SIMRAD

70 YEARS

1947-2017

UNDERWATER SCIENCE

Single Beam Systems

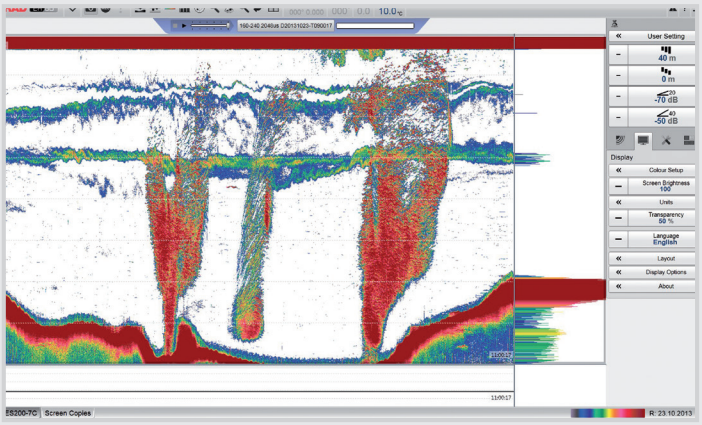
TECHNOLOGY FOR SUSTAINABLE FISHERIES

SIMRAD EK SYSTEMS

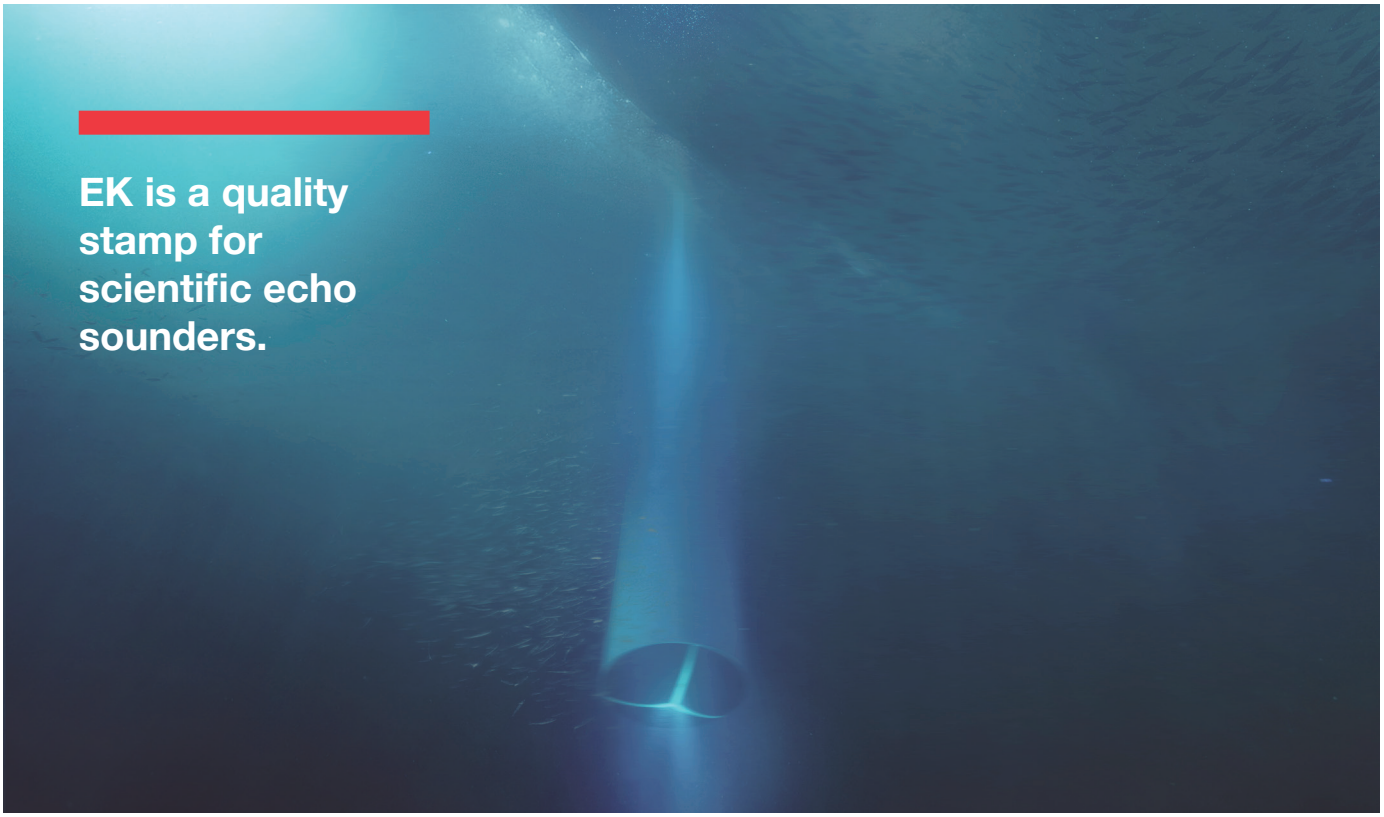
EK is our common name for all single beam echo sounders designed for research applications. The first EK sounder was introduced in the 1960's, and already back then the focus was to create a quantitative sounder that could measure biomass.

All EK systems share some common features such as built-in calibration and split beam capabilities with full beam compensation for accurate TS measurements. The focus when designing the EK system is that you should be in full control of all sounder parameters. That is why there are no automated settings in the acquisition SW. A skipper might want optimal settings displayed at all times to get a good picture of the fish, but a sudden change in ping rate or duration might corrupt a survey, with data no longer comparable.

Another common feature is a standardized RAW data format, which means that you can compare data across platforms. In many cases you need to combine your vessel data with data collected from profiling platforms to get TS measurements or measurements from deep scattering layers, and those times it is good to know that the sounders use the same currency. Simrad RAW data is an open, well documented format, as can be expected from a scientific system.



In this EK80 screen capture you see hard bottom in deep red colour, herring schools releasing gas that slowly drifts towards the surface and a substantial layer of plankton and small jelly fishes.

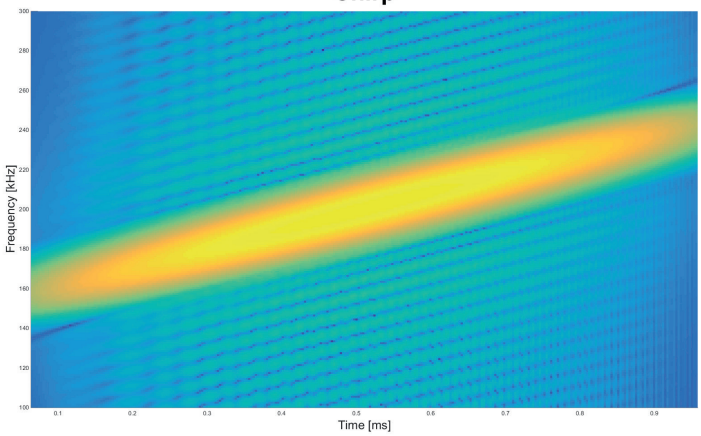


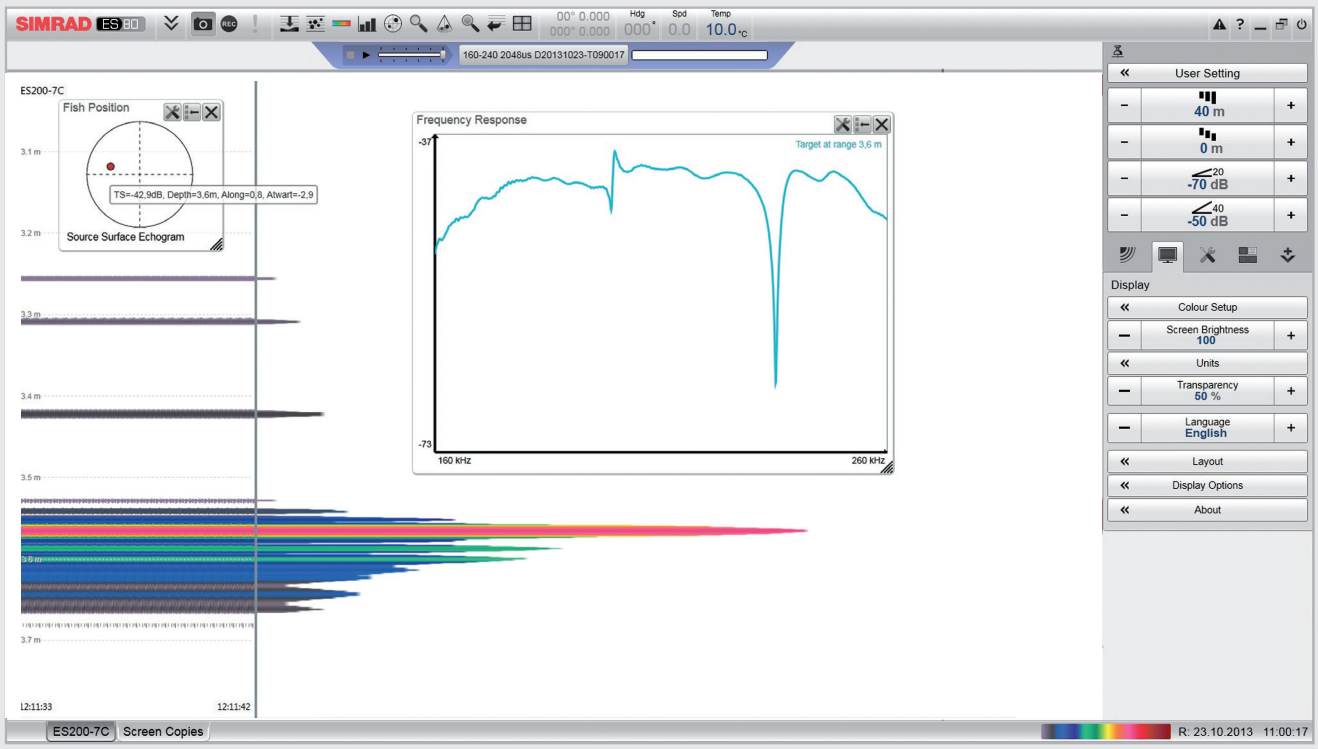
WIDEBAND ECHO SOUNDERS

The new series of EKs has wideband capabilities. That means that you can transmit a signal that varies across the transmission, called a chirp. The most common way to operate the sounder is to use a linear chirp. In an EK80 chirp you either utilize the entire effective frequency band of the transducer, or you can choose to limit the bandwidth.

Due to advanced matched filtering techniques you can correlate the returned signal with what you sent out, and the result is improved range resolution of single targets. Also, as resolution is now a function of bandwidth rather than pulse length, chirp allows for long range performance without scarifying the resolution. When you have very weak targets in the near vicinity of strong ones, such as small fish close to bottom, you might want to use a different pulse shape. A dolphin's click is shorter, but still spans over a large bandwidth and might be better suited for such environments. The EK80 is prepared for such requirements, and as the SW continues to be developed, new functions would be available.

Chirp



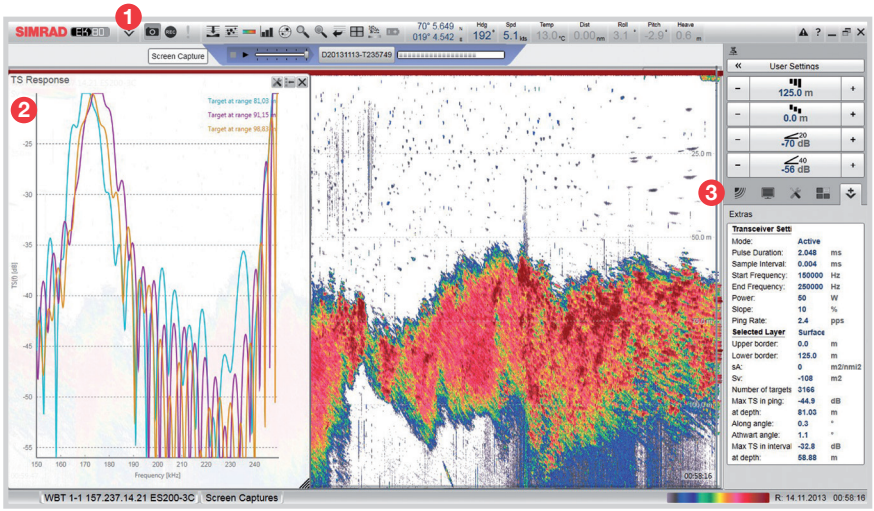


Range resolution and target ID are improved. Echo from a 38,1 mm tungsten sphere is measured, and you can clearly see how the target strength changes with frequency. This frequency response is unique to this particular target, and corresponds well with the theoretical curves. Resolution is excellent, and you can clearly see the knot on the fishing line where the suspended sphere is attached to the line, around 10 cm from the sphere itself.

EK80 SOFTWARE

The Simrad EK80 system consists of an acquisition software, one or more wideband transceivers, and transducers. When used with the EK80 real time acquisition software, the system is operated by a Windows™ based processor. Also, the system normaly requires input from auxiliary sensors such as GPS and motion sensor.

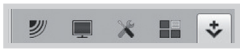
The EK80 SW is the command and storage centre of the system. This is where the user sets the parameters of the transmission and the data you want to record. The EK80 also has advanced tools for replaying and visualization of RAW data. Biomass in predefined layers is automatically calculated, and the SW has lots of new tools such as frequency response across the frequency band and a neat little zoom tool that can be used to inspect details.



1

Frequently used buttons and numerical displays such as ship heading, roll, pitch and heave are always shown on top of the EK80 SW. The EK80 has new tools that can be used to inspect and display data, when clicking on the magnifying glass you would for instance get access to a zoom tool that can come in handy when creating screen shots to use as examples.

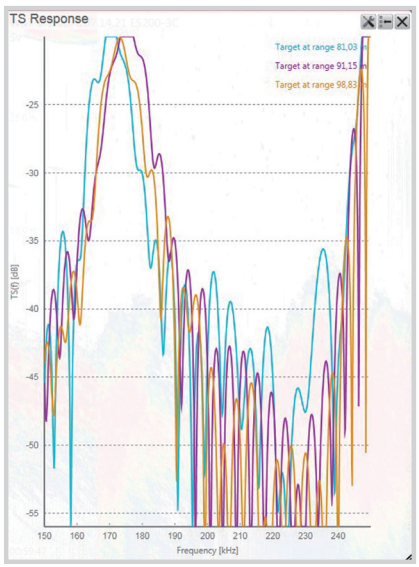
3



All settings needed to operate the EK80 SW are distributed under five main tabs for easy operation:

- The **OPERATION** menu is the place where you have all settings that are directly influencing the RAW data you record, such as transmission settings and settings related to RAW data recording.
- The **DISPLAY** menu comprises settings that regulate how the SW appears on your computer right now.
- The **SETUP** menu includes installation and calibration settings
- The ACTIVE menu contains settings and calculations for the active channel or layer. Layer definition, biomass calculation parameters and TVG settings are all set up here.
- The **EXTRAS** menu, which is displayed here, shows numerical details from the transmission, as well as the results from the active layer.

2

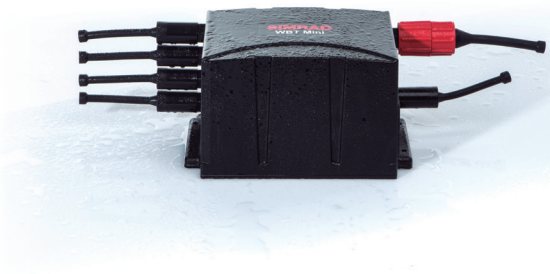


TS response for resolved targets is calculated and displayed as a function of frequency in real time in the EK80 SW. In this capture you can see three objects passing the single target criteria, all being picked out of a dense mackerel school at 81, 91 and 98 meter range. In the tool menu you can also set the parameters of what is to be recognized as single targets.

WIDEBAND TRANSCEIVER (WBT)

The Wideband Transceiver is designed for applications where performance is the top priority. The WBT has four 500 W channels that can either work independently with single beam transducers, or together with a split beam transducer. The WBT is optimized for applications where power consumption and size is not critical, typically on board a research vessel or a platform with power and and high speed Ethernet communication available.

The WBT transceiver is capable of operating on entire band from 10 kHz to 500 kHz, only limited by the transducer's bandwidth.



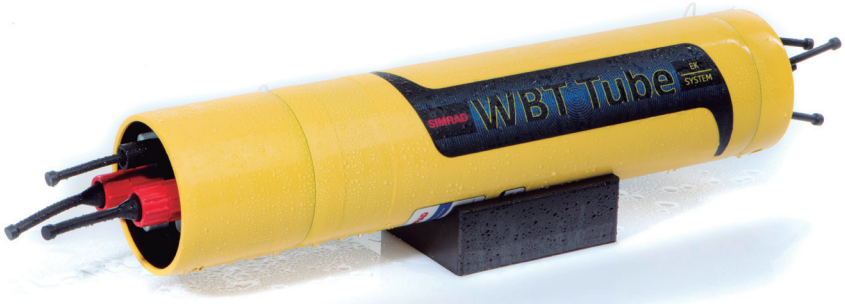
WBT MINI

As a compact version of the Wide Band Transceiver, the WBT Mini presents an energy efficient and splash proof design. The frequency range (30-500 kHz) and the output power are lower than in the WBT. In return it offers very low power consumption, perfect for platforms with limited available power and space.

The WBT Mini also has built-in multiplexing on each transceiver channel, allowing for alternation between two 4 channel split beam transducers, or a combination of 3 channel split beam and single beam transducers.

WBT TUBE

The WBT Tube is a 4000 meter depth rated version of the EK80 WBT family. The tube contains two built-in transceivers that rely on external power. It is connected to the EK80 processor through Ethernet.



EK80 PORTABLE

The EK80 Portable system has all the tools needed for your survey but in a small size. The EK80 software runs on an internal processor with built-in GPS, all controllable from your phone or tablet through WIFI connection. The WBT mini transceiver allows for a compact, energy effective solution, with up to two selectable transducers connected at the same time.

SIMRAD EK MISSION PLANNER

PLAN YOUR MISSION

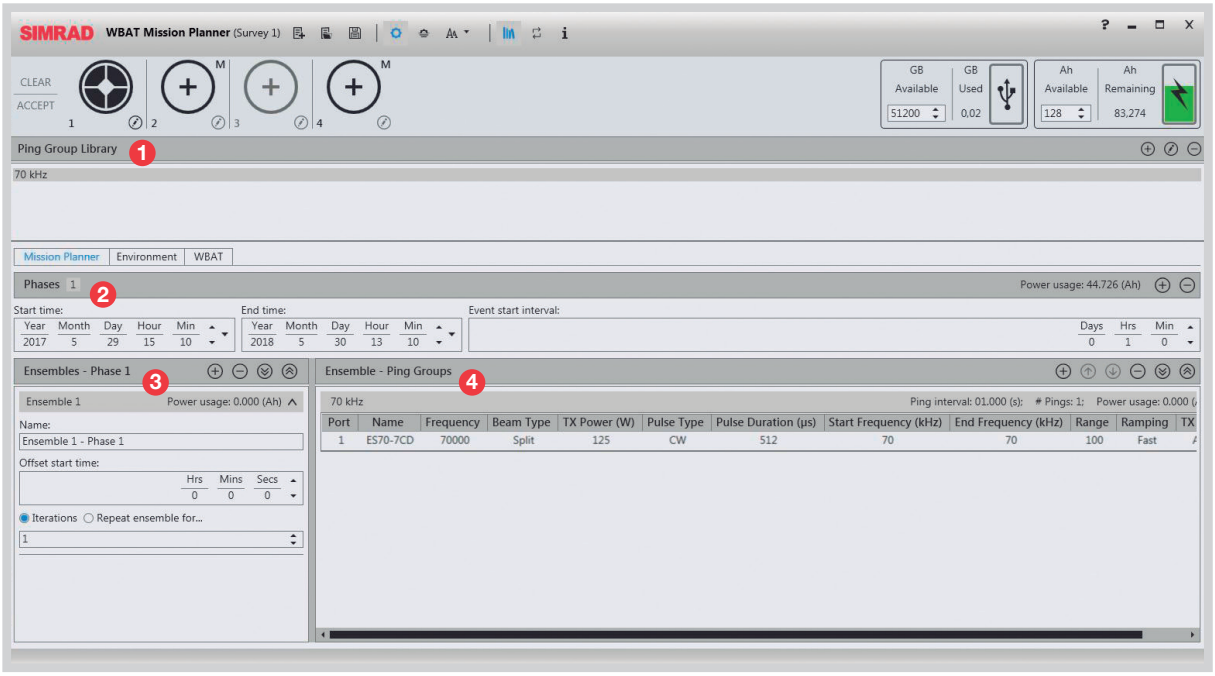
The EK80 Mission Planner is, as the name implies, a software used to plan a mission from deployment to recovery.

All details regarding when the sounder should wake up, how long it should transmit and when it should go to sleep can be set before deployment.

In the Mission Planner the user can set as many phases as the survey requires. This could be helpful if you want the transmission scheme to change throughout the deployment. You might want to do CW most of the time, while doing chirp in shorter periods to look at frequency response of targets.

After carefully planning the deployment, all settings are uploaded to the transceiver. The unit is then ready to be deployed, and the only remaining task is to click on the Activate mission button.

Apart from uploading the setup for a predefined mission, the settings created in the Mission Planners can be used in an “interactive mode” that allows the user to redefine some of the parameters even after the deployment.



1

PING GROUP LIBRARY
The ping group library contains a collection of your personal ping groups defining what the transceiver will do when it wakes up.

2

PHASE(S)
The Phase defines when and how often the transceiver should wake up during a deployment period. A mission plan must contain at least one phase. Multiple phases are also allowed. At certain intervals within a Phase the transceiver will wake up and record data as specified by the mission plan.

3

ENSEMBLES
An Ensemble is a collection of one or more Ping Groups from the Ping Group Library. Within an Ensemble, it is possible to choose several Ping Groups, for instance one for “active” CW followed by “active” FM followed by a “passive” CW ping. An Ensemble can be executed a number of times or for a period of time.

4

PING GROUPS
A Ping Group defines ping parameters, such as its frequency, power, pulse type and pulse length.

WIDEBAND AUTONOMOUS TRANSCEIVER (WBAT)

The EK Wideband Autonomous Transceiver is made for applications where it is necessary to gather scientific data from other platforms than traditional research vessels. Typically this involve long term monitoring or monitoring in places where it would not be pratical, or in some cases not even possible, to use a research vessel. As the WBAT has a standard depth rating of 1500 meter, it can also be used to profile layers in depths where hull mounted echo sounders cannot reach with high frequencies.
An autonomous EK system consists of an autonomous transceiver, one or more transducers, and a mission planner. The data from the system can also be viewed and calibrated with the EK80 SW as the RAW data format are the same.

The WBAT uses the same technlogy as the WBT wideband transceiver, but has been redesigned to be more compact and energy efficient. The four independent channels can be used as multiple single beam channels, or working together with a split beam transducer. With the built-in multiplexer you can also use two split beam transducers together using sequential pinging.

Although operating without the EK80 SW, the WBAT collects data in a format, and of a quality to be expected from any EK system. This means that the data coming from different sources can be easily integrated. Being part of the EK80 family, the WBAT is capable of split beam, the Autonomous EK is capable of split beam, which means that it can be calibrated to the same standards and with the same techniques as the EK80.

The pressure rated housing itself, along with the connections and the internal battery are already proven Kongsberg Maritime technology. The Kongsberg transponders are used globally in the oil and offshore industry, with the highest requirements for quality and safety found anywhere in the marine business. Coupled with more than 70 years of experience with underwater acoustics, the end result is reliable echo sounders that the customer can count on.

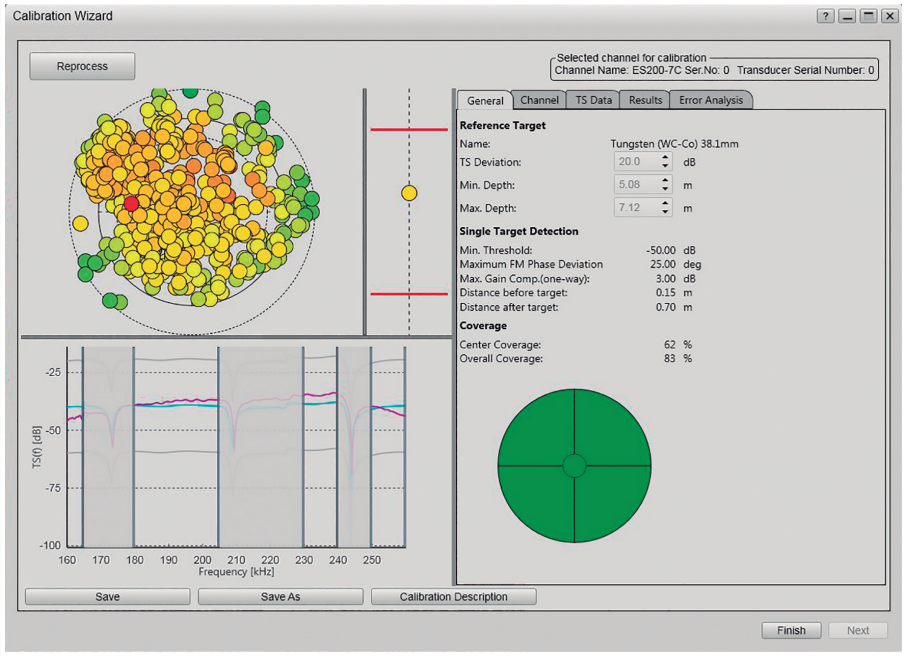
WBT MINI AUTONOMOUS MODE

As an option, the WBT Mini can also be operated in autonomous mode. In this configuration, the transceiver is preprogrammed with the EK Mission Planner. It can either operate according to a preset mission plan or interact with an external processor through the RS422 connection. The internal microprocessor can also be set up to send back compressed data suitable for satellite transmission, perfect for unmanned surface vehicles and other platforms where the user needs real time data.

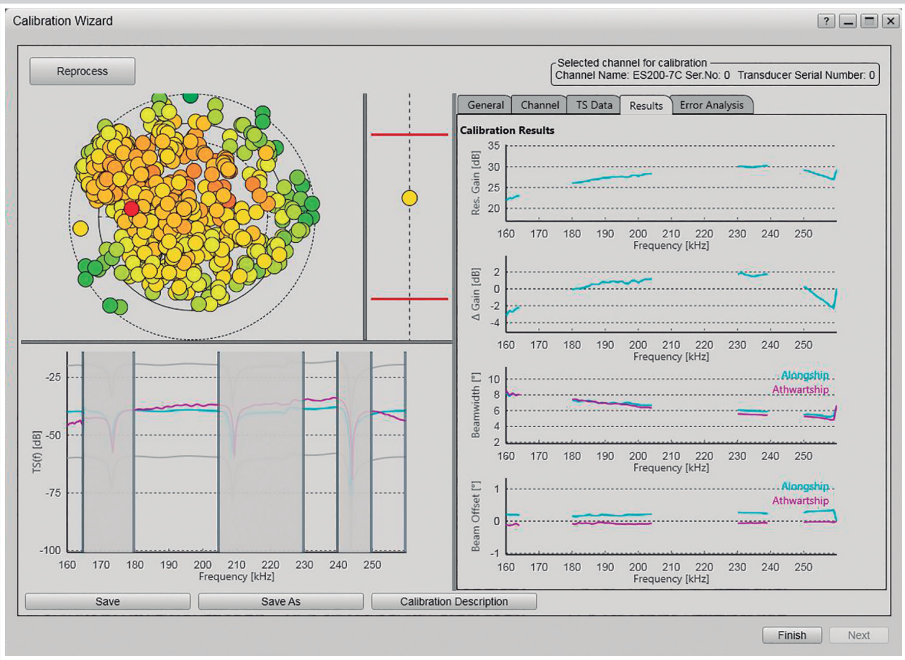
CALIBRATION

All Simrad echo sounders should be calibrated in field by the user at regular intervals. Above all, calibration is required to collect quantitative data.
There is however another good reason why you should calibrate your system frequently. A calibration is your best insurance that the system is working as expected. If a connection is unstable, or a channel in your transducer has malfunctioned, you will know instantly.

With the introduction of chirp you introduce new challenges around calibration, as both the frequency and the beamwidth change during transmission. The EK80 SW has the calibration functionality built-in. It takes care of all of this for you, calibrating the entire bandwidth with split beam techniques also for chirp transmissions.



The EK80 calibrates the full beamwidth of the split beam transducer, and across the frequency range of the transmission. There will always be areas where the calibration sphere has "nulls", frequencies where the sphere has very low target strenght. While it is these nulls that allow you to identify the particular target, these areas are not usable for calibration, and the EK80 SW lets you adjust the frequency ranges that are to be used for the particular calibration. The new and improved EK80 SW is designed to be intuitive and easy to use, and this does of course also apply to the important calibration procedure.



After you have collected data across the beamwidth it is time to view the data and apply the calibration. Note the three rings in the target detection window, where the centered ring represents the beamwidth at the center frequency of the transmission. The outer and inner rings represent the opening angle at the start and stop frequency. Only target detections that have been seen across the frequency band is accepted for the calibration.
If the results appear to be within the expected variance you save the data, click the "Finish" button and the system is calibrated.

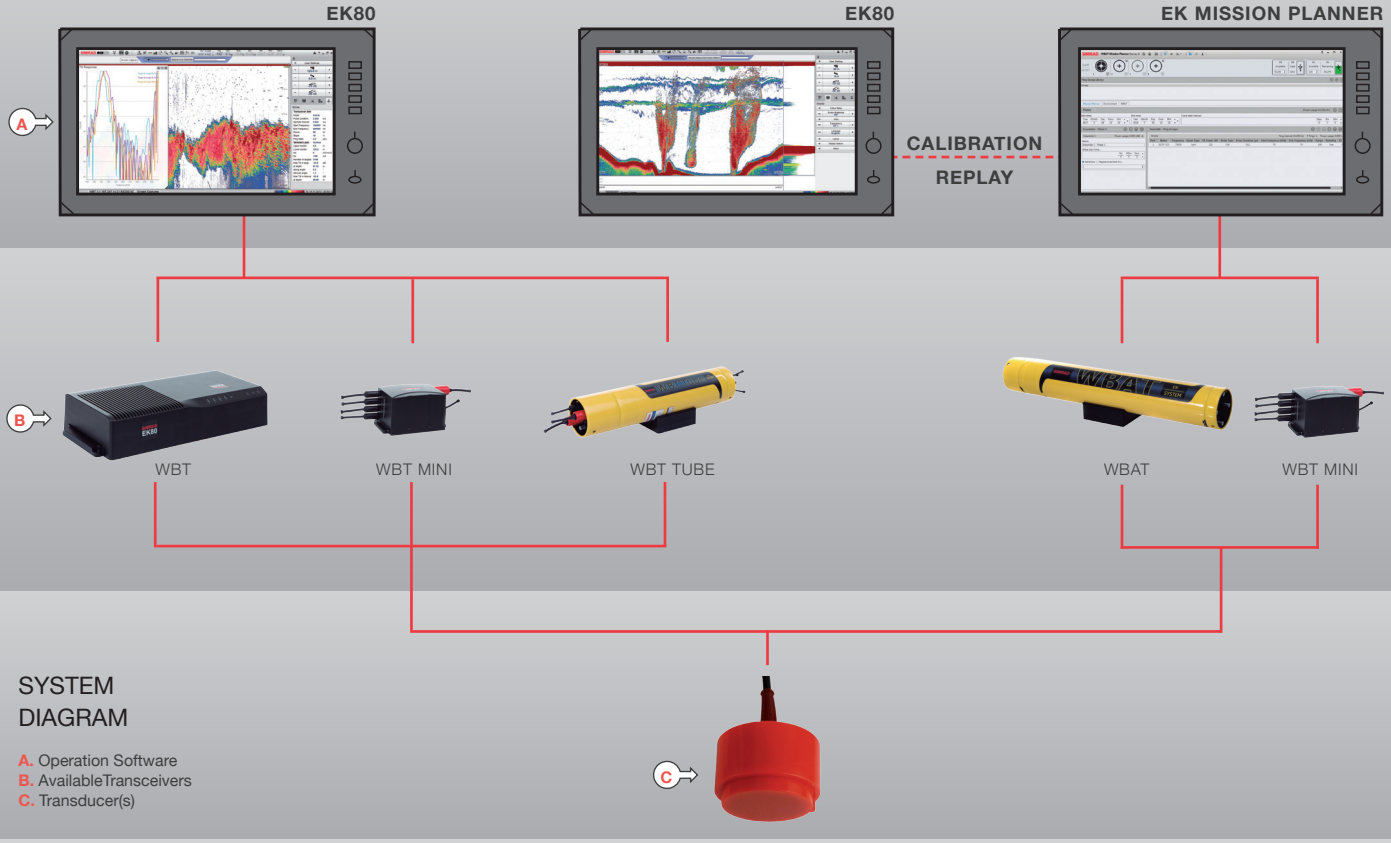
EK TRANSCEIVERS SPECIFICATIONS

	WBT	WBT Mini	WBT Tube	WBAT
Frequency Range	10-500 kHz	30-500 kHz	30-500 kHz	30-500 kHz
Pulse Duration	64-16384 µs	64-2048 µs	64-2048 µs	128- 2 µs
Pulse Forms	CW, FM (up and down sweep), Custom (future option)	CW, FM (upsweep)	CW, FM (upsweep)	CW, FM (upsweep)
Transmit Power	2000 W @55 Ω	1000 W @55 Ω	1000 W @55 Ω	1000 W @55 Ω
Number of Channels	4	4 (8 with MUX)	8 (16 with MUX)	4 (8 with MUX)
Transducer options	Single, Split	Single, Split	Single, Split	Single, Split
Internal memory	N/A	512 GB (Aut. Ver.)	N/A	512 GB (Aut. Ver.)
Depth / Width / Height	213 / 438 / 84 mm	145 / 223 / 123 mm	701 / 144 / 144 mm	166 / 166 / 1000 mm
Weight air/water	4.9 kg	5.4 / N/A kg	14.1 / 3.6 kg	25/12
Voltage requirement	12-15 VDC	12-16 VDC	12-16 VDC or 20-50 VDC	14 V (internal battery)
Power consumption 38/120/333 kHz	20 / 10 / 5 W	6 / 3 / 3 W	6 / 3 / 3 W*	6 / 3 / 3 W
Passive/Standby	4 W	2 / <0.02 W	2 W* / N/A	2 / 0.02 W
Maximum current	5 A	2.5 A (Peak)	2.5 A (Peak)	2.5 A (Peak)
Power source	External	External	External	Built-in battery
Operational temperature	-15 to +55 °C	-15 to +55 °C	-5 to +35°C	-5 to +35°C
Storage temperature	-20 to +70 °C	-20 to +70 °C	-20 to +55°C	-20 to +55°C
IP/Depth rating	N/A	IP67	4000 m	4000 m
Enclosure Material	Aluminium	Aluminium	Aluminium	Aluminium
Compass safe distance standard/other	30 cm	N/A	N/A	N/A
External Interface	Ethernet, Digital sync I/O	Eth/serial	Ethernet	Serial

*WBT tube has two transceivers available. Consumption and power requirements are given for one transceiver.

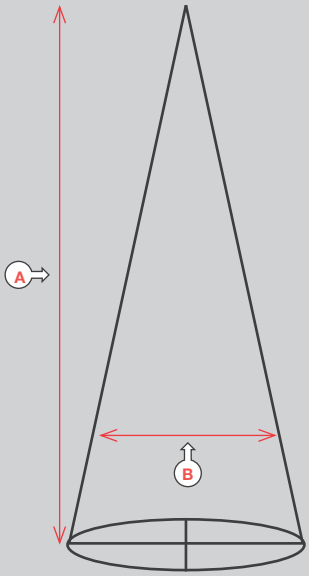
EK80 REAL TIME SYSTEM

EK80 AUTONOMOUS SYSTEM



SYSTEM DIAGRAM

A. Operation Software
B. AvailableTransceivers
C. Transducer(s)



FOOTPRINT ON DIFFERENT TRANSDUCER BEAMWIDTHS

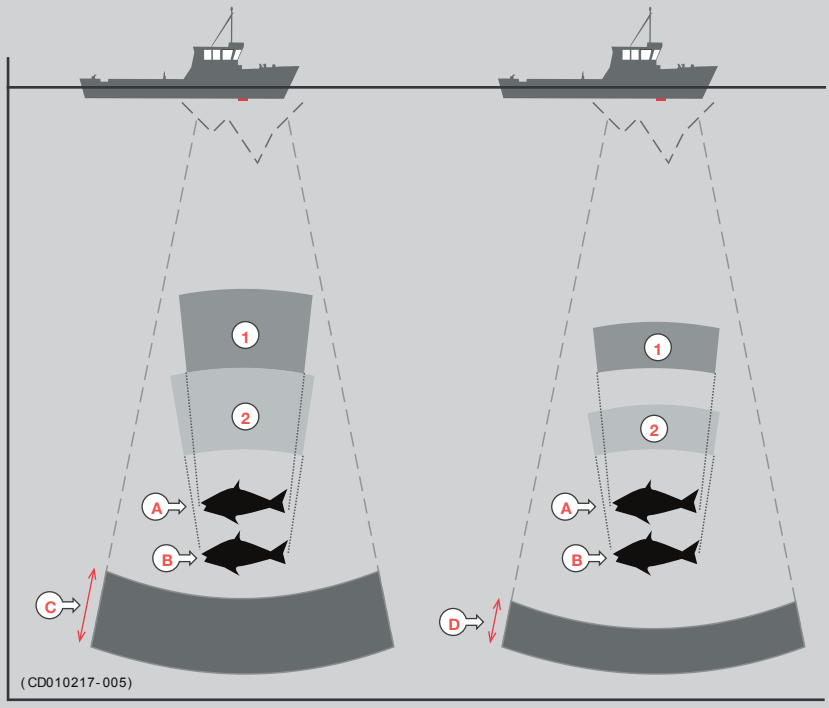
A		Meters	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
		Feet	33	66	98	131	164	197	230	262	295	328	361	394	426	459	492
		Fathoms	5	11	16	22	27	33	38	44	49	55	60	66	71	77	82
B	7°	Meters	1	2	4	5	6	7	9	10	11	12	13	15	16	17	18
		Feet	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	10°	Meters	2	4	5	7	9	11	12	14	16	18	19	21	23	25	26
		Feet	6	11	17	23	29	34	40	46	52	57	63	69	75	80	86
	13°	Meters	2	5	7	9	11	14	16	18	21	23	25	27	30	32	34
		Feet	7	15	22	30	37	45	52	60	67	75	82	90	97	105	112
	30°	Meters	5	11	16	21	27	32	38	43	48	54	59	64	70	75	80
		Feet	18	35	53	70	88	105	123	141	158	176	193	211	228	246	264

RANGE RESOLUTION ON VARIOUS TRANSDUCERS

Range resolution in CW mode is given as half the pulse length. Range resolution in chirp mode however, is given by the bandwidth (BW), not the pulse duration:
Range resolution=c/2xBW

As an example, an EK80 transmission could use 100 kHz bandwidth. Assuming a sound speed (c) of 1500 m/s, this will give a range resolution of about 8 mm, far better than in CW. Range resolution from the composite transducers is in brackets in the table below for comparative purposes.

	64µS	128µS	256µS	512µS	1024µS	2048µS	4096µS	8192µS
18 kHz				40 cm	75 cm	150 cm	300 cm	600 cm
27 kHz				40 cm	75 cm	150 cm	300 cm	600 cm
38 kHz			20 cm	40 cm	75 cm	150 cm	300 cm	
50 kHz		10 cm	20 cm	40 cm	75 cm	150 cm		
70 kHz		10 cm (2 cm)	20 cm (2 cm)	40 cm (2 cm)	75 cm (2 cm)	150 cm (2 cm)		
120 kHz		10 cm (1 cm)	20 cm (1 cm)	40 cm (1 cm)	75 cm (1 cm)			
200 kHz	5 cm (0,8 cm)	10 cm (0,8 cm)	20 cm (0,8 cm)	40 cm (0,8 cm)	75 cm (0,8 cm)			
333 kHz	5 cm (0,5 cm)	10 cm (0,5 cm)	20 cm (0,5 cm)	40 cm (0,5 cm)	75 cm (0,5 cm)			



The left vessel uses a long pulse duration (C). As you can see, this causes the echoes from the two fishes (A) and (B) to merge.

The right vessel uses a shorter pulse duration (D), and the two fishes will then appear as two separate echoes on the echogram.

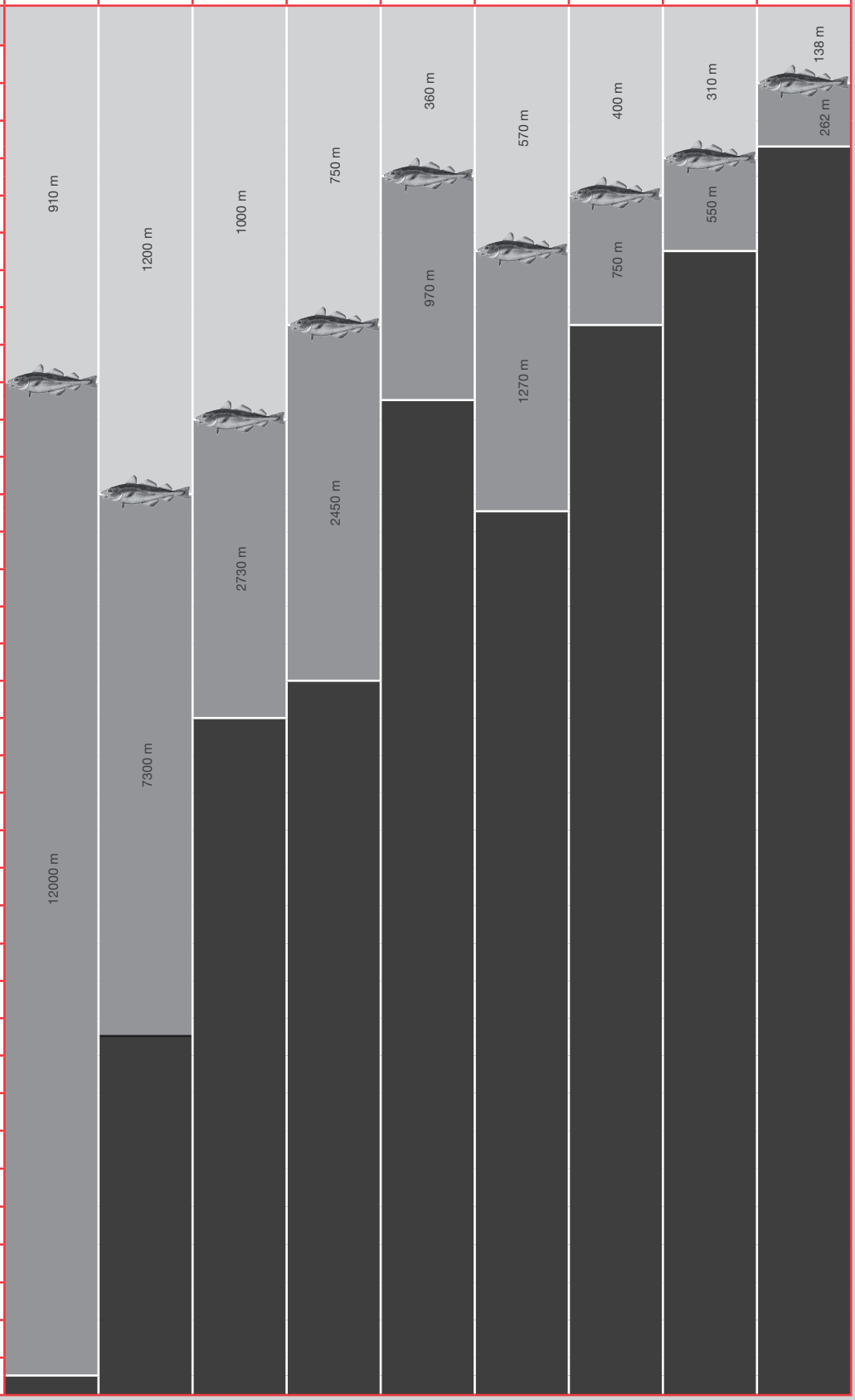
Thus, short pulses will provide the best resolution and separation of individual fishes, but the echo sounder is more sensitive to noise.

Two targets need to be min. 1/2 pulse length apart, in order to be seen as two targets. This can be measured in cm. (table above).

This is however not the case with chirp where resolution is given by the utilized bandwidth, with range resolution shown in brackets.

DETECTION DEPTHS

FREQUENCY			12 kHz	18 kHz	38 kHz		70 kHz		120 kHz	200 kHz	333 kHz
TRANSDUCER			12-16/60	ES18-11	ES38B	ES38-10	ES70-11	ES70-7C	ES120-7C	ES200-7C	ES333-7C
Meters	Feet	Fathoms									
100	320	55									
200	640	109									
300	960	164									
400	1280	219									
500	1600	273									
600	1920	328									
700	2240	383									
800	2560	437									
900	2880	492									
1000	3200	547									
1100	3520	601									
1200	3840	656									
1300	4160	711									
1400	4480	765									
1500	4800	820									
2000	6400	1093									
2500	8000	1367									
3000	9600	1640									
3500	11200	1914									
4000	12800	2187									
4500	14400	2460									
5000	16000	2734									
5500	17600	3007									
6000	19200	3280									
6500	20800	3554									
7000	22400	3827									
7500	24000	4101									
8000	25600	4374									
8500	27200	4647									
9000	28800	4921									
9500	30400	5194									
10000	32000	5467									
10500	33600	5741									
11000	35200	6014									
11500	36800	6288									
12000	38400	6561									



Note: For TS = -32dB in salt water 35ppt and 10° C at 38 kHz this relates to a cod of length 60cm. Bottom Sb = -30dB/m²

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SEPTEMBER 2017 / 429128 / REV.B