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## 1. Gear Down Protection (General Overview)

The gear down protection (GDP) feature is designed to encourage the driver to operate in the engine’s most efficient range for fuel economy. This is done by limiting the vehicle speed until the driver shifts into a higher gear. This encourages the driver to up-shift to the next highest gear and helps to maintain the engine’s most efficient speed range for fuel economy.

This document will address unique GDP functionality for International® MaxxForce™ 11 and 13 engines.

### 1.1. Feature Codes

N/A

## 2. Definitions/Acronyms

The following terms are referenced in this document:

- **GDP** – Gear Down Protection
- **ECM** – Engine Control Module
- **RSL** – Road Speed Limit
- **CCS** – Cruise Control Speed

## 3. Description and Operation

### 3.1. Operation

The feature limits the vehicle speed in top gear minus 1 and 2 (i.e. 8<sup>th</sup> and 9<sup>th</sup> gear on a 10 speed transmission). There are 2 corresponding GDP vehicle speed parameters which are customer programmable.

Appropriate settings should be chosen based on a desired engine RPM operating limit (shift point) in each gear as indicated in the following table.

Desired Engine Performance	Recommended RPM for GDP Equation
Maximum Fuel economy	1500 RPM
Maximum Horsepower	1700 RPM
Blend of Performance and Fuel Economy	Choose an RPM between 1500 and 1700 RPM

The table above indicates the recommended engine RPM limits to be input into the GDP equation, from which the resulting recommended vehicle speed limits to be used with GDP, can be found. Refer to the [GDP Calculations](#) section for more information.

The GDP equation illustrates that the vehicle speed (MPH) and engine speed (RPM) are directly related, and therefore, the vehicle speed increases along with increasing engine speed. By setting a vehicle speed (MPH) limit you are also effectively setting an engine speed (RPM) limit. This recommended limit will save fuel and encourage the driver to shift to gain more speed.

Once top gear is reached, GDP is not used and the vehicle speed will be limited to either the road speed limiting (RSL) or cruise control speed (CCS) maximum value (whichever is applicable).

**NOTE:** GDP does not limit vehicle speed or engine speed when the clutch pedal is depressed (i.e. while shifting).

### 3.2. Feature Interaction

The gear down protection (GDP) feature interacts with the following engine features:

- Cruise Control** – If GDP and Cruise Control are both active, GDP has the higher priority. For example, if cruise is control is set and engaged at 65 mph (10th gear) and the driver shifts into 9th gear (deactivates cruise and slows down) the engine will be limited by GDP if the “RESUME” button is pressed. In other words, the desired 65 mph cruise control set speed will never be reached because GDP is limiting the vehicle speed.
- Road Speed Limiting** – If GDP and RSL are both active, GDP has the higher priority. For example, if RSL set and engaged at 65 mph (10th gear) and the driver shifts into 9th gear (slows down) the engine will be limited by GDP and not the RSL feature. In other words, the desired 65 mph RSL speed will never be reached because GDP is limiting the vehicle speed. If GDP is enabled and RSL is disabled, the RSL set point should be set high (i.e. 127 mph).
- Vehicle Setup** – The GDP feature uses vehicle information in determining the correct vehicle speed. These include rear axle ratio, transmission ratios, and tire revolutions per mile. If these parameters are not configured properly, GDP and other features will not operate as desired.

## 4. Programmable Parameters

### 4.1. Required GDP Parameters

The following programmable parameters are required for gear down protection. These parameters should be programmed to encourage drivers to up-shift into the highest transmission gears while maintaining drive-ability of the vehicle.

Parameters indicated as “Customer Programmable” can be adjusted differently than the production assembly plant setting to meet the customer’s needs. If the parameter is indicated as non-customer programmable, the parameter setting is preset from the factory and can’t be changed without authorization.

Parameter Name	Description	Possible Values	Customer Programmable?	Recommended Setting
GDP Enable (7714)	<b>(Required Parameter)</b> This parameter is required to be enabled.	0: Gear Down Protection Disabled  1: Gear Down Protection Enabled	YES	This parameter must be set to (1) “Enabled” if the GDP feature is desired.
GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)	This parameter sets the vehicle speed limit in top gear minus 1.  For example with a 10 speed manual transmission, this parameter would set the vehicle speed limit in 9th gear.  This parameter is adjustable for customer preference and engine recommendations.	0-127.5 mph	YES	This parameter value is output from GDP Equation A.  Refer to “GDP Calculations” in the “Parameter Setup” section for more information.
GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)	<b>(Required Parameter)</b> This parameter sets the vehicle speed limit in top gear minus 2.  For example with a 10 speed manual transmission, this parameter would set the vehicle speed limit in 8th gear.  This parameter is adjustable for customer preference and engine recommendations.	0-127.5 mph	YES	This parameter value is output from GDP Equation B.  Refer to “GDP Calculations” in the “Parameter Setup” section for more information.
GDP Parameter #1 (7733)	<b>(Required Parameter)</b> This parameter is required to be set to (0).	0	YES	This parameter must be set to (0).



## 5.1. GDP Example

### GDP Example A:

GDP Programmable Parameter Setup for Example A:		
Parameter	Value	Units
GDP Enable (7714) =	Enabled	
GDP Vehicle Speed Limit in Top Gear Minus 1 (7716) =	56	MPH
GDP Vehicle Speed Limit in Top Gear Minus 2 (7715) =	46	MPH
Tire Size (8001) =	501	Revs/Mile
Rear Axle Ratio (8002) =	3.5	Ratio
Top Gear Minus 1 Gear Ratio (7729) =	1	Trans Ratio
Top Gear Minus 2 Gear Ratio (7730) =	1.36	Trans Ratio
Road Speed Limit (7902) OR Cruise Control Speed (7909) =	65	MPH
High Idle Engine Speed (8203) =	2200	RPM
Out of Range		

The following "Example A" graph illustrates the vehicle speed limit (and corresponding engine speed limit) in each gear on a 10 speed manual transmission with gear down protection parameters set according to the "Example A" values.

### GDP Graph (Example A):

Vehicle speed (MPH)										
70										
65										1425
60										1315
55								1607		1206
50									1461	1096
45						2200	1789		1315	986
40							2139	1590	1169	877
35						2200	1872	1391	1023	767
30						2174	1604	1192	877	658
25					2200	1812	1337	994	731	548
20				2200	1952	1450	1070	795	585	438
15			2200	1955	1450	1070	802	596	438	329
10	2200	2200	1768	1303	976	725	535	397	292	219
5	1616	1197	884	652	488	362	267	199	146	110
Transmission Gear	1	2	3	4	5	6	7	8	9	10
Gear Ratio Value	11.06	8.19	6.05	4.46	3.34	2.48	1.83	1.36	1	0.75

## "Example A" Discussion (observe the graph)

In less than 8th gear, the driver will be limited, not by GDP, but by the "High Idle Engine Speed" (8203) value (2200 RPM). For example in 7th gear the 2200 RPM limit occurs before 45 MPH as demonstrated by the light gray boxes.

In 8th Gear, GDP will limit the engine speed to 1789 RPM (limiting the vehicle speed to 46 MPH and forcing the driver to up shift) due to the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" parameter as demonstrated by the blue box. If you wanted to force the driver to shift from 8th to 9th gear sooner, the graph illustrates that the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" could be set to 40 MPH, for example, at a desired engine speed limit of 1590 RPM.

In 9th Gear, GDP will limit the engine speed to 1607 RPM (limiting the vehicle speed to 56 MPH and forcing the driver to up shift) due to the "GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)" parameter as demonstrated by the blue box. Again, If you wanted to force the driver to shift from 9th to 10th gear sooner, the graph illustrates that the "GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)" parameter could be set to 50 MPH, for example, at a desired engine speed limit of 1461 RPM.

NOTE: The limits for 8th and 9th gear above are only examples and we recommended that you use the "GDP Equation" to find appropriate GDP vehicle speed limits for your specific vehicle application.

In 10th Gear, the Road Speed Limiting (RSL) feature will limit the engine speed to 1425 RPM (limiting the vehicle speed to 65 MPH) as demonstrated by the green box.

## GDP Graph (Example B):

Vehicle speed (MPH)										
70										
65										1425
60										1315
55									1607	1206
50									1461	1096
45									1315	986
40									1169	877
35									1023	767
30						2174	1604	1192	877	658
25					2200	1812	1337	994	731	548
20				2200	1952	1450	1070	795	585	438
15			2200	1955	1450	1070	802	596	438	329
10	2200	2200	1768	1303	976	725	535	397	292	219
5	1616	1197	884	652	488	362	267	199	146	110
Transmission Gear	1	2	3	4	5	6	7	8	9	10
Gear Ratio Value	11.06	8.19	6.05	4.46	3.34	2.48	1.83	1.36	1	0.75

## "Example B" Discussion (observe the graph)

In Example B, observe what happens if the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" parameter is set incorrectly. In this example, this parameter is set to 30 mph.

Notice that the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" parameter in this example is limiting the vehicle speed to 30 MPH in 6th, 7th, and 8th gear. The vehicle in this example would most likely not be drivable as it is currently programmed.

## Setting up the appropriate Vehicle Speed Limits for Gear Down Protection:

In "Example A" (above), we arbitrarily chose 56 and 46 mph as "desired" GDP Vehicle Speed Limits for a 10 speed manual transmission. This means that in 9th gear the vehicle speed is limited to 56 mph and in 8th gear the vehicle speed is limited to 46 mph. However, it is recommended that you choose a vehicle speed limit based on an engine speed (shift point) that meets your vehicle application. Higher engine speeds provide more power, but less fuel economy.

Before you start selecting a vehicle speed it is important to understand the relationship between vehicle speed and engine speed. It is also important to understand that GDP limits the vehicle speed by limiting engine speed.

Vehicle speed changes not only based on the speed of the engine, but also based on the transmission gear ratio, rear axle ratio and the tire size (revs per mile) as shown in GDP equation A.

## GDP Equation A

"GDP Vehicle Speed Limit in Top Gear Minus 1" (7716) =

$$\frac{60 * \text{Desired RPM}}{\text{"Top Gear Minus 1 Gear Ratio" (7729)} * \text{Rear Axle Ratio (8002)} * \text{Tire Revs per Mile (8001)}}$$

For optimal fuel economy it is recommended that you choose an engine RPM value (shift point) of 1500 rpm. For performance, we recommend 1700 rpm. If a blend of performance and fuel economy is desired, we recommend 1600 rpm.

Input the "Desired RPM" (i.e. 1500) into "Equation A". Next, input the "Top Gear Minus 1 Gear Ratio (7729)" parameter value. Next, input the rear axle ratio (8002) and tire revs per mile (8001). NOTE: Rear axle ratio and tire revs per mile are already programmed into the engine software and can be retrieved using an electronic service tool.

## GDP Equation A (Results)

$$52 \text{ mph} = \frac{60 * 1500}{1.00 * 3.5 * 501}$$

In "Equation A", the resulting "MPH" is the vehicle speed limit in top gear (10th gear) minus 1, which is what the vehicle speed will be limited to in 9th gear. Note that the result is now 52 mph rather than 56 mph like the original example. The value (52 mph) is now ready to be programmed into the "GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)" parameter.

**Note 1:** Round up to the next whole number before inputting the resulting vehicle speed limit value into the "GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)" parameter (i.e. round "51.32" up to 52).

The vehicle speed limit (52 mph in 9th gear) in this example would be appropriate for a desired engine speed limit of 1500 RPM in 9th gear, but the customer may desire to adjust this vehicle speed limit further based on other needs/desires. Given the values chosen for this example, the resulting functionality would be the following: When the engine speed reaches 1500 RPM in 9th gear, the driver will need to up shift into 10th gear in order to attain a higher vehicle speed.

**Note 2:** When in top gear (10th for example) the vehicle speed is not limited by gear down protection. It is limited to the programmed maximum road speed limit (7902) value or cruise control vehicle speed limit (7909) value; whichever is applicable. Refer to the GDP Graph for more information.

Repeat the exercise above, but use "Equation B". Use the same values for engine speed, tire revs per mile and rear axle ratio, but input the "Top Gear Minus 2 Gear Ratio" (7730) parameter value rather than "top gear minus 1" to find the appropriate vehicle speed limit in 8th gear, referred to as the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" parameter value.

## GDP Equation B

"GDP Vehicle Speed Limit in Top Gear Minus 2" (7715) =

$$\frac{60 * \text{Desired RPM}}{\text{"Top Gear Minus 2 Gear Ratio" (7730)} * \text{Rear Axle Ratio (8002)} * \text{Tire Revs per Mile (8001)}}$$

Equation B is similar to Equation A, but the resulting "MPH" is the vehicle speed limit in top gear (10th gear) minus 2, which is what the vehicle speed will be limited to in 8th gear. Note that the result is now 37 mph rather than 46 mph like the original example. The value (37 mph) is now ready to be programmed into the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" parameter.

**Note 1:** Round up to the next whole number before inputting the resulting vehicle speed limit value into the "GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)" parameter (i.e. round "36.92" up to 37).

## GDP Equation B (Results)

$$37 \text{ mph} = \frac{60 * 1500}{1.39 * 3.5 * 501}$$

### 5.2. Possible GDP Applications

This section describes only a few possible feature applications and how the programmable parameters can be effectively configured for each application. This is not a comprehensive list, and does not include all possible applications that an owner/operator might encounter.

Please review the description and operation section and the programmable parameters for a better understanding of how the various engine parameters might be best configured for your vehicle.

**(Example A) – Customer desires to maximize fuel economy due to light vehicle loads.**

In this example, let’s assume that the customer desires to maximize fuel economy since the vehicle is lightly loaded.

Adjust parameters as follows:

Parameter Name	Action Required
GDP Enable (7714)	Select “enabled (1)”
GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)	To calculate this value, input a “Desired RPM” of 1500 into GDP Equation A.
GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)	To calculate this value, input a “Desired RPM” of 1500 into GDP Equation B.
GDP Parameter #1 (7733)	NONE – This value is preset to “0”
GDP Parameter #2 (7736)	NONE – This value is preset to “85” or above
GDP Parameter #3 (7735)	NONE – This value is preset to “85” or above
GDP Parameter #4 (7732)	NONE – This value is preset to “0”

**(Example B) – Customer desires to maintain engine performance due to heavy vehicle loads.**

In this example, let’s assume that the customer desires to maintain engine performance under heavy vehicle loads or due to extreme conditions such as driving through mountainous regions.

Adjust parameters as follows:

Parameter Name	Action Required
GDP Enable (7714)	Select “enabled (1)”

## Gear Down Protection (GDP)

GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)	To calculate this value, input a “Desired RPM” of 1700 into GDP Equation A.
GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)	To calculate this value, input a “Desired RPM” of 1700 into GDP Equation B.
GDP Parameter #1 (7733)	NONE – This value is preset to “0”
GDP Parameter #2 (7736)	NONE – This value is preset to “85” or above
GDP Parameter #3 (7735)	NONE – This value is preset to “85” or above
GDP Parameter #4 (7732)	NONE – This value is preset to “0”

**(Example C) – Customer desires a blend of engine performance and fuel economy.**

In this example, let’s assume that the customer desires a blend of engine performance and fuel economy.

Adjust parameters as follows:

Parameter Name	Action Required
GDP Enable (7714)	Select “enabled (1)”
GDP Vehicle Speed Limit in Top Gear Minus 1 (7716)	To calculate this value, input a “Desired RPM” of between 1500 and 1700 into GDP Equation A.
GDP Vehicle Speed Limit in Top Gear Minus 2 (7715)	To calculate this value, input a “Desired RPM” of between 1500 and 1700 into GDP Equation B.
GDP Parameter #1 (7733)	NONE – This value is preset to “0”
GDP Parameter #2 (7736)	NONE – This value is preset to “85” or above
GDP Parameter #3 (7735)	NONE – This value is preset to “85” or above
GDP Parameter #4 (7732)	NONE – This value is preset to “0”

### 6. Frequently Asked Questions

**Q: My driver gets excellent fuel economy. Will I see an improvement with GDP?**

A: No, if your driver follows the driver training recommended by Navistar this feature will provide no benefit. This feature is designed to “push” the driver to shift as the engine is designed.

**Q: Can I use this feature as part of a driver reward program?**

A: Yes, if you want your top drivers to be rewarded you can turn GDP off to allow the full engine power range to be available. This may encourage good driving behavior, such as using the cruise control feature and shutting down the engine during extended idle time.