SMARTCOOL™

The ECO³™

Installation, Operation & Troubleshooting Manual

Version 23.0

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Table of Contents

1. Introduction to the ECO³™

1.1 Primary Features

1.1.1 Design Philosophy

The ECO³™ is designed to be an add-on to the existing cooling control system. The ECO³™ is designed and to work with the existing A/C and refrigeration equipment to reduce the consumption of energy. The ECO³™ is extremely flexible so that it can be used with almost any single or dual stage air conditioning or refrigeration system. It is usually wired in series with the compressor demand signal from the cooling machine's primary controller. When a call for cooling comes from the existing control the ECO³™ determines whether savings can be made on the compressor run times with no detrimental effect on the overall system or cooled space temperatures.

1.1.2 Ability to be Bypassed

At any time, the ECO³™ can be put into manual bypass and the cooling plant returns to operating exactly as it was prior to the installation. This is an important design feature that allows for system repairs and/or troubleshooting.

1.2 Hardware

1.2.1 Package Contents

The ECO³™ is supplied complete with all internal terminal blocks and mounting plate to allow mounting to a flat, vertical surface. The installer/customer is to supply all other components required for installation. Each ECO³™ is also supplied with a user manual that should be added to the operation and maintenance manual for the plant, and sticker that can be placed next to the installed unit for quick reference on the LED status indicators.

1.2.2 Hardware Versions

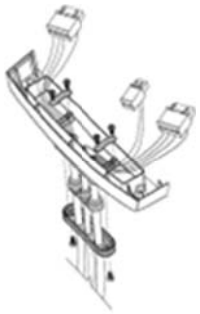
Two versions of the ECO³™ are available depending on the application. The single channel ECO³™ is designed for single compressor installations with only one stage of control. The dual channel ECO³™ is designed for two compressor or two stage installations that are cooling the same controlled space. From time to time Smartcool updates the software within the ECO³™ to give improved functionality. The software version of each ECO³™ is displayed briefly when it is initially powered up.

1.2.3 Environmental Protection

Both models of the ECO³™ are IP64 rated. This means they are totally protected against dust and are protected against low-pressure jets of water from all directions. Therefore, the product can be installed outdoors in most environments. Please note that a similarly rated power supply is required should the power supply also be installed outdoors. In extreme environments additional protection may be required. Such locations will include; areas with very heavy rain, with poor protection from wind and areas with very high levels of UV from sunlight. In certain situations where refrigeration equipment is installed in close proximity to the ECO³™ it is sensible to use extra protection to ensure that the product life is not shortened by very long periods of exceptional humidity.

1.2.4 Connection Description

The ECO³™ is connected in series with the compressor control circuit to directly influence the compressor operation. The ECO³™ units have either one (ECO³™ Single) or two (ECO³™ Dual) electrically separate, independent channels with normally open and normally closed switching.



1.2.5 Channel Voltage

The unique circuitry of the ECO³™ enables it to control and switch loads with supply voltages ranging from 24 volts to 250 volts by utilizing interface relays to switch loads.

1.2.6 Connection Specification

Connection to the ECO³™ is via pluggable terminal blocks located in the access panel at the bottom of the unit. The cable glands for the wire cover are 7mm for control cables and 6mm for power cables. If smaller cables are used the IP (Internal Protection) rating is lowered due the possibility of penetration around the sealing glands housed within the base of the ECO³™.

2. Introduction to Wiring and Hardware Installation

2.1 Basic Hardware Installation

2.1.1 Installer Qualification

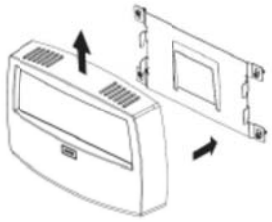
It is the installer's responsibility to ensure the installing technician is suitably qualified, certified and insured. Only professional persons must carry out installation and maintenance of the ECO³™. The ECO³™ must be installed in strict compliance with all statutory and advisory codes relevant to the locality and environment.

2.1.2 Power Supply

The power supply to the ECO³™ must be protected by a suitable fuse or circuit breaker. For USA and Canada, the ECO³™ must be connected to a class 2 transformer. If installed outside, the transformer must also have an IPXX rating for the environment in which it is installed. In installations where the power is taken from an existing 24 VAC power supply Smartcool recommends the use of a safety isolation transformer to ensure electrical separation of the ECO³™ from other parts of the system. A safety isolation transformer may be required by local wiring regulations in certain countries.

2.1.3 Hardware Installation

The back plate of the ECO³™ is attached to a flat surface via four fasteners (not provided). The ECO³™ is then inserted onto the back plate and pushed up until it clicks into place. The unit may then be wired into the system via the cable housing on the bottom of the ECO³™.



2.2 General Wiring Notes

2.2.1 Make Safe Before Starting Any Wiring

Do not attempt to install an ECO³™ without making sure that the whole system is free from all voltages.

2.2.2 Number of Channels Required

Each stage of control will require its own channel on the ECO³™. A minimum of three connections is required for each channel. A control input, control output and a reference wire connected to the system neutral or return side of the control circuit. It is advisable to use different coloured or numbered wires to facilitate identification and installation. The notes below may assist you with selecting the correct model of ECO³™ for your application:

2.2.2.1 Single Stage Applications

A. Single compressor and single compressor contactor

B. Two compressors, but a single compressor contactor (tandem)

Note: The condensing unit label showing one compressor is not a clear indication it is a single stage.

2.2.1.2 Dual Stage Applications

A. Two compressors and two compressor contactors

B. One compressor and two compressor contactors (two speed system) – This could indicate a two stage system, but could also indicate a star / delta start single stage system.

2.2.3 Channel Inputs

Each set of inputs to an ECO^{3}™ must be the same voltage and the same phase. The maximum permissible voltage to be applied to the ECO^{3}™ channel terminals is 250 VAC.

2.2.4 Electrical Disconnection

For safety and to enable servicing, a fuse with a current rating of between 50 mA and 500 mA (depending upon the supply voltage) should be installed in the electrical supply to the 24 VAC safety isolation transformer. Some installers also like to install a suitable MCB or switch to ease installation and maintenance of the ECO^{3}™ and the cooling plant.

2.2.5 Channel Voltage

The arrangement of the controls must ensure that the ECO^{3}™ always measures a voltage of between 24 VAC and 250 VAC between the IN and N terminals of any channel that is in demand. This ensures that the ECO^{3}™ always has the correct run time inputs to its savings algorithms.

2.2.6 Alternate Compressor Control Signals

The ECO^{3}™ can only operate from a stable AC voltage signal. If the existing controller uses an alternative control signal, then timers and/or relays must be used to ensure it measures a constant signal of between 24V AC and 250V AC.

2.2.7 Run Confirm Signals

If the existing (main) controller has a feedback loop to ensure compressors are running when it has told them to, then relays must be used to ensure it still receives a signal when the ECO^{3}™ has put a unit into save. This type of arrangement is often called a “run confirm signal”. The relay that introduces the false run signal is sometimes referred to as a “fooling relay”. See

diagrams and descriptions in section 3.3 and section 3.8 for further guidance.

2.2.8 **Fail Safe Requirement**

Always ensure that any ECO³™ enhanced control system allows within its design for the main controller to resume its normal operation in the event of a foreseeable failure of the ECO³™. By doing so you ensure that the installation of the ECO³™ "fails to safe." In most instances this requirement can be met by using the normally closed (NC) terminals of the ECO³™ and any relays to form the control circuit to each stage of cooling. See section 3 for further details.

2.2.9 **Existing Safety Devices**

Within the control circuit, there will be a number of safety devices that are there to ensure that the system is operating properly and that the equipment, like the compressors, is not damaged should an issue arise. Typically, the ECO³™ should be wired after these safety circuits. It is important to ensure that the safety circuits continue to operate as expected at all times. Some common safety devices that you will see are high-pressure switches, low-pressure switches, oil pressure switches and compressor proofing relays.

2.2.10 **Security of Connections**

Before closing the base of the ECO³™ check that all connections are secure. See section 4 for further post installation checks.

2.2.11 **Abrasion and Bending of Cables**

When designing the routing of cables from the ECO³™ to the connection points on the existing control circuits be sure to carefully protect the cables from any possible points of abrasion or damage made from bending the cables. Pay particular attention to protecting the cables in any areas subject to vibration and points of penetration through existing controller casings. Many countries will have regulations to ensure safe electrical installations and these must be followed very carefully. Damaged cables can cause extreme danger to persons and property including fire and electrocution.

3. Typical Integration Solutions

The differences in wiring between manufacturers and models can be significant. Knowing where and how to integrate the ECO³™ into the control circuit is paramount to the success of the project. In this section, we look at a number of scenarios, and how the ECO³™ should be wired into the control circuit. Pay careful attention to the wiring notes from the previous section, and the notes associated with each solution.

Note: In all the diagrams shown in this section it has been assumed that the mains supply voltage is 230V AC. The supply fuse shown in the diagram has been sized with this supply voltage in mind. When a different supply voltage, more suitable for your installation, is used both the transformer (T1) and the supply fuse (F1) should be changed to a suitable rating.

3.1 Basic Installation of ECO³™ Single

3.1.1 Description of System

This diagram shows the most basic installation of the ECO³™. No additional circuits are included that may be required to overcome specific issues introduced by the cooling equipment's manufacturer.

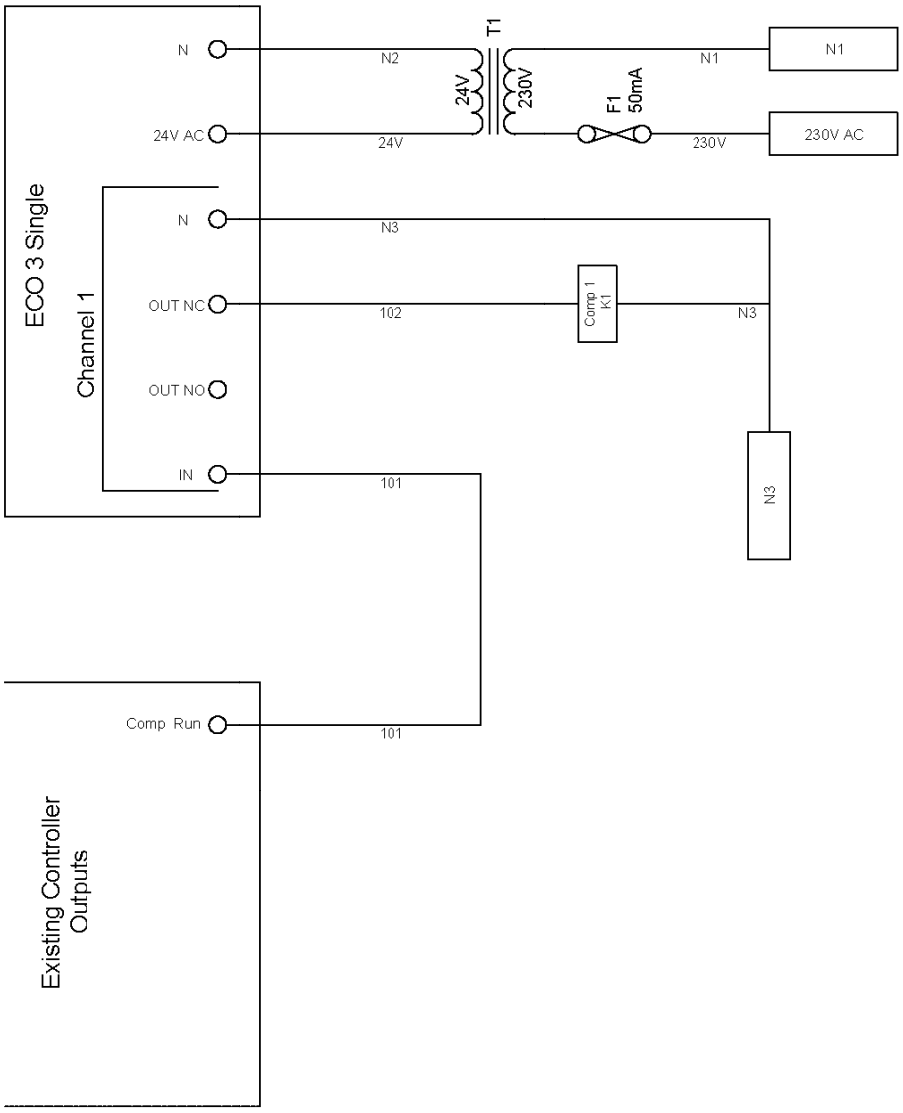
For each stage of control a "run" signal is detected by searching for a voltage between IN and N on the channel of the ECO³™ that corresponds with that compressor.

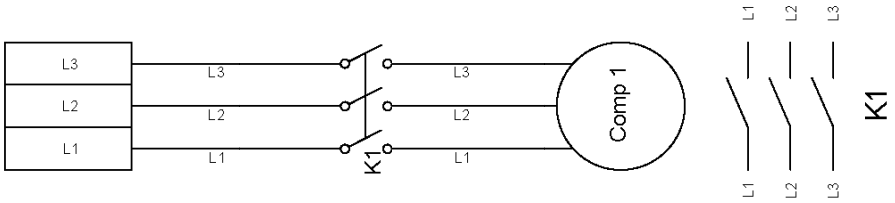
The ECO³™ is wired in series with the compressor contactor, so that during a "save" the compressor contactor is not allowed to energise.

By analysing the pattern of starts and stops of the compressor over a time frame the ECO³™ can detect the level of duty and load on the machine. The ECO³™ then applies "save" periods to match the load. Save periods are proportionally longer under lighter loads (where the machine has more capacity to recover quickly from the save) and shorter under heavy loads (where the machine has less spare capacity for recovery).

During a "save" the connection between IN and NC is broken, meaning that the compressor is not allowed to start. At the same time the NO terminal is connected to the IN, meaning that auxiliary circuits can be powered during periods of saving.

3.1.2 Diagram of System: Basic Installation of ECO³™ Single





3.2 ECO³™ Integration onto Systems with Fan and Compressor Driven from Same Controller Output

3.2.1 Description of System

On some units, the condenser fan for a single or two stage unit will be run from the same control signal as the first stage of cooling.

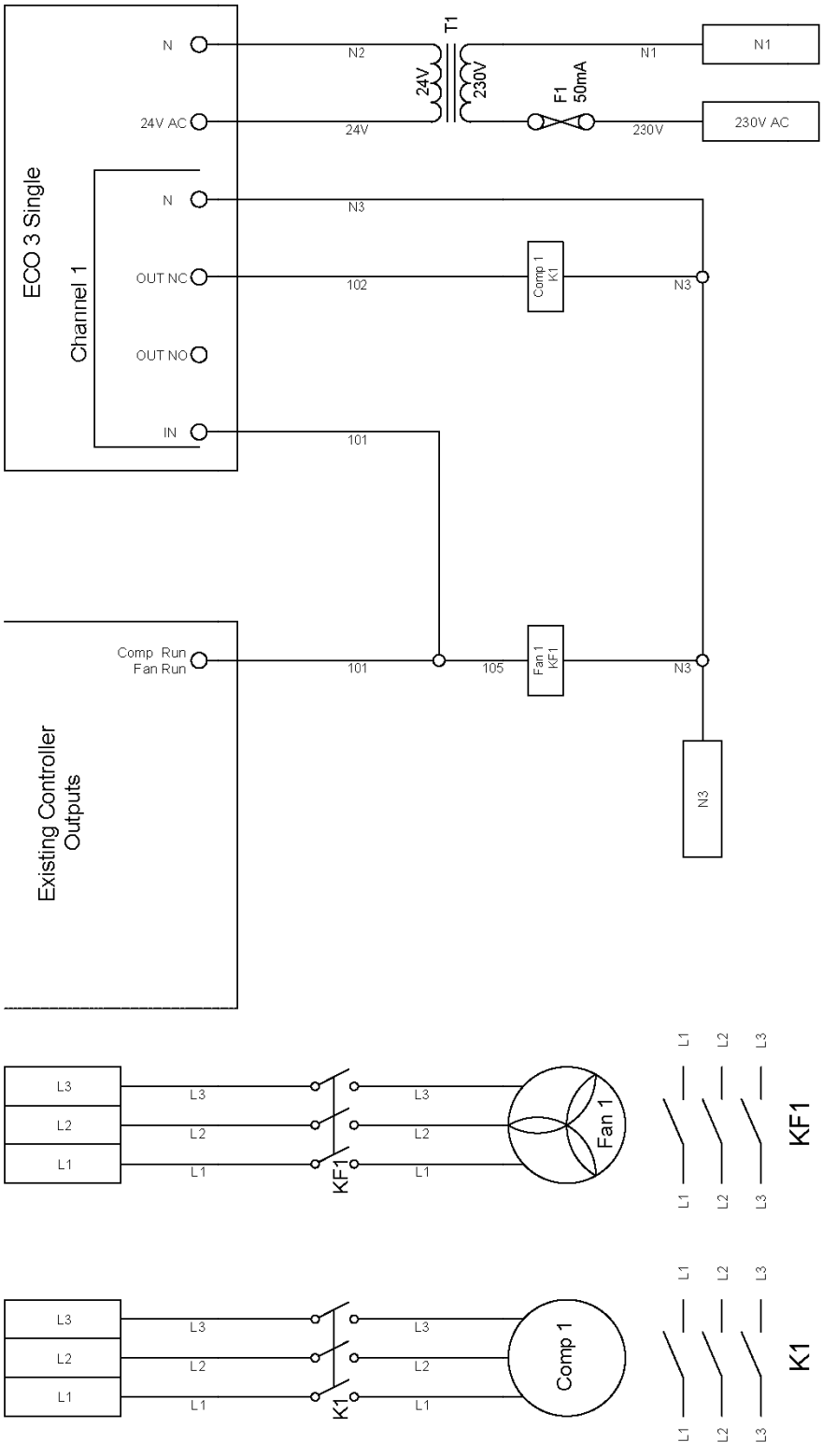
On a two-stage machine, if the ECO³™ initiates a "save" on the stage that controls the fan, the condenser fan would also stop. If this happens while the second stage continues to run it will probably cause the unit to shut down on a high-pressure fault, because the machine would not be able to reject heat quickly enough.

When using the ECO³™ Dual, one option to solve this issue is to put the ECO³™ into manual priority using dipswitch SW2. In this method, savings will always be applied to the second stage when it is running. The disadvantage of using this method is that if the control always quickly satisfies during the save, then you will also lose some of your indicated savings.

The preferred method when dealing with a two channel system, where there is no clear save priority requirement, would be to ensure that the fan continues to get a signal even when the ECO³™ has put the channel driving the condenser fan into "save". To enable this, the ECO³™ should be installed in such a way that it only interacts with the compressor and not with the condenser fan.

For simplicity we have shown a single stage system to emphasise the solution's essential features.

3.2.2 Diagram of System: Fan and Compressor Common Control



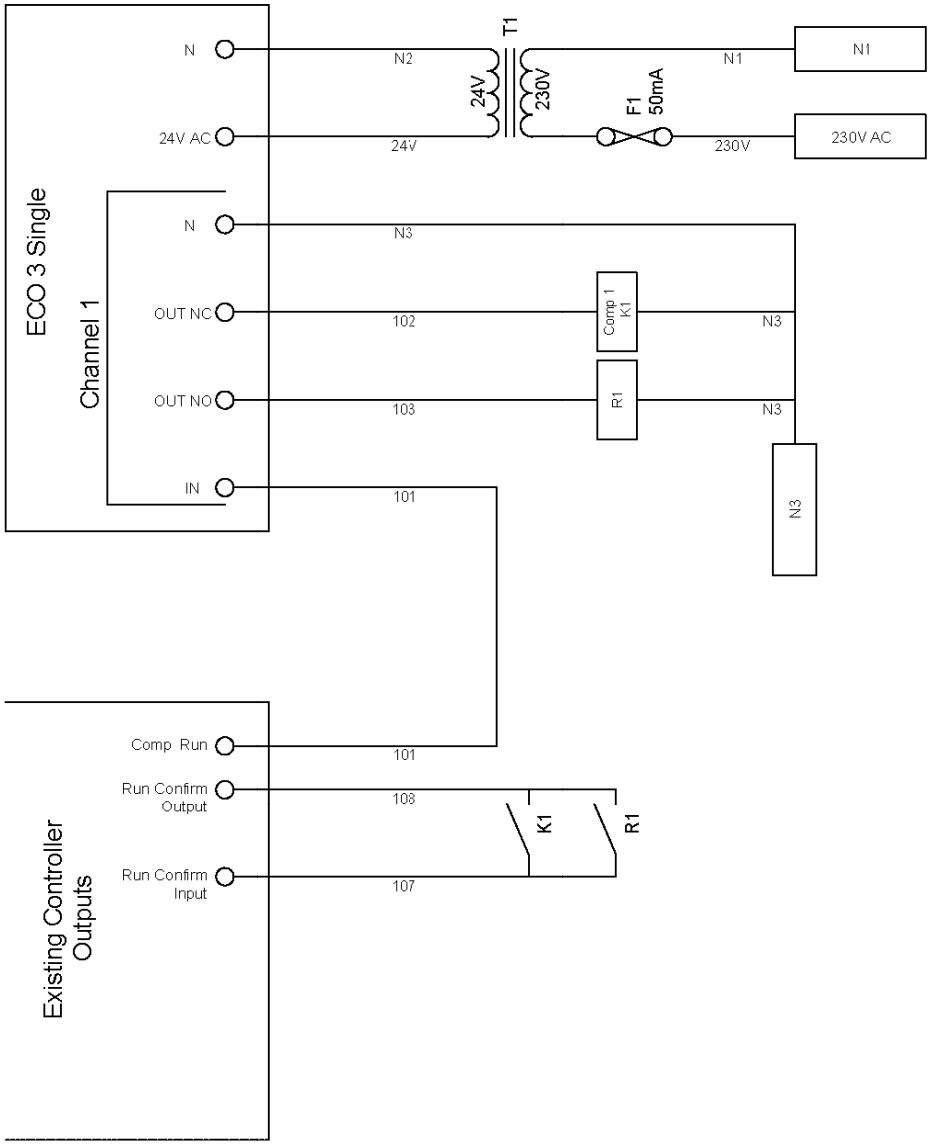
3.3 ECO³™ Single Installations with Run Confirmation

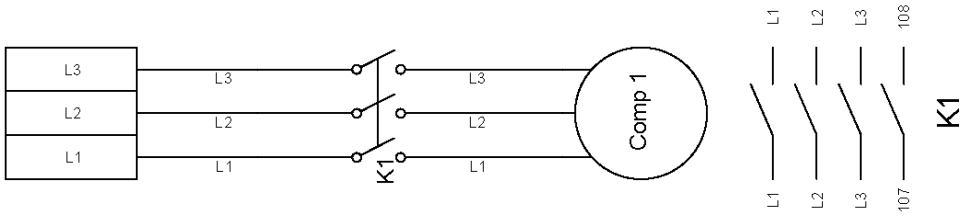
3.3.1 Description of System

Many manufacturers have now added proofing relays or current transformer (CT) circuits so that their controller can detect whether or not the compressor (or compressor capacity controller) they called for actually started running. This is so that their control can react to compressors or capacity that is not operating correctly either by raising an alarm or ignoring faulty components within their control algorithm until repairs are done.

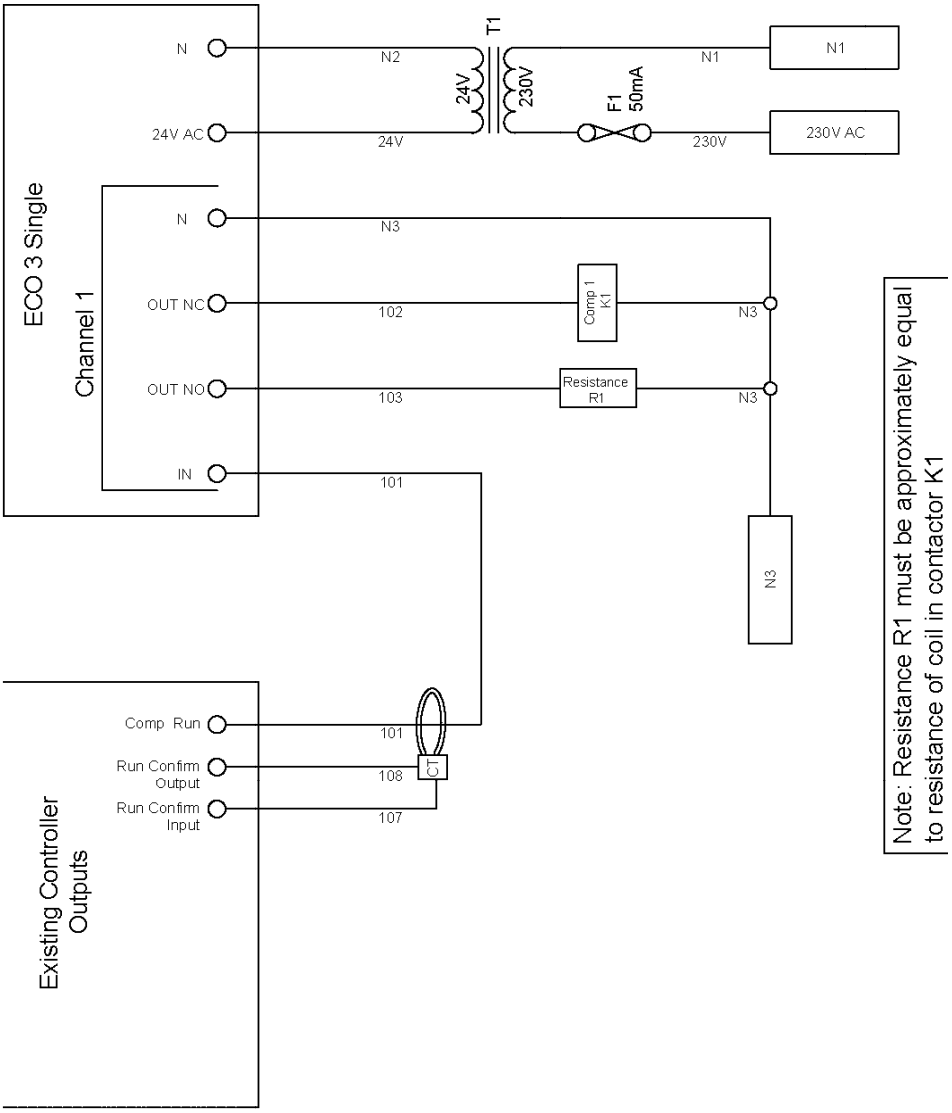
During a "save" the ECO³™ will stop or not allow starting of a compressor or compressor capacity controller that the primary controller thinks should be running. When a run confirmation circuit exists, the primary control would now issue an alarm or lock out that channel until it was reset. This means that we need to "fool" the proofing relay or circuit into seeing a signal during the ECO³™ save times. This requires the addition of a "fooling circuit" to match the signal that the existing controller expects to receive when the compressor is running. The "fooling circuit" must be carefully designed so that the controller still reacts to a genuine fault within the HAVC-R system. Two common "fooling circuits" are shown.

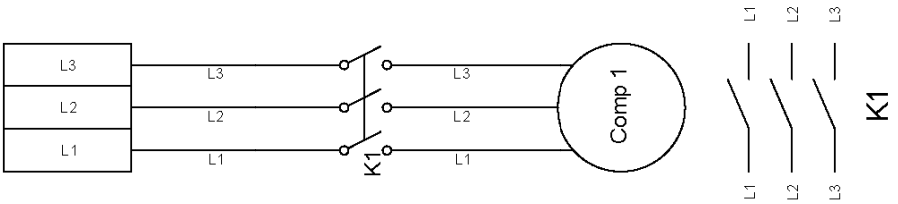
3.3.2 Diagram of System: ECO³™ Single with Relay Run Confirmation





3.3.3 Diagram of System: ECO³™ Single with CT Run Confirmation





3.4 ECO³™ Single with Control via Refrigerant Pump Down

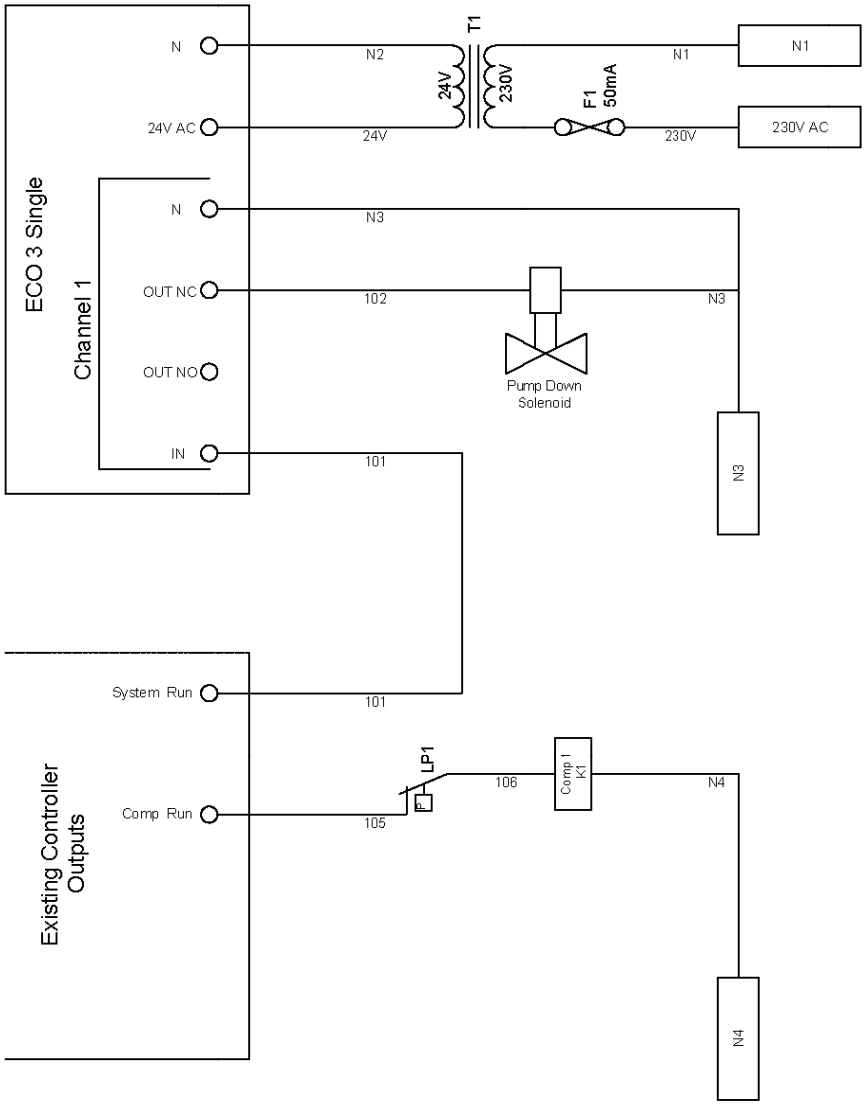
3.4.1 Description of System

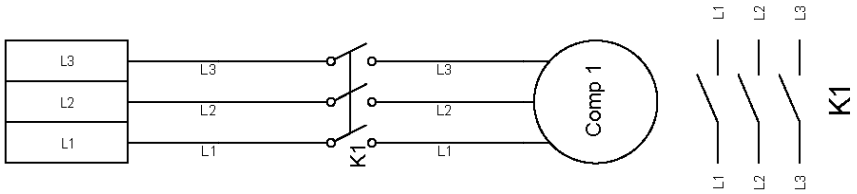
Some compressors are not immediately stopped or started by a contactor. Instead, the compressor controller is wired to the liquid line solenoid valve. On a call for cooling, the controller contacts close. This causes the solenoid coil to be energized, opening the refrigerant solenoid valve. Liquid refrigerant flows into the evaporator and the suction pressure rises above the low-pressure control set point. The contacts on the low-pressure control close and the compressor begins to run. When the thermostat is satisfied, its contacts open, causing the solenoid valve to close. This stops refrigerant flow into the evaporator. As the compressor continues to run, refrigerant is pumped out of the evaporator coil and suction pressure falls. When the suction pressure reaches the cut-out setting on the low-pressure control, its contacts open, stopping the compressor. This removes all refrigerant from the low side of the system during the off cycle.

In these circumstances, the ECO³™ is wired to the solenoid rather than to the compressor coil.

Note: It is important to identify systems that use this type of control, as failure to do so could result in damage to the compressor.

3.4.2 Diagram of System: ECO³™ Single with Pump Down





3.5 ECO³™ Single with Override Thermostat

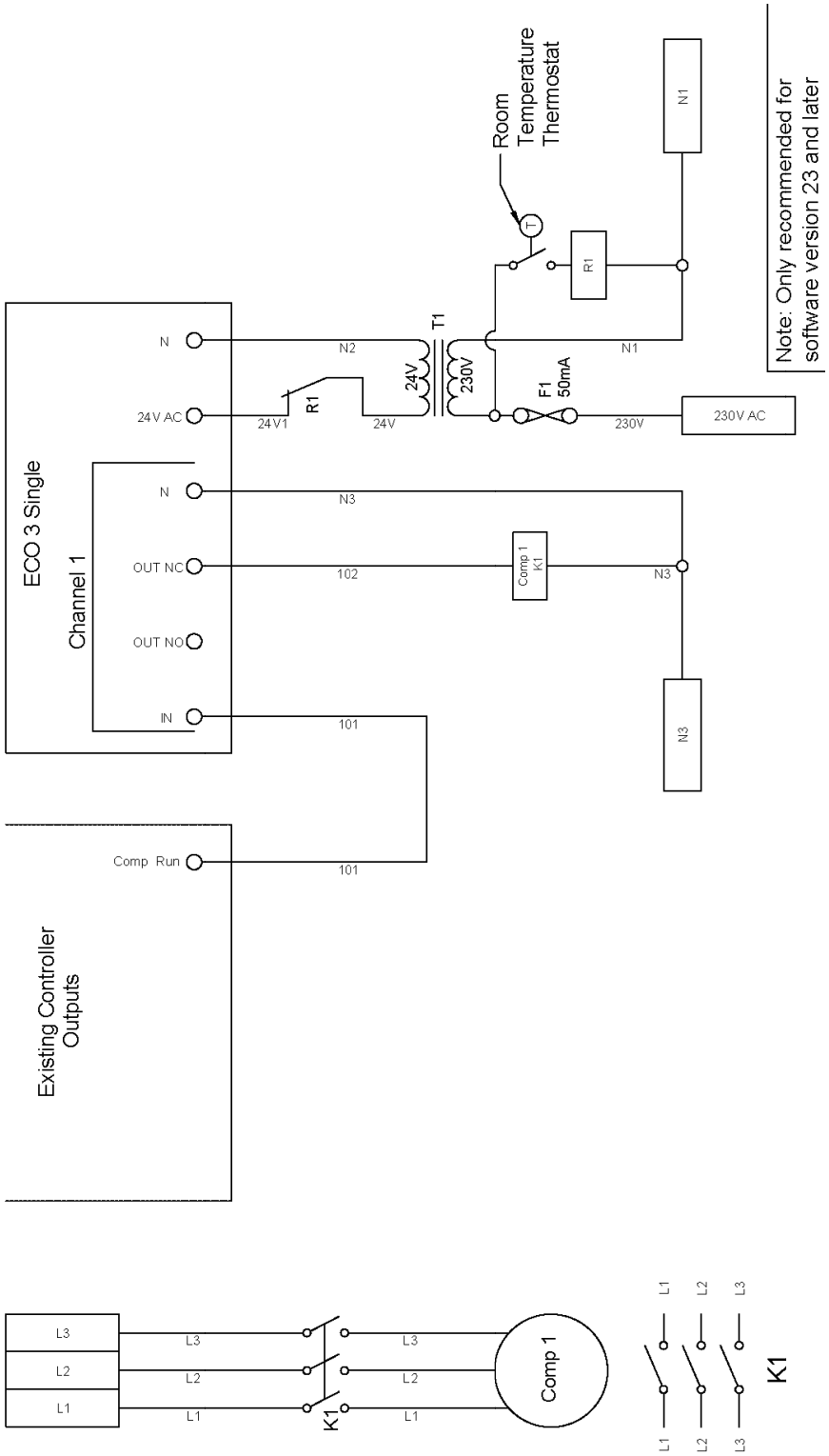
3.5.1 Description of System

To add an extra level of safety into an ECO³™ installation, a bypass system actuated by a thermostat can be inserted to bypass the ECO³™.

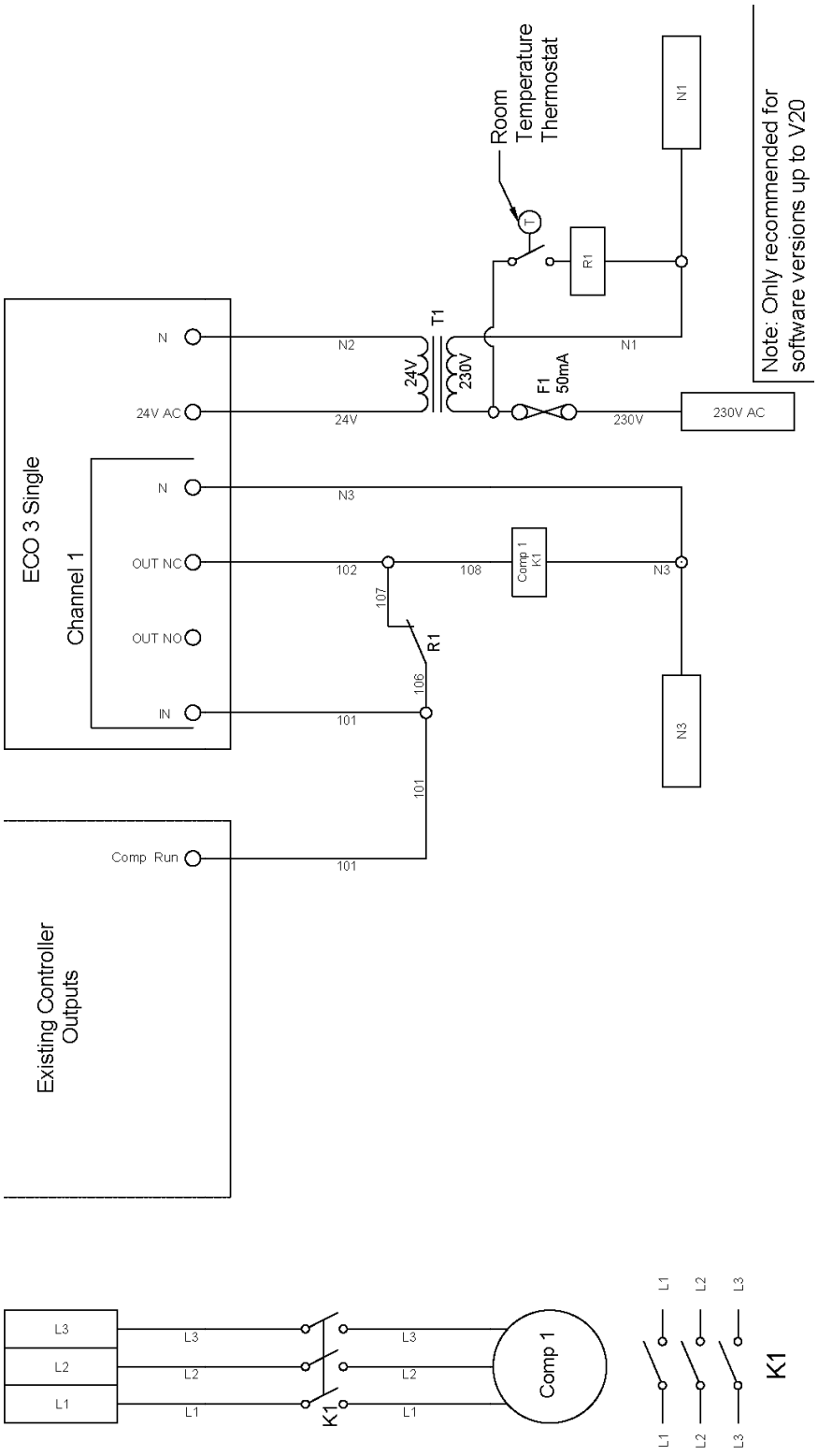
The thermostat is situated in the controlled space and is set to an appropriate temperature. Once this temperature is exceeded, the ECO³™ will be bypassed and all control reverts to the primary controller until the temperature returns below the temperature again.

This extra level of safety may be used on installations where room temperature is critical. The best solution will depend on the ECO³™ software version being used.

3.5.2 Diagram of System: ECO³™ Single (Version 23 and later) with Override Thermostat



3.5.3 Diagram of System: ECO³™ Single (Version 20 and earlier) with Override Thermostat



3.6 ECO³™ Single with Volt Free Run Signal

3.6.1 Description of System

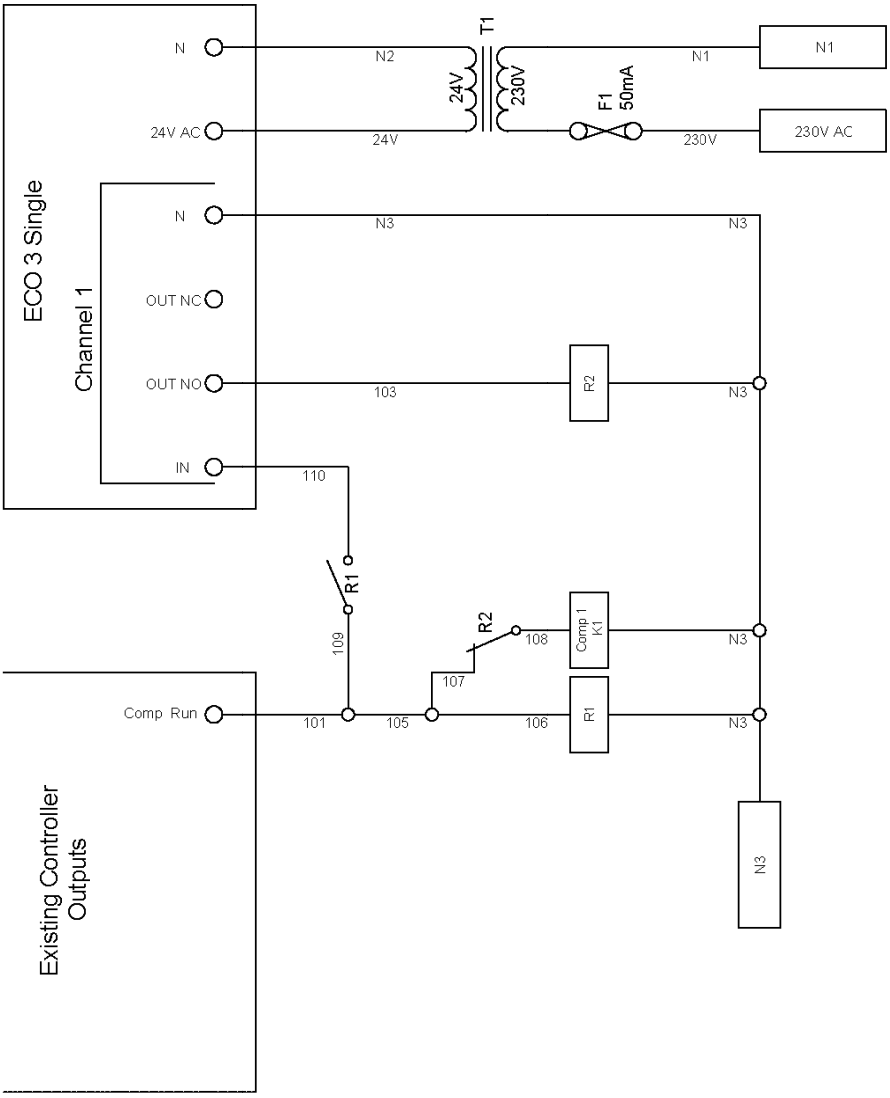
On some systems, a back feed of voltage will be present. This usually will occur in one of two ways.

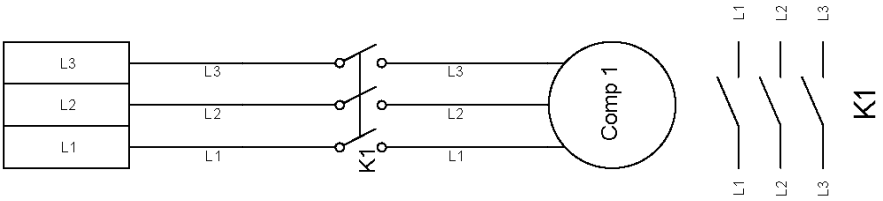
The first is a voltage less than the normal control voltage. The ECO³™ is designed to handle voltages from 24 – 250VAC; therefore it is possible for a voltage to be detected that will not activate the compressor contactor. Seeing the "run" LED lit when the compressor is not actually running can identify this.

The second type of back feed voltage that might be observed appears only when the ECO³™ internal relay activates for a "save" period. When the compressor control circuit is broken, the back feed voltage appears. This type of back feed can be identified by the "save" LED lighting up even though the compressor was not running as the ECO³™ went into a "save". This issue can also be identified if large amounts of save hours are being recorded with a lower amount of run hours.

Using the volt free run signal variation detailed here will usually overcome the challenges presented by systems like this.

3.6.2 Diagram of System: ECO³™ Single with Volt Free Run Signal





3.7 Basic Installation ECO³™ Dual

3.7.1 Description of System

This diagram shows the ECO³™ Dual in its most basic configuration with no additional circuits that may be required to overcome specific issues introduced by the cooling equipment's manufacturer.

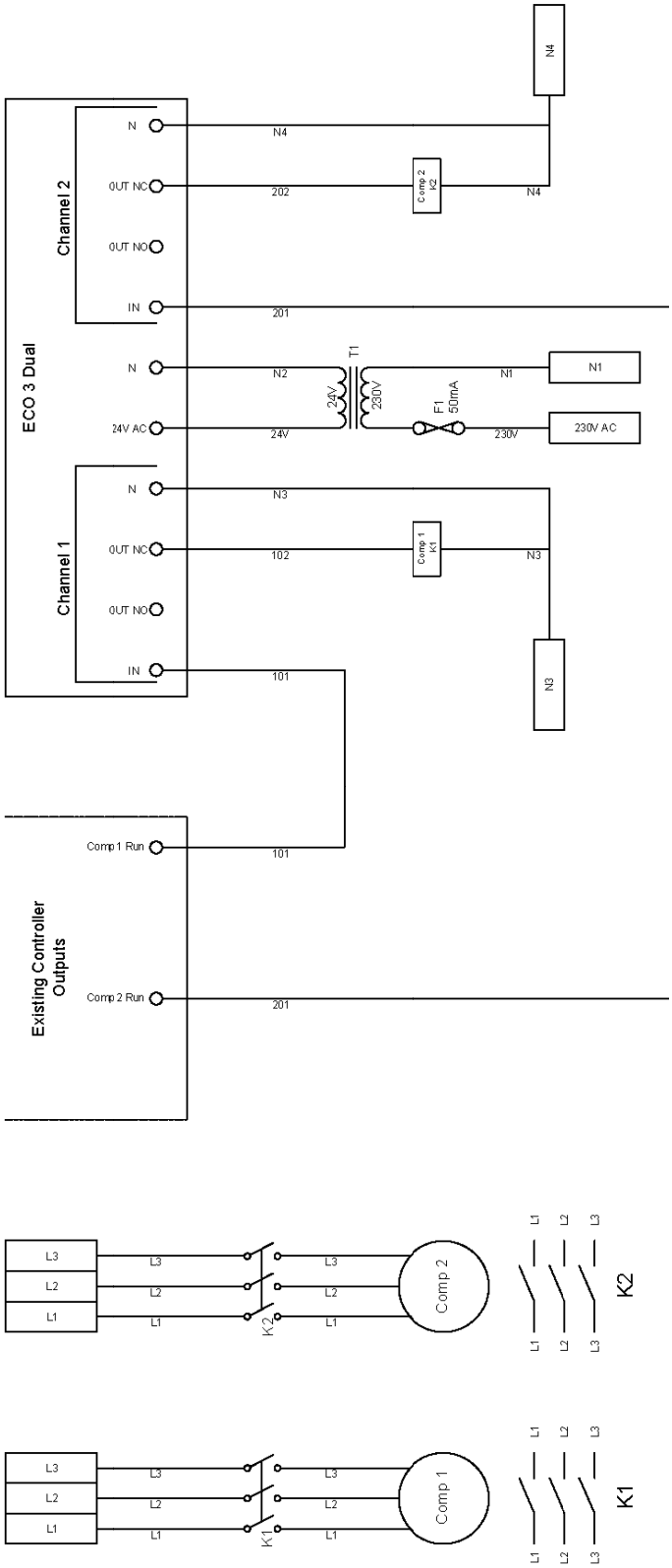
For each compressor a "run" signal is detected by searching for a voltage between IN and N on the channel of the ECO³™ that corresponds with that compressor.

Each stage of the ECO³™ is wired in series with the compressor contactor, so that during a save the compressor contactor is not allowed to energize.

By analysing the pattern of starts and stops of the compressor over a time frame the ECO³™ can detect the level of duty and load on the machine. The ECO³™ then applies "save" periods to match the load. Save periods are proportionally longer under lighter loads (where the machine has more capacity to recover quickly from the save) and shorter under heavy loads (where the machine has less spare capacity for recovery).

During a "save" the connection between IN and NC is broken meaning that the compressor is not allowed to start. At the same time the NO terminal is connected to the IN meaning that auxiliary circuits can be powered during periods of saving.

3.7.2 Diagram of System: ECO³™ Dual Basic Installation



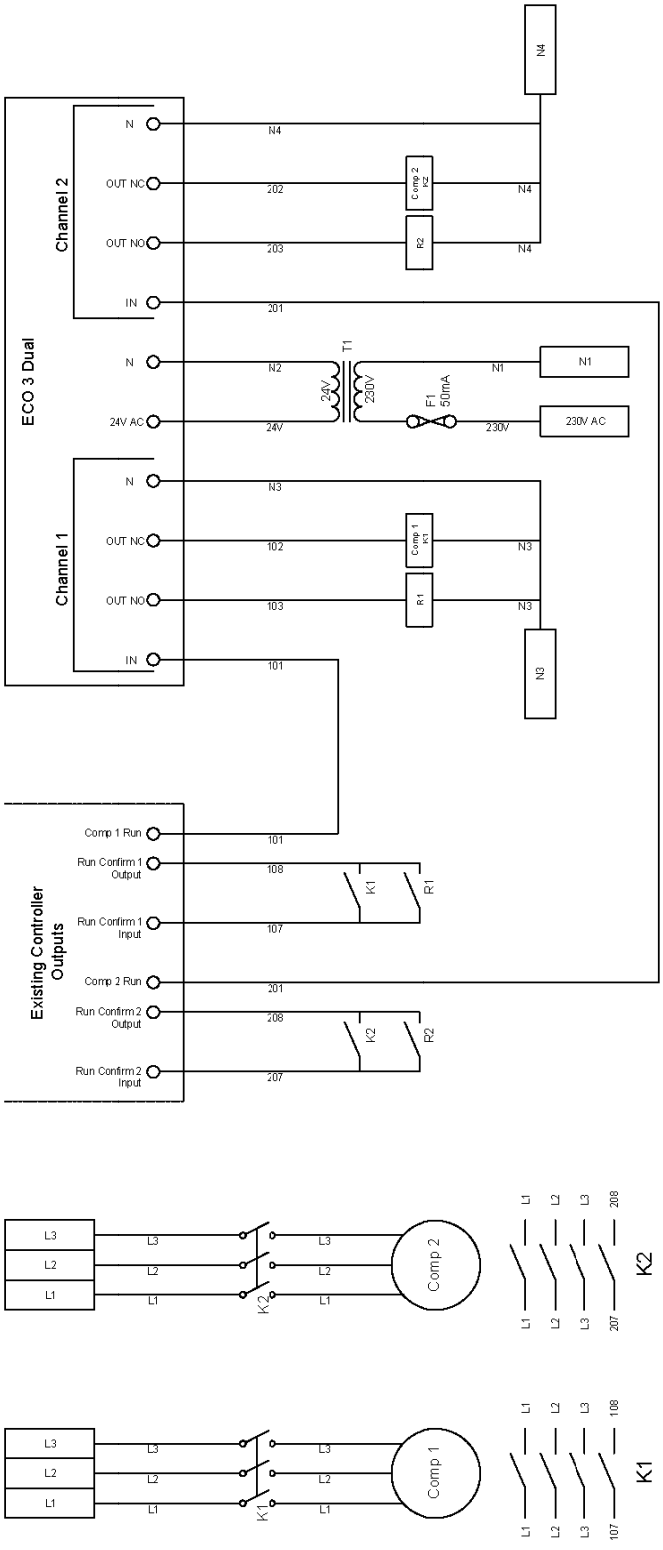
3.8 ECO³™ Dual with Run Confirmation

3.8.1 Description of System

Many manufacturers have now added proofing relays so that their controller can detect whether or not the compressor (or compressor capacity controller) they called for actually started running. This is so that their control can react to compressors or capacity that is not operating correctly either by raising an alarm or ignoring faulty components within their control algorithm until repairs are done.

During a "save" the ECO³™ will stop or not allow starting of a compressor or compressor capacity controller that the primary controller thinks should be running. When a run confirmation circuit exists, the primary control would now issue an alarm or lock out that channel until it was reset. As such, we need to "fool" the proofing relay into seeing a signal during the ECO³™ save times. This requires the addition of a "fooling circuit" to match the signal that the existing controller expects to receive when the compressor is running. The "fooling circuit" must be carefully designed so that the controller still reacts to a genuine fault within the HVAC-R system.

3.8.2 Diagram of System: ECO³™ Dual with Run Confirmation



3.9 ECO³™ Dual with Loader Driven Second Channel

3.9.1 Description of System

This type of installation can commonly be used on a plant with a single medium sized reciprocating compressor with 2 performance levels.

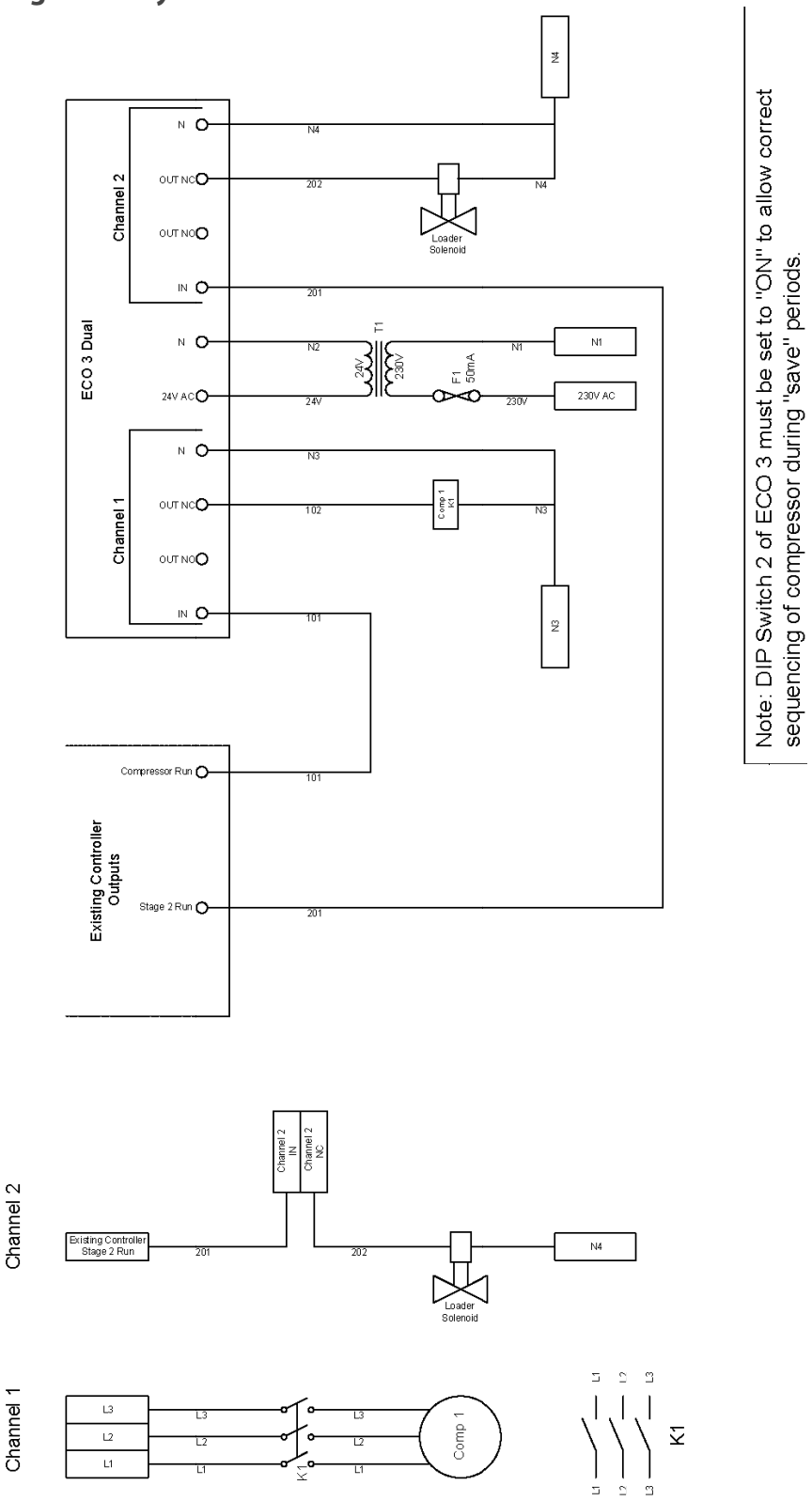
This system type energises the load solenoid in order to increase cooling capacity.

This type of system can easily be confused with the un-loader driven second stage type. It takes careful measurement and observation during the site survey to ensure that you develop the correct solution. It will often not be obvious from the plant wiring diagram which type of system you are interacting with.

The basic method of interaction for on both channels is similar to the basic integration for an ECO³™ Dual, with the exception that the second channel controls the loader solenoid rather than a second compressor.

The dipswitch SW2 should be set to the “on” position to ensure the correct save priority.

3.9.2 Diagram of System: ECO³™ Dual with Loader Driven 2nd Channel



3.10 ECO³™ Dual with Un-loader Driven Second Channel

3.10.1 Description of System

This type of installation can commonly be used on a plant with a single medium sized reciprocating compressor with 2 performance levels.

This system type de-energises the load solenoid in order to increase cooling capacity

This type of system can easily be confused with the loader driven second stage. It takes careful measurement and observation during the site survey to ensure that you develop the correct solution. It will often not be obvious from the plant wiring diagram which type of system you are interacting with.

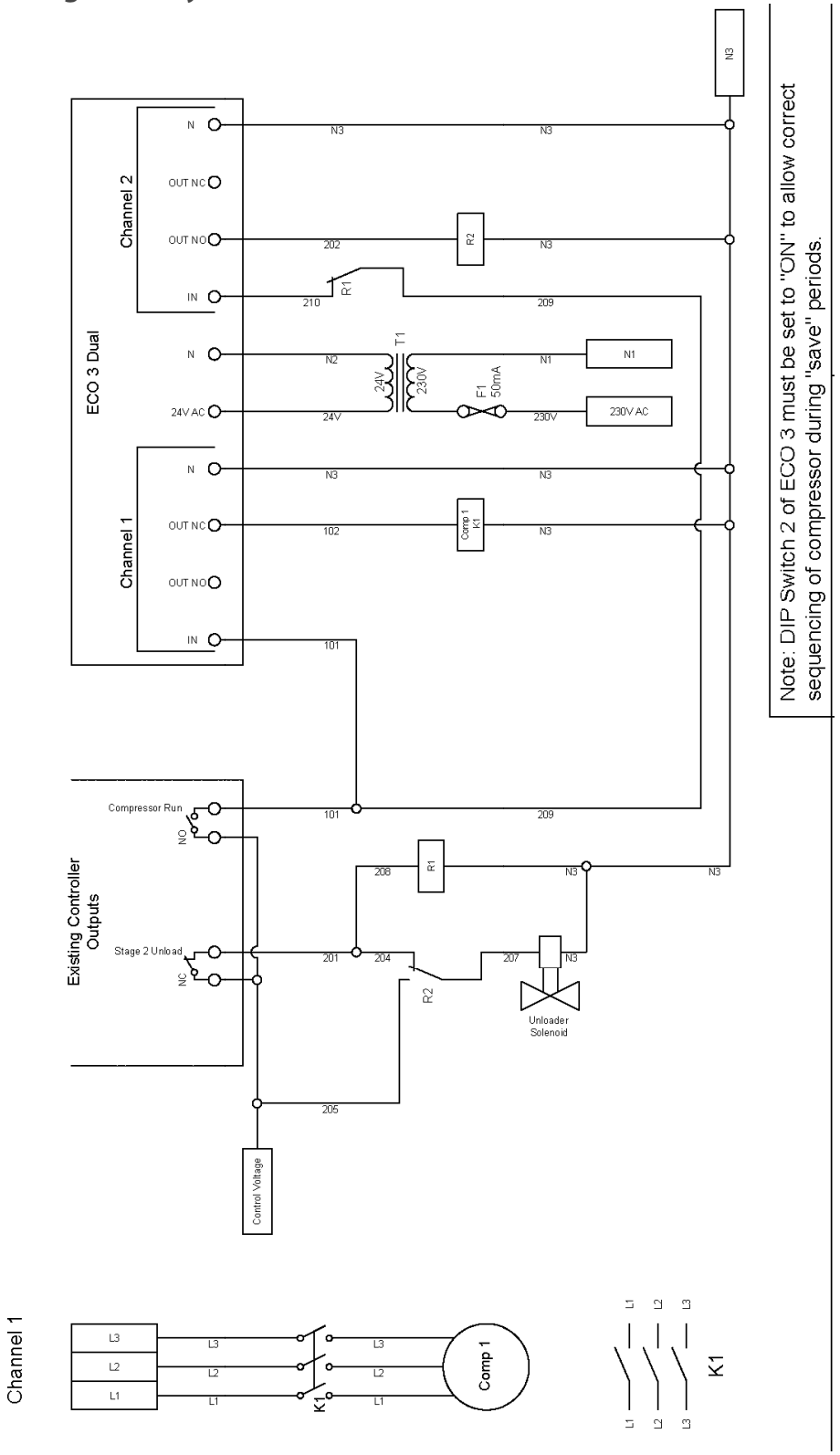
The basic method of interaction for channel 1 is similar to the basic integration for an ECO³™ Single.

The second channel allows control of the un-loader solenoid. An un-loader is the exact opposite of a loader. While a loader is energized when it is increasing the cooling capacity of a compressor, an un-loader is de-energized. This means that when a “save” is being made on the un-loader a voltage must be applied to it. This requires a simple system of relays to switch a voltage onto the un-loader during a “save”.

The run signal required for the second channel of the ECO³™ must be the inverse of that of the signal being given by primary controller. This can be achieved via a simple relay based system.

The dipswitch SW2 should be set to the “on” position to ensure the correct save priority.

3.10.2 Diagram of System: ECO³™ Dual with Un-loader Driven 2nd Channel



4. Post Installation Verification

4.1 Checks on ECO³™ Single Hardware

Use this checklist to make sure that the ECO³™ Single LEDs and display are working correctly:

- ☐ Ensure the ECO³™ has 24 VAC power to it.
- ☐ Ensure that the software version displays as the unit is started – check that all segments of the display light correctly.
- ☐ Press the Enter button once and make sure the Run LED lights up.
- ☐ Press the Enter button again and make sure the Save LED lights up.
- ☐ Press the Enter button again and make sure the Bypass LED lights up.
- ☐ Press the Enter button again and make sure the Bypass LED light flashes.

If any faults are found with the ECO³™ then replace it.

4.2 Checks on ECO³™ Dual Hardware

Use this checklist to make sure that the ECO³™ Dual LEDs and display are working correctly:

- ☐ Ensure the ECO³™ has 24 VAC power to it.
- ☐ Ensure that the software version displays as the unit is started – check that all segments of the display light correctly.
- ☐ Press the Enter button once and verify the channel 1 Run LED lights up.
- ☐ Press the Enter button again and verify the channel 2 Run LED lights up.
- ☐ Press the Enter button again and make sure that both Run LEDs lights up.
- ☐ Repeat this process for Save, Bypass and Override functions (same process as for the Single outlined above in section 4.1).

If any faults are found with the ECO³™ then replace it.

4.3 Further Checks on ECO³™ Installation

Use a multi-meter to verify when a demand is made to each stage of the cooling system. Use this to check that the ECO³™ is responding with the correct display of run signal using its LEDs. Be sure to verify that the compressor responds, as you would expect it to.

Wait for the ECO³™ to go into "save". Then check that the stage that is being saved upon reacts as you would expect (typically this would mean that the compressor stops) and that no alarms are triggered on the main controller.

CAUTION: Dangerous voltage may be present at the terminals and wires.

4.4 Dipswitch Settings

Verify all dip switches are in the proper position for the site conditions. For further information on the use of dip switches see section 5.5.

4.5 Maintenance of IPXX Rating

- ☐ Verify that any ECO³™ installed outdoors has the wiring openings facing down to maintain IP64 integrity.
- ☐ Seal any unused holes with RTV silicone sealant.
- ☐ Install wiring cover securely.
- ☐ Ensure that there are no exposed wires outside the wiring terminals.

5. Operating the ECO³™

5.1 LEDs and Display

When the display is off, the LED's indicate the current system state as per the following table:

Run	Save	Manual Bypass	Automatic Override
Yellow	Green	Red	Flashing Red

A flashing green LED on a Dual channel unit (software version 15 and above), indicates that the channel has been locked from starting when the primary control tried to bring it on.

Except in manual bypass, if the display is showing anything other than "on", the LED's indicate which hours are being shown on the display.

At power up, unless the unit is in manual bypass, the version of the software is displayed briefly and then the display will change to "on" until such time as the ENTER button is depressed.

By pressing the ENTER key on the front of the unit, the display will rotate through the number of hours from the various modes (i.e. Run, Save, Manual Bypass, Automatic Override). In version 15 or higher of the software, the Dual will display each channel and the sum total separately for each of the modes. For further details on the functions accessed by the ENTER key please see section 5.2

There are 4 displayed digits, but values up to 65000 are displayed. The display shows thousands of hours. For values up to 9,999 the format is h.hhh and for values above 9,999 the format is hh.hh Hence 5432 is displayed as 5.432 and 15,432 is displayed as 15.43

During manual bypass, the display will show the remaining bypass hours counting down until bypass is removed or the time runs out. For further detail on the manual bypass function please see sections 5.2.2 and 5.3.

5.2 ENTER Switch

The ENTER key on the front of the unit performs three functions:

5.2.1. Hour Readings

Step through the display of run, save, manual bypass and automatic override hours.

When the switch is operated briefly, the "run" LED lights up and the run hours are displayed. A second switch operation steps the LED to save, and the display to save hours. A third switch operation steps the LED to manual bypass, and the display to bypass hours. A fourth switch operation steps the LED to automatic override, and the display to automatic override hours. More switch operations cause the display to cycle through the 4 values.

In the Dual unit with version 15 or higher software, three operations of the switch are required for each mode to step through the individual channel and the sum total of the two.

5.2.2. Enter and Exit Manual Bypass

Bypass state is entered and exited by holding the ENTER switch down until the manual bypass LED comes on and the bypass timeout period appears on the display. This takes approximately 5 seconds, and is indicated by a change on the display.

Pressing the ENTER switch once for 5 seconds sets the bypass time to 2 hours.

Pressing it again for a further 5 seconds sets the bypass time to 24 hours.

Pressing it again for a further 5 seconds sets the bypass time to 168 hours (7 days).

Pressing it again for a further 5 seconds sets the manual bypass off.

Manual bypass state can be exited at any time using the ENTER switch. Simply press the switch, remembering each operation takes 5 seconds, until the bypass timeout period steps back to 0. For example, suppose the bypass time had been set to 24 hours, but you decided to cancel it after 12 hours. Press the switch for about 5 seconds, and 168 will be displayed. Release the switch and press it again for about 5 seconds, and 0 will be

displayed and the bypass LED will go out. More details on the manual bypass feature can be found in section 5.3.

5.2.3. **Clearing the Hour Logs**

By powering off the ECO³™ it is possible to reset all accumulated hours to zero. Holding down the enter key when the unit is repowered will clear the memory.

5.3 Manual Bypass

During manual bypass the signal from the primary controller is passed through the ECO³™ as if it was not even there. No savings will occur during this time.

A manual bypass time can be set using the ENTER switch, as detailed in section 5.2.2. The bypass time can be set to 2, 24 or 168 hours (7 days). At the end of the bypass period, normal operation will resume at the start of a cycle with maximum run time.

Manual bypass is retained over a power cycle. If a number of hours of bypass remain when the power is lost, when the power returns the unit will complete that number of hours of bypass. In fact, because only the number of whole hours is saved, if 10 hours and one minute of bypass remained when the power was lost, 11 hours of bypass would occur after power returned.

It is important to note that the bypass hours logged by the ECO³™ will not match the manual bypass time selected. This is because the bypass time logged only logs time when the compressor control was calling for the compressor. Therefore, if the unit was put into 168 hours of manual bypass it will accumulate some number below that in bypass hours. If it does indicate the full hours, either the compressor is running all the time or a back feed voltage is present in the system. For further help on identification of a back feed voltage please see section 7.7.

5.4 Automatic Override

The ECO³™ saving feature is automatically overridden should demand for the compressor(s) not be met for 6 full cycles. Should this occur, the ECO³™ will remain in automatic override until the thermostat is satisfied and will be indicated by the flashing red automatic override LED.

There is a dip switch in the wire tray that allows for this feature to be turned off. See notes on dip switches here in section 5.5.

5.5 Dip Switches

Two dip switches are located to the left of the power supply inputs. By setting SW1 to ON, the automatic override feature is disabled.

NOTE: By disabling the automatic override feature, temperature may be affected in the controlled space during times when the ECO^{3}™ would normally be in override. Be sure to make the customer aware of this prior to setting the switch.

In the Dual unit, SW2 set to ON will put the unit into manual priority where channel 2 is the highest priority. This will then have the unit always save on channel 2 unless it is not running at the start of the cycle.

In software version 14 or lower, setting SW1 to ON will disable the automatic override feature and set the manual priority.

6. Testing and Verification of Savings

6.1 Testing Procedure

A two-week test can be performed where the ECO^{3}™ is placed in manual bypass for a week and allowed to control the system the following week. During the first week, the actual run time of the compressor will be accumulated on the display as bypass hours (remember these only accumulate when the compressor is actually being called for). Then, during the second week, provided the unit is not put into manual bypass at all, the run hours of the compressor are then calculated by adding that week's run and override hours.

In this type of test it is important to take the readings weekly so you can see what hours are accumulated when. It is important that the external variables that may affect the cooling load during the test are kept similar as possible between the two weeks.

In many situations more accurate results can be obtained by repeating this test over a period of 4, 6 or even 8 weeks to help remove any errors caused by uneven loads on the HVAC-R system.

6.2 Demonstration Test Calculation

The results of a typical test are shown in the table below:

	Run hours	Save hours	Manual Bypass hours	Automatic Override hours
Week 1	0	0	40	0
Week 2	32	10	40	1

The actual compressor run hours in week 1 are:
0 + 0 + 40 = 40 (run hours + override hours + bypass hours)

The actual compressor run hours in week 2 are:
32 + 1 + (40-40) = 33 (run hours + override hours + bypass hours)

The saving is equal to:
1 – (compressor run hours ECO^{3}™ ON / compressor run hours ECO^{3}™ OFF) x 100%

So the saving in our example is = 1- (33/40) x 100%

This equates to a 17.5% saving in compressor run hours.

7. Troubleshooting

7.1 Introduction to Troubleshooting

When installed and configured correctly, the ECO$^{3™}$ will provide trouble free and reliable service. However, there are a number of common problems or perceived problems that may occur due to incorrect installation, poor power supply or other equipment failure.

The following charts will help to solve most start up or operational problems. A multi-meter is required for some of the following diagnostic tests.

Before carrying out the following checks, make sure there are no fault indicators on the HVAC-R systems that may be causing the problem.

7.2 Compressor Not Running

A compressor or compressor capacity controller that is connected to the ECO$^{3™}$ is not running when it should be.

Causes	Diagnostic Step	Solutions
Particular channel in "save" or "lock out".	Check the LEDs on the front of the ECO$^{3™}$.	Wait for the channel to be released at end of cycle.
No run signal from the primary controller.	Confirm there is voltage between the IN terminal and the N terminal for that channel.	If no voltage is present, then issue is with primary controller or the initial wiring of the ECO$^{3™}$.
	If voltage is present, confirm run or save LED on the ECO$^{3™}$ is on.	If run LED is not on, replace ECO$^{3™}$.
Compressor contactor or compressor failure.	Confirm there is voltage between the ECO$^{3™}$ output and N terminal for that channel.	If voltage is present, the issue is with the contactor, compressor or other system switches down stream from the ECO$^{3™}$.

7.3 Over Temperature Issues

Causes	Diagnostic Step	Solutions
ECO^{3}™ has not gone into automatic override.	Check dip switch 1 to ensure override is not disabled.	Reset dip switch 1 to correct setting. See section 5.5
ECO^{3}™ is implementing longer save periods than it should be.	ECO^{3}™ is not receiving a run signal at all times when the compressor is running. Check correct run signal is being read under all conditions	Correct wiring solution as required. Refer to typical solutions (section 3) for further guidance

To allow further diagnosis of any outstanding issues that are not solved by following the steps shown in the table above, ascertain if the over temperature problem occurs all the time, only on extreme days or, in the case of refrigeration, only after defrost.

7.4 No Display Visible

Causes	Diagnostic step	Solutions
Defective power supply.	Confirm there is no voltage across the secondary windings of the isolation transformer.	Replace the power supply.
Supply fuse blown.	Confirm there is voltage across the primary windings of the isolation transformer.	If no voltage is present, then replace the fuse.

7.5 No or Low Savings Hours Recorded

This problem can be caused by incorrect wiring or by the ECO³™ being switched to manual bypass.

Causes	Diagnostic step	Solutions
ECO³™ has been in manual bypass.	Check to see if there are more than 5 run hours on any channel or that bypass hours have increased.	If not enough run hours, wait for more run hours to see accumulation of save hours.
ECO³™ has been in automatic override.	Check to see if a lot of override hours have accumulated.	Determine why demand is not satisfying or if back feed voltage is present.
Manual priority directing savings to other channels. (ECO³™ Dual only)	Check dip switch 2 on the ECO³™ to determine if manual priority is set.	If set incorrectly, reset dip switch.
Incorrect neutral connection.	Check to see that neutral connection is correct and tight in the terminal.	If not, correct connection. Refer to typical installations (section 3) for further assistance.

7.6 More Than One Channel Appears to be in Save

Check that the both channels are actually in “save” and not that one channel is in “save” and one in “lock.”

Causes	Diagnostic step	Solutions
Channels are actually in lock, not save.	Check ECO³™ display. Flashing green LED indicates channel is locked.	Wait for release interval.
Channel stuck.	Check ECO³™ LED to see if both save LEDs are solid green.	Ensure fault clears at end of cycle. Report issue to Smartcool.

7.7 Unusually High Run and/or Save Hours

Accumulated hours should be reasonable for the period being observed. If the run hours accumulated appear to be too high then follow steps below:

Causes	Diagnostic step	Solutions
Run LED is on but compressor is not being called for by primary controller.	Test for voltage level between "CMN" and "IN" on ECO³™.	If voltage is present that is much lower than normal control voltage, a back feed is present. Follow instructions from section 3.6.
Save LED is on, but compressor is not being called for by primary controller.	Test for voltage between "CMN" and "NC" on ECO³™.	If voltage is present that is lower than normal control voltage, a back feed is present. Follow the instructions from section 3.6.

7.8 Other Issues that Require Troubleshooting

For issues not covered in this manual, try to get as much information as to what was happening before the issue arose. Be sure to provide the following details to your Smartcool technical representative:

- ☐ Current data and status information from the ECO³™.
- ☐ Software version that is running on the ECO³™ (this is displayed when the ECO³™ is restarted) and whether it is a Single or Dual.
- ☐ Any information regarding what was happening before and after the issue arose.
- ☐ If you “resolved” the issue, how was it resolved?
- ☐ Whether or not the issue recurs.

8. Removing the ECO³™

Safety Warning: Ensure that the ECO³™ and any auxiliary wiring is isolated from all voltages before the enclosure is opened or any wiring is adjusted.

8.1 Steps to Uninstall

- ☐ Turn off power to the unit and test to make sure that all inputs are "dead"
- ☐ Remove the wiring tray with the two screws.
- ☐ Slide a metal ruler or thin metal strip up the back of the unit to release the locking mechanism.
- ☐ Once released, the unit should push down and then come off of the mounting bracket.
- ☐ Be sure to reconnect all existing wiring as per the manufacturer's instructions.
- ☐ Test the system thoroughly including all safety devices to ensure that the system is safe and reliable.

9. Specifications & Standards

9.1 Equipment Specifications

	Single Channel	Dual Channel
Operating Voltage	24VAC, 350mA	24VAC, 350mA
Display	4 Digit, 7 Segment, 3 LED	4 Digit, 7 Segment, 6 LED
Enclosure	IP64	IP64
Dimensions	Height 145mm Width 159mm Depth 27mm	Height 145mm Width 159mm Depth 27mm
Environmental	-30 to +60 Celsius	-30 to +60 Celsius
Channels	One	Two
Input Voltage	250VAC (max.)	250VAC (max.)
Contact Rating	250VAC, 360VA, B300	250VAC, 360VA, B300

9.2 Testing Standards – Declaration of Conformity

9.2.1 **Australia**

Electrical Safety & EMC:

EN 61326, AS/NZS 61010.1

9.2.2 **North America**

Electrical Safety & EMC:

UL 916

C22.2 No 205-M1983

9.2.3 **European Union**

Electrical Safety & EMC:

EN 61326,

EN 61000-3-2

EN 61000-3-3

EN 61010.1

10. Smartcool Contact Information

Contact your local ECO³™ technical group or one of Smartcool's offices for support.

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