VP-200
Climate Control System

Operating and Installation Manual

August 20, 2010

Current as of
software version 21.1

Important Notice

This manual contains important information that may affect the safety of your aircraft. Do not fly the aircraft until you fully understand the installation and operating instructions, and all of the pre-flight checks have been successfully completed.

Read the Warranty / Agreement below. There is information in the Warranty / Agreement that may alter your decision to install this product. **If you do not accept the terms of the Warranty / Agreement, do not install this product.** The product may be returned for a refund if you do not accept the terms of the Limited Warranty / Agreement.

Vertical Power Inc. is not liable or responsible for a pilot's action or any situation that results in personal injury, property damage, missed commitments, lack of use of an aircraft or any expenses incurred due to: product failure, inaccuracy in displayed data or text files, display or display format issues, software bugs or problems, upgrade or customization issues, misinterpretation of the display, warning and/or limit settings, calibration problems, installation issues (leaks, mis-wiring, obstructions, damage to aircraft or components, incorrect installation of any parts, wrong parts, parts that don't fit, etc.) or any other issues related to the installation or operation of this product. All of the above are solely the pilot's and/or installer's responsibility. The pilot must understand the operation of this product before flying the aircraft. The pilot will not allow anyone to operate the aircraft that does not know the operation of this product. The pilot will keep the VP-200 Operating Manual in the aircraft at all times.

By installing this product, the aircraft owner/pilot and installer agree to hold Vertical Power Inc. harmless and in no way responsible for monetary compensation, including punitive damages for any incident, harm and/or damage associated with this product (including but not limited to the ones listed above). If you do not agree to the above, **DO NOT INSTALL THIS PRODUCT.** The pilot, owner and/or installer may want to obtain an appropriate insurance policy before installing this product. If you do not have the skills, knowledge, tools, equipment or facility, to perform and determine the installation of this product is safe, reliable and accurate and to determine this product is operating properly after installation, **DO NOT INSTALL THIS PRODUCT**. If the owner/pilot and/or installer are unwilling to take the responsibility for the installation and operation of this product, **DO NOT INSTALL THIS PRODUCT**. This product may be returned for a refund by contacting Vertical Power Inc.

The pilot must understand the operation of this product before flying the aircraft. Do not allow anyone to operate the aircraft that does not know the operation of this product. Keep the Operating Instructions in the aircraft at all times. The ability for this product to correctly control electronic components and detect a problem is directly related to the pilot's ability to properly install the system, program proper configurations and limits, and the pilot's interpretation and observation skills.

It is possible for any system to fail thereby disabling electronic components or displaying inaccurate high, low or jumpy readings. Therefore, you must be able to recognize a system failure and you must be proficient in operating your aircraft safely in spite of a system failure. **IT IS THE BUILDER AND/OR PILOT'S RESPONSIBILITY TO DETERMINE THE APPROPRIATELEVEL OF BACKUP AND REDUNDANT SYSTEMS NEEDED FOR SAFE OPERATION OF THE AIRCRAFT.** If you do not have this knowledge or skill, contact the FAA, a certified aircraft

mechanic, or a local flight instructor for training prior to building or flying the aircraft with this system.

Do not allow anyone who is not qualified to modify the configuration data. If setup data are inadvertently or improperly changed, you could get inaccurate readings that may lead to improper operation of the aircraft, flaps, trim, starter, landing gear, or engine. This could result in an unsafe configuration of the control surfaces, engine damage and/or an emergency situation.

Before flying the aircraft verify the instrument markings displayed on the system are accurate with your POH for every function displayed. Verify that each electrical device is configured correctly and behaves appropriately. The system allows the pilot to configuration data, backups and other information through a data port. These data must be verified by the pilot before it is used.

Before starting the installation, make sure that your planned installation will not interfere with the proper operation of any controls. The installer should use current aircraft standards and practices to install this product. Refer to AC 43.13-2A, Acceptable Methods, Techniques, and Practices - Aircraft Alterations and AC 43.13-1B, Acceptable Methods, Techniques, and Practices--Aircraft Inspection and Repair.

The VP-200 CCS is an experimental system limited to use in experimental aircraft. Not approved for use in aircraft with FAA or foreign type certificates.

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Vertical Power Inc. (“VP”) warrants its aircraft monitoring and electrical control system and system components to be free from defects in materials and workmanship for a period of three years after the retail invoice date. VP will repair or replace any system components under the terms of this Warranty provided the item is returned to VP prepaid. This Warranty shall not apply to any unit or component that has been repaired or altered by any person other than VP, or that has been subjected to misuse, abuse, accident, incorrect wiring, or improper or unprofessional installation by any person. THIS WARRANTY DOES NOT COVER ANY REIMBURSEMENT FOR ANYONE'S TIME FOR INSTALLATION, REMOVAL, ASSEMBLY OR REPAIR. VP reserves the right to determine the reason or cause for warranty repair.

1. This Warranty does not extend to any engine, machine, aircraft, boat, vehicle or any other device to which the VP system may be connected, attached, or used with in any way.
2. THE REMEDIES AVAILABLE TO THE PURCHASER ARE LIMITED TO REPAIR, REPLACEMENT, OR REFUND OF THE PURCHASE PRICE OF THE PRODUCT, AT THE SOLE DISCRETION OF VP. CONSEQUENTIAL DAMAGES, SUCH AS DAMAGE TO THE ENGINE OR AIRCRAFT, ARE NOT COVERED, AND ARE EXCLUDED. DAMAGES FOR PHYSICAL INJURY TO PERSON OR PROPERTY ARE NOT COVERED, AND ARE EXCLUDED.
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4. The pilot must understand the operation of this product before flying the aircraft. Do not allow anyone to operate the aircraft that does not understand the operation of the system. Keep the operating manual in the aircraft at all times.
5. VP is not responsible for shipping charges or damages incurred during Shipment, except for situations where the system fails away from the aircraft’s home base and the pilot is unable to safely fly the aircraft, at which time VP shall, at VP’s sole discretion, pay only one-way shipping charges to the purchaser (US 48 states only).
6. No one is authorized to assume any other or additional liability for VP in connection with the sale of VP products.
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Change log

Change date	Change
2-10-09	First beta release
8-30-10	Changed J8-12 connection for engine craven compressor without relay. Changed fan behavior during takeoff.

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1 Introduction

1.1 Welcome to Vertical Power!

The VP-200 Climate Control System (CCS) is a new and innovative way (for aircraft anyway) to intelligently control the air conditioning and heating system on your aircraft.

Wiring any electrical components on an aircraft is serious business. Please take the time to read and understand this manual before proceeding.

This manual describes the installation steps and techniques necessary to install the VP-200 CCS. Please refer to the VP-200 Installation Manual for more information on wiring and VP-200 system information.

1.2 Vertical Power Terms

CCS	Climate Control System. It controls both heat and air conditioning.
Load	A user of electrical power. It may be a light, radio, GPS receiver, contactor, or EFIS, just to name a few. A load is wired to a power pin on the Control Unit.
Pin	A pin refers to a physical pin on one of the Control Unit connectors that provides power to a load. Special-purpose pins are provided for flaps, trim, starter, and the battery contactor(s). Most pins, however, are generic and can be configured to match the type of load it is powering. Each pin has a maximum current rating of either 5 amps, 10 amps, or 18 amps. Certain pins simply turn loads on and off. Other pins can be configured for soft start or light dimming in addition to on/off operation.
State	There are three states: on, off, or faulted. Faulted is equivalent of a tripped circuit breaker.
Connector	Two types of connectors are used throughout the system. D-sub connectors are smaller and provide signal and low power (less than 2 amps) connections. Vertical Power uses high quality, gold plated, machined-barrel connectors. High-quality,

	Molex gold-plated connectors are used to provide power (up to 18 amps) to high current devices.
AWG	American Wire Gauge – a standard that describes the size of the wire.
Circuit breaker	While the VP-200 CCS does not use conventional circuit breakers or fuses, the term is very common and herein is used to mean the maximum current a circuit will draw before faulting.
Fault	The VP-200 CCS protects each circuit from short circuits as well as over-current conditions. When a fault occurs, the VP-200 CCS turns the faulted device off and shows a message on the screen.

1.3 Other Reference Documents

Vertical Power provides other documents that should be used in conjunction with this manual to help you thoroughly plan a safe and effective electrical system for the type of mission you fly. The following documents are available on the Documentation page of the Vertical Power web site (http://www.verticalpower.com/documents.html), and should be reviewed in conjunction with planning your system.

Document	Description
VP-200 CCS Wiring Diagram	Overall wiring diagram showing all the connections.
Connector Service Manual	Step by step instruction how to work with Molex, d-sub, insulated crimp and other connectors.
Contactor Wiring	Overview of the different types of contactors used in experimental aircraft, and step by step instructions how to wire them properly.

Additional documentation is also be available on the web site.

2 Climate Control Overview

The VP-200 CCS handles both heating and air conditioning in the aircraft. You can wire both, only the air conditioning, or only the heater.

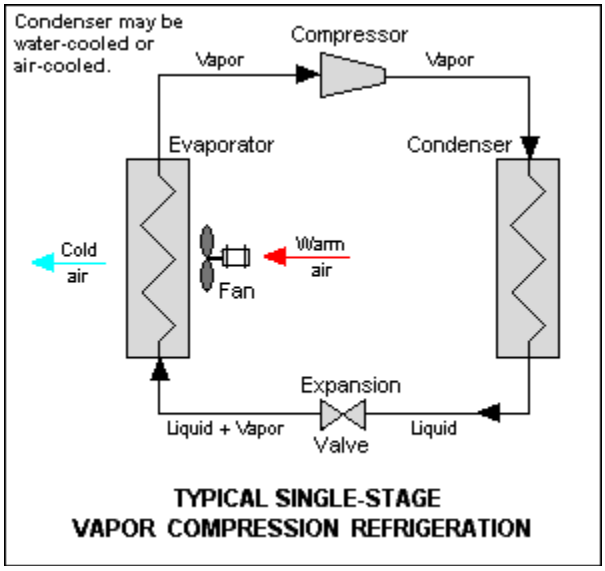
The system lets the user choose to use either the heater or air conditioning system.

The cabin volume of the aircraft, the location of the vents, and the location of the sensors all affect how the system can keep a comfortable temperature in the cabin.

The VP-200 CCS gives you the ability to “set and forget” the temperature in your cabin. It works with the VP-200 system, providing an integrated display for control, system monitoring, and alerting functions.

2.1 Air Conditioning

The VP-200 CCS has been developed in conjunction with Flightline AC and is also in testing with the Lancair AC system. The CCS has been developed with these systems in mind, but most air conditioning systems are basically the same. They work by compressing the refrigerant, removing heat through the condenser, then cooling warm air using an evaporator. The cycle then repeats itself. The evaporator and condenser are basically heat exchangers, operating at opposite parts of the cycle.



A typical AC system is made up of the following components:

Compressor	Compresses the refrigerant. Compressors can be either engine driven (a pulley off of the crankshaft) or electric-driven (an electric motor drives the compressor directly and separately from the aircraft’s engine).
Condenser	Removes heat from the refrigerant. A condenser fan blows air across the condenser and overboard to remove heat.
Evaporator	Absorbs heat to provide cold air.
Evaporator fan	The evaporator fan, or cabin fan, is typically three speeds to vary the amount of cold air in the cabin.
Evap temp sensor	Senses the temperature of the evaporator to ensure it does not get too cold and freeze, allowing ice to develop on the evaporator and blocking air flow.
Pressure sensor	Senses the system pressure to ensure there are no leaks and the system is pressurized appropriately. AKA receiver dryer switch.
Switch	The basic switches allow you turn the compressor on or off (to run the cabin fan with no cooling effect) and set the fan speed.

The VP-200 CCS does not include these components but it does control and monitor them. Each part of the system must work in a certain way for the overall cycle to operate correctly.

Here are some web sites that describe automotive air conditioning systems, which work in the same way as the one designed for your aircraft.
http://www.familycar.com/ac1.htm

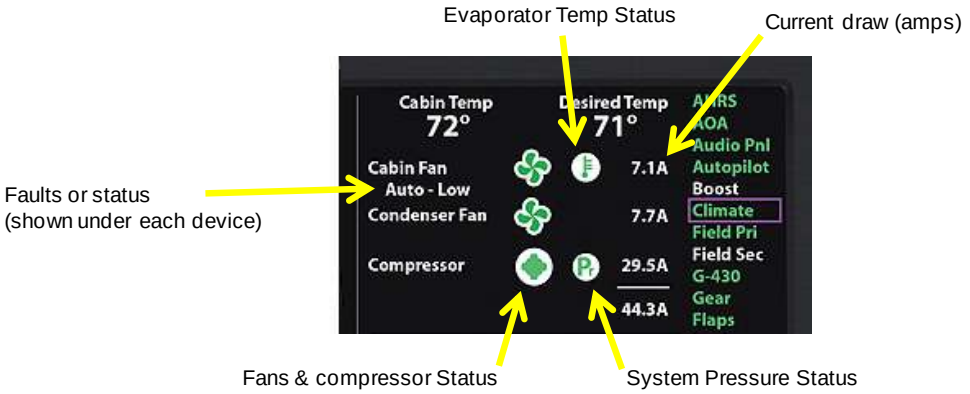
2.2 Heating

The VP-200 CCS opens and closes hot air valves that duct hot air from heat muffs on the engine exhaust to the cabin.

3 Using the VP-200 Climate Control System

The VP-200 Climate Control System (CCS) can regulate both heat and air conditioning systems to provide a comfortable environment in the aircraft.

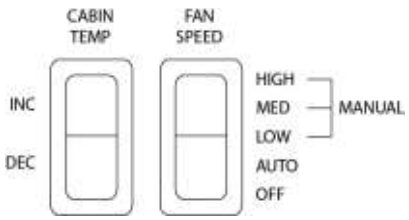
Information about the air conditioning or heater components can be found by selecting the Climate device from the device list.



You can view the status of each individual component and the amount of current it is drawing.
The VP-200 CCS gives you the ability to "set and forget" the temperature in your cabin. It works with the VP-200 system, providing an integrated display for control, system monitoring, and alerting functions.

3.1 Operational Overview

The CCS is managed using both the display and the two switches shown below.



The CCS has three states of operation: Off, Automatic, and Manual. These are described below:

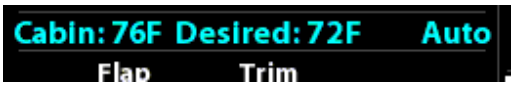
Off	Turns off the air conditioning components and closes the heater valves. The CCS will not turn on until the user presses the fan speed switch.
Automatic	The heater or air conditioning system is automatically regulated to maintain the desired cabin temperature.
Manual	You can manually set the fan speed (for air conditioning) or heater valve position (for heating).

You can select the state by pressing the fan speed switch. Each press of the switch moves to the next state: OFF – Auto – Manual Low – Manual Medium – Manual High.

The states are indicated as shown on the device list:

Climate	Off. All fans and compressors are off, and heater valves are closed.
Climate	Automatic on. The system is maintaining a desired temperature and the fans will cycle on and off during normal operation.
Climate	Manual on. A cabin fan is on either low, medium, or high.
Climate	Inhibited or closing heater servos or cool-down fan running.

Whenever the cabin temp or fan speed switches are pressed, the "Quick-Look" bar appears for two seconds, showing the cabin temperature, the desired temperature, and the system state (Off, Manual, Auto). The Quick-Look bar appears so you don't have to select the Climate device to view the current settings.



When the Climate device is selected from the device list, the soft keys change to:

The soft keys function as follows:

Automatic	Turns on the CCS to automatic state.
OFF	Turns off the CCS.
Compressor OFF	Turns the compressor and condenser fan on or off, if in manual state. This allows you to run the cabin fan only, without the compressor or the condenser fan. To enable the compressor to turn back on, go to automatic or off.
Heater/AC	Cycles between heating and cooling modes of operation. When the CCS is set to Air Conditioning, the heater valves are closed.
Reset Fault	Resets a faulted circuit. Equivalent to pressing in a circuit breaker to restore power to a circuit.

Press the key to enable the function that is shown on the soft key.

3.2 Turning on heat or air conditioning

When the VP-200 is first turned on, the CCS defaults to OFF. You must press the fan speed switch to place the system in automatic or manual state. Press once to go into automatic. Press again to set fan speeds manually.

3.3 Turning off heat or air conditioning

The CCS automatically turns off the heat or air conditioning when the engine shuts off. If the air conditioning is active at engine shut off, the cabin fan only will continue to run for a specified rest (cool down) period. During the cool down period, the AC cannot be turned back on.

To manually turn off the CCS, press the Fan Speed switch until Off is selected.

The CCS turns off along with the rest of the VP-200 system when either manually or automatically shut down. IF THE CLIMATE DEVICE IS SELECTED, THE COUNTDOWN TIMER WILL NOT SHUT OFF THE SYSTEM AUTOMATICALLY.

3.4 Setting desired cabin temperature

When in automatic (either heat or air conditioning), press the cabin temp switch up to increase the desired temperature or down to decrease the desired temperature.

When in manual air conditioning, the fan speed switch is used to adjust the fan speed. The compressor can be turned off manually by selecting the Climate device from the device list, and pressing the *Compressor OFF* soft key.

When in manual heat, the cabin temp switch opens or closes the heater valves while the switch is pressed.

3.5 Inhibiting CCS operation

The air conditioning is inhibited above and below a certain RPM range as configured in the setup menus. This enables the AC to turn off automatically during takeoff or when the engine is shut down.

When above the specified RPM, the compressor and condenser fan turn off and the cabin fan continues to operate at its last set fan speed. The evaporator coil is cold initially and eventually warms up as the cabin fan blows air across it. The amount of time you will get cold air (while the compressor and condenser are shut off) depends on the fan speed, size of the evaporator, and outside air temperature.

When heat is selected, the heater valves are kept closed while the engine oil temp is below 75°F.

If the engine data is missing AND the compressor is engine-driven, then the CCS will only operate in After-start, Taxi, Run-up, Takeoff, Cruise, Maneuver, and Landing modes and the RPM limitation are ignored.

If the engine data is missing AND the compressor is electrically-driven, then the RPM limitation are ignored.

3.6 CCS Faults

The CCS detects short circuits, over-current conditions, and disconnected wires on the fan motors and compressor. When a circuit fault occurs, the following happens:

- The CCS turns off
- The Climate device turns red and is automatically selected
- A voice alert is played “Climate control fault” and the master warning light flashes.
- The specific fault is shown on the device list display, under the faulted device.

To reset the fault, press soft key 5 while the Climate device is selected.

The following conditions cause the CCS to turn off and display an annunciator:

- CCS internal temperature exceeds limits
- Communication failure between the CCS and DU, or DU and CU.
- Pressure in the air conditioning system is too low
- A fault on one or more of the fans or compressor
- Both IAT sensors fail. A single failure will be annunciated and the CCS will use the remaining good sensor.
- Battery contactor failure
- Over-voltage condition

When the evaporator is too cold, which may cause the formation of ice and blockage of air flow to the cabin, the CCS shuts down the compressor and condenser fan and continues to run the cabin fan. An annunciator "EVAP COLD" is displayed. When the evaporator temperature is within limits, the CCS resumes normal operation.

3.7 Emergency operations

Whenever an emergency is selected on the VP-200, the CCS automatically turns off the air conditioning or the heater valves close.

You can turn the CCS back on thereafter.

3.8 Cabin Altitude Alarm

The cabin altitude alarm alerts the pilot that the cabin altitude is greater than a pre-set limit. The pressure sensor on the CCS CU is calibrated to 29.92 in hg and senses approximate altitude. It is designed to sense gross changes in cabin altitude, and may be as much as several hundred feet off. It should not be used to determine aircraft altitude.

When the cabin altitude exceeds the specified limit, the following occurs:

- CABIN ALT annunciator is displayed and must be acknowledged
- The master warn light flashes
- Audio "Cabin Altitude"

You can view the current sensed altitude by going to Options/System Info screen.

If communication with the CCS CU is lost, the cabin altitude alarm will not function and a CAB ALT FAIL annunciator is shown.

4 VP-200 CCS Installation Overview

4.1 Installation

Installing the VP-200 CCS is accomplished in five main steps:

Step 1: Install the CCS Control Unit
Step 2: Wire from the CCS to the fans, sensors, switches, battery contactor, and VP-200 Display Unit, including grounds.
Step 3: Configure the VP-200 CCS
Step 4: Test the VP-200 CCS on the ground
Step 5: Test the VP-200 CCS in the air

Following these steps will increase the likelihood of a trouble-free installation. Each step is described in detail later in this manual. **We recommend that you read through all the steps so that you better understand the system prior to beginning the planning step.**

Taking the time up front to carefully plan your installation will pay big dividends later on.

4.2 Components

Vertical Power provides the following components with the VP-200 CCS kit:

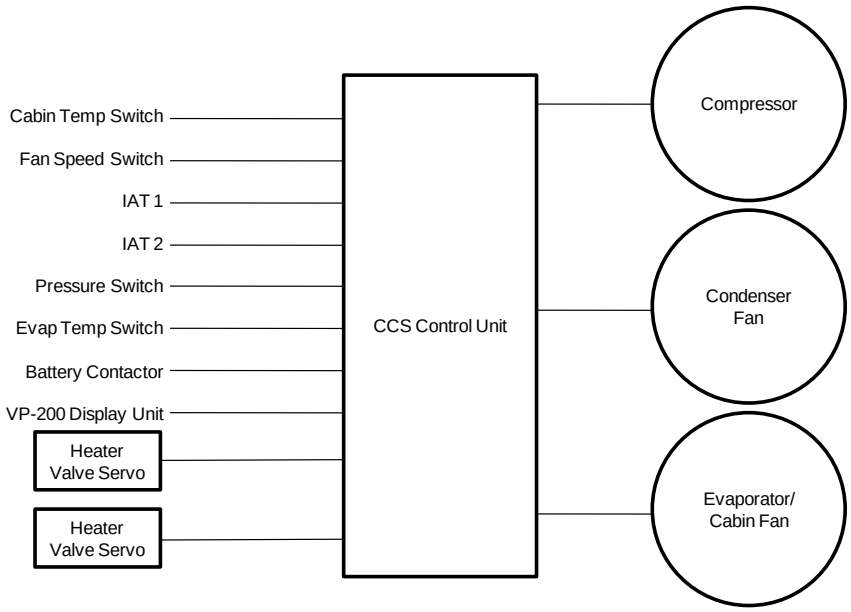
- CCS Control Unit
- Two inside air temperature sensors and insulation
- Wiring harness (heater servo wires provided upon request)
- 20A relay (specify 14v or 28v) for certain compressor clutches
- Compressor Adapter Box (for Flightline AC electric compressor only)
- Insulated crimp terminals
- 1K ohm, 1W resistor for compressor feedback
- Diode for compressor solenoid
- Two momentary (ON)-OFF-(ON) paddle switches

The following parts must be purchased separately:

- Compressor, evaporator fan, condenser fan, hoses, pressure switch, evap temp switch
- Cabin ducting and vents
- Ray Allen trim servos for heater control
- Heavy-gauge wire (between battery contactor and CCS Control Unit)
- Heavy-duty solenoids for certain compressors
- VP-200 or VP-200 Duo system

4.3 System Overview

The CCS Control Unit reads the inside cabin temperature and compares that with the desired temperature. It then operates the various air conditioning system components or heat valve servos. Circuit protection is provided inside the Control Unit so no breakers or fuses are needed, other than for the compressor. The system architecture is shown below:



VP-200 CCS System Architecture

The VP-200 CCS provides switching and circuit protection for the fans. The compressor requires an external high-current fuse or circuit breaker, and either a relay or solenoid.

The serial data lines allow the VP-200 and the VP-200 CCS to communicate status and settings. If these lines fail, the VP-200 CCS can operate independently, and the user has direct control via the fan and temperature switches.

5 Step 1: Planning

This section discusses many items and considerations that should be incorporated into your planning. Follow the air conditioning manufacturer's recommendations for locating and mounting the air conditioning components.

Wiring diagrams are available on the Vertical Power web site.

5.1 CCS Control Unit

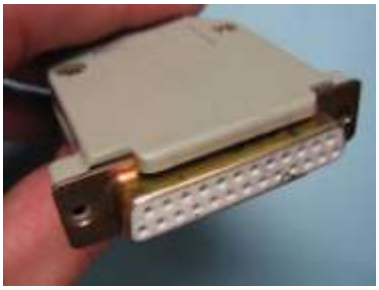
Dimensions for the CCS Control Unit are available on the Vertical Power web site.

The CCS connectors are detailed in Appendix A.

J8 is a 37-pin d-sub connector that provides connections to the sensors, switches, VP-200 Display Unit, and heater valve servos. J11 is a 16-pin power connector that provides power to the fans and compressor relay. One pin on J9 is used only if the electric compressor from Flightline AC is installed.

The photos below show the different types of connectors used in the VP-200 CCS, the big, higher-amperage power connector on the left and the smaller, low-amperage d-sub connector on the right. Note: these images are examples of the type of connector used, and not the actual number of pins.

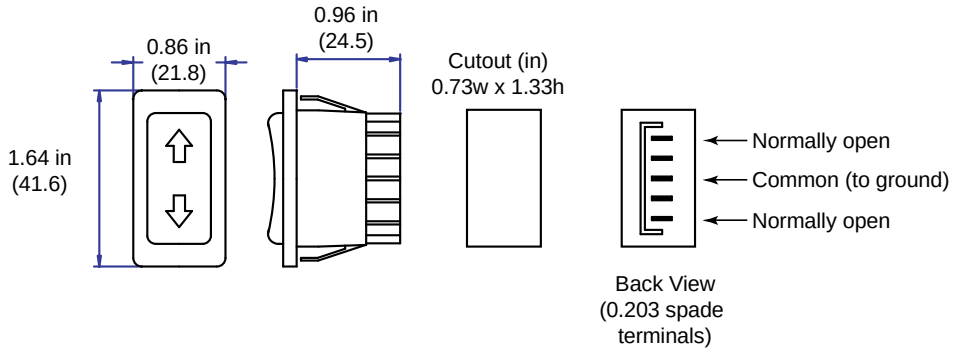
Power Connector



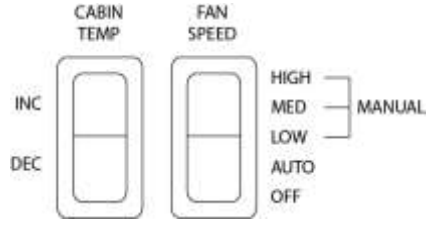
D-sub Connector

5.2 Fan and Cabin Temp Switches

These switches allow you manually control certain CCS functions. Install two momentary (ON)-OFF-(ON) switches either in the overhead console or on the instrument panel. Dimensions for the included switches are shown below, but you can use a different switch style if desired. Additional switches are available from Vertical Power, but this style is only available as a momentary action switch (i.e. if you want to group these with other switches, you should find a switch style that includes both momentary and non-momentary type switches.)



The fan speed switch allows you to cycle the CCS through off-auto-low-medium-high fan speed settings. The switches should be labeled as shown below:



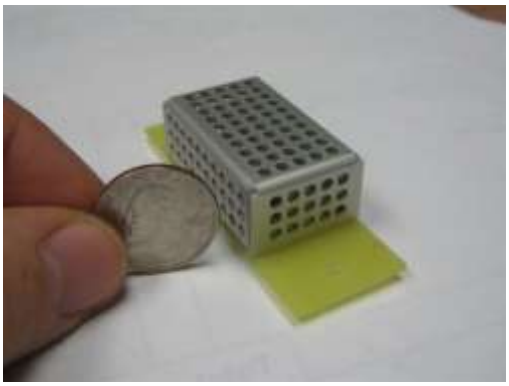
Instrument Panel or Overhead Console Layout (Typical)

The cabin temperature switch allows you to set the cabin temperature in 1 degree increments.

Whenever you activate one of these switches, the VP-200 display automatically shows the CCS information.

5.3 IAT Sensors

Two Inside Air Temperature (IAT) sensors are used to measure the cabin temperature. The CCS calculates the average temperature of the two sensors and uses that value to determine the actual cabin temperature. The sensor is shown below, and actual dimensions are available on the VP web site.



IAT sensor, next to a quarter.
Shown in silver for clarity.
Actual sensor is anodized black.

The sensor should be mounted from behind a panel so that only the rectangular protective cage is visible. A sensor element is mounted within the cage. Each sensor has two screw terminals that connect to the CCS Control Unit. Dimensions and installation drawing is available on the Vertical Power web site.

The mounting location of the sensors will greatly impact the effectiveness of the system. Cabin temperature is primarily sensed by your body in the facial area and upper body. Since it is impractical to mount a sensor in the middle of the cabin, two sensors are used with the assumption that the average reading will accurately reflect the air temperature in the center of the cabin. Air at the bottom of the cabin will generally be colder than air at the top of the cabin.

Use the following guidelines when mounting the sensors:

- Mount one sensor higher in the cabin and one lower in the cabin.
- Mount so that the sensor cannot be kicked or bumped regularly. The cage is make of 0.063" aluminum and is fairly rugged.
- If mounting the sensor on the instrument panel, be aware that avionics often generate lots of heat.
- Do not mount sensors where heated or cooled air blows directly on the sensor.
- If the sensor is mounted in a plenum that moves hot or cold air, that air will heat or cool the wire terminals and the aluminum cage around the sensor element, adversely affecting its accuracy. If you need to mount it this way, for example in an overhead console that also carries cool air, use a generous matt of insulation on the back side of the sensor and extending as far as reasonably possible around the sensor area. You might also consider blocking off the plenum so air does not blow on the back of the sensor.

5.4 Evaporator Temp and System Pressure Switches

These switches come with the air conditioning system, and are screwed into the evaporator coil and refrigerant line. Each switch has two terminals. One goes to ground and the other goes to the CCS Control Unit.

These switches must operate as follows (standard on most air conditioning systems):

- The evaporator temperature switch must be closed when above freezing
- The pressure switch must be closed when the line pressure is within normal operating limits

The system will only operate when both of these switches are closed.

5.5 Wiring Harness

A wiring harness is provided with the system. The wires are Tefzel MIL-22759/16. Reference the *Connector Service Manual* on the Vertical Power web site for information on using the connectors and crimp terminals.

The only additional wire you will need is a 6 or 8 gauge wire to connect the CCS Control Unit to the battery contactor. The pinouts, circuit breaker values, and wire sizes for the wiring harness are described in Appendix A of this manual.

The wire lengths are as follows:

Wire	Length (ft)
Cabin temp and fan switches	15
Display Unit	20
Cabin temp sensors	15
Evap temp and press	20
Ground	10
Compressor sense	20
Heater servo	10
Condenser and evap fans	20
Compressor relay	30

The harness should be installed following standard wiring practices for aircraft.

5.6 Heater Valve Servos

The CCS can operate two servos which open and close the heater valves. The servos should not be mounted in the engine compartment or on the firewall.

Depending on your aircraft, you may want to install one or two hot air servos. Both servos run together in parallel. The Ray Allen servos have enough torque to operate two vales with a single servo, if desired.

The servos are available from the Ray Allen Company, part number T2-7A or T2-10A. The T3-12A does not accurately sense motion at the travel limits and is not appropriate for heater valve control. Web site: http://www.rayallencompany.com/products/servos.html. Any servo that draws less than about an amp and has a built-in 5K ohm or 10k ohm potentiometer for feedback will work.

The servos should be connected to the valves using either a rod or flexible cable. The linkage should be designed so that the full travel of the servo fully opens and closes the heater valve. If you are

installing two servos, design the linkage so that each servo travels the same distance to fully open and close the valves.

You may choose to use manual cable controls for the heater or have the VP-200 CCS control these for you. If servos control the heater valves, you can also manually move the heater valves from the VP-200 Display Unit using the soft keys.

5.7 Battery Contactor Wiring

The CCS Control Unit has a power post where you can attach the cable from the battery contactor. The Control Unit should only receive power when the battery contactor is turned on. If the battery is located within a few feet of the CCS Control Unit, use 8 gauge wire. If the battery and CCS Control Unit are on opposite sides of the aircraft, use 6 gauge wire.

5.8 Compressor Circuit Protection

The compressor itself (electric compressor) or the compressor clutch (engine driven) draw more current that can be supplied by the CCS Control Unit. Power must be supplied directly from the battery contactor through a fuse or circuit breaker. Depending on the location of the relevant components, the circuit breaker may be mounted on the instrument panel or elsewhere in the aircraft.

Follow the air conditioning manufacturer's instructions regarding wire size and circuit protection.

The CCS requires a "sense" wire that reads when power is supplied to the compressor.

5.9 Grounding

All of the grounds shown on the CCS wiring diagram should go to the same ground block, including grounds from each of the four switches.

You are now ready to begin installing your system!

6 Step 2: Install Components and Wiring

6.1 Pre-Installation

Warning: Disconnect battery power before installation.

Prior to installation and wiring, the following should be considered:

- The battery in the aircraft should NOT be connected until the wiring is installed and each circuit is individually tested. Do not run wires while the battery is connected.
  Tip: Disconnect the battery ground cable first, then the positive cable. When re-connecting, connect the positive cable first then the ground cable. Doing so ensures you won't spark the positive connection to the airframe.
- Consider bench testing the system and the devices prior to actually installing it in the aircraft. This allows you to become familiar with the system in a comfortable environment.
- The easiest method is to run the wires from the CCS Control Unit to their destinations. For example, simply run the wire from the CCS Control Unit to the compressor fan.

- Plan the physical wire routing in your aircraft prior to installing the harnesses. Drill any necessary bulkhead holes and protect sharp edges with snap bushings, grommets or other suitable fastener.
- Leave room for service loops (extra lengths of wire), so that you can easily remove and install components later.

DO NOT GRIND, FILE, DEBURR, OR DRILL METAL OR FIBERGLASS AIRFRAME COMPONENTS WITH THE UNITS INSTALLED, AS SHAVINGS MAY GET INSIDE THE UNITS AND CAUSE INTERNAL SHORT CIRCUITS.
Use an empty Control Unit during construction.
These blanks are available for a small, fully-refundable deposit from Vertical Power.

6.2 Installing the Air Conditioning Components

Follow the manufacturer's recommendations for mounting locations.

6.3 Installing the CCS Control Unit

The CU is typically located INSIDE the pressure hull (if pressurized) and in the middle to aft section of the aircraft near the fans. A dimension drawing is available on the Vertical Power web site.

Locate the CU taking the following into account:

- The CU should be located inside the cabin, away from occupants and baggage.
- Do not locate near sensitive equipment such as a compass or AHRS. While no known interference exists, you should test and verify that an operational CU does not affect other equipment prior to finalizing the equipment locations.
- While the CU itself is water-resistant, every effort should be made to locate it away from possible water exposure. If you have a tip-up canopy or believe it may occasionally be exposed to water, use RTV silicone sealant to fill the small holes where the case meets the end caps. Do not put sealant on the connectors.
- The CU should NOT be mounted to the firewall where it is exposed to direct heat and vibration.
- Locate where you can relatively easily access the CU and the power connectors for troubleshooting during installation and in the future.
- Air should be allowed to circulate around the CU. A fan is not required.
- Do not mount where occupants can easily touch, kick, bump, or otherwise disturb the CU.
- The wiring harnesses from the CU should be secured at a point near the CU.

Suggested CU mounting locations:
Lancair ES/IV-P: Side mounted just aft or forward of main wing spar on either side. Most aircraft should have room there and it will be covered by the side covers. You may also be able to mount the CU on aft face of main wing spar. The forward face of the main wing spar may crowd the leg room.
RV-10: In the empennage aft of the cargo compartment bulkhead.

The CU is designed with two mounting holes/slots on each side, and should be secured with a minimum of two AN3 (10-32) or 8-32 bolts, one on either side of the case. Four is the preferred method.

- ☐ Mount the CU so that it is securely attached to the mounting surface.
- ☐ If mounting in a composite aircraft, or on non-conductive surface, run a wire from the CU chassis to the main ground block. Use a ring terminal around the mounting bolts or one of the

four Philips screws at the outside edge of each faceplate. The red anodization acts as an insulator, so use a toothed lock washer or gently scratch off the anodization so the ring terminal is electrically conductive with the case.

6.4 Wiring Considerations

Review the *AC Wiring Diagram*, *Connector Service Manual* and *Contactor Installation Guide* prior to proceeding with this section. These documents are available on the Vertical Power web site.

The power connectors are labeled with the pin numbers next to each hole on the black side of the connector.

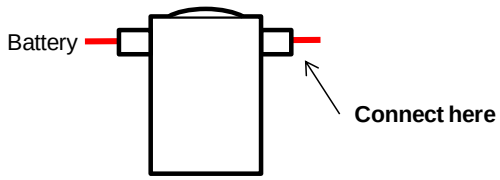
Begin the Control Unit wiring.

- ☐ **Double check that the correct wires are in the correct pins in the correct connector.** Remove any unused wires from the connector. Additional wires can be easily added later.
- ☐ Begin by plugging the connectors into the Control Unit and let the wires hang freely. Group the wires into bundles that go to a specific location in the aircraft.
- ☐ Run the bundles to their respective general locations. Keep in mind that ground return wires may also need to share space in the bundle as well.
- ☐ Determine the best way to secure the wires near the Control Unit to minimize stress on the wires at the connector.

6.5 Wiring the Power Lug

- ☐ Connect the power lug to the battery contactor using 6 or 8 gauge wire. If installing on a config 4 system (dual bus with dual battery contactors), connect the CCS Control Unit to the Bus A battery contactor. Connect on the main lug of the battery contactor OPPOSITE the side where the battery connects.

  CAUTION: DO NOT OVER-TORQUE THE POWER LUG on the CU. Max 36-in-lbs.



6.6 Wiring the Evaporator/Cabin Fan

Note: if your fan has a fuse block installed, leave the fuse installed and wire to from the CU to the fuse block. You may want to replace the fuses with 30A fuses, so circuit protection is provided entirely at the CU.

- ☐ Run a wire from J11-1 to the low speed terminal on the cabin fan.
- ☐ Run a wire from J11-2 to the medium speed terminal on the cabin fan.
- ☐ Run a wire from J11-3 to the high speed terminal on the cabin fan. NOTE: some fans have a forth high-speed (highest speed) terminal. Do NOT use this terminal.
- ☐ Run a ground wire from the common ground block to the fan.

6.7 Wiring the Condenser Fan

- ☐ Run a wire from J11-5 to the power terminal on the condenser fan.
- ☐ Run a ground wire from the common ground block to the fan.

6.8 Wiring the Compressor

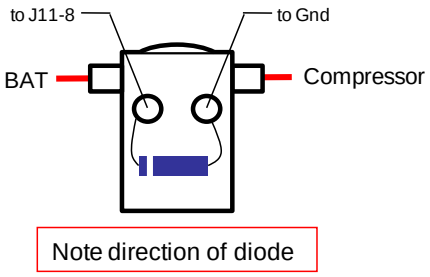
There are several types of compressors, each is wired uniquely and shown on the CCS Wiring Diagram. The three wiring methods are shown here.

6.8a Flightline AC electric compressor

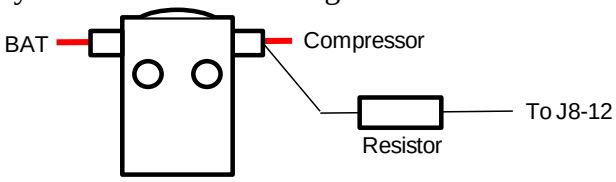
- ☐ Run a wire from J11-8 to the white wire on the compressor.
- ☐ Run the green wire on the compressor to J8-12 on the CU. If no green wire is present, contact Flightline AC.
- ☐ Install the Compressor Adapter Box, included with the CCS – see Appendix B for wiring details.
- ☐ The red and black wires on the compressor should be connected per the Flightline AC instructions.
- ☐ Be sure to secure and insulate the ends of any unused wires.

6.8b Other electric compressor

- ☐ Run a wire from J11-8 to one of the small posts on the solenoid.
- ☐ Wire the other post to ground.
- ☐ Install the supplied diode in the correct orientation across the two smaller posts using ring terminals.



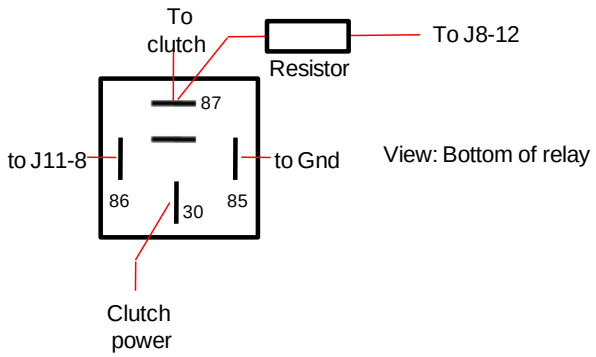
- ☐ Run the compressor sense wire from the compressor side of the compressor solenoid to J8 pin 12. Solder the supplied 1K ohm, 1 watt resistor in-line somewhere near the batter contactor and cover it with a few layers of heat shrink tubing.



6.8c Engine-driven compressor

- ☐ If the clutch draws less than about 4 amps continuous current, then you don't need a relay.
  - Wire J11-8 directly to the clutch.
  - J8-12 should be wired to the wire coming from J11-8. Make the connection near the CCS CU. J8-12 needs to sense voltage when the compressor is turned on.
- ☐ If the clutch draws more than about 3 amps continuous current, then you should use a relay.
  - Install the compressor clutch relay in a suitable location <u>inside</u> the cabin or empennage (in a pressurized location, if pressurized aircraft).
  - Run a wire from J11-8 to terminal 86 on the compressor clutch relay.
  - Run a wire from terminal 85 to ground.
  - Connect pin 30 to the clutch power source and it's circuit protection.
  - Connect pin 87 to the clutch and to the compressor sense wire.

- Solder the supplied 1K ohm, 1 watt resistor in-line somewhere near the relay and cover it with a few layers of heat shrink tubing.



6.9 IAT Sensor Wiring

The system does not differentiate between the two temperature sensors. IAT 1 and IAT 2 can each refer to either sensor.

- ☐ Connect IAT 1 inputs (J8, pins 29 & 30) to the two screw terminals on the back of an IAT sensor using ring terminals. It does not matter which wire goes to which terminal.
- ☐ Connect IAT 2 inputs (J8, pins 31 & 32) to the two screw terminals on the back of an IAT sensor using ring terminals. It does not matter which wire goes to which terminal.

6.10 Cabin Temp & Fan Speed Switch Wiring

These switches are connected using a ground wire and a 2-conductor wire connected to the CCS Control Unit.

- ☐ Connect the cabin temp decrease input (wht wire, J8 pin 1) to the cabin temp switch.
- ☐ Connect the cabin temp increase input (wht/blu wire, J8 pin 2) to the cabin temp switch.
- ☐ Connect the middle terminal (common) on the switch to ground (same ground as the CCS Control Unit)
- ☐ Connect the fan speed decrease input (wht wire, J8 pin 3) to the cabin temp switch.
- ☐ Connect the fan speed increase input (wht/blu wire, J8 pin 4) to the cabin temp switch.
- ☐ Connect the middle terminal (common) on the switch to ground (same ground as the CCS Control Unit) or to the ground wire on the cabin temp switch.

6.11 Evap Temp & System Pressure Switch Wiring

Each of these switches has two terminals on it.

- ☐ Connect the evap temp switch input (wht wire, J8 pin 5) to a terminal on the evap temp switch.
- ☐ Connect the other terminal on the evap temp switch to ground (same ground as the CCS Control Unit)
- ☐ Connect the pressure switch input (wht wire, J8 pin 6) to a terminal on the pressure switch.
- ☐ Connect the other terminal on the pressure switch to ground (same ground as the CCS Control Unit)

6.12 Display Unit Wiring

The Display Unit communicates with the CCS Control Unit over 4 wires, physically wired as two sets of two wires. The shield connects at the CCS Control Unit. Do not connect the shield at the Display Unit.

☐ Connect the four wires as follows:

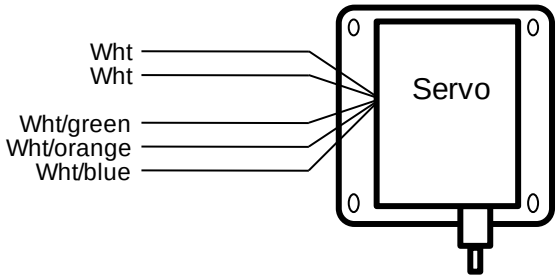
CCS Control Unit Pin		To Display Unit Pin
24	Wht	34
25	Wht/blu	35
26	Wht	32
27	Wht/blu	33

☐ Verify the shield for both wires is wired to J8 pin 28.

6.13 Heater Valve Servo Wiring

Servos from the Ray Allen Company (http://www.rayallencompany.com) are self-contained units that include the motor for the linear actuator as well as a position sensor. These servos are designed to run at 12-14 volts, and the Control Unit provides regulated 14v power to the trim motors so they can operate safely in 14v or 28v systems. The general principles described in this section apply to other brands of trim motor as well.

The Ray Allen trim servo (models T2-7A, T2-10A) has five 26ga wires, as shown in the diagram below:



The heater valve motor itself is driven by the two white wires. It does not matter how they are connected, as the polarity can be changed in the setup menus. The direction of travel is controlled by reversing the positive and negative connections to the trim motor. This is done conventionally using switches or relays, but is done in the Control Unit with solid-state circuitry. Therefore, no external relays or switches are required between the servo and the CCS Control Unit

The position sensor uses three wires to determine the position of the sensor within the servo – white/green, white/ orange, and white/blue. The three wires are connected within the servo to a potentiometer, and are wired directly to the CCS Control Unit.

☐ Install the heater valve servo(s) in the appropriate location.
☐ Using the 5-conductor wire provided, connect the wires from servo the appropriate pins on the CCS Control Unit. Each servo is grouped together on the connector, although the pins are not numerically in order.

6.14 Ground Wires

☐ Connect BOTH J8 pins 10 & 11 to the common ground block.
☐ Verify that the grounds from the fan speed switch, cabin temp switch, evap temp and system pressure switches, CCS control Unit are all grounded together on a common ground block.
☐ Verify that the ground blocks on the front and rear of the aircraft are properly connected via cable or airframe.

6.15 Testing Individual Circuits

At this point, all the wires should be connected to their respective devices. The purpose of this step is to verify correct installation of the wiring.

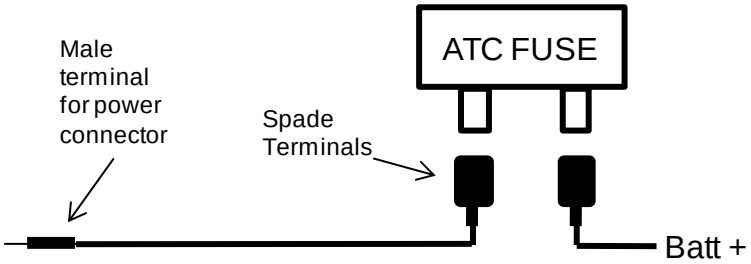
Taking your time and being methodical on this step will save troubleshooting time later.

Warning: make sure that the following are carefully checked prior to proceeding:

- Disconnect the large wire going to the starter to eliminate any chance that the starter may be accidentally engaged. Temporarily cover the exposed end of the wire with electrical tape.
- Make sure that the propeller area is clear and can rotate freely.
- Verify that the fuel system is sealed or empty.
- Verify that the area around and under the flaps is clear.
- Verify that the area around the trim motors and tabs is clear.
- Verify the high-voltage strobe wiring is either sealed or connected to a strobe light.
- Check that the fans and compressor are clear of debris.
- Check for any other conditions that may be problematic during testing.

Then proceed with the following steps:

- ☐ Disconnect the wiring harness connectors from J8 and J11 on the CCS Control Unit, if connected.
- ☐ Verify that the correct wire is in the correct connector location using the pinout table in Appendix A.
- ☐ Prepare two 18 gauge wires about 15ft long each with a male terminal (Molex P/N 19417-0048, available from Digikey or Mouser) crimped on one end and an in-line fuse (have a 10A and 20A handy) on the other. These wires are included in the Vertical Power VP-200 wiring harness kit. Using a bare-end wire, paperclip or screwdriver rather than the Molex male terminal may damage the gold coating on the terminals inside the connectors.



- ☐ Using the 18 gauge wire, connect one wire to the positive terminal of a battery (any battery is OK as long as it matches the voltage of the aircraft battery). Check that the negative on the battery is attached to the ground terminal or airframe.
- ☐ Install the correct ATC fuse for the load. Insert the male terminal in successive order into pins 1, 2, 3, 5 in J11. Verify that the appropriate fan or relay operates. DO NOT RUN THE FANS FOR MORE THAN A FEW SECONDS.
- ☐ Check compressor and feedback using the following procedure. Install the correct ATC fuse for the load. Insert the male terminal in J11-8. Verify that the compressor runs or the clutch closes in the case of engine-driven compressors. You may need to close the battery contactor for the compressor to run. DO NOT RUN THE COMPRESSOR FOR MORE THAN A FEW SECONDS.

- ☐ Attach a voltmeter to J8-12. Power J11-8 again and you should see bus voltage on J8-12. In the case of the Flightline AC electric compressor, you will see about 0.5 volts about 2 seconds after powering on the compressor. Other installations should see bus voltage immediately.
- ☐ Using an ohm meter or test lamp, verify each of the two ground wires on J8 is grounded properly.
- ☐ Using an ohm meter or test lamp, verify that the external switch inputs to the CU operate correctly. Each pin (J8 pins 1 – 4) should be grounded when its respective switch is pressed.
- ☐ Using the 22 gauge wire, connect one wire to the positive terminal of a battery (any battery is OK as long as it matches the voltage of the aircraft battery). Check that the negative on the battery is attached to the ground terminal or airframe.
- ☐ Connect the other wire to ground. Insert the wires into the correct heater valve motor power terminals (J8 pins 15 & 16, 36 & 37) and verify the trim motor operates through its expected range of motion. Flipping the pins will change the direction of the motor.
- ☐ Remove any test leads and do a sweep to check for loose or exposed wires.

You are now ready to power up the system.

- ☐ Install the connectors at J8, J9, J11 on the CCS CU.
- ☐ Turn on the VP-200. You should see a flashing green light in the hole between J8 and J9.

  Note: If you notice anything unusual, press and hold the green power button on the VP-200 Switch Panel for three seconds to shut off the system.

7 Step 3: Configure the system settings

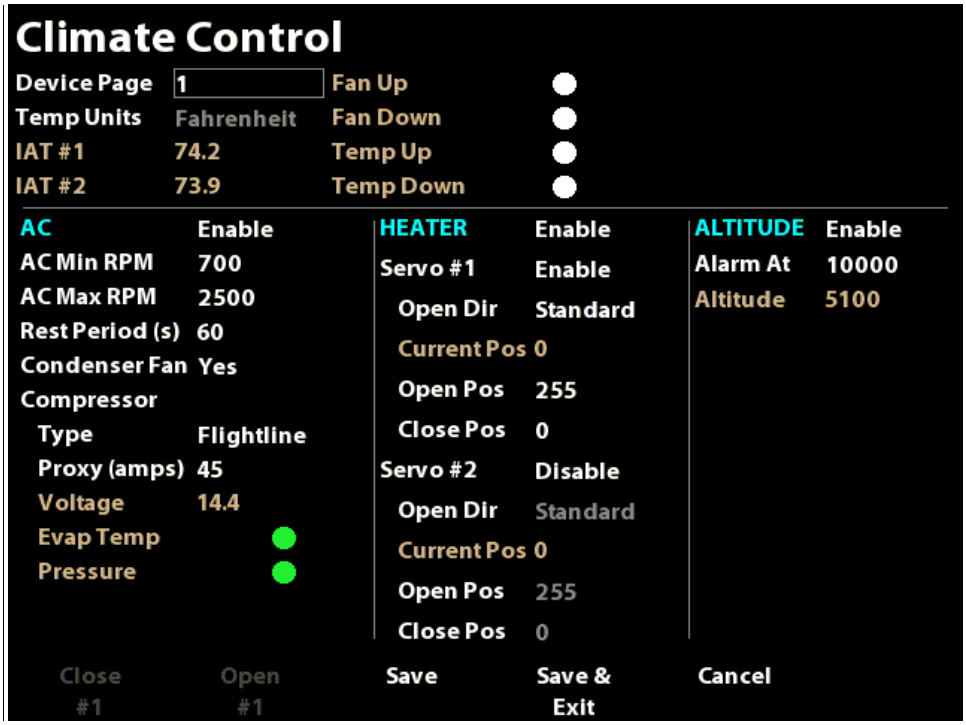
You are now ready to configure the VP-200 CCS to operate in your particular aircraft. This section describes the "mechanics" of the setup process.

Configuration is done using the Display Unit, and settings are propagated to the CCS CU. The settings can be stored on an external USB flash drive when an "Export Settings" is done.

The CCS is found under a device named **Climate** in the device list, which appears when either the air conditioning or heating is enabled. If you have created a device named Climate, delete it prior to enabling the CCS.

7.1 Setup Menu

- ☐ Go to Options-Setup-Device Setup-Device Menu-Climate Control and the following screen is shown:



Device page	Select the page (1 – 3) to show the Climate device on the Device List. Recommend placing it on page 1 so you can see the status of the climate device as it operates.
Temp Units	Currently supports Fahrenheit only.
IAT 1/2	Shows the current reading from each sensor. If a sensor is faulted, shows "FAULTED"
Fan Up/Dn	Dot turns green when switch input is active (switch is pressed). These switches are inop while in setup.
Temp Up/Dn	See Fan Up/Dn.
AC	Set to enable or disable to set all air conditioning functions.
AC MIN RPM	The minimum engine RPM that the AC can operate when the engine is on. An electric compressor can be run when the engine is off, but the engine-driven only runs when the engine is operating above this RPM.
AC Max RPM	The maximum engine RPM that the AC can operate. The AC is turned off while the engine RPM is above this limit, typically during takeoff .
Rest Period	In seconds. The cabin fan will continue to blow cold air (cool down) after the engine is shut off for the specified amount of time. The compressor and condenser are turned off.
Compressor	
Type	Select the type of compressor you have: **Flightline AC Electric** – wired per the left box on the AC wiring diagram. Assumes you have the Flightline AC with the serial converter box installed. **Generic Electric** - wired per the center box on the AC wiring diagram. **Engine-driven** - wired per the right box on the AC wiring diagram.
Proxy	Enter the current draw (amps) that the compressor draws as the CCS cannot measure this directly. The Flightline AC electric compressor draws 32 amps at 28v. An engine driven compressor draws 4 amps (for the clutch) at 14v. For other compressors,

	consult the manufacturer for the correct value. This number is used on the display and in the totals.
Voltage	Displays the voltage on pin J8-12, showing the voltage to the compressor. There should be voltage on this pin whenever the compressor is on or a fault is generated.
Evap Temp	Green indicates the sensor circuit is closed and operating correctly.
Pressure	Green indicates the sensor circuit is closed and operating correctly.
HEATER	Set to enable or disable to set all heater functions. Servo 1 and 2 are setup identically.
Servo #x	Enable if a servo is connected, disable if a servo is not connected.
Open dir	Set to either standard or inverted to change the direction of the servo. You do not need to swap the wires to change the servo direction. When you manually open the heater valve with the servo (see below item), and it closes the heater valve instead then the motor polarity is backwards and must be changed here. Press SAVE for changes to take effect.
Current Pos	Shows the current position of the servo, and this value should change as the servo moves. Not editable.
Open Pos	When selected, the soft keys allow you to open and close the heater valve using the servo. Set this value to the actual value when the valve is fully open. Note that you can set max open to any position, as it may be only "half open" on the actual valve. This will vary based on your installation.
Close Pos	When selected, the soft keys allow you to open and close the heater valve using the servo. Set this value to the actual value when the valve is fully closed.
ALTITUDE	Set to enable or disable the cabin altitude alarm.
Alarm At	Set the cabin altitude at which the alarm will activate.
Altitude	Shows the current cabin altitude.

- ☐ Verify the IAT sensors show similar temps, within a few degrees.
- ☐ Press the fan and temp switches and verify that the correct indicators turn green when the switch is pressed.
- ☐ Configure the air conditioning, heating, and cabin altitude alarm settings.

BE SURE TO SAVE THE SETTINGS BEFORE EXITING.

7.2 Notes regarding configuration

The following features are things you should know about when configuring the VP-20CCS.

- The Climate device cannot be turned on or off using the Switch Panel
- The Climate device cannot be turned on via the remote control
- The Climate device cannot be configured to flash on power on
- The circuit breaker values are pre-set and cannot be changed by the user. The values are shown in Appendix A

8 Step 4: Ground test the system

The ground test steps are performed with the engine running. If you are using an electric compressor, be sure to have a ground power plug attached that is rated for the electrical loads.

NOTE: An electric compressor can operate if the engine is not running. An engine-drive compressor is inhibited from running unless the engine is running above the specified RPM.

Read the VP-200 Operating Manual before starting the ground tests. You should complete the VP-200 system checkout prior to beginning the CCS checkout.

- ☐ Turn on the VP-200 using the green master switch.
- ☐ Start the engine if necessary. You may want to wait until the engine is broken in before long periods of idle. Lean the engine appropriately.

Note that the modes will not change automatically while a device on the Device List is selected (highlighted with a magenta box).

The directions below list only the minimum steps needed for testing. More detail about operating the system is provided in Section 3.

- ☐ Verify that air conditioning is active by Selecting Climate device. You should see the air conditioning status screen. If not, press the Air Conditioning soft key.

8.1a AC-Manual Operation

- ☐ Press the Fan switch twice to select Manual-Low, which appears in the quick look bar. The cabin should come on low and the compressor should turn on, blowing cold air into the cabin.
- ☐ Select the Climate device on the device list to see the status of individual items, or to view fault codes. Annunciators and fault codes are listed at the end of this document.
- ☐ Push the Fan Up switch to increase the cabin fan to medium speed.
- ☐ Push the Fan Up switch to increase the cabin fan to high speed.
- ☐ Push the Fan Down switch three times to go to Off

8.1b AC-Automatic Operation

- ☐ Press the fan up switch once. The quick look bar will show Auto.
- ☐ Press the Temp Up and Temp Down switches to set the desired temp. You will see the desired temp in the quick look bar or if you select the Climate device.
- ☐ Press the red emergency button. The AC should turn off.
- ☐ Press the fan up switch once. The quick look bar will show Auto. Adjust the desired temp so the fans are running.
- ☐ Shut off the engine by pulling the mixture. The VP-200 should go into post flight mode and the AC should shut off. If a rest period was specified the cabin fan should run on low. Wait until the fan shuts off.

Perform the following steps if the heater valve servo is installed and enabled.

- ☐ Verify that heater is active by Selecting Climate device. You should see the heater status screen. If not, press the Heater soft key .

8.1c Heater-Manual Operation

- ☐ Verify the engine is running, oil temp is above 75 degF, and the unit is in either After-Start, Taxi, or Run-Up mode.
- ☐ Press the Fan Up switch twice to place the heater in Manual.

- ☐ Select the Climate device on the device list to see the status of individual items, or to view fault codes. Annunciators and fault codes are listed at the end of this document.
- ☐ Push the Temp Up switch to open the heater valve. Repeat as desired.
- ☐ Push the Temp Down switch to close the heater valve. Repeat as desired.
- ☐ Press the red emergency button while the valves are open. The heater valves should close.
- ☐ Press the Fan Up switch twice to place the heater in Manual.
- ☐ Open the heater valve, then press the off soft key (when Climate device is selected) and the heater valve should close.

8.1d Heater-Automatic Operation

- ☐ Press the fan up switch once. The "quick look" bar will show Auto.
- ☐ Press the Temp Up and Temp Down switches to set the desired temp. You can see the desired temp in the quick look bar or if you select the Climate device.
- ☐ Shut off the engine by pulling the mixture. The VP-200 should go into post flight mode and the heater valves should close.

8.1e Overall Operation

- ☐ Operate the CCS in different ways to familiarize yourself with its operation prior to flight.
- ☐ Turn on multiple devices at various RPM ranges to understand the effect of the AC system on the engine and other electrical devices.

9 Step 5: Flight test the system

This section verifies the proper operation of the VP-200 during flight. The main objectives for this section are:

- Verify AC turns off during takeoff, if configured.
- Familiarization with overall characteristics during flight

Prior to flight, make sure you understand the following, which is described in the Operating Manual:

- How to clear faults
- How to switch devices on and off

This section provides a series of recommended steps, and you should incorporate these steps into the overall flight test plan as you deem appropriate. Go back and review the ground test steps, as complete and thorough ground testing will mitigate the risk of trouble while airborne.

Warning: Do not fly the aircraft until you are comfortable everything operates correctly on the ground, and you are knowledgeable about the systems and their proper operation. Be sure you understand how to acknowledge and clear faults.

9.1 Notes about first flight

It is the pilot's responsibility to develop a test plan that ensures a safe and productive first flight. Typically, the first flight is focused on verifying basic flight characteristics and proper engine operation. With that in mind, we recommend deferring electrical system tests until after you are comfortable that the engine and airframe are performing as expected, and you are comfortable flying the aircraft.

If you are installing the system as a retrofit, it is still important to complete as much of the testing on the ground as possible.

9.2 VP-200 CCS system checkout

Once airborne, keep an eye out for traffic and obstacles during the test procedure. Carry a handheld radio as a backup in case of electrical system failure. If you encounter any difficulties in flight due to improper setup or unknown electrical system behavior, land as soon as practical or simply shut the electrical system off (hold the green button for three seconds). **Problems should be noted in the air and diagnosed on the ground**. If you complete a thorough check out on the ground, the chances of problems while airborne are greatly reduced.

Verify each of the following in flight.

- ☐ Verify AC turns off during takeoff, if so configured
- ☐ Operate the CCS in different ways (heat and air conditioning, manual and automatic) during a test flight to familiarize yourself with its operation.
- ☐ Verify the cabin pressure alarm operates correctly. Note that is can be several hundred feet in error and clears when the cabin altitude is 500 ft below the alarming altitude.

10 Appendix A - CCS Control Unit Pinouts

10.1 J8 Connector

Connector is a 37-pin d-sub, female on the Control Unit, male on the wiring harness.
Pin numbers are shown on the male connector on the plastic part.

Pin	Pin Name	I/O
1	Cabin temp decrease discrete	Input
2	Cabin temp increase discrete	Input
3	Fan speed decrease discrete	Input
4	Fan speed increase discrete	Input
5	Evaporator temp switch discrete	Input
6	System pressure switch discrete	Input
10	Chassis ground	--
11	Chassis ground	--
12	Compressor power/current sense	Input
15	Heater valve motor 2 power A (white)	Output
16	Heater valve motor 2 power B (white)	Output
17	Heater valve motor 1 position feedback (wht/green)	Input
18	Heater valve motor 1 +2.5v reference voltage (wht/blue)	Output
19	Heater valve motor 1 ground (wht/orange)	--
20	Power for Flightline AC Adapter Box	Output
24	422 Xmit + To VP Display Unit pin 34*	Output
25	422 Xmit - To VP Display Unit pin 35*	Output
26	422 Rec + From VP Display Unit pin 32*	Input
27	422 Rec - From VP Display Unit pin 33*	Input
28	Shield ground for pins 24-27. Do not connect shield at other side of wire.	--
29	IAT 1 feedback	Input
30	IAT 1 ground	--
31	IAT 2 feedback	Input
32	IAT 2 ground	--
33	Heater valve motor 2 position feedback (wht/green)	Input
34	Heater valve motor 2 +2.5v reference voltage (wht/blue)	Output
35	Heater valve motor 2 ground (wht/orange)	--
36	Heater valve motor 1 power A (white)	Output
37	Heater valve motor 1 power B (white)	Output

* RS-422 ports in Display Unit serial numbers 49 and higher only.

10.2 J9 Connector

Connector is a 25-pin d-sub, female on the Control Unit, male on the wiring harness.

Pin	Pin Name	I/O
15	RS-232 receive (from Flightline AC Compressor Adapter Box pin 5)	Input

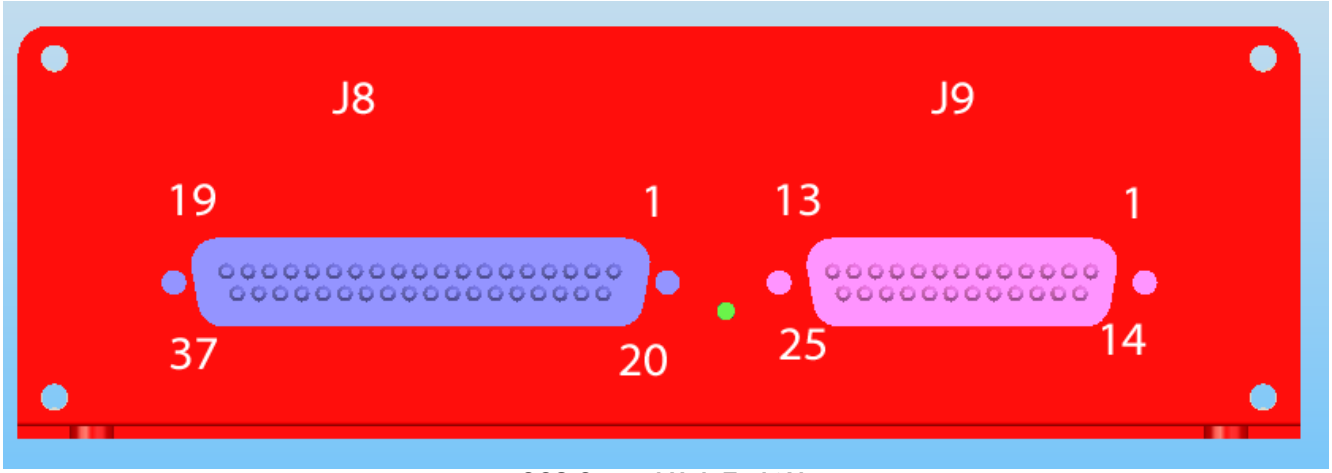
10.3 J11 Connector

Connector is a 16-pin power connector, male on the Control Unit, female on the wiring harness.

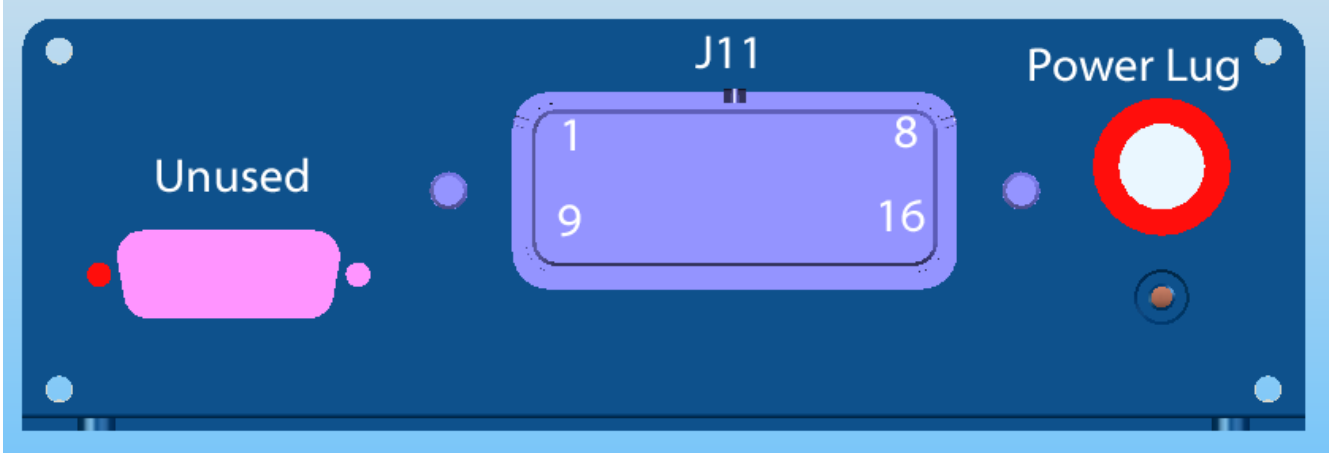
Pin	Pin Name	CB (amps)	Wire (AWG)	I/O
1	Cabin fan low	7	18	Output
2	Cabin fan medium	10	18	Output
3	Cabin fan high	14	16	Output
5	Condenser fan	17	14	Output
8	Compressor relay or power-on lead	5	20	Output

10.4 Connector Locations

The VP-200 CCS Control Unit connectors are shown below.



CCS Control Unit End 'A'



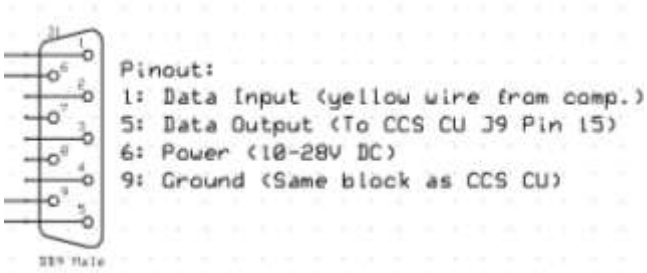
CCS Control Unit End 'B'

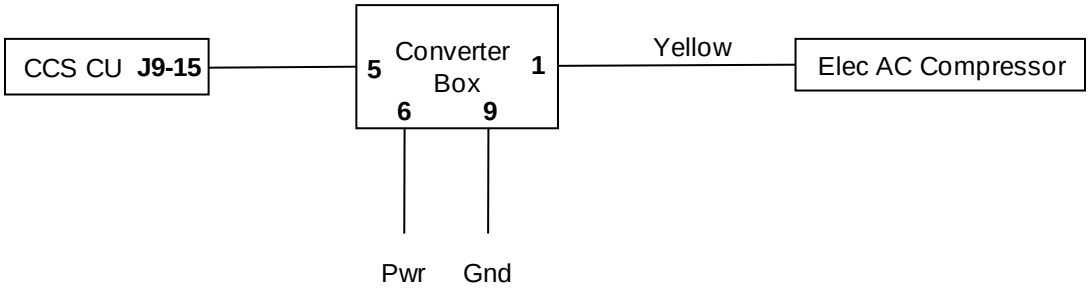
11 Appendix B – Instructions for Compressor Adapter Box

The Flightline AC electric compressor will output fault codes and other information over a serial data line. Because the data line is non-standard, an adapter box must be installed to convert it to standard RS-232 serial data format which can be read by the CCS Control Unit. Power for the box is supplied by the CCS Control Unit.

If a Flightline AC electric compressor is installed this adapter box should be installed as well. It should not be installed for any other electric compressor or engine driven compressor.

Install the box near the air conditioning and CCS Control Unit, inside the pressure vessel (if pressurized aircraft). Using the included d-sub connectors, wire the adapter box as shown in the diagram below:





Installation notes:

1. Use 22 gauge wire, minimum.
2. Pin numbers can be found on the d-sub connector itself.

- Connect pin 6 power input to CCS Control Unit J8 pin 20.
- Connect ground pin 9 to the same ground block as the CCS Control Unit.
- Connect the yellow wire from the compressor to pin 1
- Connect pin 5 to CCS Control Unit J9 pin 15

12 Appendix C: Alarm Annunciators

The following messages are shown either on the annunciator grid or on the CCS display in the Device List.

Alarm	Description
AC Pressure	The pressure switch is indicating the air conditioning system pressure it too low. Or a loose wire could cause an open circuit condition.
Bus State	That the CCS does not know the primary bus state (state of the battery contactor), caused by low voltage on the main power lug. This may occur during power-on and may be rectified once the AC is powered on.
CAB ALT FAIL	The communication link between the CCCS CU and the DU is inop and therefore the system does not know the cabin pressure and is unable to alarm if exceeded.
CABIN ALT	The cabin altitude exceeds the limit as configured by the user.
CCS COMM	The serial connection between the CCS control unit and the DU is inoperative. The AC shuts off, and the heater valves close.
CCS DISABLE	One or more of the cabin temperature and fan speed switch inputs are grounded on startup, indicating a bad switch or wiring. Repair the problem and cycle power to clear the fault.
CCS TEMP	The CCS control unit is over temp. When then unit cools down, the alarm will clear and you can resume normal operation.
Closing	The CCS is closing the heater valves.
Cool Down	The cabin fan runs on low setting after CCS shutdown for the specified period of time. You cannot turn the CCS on during the Cool Down (rest) period
Current Fault	A circuit is turned on but it is not drawing any current.
EVAP COLD	The evaporator temperature sensor is indicating the evaporator coil is too cold. The CCS turns off the compressor and evaporator fan, and continues to operate the cabin fan. The CCS restores to normal operation once the evap temp rises to normal levels. Or a loose wire can cause an open circuit condition.
IAT Fault	Either Inside Air Temperature sensor is faulted from either an open connection or short to ground. The CCS will continue to operate using the other IAT sensor. Go to Options-Setup-Device Menu-Climate Control to see which sensor has failed.
Inhibit: Mode	The CCS is inhibiting operation because it cannot be operated in the current Mode (pre-flight, before-start, etc.)
Inhibit: Oil T	The CCS is inhibiting heater operation because the oil temp must reach 75 degF before the heater can be used.
Inhibit: RPM	The CCS is inhibiting operation because the RPM is above or below the specified RPM limits.
MANUAL CCS	Both IAT sensors have failed, and the air conditioning or heater is turned off, if in automatic. You can operate the CCS using manual operation. Fault clears on power cycle.
MAX COOL	The CCS is operating at maximum cooling capacity. This is strictly advisory in nature so you know that it cannot cool at a greater rate.
MAX HEAT	The CCS is operating at maximum heating capacity. This is strictly advisory in nature so you know that it cannot heat at a greater rate.
No Power	The compressor is not working because no voltage is seen on J8-12 (which shows voltage at the compressor). A voltage is expected on J8-12 when the compressor is turned on.
Serial Converter	Short circuit or over-current condition on J8-20.
Servo Disabled	The servo ran for a maximum of 20 seconds but could not reach its set limit. There is either a mechanical stoppage or the servo is disconnected.