ULTRASONIC NON-INVASIVE LEVEL SENSOR FOR REFRIGERANT RECEIVERS

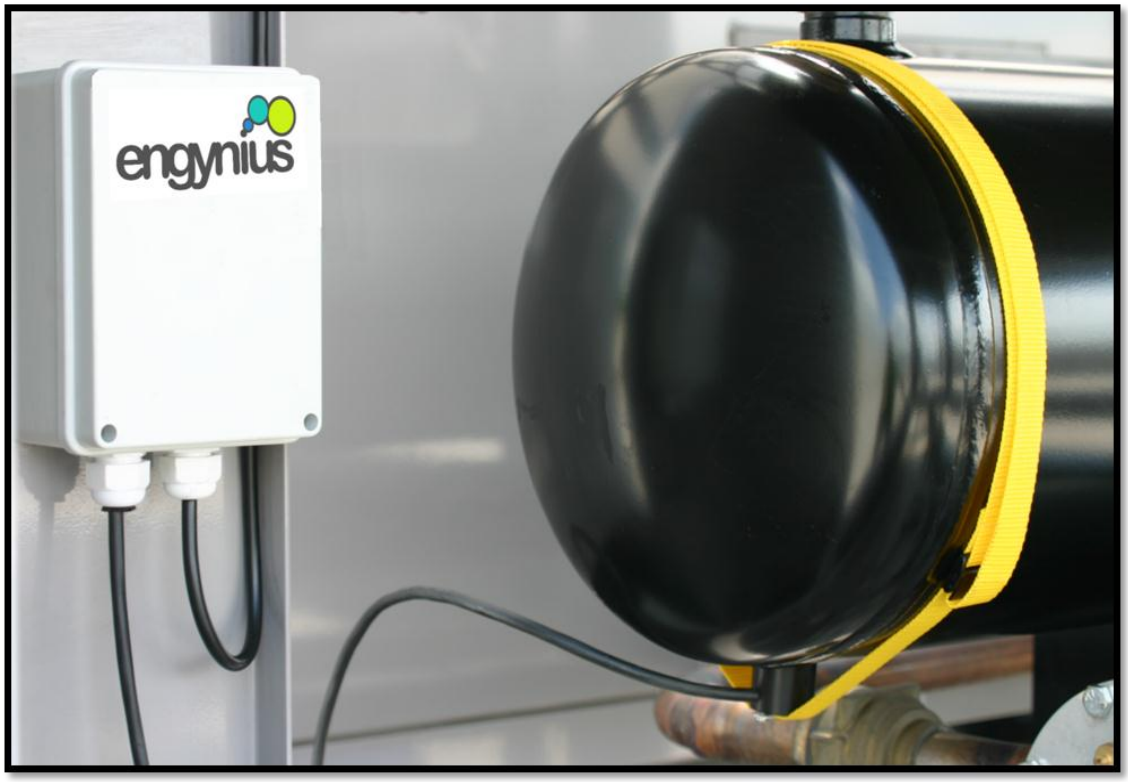


Table of Contents

ULTRASONIC NON-INVASIVE LEVEL SENSOR

FOR REFRIGERANT RECEIVERS

General Description

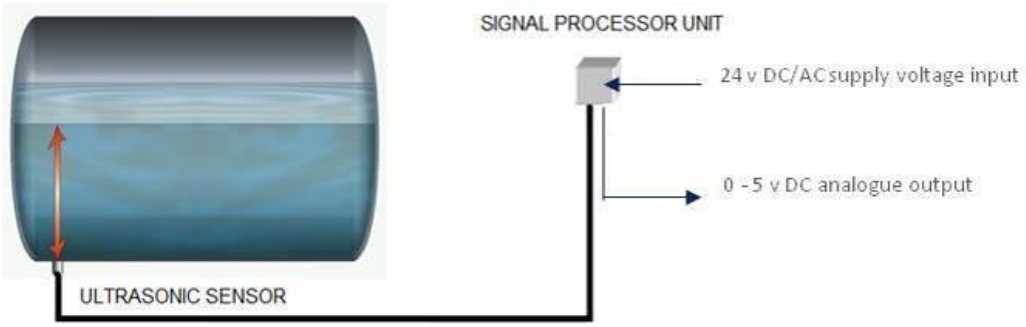
The Engynius refrigerant level sensor is a highly versatile and non-invasive liquid level measurement method designed specifically for refrigeration installations. The system comprises an ultrasonic sensor and signal processor unit, which together provide a measurement of liquid height inside a pressure vessel, providing an ideal method of remote refrigerant trend analysis to end users.

Key Features for use

- Ideal for retrofit applications – but OEM installation also apply
- Non invasive installation with system under pressure
- Easy external fitting to receiver - no need to stop plant
- No refrigerant handling issues for installation – electrical work only
- No refrigerant decanting required service or replacement
- No recalibration, non-drift, no moving parts, no leakage sources
- Sensor setup on-site to suit all vessel diameters or heights
- Suitable for any refrigerant type
- No unauthorized in-service adjustments possible due to software use controls
- No standpipe or isolation valves used that may be locked to give false levels
- System powered from a low voltage 24volt supply
- Standard 0-5 volt scalable analogue output. (options available to order)
- RS232 /485 communications port as standard. (other protocols to order)
- Use for remote refrigerant monitoring or local display as required
- Vertical vessel array options also available to order

Principle of Level Measurement

The unique non-intrusive method of level sensing makes the Engynius system ideal in situations where no existing access points or level connections to the receiver are available on the vessel.



An ultrasonic transmit-receive sensor, normally mounted on the underside of the vessel as shown above emits a series of ultrasonic pulses up through the receiver liquid contents. The time taken for an echo to be received from the liquid surface is measured electronically by the signal processing unit. This time is directly proportional to the distance to the refrigerant liquid surface.

Software enhancement and development over several years through on-site trials and testing has resulted in a system which detects and responds only to reliable echo signals from the liquid surface and provides this information continuously as an analogue of vessel fill height relative to the full span setting.

The signal processor unit houses a microprocessor control circuit board which is the heart of the level sensing system. It generates, transmits, receives, and interprets the ultrasonic signals; then conditions and filters the received echoes to a determined liquid surface height, this is reported as a user scalable analogue voltage output, or alternatively an RS232 or RS485 single point serial link (jumper selectable) is also supplied as standard with Modbus RTU or ASCII protocol. Installation

Signal Processor Unit

The signal processor unit is normally fed from the refrigeration system control panel to derive the low voltage supply, and the analogue output returned to panel using a multi-core cable. The processor unit's IP56 enclosure can be externally mounted in a sheltered location if necessary to best suit receiver vessel location.

Ultrasonic Sensor

The ultrasonic sensor is connected to the processor electronics by a single pair cable. Cable length should be kept as short as possible to reduce the possibility of electrical interference, and should not exceed 50metres. The standard sensor cable length is supplied as a 1 metre flying lead.

Electrical Supply and Cabling

The system requires a 24vAC or DC supply, from a sub-fused power source. One side of the supply must be grounded at the supply end.

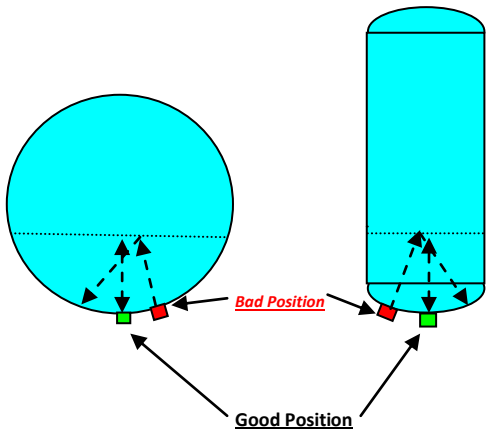
Low voltage cabling for power supply and analogue output between signal processor unit and the refrigeration system control panel would typically be made using 22 AWG (0.65mm) 5 core cabling.

Follow good practice to segregate the signal and low voltage power supply cable runs from heavy duty mains cables wherever possible especially over long common runs to limit any risk of signal disruptions.

Board Terminations

All cable connection to be made in accordance with the termination diagram as shown (page 14)

Sensor Positioning and Alignment



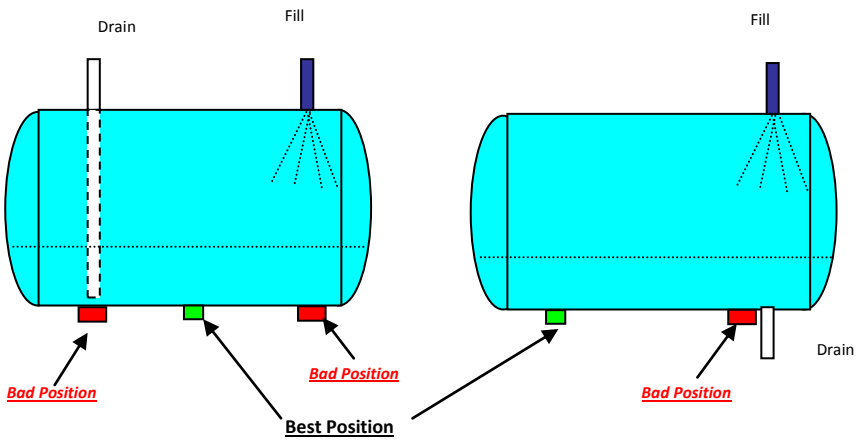
To ensure optimum performance of the sensing system to track the liquid level movements inside the vessel, it is essential that the ultrasonic sensor is installed in the most suitable location on an individual vessel. Ultrasonic sensor should be positioned to the underside of vessel so that the ultrasonic beam is perpendicular to the liquid surface formed in vessel.

Some vessels and plant are not always installed perfectly level, or have only very limited clear space below vessel for sensor location; both situations which may require special attention to sensor design and arrangement.

A maximum sensor misalignment angle of 3° from horizontal liquid surface in vessel has been found to the practical limit to ensure satisfactory vertical ultrasonic beam projection and system operation. However this limit is also subject to the distance over which the sensor beam has to transmit and the conditions at the liquid measurement surface during operation.

If the operating angle misalignment is greater than this then a special angled sensor or perhaps a vertical sensor array solution will be required. This will be determined based on an initial site surveys carried out by Engynius. Vertical receivers with poor access to underside of vessel especially may need this type of array solution.

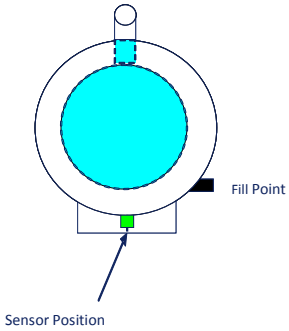
The sensor should not be placed below fill points (condenser returns), liquid outlets or where obstructions such as dip tubes or other level measurement (float type) devices may be directly in the sensors line of fire.

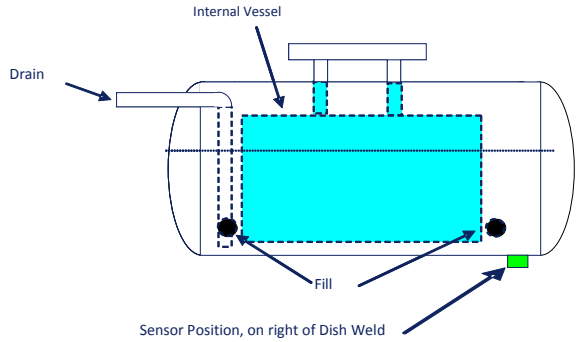


Sensors placed near or over welds and irregularities on the receiver vessel wall should be avoided. Such may prevent the sensor being located flat and true to the underside surface of the receiver. Sensor should not be located too close to the dished end knuckle radius of a horizontal vessel; make sure sensor is located on the straight section only.

Vessel Internal fittings and Restrictions

To avoid detecting false echoes from any internal vessel or fitment, the sensor must be carefully positioned, after carefully testing the echo responses. Especially important when placed near to a drain or fill points, where refrigerant flow rate may interfere with reading stability.

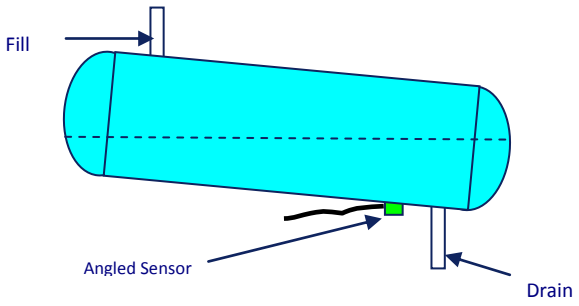




Sloping Vessels and Angled Sensors

There are certain refrigeration system with a purposely sloped receiver such as shown below, and will require a special angled sensor to present the ultrasonic beam at the correct angle to the liquid level surface within vessel. (See sketch below)

Angled sensors are a special build that must be specially matched to the slope angle of the vessel.

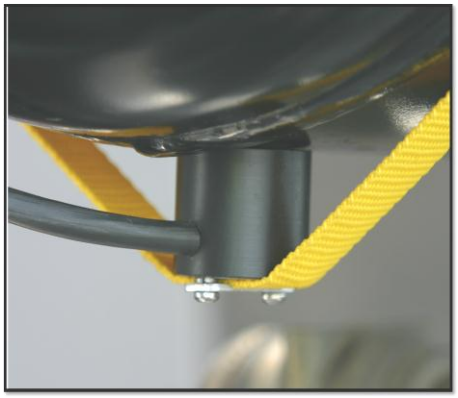


If final alignment is too poor after installation then the sensor will not react reliably and will exhibit typical signs of a misaligned sensor with signal loss at liquid level extremes.

Sensor Positioning and Final Alignment Checks

This simple assembly procedure should be carried out for horizontal vessels:

- Carry out surface preparation, and cleaning of vessel at proposed sensor location, apply non setting Kilo-Poise acoustic coupling grease to prepared surface of vessel.
- Mount the sensor into the special “spirit level” based alignment tool (where access allows) and carefully locate the sensor in the preferred position under the receiver.
- Place sensor webbing attachment strap around the vessel shell diameter and tighten loosely.
- Hold the sensor firmly in the selected position with the alignment tool (where possible), ensuring sensor face is on a truly horizontal plane. Fully tighten webbing strap to prevent any further movement. Recheck alignment remains undisturbed.
- Make off wiring connections to sensor, output cable and power supply to signal processor unit as per above.



- Verify operation that the sensor is reading correctly and viable with the commissioning process detailed below. Seal sensor strap location to vessel shell with the tamper evident adhesive labeling over strap location.

Commissioning the System

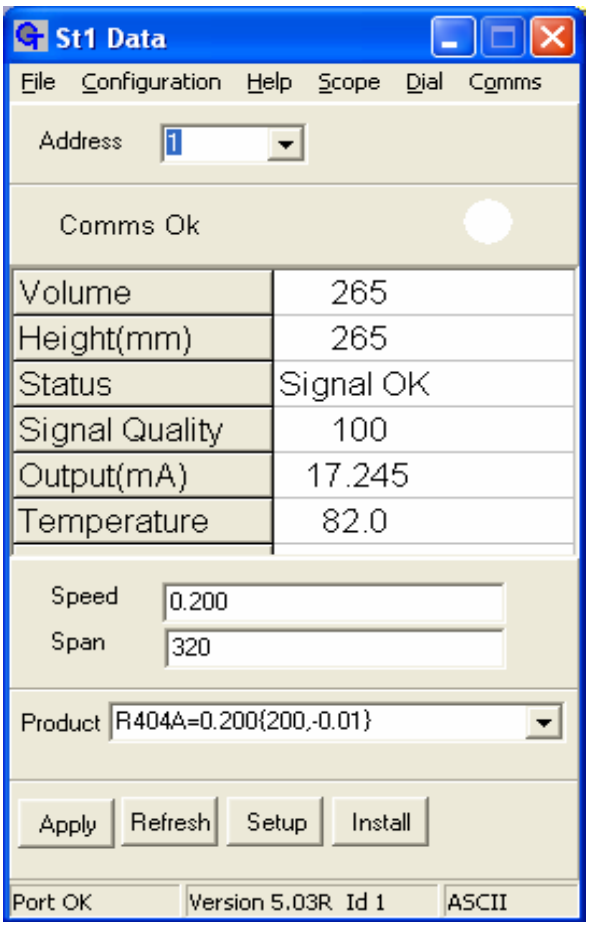
Interface Program and Display

Commissioning and adjustments to the settings of the system can only be carried out using dedicated controlled access software via a direct serial connection at site. This software is not readily available to the site service engineers to prevent unwanted changes to the refrigerant level reading output once installed.

On initial installation the system, signal type and settings are tailored to the exact vessel size, construction characteristics and refrigerant type using the interface software package.

Once correctly installed there is no need for adjustment or "recalibration" of the system. No user serviceable parts are installed on the signal processor units on this basis; again to prevent changes without the appropriate interface software after initial commissioning.

Commissioning of system is via a laptop computer with user interface display as pictured below. This details the system status in a simple readout with a recorded liquid refrigerant height in vessel (mm).

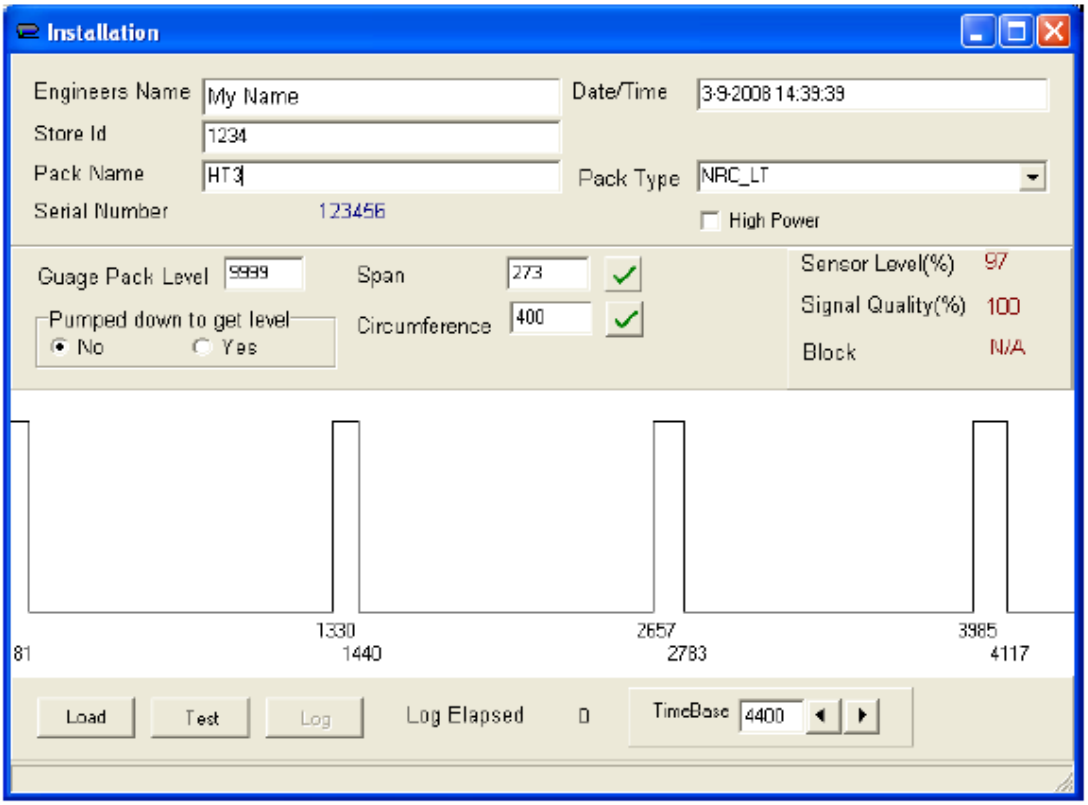


Communication settings and current status are clearly shown and easily changed where needed.

The signal processor unit has the simple commissioning inputs of refrigerant type (or acoustic velocity for other fluids) plus the span height (mm) representing the full scale of the vessel diameter or a vertical vessel height.

After the minimal manual setting inputs commissioning follows an auto-calibration process, and these values are stored in non-volatile memory once the "Install" button is clicked.

A short data log file of the initial ≈5 minute operating period recorded levels and signal quality along with system serial number, is made available at the end of commissioning process for installation record purposes.



The set up software also features advance diagnostic and level analysis tools to visualize the echo patterns recorded from the vessel in an oscilloscope type output to aid in troubleshooting any difficult sensor locations.

Low Refrigerant Levels

When level sensing system commissioning is required on equipment with little or no detectable refrigerant level in system receiver, it may be necessary to briefly “pump down” system during set up process. This would carried out by briefly closing the liquid receiver outlet valve during plant operation to allow sufficient liquid level to build up in the receiver to enable the sensing software to clearly recognize a liquid level surface inside the vessel. The sensing system set up and configuration can then be completed as above, and the equipment returned to normal operation by opening the liquid valve again to full refrigerant flow. The level sensing system will retain all settings as commissioned and provide accurate level readings, even though level may initially drop back to zero on a “completely empty” system

receiver; correct readings will still be output when refrigerant level cycles to normal again during operation.

When there is insufficient refrigerant to form a detectable level even during pump down, then the system refrigerant operating level must be corrected by the users refrigeration service contractor before level system commissioning can be completed

Technical Specifications

Signal Processor Unit

Enclosure rating:	IP56
Supply:	24 volt (AC or DC)
Power Consumption:	50mA
Ambient Temperature Range:	-10 to +40˚C
Maximum distance from vessel sensor:	50 metre

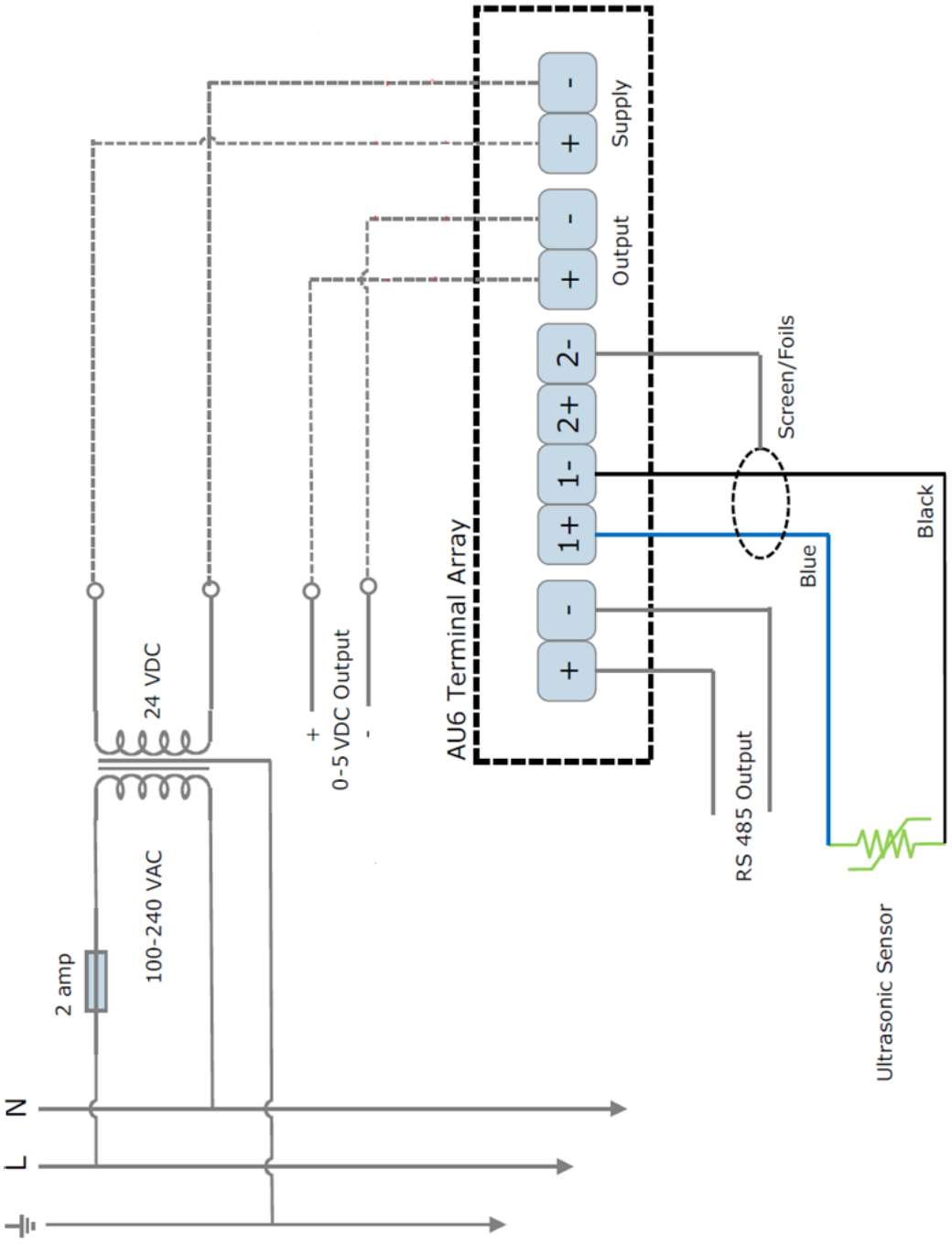
Ultrasonic Sensor (standard type)

Housing construction:	Ertacetal in Tufnol housing
Operating Temperature Range:	-20 to +125˚C continuous
Dimensions:	30mm dia. x 25 mm high
Range:	25 mm to 1000 mm (liquid depth)
Cable length:	1 metre flying lead

Analogue Outputs

Standard unit:	0 – 5 volt DC
	RS 232 / RS 485
	Modbus ASCII or RTU (install options)
Optional output:	4-20mA (on special order)
Accuracy:	Better than 1% of full scale

Termination Diagram



CONTACT INFORMATION:

Call: +44 (0) 1604 726274

Email: info@engynius.co.uk

Engynius Limited

3 Fortune Close,
Riverside Business Park,
Northampton
NN3 9HZ
United Kingdom