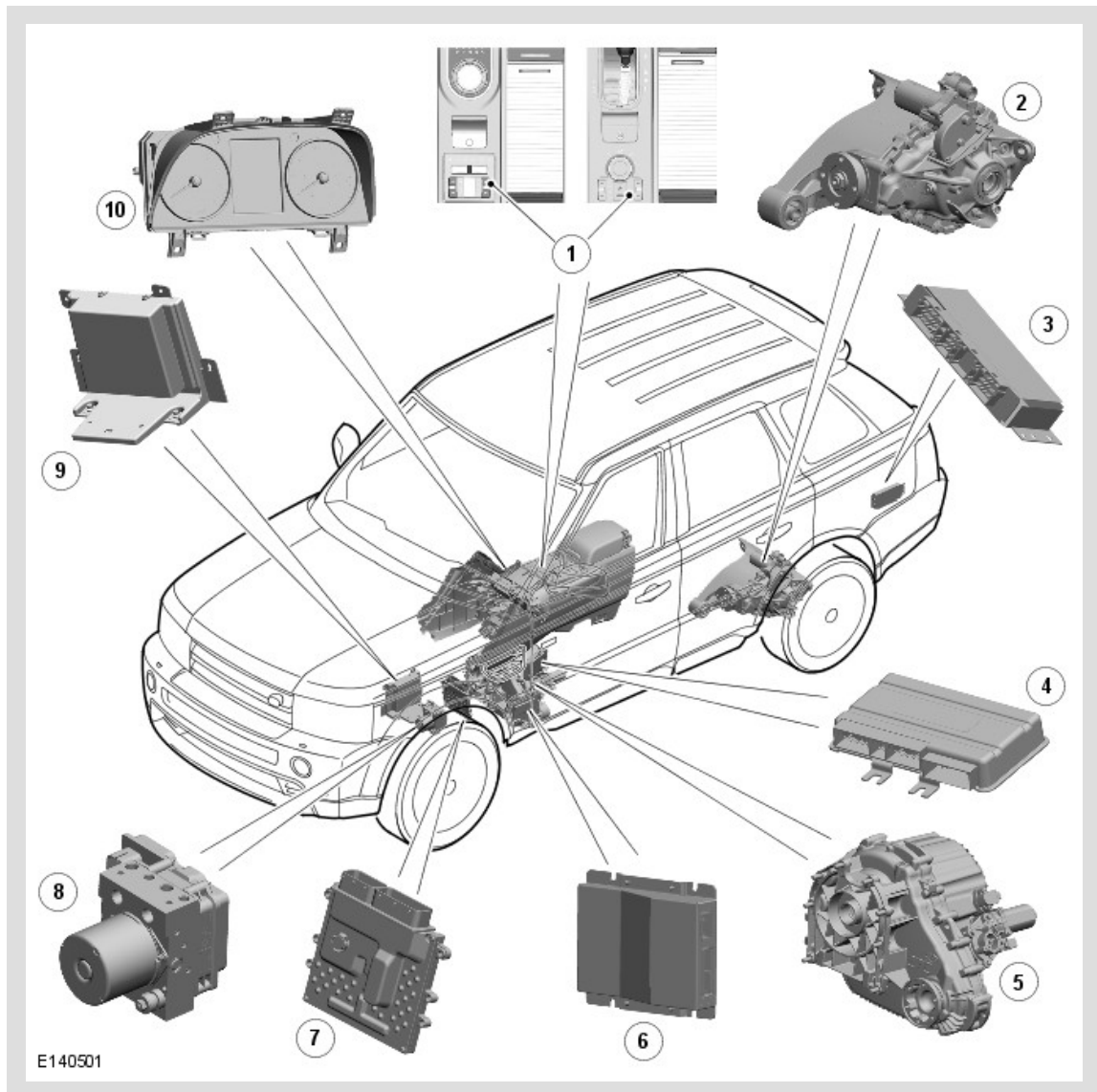


RIDE AND HANDLING OPTIMIZATION

DESCRIPTION AND OPERATION

Terrain Response - Component Location



ITEM	DESCRIPTION
1	Terrain Response control and control module
2	Rear differential

3	Rear differential control module
4	Air suspension control module
5	Transfer box (center differential and high/low range)
6	Adaptive Damping Module (ADM)
7	ECM (engine control module)
8	ABS (anti-lock brake system) module
9	Transfer box control module
10	Instrument cluster

GENERAL

The Terrain Response™ system allows the driver to select a program which aims to provide the optimum settings for traction and performance for the prevailing terrain conditions. The system cannot be switched off. The 'special programs off' is the default program and covers all general driving conditions. Four specific terrain programs are selectable to cover all terrain surfaces.

The system is controlled by a rotary control located on the center console, rearward of the selector lever (automatic transmission) or gearshift lever (manual transmission). The rotary control allows the selection of one of the following five programs:

- Special programs off
- Grass/Gravel/Snow
- Mud-Ruts
- Sand
- Rock crawl.

The rotary control can be rotated through 360 degrees or more in either direction and selects each program in turn. When Terrain Response is fitted to a vehicle the instrument cluster will display the selected program in the message center.

The Terrain Response system uses a combination of a number of vehicle subsystems to achieve the required vehicle characteristics for the terrain selected. The following subsystems make up the Terrain Response system:

- Engine management system
- Automatic transmission (if fitted)
- Transfer box (center differential)
- Rear differential (electronically controlled)

- Brake system (ABS/DSC/ETC/HDC functions)
- Air suspension.

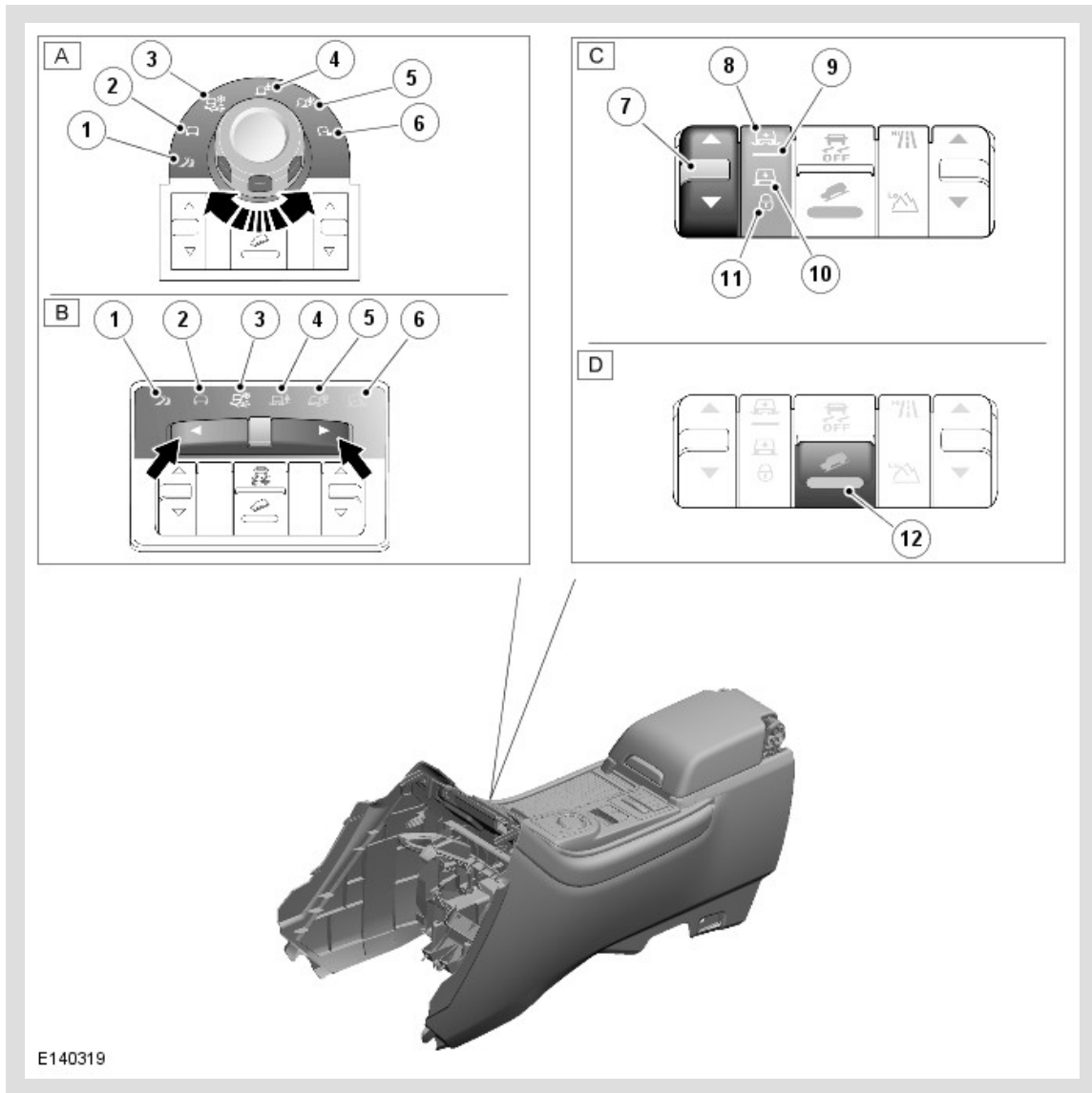
A Terrain Response control module is located below the rotary control. The control module detects the selection made on the rotary control and transmits a signal on the high speed CAN (controller area network) which is received by each of the subsystem control modules.

Each of the affected sub-system control modules contain software which applies the correct operating parameters to their controlled system for the Terrain Response program selection made.

Each sub-system control module also provides a feedback for the selected program so that the Terrain Response control module can check that all systems have changed to the correct operating parameters.

Information is displayed in the instrument cluster message center which informs the driver of improvements which can be made to the vehicle operating parameters to optimise the vehicle for the prevailing conditions. Inexperienced off-road drivers may benefit from the automatic assistance of the Terrain Response system and the driver information. Experienced off-road drivers can select the specific programs for extreme conditions to access control over the vehicle systems (e.g., throttle shift maps or traction settings) which are not accessible on vehicles without Terrain Response.

AIR SUSPENSION AND TERRAIN RESPONSE SWITCH PACK



ITEM	DESCRIPTION
A	Terrain Response™ control - Non-Electronic Transmission Shifter
B	Terrain Response™ control - Electronic Transmission Shifter
C	Air suspension switch location in switch pack
D	Hill Descent Control (HDC) switch location in switch pack
1	Dynamic
2	General program (special programs off)
3	Grass/Gravel/Snow
4	Mud-Ruts
5	Sand
6	Rock crawl

7	Raise/lower switch
8	Off-Road Mode
9	On-Road Mode
10	Access Mode
11	Crawl (Locked at Access) Mode
12	Hill Descent Control (HDC) switch

Each program is denoted by a symbol which represents the terrain encountered. The rotary control can be depressed downwards to lock it in a position flush with the trim surround. A second push of the control releases the lock and the control emerges from the surround allowing it to be rotated.

The rotary control can be rotated to select the required program. The control will only select the last program in its direction of rotation. Further rotation of the control once the last program in either direction has been selected, will have no effect, e.g. once rock crawl has been selected, further rotation in a clockwise direction will have no effect.

The Terrain Response control module is located below the rotary control. The module is connected via a harness connector which also contains the wiring for the HDC switch, the transfer box high/low range switch, the air suspension switch and the switch illumination circuits. The control module and switch uses four of these wires for a 12V battery supply when the ignition switch is in ignition position II, a ground and high speed CAN positive and negative.

TERRAIN RESPONSE OPERATION

The following vehicle subsystem control modules are used for the Terrain Response system:

- Engine management (engine control module)
- Transmission control (transmission control module - automatic transmission only)
- Transfer box control (transfer box control module)
- Rear differential control (rear differential control module - if fitted)
- Air suspension control (air suspension control module)
- Brake system (ABS/DSC/ETC/HDC functions) (ABS module)

Each subsystem operates in different ways in relation to the selected Terrain Response program to achieve the optimum traction, stability and ease of control for the terrain

encountered. The system has a safety factor built in which ensures that any program can be safely used on any surface, even when an inappropriate program selection has been made.

ECM

The ECM varies the throttle pedal response to control the engine torque output. The ECM can change the throttle maps to change the amount of torque per percentage of pedal travel. The ECM can also change the throttle response to control the allowed torque change relative to the percentage pedal travel.

Each terrain program uses a combination of operating parameters for each subsystem. Changing between terrain programs initiates a different set of operating characteristics which will be noticeable to the driver. The driver will notice differences in engine and throttle response when, for example, the throttle pedal is held in a constant position and the terrain program is changed from grass/gravel/snow to sand, the driver will notice the torque and engine speed increase. If the terrain program is changed from sand to grass/gravel/snow the driver will notice a reduction in torque and engine speed.

NOTE:

The change in torque and engine speed can take approximately 30 seconds and care must be taken not to confuse the Terrain Response system operation with an ECM fault.

TRANSMISSION CONTROL

The transmission control module changes the shift maps for the Terrain Response program selected. This changes the shift points providing early or late upshifts and downshifts.

On slippery surfaces the transmission will select 2nd gear in high range or 3rd gear in low range for starting from a standstill to minimise wheel slip. In muddy conditions the transmission will provide maximum torque output from the transmission. In sand the transmission will provide an output which passes maximum engine power from the transmission.

In rock crawl special program (low range) the transmission will select 1st gear for driving off.

Sport mode is only available when the general program is selected and the transfer box is in high range. Sport mode is disabled in low range and all Terrain Response special programs. CommandShift™ is available in any program and also in high or low range.

If the transmission is in 'Sport' mode and a special program is subsequently selected, the transmission will automatically change to manual 'CommandShift™' mode. If a

special program is already selected and the transmission selector lever is moved from drive 'D' to the 'Sport' mode position, the transmission will automatically change to 'CommandShift™' mode.

TRANSFER BOX AND REAR DIFFERENTIAL CONTROL

The transfer box electronically controlled differential and the rear electronically controlled differential (if fitted) are treated as one system. The electronic rear differential is an optional fitment on vehicles fitted with the Terrain Response system. The differential control has two operating strategies; pre-emptive and reactive.

The pre-emptive strategy anticipates and predicts the locking torque value required for each differential to minimise slip and maximise stability. Each Terrain Response program has a different threshold and input criteria for the pre-emptive strategy. The pre-emptive strategy improves vehicle traction and composure by avoiding wheel spin. This is achieved by anticipating the amount of differential lock required for the program selected. For example, a high locking torque would be applied for rock crawl or slippery surfaces.

The reactive strategy varies the amount of locking torque in response to the actual slip level and the dynamic behaviour of the vehicle. Each Terrain Response program has a different threshold and input for the reactive strategy. The reactive strategy improves vehicle traction and composure by eliminating any wheel spin which has occurred after the pre-emptive strategy was applied. The locking response applied is applicable to the terrain program selected, for example, very sensitive on slippery surfaces to provide maximum traction and minimise surface damage.

The locking torque calculations use various signals from other subsystems, for example, engine torque, throttle position, selected gear, steering angle, vehicle speed, lateral acceleration and yaw behaviour.


The Dynamic Stability Control function of the ABS system can override the Terrain Response differential control and reduce any applied locking torque during DSC action. For additional information, refer to: Anti-Lock Control - Traction Control (206-09A, Description and Operation).

AIR SUSPENSION CONTROL

The air suspension control module contains a strategy which provides automatic switching between normal and off-road heights. Changes in vehicle height settings will be relayed to the driver via the instrument cluster message center and LED (light emitting diode) illuminated icons on the switch. The automatic selection and deselection of the vehicle height provides automatic increase and decrease in ground clearance and aims to provide maximum benefit to the selected terrain program.

On a vehicle fitted with a correctly installed, Land Rover approved trailer socket, if an electrical load is sensed on the trailer socket, height changes are prohibited and the message center displays a message advising that a trailer is connected and off-road

height is not automatically selected. The driver can raise the suspension manually using the air suspension switch.

 **NOTE:**

The prohibiting of the automatic ride height selection is only operational if a Land Rover approved trailer socket is fitted and an electrical load is sensed on the socket.

ABS CONTROL

The ABS module controls several vehicle functions and adjusts the operating parameters of these functions to optimise the selected Terrain Response program.

Traction control uses different slip/acceleration thresholds to improve traction and vehicle composure. For example, the system sensitivity is increased on slippery surfaces to reduce wheel spin.

If DSC is switched off (with the DSC switch on the instrument panel) when using a Terrain Response special program, if the special program is subsequently changed for a different program DSC is automatically switched back on.

The stability control uses different threshold values for the selected program to automatically reduce DSC intervention, removing the requirement for the driver to disable the DSC system in order to reduce engine intervention which is sometimes induced in extreme off-road conditions. In extreme sand conditions, there may be an additional benefit of disabling the DSC function using the DSC switch on the instrument panel in addition to selecting the sand program.

HDC is automatically switched on or off and target speeds are adjusted in response to the Terrain Response program selected. The responsiveness of the HDC function is also increased where required.

Automatic operation of HDC aims to assist the driver by switching the system on or off when it is of most benefit. Target speeds for HDC operation are also adjusted according to the vehicle operating conditions.

INCORRECT PROGRAM USAGE

Selection of an inappropriate program is discouraged in the following ways:

- The active program icon is continually displayed in the instrument cluster message center
- The Terrain Response control module 'locks' out certain functions in some programs, e.g.

- cruise control is only available with the special programs off or grass/gravel/snow program
- transmission 'Sport' mode is deactivated in all special programs.
- In any special program, except the grass/gravel/snow program, when the ignition has been in the off position, continually for more than six hours, the Terrain Response system defaults to the Special Programs off. When in the grass/gravel/snow program, the Terrain Response system will never default to the Special Programs off. This is to allow for drivers in cold climates where continuous use of the grass/gravel/snow program would be beneficial.
- The rock crawl program is only available with the transfer box in low range.

Selection of an inappropriate program for the terrain conditions will not endanger the driver or cause damage to the vehicle. Continued use of an inappropriate program may reduce the life of some components. The driver may notice reduced vehicle response, with the engine and transmission being less responsive than in the special programs off. Also, in some programs, HDC will remain on, signified by illumination of the HDC indicator in the instrument cluster. The driver may also notice torque 'wind-up' in the center and rear differentials causing a 'braking' effect when the vehicle is manoeuvred in some special programs.

The use of the special programs in the Terrain Response system is monitored by the Terrain Response control module which records the mileage and time the vehicle has operated in a specific program in high and low range. This information can be retrieved using Land Rover approved diagnostic equipment and used by the dealer technician to check customer concerns, e.g. high fuel consumption which may be due to continued use of a certain program.

DRIVER INFORMATION

The instrument cluster contains a message center which displays vehicle information to the driver. The message center contains the Terrain Response program icons which display the currently selected program. If no symbol is displayed, no special program is selected and the system is in special programs off.

Any required changes to the subsystems are also passed to the driver in the form of indicator illumination in the instrument cluster or appropriate messages in the message center, HDC off or air suspension height change for example.

In certain operating conditions, the Terrain Response system also displays advice or warning messages to ensure the driver is using the vehicle to its full potential, e.g.

- Steering angle is displayed in the message center to avoid driving in deep ruts with steering lock applied
- gear information is displayed to recommend a gear for slippery conditions

- if the system automatically provided off road ride height, but the driver subsequently lowers the vehicle to normal height, then the system may advise that this will cause a risk of grounding.

The messages which can be displayed in the instrument cluster message center are detailed in the Information and Message Center section.

For additional information, refer to: Information and Message Center (413-08, Description and Operation).

DIAGNOSTICS

The Terrain Response control module stores information on detected Terrain Response faults and CAN errors which can be interrogated using Land Rover approved diagnostic equipment. The Terrain Response sub-systems and the instrument cluster also store fault information relating to CAN errors from the Terrain Response control module.

The control module also stores the miles travelled and time elapsed in high range for the individual programs and in low range for use of all programs which can also be retrieved using Land Rover approved diagnostic equipment. This information aids diagnosis of the Terrain Response system and also provides an indication of Terrain Response system abuse by the driver which can lead to premature component failure.

TERRAIN RESPONSE SYSTEM FAULT DIAGNOSIS

Terrain Response relies on the correct functionality of the five sub-systems. If one of the sub-systems develops a fault, the Terrain Response system will not function, even though the fault is not in the Terrain Response system. The Terrain Response control module and rotary control should only be investigated if there are no apparent faults in any of the sub-systems. If a fault in a sub-system is subsequently corrected, the Terrain Response system will function normally after an ignition on and off cycle.

Terrain Response Sub-System Faults

If a fault occurs in a sub-system, the driver is alerted by the illumination of a warning indicator and/or an appropriate message for that sub-system in the instrument cluster message center. There will be no warning of a Terrain Response system fault.

When a sub-system fault is present and the driver attempts to select a different Terrain Response program using the rotary control or at the next ignition on cycle, a message 'SYSTEM FAULT SPECIAL PROGRAMS NOT AVAILABLE' will appear in the message center. This implies that the Terrain Response system has a fault, but only because a sub-system fault is preventing its operation. This message will be displayed for 5 seconds per ignition cycle, but is repeated if a further selection is made by the driver using the Terrain Response rotary control or at the next ignition on cycle.

NOTE:

The message 'SYSTEM FAULT SPECIAL PROGRAMS NOT AVAILABLE' can also be generated by a fault in the Terrain Response rotary control or control module. See following section for details of rotary control or control module faults.

It is not possible for the Terrain Response control module to cause any fault behaviour (warning indicator illumination or message generation) in any of the five sub-systems. Illumination of a sub-system warning indicator and/or a sub-system related message will never be associated with a Terrain Response control module or Terrain Response system fault.

The sub-system control modules can detect a fault with the CAN signal from the Terrain Response control module. If a fault in the Terrain Response system is detected, the sub-system control modules will operate in the 'special programs off' setting. The sub-system control modules will record a fault code for a failure of the Terrain Response CAN signal. These faults can be retrieved using Land Rover approved diagnostic equipment and will provide useful information to indicate investigation of the Terrain Response control module or the CAN network.

Terrain Response Rotary Control or Control Module Fault

If a fault occurs in the Terrain Response rotary control, all rotary control icon amber LEDs will be turned off (background illumination will remain on) and rotation of the rotary control is ignored. The instrument cluster message center will display a message 'SYSTEM FAULT SPECIAL PROGRAMS NOT AVAILABLE' when the fault occurs, if the fault is present and the driver attempts to select a special program (if the control module is able to do this) or at the next ignition on cycle.

If a failure of a rotary control icon amber LED occurs, the Terrain Response system will still function. Any selected special program will default to 'special programs off' at every ignition on cycle, with the exception of the grass/gravel/snow program.

The Terrain Response rotary control and the control module are an integral unit. If a fault occurs in either component, the whole unit will require replacement.

CAN Faults

If a CAN fault exists and prevents Terrain Response system operation, all of the Terrain Response rotary control icon LEDs will be illuminated and rotation of the rotary control is ignored.

If the instrument cluster does not receive a Terrain Response system CAN message from the Terrain Response Control module, the message 'SYSTEM FAULT SPECIAL PROGRAMS NOT AVAILABLE' will be displayed when the fault occurs and will be repeated at every ignition on cycle.

User Error

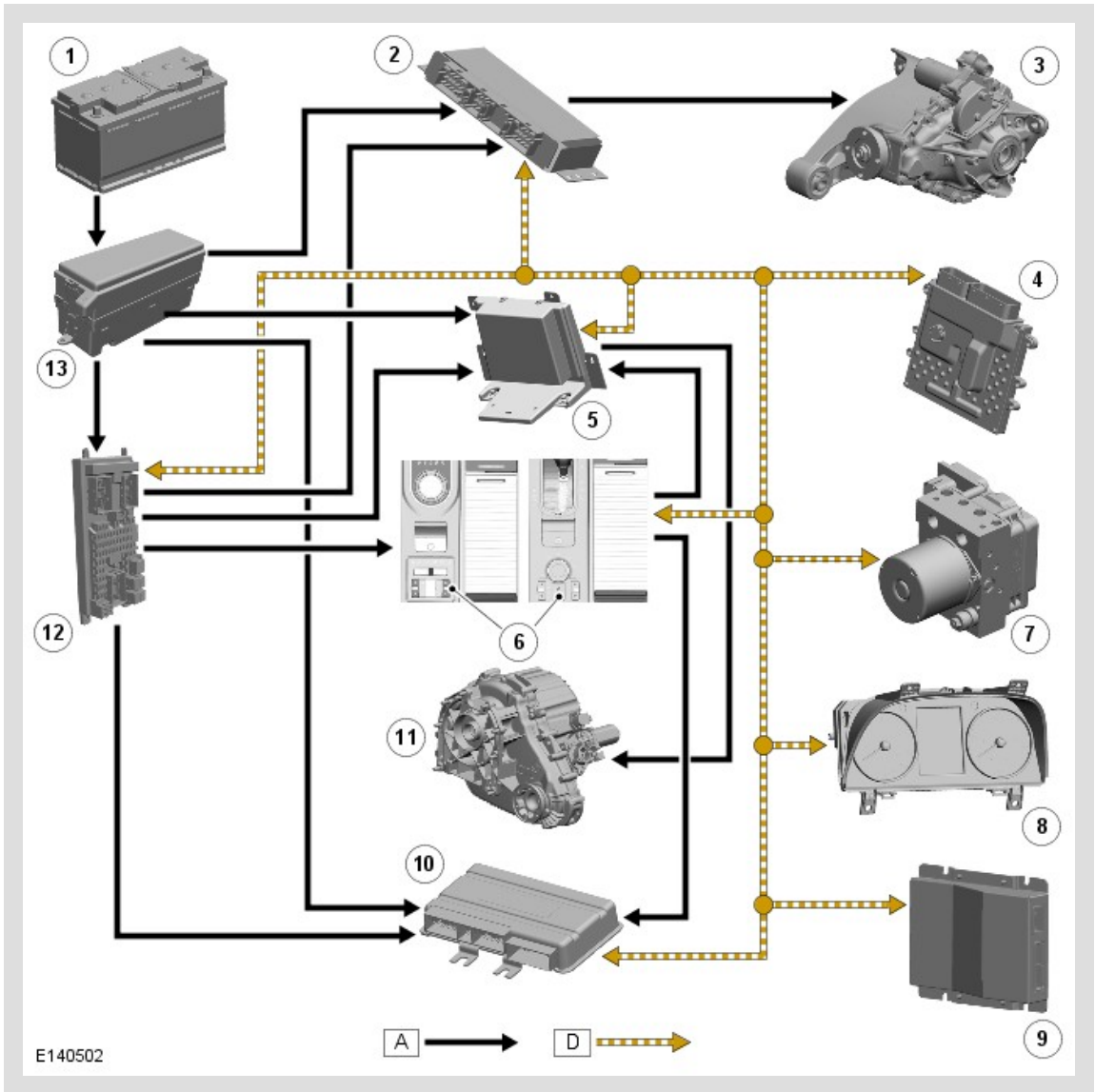
The following incorrect usage of the system may be misinterpreted as a system fault:

- Engine not running - Program changes and driver advisory messages are only available with the engine running
- Rock crawl program selected but transfer box in high range
- Special program change attempted with DSC or ABS active (this includes ABS cycling which is operational when HDC is being used on slippery or loose surfaces).
- Special program change attempted with overheat condition present on center or rear differential.

CONTROL DIAGRAM

NOTE:

A = Hardwired; **D** = High Speed CAN bus



ITEM	DESCRIPTION
1	Battery
2	Rear differential control module
3	Rear differential
4	ECM
5	Transfer box control module
6	Terrain Response control and control module
7	ABS module
8	Instrument cluster
9	Adaptive Damping Module (ADM)
10	Air suspension control module
11	Transfer box (center differential and high/low range)
12	CJB (central junction box)
13	BJB (battery junction box)