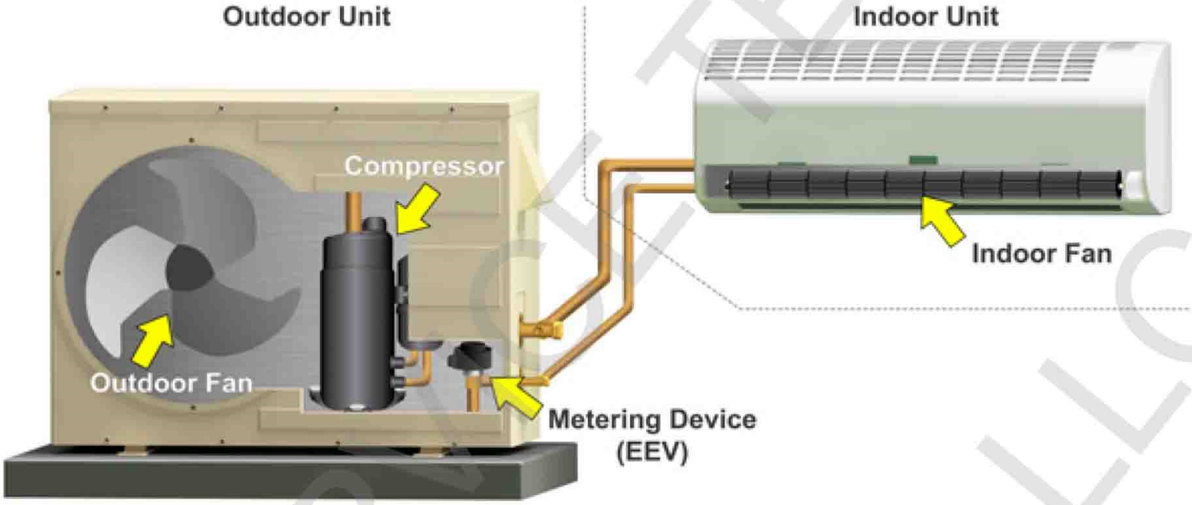

Figure 1-11: Main Components in a Mini Split System

set by the user. The use of inverter technology also allows for the possibility of multiple indoor units being connected to a single outdoor unit. Electrical operation is discussed in Unit 3. Other design innovations have led to even more increased electrical efficiency and the ability to produce heat even in cold climates.

5. Multi-Zone Mini Split Systems

Two or more indoor units can be connected to a multi-zone outdoor mini split unit. The multi-zone outdoor unit may be designed as a two zone, three zone, four zone, or five zone system (See Figure 1-12).

A technician can easily determine the number of zones on a system by counting the number of tubing flare adapter pairs on the outdoor unit (See Figure 1-13).

Figure 1-12: Multi-Zone Outdoor Unit Connected to Three Indoor Wall Mounted Units (Courtesy of Cooper&Hunter)

Figure 1-13: Multi-Zone Outdoor Unit Service Valves

I. EEV Internals

The lower body of the EEV has two tubes that enter and connect at a center chamber (See Figure 4-27). At this center chamber in the lower body, there is a pin that moves up or down to open or close the pathway between the two tubes. In the upper stainless steel shell, the pin is connected to a cylindrical permanent magnet. This permanent magnet has threads attached on the inside perimeter. In the upper shell, these threads line up with a stationary threaded post. Rotating the permanent magnet assembly, raises or lowers the pin. Typically, to move the pin upward and open the pathway in the lower body, the magnet is rotated counterclockwise, when looking downward at the top. Typically, to move the pin downward and close the pathway in the lower body, the magnet is rotated clockwise, when looking downward at the top.

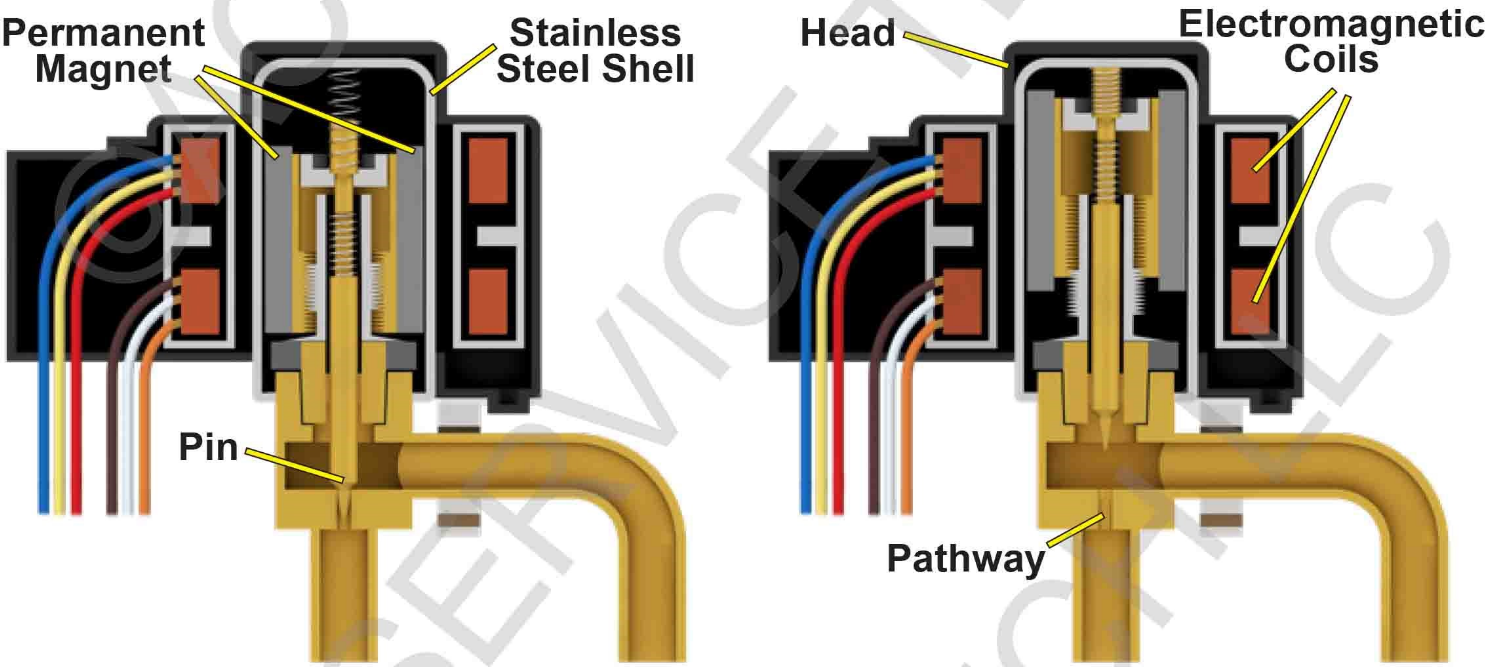

Figure 4-27: EEV in the Closed Position (Left), and in the Open Position (Right)

The specially designed permanent magnet in the upper shell has 10 or more north poles and 10 or more south poles. This differs from a standard permanent magnet which has only one north and one south pole. (A permanent magnet is one which is naturally magnetic.) The permanent magnet is attached to the pin, so rotating a separate magnet, with the same amount of north and south poles, outside the stainless steel shell, will cause the pin to slowly move up or down. The stainless steel shell around the pin assembly is there to protect and seal it. There is also a spring between the top of the shell and the permanent magnet assembly. Likewise, there is also a spring within the lower permanent magnet assembly. These springs help the threads on the magnet to return onto the threads mounted to the stationary post, after rotating from either the fully open or fully closed position.

In **Step 9**, the "10 Minute Standing Vacuum Test" is complete, no leaks are present, the micron level is holding, and the vacuum gauge is valved off from the system. The additional tools and supplies now needed are an electronic scale, a short refrigerant hose (preferably with a manual low loss valve on the end), and a refrigerant bottle with the same refrigerant that is in the outdoor unit.

Figure 7-28: Step 10-B of the Vacuum Procedure with a Bottle

Step 10-B, with Bottle (See Figure 7-28): Connect one end of the refrigerant hose to the bottle and the other end to the port on the end of the VCRT. (If using a hose with a manual low loss valve, connect the valved hose end to the VCRT port.) If using a **disposable refrigerant bottle**, the bottle must be flipped upside down to ensure liquid refrigerant exits the bottle. (If using a **reusable bottle**, the bottle does not need to be flipped upside down because there is a dip tube connected to the liquid port. This dip tube extends down inside the bottle to the bottom of the tank where the liquid is present.) Next, open the bottle handle to allow refrigerant into the hose. Purge air at the connection between the VCRT and the hose end so that only refrigerant is in the hose.

Figure 7-29: Step 11-B of the Vacuum Procedure with a Bottle

Step 11-B, with Bottle (See Figure 7-29): After purging air from the hose, place the bottle on the scale and turn the scale on. Zero out the scale. Determine the amount of refrigerant to be added based on the line set length, tube diameter, and manufacturer's data.

Figure 12-9: Non-Shielded Communication Wiring

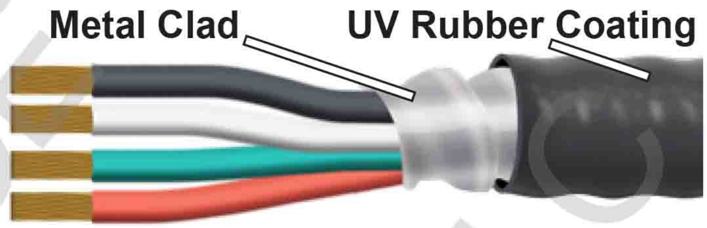

Figure 12-10: Shielded Communication Wiring

Unlike the short electrical whip for the power supply, containing three stranded wires that are loosely run through the flexible conduit, communication wiring for mini split units come in a long pre-cased roll. Communication wiring usually has four lengths of 16 gauge stranded wire. These four individually insulated, stranded wires are cased in a thin flexible rubber jacket (that resembles the outside of an extension cord) (See Figure 12-9) or cased in metal clad with UV and water-resistant rubber coating on the outside (See Figure 12-10). Although it may be common to see non-shielded communication wiring exposed outside on an existing installation, this usually does not meet code requirements. Usually, communication wiring must be shielded when running from the outdoor unit to where it enters the building structure. This is because, not only is the wiring allowing low voltage signals for communication, but also high voltage power to run to the indoor unit. Make sure that either the communication wiring is shielded with flexible conduit, or use communication wiring that is already shielded. Pre-shielded communication wiring may use metal clad with UV and water resistant rubber coating on the outside. In any case, make sure that water-tight connectors are used at the outdoor unit for the shielding/conduit connection (See Figure 12-11). If the outdoor unit is a multi-zone unit, this requires communication wiring to be installed from the same outdoor unit to each of the indoor units. If a system with a branch box is installed, the communication wiring may differ. **Make sure to read and follow the manufacturer's installation instructions before wiring as manufacturer's installation guidelines supersede any instructions in this book.**

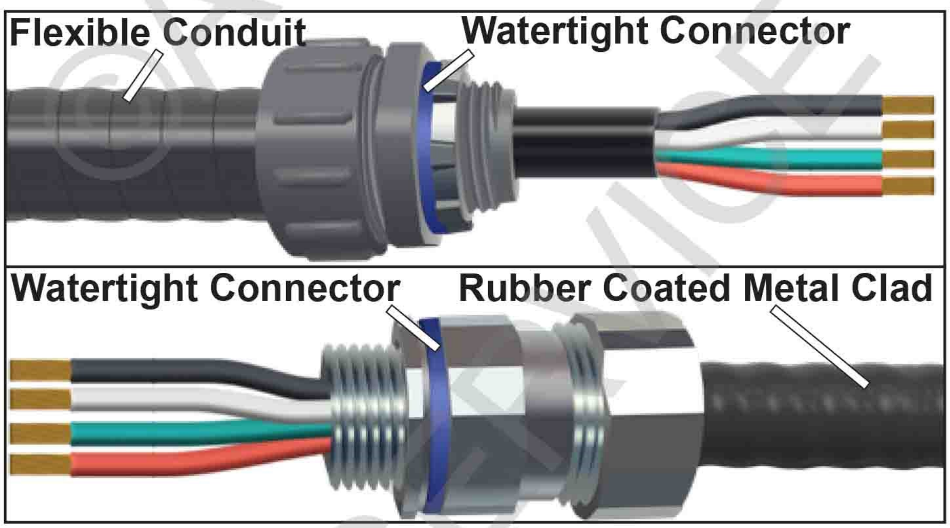

Figure 12-11: Water Tight Connectors on Flexible Conduit (Top) and Shielded Wiring (Bottom)

On a single zone system, the communication wiring connection points are fairly simple. These are labeled as 1, 2, 3, and G at both the indoor and outdoor units. Make sure to connect the green ground wire to the G ground terminal.

F. The Outdoor Unit PCB Controls the Refrigerant Compressor

The outdoor unit main PCB communicates with the outdoor compressor motor's IPM. The IPM may be a separate electrical circuit board in the outdoor unit or combined with the main PCB as a combination board. In Figure 12-27, the combination PCB/IPM powers the 3-phase wound, brushless DC compressor motor with a varying voltage and electrical frequency. The outdoor unit main PCB monitors the temperature inputs and communicates with the indoor unit PCB to determine the appropriate compressor pumping speed. For more information on the electrical operation of the refrigerant compressor, see Chapter 14, Section 4.

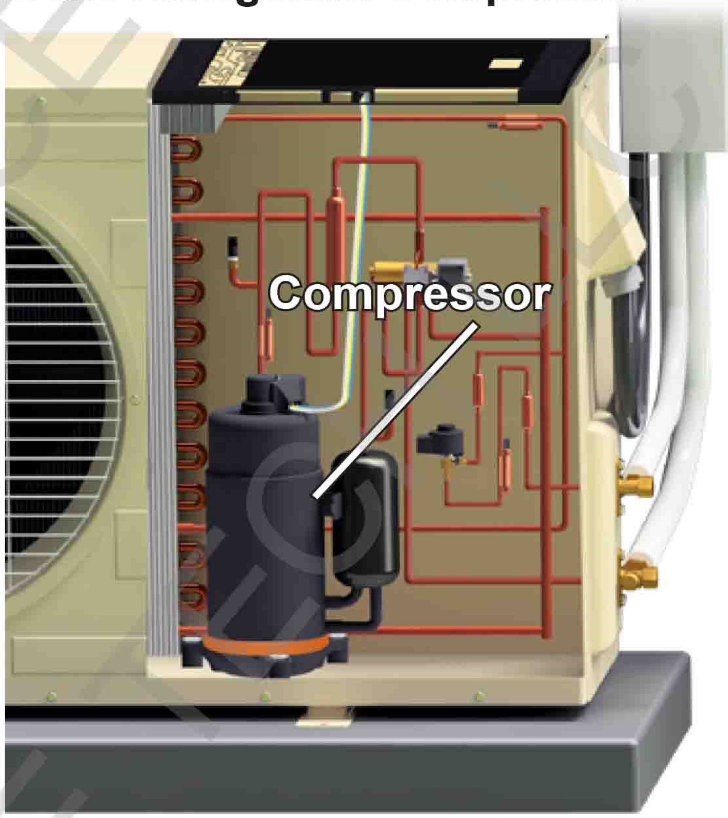

Figure 12-27: Compressor and Wiring

G. The Outdoor Unit PCB Controls the Compressor Crankcase Heater

The outdoor unit main PCB directly powers the crankcase heater (See Figure 12-28). The crankcase heater is powered in order to preheat the compressor oil. This is done prior to the compressor operating in low outdoor ambient temperatures. Preheating the compressor oil reduces the chance of refrigerant migration toward the compressor. The main PCB only powers the crankcase heater after the programmed time increment has passed, and if it measures a low enough outdoor temperature. For more information on the electrical operation of the crankcase heater, see Chapter 14, Section 5.

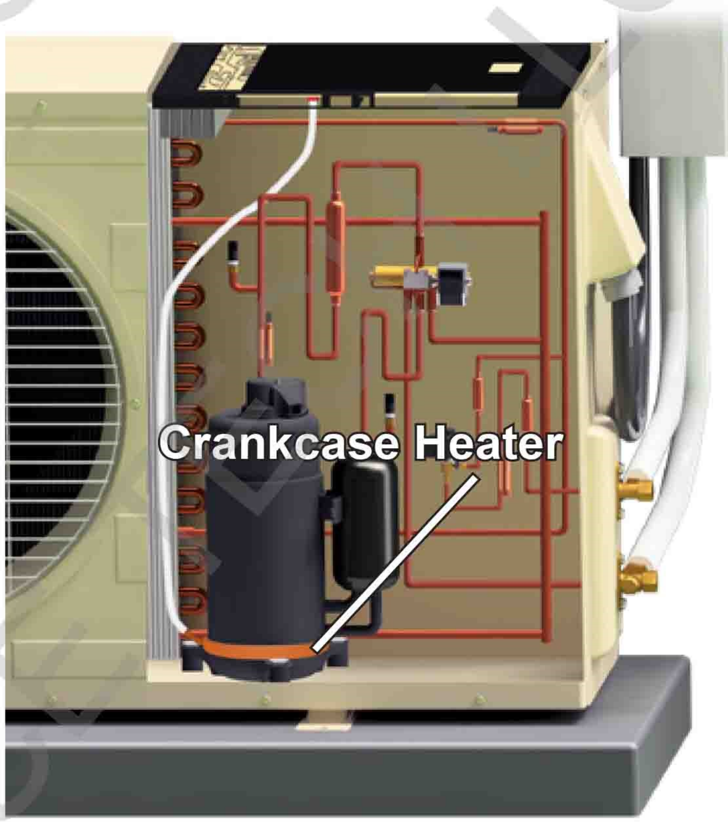

Figure 12-28: Crankcase Heater and Wiring

B. Testing

To determine if a 3-phase motor is bad, set the system on standby mode and turn the power off to the unit. Unplug the wire harness of the motor from the IPM. Make sure the motor can spin freely. Make sure there is no wobble noticed on the fan blades while spinning. Stop the motor from spinning and measure the electrical resistance of each pair of wires. Each pair should match because it is a 3-phase wound motor. Below is an example of the resistance values measured on a 3-wire, 3-phase fan motor. The ratings posted on the motor in this example are 34W, 310V, and 0.16A (See Figure 15-17).

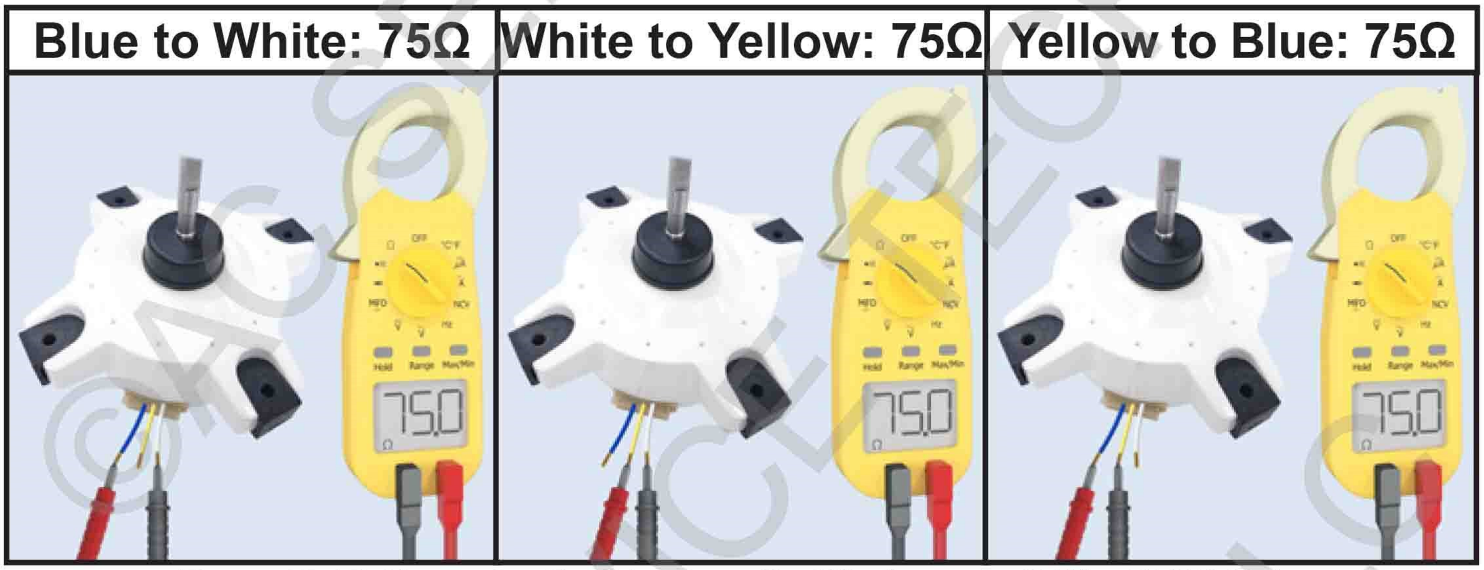

Figure 15-17: Measuring Resistance on the Windings of a 3-Wire BLDC Motor (Courtesy of Cooper&Hunter)

The electrical resistance value measured between all three pairs should match. If these values do not match, the motor is bad. If 0.L is measured between any of the pairs, this means that a motor winding is open, also indicating that the motor is bad. If the motor is bad, it must be replaced.

If there is a ground, such as a metal frame, the electrical resistance between each of the wires to the metal frame should measure 0.L. Measuring 0.L means that the windings are not shorted to the ground frame. Rarely does a 3-phase wound motor go bad, unless there is a mechanical problem that seizes the motor.

5. 5-Wire Brushless DC Fan Motor

A. Operation and Wiring

A 5-wire indoor fan motor (See Figure 15-18) has a shell that contains both a 3-phase wound BLDC motor and a BLDC motor driver board. This 5-wire DC motor assembly does not need a separate externally mounted IPM to control the