AWD Disconnect - Escaping the clutches of the dog

Brian Lee
To think outside the box you must be outside of the box.

Alfreda Doyle
Poet
AWD disconnect consensus?
The good 'ole dog clutch

Why the consensus on a dog clutch?
It's only a dog clutch. What could go wrong…?
Wedge clutch disconnect
Wedge clutch disconnect

Actuator

Magnet

Armature

Spring

Clutch

Carrier

Wedge Plate

Hub
Wedge clutch function
Wedge clutch function

Carrier

Plate

Hub

$\mu_1$

$\alpha$

$\mu_2$

$T_0$
Actuation principle

Input shaft

Carrier

Plate

Hub

Electromagnet

Switchable spring

F = X

F = -Y

F = Y
What's a switchable spring?

Diaphragm spring characteristic

Clutch engaged

Clutch disengaged
Requirements of the magnet

- Engaged
- Disengaged

Force vs. Deflection graph: + force corresponds to engaged state, - force to disengaged state.
Magnet design

- Air gap "a"
- Required force
- Required stroke

Diagram showing the relationship between force and air gap.
Magnet design

![Graph showing force versus travel with a magnet design illustration]
Clutch lockup testing

Input inertia
$1 \times 10^6$ Kg mm²

Output inertia
$5 \times 10^4$ Kg mm²

Motor

Torque meter

Test Sample
Dog clutch lockup

- Input speed
- Output speed
- Torque

![Graph showing input speed, output speed, and torque over time.](image-url)
Dog clutch lockup

- Input speed
- Output speed
- Torque
Wedge clutch

Wedge 75W-90

Wedge ATF

Torque spike in Nm vs Delta speed in RPM

0 20 40 60 80 100 120 140 160 180 200

0 20 40 60 80 100 120 140 160 180 200
Dog clutch

Torque spike in Nm

Delta speed in RPM

Dog
ATF & 75W-90
Wedge vs. dog clutch

25-30% Improvement

Torque spike in Nm
Delta speed in RPM

Dog
Wedge
ATF
Wedge 75W-90
Wedge – high speed lockup

- Input speed
- Output speed
- Torque

Speed in RPM

Time in sec
Dog – high speed lockup

- Input speed
- Output speed
- Torque

Graph showing speed in RPM and time in seconds.
High speed lockup

Dog tooth backlash

Dog tooth clash

- Input speed
- Output speed
- Torque

Speed in RPM

Time in sec
PTU disconnect
PTU disconnect

65 mm
The world hates change, yet it is the only thing that has brought progress.

Charles Kettering
1876-1958