MaxxForce® 11 and 13 (2007-2009)

Overview: *Power Train Protection*

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General Overview: Power Train Protection

The Power Train Protection feature is designed to electrically limit the engine torque in order to protect the driveline components. Benefits include improved engine performance without compromising the driveline.

This document will address unique Power Train Protection functionality for MaxxForce® 11 and 13.

Description and Operation

Operation

There are no operator interactions involved, such as switches or indicators. The feature limits torque based on the current gear ratio and zero vehicle speed. There are 3 customer programmable gear ranges with 3 corresponding torque limits.

Feature Interaction

The power train protection feature interacts with this engine feature: Power Take Off (PTO).

Programmable Parameters

The following programmable parameters are required for Power Train Protection. These parameters should be programmed to protect the driveline and PTO equipment.

Parameters shown as customer programmable can be adjusted to meet the customer's needs. Parameters indicated as non-customer programmable, are preset from the factory and cannot be changed without authorization.

Parameter Value	Description	Possible Values	Cust Pgrm	Recommended Settings
PTP Enable (7722)	This parameter must be enabled for Progressive Shift, Power Train Protection and Up-Shift indicator to operate.	0: Disable 1: Enable	YES	Customer chosen.
High Gear Ratio of Low Range - Manual (8008)	Ratio of the highest gear of the low gear range for manual transmissions.	0.6 to 20	YES	Refer to the Power train Protection (PTP) Example.
Highest Gear Ratio of High Range – Manual (8010)	Ratio of the highest gear of the high gear range for manual transmissions.	0.6 to 20	YES	Must be less than parameter 8010 setting. Refer to the PTP Example for more information.
High Gear Ratio of Intermediate Range - Manual (8009)	Ratio of the highest gear of the intermediate gear range for manual transmissions.	0.6 to 20	YES	Must be less than parameter 8008 setting. Refer to the PTP Example for more formation.
Highest Gear of Low Range -Automatic (7718)	Number of the highest gear of the low gear range for automatic transmissions.	0 to 255	YES	Must be less than the parameter (7748) setting. Refer to the PTP Example for more information.

Parameter Value	Description	Possible Values	Cust Pgrm	Recommended Settings
Highest Gear of Int. Range Automatic (7748)	Number of the highest gear of the intermediate gear range for automatic transmissions.	0 to 255	YES	Must be greater than the parameter (7718) setting. Refer to the PTP Example for more information.
Highest Gear of High Range -Automatic (7749)	Number of the highest gear of the high gear range for automatic transmissions.	0 to 255	YES	Refer to the PTP Example.
PTP Zero Vehicle Speed Maximum Torque (7712)	This parameter sets the maximum torque when the vehicle speed = 0. NOTE: Limits are in terms of engine output torque.	0 to 1600 lb-ft	YES	Must be programmed to match the lowest setting of parameters (7713), (7750), and (7751).Refer to the PTP Example for more information.
Maximum Torque in Low Gear Range (7713)	This parameter sets the maximum torque allowed in the low gear range. NOTE: Limits are in terms of engine output torque.	0 to 1750 lb-ft	YES	Must be less than the parameter (7750) setting. Refer to the PTP Example for more information.
Maximum Torque in Intermediate Gear Range (7750)	This parameter sets the maximum torque allowed in the intermediate gear range. NOTE: Limits are in terms of engine output torque.	0 to 1750 lb-ft	YES	Refer to the PTP Example.
Maximum Torque in High Gear Range (7751)	This parameter sets the maximum torque allowed in the high gear range. NOTE: Limits are in terms of engine output torque.	0 to 1750 lb-ft	YES	Refer to the PTP Example.

Required Vehicle Setup Parameters

If Power Train Protection does not function as expected, verify that all of the programmable parameters have been programmed correctly.

Parameter Setup

Possible Power Train Protection Applications

EXAMPLE A – Manual Transmission Power Train Protection configuration

In this example, assume we need to find the power Train Protection torque limits for a manual transmission.

1. First, Complete the Maximum Torque **Table 1**. Enter the vehicle maximum torque information (as shown in the example below).

This information is based on vehicle build.

Table 1- Maximum Torque Table

Component	Maximum Torque (Input Values Here)	Maximum Torque (Abbreviated Notation)
Engine Output	1700	(D)
Transmission input	1550	(E)
Transfer Case Input	13000	(F)

Component	Maximum Torque (Input Values Here)	Maximum Torque (Abbreviated Notation)
Rear Axle Input	18000	(G)

2. Next, complete **Table 2.** Enter the vehicle gear ratio information (as shown in the example below).

> *This information is based on the vehicle build.*

Table 2- Gear Ratios

Component	Gear Ratios (Input Values Here)	Gear Ratio (Abbreviated Notation)
Transmission	-	-
R Low	10.96	(AR1
R High	2.52	(AR2)
1	8.18	(A1)
2	6.07	(A2)
3	4.46	(A3)
4	3.32	(A4)
5	2.46	(A5)
6	1.83	(A6)
Transfer Case (If Equipped) Low Ratio	2.5	(K)

3. Next, complete **Table 3.** Enter the values from Table 1 and 2 into the Calculation column within the table. For example: The expression (G)/(AR1)/(K) is the rear axle input, divided by the reverse low gear ratio, divided by the transfer case (if equipped) low ratio. Perform the calculation and enter those results into the Calculated Maximum Engine Torque Value column.

Table 3 – Maximum Allowed Engine Torque

Component	Expression	Calculation (Input Values Here)	Calculated Maximum Engine Torque Values (Input Results Here)
Rear Axle			
Rear Axle(Reverse Low)	(G)/(AR1)/(K)	= 18000/10.96/2.5	657
Rear Axle (Reverse High)	(G)/(AR2)/(K)	= 18000/2.52/2.5	2857
Rear Axle 1	(G)/(A1)/(K)	= 18000/8.18/2.5	880
Rear Axle 2	(G)/(A2)/(K)	= 18000/6.07/2.5	1186
Rear Axle 3	(G)/(A3)/(K)	= 18000/4.46/2.5	1614
Rear Axle 4	(G)/(A4/(K)	= 18000/3.32/2.5	2169
Rear Axle 5	(G)/(A5)/(K)	= 18000/2.46/2.5	2927

Component	Expression	Calculation (Input Values Here)	Calculated Maximum Engine Torque Values (Input Results Here)
Rear Axle 6	(G)/(A6)/(K)	= 18000/1.83/2.5	3934
Transfer Case			
Transfer Case (Reverse Low)	(F)/(AR1)	= 13000/10.96	1186
Transfer Case (Reverse High)	(F)/(AR2)	= 13000/2.52	5159
Transfer Case 1	(F)/(A1)	= 13000/8.18	1589
Transfer Case 2	(F)/(A2)	= 13000/6.07	2142
Transfer Case 3	(F)/(A3)	= 13000/4.46	2915
Transfer Case 4	(F)/(A4)	= 13000/3.32	3916
Transfer Case 5	(F)/(A5)	= 13000/2.46	5285
Transfer Case 6	(F)/(A6)	= 13000/1.83	7104
Transmission			
Transmission	(E)	= 1550	1550

4. Begin completing **Table 4** by selecting the minimum value from the calculated maximum engine torques for each gear from **Table 3**. For example, take the Rear Axle (Reverse Low) result and the Transfer Case (Reverse Low) result and choose whichever value is lower.

In this example, the value 657 is less than 1186; therefore the value 657 can be entered into **Table 4**. Continue selecting minimum values to complete the table.

Table 4 – Maximum Engine Torque

Gear	Maximum Engine Torque
Reverse Low	657
Reverse High	Do not need Power Train Protection, because the calculated torque limit value is greater than the engine output torque.
1	880
2	1186
3	1614
4	Do not need Power Train Protection, because the calculated torque limit value is greater than the engine output torque
5	
6	

5. As indicated in **Table 4** (above), any calculated torque limit results that are less than the output torque of the engine indicates a need to use Power Train Protection torque limiting. Power Train Protection torque limiting is not required if the torque limit result is greater than the engine output torque.

The number of maximum engine torque limit results will vary depending on the vehicle. There are 4 results in this example, but Power Train Protection has only 3 torque limits to be programmed: Maximum Torque in Low Gear Range (7713), Maximum Torque in Intermediate Gear Range (7750), and Maximum Torque in High Gear Range (7751). Group the torque limits into 3 bands and select the lowest torque value of each band.

It is recommended to group reverse low and 1st gear together as shown in the "green" shaded area. Since 651 is less than 880 within that group, we will use 651 for the Maximum Torque in Low Gear Range (7713) setting.

Since there are only 2 values left in the table, directly enter the values into the remaining torque limit parameters (i.e. 1186 for the Maximum Torque in Intermediate Gear Range (7750) setting and 1614 for the Maximum Torque in High Gear Range (7751) setting).

If there are more than 2 gears remaining that require torque limiting, group the next 2 gears together, again using the lower torque limit of the two gears.

6. Next, to find the PTP Zero Vehicle Speed Maximum Torque Limit (7712) setting, simply use the lowest value of the 3 parameter settings: Maximum Torque in Low Gear Range (7713), Maximum Torque in Intermediate Gear Range (7750), and Maximum Torque in High Gear Range (7751). In this example, 651 is the lowest, will be used setting PTP Zero Vehicle Speed Maximum Torque Limit (7712).

7. Finally, program the values for the following parameters:

• High Gear Ratio of Low Range - Manual (8008) – This is obtained by multiplying the transfer case ratio * 1st gear ratio (2.5 * 8.18) = 20.45 in this example. This means that all gear ratios lower than 20.45 will be limited to the Maximum Torque in Low Gear Range (7713) parameter setting (657 in this example)

• High Gear Ratio of Intermediate Range - Manual (8010) – This is obtained by multiplying the transfer case ratio * 2nd gear ratio (2.5 * 6.07) = 15.175 in this example. This means that all gear ratios lower than 15.175 will be limited to the Maximum Torque in Intermediate Gear Range (7750) parameter setting (1186 in this example).

• High Gear Ratio of High Range - Manual (8009) – This is obtained by multiplying the transfer case ratio * 3rd gear ratio (2.5 * 4.46) = 11.15 in this example. This means that all gear ratios lower than 11.15 will be limited to the Maximum Torque in High Gear Range (7751) parameter setting (1614 in this example).

EXAMPLE B – Automatic Transmission Power Train Protection configuration.

In this example, let's assume we need to find appropriate Power Train Protection torque limits for an automatic transmission.

1. First, complete **Table 5.** Enter the maximum torque information (as shown in the example below).

This information is based on vehicle build.

Table 5 – Maximum Torques

Component	Maximum Torque (Input Values Here)	Maximum Torque (Abbreviated Notation)
Engine Output	1700	(D)
Transmission input	1550	(E)
Transfer Case Input	15000	(F)
Rear Axle Input	26000	(G)

2. Next, complete **Table 6**. Enter the gear ratio information (as shown in the example below)

This information is based on vehicle build.

Table 6 – Gear Ratios

Component	Gear Ratios (Input Values Here)	Gear Ratio (Abbreviated Notation)
Transmission	-	-
R Low	N/A	(AR1
R High	4.8	(AR2)
1	3.51	(A1)
2	1.91	(A2)
3	1.43	(A3)
4	1	(A4)
5	.74	(A5)
6	N/A	(A6)
Torque Converter (If equipped)	2.42	(J)
Transfer Case (If Equipped) Low Ratio	2.1	(K)

3. Next, complete **Table 7**. Enter the values from Table 5 and 6 into the Calculation column within the table.

For example: The expression (G)/(AR2)/(J)/(K) is the rear axle input, divided by the reverse high gear ratio, divided by the torque converter (if equipped) ratio, divided by the transfer case (if equipped) low ratio. Perform the calculation and enter the results into the Calculated Maximum Engine Torque Values column

Table 7 – Maximum Allowed Engine Torque

Component	Expression	Calculation (Input Values Here)	Calculated Maximum Engine Torque Values (Input Results Here)
Rear Axle			

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Component	Expression	Calculation (Input Values Here)	Calculated Maximum Engine Torque Values (Input Results Here)
Rear Axle(Reverse Low)	N/A	N/A	N/A
Rear Axle (Reverse High)	(G)/(AR2)/(J)/(K)	= 26000/4.8/2.42/2.1	1066
Rear Axle (1st Low)	(G)/(A1)/(J)/K)	= 26000/3.51/2.42/2.1	1457
Rear Axle (2nd Low)	(G)/(A2)/(J)/(K)	= 26000/1.91/2.42/2.1	2678
Rear Axle (3rd Low)	(G)/(A3)/(J)/(K)	= 26000/1.43/2.42/2.1	3577
Rear Axle (4th Low)	(G)/(A4/(J)/(K)	= 26000/1/2.42/2.1	5116
Rear Axle (5th Low)	(G)/(A5)/(J)/(K)	= 26000/0.74/2.42/2.1	6913
Rear Axle (6th Low)	N/A	N/A	N/A
Transfer Case			
Transfer Case (Reverse Low)	N/A	N/A	N/A
Transfer Case (Reverse High	F)/(AR2)/(J)	= 15000/4.8/2.42	2238
Transfer Case 1	(F)/(A1)/(J)	= 15000/3.51/2.42	3060
Transfer Case 2	(F)/(A2)/(J)	= 15000/1.91/2.42	5625
Transfer Case 3	(F)/(A3)/(J)	= 15000/1.43/2.42	7513
Transfer Case 4	(F)/(A4)/(J)	= 15000/1/2.42	10743
Transfer Case 5	(F)/(A5)/(J)	= 15000/0.74/2.42	14518
Transfer Case 6	N/A	N/A	N/A
Transmission			
Transmission	(E)	=1500	1550

4. Begin completing **Table 8** by selecting the minimum value from the calculated maximum engine torques for each gear from Table 7. For example, take the "Rear Axle (Reverse High)" result and the "Transfer Case" (Reverse High) result and choose whichever value is lower.

In this example, the value 1066 is less than 2238; therefore the value 1066 can be entered into **Table 8.** Continue selecting minimum values to complete the table.

Table 8 – Maximum Engine Torque

Gear	Maximum Engine Torque
Reverse Low	N/A
Reverse High	1066
1	1457
2	

Gear	Maximum Engine Torque
3	Do not need Power Train Protection, because the calculated torque limit value is greater than the engine output torque.
4	
5	
6	N/A

5. As indicated in **Table 8** (above), any calculated torque limit results that are less than the output torque of the engine indicates a need to use Power Train Protection torque limiting. Similarly, Power Train Protection torque limiting is not required if the calculated torque limit result is greater than the engine output torque.

The number of maximum engine torque limit results will vary depending on the vehicle. There are 2 results in this example, but Power Train Protection has only 3 corresponding torque limits to be programmed: Maximum Torque in Low Gear Range (7713), Maximum Torque in Intermediate Gear Range (7750), and Maximum Torque in High Gear Range (7751). Therefore, we need to program the parameters as follows:

• Program the Maximum Torque in Low Gear Range (7713) parameter to the value of reverse high (1066 in this example).

• Program the Maximum Torque in Intermediate Gear Range (7750) parameter to the value of 1st Gear (1457 in this example).

• Program the Maximum Torque in High Gear Range (7751) parameter to 1700, effectively disabling it.

> *This parameter should be set to the value of 2nd gear if there is a need for Power Train Protection in that gear; however, for this example it must be disabled.*

6. Next, to find the PTP Zero Vehicle Speed Maximum Torque Limit (7712) parameter setting, simply use the lowest value of the 3 settings: Maximum Torque in Low Gear Range (7713), Maximum Torque in Intermediate Gear Range (7750), and Maximum Torque in High Gear Range (7751). In this example, 1066 is the lowest, and therefore we will use 1066 for parameter Zero Vehicle Speed Maximum Torque Limit (7712).

7. Finally, program the values for the following parameters:

• Highest Gear of Low Range - Automatic (7718) – This is obtained by multiplying the transfer case ratio * 1st gear ratio (2.1 * 3.51) = 7.371 in this example. This means that all gear ratios lower than 7.371 will be limited to the Maximum Torque in Low Gear Range (7713) parameter setting (1066 in this example).

• Highest Gear of Intermediate Range - Automatic (7748) – This is obtained by multiplying the transfer case ratio * 2nd gear ratio (2.1 * 1.91) = 4.011 in this example. This means that all gear ratios lower than 4.011 will be limited to the Maximum Torque in Intermediate Gear Range (7750) parameter setting (1457 in this example).

• Highest Gear of High Range - Automatic (7749) – This is obtained by multiplying the transfer case ratio * 3rd gear ratio (2.1 * 1.43) = 3.003 in this example. This means

that all gear ratios lower than 3.003 will be limited to the Maximum Torque in High Gear Range (7751) parameter setting (1700 in this example).

Definitions/Acronyms

The following terms are referenced in this document:

Acronym	Definition
ECM	Engine Control Module
PTO	Power Take Off
PTP	Power Train Protection