Donaldson
BOFA™

TCU
Temperature Control Unit

User Manual
Installation, Operation, and Service Information

This manual contains specific precautions related to worker safety. The hazard alert image denotes safety related instructions and warnings in this manual. DO NOT install, operate, or perform maintenance on this system until you have read and understood the instructions, precautions and warnings contained within this manual.

English
Original Instructions

UM-TCU-BOFA-US
Revision 1.2

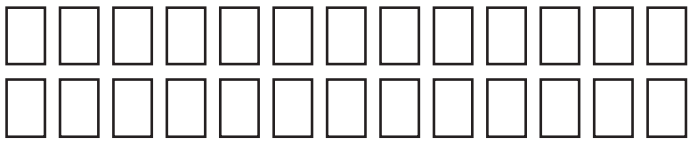
Donaldson BOFA Technical Service

If a problem arises with your system, please refer to the troubleshooting section of this manual. If the problem is still not resolved, please:

- Visit our website at donaldsonbofa.com for online help.
- Or contact the helpline:
    1. ROW: +44 (0) 1202 699 444 (Mon-Fri 9am-5pm GMT)
    2. US: +1 (618) 205 5007 (Mon-Fri 9am-5pm CST).
- Email:
    3. ROW: bofatechnical@donaldson.com
    4. US: bofatechnicalus@donaldson.com

Serial Number

For future reference, fill in your system details in the space provided. The serial number is on the rating label located on the side/rear of the system.



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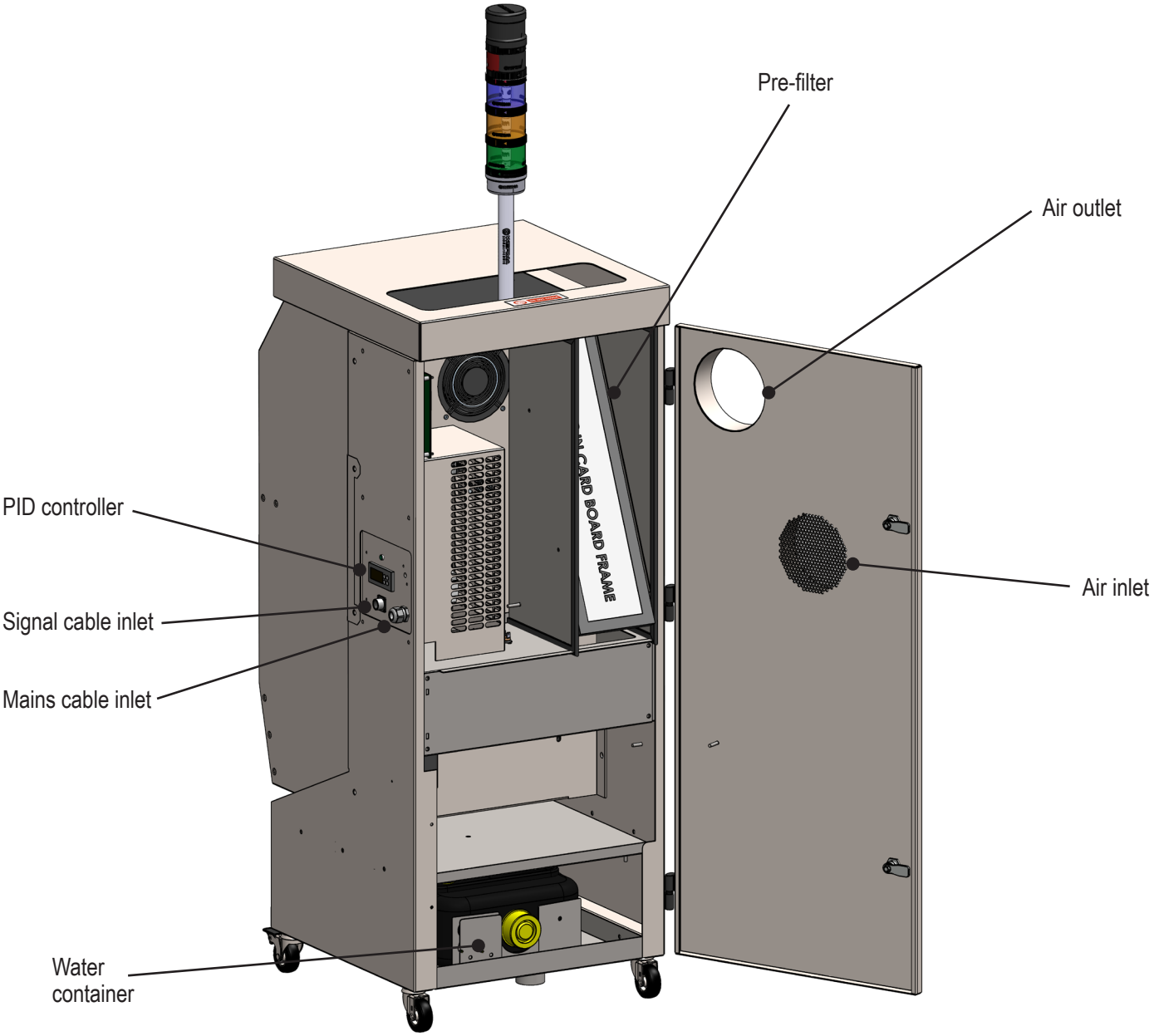
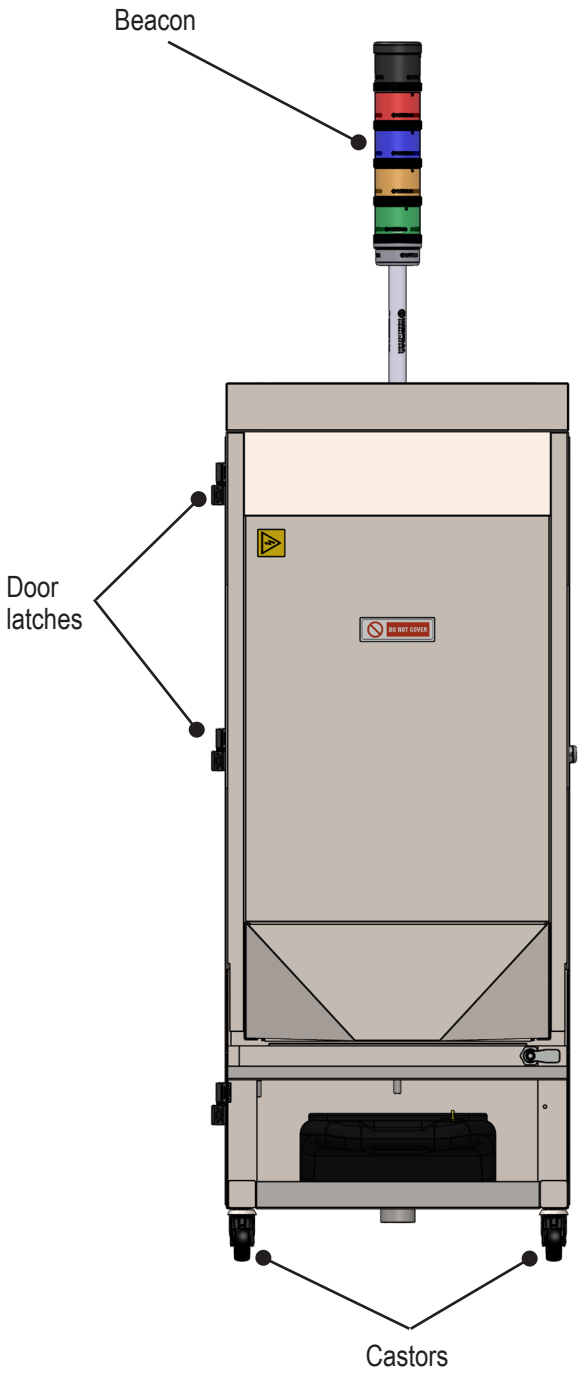
1.1. Front view of TCU



1.2. Rear view of TCU



2 Safety information

2.1. Important safety notes

To ensure the safe operation of equipment, all personnel must follow generally accepted safety procedures. These procedures ensure their own safety and the safety of those around them. In this manual and on the system, safety symbols of the type described below are shown when a potential hazard is given, the advisory notices should be heeded at all times.

Symbol	Meaning	
	ELECTRICAL HAZARD	High electrical voltage is present that could cause injury or death. Do not remove protective covers from the equipment housings or override protective devices.
	CAUTION	Refers to a possibly harmful situation. If not avoided, damage could be caused to the product or something in its environment.
	CAUTION MOVING PARTS	Beware of moving parts. Rotating blowers are present that could cause injury or death. Switch off power to blower before removing panels and proceed with caution.
	DANGER	Ensure the system is isolated from all sources of electrical energy before removing access covers for service and maintenance.
	CAUTION DO NOT COVER	Care must be taken to ensure airflow through the air conditioning unit. Ensure it is not obstructed. Overheating and possible failure of the system may occur if not observed.
	PROTECTIVE EARTH CONNECTION	If it is necessary to remove protective earth connections to enable repair/ maintenance, care should be taken to ensure connections are remade on completion and prior to reinstating the system power supply.

	CAUTION	Use only as described. Consult manufacturer before using for any other purposes.

Intended use

The TCU is a precision temperature control unit designed to enhance the print process by providing a highly stable and accurately controlled air temperature within the printer.

The operating range of the TCU offers wide control of the process temperature on either side of the factory ambient. As applications become more varied, the requirement to produce high-yield results can be aided by the ability to heat as well as to cool from factory ambient.

The TCU uses a recirculating air system. Air entering the TCU is passed via a blower through an air conditioning module where it is cooled and dehumidified before being ducted into a plenum containing air heaters. A PID controller modulates the power output of the heaters to accurately achieve the required set temperature. The temperature conditioned air then passes through a filter and is fed through ducting into the print process area of the printer. The air is then recirculated back to the TCU.

Due to its optimized design and recirculating system, the TCU is energy efficient and requires minimal input power from a single-phase mains supply. The design minimizes the production of waste heat, which is vented through the top of the TCU, alleviating the need for any connection to factory extraction systems.

To prevent process contamination, conditioned air is passed through a filter before entering the printer. The possibility of process contamination is further reduced due to the TCU maintaining a higher air pressure within the printer compared to the surrounding environment, thus limiting the ingress of airborne particles.

The module's operating status is indicated by the provision of a 'four colour' beacon, clearly visible to line operators. Any condensate produced can be gravity piped to a drain or collected in an easy to empty 5-litre container. Two sensors monitor the condensate level and give a warning via the beacon when the container requires emptying. The TCU will automatically shut down if the container is not emptied to prevent overflow.

The TCU has been designed for robust, reliable operation, resulting in a long lifetime product. Ergonomic modular design features allow for ease of maintenance without any requirement for specialist refrigeration resource.

3 Installation

3.1. Required services

Donaldson BOFA requires additional system supply protection with the fitment of an external double pole circuit breaker conforming to national/federal regulations. Use the following table to ensure the recommended circuit breaker is used.

Voltage	Frequency	Value of supply circuit breaker
230 V +/- 10%	50/60 Hz	16 A

	CAUTION	An over current circuit breaker protects the system's internal wiring and components from overheating or catching fire during fault conditions. Under no circumstances must a circuit breaker of greater value than 16 A be used.
	CAUTION	The system **MUST** be connected to a properly earthed outlet.

3.2. Power supply connection

	CAUTION	All electrical connections should be carried out by suitably qualified personnel ensuring relevant rules and regulations are observed.
	CAUTION	To reduce the risk of fire, electric shock, or injury: connect to a properly earthed/ grounded outlet. Use only as described in the manual. Isolate from power supply before opening covers.
	WARNING	Dangerous voltages exist within this equipment. Ensure all electrical covers and main system covers are fitted before operating equipment.
	WARNING	If any damage to the electrical cable is found the unit must not be connected. Installation is to cease until inspected by a qualified electrician.

1. Check the integrity of the electrical power supply cable.
2. Test the mains input at the isolated supply. Ensure is the correct voltage and frequency before proceeding.
3. Connect to the mains supply.

3.3. Temperature sensor placement

Install the temperature sensor as close to the operating area of the printer, without affecting the printing process.

3.4. Condensate collection

Condensate is collected in the plastic container at the base of the unit and is accessed from the rear (Figure 1):

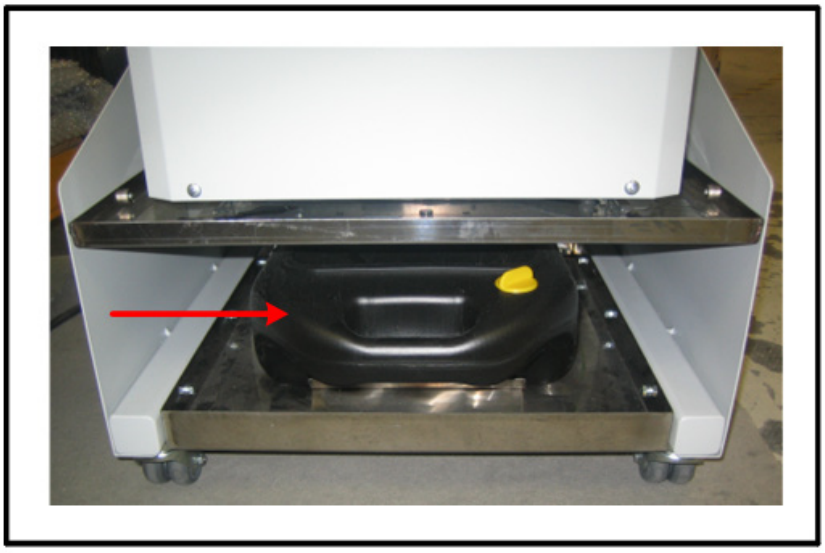


Figure 1

Alternatively, condensate can be diverted directly to a drain via pipe work (not included) connected to the spout on the underside of the condensate tray (Figure 2 – condensate collector removed):

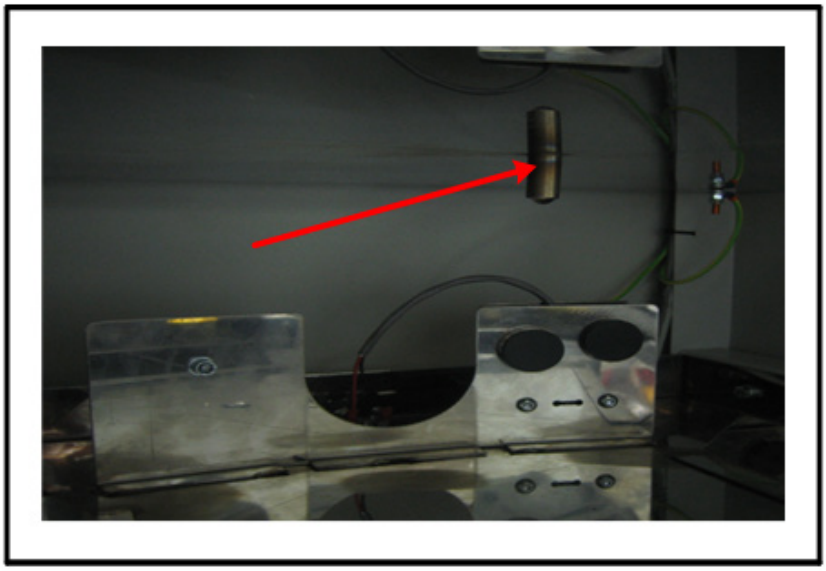


Figure 2

3.5. Indicator beacon

Remove the indicator beacon from its protective packaging. Pass the beacon loom connector through the plenum base into the electrical compartment (Figure 3) and secure the beacon with the supplied fasteners (Figure 4):

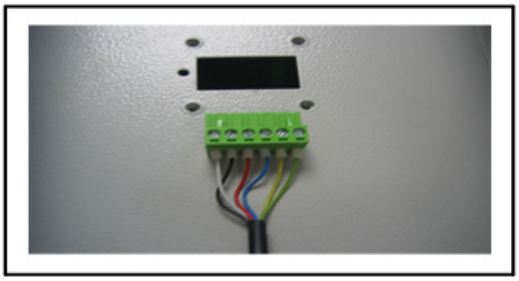


Figure 3

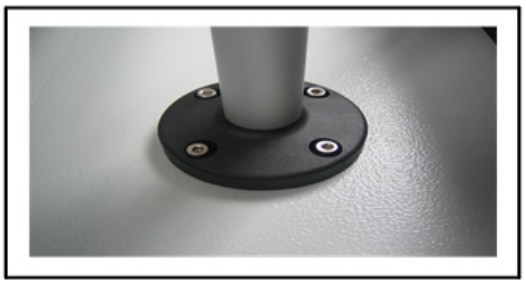


Figure 4

Connect the beacon loom to the Control PCB connector CN2:

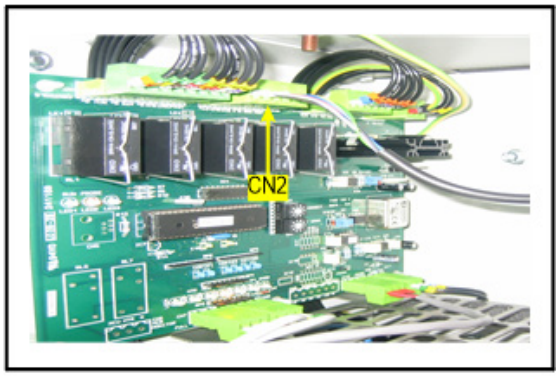


Figure 5

	ELECTRICAL HAZARD	Ensure isolator is in the OFF position before opening access door.
	CAUTION MOVING PARTS	Allow time for blower rotation to cease before opening access door.

3.6. Air ducting hose

Connect air ducting hoses to the TCU using the supplied hose clips. The upper port is the conditioned air outlet. The lower port is for air returning from the printer.

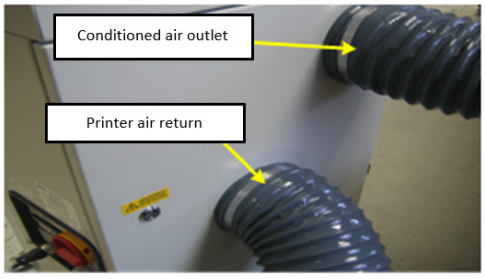


Figure 6

	CAUTION MOVING PARTS	Do not operate printer with blanking plate removed and TCM ducting not fitted.

4 Operation

4.1. Initializing the system

4.1.1. On completion of the printer/TCU installation, turn the TCU isolator to the ON position (Figure 7). The green lamp should illuminate, indicating that the TCU is energized and the controller display will initially show as (Figure 8) with 'tESt' flashing.

Figure 7

Figure 8

4.1.2. After approximately 5 seconds, the controller display will change. If no output, temperature signal is available from the printer, the controller will display 'UUUU' and the orange beacon segment will flash quickly. The TCU will not start (Figure 9).

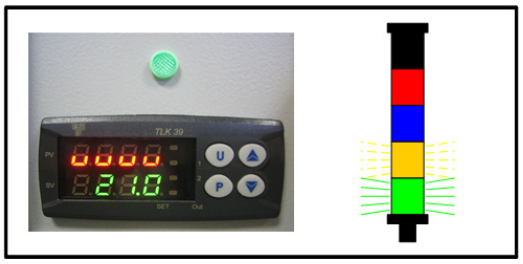


Figure 9

Note:

The printer does not output a temperature signal to the TCU until the initialization sequence has completed. If ,after 1 minute, a temperature signal is still not present, the orange beacon flashes at a slower rate. After a further 1 minute without signal, the amber beacon is continuously lit. These periods are determined by the 'Disconnect' and 'Shutdown' settings on the control PCB.

4.1.3. When an output temperature signal is available from the printer, the controller shows the actual printer temperature (PV) in red, with the target temperature (SV) displayed in green (Figure 10). The TCU will start and begin working to achieve the target temperature.

Figure 10

4.1.4. The target or desired operating temperature (SV) of the printer can be adjusted to a value between 66 °F (19°C) and 86 °F (30°C). To adjust the desired target temperature, press button 'P'. The display will change with 'PV' showing 'SP 1' (Figure 11):

Figure 11

The '▲ ' and '▼ ' keys can be used to select a target temperature value (SV) between 66 °F (19°C)and 86 °F (30°C).

Figure 12

On reaching the desired target temperature, press key 'P'. The display will return to normal showing current printer temperature (PV) and new target temperature (SV). (Figure 13):

Figure 13

A sticker on the unit, adjacent to the controller, can be used as a guide for the procedure described (Figure 14):

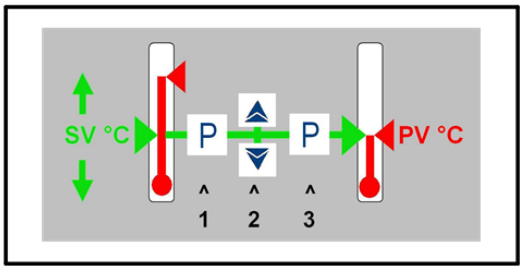


Figure 14

4.1.5. The process temperature (PV) within the printer should move towards and stabilize within +/- 34 °F (1°C) of the set value temperature (SV) in approximately 30 minutes (Figure 15):

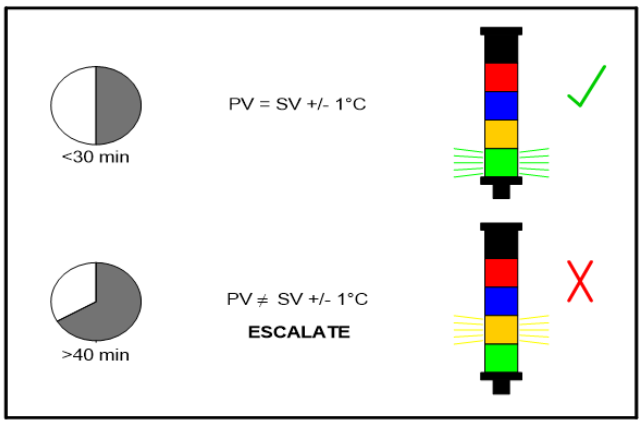


Figure 15

4.1.6. During TCU operation, condensate will be produced by the air conditioning unit (ACU). Condensate will be collected in the condensate container. The beacon will indicate the state of the condensate container. Failure to empty the condensate container will result in automatic TCU shutdown to prevent further condensate being produced (Figure 16):

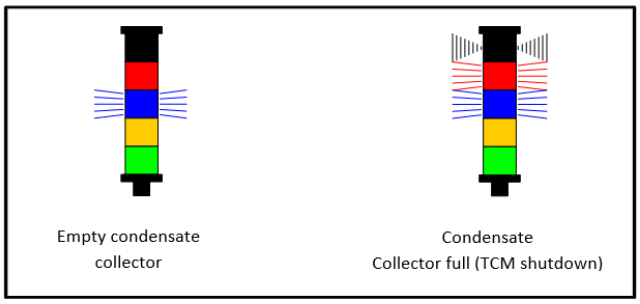


Figure 16

4.1.7. Fit the drip tray plug to the condensate container to prevent spillage and allow condensate container to be carried using the handle. Remove the drip tray plug when replacing container (Figure 17):

Figure 17

If the condensate container is not replaced after emptying or refitted with the plug still fitted, condensate will collect on the lower tray. Sensor probes at the front of the lower tray will detect the presence of condensate and cause the TCU to shut down (Figure 18).

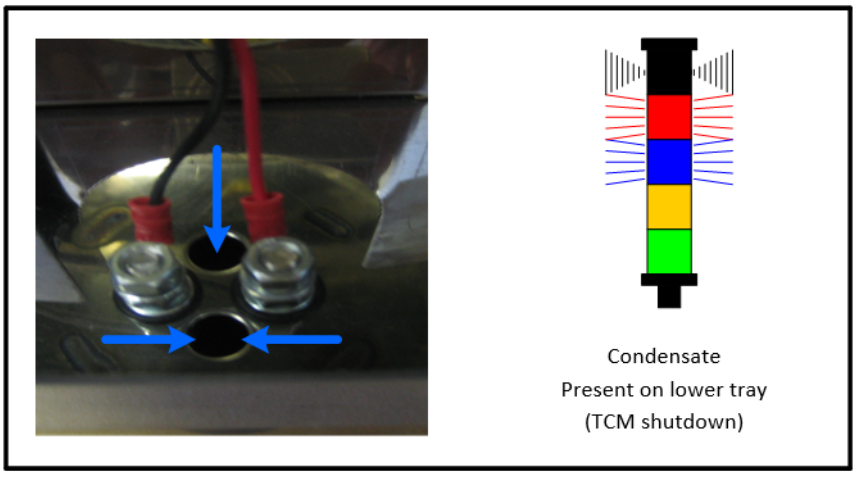


Figure 18

Remove the cap from the lower tray to allow condensate to drain from the tray and empty any condensate within the cap to clear the fault. The TCU will automatically commence operation (Figure 19):

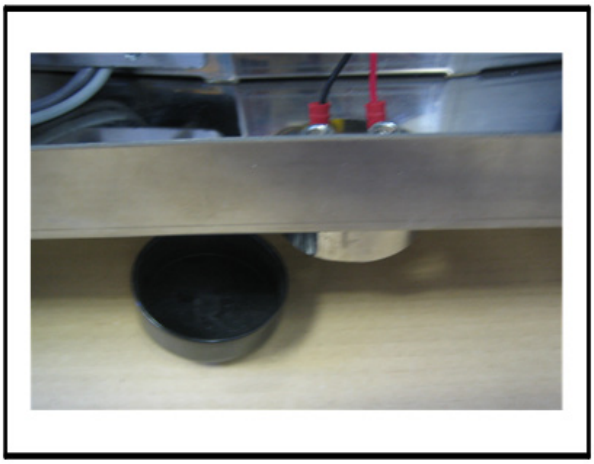


Figure 19

4.2. Disconnect and shutdown periods

	ELECTRICAL HAZARD	Ensure isolator is in the OFF position before opening access door.

The Control PCB is fitted with two rotary switches (Figure 20):

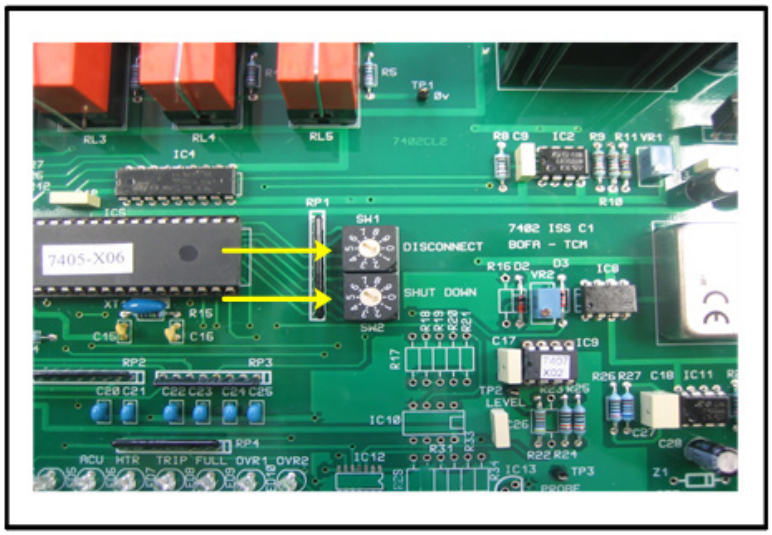


Figure 20

DISCONNECT – This defines the period between the temperature signal to the TCU being removed or disconnected and the TCU entering a SHUTDOWN period. The DISCONNECT period is adjustable between 0 – 9 minutes in 1-minute increments. The default setting is 1 minute. The amber beacon will flash rapidly during the DISCONNECT period. If the temperature signal to the TCU is reinstated during the disconnect period, the TCU will continue to run and not enter a SHUTDOWN period.

SHUTDOWN – If on completion of the DISCONNECT period no temperature signal is present, the TCU will cease operation and enter a SHUTDOWN period. The SHUTDOWN period is adjustable between 0 – 9 minutes in 1-minute increments. The default setting is 1 minute. The amber beacon will flash slowly during the SHUTDOWN period. If the temperature signal is reinstated during this period, the TCU will not commence operation until the SHUTDOWN period is complete. The amber beacon will illuminate continuously on completion of the SHUTDOWN period with no temperature signal present.

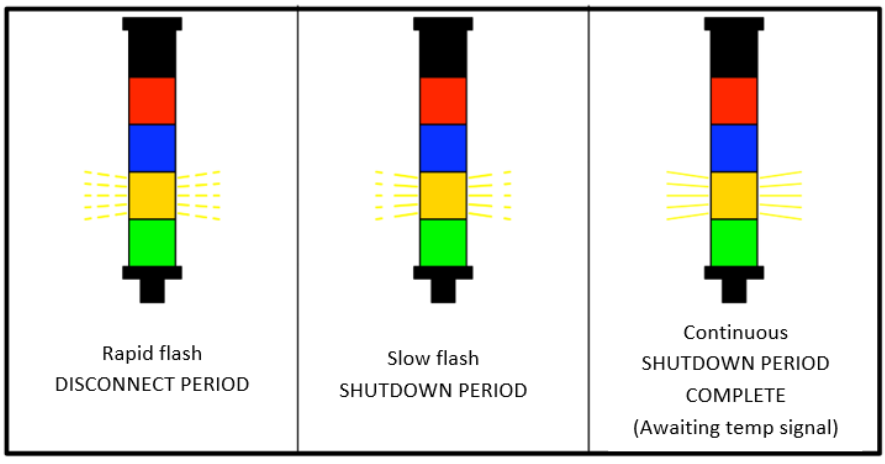


Figure 21

5 Maintenance

5.1. Preventative maintenance

5.1.1. Checking the discharge filter

	ELECTRICAL HAZARD	Ensure isolator is in the OFF position before opening access door.
	CAUTION MOVING PARTS	Allow time for blower rotation to cease before opening access door.

The life span of the TCU discharge filter will vary depending on the level of contamination of the ambient air. The filter can be deemed serviceable if the TCU can maintain the process temperature (PV) within +/- 34 °F (1°C) of target temperature (SV) (Figure 22):

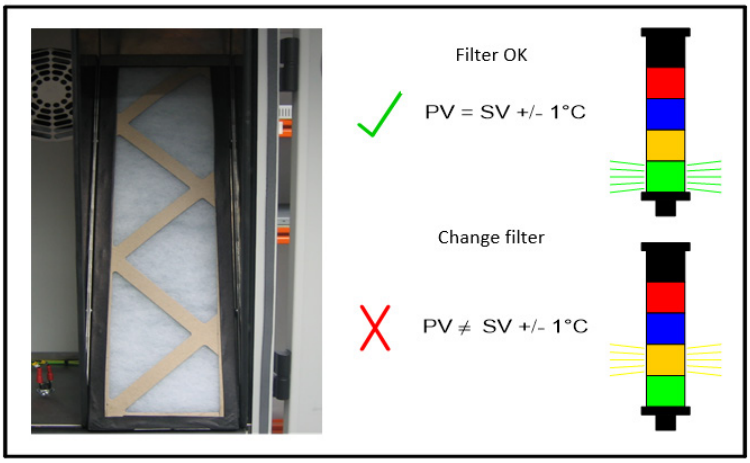


Figure 22

5.1.2. Condenser blower/coil

	ELECTRICAL HAZARD	Ensure isolator is in the OFF position before opening access door.
	CAUTION MOVING PARTS	Allow time for blower rotation to cease before opening access door.

The condenser blower intake grills should be visually checked on a regular basis to ensure they are free from obstruction with no impedance to air flow (Figure 23):

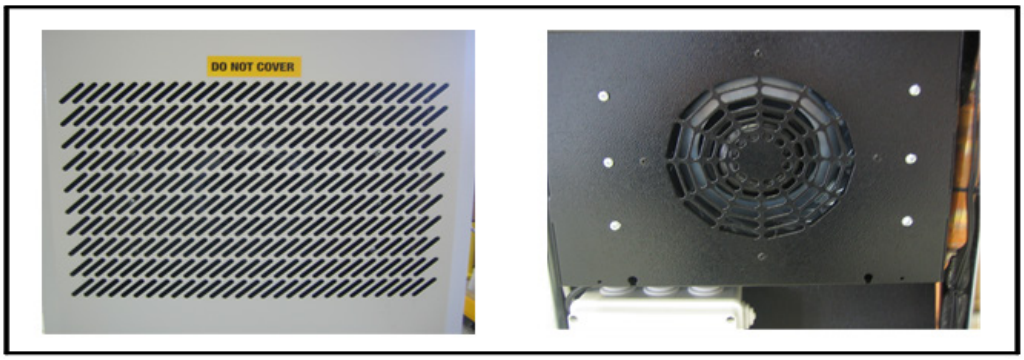


Figure 23

If it is thought likely that the underside of the condenser coil may be obstructed, air applied as shown below may help improve TCU operating performance (Figure 24):

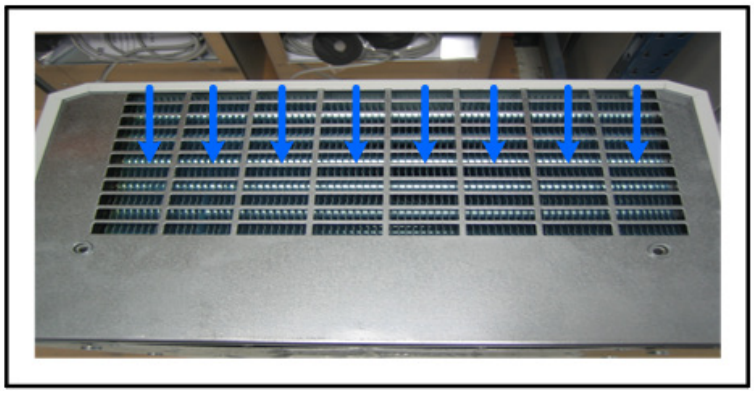


Figure 24

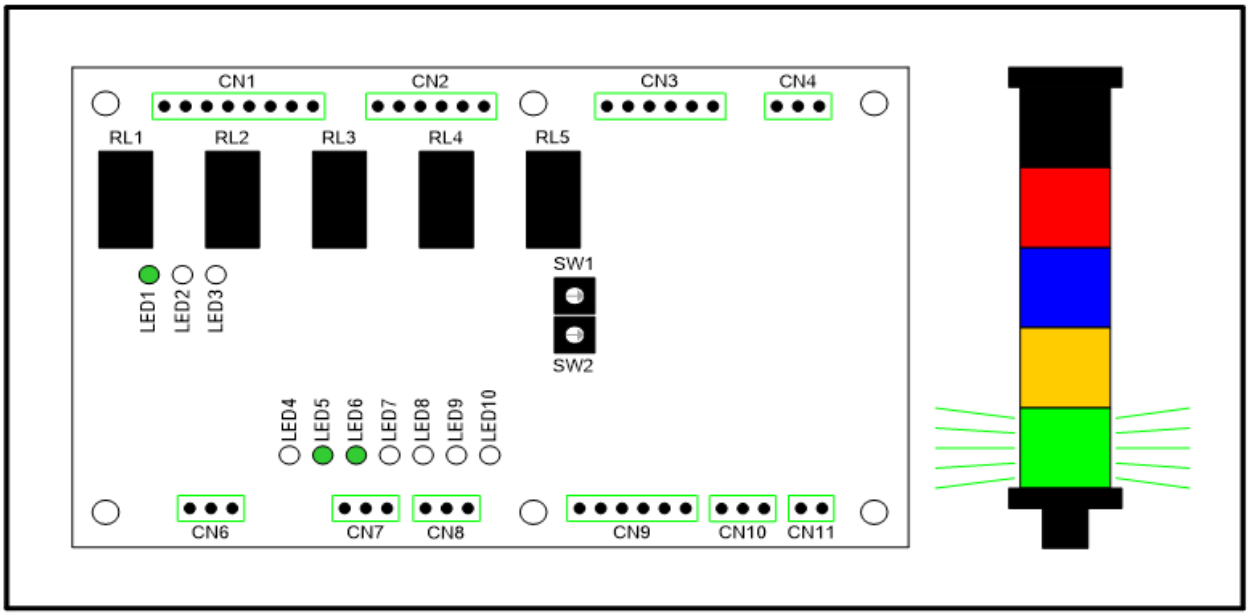
5.2. Scheduled maintenance

Scheduled maintenance task	Frequency	Date	Comments	Engineer
Check/replace TCU filter	Monthly			
Check/clean condenser blower intake is clear	Monthly			
Check condensate collector for leaks and level sensors are in place	Monthly			
Check condesate drainage path is clear	Monthly			
Inspect flexible ducting connections	Monthly			
Check condition of mains input lead	Monthly			
Check condition of temperature sensor loom	Monthly			
Check all earth leads and bonding points are connected	Monthly			
Check/clean condenser blower	Yearly			
Check/clean evaporator blower	Yearly			
Check/clean condenser coil	Yearly			
Check/clean evaporator coil	Yearly			

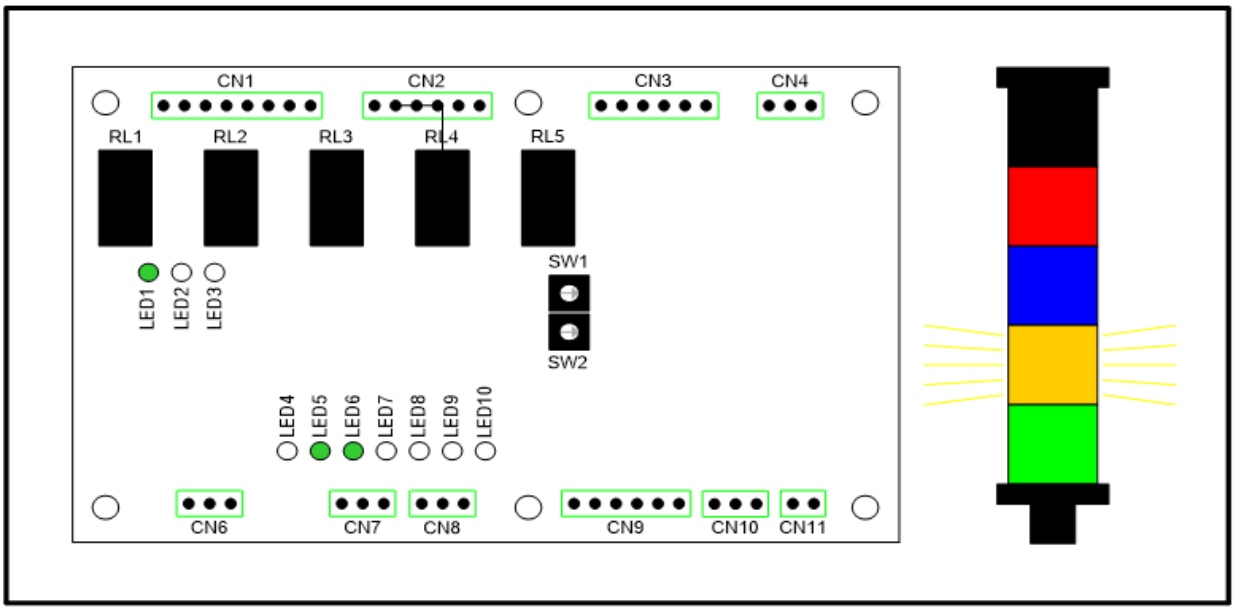
6 Troubleshooting

6.1. Beacon and PCB interpretation

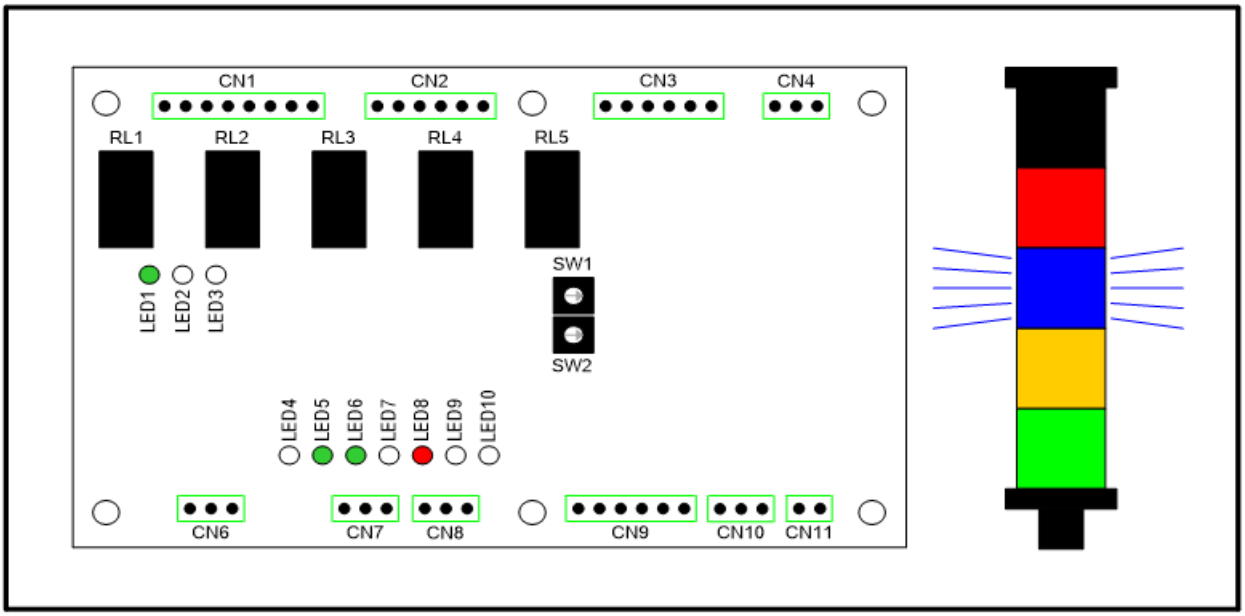
1. TCU OK and the printer (PV) within+/- 34 °F (1°C) of target temperature (SV):



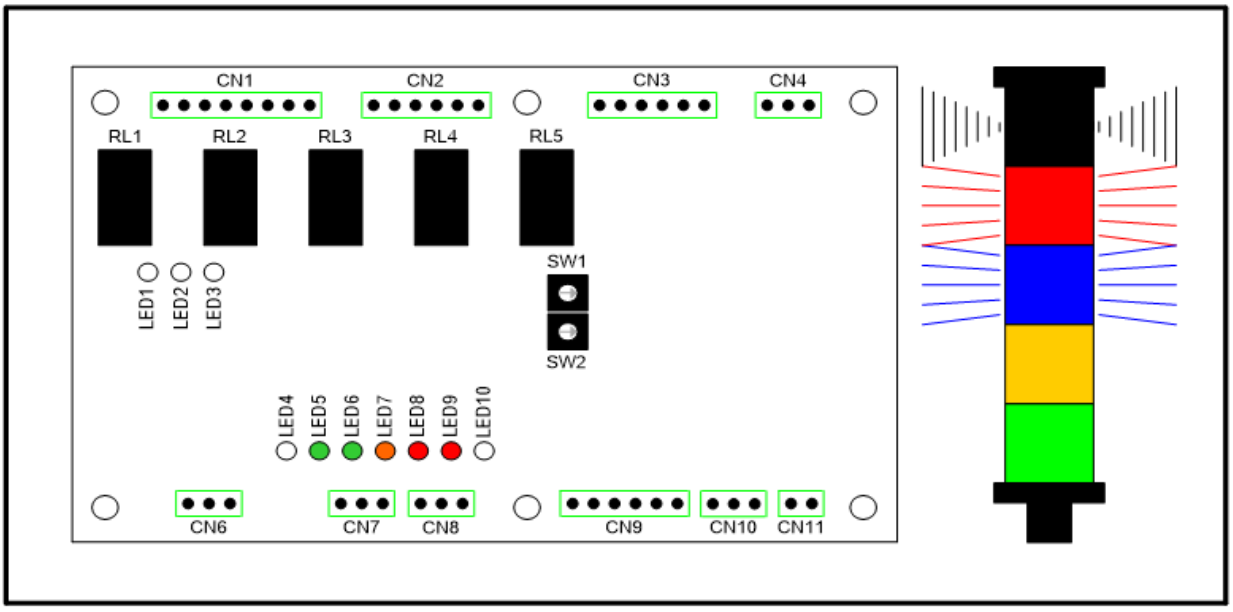
2. TCU OK but the printer (PV) > +/- 34 °F (1°C) from target temperature (SV):



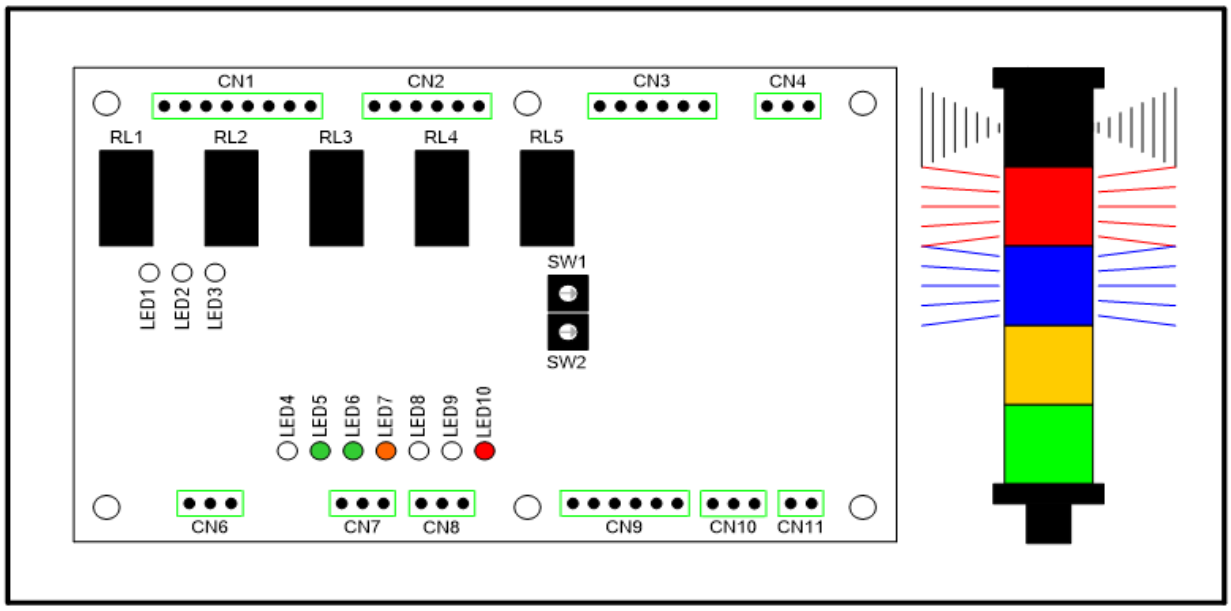
3. Condensate container is full and requires emptying:



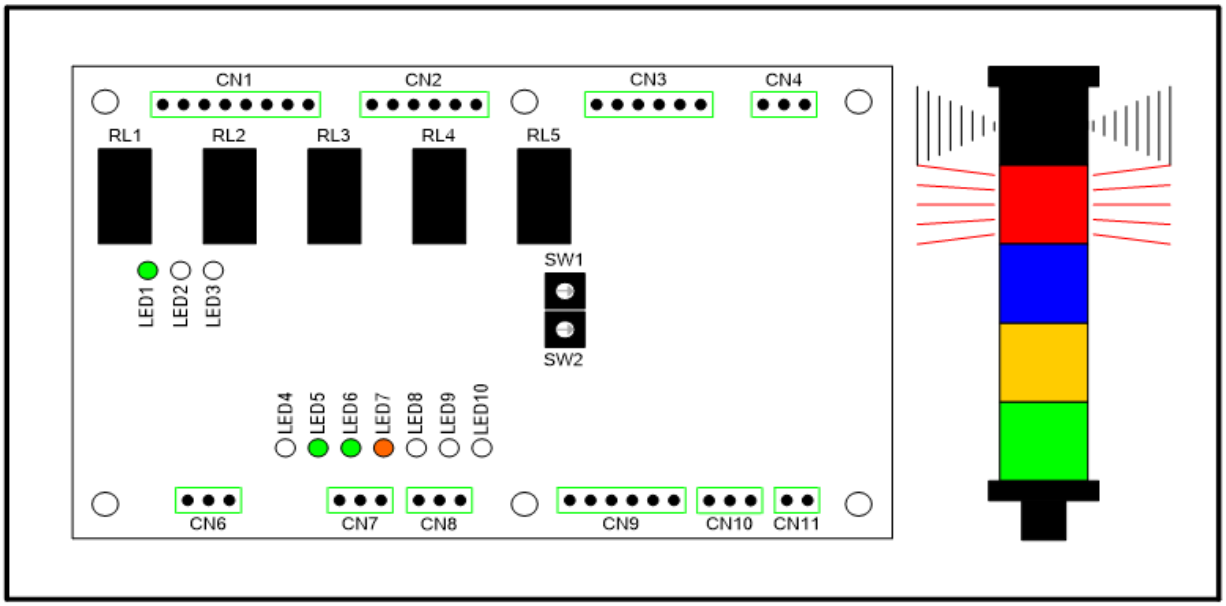
4. Condensate container overflow (automatic shutdown):



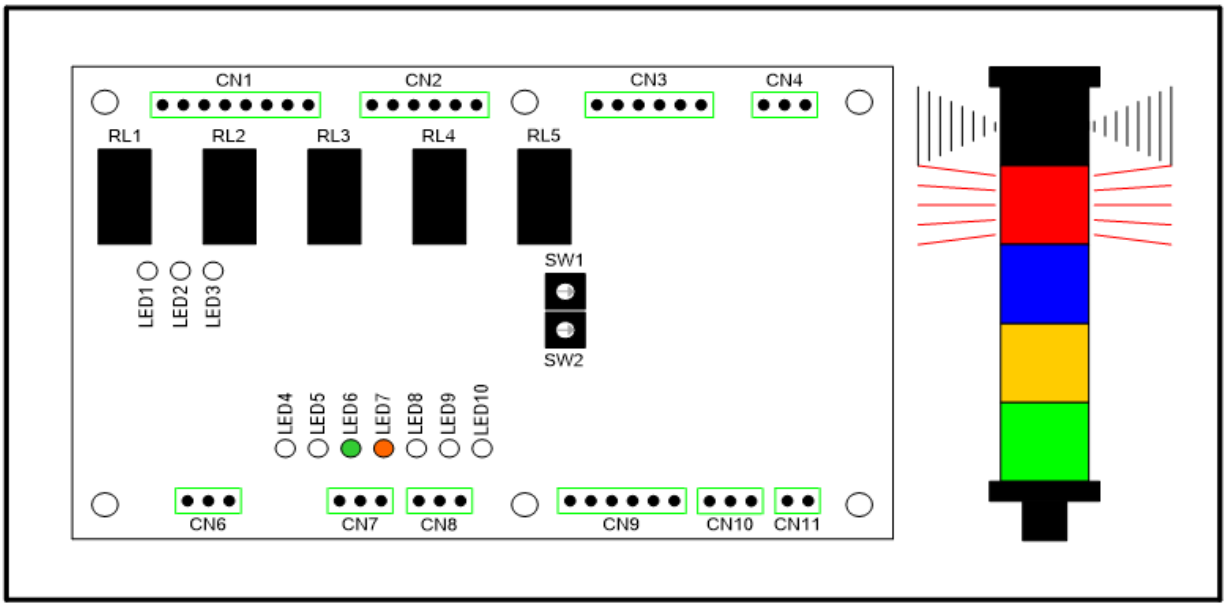
5. Condensate present on lower collection tray (automatic shutdown):



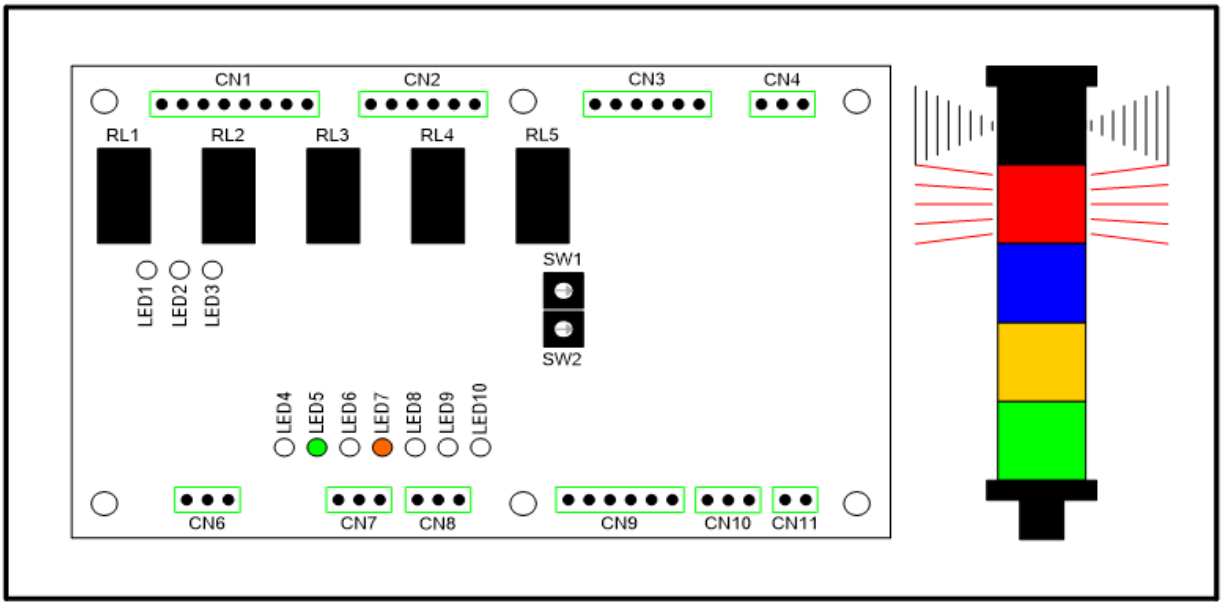
6. Heater enclosure over-temperature (automatic shutdown):



7. Air conditioning unit circuit breaker open (automatic shutdown):



8. Heater circuit breaker open (automatic shutdown):



6.2. Display and condensate error checklist

Error	Remedy
PV displayed as flashing UUUU	Printer turned off or not initialized.
	Temperature sensor loom between printer and TCU disconnected. Check connections.
SV not reached within 40 minutes PV not maintained within +/- 1°C of SV	Check/replace TCU discharge filter.
	Check air in and air return ducting is correctly fitted.
	Check all printer covers are fitted and closed.
	Check controller PV is not displayed as UUUU (see above).
	Check SV is set to a value within +/- 46 °F (8°C) of ambient temperature.
	Check ACU condenser grills are not blocked or obstructed.
	No beacon and/or controller display (see electrical faults section).
	TCU fails to move PV towards SV. Possible fault with ACU, heater, or control module. **ESCALATE.**
	Check supply voltage has not dropped below 207 V.
	Possible anomaly of the controllers EPROM memory. Press the P key.
ErEP displayed on controller	Condensate container full and approaching overflow condition. Empty condensate container.
Blue and red beacon (TCU Shutdown)	Condensate on lower tray. Drain condensate from tray and ensure condensate container is in place, drip tray plug is removed, and container is not leaking.

6.3. Electrical faults

Error	Remedy
Red beacon (No blue) (TCU shutdown)	Check ACU circuit breaker is closed. Check heater circuit breaker is closed Heater enclosure thermal trip may have operated due to an over-temperature condition. Investigate cause of failure. **ESCALATE.**
No display on beacon or controller	Check control module circuit breaker is closed.

	ELECTRICAL HAZARD	Ensure isolator is in the OFF position before opening access door. The following procedures should only be carried out by suitable personnel.

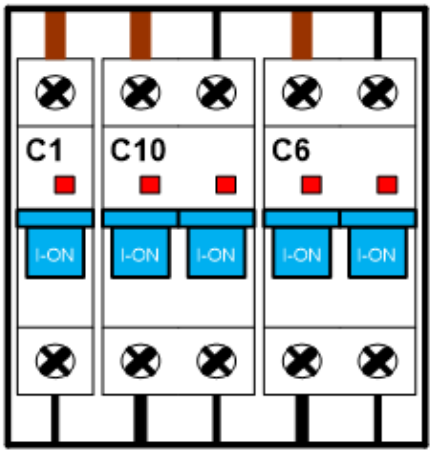


Figure 25

Circuit breakers (located on the control module) protect components and wiring in the 24 VDC control (C1), heater (C10), and air conditioner unit (C6) circuits from excessive currents. Should a circuit breaker open, the cause must be investigated before closing and re-energizing the circuit. **ESCALATE** if fault persists and circuit breaker will not remain closed.

7 System specifications

System: **TCU**

Process temperature range: +/- 46 °F (8°C) of ambient within a programmable range of 66 °F (19°C) to 86 °F (30°C)

Process temperature control: +/- 34 °F (1°C)

Air delivery system: Recirculating

Cooling capacity: 2000 W

Temperature sensor: 0-10 VDC 32-122 °F (0-50°C) shared output from printer sensor

Refrigerant gas: R134a/0.75 kg

Electrical supply: 230 V +/- 10%

Full load current: 12.6 A

Start-up current: 20 A

Frequency: 50/60 Hz

Power supply cables: L= Brown, N= Blue, E= Green/Yellow

Noise level: Below 75 dB(A) (at typical operating speed)

Weight: 220 lbs (100 kg)

Condensate: Collected in a 1.1 gallon (5 litre) container for disposal or diverted directly to a drainage system where available

Environmental operating range:

Temperature: +59 °F (15°C) to + 95 °F (35°C)

Humidity: 30-70% @ 68 °F (20°C)

Size:

	Imperial (inches)	Metric (mm)
Height	68.3	1735
Width	21.3	540
Depth	26.4	670

* Height including beacon

Internal power wiring:

0.02” (0.5 mm) (22AWG) 600 V, 221 °F (105°C)

0.06” (1.5 mm) (16 AWG), 600 V 221 °F (105°C)

Process fume/gas entering this system should be within the above temperature range.

Wiring schematic and spare parts list available upon request.

8 Contact information

Donaldson BOFA head office – UK & ROW:

19-20 Balena Close
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Poole
Dorset
BH17 7DU
United Kingdom

Tel. +44 (0) 1202 699 444
Email: bofasales@donaldson.com

Donaldson BOFA German office:

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Donaldson BOFA US office:

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62088 USA

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9 Inspection record

Donaldson BOFA™

Inspection Record

Local Exhaust Ventilation System

Health & Safety at Work Act 1974 - Control of Substances Hazardous to Health - Regulation 9 (2002) Thorough Examination and Testing of Local Exhaust Ventilation Systems

Company:	System Designation:	System Installation Date:
Designated Person:		

Inspection and Maintenance Schedules

1. Daily checks.
2. Weekly inspection of process enclosure, extract offtake, hose/ducting, and extraction system.
3. Monthly inspection of process enclosure, extract offtake, hose/ducting, and extraction system.
4. Yearly inspection/testing.

Process enclosure, extract offtake(s), hose/ducting, and extraction system.

Inspection and Maintenance Record

1. **Daily inspection**
   Inspection of the process to ensure extract devices/nozzles/enclosures/hoses are in place and correctly positioned. Examination of the extraction system to ensure it is running. This to be carried out by the operator. Daily inspection not recorded.

2. **Weekly inspection**

Weekly inspection by supervisor of physical condition of extract devices/nozzles/enclosures/hoses and extraction system for damage, change (parts added or removed) and correct operation, etc. Check also that daily inspections have been completed. Tick boxes to confirm system ok/change. Add details of any changes.

Report changes to Engineering Manager. Record any remedial actions taken.

Week number	Date	System ok	System change	Details of change/repairs, etc.	Initial
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Weekly inspection by supervisor of physical condition of extract devices/nozzles/enclosures/hoses and extraction system for damage, change (parts added or removed) and correct operation, etc. Check also that daily inspections have been completed. Tick boxes to confirm system ok/change. Add details of any changes.

Report changes to Engineering Manager. Record any remedial actions taken.

Week number	Date	System ok	System change	Details of change/repairs, etc.	Initial
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					

3. **Monthly inspection**

In addition to weekly checks, disconnect hoses and check for blockage and smooth operation of fan, signs of dust or vapor/gas/odor carry over. Tick boxes to confirm system ok/change. Add details of any changes. Report changes to Engineering Manager. Record any remedial actions taken.

Week number	Date	System ok	System change	Details of change/repairs, etc.	Initial
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

4. **Yearly inspection**

	Comments	Supervisor signature:	Date:
Annual service to include all regular checks, inspection of filter condition, blower, and electrical system, and a filter replacement (if not changed within the previous 12 months).			
Annual thorough inspection and testing of LEV system in accordance with C.O.S.H.H. regulation 9 (max interval 14 months) including reporting.			