

4 WHEEL DRIVE SYSTEMS

THE BASICS





Purpose

To enable an individual to understand and correctly use the mechanical features of their vehicles 4WD system



Course outline

- Part time 4WD [Selectable 4WD]
- Permanent 4WD [Full time 4WD]
- What is True 4WD?



Part time 4WD [Selectable 4WD]

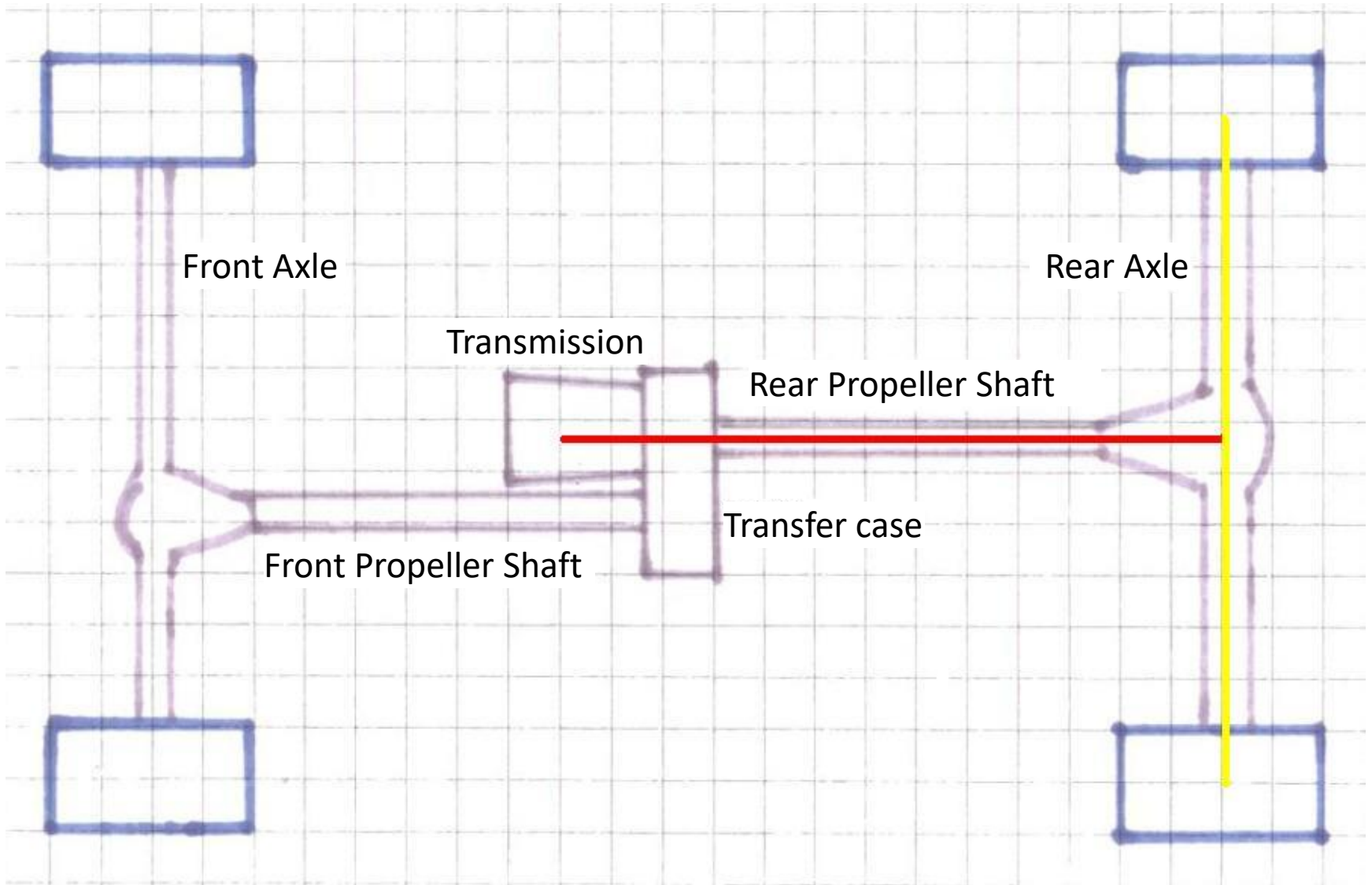
- The most basic system giving the driver the choice of when to engage 4WD
- Transfer case locks the front and rear propeller shafts together.
- Transfer case provides for low range
- Propeller shafts from the transfer case to the front and rear axles turn at the same speed
- Advisable not to engage 4WD of firm surfaces or when cornering



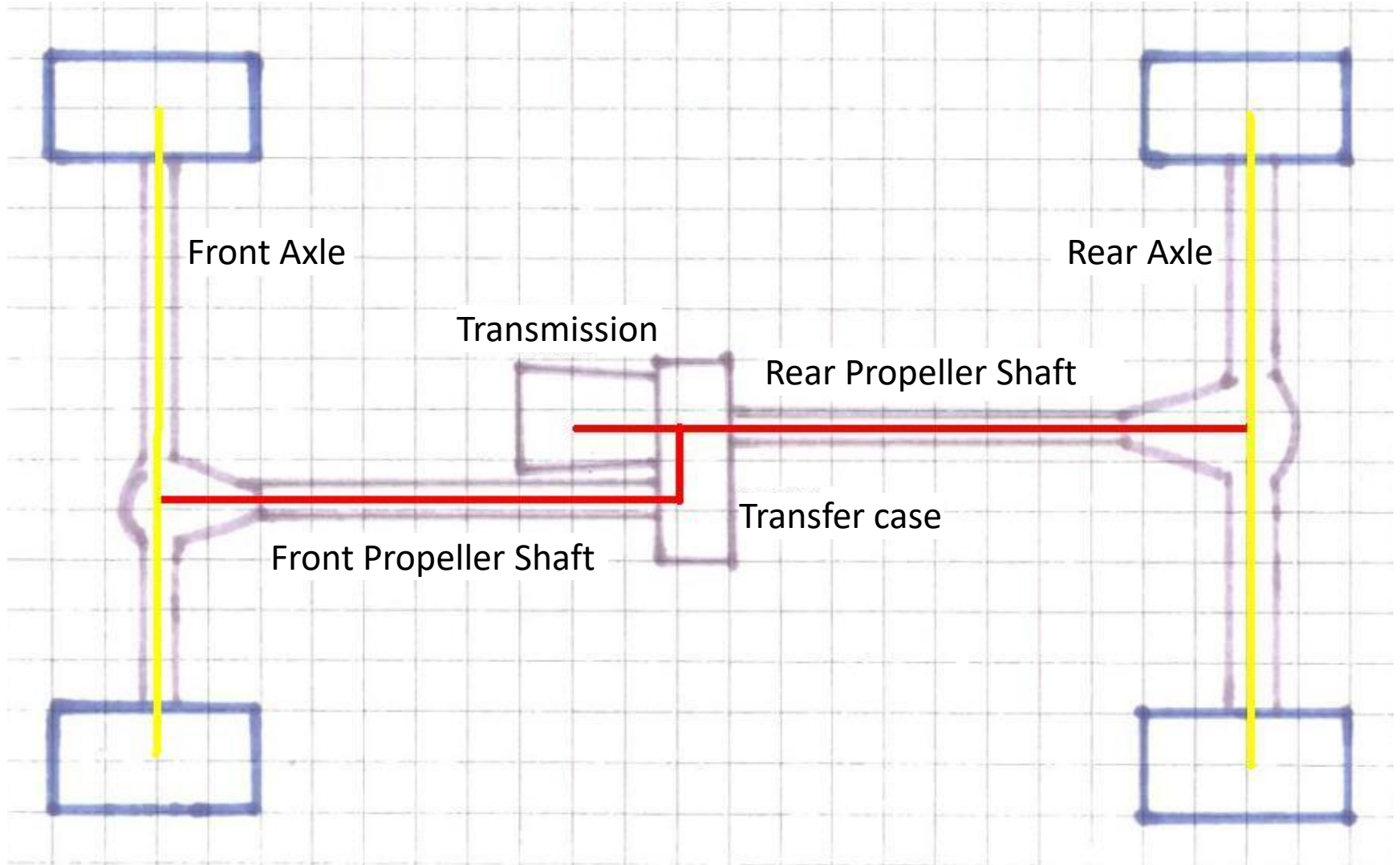
Transfer Case

- Stock (factory) transfer case in low range, per owner's manual, generally requires 4WD
- After market transfer cases – ATLAS – enable engagement of both front and/or rear axles in low /high range.
- Only using one axle in low range, although possible, does exert additional load on the axle in use.

Part time 4WD [Selectable 4WD] cont.



Part time 4WD [Selectable 4WD] cont.

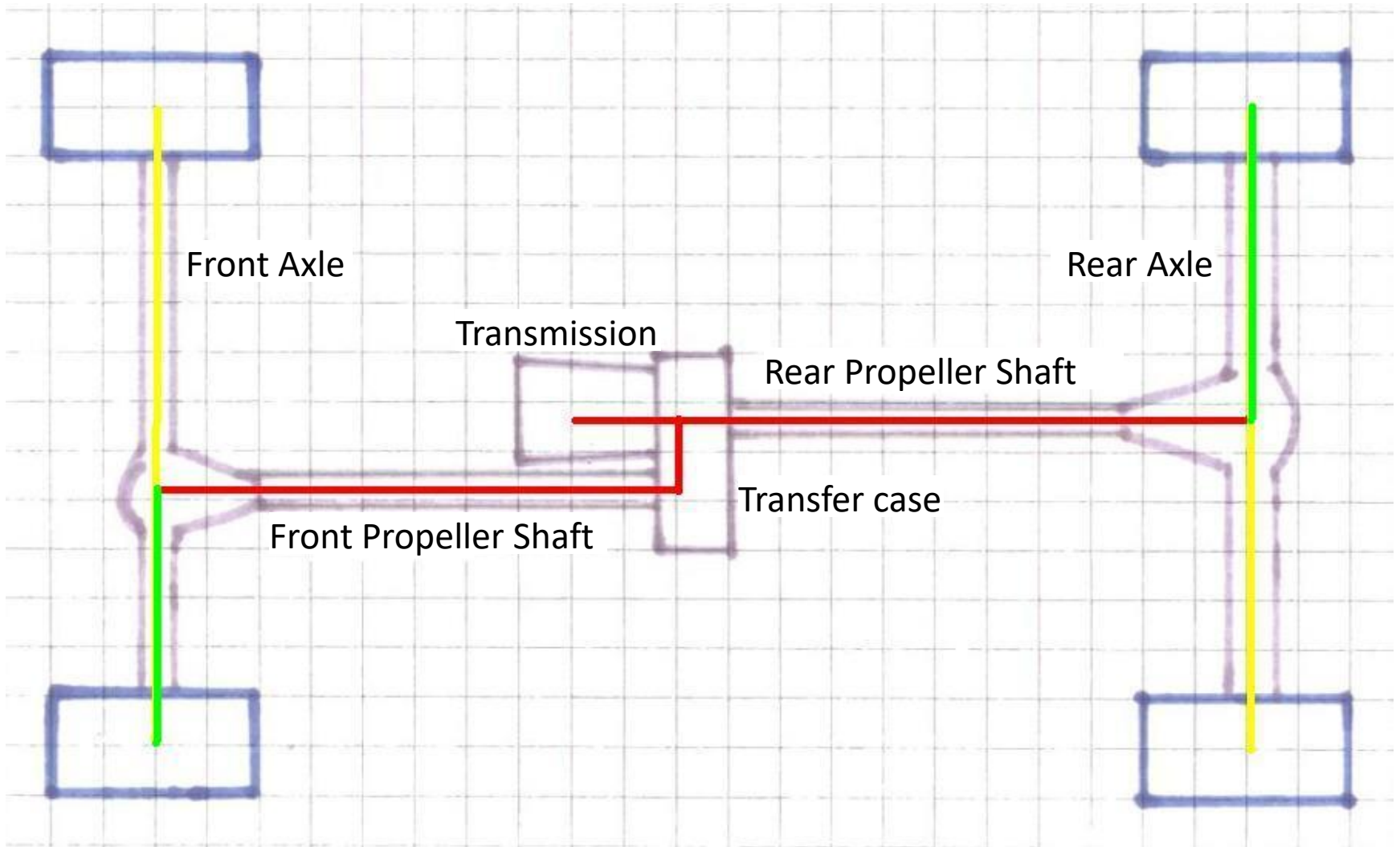




Part time 4WD [Selectable 4WD]

- Power will go to **both front and rear axles** when a part time 4WD transfer case is engaged.
- This is because the front and rear propeller shafts are locked and so turn together.
- This is a significant difference compared with a Permanent 4WD [Full time 4WD] system.

Part time 4WD [Selectable 4WD] cont.





Part time 4WD [Selectable 4WD] cont.

- In low traction environment power will go to at least one wheel on the front axle **AND** at least one wheel on the rear axle giving at least 2 wheels under power.
- This is a result of a difference between Part time 4WD and Full time 4WD [without the center differential engaged]: at least 2 wheels under power vs. one wheel under power



Part time 4WD [Selectable 4WD] cont.

- High range or low range behave similarly
- Great for straight ahead traction but can be disadvantageous in corners – propeller shaft bind up exerts load on drive train
- Load is created by steering axle wheel rotation differing from non-steering axle wheel rotation
- Difference in distance traveled by the wheel on the front axle compared with the wheel on the rear axle.



Part time 4WD [Selectable 4WD] cont.

- The rear axle wheels take a short cut – wheel cheat – and so turn less relative to the wheels on the front axle.
- The inside front wheel needs to go further than the inside rear wheel.
- The outside front wheel needs to go further than the outside rear wheel.
- The result is that the front propeller shaft wants to turn more than the rear propeller shaft but can't as they are locked together.
- The result is a bind up between the front and rear propeller shafts and this occurs in the part time 4WD transfer case.



Part time 4WD [Selectable 4WD] cont.

- Driving around in circles with a Part time 4WD transfer case engaged on a traction perfect surface can cause severe driveline damage.
- Symptoms include difficulty disengaging the Part time 4WD transfer case.
- In some cases jacking up the wheel of the front or rear axle may release the bind up and allow the Part time 4WD transfer case to be disengaged
- With manual free wheeling hubs, disengaging the free wheeling hubs has the same effect.



Part time 4WD [Selectable 4WD] cont.

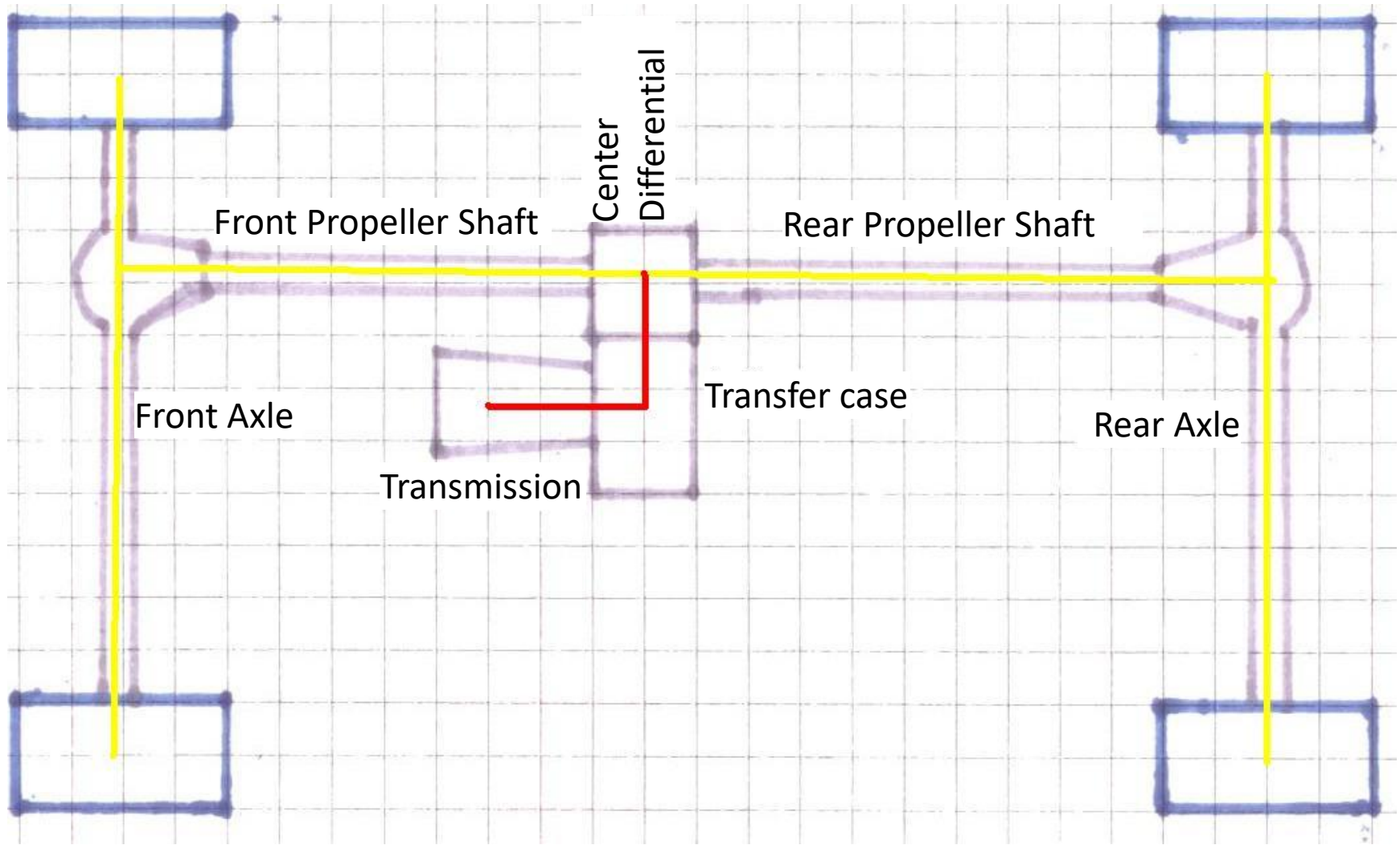
- A Part time 4WD engaged transfer case is much like an axle differential lock engaged with regards to influence on the propeller shafts and axle drive shafts respectively.
- The tires chirping is how the locked axle differential releases the bind up caused by differing wheel speeds.
- On slippery surfaces the propeller shaft bind up is similarly released by wheel spin [wheels slipping on the slippery surface].
- This is another significant difference between Part time 4WD and Full time 4WD systems.
- I recommend getting into the habit of disengaging a Part time 4WD transfer case periodically when driving off-highway.



Permanent 4WD [Full time 4WD]

- Generally more user friendly.
- Most Full time 4WD vehicles have a center differential located between the front and rear propeller shafts.
- This center differential prevents propeller shaft wind up caused by the different rotation speeds of the front and rear axles and therefore can be safely used on sealed high traction surfaces – roads.

Permanent 4WD [Full time 4WD] cont.





Truth about differentials

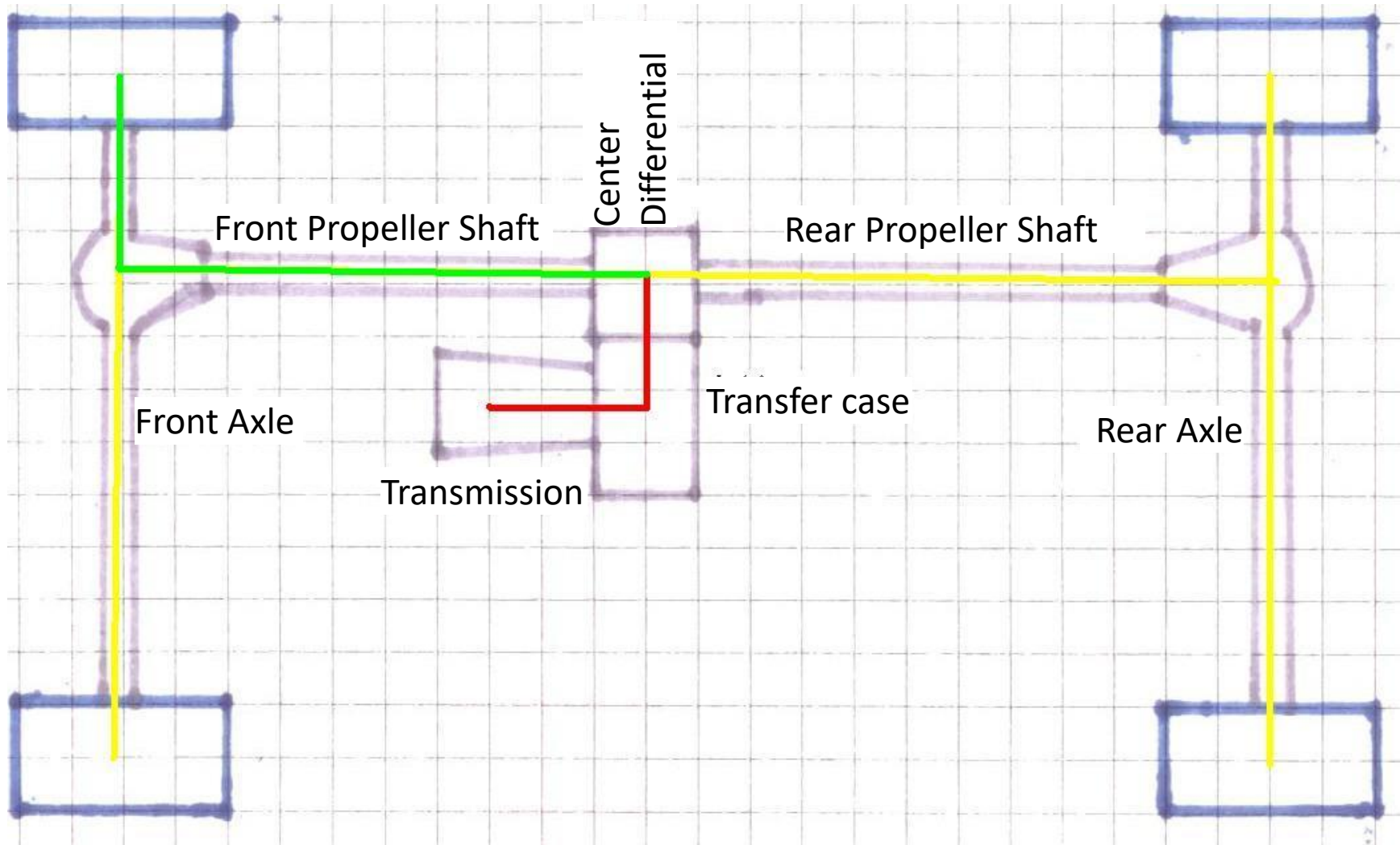
- An open differential allows the wheels on the axle to turn at different speeds
- Myth: If one wheel has no traction, the other wheel will not get any torque. Not strictly true
- The function of an open differential is to balance torque between the left and right wheels [or propeller shafts]
- Even with one wheel spinning in the air, torque is required to overcome friction and cause the wheel to spin.
- The equivalent amount of torque is applied to the other wheel although that amount of torque may be insufficient to move the vehicle giving the appearance that it gets no torque.



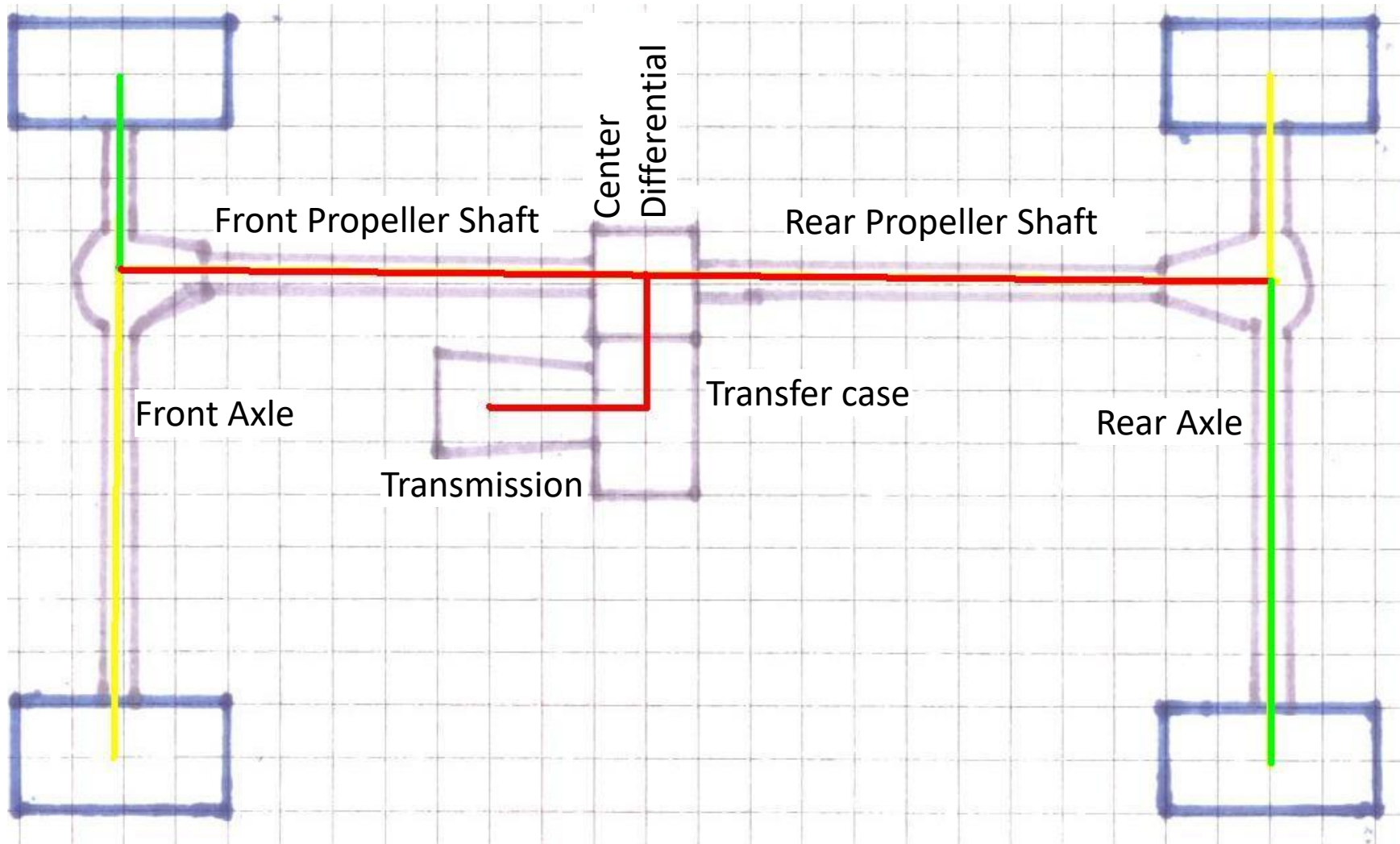
Permanent 4WD [Full time 4WD] cont.

- This center differential is much like an open axle differential: when one wheel has no traction, the other wheel may not turn.
- A Full time 4WD system without a center differential lock engaged is not true 4WD in that if any wheel is without traction insufficient torque goes to the wheel(s) with traction = stuck 😞.
- Thus if one wheel spins on the front axle because of no traction the propeller shaft going to that axle will spin and the propeller going to the rear axle will not turn if the torque is insufficient to overcome the traction of the wheels on the rear axle.
- The result is torque spinning only 1 wheel compared with 2 wheels in the Part time 4WD system
- With a Full time 4WD system, one wheel on either axle without traction can cause the vehicle to stop.
- With a Part time 4WD system no traction on a wheel on the front axle **AND** no traction on a wheel on the rear axle can cause the vehicle to stop.

Permanent 4WD [Full time 4WD] cont.



Permanent 4WD [Full time 4WD] cont.





Permanent 4WD [Full time 4WD] cont.

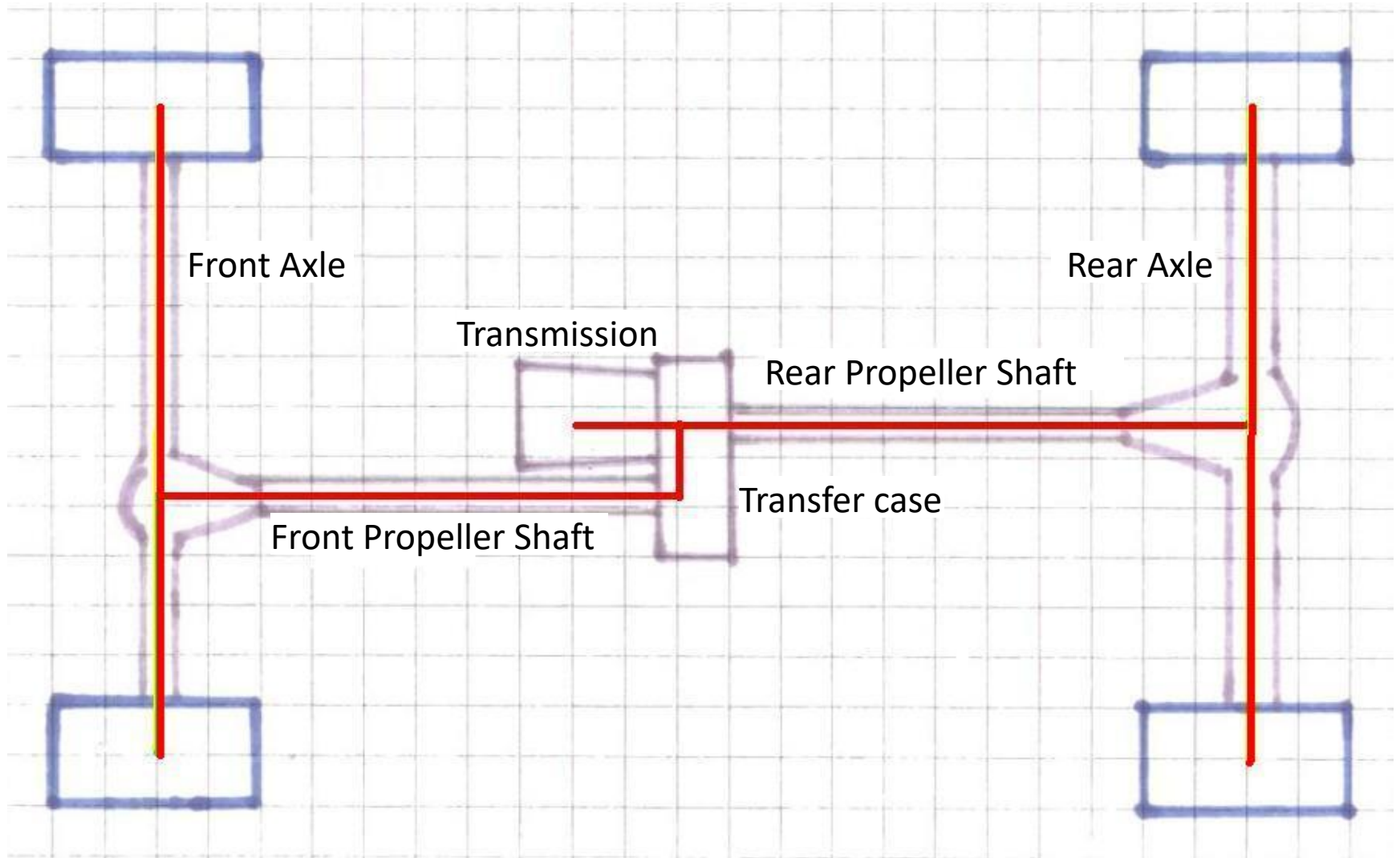
- Many Full time 4WD systems have a center differential lock.
- Engaging a Full time 4WD transfer case center differential lock produces an identical result as engaging a Part time 4WD transfer case.
- The result is locking the front and rear propeller shafts together.
- Propeller shaft bind up can be the result.
- As such I recommend getting into the habit of disengaging a Full time 4WD center differential lock periodically when driving off-highway.



What is True 4WD?

- True 4WD occurs only when equivalent power is directed to all 4 wheels at all times.
- This requires:
 - front and rear axle differential locks
 - Center differential lock engaged in a Permanent 4WD system
 - Part time 4WD system engaged

What is True 4WD?





What is True 4WD?

- Optimum traction at a price
- Ideal for straight ahead driving
- When used need to account for and be aware of
 - Propeller shaft wind-up
 - Steering difficulty and restriction due to front axle locker
 - Directional difficulty when cornering and on slippery off camber surfaces.
 - Can result in being bogged down on soft surfaces – sand – especially when cornering
 - Places significant stress on drive train components
 - Uneven tire wear
 - Only used in extreme situations



Other 4WD Systems

- All wheel Drive [AWD]
 - Similar to Full-time 4WD but without low range and often without center differential lock.
 - Often use sophisticated electronics to direct power to wheels [Speed sensors, ABS, etc.]
- Automatic 4WD
 - Operates in 2WD until slippage is sensed [usually at rear wheels] and then shifts automatically into 4WD by engaging front axle



Conclusions

- Part time 4WD
 - Creates propeller shaft bind up when engaged and used on sealed surfaces
 - Under low traction:
 - Permits power to both front axle and rear axle
 - Permits power to a minimum of two wheels
- Full time 4WD
 - No propeller shaft bind up when used on sealed surfaces as long as center differential is not locked
 - Under low traction:
 - Permits power to only one axle
 - Permits power to only one wheel
 - When center differential is engaged performs as an engaged Part time 4WD system



Conclusions cont.

“Off highway 4WD systems”

- Part time 4WD [Selectable]
 - Has low range
- Permanent 4WD [Full time 4WD]
 - Has low range and central differential lock
 - Good “On highway 4WD system”

“On highway 4WD systems”

- Automatic 4WD
 - Usually does not have low range
- All wheel drive
 - Usually does not have low range



Which one is better?

- Full-time 4WD system equipped with a center differential lock can be used without disadvantage on sealed and unsealed surfaces.
- A Full time 4WD system equipped with a center differential lock offers better performance than a Part time 4WD system on sealed surfaces.
- A Full time 4WD system equipped with a center differential lock offers the same performance as a Part time 4WD system on low traction surfaces.
- **Bottom line: Understand and drive within the parameters of your 4WD system**