Jun 2021
Tsurumi-Seiki Co., Ltd.

For all users of XBT/XCTD system

Model change information about XCTD probe

Thank you very much for your continued support.
We started shipping new models in April 2021.

a) The new model has an "N" at the end and is written as XCTD-1N, XCTD-2N, XCTD-3N, XCTD-4N.
b) There is no change in the performance or specifications.
c) The convertor (MK-130/150N) and hand launcher, are used as usual.
d) The Windows software should be updated.
e) The new software can be used with both previous model and new model.

[Plug label design]

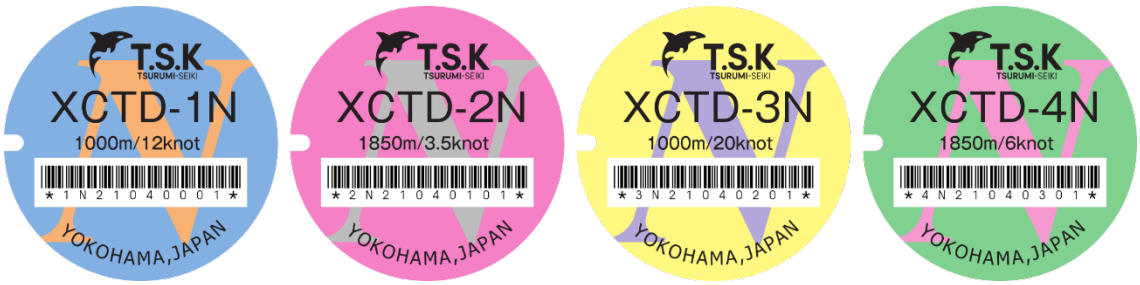


fig.1

Contact the probe supplier for new software.
More information is provided on our website.
< http://tsk-jp.com/nxctd_en/ >

1. Details of model change

a) With more and more circuit components/parts in the probe no longer in production, it's difficult to obtain the equivalent or compatible ones. We have decided to switch to a "New circuit board" that uses alternative/ succeeding parts.
b) Regarding the water temperature circuit, we have reviewed the conversion formula which converts the resistance to the water temperature, and have adopted another conversion formula that has less variation.

2. Software update

a) The windows software, that changes the conversion formula of water temperature, is in preparation.
b) Though the current software can also operate the new probe, there will be errors due to different conversion formula.
c) Though the errors are less than the resolution (0.01degC), have almost no effect. Please apply the updated software version.

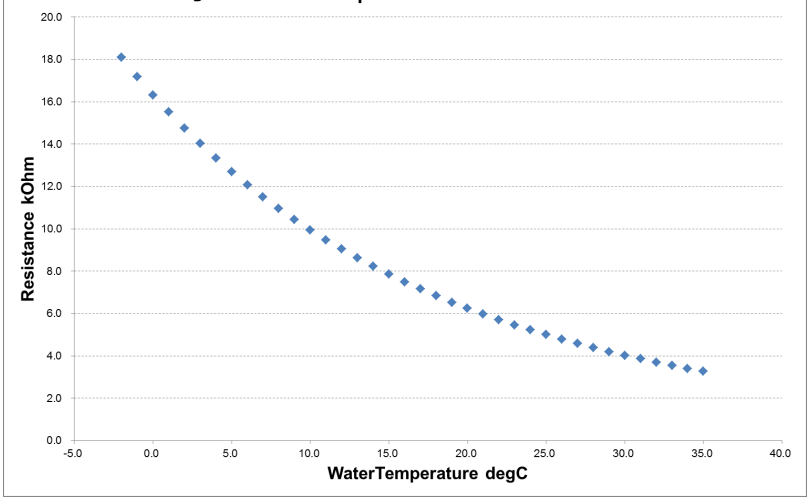
Customers of MK-150N
An updated software version of standard product will be provided by download. For customers using special specifications such as the Auto launcher, as its software should be customized, please contact us and then take suitable measures.

Customers of MK-130 (Old product)
It has been more than 10 years since the end of product shipment. It will be difficult to update all versions including special specifications. For the time being, the update for the following standard versions will be provided by download. Ver2.06: updated for XCTD-1N new probe. Ver3.02, 3.07, 3.09, 3.11, 3.12, 3.13: updated for XCTD-1N, 2N new probes.

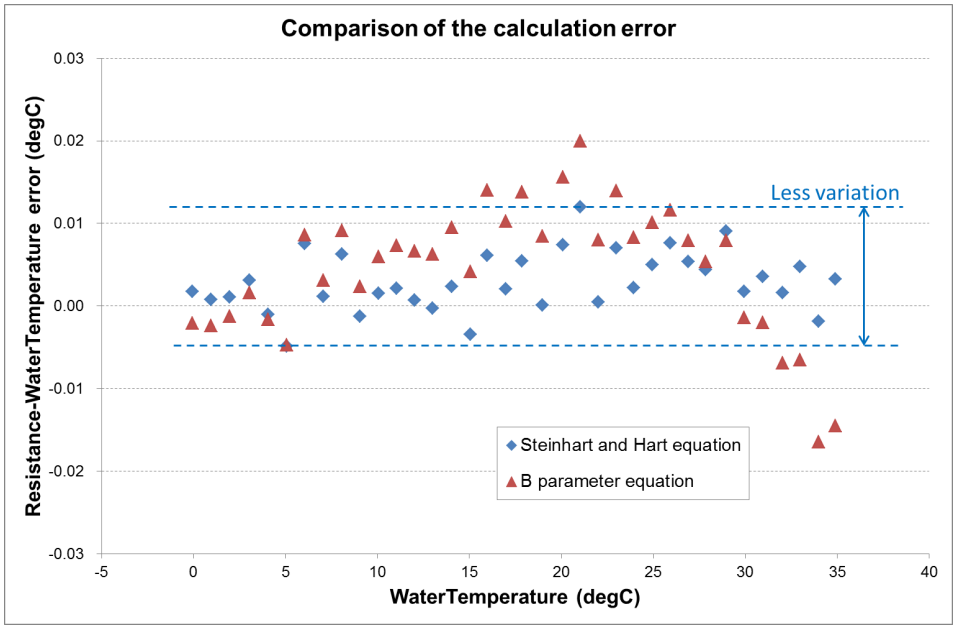
EXPLANATION

1. About water temperature conversion formula
a) A device called thermistor, whose resistance changes greatly with temperature, is used to measure water temperature.
b) The characteristic of the thermistor is that its resistance is large at low temperature and decreases as temperature rises.

fig.2 WaterTemperature-Resistance



c) The B parameter equation is generally used for converting the thermistor



resistance to temperature. The current MK130/150N convertor also adopts this equation.

fig.3

d) On the other hand, another formula, named Steinhart-Hart equation, is found that has a close approximation. The above graph [Comparison of the calculation error] shows an example of temperature errors between real value and the current B parameter equation or the Steinhart-Hart equation, after it's calibrated at 0, 15, 30degC.

e) Since the Steinhart-Hart equation has less variation and better expression to the thermistor characteristic, we will switch the water temperature conversion formula to it with the model change this time.

$$T = \left(\frac{1}{\left(B_1 + C_1 ln(B_2) + E_1 ln(B_2)^2\right) + F_1 ln(B_2)^3} \right) - 273.15 \ \ (\text{degC})$$

$B_1 = 0.12901230e^{-2}$
$C_1 = 0.23322529e^{-3}$
$E_1 = 0.45791293e^{-6}$
$F_1 = 0.71625593e^{-7}$
$B_2 = \text{thermistor resistance}(\text{k}\Omega)$

2. Errors when using the new probes with the current software

a) We calibrate and set the probe circuit, so that it gets the same digital values at 0, 15, 30degC as the current product. Therefore the errors are

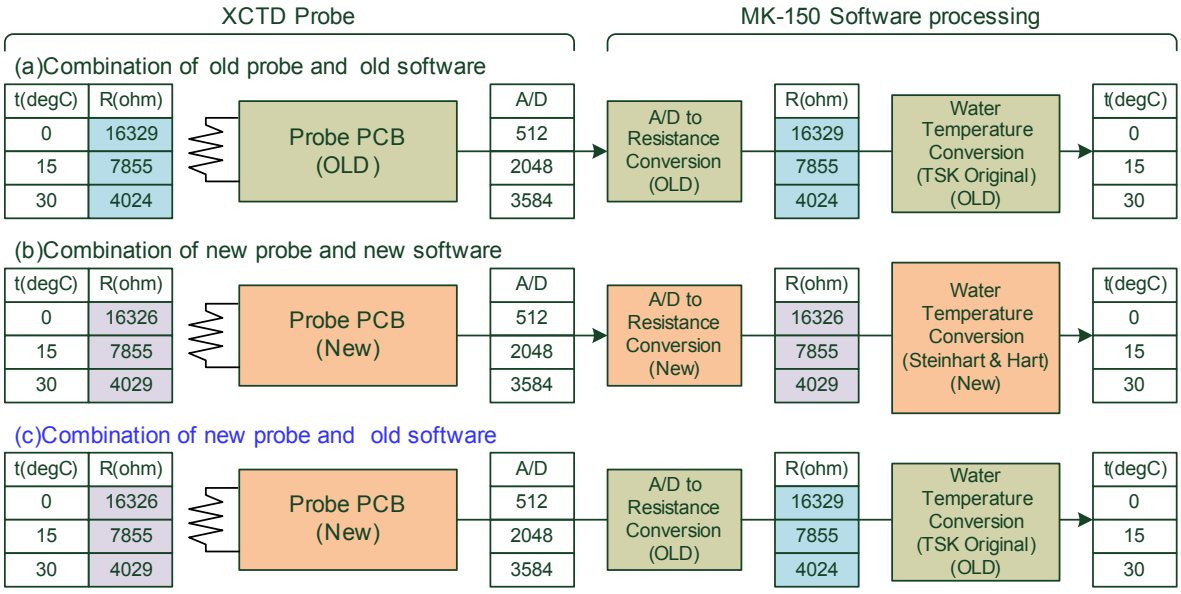


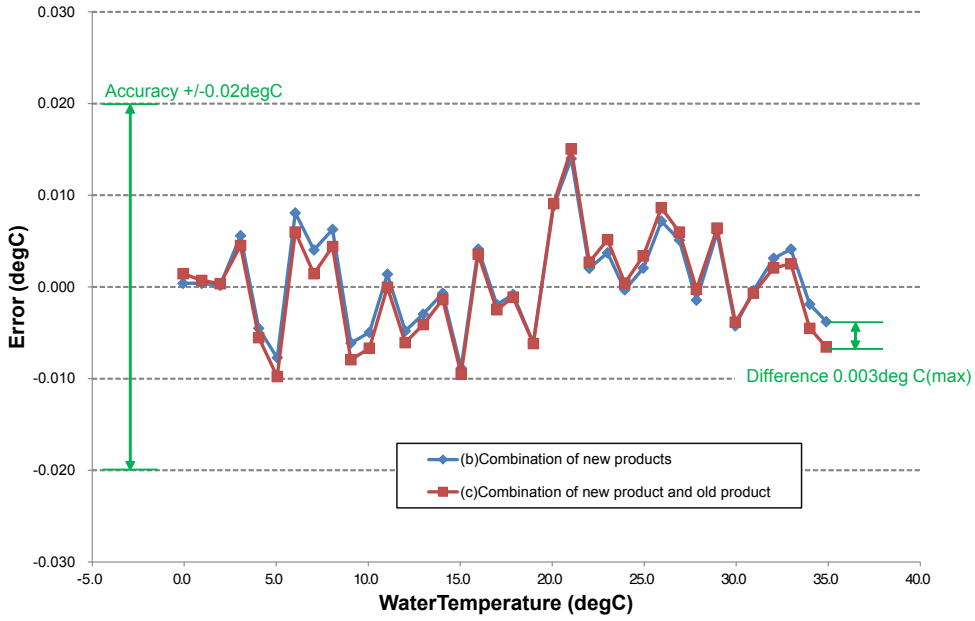
fig.4

suppressed.

b) Since the probe circuit digitizes with 12 bits (4095 steps), the digitization error is also occurred with the Steinhart-Hart equation. We use the same data in graph [fig.3 Comparison of the calculation error], and compare the errors calculated by the 2nd and 3rd combination respectively. The result is shown below.

c) The 3rd combination, which uses old software for new probes, will have a maximum error of 0.003degC.
d) If the water temperature shifts by maximum 0.003degC,the salinity will shift maximum 0.003PSU after conversion.

fig.5 **Digitization error**



Note) the graph is an example of thermistor picked up and inspected randomly. The result varies depending on individual differences.

3. File compatibility
a) There is no change in the file format. Both the old and new software can process data replay, print etc.
b) For a raw data file (*.RAW), the water temperature is converted after file read. Calculation error will occurred when it's opened with the old software version.

4. No effect on XBT probe
a) Although the XBT and XCTD use the same thermistor, there is no effect on the nominal accuracy (+/-0.2degC) of XBT.
b) There is no change in XBT processing in MK-30N, MK-130, MK-150N.