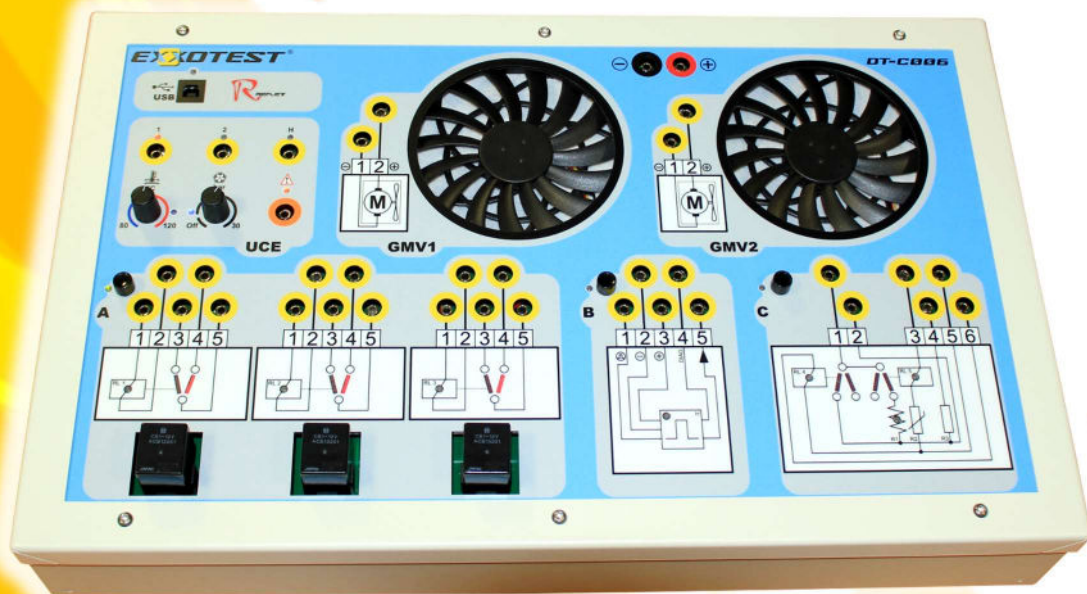


Benchtop Learning Module

STUDY OF ELECTRIC FAN CONTROL SYSTEMS



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1. ELECTRIC FAN CHARACTERISTICS

1.1. COOLING

1.1.1. General function

All engines are equipped with a cooling system to counter the heat given off during combustion. Some motor vehicle (including motorcycle) and boat engines are air-cooled. In these systems, the outer surface of the cylinder is divided into a series of cooling fins with a large metallic surface area to diffuse the heat from the cylinder.

Other engines are water-cooled, and their cylinders are enclosed in a jacket filled with water. In motor vehicles, a pump causes the liquid to circulate inside the jacket. Cooling occurs as the water flows through the tubes of a radiator.

For greater efficiency, the engine temperature must be kept at around 96°C (* depending on the vehicle). As the engine water temperature varies according to engine use (vehicle idling, under load, air conditioning running, etc.), an optimum temperature can be maintained by managing an electric fan unit.

**Maintained at a constant value (between 96°C and 108°C on the model).*

1.1.2. System operation

Study of the inputs and outputs

Inputs		Outputs
+BAT	Engine Control Unit	Warning light
+APC (+IGN)		Air conditioning off
High pressure sensor		Fan low speed control
Air conditioning		Fan high speed control
Engine temperature sensor		PWM control (chopper setup)

Engine cooling management system operation

Various engine water temperatures will determine various fan control thresholds.

Engine water temperature	State of cooling management unit outputs
$T^{\circ} \leq 96^{\circ}\text{C}$	Engine cold information. No fan
$96^{\circ}\text{C} \leq T^{\circ} \leq 105^{\circ}\text{C}$	Fan low speed control (16% PWM)
$105^{\circ}\text{C} \leq T^{\circ} \leq 112^{\circ}\text{C}$	Fan high speed control (80% PWM)
$112^{\circ}\text{C} \leq T^{\circ} \leq 118^{\circ}\text{C}$	Air conditioning prohibited + Fan high speed
$T^{\circ} > 118^{\circ}\text{C}$	Dash warning light control + Fan high speed

Threshold temperatures can vary according to the vehicle.

A linear sensor monitors coolant pressure in the air conditioning HP circuit. The values reached set other fan activation thresholds.

The fans can be controlled in different ways (three-relay setup, chopper setup and two-speed setup).

Above table valid for three-relay setup and two-speed fan control.

Fan speed	DIAG terminal voltage
At standstill	0 V
Low speed	6 V
High speed	12 V

Chopper setup

The diagnostic information is 0 V when the fan is not running. The diagnostic information output voltage reaches 12 V when the fan is activated. In this case, the fan is activated by a PWM signal.

Engine temperature in °C	Air Conditioning pressure in bar (pressure rise)	Chopper control percentage
$T \leq 96$	$\text{Off} \leq P \leq 10$	0%
$T = 96$	$P = 10$	16%
$T = 100$	$P = 12$	40%
$T = 105$	$P = 21$	80%
$T > 118$	$P > 21$	80%

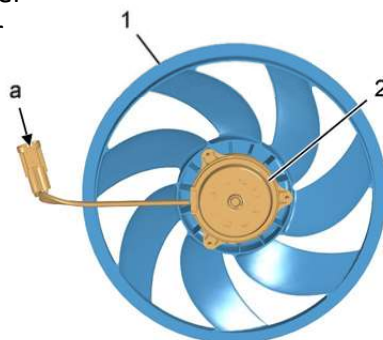
A post-cooling function is integrated into the engine electronic control unit. When the engine is switched off and the engine water temperature is higher than approximately 97°C (variable according to the vehicle), the fan remains powered up at low speed for approximately 5 minutes.

1.1.3. Fan operation

The fan creates an air flow to enhance powertrain cooling.

When the fan motor is actuated, the impeller is driven and creates the air flow that cools the various heat exchangers present:

- ✓ Cooling radiator (primarily)
- ✓ Air conditioning condenser
- ✓ Intake air heat exchanger
- ✓ Power steering oil heat exchanger
- ✓ Gear oil heat exchanger



1. Fan impeller

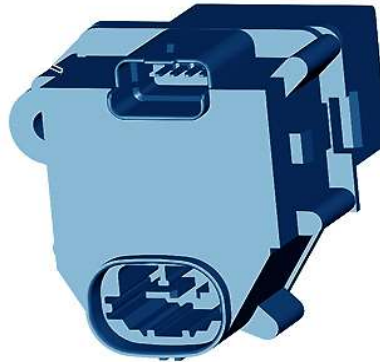
2. Fan motor

a. Two-way connector

1.1.4. Two-speed electric fan control unit

Role

The two-speed electric fan control unit drives the fan unit at low speed or high speed according to cooling requirements.



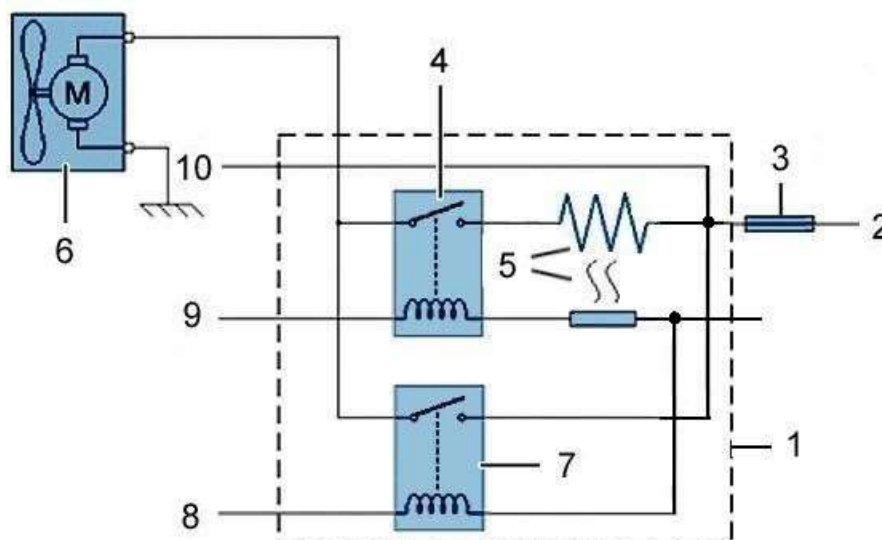
Operation

Low speed

When the engine control unit requests activation of the electric fan unit at low speed, power is supplied via the low-speed relay and via a resistor coupled to a thermal fuse: battery voltage halved = low speed.

High speed

When the engine control unit requests activation of the electric fan unit at high speed, power is supplied via the high-speed relay and powers the fan unit directly: battery voltage across the fan terminals = high speed.



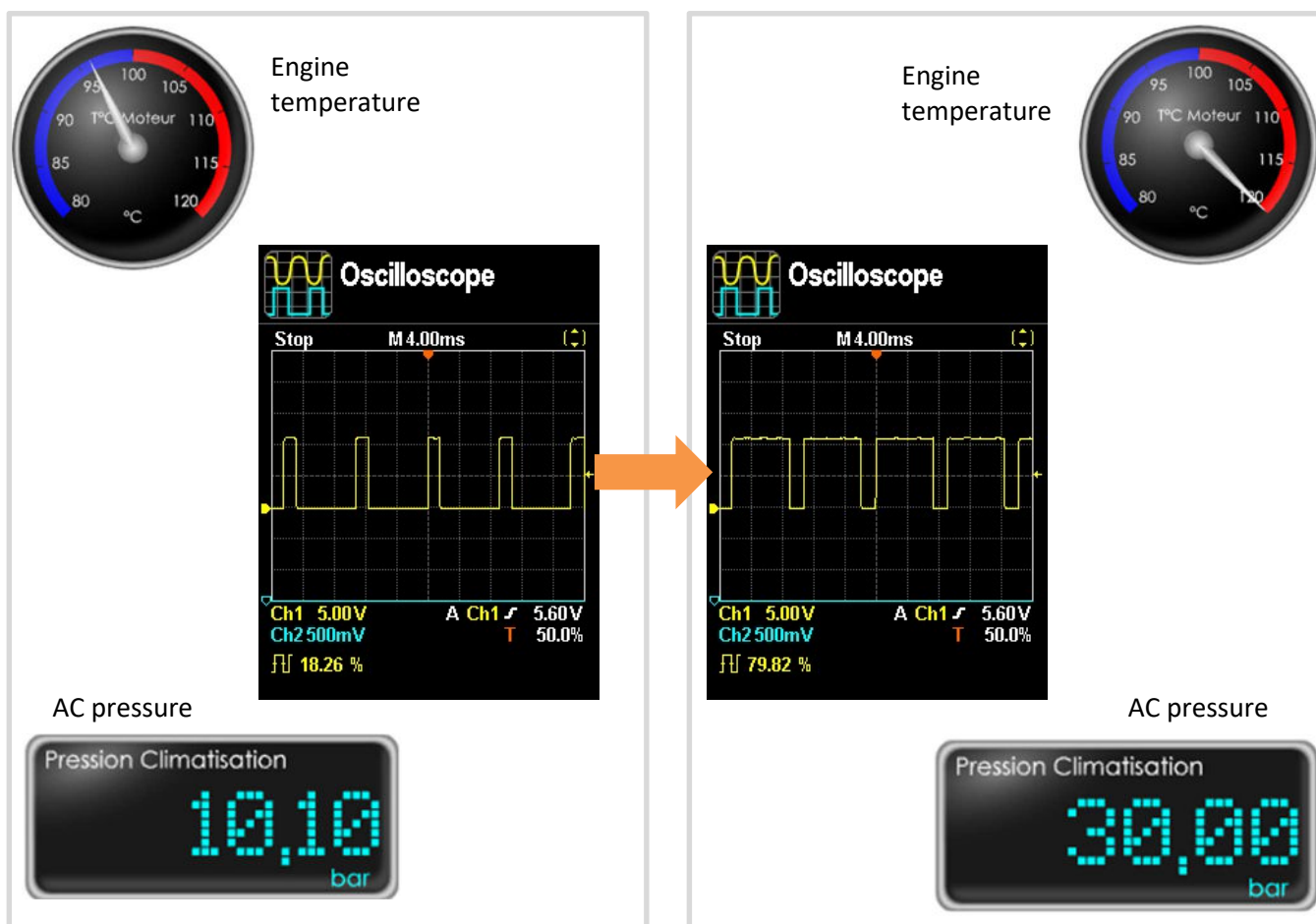
Number	Description	Number	Description
1	Two-speed electric fan control unit	6	Electric fan unit
2	Power supply: Two-speed electric fan control unit	7	High-speed relay
3	Protective fuse	8	High-speed control
4	Low-speed power relay	9	Low-speed control
5	Resistor + thermal fuse	10	Diagnostic line of two-speed electric fan control unit

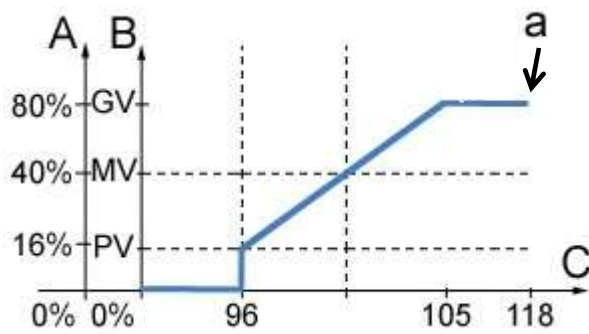
1.1.5. Electric fan unit controlled by electronic chopper

Chopper

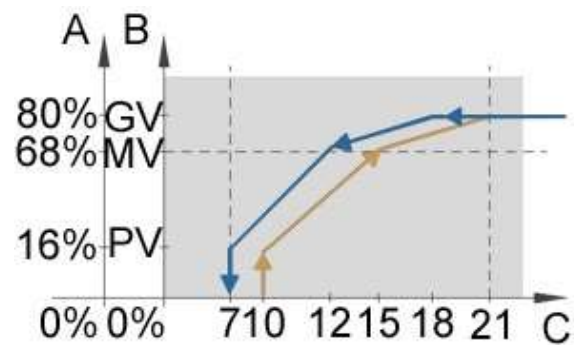
Choppers are DC-DC converters with the function of supplying a variable DC output voltage (PWM*) from a fixed DC input.

PWM = Pulse Width Modulation





- Open cycle ratio (PWM, %)
- Electric fan unit speed (%)
- "a" Engine water temperature warning (light on)
- Engine water temperature (°C)



- (A) Open cycle ratio (PWM, %)
- (B) Electric fan unit speed
- (C) Cooling pressure (bar)
- (GV) High fan unit speed
- (MV) Medium fan unit speed
- (PV) Low fan unit speed

1.1.6. Three-relay setup

The two fans are controlled by three relays. The low speed control is activated by powering the first relay that places the two fans in series. They rotate at half-speed.

The high speed control is activated by the three relays that place the two fans in parallel. They are thus powered separately and rotate at full speed.

What is a relay?

A relay is an electronic accessory containing a small electromagnet. When a weak electric current is sent to the relay, this electromagnet activates a sort of small switch of higher quality and greater capacity than the original switch. The first circuit is the "control circuit", and the second one the "power circuit".

The main advantage is that the electric current flowing through the original switch is much lower than in a "direct" setup. It also allows the part of the electric wiring conducting strong electric current to be shortened.

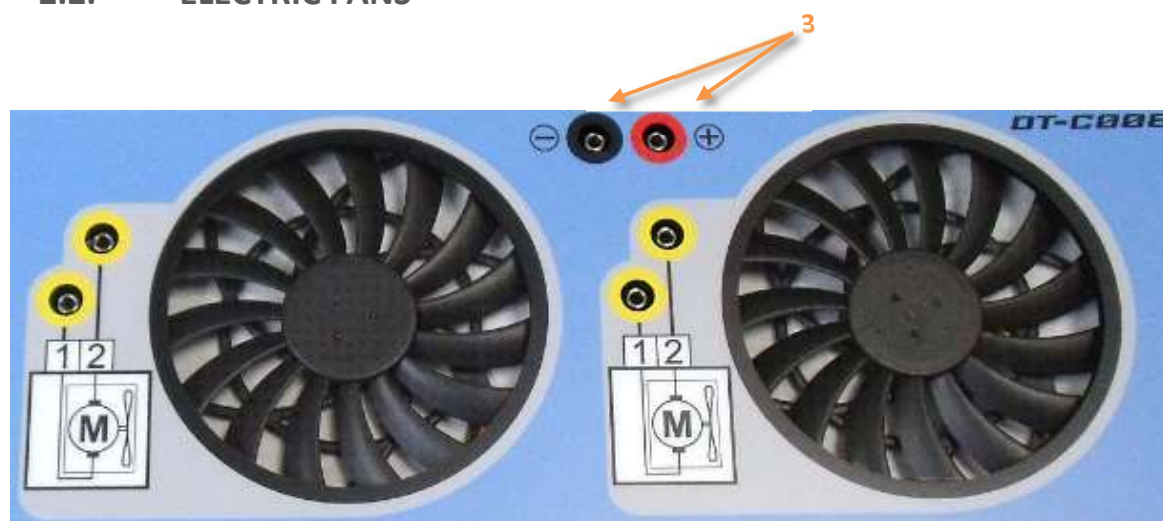
2. DESCRIPTION OF MODULE DT-C006

2.1. CONTROL UNIT (UCE)



No.	Description
1	USB port: Reflet update
2	Low speed control
3	Engine water temperature setting (°C)
4	Air conditioning pressure setting (bar)
5	High speed control
6	Chopper control (16 to 80%)
7	Diagnostic fault/info indicator

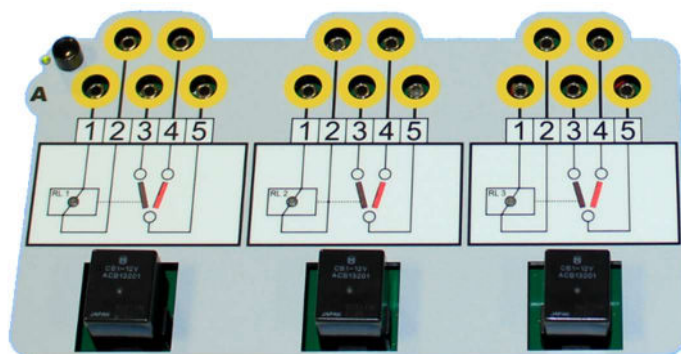
2.2. ELECTRIC FANS






Number	Description
1	Fan unit ground
2	Fan unit power supply
3	"Battery out" terminals



2.3. SETUP A: THREE RELAYS, LOW AND HIGH SPEED

No.	Description
1	Coil control
2	Coil control
3	Output make circuit (activated)
4	Output break circuit (non-activated)
5	Power input

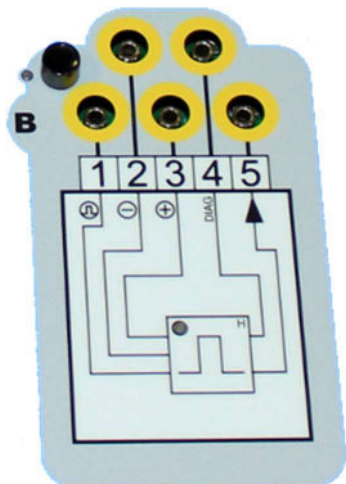


Operating phase

Setup A	Cooling T (°C)	T < 96	96 < T < 105	105 < T < 112	112 < T < 118	T > 118
Low fan speed (PV)	Led 1	out	lit	lit	lit	lit
	socket	-	ground	ground	ground	ground
High fan speed (GV)	Led 2	out	out	lit	lit	lit
	socket	-	-	ground	ground	ground
Diag info	Led 	Out with socket=0V, otherwise lit	Out with socket=6V, otherwise lit	Out with socket=12V, otherwise lit	Out with socket=12V, otherwise lit	Out with socket=12V, otherwise lit
	out	out	out	out	out	lit
	See table below				A/C prohibited (Led out)	A/C prohibited (Led out)

SETUP A	A/C P (bar)	Off ≤ P ≤ 2.5	2.5 < P < 10	10 < P < 21	P > 21
Pressure increase	A/C Led 	out	lit	lit	lit
	Low speed	-	-	activated	activated
	High speed	-	-	-	activated
	A/C P (bar)	P > 18	7 < P < 18	2.5 < P < 7	2.5 > P ≥ Off
Pressure reduction	A/C Led 	lit	lit	lit	out
	Low speed	activated	activated	-	-
	High speed	activated	-	-	-

2.4. SETUP B: CHOPPER



Number	Description
1	Fan unit control
2	Ground
3	Chopper power supply
4	Fan unit diagnostic info
5	Fan unit power supply

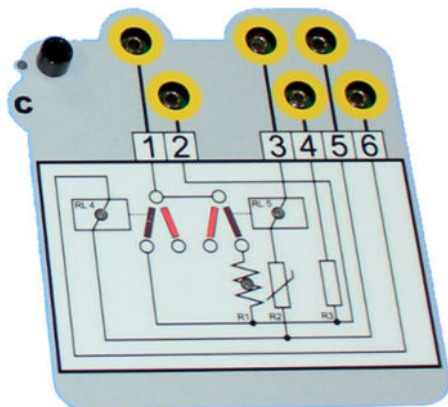
Operating phase

For $96 < T < 105$, chopper control varies from 16 to 80% – see 1.1.5

Setup B	Cooling T (°C)	T < 96	T = 96	T = 100	T = 105	T > 118
Low fan speed (PV)	Led 1	out	out	out	out	out
	socket	-	-	-	-	-
High fan speed (GV)	Led 2	out	out	out	out	out
	socket	-	-	-	-	-
Chopper (%)	Chopper Led	out	lit	lit	lit	lit
	socket	0%	16%	40%	80%	80%
Diag info	No fault = led out with socket voltage at 0V					
	Fault = led lit with socket voltage at 12V (battery voltage)					
	out					lit
	See table below				A/C prohibited (Led out)	A/C prohibited (Led out)

Setup B	A/C P (bar)	Off ≤ P ≤ 2.5	2.5 < P < 10	10 < P < 21	P > 21
Pressure increase	A/C Led	out	lit	lit	lit
	Chopper Led	out	out	lit	lit
	Chopper socket	0%	0%	16% to 80%	80%
	A/C P (bar)	P > 18	18 < P < 7	2.5 < P < 7	2.5 > P ≥ Off
Pressure reduction	A/C Led	lit	lit	lit	out
	Chopper Led	lit	lit	out	out
	Chopper socket	80%	80% to 16%	0%	0%




2.5. SETUP C: TWO-SPEED UNIT (WITH RESISTOR)





Terminals	Description
1	+ Battery
2	Fan unit power supply

Terminals	Description
3	Electric fan low speed control (grounding)
4	Fan unit diagnostic info
5	Positive supply of relay windings
6	Electric fan high speed control (grounding)

Operating phase

Setup C	Cooling T (°C)	T < 96	96 < T < 105	105 < T < 112	112 < T < 118	T > 118
Low fan speed (PV)	Led 1	out	lit	out	out	out
	socket	-	ground	ground	ground	ground
High fan speed (GV)	Led 2	out	out	lit	lit	lit
	socket	-	-	ground	ground	ground
Diag info (V)	Led 	Out with socket=0V, otherwise lit	Out with socket=6V, otherwise lit	Out with socket=12V, otherwise lit	Out with socket=12V, otherwise lit	Out with socket=12V, otherwise lit
	out	out	out	out	out	lit
	See table below				A/C prohibited (Led out)	A/C prohibited (Led out)

SETUP C	A/C P (bar)	Off ≤ P ≤2.5	2.5 < P < 10	10 < P < 21	P > 21
Pressure increase	A/C Led 	out	lit	lit	lit
	Low speed	-	-	controlled	-
	High speed	-	-	-	controlled
	A/C P (bar)	P > 18	7 < P < 18	2.5 < P < 7	2.5 > P ≥ Off
Pressure reduction	A/C Led 	lit	lit	lit	out
	Low speed	-	controlled	-	-
	High speed	controlled	-	-	-

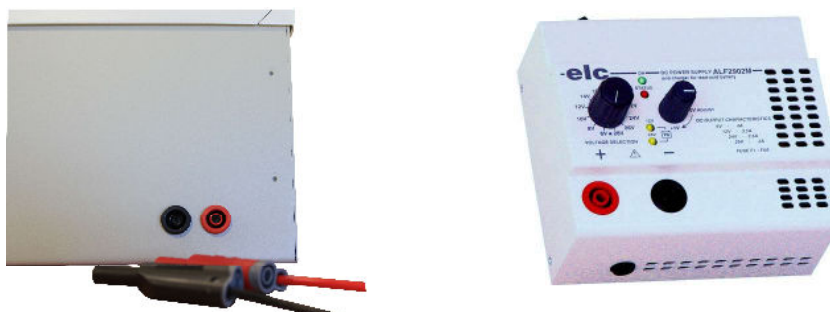
3. USER FILE

3.1. STARTING MODULE DT-C006

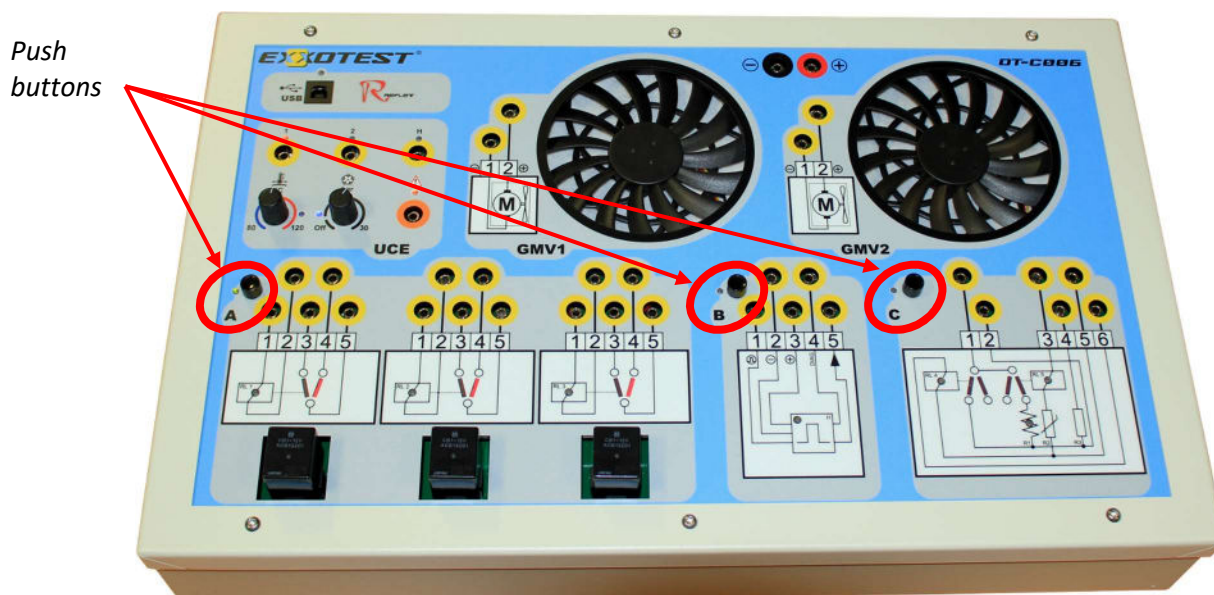
All control panel components are rated for use with a 12V supply only.

DT-C006 is protected against surges. It is delivered with its cables and power supply.

- Connect the power supply unit provided to the 230 V mains supply (ELC ALF2902M).
- Check that the power supply switch is set to **1**.
- Connect the red and black cables to the rear of the module and to power supply ALF 2902M.

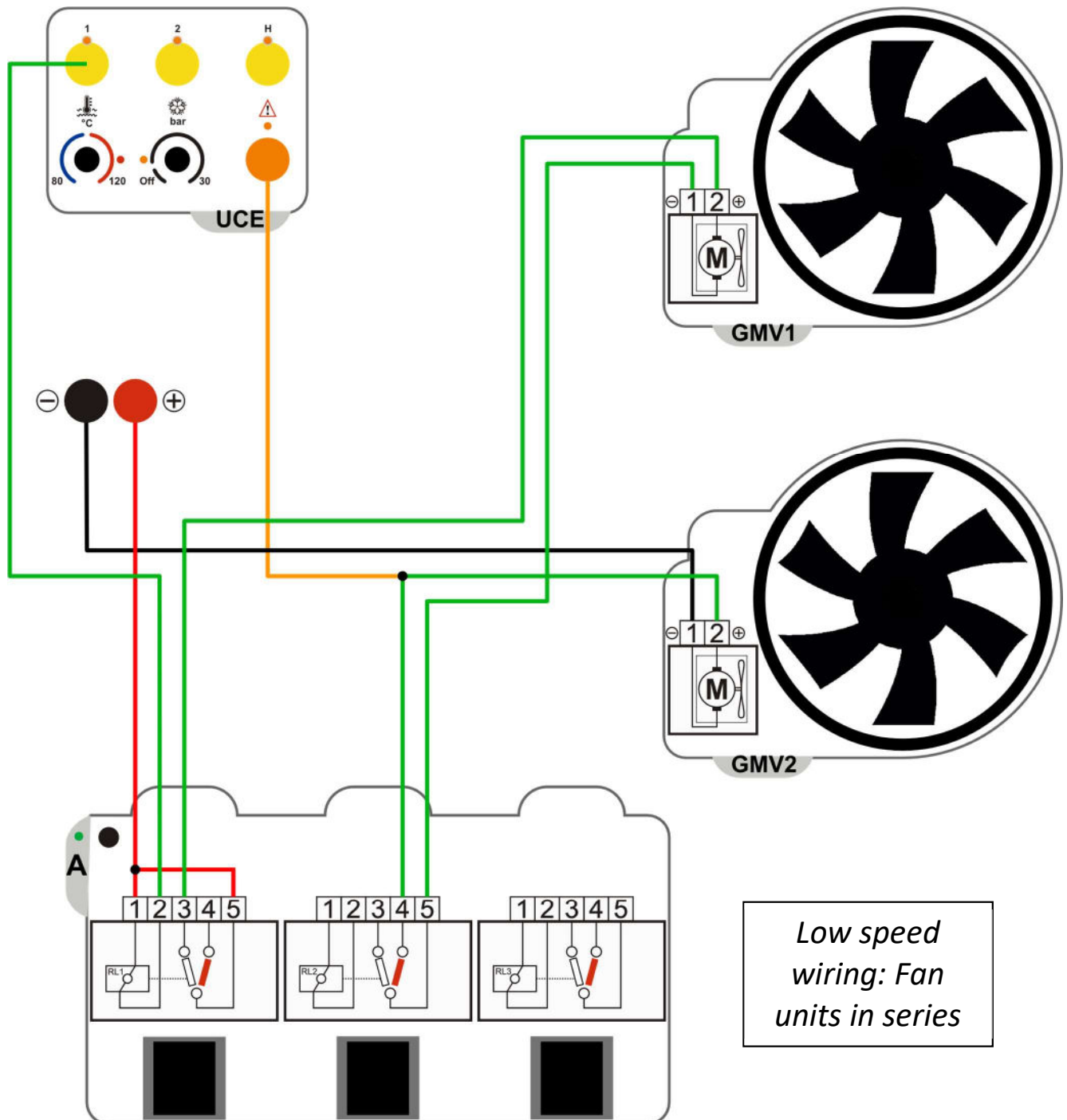


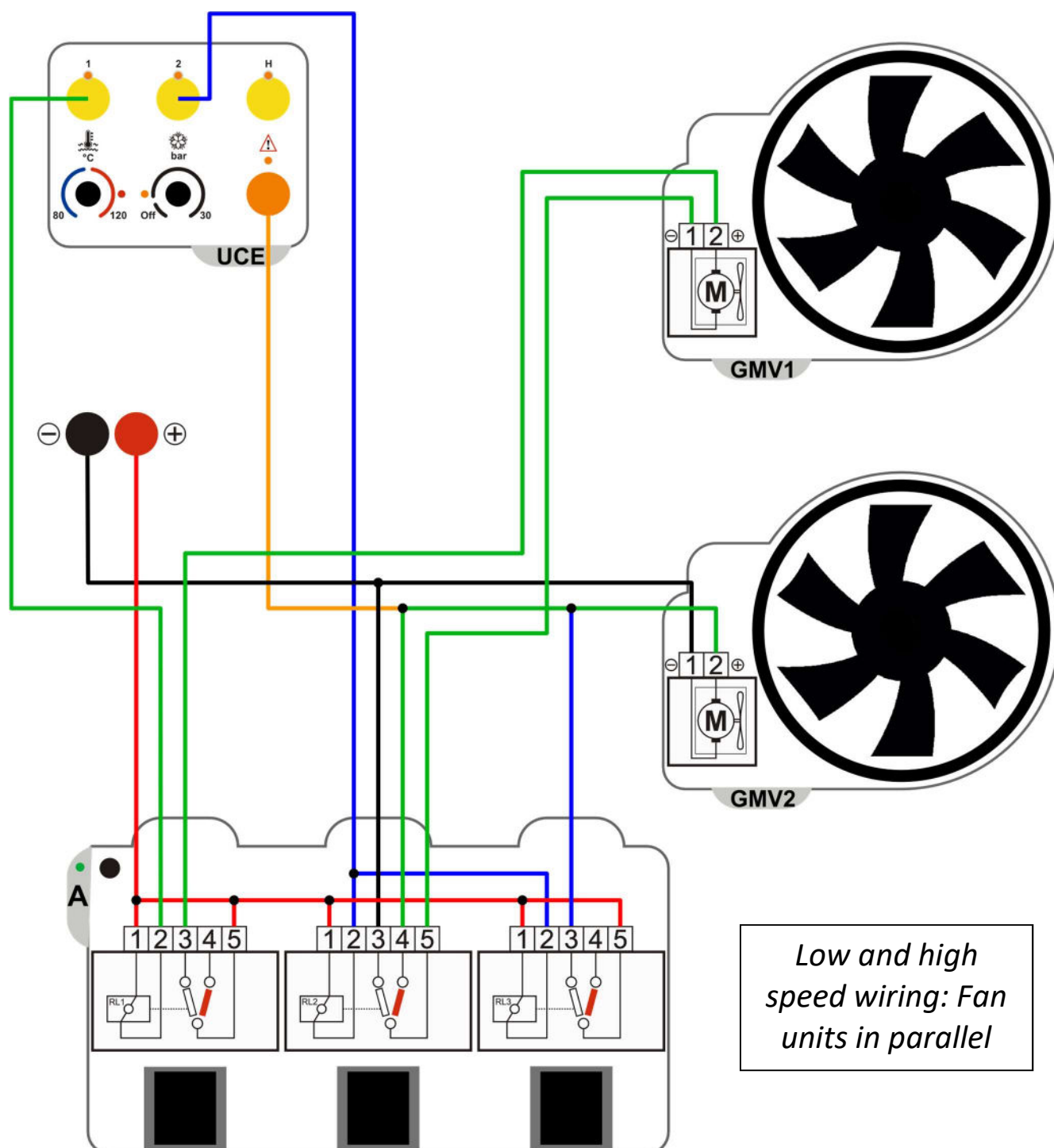
- To activate one of the setups, press the corresponding pushbutton:



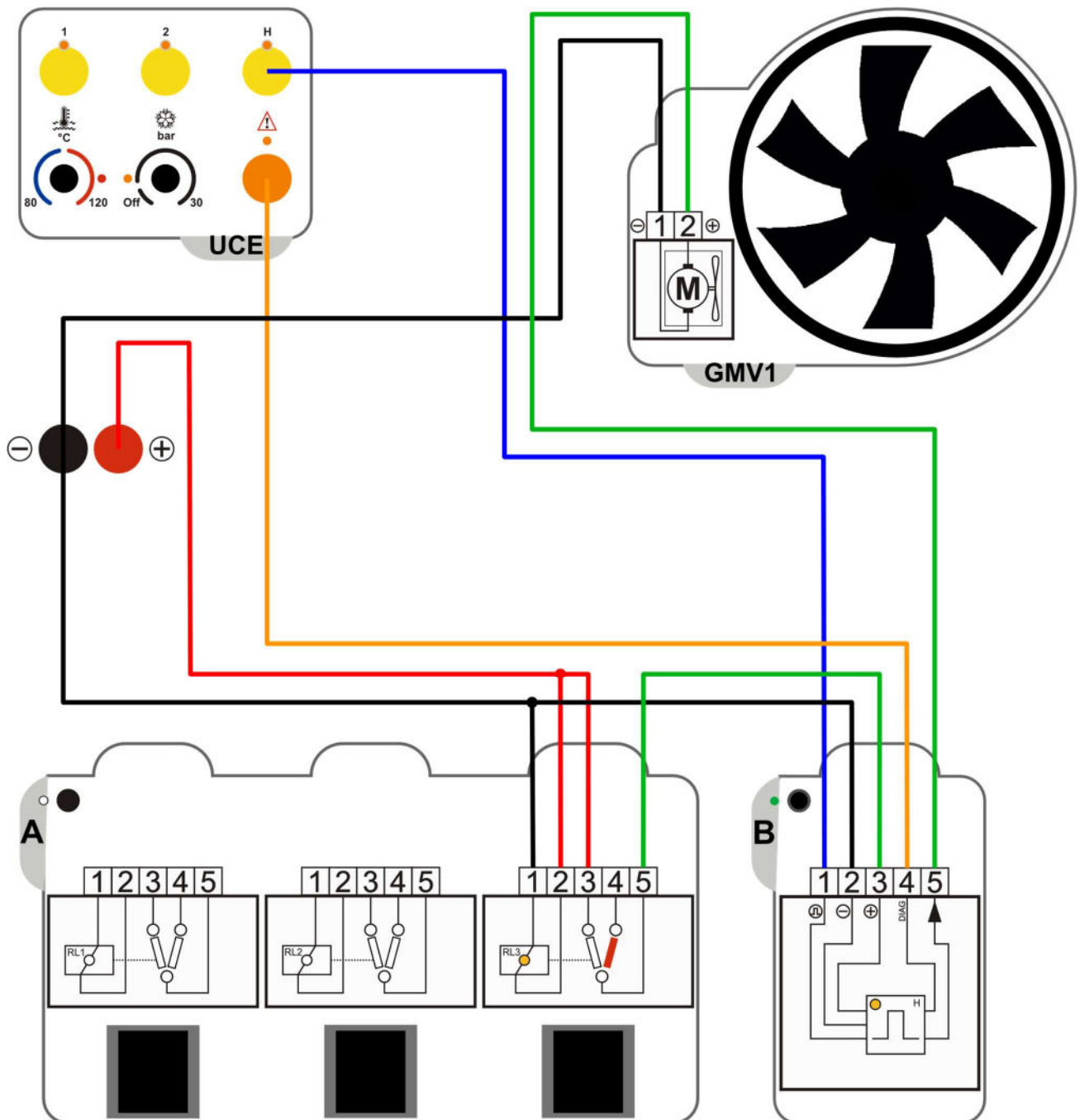
- Now wire up as illustrated below.

3.2. WIRING DIAGRAM: SETUP A, FAN UNITS IN SERIES OR PARALLEL

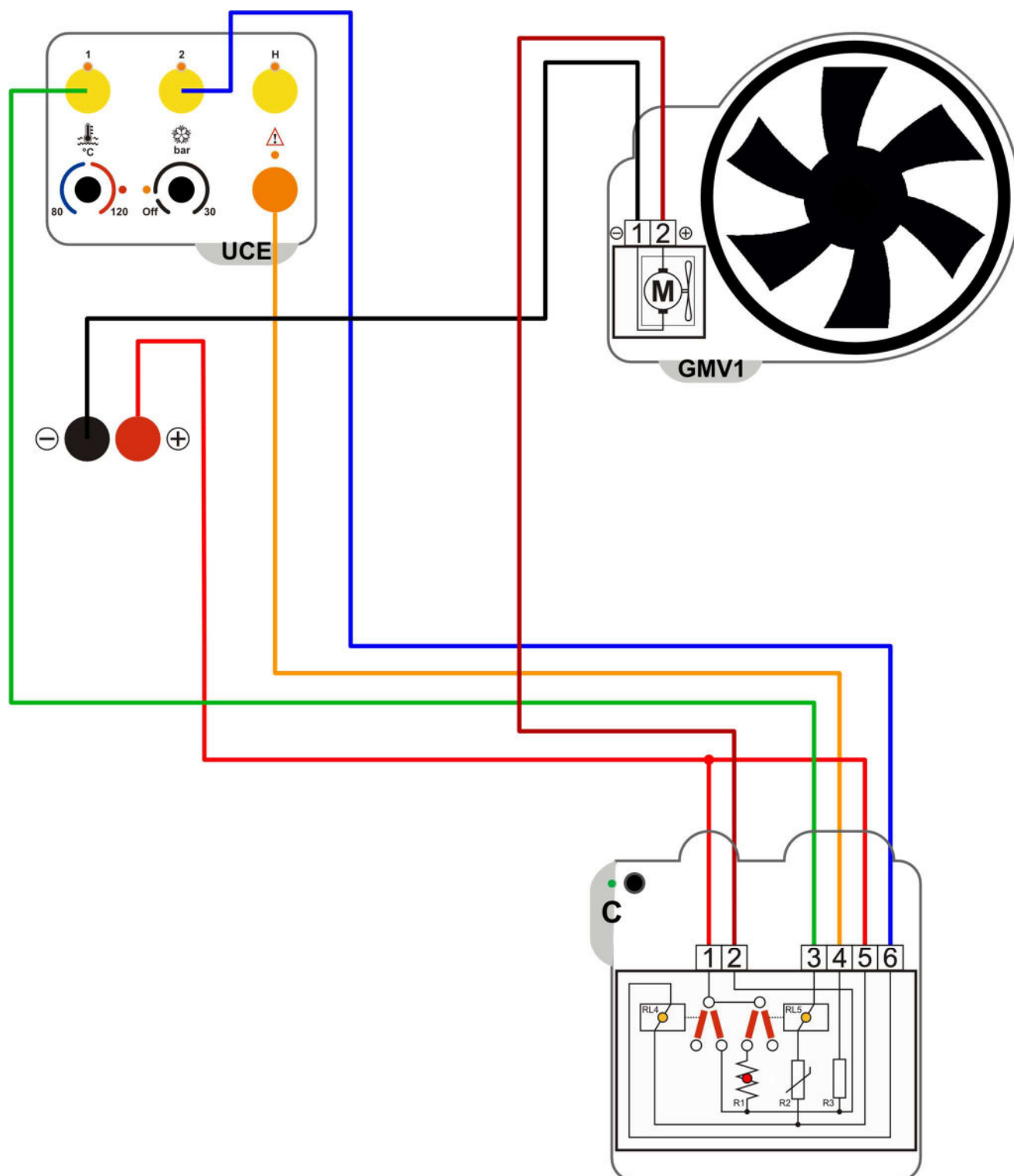




3.3. WIRING DIAGRAM: SETUP B, CHOPPER



3.4. WIRING DIAGRAM: SETUP C, TWO-SPEED UNIT



CE DECLARATION OF CONFORMITY



Manufacturer Name: **ANNECY ELECTRONIQUE SAS**
 Street: **1, rue Callisto - Parc Altaïs**
 Town: **74650 CHAVANOD**
 Country: **France**

Represented by the signatory below, declares that the following product:

Product reference	Product name	Make
DT-C006	Benchtop learning module: Controlling electric cooling fan units	EXXOTEST

complies with all requirements of European directives relating to the design of Electrical & Electronic Equipment (EEE) and the management of Waste Electrical & Electronic Equipment (WEEE) in the EU:

- Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)
- Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS)
- Electromagnetic Compatibility Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004.

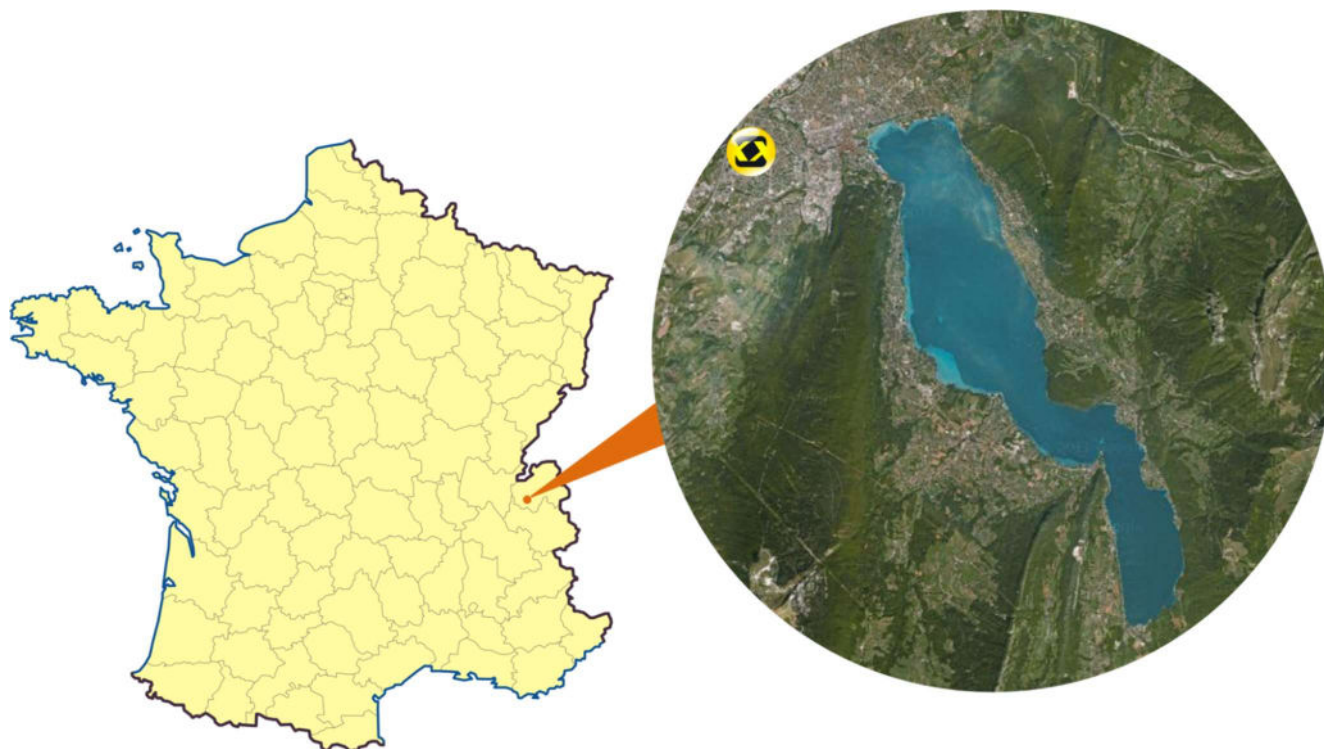
The product has been manufactured in accordance with the requirements of European directive:

- Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.

Signed in Chavanod on 20 July 2015

Stéphane Sorlin, Chairman

A handwritten signature in blue ink, consisting of a stylized 'S' followed by a horizontal line.



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Original Instructions

Document No. 00302001-v4

ANNECY ELECTRONIQUE, Designer and Manufacturer of Exxotest and Navylec equipment

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