

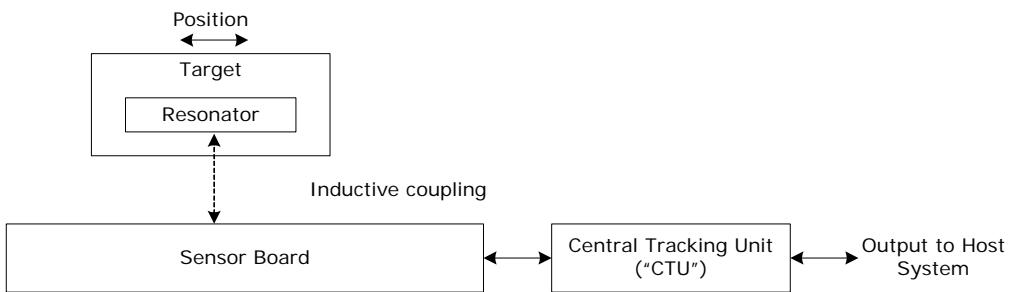
Overview

Resonant Inductive Position Sensing is used to track the position of a target without mechanical or electrical contact. The target includes an inductively coupled resonator which is measured relative to a sensor.

The sensor is usually implemented using conventional Printed Circuit Board (PCB) technology, when it is referred to as a Sensor Board.

An electronic processing system interacts with the sensor to power the resonator and to detect the signals that it returns. The detected amplitudes of these signals are processed to calculate position.

CambridgeIC's single-chip processing solutions are called Central Tracking Units ("CTUs"). These have been designed to enable customers to develop applications themselves with the minimum of effort, and to deploy those solutions in high volume at low cost.



Features and Benefits

- Robust and non-contacting
- One processor can support multiple sensors
- Large gaps possible
- Tolerant to misalignment
- Stable across temperature
- Reproducible performance across sensors
- Can use PCB technology to manufacture sensors
- Simple design-in and manufacture

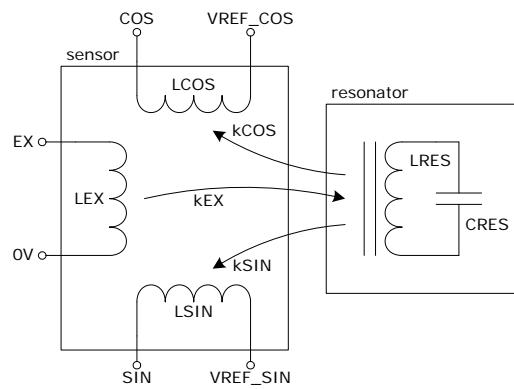
Applications

- Motion control
- Actuator position feedback
- Precision front panel controls
- Valve position sensing
- Industrial potentiometer replacement
- LVDT/RVDT replacement
- Absolute optical encoder replacement

Sensor Equivalent Circuit

The figure to the right illustrates the equivalent circuit of a "Type 1" resonant inductive position sensor. The sensor has one coil to inductively power the resonator (the excitation coil: EX) and two sensor coils to detect the signals returned by the resonator (the COS and SIN coils). The figure shows the equivalent circuit of the sensor and the resonator. The sensor part includes an excitation coil (LEX) connected to EX and OV, and two sensor coils (COS and SIN) connected to VREF_COS and VREF_SIN respectively. The resonator part is represented by an inductor (LRES) and a capacitor (CRES) in series. The coupling factors between the resonator and each sensor coil are labeled as kCOS and kSIN.

The COS and SIN coils are patterned so that the coupling factor between the resonator and each sensor coil changes with position in a predetermined way. Electronic processors differ in the approaches that they use to interrogate the sensor and the number of excitation and sensor coils. However they all measure coupling factors, and use the result to calculate position.



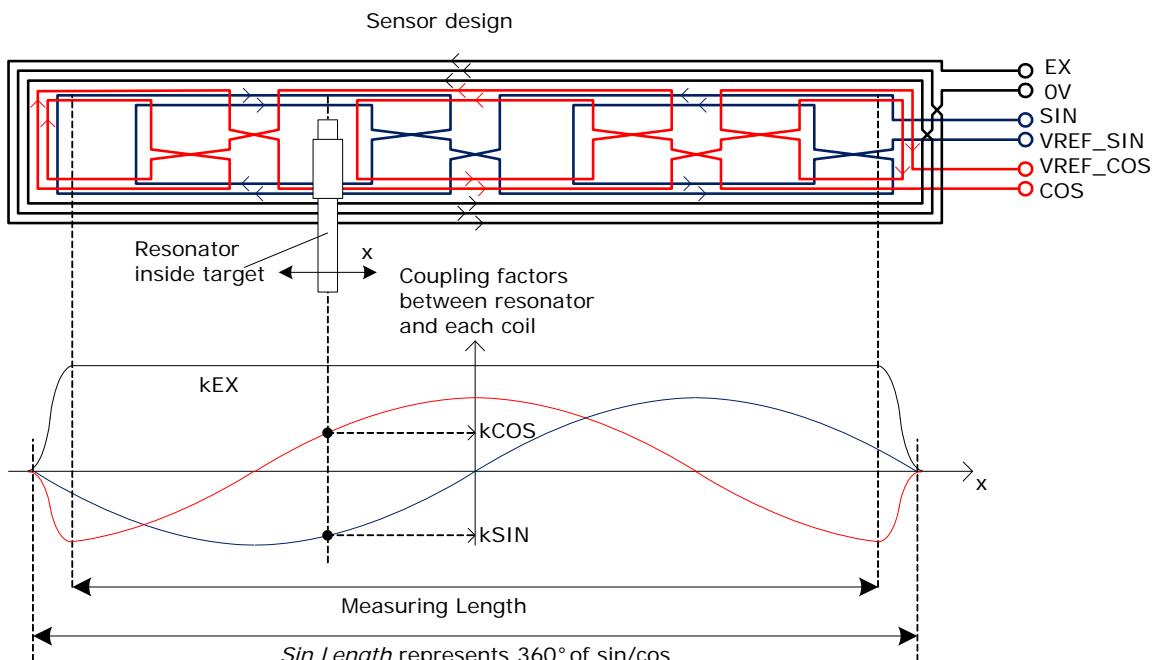
Linear Type 1 Coil Design

The figure below illustrates a simplified version of a Type 1 sensor coil design used by CambridgeIC for linear position sensing. Rotary sensors use a similar principle, with the coils arranged in a circle.

The excitation coil is shown in black and surrounds the two sensor coils. As shown on the graph underneath, its coupling factor to the resonator is approximately constant, so that the resonator is always powered when the resonator is within the Measurement Range.

The COS and SIN coils are patterned so that their coupling factors to the resonator k_{COS} and k_{SIN} vary sinusoidally along the Measurement Range. This approach is also commonly used in LVDTs, RVDTs and resolvers.

Sensor coils are balanced (they have portions wound in opposite directions) so that inductive interference cancels.

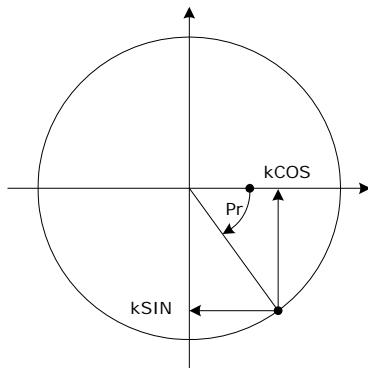


Position Calculation

Position Calculation is performed automatically inside CambridgeIC's CTU chips. The type of position calculation depends on the arrangement of coils in the sensor. Resonant Inductive Position Sensors use ratiometric calculations for immunity to resonator Q-factor, supply voltage and component variations.

The sensor coils of a Type 1 sensor are patterned to produce a SIN/COS variation of coupling factor with changes in position. The calculation of position (Pr in the figure to the right) is equivalent to the calculation of phase angle, and is performed with a 4-quadrant inverse tangent.

This section dealt with how measurements of coupling factors can be used to determine position. The next section deals with how those coupling factors are measured electronically by the CTU.



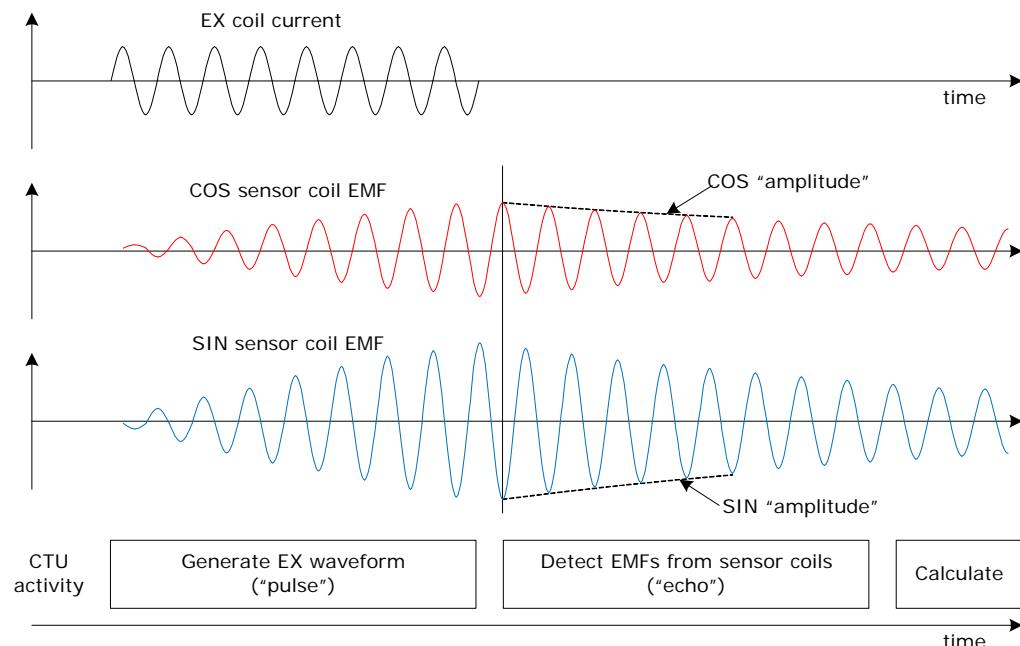
Electronic Interrogation

CambridgeIC's CTU chips generate a drive waveform that is used to power the resonator, and detection circuitry to measure the levels of return signals from which coupling factors are determined.

The normal measurement approach is "pulse echo", where the drive waveform is applied to power the resonator and is then removed for detection. This

approach minimises errors due to direct coupling from the excitation to sensor coils, including any connecting leads that may be used. The sequence of events is illustrated below.

CTU chips detect resonator frequency, and they continuously adjust their operating frequency to match the resonator for optimum signal level.



Document History

Revision	Date	Description
A	2008	First draft
0001	26 January 2010	Updated logo and style

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