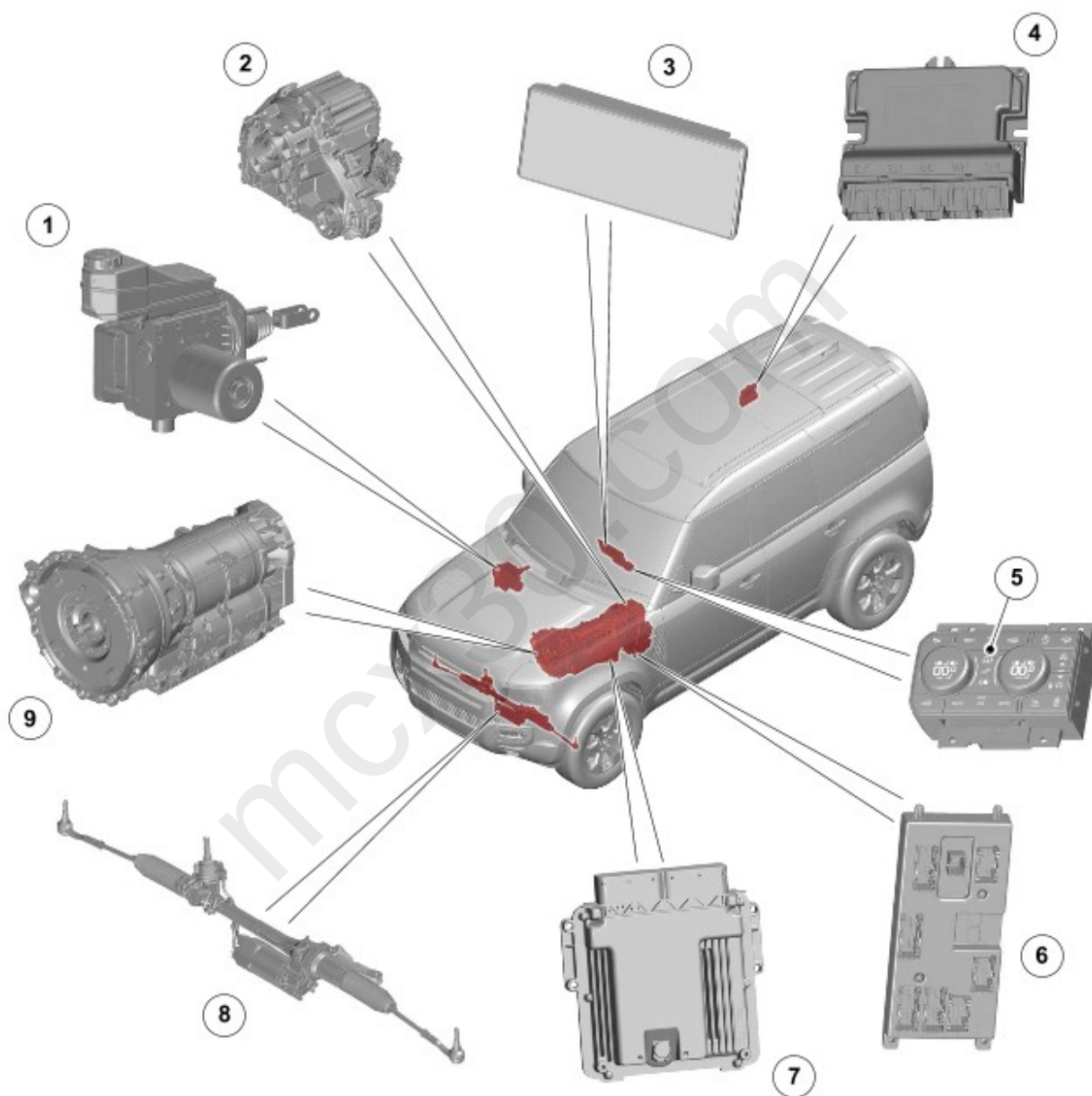


PUBLISHED: 10-JAN-2020  
2020.0 DEFENDER (LE), 204-06

# RIDE AND HANDLING OPTIMIZATION (G2341727)

mcx30.com

## COMPONENT LOCATION



E254000

| ITEM | DESCRIPTION                           |
|------|---------------------------------------|
| 1    | Integrated Power Brake                |
| 2    | Transfer Case Control Module (TCCM)   |
| 3    | Interactive Display Module 'A' (IDMA) |

| ITEM | DESCRIPTION                                       |
|------|---------------------------------------------------|
| 4    | Chassis Control Module (CHCM)                     |
| 5    | Interactive Control Interface Module 'A' (ICIMA)  |
| 6    | Body Control Module (BCM)/ Gateway Module A (GWM) |
| 7    | Powertrain Control Module (PCM)                   |
| 8    | Power Steering Control Module (PSCM)              |
| 9    | Transmission Control Module (TCM)                 |

## OVERVIEW

The Terrain Response (TR) 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 default 'Comfort program' is an active program that covers all general driving conditions.

The TR system allows selection of the following programs:



### NOTE:

The available Terrain Response (TR) programs may vary depending on vehicle specification.

- Eco program
- Comfort program
- Grass, Gravel, Snow program
- Mud, Ruts program
- Sand program
- Rock crawl program
- Wade program
- Configurable TR program
- Auto program.

The TR system uses a combination of a number of vehicle sub-systems to achieve the required vehicle characteristics for the terrain selected.

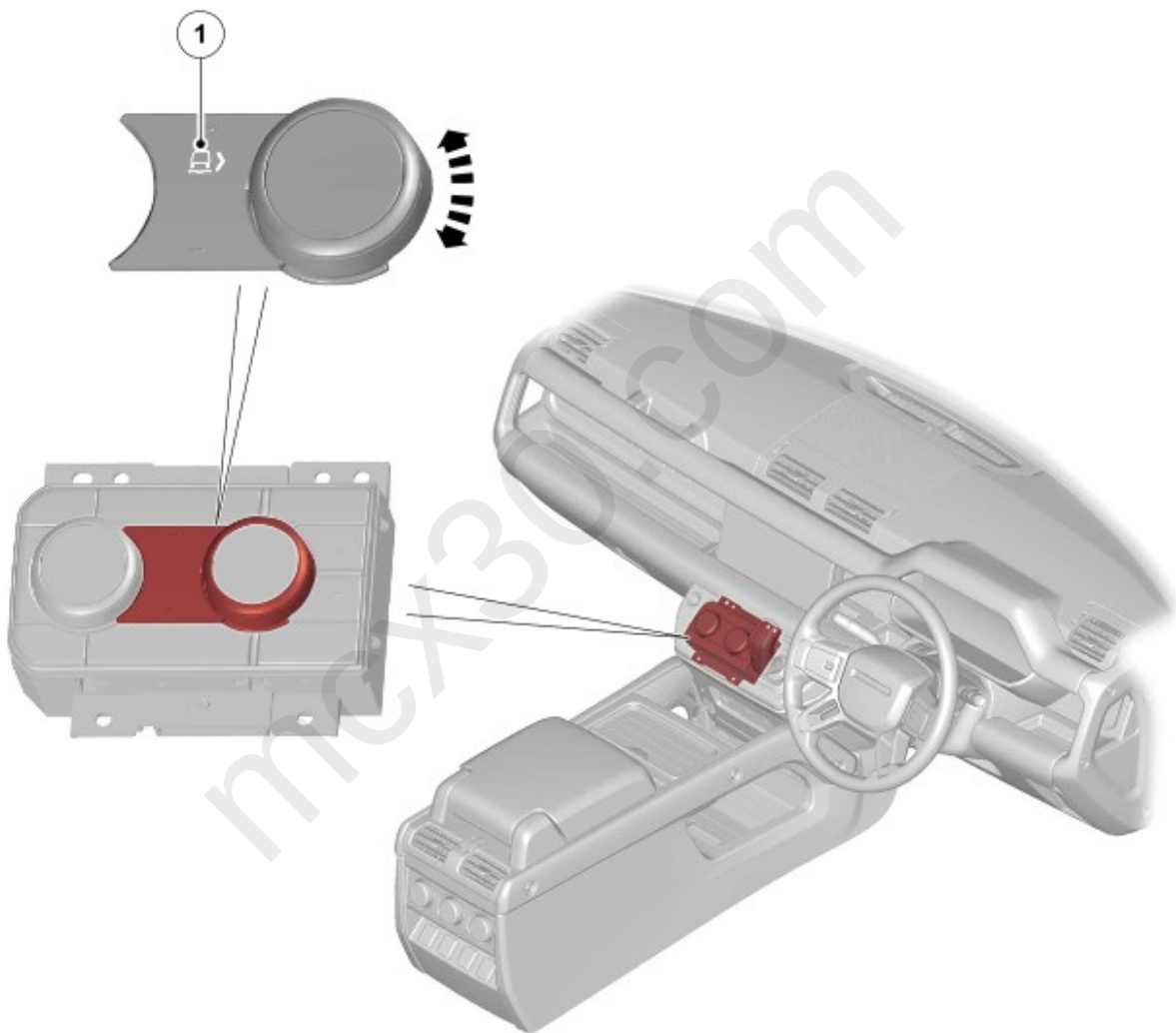
The following sub-systems are used in the TR system:

- The TCCM
- The TCM
- The PCM

- The Integrated Power Brake control module
- The CHCM
- The PSCM - Configurable TR program only.

DESCRIPTION

TERRAIN RESPONSE SWITCHPACK



E254002

| ITEM | DESCRIPTION                      |
|------|----------------------------------|
| 1    | Terrain Response switchpack (TR) |

The Terrain Response (TR) program selection available on the IDMA menu. Each program is denoted by a symbol that represents the related terrain.

To select a TR program:

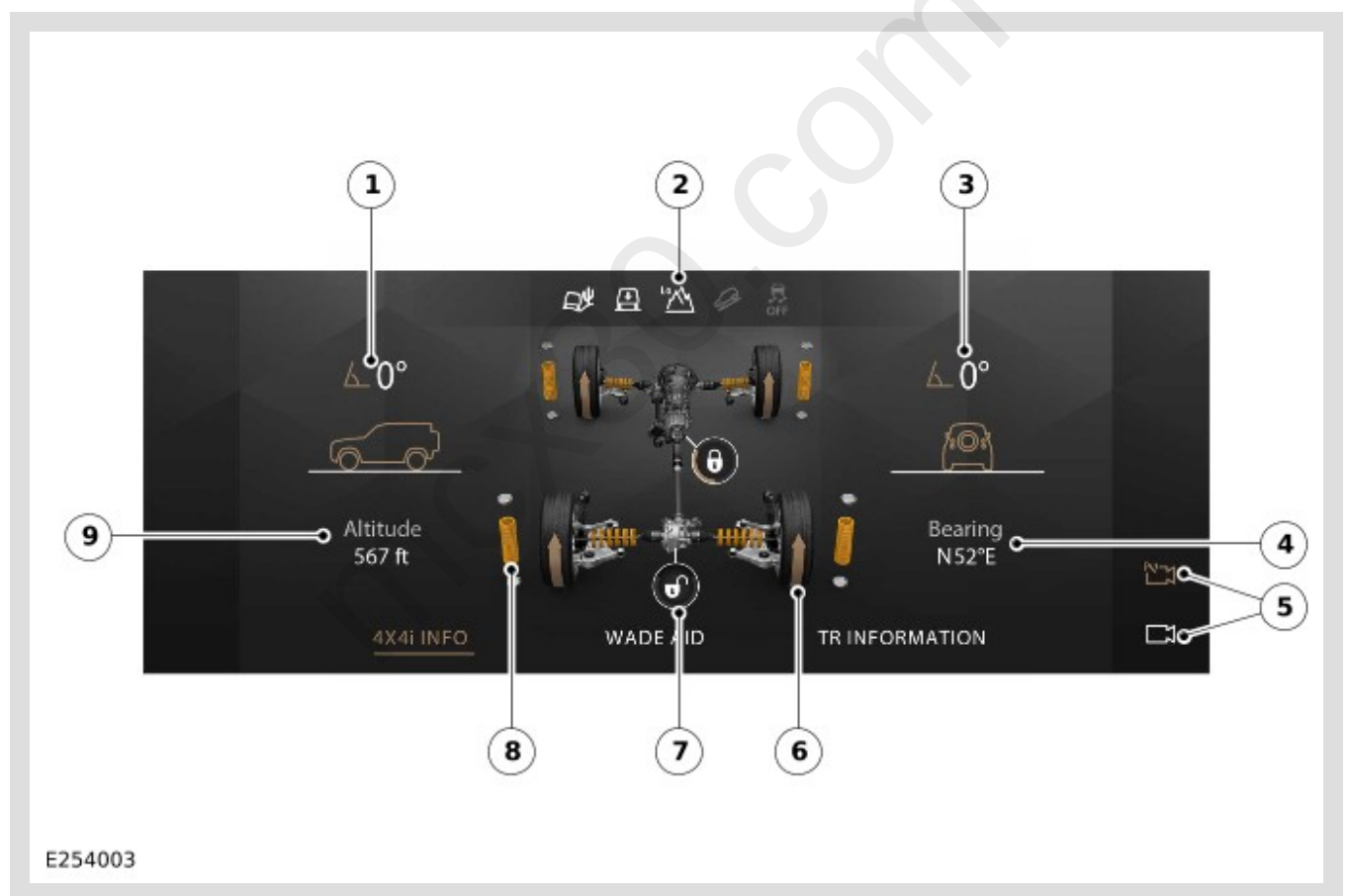
- Press the TR button on the ICIMA. The IDMA displays the available driving programs.
- Rotate the driver side heater control rotary switch to select the appropriate driving program.

The IDMA displays a confirmation message, and the appropriate icon for the selected driving program. The Instrument Panel Cluster Control Module (IPC) also displays the same configuration message and the appropriate icon.

The IDMA also displays vehicle status on the '4x4i Info' screen.

To view '4x4i Info' screen, select 'APPS' on the IDMA Home screen, then tap to 4x4i icon.

#### 4X4I INFO SCREEN



| ITEM | DESCRIPTION                    |
|------|--------------------------------|
| 1    | Vehicle pitch                  |
| 2    | Off-road driving system status |
| 3    | Vehicle roll                   |
| 4    | Bearing                        |

| ITEM | DESCRIPTION              |
|------|--------------------------|
| 5    | Camera icons             |
| 6    | Wheel spin status        |
| 7    | Differential lock status |
| 8    | Suspension height status |
| 9    | Altitude                 |

The wheel spin arrows change color according to the amount of traction being lost:

- A yellow arrow indicates a low level of wheel spin.
- An orange arrow indicates a medium level of wheel spin.
- A red arrow indicates a high level of wheel spin.

The differential lock icons indicate if a differential is locked or unlocked. A status bar around the icon indicates the amount of lock being applied.

The suspension movement icons change color incrementally to represent suspension articulation. The associated wheel changes color when the suspension reaches its travel limit.

## OPERATION

When the Terrain Response (TR) switch operated, and the rotary switch turned to select, the signal goes from the ICIMA:

- To the HVAC Control Module (HVAC) through the Private High Speed (HS) Controller Area Network (CAN) bus connection.
- The HVAC transmit the signal to the BCM/ GWM through the HS CAN power mode zero systems bus.
  - The BCM/ GWM then informs all affected control modules regarding the activation, through the FlexRay bus.
- Selection request also goes from ICIMA to the IDMA through the HS CAN Human Machine Interface (HMI) systems bus.

The IPC also displays the selected program. The IPC receives signal directly from the HVAC through the HS CAN HMI system bus. Each sub-system operates in different ways in relation to the selected TR program to achieve the optimum traction, stability and ease of control for the terrain encountered.

## ALL TERRAIN PROGRESS CONTROL



### NOTES:

- All Terrain Progress Control (ATPC) inhibits cruise control and stop/start.

- ATPC cannot be enabled if tow assist, park assist or wade sensing features are currently switched on.
- Selecting ATPC full function mode disables low traction launch if it was previously switched on.

The ATPC is a low speed control function for every type of terrain. By precisely controlling the braking and powertrain systems, the function delivers optimum traction in low grip conditions.

The ATPC helps the driver to maneuver the vehicle on slippery surfaces, like ice, snow, grass, gravel, sand, mud. The ATPC operates in either a forward or a reverse direction at low vehicle speeds. The ATPC is useful when pulling away from a standstill, ascending or descending an incline and when driving on unstable and slippery driving surfaces.

The ATPC offers the driver a speed based control where a desired vehicle speed can be set. This allows the vehicle to travel at the set speed from the current speed or from standstill. The function operates without any brake /accelerator pedal inputs being required by the driver when the brake is released, thus reducing workload, improving driveability and composure.



**NOTE:**

The driver can always intervene by pressing the accelerator or brake pedal.

The ATPC functions in the following conditions:

- Forward or reverse direction
- Driver seatbelt is buckled and all doors are closed.

The ATPC system can be activated manually using the combined Hill Descent Control (HDC)/ ATPC switch, located on the ICIMA. The first press of the switch enables the HDC system. The second press of the switch disables the HDC and activates the ATPC function. The third press of the switch deactivates ATPC.

When the ATPC is active the warning indicator within the switch is illuminated.

When ATPC is selected the system status enters either 'active' or 'standby' mode, determined by the vehicle speed and functions as follows:

- The ATPC does not enter 'active' or 'standby' mode if the vehicle speed is above 80 km/h (50 mph). The message center displays the following message, 'Speed too high for ATPC'.
- The ATPC enters standby when the vehicle speed is within the selectable speed range (below 80 km/h (50 mph)) but out of the operational range (above 30 km/h (18.6 mph)). Pressing 'SET +' between 30 km/h and 80 km/h (18 mph and 50 mph) , while ATPC is enabled, triggers the following message center display, 'ATPC active below 30 km/h (18.6 mph)'
- The ATPC becomes active when the vehicle speed is within the operational range 0 km/h (0 mph) and 30 km/h (18.6 mph). The message center displays the following advisory message to inform the driver of the action needed to engage the full system functionality, 'ATPC selected, press SET+ to set speed'.
- Selectable range: 0-80 km/h (0-50 mph).

- Operational range: 0-30 km/h (0-18.6 mph).
- Standby range: 30-80 km/h (18.6-50 mph).
- Set speed range: 3-30 km/h (1.86-18.6 mph).

The ATPC has the following operational modes:

- Off
- Descent control mode
- Full function mode.

When first enabled, the ATPC starts in descent control mode.

The ATPC is manually deactivated by pressing the ATPC switch or automatically deactivated when the vehicle speed exceeds 80 km/h (50 mph).

The ATPC is automatically deselected if the ignition is switched OFF for more than 6 hours.

On deactivation, the ATPC system 'fades out' or switches off immediately. This is determined by if the ATPC was either in 'active' or in 'standby' mode respectively, at the time the ATPC switch was pressed.

The driver is alerted as follows:

- If ATPC switches off immediately the IPC message center displays 'ATPC off' message and the warning indicator is extinguished.
- If ATPC fades out, the IPC warning indicator flashes at a rate of 2 Hz for approximately 60 ms to 2 seconds before switching off, prior to the message center displaying 'ATPC off'.



**NOTE:**

The ATPC fade out mode is triggered to protect the driver when the ATPC is inadvertently switched off during a maneuver.

This mode allows the vehicle speed to gradually increase/decrease depending on the characteristics of the terrain.

#### **DESCENT CONTROL MODE**

Descent control mode operates only when the vehicle is traveling downhill and uses the brakes only to control the selected vehicle speed. Descent control mode can be used in DRIVE (D), NEUTRAL (N), either in automatic and manual gear selection modes and REVERSE (R). The system remains in descent control mode, until it detects the use of the cruise control 'SET'+ switch.

The system functions in the following manner when pressing the accelerator or brake pedal:

- Pressing the accelerator pedal while in descent control mode, ATPC stops intervention while the driver is overriding the vehicle speed.

- Pressing the brake pedal does not affect the set speed.
- When in descent control mode the set speed can only be adjusted by operating the 'SET-' switch on the right steering wheel switchpack. Pressing 'SET+' switch enables full function mode.

The currently selected TR program determines the default speed of descent control mode.

The default speed varies from a minimum of 3 km/h (1.86 mph) up to a maximum of 12 km/h (7.5 mph):

- 'Comfort' and 'ECO' programs: 10 km/h (6.2 mph)
- 'Grass, Gravel, Snow' program: 7 km/h (4.32 mph)
- 'Mud-Ruts' program: 3 km/h (1.86 mph)
- 'Sand' program: 12 km/h (7.45 mph)

The above is applicable irrespective to the vehicle speed descent control was enabled at.

### FULL FUNCTION MODE

Full function mode is selected manually by pressing the cruise control 'SET+' switch when descent control mode is active. System feedback, provided by the IPC and ATPC warning indicator, informs the driver of the ATPC status.

Full function mode is used when cruise control is required. For example, while making an ascent, pulling away on level ground, or when driving on difficult terrains. Full function mode can be used in REVERSE (R) and either in automatic and manual gear selection modes in DRIVE (D). If full function mode is selected when the vehicle is in either PARK (P) or NEUTRAL (N), the full function mode is inhibited. The following message is displayed in the IPC message center: 'ATPC on, descent only, select gear'.

Full function mode can be selected when the Electric Park Brake (EPB) is applied. The vehicle does not pull away automatically until the EPB is manually released by the driver. If the EPB is applied when full function mode is active the ATPC status defaults to descent control mode.



#### NOTE:

The EPB may be released automatically when the driver selects DRIVE (D) or REVERSE (R) and presses the accelerator pedal. The ATPC operation is meant to promote a 'pedals off' operation, preventing loss of traction when driving the vehicle in adverse conditions (ice, snow). This action would override the system and might affect the launch composure or induce a wheel slip event.

The ATPC remains in descent control mode, until it detects the use of the cruise control 'SET+' switch.

The ATPC functions in the following manner when pressing the accelerator pedal or brake pedal:

- Pressing the accelerator pedal while in full function mode, ATPC stops intervention while the driver is overriding the vehicle speed. Only acceptable if the request through the accelerator pedal is higher than ATPC requested.
- Pressing the brake pedal or operating the 'SET-' switch in full function mode, the set speed is decreased.

If full function mode is selected and the vehicle is brought to standstill by using the brakes, the ATPC defaults to descent control mode.

If full function mode is enabled at standstill the full function mode set speed would be carried over from descent control mode set speed.

If full function mode is enabled while the vehicle is moving, the current vehicle speed becomes the full function mode set speed.

Full function mode set speed is modified by the driver as follows:

- Increase the set speed by pressing the cruise control 'SET+' switch.
- Decrease the set speed by pressing the cruise control 'SET-' switch or by gently applying the brake pedal.

**Full function mode can be canceled in the following ways:**



**NOTE:**

For safety reasons if the driver applies a brake pressure above 40 bar (580 psi), the full function mode gets canceled.

- Pressing 'Cancel' switch - Defaults ATPC status to descent control mode.
- Pressing 'ATPC' switch - Switches ATPC off, allowing for the fadeout phase.
- Vehicle speed exceed 80 km/h (50 mph) - ATPC automatically switched off.

#### ALL TERRAIN PROGRESS CONTROL FAULTS

In extreme circumstances, the ATPC may cause brake temperatures to exceed their pre-set limits. If this occurs the ATPC may become temporarily unavailable. However prior to unavailability the ATPC will 'fade out', allowing the vehicle speed to gradually increase/decrease, depending on the characteristics of the terrain (gradient, friction).

Under these circumstances the following warnings are displayed:

- The IPC message center displays 'ATPC Temporarily Not Available'.
- The IPC warning indicator flashes during the fade out phase.
- The IPC warning indicator indicates the system is not available, when the system completes the fade out phase. The warning indicator is accompanied by an amber warning alert icon.

When the brakes have reached an acceptable temperature, the IPC message and the amber warning alert icon extinguishes. The ATPC descent control mode reinstates.

If the ATPC is active and a fault is detected, the IPC displays the following permanent caution message, 'ATPC Not Available'.

If a fault is detected in the engine torque management system the ATPC defaults to a safe mode for the rest of the ignition cycle. In this fault mode, the 'SET+' switch operation adjusts the ATPC descent control mode set speed.

- The IPC message center displays 'ATPC Only Descent Control Available'.
- The message center warning indicator indicates the ATPC is not available. The warning indicator is accompanied by an amber warning alert icon.

Restarting the engine might clear the engine torque management faults.

#### **LOW TRACTION LAUNCH**

Low traction launch helps to further enhance low speed maneuvering and pulling away from a standstill, in adverse conditions. Low traction launch operates with either the 'Auto' program, 'Comfort' program, or 'Grass Gravel Snow' program selected.

Low traction launch only operates at vehicle speeds below 30 km/h (19 mph).

To enable low traction launch, the vehicle must be stationary, without accelerator pedal input, ATPC off or in descent control mode.

The operation of low traction launch is optimized if the 'Grass Gravel Snow' driving program is selected. Low speed maneuvers and pulling away from a standstill are complete when the vehicle speed reaches 30 km/h (19 mph). Low traction launch is then automatically disabled.

#### **ENGINE MANAGEMENT SYSTEM**

The PCM changes the accelerator pedal maps to modify the amount of torque per percentage of pedal travel.

Each Terrain Response (TR) program uses a combination of operating parameters for each sub-system. Changing between terrain programs initiates a different set of operating characteristics which is noticeable to the driver.

For example, the driver may notice an increase in torque and engine speed if:

- The accelerator pedal is held in constant position.
- And the TR program is changed from 'Grass Gravel Snow' to 'Sand'.

If the TR program is changed from 'Sand' to 'Grass Gravel Snow', the driver may notice a reduction in torque and engine speed.

#### **TRANSMISSION CONTROL**

The TCM changes the shift maps for the Terrain Response (TR) program selected. This changes the shift points providing early or late upshifts and downshifts when compared to general program.

For example, in the 'Sand' program, the transmission performs later upshifts and earlier downshifts to maintain a higher engine speed.

## TRANSFER CASE AND REAR DIFFERENTIAL CONTROL

The transfer case and the rear electric differential (if equipped) are treated as 1 system. The rear electric differential is an optional assembly on vehicles equipped with the Terrain Response (TR) system.

The differential control has 2 operating strategies:

- Pre-emptive
- Reactive.

The pre-emptive strategy anticipates and predicts the locking torque value required for each differential to minimize slip and maximize stability. Each TR 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 behavior of the vehicle. Each TR 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 minimize surface damage.

The Dynamic Stability Control (DSC) function of the Anti-lock Brake System (ABS) can override the TR differential control and reduce any applied locking torque during DSC action.

For additional information, refer to: [Anti-Lock Control](#) (206-08 Brake Controls and Actuation, Description and Operation).

## INTEGRATED POWER BRAKE CONTROL MODULE

The Integrated Power Brake control module controls several functions and adjusts the operating parameters of these functions to optimize the selected Terrain Response (TR) program.

## TRACTION CONTROL

Traction control uses different slip thresholds to improve traction and vehicle composure. For example, the system sensitivity is increased on slippery surfaces such as wet grass or snow to reduce wheel spin. If wheel spin was allowed in these circumstances, loss of traction may result from surface damage (wet grass) or the vehicle being unable to move (snow).

## DYNAMIC STABILITY CONTROL

The DSC uses different threshold values for the selected Terrain Response (TR) program to optimize DSC intervention. It removes the requirement for the driver to disable the DSC system for reduced 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 manually in addition to selecting the 'Sand' program.

In the 'Mud-Ruts' program the system is calibrated to tolerate a higher yaw threshold. This allows a greater differential between the actual and desired vehicle turning behavior, before DSC intervenes. This allows the DSC system to ignore the effect of ruts 'jarring' the vehicle or adjusting the front wheel steering angle.

The DSC can be manually switched off when using a TR special program. The DSC switches back on when the special program is subsequently changed for a different program.

## HILL DESCENT CONTROL



### NOTES:

- The Hill Descent Control (HDC) system is automatically selected by some of the Terrain Response (TR) driving programs.
- The HDC system is automatically deselected if the ignition is switched OFF for more than 6 hours.

The Hill Descent Control (HDC) system restricts the vehicle speed to a set limit when traveling downhill. The responsiveness of the HDC function is also increased, when required.

The HDC is automatically switched on or off and target speeds are adjusted in response to the Terrain Response (TR) program selected.

Depending on the transfer case range selection status, the HDC is automatically enabled in the following TR driving programs:

- In 'Mud-Ruts' mode, when the transfer case is in high range.
- In all TR programs, except 'Sand' mode, when the transfer case is in low range.

The HDC system can be activated manually using the combined HDC/ ATPC switch, located on the ICIMA. The first press of the switch enables the HDC system. The second press of the switch disables the HDC and activates the ATPC function. The third press of the switch deactivates ATPC.

When the HDC system enabled the HDC warning indicator illuminates to confirm selection.

If the HDC system is deselected while operating, the warning indicator extinguishes and HDC operation fades out, allowing the vehicle's speed to gradually increase.

The HDC system only operates at vehicle speeds of less than 50 km/h (31 mph). If this criteria is not met, the warning indicator illuminates gray and a warning message displays. The HDC warning indicator also flashes.

If the brake pedal is pressed when the HDC system is active, a pulsation might be felt through the brake pedal. When the brake pedal is released, HDC operation resumes.

If a HDC system is active and a fault is detected, the IPC displays the 'HDC Fault System Not Available' message. If a fault is detected during operation of the HDC system, HDC operation fades out.

## **GRADIENT RELEASE CONTROL**

Gradient release control operates when the vehicle is pulling away from standstill on an incline or a decline. When the vehicle's brakes are released, gradient release control automatically delays and graduates the brake release to allow the vehicle to pull away smoothly.

Gradient release control automatically operates in forward and reverse gears. No driver intervention is required.

If the brakes are applied with Hill Descent Control (HDC) switched on, gradient release control activates to allow a smooth transition into HDC operation.

## **POWER STEERING SYSTEM CONTROL**

The PSCM changes the steering maps for the Terrain Response (TR) program selected. This changes the active steering (self-centering) and active damping functions of the steering system when compared to general programs.

## **INCORRECT PROGRAM USAGE**

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

- The Terrain Response (TR) system prohibits certain functions in some programs, for example:
  - Cruise control is only available with the 'Comfort' program or 'Grass, Gravel, Snow' program.
  - Auto stop/start feature is available for 'Dynamic', 'Eco', 'Comfort' and 'Grass, Gravel, Snow' programs.

Selection of an inappropriate program for the terrain conditions could 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 'Comfort' program. Also, in some programs, Hill Descent Control (HDC) remains on, signified by illumination of the HDC warning indicator in the IPC.

## **DIAGNOSTICS**

The BCM/ GWM stores information on detected Terrain Response (TR) faults and CAN errors. These errors can be interrogated using the Jaguar Land Rover (JLR) approved diagnostic equipment. The TR sub-systems and the IPC also store information relating to CAN errors from the TR system.

The BCM/ GWM also stores the distance traveled and time elapsed for the individual programs which can also be retrieved using the JLR approved diagnostic equipment.

This information aids diagnosis of the TR system, for example:

- Providing an indication of TR system abuse by the driver which can lead to premature component failure.
- Checking customer concerns, for example, high fuel consumption which may be due to continued use of a certain program.

## **TERRAIN RESPONSE SYSTEM FAULT DIAGNOSTICS**

The Terrain Response (TR) relies on the correct functionality of the sub-systems. If 1 of the sub-systems develops a fault, the TR system does not function, even though the fault is not in the TR system.

The BCM/ GWM is unable to cause any fault behavior (warning indicator illumination or message generation) in any of the sub-systems. Illumination of a sub-system warning indicator and/or a sub-system related message are never be associated with a BCM/ GWM or TR system fault.

If a fault in a sub-system is subsequently corrected, the TR system functions normally after the next ignition cycle.

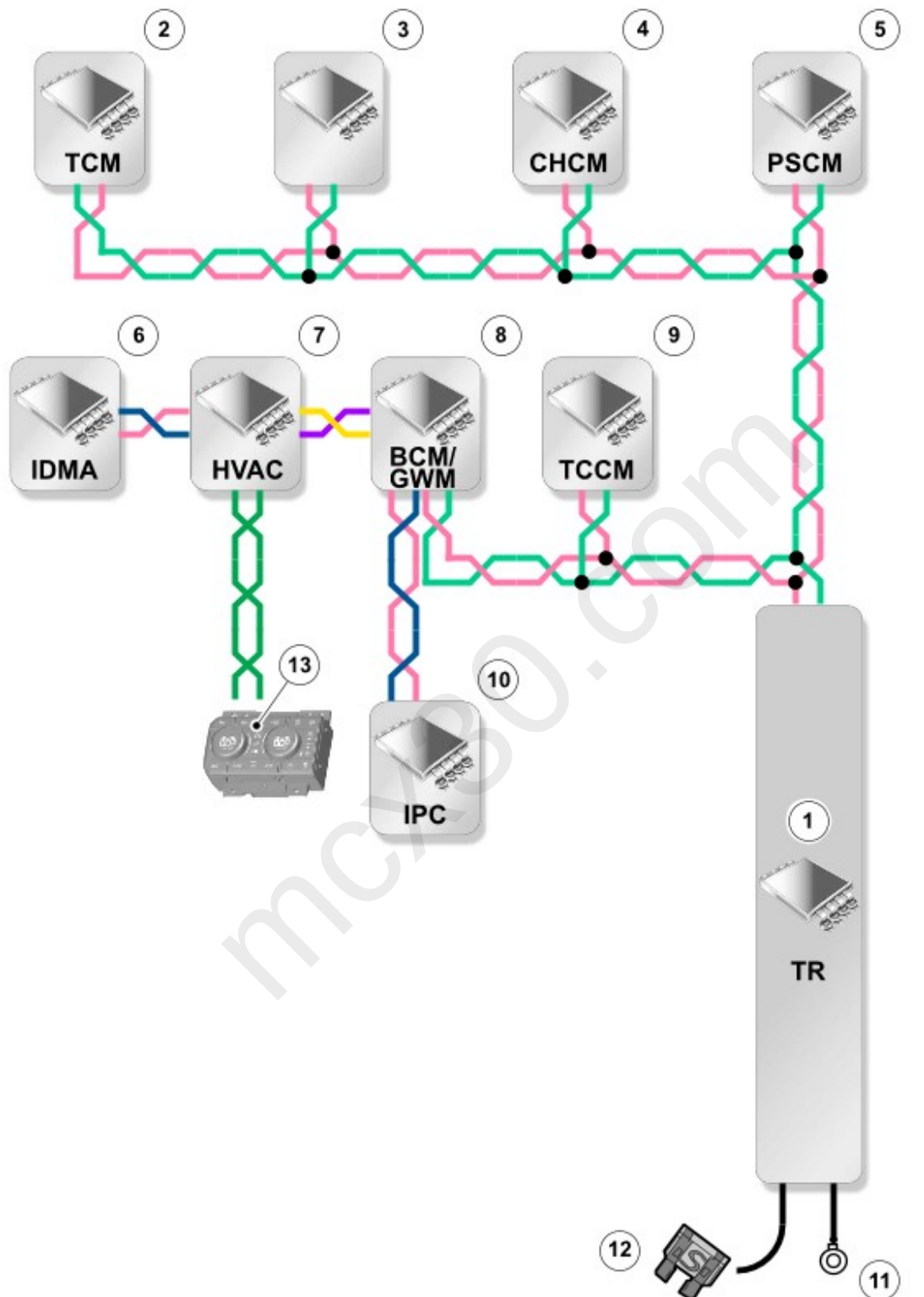
#### **TERRAIN RESPONSE SUB-SYSTEM FAULTS**

When a fault occurs in a Terrain Response (TR) the driver is alerted by the illumination of a warning indicator and/or an appropriate message for that sub-system in the IPC message center. There is no warning of a TR system fault.

This implies that the TR system has a fault, but only because a sub-system fault is preventing its operation. When a sub system fault is present, the TR system is set to 'Comfort' program as standard.

mcx30.com

# CONTROL DIAGRAM



E254001

U

AX

AY

BA

U = HS CAN PRIVATE SYSTEMS BUS: AX = FLEXRAY: AY = HS CAN POWER MODE ZERO SYSTEMS BUS: BA = HS CAN HMI SYSTEMS BUS.

| ITEM | DESCRIPTION                           |
|------|---------------------------------------|
| 1    | Terrain Response (TR) system          |
| 2    | TCM                                   |
| 3    | Integrated Power Brake control module |
| 4    | CHCM                                  |
| 5    | PSCM                                  |
| 6    | IDMA                                  |
| 7    | HVAC                                  |
| 8    | BCM/ GWM                              |
| 9    | TCCM                                  |
| 10   | IPC                                   |
| 11   | Ground                                |
| 12   | Power supply                          |
| 13   | TR switch - ICIMA                     |