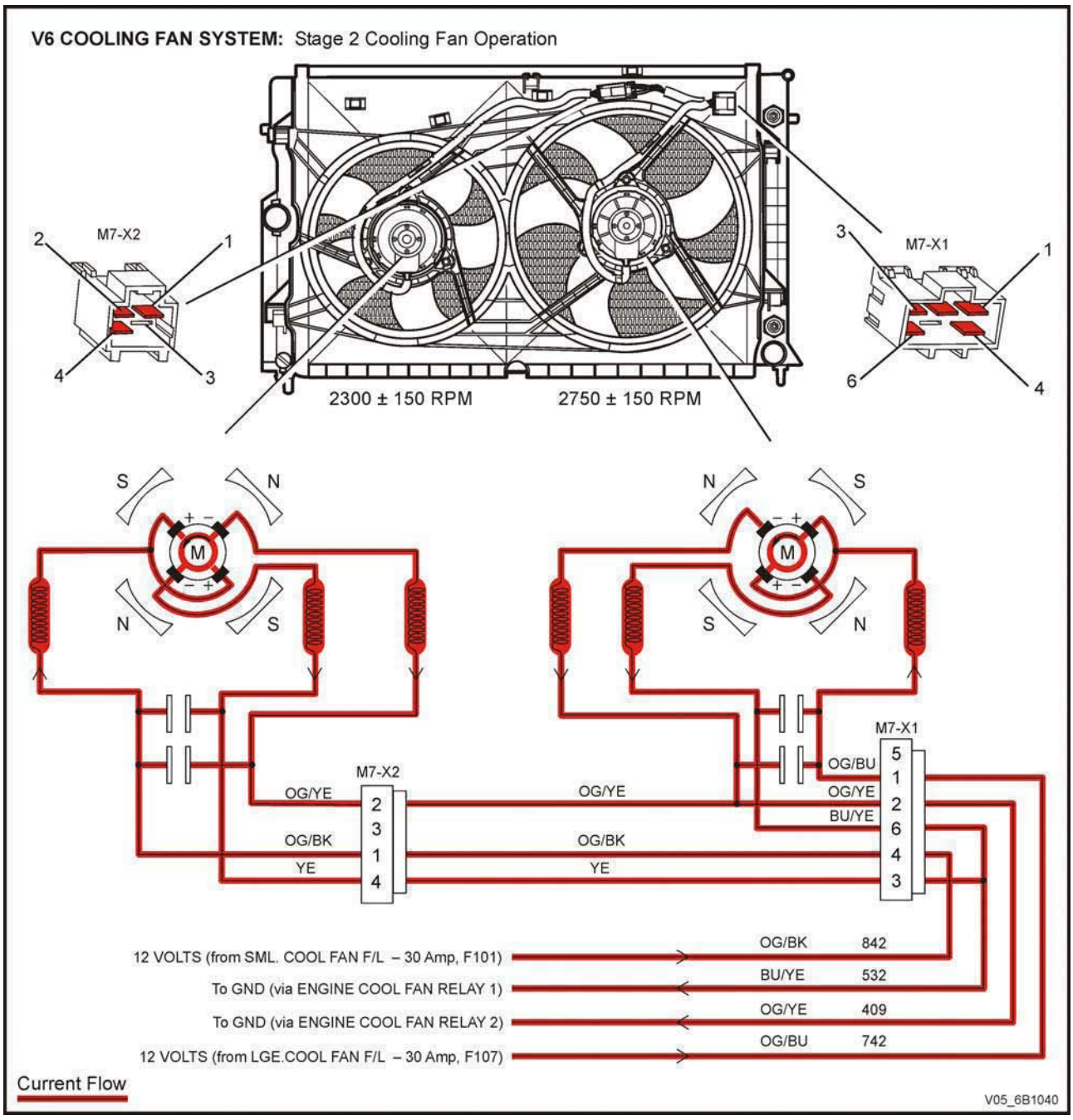

Figure 6B1 – 17

Conditions for Stage 2 Fan Operation

The ECM determines when to enable the Engine Cooling Fan Relay 2, based on inputs from the ECT sensor.

1 Engine Cooling Fan Relay 2 is turned ON if the Engine Cooling Fan Relay 1 has been energised for one second and the following conditions have been met:

- If there is a ECM message response fault, setting a DTC P1258;
- An ECT sensor failure is detected by the ECM.
  Refer to Section 6C1-2 Engine Management – V6 – Diagnostics in this Service Information for additional information;
- Engine coolant temperature is above 108° C; or
- Air conditioning pressure is greater than 2,000 kPa.

2 If Stage 2 has been enabled, the ECM reverts to Stage 1 operation when:

- The engine coolant temperature is less than 103° C; and
- Air conditioning request is not indicated (NO); or
- Air conditioning request is indicated (YES) and the pressure is less than 1,500 kPa.