1. Power Train Protection (General Overview)

The power train protection (PTP) feature is designed to electronically limit the engine torque in order to protect the driveline components. Benefits include improved engine performance without compromising the driveline.

Programmable parameters within the engine control module (ECM) provide PTP related options that can be adjusted to suit the customer's needs.

This document will address unique PTP functionality for MaxxForce® 11 and 13 engines.

To set up the PTP feature it is recommended that you use one of the example settings, referenced in the "Parameter Setup" section, and then modify only the specific parameters that will help meet your vehicle application.

1.1. Feature Codes

N/A

2. Definitions/Acronyms

The following terms are referenced in this document:

- **ECM** – Engine Control Module
- **PTO –** Power Take Off
- **PTP –** Power Train Protection

3. Description and Operation

3.1. 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 and 3 corresponding torque limits. These limits should be set to protect the driveline and/or PTO equipment.

While the vehicle is stationary, torque is limited by a customer selectable zero vehicle speed torque limit; however, this limit is not active while PTO mode is active (including mobile PTO).

3.2. Feature Interaction

The power train protection (PTP) feature interacts with the following engine features:

- PTO – If using engine speed control, the PTP zero vehicle speed torque limit may not apply.

4. Programmable Parameters

The following programmable parameters are required for PTP. These parameters should be programmed to protect the driveline and/or PTO equipment.

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
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 - MAN (8008)	Ratio of the highest gear of the low gear range for manual transmissions.	0.6 to 20	YES	Refer to the PTP Example.
HIGH GEAR RATIO OF INT. RANGE - MAN (8010)	Ratio of the highest gear of the intermediate gear range for manual transmissions.	0.6 to 20	YES	Must be less than the parameter (8008) setting. Refer to the PTP Example for more information.

PTP Highest Gear Ratio for Maximum Torque – Manual (8009)	Ratio of the highest gear of the high gear range for manual transmissions.	0.6 to 20	YES	Must be less than the parameter (8010) setting. Refer to the PTP Example for more information.
HIGHEST GEAR OF LOW RANGE - AUTO (7718)	Number of the highest gear of the low gear range for automatic transmissions.	0 - 255	YES	Must be less than the parameter (7748) setting. Refer to the PTP Example for more information.
HIGHEST GEAR OF INT. RANGE - AUTO (7748)	Number of the highest gear of the intermediate gear range for automatic transmissions.	0 to 18	YES	Must be greater than the parameter (7718) setting. Refer to the PTP Example for more information.
HIGHEST GEAR OF HIGH RANGE - AUTO (7749)	Number of the highest gear of the high gear range for automatic transmissions.	0.6 to 20	YES	Refer to the PTP Example.
PTP Zero Vehicle Speed Maximum Torque Limit (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.
MAX 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 1600 lb-ft	YES	Must be less than the parameter (7750) setting. Refer to the PTP Example for more information.
MAX TORQUE IN INT. 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 1600 lb-ft	YES	Refer to the PTP Example.
MAX 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 1600 lb-ft	YES	Refer to the PTP Example.
PTP Parameter #1 (7734)	N/A	N/A	YES	Must be set to 100.

4.1. Required "Vehicle Setup" Parameters

If PTP does not function as expected, verify that all of the programmable parameters associated with this feature have been programmed correctly.

NOTE: The "Vehicle Setup" feature parameters are initially based on the vehicle build.

Refer to the Programmable Parameters section for more information.

5. Parameter Setup

5.1. Possible PTP Applications

(Example A) – Manual Transmission PTP configuration

In this example, let's assume we need to find appropriate PTP torque limits for a manual transmission.

1. First, complete Table 1 by inputting the appropriate maximum torque information (as shown in the example below). NOTE: This information is based on the vehicle build.

Table 1 – Maximum Torques

Component	**Maximum Torque** (Input Values Here)	**Maximum Torque** (Abbreviated Notation)
Engine Output	1700	(D)
Transmission Input	1550	(E)
Transfer Case Input	13000	(F)
Rear Axle Input	18000	(G)

2. Next, complete Table 2 by inputting the appropriate gear ratio information (as shown in the example below). NOTE: This information is based on the vehicle build.

Table 2 – Gear Ratios

Component	**Gear Ratio** (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 by inputting 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 input those results into the "Calculated Maximum Engine Torque Values" 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
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 input 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	Don't need PTP, because the calculated torque limit value is greater than the engine output torque.
1	880
2	1186
3	1614

4	Don't need PTP, 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 PTP torque limiting. Similarly, PTP 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 4 results in this example, but PTP has only 3 corresponding torque limits to be programmed; (7713), (7750), and (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 indicated by the green shaded area. Since 651 is less than 880 within that group, we will use 651 for the ***"MAX TORQUE IN LOW GEAR RANGE" (7713)*** setting.

   Since there are only 2 values left in the table, directly input the values into the remaining torque limit parameters (i.e. 1186 for the ***"MAX TORQUE IN INT. GEAR RANGE" (7750)*** parameter setting and 1614 for the ***"MAX TORQUE IN HIGH GEAR RANGE" (7751)*** parameter 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)*** parameter setting, simply use the lowest value of the 3 parameter settings: (7713), (7750), and (7751). In this example, 651 is the lowest, and therefore we will use 651 for parameter (7712).

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

   - ***"HIGH GEAR RATIO OF LOW RANGE - MAN" (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 "MAX TORQUE IN LOW GEAR RANGE" (7713) parameter setting (657 in this example).

   - ***"HIGH GEAR RATIO OF INT. RANGE - MAN" (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 "MAX TORQUE IN INT. GEAR RANGE" (7750) parameter setting (1186 in this example).

   - ***"HIGH GEAR RATIO OF HIGH RANGE - MAN" (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 "MAX TORQUE IN HIGH GEAR RANGE" (7751) parameter setting (1614 in this example).

(Example B) – Automatic Transmission PTP configuration

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

1. First, complete Table 5 by inputting the appropriate maximum torque information (as shown in the example below). NOTE: This information is based on the 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 by inputting the appropriate gear ratio information (as shown in the example below). NOTE: This information is based on the vehicle build.

Table 6 – Gear Ratios

Component	**Gear Ratio**	**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	0.74	(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 by inputting 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 input those 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			
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)	= 1550	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 input into Table 8. Continue selecting minimum values to complete the table.

Table 8 – Maximum Engine Torque

GEAR	**MAXIMUM ENGINE TORQUE**
R Low	N/A
R High	1066
1	1457
2	Don't need PTP, because the calculated torque limit value is greater than the engine output torque.
3	
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 PTP torque limiting. Similarly, PTP 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 PTP has only 3 corresponding torque limits to be programmed; (7713), (7750), and (7751). Therefore, we need to program the parameters as follows:

   - Program the ***"MAX TORQUE IN LOW GEAR RANGE" (7713)*** parameter to the value of reverse high (1066 in this example).
   - Program the ***"MAX TORQUE IN INT. GEAR RANGE" (7750)*** parameter to the value of 1st Gear (1457 in this example).
   - Program the ***"MAX TORQUE IN HIGH GEAR RANGE" (7751)*** parameter to 1700, effectively disabling it. NOTE: This parameter should be set to the value of 2nd gear if there is a need for PTP 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 parameter settings: (7713), (7750), and (7751). In this example, 1066 is the lowest, and therefore we will use 1066 for parameter (7712).

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

   - ***"HIGHEST GEAR OF LOW RANGE - AUTO" (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 "MAX TORQUE IN LOW GEAR RANGE" (7713) parameter setting (1066 in this example).
   - ***"HIGHEST GEAR OF INT. RANGE - AUTO" (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 "MAX TORQUE IN INT. GEAR RANGE" (7750) parameter setting (1457 in this example).
   - ***"HIGHEST GEAR OF HIGH RANGE - AUTO" (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 "MAX TORQUE IN HIGH GEAR RANGE" (7751) parameter setting (1700 in this example).

6. Frequently Asked Questions

N/A