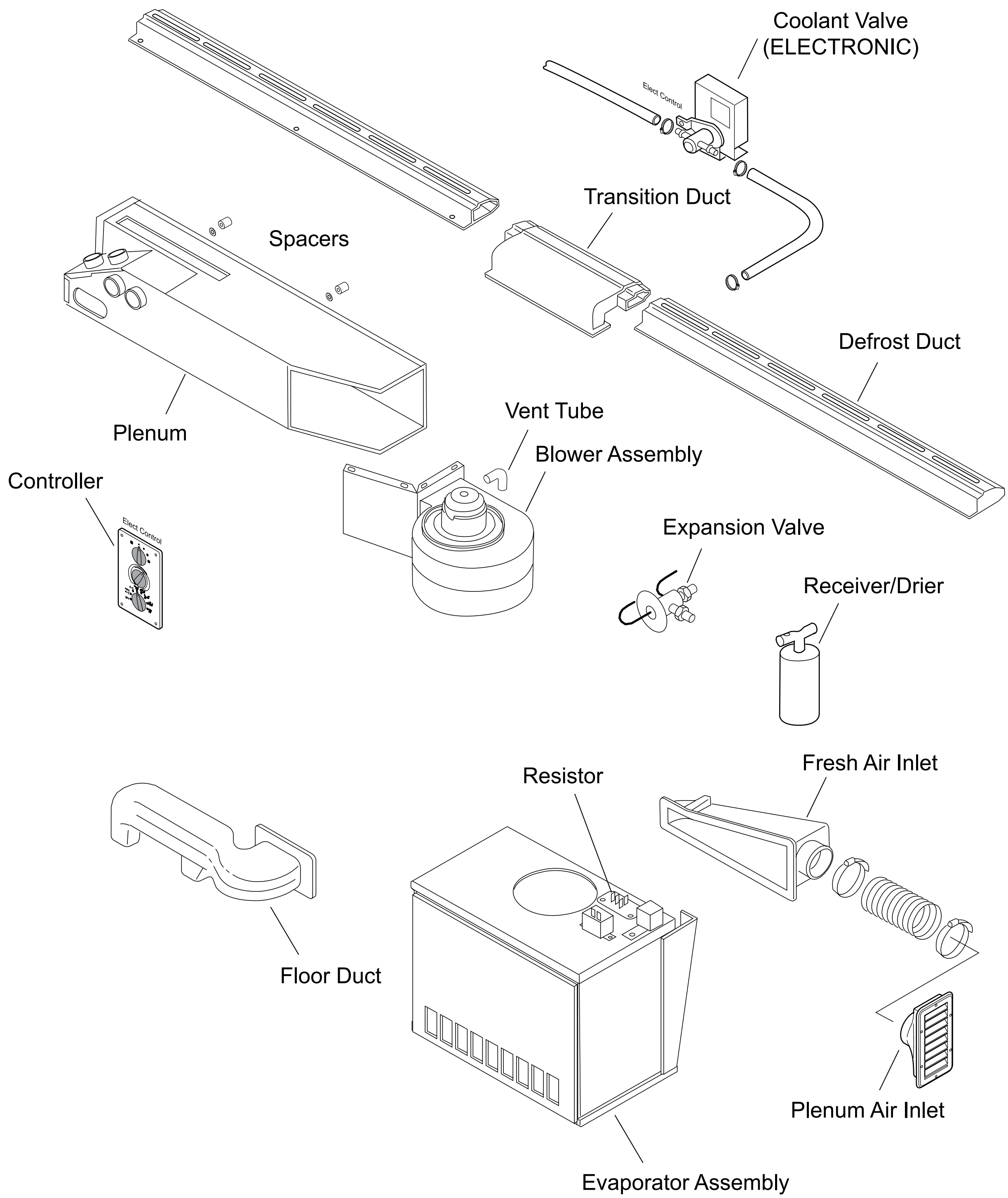
UTILIMASTER
A SPARTAN MOTORS COMPANY

# Service Guide

# Air Conditioning Overview

## Contents




*Heating and air-conditioning system (HVAC)*

## System Components

**⚠WARNING**

*Utilimaster recommends that a licensed automotive air-conditioning specialist work on the vehicle's air-conditioning (HVAC) system.*

### Compressor

The compressor is a pump powered by the engine via a drive belt. It draws in low-pressure refrigerant gas and exhausts it as high-pressure gas.

### Condenser

The air-conditioning condenser is located in front of the radiator. The condenser receives compressed (therefore heated) refrigerant gas from the compressor. As the hot refrigerant gas flows through the condenser, it is cooled by air passing over the fins. The cooled, compressed refrigerant gas condenses to liquid refrigerant, which then flows into the receiver/drier.

### Control Module

This driver-operated device is mounted on the dash. The control module sets the cab temperature, blower speed, and distribution of airflow for driver convenience. *See System Controls*

### Evaporator Assembly

The evaporator assembly is mounted to the right side of the dash and extends into the engine compartment. The resistor, thermostat, outside/recirculation door, heater core, and evaporator core are serviced from the vehicle interior. The drain hose and right-angle expansion valve are serviced from the engine compartment.

### Evaporator Core

The evaporator core used is a fin and tube core where liquid refrigerant flows into the expansion valve and vaporizes as it passes through the core. When the cooling system is in operation, the liquid refrigerant flows from the condenser unit through to the evaporator where it is allowed to evaporate at a reduced pressure, to cool the evaporator. Air is blown through the evaporator fins and is thus cooled by the evaporator.

### Expansion Valve

The expansion valve releases refrigerant into the evaporator according to cooling requirements. The restrictive effect of the expansion valve, while limiting the refrigerant flow to the evaporator, results in reduced evaporator pressure. The expansion valve consists of a valve and a temperature-sensing capillary tube and bulb. The valve is connected to the inlet tube of the evaporator, and the sensing bulb is clamped to the outlet tube of the evaporator.

The expansion valve is opened and closed by opposing pressures on either side of the diaphragm. The temperature-sensing bulb that is clamped to the evaporator outlet tube usually contains refrigerant. As the evaporator outlet temperature rises, the refrigerant expands and exerts pressure against the diaphragm to open the valve farther and admit more refrigerant into the evaporator for increased cooling. As the evaporator outlet temperature falls, the pressure against the diaphragm is decreased. Inlet pressure on the opposite side of the diaphragm then starts closing the valve. The valve tends to seek a position to control the refrigerant flow to maintain near-maximum cooling from the evaporator.

The temperature-sensing bulb, clamped to the suction (outlet) tube on the evaporator, measures the temperature of the refrigerant in the suction tube and transmits the temperature variation to the expansion valve. This temperature variation regulates the refrigerant flow to the evaporator core. When the bulb senses a high temperature, the valve opens and allows refrigerant to flow into the evaporator core. When the bulb senses a low temperature, the valve starts closing to reduce the refrigerant flow to the evaporator core.

### Manual Valves

Some vehicles are equipped with manual valves at the compressor similar to service valves. These valves do not have service ports and are used only to isolate the compressor.

### Receiver/Drier Unit

The air-conditioning system stores the liquid refrigerant under pressure in a combination receiver and dehydrator. The pressure in the receiver normally varies from about 552 to 2068 kPa (80 to 300 PSI), depending on the surrounding air temperature and compressor speed. The drier serves the purpose of removing any traces of moisture that may have accumulated in the system. Even one drop of moisture will cause an air-cooling unit to malfunction.

Whenever the air conditioning system has been opened (exposed to outside air), the receiver dryer shold be considered contaminated and be replaced.

### Service Valves

These valves are similar to a tire valve. The service valve in the high-pressure line (from compressor to condenser) allows access to the high-pressure side of the system for attaching a service hose and pressure gauge. The service valve in the low-pressure line (from evaporator to compressor) allows access to the low-pressure side of the system for attaching a service hose and pressure gauge.

### Suction Receiver/Drier

The receiver/drier is a canister between the condenser and the evaporator that removes water and acts as a storage reservoir for liquid refrigerant.

### AC Pressure Transducer

The 2016 and later Ford 6.8L gasoline engine has a pressure transducer that replaces the AC high pressure switch. The transducer sensor port is located on the compressor-condenser hose and connects to the chassis harness with a jumper harness.

## System Controls Overview

This section deals with the controls and components that are peculiar to the AC and heater system of Utilimaster vans with electronic controls.

The air conditioner used on the Utilimaster walk-in vans is an integral air-conditioner/heater system (stacked coil design) and is composed of an AC-heater plenum mounted on the right side of the cowl panel and an air distribution plenum and ductwork located behind the instrument panel. The control module assembly is located on the instrument panel, to the right of the steering column. The outlet registers can be adjusted to direct air.

### Blower Control Switch (11)

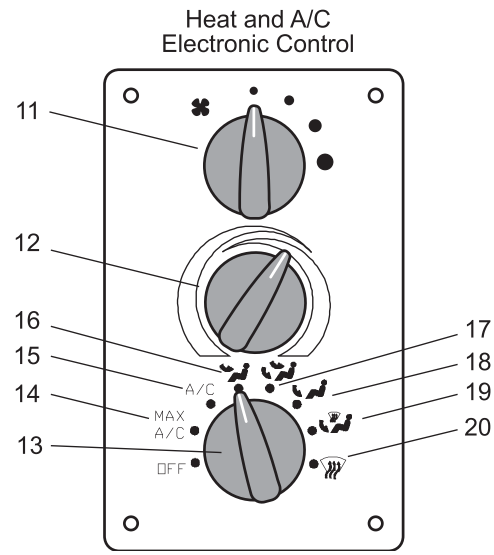
Off, Low, Medium Low, Medium, High

The blower motor is a variable-speed motor. The higher the voltage applied to the motor, the faster the speed.

### Cold/Hot Temperature Control (12)

The temperature control operates the coolant valve located in the engine compartment. The water flow to the heater core is proportional to the setting of the control knob.

The temperature control operates an electric servo attached to the coolant valve located in the engine compartment. The coolant valve is located in the engine compartment in the heater coolant inlet hose.




*Control module heater with AC*

### Function Selector (13)

The function selector actuates electric servomotors—one each for dash door, floor door, defrost door, and the outside/recirculating door. In the AC and Defrost positions, the compressor operation is dependent upon the evaporator thermostat settings. The thermostat senses the temperature of the evaporator core; the cutout temperature is 32 F ±2° F [0° ±1.1° C] (clutch is disengaged), and the cut-in temperature is 42° F ±2° F [5.5° ±1.1° C] (clutch is engaged).

With the function selector in the Off position, the outside/recirculation door is in the Recirculate Air position. It is closed to outside air, and no air passes through the system. The blower motor is off.

### Max AC (14)

In the Max A /C position the outside/recirculation door is in the Recirculated Air position. All of the air discharges through the panel louvers, except for a small amount of floor bleed. The AC compressor operates in this function control setting.

### AC (15)

In the A /C position the outside/recirculation door is open to the outside, and outside air is discharged through the panel louvers with a small amount of floor bleed. The AC compressor operates at this function control setting.

### Panel (16)

In the Panel position the outside/recirculation door is open to the outside, and outside air is discharged through the panel louvers, except for a small amount of floor bleed.

**Panel/Floor (17)**

In the Panel/Floor position the outside/recirculation door is open to outside air. Air is discharged through the heater outlet floor ducts and panel louvers.

**Floor (18)**

In the Floor position the outside/recirculation door is open to outside air. Air is discharged through the heater outlet floor ducts, and a small amount of bleed is directed to the windshield.

**Defrost/Floor (19)**

In the Defrost/Floor position air is discharged through both the windshield defroster hose nozzles and heater outlet floor ducts in approximately equal amounts.

**Defrost (20)**

In the Defrost position the air is discharged through the windshield defroster hose nozzles. There is also a small amount of floor bleed. The AC compressor operates in this control setting to help dehumidify the air.

## Refrigerant Precautions

The most commonly used refrigerant in automotive air-conditioner systems has been Refrigerant-134a. Refrigerant 134a is nonexplosive, nonflammable, and heavier than air. Although it is classified as a safe refrigerant, certain precautions must be observed to protect the parts involved and the person who is working on the unit.

**⚠WARNING**

*Utilimaster recommends that a licensed automotive air-conditioning specialist work on the vehicle's air-conditioning (HVAC) system.*

*Avoid breathing AC refrigerant and lubricant vapor or mist.*

*If accidental system discharge occurs, ventilate work area BEFORE resuming service. Additional health and safety information may be obtained from refrigerant and lubricant manufacturers.*

*Always wear safety goggles when servicing any part of the refrigerant system.*

*Certain precautions must be observed to protect the parts involved and the person who is working on the unit.*

*To remove R-134a from the AC system, use service equipment certified to meet the requirements of SAE J2210 (R-134a recycling equipment).*

*Liquid Refrigerant 134a, at normal atmospheric pressures and temperatures, evaporates so quickly that it has the tendency to freeze anything it contacts. For this reason, be very careful to prevent any liquid refrigerant from coming in contact with the skin and especially the eyes.*

*Refrigerant-134a is readily absorbed by most types of oil. It is therefore recommended that a bottle of sterile mineral oil and a quantity of weak boric acid solution be kept nearby when servicing the air-conditioning system.*

*Should any liquid refrigerant get into the eyes, immediately use a few drops of mineral oil to wash them out, then wash the eyes clean with a weak boric acid solution. Seek a doctor's aid immediately, even though irritation may have stopped.*

*The refrigerant in the system is always under pressure. Because the system is tightly sealed, heat applied to any part would cause this pressure to build up excessively.*

*To avoid a dangerous explosion, never weld, use a blow torch, solder, steam clean, bake body finishes, or use an excessive amount of heat on or in the immediate area of any part of the air-cooling system or refrigerant supply tank while they are closed to the atmosphere, whether filled with refrigerant or not.*

*The liquid refrigerant evaporates so rapidly that the resulting refrigerant gas will displace the air surrounding the area where it is released. The refrigerant will displace the oxygen, so always work in well-ventilated areas to prevent suffocation.*

*The discharge of refrigerant gas near open flame can produce a very poisonous gas. This gas will also attack all bright metal surfaces. This poisonous gas is generated when a flame-type leak detector is used. Avoid inhaling the fumes from the leak detector.*

**⚠WARNING**

*Never heat a refrigerant container with an open flame. If the container must be warmed, place the bottom of the container in a pail of warm water.*

*Never intentionally drop, puncture, or incinerate refrigerant containers.*

*Never store or heat refrigerant containers above 125° F [52° C].*

*If it is necessary to carry a container of refrigerant in a vehicle, do not carry it in the passenger compartment.*

*Always replace the metal screw cap to protect the valve and safety plug of the Refrigerant-134a container from damage when not in use.*

**⚠CAUTION**

*Use only Refrigerant-134a. Do NOT use refrigerant canned for pressure-operated accessories (such as boat air horns). This type is not pure Refrigerant-134a and will cause a malfunction.*

*R-12 refrigerant and R-134a refrigerant must never be mixed, even in the smallest of amounts. They are incompatible with each other. If the refrigerants are mixed, compressor failure is likely to occur.*

*Use only specified lubricants and components in the AC system. If lubricants other than those specified are used, compressor failure is likely to occur. All fittings and O-ring seals should be coated with clean mineral oil to provide a leakproof seal and aid assembly and disassembly.*

*Do NOT introduce compressed air to any refrigerant container or refrigerant component, because contamination will occur.*

**⚠WARNING**

*Before opening the refrigerant system, make sure the work area is well-ventilated. Welding or steam-cleaning operations should not be done on or near refrigeration system lines or other air-conditioning parts on the vehicle.*

**⚠CAUTION**

*All metal tubing lines should be free of dents or kinks to prevent loss of system capacity due to line restriction. Do NOT let the connection become kinked, crushed, or cross-threaded.*

*Never bend flexible hose lines to a radius of less than four times the diameter of the hose.*

*Do NOT allow flexible hose lines to come within a distance of 2.5" [6.5 mm] of the exhaust manifold.*

*Inspect flexible hose lines regularly for leaks or brittleness and replace with new lines if deterioration or leaking is found.*

*When disconnecting any fitting in the refrigerant system, the system must be discharged of all refrigerant. However, proceed very cautiously, regardless of the gauge readings. Open fittings very slowly, keeping your face and hands away so that no injury can occur. If pressure is noticed when a fitting is loosened, allow it to bleed off very slowly.*

**⚠ CAUTION**

*Alcohol should never be used in the refrigeration system in an attempt to remove moisture. Damage to system components could occur.*

*If any refrigerant line is opened to the atmosphere, cap immediately to prevent the entrance of moisture and dirt. Moisture and dirt can cause internal compressor wear or plugged lines in the condenser and evaporator core, expansion (orifice) tubes, or compressor inlet screens.*

*Remove sealing caps from subassemblies just before making connections for final assembly. Use a small a mount of clean mineral oil on all tube and hose joints. Use new O-ring seals dipped in mineral oil when assembling joints. The oil will aid in assembly and help provide a leakproof joint. O-ring seals and seats must be in perfect condition because a burr or a piece of dirt can cause a refrigerant leak.*

*It is important to use the proper wrenches when making connections on O-ring seal fittings. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connecting lines or components. When connecting the flexible hose connections, it is important that the crimped fitting and flare nut, as well as the coupling to which it is attached, be held at the same time using two different wrenches to prevent turning the fitting and damaging the seat. Tighten tubing connections to the specified torque.*

**⚠ CAUTION**

*Whenever it becomes necessary to disconnect a hose connection, wipe away any dirt or oil at or near the connection to eliminate the possibility of dirt entering the system. Both sides of the connection should be capped, plugged, or taped as soon as possible to prevent the entrance of dirt and moisture. Remember that all air contains moisture. Air that enters any part of the refrigeration system will carry moisture with it, and the exposed surfaces will collect the moisture quickly.*

*Keep tools clean and dry. This includes the manifold gauge set and all replacement parts.*

*When adding polyalkaline glycol (PAG) refrigerant oil, the container/transfer tube through which the oil will flow should be exceptionally clean and dry. Refrigerant oil must be as moisture-free as possible.*

*When it is necessary to "open" an air-conditioning system to the atmosphere, have everything needed ready so that as little time as possible will be required to perform the operation. Do NOT leave the air-conditioning system open any longer than necessary.*

*Anytime the air-conditioning system has been "opened," it should properly evacuated before recharging.*

## Diagnosis and Testing

**WARNING**

*Utilimaster recommends that a licensed automotive air-conditioning specialist work on the vehicle's air-conditioning (HVAC) system.*

**NOTICE**

*Details about your vehicle may vary from the general information provided here.*

### Overview (Refrigerant System)

Diagnosis of the refrigerant system must be done by analyzing the system's high- and low-pressure readings. Compare the pressure readings to the chart shown in Illustration to determine if the system pressures are normal. The conditional requirements for the refrigerant system tests must be satisfied to obtain accurate pressure readings.

If the conditional requirements are not satisfied, the pressure readings will not be accurate and could indicate that a normal system is not functioning properly. If the conditional requirements cannot be satisfied, the pressure readings will not be accurate but can be used to determine what is causing the problem in the system.

### Proper Use of Manual Valves

Manually operated valves are used in some vehicle applications. When in the “back seated” position, the low-pressure valve is open between the suction side of the compressor and the evaporator. The high-pressure valve is open between the discharge side of the compressor and the condenser. This is the normal operating position. In the “front seated” position, the low-pressure valve cuts off the suction side of the compressor from the evaporator. The high-pressure valve cuts off the discharge side of the compressor from the condenser.

### Attaching the Manifold Gauge Set

Test equipment **must** be connected to the refrigerant system when performing any of the various tests. If charge-station type of equipment is used, follow the instructions of the manufacturer. To attach a manifold gauge set to the service access gauge port valves, proceed as follows:

1. Turn both manifold gauges set valves fully clockwise to close the high- and low-pressure hoses at the gauge. Remove the caps from the high- and low-pressure service (Schrader) access gauge port valves in the high- and low-pressure lines.
2. Connect the high- and low-pressure refrigerant hoses with adapters containing depressing pins to the respective high- and low-pressure service access gauge port valves.
3. Connect the hoses attached to the manifold center fitting to refrigerant supply tank and vacuum pump valves.

### Checking for Leaks

1. Attach the manifold gauge set.  Leave both manifold gauge set valves at the maximum clockwise position.  Both gauges should show  approximately 60–80 PSI [414–551 kPa] 75° F [23.9° C] with the engine not running.
2. If very little or no pressure is indicated, leave the vacuum pump valve closed, open the refrigerant tank valve, and turn the low-pressure (suction) manifold gauge set valve to the counterclockwise position.  This opens the system to tank pressure.
3. Check all connections, the compressor head gasket, oil filter plug, and the shaft seal for leaks, using either the Rotunda Electronic Leak Detector 055-00014 or equivalent.

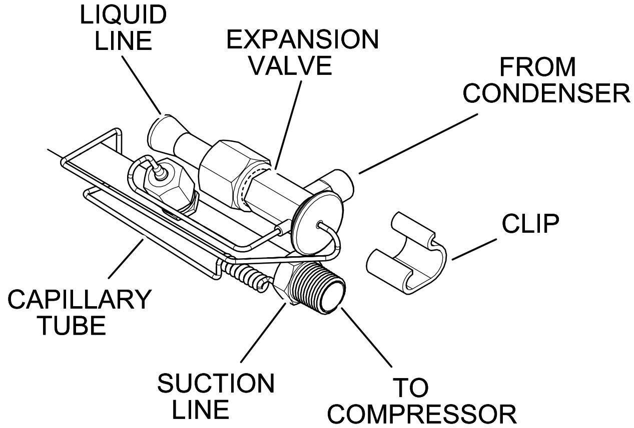
**NOTICE**

*Use compressed air to blow off excessive oil from the shaft seal area to reduce the possibility of an erroneous detection of refrigerant retained in the refrigerant oil.*

### Electronic Leak Detector

The battery-operated Electronic Refrigerant Leak Detector (Rotunda Model No. 055-00014 or equivalent) is an electronic instrument that will locate a much smaller type of refrigerant leak than can be detected by the flame-type leak detector.  Follow the directions with the leak detector to ensure absolute accuracy.  When the instrument is set to the On position, it automatically calibrates itself and is ready for detecting.  The counter-ticking/beeping signal will speed up as the flexible probe head comes closer to the refrigerant leak.

## Expansion Valve Test




*Expansion valve and capillary tube assembly*

In the properly operating standard refrigerant system, the expansion valve and capillary tube assembly will maintain the refrigerant flow required for maximum refrigerant system efficiency. Corrosion of the polished metal surfaces of the internal valve seat or valve stem in the expansion valve can cause erratic compressor suction and discharge pressures. This would be seen as a sudden increase in the discharge (high) pressure and, at the same time, the suction (low) pressure will suddenly decrease. The reverse might also happen—a sudden decrease in discharge (high) pressure combined with a sudden increase in the suction (low) pressure. Refrigerant system contamination in the form of sludge or moisture may also cause a similar compressor suction and discharge-pressure reaction. The blocking action of sludge in the valve seat will cause an increase in the compressor discharge pressure and a reduction of the suction pressure. When the sludge clears the valve seat opening, the discharge pressure will suddenly reduce, and the suction pressure will suddenly increase. Moisture, on the other hand, may cause the valve to stick in any position. When the valve is stuck closed, the higher compressor discharge pressure and temperature will soon thaw the frozen area and release the refrigerant, causing a sudden drop in compressor discharge pressure and increase in suction pressure. When the valve is stuck open, the increase in evaporator (suction) pressure and temperature aids in the thawing of the frozen area, and the expansion valve begins to function again.

To test the expansion valve:

1. Start the engine and run at fast idle (approximately 1500 RPM) in Max AC mode and blower speed on High for approximately 10 minutes.
2. Remove the insulation from the expansion valve temperature-sensing bulb. Remove the clamp and expose the bulb to the high engine compartment temperatures. The expansion valve should open with a resulting drop in compressor discharge pressure and an increase in compressor suction pressure.
3. Immerse the temperature-sensing bulb into a container of salted, melting, chipped ice or spray with liquid refrigerant. The expansion valve should close with a resulting increase in compressor discharge pressure and a reduction in compressor suction pressure.

The compressor pressures observed in Steps 2 and 3 should be smooth and deliberate. If at any time during the pressure change period you should see a hesitation followed by a jump in the pressure-gauge readings, the system may be contaminated and require cleaning. Corrosion of the valve stem may also be interfering with proper valve operation. If the compressor discharge pressure does not increase when performing Step 3, the expansion valve will have to be replaced.

### Measuring Temperature

This guide was developed to assist in evaluating air-conditioning systems. The information given is the result of extensive testing in laboratory conditions. Actual results may vary by as much as ±4° F [±2.2° C] due to variances in installation technique or chassis manufacturer.

The moisture content of the ambient air plays an important role in air-conditioner performance. Warmer air can contain more moisture than cooler air. In the cooling process, air often reaches "saturation" temperature, at which point no additional cooling can occur without a corresponding drop in moisture content. As relative humidity of the air to be cooled increases, a greater percentage of the system's refrigeration capacity is needed to extract the moisture, and less is available for actual cooling.

In the process of removing moisture, it is important that ice not be allowed to form and block the flow of air through the cooling (evaporator) coil. The system is equipped with a thermostat that will turn off the compressor clutch when the evaporator coil drops to a temperature at which ice could form. The discharge air temperature will be approximately 37° F [2.8° C] when the thermostat cycles the system off.

When testing the system it is important that the air entering the evaporator coil be the same temperature as the ambient air surrounding the coach. **Set the air-conditioner control to the NORMAL AC position (not Max AC).**

| R-134a TEMPERATURE PRESSURE CHART | | | | | | | |
|---|---|---|---|---|---|---|---|
| TEMP F | | PSIG | TEMP F | PSIG | TEMP F | | PSIG |
| 16 | | 15.69 | 60 | 57.47 | 110 | C | 146.50 |
| 18 | | 17.04 | 65 | 64.10 | 112 | O | 151.30 |
| 20 | | 18.43 | 70 | 71.19 | 114 | N | 156.10 |
| 22 | E | 19.87 | 75 | 78.75 | 116 | D | 161.10 |
| 24 | V | 21.35 | 80 | 86.80 | 118 | E | 166.10 |
| 26 | A | 22.88 | 85 | 95.40 | 120 | N | 171.30 |
| 28 | P | 24.47 | 90 | 104.40 | 122 | S | 176.60 |
| 30 | O | 26.10 | 91 | 106.30 | 124 | E | 182.00 |
| 32 | R | 27.79 | 92 | 108.20 | 126 | R | 187.50 |
| 34 | A | 29.52 | 93 | 110.20 | 128 | | 193.10 |
| 36 | T | 31.32 | 94 | 112.10 | 130 | R | 198.90 |
| 38 | O | 33.17 | 95 | 114.10 | 135 | A | 210.70 |
| 40 | R | 35.07 | 100 | 124.30 | 140 | N | 229.40 |
| 42 | | 37.03 | 102 | 128.50 | 145 | G | 245.80 |
| 44 | | 39.05 | 104 | 132.90 | 150 | E | 263.00 |
| 45 | | 40.08 | 106 | 137.30 | 155 | | 281.00 |
| 50 | | 45.48 | 108 | 141.90 | 160 | | 300.00 |
| 55 | | 51.27 | | | 165 | | 320.00 |
| | | | | | 170 | | 340.80 |

*Air-conditioner pressure performance chart*

## Measuring Pressure

Dash outlet temperature and pressures developed on the high-pressure (discharge) and low-pressure (suction) side of the compressor indicate whether or not the system is operating properly.

1. To test the system, attach the manifold gauge set with both gauge valves at the maximum clockwise, or closed, position. It will not be necessary to attach the refrigerant tank.
2. Check the system pressures with the engine running at 1500 RPM, all controls set for maximum cooling, and the front of the vehicle at least 5 feet from any wall. Use a large fan in front of the condenser to simulate vehicle motion. Operate the system under these conditions for 5–10 minutes in order for pressures to stabilize.
3. The actual pressures indicated on the gauges will depend on the temperature of the surrounding air and the humidity. Higher air temperatures along with high humidity will give higher system pressures. At idle speed and a surrounding air temperature of 100–110° F [37.7–43.3° C], the high pressure may go as high as 300 PSI [2069 kPa] or more. If it becomes necessary to operate the air conditioner under these conditions, keep the high pressure down with a fan directed at the condenser and radiator.
4. Measure the ambient (outside) air temperature with a thermometer held in front of the condenser. Referring to the Temperature Pressure Chart , compare the suction and discharge pressures to the values shown.

**NOTICE**

*Relative humidity of the air affects air-conditioner performance. As humidity increases, air-conditioning performance decreases.*

5. If the pressures are within or near the specified limits, but the cooling performance is poor, the problem may be related to the heater control valve. The evaporator/heater unit is a “stacked coil” design in which the conditioned air passes through both the evaporator and heater coils. The smallest amount of hot engine coolant in the heater coil will affect AC performance. Both the inlet and outlet heater lines at the unit should be cool if the heater control valve is functioning properly. Adjust or replace a leaking cable-operated valve or proceed to the Voltage Test (Temperature Control).
6. If the discharge (High Side) or suction (Low Side) pressures are not within the specified limits, see the possible causes chart below.

| | High Side Pressure | |
|---|---|---|
| **Low Side Pressure** | **Too Low** | **Too High** |
| **Too Low** | • Low refrigerant charge<br>• Expansion valve stuck closed<br>• Ice on evaporator due to defective thermostat<br>• Moisture in system causing ice in expansion valve | • Collapsed hose on high side<br>• Clogged receiver/drier |
| **Too High** | • Inoperative or defective compressor | • Overcharge<br>• Defective condenser fan<br>• Clogged condenser fins<br>• Expansion valve stuck open<br>• Contaminants in system |

### Redeiver/Drier Test

1. Operate the air conditioner for about 5 minutes.
2. Slowly move your hand across the length of the unit from one end to the other. There should be no noticeable difference in temperature.
3. If cold spots are felt, it indicates that the unit is restricting the refrigerant flow, and the receiver/drier must be replaced.

### Magnetic Clutch Test

1. If the magnetic clutch on the compressor does not pull in as it should, the battery should be checked for operation voltage (10 volts minimum).
2. If the operating voltage is within specifications, disconnect the electrical connector at the clutch coil.
3. Apply battery voltage to the coil feed wire. If the clutch engages, the clutch is OK, and the electrical problem is elsewhere in the system. If the clutch does not engage, replace the clutch.

### Excess Moisture

One of the characteristics of an air conditioner is that it will remove moisture from air passing through the cooled evaporator core. This moisture condenses, runs off the evaporator core, and is drained from the evaporator case. Because the AC system is a draw-through design (blower downstream of the evaporator core), the primary cause of condensation dripping or blowing into the passenger compartment is air being drawn through the drain tube, housing seals, holes or cracks in the housing, or other air-leak paths, thereby inhibiting condensation drainage. In some instances, due to environmental conditions (leaves or other foreign material plugging the drain) and sometimes mechanical conditions (damaged or kinked drain tube), the condensation is prevented from draining from the evaporator case. If either of these conditions exist, condensation may drip from the blower housing or be blown from the instrument panel registers.

Performing the following inspection and corrections can best eliminate the cause of insufficient evaporator case drainage or leaks.

1. Inspect the vehicle for missing grommets, plugs, or seals. Replace any missing grommets, plugs, or seals.
2. Inspect for correct sealing of the evaporator case-to-plenum gasket. Tighten the evaporator case-to-dash retaining nuts to correct a seal leak between the evaporator case and the cowl panel.
3. Inspect for possible air leaks around the refrigerant lines at the evaporator case. Seal any leaks around the refrigerant lines with Motorcraft® Insulating Tape YZ-1, Caulking Cord D6AZ-19560-A, or equivalent.

### Temperature Control Voltage Tests

The temperature is controlled by adjusting the center knob on the control head.

With the control set to the Max Cold position, the output of the dash potentiometer will be more than 11 volts. This voltage is fed to Pin 9 of the servo motor. The motor is then driven to the Max Cold position. As the dash control is turned to the Max Hot position, the voltage is decreased, and the servo is driven to match the voltage set at Pin 9 (Red/Black wire) of the servo. At the Max Hot position the output of the dash potentiometer will be less than 0.75 volts.

### Blower Motor Power

Blower motor power is supplied from the blower motor power relay.

Blower motor power relay supplies ignition switch power to the coil on Pin 88 (Blue wire) of the relay. A Gray wire from Pin 85 of the relay to Pin 20 of the controller is grounded through the controller in any position except Off, closing the relay contacts and energizing the blower motor.

### Blower Control

The blower motor is a variable-speed motor. The higher the voltage applied to the motor, the faster the speed.

When the heater and HVAC Control Head is in the Off position, no voltage is applied to the Low blower relay. The relay is Off, and no voltage is applied to the blower motor.

When in any other mode except Off, voltage is applied to the Low blower relay, and voltage is applied to the blower switch and the blower motor resistors.

When the blower switch is in Low, voltage is applied though the blower relay and blower motor resistors to the blower motor. The blower motor runs at low speed.

As the blower switch is moved though positions Medium Low and Medium, the switch bypasses part of the blower motor resistors, allowing more voltage to be applied to the blower motor. This will increase its speed.

When the blower motor switch is in High, voltage is applied to the coil of the High blower relay. The High blower relay is energized, removing the blower motor resistors from the circuit. Battery voltage is applied directly to the blower motor though the High blower relay contacts. The blower motor runs at maximum speed. The resistor assembly is located behind the right-hand floor duct.

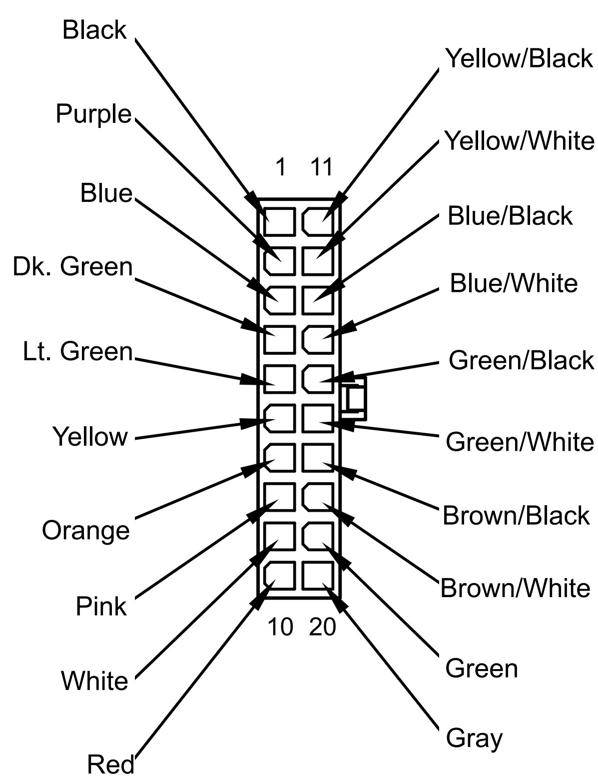
### AC Clutch Control

The AC clutch is energized in Max AC, AC, and in defrost mode to aid in defogging the windshield.

The AC clutch is supplied power to the coil on Pin 85 of the relay (Blue wire). Current then flows to the deicing switch on the Black/White wire. The de-icing switch closes above 35° F [1.7° C], allowing current to flow to the control module, grounding the relay and allowing the contacts to close. Current flows to the relay on Pin 30 through the closed contacts out Pin 87a on the Green wire to the high-pressure switch mounted on the receiver/drier. From the high-pressure switch the current flows to the low-pressure switch located on the inlet fitting of the evaporator. Then, via the Green wire, current flows to the AC clutch.

### Electronic Control Module Switch Test

1. Disconnect wire harness from the Control Module.
2. Using a DVOM (Digital Voltmeter), measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 2 (Purple wire) with the control switch in the Off position.
3. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Purple wire. If wires are OK, replace the control module switch.
4. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 3 (Blue wire) with the control switch in the Max AC position.
5. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Blue wire. If wires are OK, replace the control module switch.
6. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 4 (Dark Green wire) with the control switch in the AC position.
7. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Dark Green wire. If wires are OK, replace the control module switch.
8. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 5 (Light Green wire) with the control switch in the Panel position.
9. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Light Green wire. If wires are OK, replace the control module switch.
10. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 6 (Yellow wire) with the control switch in the Floor/Panel position.
11. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Yellow wire. If wires are OK, replace the control module switch.
12. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 7 (Orange wire) with the control switch in the Floor position.
13. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Orange wire. If wires are OK, replace the control module switch.
14. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 8 (Pink wire) with the control switch in the Floor/Defrost position.
15. If less than 2 ohms, go to the next step. If more than 2 ohms, check for an open circuit in the Black or Pink wire. If wires are OK, replace the control module switch.




*Control module connector*

16. Using a DVOM, measure the resistance from Pin 1 (Black wire) of the control module connector to Pin 9 (White wire) with the control switch in the Defrost position.
17. If more than 2 ohms, check for an open circuit in the Black or White wire. If wires are OK, replace the control module switch.

## Electronic Control Module Tests

| Mode Switch | Rec Motor | Defrost Motor | Panel Motor | Floor Motor | A\C Clutch |
|---|---|---|---|---|---|
| Off | Closed | Closed | Closed | Closed | On |
| Max A/C | Open | Closed | Open | Closed | On |
| A/C | Closed | Closed | Open | Closed | Off |
| Panel | Closed | Closed | Open | Closed | Off |
| Floor/Panel | Closed | Closed | Open | Open | Off |
| Floor | Closed | Closed | Closed | Open | Off |
| Floor/Defrost | Closed | Open | Closed | Open | Off |
| Defrost | Closed | Open | Closed | Closed | On |

### Off

In the Off position the current flows from the control module on the Purple wire to the mode switch to the control module ground. The blower motor power relay is de-energized, and all mode door are driven closed. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | +12v | 0v | +0 | +12v | +12v | 0v |
| Off 30 seconds after switched | +12v | +12v | +12v | +12v | +12v | +12v |

| | Rec Motor | | AC Relay |
|---|---|---|---|
| | Brown/White | Brown/Black | Green |
| Off | 0v | +12v | 0v |
| Off 30 seconds after switched | +12v | +12v | |

### Max AC

In the Max AC position the current flows from the control module on the Blue wire to the mode switch to the control module ground. The blower motor power relay is energized. The panel door is driven open, the rec door is driven closed to outside air, and the AC clutch relay is energized. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | +12v | 0v | +0 | +12v | +12v | 0v |
| Off 30 seconds after switched | +12v | +12v | +12v | +12v | +12v | +12v |

| | Rec Motor | | AC Relay |
|---|---|---|---|
| | Brown/White | Brown/Black | Green |
| Off | 0v | +12v | 0v |
| Off 30 seconds after switched | +12v | +12v | |

### AC

In the AC position the current flows from the control module on the Dark Green wire to the mode switch to the control module ground. The blower motor power relay is energized. The panel door is driven open, the Rec door is driven closed to inside air, and the AC clutch relay is energized. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | +12v | 0v | +0 | +12v | +12v | 0v |
| Off 30 seconds after switched | +12v | +12v | +12v | +12v | +12v | +12v |
| | Rec Motor | | AC Relay | | | |
| | Brown/White | Brown/Black | Green | | | |
| Off | +12v | 0v | 0v | | | |
| Off 30 seconds after switched | +12v | +12v | | | | |

### Panel

In the Panel position the current flows from the control module on the Light Green wire to the mode switch to the control module ground. The blower motor power relay is energized, and floor and defrost doors are driven closed. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | +12v | 0v | 0v | +12v | +12v | 0v |
| Off 30 seconds after switched | +12v | +12v | +12v | +12v | +12v | +12v |
| | Rec Motor | | AC Relay | | | |
| | Brown/White | Brown/Black | Green | | | |
| Off | +12v | 0v | +12v | | | |
| Off 30 seconds after switched | +12v | +12v | | | | |

### Panel/Floor

In the Panel/Floor position the current flows from the control module on the Yellow wire to the mode switch to the control module ground. The system power relay is energized. The panel and floor outlet doors are driven open. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | +12v | 0v | 0v | +12v | 0v | +12v |
| Off 30 seconds after switched | +12v | +12v | +12v | +12v | +12v | +12v |
| | Rec Motor | | AC Relay | | | |
| | Brown/White | Brown/Black | Green | | | |
| Off | +12v | 0v | +12v | | | |
| Off 30 seconds after switched | +12v | +12v | | | | |

### Floor

In the Floor position the current flows from the control module on the Orange wire to the mode switch to the control module ground. The system power relay is energized. The floor outlet door is driven open, and the panel door is driven closed. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | +12 V | 0 V | +12 V | 0 V | 0 V | +12 V |
| Off 30 seconds after switched | +12 V | +12 V | +12 V | +12 V | +12 V | +12 V |
| | Rec Motor | | A/C Relay | | | |
| | Brown/White | Brown/Black | Green | | | |
| Off | +12 V | 0 V | +12 V | | | |
| Off 30 seconds after switched | +12 V | +12 V | | | | |

### Floor/Defrost

In the Floor/Defrost position the current flows from the control module on the Pink wire to the mode switch to the control module ground. The system power relay is energized. The floor and defrost outlet doors are driven open. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | 0 V | +12 V | +12 V | 0 V | 0 V | +12 V |
| Off 30 seconds after switched | +12 V | +12 V | +12 V | +12 V | +12 V | +12 V |
| | Rec Motor | | A/C Relay | | | |
| | Brown/White | Brown/Black | Green | | | |
| Off | +12 V | 0 V | +12 V | | | |
| Off 30 seconds after switched | +12 V | +12 V | | | | |

### Defrost

In the Defrost position the current flows from the control module on the White wire to the mode switch to the control module ground. The system power relay is energized. The defrost outlet door is driven open, and the floor door is driven closed. The motors are driven to position for 30 seconds after the mode is selected, and then both motor inputs go high (+12 V to ground).

| Mode Switch | Defrost Motor | | Panel Motor | | Floor Motor | |
|---|---|---|---|---|---|---|
| | Green/White | Green/Black | Blue/White | Blue/Black | Yellow/White | Yellow/Black |
| Off | 0 V | +12 V | +12 V | 0 V | +12 V | 0 V |
| Off 30 seconds after switched | +12 V | +12 V | +12 V | +12 V | +12 V | +12 V |
| | Rec Motor | | A/C Relay | | | |
| | Brown/White | Brown/Black | Green | | | |
| Off | +12 V | 0 V | 0 V | | | |
| Off 30 seconds after switched | +12 V | +12 V | | | | |

## Torque, Voltage, and Charge Specifications

**NOTICE**

*This vehicle was designed using English (S.A.E.) measurements.* ***Utilimaster provides metric conversion equivalents as a courtesy if metric tools must be used, but Utilimaster does not warrant metric values given in this manual.***

| Description | N•m | Ft•Lb |
|---|---|---|
| Expansion valve to Evaporator Core | 21-27 | 15-20 |
| Liquid Line to Expansion Valve | 14-20 | 10-15 |
| Liquid line to receiver/Dryer Suction Line to Evaporator Core | 41-47 | 30-35 |
| Suction Line to Compressor | 34 | 25 |
| Discharge to Compressor | 22 | 18 |
| Compressor fitting Tube-O | 41 | 30 |
| Compressor to Manifold Hold Down Clamp Bolt ( GM chassis) | 35 | 26 |
| Hose Clamp,Worm Screw | 3.9-5.1 | 35-45 In•Lb |
| T-Bolt | 7.3-8.5 | 65-75 In•Lb |
| Pressure switches | 5 | 44 In•Lb |
| Control Head Illumination Bulbs | Trade Number 53 | |
| Plenum to Cowl 1/4” studs | 27 | 20 |
| Plenum to Cowl 3/8” studs | 43 | 32 |
| Evaporator to Cowl | 27 | 20 |

### Torque Specifications
### Line Fittings Torque Specifications

**NOTICE**

*Use Steel Tubing Torque Specifications when mate is steel-to-steel. If steel connection is made to aluminum or copper tube fittings, use appropriate Aluminum or Copper Tubing Torque Specifications.*

| Metal Tube Outside Diameter | Thread and Fitting Size | Steel Tubing Torque | Aluminum or Copper Tubing Torque | Nominal Torque Wrench Span |
|---|---|---|---|---|
| 1/4” | 7/16” | 13 ft•lb | 71 in•lb | 5/8” |
| 3/8” | 5/8” | 32 ft•lb | 12 ft•lb | 3/4” |
| 1/2” | 3/4” | 32 ft•lb | 17 ft•lb | 7/8” |
| 5/8” | 7/8” | 32 ft•lb | 24 ft•lb | 1-1/16” |
| 3/4” | 11/16” | 32 ft•lb | 30 ft•lb | 1-1/4” |

## Blower Voltage Chart

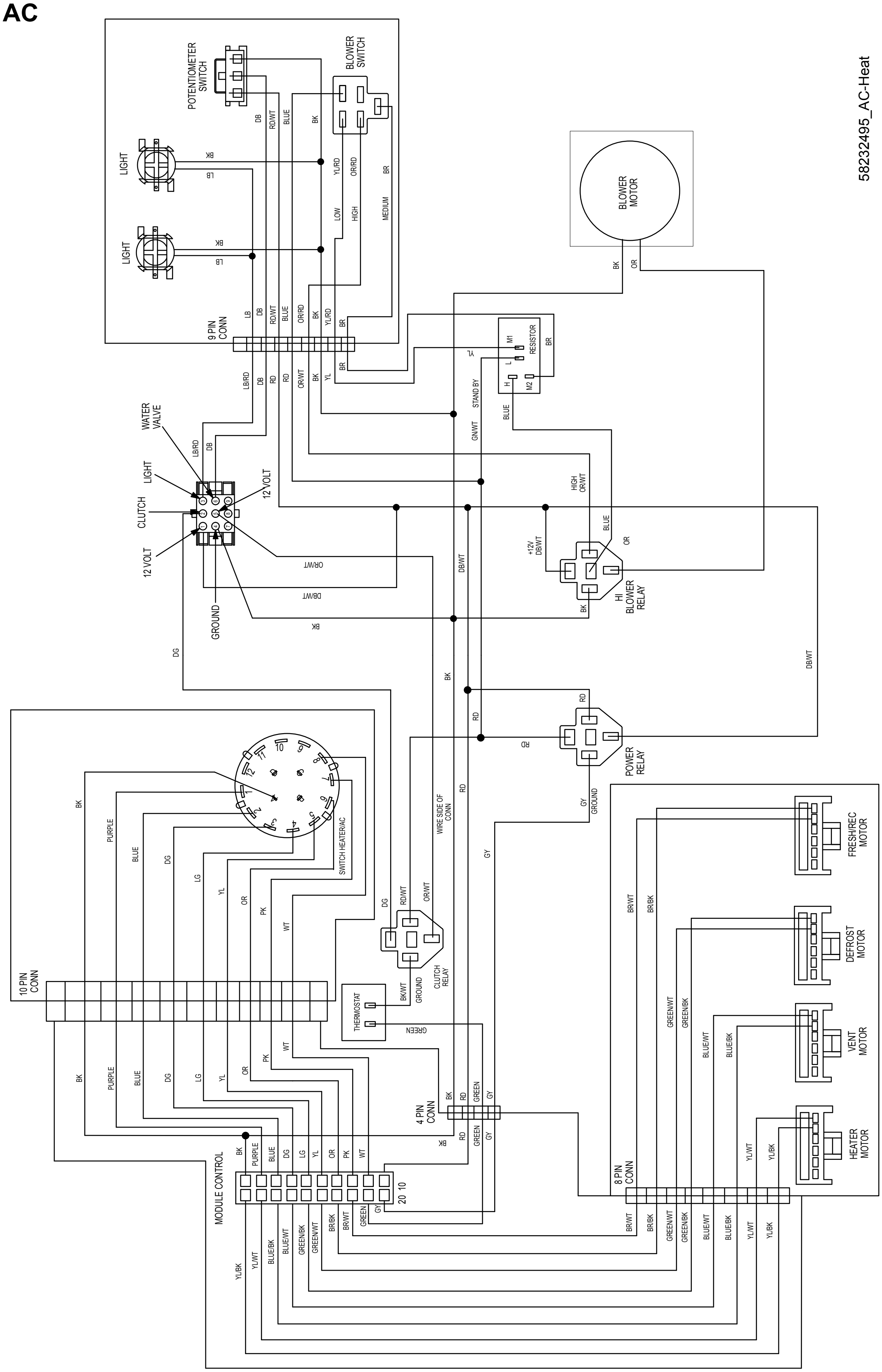
| BLOWER SPEED | CURRENT | BLOWER VOLTAGE |
|---|---|---|
| Low | 4.9 A | 4.6 V |
| Medium Low | 7.0 A | 5.9 V |
| Medium | 12.3 A | 9.2 V |
| High | 16.9 A | 11.9 V |

## Charge Weights

| CHASSIS | Charge Weight |
|---|---|
| Wh. W/ Prep Package | 44 oz (2.75 lb.) |
| WH W/ SCS Condenser | 35 oz (2.18 lb.) |
| Ford All | 40 oz. (2.50 lb.) |
| Freightliner /Fedex | 40 oz. (2.50 lb.) |
| Freightliner/Non-FedEx | 40 oz. (2.50 lb.) |
| Navistar | 35 oz (2.18 lb.) |

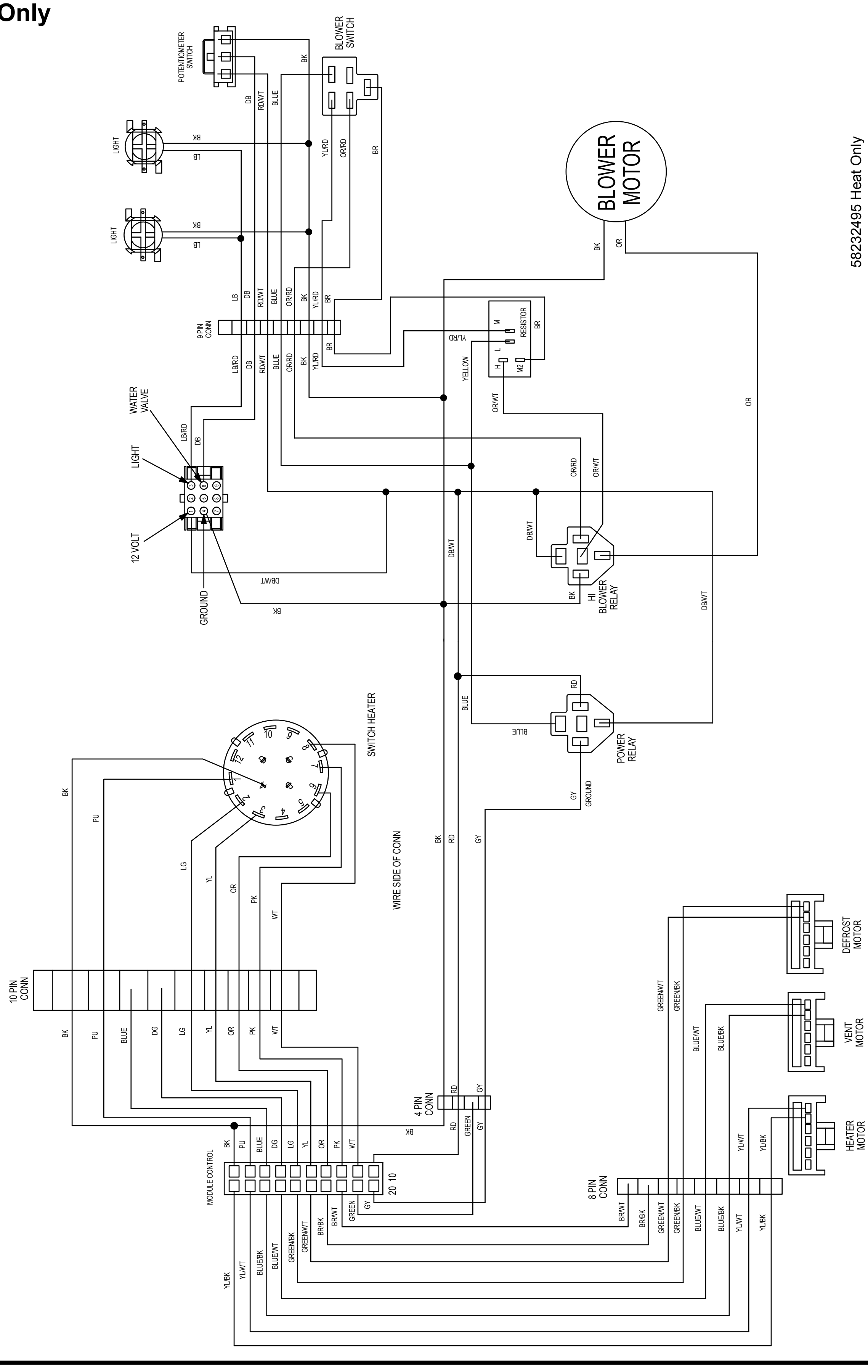
# Wiring Diagram

## Heat and AC

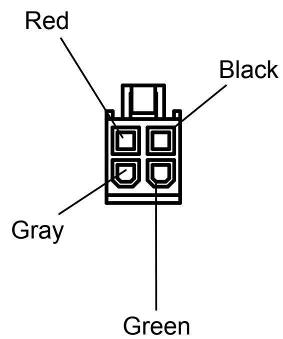


# Wiring Diagram

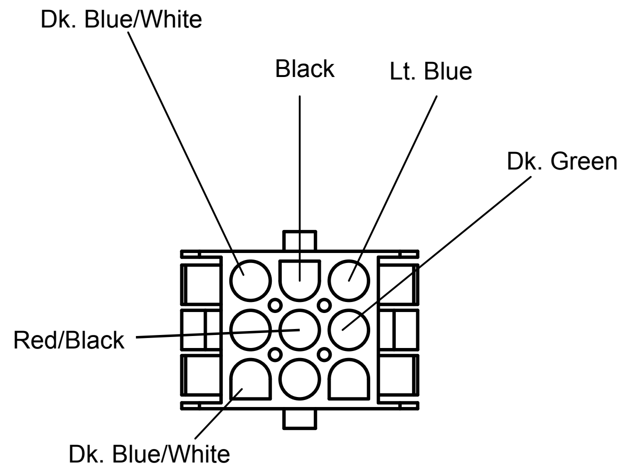
## Heat Only



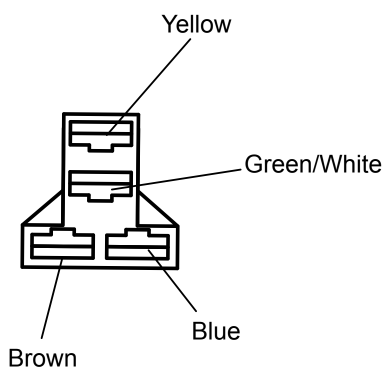
## Connectors



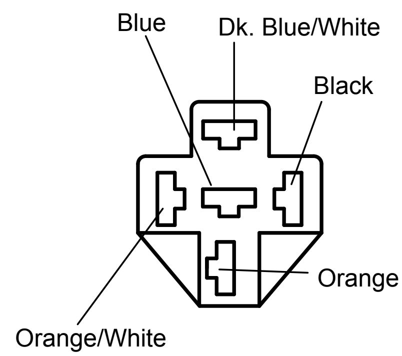

**Main Harness to Control Harness**



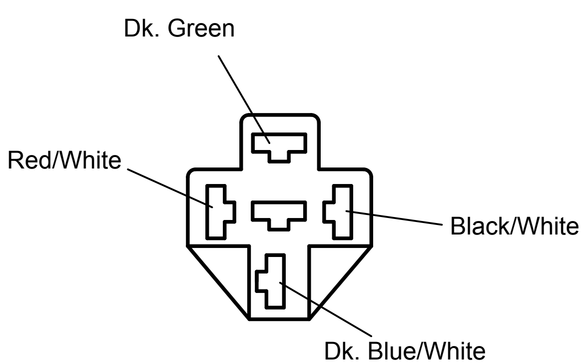

**Body Interface**



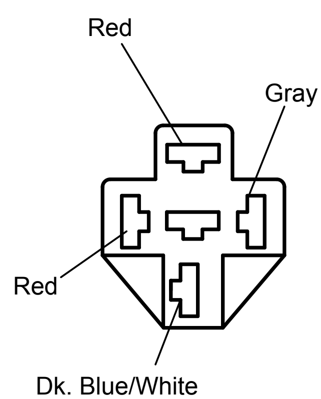

**Blower Resistor**



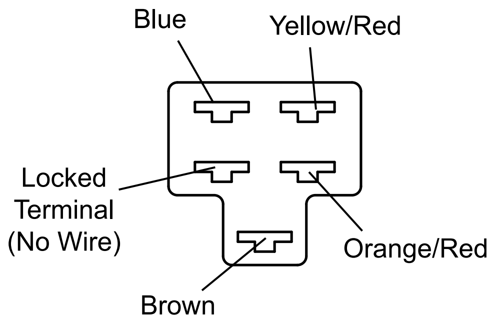

**Blower: High Speed**



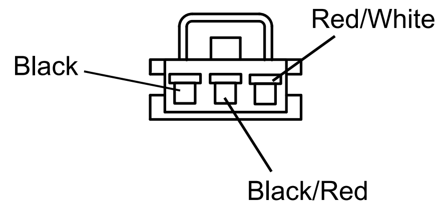

**AC Clutch Relay**



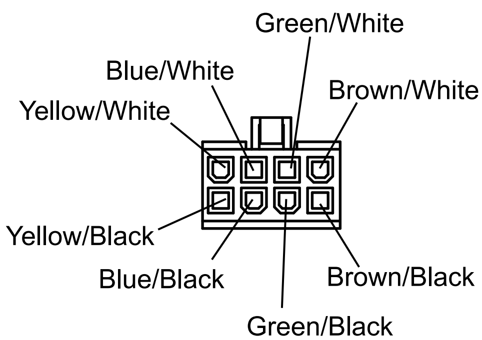

**Blower Power**



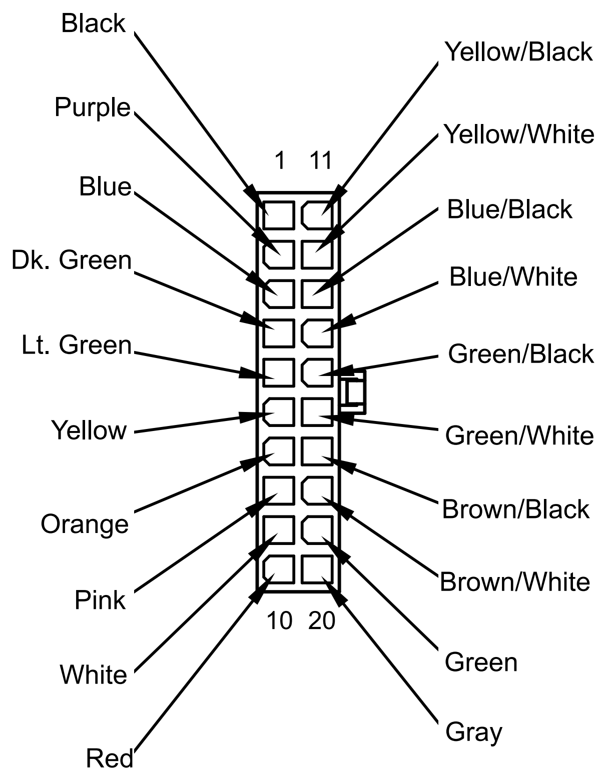

Blower Switch

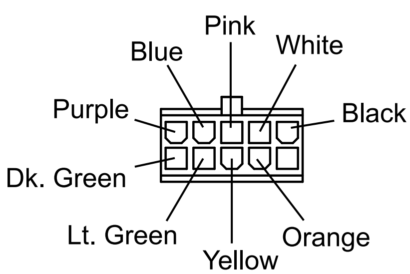



**Temperature Control**

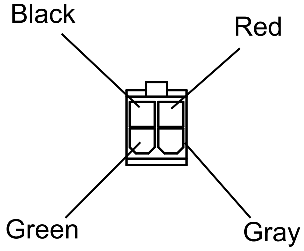



Control Harness to Servo Harness

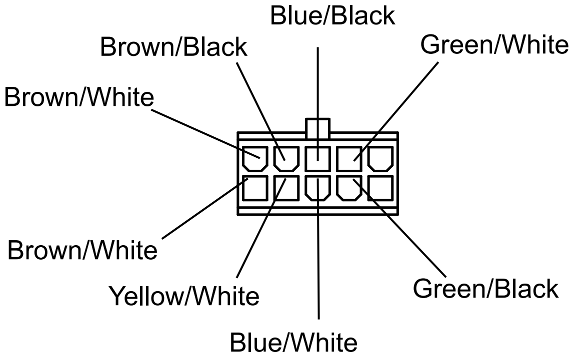


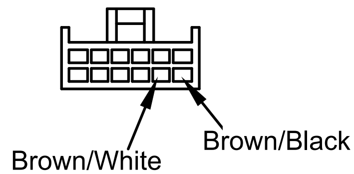

Control Harness to Control Switch



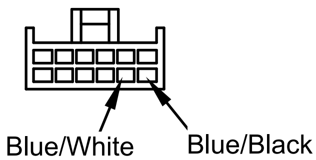

Control Harness to Main Harness



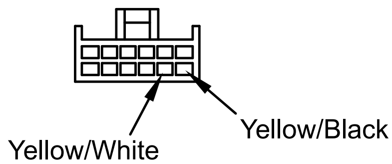

**Control Harness to Main Harness**



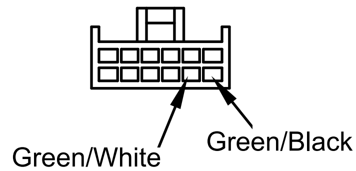

**Rec Motor**




**Vent Motor**




**Floor Motor**




**Defrost Motor**

**Utilimaster Customer Service**

# 574-848-2200

**Email: Parts@Utilimaster.com**

**Air Conditioning Overview, September 2016**