USER OPERATION

MANUAL

FOR

M-TRAC1

DIRECT FIRED HEATING CONTROLLER

RECOGNIZED COMPONENT
C ETL LISTED US
Intertek

RECOGNIZED COMPONENT
ETL LISTED US
Intertek

UNIT MODEL NO. _____
UNIT SERIAL NO. _____
SERVICED BY: _____
TEL. NO: _____

CANADIAN HEAD OFFICE AND FACTORY

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CALGARY, ALBERTA
T2G 4C8
Ph: (403) 287-2590
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1175 TWINNEY DRIVE
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SALES OFFICES ACROSS CANADA AND USA

Retain instructions with unit and maintain in a legible condition.
Please give model number and serial number when contacting factory for information and/or parts.

www.engineeredair.com

M-TRAC1

The M-TRAC1 has been certified by Intertek (ETL) for use with Engineered Air appliances only. It has been evaluated to CSA C22.2 No. 24 Temperature-Indicating and Regulating Equipment and UL 873 UL Standard for Safety Temperature-Indicating and Regulating Equipment. This is a User Operation Manual and therefore not subject to evaluation.

If any errors or omissions are noted please contact the nearest Engineered Air Technical Service Department.

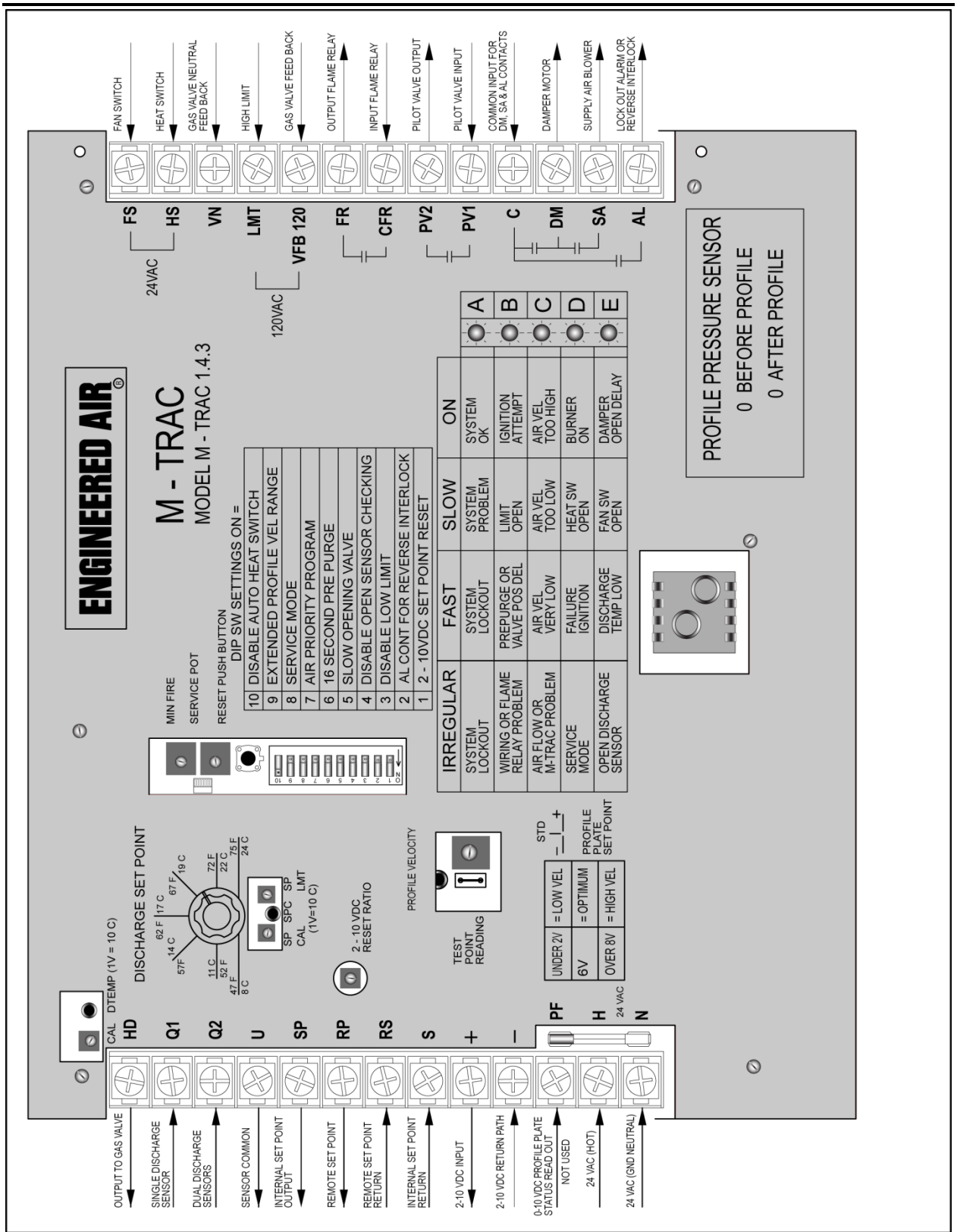
To ensure warranty is honored, only qualified personnel should be employed for service and troubleshooting. If further information is required please contact the nearest Engineered Air office.

There are two sets of electrical drawings and unit function sheets provided with the appliance. One set is in an envelope which also contains the Operation, Installation and Maintenance manual(s). This package is for copying, then should either be returned to the appliance or stored in a safe place. The other set is attached to the control panel door and should never be removed.

Please report any omissions to the national service manager.

Warning: ⚠	**Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.**

Warning: ⚠ ⚠	**This unit is connected to high voltages. Electrical shock or death could occur if instructions are not followed. This equipment contains moving parts that can start unexpectedly. Injury or death could occur if instructions are not followed. All work should be performed by a qualified technician. Always disconnect and lock out power before servicing. DO NOT bypass any interlock or safety switches under any circumstances.**



M-TRAC 1.4.3 CONTROLLER

EngA ENGINEERED AIR

REVISIONS: NOVEMBER 30 2011			
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INTRODUCTION

The M-TRAC1 is a discharge air temperature controller of large (BTUH) single volume direct-fired Engineered Air equipment, using 120 Vac safety shut off valves, and operating a modulating ball valve actuator.

The information used in this manual should be used in conjunction with the unit function sheet(s) and the HE series Installation, Operation, and Maintenance manual.

The M-TRAC1 is designed to control only Engineered Air equipment. Various upgrades and improvements have been made over time. Always include any suffix letters and numbers for troubleshooting and/or replacement. All M-TRAC1 models are backwards compatible, however some additional wiring may be required. M-TRAC1 controllers with a (- P) designation are designed for propane fuel.

Note: It is necessary that all of the remote wiring and controls be complete and operational before starting the appliance.

CONTROLLER RATINGS

Power requirements: 24 Vac, 40 VA.
Contact Rating: 120V 3A inductive
0-10 Vdc input impedance: 2 kΩ
Environment: -40 to 120°F (-40 to 50°C) non-condensing.
Fuse Rating: 1.25 GDC slow-blow

CONTROLLER DESCRIPTION

TERMINALS

TABLE 1

Terminal	Description
HD	0-10 Vdc output to ball valve actuator
Q1	Input terminal for single discharge sensor
Q2	Input terminal for two discharge sensors wired in series
U	Sensor common
SP	Output from the built in set point POT.
RP	Positive supply for a remote set point POT.
RS	Return from the remote set point POT.
S	Setpoint enable
+ / -	2 to 10 Vdc input
PF	Not used
H	24 Vac hot
N	24 Vac neutral
FS	Fan switch input
HS	Heat switch input
LMT	Input from safety limit (high limit)
VN	Neutral for the 120 Vac Main gas valve feedback
VFB 120	Hot for the 120 Vac Main gas valve feedback
FR	Flame relay control
CFR	Flame relay control common
PV1 / PV2	Pilot Valve control contacts
C	Input power supply to feed DM, SA and AL outputs
DM	Damper enable output
SA	Supply blower output
AL	Alarm output or Reverse interlock control output

DIP SWITCHES

The M-TRAC1 options are configured by DIP switch selection and/or wiring connections. DIP switch settings are noted on the internal wiring diagram, and should not be altered.

TABLE 2

DIP SW	Description
10	Disable Auto Heat Switch. If enabled the M-TRAC1 will monitor the discharge air temperature and disable the heat if the temperature is constantly greater than the Setpoint (> 3˚F).
9	Extended Profile Velocity Range. Allows the M-TRAC1 to be compatible with older equipment.
8	Service Mode. Enable to manually control the firing rate.
7	Air Priority Program. See Blower Control.
6	16 Second Pre-purge. Heating will delay on after fan starts.
5	Slow Opening Valve. See Modulating Valve Light Off Position.
4	Disable Open Sensor Checking. See Discharge Air Setpoint.
3	Disable Low Limit. See Low Limit.
2	Alarm contact to be used for reverse interlock. See Reverse Interlock.
1	2-10 Vdc Set Point Reset. See Temperature Reset.

Note: Table based on model M-TRAC 1.4.3

INDICATION AND DIAGNOSTIC LIGHTS

There are 5 status lights on the M-TRAC1 labeled A to E. They operate in 4 patterns: an irregular flash (.. __ .. __ ..), fast flash (…….), slow flash (. . .), or constantly on (_____).

TABLE 3

IRREGULAR	FAST	SLOW	ON	LIGHT
System Lockout	System Lockout	System Problem	System Ok	A – GREEN
Wiring Or Flame Relay Problem	Prepurge Or Valve Positioning Delay	Limit Open	Ignition Attempt	B – RED
Air Flow Or M-TRAC Problem	Air Velocity Very Low	Air Velocity Too Low	Air Velocity Too High	C – RED
Service Mode	Ignition Failure	Heat Switch Open	Burner On	D – RED
Open Discharge Sensor	Discharge Temp Low	Fan Switch Open	Damper Open Delay	E – RED

ADJUSTMENT POTS

There are a number of setting and calibration potentiometers (POT's) located on the face of the M-TRAC1. Modifications to these should only be performed by experienced and qualified personnel.

TABLE 4

POT	Description
SP LMT	Limits the maximum discharge temperature set point.
CAL DTEMP	Discharge air sensor temperature calibration.
SP CAL	Setpoint dial calibration.
MIN FIRE	Adjusts the minimum valve output for low fire.
SERVICE POT	Manually sets burner firing rate for service. Located just above the centre. When the service switch is on, this POT can be used to adjust the modulating gas valve from low to high fire. When the service DIP switch is on, light 'D' blinks irregularly.
2-10 Vdc RESET RATIO	Sets the reset temperature range. This adjusts the amount of reset range the 2-10 Vdc room thermostat will have. This allows an adjustment band between 5°F and 50°F (3°C and 28°C).
PROFILE VELOCITY	Allows a narrow adjustment for Profile pressure set point.

MULTIMETER TEST POINTS

The M-TRAC1 has readout test points for discharge air temperature, discharge set point and profile plate velocity status. **Temperature readings are indicated by Vdc referenced to ground.**

MAXIMUM DISCHARGE SET POINT LIMIT SETUP (SP LMT)

Regulations, design or authorities having jurisdiction may limit the maximum discharge air temperature the appliance is allowed to reach. This may be set by the potentiometer SP LMT, which is located below and to the right of the M-TRAC1 discharge set point knob. Vdc readout = °C / 10. See Table 5.

CALCULATED SETPOINT (SPC)

The SPC measurement point is located just below the M-TRAC1 set point knob. This temperature is the current operating set point after all applicable temperature resets have been applied to primary or base set point. Vdc readout = °C / 10. See Table 5.

DISCHARGE TEMPERATURE (DTEMP)

The DTEMP measurement point is located on the top left corner of the M-TRAC. The voltage reading relates to the actual temperature of the discharge sensor.

Table 5

Voltage (Vdc)	˚C	˚F
1	10	50
1.5	15	59
2	20	68
2.5	25	77
3	30	86
3.5	35	95
4	40	104

NOTE: Sensor accuracy is diminished at temperatures greater than those noted in this table.

PROFILE PLATE VELOCITY

The profile plate has been factory set for the airflow shown in the submittal record.

The profile plate air velocity status can be determined by reading the DC volts measured between the profile measurement point (located close to terminal S) and terminal N. When the profile velocity is optimum, the reading is 6 Vdc. For other voltage readings see Table 6.

Note that if the airflow is reduced below safe operating conditions there are delays built into the M-TRAC1 that will shut off the flame within 45 seconds.

TABLE 6

Test Point Reading	Status	Result
Below 0.8 volts	Very low or no airflow	Unit lockout
Between 0.8 and 4.0 volts	Low airflow	If the burner is already off it is disabled. If the burner is on, variable timed lockout.
Between 4.0 and 7.0 volts	Operating range	Normal
Over 7.0 volts	High airflow	If the burner is already off it is disabled. If the burner is on, variable timed lockout.

M-TRAC models with a (-P) designation (propane) will operate with a slightly higher airflow.

LOCKOUT RESET

To reset the M-TRAC1 from a lockout condition push the “Reset Push Button” located just above the DIP switch block. If the M-TRAC1 looses power while locked out, the status codes

(reason for the lockout) will be lost. When power is resumed the M-TRAC1 will remain locked out, but only green LED flashing irregularly.

CONTROL

SYSTEM TIMING

Damper opening delay: Depends on type of damper actuator used.
Blower startup: 54 seconds after terminal FS is energized.
Low Limit bypass: 4.5 minutes from initial startup, 50 seconds nuisance timer.
Trial for ignition: 30 sec.

DISCHARGE AIR SETPOINT

The M-TRAC1 is a discharge air temperature controller with a built in face mounted set point knob (that is activated by connecting terminal S to SP). Optionally, the M-TRAC1 is available with a remote set point, with varying set point ranges. When a remote setpoint is provided, the M-TRAC1 face mounted set point will have no effect.

Additional methods of resetting the discharge air temperature setpoint may be used. Refer to the unit function and electrical drawing.

DISCHARGE AIR SENSOR

The M-TRAC1 is designed to use either a single or dual discharge sensors, wired in series. Dual sensors are always used in equipment with temperature rise over 100˚F (55°C) or with dual fans. In most applications the discharge air sensor(s) is located in the supply blower outlet.

The discharge air sensor also serves as a low limit (or freeze protection) sensor. The part number of the sensor is noted on the electrical drawing.

The M-TRAC1 automatically checks the discharge air sensor(s). If the M-TRAC1 reads an open sensor it will disable temperature control and reduce the firing rate to low fire, then shutdown the appliance. Open sensor checking may be disabled by switching on DIP switch #4.

LOW LIMIT

The M-TRAC1 control is typically configured so that the discharge air temperature sensor also performs the function of a low limit or freeze stat. If DIP switch 3 is ‘off’ the low limit function is enabled. If the discharge temperature falls below 40˚F (4°C) the appliance will shut down and the LED for low discharge temperature will begin flashing. On initial startup the M-TRAC1 will internally bypass the low limit for 3 minutes. After this time, the low limit discharge temperature must be below the low limit setpoint (40°F / 4°C) for 50 seconds before the M-TRAC1 will shut the appliance off.
If DIP switch 3 is ‘on’, the low limit safety function is disabled.

DAMPER CONTROL

The inlet damper actuator(s) is enabled through output terminal DM. The M-TRAC1 allows time for the dampers to open prior to starting the supply blower.

BLOWER CONTROL

The M-TRAC1 uses output terminal SA to control the supply air fan. There are, however, a number of internal and/or external components that may be required to be functional prior to starting the blower. Proof of air flow is confirmed by the profile pressure sensor.

In some applications continuous airflow is more important than temperature control. The M-TRAC1 has two blower control program options. They are referred to as **airflow** priority, and **comfort** priority. See Table 7 for the differences between the two priorities. Priority type is selected by DIP switch 7.

For the comfort priority program, minimum airflow is defined as 60% of required airflow. Airflow priority is defined as 40% of required airflow.

TABLE 7

	Priority Level	
Status	**Comfort**	**Air Flow**
Heat switch off. Low airflow	Lock out in 50 seconds.	Blower will remain on until the discharge air temperature falls below 40˚F (4°C).
Flame failure, with discharge temperature greater than 40°F (4˚C).	Burner and blower off.	Burner off, blower continues to run.
Heat on, but sensing a high air velocity condition.	Unit will shutdown after 60 seconds.	Burner will lockout after 60 seconds. Blower will remain on until the discharge air temperature falls below 40˚F (4°C).
Heat on, with the high limit control open.	Unit will shutdown after 4 seconds.	Burner will lockout after 4 seconds. Blower will remain on until the discharge air temperature falls below 40˚F (4°C).

BURNER CONTROL

The M-TRAC1 outputs a 0 to 10 Vdc signal to a modulating actuator / ball valve assembly to control and maintain a defined discharge air temperature setpoint. 10Vdc is the maximum firing rate (high fire).

PROFILE PLATE VELOCITY SENSING SYSTEM

The M-TRAC1 has a built in profile pressure sensor to prove and monitor air flow across the burner. This allows the burner to operate safely and efficiently by proving the airflow is within proper air velocity limits.

The profile pressure sensor has three non-adjustable air settings: 40, 60 and 120% of normal airflow. These perform the equivalent function of the high (120%) and low (60%) velocity air switches while providing an additional very low (40%) velocity for use in process applications, when providing air is more crucial than temperature control.

The normal profile plate pressure drop is 0.48”w.c.

TEMPERATURE RESET

MAKE / BREAK THERMOSTAT

The set point can be configured for two-level discharge air temperature control, initiated by a override contact or space mounted, single stage thermostat, with the second (upper) level adjustable from 75˚(24°C) to 170˚F (77°C) by the SP LMT POT.

2 – 10 Vdc SIGNAL

The set point can be adjusted linearly upwards from 5°F to 50 °F (3°C to 28°C) from a 2-10 Vdc BMS input on terminals - and +. When equipped with a 2 to 10 Vdc room thermostat, this option becomes a linear room reset. The discharge set point dial, either face mounted or remote mounted, is the minimum set point. The maximum reset amount is adjusted by the 2-10VDC RESET RATIO POT located beside terminals RS and RP.

RESET EXAMPLE

SP LMT set at 95˚F, Dial set point set at 50˚F.
2-10 Vdc reset ratio POT adjusted to give 30˚F reset at 10 Vdc.
The resulting control will be:
At 0-2 Vdc = 50˚F discharge
At 6 Vdc = is ½ of the reset authority. Half of 30˚F equals 15˚F, therefore the discharge setpoint will be at 65˚F (50° + 15° = 65°). At 10 Vdc = full reset. Discharge will be at 50° + 30° = 80˚F. This will not be limited by the SP LMT (at 95°F), unless the setpoint dial is turned up more than 15°F.

OPERATION

EXHAUST FAN INTERLOCKING

There are a number of different exhaust interlocking options available. Always refer to the wiring diagram and unit function sheet to determine the exact type of interlocking used.

The AL output contact may be switched from an alarm output to a exhaust fan enable output contact for control of reverse interlock control systems (DIP sw #2). In this mode terminal AL will close on proof of supply air flow.

MODULATING VALVE LIGHT OFF POSITION

The appliance the M-TRAC1 is controlling may use either a fast opening (solenoid) safety shut off valve, or a slow opening (hydraulic) valve. To ensure the modulating valve is positioned correctly for initial ignition and avoid high fire ignition, DIP switch 5 is factory set depending on the type of safety shut off valve.

The M-TRAC1 is designed to ignite the burner at approximately 40% of full fire (non-adjustable). The positioning time delay allows the modulating valve actuator time to reach the correct light off position before an ignition attempt is made.

Set DIP switch 5 to “on” when ever the main gas valve is a slow opening. For fast opening valve, set DIP switch 5 to the “off” position.

LOW FIRE

The M-TRAC1 may control a broad range of burner sizes, all with unique minimum firing rates (low fire). The ball valve actuator minimum position voltage to set low fire is adjusted using the built in M-TRAC1 POT labeled “Min Fire”. The POT can be adjusted from 0 to 40% of full fire, and is located immediately to the right of the discharge air setpoint knob.

CALIBRATION

While the heater and M-TRAC1 is factory tested and calibrated, field conditions may affect airflow and sensor readings. After making any calibration adjustment, it may take a few minutes for the M-TRAC1 to reflect the changes. After this time, turn the appliance off for a few seconds, and then turn the appliance back on. Re-confirm the calibration.

SETPOINT (SPC)

Check the wiring diagram to determine if the M-TRAC1 is using the face mounted setpoint dial or an optional remote mounted setpoint dial. The most commonly used remote control panel includes fan and heat on/off switches and a setpoint dial. A jumper will be installed across terminals S and SP if the M-TRAC1 is using its built in setpoint dial.

1. Disable any external temperature resets (DIP switch 1 off) or lower the room thermostat settings so there is no call for additional heat.
2. Use a voltmeter to measure the Vdc output on the SPC measurement point.
3. Compare to the Setpoint dial and adjust the SP CAL POT (located near the face mounted setpoint dial) so they match (1 Vdc = 10°C).
4. Turn DIP switch 1 on, or return the room thermostat to its normal position.

Note: If the adjustments have no effect on the discharge temperature, the set point may be under the authority of the maximum set point limiting POT (SP LMT).

DISCHARGE AIR TEMPERATURE (DTEMP)

The discharge sensor must be located so that its temperature remains stable. Due to the nature of direct fired appliance, the air temperature leaving the supply blower is often very stratified. It is important to understand that the supply blower does not significantly mix the air. As well, the stratification pattern will change with different firing rates, wind conditions, ducting and blower configurations.

Field conditions may result in differences between the sensed temperature and the actual temperature. Adjusting the location of the discharge sensor a few inches will often correct temperature differences. If a section of duct is connected to the discharge opening, the sensor may be moved downstream up to 10 ft. (3 meters). Moving the sensor too far downstream may result in sensing lag, which could compound control error.

1. Accurately measure the temperature at the discharge air sensor.*
2. Compare the temperature to the DTEMP test point voltmeter reading.
3. Match the readings by adjusting the CAL DTEMP POT (located near terminal Q1, 1 Vdc = 10°C).

* The discharge sensor may be temporarily replaced with a resistor to confirm calibration. Refer to the Sensor Table, or use a 1kΩ resistor for 21.1°C (70°F) or a 2 kΩ resistor is using dual sensors (using terminal Q2). Do not leave the resistor in place for normal operation!

PROFILE VELOCITY

Profile velocity test point readings outside the 4.0 -7.0 Vdc range generally indicate improper airflow through the heater, not a problem with the M-TRAC1. Before attempting to adjust the profile velocity ensure the heater is operating at the required nameplate air volume.

The Profile Velocity POT is typically set to the '12' o'clock position. Outside air temperature will affect the pressure drop across the burner.

2-10 VDC RESET SET UP

1. The 2-10 VDC RESET RATIO POT is located beside terminal RP.
2. Turn off DIP switch 1 and turn the discharge set point knob (face mounted or remote) to the minimum required set point.
3. Set the voltage across terminals + and – to maximum (10 volts).
4. Calculate the maximum required discharge temperature (°C) and divide by 10.
5. Turn on DIP switch 1 and adjust 2-10 Vdc reset POT ratio until the SPC voltage is equal to the number calculated in the above step.
6. Adjust SP LMT until the voltage reading is the same as was recorded in step 5.

SERVICE

SERVICE MODE

Placing the M-TRAC1 into service mode allows for direct control of the burner firing rate. Once the heater has started, the M-TRAC1 can be placed into the service mode by turning on DIP switch 8. The service POT, located above the reset push button, will control the position of the modulating valve to any position from low to high fire.
Note: The service mode does not bypass any safeties, heat or fan switches.

SETPOINT REMOTE WIRING

Impedance from long wiring runs may cause the setpoint to be out of calibration. Refer to the setpoint calibration section if adjustment is required.

AIR PRESSURE SENSOR

The M-TRAC1 has an internally mounted air pressure sensor. Do not blow onto the pressure ports – too much air pressure will damage it. The ports are fragile and can easily break.

During initial startup, the space the appliance is feeding may be under negative or positive pressure. To accurately check the M-TRAC1 pressure sensor, remove the sensing tubes from the M-TRAC1, while the fan is on, and the reading should be 0 Vdc.

Before making any modifications to the profile opening contact Engineered Air.

INPUT CONTACTS BY OTHERS

Mechanical relay (dry) input contacts must be used. The use of solid state relay's (SSR's) may cause the M-TRAC1 to malfunction due to reverse leakage current when 'open'.

BMS SENSOR LOCATION

The Engineered Air sensor must be calibrated to match its operation with the Engineered Air control. Do not calibrate it to match BMS readout if one exists.

If there is a BMS sensor located in the discharge duct, that sensor must be mounted within ½ inch of the Engineered Air sensor.

Note: BMS (Building Management System) discharge air temperatures should never be used to reset the temperature of the heater. Only use space or room mounted sensors.

M-TRAC1 LOCK OUT DESCRIPTION

Table 8

LED Code	Reasons
B Irregular	Faulty flame relay or wiring error. Ignition control and safety shut off valve should be off (FR and CFR contact 'open', but receiving power to VFB120 indicating valve is still on.
	Faulty flame relay or wiring error. FR and CFR contacts closes, but feedback from safety shut off valve to VFB120 happening too fast.
B Slow	High limit open.
C Irregular	Air sensor self test. When the blower is off, the sensor reading should be below 0.7 Vdc.
	Then the fan turns on, the air sensor reading should increase,
C Fast	Very low air flow. Sensed air flow is below 40%.
C Slow	Low air flow. Sensed air flow is below 60%.
C On	High air flow. Sensed air flow is over 120%.
D Fast	Ignition failure.
E Irregular	Open discharge air sensor. Sensor resistance should not exceed 1940, or 3450 Ω for dual sensors.
E Fast	Low limit. Discharge temperature has fallen below 40°F (4°C).

SENSOR TABLE

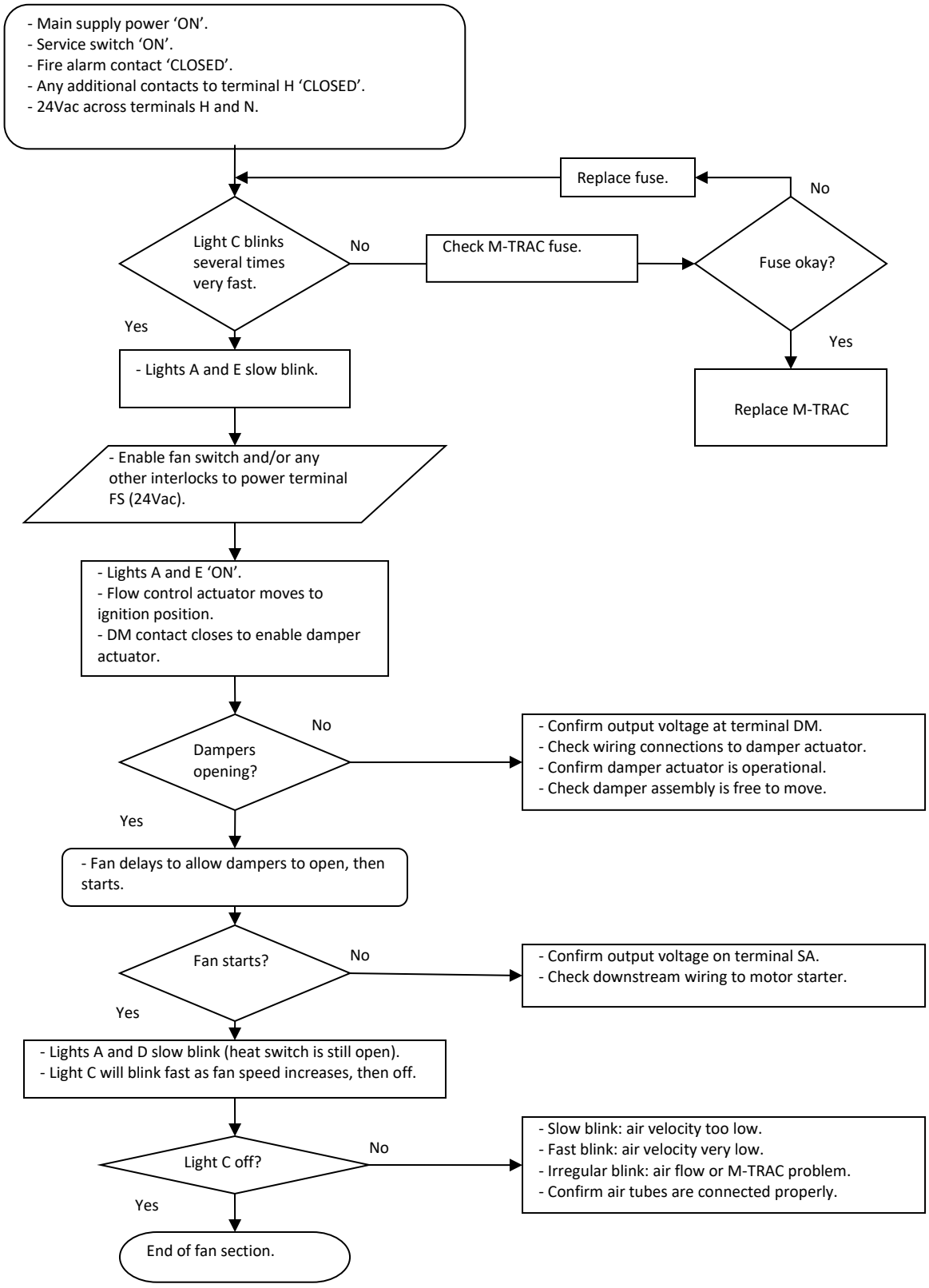
Sensor Resistance Chart for TE 6100-960 and TE600EA3.

Table 9

˚C	˚F	Resistance Ω	˚C	˚F	Resistance Ω	˚C	˚F	Resistance Ω
-40	-40	597	4.4	40	877	48.9	120	1229
-34.4	-30	629	10	50	916	54.4	130	1279
-28.9	-20	661	15.6	60	958	60	140	1329
-23.3	-10	694	21.1	70	1000	65.6	150	1381
-17.8	0	728	26.7	80	1043	71.1	160	1433
-12.2	10	763	32.2	90	1088	76.7	170	1487
-6.6	20	800	37.8	100	1134	82.2	180	1542
-1.1	30	838	43.3	110	1181	87.8	190	1599

Note: Reference resistance is 1035 ohms at 77˚F. Resistance tolerances are ±0.05 to 0.15% at 77˚F.

FAN OPERATION FLOWCHART



HEAT OPERATION FLOWCHART