RLS merilna tehnika d.o.o.
Poslovna cona Žeje pri Komendi
Pod vrbami 2
SI-1218 Komenda
Slovenia

T +386 1 5272100
F +386 1 5272129
E mail@rls.si
www.rls.si

Technical article
AksIM™ single-track encoder
18th February 2013

AksIM™ – new family of single-track magnetic absolute position encoders

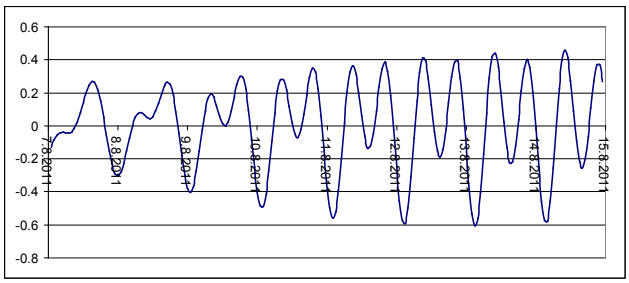
AksIM™ is a single-track absolute encoder system

RLS adds to its proven magnetic encoder range with the new true absolute single-track magnetic encoders

Spending the holidays at the seaside, one often notices the sea level rises and falls several times a day. This well-known periodic phenomenon is known as the tides and can be explained as the effect of the Moon's and the Sun's attraction on the Earth.

One also observes that the tidal amplitude depends on the relative positions of the Sun and the Moon – the difference between high tide and low tide levels is greater when the Earth, Moon and Sun are aligned in a straight line, rather than forming a right angle. The tidal amplitude is also greatly influenced by the shape and depth of the sea bottom. The differences between the high and the low tides in the shallow Gulf of Trieste in the northern Adriatic Sea can exceed one meter and are several times higher than in the Southern Adriatic sea, e.g. in Dubrovnik; while the tidal ranges in the English Channel can be as large as ten meters.

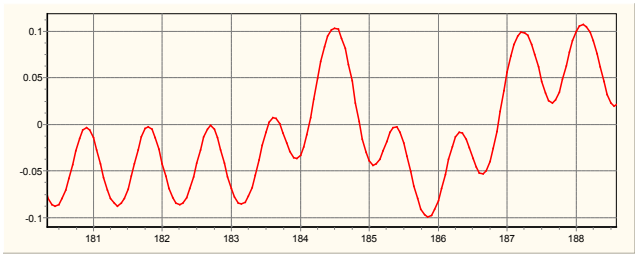
The tides can be predicted well. The diagram below shows the forecast for the Gulf of Trieste for August 2011 as the predicted deviation from the mean sea level in meters for each day between August 7 and 15.



A forecast can also be reformulated into a question. Let's say we are presented with the tidal records for a longer time period, but with no data about the sampling dates. Could these measurements be used to find the time period when the measurements were recorded? Certainly. Spectral analysis of measurements can be used to determine the relative positions of Moon and Earth, and Moon and Sun, respectively. This should suffice for finding the days of measurement on a calendar showing the lunar phases.

Similarly, we can ask ourselves whether it is possible to magnetise a magnetic tape in such a way that the magnetic field above the tape is essentially periodic, but with an additional component enabling the detection of position on the tape only from a short scan of the magnetic field?

Once again, the answer is affirmative. RLS merilna tehnika d.o.o. has developed the AksIM™ range of non-contact absolute magnetic encoders, where the information carrier is a tape magnetised in an innovative way, while the magnetic field detection and innovative signal processing are done by a compact readhead.



The dimensions of the magnetised tape are the same as for the tapes used in incremental linear magnetic encoders. A 10 mm wide and 1 mm thick ferrite polymer composite layer is bonded onto a thin steel carrier, giving the tape the required mechanical rigidity.

The new product range also includes angle encoders. In this case, the magnetised ferrite polymer composite is bonded onto a metal ring, or a rubber layer with ferrite particles is applied to the metal ring by vulcanisation.

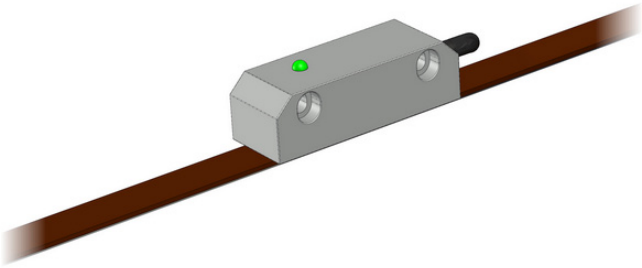
AksIM™ absolute encoder technology

The readhead of the new absolute encoders consists of two main parts. The first is a custom-made magnetic field detection ASIC, and the other is a 32-bit ARM microprocessor which reads and evaluates the signal coming from the custom-made ASIC. The microprocessor performs spectral analysis to first determine the periodic component (speaking in terms of the tides analogy, this component corresponds to the attraction of the Moon) and then extracts the coded component of the field (analogue to the additional contribution of the Sun). The coded signal component provides a rough but unique information about the position, as any code combination is only encountered once along the total tape length or around one revolution of the ring. The position resolution is enhanced by additional analysis of the periodic signal component. The microprocessor therefore calculates the position of the readhead over the scale by combining the position of the unique code combination and the part interpolated from the periodic signal component. The readhead position as such is absolute, meaning the information about the position is already correct once the encoder is powered up, and no referencing is required as is the case with incremental encoders.

The microprocessor also takes care of communication with higher-level devices, such as the motion controller.

The sensor part of the readhead is realised as a custom-made ASIC, manufactured using 0.35 µm CMOS technology. The chip consists of more than 50 Hall sensors in a row, detecting the magnetic field component perpendicular to the chip's surface, multiple signal adjustment blocks, control registers and a 12 bit A/D converter. The distance between the outermost Hall sensors is 8 mm. Also integrated is a temperature sensor monitoring the operating conditions. The chip's operating temperature range is between -40 °C and +85 °C.

Two-way communication between the chip and the microprocessor is realised over the SPI bus, enabling writing into the chip's control registers and transfer of the magnetic field readings into the microprocessor. The sensor signals are also available in analogue format.



The readhead design is quite compact, as it only consists of the two aforementioned components.

For the AksIM™ angular encoders, there is no need for the printed circuit board to cover the whole ring. The user will therefore be able to install the ring and the readhead without a significant change to the product's external dimensions.

The measuring length of position encoders with a magnetisation period of 1 mm is limited to 230 mm. The maximum rideheight is 0.3 mm. For applications requiring more generous installation tolerances, the maximum distance between the readhead and the scale can be increased, but the measuring length is then reduced to 130 mm.

The outer diameter of the angular encoder rings is 49 mm or 80 mm. For the smaller ring the maximum rideheight is 0.35 mm. The internal diameter of both rings is large enough so the ring can be press-fitted on a rotary axis, or to accommodate the cables.

The smaller ring offers 131,072 positions per revolution at 17 bit resolution. The 80 mm ring has 262,144 positions (18 bit). The linear encoder resolution is 1 µm. The accuracy of AksIM™ magnetic encoders is ±20 µm for linear and ±0.1 deg for angular measurements. With further corrections better accuracy can be achieved. The maximum permissible readhead speed is over 20 m/s, and the ring may rotate with more than 12,000 revolutions per minute. And since the AksIM™ encoders use Hall sensor technology, there is no electrical hysteresis, which is an undesired characteristic of magnetoresistive sensor encoders.

The AksIM™ magnetic encoder range uses 5 V power supply and offers many different output signal formats: from digital SSI, SPI, I²C, serial RS422, serial RS485 and CAN, to analogue current and voltage signals. In addition to the position information, the status of the measurement is also provided by real time monitoring of several internal parameters.

AksIM™ applications

These characteristics and the affordable pricing make the new single-track absolute encoders useful for a wide range of applications. The non-contact design makes them a feasible substitution for linear potentiometers, which are prone to wear. They are found in video-surveillance systems measuring the angle of camera rotation, in robotic arm joints, in motors for position detection, and on sailboats measuring the rudder angle, to name a few.

And if our story began with the tides, let's also finish it at the sea coast. Why is it that there are two high tides and two low tides every time the Moon completes one virtual revolution around the Earth?

For further information visit www.rls.si/aksim.