GENERATION 7

ems
European Ltd

Enviro+™
Intelligent Single Phase
Motor Power Control
Installation &
Commissioning Guide

Version 2.5 August 2010

10A AND 15A

Single Phase Enviro+™ Motor Energy Control

IMPORTANT WARNING

Failure to read and comply with this manual may result in damage to the Enviro+ Unit and driven equipment and may render the warranty invalid.

1. **Only a competent electrician should carry out the electrical installation.**

2. **Enviro+ must be earthed with an earthing conductor connected to the earthing terminal.**

3. **Before installation check the motor rating plate and Section Two of this manual to ensure that the Enviro+ is correctly rated for the application.**

4. **Internal components and areas of the control circuit boards, (except the isolated I/O terminals), can be at mains potential when the Enviro+ is connected to a supply. The voltage is extremely dangerous and may cause death or severe injury if you come into contact with it.**

5. **When the Enviro+ is connected to the mains, the output connections should be treated as being live even if the load is not being driven.**

6. **The control I/O terminals are isolated from mains potential but the relay outputs may have dangerous voltages present even if the mains are not connected.**

7. **Do not make any connections when the Enviro+ is connected to any live supply.**

8. **Do not make voltage withstand tests on any system to which Enviro+ is installed without first isolating the Enviro+ unit.**

9. **Do not touch IC-circuits on the PCB. Certain items are static-sensitive and static voltage discharge may destroy the components.**

10. **Make sure no power-factor correction capacitors are connected to the load cable except in a safe manner. (See body text of this document for details).**

11. **Make sure the cover is closed before applying mains voltage to the Enviro+.**

12. **Updated and current Installation and Commissioning Guides are maintained on the EMS (European) web site at http://www.envirostart.com; always check the web site for latest issue documents before commencing installation.**

CONTENTS

1 <u>INTRODUCTION</u>

Thank you for choosing the **Enviro+** Single Phase Motor Energy Control. The system has been designed with ease of use and set up in mind. The majority of applications will operate without the need to make any changes to the default settings however to gain effective savings and motor management using this system it is imperative that you understand the three operational modes of the unit:

- Time of operation management

- Motor energy control management

- Thermal mass management

This Installation and Commissioning Guide provides the details of these modes of operation and how they interact so familiarising yourself with the contents of this guide is essential.

Enviro+ has been designed to provide a long life; components have been selected with reliability in mind and have generally been over-rated for the power of the unit manufactured. Using the standard IQA, (Institute of Quality Assurance), methodologies the expected lifetime of **Enviro+** is rated at >130,000 hours continuous use, (fifteen years),

In the unlikely event that you do need further support please contact your local EMS (European) Distributor or failing that contact us directly either by e-mail or fax. All details of how to contact us are available on our web site at http://www.envirostart.com, please remember that we are constantly updating documentation and information about the **Enviro+**, all such information is posted and publicly available on the web site.

1.1 FEATURES

The **Enviro+** is a high specification digital Motor Energy Control with additional time of operation and thermal management capabilities available; the systems are available in both 10A and 15A rating.

In addition to the provision of a unique single phase soft-start, the **Enviro+** incorporates state of the art Motor Energy Control technology to substantially reduce the electricity consumption of synchronous electric induction motors whilst they are operating at less than their full load capacity, the system also allows for the switching off of the controlled motor up to three times in any one day with the provision of a ten year real time calendar and clock function to accommodate public holidays up to ten years in advance and additionally when associated with split-AC systems, the unit utilises the stored thermal mass within the piping to aid in the reduction of consumed energy by better managing the refrigeration compressor run time.

▸ CONFIGURABLE ENERGY CONTROL

▸ SWITCHABLE SOFT START or

▸ DOL START TO OVERCOME HIGH INTERTIA LOADS

▸ TIME OF OPERATION CONFIGURABLE USING A REAL TIME, TEN YEAR CALENDAR AND CLOCK FUNCTION

▸ THERMAL MASS MANAGEMENT TO UTILISE THE STORED REFRIGERATION MASS IN PIPEWORK ASSOCIATED WITH BOTH SPLIT AND REMOTE COMPRESSOR AIR CONDITIONING AND REFRIGERATION SYSTEMS

▸ FULL SYSTEM STATUS LED's

▸ SIMPLE TO INSTALL AND COMMISSION VIA USB INTERFACE

▸ RUGGED HOUSING, IP54, NEMA 1. (Can be fitted into cabinet to increase to IP 65)

▸ 110V and 220V, 50Hz and 60Hz MODELS AVAILABLE

2   CORRECT Enviro+ SELECTION

The **Enviro+** must be rated according to the motor rated current (FLC).

However, on certain applications it may be necessary to oversize the unit to cope with the maximum operating parameters associated with particularly heavy-duty operations such as high repetitive on-load starts or elevated ambient operating conditions.

Please note that these environmental factors (temperature, ventilation, altitude, ambient temperature & relative humidity) do affect sizing and failing to take proper notice of such conditions will invalidate any warranty associated with the system as supplied. Where the **Enviro+** is expected to operate outside the normal specifications and you are uncertain as to the selection of a unit please contact EMS (European) or your local Distributor, we will always be happy to assist to ensure your application is correctly supported.

IMPORTANT NOTE

THE ENVIRO+ MOTOR ENERGY CONTROL IS A SOPHISTICATED SOLID STATE MOTOR SOFT START AND ENERGY MANAGEMENT SYSTEM WITH A RANGE OF INBUILT PROTECTION DEVICES AND MONITORING SYSTEMS IT IS HOWEVER NOT A REPLACEMENT FOR PROPERLY RATED CURRENT OVERLOADS AND FUSES WHICH SHOULD BE FITTED FOR MAXIMUM PROTECTION OF THE MOTOR.

2.1 CE DECLARATION OF CONFORMITY

$\mathsf{C}\mathsf{E}$

MANUFACTURERS DECLARATION OF CONFORMITY

This declaration covers all **Enviro+** Motor Energy Control units.

This product fulfils the following European Community Directives when applied as follows:

Low Voltage Directive

The above products fulfil the Low Voltage Directive 73/23/EEC, 89/336/EEC and 93/68/EEC amendment for industrial equipment; however, they must be installed to general good electrical engineering practices and regulations by a suitably qualified person with strict reference to the instructions in the product's Technical Manual.

EMC Directive

The above products are intended to be a component in a system or a machine. They must be mounted into an appropriate enclosure and system designed to fulfil the CE directives plus IEC and local industrial standards. Units must be installed by a suitably qualified person to comply with general good electrical engineering practices and regulations with strict reference to the instructions in the product's Technical Manual. To meet all EMC directives, the above products are available with an optional RFI Filter.

IEC-1000-4-2 Level 3; IEC-1000-4-3 Level 3; IEC-1000-4-4 Level 4; IEC-1000-4-5 Level 3; IEC-1000-4-12 Level 3.

The above is based on test results from an independent test laboratory (Steatite Group Ltd.) to test specification EN 50081-2, EN 50082-1 and EN 50082-2.

Harmonised Standards Applicable

BS EN 6094.4.4 (which calls on EN 56011); EN 55022; EN 51000.4.2;
EN 61000.4.3; EN 51000.4.4; EN 61000.4.5; EN 61000.4.6; EN 61000.4.8;
EN 61000.4.11; BS EN 50081.1; BS EN 50081.2; BS EN 50082.2; EN 6094.4.2;
IEC-947-4-1; IEC-68-2-6, (NFC2076; BV1); IEC-947-4-2.
EN 60439; EN 60831.1, EN 60831.2, EN 61921.2003

Electrical Requirements Specification G5/4 - 2 (2008)

Dated: August 2010

3. GENERAL SPECIFICATION

3.1 TECHNICAL SPECIFICATION

SUPPLY VOLTAGE	Nominal 110V or 220V Single Phase AC (This must be specified when unit is ordered)
FREQUENCY	50Hz
STARTS PER HOUR	≤45 starts at T_{amb} +20°C
START DUTY	3 x Unit FLA for 5s at T_{amb} +20°C
START FULL POWER TIME (Energy Save)	10s on Initial Start Up 5s on Restart Following Load Change
SOFT START TIME	Selectable Logarithmic Ramp $\cong$3s
COOLING	Naturally Cooled Isolated "Cold Wall" Back Plane Enclosure
CONTROL CIRCUIT	48MHz clocked Atmel MPIC
POWER SWITCHING	Isolated Base Triac
CONTROL SUPPLY	Integrated Transformer Providing PCB Supply from Mains Supply or Independent 240V Supply
MECHANICAL RATING	IP54, $\geq$NEMA 2 Powder Coated Galvanized Metal Enclosure
EU DIRECTIVES	Meets all EMC and Low Voltage Directives
UL DIRECTIVES	Complies with all UL Requirements for Power Control Electronic Systems
OPERATING HUMIDITY	Up to 95% Non Condensing (Conformally Coated Systems Can Be Provided)
OPERATING TEMP	-15°C to +40°C (De-rate Current by 20%/10°C above +40°C)
ALTITUDE	4000m Above Sea Level. De-rate Current by 1%/100m Above 4000m

3.2 GENERAL CONSIDERATIONS

1. The installer should be a competent person for installation of electrical goods.
2. The power should be disconnected before installation and only put back on once installation is complete.
3. The only motors for which the Single Phase Enviro+ is suitable are 110V and 220V AC single-phase induction motors. (Also known as "Cage" or "Squirrel Cage" motors). Enviro+ cannot be used on DC motors, Switched Reluctance motors or any form of Three Phase motor.
4. Check that the current rating of the **Enviro+** unit is the same or higher than the full load current (FLA or FLC) of the motor, which should be on the nameplate of the motor. If in doubt contact the motor manufacturer or supplier.
5. Use the correct size of cable for the current rating of the unit, (See Section 3.12)
6. The **Enviro+** must be installed as the last piece of equipment before the motor. (See wiring and installation recommendations in Section 5 of this Installation and Commissioning Guide).
7. If the start/run capacitor is switched via the on-board relay then ensure that appropriately rated cable is used remembering that capacitive currents should be multiplied by 1.5x nominal for all cable selection.

3.3 HARMONICS

The **Enviro+**, like all electronic systems, does produce low-level harmonics during operation. The **Enviro+** is however a controlled system, switching taking place at or very near to the zero crossover points of the waveforms therefore significantly reducing radiated and conducted harmonic content.

As the **Enviro+** units produce negligible harmonic levels during normal running it is excluded from the constraints of such specifications by definition; however with our policy of ensuring maximum compliance and minimum environmental pollution our design standards ensure that we fall well below the limits set. Typical test values* of harmonic currents on an **Enviro+** controlled motor operating in Energy Save Mode yielded <14% for 5th Harmonic and <4% for 7th harmonic, significantly within the accepted and specified limits of G5/4-2.

Maximum limits are unlikely to be exceeded in normal operation even during ramp up and ramp down periods.

3.4 HEAT LOSSES

For heat calculation purposes it should be assumed that **Enviro+** units have a power loss of 4W/A at full conduction.

3.5 CONTROL PANELS/CABINETS WITH MULTIPLE UNITS

If more than one **Enviro+** is to be installed in a single enclosure the heat dissipation figures should be added together before selecting cooling system requirements.

3.6 IMMUNITY FROM INTERFERENCE

Enviro+ generally has a high level of immunity to externally generated interference and as a zero volt switching control is a minimal contributor.

3.7 COIL SUPPRESSION

Any coil that is connected to the **Enviro+**, shares a common control supply or is mounted in the same enclosure must be suppressed using RC circuits. (Most commercially available relays and similar contain inbuilt suppression systems to comply with statutes).

3.8 LIGHTNING STRIKES/VERY HIGH VOLTAGE TRANSIENTS

In areas subject to frequent lightning strikes or other high voltage transients, a suitably rated metal oxide Varistor (MOV) or transient voltage suppressor (TVS) should connect each input line to earth.

3.9 CONTROL VOLTAGE TRANSIENTS

Where the control supply to the Enviro+ is thought to be subject to mains-borne interference a suitable line filter with transient interference suppression should be fitted between the control supply and the Enviro+.

3.10 INPUT/OUTPUT CONTROL CONNECTIONS

To avoid interference and cross talk, all input and output control cables should be kept as short as possible and should if possible, be shielded. If noise free lines cannot be guaranteed, an interposing relay with suitable suppression should be used, this should be mounted as close to the **Enviro+** as possible. In the case of the temperature sensor connections see Section 4.1.1 Notes 4 and 5.

3.11 EMISSIONS

Enviro+ units produce relatively low Radio Frequency Interference (RFI) compared with frequency inverters and no external filters are required in normal circumstances. (See also Section 3.3 – Harmonics).

3.12 CABLE AND INPUT FUSE RATINGS

Incoming fuses and power cables should generally comply with the ratings as shown in the table below. It is recommended that all cable be tri-rated compliant with BS 6231 and that all fuses be motor rated, bolt fitting, compliant with BS 88 Part 2. (It is not necessary to use motor rated fuses if the unit is being used in DPR Mode).

MODEL	FUSE RATING	CABLE RATING		MODEL	FUSE RATING	CABLE RATING
110-ACMECG7-10A	10A	14A/1.5mm/18AWG		**220-ACMECG7-10A**	10A	14A/1.5mm/18AWG
110-ACMECG7-15A	15A	14A/2.0mm/16AWG		**220-ACMECG7-15A**	15A	14A/2.0mm/16AWG

The above detail refers to new installations, where the **Enviro+** is fitted into an existing installation; cable should be rated according to the fuses already fitted.

4. INSTALLATION

4.1 GENERAL PROCEDURES

When ready to install the **Enviro+**, unscrew and remove the lid. Make ready your connection cables from the supply and to the motor to be controlled and thread them through the glands found on the base of the unit. Make the ends of the cable off and connect into the terminals, which are found on the circuit board. Make sure the earth cables are connected between the box, lid and circuit board terminal block and replace the lid.

The **Enviro+** provides terminals for the incoming mains supply and also a set of auxiliary connections to provide supply for additional components that cannot be optimized such as secondary fans in refrigeration systems and condenser pumps in freezers.

The controlled output to the motor is found on a separate connector set clearly marked "Motor". Under no circumstances should the supply voltage be applied to this connector block as damage may occur to the unit as a result of such a connection.

If you wish to short the unit out then use the Supply Connectors on the PCB

4.1.1 PCB CONNECTOR IDENTIFICATION

TERMINAL	LOCATION	FUNCTION
Live Supply[1]	PCB	110V OR 220V AC Supply Input Positive
Neutral Supply	PCB	110V OR 220V AC Supply Input Neutral
Motor Live	PCB	Motor Feed Positive
Motor Neutral	PCB	Motor Feed Neutral
1(NC) 3(NO) 5(COM)[2]	PCB	Run Relay RL2 Changeover Contact Pair 10A
2(NC) 4(NO) 6(COM)[3]	PCB	Run Relay RL1 Changeover Contact Pair 2A
7(Blue) 9(Red/Screen)[4]	PCB	Temperature Sensor 2 Input
8(Blue) 10(Red/Screen)[5]	PCB	Temperature Sensor 1 Input
11 12 13 14[6]	PCB	Override Timer Enable (Momentary Action Enables OR)
13 14 15 16[7]	PCB	Start (must be kept closed for motor to run)

NOTES

1. A link is required between the two live supply terminal connections on the PCB in order to power the PCB. Supply voltage is determined by the transformer fitted to the PCB. This has to be specified at the time of order placement. Ensure that the voltage of the unit corresponds to the voltage of the **Enviro+,** if it is not then you may damage the unit.

   If the link is removed then an independent 240V or 110V supply can be provided to the PCB to keep it live at all times, (for example when using the over-ride function), in this case use the connector closest to the edge of the PCB. The inner of the two live connectors will then take the "switched" or non permanent supply.

2. Connectors 1, 3 and 5 provide a single NC and a single NO switch via relay RL2. The relay is rated at 250V 7A. It is programmed to change state 2s after the motor has been started using connectors 13 through 16, (see note 6 and the general wiring diagram below). It can therefore be used to disconnect a start/run capacitor so that the motor runs without the capacitor in circuit.

   It is necessary that there is no capacitor in the motor circuit when the unit is running otherwise energy savings will be compromised if Motor Energy Control is being used.

   If motor energy control is NOT being used this is not important and the capacitor can be left in circuit.

3. Connectors 2, 4 and 6 provide a single NC and a single NO switch via a relay RL1. The relay is rated at 250V 2A. Unlike RL2, (see note 2 above), this changes state at any time when the motor is started or stopped.

4. Connectors 7 and 9 provide the input for Temperature Sensor 2 associated with the thermal management function. The connectors are polarized, live, (red), and the cable screen should be connected to terminal 9 and the neutral, (blue), should be connected to terminal 7.

5. Connectors 8 and 10 provide the input for Temperature Sensor 1 associated with the thermal management function. The connectors are polarized, live, (red), and the cable screen should be connected to terminal 10 and the neutral, (blue), should be connected to terminal 9.

6. Connectors 11, 12, 13 and 14 enable the override timer to take effect. To have the override function in place put a link between connectors terminals 11 and 13 and then a switch between connector terminals 12 and 14. A momentary closing of the switch

between 12 and 14 via a push button or switch overrides the "Off Time" function and drives the motor for one count of the period as is defined within the "Temperature Control Function" window, see Section 4.2.1.1. The indicator in the Interface Module Window will change state from red to green and a tick will appear in the associated box when the motor is running because of an override input signal.

7. Connectors 12, 13, 14 and 15 enable the motor start function. Terminals 13 and 15 should be linked and connector terminals 14 and 16 should be permanently linked (via switch or link) to cause the motor to start. The circuit is designed to accommodate, direct switching, NPN, (sink) or PNP (source) switching should it be necessary to switch directly from a PLC or other micro device. When the connection between either pair of the terminals is open circuit and the unit is still mains voltage powered, the motor will stop.
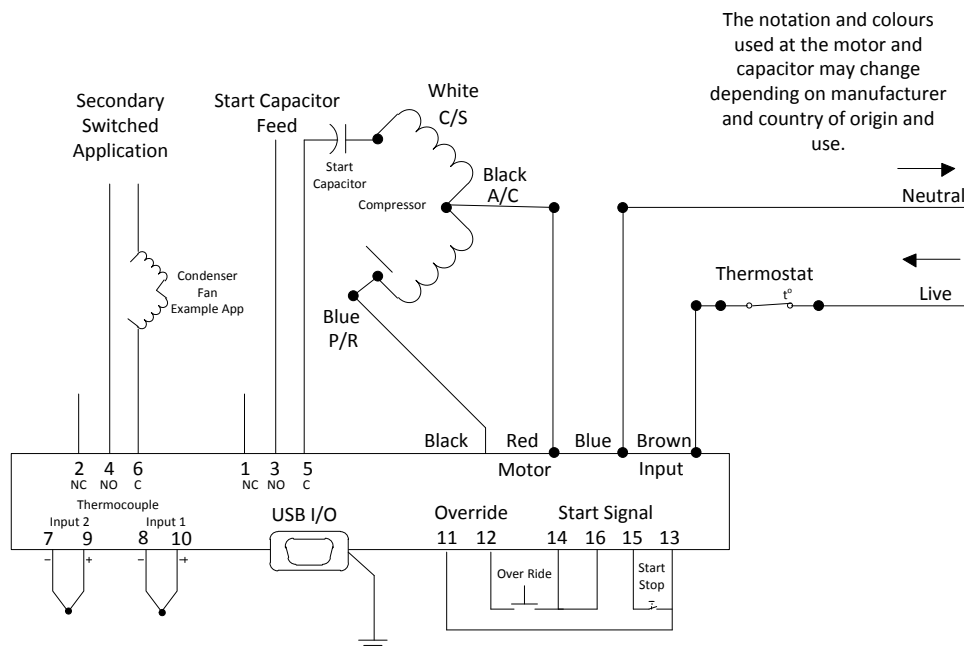
The **Enviro+** is designed to be mounted either within an existing cabinet or adjacent to the refrigeration compressor. The unit is IP54 rated and as such, if mounted vertically, with the glands facing downwards it is possible to mount in a lightly exposed position. The cabinet will not withstand pressure water washing or intense rainfall but will withstand showers and general water splashes without any problem. If the unit is mounted on an exposed wall then it would be wise to use a cabinet.

General Enviro+ Connection Diagram

4.2 SETTING UP

The Enviro+ should be set up using the PC interface via the USB connector to be found on the PCB.

Initially when you connect your Enviro+ to a PC the "found new hardware" wizard will detect the "new" system, follow the on screen instructions at this stage and, if you haven't already done so, install the control software from the software available from the EMS (European) website. This software is essential for setting up all of the various functions of your Enviro+.

You will use the software interface to determine which of the three functions you will have enabled; Time Management, Motor Energy Management and Thermal Management. It is not possible to have "no function" selected but any other combination of the three functions can be chosen. See Section 4.2.1.

All software adjustments and settings can be implemented without the need to have the unit powered, the supply from the USB interface is sufficient to drive the on board processor and allow for the uploading and downloading of programmes as required.

With the above in mind it is recommended that the system be set up prior to initially connecting the mains AC power to the **Enviro+.**

After making sure all the connections are correct, and that the functions that are required are selected and set correctly the unit can be powered up. It is recommended that any switching of the motor be carried out by using the on-board control through connections 13 to 16 or by switching the supply to the **Enviro+** and not by switching the load.

As power is applied to the **Enviro+**, (even just the power via the USB cable), a Red Power-on LED should light up on the PCB and if the appropriate connections are applied to connectors 13 through 16, the motor should start turning immediately, ramping from stationary to full speed. If the motor energy control function is enabled it will take approximately 2.5s after the motor has reached its top of ramp speed before the energy saving routine is initiated. Depending upon the operational mode selected, fully automatic or fixed pedestal voltage, the optimization routine will then take approximately five seconds to fully establish itself.

4.2.1 CONFIGURATION TOP LEVEL MENUS

To configure the **Enviro+** you need to have the software installed on your PC and the **Enviro+** linked to the PC via a USB cable. When first plugged in your PC should recognise the **Enviro+**. If it does not then using Control Panel from within Windows, remove the **Enviro+** software and re-install it.

Once you have the USB cable plugged into the **Enviro+** LED 6 should illuminate Red which indicates that the PCB is powered. LED 5 should be flashing Green four times with a pause in between; this indicates that the **Enviro+** is ready to be programmed.

At this time you should open the ACMEC programme that has been loaded onto your PC. The initial screen should look like the following:
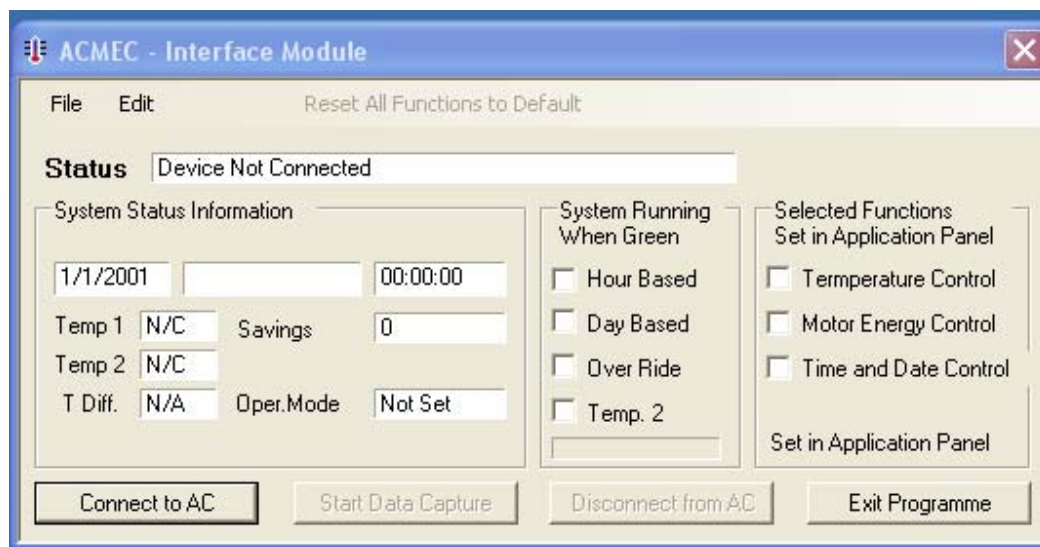
At this time the PC is not talking to the **Enviro+**, to enable this click on the "Connect to AC" button. When you do this the Status should change to "Device Detected", the Connect to AC

button should grey out, the "Start Data Capture" button should highlight and the "Reset All Functions to Default" should highlight in the Menu Bar.

If this is the first time that you have set up this particular **Enviro+** then it is a good idea to use the "Reset All Functions to Default" function prior to making any other changes as this will set everything back to a base condition which will ensure that the motor will operate. When you click on this function you will see a confirmation message as follows:
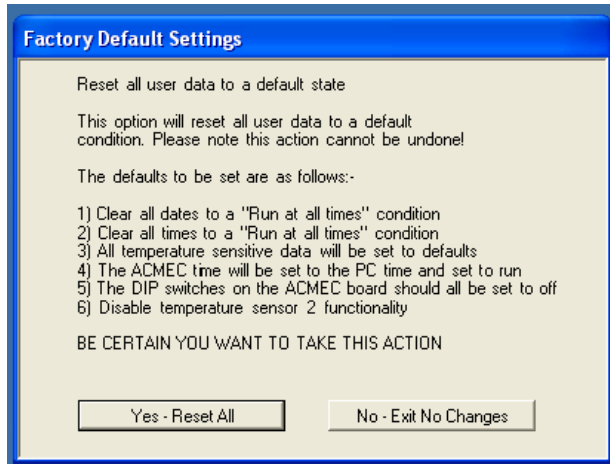

You should click "Yes – Reset All" at this stage. This operation will take up to 15s following which you will see a confirmation dialog box advising that all base data has been reset.

At this time click on the "Start Data Update" button. You will immediately see that the detail changes to reflect what is now programmed in the **Enviro+**, you will also note that the clock and date details shown synchronise with your PC and that the "Update Time" bar keeps counting down, (though unseen, from 60s). The **Enviro+** does not update the parameters on the chip within the unit continuously otherwise the interrupts would disturb the motor control sequence; as such we address the unit and action changes to the parameters every minute – this does not affect the operation of the control from the unit to the motor which is running with a 12MHz refresh rate.
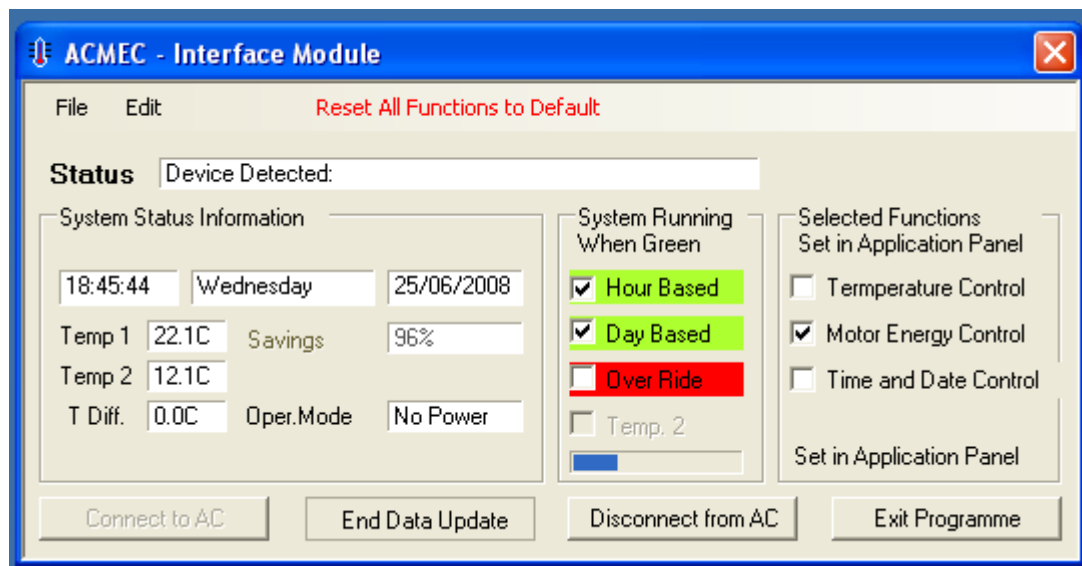

At this stage you now have a functional interface with the **Enviro+** and can implement changes to the various operational modes. These activities are accessed via the "Edit" function in the Menu Bar; the first of these menu items is "Control Application Configuration" shown here. Note that the time and date shown on the Interface Module, above, should be coincident with the time and date on the PC with which you are programming the **Enviro+**. If it is not then use the "Clock Control" functions within the Application Configuration window. If you cannot synchronise the time and date from this window then check the cabling is properly inserted into the connectors.
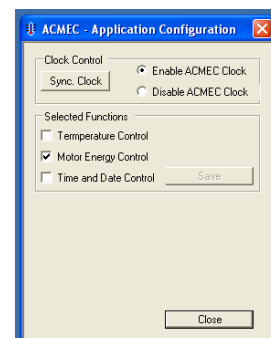
The Application Configuration window, accessed via the top line Edit command allows the

selection of the three primary functions of the unit, Temperature Control, Motor Energy Control and Time and Date Control. It is not fixed which controls you use however at least one function must be selected. The default condition is that just Motor Energy Control is selected as shown.

To change the selection use the tick boxes and ensure that you save the changes made. Once you have the appropriate functions selected and have saved the changes and closed the dialog window you will see that the changes will reflect in the "Interface Module" as is shown below.
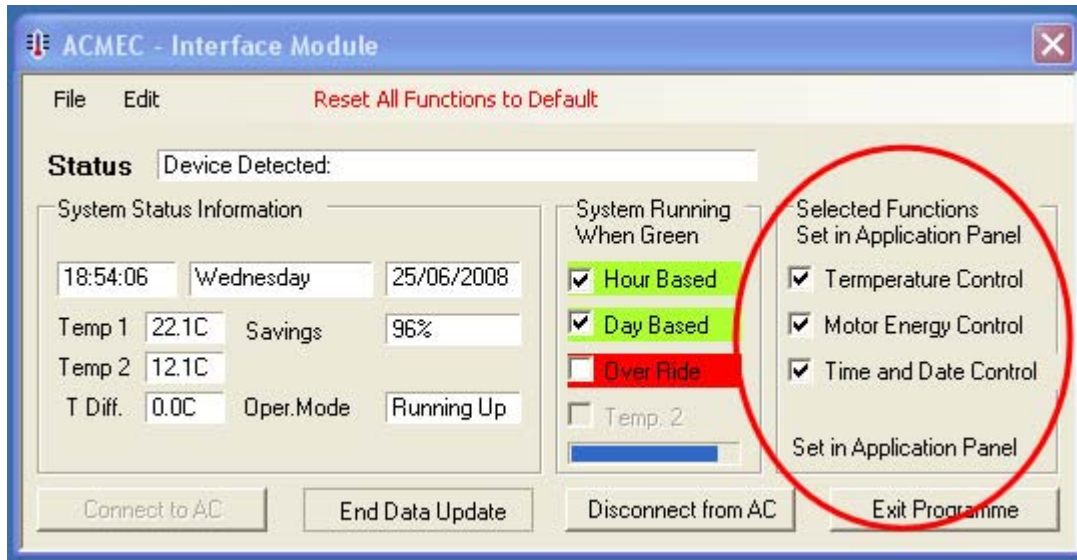

Having selected the functions that you want to be operational you need to set the parameters for that function. All of these areas are set via the Edit function accessed from the Menu Bar.

Note that the "Savings" percentage is an indication of the instantaneous savings only and is not to be taken as the overall savings that will be achieved by the unit in operation; this must be determined using effective data logging.

4.2.1.1 CONFIGURATION - THERMAL MANAGEMENT

The Temperature Control Function when opened should look like this:
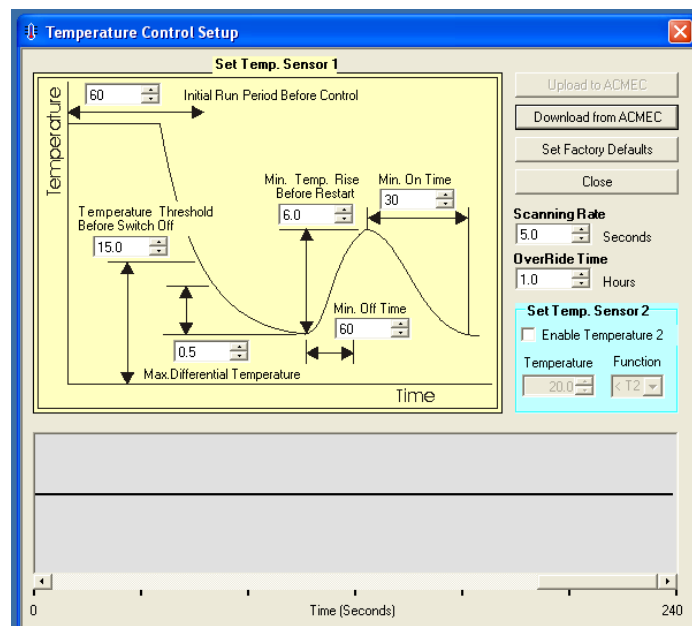
This window will allow you to change the parameters associated with the temperature control functions. The main part of this window is associated with adjustments and configuration for Temperature Sensor 1. Additionally you can adjust the System Scan Rate time period, the Override time period and also set up the conditional configuration associated with Temperature Sensor 2. (For details of these functions see Section 4.3 Commissioning.

The settings for temperature sensor 1 and 2 are independent of each other and in the case of temperature sensor 1 there is no need to have a sensor attached for the function to be configured; note however that whilst changes and amendments to the settings can be made without temperature sensor 1 being attached, for this function to operate it is essential that a temperature sensor is attached to the **Enviro+**. Without a sensor, even with the Temperature Control function enabled in the Application Configuration Window the function will default to having the motor running at all times.

The sub window associated with the settings for temperature sensor 2, "Set Temp. Sensor 2" allows the conditional switching relating to temperature sensor 2 to be set, in this also see Section 4.3.2.1.2.

Within the "Temperature Control Setup" window you can also change the time period associated with the override timer operation control, see Note 6 of Section 4.1.1 and Section 4.3.3. The override time set here is the period that the motor will continue to run if connectors 12 and 14 are momentarily made via a momentary push button or other form of switch. The override period can be set to be between 0.5 and 2.5 hours.
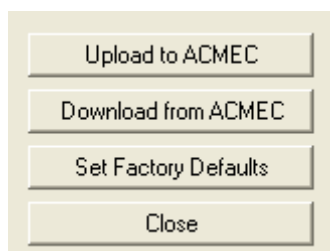
If any changes are made to the detail on this page then the "Upload to ACMEC" button will highlight and if you attempt to exit without saving you will be asked to confirm you want to leave the page without saving the changes.
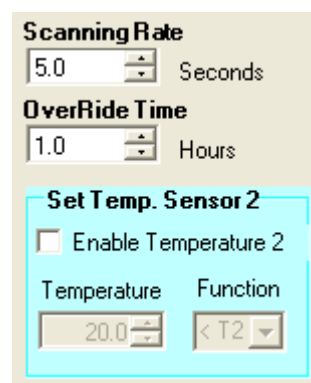
If you want to see what detail is already stored within the **Enviro+** then you need only click on the "Download from ACMEC" button and the data as held within the memory of the unit processor will be downloaded to your control screen. (Note that this will overwrite the details that you have on the screen).

4.2.1.2 CONFIGURATION - MOTOR ENERGY CONTROL

The Motor Energy Control operational functions on the Enviro+ are broadly the same as the Single Phase Motor Energy Controls, (SPMEC) and the DIP Switches replicate the controls provided on the SPMEC systems, with some additions, (see also the Single Phase Motor Energy Control Installation and Commissioning Guide).

As with the SPMEC all Enviro+ DIP Switches are polled continuously and it should be possible to make changes whilst the unit is running to change between operational modes. It is however good practice, and safer, to make changes whilst the unit is switched off and disconnected from the mains 110V or 220V supply to ensure that the software is not "hung" or "corrupted" as a result of a spike being transmitted to the chip during "live" switching and also that there is no risk to the person making the changes.

Note that when the system starts the motor the **Enviro+** will run at full power for a period of 5s prior to moving into energy control mode; this is to ensure that the motor is running properly prior to any torque management being applied.

Be aware that mains voltages exist at various points of the PCB and that great care should be taken when working on or connecting to any live equipment. If in doubt always ask or be safe and make the changes with the unit fully isolated.

DIP SWITCH SETTINGS

DIP SWITCH	FUNCTION	DEFAULT SETTING	RESULT	SOFTWARE SETTING*	SEE SECTION
Switch 1	Energy Saving Mode Select	OFF	Motor Run Energy Savings Enabled	Motor Energy Control is Disabled	4.3.1
Switch 2	Not Assigned				
Switch 3 & 4	Energy Saving Level	3 OFF 4 ON	Level 3 Energy Savings	Level 3 Energy Savings	4.3.1
Switch 5	Soft Start Select 3s Start Ramp	OFF	Soft Start Disabled	Not Software Controlled	4.3.5
Switch 6	Two Minute Time Re-Start Delay	OFF	Timer Not Enabled	Not Software Controlled	4.3.6
Switch 7	Not Assigned				
Switch 8	Not Assigned				

*See the appropriate section for information regarding the software settings

4.2.1.3 CONFIGURATION - TIME

Time and Date Control are set through two windows; the first dealing with time is as follows:
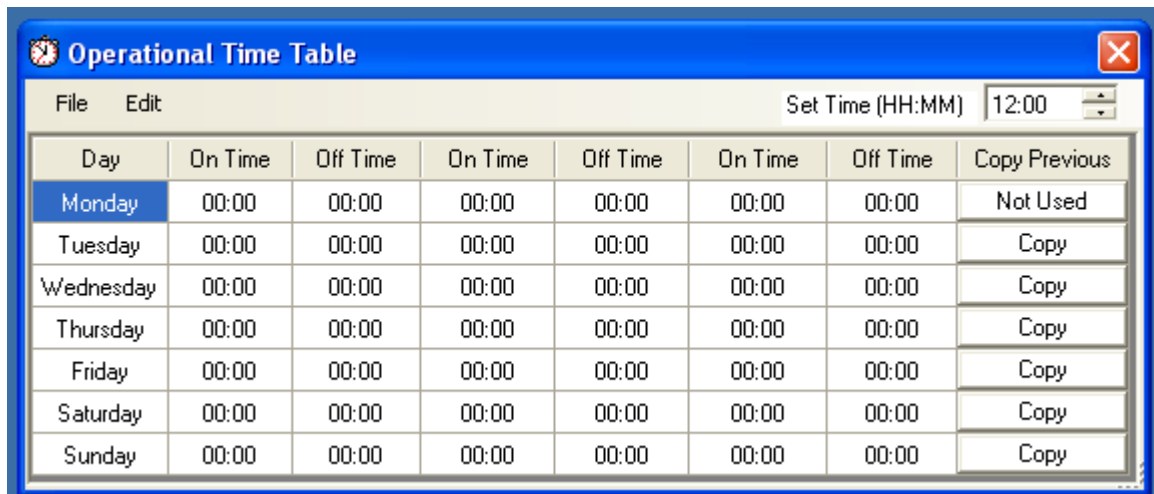
You can set the start and stop times for the **Enviro+** manually if required, by using the "Set Time" function to the top right of the window or if you highlight an "On Time" and then right click with the mouse you will call up the "Time Select Slider" window which allows you to input start and stop run times visually.

This is easier and less fiddly than direct entry but is less fine in its control.

Having set the details for one day they can easily be copied to the next day using the "Copy" button which is the right most column in the window. Once data is entered it must be uploaded to the **Enviro+**
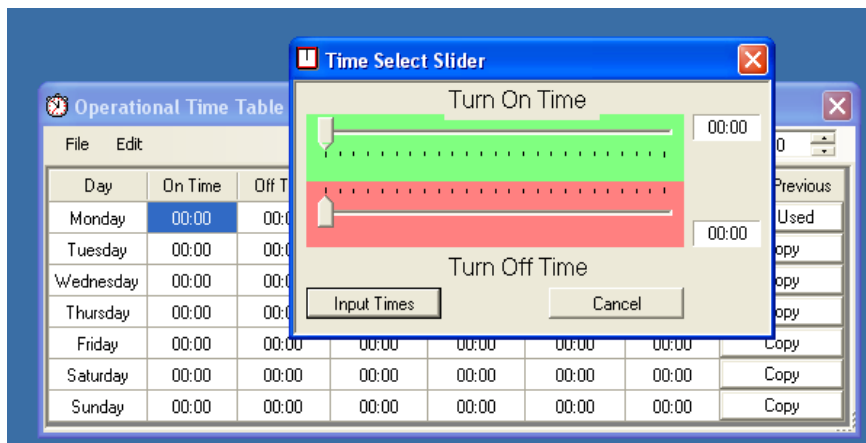
If any changes are made to the detail on this page then the "Upload to ACMEC" button will highlight and if you attempt to exit without saving you will be asked to confirm you want to leave the page without saving the changes. When you upload the detail the day detail on the left of the window will change to pink to confirm that the detail has been uploaded. If you download from the **Enviro+** then the days detail on the left of the window will change to blue to confirm that the detail has been downloaded.

4.2.1.4 CONFIGURATION - DATE

The date configuration window looks like this:
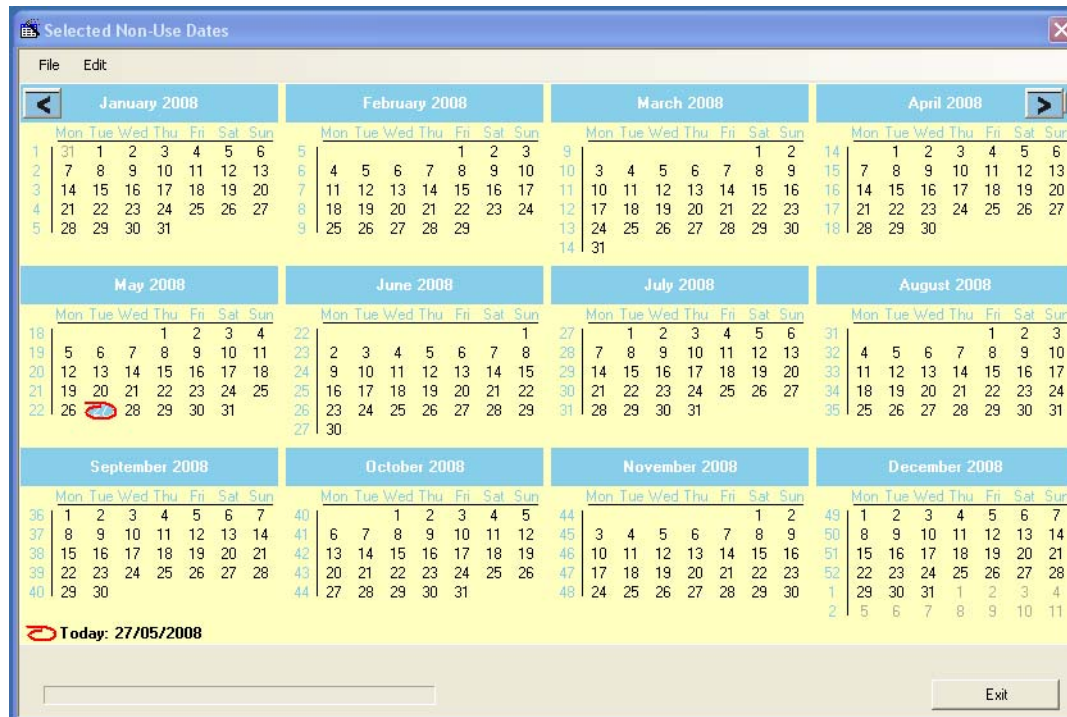
Selecting Non Use Dates allows you to utilise the onboard ten year calendar to tell the **Enviro+** to shut off the motor for a given day irrespective of what is selected in the Run Times described above. This would allow for the exclusion of use on public holidays for example or factory shutdowns.

As with the previous two functions if you make changes they must be transferred to the **Enviro+** itself using the Upload and Download functions to be found in Edit on the Menu Bar. Both uploads and downloads are confirmed by a progress bar which should highlight when the upload or download command is given.

In all the cases above it is possible not only to send the detail to the **Enviro+** but also to store it as a named file. This is the normal windows operation and would allow you to set up one **Enviro+** save the details in a file and then recall those and use those parameters for any other units fitted on site; you may even want to create a "template function" for bottle coolers, vending machines, refrigeration compressors and the like so as to create a library.

4.3 COMMISSIONING – GENERAL

When commissioning it is initially wise to have the unit operating without any time switching limitations so as to avoid the possibility of becoming confused by the unit not operating because of time exclusions and to have a base set of parameters in place which should "run" the motor without complication. To do this open the ACMEC control programme by clicking on the icon which should have been placed on your desktop when the ACMEC software was installed, this will open the ACMEC Interface Module; if an ACMEC is connected via a USB cable to your PC at this time and you have used the "Connect to AC" button then you will see "Status" as showing "Device Connected" and the "Reset All

Functions to Default" should be highlighted and available. Click on this reset function and accept the changes, this will reset all the parameters of the ACMEC to a base level and will clear all the timers held in the system; it will also have the effect of synchronising the clock on the ACMEC with the clock on your PC. This is good practice the first time you connect to a new **Enviro+** as it clears all temporary test files that may have been installed during final inspection prior to shipping.

<table>
<tr><td style="background-color:red">If you are in any doubt with regard to how to do this then review Section 4.2.1 above which provides full detail of these actions</td></tr>
</table>

Having the **Enviro+** in a default setting configuration allows you to confirm that the wiring and basic operational integrity is good. Only after this should you set up the parameters that will action switching, motor optimisation and thermal management.

To set up the various functions review Sections 4.2.1.1 through 4.2.1.3 of this guide.

Assuming that you are planning to use all three control functions we would suggest that they be set in the following order of priority end operation established with each one before moving to the next:

1. Motor Energy Control

2. Thermal Management

3. Time Management

4.3.1 COMMISSIONING – MOTOR ENERGY CONTROL

The default energy saving Level 2 will operate for the majority of motor and it is unlikely that you will have to make changes to DIP Switches 3 and 4 however if you do be cautious of the potential hazards and live voltages that exist within the **Enviro+** if changes are made whilst the unit is operational.

If the motor is unstable with the default settings of having DIP Switch 3 in the ON position then initially disable energy savings using DIP Switch 1.

Table 1   Energy Save Mode Selection

SWITCH 1	ENERGY SAVING MODE
OFF	**Energy Savings Enabled (Default)**
ON	**Energy Saving Disabled (Full Power)**

If the motor becomes stable with DIP Switch 1 in the ON position that is with energy savings disabled, (full power), then try sequentially reducing the savings to see if that stabilises the motor. The level of energy savings applied to the motor can only be adjusted via the DIP Switches as shown below; there is no available software control over this feature.

The software control enables or disables the Motor Energy Control function of the **Enviro+** however DIP Switch 1 will have to be in the OFF position for energy optimisation to be enabled. If DIP Switch 1 is in the ON position then the unit will remain in full power irrespective of the software setting enabling or disabling the Motor Energy Control function.

Table 2   Automatic Saving Level Selection

SWITCH 3	SWITCH 4	ENERGY SAVING
OFF	OFF	Max. Saving. Level 1
ON	OFF	Level 2
OFF	ON	Level 3 (Default)
ON	ON	Min. Saving. Level 4

It would be expected that either Level 2 or Level 3 would operate the motor smoothly. It is rare that the savings levels have to be set at Level 4.

In very rare cases it is not possible for the **Enviro+** to be able to provide motor energy control optimisation. In these cases this function should be disabled and savings gained through either simple time control or thermal management or a combination of those two functions.

Table 3   Equivalent Back-stop Voltage Saving Level (Indicative Only).

SWITCH 3	SWITCH 4	PEDESTAL VOLTAGE
OFF	OFF	≅ 70% Supply Voltage (≅30% Savings)
ON	OFF	≅ 80% Supply Voltage (≅20% Savings)
OFF	ON	≅ 85% Supply Voltage (≅15% Savings Default)
ON	ON	≅ 90% Supply Voltage (≅10% Savings)

The voltages shown in Table 3 are not absolute but indications only. Input voltage and load conditions will cause the output voltage to change from that shown based on a supply voltage of 220V.

4.3.2 COMMISSIONING – THERMAL MANAGEMENT

The purpose of the thermal management control is to utilize the stored "cold mass" within the refrigerant filled piping within an air conditioning system.

It is necessary to have a temperature sensor linked to the Sensor 1 connectors 8 and 10, (see Section 4.1.1) of the **Enviro+** for the thermal management to work. When a sensor is connected you will see a temperature reading on the Interface Module, when the sensor is disconnected or is improperly connected the Interface Module will show "N/C" in either or both Temp 1 or Temp 2 boxes as appropriate. Note that the "T Diff", (temperature differential detail presented here is not the difference between Sensor 1 and Sensor 2 temperatures but the difference between the threshold and target temperatures set within the "Temperature Control Setup" window.

The control window is divided in effect into four sections, "Set Temp Sensor One", which is the graphical area to the left top of the window, "Set Temp Sensor Two" to the mid right area of the window in light blue, the Scanning Rate and Over Ride time settings to the middle right of the window and finally the graphical area at the bottom of the window which provides a graphical representation of the temperature as measured by Temp Sensor 1. (This is particularly useful when monitoring the change of temperature of the output air of an AC unit where sensor one is in the output air flow.

The settings installed with the "Set Factory Defaults" button on the Temperature Control Setup Window, (see Section 4.2.1.1), will be applicable to the majority of split Air Conditioning systems of 5 – 12,000BTU with which this unit is used and it will generally not be necessary to change any of the parameters. Should you make changes however they are effective as soon as they are uploaded to the **Enviro+** unit.

Descriptions of the parameters and their limits are to be found by holding the mouse cursor above the description details on the setup window.

Be cautious when making changes to the temperatures and the times within this page as the parameters are all interlinked and moving one too far can cause the controlled air conditioning system to have problems which may cause it to shut down. Wherever possible make small moves in the parameters and test the effects prior to saving them as the final settings or storing them as a file for later use.

The bottom of the Temperature Control Setup window is a graphical representation of the temperature that is being registered by Sensor Input 1. This allows you to track the reason for the motor switching as generated by the thermal management control.

You can also track the operation of the motor by looking at the Interface Module.
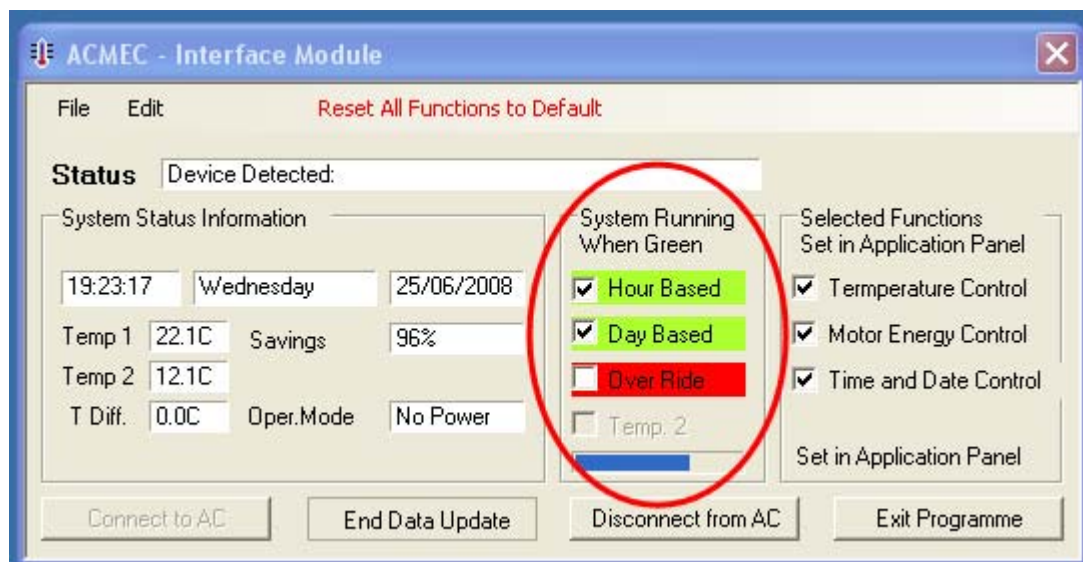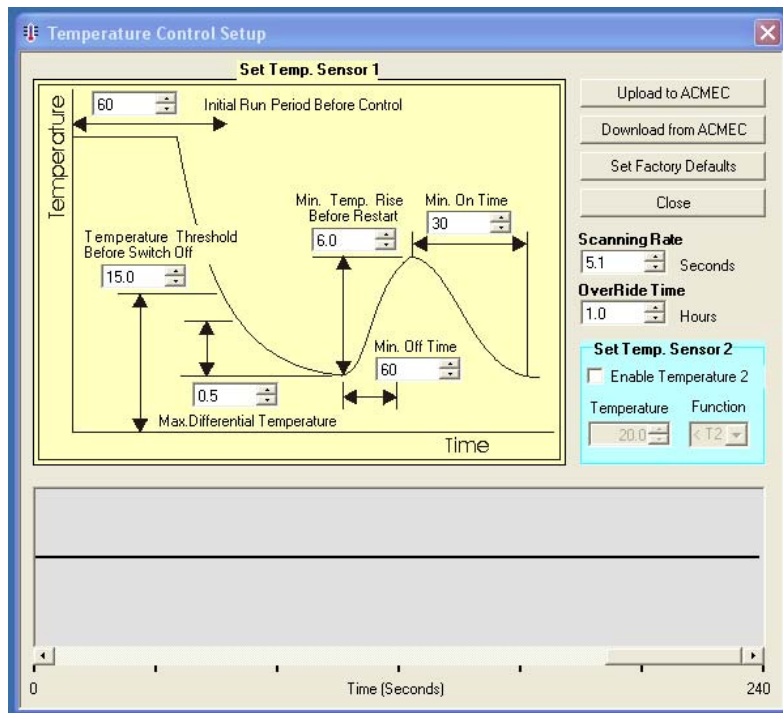
The system identifies for you when the motor will be running as a result of Timing or Sensor Two function so should you find that the motor is not running you can quickly see whether it is supposed to be running or not.

The rule here is, always to check that all the systems are saying that the motor should be running prior to assuming that there is a problem. Note that "Temp 2" will only be highlighted if the "Enable Temperature 2" box is ticked in the "Set Temp. Sensor 2" sub window within the "Temperature Control Setup" window.

Be aware that the majority of air conditioning systems, particularly split air conditioning systems, have a start timer which means that the main compressor will not come on for between 2 and 4 minutes after initial switch on. If you enable the system and the main compressor does not come on immediately ensure that it is not being held off by the air conditioning timer delay, do not immediately assume there is a problem with the **Enviro+**.

4.3.2.1 COMMISSIONING – TEMPERATURE SENSORS

For the temperature control function to operate it is necessary that there be a temperature sensor connected to at least Temperature Sensor 1; additionally you may want to have a sensor on Temperature Sensor to in order to provide conditional control over the function of the total controlled system. Note that temperatures are optional items and not shipped with the **Enviro+** as standard; they are available with 3m, 5m and 10m leads.

4.3.2.1.1 COMMISSIONING – TEMPERATURE SENSOR 1

It is necessary to have a temperature sensor on temperature sensor input 1, connectors 8 and 10 on the PCB, see Section 4.1.1, for the thermal management to operate. When such a sensor is correctly connected to the system you should see an appropriate temperature reading in the relevant box in the "Interface Module" window; if the sensor is improperly connected or is missing then the designation "N/C" will appear in the box and the temperature control function will be disabled.

4.3.2.1.2 COMMISSIONING – TEMPERATURE SENSOR 2

A second temperature sensor can be connected to temperature sensor input 2, connectors 7 and 9 on the PCB, see Section 4.1.1. This sensor provides a logical inhibit operation control which is defined via the "Sensor 2 Control" window

This window is accessed via the "Temperature Control Setup" window and allows the user to set a logical "Above" or "Below" against a given temperature setting such that the system will not operate if the temperature, as registered on sensor 2, is "below a specified value" or alternatively that the system will not operate if the temperature, as registered on sensor 2, is "above a specified value". (The specified value can be any integer value in ^{o}C between 5 and 40).
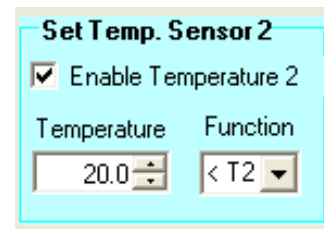
This allows the **Enviro+** to inhibit the motor in the case, for example, that a heating system was also available to the end user and that it was required that the air conditioning compressor should not run if the heating was on and operational or, for example, if the outside temperature was below a given temperature and therefore there was no need for refrigerated air to be generated.

4.3.2.2 COMMISSIONING – TEMP SENSOR SCANNING RATE

The scanning rate defines the frequency in seconds that temperature sensor 1 is polled for information to update the buffers associated with the measurement. This function can be set to between 1s and 25s but has a default of 5s.

If set to a low figure the scan may detect every slight anomaly in the temperature and never "identify" the five consecutive "equal" measurements, within the confines of the defined "maximum differential set temperature".
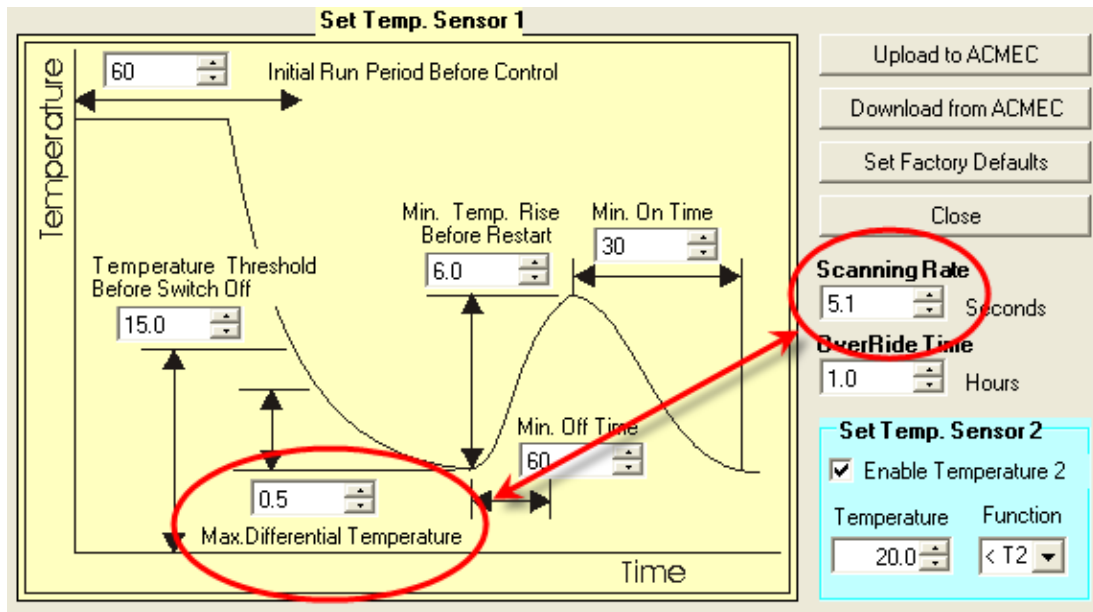
If this rate is set to too high a figure the same can apply in that the system will never detect five consecutive equal counts and therefore never switch off the controlled motor.

It is always a balance between the "damping" effect of the "Max Differential Temperature" setting and the scanning rate. For almost all applications 5s and $0.5^{\circ}C$ is effective.

If changes to these numbers are made, try out the adjustments on a non-critical system and watch the effects of the changes to the switching time and control of the motor to ensure that the operation of the motor is still smooth, and as expected and that the "off time" is not compromised. (Note that you can check the operation of this feature by watching the charted temperature measurement shown in the lower part of the "Temperature Control Set Up" window.

The time within this graphical area can be changed by right clicking the mouse and selecting a full scale time of between 60s and 20m. The data held is dynamic being held only in a buffer memory so changing the time during a graphing operation will lose any previously held data. Note that the graph will not function if there is no sensor present on sensor input 1.

4.3.3 COMMISSIONING – OVER-RIDE TIMER

Having set the primary thermal management parameters note whether the installation has included the installation of an override button function to allow the system operator to temporarily override the timing function as set by the time and date management windows detailed in Section 4.3.5 below.

With a link between connectors 11 and 13 then if connectors 12 and 14 on the PCB are momentarily made through a push button or switch then the controlled motor will run on for a period as defined by the time, in hours, shown in the data entry box as detailed within Section 4.3.5. Multiple presses of the switch will not yield multiples of this time.

This function is intended to allow system users who may want to operate equipment outside of the "normal" defined operational hours as set within the time and date function; this would be particularly applicable to office air conditioning systems where someone may be working overtime and want the refrigeration compressor to continue working outside of the normal operating hours.

The over-ride time period can be set between 0.5 and 4.0 hours.

The over-ride timer function requires that the PCB be powered throughout its operation, if power is dropped from the PCB, by for example, the thermostat on a refrigeration system

cutting out, then the over-ride would reset and when the thermostat called for the motor to run again, if the **Enviro+** was holding the motor off because of its timer function, then the motor would not restart even if this was within the "over-ride set time". To ensure that the over-ride operates correctly if the event of the above, then it will be necessary to separately power the PCB.

To do this remove the link between the two incoming "Live Supply" terminals on the PCB and feed a permanent 240V AC supply to the terminal connector nearest to the edge of the PCB and the thermostat, (or switched), supply to the "Live Supply" terminal connector adjacent to the "Motor Live" connector. This will ensure that the PCB is powered at all times allowing the over-rid function to continue to operate irrespective of the switching of the thermostat or other external control switch.

The system will continue to operate for the period set by the over-ride timer with the thermostat or other switch also switching the motor on and off during this period as in normal operation.

4.3.4 COMMISSIONING – TIME AND DATE MANAGEMENT

This function requires little explanation if you have familiarized yourself with the basic operation as detailed in Sections 4.2.1.2 and 4.2.1.3.

Initially set up the operating hours for each day; you can independently set up to three on and off times in a given twenty four hour period and can independently set different times for each day of the week.

When setting operating times be careful to understand the demands of the application such that for example on a vending application, you may have the unit turn off at the end of the shop opening hours however if you want the goods to be cold when the shop opens in the morning then the system will have to be started a few hours prior to opening.

Never use Date or Time Management where perishable goods are being cooled!

The date function runs for a period of ten years from the date the real time clock within the **Enviro+** is synchronised with the clock on the PC. It is possible therefore to set exclusion dates up to ten years in advance.

On days where the unit is identified as being excluded from operation the software will continue to run however the "Day Based" running indicator on the Interface Module window will be red.

It is possible to use the left hand mouse to highlight many dates simultaneously to create a period of exclusion beyond one day.

4.3.5 COMMISSIONING – MOTOR SOFT START

In the event that you want a soft start function, for example, with a water pumping application, then this can be enabled by putting DIP Switch 5 into the ON position. This switch will enable a 3s ramp start prior to a 2.5s DOL period after which time the system will go into energy save mode, (assuming that Motor Energy Control is enabled, see Section 4.2.1).

4.3.6 COMMISSIONING – MOTOR RESTART DELAY

With some older systems it may be desirable to delay the restart of the compressor or controlled motor in order to allow, for example, suction and discharge pressures to equalise. Where no other systems exist within the controls then the **Enviro+** has a two minute start

delay function available on DIP Switch 6 which means that even if the thermal management and time management were calling for the motor to be on it would not restart within two minutes of the last stop function being called.

The applications where such a need would arise are primarily refrigeration controls where the thermal management was by bi-metallic strip and was not electronically controlled in any way.

4.4 PCB MOUNTED LED INDICATORS

LED 1	Not Assigned	
LED 2	Not Assigned	
LED 3	Not Assigned	.
LED 4	Motor Energy Control Operational	Indicates that the MEC is operational and that savings are being made.
LED 5	Enviro+ Operational Status Indicator	**This LED has multiple indications as follows:** On Continuously – Temperature Sensor 1 temperature rising. 1 Flash – Normal Run/Temperature Sensor 1 temperature falling. 2 Flash – Run mode inhibited by time clock. 3 Flash – Run mode inhibited by calendar. 4 Flash – Run inhibited by lack of mains power. 5 Flash – Run inhibited by start input not being on. 6 Flash – Initial start up from a reset condition. 7 Flash – Power off state caused by two minute delay timer. 8 Flash – Soft start function enabled. 9 Flash – Run mode inhibited by Temperature Sensor 2 function.
LED 6	Power	Indicates that the unit is powered, either by the USB feed or by the supply.
LED 7	Power	Additionally lights when the unit is being fed by a 220V supply.

Note that LED 1 through LED 6 are in one bank adjacent to the USB connector on the PCB whilst LED 7 is separate and located near to the toroidal choke.

4.5 PCB MOUNTED BATTERY

The **Enviro+** has an on board battery to maintain the time and date functions. The battery has an extended life thanks to the power management inbuilt into the timer control chip. If the timer ceases to function then replace the battery with a 3V Lithium CR1220 or equivalent. It is imperative that you insert the battery the correct way, positive face up, otherwise damage may be caused to the timer chip.

If the battery is replaced it is wise to re-synchronize the Enviro+ timer to ensure that time and date registration has not been lost. The Enviro+ will retain the time and date settings for a short period, (approximately 5 minutes), without the battery in place.
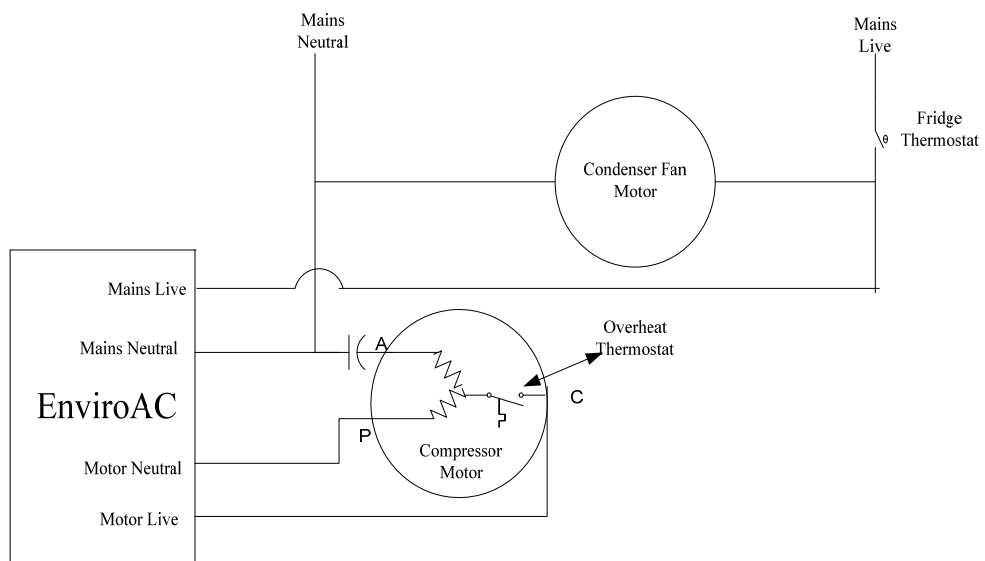
5. INSTALLATION
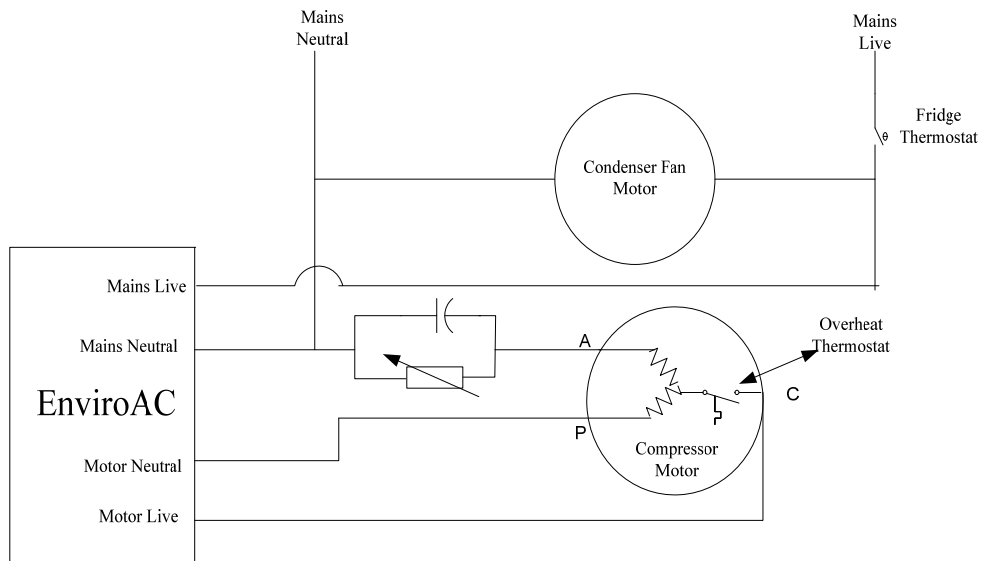
5.1 REFRIGERATION COMPRESSOR INSTALLATION WIRING

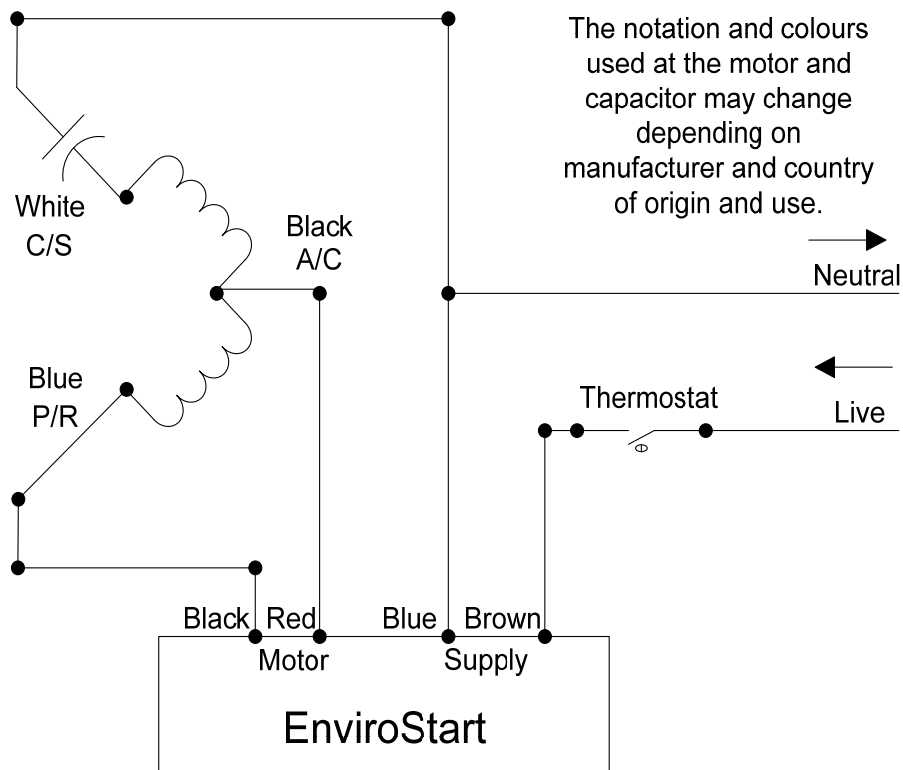### CSR Two Capacitors - Capacitor Start, Capacitor Run
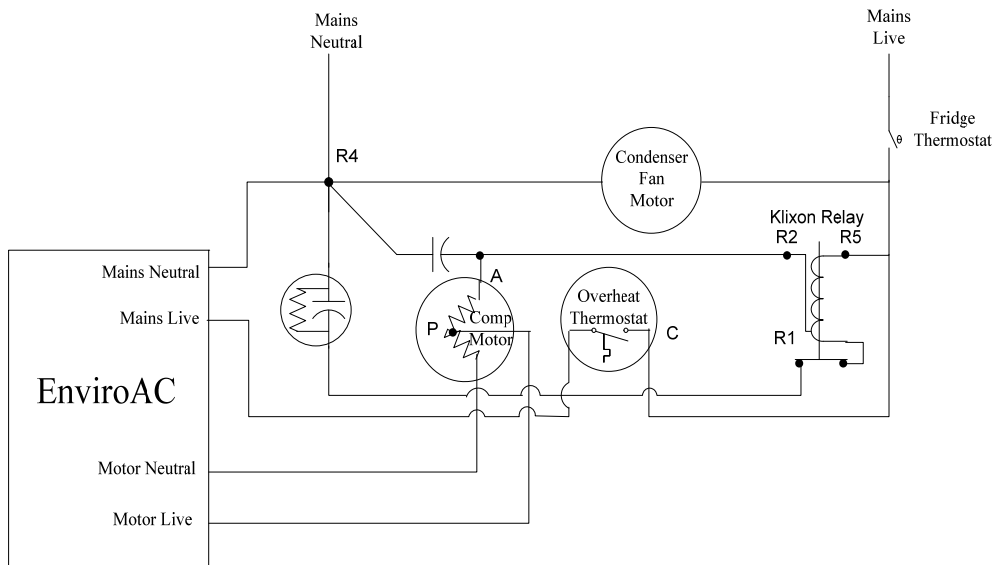
PSC Single Capacitor Start and Run
(Integral Overheat Thermostat)

PTCSCR Single Capacitor Start and Run with variable resistor (Integral Overheat Thermostat)
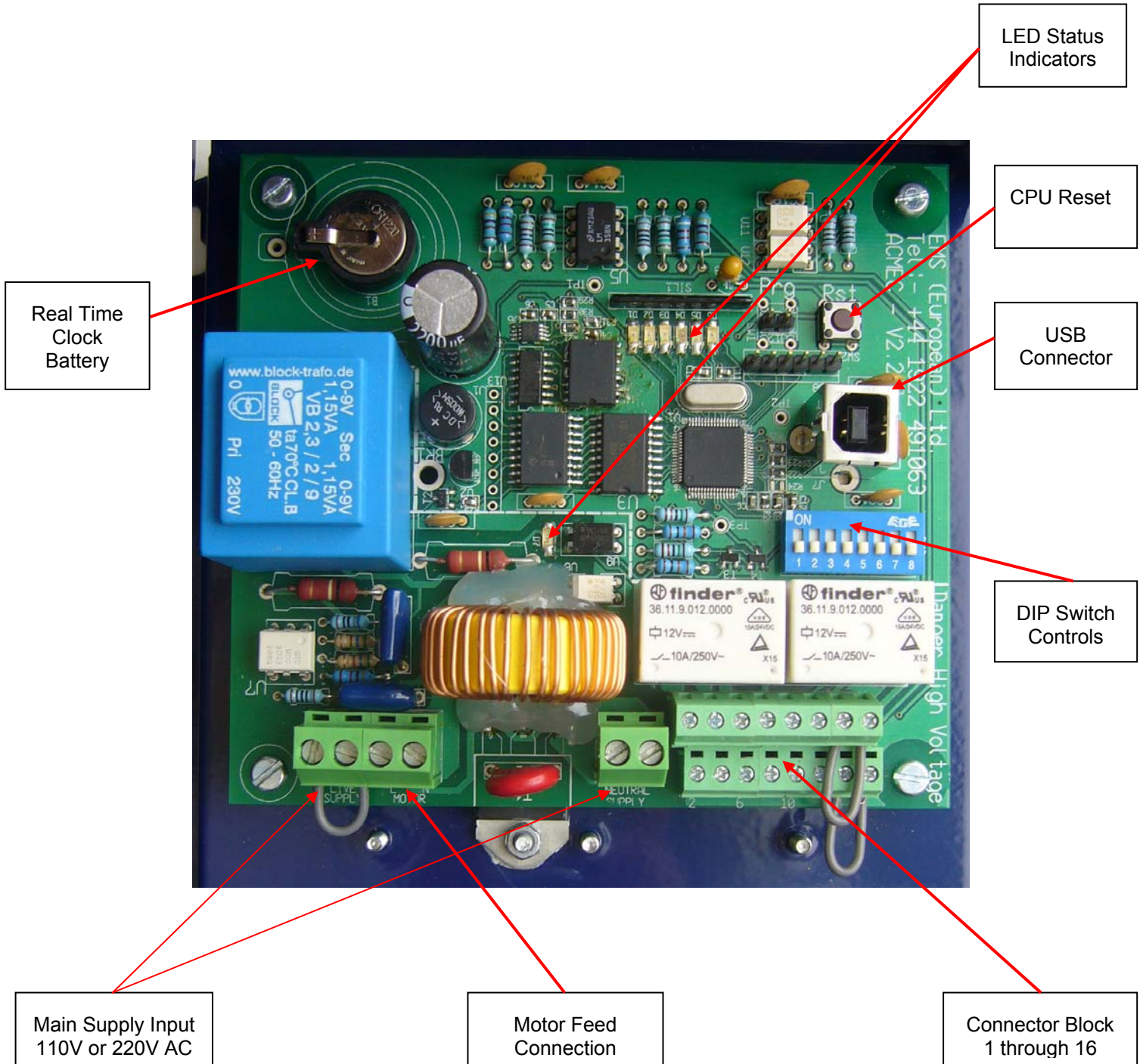

5.2 GENERALISED INSTALLATION WIRING DIAGRAM

The notation and colours used at the motor and capacitor may change depending on manufacturer and country of origin and use.

INSTALLATION AND COMMISSIONING GUIDE
END

APPENDIX 1

PCB LAYOUT AND CONNECTION DIAGRAM

LED Status Indicators

CPU Reset

USB Connector

Real Time Clock Battery

DIP Switch Controls
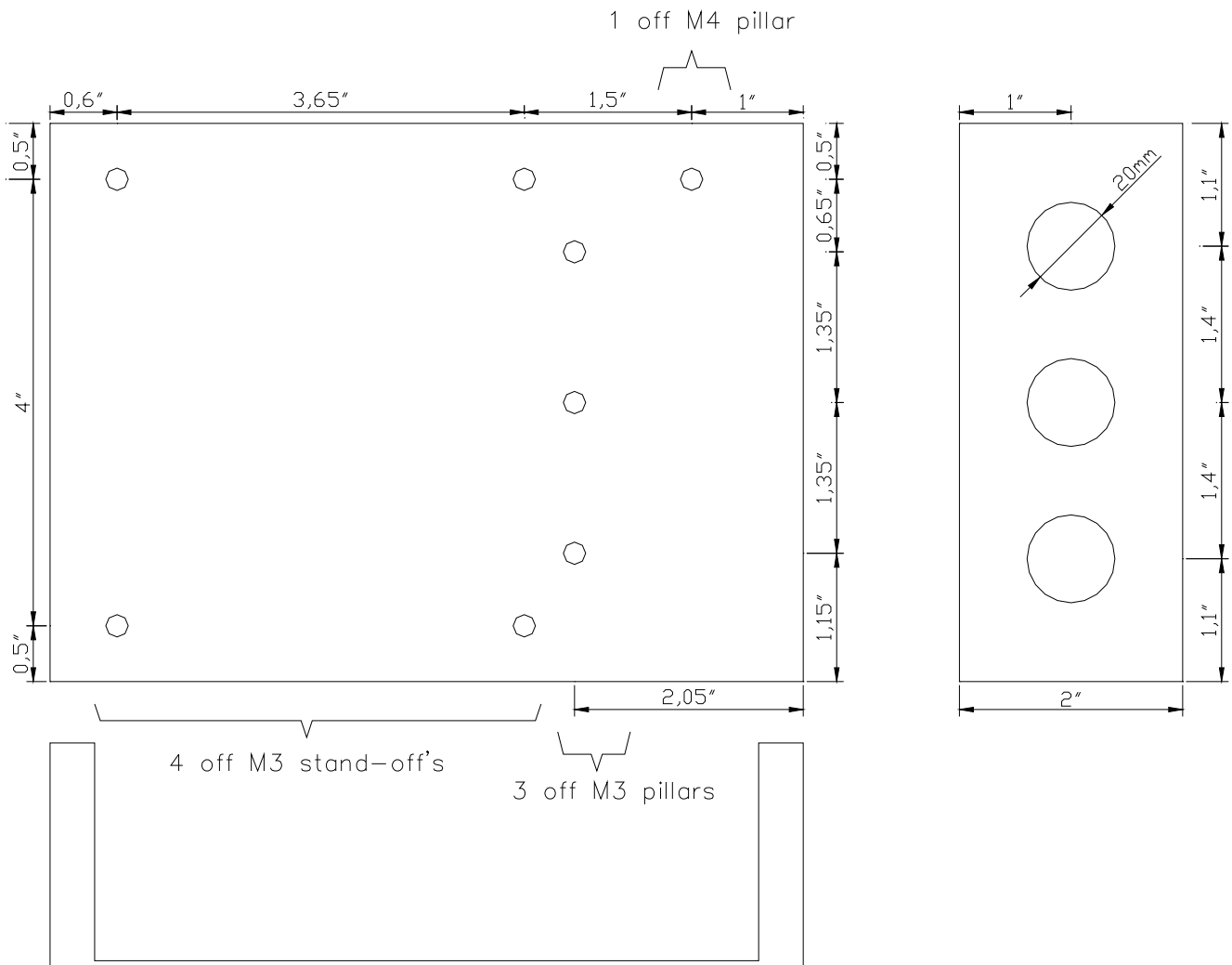
Main Supply Input 110V or 220V AC

Motor Feed Connection

Connector Block 1 through 16

Please note that not all components are fitted to every Enviro+ unit – the above photograph is therefore representative only

APPENDIX 2

Mechanical Drawing

APPENDIX 3

Fault Finding Chart

System Calling for Motor Motor Not Running

D7 Illuminated

No

Check R20

Good — **Burnt Out**

Check Supply I/P Voltage — **Repair R20**

Present — **Missing**

Return Unit To EMS — **Resolve Supply**

Yes

D6 Illuminated

No

Programme Not Running

Return to EMS

Yes

D5 Illuminated

1 Flash – Return to EMS Everything Else – Control Fault Check D5 Flash Count & Refer to Section 4.4

24Hr Technical Help Line 07809 504465