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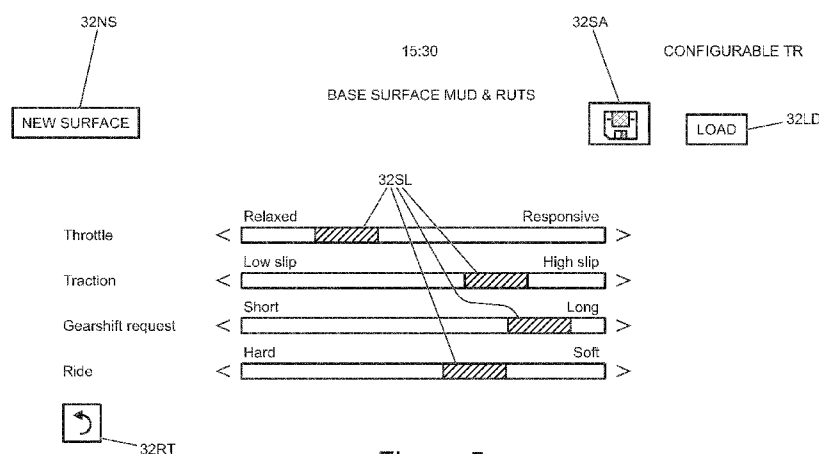


Figure 5

(57) **Abstract:** A vehicle control system for a vehicle transmission, the system comprising gear-shift trigger means for allowing a user to provide an input to the system indicating that the user wishes the transmission to undergo a gear-shift, wherein the system is configured to cause the transmission to undergo the gear-shift in response at least in part to the input received from the user via the gear-shift trigger means provided the user provides the input indicating the user wishes the transmission to undergo the gear-shift via the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration, the control system being configured to allow a user to adjust, via the input means, the length of the predetermined gear-shift request signal duration.



CONTROL SYSTEM FOR A VEHICLE AND METHOD

INCORPORATION BY REFERENCE

5 The content of co-pending UK patent applications GB2507622 and GB2499461 are hereby incorporated by reference. The content of US patent no US7349776 and co-pending international patent applications WO2013124321 and WO2014/139875 are incorporated herein by reference. The content of UK patent applications GB2492748 and GB2499279 and UK patents GB2492655 and GB2508464 are also incorporated herein by reference.

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TECHNICAL FIELD

The present disclosure relates to a vehicle controller and control method and particularly, but not exclusively, to a controller and a method for controlling operation of one or more vehicle systems or subsystems in a land-based vehicle capable of driving in a variety of different and extreme terrains and conditions. Aspects of the invention relate to a controller, to a control system, a vehicle, a method, a non-transitory computer readable carrier medium carrying a computer readable code, a computer program product executable on a processor, a computer readable medium and a processor.

20 BACKGROUND

It is known to provide a control system for a motor vehicle for controlling one or more vehicle subsystems. US7349776 discloses a vehicle control system comprising a plurality of subsystem controllers including an engine management system, a transmission controller, a steering controller, a brakes controller and a suspension controller. The subsystem controllers are each operable in a plurality of subsystem function or configuration modes. The subsystem controllers are connected to a vehicle mode controller which controls the subsystem controllers to assume a required function mode so as to provide a number of driving modes for the vehicle. Each of the driving modes corresponds to a particular driving condition or set of driving conditions, and in each mode each of the sub-systems is set to the function mode most appropriate to those conditions. Such conditions are linked to types of terrain over which the vehicle may be driven such as grass/gravel/snow, mud and ruts, rock crawl, sand and a highway mode known as 'special programs off' (SPO). The vehicle mode controller may be referred to as a Terrain Response (TR) (RTM) System or controller. The driving modes may also be referred to as terrain modes, terrain response modes, or control modes.

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As noted above, for each of the driving modes each of the sub-systems is set to the function mode most appropriate to those conditions. The present applicant has recognised that the

particular configuration of a subsystem in a given driving mode may not be optimum for the actual prevailing conditions, or a driver may have a particular preference for the manner in which one or more of the subsystems are configured in a given driving mode other than the default configuration corresponding to the driving mode. By way of example, it is to be understood that the Sand driving mode may not provide optimum vehicle performance when driving on wet or damp sand, compared with dry sand.

It is against this background that the present invention has been conceived. Embodiments of the invention may provide an apparatus, a method or a vehicle which addresses the above problems. Other aims and advantages of embodiments of the invention will become apparent from the following description, claims and drawings.

SUMMARY OF THE INVENTION

In one aspect of the invention for which protection is sought there is provided a vehicle control system for a vehicle transmission, the system comprising gear-shift trigger means for allowing a user to provide a user input to the system indicating that the user wishes the transmission to undergo a gear-shift, wherein the system is configured to cause the transmission to undergo the gear-shift in response at least in part to the user input being received from the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration, and wherein the control system is configured to allow a user to adjust, via input means, the length of the predetermined gear-shift request signal duration.

It will be understood that the system is configured to cause the transmission to undergo the gear-shift in response at least in part to the input received from the user via the gear-shift trigger means provided the user provides the input indicating the user wishes the transmission to undergo the gear-shift via the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration, the control system being configured to allow a user to adjust, via the input means, the length of the predetermined gear-shift request signal duration.

Embodiments of the invention have the feature that a user may customise operation of the vehicle by adjusting the amount of time for which they must provide the indication that they wish the transmission to undergo a gear-shift before the request is actioned by the control system. Thus, in the case that a risk exists that a user may inadvertently cause the transmission to undergo a gear-shift, for example by unintentionally actuating gear-shift trigger means such as a shift-paddle, shift-button or other gear-shift trigger means during turning of a steering wheel, the user may customise the responsiveness of the control

system to input by the user by adjusting the predetermined length of time. The user may for example lengthen the amount of time for which they must provide the indication that they wish the transmission to undergo a gear-shift, in order to reduce the risk that they inadvertently provide the input to the system indicating that they wish the transmission to undergo a gear-shift.

In an example scenario, if a user is operating in off-road conditions requiring relatively rapid turning of a steering wheel of the vehicle, the user may inadvertently actuate the gear-shift trigger means such that an indication that the user wishes the transmission to undergo a gear-shift is provided for a relatively short period of time. The user may therefore, when operating in such off-road conditions, set the length of the predetermined gear-shift request signal duration to a period exceeding the relatively short period of time over which the gear-shift signal may be generated by accidental actuation. Thus, in the case that accidental actuation typically results in the gear-shift request signal being generated for a period of 0.5s, the user may set the length of the predetermined gear-shift request signal duration to a period greater than 0.5s, such as 0.8s, 1s or any other suitable period.

In an alternative example scenario, if a driver is driving the vehicle in such a manner as to require more immediate response to a request for a gear change, the driver may increase the sensitivity of the control system to provision by the driver of the input indicating that the user wishes the transmission to undergo a gear-shift. The more immediate response by the control system may provide a more 'dynamic' feeling to vehicle handling. This may be helpful, for example, when negotiating a track at speed.

Optionally, the gear-shift trigger means comprises means for generating a gear-shift request signal in response to the input indicating the user wishes the transmission to undergo a gear-shift,

wherein the system is configured to cause the transmission to undergo the gear-shift in response at least in part to receipt by the control system of the gear-shift request signal provided the user causes the gear-shift request signal to be generated for a period exceeding a predetermined gear-shift request signal duration.

Optionally, the gear-shift trigger means for allowing a user to generate a gear-shift request signal comprises a gear-shift request input device comprising a user-actuated element operable to be actuated from a first condition to a second condition and to remain in the second condition until a user releases the element and the element returns to the first condition, the gear-shift request input device being configured to generate the gear-shift

request signal substantially for the duration of the period the element is in the second condition.

5 Optionally, the control system is configured to cause the transmission to undergo the gear change by transmitting a gear-shift command signal to the transmission.

10 The control system may further comprise a subsystem controller for initiating control of one or more vehicle subsystems in one of a plurality of subsystem control modes by setting at least one control parameter of the or each subsystem to a predetermined, stored, value or state applicable to that control mode, each subsystem control mode corresponding to one or more different driving conditions for the vehicle,

15 wherein, for at least one of the plurality of subsystem control modes, the control system is configured to allow a user to adjust, via the input means, the value or state of at least one of said at least one control parameters to customise operation of the vehicle.

It is to be understood that the control modes may also be referred to as driving modes. The input means may comprise a rotary selector dial, a lever arrangement, a touchscreen, one or more softkeys or any other suitable means.

20 Embodiments of the invention have the feature that a user may customise operation of the vehicle by adjusting the value or state of one or more control parameters from the predetermined value or state stored by the control system for at least one control mode. Thus, if a user determines that vehicle operation in a given control mode may be improved by adjustment of the value or state of at least one of said at least one control parameters,
25 the user may adjust the value or state and obtain the desired improved operation.

Optionally, the subsystem controller is configured to initiate control of the transmission, being comprised by a subsystem of the vehicle, in one of a plurality of control modes, the subsystem controller being configured to set the predetermined gear-shift request signal
30 duration, being a control parameter of the transmission, to a predetermined value that is dependent at least in part on the subsystem control mode in which control of the subsystem has been initiated.

35 Thus it is to be understood that the predetermined gear-shift request signal duration may be dependent on the identity of the subsystem control mode in which control of the subsystem has been initiated. In the case of a subsystem control mode for driving conditions in which rapid turning of the steering wheel or relatively rapid suspension oscillation of relatively large

magnitude is to be expected, such as a mode suitable for negotiating rocky terrain at low speed, the predetermined gear-shift request signal duration may be set to a period that is larger than in the case of a subsystem control mode for driving conditions in which such experiences are not to be expected, such as an on-highway driving mode.

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The subsystem controller may be configured to communicate the predetermined gear-shift request signal duration to a transmission controller.

10 The control system may be configured to allow a user to adjust, in respect of at least one control mode, the value or state of at least one said at least one control parameter of at least one subsystem to customise operation of the vehicle in the at least one control mode, wherein the allowable range of values or states of said at least one control parameter of the or each subsystem is dependent at least in part on the subsystem control mode.

15 It is to be understood that in some embodiments the subsystem control mode which the user adjusts via the input means may be the currently selected control mode, i.e. the control mode in which the vehicle is configured to operate at the time adjustment is made. Thus, following selection of a control mode, the user may be permitted to adjust at least one control parameter of that control mode. In addition or instead, in some embodiments the
20 control system may be configured to allow the user to adjust at least one control parameter of a control mode even if that control mode is not the currently selected control mode in which the vehicle is configured to operate.

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30 of a control mode even if that control mode is not the currently selected control mode in which the vehicle is configured to operate.

Thus, in some embodiments the user may be able to adjust, for example, the predetermined gear-shift request signal duration that is employed by the control system when operating in
35 each of a plurality of control modes, regardless of the control mode in which the control system is currently operating.

The control system may be configured to allow a user to adjust, via the input means, the value or state of each of a plurality of control parameters of at least one subsystem to customise operation of the vehicle in the at least one control mode, wherein the allowable range of values or states of at least one of the plurality of control parameters is dependent at least in part on the value or state of at least one other of the plurality of control parameters.

Thus, if a user adjusts the value or state of one parameter, the allowable range of values or states of one or more other parameters may also change.

For example, if the user adjusts a control parameter of a power assisted steering system so as to increase the amount of steering assistance provided to a user, reducing the amount of torque required to turn the steering wheel at a given moment in time, the control system may reduce the allowable range of values of the predetermined gear-shift request signal duration, so that the lower limit of allowable range of values of duration is increased. This has the effect that the driver is not able to request values of predetermined gear-shift request signal duration that are as low as in the case that a lower amount of steering assistance is provided. This may be helpful in reducing the risk that the driver causes an unwanted gear-shift when turning the steering wheel at a particularly high rate. Higher rates of turning of the steering wheel may be associated with relatively high amounts of steering assistance, due to the relative ease with which the wheel may be turned.

By way of a further example, if the user adjusts a parameter that affects responsiveness of an accelerator pedal, such that the powertrain has an increased responsiveness to depression of the accelerator pedal, for example by developing an increased amount of drive torque for a given amount of travel of the accelerator pedal, the control system may increase the amount of wheel slip that must occur in order to trigger the TC function to intervene to reduce the amount of torque applied to one or more wheels by the powertrain. That is, the control system may cause the TC function to operate in such a manner as to allow more wheel slip before it intervenes to attempt to reduce the amount of slip.

The control system may be configured to allow a user to store the adjusted value or state of each said at least one control parameter in the form of a customised control mode.

In some embodiments, in the event the user adjusts the value or state of one or more parameters, the system may permit the user to overwrite the stored value or state, the value or state of which has been changed. Alternatively or in addition, the system may permit the user to store the new value or state of each control parameter that has been changed, or the

value or state of each control parameter following adjustment of one or more parameters, in the form of a new mode or sub-mode. In some such embodiments, the new mode or sub-mode may remain linked to the control mode that was originally adjusted, such that the allowable range of values of the control parameters remain dependent at least in part on the identity of the control mode that was originally adjusted. The control mode that was originally adjusted may be referred to as a baseline or base control mode.

The control system may be configured to allow a user to select the customised control mode via the input means.

The control system may be configured to allow a user subsequently to adjust, for the customised control mode, the value or state of at least one of said at least one control parameters of at least one of the plurality of subsystems.

Optionally, the input means comprises at least one selected from amongst a rotary switch selector device, a lever-type switch selector device, one or more button devices and one or more touchscreen devices.

The one or more button devices may include one or more softkeys.

Optionally, the control modes comprise at least one control mode adapted for driving on a driving surface of relatively low surface coefficient of friction.

Optionally, the control modes comprise at least one control mode adapted for driving on at least one of a snowy surface, an icy surface, grass, gravel, snow, mud and sand.

Optionally, at least one said at least one subsystem includes a powertrain subsystem, a brakes subsystem or a suspension subsystem.

The control system may comprise an electronic processor having one or more electrical inputs for receiving a signal from the gear-shift trigger means and a signal from the input means allowing the user to adjust the length of the predetermined gear-shift request signal duration, and an electronic memory device electrically coupled to the electronic processor and having instructions stored therein,

wherein the processor is configured to access the memory device and execute the instructions stored therein such that it is operable to allow a user to adjust, via the input

means, the length of the predetermined gear-shift request signal duration to customise operation of the vehicle.

5 In an aspect of the invention for which protection is sought there is provided a vehicle comprising a control system according to a preceding aspect.

In one aspect of the invention for which protection is sought there is provided a method of controlling a vehicle transmission implemented by means of a control system, the method comprising:

- 10 receiving a user input from gear-shift trigger means indicating that a user wishes the transmission to undergo a gear-shift, and
- causing the transmission to undergo the gear-shift in response at least in part to the user input being received from the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration, and
- 15 the method further comprising allowing a user to adjust, via input means, the length of the predetermined gear-shift request signal duration.

- It will be understood that the method comprises causing the transmission to undergo the gear-shift in response at least in part to the input received from the user via the gear-shift
- 20 trigger means provided the user provides the input indicating the user wishes the transmission to undergo the gear-shift via the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration,
- the method further comprising allowing a user to adjust, via input means, the length of the predetermined gear-shift request signal duration.

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In an aspect of the invention for which protection is sought there is provided a non-transitory computer readable carrier medium carrying a computer readable code for controlling a vehicle to carry out the method of another aspect.

- 30 In an aspect of the invention for which protection is sought there is provided a computer program product executable on a processor so as to implement the method of another aspect.

- In an aspect of the invention for which protection is sought there is provided a non-transitory
- 35 computer readable medium loaded with the computer program product of another aspect.

In an aspect of the invention for which protection is sought there is provided a processor arranged to implement the method of another aspect, or the computer program product of another aspect.

5 Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such
10 features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

15 BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic illustration of a vehicle according to an embodiment of the present
20 invention;

FIGURE 2 is a block diagram to illustrate a vehicle control system in accordance with an embodiment of the invention, including various vehicle subsystems under the control of the vehicle control system;

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FIGURE 3 is a table showing which vehicle subsystem configuration mode is selected in each respective vehicle operating mode;

FIGURES 4 to 10 are schematic illustrations of a display provided to a user via an HMI
30 module.

DETAILED DESCRIPTION

FIG. 1 shows a vehicle 100 according to an embodiment of the invention intended to be suitable for off-road use, that is for use on terrains other than regular tarmac road, as well as
35 on-road. The vehicle 100 has a powertrain 129 that includes an engine 121 that is connected to a driveline 130 having an automatic transmission 124. The transmission 124 has a

transmission mode selector dial 124L permitting a driver to select the required transmission operating mode selected from park (P), forward drive (D), neutral (N) and reverse drive (R).

5 The driveline 130 is arranged to drive a pair of front vehicle wheels 111,112 by means of a front differential 135F and a pair of front drive shafts 118. The driveline 130 also comprises an auxiliary driveline portion 131 arranged to drive a pair of rear wheels 114, 115 by means of an auxiliary driveshaft or prop-shaft 132, a rear differential 135 and a pair of rear driveshafts 139. It is to be understood that embodiments of the present invention are suitable for use with vehicles in which the transmission 124 is arranged to drive only a pair of front
10 wheels 111, 112 or only a pair of rear wheels 114, 115 (i.e. front wheel drive vehicles or rear wheel drive vehicles) or selectable two wheel drive/four wheel drive vehicles, or permanent four wheel drive vehicles. In the embodiment of FIG. 1 the transmission 124 is releasably connectable to the auxiliary driveline portion 131 by means of a transfer case 137, allowing selectable two wheel drive or four wheel drive operation. It is to be understood that
15 embodiments of the invention may be suitable for vehicles having more than four wheels or less than four wheels.

In the present embodiment the transfer case 137 is operable in a 'high ratio' ('hi') or a 'low ratio' ('lo') configuration, in which a gear ratio between an input shaft and an output shaft
20 thereof is selected to be a high or low ratio. The high ratio configuration is suitable for general on-road or 'on-highway' operations whilst the low ratio configuration is more suitable for negotiating certain off-road terrain conditions and other low speed applications such as towing. In some embodiments the transfer case 137 may be operable in only one gear ratio configuration rather than one of two ratio configurations.

25 The vehicle 100 has an accelerator pedal 161, a brake pedal 163 and a steering wheel 181. The steering wheel 181 is supported by a steering column 181SC. The steering wheel 181 has a cruise control selector button 181C mounted thereto for activating an on-highway cruise control system 10CC that is implemented in software by a vehicle central controller, referred to as a vehicle control unit (VCU) 10 described in more detail below. The steering
30 wheel 181 is also provided with a low speed progress control system selector button 181LSP for selecting operation of a low speed progress (LSP) control system 10LSP which may also be referred to as an off-road speed control system or off-road cruise control system. The LSP control system 10LSP is also implemented in software by the VCU 10. In addition to the
35 cruise control system 10CC and LSP control system 10LSP the VCU 10 is configured to implement a hill descent control (HDC) system 10HDC that limits maximum vehicle speed when descending an incline by automatic application of a brakes (or braking) system 12d

(FIG. 2) described in more detail below. The HDC system 10HDC may be activated via human machine interface (HMI) module 32.

The steering column 181SC also carries a respective left and right paddle control 181PL, 181PR. The paddle controls 181PL, 181PR are lever-type devices and may be actuated by pulling towards the driver from a default position to an actuated position. The controls 181PL, 181PR are monostable and return to the default position upon release.

When a paddle control 181PL, 181PR is in an actuated condition a gear-shift request signal 181PGS (FIG. 2) is generated. The gear-shift request signal 181PGS comprises an indication of the identity of the paddle control 181PL, 181PR that has been actuated. The gear-shift request signal 181PGS is transmitted to a transmission controller 124C, which controls operation of the transmission 124. If the paddle control 181PG is pulled towards the driver the gear-shift request signal 181PGS indicates to the controller 124C that the transmission 124 is required to up-shift, whilst if the paddle control 181PG is pushed away from the driver the gear-shift request signal 181PGS indicates to the controller 124C that the transmission 124 is required to down-shift. In response to receipt of the gear-shift request signal 181PGS the transmission 124 executes the requested up-shift or down-shift provided the requested shift is allowable. It is to be understood that an up-shift or down-shift may be prohibited under certain circumstances, for example where engine or transmission over-speed may result if the shift is executed. That is, an up-shift or down-shift may be prohibited if the engine speed and/or transmission speed might exceed a predetermined maximum allowable value if the shift were executed. The paddle controls 181PL, 181PR may be referred to as gear-shift trigger means.

The transmission controller 124C is configured to trigger an up-shift or down-shift if the gear-shift request signal 181PGS is received for a period exceeding a predetermined gear-shift request signal duration parameter. The transmission controller 124C stores the value of predetermined gear-shift request signal duration parameter in a memory thereof.

The VCU 10 receives a plurality of signals from various sensors and subsystems 12 provided on the vehicle 100.

FIG. 2 is a schematic diagram illustrating operation of the VCU 10 in more detail. The VCU 10 controls a plurality of vehicle subsystems 12 including, but not limited to, an engine management system 12a, a transmission system 12b that includes the transmission 124 and transmission controller 124C, an electronic power assisted steering unit 12c (ePAS unit), the

brakes system 12d and a suspension system 12e. These vehicle sub-systems can be considered to form a first group of subsystems. Although five subsystems are illustrated as being under the control of the VCU 10, in practice a greater number of vehicle subsystems may be included on the vehicle and may be under the control of the VCU 10. The VCU 10 includes a subsystem control module 14 which provides control signals via line 13 to each of the vehicle subsystems 12 to initiate control of the subsystems in a manner appropriate to the driving condition, such as the terrain, in which the vehicle is travelling (referred to as the terrain condition). The subsystems 12 also communicate with the subsystems control module 14 via signal line 13 to feedback information on subsystem status. In some embodiments, instead of an ePAS unit 12c, a hydraulically operated power steering unit may be provided. As described in more detail below, the subsystem control module 14 is configured to communicate with the transmission controller 124C to adjust the value of predetermined gear-shift request signal duration parameter stored by the controller 124C.

CONTROL (DRIVING) MODES

The vehicle is configured to be caused to operate, by the VCU 10, in one of a plurality of predetermined control modes, which may also be referred to herein as driving modes or terrain modes. In each control mode, the subsystems 12 are caused to operate in a predetermined subsystem configuration mode suitable for a given terrain type. The control modes include a grass/gravel/snow control mode (GGs mode) that is suitable for when the vehicle is travelling in grass, gravel or snow terrain, a mud/ruts control mode (MR mode) which is suitable for when the vehicle is travelling in mud and ruts terrain, a rock crawl/boulder mode (RC mode) which is suitable for when the vehicle is travelling in rock or boulder terrain, a sand mode which is suitable for when the vehicle is travelling in sand terrain (or deep soft snow) and a special programs OFF mode (SP OFF mode or SPO mode, also referred to as a Highway or 'on-highway' mode) which is a suitable compromise mode, or general mode, for all terrain conditions and especially vehicle travel on motorways and regular roadways. Many other control modes are also envisaged including those disclosed in US2003/0200016, the content of which is hereby incorporated by reference.

The different terrain types are grouped according to the friction of the terrain and the roughness of the terrain. For example, it is appropriate to group grass, gravel and snow together as terrains that provide a low friction, smooth surface and it is appropriate to group rock and boulder terrains together as high friction, very high roughness terrains.

FIG. 3 is a table taken from US2003/0200016 showing the particular sub-system configuration modes that may be assumed by the subsystems 12 of a vehicle according to

some embodiments of the invention in the respective different driving modes or operating modes in which the VCU 10 may operate in some embodiments.

The driving modes are:

- 5 (a) A motorway (or highway) mode;
- (b) A country road mode;
- (c) A city driving (urban) mode;
- (d) A towing (on-road) mode;
- (e) A dirt track mode;
- 10 (f) A snow/ice (on-road) mode;
- (g) A GGS mode;
- (h) A sand mode;
- (i) A rock crawl or boulder crossing mode (RC); and
- (j) A mud/ruts (MR) mode

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In the present embodiment, the vehicle 100 is limited to operating in the GGS mode, MR mode, RC mode, Sand mode and SPO (Highway) mode, however it will be appreciated that the invention is not limited to such an arrangement and any combination of on and off road control modes may be used within the scope of the present invention. In some
20 embodiments, instead of a GGS mode the vehicle may have a 'Grass/Snow' (GS) mode in which vehicle handling is optimised for travel over grass or snow, and a separate 'Gravel' (G) mode in which vehicle handling is optimised for travel over gravel. In some embodiments the vehicle may have a 'Wade' mode in which vehicle handling is optimised for wading operations in which the vehicle travels through water. In some embodiments, in the wade
25 mode the vehicle 100 is operated in such a manner that the engine 121 remains switched on at all times and the speed of the engine 121 does not fall below a predetermined value. This is so as to reduce the risk that liquid through which the vehicle is wading enters the engine exhaust system due to the head of liquid at an exhaust gas outlet of the exhaust system.

30 With reference to FIG. 3, the configuration of the suspension system 12e is specified in terms of ride height (high, standard or low) and side/side air interconnection. The suspension system 12e is a fluid suspension system, in the present embodiment an air suspension system, allowing fluid interconnection between suspensions for wheels on opposite sides of the vehicle in the manner described in US2003/0200016. The plurality of subsystem
35 configuration modes provide different levels of said interconnection, in the present case no interconnection (interconnection closed) and at least partial interconnection (interconnection open).

The configuration of the ePAS steering unit 12c may be adjusted to provide different levels of steering assistance, wherein steering wheel 181 is easier to turn the greater the amount of steering assistance. The amount of assistance may be proportional to vehicle speed in some driving modes. As shown in FIG. 3, the amount of assistance is 'speed proportional' in each mode shown except the Rock Crawl (RC) mode.

The brakes system 12d may be arranged to provide relatively high brake force for a given amount of pressure or 'effort' applied to the brake pedal 163 or a relatively low brake force, depending on the driving mode.

The brakes system 12d may also be arranged to allow different levels of wheel slip when an anti-lock braking system is active, (relatively low amounts on low friction ("low-mu" surfaces) and relatively large amounts on high friction surfaces).

An electronic traction control (ETC) system may be operated in a high mu or low mu configuration, the system tolerating greater wheel slip in the low mu configuration before intervening in vehicle control compared with the high mu configuration.

A dynamic stability control system (DSC) may also be operated in a high mu or low mu configuration.

The engine management system 12a may be operated in 'quick' or 'slow' accelerator (or throttle) pedal progression configuration modes in which an increase in engine torque as a function of accelerator pedal progression is relatively quick or slow, respectively. The rate may be dependent on speed in one or more modes such as Sand mode.

The transfer case 137 may be operated in a high range (HI) subsystem configuration mode or low range (LO) subsystem configuration mode as described herein.

In some embodiments, a centre differential and a rear differential may be provided that each include a clutch pack that is controllable to vary the degree of locking of the respective differential between a "fully open" and a "fully locked" state. The actual degree of locking at any one time may be controlled on the basis of a number of factors in a known manner, but the control can be adjusted so that the differentials are "more open" or "more locked". Specifically the pre-load on the clutch pack can be varied which in turn controls the locking torque, i.e. the torque across the differential that will cause the clutch, and hence the

differential, to slip. A front differential may be controlled in the same or similar way in some embodiments.

The VCU 10 also receives a signal from the electronic power assisted steering unit (ePAS unit 12c) of the vehicle 100 to indicate the steering force that is applied to the wheels (steering force applied by the driver combined with steering force applied by the ePAS unit 12c).

The VCU 10 receives a plurality of signals 16, 17 from a plurality of vehicle sensors and are representative of a variety of different parameters associated with vehicle motion and status.

The sensors (not shown) on the vehicle include, but are not limited to, sensors which provide continuous sensor outputs 16 to the VCU 10, including wheel speed sensors, an ambient temperature sensor, an atmospheric pressure sensor, tyre pressure sensors, yaw sensors to detect yaw, roll and pitch of the vehicle, a vehicle speed sensor, a longitudinal acceleration sensor, an engine torque sensor (or engine torque estimator), a steering angle sensor, a steering wheel speed sensor, a gradient sensor (or gradient estimator), a lateral acceleration sensor (part of a stability control system (SCS)), a brake pedal position sensor, an accelerator pedal position sensor and longitudinal, lateral and vertical motion sensors. In some other embodiments, only a selection of the aforementioned sensors may be used.

The vehicle 100 is also provided with a plurality of sensors which provide discrete sensor output signals 17 to the VCU 10, including a cruise control status signal (ON/OFF), a transfer box or transfer case 137 status signal (whether the gear ratio is set to the high (HI) range or low (LO) range), a Hill Descent Control (HDC) status signal (ON/OFF), a trailer connect status signal (ON/OFF), a signal to indicate that the Stability Control System (SCS) has been activated (ON/OFF), a windscreen wiper signal (ON/OFF), an air suspension ride-height status signal (HI/STD/LO, indicating whether the ride-height is set to a high, standard or low setting, respectively), and a Dynamic Stability Control (DSC) signal (ON/OFF).

As described in further detail below, the signals 16, 17 provide, or are used to calculate, a plurality of driving condition indicators which are indicative of the nature of the conditions in which the vehicle is travelling. The manner in which this is accomplished is explained in more detail in UK patent GB2492655 to the present applicant, the content of which is incorporated herein by reference as noted above.

In addition, for each subsystem control mode, each of the discrete sensor signals (also considered to be driving condition indicator signals) 17 (e.g. trailer connection status ON/OFF, cruise control status ON/OFF) is also used to calculate an associated probability for each of the control modes, GGS, RC, Sand, MR or SP OFF. So, for example, if cruise control is switched on by the driver of the vehicle, the probability that the SP OFF mode is appropriate is relatively high, whereas the probability that the MR control mode is appropriate will be lower.

The vehicle subsystems 12 may be controlled automatically in a given subsystem control mode (in an “automatic mode” or “automatic condition” of operation of the VCU 10) in response to a control output signal 30 from the selector module 20 and without the need for driver input. In the present embodiment, if the VCU 10 is in the automatic mode of operation the vehicle subsystems are caused automatically to assume the subsystem control mode corresponding to the control output signal 30 from the selector module 20. Alternatively, the vehicle subsystems 12 may be operated in a given subsystem control mode according to a manual user input (in a “manual mode” or “manual condition” of operation of the VCU 10) via the HMI module 32. Thus in the manual mode of operation the user determines in which subsystem control mode the subsystems will be operated by selection of a required system control mode (operating mode). The HMI module 32 comprises a display screen (not shown) and a user operable switchpack 170. The user may select between the manual and automatic modes (or conditions) of operation of the VCU 10 via the switchpack 170. When the VCU 10 is operating in the manual mode or condition, the switchpack 170 also allows the user to select the desired subsystem control mode. The selector module 20 receives a signal 170S from the switchpack 170 as shown in FIG. 2, by means of which the selector module 20 determines whether to operate in the manual mode or automatic mode.

For each driving mode (subsystem control mode), i.e. GGS, MR, RC, Sand or SPO in the present embodiment, an algorithm run by the selector module 20 performs a probability calculation, based on the driving condition indicators, to determine a probability that each of the different control modes is the most appropriate. The selector module 20 includes a tuneable data map which relates the driving condition indicators (e.g. vehicle speed, road roughness, steering angle) to a probability that a particular control mode is appropriate. Each probability value typically takes a value of between 0 and 1. So, for example, the vehicle speed calculation may return a probability of 0.7 for the RC mode if the vehicle speed is relatively low, whereas if the vehicle speed is relatively high the probability for the RC mode will be much lower (e.g. 0.2). This is because it is much less likely that a high vehicle speed is indicative that the vehicle is travelling over a rock or boulder terrain.

Once the VCU 10 has determined the most appropriate control mode on the basis of the driving condition indicators, the VCU 10 automatically causes each of the subsystems 12 to operate in the respective subsystem configuration mode corresponding to that control mode.

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It is to be understood that, for certain subsystems 12, the subsystem 12 may be placed in the same subsystem configuration mode when the vehicle is operated in more than one control mode. For example, in the case of a suspension subsystem, the subsystem configuration modes may include different vehicle ride height values. The suspension subsystem may be placed in the same configuration mode, i.e. the ride height may be set to the same ride height value, in more than one control mode. Thus, it is to be understood that if the subsystem control modes are considered to control modes, a given subsystem may remain in the same subsystem configuration mode (e.g. assume the same ride height value) in more than one control mode.

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For example, as described below, in the present embodiment the air suspension system of the vehicle has three subsystem configuration modes: low ride-height, medium ride-height and high ride-height subsystem configuration modes. The suspension system may be set to the medium ride-height subsystem configuration mode when the vehicle is operating in more than one control mode (driving mode), such as an on-highway control mode and a grass/gravel/snow control mode. Thus, if the vehicle operates in the on-highway control mode, the suspension system is set to the medium ride-height subsystem control mode, and may be referred to as operating in the on-highway control mode. Similarly, if the vehicle operates in the grass/gravel/snow mode, the suspension system is set to (or remains in) the medium ride-height subsystem control mode, and may be referred to as operating in the grass/gravel/snow control mode. Thus, the subsystem configuration modes are unique, distinct modes in which a given subsystem may be configured, whilst a given subsystem may operate in the same subsystem configuration mode in each of a plurality of control modes (driving modes).

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It is to be understood that the subsystem controller 14 may itself control the vehicle subsystems 12a-12e directly via the signal line 13, or alternatively each subsystem may be provided with its own associated intermediate controller for providing control of the relevant subsystem 12a-12e. In the latter case the subsystem controller 14 may only control the selection of the most appropriate subsystem control mode for the subsystems 12a-12e, rather than implementing the actual control steps for the subsystems. The or each

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intermediate controller may in practice form an integral part of the main subsystem controller 14.

In the present embodiment the VCU 10 is configured to permit a user to change the configuration of each of a plurality of vehicle subsystems in each of a predetermined set of driving modes. In the present embodiment, the configuration of a predetermined set of subsystems may be changed in each of the following driving modes: GGS mode, MR mode, RC mode and Sand mode.

In order to adjust the configuration of the plurality of vehicle subsystems, a user selects a 'configurable TR' (configurable terrain response) mode of operation. FIG. 4 is a schematic illustration of a display provided to a user via HMI module 32 when the configurable TR mode is selected. As can be seen from FIG. 4, the user is presented with a list of the four driving modes for which the configuration of a plurality of vehicle subsystems may be adjusted. The 'default' settings of the driving modes are referred to as 'base settings', and the driving modes with default (unadjusted) settings may be referred to as 'base driving modes'. The base driving modes each correspond to a different type of driving surface, and the driver is asked to select the base driving mode (or 'base surface' mode) that is to be adjusted. In the present embodiment, the driver selects the driving mode that is to be adjusted by touching the display screen of the HMI module 32 at the location of the text identifying the base driving mode that is to be adjusted. The VCU 10 then displays a screen that permits the user to adjust the parameters that are permitted to be adjusted for the particular selected base driving mode.

FIG. 5 shows, by way of example, the screen that is displayed if a user selects the mud/ruts (MR) base driving mode. The parameters that the user is permitted to adjust are listed as 'throttle', 'traction', 'gear-shift request' and 'ride'. Input means in the form of sliders 32SL permit the user to adjust each of the parameters between extremes by sliding the slider between left and right positions. It is to be understood that in some embodiments, one or more other input means may be provided in addition or instead, for adjusting one or more parameters. For example, in some embodiments a rotary knob or a lever may be provided.

As can be seen from FIG. 5, the 'throttle' parameter permits the user to adjust the responsiveness the throttle between a 'relaxed' condition (slider 32SL fully to the left of the allowable range of travel, as shown in FIG. 5) and a 'responsive' condition (slider 32SL fully to the right of the allowable range of travel). In the 'relaxed' condition, the amount of torque

developed by the engine 121 for a given amount of initial travel of the accelerator pedal 161 is less than that in the 'responsive' condition.

The 'traction' parameter allows the user to adjust the amount of wheel slip permitted by the traction control (TC) function of the SCS ECU. With the slider fully to the left of travel, the TC function allows relatively little slip under a given set of conditions before the TC function intervenes to prevent or reduce wheel slip, whilst with the slider fully to the right of travel the TC function allows a relatively large amount of slip under the same set of conditions.

The 'gear-shift request' adjustment allows the user to adjust the responsiveness of the paddle gear-shift control 181PG mounted to the steering column 181SC. In the present embodiment, the slider corresponding to the 'gear-shift request' adjustment allows the value of the predetermined gear-shift request signal duration parameter, described above, to be adjusted. As noted above, the predetermined gear-shift request signal duration parameter determines the amount of time for which a user must cause the paddle control signal 181PGS to be generated by one of the paddle controls 181PL, 181PR before the transmission controller 124C causes a corresponding upshift or downshift, assuming the requested up-shift or down-shift is permissible. The user may adjust the value of the gear-shift request signal duration parameter from a relatively short duration (slider 32SL fully to the left of travel) to a relatively long duration (slider 32SL fully to the right of travel). When the VCU 10 causes the subsystems 12 to operate in a given driving mode, the subsystem controller 14 transmits a signal to the transmission controller 124C indicative of the value of gear-shift request signal duration parameter to be employed by the controller 124C. The controller 124C stores the value of this parameter in the memory thereof and employs this value as the prevailing value for subsequent gear-shift requests.

The 'ride' parameter allows the user to adjust ride hardness by sliding the slider between a 'hard' condition, with the slider fully to the left of travel, and a 'soft' condition, with the slider fully to the right of travel. In the 'hard' condition, the fluid (air) suspension is set to provide a relatively highly damped (hard) ride experience whilst in the 'soft' condition the suspension is set to provide a relatively undamped (soft) ride experience.

In the present embodiment, the VCU 10 permits the 'configurable TR' mode to be selected and adjustment of parameters to take place only if the vehicle is stationary and the transmission is in the park (P) mode. In some alternative embodiments, the configurable TR mode may be selected and adjustment of one or more parameters made regardless of the selected transmission mode provided the vehicle is stationary. In some alternative

embodiments the configurable TR mode may be selected even if the vehicle is moving, but adjustment of the one or more parameters may be made only whilst the vehicle is stationary. In some still further embodiments, parameter adjustment may take place even if the vehicle is moving. Other arrangements may be useful in some embodiments.

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Once a user has adjusted one or more parameters, the user may save the adjusted configuration by pressing 'save' icon 32SA. If the 'save' icon 32SA is pressed, the user is taken to a 'save' screen. A schematic illustration of an example of such a screen is presented in FIG. 6. The user is invited to input a name for the adjusted driving mode parameter profile they have created, pressing an 'OK' icon when the name has been entered. As shown in FIG. 6 the name is input via an alphanumeric keypad displayed on the touchscreen display of the HMI 32. Once the name has been entered and the 'OK' icon pressed, the VCU 10 stores a record of the adjusted parameters, the identity of the base surface (in the present example 'MR') and the name of the profile assigned by the user, in a memory of the VCU 10. The display screen of the HMI 32 then returns to the previous screen shown in FIG. 5. The user may exit the display by pressing the 'return' icon 32RT, in which case the display reverts to the original 'configurable TR' screen (FIG. 4). The saved 'adjusted configuration' may be referred to as a user-configured driving mode or user-adjusted driving mode.

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The user may reload an existing adjusted configuration that has been previously saved by pressing the 'Load' icon 32LD. Alternatively, the user may reset the parameters to their default values for the selected base driving mode by pressing the 'New Surface' icon 32NS. The user may then adjust one or more of the parameters again, and save a further adjusted configuration if they so desire.

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In order to access user-configured driving modes that have been saved, the user may select any such profile from a 'configurable TR' profiles list shown in FIG. 7. This list may be caused to be displayed by selection of a 'saved profiles' function via HMI 32. When the profiles list is displayed, as shown in FIG. 7, the user may scroll through a list of saved profiles and select the user-configured driving mode in which the user wishes to operate. When a given profile is selected, the VCU 10 configures each vehicle subsystem 12a-12e according to the base driving mode that the user-configured driving mode corresponds to (such as the MR mode in the example given above) but sets each of the parameters that were user-adjusted to the user-adjusted, stored values.

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It is to be understood that the predetermined parameters that may be adjusted for a given base surface driving mode may differ. FIG. 8 is a schematic illustration of an example of a display that may be provided by the VCU 10 on the display screen (touch screen) of HMI 32 when a different base surface is selected, other than the MR base surface. For this base surface, the parameters are listed as 'steering', 'throttle', 'gears', 'differential' and 'traction'. Adjustment of parameters 'throttle' and 'traction' has been described above with respect to FIG. 5.

The 'steering' parameter allows the user to adjust the amount of steering assistance provided to a driver by the ePAS unit 12c when turning the steering wheel 181. The higher the value of the steering parameter, the lower the amount of torque that a user is required to apply to the steering wheel 181 to turn the wheel 181. That is, the amount of torque assistance provided by the ePAS unit 12c to assist the user in turning the wheel is greater the greater the value of the steering parameter. In the present embodiment the amount of steering assistance is proportional to vehicle speed in each of the driving modes except the RC mode, where the amount of steering assistance is set to 'high' and is substantially independent of vehicle speed. This is because, in the RC mode, the vehicle 100 is typically driven at crawl speed over highly uneven rocky terrain, typically requiring relatively abrupt changes in steering angle as the rocky surface is negotiated. With reference to FIG. 8 and the 'steering' parameter, movement of the slider to the leftmost limit of travel ('light') increases the amount of steering assistance provided by the ePAS unit 12c at a given speed, whilst movement of the slider to the rightmost limit of travel ('heavy') decreases the amount of steering assistance provided by the ePAS unit 12c at a given speed.

The 'gears' parameter allows the user to adjust the relative abruptness of gear changes effected by a controller of the automatic transmission 124. The amount of time taken may be varied from a relatively short period, i.e. gear changes are relatively abrupt, with the slider at its leftmost extent of travel, to a relative long period, with the slider at its rightmost extent of travel. It is to be understood that relatively abrupt gear changes may result in more harsh variations in the amount of torque applied to driven wheels of the vehicle and may therefore not be suited to relatively slippery surfaces such as those for which GGS mode may be configured. It is to be understood that the values of engine speed at which shifts between a given pair of gears occur in a given driving mode may be different from one driving mode to another.

The 'differential' parameter allows the user to adjust the amount of cross-axle lock provided by rear differential 135, and optionally in some embodiments front differential 135F. With the

slider fully to the left of travel the differential 135 is fully open, whilst with the slider fully to the right of travel the differential 135 is substantially fully locked (to the extent the differential 135 permits). In embodiments having a centre differential, the VCU 10 may permit the amount of lock of the centre differential to be adjusted by means of a similar slider or other arrangement.

FIG. 9 shows another example of a display screen allowing a different combination of parameters to be adjusted, in the example shown the parameters are 'steering', 'throttle', 'gears', 'differential' and 'ride', each of which has been discussed above with respect to FIG. 5 or FIG. 8.

In some embodiments, in one or more driving modes the user may be permitted to adjust one or more other parameters, such as vehicle crawl speed. By crawl speed is meant the speed at which the vehicle will crawl, on a relatively flat, smooth surface, with the accelerator pedal 161 and brake pedal 163 fully released.

FIG. 10 shows a further example of a display screen, in this case the display screen of FIG. 9, where the default positions of the sliders are shown in 'grey' 32SLD whilst the user-adjusted position of each slider is shown in an orange colour 32SLA (shown hatched in FIG. 10). This feature enables the user to appreciate the extent to which the slider 32SL has been moved from its default position.

It is to be understood that, in some embodiments, adjustment of one slider position may cause the VCU 10 to change the allowable range over which the user is permitted to adjust another parameter displayed on the screen. In some embodiments this feature may be implemented in order to reduce the risk of loss of composure of the vehicle, for example due to experiencing excessive slip under certain conditions. For example, if the user selects the GGS base driving mode and selects a relatively short gear change period, the VCU 10 may limit the allowable range of values of parameter 'traction', such that a very 'tight' traction control is not permitted. This is at least in part because a GGS surface is typically a surface of relatively low surface coefficient of friction where slip may be particularly undesirable due to the risk of surface modification. By 'tight' traction control is meant that the TC function intervenes to reduce the amount of wheel slip when the amount of wheel slip exceeds a traction control intervention slip threshold value that is relatively low. It is to be understood that relatively abrupt changes in the amount of torque applied to a driven wheel may occur if relatively short gear change periods are employed, resulting in an increased risk of wheel slip on surfaces presenting a relatively low surface coefficient of friction. As noted herein,

this may be highly undesirable in the case of relatively fragile surfaces such as grass, where undesirable surface modification may occur as a result. In contrast, slip on a sandy surface may be less problematic in terms of the risk of surface modification. Indeed, a certain amount of wheel slip when travelling over a sandy surface may be desirable in order to
5 improve traction due to compaction of the sand.

In some embodiments, an indication may be provided on the display screen of the allowable range of travel of the sliders 32SLA displayed thereon. The indication of the allowable range of travel of one slider 32SLA may change dynamically in response to movement of another
10 slider 32SLA. Thus, the allowable range of travel of one slider 32SLA may narrow, or broaden, in response to movement of another slider 32SLA. This feature has the advantage that guidance may be provided to a user to help them in establishing an appropriate vehicle subsystem configuration.

15 It is to be understood that embodiments of the present invention are suitable for use with vehicles not having an automatic driving mode selection mode, but which are limited to manual driver selection of the required driving mode. Thus, the driver may select operation of the vehicle 100 in either a base driving mode or a customised driving mode.

20 It will be understood that the embodiments described above are given by way of example only and are not intended to limit the invention, the scope of which is defined in the appended claims.

Throughout the description and claims of this specification, the words “comprise” and
25 “contain” and variations of the words, for example “comprising” and “comprises”, means “including but not limited to”, and is not intended to (and does not) exclude other moieties, additives, components, integers or steps.

Throughout the description and claims of this specification, the singular encompasses the
30 plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

Features, integers, characteristics, compounds, chemical moieties or groups described in
35 conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

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CLAIMS:

1. A vehicle control system for a vehicle transmission, the system comprising gear-shift trigger means for allowing a user to provide a user input to the system indicating that the user wishes the transmission to undergo a gear-shift,

wherein the system is configured to cause the transmission to undergo the gear-shift in response at least in part to the user input being received from the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration, and wherein

the control system is configured to allow a user to adjust, via input means, the length of the predetermined gear-shift request signal duration.

2. A vehicle control system according to claim 1 wherein the gear-shift trigger means comprises means for generating a gear-shift request signal in response to the user input indicating the user wishes the transmission to undergo a gear-shift,

wherein the system is configured to cause the transmission to undergo the gear-shift in response at least in part to receipt by the control system of the gear-shift request signal provided the user causes the gear-shift request signal to be generated for a period exceeding a predetermined gear-shift request signal duration.

3. A control system according to claim 2 wherein the gear-shift trigger means for allowing a user to generate a gear-shift request signal comprises a gear-shift request input device comprising a user-actuated element operable to be actuated from a first condition to a second condition and to remain in the second condition until a user releases the element and the element returns to the first condition, the gear-shift request input device being configured to generate the gear-shift request signal substantially for the duration of the period the element is in the second condition.

4. A control system according to any preceding claim wherein the control system is configured to cause the transmission to undergo the gear change by transmitting a gear-shift command signal to the transmission.

5. A control system according to any preceding claim further comprising a subsystem controller for initiating control of one or more vehicle subsystems in one of a plurality of subsystem control modes by setting at least one control parameter of the or each subsystem to a predetermined, stored, value or state applicable to that control mode, each subsystem control mode corresponding to one or more different driving conditions for the vehicle,

wherein, for at least one of the plurality of subsystem control modes, the control system is configured to allow a user to adjust, via the input means, the value or state of at least one of said at least one control parameters to customise operation of the vehicle.

5 6. A control system according to claim 5 wherein the subsystem controller is configured to initiate control of the transmission, being comprised by a subsystem of the vehicle, in one of a plurality of control modes, the subsystem controller being configured to set the predetermined gear-shift request signal duration, being a control parameter of the transmission, to a predetermined value that is dependent at least in part on the subsystem
10 control mode in which control of the subsystem has been initiated.

7. A control system according to claim 5 or 6 configured to allow a user to adjust, in respect of at least one control mode, the value or state of at least one said at least one control parameter of at least one subsystem to customise operation of the vehicle in the at
15 least one control mode, wherein the allowable range of values or states of said at least one control parameter of the or each subsystem is dependent at least in part on the subsystem control mode.

8. A control system according to any one of claims 5 to 7 configured to allow a user to
20 adjust, via the input means, the value or state of each of a plurality of control parameters of at least one subsystem to customise operation of the vehicle in the at least one control mode, wherein the allowable range of values or states of at least one of the plurality of control parameters is dependent at least in part on the value or state of at least one other of the plurality of control parameters.

25 9. A control system according to any one of claims 5 to 8 configured to allow a user to store the adjusted value or state of each said at least one control parameter in the form of a customised control mode.

30 10. A control system according to claim 9 configured to allow a user to select the customised control mode via the input means.

11. A control system according to claim 9 or 10 configured to allow a user subsequently to adjust, for the customised control mode, the value or state of at least one of said at least
35 one control parameters of at least one of the plurality of subsystems .

12. A control system according to any preceding claim wherein the input means comprises at least one selected from amongst a rotary switch selector device, a lever-type switch selector device, one or more button devices and one or more touchscreen devices.

13. A control system according to any preceding claim wherein the control modes comprise at least one control mode adapted for driving on a driving surface of relatively low surface coefficient of friction.

14. A control system according to claim 13 wherein the control modes comprise at least one control mode adapted for driving on at least one of a snowy surface, an icy surface, grass, gravel, snow, mud and sand.

15. A control system according to any claim 5 or any claim depending therethrough wherein at least one said at least one subsystem includes a powertrain subsystem, a brakes subsystem or a suspension subsystem.

16. A control system according to any preceding claim comprising an electronic processor having one or more electrical inputs for receiving a signal from the gear-shift trigger means and a signal from the input means allowing the user to adjust the length of the predetermined gear-shift request signal duration, and an electronic memory device electrically coupled to the electronic processor and having instructions stored therein,

wherein the processor is configured to access the memory device and execute the instructions stored therein such that it is operable to allow a user to adjust, via the input means, the length of the predetermined gear-shift request signal duration to customise operation of the vehicle.

17. A vehicle comprising a control system according to any preceding claim.

18. A method of controlling a vehicle transmission implemented by means of a control system, the method comprising:

receiving a user input from gear-shift trigger means indicating that a user wishes the transmission to undergo a gear-shift, and

causing the transmission to undergo the gear-shift in response at least in part to the user input being received from the gear-shift trigger means for a period exceeding a predetermined gear-shift request signal duration, and

the method further comprising allowing a user to adjust, via input means, the length of the predetermined gear-shift request signal duration.

19. A non-transitory computer readable carrier medium carrying a computer readable code for controlling a vehicle to carry out the method according to claim 18.

5 20. A computer program product executable on a processor so as to implement the method of claim 18.

21. A computer readable medium loaded with the computer program product of claim 20.

10 22. A processor arranged to implement the method of claim 18, or the computer program product of claim 20.

23. A control system, vehicle, method, carrier medium, computer program product, computer readable medium or processor substantially as hereinbefore described with
15 reference to FIG.'s 1 to 10.

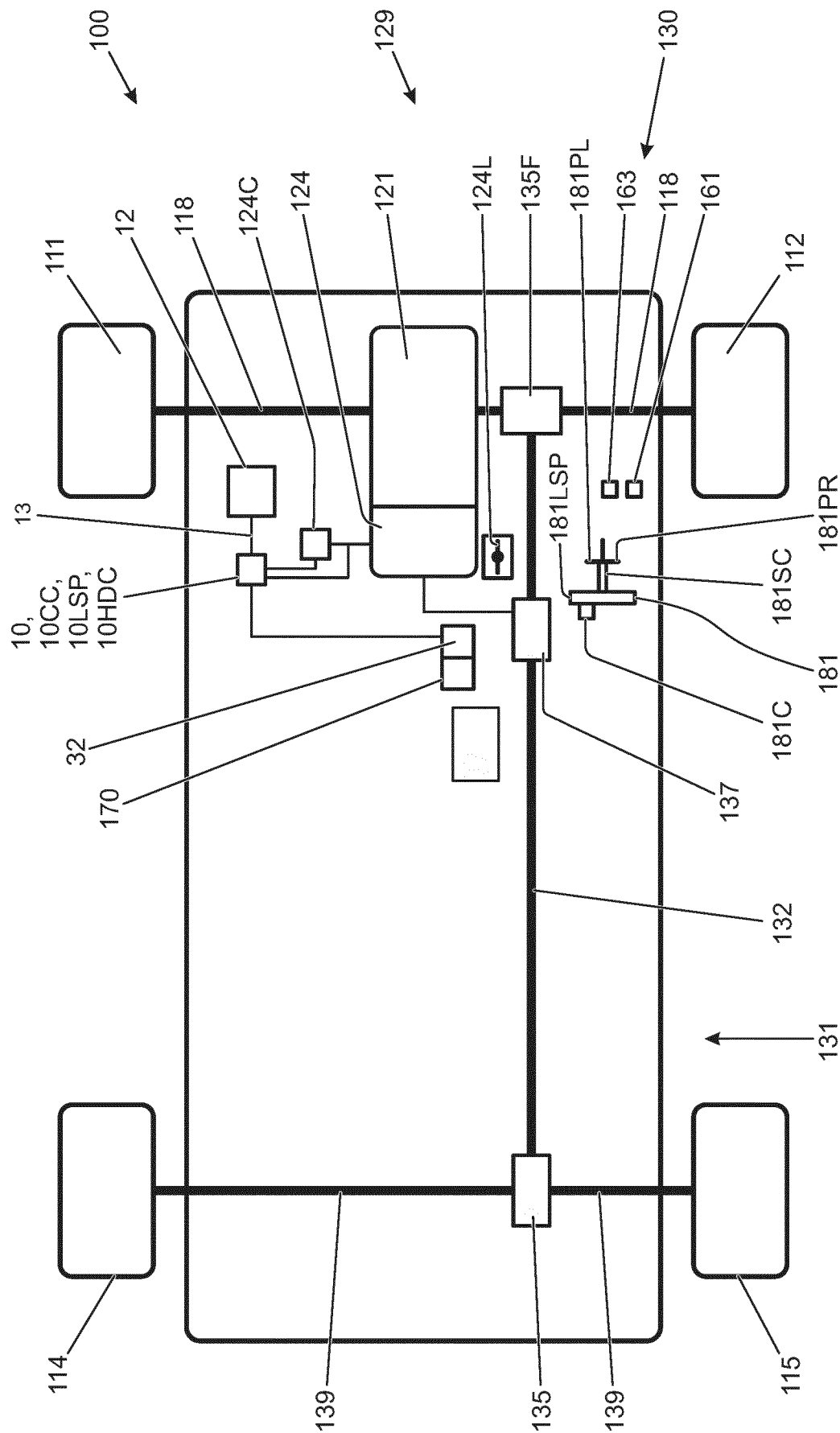


Figure 1

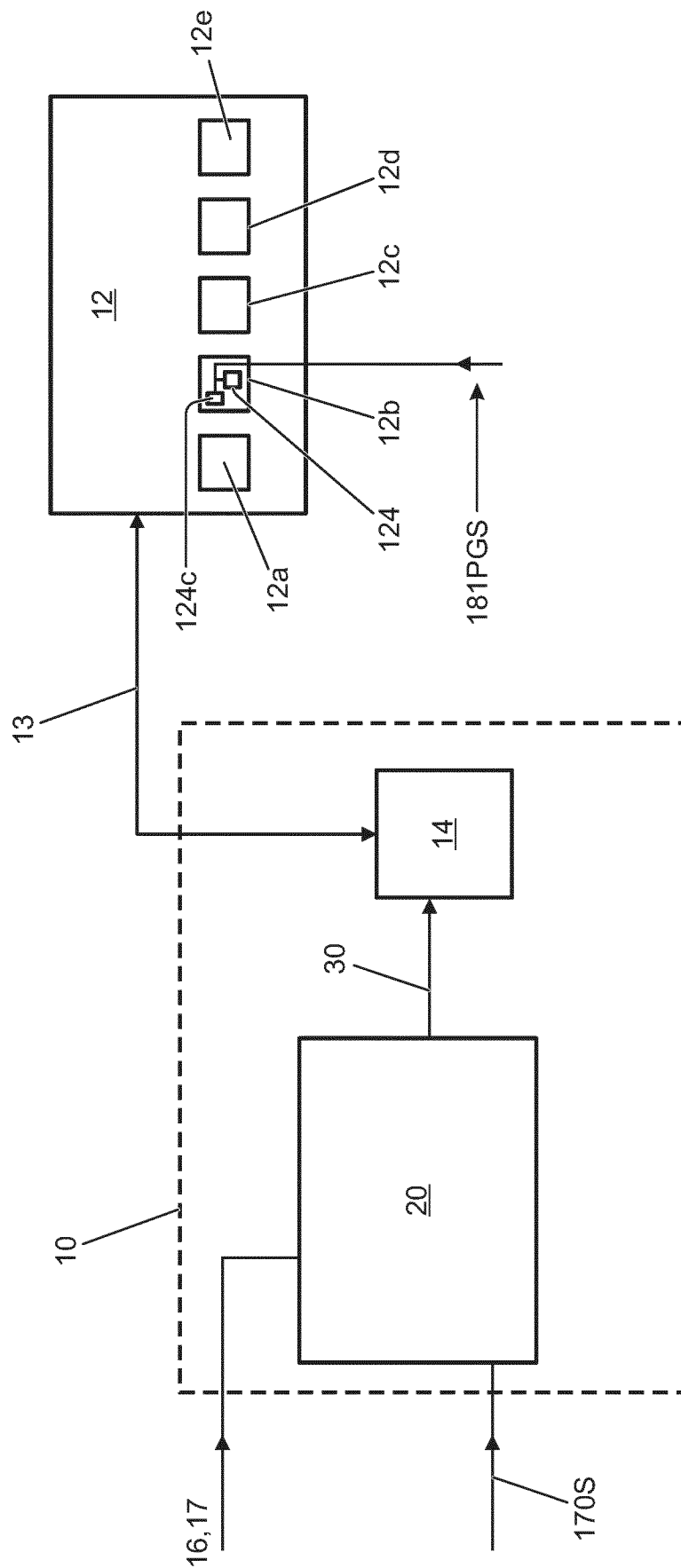


Figure 2

Column Titles Key (CT1 to CT10)		CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10
Suspension Ride Height	High									X	
	Standard		X	X	X	X	X	X	X		X
	Low	X									
Side / Side Air Interconnection	Closed	X	X	X	X	X	X				
	Open							X	X	X	X
Steering Assistance	High	SP	SP	SP	SP	SP	SP	SP	SP	X	SP
	Low										
Brake Pedal Efforts	High	X	X			X	X	X	X		X
	Low		(X)	X	X					X	
A.B.S. Mode	High mu	X	X	X	X					X	
	Low mu					X	X	X			X
	Plough Surface								X		
E.T.C. Mode	High mu	X (2)	X	X	X						
	Low mu					X	X	X		X	X
D.S.C. Mode	High mu	X	X	X	TM					X	
	Low mu					X	X	X	X		X
Throttle Progression	Quick		(X)		(X)				X		
	Slow	X	X	X	X	X	X	X		X	X
Transfer Box	High Range	X	X	X	X	X	X				
	Low Range							X	X	X	X
Centre Diff Lock	Open	X	X	X	X	X	X				
	Locked							X	X	X	X
Rear Diff Lock	Open	X	X	X	X	X	X	X			
	Locked								(X)	X	X

SP = Speed Proportional
TM = Towing Mode

FIGURE 3

Column Titles Key (CT1 to CT10)

CT1	Motorway
CT2	Country Road
CT3	City Driving
CT4	Towing (on Road)
CT5	Dirt Track (Developing World Road)
CT6	Snow / Ice (Scandinavian North American conditions)
CT7	Grass / gravel / snow
CT8	Sand
CT9	Rock / Crawl / Boulder Crossing
CT10	Mud & ruts

FIGURE 3 continued

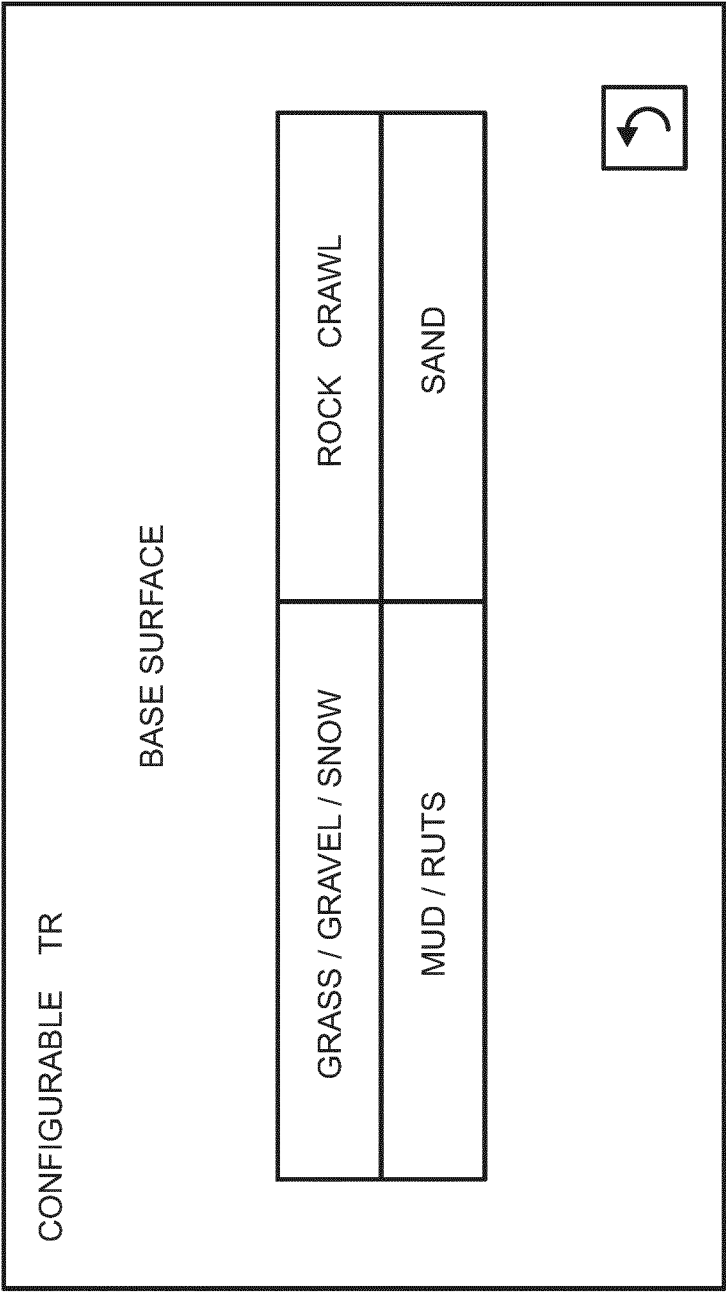


Figure 4

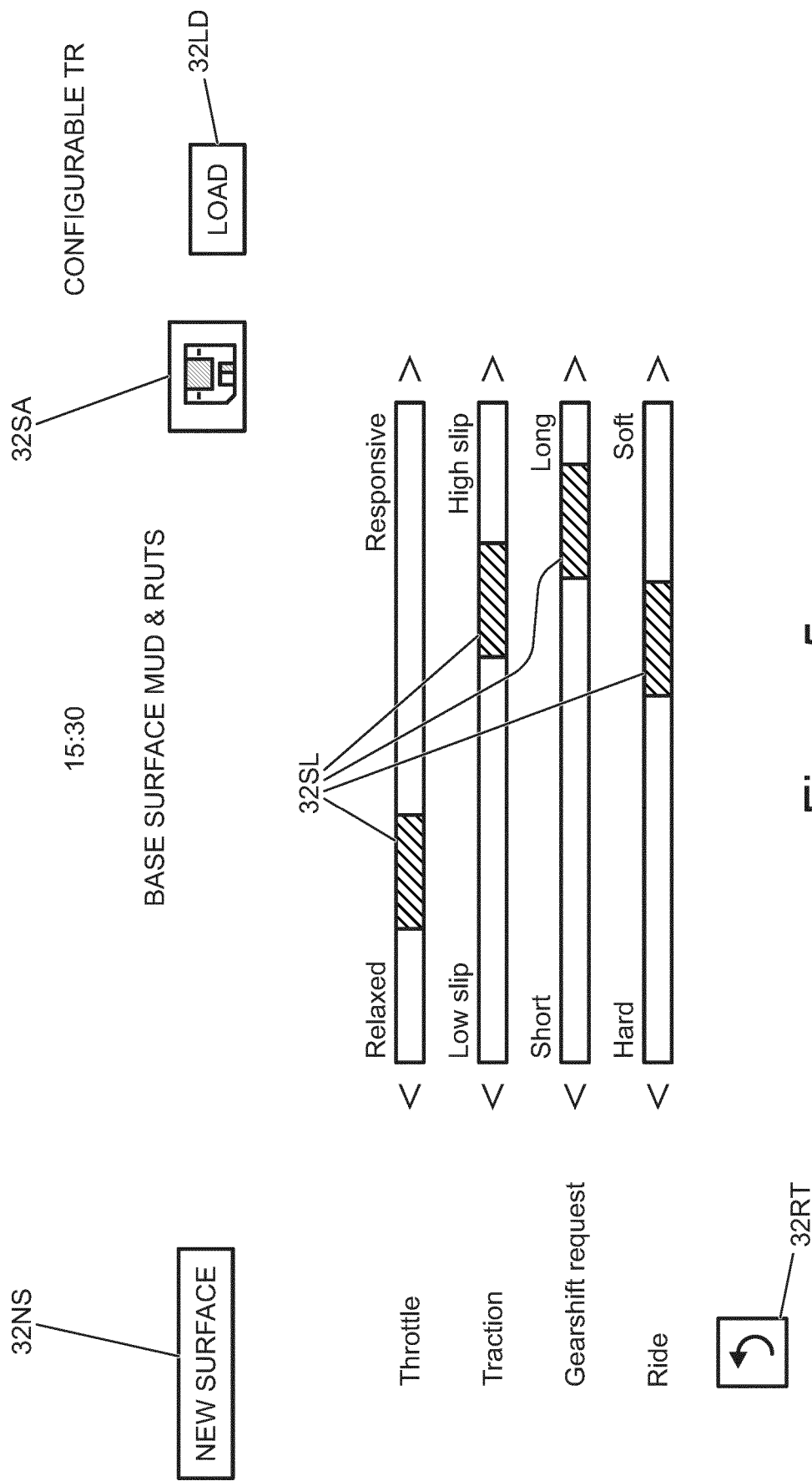


Figure 5

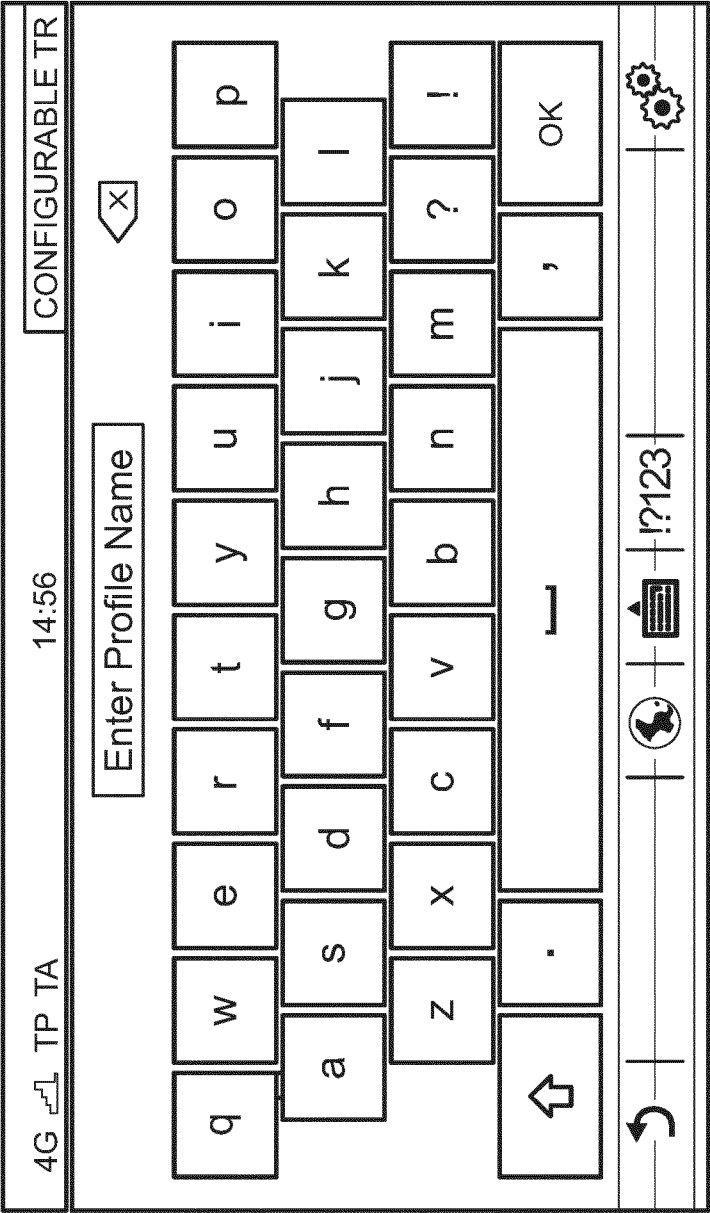


Figure 6

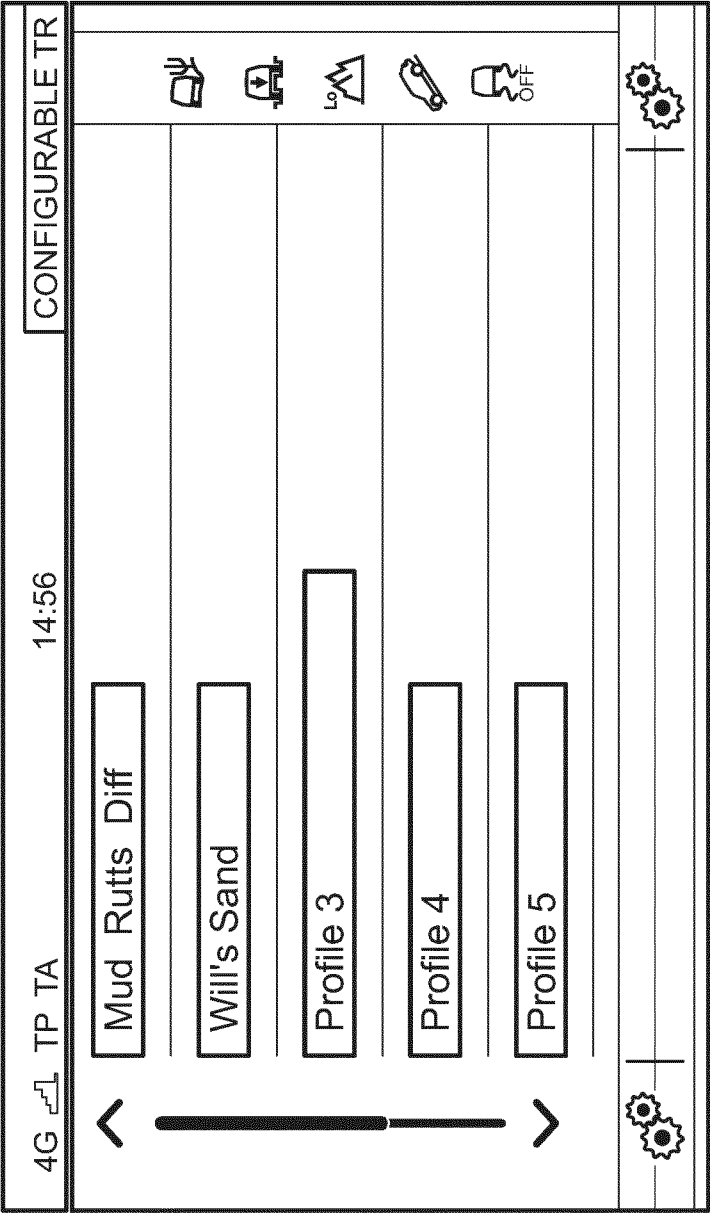


Figure 7

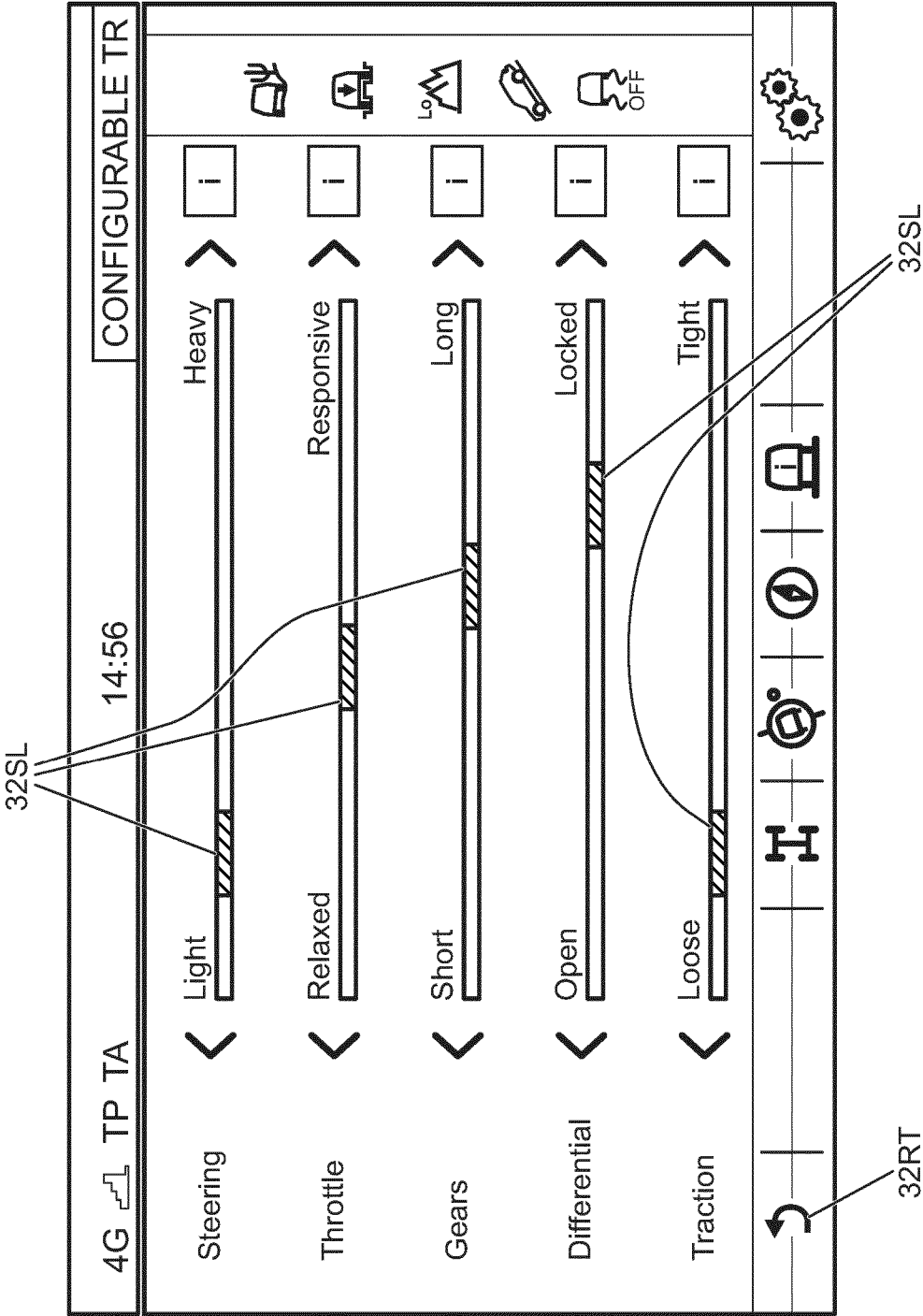


Figure 8

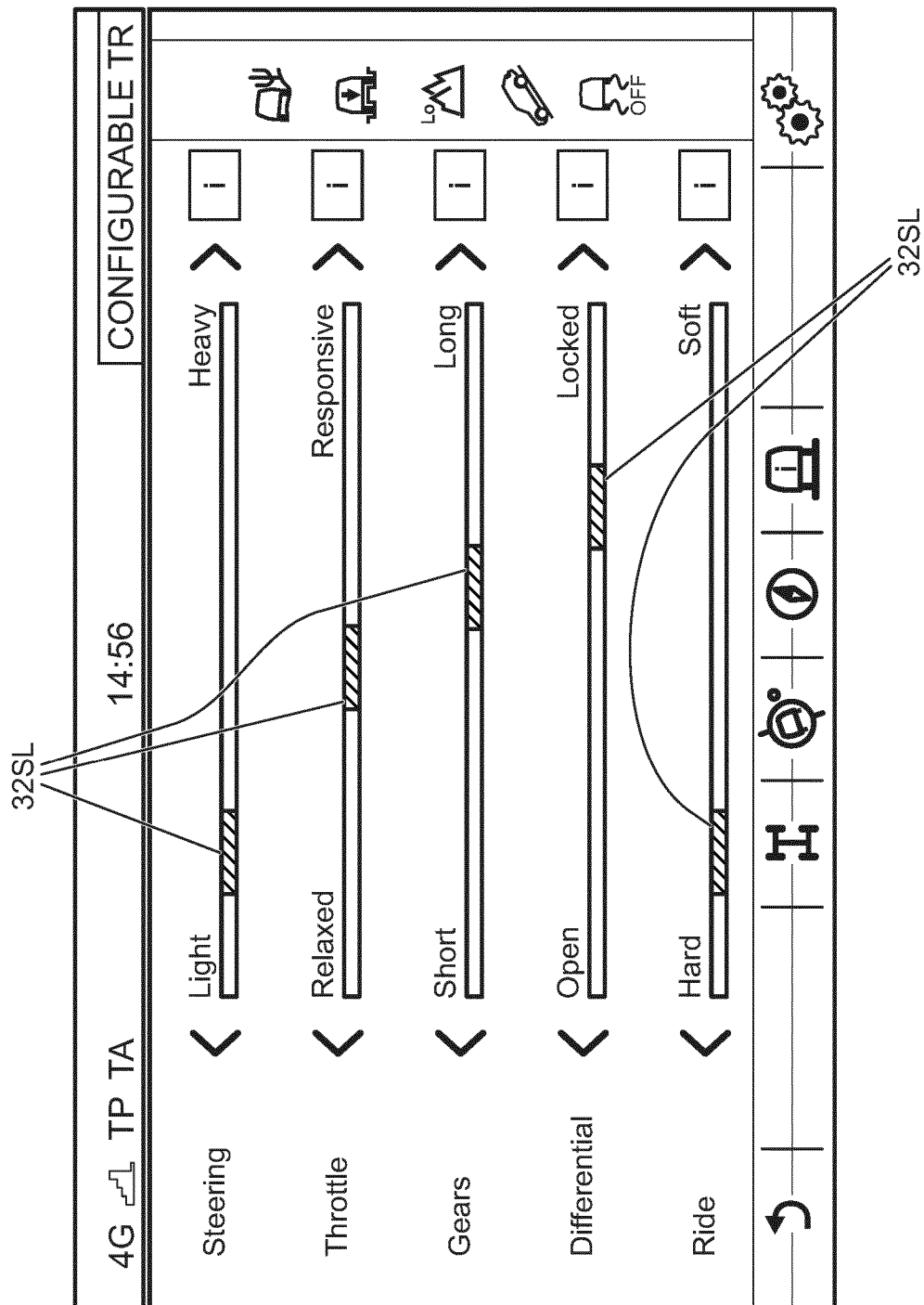


Figure 9

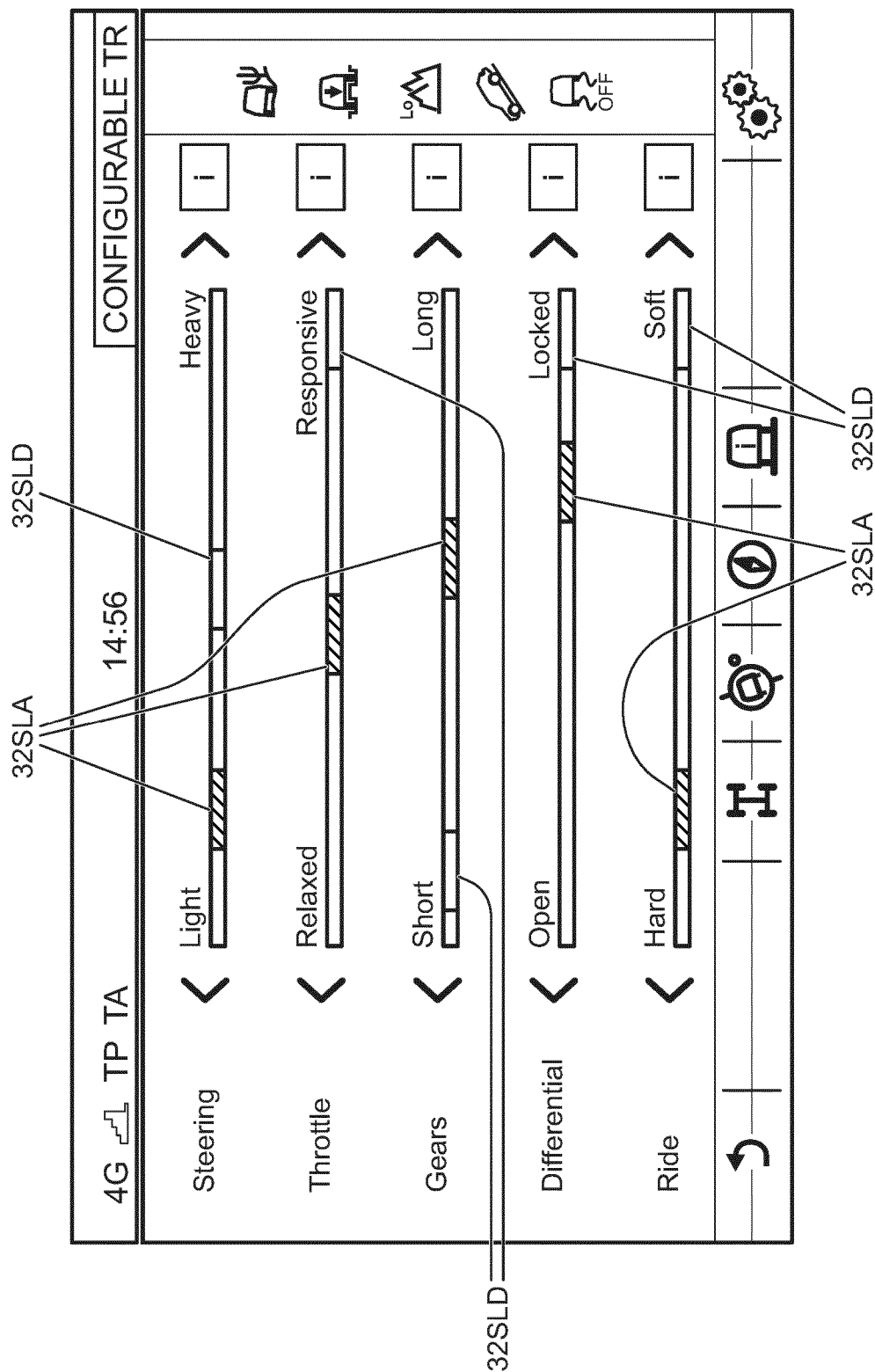


Figure 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/080842

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16H61/02 B60W50/08 B60W10/11
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16H B60W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 9 212 741 B1 (HO JAY [US] ET AL) 15 December 2015 (2015-12-15)	23
A	column 4, line 65 - column 5, line 30; figures	1-22
X	US 2012/329605 A1 (KAWAMURA YASUYUKI [JP] ET AL) 27 December 2012 (2012-12-27)	23
A	paragraphs [0079], [0080], [0084]	1-22
X	US 2003/200016 A1 (SPILLANE ANTHONY FRANCIS [GB] ET AL) 23 October 2003 (2003-10-23)	23
A	cited in the application abstract; figures paragraph [0086]	1-22
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

3 March 2017

Date of mailing of the international search report

10/03/2017

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Authorized officer

Meritano, Luciano

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/080842

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	paragraphs [0030], [0031]; figures -----	1-22
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A	claim 4; figures -----	1-22
X	WO 2014/037515 A1 (JAGUAR LAND ROVER LTD [GB]) 13 March 2014 (2014-03-13)	23
A	abstract; figures page 34, lines 1-15 -----	1-22
X	EP 1 150 043 A2 (EATON CORP [US]) 31 October 2001 (2001-10-31)	23
A	abstract; figures paragraph [0051] -----	1-22

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