

Air Conditioning and Battery Charge Controller

OEM Reference Manual

Revision 400

Outback Marine

17/10/2019



Describes the installation and operation of a controller for a truck sleeper cab air conditioning system.

Outback Marine Australia Pty Ltd

Outback Marine provides system design and product solutions for marine, mobile and off grid applications including electrical, electronics, refrigeration, desalination, air conditioning and fit out equipment for boats, trucks, caravans, mobile homes, camping trailers and off grid accommodation.

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Product Description

There are two components to the system. The system controller is a programmable device that has a custom program to implement the required functionality. Unlike fixed function dedicated controllers, every parameter is capable of being programmed and custom logic can be implemented.

The controller connects to a keypad, engine unit, evaporator and condenser. It has a 3 digit 7 segment display that is used for display of system parameters and error conditions. The controller connects to a wiring loom using two 16-pin connectors.

A keypad located in the cabin area is used to operate the system. The bottom four keys are used to control the operation mode of the system while the top four keys are used to make adjustments. The keypad connects to the wiring loom using a 6-pin connector.

Features

- Engine Unit Connections: fuel solenoid, starter motor, engine fans, oil pressure contact, temperature contact, compressor clutch
- Condenser Unit Connections: condenser fan, high pressure cut-out
- Evaporator Unit Connections: evaporator fan (PWM speed control), evaporator air input temperature, evaporator air outlet temperature
- Wide supply voltage range: 12V: 9-16VDC; 24V: 9-32VDC
- Channel Connections: Molex MX150L 16 circuit
- Ambient Operating Temperature: -20 to +70 degrees Celsius
- Enclosure: IP65 ingress rating
- Controller Dimensions: 230 x 106 x 38 mm



Operation

There are four basic modes of operation – Off Mode, Charge Mode, Climate Air Conditioning Mode and Manual Air Conditioning mode.

Battery Charging Mode

The CHARGE key (shown as a battery symbol) places the unit in battery charging mode. The engine will automatically start if the voltage is below 12.2 volts for longer than 30 seconds. The engine will stop after a 2 hour running period. When stopped for a minimum rest time of 10 minutes, the engine can restart if the battery voltage again falls below 12.2 volts. The air conditioning is not running in this mode.

- 1 press of the CHARGE key will activate this mode however the engine will only start if the battery voltage is below 12.2 volts. The charge LED will indicate that the mode is activated as a continuous light.
- A press and hold of the CHARGE key for 3 seconds will immediately start the engine irrespective of battery voltage.
- Pressing the stop button at any time will stop the charge cycle (all LEDs will be off).
- When switching directly from either climate or manual air conditioning mode, the engine will first stop and then resume running when the battery voltage is less than 12.2 volts.
- In battery charge mode the controller LED display shows the battery voltage.

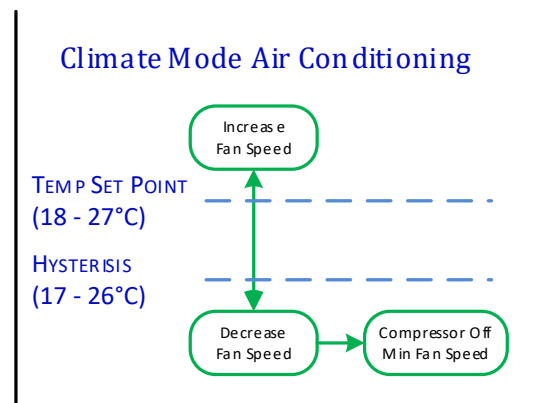
When in the CHARGE mode, the fan can be set to ventilate by pressing the fan UP or DOWN key.

Climate Control Air Conditioning Mode

Pressing the air conditioning AIRCON key will start the engine (if not already running) and place the system in Climate Control air conditioning mode. The system will keep the evaporator inlet at a constant temperature as set

by the TEMP up/down key. The fan speed will be automatically adjusted to the lowest setting that will maintain the evaporator inlet temperature.

- The compressor clutch is turned on and off to maintain the evaporator outlet temperature between 6 and 8 °C.
- The fan speed automatically adjusts to maintain a cabin temperature as set by the temperature adjustment (between 18 and 26 °C). As the cabin temperature reaches the set temperature, the fan speed will reduce to the lowest setting. At the lowest fan speed, temperature is regulated by the compressor.
- The system will remember the last climate control cabin temperature setting. The LED's show the setting.
- In climate mode, the controller LED display shows evaporator air input temperature.



Manual Air Conditioning Mode

Adjusting the fan speed while in Climate Control air conditioning mode will place the system in manual air conditioning mode. The air outlet temperature and fan speed are manually controlled by their respective up/down keys.

- The evaporator temperature is set by the temperature up/down adjustment in 1 °C steps between 6 and 14 °C. The compressor clutch is turned on and off to maintain the evaporator temperature within a 2 °C differential. The LED's show the temperature setting.
- The fan speed can be manually adjusted between lowest and highest.
- In manual mode the controller LED display shows evaporator air outlet temperature.

Off Mode

Pressing the OFF key will terminate any of the active modes. The controller LED display will indicate total engine run hours. Successively pressing the OFF key will cycle the controller display to indicate the following data.

- Hours since last service
- Total engine run hours / 10
- Compressor run hours / 10
- Software version number

The fan can be set to ventilate by pressing the fan UP or DOWN key.

Status LEDs

LEDs indicate the current mode of operation and provide error indication.

- Battery Charging – Charge LED Solid ON
- Climate Control/Manual Air Conditioning – Aircon LED Solid ON
- Error – Fault LED solid ON – error number shown on controller
- Service Due – Service LED short blink when system is OFF
- Service Overdue – Service LED solid ON



Engine Starting

For all modes there is an engine start sequence. Before cranking, the unit will look for the oil pressure to indicate no oil pressure. It will crank for 1.2 seconds and then wait to see if the oil pressure is up. If the oil pressure is OK,

the engine will go into run mode. If not, the sequence will repeat 4 times with a 10 second delay between attempts. If after 5 attempts the engine is still not running then a crank error condition exists. Pressing the stop button will acknowledge the error from which point another attempt can be made.

Start Error Override

For a pre-crank oil pressure error, the engine start sequence will abort and an E03 error will show on the controller. After ascertaining that the error is an oil pressure switch failure and clearing the error by pressing the OFF key, it is possible to override the start sequence by holding in the CHARGE key until the engine cranks. The engine should start.

If the pre-crank error occurs during an air conditioning start up cycle, press the CLIMATE or MANUAL key after starting the engine using the CHARGE key as described above.

Service Warning

When the service is due, the status LED will flash briefly while in OFF mode and the controller display will flash the service hours.

Service Overdue

When the service is overdue by more than 25 hours the engine cannot be started until it is serviced, and the service interval indicator reset.

Service Interval Indicator Reset

The service interval indicator can be reset at any time by holding down the SERVICE key for 5 seconds. If the service is not overdue, the service LED will flash for 1 second to indicate the reset has occurred. If the service is already overdue, the service LED will turn off to indicate the reset has occurred.

Display Modes

The controller has a 3 digit 7 segment display that is used as to display system parameters, error codes and program variables. The display will show associated system parameters in context with the current operation mode. When in each mode, the displayed parameters can be scrolled by pressing the associated mode key. The data displayed is in the order shown below.

Mode	Display	Example	Note
OFF	Service Hours	128	This is the time since last service. Display will flash if service hours is greater than 250.
	Total Engine Hours	78.6	The total engine hours (x10) since the engine was new.
	Compressor Hours	5.65	The total compressor hours (x10) since the compressor was new.
	Software Revision	400	The installed software revision.
CHARGE	Battery Volts	13.5(27.0)	Measures the current battery volts.
CLIMATE	Cabin Temperature	24.4	Measures the cabin temperature at the return air inlet.
	Outlet Temperature	11.5	Measures the air conditioning outlet temperature.
MANUAL	Outlet Temperature	11.5	Measures the air conditioning outlet temperature.
	Cabin Temperature	24.4	Measures the cabin temperature at the return air inlet.

Error Conditions

In the case of an error condition, the keypad fault LED will be lit. The LED display on the controller will indicate an error number as shown in the table below. Most errors will shut down the engine. Pressing the off key will clear any error condition and allow a new operation to start.

On retrofit installations it is possible that the alternator lamp monitoring feature may not be installed. The system automatically detects if the wiring is installed by checking that the alternator lamp input is low at the beginning of engine crank. If the signal is not detected then the software will not monitor the input when the engine is running.

Error	Error Name	Note
E01	High Temperature	The engine high temperature switch is activated causing the engine to stop.
E02	Low Oil Pressure	The engine oil pressure switch is activated causing the engine to stop.
E03	Pre-Crank Oil Pressure	The engine could not attempt a start because the oil pressure switch was indicating oil pressure OK when the engine was not running. Check oil level, pressure switch and wiring. Provided that everything checks out OK, it is possible to override this error. See "Start Error Override" above.
E04	Re-crank	The maximum number of crank attempts has been met. The engine did not start. Could be a fuel issue.
E05	High Voltage	The battery voltage has exceeded the high voltage set point (15 volts) causing the engine to shut down. Indicates a faulty alternator.
E06	Low Voltage	The battery voltage is less than the low voltage set point (12.2 volts) causing the engine to shut down. Indicates a faulty alternator.
E07	Reserved	Reserved
E08	Fuse Trip	A fuse has tripped on the system controller. A red flashing LED on a controller channel will indicate which fuse has tripped. Pressing the OFF key will clear the condition. Repeated tripping indicates a circuit problem which must be located and rectified.
E09	Engine Stopped	This is a special error condition whereby the engine stopped running without having a temperature or oil pressure alarm. The alternator lamp signal is used to initiate the error if it comes on (low signal) when the engine is running. When the engine stops (signalled by loss of oil pressure), an error condition is displayed. If the lamp signal is a result of the belt breaking or an alternator failure, the engine will continue running until a low voltage error occurs in which case a low voltage alarm will be generated.
SERVICE	Service Warning	When the 250 hour service interval is due, the service hour indicator will flash and the status LED will blink. If the service is more than 25 hours overdue, the status LED will flash and the engine cannot be started until the engine is serviced and the service interval is reset.

High Gas Pressure

The condenser high pressure switch opens when the condenser pressure is too high. The engine, condenser fan and evaporator fan will keep running but the compressor clutch will be disengaged. The compressor will come back on when the pressure is back to normal. There is a 1 second on and off delay for the pressure switch.

The LED associated with the high pressure switch channel 15 will be lit when a high pressure condition is active.

Programming

Parameters such as timers, voltage and temperature are defined as system constants and variables. Constants are programmed into the controller and can only be altered by changing the program. Variables on the other hand can be changed to customise the controller to individual characteristics of the installation.

Variables

To enter variable programming mode, press the FAN DOWN key and the OFF key for 3 seconds.

The system has up to 8 variables that can be changed. Toggling the SERVICE key will alternately show the variable number and the variable setting while the temperature UP/DOWN keys can change the variable number and setting. After selecting the variable number, press the SERVICE key to display the value. Change the value with the temperature UP/DOWN keys. Press the SERVICE key to return to variable select mode. Press and hold the OFF key for 3 seconds to exit programming mode.

Each of the variables has a default factory setting. While in VARIABLE mode, press and hold the FAN DOWN key and while pressing, press the OFF key to reset to defaults.

Variable	Index	Default	Note	Address
EngV.CrankTime	P00	1.2 Sec	Defines the cranking time. After cranking, engine is assumed to be running and the Engine Warm-up state is entered. (0.5-2.5 Seconds)	0-15
ChargeV.OnVolt	P01	12.2(24.4) Volts	In Charge mode when the engine is off, the battery voltage is monitored. When the battery voltage falls below ChargeV.OnVolt, an engine start is initiated. The engine will keep running for the time specified by ChargeV.EngOnTime. (12.0-12.6 Volts)or (24.0 to 25.2)	16-31
ChargeV.EngOnTime	P02	2.0 Hours	Specifies the time that the engine will run before returning to Charge.EngOff. (0.1 - 5.0 Hours)	32-47
ClimateV.Change Time	P03	10.0 Sec	In climate mode, the fan speed is stepped higher or lower to keep the cabin at the set temperature. This variable controls the time between steps. (1.0 - 60.0 Seconds)	48-63
Reserved	P04			64-79
Reserved	P05			80-95
Reserved	P06			96-111
Reserved	P07			112-128

System Resets

The system hour counters can be reset as required. To reset service hours, press and hold the SERVICE key for 5 seconds. The hours will be reset to 0.

While in VARIABLE programming mode, while holding the FAN DOWN key, press the AIRCON key to reset engine hours and the CHARGE key to reset compressor hours. Pressing the OFF key will reset all system variables to the initial factory default.

Constants

The constant names and the programmed settings are listed below. These values are correct for the latest software revision. Constant values can be changed by software revision.

Constant Variable	Setting	Note
EngV.PreCrankTime	4 Seconds	Defines the time period before cranking. During Pre-crank, the fuel solenoid/fuel pump is turned on and allowed to settle. During this time, the Oil Pressure contact is checked for “no oil pressure”. If the oil pressure check is OK, then the state proceeds to engine cranking as defined by. P00-EngV.CrankTime .Otherwise a Precrank Oil Pressure error is initiated.
EngV.WarmUpTime	4 Seconds	The Warm Up time period allows the oil pressure to settle which will indicate that the engine is started and running. If after the Warm Up time there is no oil pressure then a Re-crank is attempted. The oil pressure signal has an on filter time (losing oil pressure) of 2 seconds and an off filter time (acquiring oil pressure) of 2 seconds.
EngV.RecrankTime	4 Seconds	Re-crank is the time interval between a warm-up timeout and the next pre-crank. During this time the fuel solenoid is turned off and the starter motor/battery has an opportunity to rest.
EngV.StopTime	2 minutes	Defines the amount of time that the engine is in stop mode before going to idle state. In stop mode, the fuel solenoid is off but engine fans are still running. The engine can still be restarted before the stop time expires.
EngV.CrankCount	5	Defines the number of times that the engine will crank before aborting. When the count is exceeded, Re-crank error is activated which will cause a transition to an Engine Error state.
EngV.HiVolt	15.0 Volts	Battery voltage is monitored. If the voltage exceeds 15 volts an engine Volts High error condition is met and the engine will shut down.
EngV.LowVolt	11.8 Volts	The low battery set point used for Low Volt Time below.
EngV.LowVoltTime	5 Minutes	If battery voltage stays low for longer than Low Volt Time an engine Low Volts Error condition occurs. The engine will shut down.
ChargeV.OnVoltDelay	30 Seconds	The battery voltage must be below the ChargeV.OnVolt amount for 30 seconds before initiating an engine restart when in CHARGE mode.
ChargeV.MinEngOffTime	5 minutes	Specifies the minimum time that the engine must be off before it can restart in CHARGE mode.
Climate Temperature Range	18 – 27 Celcius	The evaporator inlet air temperature range is set for 10 steps from 18 degrees to 27 degrees Celsius. There is a 1 degree negative hysteresis.
Fan Speed Range	10 to 100%	The fan is adjustable in 10 steps from 10% to 100%. The default speed setting for Climate and Manual mode is 50%.
Manual Temperature Range	8 – 17 Celcius	The evaporator outlet temperature range has 10 steps from 8 to 17 degrees Celsius with a 2 degree negative hysteresis. The default setting for manual mode is 13 degrees. The default setting for climate mode is 8 degrees.
Service Hours	250	The engine service interval. When these hours are exceeded the engine hours will flash.
Service Hours Grace	25	The grace period during which the engine can still be started using a Service Warning Override procedure.

Installation

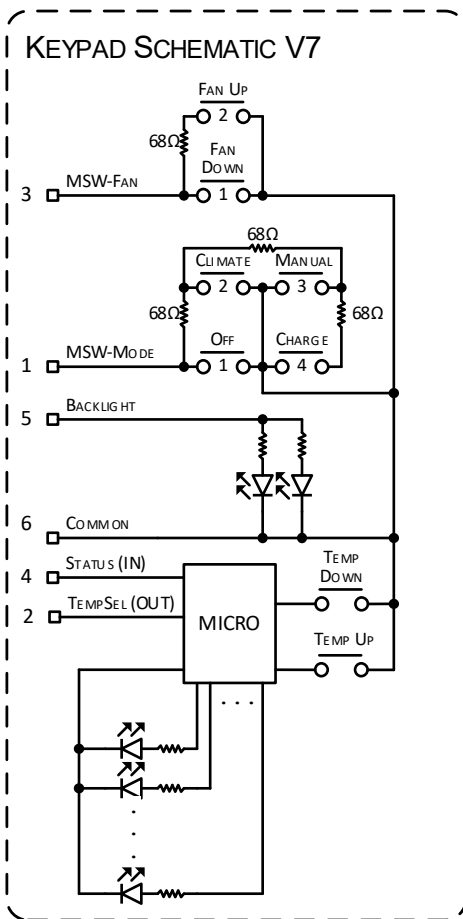
The figures below show the schematic diagram of the keypads and system. Individual ground returns for the Keypad, EvapInTemp and EvapOutTemp must be used as shown. All other ground returns can be made via the vehicle chassis or by dedicated channel ground returns.

All inputs and outputs are referred to as channels. Channels 1 to 8 are assigned to connector 1 and channels 9 to 16 are assigned to connector 2. See the controller connection list below for details.

The positive and negative power cables must be adequately sized so that the imposed round trip voltage drop is less than 2% under maximum load as measured between the power terminals on the controller and engine chassis connection. The maximum load condition will be when the unit is in an air conditioning mode with the compressor clutch engaged.

Keypad Selection

The system is compatible with V7 keypads. It is not compatible with V6.3 and earlier keypads.



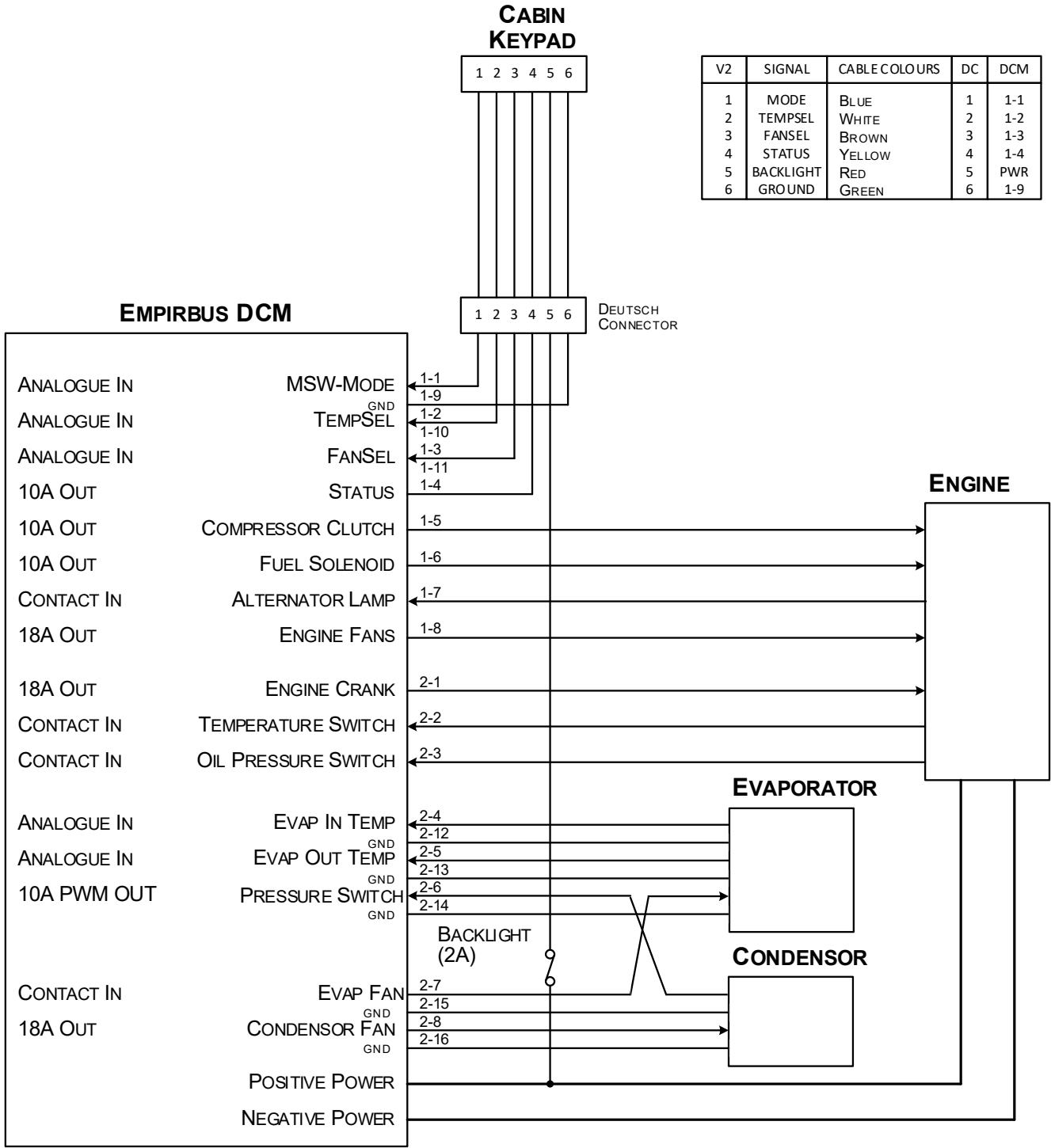


Figure 1 System Schematic

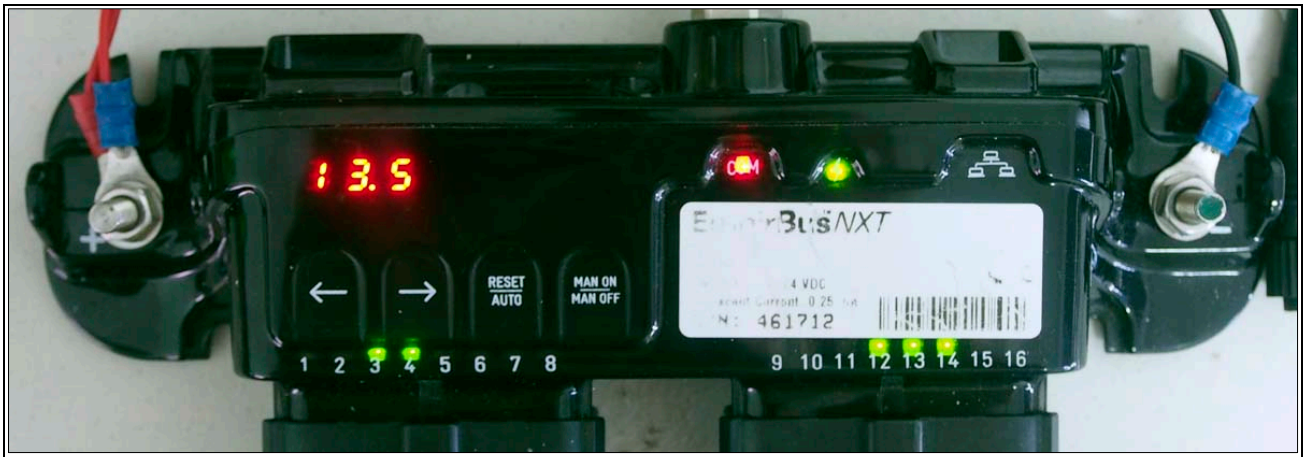


Figure 2 DCM Module

Controller Connection List

Channel #	Name	Function	Fuse Rating /Note	Connector
1	MSW1	Input for keypad OFF, CHARGE, AIRCON and SERVICE keys.	Multiswitch	1-1
2	TempSel	Input for keypad Temperature	Voltage	1-2 1-10 Gnd
3	MSW2	Input for Fan Keys	Multiswitch	1-3
4	Status	Output signal for Keypad Processor	1 amp	1-4
5	Clutch	Output for compressor clutch.	10(8) amp	1-5
6	Fuel Solenoid	Output for fuel solenoid.	10(8) amp	1-6
7	Alternator Lamp	Signal from alternator lamp to determine if the engine has stopped for a reason other than temperature or oil pressure. System will auto detect lamp wiring on start-up.	Ground	1-7
8	Engine Fans	Output for engine cooling fans.	18(15) amp	1-8
9	Engine Crank	Output for engine starter motor solenoid.	10(8) amp	2-1
10	Temperature	Input for high temperature switch. Grounded when temperature is high.	Contact	2-2
11	Oil Pressure	Input for oil pressure switch. Grounded when oil pressure is low.	Contact	2-3
12	Evap In Temperature	Sensor input for evaporator return air temperature.	100Ω NTC	2-4 2-12 Gnd
13	Evap Out Temperature	Sensor input for evaporator outlet temperature.	100Ω NTC	2-5 2-13 Gnd
14	Head Pressure	Input for high head pressure. Grounded when pressure is high.	Contact	2-6
15	Evap Fan	Output for evaporator fan. 100 Hz PWM variable speed control.	10(10) amp	2-7
16	Condenser Fan	Output for condenser fan.	15(10) amp	2-8

Software Revision

The software revision is represented by 3 digits - for example 403. The first digit is a major revision that will change only when there is a significant functional change that utilises different wiring or hardware. The two remaining digits are incremental minor revisions. Each software revision has a document revision (this document) of the same number with a possible revision level of character if the document revision did not entail a software release. The table below shows the revision history.

The firmware revision is internal to the Empirbus DCM. A new software release may be dependent on a firmware revision. The unit firmware revision appears on the display for a short time after applying power or downloading software.

Software	Firmware	Date	Note
400	1.35	11/06/2018	Initial release.

Part List and Accessories

The following parts and accessories will be required for an Air Conditioning Controller installation.

Production Components

Item	Description
EMB.2010102-11	Empirbus 12 volt DCM
EMB.2020107-11	Empirbus 24 volt DCM
OMA.RTE07	RTE Sleeper Air Keypad - Version 7
OMA.TM100	Temperature Sensor - 100 ohm / 25C
