



KRAL Smart Solution.

Compact electronic unit supplies measured values via Modbus.



Flow Measuring Technology With the Smart Solution.

A compact KRAL electronic unit in combination with KRAL flowmeters.



What is the KRAL Smart Solution?

The Smart Solution is a compact electronic unit to which a KRAL flowmeter, i.e. a KRAL Volumeter®, is connected. The Smart Solution processes the signals that the KRAL flowmeter generates with its integrated sensors in such a manner that measured values are available that can be passed on via the Modbus.

Up to 32 Smart Solution electronic units can be switched in series and thus save a multitude of cabling and their installation in comparison to conventional measured data acquisition.

It is often assumed that the liquid in the piping flows uniformly and smoothly. In many applications, however, this is not the case. It can be very turbulent in the piping: The direction of flow can reverse

briefly and unanticipated due to pulsations – caused by pumps and/or engines (consumers). Similarly the liquid can have different temperatures at different measuring points. KRAL flowmeters supply very precise measured values like the flow quantity, the flow direction and temperature to the Smart Solution. The Smart Solution processes this information into a flow value. At KRAL we call this the "rectified measured value". If the operating conditions in the piping were not taken into consideration, a significant measuring error would result.

The Smart Solution.

Supply:	9 to 36 VDC.
Operating temperature:	-20 to 85 °C.
Degree of protection:	IP 67.
Interfaces:	RS485.
Baud rates:	9600 / 19200 / 38400 / 57600 / 115200.
Protocol:	Modbus RTU.
Character format:	1 start bit, 8 data bits, 2 stop bits, no parity.



Inexpensive – simple installation – low-maintenance.

Cables and their installation are expensive. Cable ducts, cable bushings through walls. The routing and the connections of the cables are time-consuming and can result in faults and errors. In particular in the case of subsequent installation the associated costs are considerable.

KRAL Smart Solution requires only one cable. The cable is simply looped from box to box, meaning that only one cable has to be connected to the Monitoring System. Other outputs remain free.

No individual local displays – one display with the collected data and values.

Quite a few instruments and monitors are usually installed on the ship's bridge, in the control room of an industrial plant or in a power plant. Each further monitor or each light source can disturb. We deliberately did not provide the Smart Solution with its own display. The measured values can be passed on to and displayed on existing Monitoring Systems via Modbus.



Volume measurement – mass calculation.

The density values of common liquids are stored in the Smart Solution in the factory. The Smart Solution directly calculates the mass value of the flow by means of the measured values of the volume and of the temperature as well as the stored density value.

Apart from the mass value, the Smart Solution can also carry out temperature compensation for the measured volume flow by means of the stored density values.

This function references the measured flow quantity to a reference temperature, thus making the measured value comparable with other temperature-compensated measured values. The customer has the possibility to configure the Smart Solution via the Modbus and to call up the desired measured data.

Condition Monitoring and Performance Monitoring.

In addition to the main measured values "flow quantity" and "flow rate", all other measured values are available openly to the user. These are, as already mentioned, the temperatures at the measuring points and the indication of return flows. Our customers interpret the measured data on the basis of their own operating experience and derive information from these about the state of the plant in order to organize maintenance intervals or repairs.

Example: The low-pressure fuel system of an engine is not supplied ready to use by the engine manufacturer, but rather installed and connected individually on site. After the installation a check is carried out for leaks, but almost never whether the liquid is flowing as it should. However, the reality is that pulsations in the piping (caused by pumps/engines) cause multiple brief return

flows which can result in considerable inaccuracy of the measured value. Thanks to the interpretation of all the measured values by the Smart Solution the operating personal can uncover such irregularities and prevent consequential damage to engines and consumers.

The Smart Solution.

Simple installation – manifold usages.

■ **Up to 32 Smart Solution electronic units.**

32 Smart Solution electronic units can be switched in series and thus save a multitude of cabling and their installation in comparison to conventional measured data acquisition.

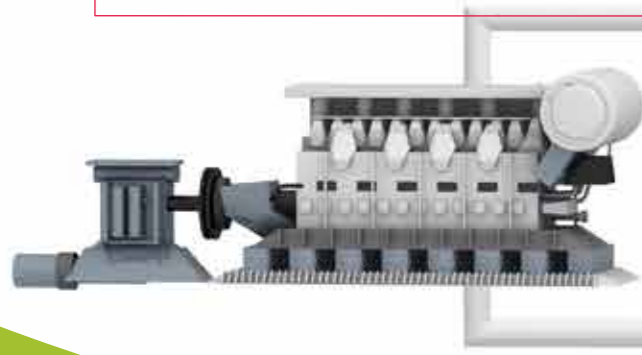
■ **Differential measurement.**

To ensure precise measurement one KRAL flowmeter each has to be installed in the supply and return lines. Two KRAL flowmeters are required per engine. The difference between the supply quantity and the return quantity is the fuel consumption.



■ **Temperature 1 and 2.**

The temperature of the fuel in the return line can lie up to 30 °C higher than in the supply line. The KRAL fuel consumption measurement detects the temperatures of the supply and feed lines and calculates the consumption for a temperature level that can be freely selected.



**Condition Monitoring.
Performance Monitoring.**

Our customers interpret the measured data on the basis of their own operating experience and derive information from these about the condition of the plant.

■ **Single-line measurement.**

In the simplest case a KRAL flowmeter can be installed before the mixing tank.

■ **Smart Solution separated from flowmeter.**

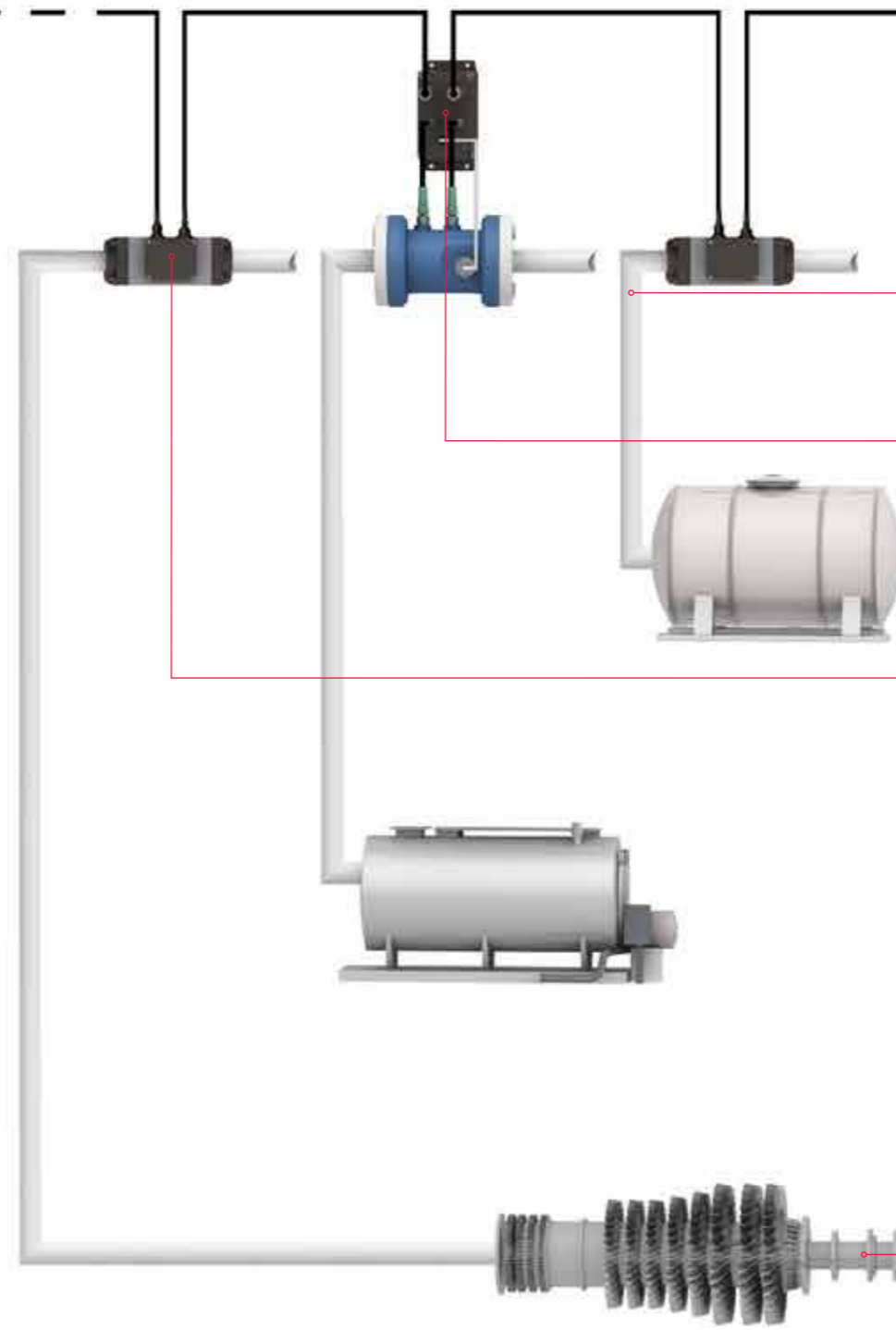
Pick-up and temperature sensor are connected via plug connectors to the Smart Solution. The individual interfaces only have to be connected. The voltage is supplied via the Modbus cable.

■ **Smart Solution integrated in the flowmeter.**

Pick-up and temperature sensor are integrated in the flowmeter. The individual interfaces only have to be connected. The voltage is supplied via the Modbus cable.

■ **Pulsations.**

The fuel does not flow smoothly through the lines. It pulsates and can even change its flow direction. If this effect is not taken into consideration, the consumption measured value is false. KRAL flowmeters inherently measure in both directions.



Your Advantages.

Smart solutions at a glance.



- Evaluation of two sensor signals for flow direction detection possible.
- Temperature and pressure pulse compensation.
- Mass conversion.
- 7-point linearization possible.
- Simple installation with only one cable.
- Information from up to 32 flowmeters can be called up via only one cable.

Examples in Practice.

The various measuring possibilities.

Cylinder oil measurement in single line.

Medium: Cylinder lubricating oil.
Flow rate: 5 to 50 l/h (0.1 to 1.0 l/min).
Pressure: 0.5 to 2 bar.
Temperature: 5 to 50 °C (ambient temperature).
Viscosity: 10 to 150 mm²/s.
Measuring device: KRAL OMG.

Cylinder lubricating oil for the engines is as a rule drawn directly from the storage tank without a feed pump.

Since there is no feed pump, the pressure drop in the consumption measurement may only be very low. Consequently, the KRAL Volumeter with their straight-lined flow are the ideal choice.

Pulsation within the engine is quite high in particular at engines that run slowly. This pulsation results in reactions and thus return flows of the oil in the supply line because there is no pump pressure counteraction. KRAL flowmeters are equipped with a second sensor to recognize the flow direction and to compensate it in the evaluation electronics.

At low flow rates a high resolution at the measured value acquisition is very important. This is always ensured when an OMG is selected (up to 7,500 pulses/liter).

Consumption measurement main engines / generators (differential measurement).

Medium: Diesel / heavy fuel oil.
Flow rate: 1,000 to 20,000 l/h (15 to 330 l/min).
Pressure: 5 to 16 bar.
Temperature: 30 to 150 °C.
Viscosity: 5 to 20 mm²/s.
Measuring devices: Two KRAL OMPs.

In the circulation before an engine or generator the flow has to be measured in the supply and return lines in order to determine the consumption.

The overall error (precision) of the consumption is thus neither the individual error of a single flowmeter, nor the simple sum of both flowmeters, but rather the overall error that results from the Gaussian formula. In particular at slow steaming or low load the overall error is several times higher than that of the individual flowmeter. KRAL Volumeter with a precision of 0.1% are therefore predestined for this measuring task.

Injection systems can cause high pressure peaks in the piping that can result in an inconsistent flow and even in return flows. KRAL flowmeters recognize the return flows and compensate them in the evaluation electronics.

Plant measurement – engines, generators, boilers, burners, etc.

Medium: Diesel / heavy fuel oil, cylinder oil.
Flow rate: 5 to 20,000 l/h (0.1 to 330 l/min).
Pressure: 0.5 to 16 bar.
Temperature: 5 to 150 °C.
Viscosity: 2 to 150 mm²/s.
Measuring devices: KRAL OMP/OMG.

At multiple-engine or plant measurement single-line and differential measurement are often combined. In this case correct calculation of the flows and dimensioning of the flowmeters are important. Our customer center provides professional support here. The number of flowmeters determines the work required for cabling and its installation.

With the KRAL Smart Solution only one Modbus line is required that is looped from one flowmeter to the next one. This means that all the flowmeters can be connected, read out and evaluated with only one cable in the Monitoring System.

The optimal dimensioning and specification of the flowmeter has to be ensured for each application. KRAL has a wide range of products and can always offer the optimum solution.

