Energy Tech 301

Installation, Commissioning, Operating & Maintenance Manual
CODEL International Ltd is a UK company based in the heart of the Peak District National Park at Bakewell, Derbyshire. The company specialises in the design and manufacture of high-technology instrumentation for the monitoring of combustion processes and atmospheric pollutant emissions.

The constant search for new products and existing product improvement keeps CODEL one step ahead. With a simple strategy, to design well-engineered, rugged, reliable equipment, capable of continuous operation over long periods with minimal maintenance, CODEL has set standards both for itself and for the rest of the industry.

All development and design work is carried out 'in-house' by experienced engineers using proven state-of-the-art CAD and software development techniques, while stringent assembly and test procedures ensure that the highest standards of product quality, synonymous with the CODEL name, are maintained.

High priority is placed upon customer support. CODEL’s dedicated team of field and service engineers will assist with any application problem to ensure that the best possible use is derived from investment in CODEL quality products.

If you require any further information about CODEL or its products, please contact us using one of the numbers below or alternatively visit our web site.

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Important

The warning signs (and meanings) shown below, are used throughout these instructions and are intended to ensure your safety while carrying out installation, operation and maintenance procedures. Please read these instructions fully before proceeding.

⚠️ Caution, risk of electric shock.

⚠️ Caution, risk of danger.

⚠️ Caution, hot surface.

接地（地）端子

任何时候将端子用于保护导体终端

Any important information in this manual is preceded by this sign.

Warning ! We wish to point out that the maximum rating of the Alarm Output Relay is now 60W @ 250V max. Please bear this in mind when ordering the output cable, if not supplied with EnergyTech 301 by CODEL.
# Table of Contents

1. General Description  
2. Specification  
3. Principles of Operation  
4. Description  
5. Installation  
6. Commissioning  
7. Maintenance
1. General Description

Continuous Indicative Particulate Monitoring

With the recent increase in world-wide environmental legislation, there has evolved a general requirement for operators to monitor the performance of their dust collectors and ensure that emissions to atmosphere are kept below the maximum legal enforcement level.

In the case of small collectors or non-critical processes, it has been accepted by legislators in the UK, that low cost continuous indicative particulate monitors may be used. These devices give an output that shows the operator a relative increase or decrease in dust loading and have the facility to initiate alarms if an unacceptable level is exceeded. Such instruments are described as ‘indicative’ and are not intended to give quantitative results. They are normally set up using subjective criteria and without reference to a standard gravimetric stack test.

The better indicative monitors, such as Energy Tech 301, have an analogue and RS485 output that can be used to constantly record the output from the instrument and enable the operator to review the results and identify impending filter failure at an early stage. The results may also be used to show evidence of good practice to environmental authorities.

Whilst it is not recommended to calibrate this class of instrument in mg/m$^3$, the operator may wish to set an alarm point with reference to a specific mass concentration of particulate required by law. This manual will show a method that satisfies this requirement using a single iso-kinetic stack test.

If emissions are required to be quantified in mg/m$^3$ on a continuous basis, then please contact Codel for advice.
2. Specification

Electronics enclosure

- Aluminium casting
- Access via lid
- 2 LED's:
  - alarm LED
  - relative dust level LED
- Epoxy paint finish:
  - colour RAL 5010 Traffic Blue
- Damping:
  - menu driven
- Sensitivity:
  - menu driven
- Alarm level:
  - menu driven
- Power Requirement:
  - 85 - 265V A.C.
  - 25 VA, 0.25 A max
- Outputs:
  - 1 x 4-20mA output
  - 1 x Contact output
  - RS485 Modbus
- Display:
  - 16 x 2 LED Display
  - flashing green LED where the pulse duration increases with dust level
  - red alarm LED
- Enclosure weatherproofing:
  - to IP67 standard
- Mains Connection:
  - IP67 4-way plug and socket
- Output Connections:
  - IP67 7-way plug and socket

Intrusive Probe

- Stainless steel bar Ø12mm²
- Available lengths 250, 500, 750, 1000mm (customer requirement)
- Probe protection:
  - insulating sleeve on first 200mm of probe
Temperature Constraints

- Stack gas
  - -20°C to +200°C

Operating Range (typical)

- 0 - 2500 mg/m³ mass concentration
- Particle size range 0.1 to 100 µm

Cabling (if supplied by Codel)

- Mains cable: 3-core, PVC insulated, 24/0.2mm
- Output cable: 8-core, PVC insulated, screened, 16/0.2mm, Ø9.5mm maximum. Core colours - green, brown, yellow, violet, white, black, red and blue (not used).

Note; if the cable length is greater than 1km it is recommended to use cable spec 0.75 mm²-24/0.2. If unsure please contact Codel.
3. Principles of Operation

When a particle moving in a duct collides with (or passes near) a probe that is grounded to earth, a transfer of charge takes place from the particle to the conductor. This is known as tribo-electricity or frictional electrification and results in a charge being imparted to the probe.

It can be shown that the following empirical relationship exists:

$$ I = \frac{K_a M V^b}{d} $$

Where
- $I$ = frictional current in Amps
- $K_a$ = a material constant
- $M$ = mass flow rate of particles
- $V$ = particle velocity
- $b$ = a constant derived from whether the particle collision was elastic or plastic (a value typically between 1.4 and 1.9)
- $d$ = particle diameter.

It can be seen that the resultant current is dependent on a number of factors such as the nature of the material ($K_a$), mass flow ($M$) and velocity ($V$) and any significant changes in these would result in a change in current output.

In practice, the material will often be of a 'monotype' with a particle size distribution that will vary little given the characteristics of the dust collection method. Bag filters, cyclones and electrostatic precipitators constantly produce a small leakage of particles that are all approximately the same size, and if the velocity of the particles remains fairly constant (say $\pm 15\%$), this has a very small effect on the frictional charge.

So it can be seen that although tribo-electric probes are affected by changes in velocity and particle size distribution, in practice, the amount of drift this induces may be very small and inconsequential for indicative systems. If your application is subject to massive swings in velocity, consult Codel for advice.

The main advantages of tribo-electric instruments are as follows:

- They are extremely sensitive to fine dusts and are sensitive over a range of $<1\text{mg/m}^3$ up to $2500\text{mg/m}^3$.
- They are able to detect particulates in a size range of 0.1 to 100 m.
- They are easy to install and do not require critical alignment.
- They have no optical surfaces to keep clean.
- Energy Tech 301 is easy to remove and clean and has very low maintenance requirements.
- There are no moving parts and consequently servicing requirements are very low.
4. Description

The Energy Tech 301 continuous indicative particulate monitor consists of a **stainless steel intrusive probe** attached to a **robust aluminium enclosure** that contains the electronics to amplify and process the incoming signal. The key feature of the unit is its compactness, as all the electronics and display are contained within the head. Furthermore, the Energy Tech 301 is designed to be **easy to install and commission**.

The static charge caused by the particulate is conducted down the probe to the electronics module where it is amplified and then conditioned. The Energy Tech 301 incorporates damping circuitry, manually adjustable by the operator, to ‘smooth’ the output of the instrument to suit application conditions, for example, to prevent spurious alarms caused by cleaning events within the collector. The analogue output signal is also provided with adjustable smoothing to accommodate different application conditions.

The instrument has two visual displays. A **flashing green** LED pulses proportional to the dust level (i.e. it pulses more as the dust level increases and less as the dust level decreases). A **constant red** LED is activated when the high level dust alarm threshold is exceeded.

A 4-20mA output is available for analogue data-logging and a user selectable volt-free or 24V SPCO relay for activating an external visible or audible alarm at high dust levels.

One of the main concerns about tribo-electric systems has been an effect called ‘**bridging**’, where conductive material builds up on the probe eventually making contact with the duct wall, effectively ‘shorting-out’ the probe and producing an alarm. This has been overcome by other manufacturers by incorporating a high pressure air purge, that continually blasts air down the length of the probe. Whilst this may prevent bridging, it also prevents particulate from impinging on the probe with a consequential loss of signal. The Energy Tech 301 incorporates an insulated sheath attached to the probe, allowing the bridge to form without shorting-out the probe.

![Diagram of Energy Tech 301 - Full system](image)

**Figure 1: Energy Tech 301 – Full system**
5. Installation

Selecting a Suitable Sensor Location

There are a number of factors to consider when selecting the position to mount the Energy Tech 301 unit. These are, in order of importance:

- Are there any legal constraints that might restrict its location?

  For indicative monitors this is unlikely, but it’s worthwhile checking. **There are no such constraints in the UK and USA.**

- The probe must protrude more than halfway into the duct to ensure good sensitivity.

- Choose a location where there is unrestricted flow path and where the probe is within the main flow of particulate. Ideally, the unit should be placed 5 duct diameters upstream (or downstream) from any obstruction such as a bend, fan, damper, duct exit or pipe junction, as illustrated in Figure 2.

  In practice of course, it is not always easy to select a location 5 duct diameters from an obstruction, so some compromise may be necessary. If this is the case, Figure 3 shows alternative mounting strategies.

- Energy Tech 301 should be located where maintenance staff can occasionally gain easy access.

- The unit should not be located where it is vulnerable to knocks. Nor should it be mounted close to steam traps or other sources of extreme heat.

- Energy Tech 301 should not be placed on the bottom of a horizontal duct as dust and debris will soon accumulate around the base of the probe, leading to bridging.

- Energy Tech 301 should be placed well away from any iso-kinetic sampling ports if possible.

- If the dust level display is required to be viewed regularly to confirm acceptable levels, if possible, install the **Energy Tech 301** where the display can be easily seen by plant operators.

Avoid mounting Energy Tech 301 on a vertical duct that vents to atmosphere as it may be affected by rain ingress.

Figure 2: Energy Tech 301 - Preferred Locations
Installing the Mounting Stub

WARNING !!!!!!

We strongly advise that the dust collector be turned off, especially when drilling holes or welding the stub. The duct may be under pressure and debris and air under pressure will be ejected through any hole and could damage eyes or may be swallowed. If you must work on the collector when it is on line, suitable eye protection and a breathing mask must be worn.

Steel Stacks

Manufacture the mounting stub shown in Figure 4. Normally this would be in mild steel, but check the construction material of the stack or duct. If this is stainless steel for example, consider using the same material, but in any case use an appropriate welding rod, as failure to do so could present welding problems and cause eventual weld weakness or failure.
Cut a hole Ø28mm (1 1/8 ins) at the selected location and offer up the stub. **DO NOT attempt to weld the stub to the stack with the probe attached to the stub, as the heat generated (and the electric arc) will severely damage the probe and electronics.** Ensure the stub remains at 90° to the stack, but **DO NOT weld when the collector is on line, as the weld pool may super-cool and cracking may result.** Paint the stub with a suitable corrosion resistant paint, prior to mounting the Energy Tech 301.

If the stack wall is thin gauge and will not weld easily or will not bear the weight of the probe, follow the method below.

**Thin-Walled Stacks**

Manufacture a stub as described above. Prepare the mounting plate shown in Figure 5. Cut a hole Ø28mm (1 1/8 ins) at the centre and drill for large pop rivets or self tapping screws. Bend the plate to the curvature of the stack and weld the stub to the plate as outlined above. **DO NOT attempt to weld the stub to the plate with the probe attached to the stub as the heat generated (and the electric arc) will severely damage the probe and electronics.**

Drill a hole Ø28mm (1 1/8 ins) in the stack. Offer up the plate and drill the securing holes. **It is important to make the plate as large as possible to improve its load bearing capabilities.**

Before securing the plate to the stack, coat its underside with a silicon sealer to ensure that the plate does not allow any leakage. Paint the stub and mounting plate with a suitable corrosion resistant paint.

If the probe is to be installed on a non-metallic duct, it will be necessary to install an electrostatic (Faraday) shield around the area of the duct where the probe resides. The shield should be of copper and connected to the enclosure by means of the earth plug at the front of the enclosure and then on to ground. The shield will ensure that the probe does not detect any stray electrical fields.
Mounting the Sensor

The Energy Tech 301 itself is supplied in two parts, the head and the probe. Cable and cable plugs are supplied as loose items. First attach the probe to the head by placing the threaded end (it's an ordinary RH thread) through the brass fitting and screw in place. Insert a rod or screwdriver through the hole in the sensor probe and 'nip it up'.

Remove the front part of the brass fitting from the probe (leaving the lock nut and compression gland on the probe), and screw onto the mounting stub. Coat the thread in copper grease to ensure easy removal. **DO NOT use insulating tape as this will prevent the instrument grounding to earth via the boss.**

Offer up the probe to the mounting stub and tighten the locknut. **DO NOT over-tighten as the unit will need to be removed occasionally for maintenance purposes.** Ensure that the unit is positioned with the two LED's horizontal, and with the electrical connection sockets at the bottom.

![System Schematic](image)

Figure 6: System Schematic

Wiring the Mains Connector

**WARNING !!!!!!!**

This task should be only be undertaken by qualified personnel, familiar with site safety regulations. While connecting the cores of the mains cable to the connector, ensure that the cable is disconnected from the power source.

Separate the two halves of the mains connector (it has 4 sockets), by holding the body and unscrewing the end containing the pins. Feed the cable through the body via the compression nut. Carefully remove the cable clamp (it is a tension fit). Strip 6mm (¼ ins) of insulation from the end of each core and insert in the appropriate socket. The sockets are all numbered (you may need a magnifying glass) and the earth socket is raised slightly above the rest. Screw the body on to the front section and then tighten the compression gland at the back of the assembly to ensure it is weatherproof. See Figure 7.
Output connector

Separate the two halves of the output connector (it has 7 plugs), by holding the body and unscrewing the end containing the pins. Feed the cable through the body via the compression nut. Carefully remove the cable clamp (it is a tension fit). Strip 6mm (¼") of insulation from the end of each core and insert in the female end of the pin. The pins are all numbered at their base, you may need the magnifying glass again. Solder each wire into its pin in turn. Screw the body on to the front section and then tighten the compression gland at the back of the assembly to ensure it is weatherproof. See Figure 8.
Figure 9: 24V Output

Optional – RS485 looped with output connection, for maintenance only.

Figure 10: RS485 Connector
Wiring to Power PCB connectors

A wiring diagram is shown at Figure 11 for reference purposes only. These connections are normally made at the factory.

![Mains Connector Diagram](image)

<table>
<thead>
<tr>
<th>Mains Connector</th>
<th>Volt free Output</th>
<th>24V Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+MA 1</td>
<td>+ 1</td>
</tr>
<tr>
<td></td>
<td>-MA 2</td>
<td>- 2</td>
</tr>
<tr>
<td></td>
<td>NO1 3</td>
<td>N/C 3</td>
</tr>
<tr>
<td></td>
<td>W1 4</td>
<td>+24V 4</td>
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<tr>
<td></td>
<td>NC1 5</td>
<td>0V 5</td>
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<td></td>
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<td></td>
<td>ISO 8</td>
<td>ISO 8</td>
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</tbody>
</table>

Figure 11: Wiring Diagram
6. Commissioning

**WARNING !!!!!!!**

In order to commission the Energy Tech 301, it is necessary to work closely with mains voltages. Only trained and competent persons should commission this unit using insulated tools and wearing the appropriate safety equipment. The technician should acquaint himself with site safety instructions and proceed with due caution.

Ensure that the dust collector is in good working order with no leaking filter bags and the process is not subject to upset conditions. It is essential to the future accurate operation of the EnergyTech 301 that the dust collection system is operating at its normal efficiency. Failure to do so may result in poor results when the system is returned to normal.

Energy Tech 301 Commissioning

1. **Power-Up:**
   a. Turn on the power
   b. Wait for power-up sequence to complete and Data validity:
      - Wait for data valid LED (green) to come on.
      - In normal working conditions, the data valid LED will come on when the power-up time has elapsed (by default, set to 0x01 minute – byte at 0x7E48) and the system has performed the configured calibration (by default, set to Zero Calibration (0x10) – byte at 0x7E49).

2. **Zero Check**
   a. In Setup Mode scroll to 4.9 passcode, input password 1234 and press enter.
   b. Still in setup mode select 4.3 parameters, scroll to find running mode and set the running mode to maintenance. Press enter to exit.
   c. In setup mode, select 4.2 span cal and set the span target to 00.00%.
   d. Still in 4.2 span cal, select the span path ‘Elec span sim’ then press enter to exit.
   e. In setup mode, select 4.3 span cal and set the span to 00.00%.
   f. Still in 4.3 parameters, scroll to running mode and select ‘Normal’ press enter to exit.

3. **Insitu Span calibration** (Hardware Gain setting):
   a. In setup mode 4.2 Span cal set the span cal target to current emission level if known (10% by default)
   b. Still in 4.2 Span Cal select ‘Insitu span cal’ and then press enter to initiate an insitu span cal.
      i. Waiting for ISC will be displayed and Data valid LED should go off for around 5 minutes and come back on upon successful completion of the span cal. A span cal failure is usually due to wrong span target, if this situation occurs, the analyser will keep pre-span cal data.
      ii. In the event of a span cal failure, the Span error cal should be cleared then make adjustment manually enter setup mode 4.4 signal:
          - Clear span cal error by sending clear performance error command 0x00002 to 0x0000E/0F
          - Set stage 1 gain to minimum by sending 0x0000 to 0x00FF
          - Set stage 2 gain to minimum by sending 0x0001 to 0x0004
          - Adjust stage 1 gain to mid-range by sending 0x007F to 0x7E76/77
          - If emission levels are below 5%, apply x10 gain to stage 3 gain by sending 0x0002 to 0x7E7A/7B then reduce stage 1 gain until the emission levels are around 10%.
4. **Analogue output configuration:**
   a. **In setup mode 4.5 mA Output:**
      The mA output is by default configured to the following:
      - Outputted Data: Abs location, set to 0x01F6 (measurement in percentage)
      - mA Type set to 4 – 20 mA
      - mA Validity state set to measured.
      - mA Smoothing Coefficient set to 0x000A (=10)
      - mA Span set to 1000 (0x03E8) (measurement in percentage)
      - mA Zero set to 0000 (0x0000) (measurement in percentage)

   b. **Contact Output:**
      The Contact output is by default configured to the following:
      - Outputted Data: Abs location, set to 0x01F6 (measurement in percentage).
      - Contact mA Smoothing Coefficient set to 0x000A (=10)
      - Contact direction set to Reverse.
      - Contact Level set to 0x03E8
      - Contact Data Type set to Byte.

5. **Damping**
   a. The system has a basic 15 seconds T90 response.
7. Maintenance

**WARNING !!!!!!!**

Heat may be conducted from the process duct to the enclosure and care should be taken when maintenance work is required, to ensure that suitable protective gloves are worn before handling. Remember also that the probe may also be hot and should be allowed to cool before cleaning.

**Cleaning Interval**

The primary maintenance task associated with Energy Tech 301 is cleaning the probe. In some applications, particulates impacting on the probe may eventually form a coating on the leading edge. This causes a reduction on sensitivity and eventually to a very small output. Due to wide process variations such as the siting of the probe, the nature of the particulate, particle velocity etc., it is difficult to specify a precise interval for cleaning the probe. Depending on process conditions this may vary from annually to weekly, but monthly cleaning is more likely. After a few days, the probe usually takes on a thin even coating that will normally remain constant. To establish a cleaning routine, proceed as follows:

a) After 1 week, inspect the probe for visible signs of a build-up. Remove and clean the probe. If there is no significant visible coating, extend the period to 2 weeks.

b) Note the average output of EnergyTech 301 prior to removing the probe. Carry on extending the maintenance period, doubling the previous one, until there is a significant visible coating. Always clean the probe before re-fitting it.

c) When a significant visible coating is observed, the time taken for this to occur becomes the maintenance interval. On re-fitting the probe, again note the output of Energy Tech 301. The difference between the probe output before and after cleaning should now be apparent. If the output change is unacceptable, then clean the probe more frequently.

**Bridging**

This condition arises when particulate forms a ‘bridge’ between the duct wall and the probe. Processes that involve conductive particulate, condensed moisture or acidic emissions are particularly prone to this problem. The result of bridging is usually a high dust alarm. The Energy Tech 301 is fitted with an insulated sleeve to significantly reduce the incidence of bridging.

If bridging becomes a regular problem, adjust the intervals between cleaning the probe accordingly. Note the date a bridge occurs, then note the date of the next occurrence. Subtract one week and this becomes the maintenance interval.

**Probe Material**

The Energy Tech 301 is normally fitted with a stainless steel (Grade 316L) probe. However, on certain processes, it may be necessary to use probes of a different material, e.g. tungsten carbide where the particulate is of an abrasive nature, or Inconel for corrosive gases. If there is any doubt as to the suitability of the stainless steel probe, contact Codel, giving full details of the process application, and we will be pleased to help.

**Removing the Probe from the Head**

Simply place a screwdriver blade or a small diameter bar through the hole in the probe and unscrew.
Serious Instrument Failure

In the unlikely event that the instrument gives no output whatsoever or only limited output, first check that the instrument is connected to a suitable electrical supply. If the power supply is within the specified range (85/265V AC, 47/440Hz) and the condition persists, do not attempt to repair the Energy Tech 301 as this will either invalidate your warranty or increase repair costs if the instrument is out of warranty. Just return the instrument to Codel for repair.

The Energy Tech 301 has a diagnostic socket that enables Codel to communicate with the unit and establish the fault. The electronics package will then be repaired or a new package fitted.

Codel is proud of its quick 'turn-around' time on servicing these units and acknowledges that the Energy Tech 301 needs to be returned as quickly as possible to continue its important work.