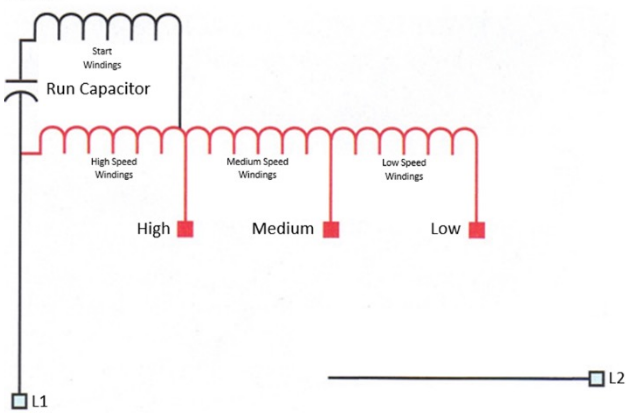
UNDERSTANDING VOYAGER'S TWO-SPEED COMBUSTION FAN MOTOR FOR THE POWER BURNER

The purpose of this Tech Tip is to explain Voyager's two-speed combustion fan motor (CFM) windings and internal connections to help better understand operation and troubleshooting. Additionally, it is to call out service bulletin RT-SVB106A-EN from November 6, 2012. This motor can be tough to understand and can leave the best of techs scratching their heads.

PSC Motors

To begin, we must understand how the windings of a 208-230v, single-phase, multi-speed, permanent split capacitor (PSC) motor are internally wired. See Figure 1.

Figure 1

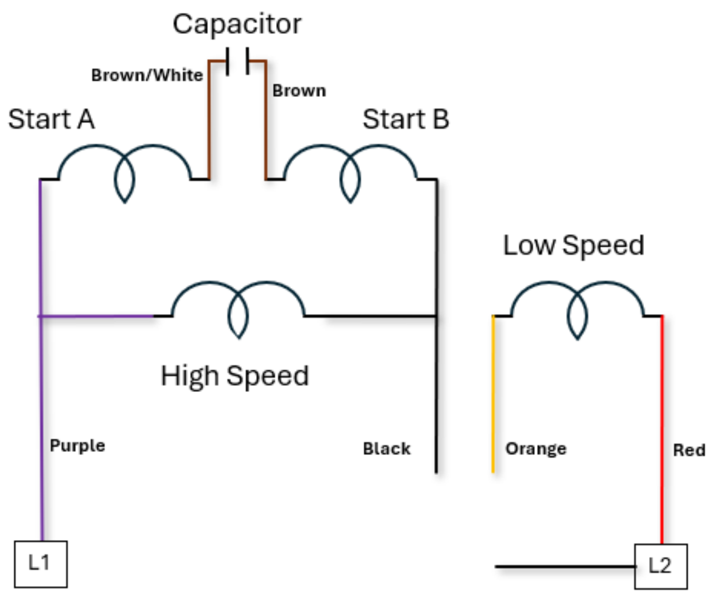


With one leg of the mains on L1 connected to the beginning of the start and run windings, you can then apply L2 with the other leg from the mains to any speed tap. A connection from L2 to the high-speed tap results in power flowing from L1 to L2 through the high-speed and start windings. The motor will run at high speed. Putting L2 on the medium speed increases the distance between L1 and L2 through the high and medium-speed windings. This increases the resistance, and the motor runs slower on medium speed. When L2 is put to the low-speed tap, the resistance between L1 and L2 is even greater, and the motor runs at a low speed. The high-speed tap is always closest to L1 and has the least resistance resulting in the highest speed. The further you get from there, the higher the resistance and the slower the motor runs. These three speeds are internally wired within the motor housing.

Voyager's CFM

Now, let's see how the windings of Voyager's 208-230v, single-phase, two-speed, PSC motor or CFM (combustion fan motor) are internally wired. See Figure 2.

Figure 2

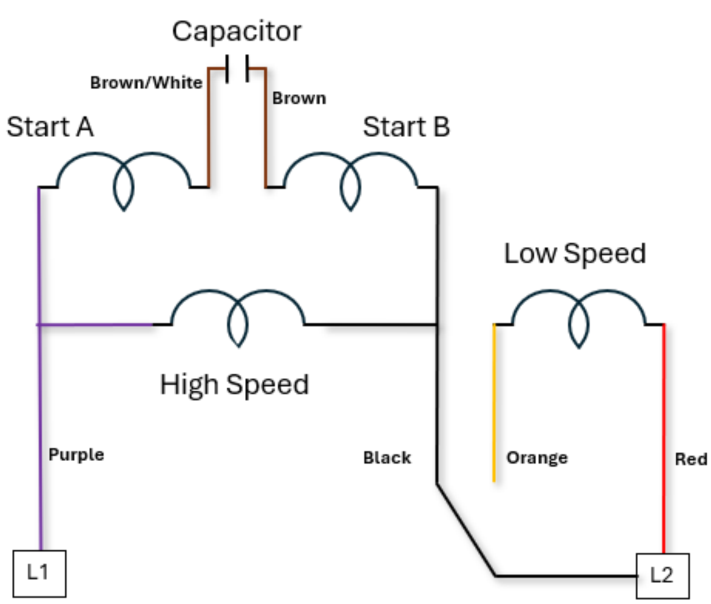


It's similar to the multi-speed PSC motor shown in Figure 1, but is missing the medium-speed and internal winding connections. The capacitor is also splitting the start windings, but otherwise does not change the operation. Each tap is labeled with the color found on these motors. There are a few different control schemes used, such as microcontrols and ReliaTel, but let us focus on just the motor. The motor will always work the same way. With one leg of power on L1 and the other on L2, there is no path for power to flow between L1 and L2 through the windings, and the motor will not run.

High Speed

How do we get the motor to run at high speed? We need a path for power to flow between L1 and L2. For high speed, it's through the high-speed windings. See Figure 3.

Figure 3

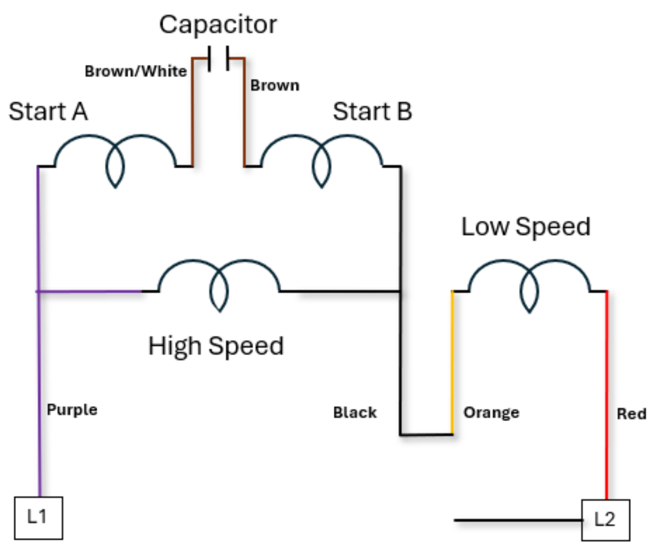


L1 and L2 remain connected to purple and red, but with nothing connected to orange, no power can flow through the low-speed windings. With L2 connected to black, power can flow between L1 and L2 through the start and high-speed windings, resulting in the least amount of resistance, and the motor spins at high speed. If the unit wants to run at high speed, the control scheme powers the purple and red taps, then connects L2 to the black tap, running the motor at high speed.

Low Speed

How do we get it to run at low speed? We need a path for power to flow between L1 and L2. For low speed, it's through the high-speed and low-speed windings. See Figure 4.

Figure 4



L1 and L2 remain connected to Purple and Red. Making an external connection between the end of the high-speed tap and the beginning of the low-speed tap, power can now flow between L1 and L2 through the high, start and low-speed windings, resulting in the highest resistance and the motor spins at low speed. If the unit wants low speed to run, the control scheme powers the purple and red taps, then connects the black and orange taps externally, running the motor at high speed.

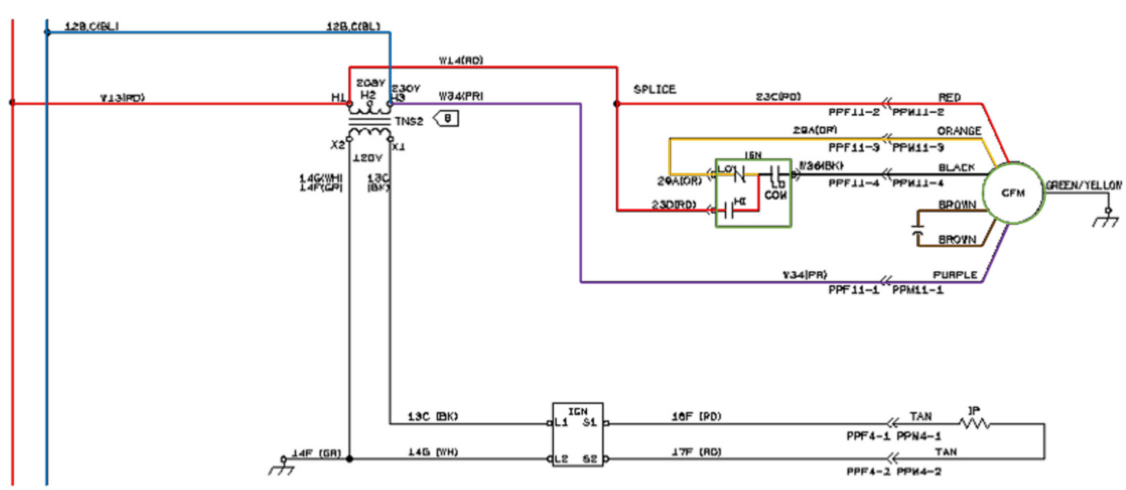
Motor Summary

This motor is nothing more than a 208-230v, single-phase, two-speed PSC motor that does not have internal connections between the high- and low-speed windings. The control scheme either puts L2 on the high-speed tap to run at high speed or makes an external connection between the high and low-speed windings to run at low speed.

Control Scheme

One control scheme in a Voyager, 208-230v, two-stage gas heat unit with ReliaTel controls is seen in Figure 5.

Figure 5



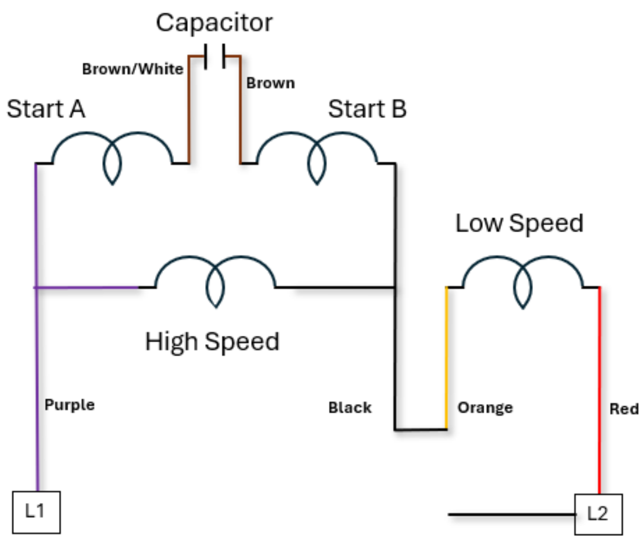
We see our CFM on the right with purple, black, orange and red taps. Purple and red are connected to L1 and L2 on the left through the primary connections at the igniter transformer. This means if the unit is powered, the red and purple are powered on the CFM. To the left of the CFM is the green box labeled IGN. This is the ReliaTel gas heat ignition control module. It connects the black wire to red or L2 for high speed. For low speed, it connects black to orange.

Troubleshooting

How to troubleshoot its operation? Start by verifying that you have 208-230v between red and purple. Pull black and orange from the ignition board. The motor should not be running. Jump black and orange together. The motor now has a path between L1 and L2 through the high- and low-speed windings, and it should run. Use caution when handling high-voltage wires. Possible reasons for motor failures are shorted windings to each other or to the ground, a bad capacitor or a foreign object wedged in the wheel.

You can also test resistance through the CFM. To start, disconnect the Molex plug at the motor and pull both brown wires from the capacitor. Measure resistance between the chassis ground and any tap. Greater than one mega ohm should be read. Anything less than one mega ohm is considered a short to ground. Next, test resistance tap to tap. See Figure 6 for resistance readings.

Figure 6



Purple to black = 58Ω - 68Ω	Black to Brown = 20.2Ω - 23.8Ω
Purple to Orange = OL	Black to Orange = OL
Purple to Red = OL	Black to Red = OL
Purple to Brown/White = 20.2Ω - 23.8Ω	Orange to Red = 82.2Ω – 96.4Ω

Test the resistance through the high-speed windings from purple to black ≈ 58Ω - 68Ω, the low-speed windings from red to orange ≈ 82.2Ω – 96.4Ω, start windings A at purple to brown/white ≈ 20.2Ω - 23.8Ω and finally start windings B from brown to black ≈ 20.2Ω - 23.8Ω. Values may differ slightly due to temperature.

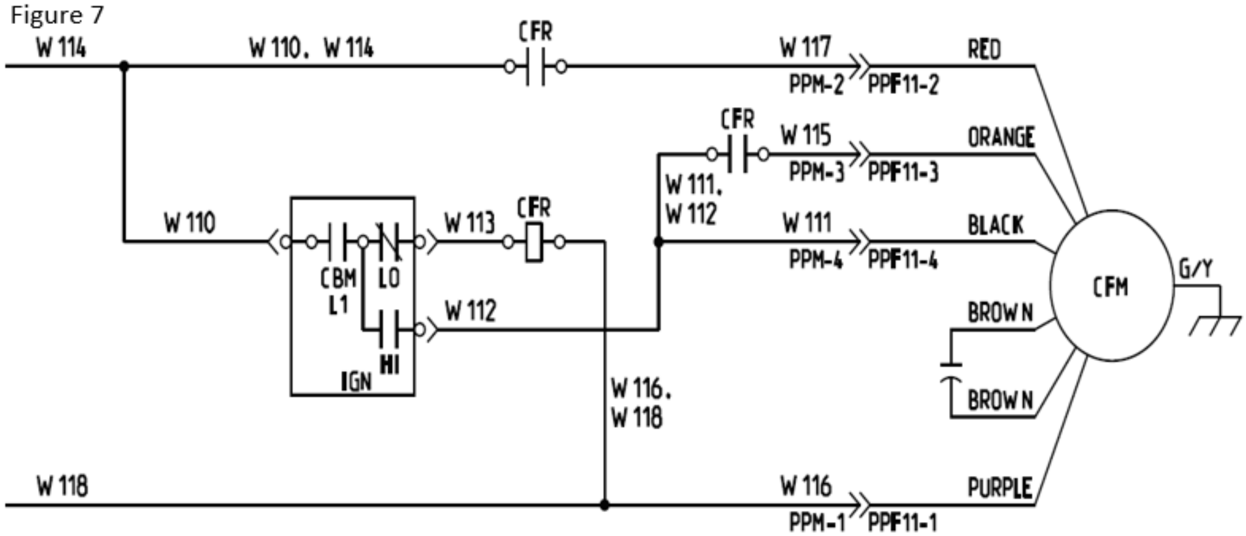
Example

Let's say you get to a Voyager unit with ReliaTel controls, and the CFM runs anytime the unit is powered, but you are in cooling mode. Why would the CFM run with no call for heat? How do you troubleshoot this? Well, the CFM should not run without a call for heat. Remove the black and orange wires from the ignition board. In this case, you can use the schematic in Figure 5. Does the motor still run? If not, the problem is back somewhere in the unit. If it still runs, the motor is bad. The windings are either shorted to each other or to ground, creating a short path between L1 and L2, L1 to ground, or L2 to ground, making the motor run. Test it out! Use the resistance values in Figure 6 to verify your initial findings.

Troubleshooting Summary

This is where the general service bulletin RT-SVB106A-EN from November 6, 2012 comes in. There are only four ways you are going to see this motor controlled. The first is with the older Microcontrol's big nine-inch square control board in the unit. This uses a heat relay to break one leg of power to the motor. The next is the most current version of ReliaTel, which also uses a relay to break one leg of power to the motor. Another way is from early 2007 to mid-2010, ReliaTel units did not break one leg of power to the motor. Purple and red were always connected to L1 and L2. See General Service Bulletin RT-SVB106A-EN. This bulletin describes the addition of KIT15855 to add a relay to break one leg of power to the motor. This will prevent the motor from running continuously as described in the example above should the motor shorten internally. The fourth way to control this motor is with ReliaTel and the addition of KIT15855 shown in Figure 7. Note, that this schematic is very similar to Figure 5, but the KIT15855 has been added showing the use of a combustion fan relay (CFR). ReliaTel units produced after 2010 have the CFR already in the unit.

Figure 7



For questions, contact Munch's Supply's Technical Support Department at **(815) 215-5020**.