

2022 EK60/80 Calibration Report

NOAA Ship *Okeanos Explorer*

EX-22-04: Voyage to the Ridge 1 (Mapping)

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Table of Contents

Introduction	2
Location and Conditions	2
Calibration Parameters	3
Calibration Procedure	6
Calibration Results	7
Appendix A: Channel Results	10
Appendix B: General Results	17
Appendix C: Results	31
Appendix D: Error Analysis	38
Appendix E: Detailed List Calibration Files	44
Appendix F: Vessel Offsets for Transducer Hull Locations	Error! Bookmark not defined.

Introduction

NOAA Ocean Exploration is the only federal program dedicated to exploring the global ocean, closing prominent gaps in our basic understanding of U.S. deep waters and the seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology, NOAA Ocean Exploration explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, NOAA Ocean Exploration allows scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. To better understand our ocean, we make exploration data available to the public. This allows us, collectively, to more effectively maintain ocean health, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

This document provides information for the 2022 calibration of the Simrad EK60/80 echosounders on NOAA Ship *Okeanos Explorer* during EX-22-04. The calibration occurred on June 6, 2022 while drifting in Conception Bay, Newfoundland. During this procedure, the general purpose transceiver (GPT) frequencies - 120, and 200 kilohertz (kHz) - were calibrated at the pulse length of 1.024 milliseconds (ms) and maximum power for each frequency. The 38 and 70 kHz wideband transceivers (WBT) were calibrated in continuous wave (CW) mode at pulse lengths of 1.024 and 2.048 ms. The FM mode for the 38 kHz was calibrated at the 1.024 ms pulse length.

Location and Conditions

- The calibrations occurred in Conception Bay, Newfoundland.
 - Starting coordinates 47° 38.25', -53° 5.18'
- The vessel was drifting in waters deeper than 50 meters.
- A CastAway conductivity, temperature, depth (CTD) cast was performed before commencing the calibration to obtain the required oceanographic properties necessary for calibration, including the temperature and salinity at the depth of the sphere.
- Average speed of sound at the calibration depth (15 meters) for the 38, 70, 120, and 200 kHz transducers was 1465.5 meters per second, with an average temperature of 4.372 °C and average salinity of 31.702 psu (practical salinity units).

Calibration Parameters

- All frequencies within the pod (38, 70, 120, 200 kHz) were calibrated with a pulse length of 1.024 ms. The 38 kHz and 70 kHz CW modes were additionally calibrated at 2.048 ms. The 38 kHz FM mode was calibrated at 1.024 ms. The 18kHz was not calibrated at this time.
- Ping rate was 1 ping/second.
- Power was set to maximum for each frequency.
- See **Tables 1 and 2** of this document for a complete list of parameters used during calibration.

Table 1. List of relevant parameters and initial settings used during the 2022 calibration of the EK60 General Purpose Transceivers (GPTs). For more information, see Appendix A containing the channel tab for each frequency calibrated.

Frequency (kHz)	120	200
EK 80 software version	2.0.0.0	2.0.0.0
Transducer model	ES120-7C	ES200-7C
Transducer serial number	1256	596
Transducer draft setting (m)	4.59	4.59
Transmit power (W)	250	150
Pulse length (ms)	1.024	1.024
Two-way beam angle (dB)	-20.70	-20.70
Transducer peak gain (dB)	27.00	26.00
Sa correction (dB)	-0.21	-0.20
Absorption coefficient (dB/km)	0.00	0.00
Speed of sound (m/s)	1465.5	1465.5
3 dB beamwidth (°) alongship/athwartship	7.00/7.00	7.00/7.00
Angle offset (°) alongship/athwartship	0.00/0.00	0.00/0.00

Table 2. List of relevant parameters and initial settings used during the 2022 calibration of the EK80 Wide Band Transceivers (WBTs) in CW and FM mode. For more information, see Appendix A containing the channel tab for each frequency calibrated.

Frequency (kHz)	38 (CW)	38 (CW)	38 (FM)	70 (CW)	70 (CW)
Frequency Range (kHz)	38	38	34 to 45	70	70
GPT/WBT serial number	WBT 748247	WBT 748247	WBT 748247	WBT 746998	WBT 746998
EK 80 software version	2.0.0.0	2.0.0.0	2.0.0.0	2.0.0.0	2.0.0.0
Transducer model	ES38-7	ES38-7	ES38-7	ES70-7C	ES70-7C
Transducer serial number	291	291	291	343	343
Transducer draft setting (m)	4.59	4.59	4.59	4.59	4.59
Transmit power (W)	2000	2000	2000	750	750
Pulse length (ms)	1.024	2.048	1.024	1.024	2.048
Slope (%)	10.280	5.140	11.489	2.790	1.395
Two-way beam angle (dB)	-20.70	-20.70	-20.70	-20.70	-20.70
Transducer peak gain (dB)	27.11	25.50	25.55 - 29.13	27.82	27.00
Sa correction (dB)	-0.05	0.000	0.000	0.03	0.000
Absorption coefficient (dB/km)	0.0000	0.0000	0.0000	0.0000	0.0000
Speed of sound (m/s)	1465.5	1465.5	1465.5	1465.5	1465.5
3 dB beamwidth (°) along/athwart	6.28/6.50	6.31/6.33	see XML file	6.69/6.62	6.63/6.66
Angle offset (°) along/athwart	-0.03/-0.02	-0.08/0.00	-0.03/-0.02	-0.04/0.03	-0.03/0.05

Calibration Procedure

To minimize the time and setup required, one sphere (38.1 mm tungsten carbide with a 6% cobalt binder) was used to calibrate all frequencies. The pod below refers to the transducers (38, 70, 120 and 200 kHz) that are near each other on the hull of the ship. Reference Appendix G for the X, Y, and Z hull locations for each of the transducers.

Calibrations were performed using Simrad's EK80 calibration software (version 2.0.0.0) and custom EchoCAL software developed by the NOAA Northeast Fisheries Science Center (NEFSC) to electronically control the downriggers. For the setup of the downriggers, consult the NOAA Ocean Exploration Standard Operating Procedure: EK60/EK80 Calibration¹.

For the pod setup calibration, the sphere was suspended about 5 meters (16 feet) below the swivels and a five pound lead fishing weight was suspended about 3 meters (10 feet) below the sphere for stability.

The three calibration lines were joined by lowering a line under the bow with the port side calibration line attached to the end of it and retrieving it from the starboard side once passed under the keel. Prior to deployment, the sphere was soaked in a soapy water solution to break surface tension. The sphere was then lowered to a depth of approximately 15 m from the surface of the water (range of about 10 m from the transducers). This depth was achieved by having 55 feet of line out of each downrigger for the pod.

The target strength (TS) of the sphere used for calibration was calculated based on the CastAway CTD measurements of salinity, temperature, and depth of the sphere. See **Table 3** for the TS values of the sphere for each frequency and consult the Location and Conditions section for the CTD values. For each frequency, the sphere was initially positioned in the center of the transducer beam (on-axis) and data were recorded for several minutes. The sphere was moved throughout the beam to achieve adequate coverage (greater than 70% coverage in the center and overall - see Appendix B).

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Table 3. Target strength (TS; units=dB) values of the spheres used during calibration based on the values calculated in the Simrad EK80 calibration software from the CTD provided temperature and salinity.

Frequency (kHz)	38.1 mm diameter tungsten carbide sphere TS (dB)
38 (CW)	-41.89
38 (FM)	See XML file
70 (CW)	-40.79
120	-41.64
200	-40.96

Calibration Results

There was very good coverage for all frequencies with over 300 sphere detections in each beam and root mean square (RMS) error values below the recommended 0.4 threshold (per manufacturer recommendations). See Appendix C (and XML files) for the total number of sphere detections in the beam for each frequency calibrated. See Appendix E (and XML files) for beam coverage and error values of each of the calibrated frequencies. All .raw and .xml files were saved and recorded and the updated calibration settings were applied to each transducer. See Appendix F for a complete list of the .raw and .xml files recorded during calibration.

The calibration results were comparable to the 2021 calibrations on NOAA Ship *Okeanos Explorer* (**Table 4**).

Table 4. 2021-2022 calibration results. See Appendix D for the screenshots detailing the results from the 2022 calibration.

38 kHz(CW): Pulse length: 1.024 ms	2021 Results	2022 Results
Transducer peak gain (dB)	26.74	27.13
Sa correction (dB)	0.0106	-0.04
Beamwidth (°) alongship/athwartship	6.32/6.40	6.30/6.44
Beam offset (°) alongship/athwartship	-0.08/-0.01	-0.07/-0.02

RMS deviation (dB)	0.14	0.07
38 kHz(CW): Pulse length: 2.048 ms	2021 Results	2022 Results
Transducer peak gain (dB)	26.75	27.14
Sa correction (dB)	-0.1628	0.0064
Beamwidth (°) alongship/athwartship	6.51/6.66	6.28/6.50
Beam offset (°) alongship/athwartship	-0.09/0.02	-0.03/-0.02
RMS deviation (dB)	0.08	0.09
38 kHz(FM): Pulse length: 1.024 ms	2021 Results	2022 Results
Transducer peak gain (dB)	25.62 to 28.15	25.55 to 29.13
Sa correction (dB)	0.0000	0.0000
Beamwidth (°) alongship/athwartship	See XML file	See XML file
Beam offset (°) alongship/athwartship	See XML file	See XML file
RMS deviation (dB)	0.1661 to 0.2429	0.08 to 0.49
70 kHz (CW): Pulse length: 1.024 ms	2021 Results	2022 Results
Transducer peak gain (dB)	27.05	27.81
Sa correction (dB)	-0.0954	-0.0031
Beamwidth (°) alongship/athwartship	6.64/6.57	6.63/6.66
Beam offset (°) alongship/athwartship	-0.02/0.00	-0.03/0.05
RMS deviation (dB)	0.19	0.05
70 kHz (CW): Pulse length: 2.048 ms	2021 Results	2022 Results
Transducer peak gain (dB)	27.21	27.00

Sa correction (dB)	-0.0786	0.00
Beamwidth (°) alongship/athwartship	6.48/6.63	6.63/6.66
Beam offset (°) alongship/athwartship	-0.06/0.04	-0.03/0.05
70 kHz (CW): Pulse length: 2.048 ms	2021 Results	2022 Results
RMS deviation (dB)	0.09	0.04
120 kHz: Pulse length: 1.024 ms	2021 Results	2022 Results
Transducer peak gain (dB)	25.51	26.23
Sa correction (dB)	-0.2628	-0.21
Beamwidth (°) alongship/athwartship	6.90/6.68	6.54/6.55
Beam offset (°) alongship/athwartship	-0.18/0.08	-0.07/0.10
RMS deviation (dB)	0.21	0.17
200 kHz: Pulse length: 1.024 ms	2021 Results	2022 Results
Transducer peak gain (dB)	26.21	25.80
Sa correction (dB)	-0.2987	-0.20
Beamwidth (°) alongship/athwartship	6.27/6.49	6.41/6.40
Beam offset (°) alongship/athwartship	0.04/0.12	0.11/0.15
RMS deviation (dB)	0.21	0.16

Appendix A: Channel Results

38 kHz (CW): 1.024 ms

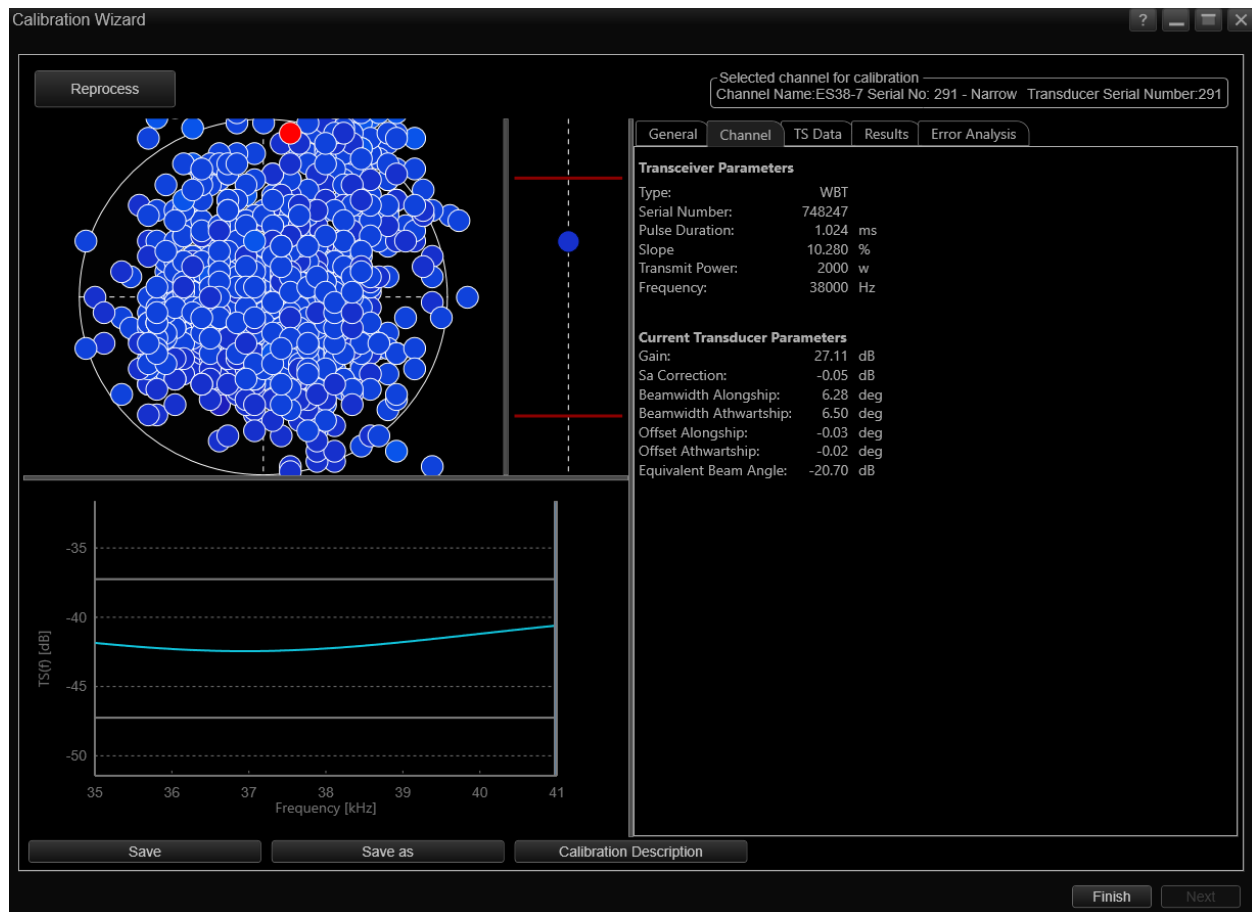


Figure 1. Screenshot of EK80 Calibration Wizard channel results for the 38 kHz calibration at 1.024 ms in continuous wave (CW) mode.

38 kHz (CW): 2.048 ms

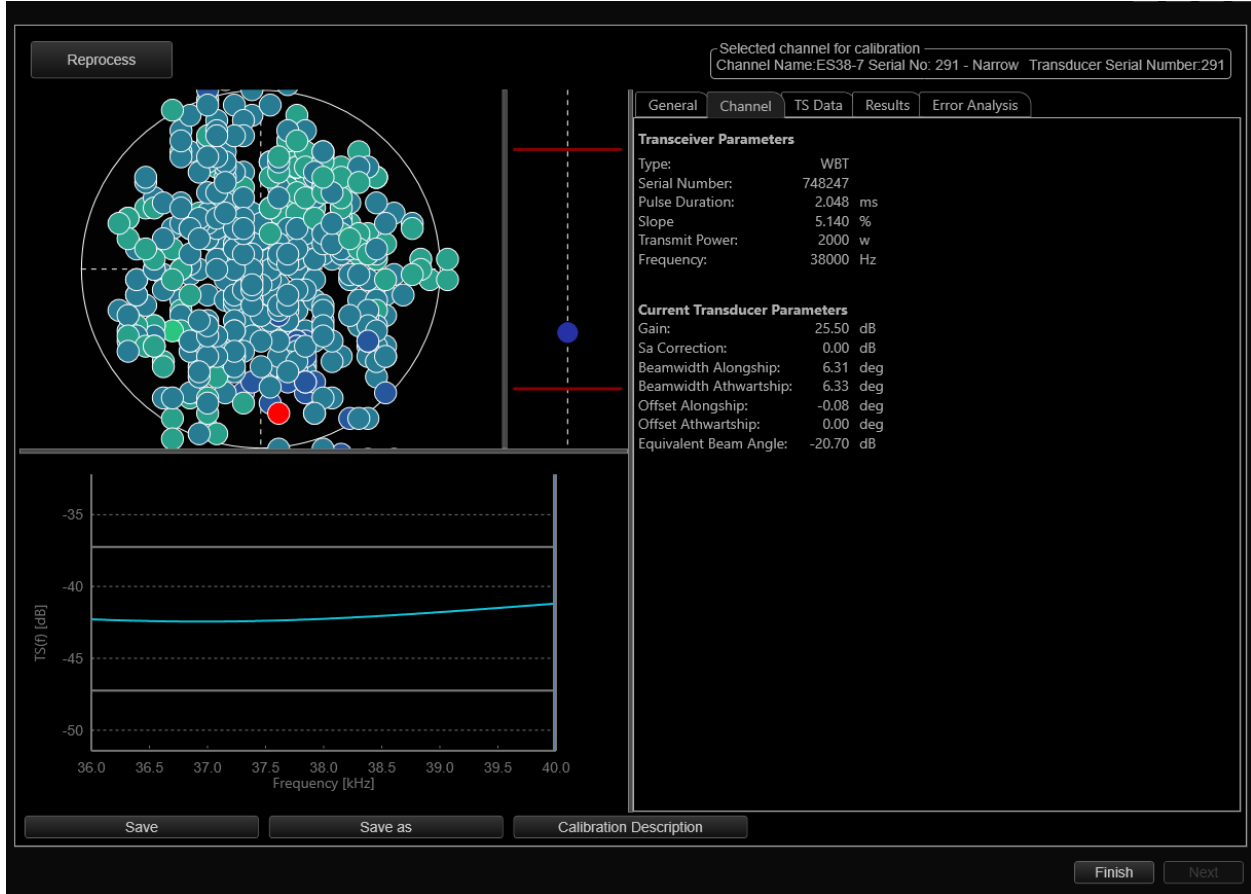


Figure 2. Screenshot of EK80 Calibration Wizard channel results for the 38 kHz calibration at 2.048 ms in continuous wave (CW) mode.

38 kHz (FM): 1.024 ms

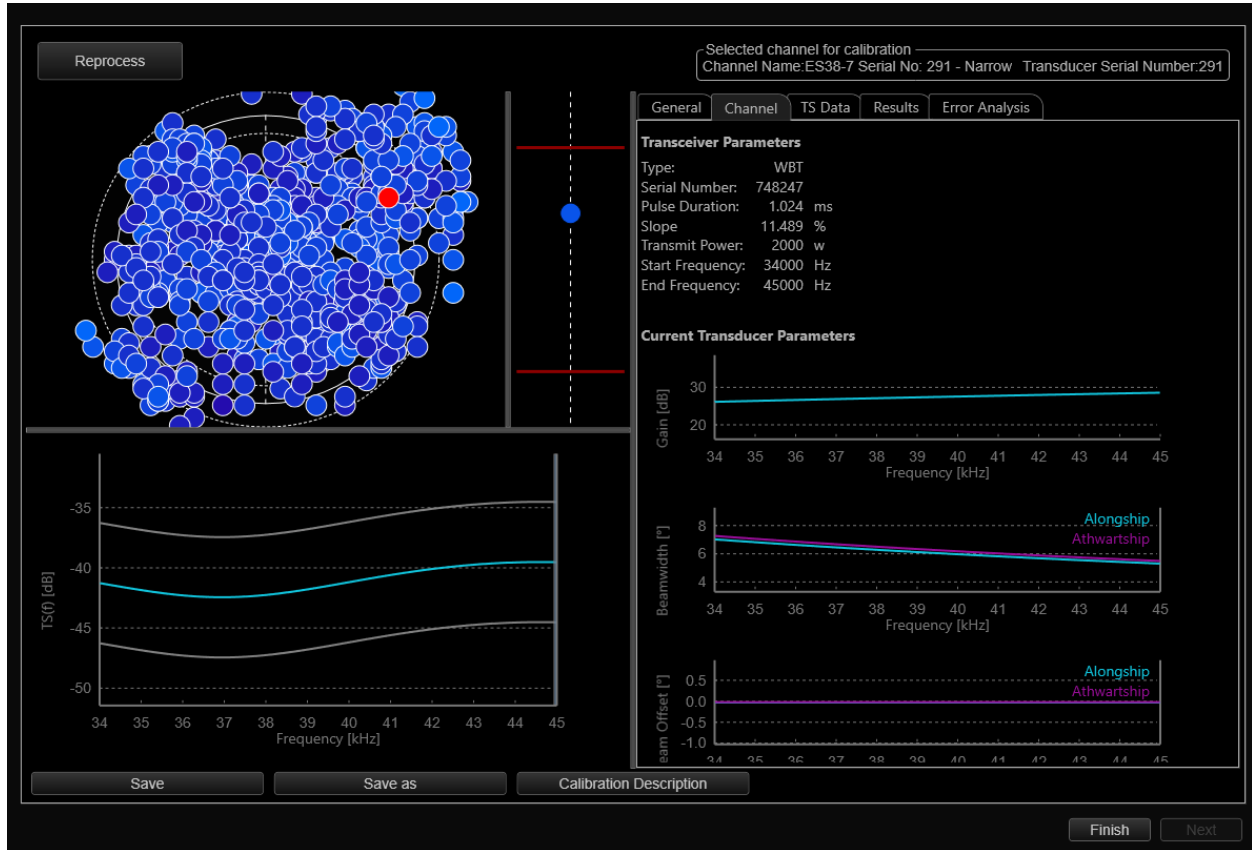


Figure 3. Screenshot of EK80 Calibration Wizard channel results for the 38 kHz calibration at 1.024 ms in frequency modulated (FM) mode.

70 kHz (CW): 1.024 ms

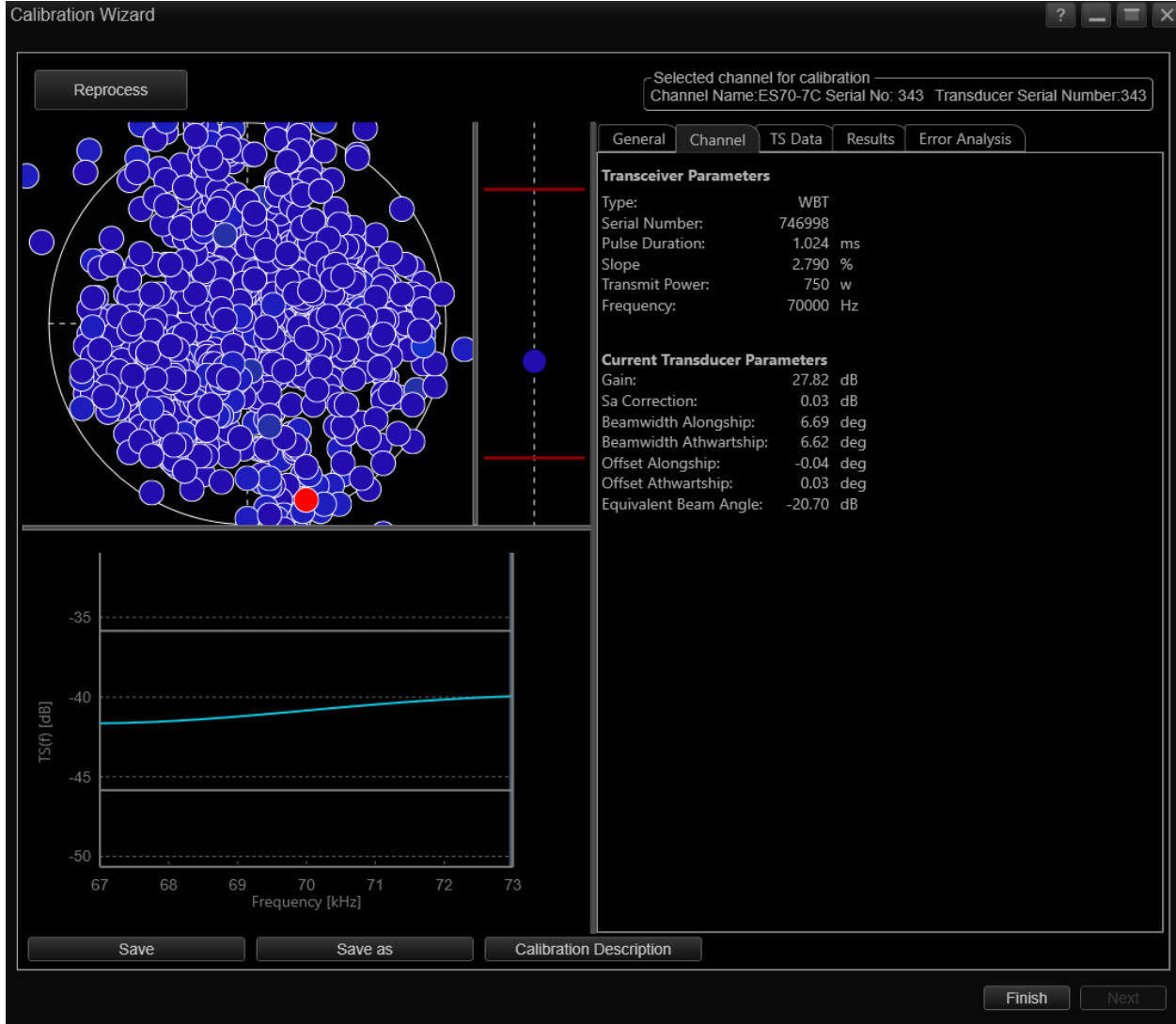


Figure 4. Screenshot of EK80 Calibration Wizard channel results for the 70 kHz calibration at 1.024 ms in continuous wave (CW) mode.

70 kHz (CW): 2.048 ms

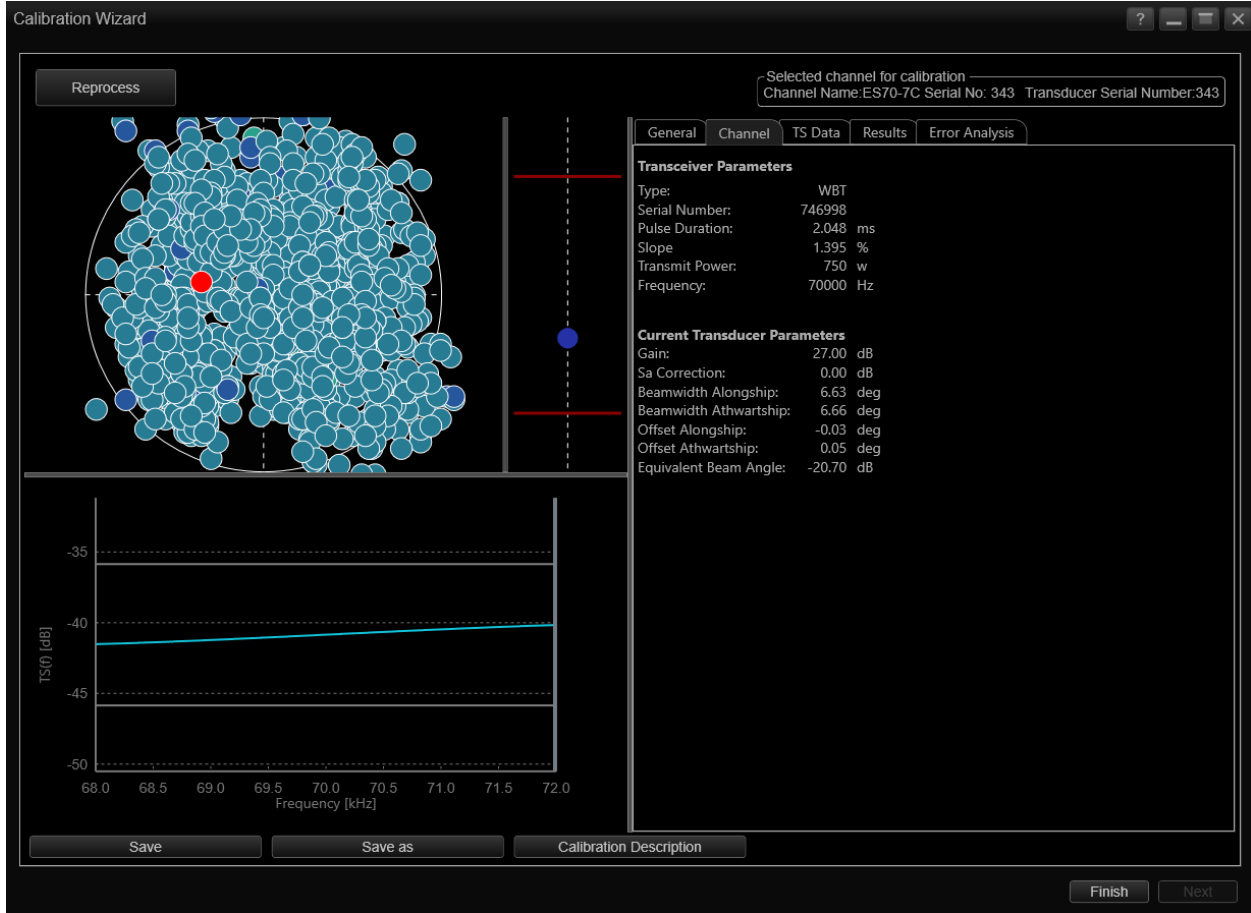


Figure 5. Screenshot of EK80 Calibration Wizard channel results for the 70 kHz calibration at 2.048 ms in continuous wave (CW) mode.

120 kHz: 1.024 ms

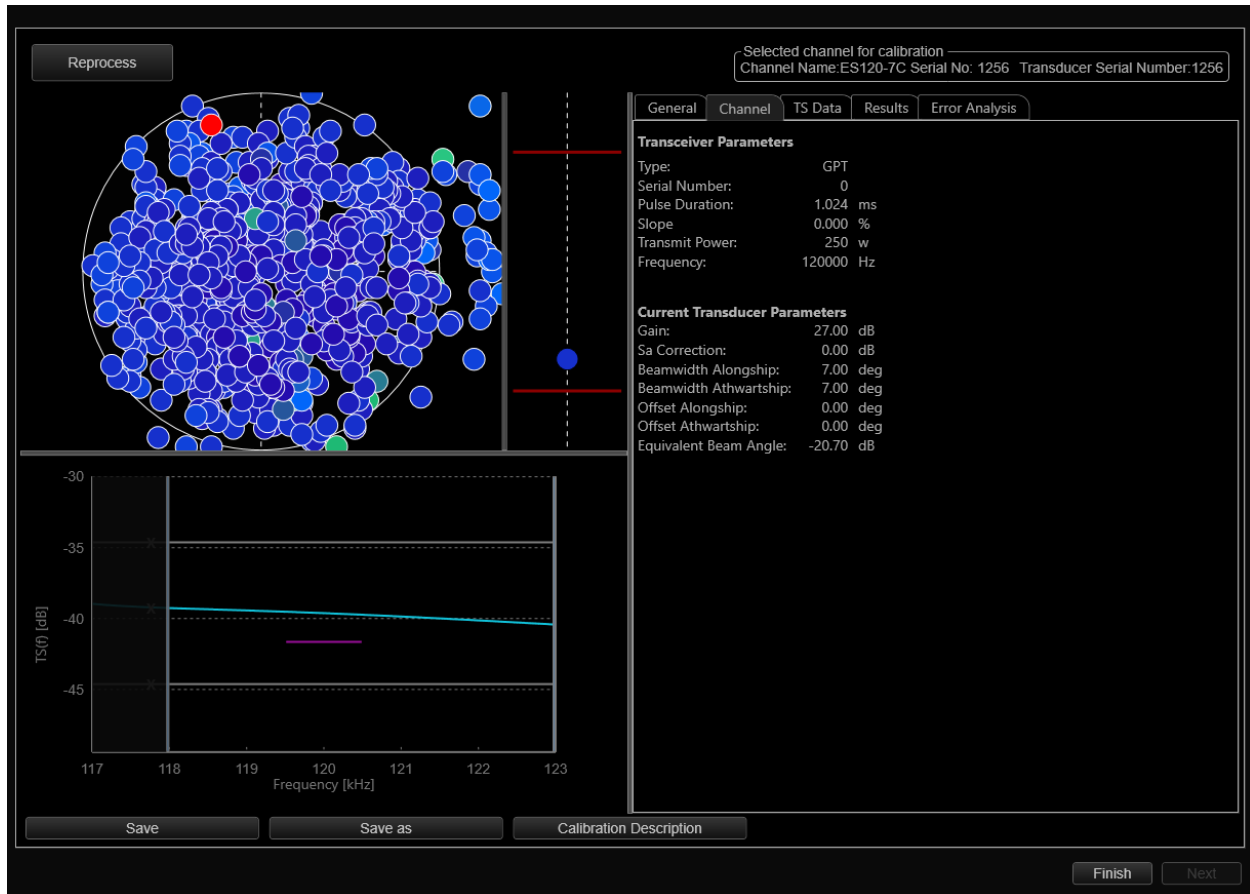


Figure 6. Screenshot of EK80 Calibration Wizard channel results for the 120 kHz calibration at 1.024 ms.

200 kHz: 1.024 ms

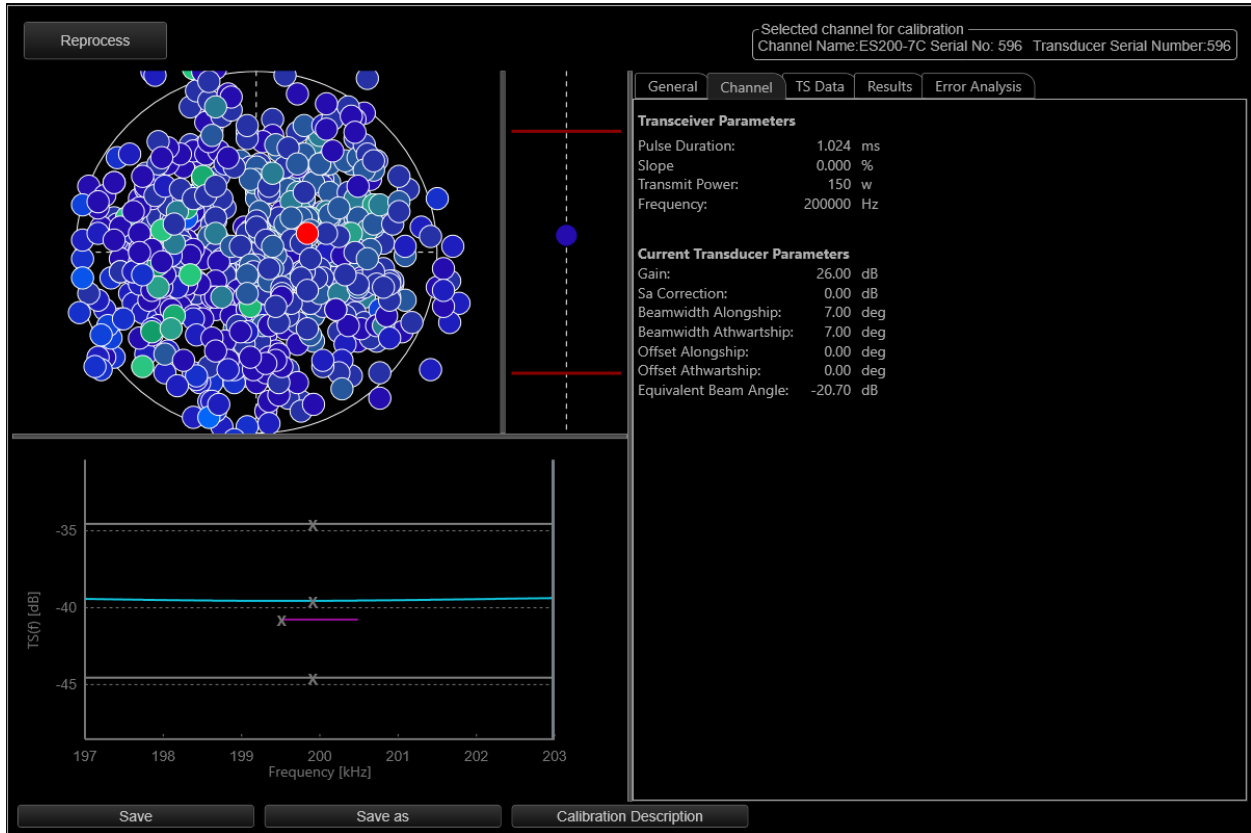


Figure 7. Screenshot of EK80 Calibration Wizard channel results for the 200 kHz calibration at 1.024 ms.

Appendix B: General Results

38 kHz (CW): 1.024 ms

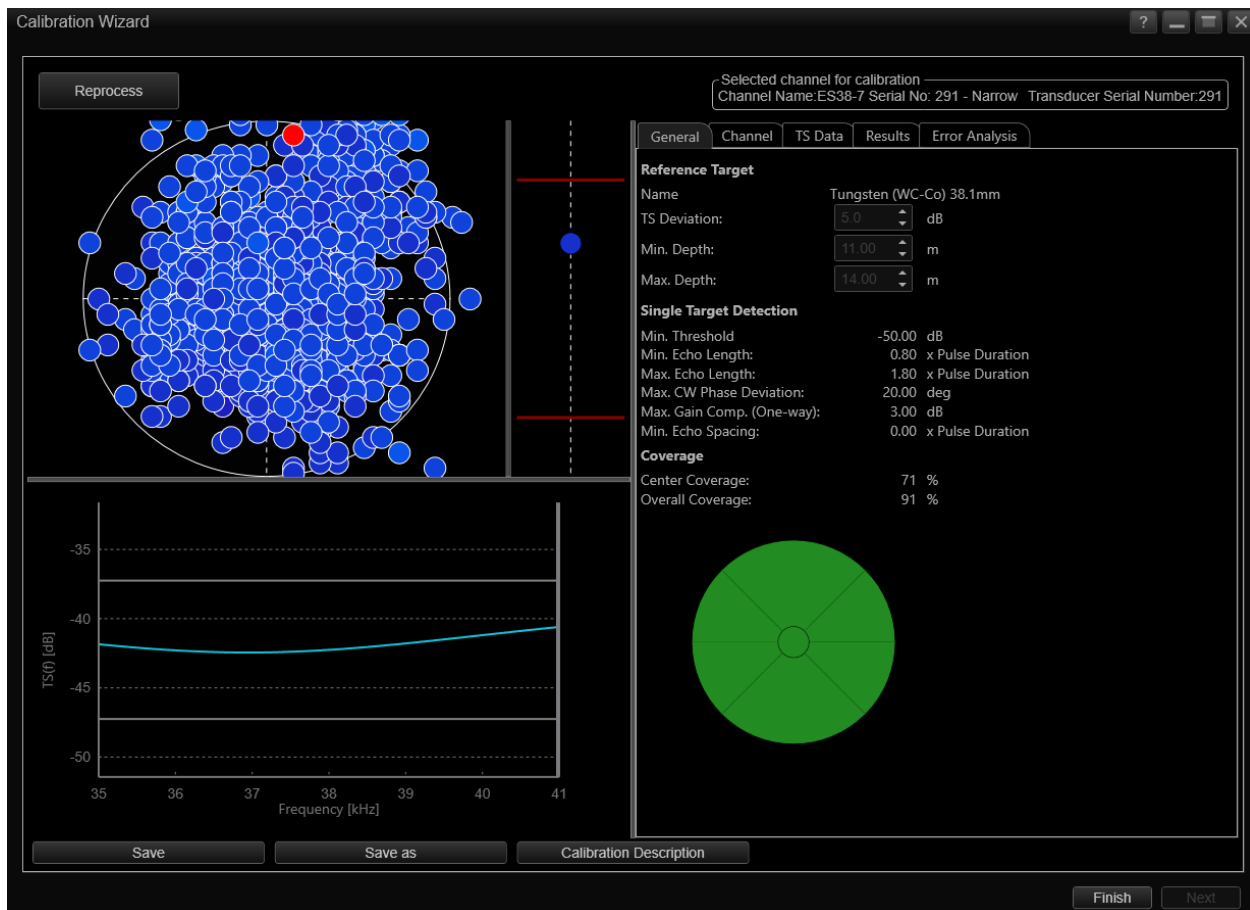


Figure 8. Screenshot of EK80 Calibration Wizard general results for the 38 kHz calibration at 1.024 ms in continuous wave (CW) mode.

38 kHz (CW): 2.048 ms

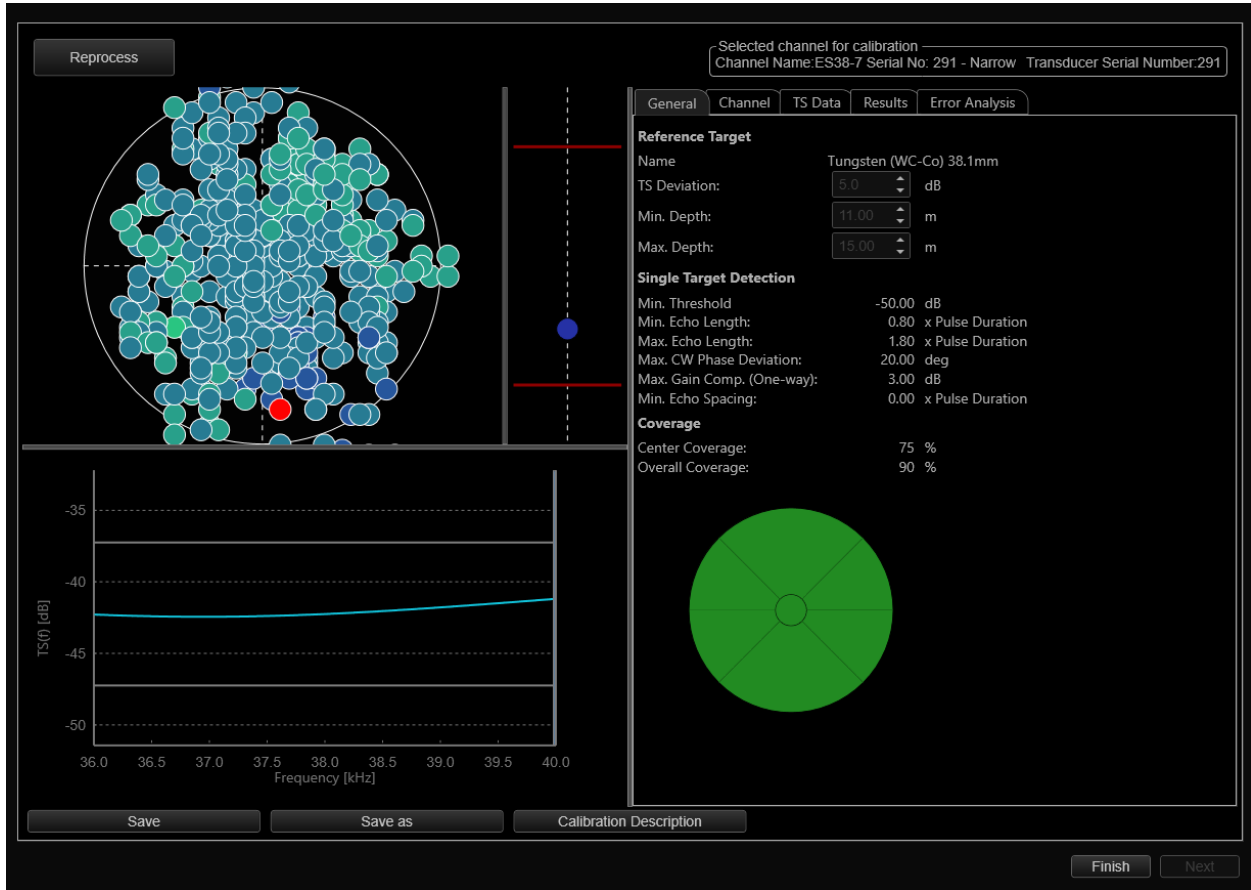


Figure 9. Screenshot of EK80 Calibration Wizard general results for the 38 kHz calibration at 2.048 ms in continuous wave (CW) mode.

38 kHz (FM): 1.024 ms

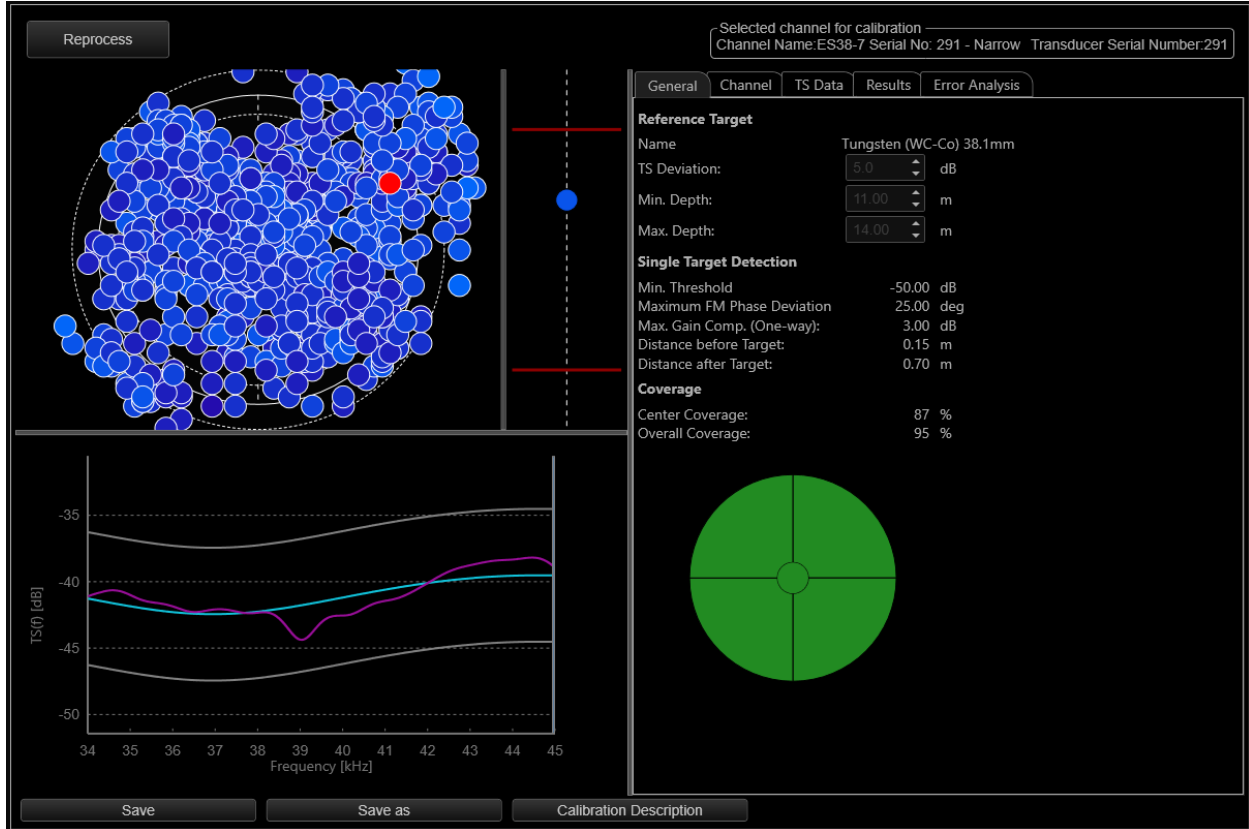


Figure 10. Screenshot of EK80 Calibration Wizard general results for the 38 kHz calibration at 1.024 ms in frequency modulated (FM) mode.

70 kHz (CW): 1.024 ms

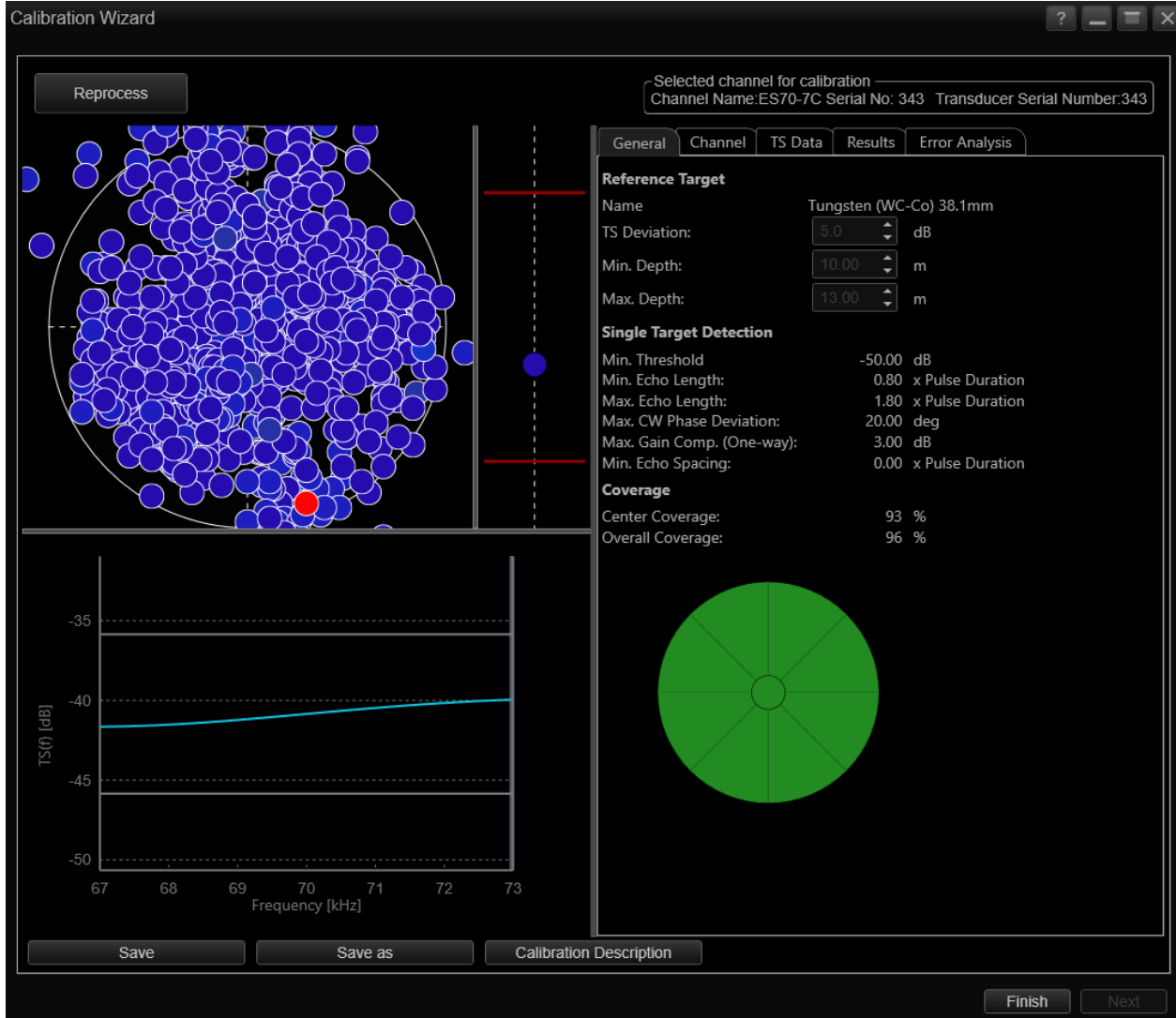


Figure 11. Screenshot of EK80 Calibration Wizard general results for the 70 kHz calibration at 1.024 ms in continuous wave (CW) mode.

70 kHz (CW): 2.048 ms

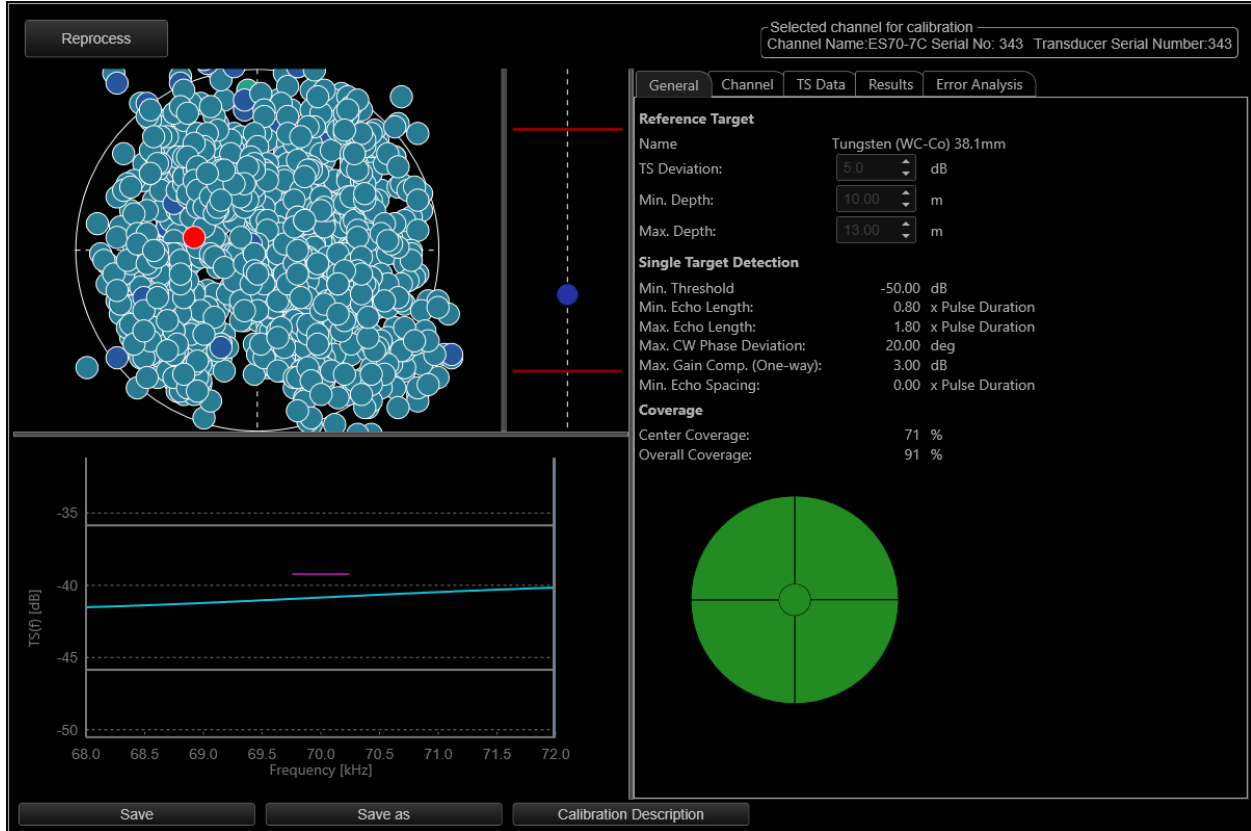


Figure 12. Screenshot of EK80 Calibration Wizard general results for the 70 kHz calibration at 2.048 ms in continuous wave (CW) mode.

120 kHz: 1.024 ms

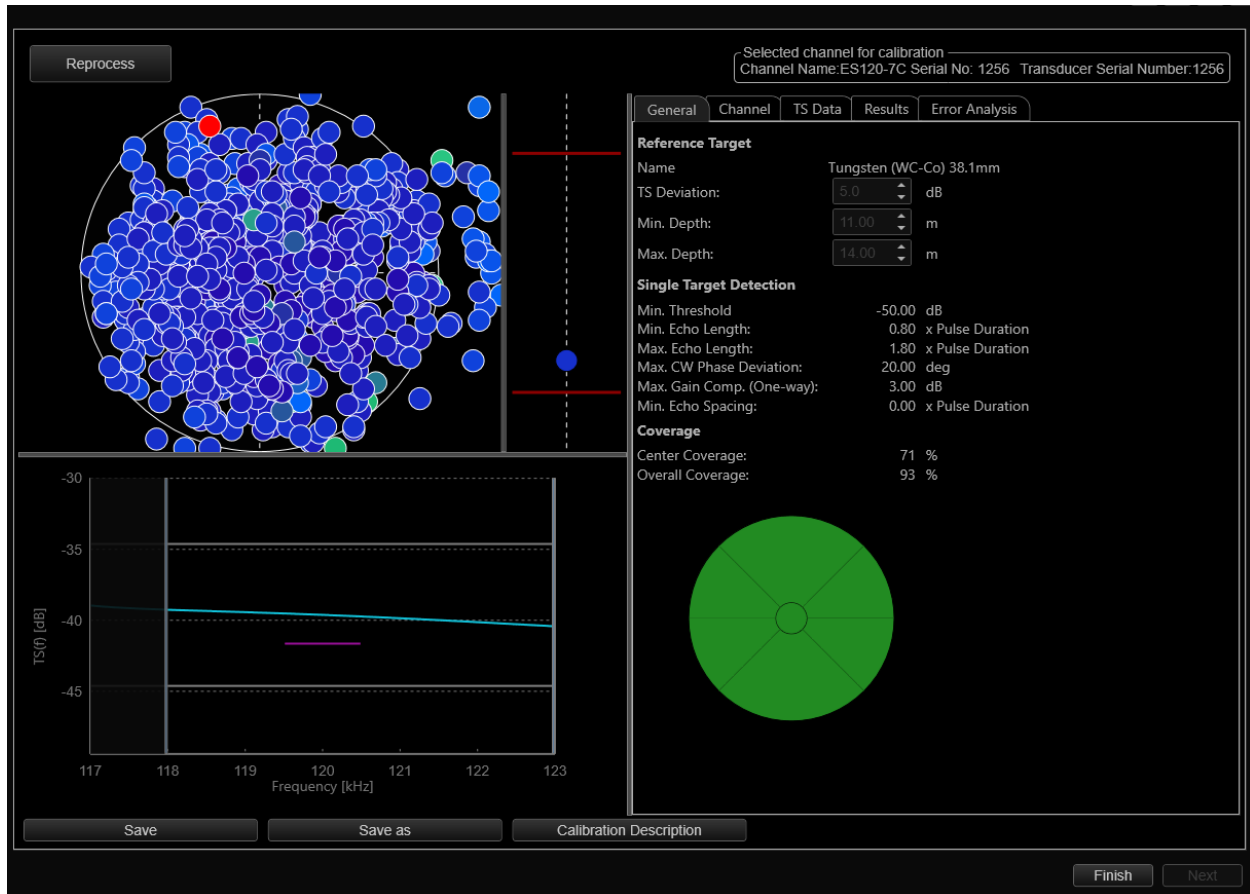


Figure 13. Screenshot of EK80 Calibration Wizard general results for the 120 kHz calibration at 1.024 ms.

200 kHz: 1.024 ms

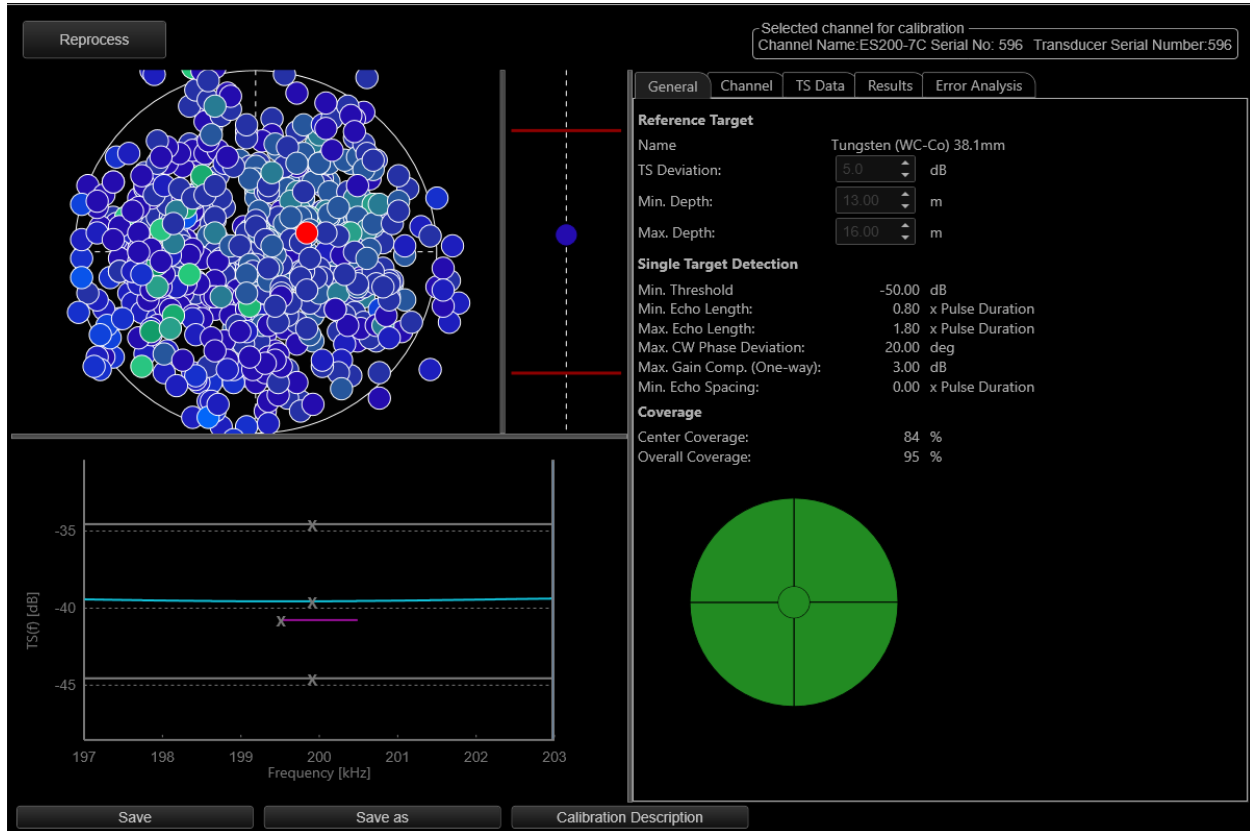


Figure 14. Screenshot of EK80 Calibration Wizard general results for the 200 kHz calibration at 1.024 ms.

Appendix C: TS Results

38 kHz (CW): 1.024 ms

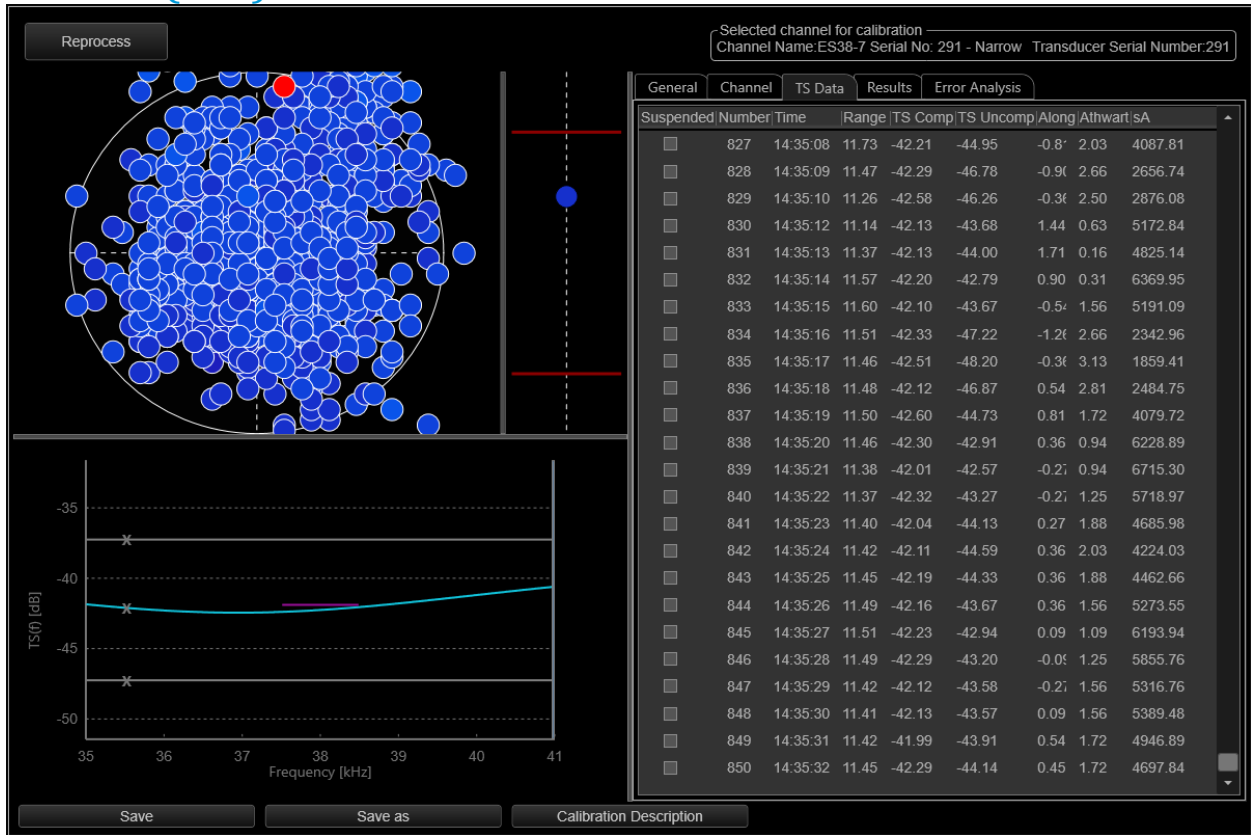


Figure 15. Screenshot of EK80 Calibration Wizard general results for the 38 kHz calibration at 1.024 ms in continuous wave (CW) mode.

38 kHz (CW): 2.048 ms

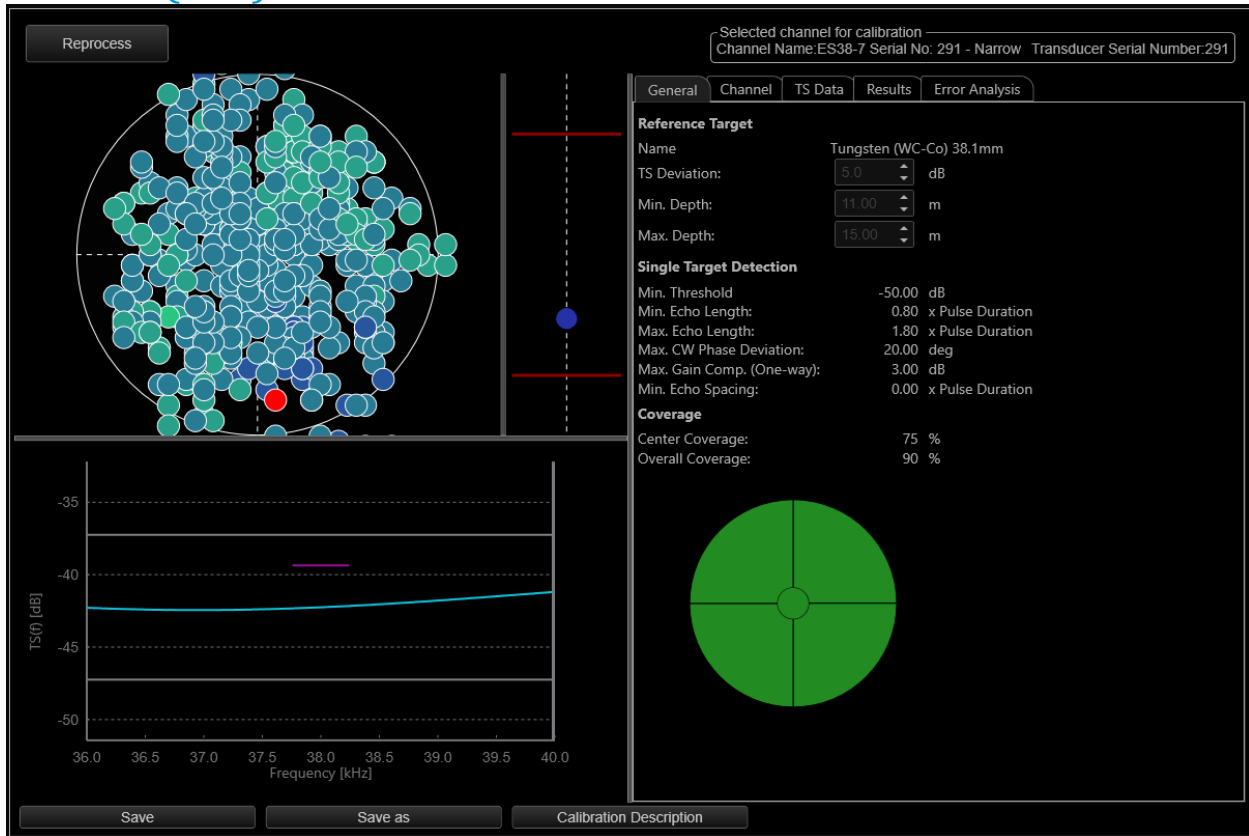


Figure 16. Screenshot of EK80 Calibration Wizard general results for the 38 kHz calibration at 2.048 ms in continuous wave (CW) mode.

38 kHz (FM): 1.024 ms

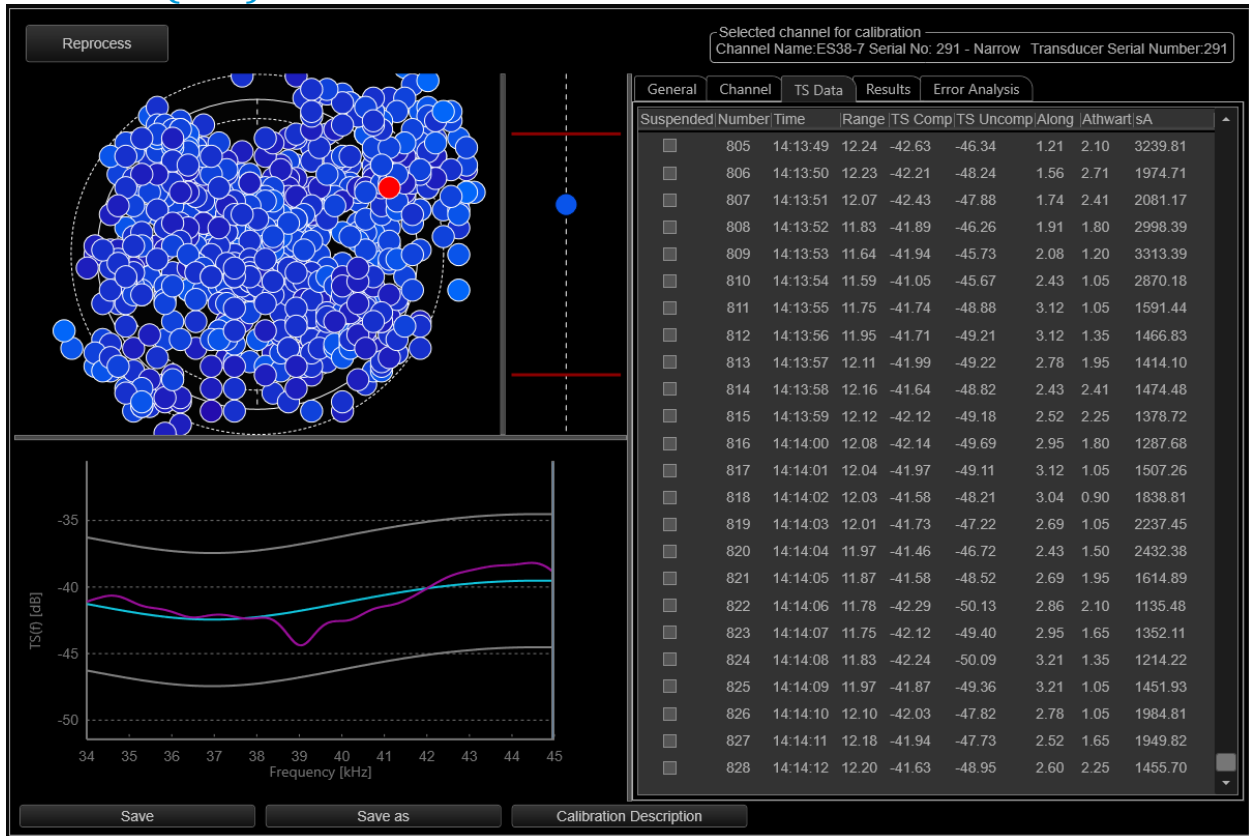


Figure 17. Screenshot of EK80 Calibration Wizard general results for the 38 kHz calibration at 1.024 ms in frequency modulated (FM) mode.

70 kHz (CW): 1.024 ms

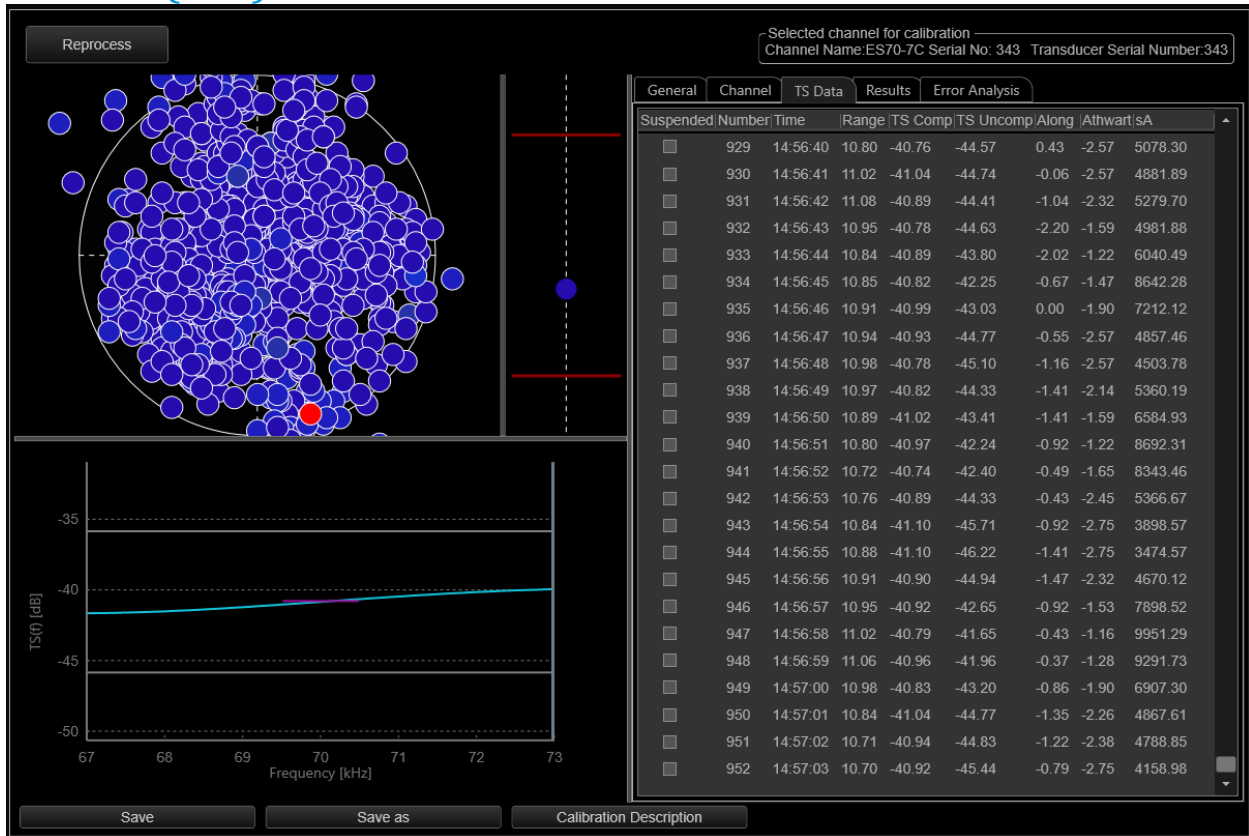


Figure 18. Screenshot of EK80 Calibration Wizard general results for the 70 kHz calibration at 1.024 ms in continuous wave (CW) mode.

70 kHz (CW): 2.048 ms

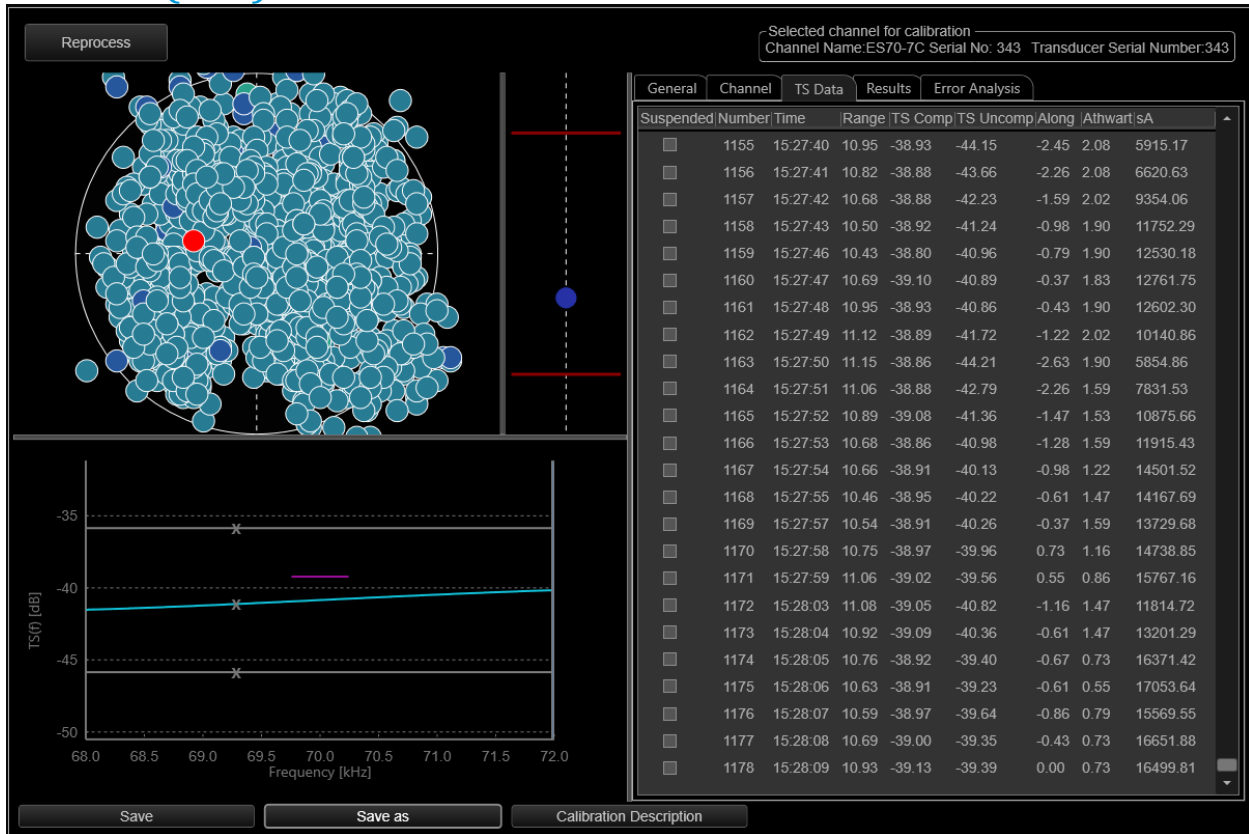


Figure 19. Screenshot of EK80 Calibration Wizard general results for the 70 kHz calibration at 2.048 ms in continuous wave (CW) mode.

120 kHz: 1.024 ms

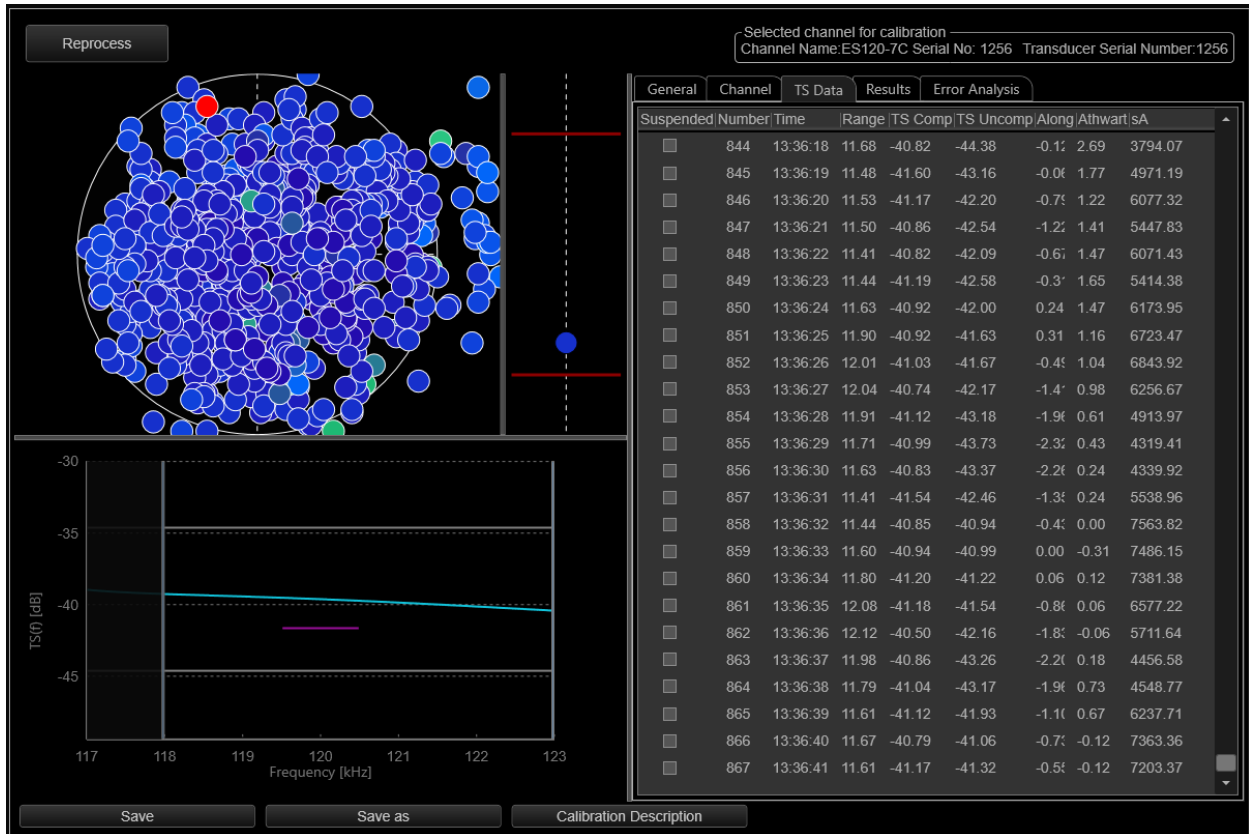


Figure 20. Screenshot of EK80 Calibration Wizard general results for the 120 kHz calibration at 1.024 ms.

200 kHz: 1.024 ms

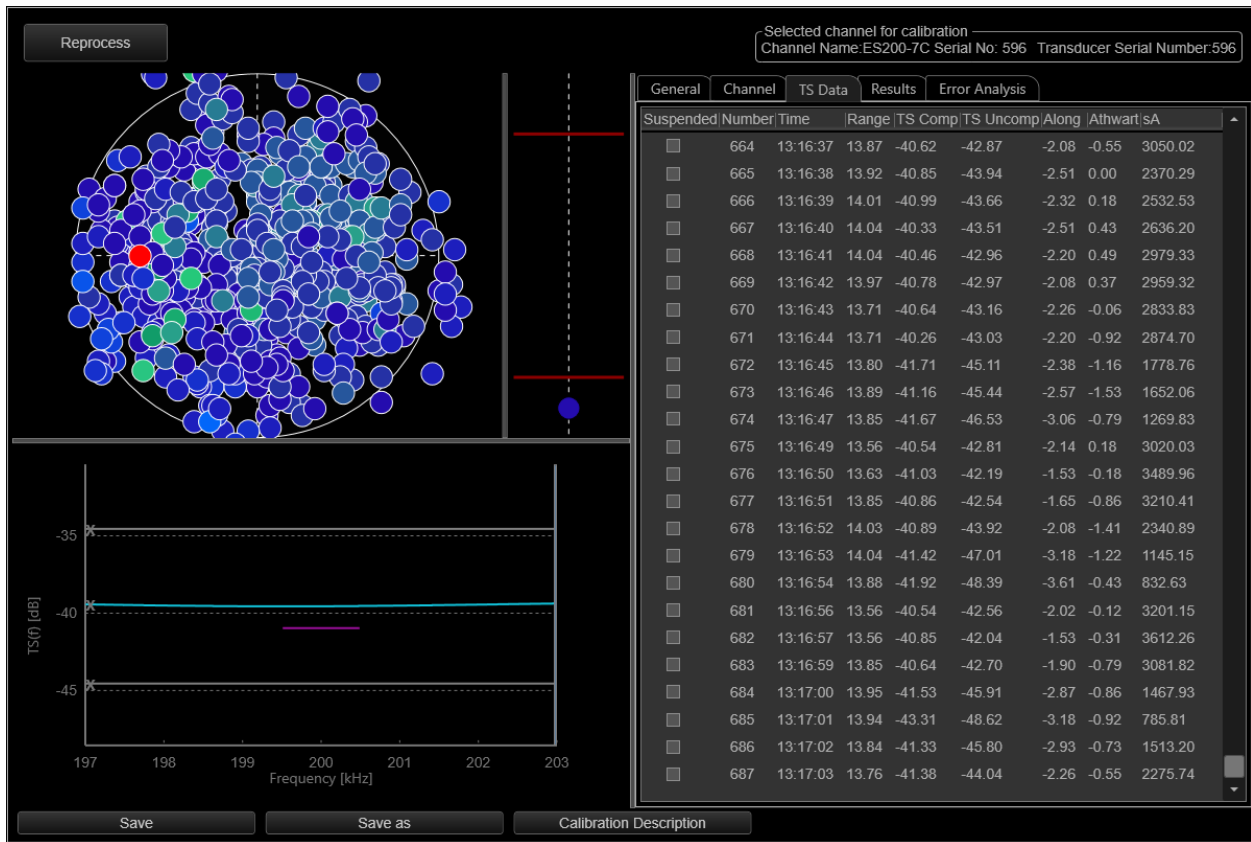


Figure 21. Screenshot of EK80 Calibration Wizard general results for the 200 kHz calibration at 1.024 ms.

Appendix D: Results

38 kHz (CW): 1.024 ms

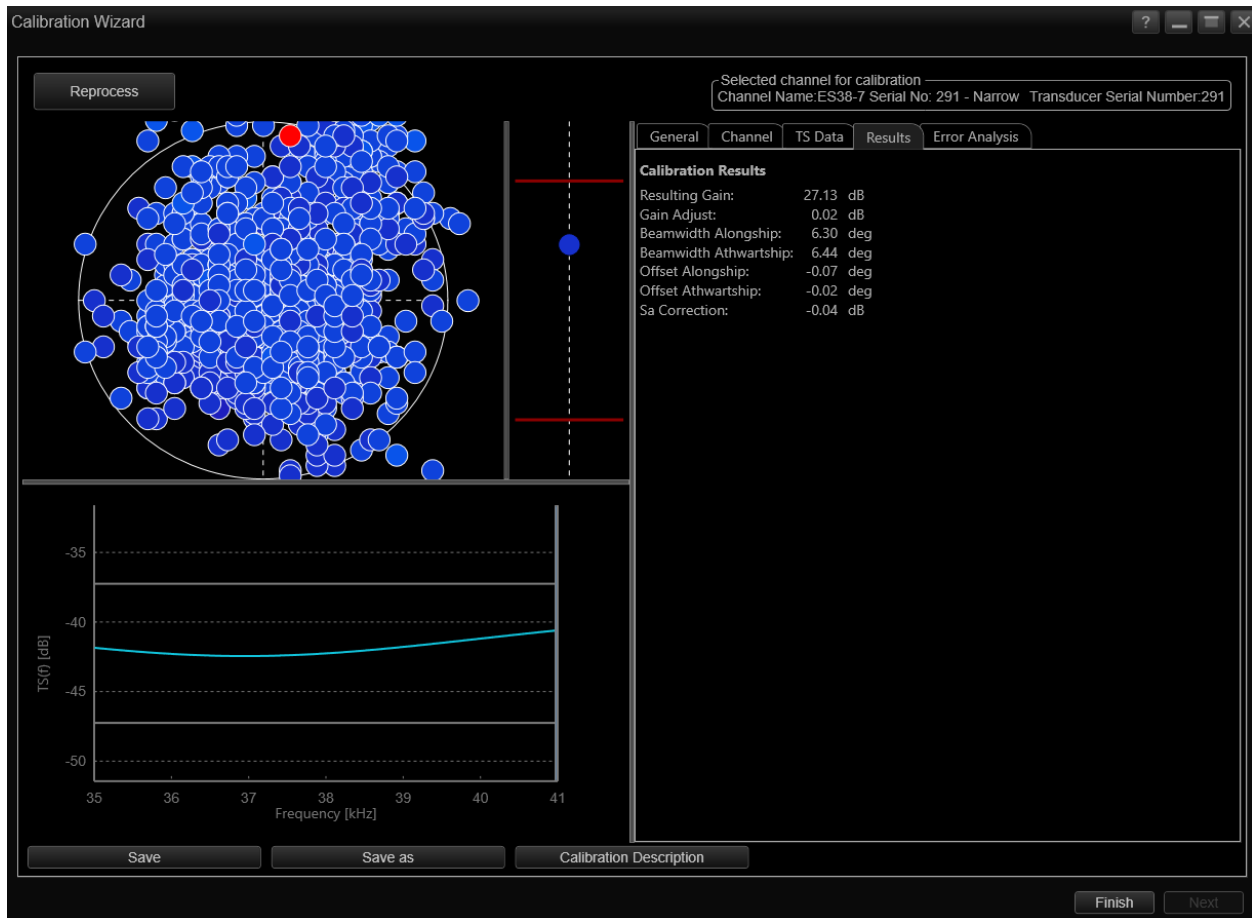


Figure 22. Screenshot of EK80 Calibration Wizard results for the 38 kHz calibration at 1.024 ms in continuous wave (CW) mode.

38 kHz (CW): 2.048 ms

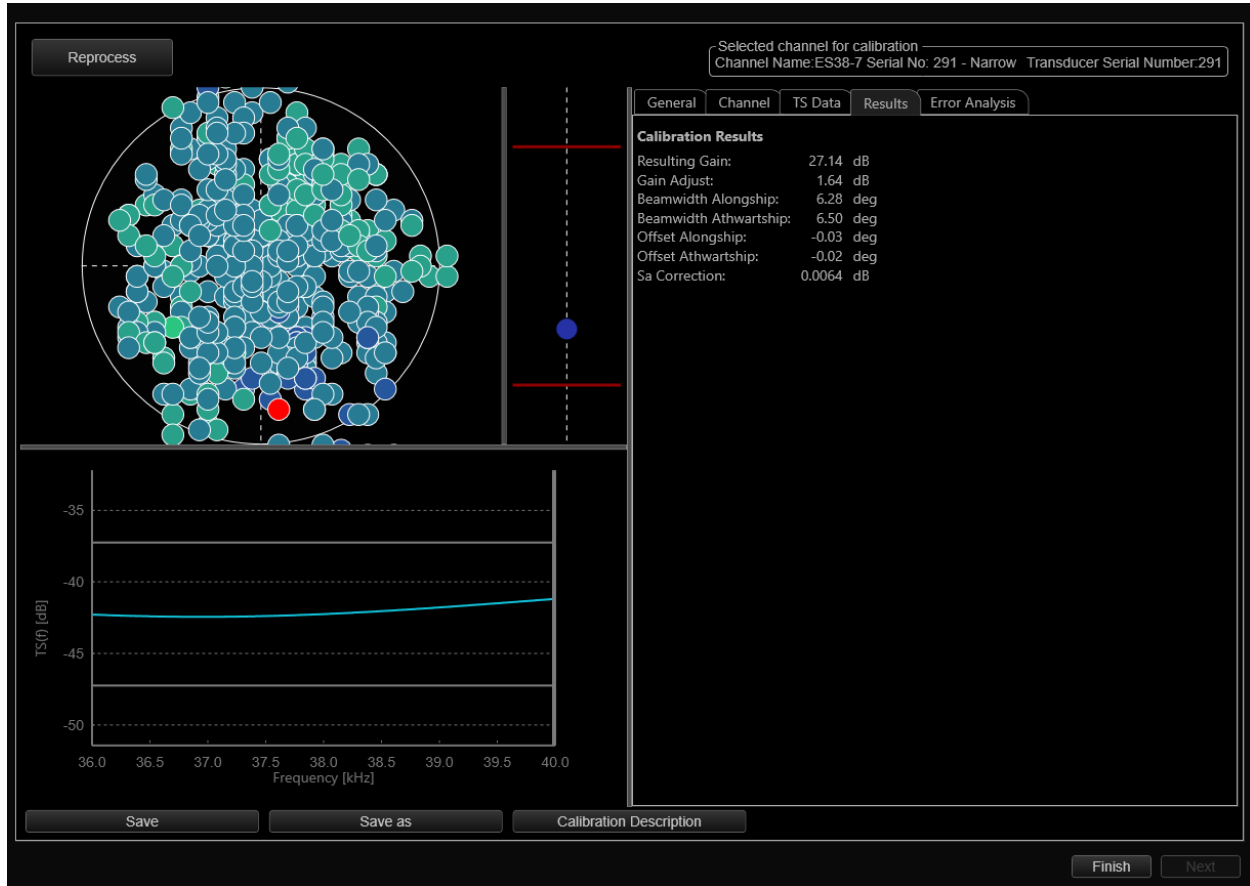


Figure 23. Screenshot of EK80 Calibration Wizard results for the 38 kHz calibration at 2.048 ms in continuous wave (CW) mode.

38 kHz (FM): 1.024 ms

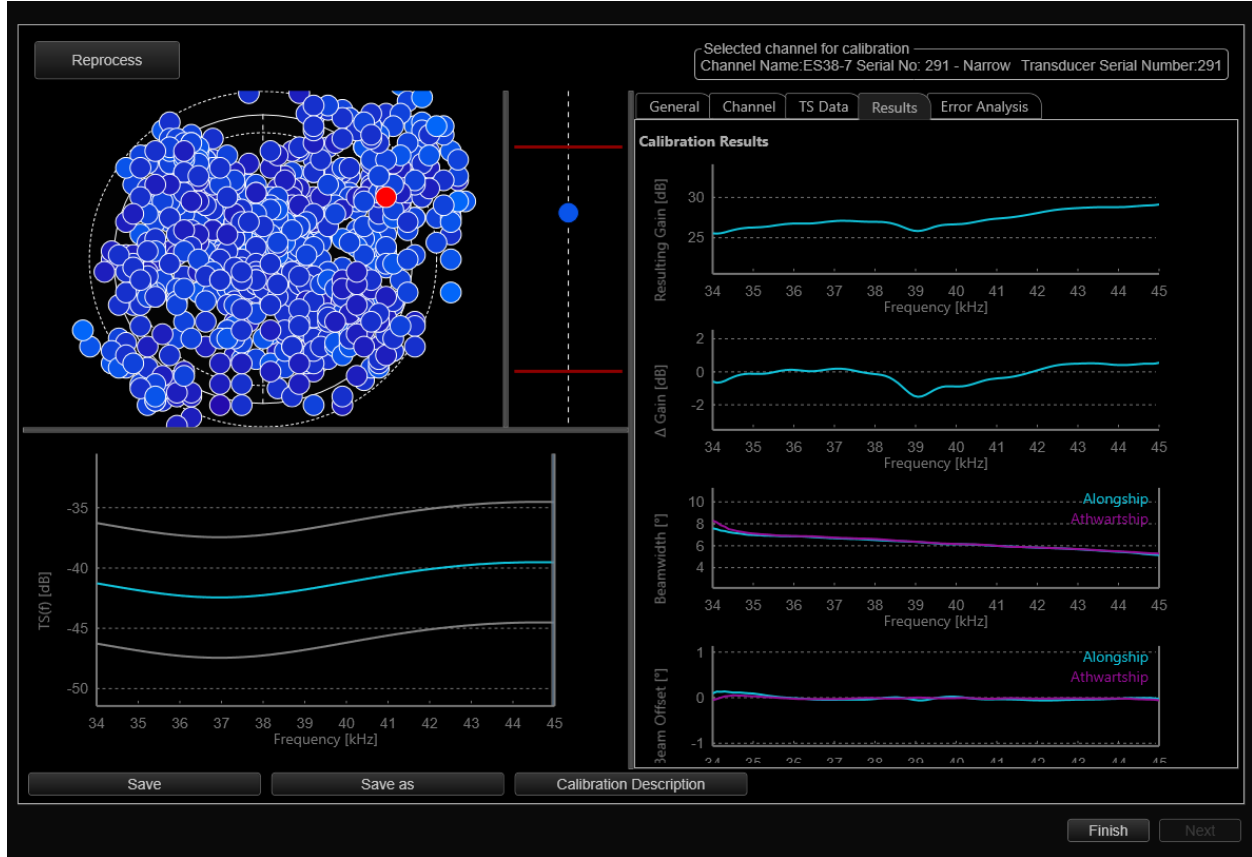


Figure 24. Screenshot of EK80 Calibration Wizard results for the 38 kHz calibration at 1.024 ms in frequency modulated (FM) mode.

70 kHz (CW): 1.024 ms

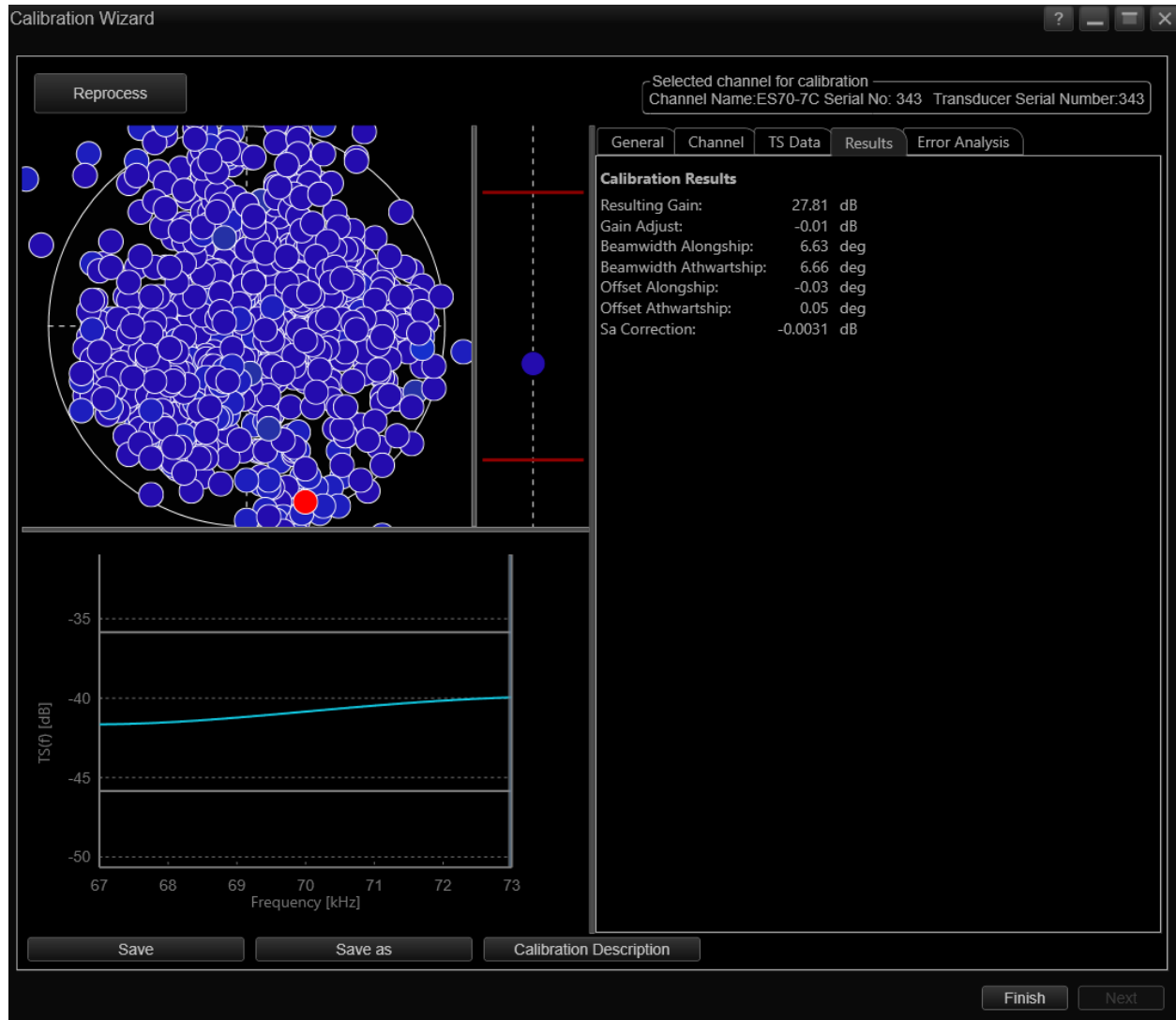


Figure 25. Screenshot of EK80 Calibration Wizard results for the 70 kHz calibration at 1.024 ms in continuous wave (CW) mode.

70 kHz (CW): 2.048 ms

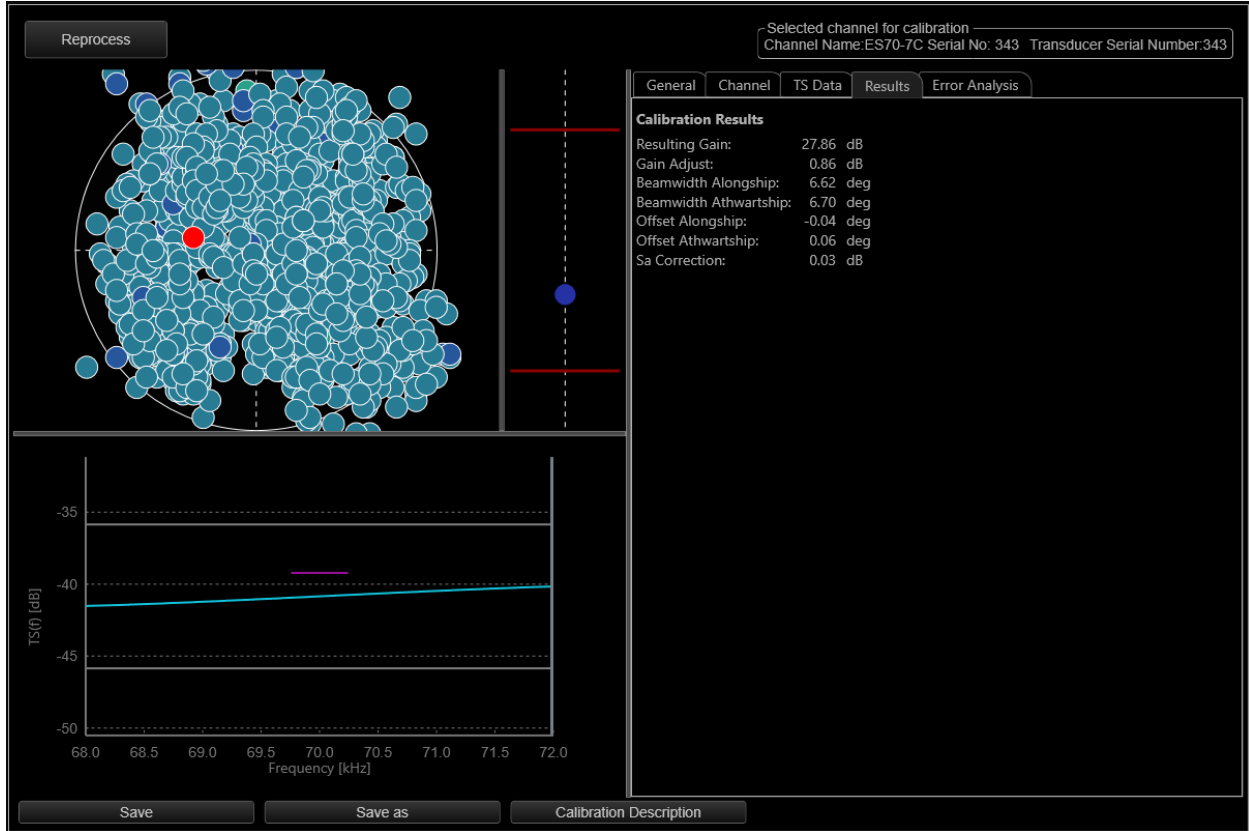


Figure 26. Screenshot of EK80 Calibration Wizard results for the 70 kHz calibration at 2.048 ms in continuous wave (CW) mode.

120 kHz: 1.024 ms

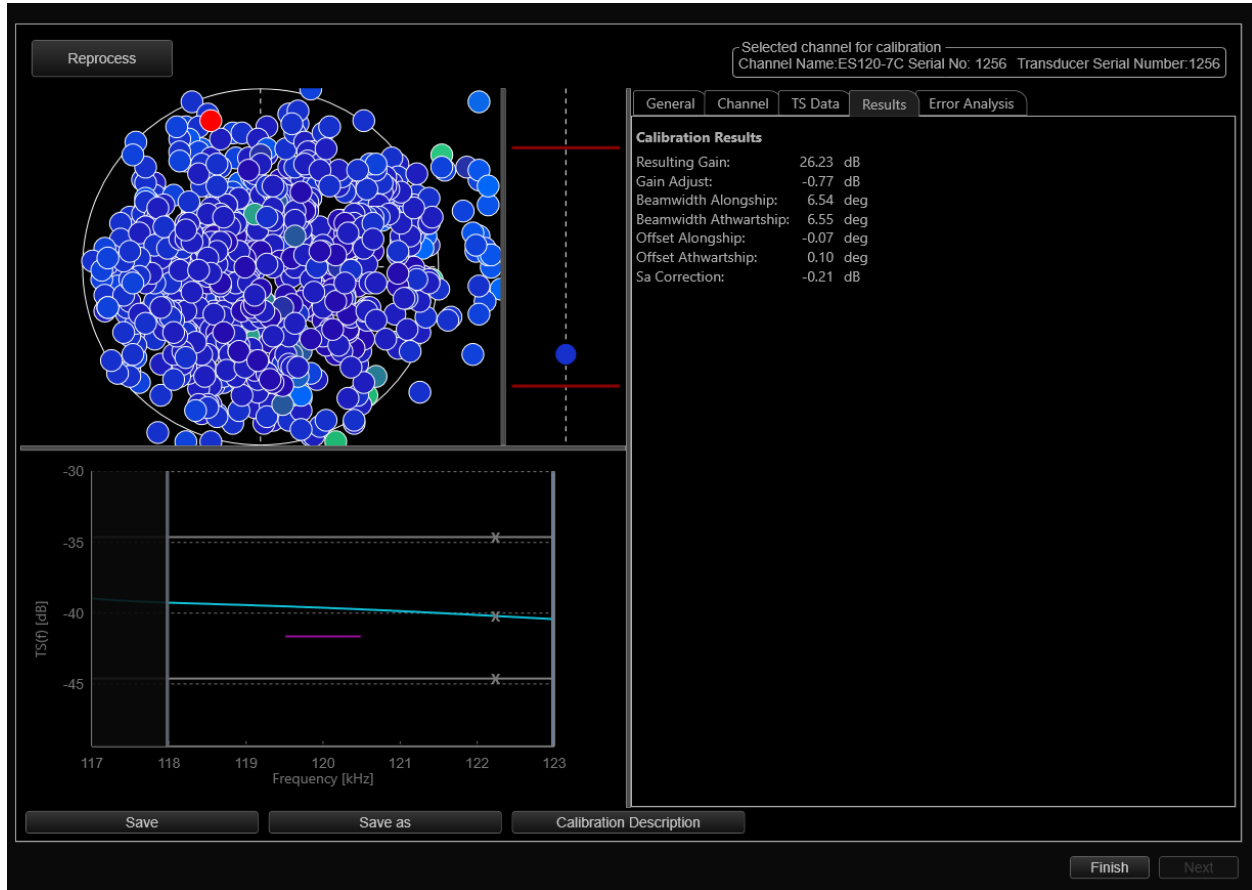


Figure 27. Screenshot of EK80 Calibration Wizard results for the 120 kHz calibration at 1.024 ms.

200 kHz: 1.024 ms

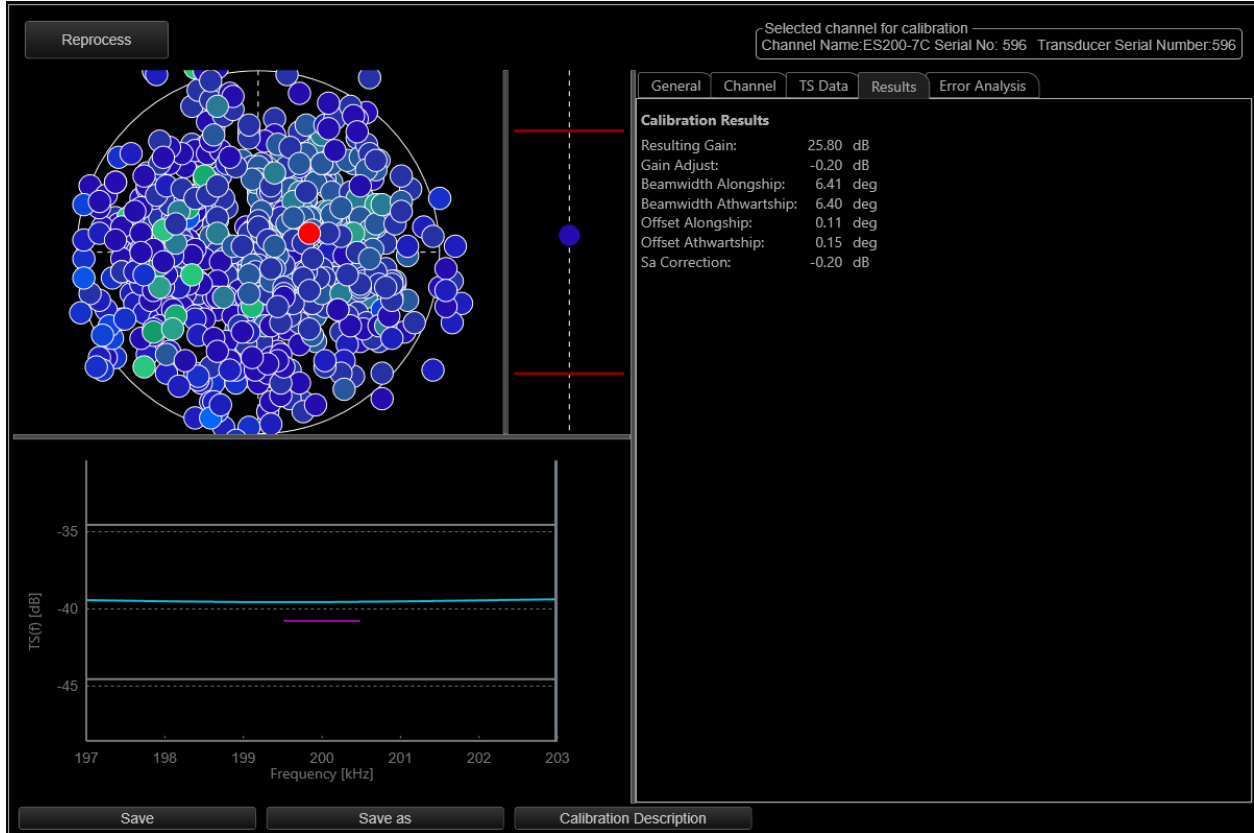


Figure 28. Screenshot of EK80 Calibration Wizard results for the 200 kHz calibration at 1.024 ms.

Appendix E: Error Analysis

38 kHz (CW): 1.024 ms



Figure 29. Screenshot of EK80 Calibration Wizard error analysis for the 38 kHz calibration at 1.024 ms in continuous wave (CW) mode.

38 kHz (CW): 2.048 ms

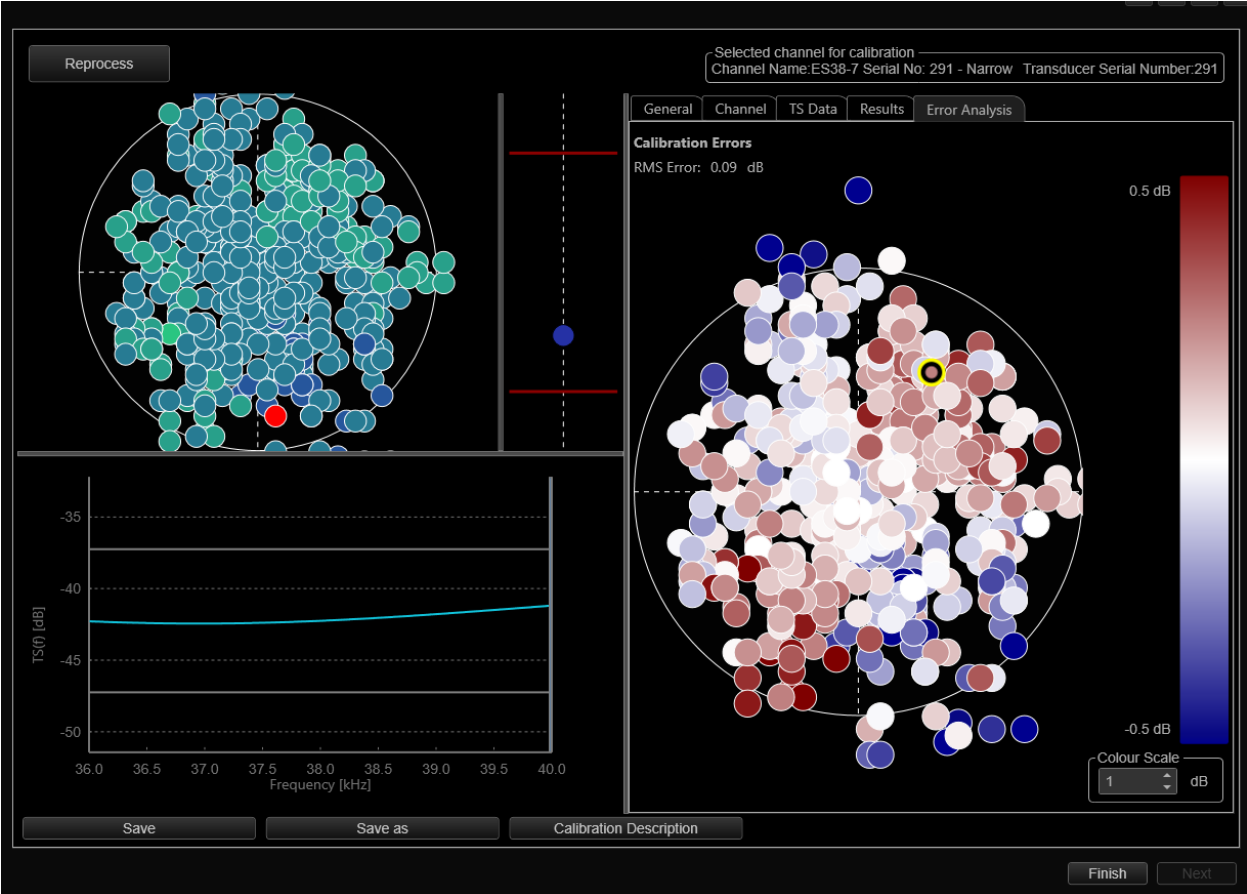


Figure 30. Screenshot of EK80 Calibration Wizard error analysis for the 38 kHz calibration at 2.048 ms in continuous wave (CW) mode.

38 kHz (FM): 1.024 ms

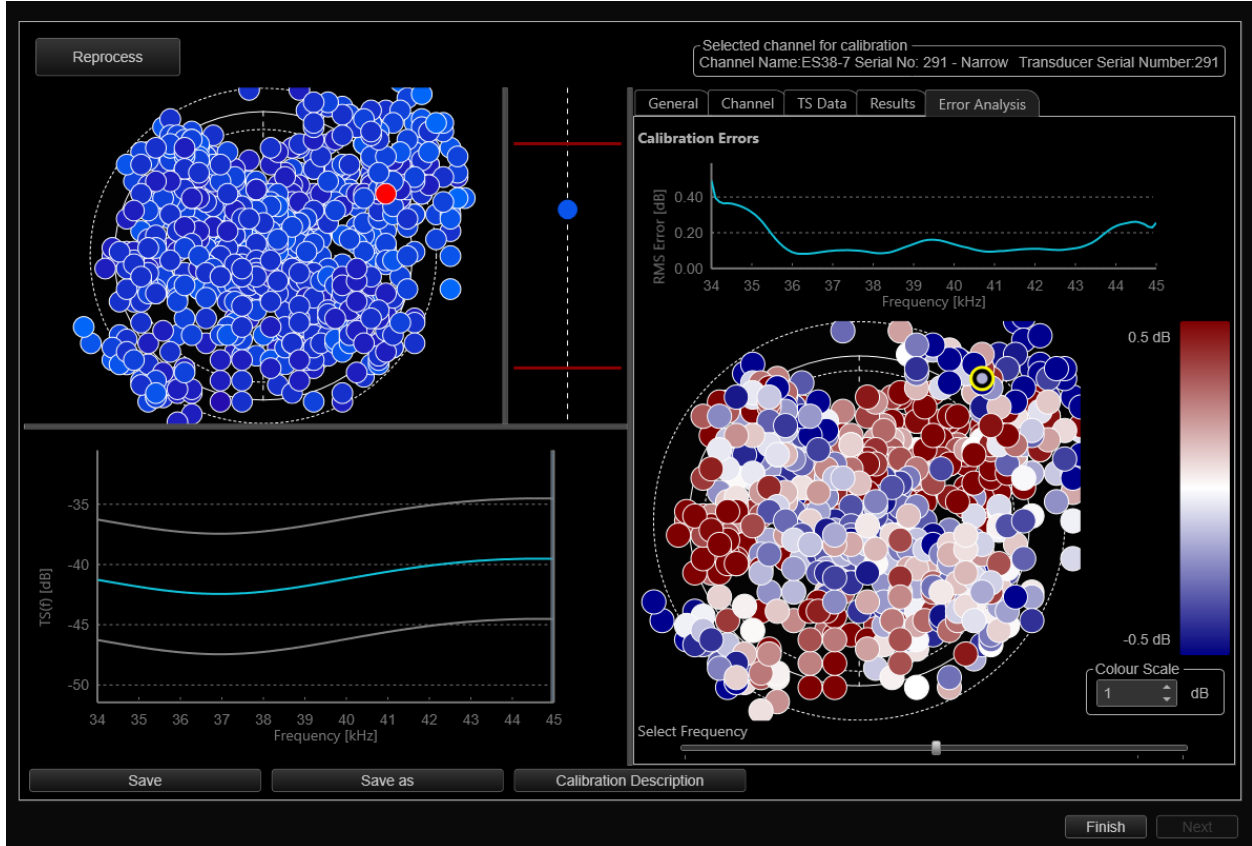


Figure 31. Screenshot of EK80 Calibration Wizard error analysis for the 38 kHz calibration at 1.024 ms in frequency modulated (FM) mode.

70 kHz (CW): 1.024 ms

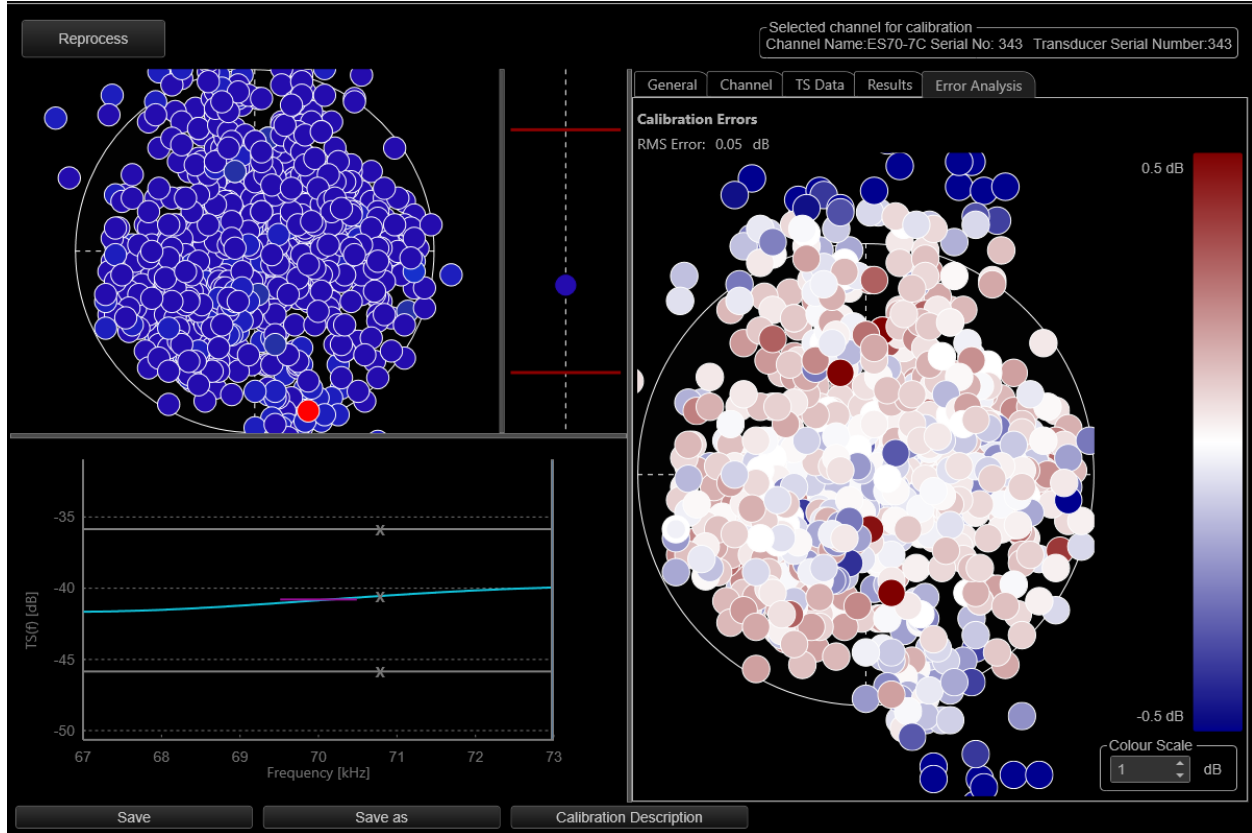


Figure 32. Screenshot of EK80 Calibration Wizard error analysis for the 70 kHz calibration at 1.024 ms in continuous wave (CW) mode.

70 kHz (CW): 2.048 ms

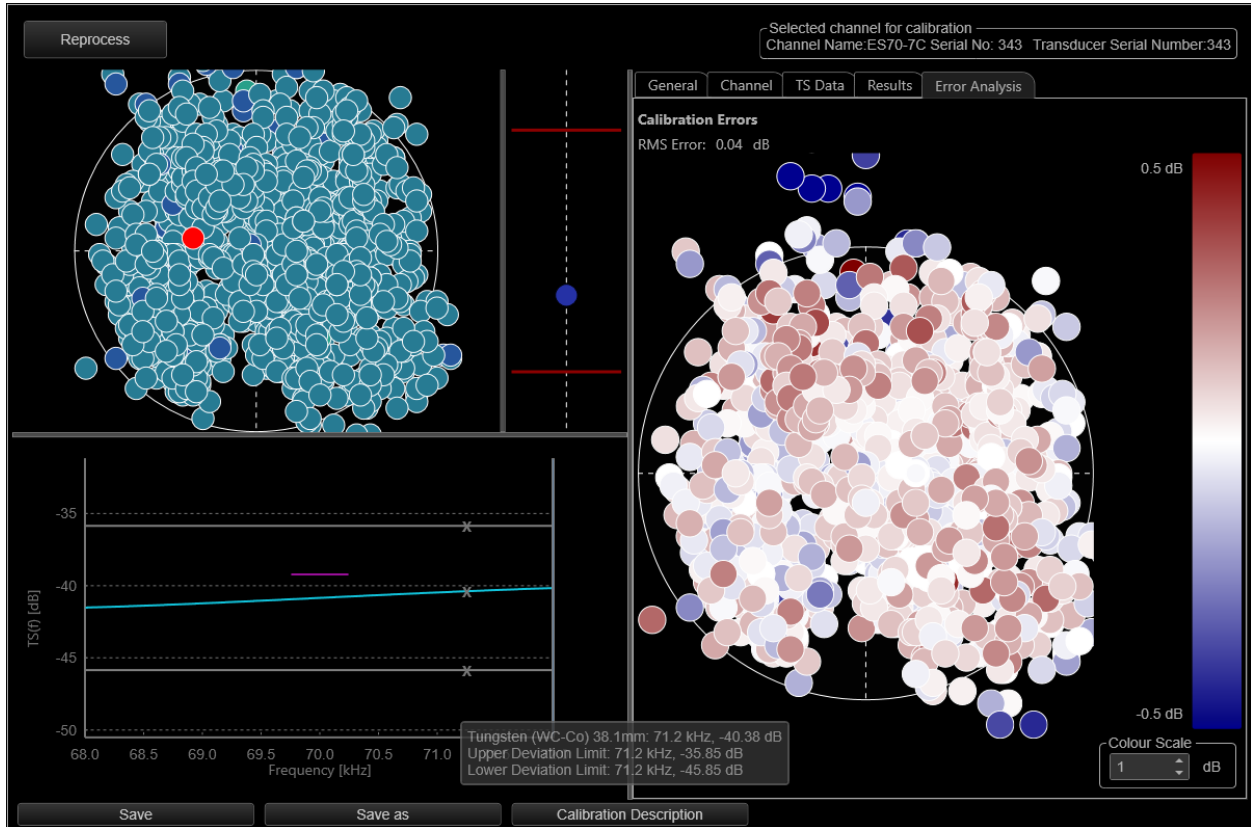


Figure 33. Screenshot of EK80 Calibration Wizard error analysis for the 70 kHz calibration at 2.048 ms in continuous wave (CW) mode.

120 kHz: 1.024 ms

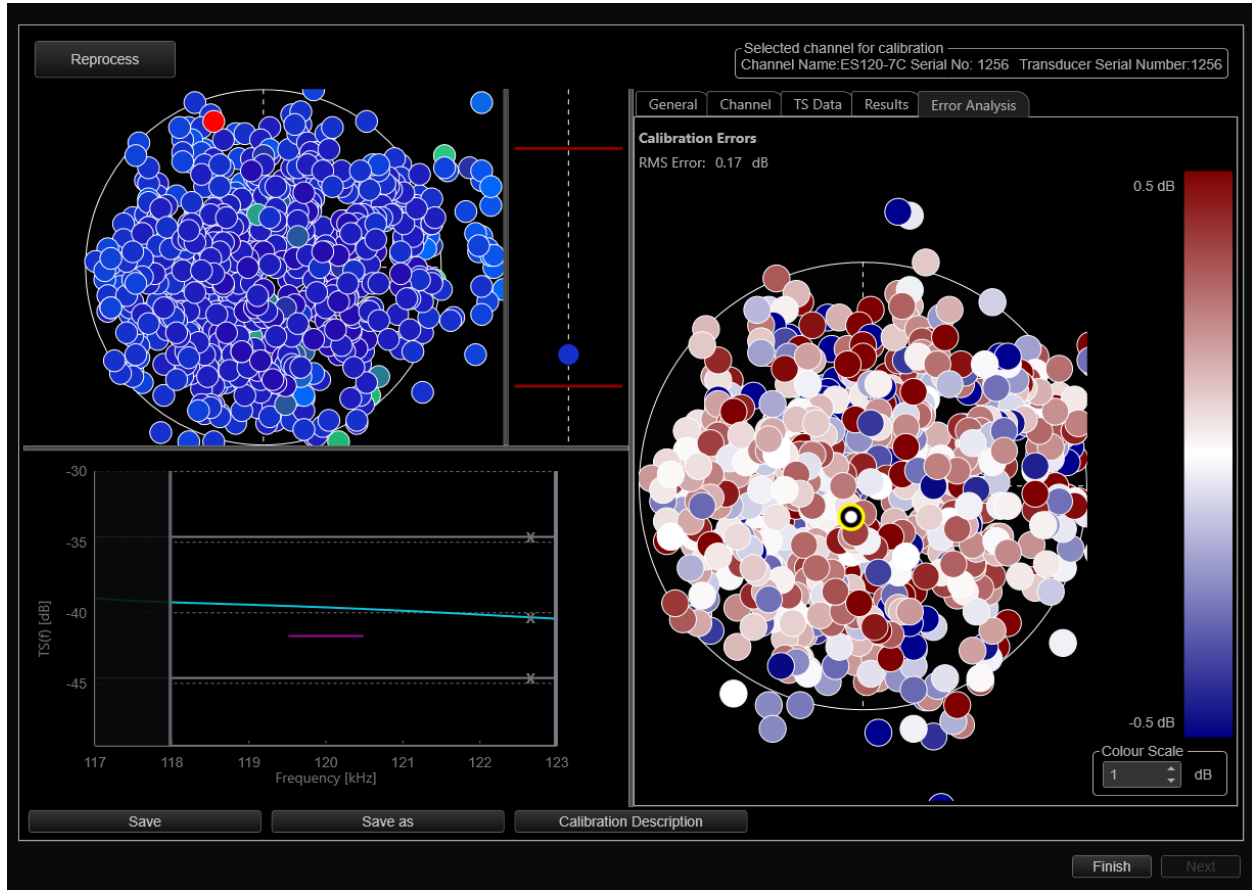


Figure 34. Screenshot of EK80 Calibration Wizard error analysis for the 120 kHz calibration at 1.024 ms.

200 kHz: 1.024 ms

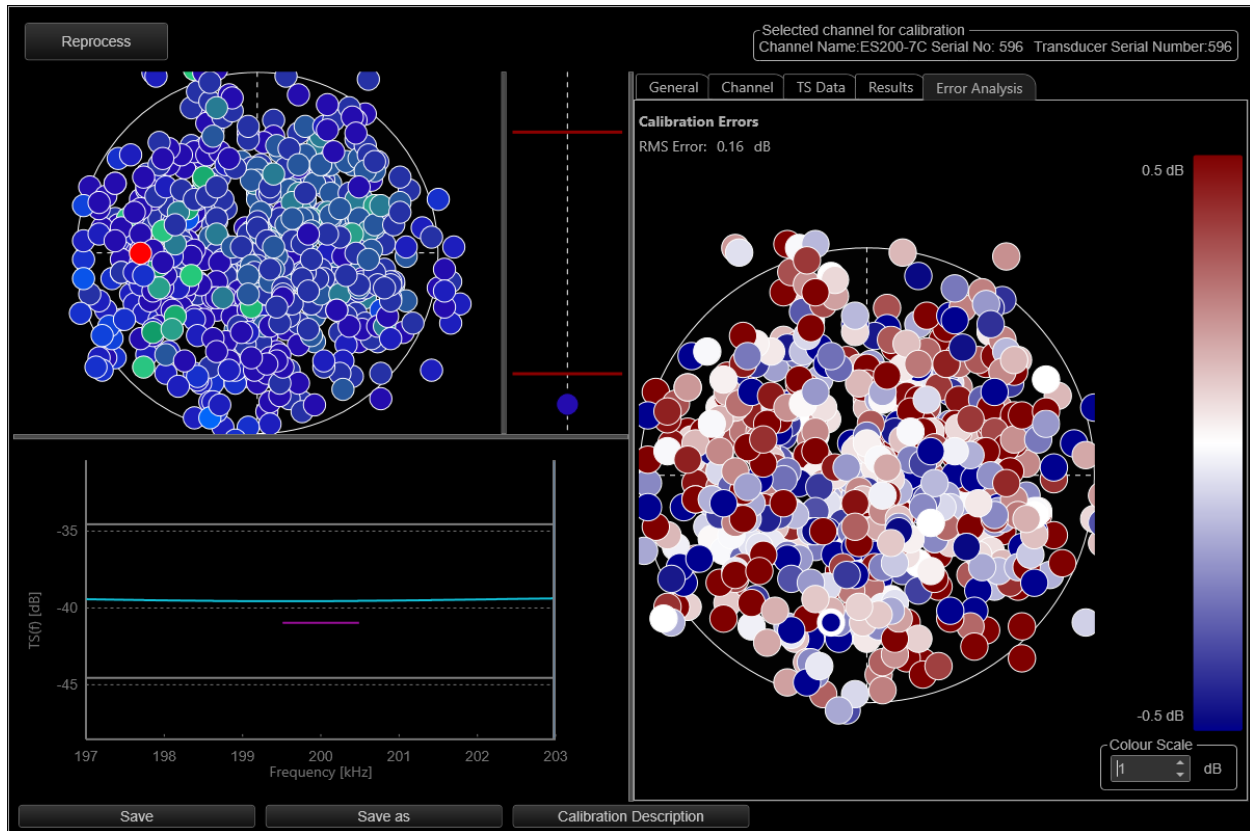


Figure 35. Screenshot of EK80 Calibration Wizard error analysis for the 200 kHz calibration at 1.024 ms.

Appendix F: Detailed List Calibration Files

File name	Date (UTC)	Frequency (pulse length)
EX2204_EK60_calibration-D20220606-T181738.raw	06/06/2022	38 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T181738.idx	06/06/2022	38 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T181802.raw	06/06/2022	38 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T181802.idx	06/06/2022	38 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T181924.raw	06/06/2022	38 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T181924.idx	06/06/2022	38 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T173938.raw	06/06/2022	38 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T173938.idx	06/06/2022	38 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T174021.raw	06/06/2022	38 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T174021.idx	06/06/2022	38 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T174053.raw	06/06/2022	38 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T174053.idx	06/06/2022	38 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T175952.raw	06/06/2022	38 kHz - FM (1.024 ms)
EX2204_EK60_calibration-D20220606-T175952.idx	06/06/2022	38 kHz - FM (1.024 ms)
EX2204_EK60_calibration-D20220606-T183811.raw	06/06/2022	70 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T183811.idx	06/06/2022	70 kHz - CW (1.024 ms)
EX2204_EK60_calibration-D20220606-T185940.raw	06/06/2022	70 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T185940.idx	06/06/2022	70 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T190602.raw	06/06/2022	70 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T190602.idx	06/06/2022	70 kHz - CW (2.048 ms)
EX2204_EK60_calibration-D20220606-T171955.raw	06/06/2022	120 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T171955.idx	06/06/2022	120 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T165626.raw	06/06/2022	200 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T165626.idx	06/06/2022	200 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T170139.raw	06/06/2022	200 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T170139.idx	06/06/2022	200 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T170415.raw	06/06/2022	200 kHz (1.024 ms)
EX2204_EK60_calibration-D20220606-T170415.idx	06/06/2022	200 kHz (1.024 ms)

.xml file name	Date (UTC)
CalibrationDataFile-D20220606-T181933_38kHz_CW_1024ms	06/06/2022
CalibrationDataFile-D20220606-T174234_38kHz_CW_2048ms	06/06/2022
CalibrationDataFile-D20220606-T180009_38kHz_FM_1024ms	06/06/2022
CalibrationDataFile-D20220606-T183933_70kHz_CW_1024ms	06/06/2022
CalibrationDataFile-D20220606-T190607_70kHz_CW_2048ms	06/06/2022
CalibrationDataFile-D20220606-T172034_120kHz_1024ms	06/06/2022
CalibrationDataFile-D20220606-T170428_200kHz_1024ms	06/06/2022

Appendix G: Vessel Offsets for Transducer Hull Locations

Vessel Offsets (meters)			
Transducer	X	Y	Z
ES38-B (38 kHz)	5.7288	3.3967	6.7955
ES70-7C (70 kHz)	6.5095	3.3939	6.7903
ES120-7C (120 kHz)	5.2481	3.3954	6.7895
ES200-7C (200 kHz)	6.1682	3.2258	6.7920