Manual Transmission / Transaxle

\[ \text{Power} = \text{Force (torque)} \times \text{Speed (rpm)} \]
A five speed tranny might have these gear ratio’s:
3.5:1   2.8:1   1.7:1   1:1   0.8:1

Which is the LOWEST gear in this 5 speed tranny?
1st gear

Which of these ratio’s is the LOWEST gear ratio?
3.5:1
First Gear

Low Gear Ratio’s

3.5:1 (3.5 to 1) Input Speed is High

3.5:1 (3.5 to 1) Output Speed is LOW

3.5:1 (3.5 to 1) Input Torque is Low

3.5:1 (3.5 to 1) Output Torque is High
A five speed tranny might have these gear ratio’s:

3.5:1  2.8:1  1.7:1  1:1  0.8:1

What gear gives the most Torque?

1st Gear - 3.5:1

What gear gives the most Speed?

5th Gear - 0.8:1

What gear gives the most Power?

All gears transfer equal power

1 horsepower = 550 foot-pounds per second

Power = ft lbs ÷ speed
Manual Transmission / Transaxle
Manual Transmission / Transaxle

Identify common gear nomenclature...

**Pitch** = distance between teeth on a gear

**Pitch Line** separates the **Face** from **Flank**

**Pitch Diameter** used to calculate gear **Pitch**
Gear Pitch

For any 2 gears to properly mesh they MUST have the same pitch.

Pitch = Number of Teeth ÷ Gear Diameter

Drive gear has 1” diameter and 20 teeth

Driven gear has 2” diameter and ? Teeth

(Will the larger gear have more teeth?)
Drive gear has 1” diameter and 20 teeth

Pitch = Number of Teeth ÷ Gear Diameter

\[
\frac{20}{1} = 20 \text{ the Drive gear has a pitch of 20}
\]

Driven gear has 2” diameter and ? teeth

using algebra... \[
\frac{20}{1} = \frac{X}{2} \text{ is the same as } \frac{2}{1} \times \frac{20}{1} = \frac{2}{1} \times \frac{X}{2}
\]

\[2 \times 20/1 = 40/2\]

40 the Driven gear must have a pitch of 40
2:1 gear ratio

Diameter of Gears
input = 1 inch    output = ?  2 inch

Number of Teeth
input = 25 teeth   output = ?  50 teeth

Force of Gears
input 100 = ft lbs  output = ?  200 ft lbs

Speed of Gears
input = 2,000 rpm   output = ?  1,000 rpm
Calculate Gear Ratio

Input gear = 1”  Output Gear = 3.5”  Ratio = ?

3.5:1

Input teeth = 10   Output teeth = 35  Ratio = ?

3.5:1

Input force = 100 ft lbs  Output force = 350 ft lbs

Ratio = 3.5:1

Input speed = 3,500 rpm  Output speed = 1,000 rpm

Ratio = 3.5:1
Calculate Gear Ratio

Input gear = 1”  Output Gear = 2.8"
Ratio = 2.8:1

Input teeth = 10  Output teeth = 17
Ratio = 1.7:1

Input force = 100 ft lbs  Output force = 100 ft lbs
Ratio = 1:1

Input speed = 2,400 rpm  Output speed = 3,000 rpm
Ratio = 0.8:1  (overdrive)
A five speed tranny might have these gear ratio’s:

3.5:1  2.8:1  1.7:1  1:1  0.8:1

Which is the LOWEST gear in this 5 speed tranny?
1st gear

Which of these ratio’s is the LOWEST gear ratio?
3.5:1
A five speed tranny might have these gear ratio’s
3.5:1    2.8:1    1.7:1    1:1    0.8:1

What is the ratio for second gear?
2.8:1

What is the ratio for third gear?
1.7:1

What is the ratio for fourth gear?
1:1

What is the ratio for fifth gear?
0.8:1
A five speed tranny might have these gear ratio’s

3.5:1     2.8:1     1.7:1     1:1     0.8:1

What is the lowest gear ratio?
3.5:1

What is the highest gear ratio?
0.8:1

What gear is Direct Drive?
4th Gear - 1:1

What gear uses Over Drive?
5th Gear - 0.8:1
A five speed tranny might have these gear ratio’s
3.5:1  2.8:1  1.7:1  1:1  0.8:1

What gear gives the most Torque?
1\textsuperscript{st} Gear - 3.5:1

What gear gives the most Speed?
5\textsuperscript{th} Gear - 0.8:1

What gear gives the most Power?
All gears transfer equal power

1 \text{ horsepower} = 550 \text{ foot-pounds per second}

\text{Power} = \frac{\text{ft lbs}}{\text{speed}}
Which gear turns fastest, A or C?
Which gear turns with most Torque, A or C?
A turns Clockwise, which direction do B and C turn?
Gears freewheel on output shaft until selected
Which is low gear? (1\textsuperscript{st} gear)
Which is high gear? (5\textsuperscript{th} gear)
Is 5\textsuperscript{th} gear an overdrive?
Input shaft (clutch shaft) turns Clockwise
Which direction does the Counter Shaft turn?
Which direction does gear E turn?
Which direction does gear F turn?
External gears reverse rotational direction
Spur Gear

Often used for reverse

Noisy - whines at higher RPM

No thrust load
Axial or Thrust Load must be controlled when Helical Gears are used.
Helical Gear

Stronger – more tooth contact area.

Requires Thrust washers or bearings

Quieter than Spur Gear

Used in some transmissions for Reverse Gear
FIGURE 4-3 Helical gears produce a side thrust action because of the angle of the gear teeth.

FIGURE 4-4 External gears in mesh. Spur gear teeth placed around the outside diameter of a pinion and wheel will rotate in opposite directions.
Synchronizers

ALL Gears are in Constant Mesh (except reverse in some transmissions)

Gears on Output Shaft freewheel and ALL turn at different speeds

Synchronizer is a Clutch that will speed or slow gears to match the speed of output shaft
Synchronizer in neutral position before shift
The Hub is splined to the Output Shaft
Synchronizer in Neutral
both gears freewheel on output shaft
Synchronizer Sleeve moves Blocker Ring Towards desired gear
Blocker Ring contacts Cone of Driven Gear

Friction will cause driven gear to spin at the same speed of the Output Shaft
Shift Sleeve slides over Dog Teeth of Blocker Ring and Clutch Teeth on Driven Gear
Driven Gear is now fully locked to Output Shaft
Teeth must not be pitted, cracked, chipped, or broken.

Inspect clutch teeth.

Clutch Teeth lock to Synchro Sleeve and Hub.

Blocker Ring Contact

Tapered area must be smooth

Bore must be smooth to freewheel on Output Shaft.
Blocker Rings have sharp teeth to cut through gear oil
Made of Brass to resist heat of friction
Blocker Rings wear - need replaced when rebuilding

![Diagrams showing sharp and dulled teeth](diagram.png)
Shift Linkage

Can be:

External Rod & Lever
External Cable
Internal

Most are adjustable
– be sure to read procedures
Rod & Lever linkage
Cable linkage
Alignment hole

Shift linkage adjustment nuts
Internal Linkage

Internal linkage is located in this housing.

Transmission input shaft

Transmission housing

Gearshift
Internal Linkage

LEVER BALL
CAP
SPRING SEAT
FIRST-SECOND RAIL
SHIFT LEVER
INTERLOCK PIN
HOUSING ASSEMBLY
PIN (2)
BACKUP LIGHT SWITCH
FIRST-SECOND SWITCH
FIRST-SECOND SHIFT FORK
REVERSE SHIFT FORK
FIRST-SECOND GATE
THIRD-FOURTH GATE
THIRD-FOURTH SHIFT FORK
POPPET BALLS AND SPRINGS
REVERSE PLUNGER AND SPRING
REVERSE GATE
SHIFT RAIL PLUGS
THIRD-FOURTH RAIL
INTERLOCK PLUGS
REVERSE RAIL
REVERSE RAIL
Detent vs Lockout

Shift linkage will use a spring loaded detent

Detents will “pop” into position to hold in gear and provide feedback to driver

Lockout will move to only allow one shift fork or shift rail to move at a time.

“locks out” selecting 2 gears at the same time
DETECTION BALLS

DETECTION BALLS

TWO OF THREE SHIFT RAILS

INTERLOCK PINS

UPPER BORE
(1-2)

MIDDLE BORE
(3-4)

BOTTOM BORE
5TH-REVERSE

SPRINGS SHORTER IN LENGTH
Manual Transmission / Transaxle Lubrication

Proper Lubrication will...

… Reduce friction and power loss

… Protection against rust and corrosion

… Cool the Bearings and Gears

… Carry away metal particles

… Reduce noise from the gear box
Gear Lubricants can be Multi-Viscosity. Rated by Society of Automotive Engineers (SAE)

W stands for Winter or the Viscosity when COLD 80W-90 has viscosity of 80 when cold and 90 hot.
The American Petroleum Institute (API) also rates gear oil.

GL-4 and GL-5 are commonly specified.

GL stands for Gear Lube

GL-4  for most transmissions using Gear Lube
GL-5 has about twice the Extreme Pressure additives
   Required for some transmissions and Differentials

BE SURE TO LOOK UP PROPER LUBRICANT
Always be Positive you use the Proper Lubricant
Wrong lube causes foaming, leaks, hard shifting, burned shafts and bearings

Proper Lubricant Might Be…

… SAE 75W to SAE 140W Gear Lube
… Multi-viscosity such as: 75W-90
… Engine Oil (Single or Multi Viscosity)
… Synchromesh Transmission Fluid (STF)
… Automatic Transmission Fluid

LOOK UP Proper Lubricant before adding any oil
Servicing Manual Transmission / Transaxle

Identify importance of visual inspection and attention to oil leaks
Visual Inspection

Motor Mounts
Shift Linkage
Clutch evaluation
Check for Oil leaks
Inspect drive shafts
Oil Leaks

Improper lubricant may foam out of vent
Overfilled Transmission leaks out vent
Worn bearing allowing shaft movement causing leaks at seals
Loose case bolts
Plugged vent causes leaks at seals
Worn seal or Output shaft bushing
Transmission Oil Leaks

Minor leaks/fluid stains are normal

Some seals and gaskets can be replaced without dis-assembly

Over-fill can cause leakage
Wrong – contaminated lubricant can cause leaks

Recommend changing transmission oil when repairing transmission leaks

Do not partially disassemble gears, shafts or cases without properly overhauling transmission
Proper Fluid Level

Over-filling will cause tranny leaks at vent

Some units have dipstick

Warm fluid expands

Fill to within 1/4 inch of fill plug hole

(If tranny is hot, fill to bottom of fill plug)

Insure proper fill plug is removed

Some transaxles use separate fill plug for differential
Changing Transmission Fluid

Drive vehicle to warm fluid

Drain lubricant
(warm fluid drains more completely)

Replace drain plug washer
or use sealer on pipe plug

Check for accurate fill level

Over-full = leakage at vent

Under-full = overheating
Troubleshooting Transmission/Transaxle

Many problems can be solved with careful inspection of Clutch, Driveline, Motor Mounts, Shift Linkage, Linkage Adjustment
Vibration

May be caused by out of balance drive line,

...worn universal or CV joints,

...improper drive line angle,

...imbalanced wheels,

...misadjusted wheel bearings

...clutch problems.

Most Transmission and Transaxle Vibrations Will Also Cause Abnormal Transmission Noise
Gear Clash or Grinding

Clutch drag – not fully releasing

Lubricant level low (cause binding gears)

Lubricant viscosity too thick

Worn mis-adjusted shift linkage (not fully engaging)

Bent or worn shift fork (rebuild or replace tranny)

Worn Synchronizer assembly (rebuild/replace tranny)

Binding gears / misaligned shafts (rebuild/replace tranny)
Causes for Hard to Shift

Any condition that can cause gear clash can cause hard shift into gear. (see previous slide)

shift linkage (always check adjustment first)

bent/damaged shift forks (rebuild/replace tranny)

malfunctions with detents, shift gates (rebuild/replace tranny)

any condition that causes a hard shift can also cause the transmission to stick in gear
Jumping out of gear

Loose/broken motor mounts

Clutch Bell housing misaligned

Binding or misadjusted shift linkage

Worn pilot bearing or input shaft bearing

Worn synchronizer

Worn shift forks or internal linkage

Worn detent spring
Transaxle Mis-Alignment

Can occur when replacing clutch, engine or transaxle

Causes Torque steer

Improper wheel alignment

Vibration

Check cradle alignment holes

measure motor mounts