Handy tools for counting the revs

By **Josh Giumelli**

Measurement is something we all probably take for granted, but some items are tricky to measure.

Shaft speed is one such measurement which can be difficult to measure directly. Unless the rotational speed of the shaft is very slow, and can be counted visually, there is little chance of estimating an accurate result.

Shaft speed is measured in revolutions per minute, or rpm, using a tachometer. The ability to measure rpm is vital when designing machinery, tuning it for best performance, or fault-finding when something is not operating as it should. This month, we look at the various ways of determining shaft speed and some handy tools to help us.

Fortunately, much of our machinery today has multiple shaft speed sensors fitted, enabling speed to be checked through a

Spin that wheel: There are many tools you can use for measuring shaft speed, and the good news is you don't need to spend a fortune. Photos: Josh Giumelli

Spin sensor: This spreader uses a magnet secured by a hose clamp on the shaft and a Hall effects sensor to measure spinner speed.

monitor or on a dash display. Most sensors operate off proximity, sending a digital pulse when a metallic object or magnet passes close by, such as a bolt head.

Accurate speeds on slower turning shafts often require the use of more than one proximity item, such as multiple bolt-heads placed around a pulley hub, or slots cut into a disc. Others may generate a pulse by the small current produced when a magnet on a shaft or pulley passes close by. Analogue tachometers produce a voltage which is proportional to shaft speed but are rarely used these days.

MEASURING RPM

There are plenty of ways to measure the rotational speed of a shaft. In the past, petrol-engined vehicles would simply use a low tension electrical pulse off the ignition system to feed to a tachometer.

Diesel engines, which have no ignition system, used a rotating cable driven from the engine, or rear of the alternator/generator to operate a mechanical tachometer.

Later systems used a voltage tapping from the alternator to generate a speed signal. Now, displaying engine speed involves a few lines of computer code in the engine's ECU to calculate and display rpm.

Measuring rpm by hand can be done by two main methods – contact and non-contact. Contact methods involve placing a tachometer in direct contact with the end of a rotating shaft which involves risk of entanglement and injury. Non-contact tachometers are a more recent innovation and allow rpm to be sensed by using a laser to detect a piece of reflective tape attached to a shaft. Apart from the improved safety, this has the advantage that the shaft end does not need to be accessed.

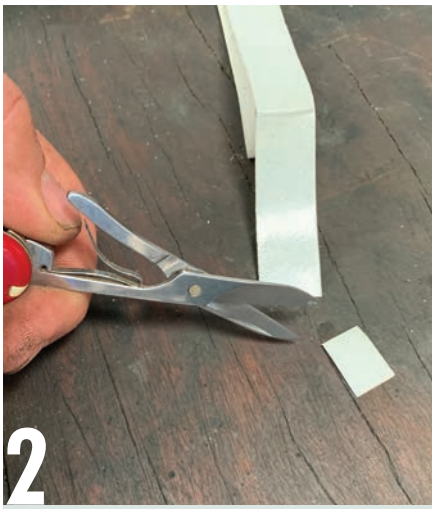
SAFETY WARNING

By its very nature, measuring shaft speed puts you in close proximity to spinning machinery and associated entanglement risks. While non-contact measurement tools are far safer, they often involve removing guards in order for the tool to have optical access. Take maximum care when using any of the measurement methods displayed in this article. Make sure long clothing or hair is kept well out of the way, and always replace any guards removed.

MEASURING RPM – NON-CONTACT

1

This non-contact tachometer is low cost and easy to use. While similar versions can be purchased for around $40-$50, we bought this unit for only $23 on ebay.com.au. It takes a single 9V battery.



2

The unit is supplied with a length of reflective tape. Cut a small amount off and remove the sticky backing.

3

Attach the tape to a shaft or pulley. The tape must not cover more than half the shaft. If the shaft is overly shiny or reflective, the tacho may not pick up the tape and give erroneous readings. If this is the case, simply wrap the shaft in black insulation tape before attaching the reflective tape.

MEASURING RPM – NON-CONTACT (continued)

4

Set the shaft in motion. With the tacho held a safe distance from the shaft, focus the laser dot on the shaft where the tape is attached. After a few seconds you should get a stable rpm reading.

5

Of course, there is nothing wrong with attaching the reflective tape to the face of a shaft or pulley. Choose the option which allows you to measure the speed in the safest manner. As the tacho basically measures the time between optical flashes, it will become less accurate on overly slow shaft speeds. If this is the case, simply attach two sections of reflective tape spaced 180 degrees apart and divide the rpm measurement by two.

MEASURING RPM – CONTACT

1

This digital tacho features both contact and non-contact functions for measuring rpm, and can measure surface speed using the contact wheel. The use of the non-contact tacho function is essentially the same as outlined previously.

2

The unit is supplied with a range of shaft adaptors for contact rpm measurement, as well as a wheel for measuring surface speed. The pointed adaptor is the one used most often.

3

Set the shaft in motion and press the pointed adaptor into the end of the shaft. If there is no centre drilling in the shaft end, you may be able to use a flat adaptor, but this is more tricky to centre the tacho on the shaft and get a reading without it slipping.

MEASURING RPM – CONTACT (continued)

4

Make sure the tacho is set to the contact – rpm setting. Depress the test/measure button and the speed should be displayed on screen.

5

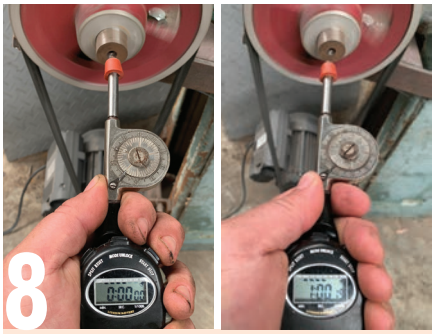
There are also mechanical hand-held contact tachometers which have the advantage of not requiring batteries. This tachometer displays speed on an analogue dial, with various rpm range settings selected via a sliding switch on the side. The reading on the face is then multiplied by the rpm range selector.

6

Some farmers may have one of these Starrett speed indicators hanging around in a collection of old tools. While they are a little more involved to use, they have the advantage of effectively averaging the shaft speed over a period of time. The unit is basically a worm drive counting wheel with a reduction ratio of 100:1. Make sure the mechanism is perfectly free before use.

7

The centre dial remains stationary when in use and is used to zero the outer dial which rotates. Rotate the inner dial so the raised bump lines up with the zero bump on the outer dial. There is no need to manually rotate the shaft to zero-in the tool. Note the graduated scale from zero to 100 revolutions runs both clockwise and anticlockwise to cater for different shaft rotation directions.



8

The easiest way to use the tool is simply time a minute with a stopwatch or a phone. Start the timer as the rev counter is engaged with the shaft, then disengage it when a minute is up. Count the number of times the raised bump on the outer dial makes a complete revolution. You can actually do this simply by feeling it with a finger each time it goes around.

9

Now examine the dial. Based on the rotation direction, we can see the outer dial has turned another 10 revolutions, as it lines up with the bump on the centre dial. As the dial made six complete revolutions during the minute, the shaft speed is 610rpm, which corresponds to that measured previously with the other contact tacho. To save time, you can measure for 30 seconds and double the result.

MEASURING RPM – IGNITION PULSE

1

There are several generic versions of these ignition pulse sensors available, commonly known as a Tiny Tach. A genuine Tiny Tach costs about $140, but this unit was purchased from ebay.com.au for around $20. They use a wire tail wrapped around the ignition high-tension lead to measure a slight induced current for each crankshaft revolution. Apart from the tacho function, they can also be hard-wired into any petrol stationary engine, doubling as an hour meter. Tiny Tachs for diesel engines are available (around $180) which use a small transducer attached to the injector pipe.

2

Here we are using the unit to test the idle and maximum rpm of a chainsaw. Wrap the wire tail four turns around the ignition lead. If it doesn't stay attached, use some insulation tape to hold it in place.

MEASURING RPM – IGNITION PULSE (continued)

3

Place the tacho in a convenient location where it can be easily read. Now start the saw or engine and measure the speed. Our idle speed (left) and maximum rpm (right) are shown above.

4

Most petrol engines produce one spark per crankshaft revolution, but there are variations for some models. A four-stroke engine with a camshaft-driven magneto or distributor will produce a spark every second crankshaft revolution. The tacho's default setting is one spark per rotation, but if it needs to be changed, hold the S1 button in for four seconds to cycle between 01 (spark plug fires twice per revolution – rarely used), 02 (fires once per revolution) or 03 (every second revolution).

MEASURING SURFACE SPEED

1

There are times when surface speed needs to be measured rather than rpm. This is most often when determining belt speed, or surface speed for machining operations. Although it can be easily calculated from shaft rpm, the optical/contact tacho featured previously has a surface speed function with output in metres per minute or feet per minute. Select the appropriate unit and attach the wheel supplied with the tacho.

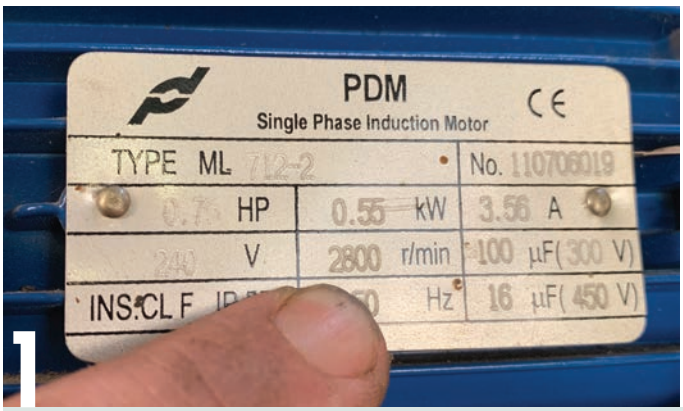
2

Carefully bring the wheel into contact with the belt, or the pulley rim if it sits flush with the belt and depress the measure button. The belt above is travelling at 306 metres per minute, or 306/60 = 5.1 metres per second.

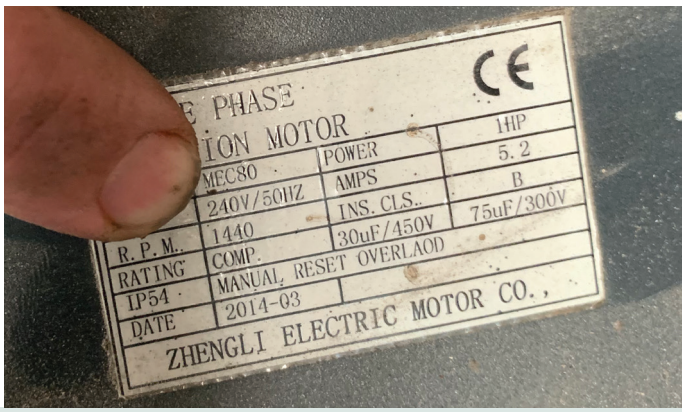
3

Alternatively, to calculate the speed from our rpm measurement, measure the pulley diameter. So for a 150mm pulley (0.15m diameter) turning at 608rpm, we simply multiply pulley circumference by shaft speed, or pi x D x rpm. So 3.142 x 0.15 x 608 = 286 metres per minute, or 286/60 = 4.8 metres per second, reasonably close to the previous measurement.

ELECTRIC MOTORS



1



Quite often, there is no need to directly measure rpm on machinery driven by electric motors. Single-phase electric motors generally turn at about 1400rpm (most common), or 2800rpm (less common, and mainly found on pumps) depending on how they are wound. Unless there is a variable speed control, or they are electrically commutated (EC), their speed is set by the supply frequency which in Australia is 50 Hertz or 50 cycles per second. The speed of driven equipment through a belt drive then can be easily calculated using the proportion of the pulley diameters. For example, a 1440rpm motor with a 150mm pulley drives a compressor with a 350mm diameter pulley. Therefore, the compressor will turn at about 1440 x (150/350) = 617rpm.

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