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Hydrometry — Echo sounders for water depth measurements

Hydrométrie — Sondeurs à écho pour le mesurage de la profondeur de l'eau

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4366 was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 5, *Instruments, equipment and data management*.

This second edition cancels and replaces the first edition (ISO 4366:1979), which has been technically revised.

Hydrometry — Echo sounders for water depth measurements

1 Scope

This International Standard provides information concerning the principles of operation, selection and performance criteria for echo sounders used in depth measurements for open-channel flow (and related) measurements. The use of standard terminology is promoted.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 772, *Hydrometric determinations — Vocabulary and symbols*

ISO 6420, *Liquid flow measurement in open channels — Position fixing equipment for hydrometric boats*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 772 and the following apply.

3.1
tracking window
vertical distance of limited size that follows and automatically centres itself on the depth indicated by the last received echo

NOTE If the next echo falls within the window, the signal is accepted as correct; if it does not, the signal is rejected. The purpose of a tracking window is to screen out erroneous readings caused by reflecting materials in the water (fish, debris, etc.).

4 Units of measure

The units of measurement used in this International Standard are SI units and decibels.

5 Principles of operation

5.1 General

The state-of-the-art of echo sounders is well advanced, and sounders have been put into widespread use for many different applications. Consequently, a variety of specialized echo sounders have evolved to best meet the specific requirements of the application. A digital echo sounder with an integrated analog chart generated by a thermal or inkjet print head is the most common echo sounder used for open-channel applications. Multiple-transducer systems are in common use by many professional surveyors and the use of single-transducer, multibeam-swath systems is expanding rapidly.

5.2 Theory of operation

The echo sounder is an electroacoustic instrument that determines the depth of water by measuring the time required for a burst of acoustic energy to travel from a transducer to the streambed and reflect back to the transducer (Figure 1). The travel time of the reflected wave can be converted to distance by use of the following equation:

$$d = \frac{vt}{2} + k + d_r \qquad (1)$$

where

d is the distance from the reference water surface to the streambed;

v is the average velocity of sound in the water column;

t is the travel time of the acoustic energy from the transducer to the bottom and back to the transducer;

k is the system index constant;

d_r is the distance from the reference water surface to the transducer (draft).

NOTE All distance units are consistent.

The velocity of sound varies with the density and elastic properties of the water, which are primarily a function of the water temperature and suspended or dissolved constituents (i.e. salinity). Large variations in temperature and/or salinity with depth are not uncommon. For practical depth measurement with an echo sounder, the velocity of sound is usually determined by calibration (see 8.1), since measuring and correcting for the actual variation at each depth interval is difficult.

The travel time of the acoustic energy is recorded either electronically by a digital echo sounder or graphically by an analog chart echo sounder. The shape, or sharpness, of the reflected acoustic energy pulse plays a significant role in the accuracy of a depth measurement (Figure 1). The shape and magnitude of the reflected energy pulse is a function of the acoustic attenuation, background noise and acoustic reflectivity characteristics of the target.

The system index constant (k) contains all electrical and/or mechanical delays inherent in the measuring system, including return signal threshold detection variations. The system index constant also contains any constant correction due to the change in the velocity of sound between the upper surface level and the average velocity used for the site. Therefore, the draft (d_r), set during calibration, is not necessarily the actual draft of the transducer that would be obtained by a physical measurement from the water surface to the transducer, but also includes corrections for the system index constant determined during on-site calibration.

5.3 System components

The echo sounder consists of two elements: the electronic assembly, which usually includes a display and/or recording device, and the acoustic assembly commonly called the transducer. The electronic circuitry generates high frequency electrical energy and provides regulated bursts of this energy to the transducer. When a burst of energy is released, time is measured until the reflected energy is received, then Equation (1) is solved and the depth is displayed or recorded.

The transducer is an electroacoustic assembly that acts as a two-way energy conversion device. During transmission, it converts pulses of electrical energy into pulses of acoustic energy that travel through the water to the bottom. During reception, it receives the reflected acoustic energy (echo) from the streambed and converts it into electrical energy for processing by the electronic circuits.

