International® A26 Engine (2017)

Overview: *Gear Group Torque Limit and Engine Speed Limit Powertrain Protection (PTP) Feature*

TABLE OF CONTENTS

Definitions/Acronyms

The following terms are referenced in this document:

Acronym	Definition
PTP	Powertrain Protection
PTO	Power Takeoff
MT	Manual Transmission
AMT	Automated Manual Transmission
AT	Torque Converter Automatic Transmission
AESC	Auxiliary Engine Speed Control
ECM	Engine Control Module

General Overview: Powertrain Protection (PTP) Description and Scope

Powertrain Protection (PTP) is a two-part feature designed to electrically protect vehicle driveline components and Power Takeoff (PTO) equipment. The feature is composed of Gear Group Torque Limit PTP and Engine Speed Limit PTP which may be individually enabled. Benefits include improved engine performance without compromising the driveline.

Gear Group Torque Limit PTP is required on all vehicles configured with direct drive transmissions, (top gear ratio = 1.0), and it may be optionally ordered for any other transmission configurations. Engine Speed Limit PTP is required on all vehicles with direct drive MT's, and it may be optionally ordered for any other MT's. See table summary below.

Table 1 - Summary of Recommended PTP Configurations

Feature	Direct Drive MT (Top gear ratio = 1.0)	Overdrive MT	Direct Drive AMT (Top gear ratio = 1.0)	Overdrive AMT	All AT
Gear Group Torque Limit PTP	Required (Turned On)	Customer Chosen (Turned On/Off)	Required (Turned On)	Customer Chosen (Turned On/Off)	Customer Chosen (Turned On/Off)
Engine Speed Limit PTP	Required (Turned On)	Customer Chosen (Turned On/Off)	Turned Off	Turned Off	Turned Off

The document will address unique PTP functionality for the A26 Engine. Gear Group Torque Limit PTP and Engine Speed Limit PTP are presented separately below.

Overview: Gear Group Torque Limit PTP

Gear Group Torque Limit Powertrain Protection (PTP) is a feature designed to electrically protect vehicle driveline components and Power Takeoff (PTO) equipment by limiting engine torque. Benefits include improved engine performance without compromising the driveline.

The feature limits torque based on both stationary conditions (zero vehicle speed, clutch not depressed) and gear groups (driving in gear group 1, gear group 4, etc.) that read transmission gear status.

Gear Group Torque Limit PTP Programmable Parameters

The following programmable parameters are populated for Gear Group Torque Limit PTP.

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. Recommended settings are strongly encouraged for peak engine performance.

Table 2 – Programmable Parameters for Gear Group Torque Limit PTP

Parameter Value	Description	Possible Values	Customer Programmable?	Recommended Settings
Gear Group Torque Limit PTP Enable (77171)	This parameter must be enabled for Gear Group Torque Liming PTP to operate.	0: Disable 1: Enable	NO	See Table 1 above If direct drive MT or direct drive AMT: Enable Else: Customer Chosen
Transmission Type (82002)	This parameter sets the transmission type inside the ECM. It must be set correctly for Gear Group Torque Limiting PTP to operate as expected.	0: Manual 1: AMT with Clutch Pedal 2: AMT without Clutch Pedal 3: Torque Converter Automatic	NO	Manual : 0 AMT with Clutch Pedal: 1 AMT without Clutch Pedal: 2 Torque Converter Automatic: 3
Highest Gear Ratio of Low Range – Manual (MT's) (77450)	Highest gear ratio of the low gear range for MT's. Gears with ratios greater than or equal to this value will be placed in gear group 1.	1 to 16	YES	Default value: Parameter (82601) (Ratio of 1st gear) NOTE: Must be greater than parameter (77460) setting. Refer to example for more info.
Highest Gear Ratio of Intermediate Range – Manual (MT's) (77460)	Highest gear ratio of the intermediate gear range for MT's. Gears with ratios greater than or equal to this value and less than parameter (77450) will be placed in gear group 2.	1 to 16	YES	Default value: Parameter (82591) (Ratio of 2nd gear) NOTE: Must be less than parameter (77450) setting. Refer to example for more info.

Parameter Value	Description	Possible Values	Customer Programmable?	Recommended Settings
Highest Gear Ratio of High Range - Manual (MT's) (77470)	Highest gear ratio of the high gear range for MT's. Gears with ratios greater than or equal to this value and less than parameter (77460) will be placed in gear group 3. Gears with ratios less than this value will be placed in gear group 4.	1 to 16	YES	Default value: Parameter (82581) (Ratio of 3rd gear) NOTE: Must be less than parameter (77460) setting. Refer to example for more info.
Highest Gear of Low Range - Automatic (AMT's/AT's) (77182)	Highest gear number of the low gear range for AMT's/AT's. Gear numbers less than or equal to this value will be placed in gear group 1.	1 to 16	NO	Default value: 1 NOTE: Must be less than the parameter (77481) setting.
Highest Gear of Intermediate Range - Automatic (AMT's/AT's) (77481)	Highest gear number of the intermediate gear range for AMT's/AT's. Gear numbers less than or equal to this value and greater than parameter (77182) will be placed in gear group 2.	2 to 16	NO	Default value: 2 NOTE: Must be greater than the parameter (77182) setting.
Highest Gear of High Range - Automatic (AMT's/AT's) (77491)	Highest gear number of the high gear range for AMT's/AT's. Gear numbers less than or equal to this value and greater than parameter (77481) will be placed in gear group 3. Gear numbers greater than this value will be placed in gear group 4.	4 to 16	NO	Default value: 3 NOTE: Must be greater than the parameter (77481) setting.
PTP Zero Vehicle Speed Maximum Torque (77123)	This parameter sets the maximum torque when the clutch pedal is not depressed and the vehicle is not moving. NOTE: Limits are in terms of engine output torque.	800 to 1700 lb-ft	YES	Default value: 1050 lb-ft NOTE: Must match lowest torque setting of parameters (77132), (77502), and (77512). Refer to example for more info.
Max Torque in Low Gear Range (77132)	This parameter sets the maximum torque allowed in gear group 1. NOTE: Limits are in terms of engine output torque.	800 to 1700 lb-ft	YES	Default value: 1050 lb-ft NOTE: Must be less than or equal to parameter (77502) setting. Refer to example for more info.
Max Torque in Intermediate Gear Range (77502)	This parameter sets the maximum torque allowed in gear group 2. NOTE: Limits are in terms of engine output torque.	800 to 1700 lb-ft	YES	Default value: 1050 lb-ft NOTE: Must be less than or equal to parameter (77512) setting. Refer to example for more info.
Maximum Torque in High Gear Range (77512)	This parameter sets the maximum torque allowed in gear group 3. NOTE: Limits are in terms of engine output torque.	800 to 1700 lb-ft	YES	Default value: 1700 lb-ft NOTE: Must be greater than or equal to parameter (77502) setting. Refer to example for more info.

Gear Group Torque Limit PTP Operation and Description

Operation: There are no operator interactions involved such as switches, buttons, or indicators. The feature is active for all key-on, engine running scenarios.

Zero Vehicle Speed Gear Group Torque Limit PTP: Stationary condition for Gear Group Torque Limit PTP is satisfied when vehicle is not in motion and clutch pedal is not depressed. Under these conditions, feature will limit torque to the minimum of parameters zero vehicle speed torque (77123) and gear group 1 torque (77132).

When clutch is depressed and vehicle is not moving, feature will limit torque to max torque for gear group 1, parameter (77132).

Vehicle Moving Gear Group Torque Limit PTP: When vehicle is moving, feature will limit torque according to programmed gear groups. Groups are defined by parameters (77450), (77460), and (77470) for MT's. Groups are defined by parameters (77182), (77481), and (77491) for AMT's/AT's. Group torques for all transmissions are defined by parameters (77132), (77502), and (77512).

When vehicle is moving in gear group 1 under 16 km/hr, feature limits torque to parameter (77132).

When vehicle is moving in gear group 1 at or above 16 km/hr, feature allows for max engine torque.

When vehicle is moving in gear group 2, feature limits torque to parameter (77502).

When vehicle is moving in gear group 3, feature limits torque to parameter (77512).

When vehicle is moving in gear group 4, feature allows for max engine torque.

Gear Group Torque Limit PTP Customer Parameter Setup Examples

EXAMPLE A – Direct Drive MT Gear Group Torque Limit PTP Configuration

In this example, assume Gear Group Torque Limit PTP is being enabled for a vehicle with an Eaton Fuller 13GAP Model FRM-15210B direct drive 10-speed MT. For this configuration, transmission ratios are summarized in Table 1A.

Table 1A - Eaton Fuller 13GAP Direct Drive MT Ratio Summary

Gear Number	1	2	3	4	5	6	7	8	9	10
Gear Ratio	14.80	10.95	8.09	5.97	4.46	3.32	2.45	1.81	1.34	1.00

For this direct drive MT (top gear ratio = 1.0), recommended Gear Group Torque Limit PTP parameter settings are as follows in Table 2A.

Table 2A - Direct Drive MT Gear Group PTP Parameter Summary

Parameter	Programmed Value
Gear Group Torque Limit PTP Enable (77171)	Enable
Transmission Type (82002)	Manual
Highest Gear Ratio of Low Range – Manual (77450)	14.80
Highest Gear Ratio of Intermediate Range – Manual (77460)	10.95

Parameter	Programmed Value
Highest Gear Ratio of High Range - Manual (77470)	8.09
Highest Gear of Low Range - Automatic (77182)	1
Highest Gear of Intermediate Range -Automatic (77481)	2
Highest Gear of High Range - Automatic (77491)	3
PTP Zero Vehicle Speed Maximum Torque (77123)	1050 lb-ft
Max Torque in Low Gear Range (77132)	1050 lb-ft
Max Torque in Intermediate Gear Range (77502)	1050 lb-ft
Maximum Torque in High Gear Range (77512)	1700 lb-ft

For this configuration, a summary of gear groups and torque limits for is presented in Table 3A.

Table 3A - PTP Gear Groups and Torque Limits for Direct Drive Example A

Gear Number	1	2	3	4	5	6	7	8	9	10
Gear Ratio	14.80	10.95	8.09	5.97	4.46	3.32	2.45	1.81	1.34	1.00
PTP Gear Group	1	2	3	4	4	4	4	4	4	4
PTP Torque Limit	*1050 lb-ft	1050 lb-ft	1700 lb-ft	**Max.	Max.	Max.	Max.	Max.	Max.	Max.

*For vehicle speed less than 16 km/hr; maximum engine torque for speeds greater than or equal to 16 km/hr
**Maximum engine torque

Gear groups follow parameters (77450), (77460), and (77470) for the MT setting. The torque limit increases with decreasing gear ratio until max engine torque is allowed.

EXAMPLE B – Overdrive AMT Gear Group Torque Limit PTP Configuration

In this example, assume Gear Group Torque Limit PTP is being enabled for a vehicle with an Eaton Fuller 13GYG Model FAOM-15810C-EA3 10-speed AMT by customer request. For this configuration, transmission ratios are summarized in Table 1B.

Table 1B - Eaton Fuller 13GYG Overdrive AMT Ratio Summary

Gear Number	1	2	3	4	5	6	7	8	9	10
Gear Ratio	12.80	9.25	6.76	4.90	3.58	2.61	1.89	1.38	1.00	0.73

For this overdrive AMT setup, default Gear Group Torque Limit PTP parameter settings are as follows in Table 2B.

Table 2B – Overdrive AMT Gear Group PTP Parameter Summary

Parameter	Programmed Value
Gear Group Torque Limit PTP Enable (77171)	Enable
Transmission Type (82002)	Automated Manual
Highest Gear Ratio of Low Range – Manual (77450)	12.80
Highest Gear Ratio of Intermediate Range – Manual (77460)	9.25
Highest Gear Ratio of High Range - Manual (77470)	6.76
Highest Gear of Low Range - Automatic (77182)	1
Highest Gear of Intermediate Range -Automatic (77481)	2
Highest Gear of High Range - Automatic (77491)	3
PTP Zero Vehicle Speed Maximum Torque (77123)	1050 lb-ft
Max Torque in Low Gear Range (77132)	1050 lb-ft
Max Torque in Intermediate Gear Range (77502)	1050 lb-ft
Maximum Torque in High Gear Range (77512)	1700 lb-ft

For this configuration, a summary of gear groups and torque limits is presented in Table 3B.

Table 3B - PTP Gear Groups and Torque Limits for Overdrive AMT Example B

Gear Number	1	2	3	4	5	6	7	8	9	10
Gear Ratio	12.80	9.25	6.76	4.90	3.58	2.61	1.89	1.38	1.00	0.73
PTP Gear Group	1	2	3	4	4	4	4	4	4	4
PTP Torque Limit	*1050 lb-ft	*1050 lb-ft	*1700 lb-ft	**Max.	Max.	Max.	Max.	Max.	Max.	Max.

*For vehicle speed less than 16 km/hr; maximum engine torque for speeds greater than or equal to 16 km/hr
**Maximum engine torque

Gear groups follow parameters (77182), (77481), and (77491) for the AMT setting; torque converter automatic setups (AT's) will be the same as the AMT case. Vehicle speed threshold applies for all gears that fall into gear group 1. The torque limit increases with decreasing gear ratio until max engine torque is allowed.

Overview: Engine Speed Limit PTP

The Engine Speed Limit PTP feature is designed to limit engine speed upon takeoff to protect driveline components and PTO equipment from heavy clutch dumps on

vehicles with MT's. Engine Speed Limit PTP is required on all vehicles configured with direct drive MT's (top gear ratio = 1.0), and it may be optionally enabled on vehicles configured with overdrive MT's.

The feature limits engine speed based on conditions for vehicle speed, clutch pedal, PTO, and parking brake status.

Engine Speed Limit PTP Programmable Parameters

The following programmable parameters are populated for Engine Speed Limit PTP.

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. Recommended settings are strongly encouraged for peak engine performance.

Table 3 – Programmable Parameters for Engine Speed Limit PTP

Parameter Value	Description	Possible Values	Customer Programmable?	Recommended Settings
PTP Engine Speed Limit PTP Enable (77221)	This parameter must be enabled for Engine Speed Limit PTP to operate.	0: Disable 1: Enable	YES	See Figure 1 Above If direct drive MT: Enable If overdrive MT: Customer Chosen Else: Turned Off
Transmission Type (82002)	This parameter sets the transmission type inside the ECM. It must be set correctly for Engine Speed Limit PTP to operate as expected.	0: Manual 1: AMT with Clutch Pedal 2: AMT without Clutch Pedal 3: Torque Converter Automatic	NO	Manual : 0 AMT with Clutch Pedal: 1 AMT without Clutch Pedal: 2 Torque Converter Automatic: 3
PTP Powertrain Protection Engine Speed (77900)	This parameter sets the maximum engine speed limit with parking brake not active, clutch pedal depressed, and hysteresis-filtered vehicle speed below threshold determined by (77910).	700-3000 rpm	NO	Default value: 800 rpm
PTP Powertrain Protection Vehicle Speed Threshold (77910)	This parameter feeds into a hysteresis filter to determine low vehicle speed scenarios for engine speed limit PTP activation.	0-80 mph	NO	Default value: 1.25 mph

Engine Speed Limit PTP Operation, Entry, and Description

Operation: There are no operator interactions involved such as switches, buttons, or indicators.

Entry: When enabled with programmable parameter (77221), Engine Speed Limit PTP is designed to activate during takeoff scenarios to prevent damage to drivetrain during clutch dump scenarios. When active, the feature lowers the high idle limit from base high idle (2200 rpm) to programmable parameter (77900).

The feature will activate when the following conditions are simultaneously met:

1. Transmission type – transmission type programmable parameter (82000) must be set to 'manual' for Engine Speed Limit PTP to activate.

2. Clutch pedal – clutch pedal must be pressed for feature to activate.

3. Parking brake – parking brake must be released for feature to activate.

4. Vehicle speed – vehicle speed must satisfy hysteresis function. When accelerating from standstill, Engine Speed Limit PTP will remain active (with other conditions met) until vehicle speed reaches programmable parameter (77910) plus 5 km/hr offset. Feature will not reactivate until vehicle speed is decelerated below programmable parameter (77910) (and other conditions are met). This is to prevent rapid activation and deactivation when moving at low speeds.

If PTO is active and the above entry conditions are met, the feature will continue to limit engine speed to programmable parameter (77900).

If above entry conditions are not met, the feature will not limit engine speed regardless of PTO status.

Engine Speed Limit PTP Customer Parameter Setup Examples

EXAMPLE C – Direct Drive MT Engine Speed Limit PTP Configuration

In this example, assume Engine Speed Limit PTP is being enabled for a vehicle with an Eaton Fuller 13GAP Model FRM-15210B direct drive 10-speed MT. For this direct drive MT (top gear ratio = 1.0), recommended Engine Speed Limit PTP parameter settings are as follows in Table 1C.

Table 1C - Direct Drive MT Engine Speed PTP Parameter Summary

Parameter	Programmed Value
PTP Engine Speed Limit PTP Enable (77221)	Enable
Transmission Type (82002)	Manual
PTP Powertrain Protection Engine Speed (77900)	800 rpm
PTP Powertrain Protection Vehicle Speed Threshold (77910)	1.25 mph (2 km/hr)

Standstill to takeoff: With the above configuration, when the driver releases the parking brake and presses the clutch pedal, engine speed will be limited to 800 rpm until the vehicle has accelerated above 7 km/hr (4.35 mph) (2 km/hr + 5 km/hr offset) regardless of PTO activation. Above this speed, Engine Speed Limit PTP will not be active; engine speed will not be limited.

Moving to standstill: With the above configuration, Engine Speed Limit PTP will not reactivate until parking brake is released, clutch pedal is pressed, and the driver decelerates below 1.25 mph (2 km/hr). Engine speed will only be limited to 800 rpm when feature is reactivated.

Frequently Asked Questions

Will Engine Speed Limit PTP be active if the driver is coasting in neutral below the speed limit threshold?

Yes, regardless of transmission status (neutral or in gear), Engine Speed Limit PTP will activate when parking brake is released, clutch is pressed, and vehicle speed is below threshold simultaneously. This can occur when the driver has put the transmission into neutral and is rolling or if the driver is coasting in a low gear.

Can Engine Speed Limit PTP be enabled for AMT's/AT's?

This PP can be <u>enabled</u> via parameter (77221), however the feature will not <u>activate</u> for AMT's/AT's. The feature checks the transmission type parameter (82002) before applying the engine speed limit, and the limit will not be applied unless transmission type is MT.

Will PTP operate in reverse?

Yes, both Gear Group Torque Limit and Engine Speed Limit PTP features will operate in reverse gears for MT's. Analogous to forward driving, the reverse gear ratio will determine gear group, and torque will be limited to the programmed value corresponding to that group. Engine speed limit PTP will limit engine speed to programmable parameter (77900) so long as entry for parking brake, clutch pedal, and vehicle speed are simultaneously satisfied.

Will Gear Group Torque Limit PTP recognize skip shifts?

Yes, the feature reads signals from the transmission that rapidly broadcast transmission gear number, so any shift performed by the driver will be tracked.

Will Gear Group Torque Limit PTP operate under stationary conditions in an AMT?

Yes, stationary condition for Gear Group Torque Limit PTP is satisfied when vehicle is not in motion and clutch pedal is not depressed. For an AMT without a clutch pedal, entry for clutch will automatically be satisfied. For zero vehicle speed, feature will limit torque to the minimum of parameters zero vehicle speed torque (77123) and gear group 1 torque (77132) in an AMT.