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Operation of Driver Controlled Differential Locks (DCDL)

Introduction to DCDL in the Vehicle:

The AxleTech Driver Controlled Differential Lock (DCDL) is a carrier-mounted traction device manually operated from the vehicle cab.

The purpose of the DCDL is to fully lock the differential and provide maximum vehicle traction when encountering unfavorable operating conditions.

When encountering a poor traction condition, the operator can activate the DCDL to temporarily force each driving wheel to use all the tractive effort available to the axle, and then deactivate as soon as the vehicle is through the area.

A DCDL consists of a shift assembly mounted on the axle carrier.

Actuating the Differential Lock moves a shift fork, connected to a rotating shift collar, along the splines of the axle shaft, toward the differential case. When the splines on the shift collar engage with the splines on the differential case, the shafts and the differential assembly lock together, forcing both wheels to turn at the same speed and with equal torque.

Features and Benefits of DCDL

A fully locked differential provides superior vehicle traction and control over other traction assist devices.

- Fewer parts compared to other traction control devices which means lower cost, less maintenance; easily serviced.
- No special friction modifying oil additives like some clutch pack traction devices and does not generate wear particles.
- “Driver Controlled” means the DCDL is used only when needed, otherwise it operates as a typical differential with all the associated benefits.

Figure 1: Differential case half showing shift collar, shift fork (red), and actuator.

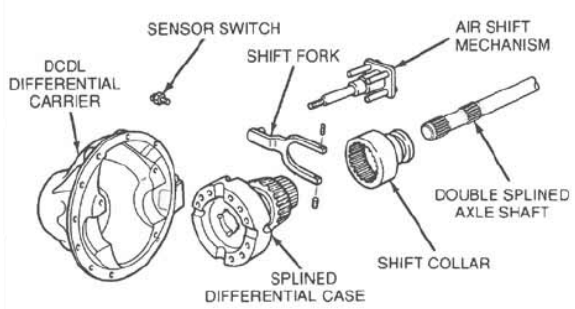

Figure 2: DCDL consists of 7 unique components

DCDL Vehicle Setup

Actuation of the DCDL is typically by an instrument panel switch, allowing the driver to lock or unlock main differential action as poor traction conditions are encountered.

Figure 3: In-cab Differential Lock Switch

Indicator lights on the instrument panel are highly recommended to ensure operator awareness of DCDL actuation status – light on when the DCDL is engaged, light off when not engaged.

Signals verifying DCDL clutch collar position are provided by a sensor in the DCDL unit.

An audible signal indicating a DCDL lock condition is also a good idea. An alternative is to use a hold-down type switch to apply the DCDL, which disengages it when the button is released.

It is recommended that the vehicle system be set up such that front and rear wheel drives must be engaged, through the transfer case, before the DCDL can be engaged.

One way to ensure this engagement sequence is to install the DCDL on the declutched axle. This would require that both front and rear drive axles be engaged before use of the DCDL.

This setup, in effect, allows drive torque to be available to at least three of the four wheels. If the vehicle encounters a situation where three wheels are slipping (three wheels on ice), locking a second DCDL would send nearly 100% of available torque to one wheel. It is likely that the design limits of the axle shafts and planetary gearing will be exceeded.

It is recommended that a maximum speed for DCDL lockup be set based on how the vehicle will be used, configuration, and expected handling behavior. In any case speed must not exceed 25 mph (40 kph).

The DCDL system on some vehicles can be connected through the low speed range of the transmission. This type of regulation ensures that the differential can be locked only if the transmission is operating in the low speed range.

Key Operating Tips:

It is important that the driver remember to...

- Never actuate or use when going downhill or while going around a corner or sharp curve;
- Never engage while the wheels are in a spinout condition.
- Only use at low vehicle speed; under 25 mph (40 kph);

We also recommend placing a warning label (available from AxleTech) on the dashboard in view of the vehicle operator.

Figure 4: Typical Caution Label

The DCDL is intended to be used only in poor traction conditions and unlocked as soon as traction improves:

- Poor surface condition = ground coefficient less than 0.4 typically encountered in mud, snow, or ice.
- Improved surface condition = ground coefficient greater than 0.4; pavement, packed dirt, or packed gravel.

DCDL should never be engaged on improved surfaces due to potentially unexpected changes in vehicle handling characteristics and risk possible driveline damage.

1. The DCDL can be locked or unlocked if the vehicle is standing still or moving at a constant low speed when the wheels are not spinning, slipping, or losing traction.

2. When the DCDL is locked, operate the vehicle at low speeds.

3. When the DCDL has locked the axle, the vehicle's turning radius will increase. This condition is called "understeer." The driver must use caution when operating the vehicle with the DCDL locked.

4. Always unlock the DCDL as soon as the need for maximum traction has passed.

5. The DCDL should not be engaged during spin-out or while in a turn. Tight turns must be avoided while the differential is locked and the DCDL should never be engaged while in a full-lock steer condition.

6. Do not lock the DCDL when the vehicle is traveling down steep grades; changes in vehicle stability could result in loss of vehicle control.

Locking the DCDL:

Follow these recommended steps when encountering poor operating conditions where maximum traction is needed:

1. Without the wheels spinning, slipping, or losing traction, engage the DCDL lock switch while maintaining a constant vehicle speed under 25 mph (40 kph).

2. Let up momentarily on the accelerator to relieve torque on the gearing, allowing the DCDL to move into lock position.

3. When the DCDL is fully activated, an indicator light will be on and/or an audible signal will alert the driver.

Unlocking the DCDL:

Follow these recommended steps to disengage the DCDL when the vehicle can safely operate at speeds below 25 mph (40 kph) and driving conditions have improved,

1. Disengage the DCDL using the unlock switch when the vehicle is stopped or when the wheels are not spinning, slipping, or losing traction.

2. Let up momentarily on the accelerator to relieve torque on the gearing, allowing the DCDL to unlock. It may take a considerable driving distance before the clutch collar can fully disengage.

3. When the DCDL is deactivated, the indicator light should be off or the audible signal should stop.

4. Resume driving at normal speed using good driving judgment.

Difference between DCDL and IAD Lock

An inter-axle differential (IAD) is a differential mounted in the carrier of the front axle of a tandem axle set. It's installed between the input shaft of the front axle and output shaft to the rear axle.

An IAD works in a similar manner to a standard axle differential. An IAD allows for speed differences between two axles of a tandem set rather than two wheel ends of an axle.

The IAD Lock, like the DCDL, is driver controlled. A locked IAD delivers equal speed and torque to each axle of the tandem.

Unlike the DCDL, IAD Lock may be engaged at-speed (assuming both axles are rolling and spin-out has not started to occur), and can remain engaged for long periods of time during poor weather conditions such as snow or heavy rain.

DCDL on each axle, combined with an IAD Lock between the tandem axles, locks all wheels together for maximum traction (all wheels turning at the same speed and with equal traction).

Recommended Sequencing of Traction Devices:

AxleTech's recommended sequence for driving in poor traction conditions is:

1. Engage front and rear drive axles.
2. If with a tandem axle setup, engage the IAD lock.
3. If adequate traction is still not available, engage the rear axle DCDL(s).
4. If traction is still not available, engage the front axle DCDL.

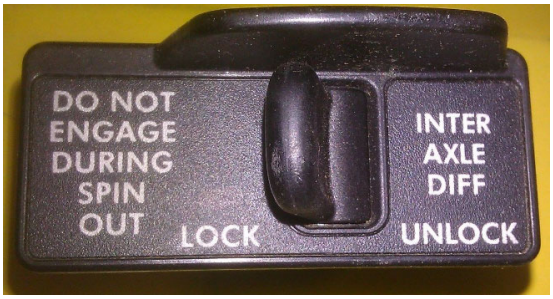

Figure 5: Typical IAD switch

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DCDL Background Information:

When used improperly, axle component life can be significantly reduced or lead to driveline damage.

Because of this damage risk, drivers of DCDL equipped vehicles require a higher level of training on proper use than they would with vehicles equipped with some other traction control devices.

The damage risk is due to undesirable high torque wrap-up in axle shafts if used improperly. For example, with a front axle DCDL engaged (differential locked) during steering, an axle shaft will wrap to tire slip torque in a very short distance; within a few feet at full steer.

AxleTech Planetary Axles are not designed to experience frequent slip torque events on high-traction surfaces. The axle shafts in particular are highly stressed at this torque level. Designing for frequent tire slip would require a significant increase in axle size and weight.

The vehicle speed at which the DCDL is engaged is not as important to component life as the relative speeds of the tires. A difference in wheel speeds can prevent the DCDL lock collar from fully engaging.

While not intended for use on improved surfaces, an exception is when one wheel has no load to provide tractive effort for movement (i.e. one wheel off the ground). In this scenario, an attempt at movement by first engaging all drive axles is preferred before using the DCDL. If the DCDL is then required, its use should be only momentary with wheels pointing straight ahead.

Remember that the DCDL is intended to be used only in poor traction conditions and unlocked as soon as traction improves.

For further information, contact AxleTech Customer Service at 1-877-547-3907.