UCM-60 / UCM-60DL
Technical Description

Revision 1.10

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1 Document Scope

This document is an introduction to the UCM-60 Ultrasonic Current Meter, giving a short description of the operating principles and the instrument features. It also includes the technical specification.

1.1 Parameters

The UCM-60 Ultrasonic Current Meter is basically designed for the measurement of:

- Current speed
- Current direction related to current meter orientation or true current direction
- Sound velocity
- Tilt

Additional sensors are available for the measurement of:

- Sea temperature
- Depth or pressure
- Conductivity

The UCM-60 further performs calculation of:

- Salinity
- Density

1.2 Configurations

Both direct reading and recording configurations are available. The direct reading configuration provides bi-directional communication with external terminal, enabling real-time data output as well as user-interaction. The recording configuration contains a FLASH-RAM memory module. Computed data stored in the memory enables data retrieval without opening the current meter housing.

Operating parameters such as sampling rate, sampling schedule, data averaging period etc., may be defined and programmed by the user.

The absence of moving parts reduces mechanical wear to a minimum and makes it less sensitive to marine growth and pollution in the sea.

1.3 Sensors

The current meter does not need to be aligned with the current direction before an accurate measurement can take place. The current may therefore be measured at high sampling rates in order to detect rapid changes in the fluid flow. As the measurement is not based on the acceleration of any physical mass, a very low velocity threshold is offered (1 mm/s) with a wide dynamic range (1 mm/s - 3 m/s or 2 mm/s - 6 m/s).

A compass can be included to establish the true direction of the current velocity.

The sea temperature is sensed by means of a fast response Pt-element protruding from the lower part of the instrument case. The standard measuring range is -5°C to +45°C.

For measuring the pressure of water head above the current meter (instrument depth), a high impedance pressure transducer can be mounted on the lower part of the instrument case (option). Different ranges available.

Conductivity is measured by an electrode less induction type conductivity cell. The standard measuring range is 2-77 mmho/cm. The conductivity cell, which is an optional extra, can be mounted on the lower part of the instrument case.

1.4 Microprocessor

The UCM-60 is software controlled. A 16-bit microprocessor controls data acquisition from the various sensors. The analogue signals for current, temperature, pressure and compass are converted by an external A/D-converter. The digital outputs from the A/D-converter are read by the microprocessor, together with the digital output signals from the sound velocity and conductivity measurements. The microprocessor performs continuous data averaging based on pre-set sampling period and integration period. The microprocessor also executes continuous calculations of current speed and direction. Density and salinity are calculated from CTD parameters.

The UCM-60 software also controls a power-off function between each observation period.

1.5 Communication

The microprocessor includes a bi-directional UART (full duplex serial port) to handle the bi-directional transmission. The UART may be programmed to various baud rates. The utilised format is 8-bit data, no parity and one stop bit.

Baud rates 300, 600, 1200, 2400, 4800, 9600 or 19200 baud.

Note! 9600 bits/s at cold reset (default value).

Available data interface is RS232C .

1.6 Real - Time Clock

The internal real-time clock keep count of year, month, hours, minutes and seconds.

A Start time (alarm) can be pre-set up to 30 days to initialise current meter operation. By means of lithium batteries, the real-time clock and the RAM will provide exact time and logging format for approximately 5 years.

1.7 Data Output

ID	Date	Time	E	Hor	Dir	Vert	Sound	Temp	Dept	Comp	Tilt	XY
00	950622	095608	0	4	8	1	1497	2531	1	319	0	0
00	950622	095609	0	1	45	0	1497	2531	0	319	0	0
00	950622	095609	0	2	30	-2	1497	2531	0	319	0	0
00	950622	095609	0	1	135	-0	1497	2529	0	319	0	0
00	950622	095609	0	1	34	1	1497	2530	0	319	0	0
00	950622	095609	0	3	52	-0	1497	2531	0	319	0	0

Figure 1. Data Output Example

Heading line description:

ID	Instrument identification number (address)
DATE	YYMMDD (Year, Month, Day)
TIME	HHMMSS (Hour, Minute, Second)
E	Error message
Hor	Horizontal velocity; mm/s
DIR	Direction; degrees
Vert	Vertical velocity; mm/s
Sound	Sound velocity; m/s
Temp	Sea temperature; 1/100°C
Dept	Current meter depth; m (dm)
Comp	Compass reading
Tilt XY	Tilt in X and Y directions; degrees (pos.. value X = centre leg tilted down, refer fig.1.3) (pos.. value Y = right leg tilted down, refer fig. 1.3)

In addition may the following be displayed if sensor installed:

Cond	Conductivity; 10^{-5} mho/cm
Salin	Salinity; ppm
Densi	Density; 10^{-5} kg/dm3

1.8 Ultrasonic Measuring principle

The UCM-60 Ultrasonic Meter is based on a precise measurement of the difference in transit time between an ultrasonic wave that is propagated along a defined distance through the water, and an ultrasonic wave that is simultaneously transmitted in the opposite direction over the same distance. The transit time for a pulse along one path is dependent upon the fluid velocity component along the same path. The difference in transit time for the two pulses transmitted simultaneously in opposite directions will therefore be a direct expression for the current speed resolved along the same axis.

The velocity of the acoustic pulse will vary with the water temperature, pressure (depth) and salinity. The current meter, however, automatically compensates for variations in the sound velocity by measuring the pulse transit time, deriving the actual sound velocity and adjusting the sensitivity to the correct value.

The turbulence and wake effects are compensated for in software.

1.8.1 Travel time difference principle

The UCM-60 Ultrasonic Current Meter works on the travel time difference principle exploiting the interaction effects between a moving fluid and acoustic waves.

By exciting two piezoelectric transducers with sharp voltage steps of approximately 350 V at a repetition rate of typically around 20 excitations per second simultaneously, each of the transducers generate bursts of high frequency ultrasound, typically 4 MHz, at the same repetition rate.

If the transducers, the active parts of which are small discs of piezoelectric material, stay in the moving fluid at an internal distance l, it can be shown that the time difference Δt between up and down stream sonic travel times, t_1 and t_2 respectively, corresponds to the mean flow velocity along the sonic path according to the equation.

$t_2 - t_1 = \Delta t = 2 \cdot l \cdot v / c^2$
l = the sound path between transducers.
v = the mean flow velocity component along the acoustic path.
c = the sound velocity through the fluid.

In order to reduce the effects of current flow circulation and wake around the transducer probes, compensation is performed by the computer.

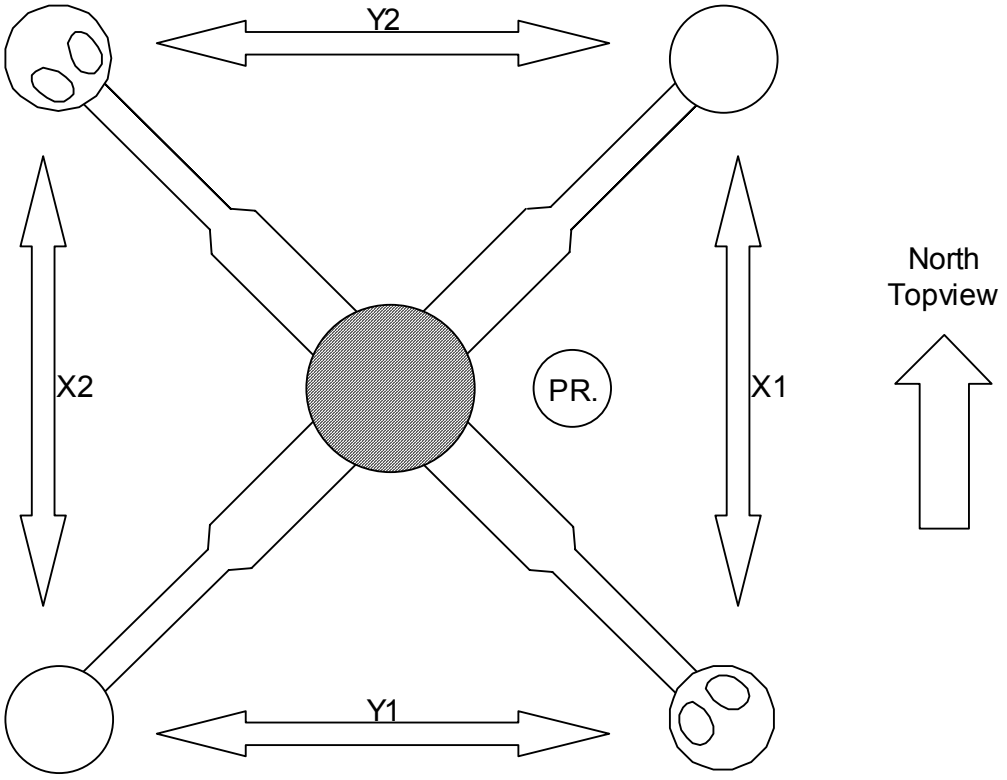

Figure 2. UCM-60 Ultrasonic Current Meter, Measuring Principle

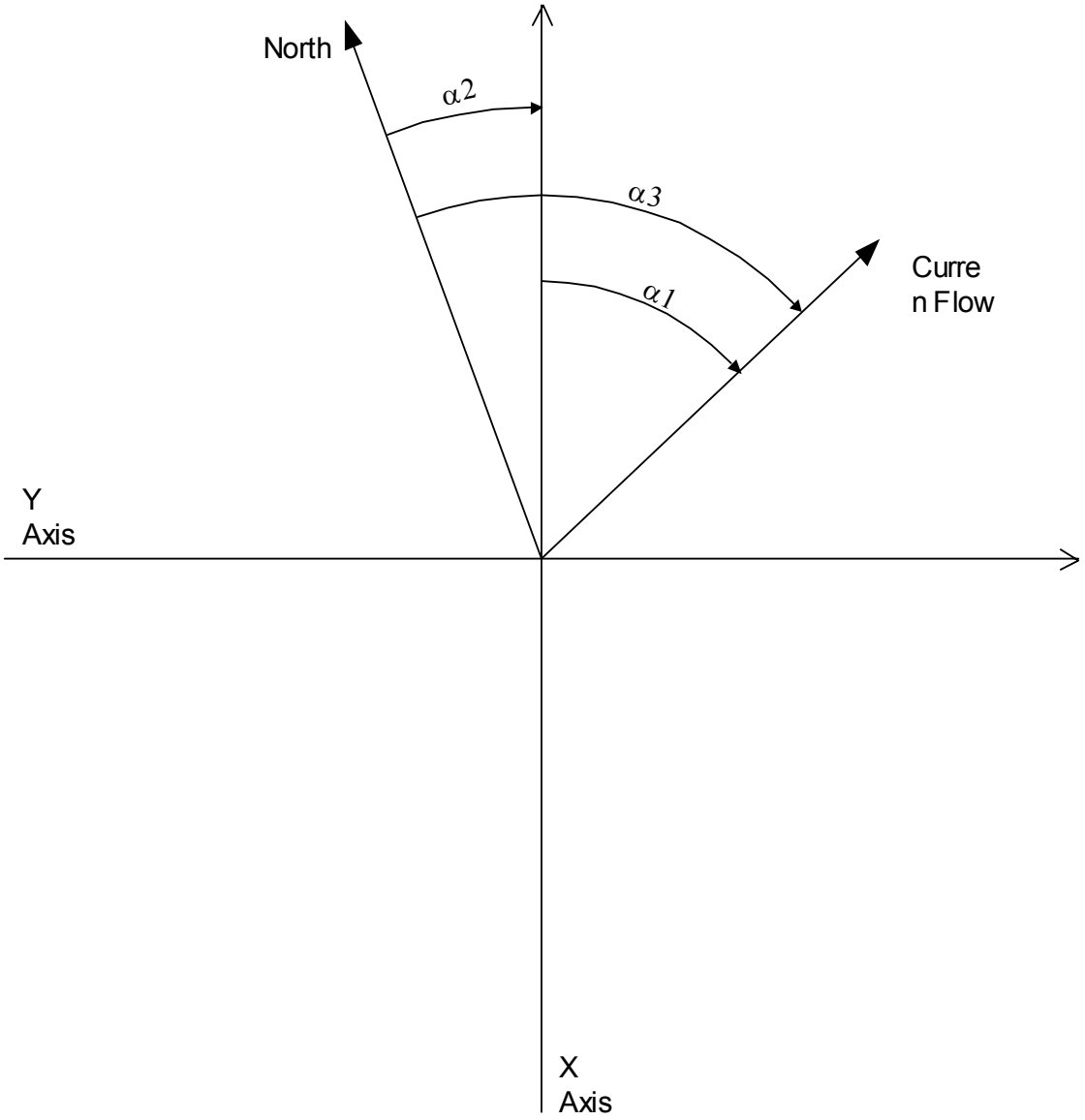

Figure 3. Current Direction referred to UCM-60 Axes and North.

α1 Current direction output (no compass included, current direction ref. To instrument)

α2 Compass reading ref. To instrument

α3 α1 + α2 = current dir. Ref. To north

If a SENSOR TEST is performed for this figure
X current = positive
Y current = negative (~3/4 X value)
Compass reading = ~ 10°

1.9 Timing principal

The principle of timing is laid out below. In the standard and opti program a sample is one cycle of single read-outs of all the sensors. Defined by the *number of integration* setting a number of samples are integrated into one observation. Observations are presented on the screen and/or written to flash memory. How many observations there are in one observation period is defined by the *number of observations* parameter.

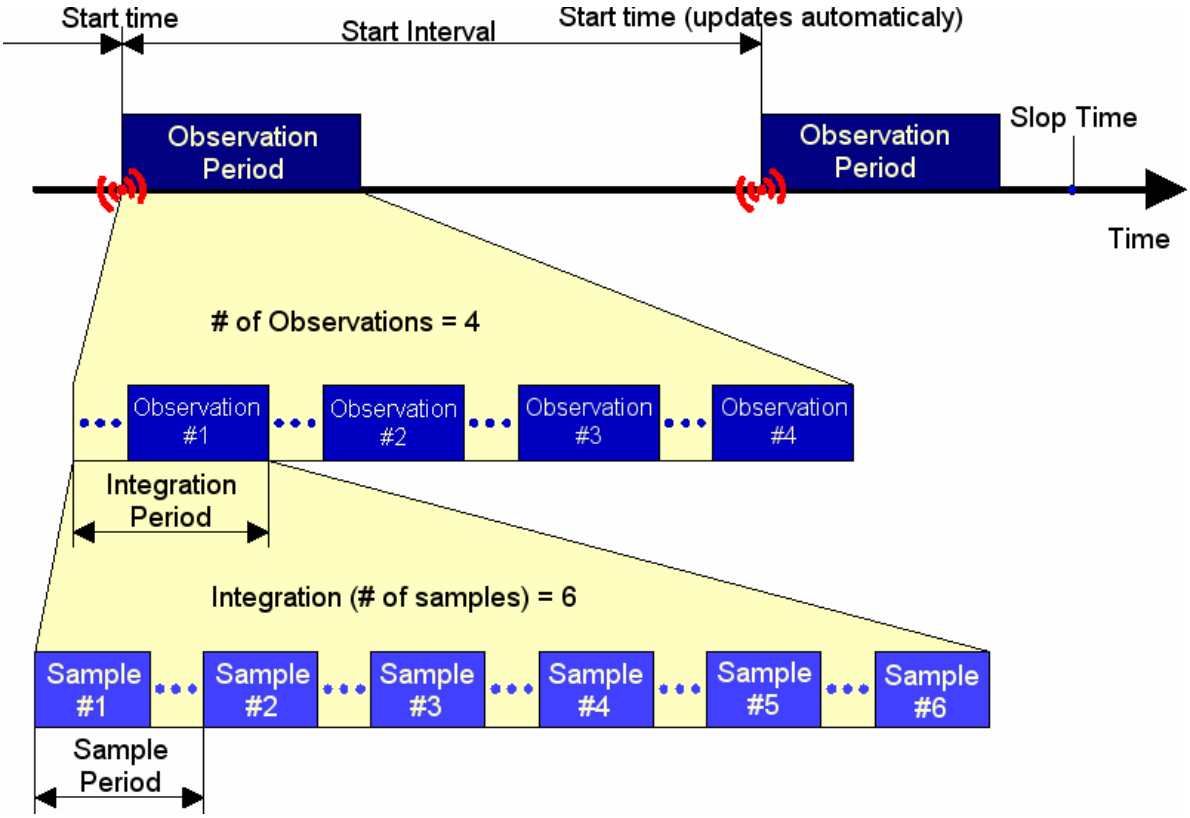

Figure 4. Relationship of timing parameters.

Under normal circumstances, i.e. not in standby mode, the instrument is turned off between observation periods. The instrument is awakened by an alarm function in its Real Time Watch. The *start time* reflects the alarm setting. At the beginning of each observation period the start time of the next observation period is calculated and updated. If *stop time* has expired the alarm function will be disabled.

Note !
Ensure that power is applied before "start time" arrives. If "Start Time" elapses before power is connected, the UCM-60 will not start. If you want auto operation, a new "Start Time" has to be set.

The programming determines, Limits:

Start time	Any day and time of the month (Updated with Start interval at each alarm).

Start interval	Same format as Start time and being added to Start time at each alarm.
Stop time	Same format as watch (YY MM DD HH MM SS WD WN). Ends setting of new alarms after Stop time passed.
Observations	Setting in no's of Observations (Integration periods) up to 65535.
Integrations	Setting in no's of Samples up to 65535.
Sample period	50 ms to 65535 ms

1.10 Application

The versatility of the UCM-60 makes it an ideal instrument for a wide variety of purposes:

- Measurement in connection with general oceanographic research and meteorological forecasts
- Water column profiling
  - CTD measurements
- Near bottom measurement in connection with
  - pipe laying
  - sub sea constructions
  - bottom surveying
  - submarine ROV operations
  - erosion measurements
- Measurements in the intermediate layers in connection with
  - pipe laying
  - estimation of forces on cables
  - estimation of forces on risers
  - estimation of forces on sub sea constructions
  - estimation of transport of particles and polluting material
- Measurement in the surface layer in connection with
  - offshore loading and unloading activities
  - navigation and positioning (offshore and in harbour)
  - anchoring
  - estimation of forces on constructions
  - search and rescue operations
  - anti pollution operations (dimensioning Criteria etc.)
- River flow measurements
- Fish-farming
- Harbour control

2 Technical specifications

2.1 General

Power supply	12 - 28 VDC
Power consumption	1.5 W
Sampling frequency	Up to 20 Hz
Output (input) signals	ASCII RS232C 8 bit data, no parity, 1 stop bit
Input/output connections	8 wires power lines, 4 data lines, 2 control lines Underwater plug able connector
Depth capability	2000 m (Optional: 6000m)

2.1.1 Container tube

Material, cylinder	Stainless steel AISI-316L
Material, lower part	Stainless steel AISI-316L

2.1.2 Dimensions

Total length	1015 mm
Cylinder diameter.	100 mm

2.2 Sensors

2.2.1 Current Velocity Sensors

Measuring principle	Acoustic travel time difference
Velocity vectors	Three axes: X, Y and Z
Range (programmable)	0 to +/-3 m/s, 0 to +/-6 m/s
Resolution (depends on range)	1 mm/s or 2 mm/s
Accuracy, normal operation	+- 5mm/sec or 1% whichever is greater
" , worst case, heavy tilted	3% of range +- 5mm/sec. (mean value)
Acoustic carrier frequency	approx.. 4 MHz

2.2.2 Sound Velocity Sensor

Range	1380 - 1580 m/s
Resolution	2.0 m/s
Accuracy	5 m/s

2.2.3 Temperature Sensor (optional)

Type	CS-1/10 Platinum resistance detector element, NE-Sensortec housing
Range	-5°C to +45°C
Resolution	0.01°C
Accuracy	0.1°C(0.02°C option)
Response time	<1.0 s(60 ms option, at flow rate 1 m/s.)

2.2.4 Pressure Sensor (optional)

Type	Piezo-resistive, High Impedance Corrosion Resistant Pressure Transducer
Range	0-20 bar (standard)(From 5 to 200 bar FS option)
Resolution	0.04% FS
Accuracy	Within 0.2% of F.S
Response time	<50 ms

2.2.5 Conductivity Sensor (optional)

Type	Aanderaa 2990S, Inductive cell
Range	2-74 mmho/cm
Resolution	0.01 mmho/cm
Accuracy	0,06 mmho/cm
Response time	0.05 s

2.2.6 Tilt Sensor

Type	Electrolytic Tilt Sensor
Range	+/-30°
Resolution	1°
Accuracy	10% of reading
Response time	<0.05 s

2.2.7 Compass

Type	3 - AXIS Fluxgate
Resolution	1°
Accuracy	+/- 1 deg.

Response time	0,05 s

2.3 Processor

Type	INTEL 80C196NT

2.3.1 Output channels

- Identification number
- Date (Day, Month, Year)
- Time (Hour, Minute, Second)
- Status data
- Current velocity, horizontal plane (compensated for compass and tilt)
- Current velocity, vertical plane (compensated for tilt)
- Sound velocity
- Temperature
- Pressure
- Conductivity
- Salinity (calculated)
- Density, based on CTD parameters
- Compass direction
- Tilt

2.3.2 Initialisation menu

- Addressing
- Setting/check of date/time
- Selection of channels to be sampled
- Setting of observation-, integration periods and start-up times

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