Title of the Invention: Hill descent control
Abstract Title: Hill descent control using engine braking through two modulated transmission clutches

Vehicle control method having two clutches A, B (e.g. power shift / dual clutch) coupled to selectable gear ratios to transmit torque from an engine. A first gear ratio is selected and engaged via first clutch A to provide retardant torque / engine braking to vehicle wheels. A second gear ratio is pre selected via second clutch B, and subsequent engagement is modulated (clutch slipped) to provide further negative torque to the wheels. The selected gears may be forward (1<sup>st</sup> – 6<sup>th</sup>) and reverse (RL, RH) ratios. Clutches A, B may be friction clutches. Method may be used when a vehicle is moving forwards or backwards down a slope / gradient. Initial gear selection may be changed during braking, i.e. from first forwards to first reverse, and second reverse to first forwards. Method steps may be prompted by transmission temperature threshold being reached to prevent clutch damage, or by performance threshold being reached to prevent clutch slip.
HILL DESCENT CONTROL

TECHNICAL FIELD
The present disclosure relates generally to hill descent control and particularly, but not exclusively, to a method of traction control for a vehicle, particularly a vehicle that is descending a hill, to a control system for implementing a control method, to a powertrain equipped with such a control system, and to a vehicle equipped with such a powertrain or control system.

BACKGROUND OF THE INVENTION
It is known to provide a vehicle with a traction control system, which may be provided with a 'hill descent' mode, particularly but not exclusively for 4x4 vehicles, and particularly but not exclusively for use in such vehicles that may be required to operate off-road and/or in challenging conditions, said conditions being challenging either as a result of terrain type or of weather conditions. Such conditions may include one or more of Grass, Gravel and Snow (GGS), but may also include rocky terrain, mud and/or ruts, ice, sand and/or steep gradients. In particular, such vehicles may be required to make descents on slopes comprising gradients that are particularly steep. Such vehicles may be provided with 'hill descent' mode especially for such situations, which nominally allows the vehicle to descend such slopes with the minimum or a zero requirement for driver interaction with, in particular, brakes, and in other vehicles, gear changing apparatus. The use of hill descent mode nominally means that a driver is not required to manually activate brakes or manually change gears in order to maintain a controlled descent of a steep slope.

One aspect of traction control methods is to control the amount of 'wheel slip' that is allowed by any one wheel or set of wheels at any particular time. If a wheel or set of wheels is seen to be unduly speeding up, then a method of traction control in the prior art relies first on the use of 'engine braking' to provide negative torque from the engine via the driveline, and additionally the supplementary use of wheel braking in order to provide a negative or retarding torque in order to maintain vehicle speed and/or traction. In hill descent modes, both engine braking and/or wheel braking are typically used in the prior art in order to maintain a constant desired controlled descent, said control potentially including control of speed.

There are, however, limitations to this methodology, particularly as regards the use of wheel braking.
Wheel brake usage tends to suffer limitations, one such limitation being due to the possible resolution of speed measurement that is available. When a wheel is turning very slowly, inputs to a speed measurement device can be intermittent – or the calculation of wheel speed may be comparatively slow, due for example to a low rate of pulses coming from a pickup sensor. This problem of low-speed measurement will be readily understood by the person skilled in the art. This makes control via braking of the wheels, based on such speed calculation, difficult, and can result in 'judder' or other undesirable characteristics with the effect that wheel speeds may vary in an unpredictable manner – potentially varying in speed quite suddenly and fundamentally resulting in sub-optimal control of the target wheel speed.

Another issue with brake use in hill descent mode is that the braking friction available at any particular moment via the wheel brakes is not necessarily constant. Brake discs and pads, for example, can become covered in water or mud or other substances which can at least momentarily alter the friction coefficients of the braking surfaces, and the friction coefficients change again as they are subsequently wiped clean in use. This makes the modelling of braking in a traction control module problematic and may necessitate the use of a feedback loop in order to provide sufficient braking control on a real time basis. Such feedback systems, if used, themselves suffer intrinsically from lag. Further, in particular where brake components may be prone to contamination as noted above, use of the brakes to slow a vehicle may result in accelerated wear of these components, which is also undesirable.

A further issue with wheel braking is that wheel brake system actuators have a limited degree of fineness in control - variance in 'brake on' pressure is not necessarily very sensitive and it is possible for wheels to be brought to a total halt when in fact it would be preferable or was intended to simply slow them down. Brakes that are 'locked on' must then be released in order to allow the wheel to move again, which has its own problems – first there is the problem of 'stiction' to overcome to allow release of (for example) brake pads from brake discs, which may give rise to sudden wheel movement, and secondly 'brake off' pressure is typically produced, as a rule, by means such as the spring effect of the piston seals or other 'passive' means – there is rarely, if ever, a controlled actuator for providing 'brake off' movement, and so control of braking in a situation where the amount of braking is being reduced is even less precise. This latter problem is an issue both in a situation where a given amount of braking on a moving wheel is being reduced as well as where a brake is being released from a stationary wheel.
A yet further issue with brake use as part of a Hill Descent system is that the constantly fluctuating use of the braking system to cope with momentary wheel slip instances can result in discomfiting feedback to a driver of the vehicle through the brake pedal. This may be particularly apparent when said driver wishes to apply additional amounts of overall braking to the vehicle.

The use of brakes in traction control is further undesirable in that their use is generally readily heard and felt by a driver and passengers, with concomitant reduced ride quality and a potential feeling of insecurity or discomfort, particularly where the brake use results in sudden or jolting decelerations and accelerations.

Such situations may commonly be referred to as drive flank and overrun flank and when these are crossed the negative aspects of backlash are seen. It would be desirable for a hill descent control type traction control system to have a faster response rate and for such instances to occur less frequently.

It is desirable to make improvements to hill descent systems, preferably improvements addressing at least some of these problems.

**SUMMARY OF THE INVENTION**

Modern vehicle transmissions may include multi-speed gearboxes for example ‘power shift’ or ‘dual clutch’ gearboxes with the ability to pre-select a plurality of gear ratios and shift between such selected ratios.

It is known to provide, and it is envisaged that embodiments of the invention will provide for, a multi-speed constant mesh gearbox having at least one input and an output, two or more forward speed ratios and one or more reverse speed ratios between said input or inputs and output, further being provided with a plurality of clutches, at least one of said clutches preferably being a friction clutch, which may be engaged in various combinations with a plurality of gears and gearbox shaft components in order to enable the various speed ratios, said gearbox being adapted for pre-selection of a next required speed ratio in use, and for changing from a current speed ratio to said next required speed ratio; wherein said speed ratios are arranged for pre-selection to provide a shift between two forward speed ratios, a shift between two reverse speed ratios, and/or a shift between forward and reverse speed ratios.
There may be two inputs to such a gearbox, typically relating to a dual clutch transmission (DCT) in which two inputs from a source of motive power, such as an internal combustion engine, are used alternately to provide drive to the transmission. A DCT transmission is typically characterized by two clutches which are alternately engaged, one clutch being associated with ‘odd’ ratios, and one clutch being associated with ‘even’ ratios. Generally speaking one of the clutches is adapted for engagement from a condition in which a motor vehicle is stationary, and is associated with normal first speed ratio of a set of speed ratios associated with a highway transmission. DCT transmissions are well known, and need not be further described here.

The arrangement of gear wheels, shafts and clutches within the transmission according to embodiments of the invention provides for a shift (with continuous transmission of torque to the vehicle driving wheels) between forward speed ratios, between reverse speed ratios, and between forward and reverse speed ratios. Such an arrangement ensures versatility in a transmission suitable for both on-highway and off-highway use.

Surprisingly it has been found that a transmission as described above can provide advantages with regards to the problems of hill descent control as also herein described.

According to an aspect of the present invention there is provided a method of controlling a vehicle provided with:

- a transmission comprising at least two selectable gear ratios;
- at least two clutches, each able to connect at least one gear ratio an output of an engine of the vehicle;
- at least one wheel driven via the transmission;

the method comprising:

- selecting and engaging a first gear ratio via a first clutch, such as to allow provision of retardant torque to at least the one wheel by means of engine braking;
- pre-selecting a second gear ratio via a second clutch, and;

modulating engagement of the second clutch associated with said selected second gear ratio so as to allow the provision of further retardant torque to at least the one wheel.

In an embodiment, the first selected gear ratio is a forwards gear ratio and the second selected gear ratio is a reverse gear ratio.
In an embodiment, the first selected gear ratio is a forwards gear ratio and the second selected gear ratio is a further forwards gear ratio.

In an embodiment, the first selected ratio is a reverse and the second is a forwards ratio.

In an embodiment, the first selected ratio is a reverse and the second is a further reverse ratio.

In embodiments, one or both of the clutches is a friction clutch.

This method allows for an increased control of the descent speed of a vehicle as it descends a hill. In accordance with standard prior art methods, a forward gear is engaged via one first clutch, and engine braking is used for initial retardation of the vehicle. However, in a situation arising where the amount of negative torque required exceeds the capacity of the engine, in prior art methods, the engine braking would thus be supplemented by the use of wheel braking, with the various concomitant disadvantages outlined. In this aspect of the present invention, a further gear has been pre-selected and modulation of engagement of a second clutch in this torque path allows for control of the speed of the vehicle without recourse to the use of wheel brakes. Should the additional negative torque available by use of the additional gear not be required, control of the vehicle speed can be performed purely by modulation of the first clutch.

It will be readily understood by one skilled in the art that full engagement of two gear ratios simultaneously would result in 'lock up' of a transmission, and great effort is usually made to ensure this in particular, and simultaneous engagement in general, does not occur. In typical prior art systems where shifts occur between gears where one gear is engaged and another is preselected, sophisticated management systems are usually employed to handle the change of torque path/gear ratio to ensure smooth transition with at least some constant torque application to final drive whilst preventing such 'lock up'.

However, in an aspect of the present invention the modulation of at least one clutch in one of two engaged gear ratio torque paths is deliberately undergone in such a manner so as to introduce braking torque to the vehicle. The two torque paths/gear ratios are engaged to some degree simultaneously so as to deliberately introduce a degree of 'lock up' which manifests as a braking torque.
In an aspect of the present invention, where a vehicle is descending a slope, the initially selected gear ratio is in the direction of travel – i.e. normal 'first' gear if the vehicle is going down the slope forwards, and the subsequently selected gear is in the other direction, i.e. reverse gear. The selection of the subsequently selected gear is particularly effective as it introduces torque to the drivetrain such as to provide drive to the vehicle in a direction opposite to the direction of travel, i.e. uphill. It will be readily understood that the vice versa situation will also be true.

Where the initially selected gear ratio is in one direction of travel and the subsequently selected gear ratio is in the same direction of travel, it will be understood that a further advantage becomes apparent, in that the initially selected gear may be chosen so as to provide the most appropriate degree of engine braking for the particular gradient the vehicle is traversing, and/or also the most appropriate degree of engine braking for the particular speed that a driver of the vehicle wishes to maintain. This may be necessary where, for example, a particular number of RPM of the engine of the vehicle is desirable, either for provision of a particular braking torque, or where it is desirable to keep an engine 'on boost' (i.e. with turbocharger running) so as to allow for faster engine response to a subsequent torque demand increase.

Further aspects and embodiments of the invention are enabled where the transmission includes a gearbox comprising at least two forward and two reverse gears. It will be understood by the person skilled in the art that the introduction of extra braking torque by use of the engagement of a plurality of gear ratios in a transmission will result in the generation of significant amounts of heat. Means for dissipating or using that heat may be provided, or alternatively a method of ensuring that the heat generation does not reach a level at which it may cause damage to components, or an excessive reduction in their effectiveness, may be employed.

Advantageously, such changes to clutch engagement are relatively fast.

Methods in accordance with aspects of the invention will obviate to some degree the requirement for use of wheel brakes – the use of the clutches is comparable in speed of response and is much more predictable as against the disadvantages of wheel braking, as noted herein. The wheel speed may in effect be controlled by the use of the clutches in the transmission, rather than by control of the wheel speed by supplementary use of brakes. A further advantage is that various elements of the transmission driveline to the wheels will be rotating at higher speeds than the wheels themselves, and effective measurement of wheel
speed can thus be taken by inference or calculation from a speed reading taken at such an element – the speed and granularity of such measurement can then be quantitatively and qualitatively superior to a speed measurement taken at the actual wheel with the limitations as discussed for prior art systems, allowing for better measurement and control of the resultant wheel speed.

Use of the transmission via the clutches to control the wheel speed will also advantageously minimise the likelihood of sudden impulses of torque coming down the drivetrain to the wheels, causing undesirable jerking effects and possible loss of traction. Similarly, the problems of brake release, stiction and so on are also reduced as much lower use is made of the wheel brakes to affect wheel speed control.

Predictability of a wheel speed control system as per aspects of the invention, wherein control is enacted by two clutches controlling drive bias between two pre-selected gear ratios in the driveline, is also enhanced. The problems of predicting the effects of a wheel brake, wherein the momentary effects of dirt, grease, mud etc. may be present, are avoided. Control of clutches will be well understood by the man skilled in the art as being comparatively precise, and clutches in driveline/powertrain systems comprising a power shift or dual clutch gearbox as described may even have actuators for disengagement as well as engagement of the clutches, in contrast to wheel brakes, as discussed elsewhere herein.

A further advantage of the invention over the prior art is that in the prior art, a vehicle with a hill descent type braking system which relies on brakes may at some point come to the foot of a slope and begin to travel ‘on the flat’. At this point, the characteristics of a vehicle with a hill descent function may become non-optimal. When travelling down the hill, the ‘target speed’ of the vehicle will tend to be controlled by the accelerator pedal position. When the driver ‘lifts off’ the pedal, more braking is applied, potentially both by the engine and the brakes. This is acceptable on a hill, where the desired speed is likely to be slow and large amounts of braking are necessary. On the flat, however, if both engine braking and friction brake forces are applied, the amount of braking overall may begin to feel excessive to the driver, and the feeling of braking due to the friction brakes will be atypical of a vehicle travelling on straight and level road, where normally only engine braking would apply. In extremis, noise and clatter may be detected in the vehicle cabin as a result of the friction brakes being applied. Where, in accordance with aspects of the present invention, it is possible to provide braking in a hill descent scenario without using the friction brakes, the friction brakes will not then come into play once the vehicle is ‘on the flat’ and so the problem will not arise.
A yet further advantage of the invention is that in contrast with prior art Hill Descent systems which are reliant on friction brakes to provide braking, differentials within the vehicle may be 'locked' as the vehicle descends the hill. This is not possible in the prior art as the control of speed by the brakes tends to require that the brakes may control each wheel individually – and accordingly, the differentials need to be 'open' in order that individual wheel speeds may be different. This is necessary as braking systems tend to only register the speed of wheels and not any amount of torque delivered to them. In aspects of the present invention, the differentials may be locked and this extends the range of operation of the invention on steep, uneven or slippery slopes with the attendant benefits of driver comfort, composure and quiet operation.

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 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.

**BRIEF DESCRIPTION OF THE DRAWINGS**

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic pictorial of a vehicle in situations in which the use of hill descent control would be considered;

Figure 2 shows a schematic of a dual clutch gearbox which may be used in accordance with embodiments of the invention.

**DETAILED DESCRIPTION**

A method in accordance with an embodiment of the present invention is described herein with reference to the accompanying Figures.
Figure 2 is a diagrammatic representation of a multi-speed constant mesh dual clutch gearbox having two inputs (21, 22), each with an associated friction clutch, one output (23), two or more forward speed ratios and two or more reverse speed ratios between said inputs and output, said speed ratios comprising individually selectable gear wheel trains, one of said forward speed ratios and one of said reverse speed ratios being associated with one input, one of said forward speed ratios and one of said reverse speed ratios being associated with the other input; said gearbox being adapted for pre-selection of a next required speed ratio in use, and for power shifting from a current speed ratio to said next required speed ratio by shifting drive between said inputs; wherein said speed ratios are arranged for pre-selection to provide a power shift between two forward speed ratios, a power shift between two reverse speed ratios, and a power shift between forward and reverse speed ratios.

In the embodiment shown, the first input (21) is associated with clutch A and the following gear ratios: Reverse Low (RL), 1\textsuperscript{st}, 3\textsuperscript{rd}, and any further ‘odd’ ratios, such as 5\textsuperscript{th} gear. The second input (22) is associated with clutch B and the other gear ratios Reverse High (RH), 2\textsuperscript{nd}, 4\textsuperscript{th}, and any further ‘even’ ratios, such as 6\textsuperscript{th}. In common with the prior art, when the Vehicle (1) of Figure 1 is descending a steep slope (2) in the direction of arrow (5), a driver (3) of the Vehicle, or a suitable Control System (4), may select a ‘Hill Descent’ mode. In this mode, first input 21 is fully engaged via its clutch A to the rest of the driveline and the corresponding 1\textsuperscript{st} gear is engaged. Engine braking is then used to provide braking torque through the driveline to the wheels (6). In accordance with the prior art, if the engine braking is insufficient, the wheel brakes of the Vehicle would be utilised to provide further braking torque and control the downhill speed. According to aspects of the present invention however, pre-selection of the gear ratio RH associated with the second input (22) is made. Should the combination of engine braking with a fully engaged 1\textsuperscript{st} gear not provide sufficient braking torque to the Vehicle, such that the Vehicle begins to accelerate down the slope, the clutch B associated with the second input is engaged so as to provide further braking torque via the RH gear train.

It will be appreciated that the clutch B associated with the second input will not be fully engaged, as this would result in ‘lock up’ of the drivetrain. Accordingly, clutch B will be operated in a ‘slip’ mode. It will be further appreciated that as a result of this, extended use of the second input and clutch B will result in significant heating of the clutch. Whilst means may be provided for dissipating that heat, there is likely to come a point at which the clutch B will need to be disengaged from slip to prevent damage to components or a reduction in
effectiveness. In accordance with aspects of the invention, a sequence may then occur as follows:

Clutch A is disengaged and first input 21 is pre-selected to gear ratio RL. During this period braking torque is provided solely by clutch B operating via input 22 in gear ratio RH.

Clutch A is power-shifted to gear ratio RL. Both clutches A and B may then be modulated so as to share the load.

Clutch B is disengaged and input 22 is pre-selected to gear ratio 2\textsuperscript{nd}. During this period braking torque is provided solely by clutch A operating via input 21 in gear ratio RL.

Clutch B is power-shifted to gear ratio 2\textsuperscript{nd} and fully engaged so that engine braking is being applied through a forwards gear (2\textsuperscript{nd}) as per ‘normal’ Hill Descent, whilst Clutch A, engaged with gear ratio RL, provides further braking torque as necessary by modulation of engagement or slip.

Accordingly, Clutch B is no longer operating in ‘slip’ (it is now fully engaged with a forwards gear), and so may have chance to cool, and Clutch A, previously fully engaged and not subject to heating due to slip, is now associated with a reverse gear, and may operate in slip until such time as it begins to heat excessively, in which case a suitable method, effectively the reverse of that outlined above, may be employed. In the light of the disclosure in this application, the skilled person would readily understand and be able to formulate such a further method. Further it will be readily understood how a method in accordance with aspects of the invention may be applied to other gearboxes, drivetrains or powertrains where a plurality of gear ratios may be engaged via a plurality of clutches. In other embodiments, a gearbox may be provided with further forwards and reverse gear ratios to which the method may be employed. In other embodiments, there may be further alternative drive paths.

It will further be readily understood that the method could equally be employed in a situation where a vehicle is reversing down a hill, which may briefly be summarised as follows:

RL is engaged with first input 21 and clutch A – engine braking will operate in the usual fashion.
2\textsuperscript{nd} gear is also engaged with second input 22 and clutch B. Where engine braking via input 21/clutch A is insufficient to maintain steady vehicle speed, modulation of clutch B provides further retardation.

5 Clutch B begins to approach a threshold temperature. The threshold temperature may be a temperature at which clutch B begins to suffer damage or at which clutch B begins to lose efficiency. In an embodiment the threshold temperature is a temperature some degrees removed from a temperature at which damage or efficiency loss occurs, such that the clutch may be disengaged some time before such a temperature is reached or to enable further engagement of the clutch for an amount of time before such temperature is reached.

Clutch A is disengaged and 1\textsuperscript{st} gear is pre-selected. Momentarily, Clutch B is providing all the retardation for the vehicle via 2\textsuperscript{nd} gear.

15 Clutch A/input 21 is power-shifted to 1\textsuperscript{st} – modulation of vehicle speed then managed by modulation of both clutches.

Clutch B disengaged and RH preselected for input 22. Momentarily, Clutch A via input 21 is providing all the retardation for the vehicle via 1\textsuperscript{st} gear.

20 Clutch B/input 22 power-shifted to RH.

Clutch B fully engaged to join input 22 to RH gear and engine braking applies via RH – modulation of Clutch A slip as necessary to provide extra vehicle retardation via 1\textsuperscript{st} gear.

25 Accordingly it can be seen that methods according to aspects of the invention can be applied where a vehicle is travelling down a slope in forwards or reverse vehicle direction, and in embodiments heat management of slipping clutches can be managed particularly where at least two forward and two reverse gear ratios within a transmission are selectable. In embodiments this may be a Dual Clutch Transmission (DCT). It will be apparent to those skilled in the art that other arrangements may be utilised to enable the methods.

It will be appreciated that various changes and modifications can be made to the present invention without departing from the scope of the present application. Further aspects and embodiments of the present invention will now be set out in the accompanying numbered paragraphs:
1. A method of hill descent control for a vehicle provided with:
   a transmission comprising at least two selectable gear ratios;
   at least two clutches, each able to connect at least one gear ratio to torque
   from an engine of the vehicle;
   at least one wheel driven via the transmission;
   The method comprising the steps:
   Selecting and engaging a first gear ratio via a first clutch, such as to allow
   provision of retardant torque to at least the one wheel by means of engine
   braking;
   Pre-selecting a second gear ratio via a second clutch;
   Modulating engagement of the second clutch associated with said selected
   second gear ratio so as to allow the provision of further retardant torque to at
   least the one wheel.

2. A method according to Paragraph 1 wherein the first selected gear ratio is a
   forwards gear ratio and the second selected gear ratio is a reverse gear ratio.

3. A method according to Paragraph 1 wherein the first selected gear ratio is a
   forwards gear ratio and the second selected gear ratio is another forwards gear
   ratio.

4. A method according to Paragraph 1 wherein the first selected gear ratio is a reverse
   gear ratio and the second selected gear ratio is a forwards gear ratio.

5. A method according to Paragraph 1 wherein the first selected gear ratio is a reverse
   gear ratio and the second selected gear ratio is a further reverse gear ratio.

6. A method according to Paragraph 1 wherein one or both of the clutches is a friction
   clutch.

7. A method of hill descent control for a vehicle provided with:
   a transmission comprising at least two forward and two reverse selectable
   gear ratios;
   a first friction clutch able to connect at least a first forwards gear ratio and at
   least a first reverse gear ratio in turn to torque from an engine of the vehicle
   via a first input shaft;
a second friction clutch able to connect at least a second forwards gear ratio
and at least a second reverse gear ratio in turn to torque from an engine of
the vehicle via a second input shaft;
at least one wheel driven via the transmission;

The method comprising the steps:
Selecting and engaging one of the first forwards or first reverse gear ratios via
the first friction clutch and first input shaft, such as to allow provision of
retardant torque to at least the one wheel by means of engine braking;
Pre-selecting one of the second forwards or second reverse gear ratios via
the second friction clutch and second input shaft, and;
Modulating engagement of the second friction clutch associated with said selected
second forwards or reverse gear ratio so as to allow the provision of further
retardant torque to at least the one wheel.

8. A method according to paragraph 7 in which:
the vehicle is moving forwards or facing forwards down a slope;
the gear selection of the first friction clutch is the first forwards gear ratio;
the gear selection of the second friction clutch is the second reverse gear
ratio;
comprising the further steps;
pre-selecting the first reverse gear ratio;
shifting gear to select the first reverse gear ratio via the first input shaft and
first friction clutch;
pre-selecting the second forwards gear ratio;
shifting gear to select the second forwards gear ratio via the second input
shaft and second friction clutch;
such that retardant torque is provided to at least the one wheel by means of engine
braking via the second forwards gear, second input shaft and second friction clutch,
and;
Modulating engagement of the first friction clutch so as to allow provision of further
retardant torque to at least the one wheel via the first reverse gear ratio, first input
shaft and first friction clutch.

9. A method according to paragraph 7 in which:
the vehicle is moving backwards or facing backwards down a slope;
the gear selection of the first friction clutch is the first reverse gear ratio;
the gear selection of the second friction clutch is the second forwards gear ratio;

comprising the further steps;

pre-selecting the first forwards gear ratio;

5 shifting gear to select the first forwards gear ratio via the first input shaft and first friction clutch;

pre-selecting the second reverse gear ratio;

shifting gear to select the second reverse gear ratio via the second input shaft and second friction clutch;

such that retardant torque is provided to at least the one wheel by means of engine braking via the second reverse gear, second input shaft and second friction clutch, and;

Modulating engagement of the first friction clutch so as to allow provision of further retardant torque to at least the one wheel via the first forwards gear ratio, first input shaft and first friction clutch.

10. A method according to paragraph 8 or 9 in which any further step occurs in response to a temperature threshold being reached.

11. A method according to paragraph 10 in which the temperature threshold is a temperature of a transmission component or fluid.

12. A method according to paragraph 11 in which the temperature of the transmission component or fluid is measured directly at the component or fluid, or measured or calculated by reference to the temperature of another component or fluid, or measured or calculated by reference to performance criteria of the same or another component or fluid.

13. A method according to paragraph 11 in which the transmission component is a clutch or the fluid is a clutch fluid.

14. A method according to paragraph 13 in which the temperature threshold is:

i/ a temperature at which the clutch will likely suffer damage

ii/ a temperature at which the clutch will likely suffer a loss of effectiveness

iii/ a pre-determined temperature some degrees removed from i/ or ii/ at which the further step or steps are performed such that temperatures i/ or ii/ are not in fact reached even upon performance of any of the steps.
15. A method according to paragraph 12 in which the performance criteria is an amount of slip in a friction clutch for a given amount of clutch plate pressure.

16. A method according to paragraph 8 or 9 in which any further step occurs in response to a threshold performance criteria being reached.

17. A method according to paragraph 16 in which the threshold performance criteria is a performance criteria of a friction clutch, optionally an amount of slip in said clutch for a given amount of clutch plate pressure.

18. A method according to paragraph 1 or 7 in which any step happens automatically.

19. A controller for implementing the method of paragraphs 1 or 7.

20. A system comprising a controller as described in paragraph 19.

21. A system as described in paragraph 20 comprising any or all of a gearbox, transmission, driveline, chassis or vehicle.

22. A system as described in paragraph 20 comprising a power-shift or dual clutch transmission gearbox.

23. A method as described in paragraphs 1 or 7 wherein the transmission comprises a power-shift or dual clutch transmission gearbox.
CLAIMS:

1. A method of controlling a vehicle provided with:
   a transmission comprising at least two selectable gear ratios;
   at least two clutches, each able to couple at least one gear ratio to torque
   from an engine of the vehicle; and
   at least one wheel driven via the transmission;
   the method comprising:
       selecting and engaging a first gear ratio via a first clutch, such as to allow
   provision of retardant torque to at least the one wheel by means of engine
   braking;
   pre-selecting a second gear ratio via a second clutch; and
   modulating engagement of the second clutch associated with said selected
   second gear ratio so as to allow the provision of further retardant torque to at
   least the one wheel.

2. A method according to Claim 1 wherein the first selected gear ratio comprises a
   forwards gear ratio and the second selected gear ratio comprises a reverse gear
   ratio.

3. A method according to Claim 1 wherein the first selected gear ratio comprises a
   forwards gear ratio and the second selected gear ratio comprises another forwards
   gear ratio.

4. A method according to Claim 1 wherein the first selected gear ratio comprises a
   reverse gear ratio and the second selected gear ratio comprises a forwards gear
   ratio.

5. A method according to Claim 1 wherein the first selected gear ratio comprises a
   reverse gear ratio and the second selected gear ratio comprises a further reverse
   gear ratio.

6. A method according to any of Claims 1 to 5 wherein one or both of the clutches
   comprises a friction clutch.

7. A method of hill descent control for a vehicle provided with:
a transmission comprising at least two forward and two reverse selectable gear ratios;
a first friction clutch able to couple at least a first forwards gear ratio and at least a first reverse gear ratio in turn to torque from an engine of the vehicle via a first input shaft;
a second friction clutch able to couple at least a second forwards gear ratio and at least a second reverse gear ratio in turn to torque from an engine of the vehicle via a second input shaft; and
at least one wheel driven via the transmission;

the method comprising:
selecting and engaging one of the first forwards or first reverse gear ratios via the first friction clutch and first input shaft, such as to allow provision of retardant torque to at least the one wheel by means of engine braking;
pre-selecting one of the second forwards or second reverse gear ratios via the second friction clutch and second input shaft; and
modulating engagement of the second friction clutch associated with said selected second forwards or reverse gear ratio so as to allow the provision of further retardant torque to at least the one wheel.

8. A method according to claim 7 in which:
the vehicle is moving forwards or facing forwards down a slope;
the gear selection of the first friction clutch is the first forwards gear ratio; and
the gear selection of the second friction clutch is the second reverse gear ratio;

the method comprising:
pre-selecting the first reverse gear ratio;
shifting gear to select the first reverse gear ratio via the first input shaft and first friction clutch;
pre-selecting the second forwards gear ratio;
shifting gear to select the second forwards gear ratio via the second input shaft and second friction clutch;
such that retardant torque is provided to at least the one wheel by means of engine braking via the second forwards gear, second input shaft and second friction clutch; and
modulating engagement of the first friction clutch so as to allow provision of further retardant torque to at least the one wheel via the first reverse gear ratio, first input shaft and first friction clutch.
9. A method according to claim 7 in which:
   the vehicle is moving backwards or facing backwards down a slope;
   the gear selection of the first friction clutch is the first reverse gear ratio;
   the gear selection of the second friction clutch is the second forwards gear ratio;
   the method comprising;
   pre-selecting the first forwards gear ratio;
   shifting gear to select the first forwards gear ratio via the first input shaft and
   first friction clutch;
   pre-selecting the second reverse gear ratio;
   shifting gear to select the second reverse gear ratio via the second input shaft and second friction clutch;
   such that retardant torque is provided to at least the one wheel by means of engine braking via the second reverse gear, second input shaft and second friction clutch; and
   modulating engagement of the first friction clutch so as to allow provision of further retardant torque to at least the one wheel via the first forwards gear ratio, first input shaft and first friction clutch.

10. A method according to claim 8 or 9 in which one or more steps occur in response to a temperature threshold being reached.

11. A method according to claim 10 in which the temperature threshold is a temperature of a transmission component or fluid.

12. A method according to claim 11 in which the temperature of the transmission component or fluid is measured directly at the component or fluid, or measured or calculated by reference to the temperature of another component or fluid, or measured or calculated by reference to performance criteria of the same or another component or fluid.

13. A method according to claim 11 or 12 in which the transmission component is a clutch.

14. A method according to claim 13 in which the temperature threshold is:
i/ a temperature at which the clutch will likely suffer damage;
ii/ a temperature at which the clutch will likely suffer a loss of effectiveness; and/or
iii/ a pre-determined temperature some degrees removed from ii/ at which the further step or steps are performed such that temperatures i/ or ii/ are not in fact reached even upon performance of any of the steps.

15. A method according to claim 12 in which the performance criteria comprises an amount of slip in a friction clutch for a given amount of clutch plate pressure.

16. A method according to claim 8 or 9 in which any one or more steps occurs in response to a threshold performance criteria being reached.

17. A method according to claim 16 in which the threshold performance criteria comprises a performance criteria of a friction clutch, optionally an amount of slip in said clutch for a given amount of clutch plate pressure.

18. A method according to any preceding claim in which any step happens automatically.

19. A controller for implementing the method of any of claims 1 to 18.

20. A system comprising a controller as claimed in claim 19.

21. A system as claimed in claim 20 comprising any or all of a gearbox, transmission, driveline, chassis or vehicle.

22. A system as claimed in claim 20 or 21 comprising a power-shift or dual clutch transmission gearbox.

23. A method as claimed in any of claims 1 to 18 wherein the transmission comprises a power-shift or dual clutch transmission gearbox.

24. A vehicle having a system or a controller as claimed in any of claims 19 to 21.
**Patents Act 1977: Search Report under Section 17**

**Documents considered to be relevant:**

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<td>X: 1 to 4, 6, 18 to 24; Y: 5, 7 to 17</td>
<td>DE102007048268 A1 (BOSCH) See particularly paragraphs [0006], [0007], [0020], [0022], and [0023], and clutches 8, 9 in figures 1 and 2.</td>
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<td>US2007/0010927 A1 (ROWLEY et al.) See paragraphs [0043] to [0055], and figure 14.</td>
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<td>US2004/0088099 A1 (CHESS) See paragraphs [0005], [0022], and [0024], and figures 1 to 3.</td>
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**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC:

Worldwide search of patent documents classified in the following areas of the IPC:

- B60W;
- F16D;
- F16H

The following online and other databases have been used in the preparation of this search report:

- EPODOC, WPI
### International Classification:

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