```
==================================================
VNA Tools V2.4.3 (2.4.7661.25994) - 22.12.2020
==================================================


- Uses improved METAS UncLib V2.4.3:
  - Interpolation improved (use epsilon for extrapolation check).
  - Numeric format control added to toolstrip of GuiUncBudget and
GuiUncListBudget.
  - GuiUncListBudget improved (the largest uncertainty of the list is
100%, before each item of the list was 100%).
  - License modified (NZ 512212 patent removed).
- Agilent PNA Series driver improved:
  - Support for Keysight USB VNAs (P937x) added.
- VnaToolsRealTime class improved and VnaToolsRealTimeCOM4 class added.
The following methods were added:
  - SaveSParamDataAsXml
  - SaveSParamDataAsCovarianceText
  - SaveSParamDataAsTouchstone
  - SaveSParamDataAsTouchstoneV2
  - SaveSParamDataAsFrequencyList
  - SaveVnaDataAsXml
  - SaveVnaDataAsCovarianceText
  - SaveVnaDataAsCiti
  - SaveVnaDataAsFrequencyList
  - LoadCollectionItemAsVnaData
  - SaveVnaDataCollectionAsBinary
  - SaveVnaDataCollectionAsCovarianceText
- License modified (NZ 512212 patent removed).


==================================================
VNA Tools V2.4.2 (2.4.7633.29769) - 27.11.2020
==================================================


- Uses improved METAS UncLib V2.4.2:
  - User references updated.
- Reflection Normalization incomplete calibration added.
- Transmission Normalization incomplete calibration added.
- One Path Two Ports incomplete calibration added.
- Unknown Error Terms added to VNA Device.
- SOLT_RawData added to SParamTools.
- SOLT_RawData added to WaveParamTools.
- AddNPNP and MultiplyNPNP added to WaveParamTools.
- Constants replaced with Const.c0, Const.u0 and Const.E0.
- Support for Rohde & Schwarz NRX improved (resolution).
- Anritsu_ShockLine_Socket driver added.
- Anritsu ShockLine drivers improved (timeout increased to 5s and trigger
hold before setting sweep mode or segment table).
- VnaDeviceDatabaseItemCOM2 class improved. The following property and
method were added:
  - UnknownErrorTerms
  - InitUnknownErrorTermsElectricalSpec
- VnaUnknownErrorTermsElectricalSpecCOM class added.
- Typos fixed.
```

```
================================================
VNA Tools V2.4.1 (2.4.7591.29500) - 13.10.2020
================================================

- Uses improved METAS UncLib V2.4.1:
  - Bug in DLLPath fixed (Intel MKL DLL Path METAS UncLib Installation
64-bit).
- Help button added to VNA Tools. It contains the following items:
  - User Manual
  - Math Reference
  - Data Formats
  - Programming Reference
  - Website
  - Forum
  - License
  - About
- Help button added to Data Explorer. It contains the following items:
  - User Manual
  - Data Formats
  - Website
  - License
  - About
- Data Explorer improved: Make Reciprocal menu item added to content
menu.
- Phase Delay improved (unwrapped phase starts at DC between -90 deg and
90 deg). This works for opens, shorts and transmission measurements.
- Unwrap method improved (remove NaNs for linear fit to DC).
- Unwrap, Phase Delay and Group Delay methods improved (try to find out
cutoff frequency).
- VnaToolsRealTimeCOM3 class added. The following methods were added:
  - NewProject2
  - NewVnaData
  - LoadVnaData
  - SaveVnaData
  - ConvertSParamData2VnaData
  - ConvertVnaData2SParamData
  - NewVNADevice2
  - LoadVNADevice2
  - SaveVNADevice2
  - NewPowerSensorDatabased
  - LoadPowerSensorDatabased
  - SavePowerSensorDatabased
  - NewPowerSensorTable
  - LoadPowerSensorTable
  - SavePowerSensorTable
- VnaToolsRealTimeProjectCOM2 class added. The following properties and
methods were added:
  - TempDUTFileName_sdatb
  - TempDUTFileName_vdatb
  - AddMeasurement (VnaDataCOM)
  - AddMeasurementAndComputeErrorCorrection (VnaDataCOM)
  - AddTempDUTMeasurementAndComputeErrorCorrection (VnaDataCOM)
  - AddPowerSensorMeasurement (VnaDataCOM)
  - AddPowerSensorMeasurementAndComputeErrorCorrection (VnaDataCOM)
  - AddTempDUTPowerSensorMeasurementAndComputeErrorCorrection
(VnaDataCOM)
- VnaDataCOM, VnaParameterDataCOM and VnaDataToolsCOM classes added.
- PowerSensorDatabasedDatabaseItemCOM, PowerSensorTableDatabaseItemCOM,
PowerSensorTableItemCOM and PowerSensorUncertaintiesCOM classes added.
- COM Wrapper improved (initialize .NET objects).
```

- VnaData added to Metas.Vna.RealTime.
- Check file extensions added to Metas.Vna.RealTime.
- AddPowerSensorMeasurement added to Metas.Vna.RealTime.
- PowerSensorDatabased and PowerSensorTable added to Metas.Vna.RealTime.
- AddPowerSensorMeasurements, SplitVnaDataAndPowerSensorMeasurements and ContainsPowerSensorMeasurements methods improved (allow multiport VNA measurements with a common source port).
- GetCommonSourcePort method added to VnaDataTools class.
- OpenPowerMeter and OpenPowerMeterDB methods added to script class.
- Script improved (don't show background worker helper dialog).
- Variable Gamma property added to line section of primary airline and offset short standards.
- PrimaryCalibrationStandard ComputeLine method improved (single z-Position and no z-Position).
- PrimaryCalibrationStandard Zr bug fixed (change reference impedance of simulated data to Zr).
- Support for CITI dat and unc files added.
- Agilent ENA driver improved (E5063A doesn't support FrequencyCW, Source1PowerSlope, Port1Attenuator and Port2Attenuator).
- Support for Rohde & Schwarz NRX improved.
- LRRM Calibration bug fixed (additional boundary condition added for unknown reflect 2 standard).
- Bug in GuiVnaCovariance fixed (null data).
- Bug in GuiVnaPlot fixed (only update plot when parameter is changed).
- Bug fixed in PowerSensor.Uncertainties (default value).
- Bug when opening a file from the command prompt fixed.
- Validate Option Dialog.

==
VNA Tools V2.4.0 (2.4.7541.23214) - 24.08.2020
==

- Support for wave parameters added:
  - Power calibration standard types added:
    - Power Sensor Table
    - Power Sensor Databased
  - Measurement of a power sensor added to measurement journal.
  - Power calibration added.
  - Error correction improved (including wave parameters).

==
VNA Tools V2.3.2 (2.3.7541.19337) - 24.08.2020
==

- Uses improved METAS UncLib V2.4.0:
  - DoubleHelper class improved (Intersection method added).
  - ComputeJacobiEig improved (limit set to 1e-15 * largest eigenvalue, return number of non-zero eigenvalues).
  - ComputeInvJacobiEig added.
- Small Unc Limit added to VNA Tools Options dialog.
- Reflection submenu improved (e.g.: S1,1 and S2,2 added).
- IDatabasedCalibrationStandard interface added with DefinitionFrequency read-only property.
- Interpolation property added to FileVerificationConfigStd class.
- Interpolation column added to verification config.
- VerificationTools.Compute improved:
  - Databased standard and no interpolation --> use common frequency list.
  - Model standard or frequency interpolation --> use measurement frequency list.

- CreateScreenshots method modified.
- New Calibration Dialog: Tool tips added.
- AddFirewallRule method added (Metas.Vna.Tools.exe -firewall).
- Shortcuts added:
  - New Project   (Ctrl+Shift+N)
  - Options   (Ctrl+Shift+O)
  - Measurement Series   (Ctrl+M)
  - Measurement Last Setup (Ctrl+L)
  - New Item   (Ctrl+N)
  - Open Item   (Ctrl+O)
  - Save Item   (Ctrl+S)
  - Save Item As   (Ctrl+Shift+S)
  - Run / Start   (Ctrl+R)
  - Cancel / Abort (Ctrl+T)
- Compute normalized error using the eigenvalue decomposition (fixes the problem with covariance matrices which are not positive definite).
- Verification result improved (tiny differences smaller than 1e-15 are set to zero which yields to a normalized error of 0).
- Compare cal config standard description method improved (optional ignoreVarIdAndWeights argument added).
- Rohde_Schwarz_ZNx_ZVx driver improved:
  - Support improved for ZNL and ZNLE (identification strings).

==
VNA Tools V2.3.1 (2.3.7440.18717) - 15.05.2020
==

- 'METAS VNA Tools II' renamed to 'METAS VNA Tools'.
- License modified.
- Third party licenses added to License folder.
- Uses improved METAS UncLib V2.3.1:
  - NumLib.Fft and NumLib.Ifft methods improved:
    - Optional argument withoutUnc = false added.
    - Intel.MKL FFT used for the case without uncertainties.
  - diag function improved (support from vector to diagonal matrix added).
  - mpower function improved (support for matrix power and matrix exponent added).
  - MATLAB wrappers improved (mlint warnings).
- Data Explorer improved:
  - Mag^2 format added.
  - Units (V/sqrt(kOhm), mW and dBm) added for single receiver values (wave parameters).
  - Single receiver values are formatted in log (similar to transmission S-parameters).
- Time gating dialog improved:
  - Uncertainty option added.
  - Warning for time gating and uncertainty propagation with more than 1000 data points added.
  - Use Intel MKL FFT for time gating without uncertainties.
  - Minimum timespan set from 100 ps to 1 ps.
- Bug (er) in compute gamma of a rectangular waveguide fixed.
- GuiJournalEditor improved (Measurement Last Setup).
- GuiLoggerDevice improved:
  - Uses DataGridViewComboBoxDropDownColumn for driver.
  - Uses DataGridViewComboBoxVisaResourceColumn for resource.
- Check if form is visible on screen added before resetting the old window location and size.

```
=================================================
VNA Tools V2.3.0 (2.3.7347.23243) - 12.02.2020
=================================================


- Uses improved METAS UncLib V2.3.0:
  - High DPI scaling improved.
- Agilent PNA Series driver improved:
  - Support for Keysight PXI VNAs (M937x, M948x and M980x over HiSLIP)
added.
  - Support for Keysight USB VNAs (P50xx) added.
  - Workaround for bug in set up parameters (delete all traces) added.
- Rohde_Schwarz_ZNx_ZVx driver improved:
  - Support added for ZNL and ZNLE.
- EcologNetLogger driver improved.
- IVna interface changed: SetSingleFrequency(double freq) and
SetSingleFrequency(double[] freq, int index) methods added.
- VnaHelper class modifed: InitSingleFrequency(IVna vna, double[] freq,
out bool cwmode, out double zerospan) and SetSingleFrequency(IVna vna,
double[] freq, int index, bool cwmode, double zerospan) methods added.
- VNA Characterize Noise uses new IVna.SetSingleFrequency method.
- Reference impedance bug fixed in SOLT calibration without
uncertainties.
- On-Wafer Heinrich model modified (FORTRAN code from Heinrich 1993 is
newer than paper from 1993).
- GuiJournalMeasurementSeries improved (set VNA parameter matrix only
when changed).
- Add items only to look up table when they are stored inside the
database root path.
- VnaDataTools.NormPhaseToReferenceReceiverOfSourcePort added.
- High DPI scaling improved.
- Licenses modified (redistribution, RTI).


=================================================
VNA Tools V2.2.7 (2.2.7258.29341) - 15.11.2019
=================================================


- Uses improved METAS UncLib V2.2.7:
  - Error function added (Erf28 class changed from internal to public).
  - Optimizer Levenberg-Marquardt improved:
    - Stores recovery state every 12 hours.
    - Stores temp debug information every 12 hours.
    - Auto restores recovery state after restart.
    - Deletes recovery state after optimizer finished.
  - OptimizerLevenbergMarquardt and OptimizerTrustRegion use Cholesky
decomposition and solve a triangular matrix equation (faster than
inverting the triangular matrix) for covariance weighting.
  - OptimizerLevenbergMarquardt and OptimizerTrustRegion performance
improved (faster user weighting, faster compute covariance).
- Linearity uncertainty generator improved:
  - Old version was uniform distributed +-0.05 dB (sigma of 0.0289) with
5 x 0.02 dB bins. Correlation of 1 to 0 (0.2 steps) for a power offset of
0 to 0.1 dB.
  - New version is normal distributed with sigma of 0.01 dB using 11 x
0.02 dB bins. Correlation of 0.5 for a power offset of 0.05 dB.
- OptimizationCalibration2 (all frequencies at once) and
OptimizationCalibrationBigShaker (all frequencies at once and multiple
calibration configurations) use the improved Levenberg-Marquardt
optimizer:
  - Store recovery state every 12 hours.
  - Store temp debug information every 12 hours.
```

- Auto restore recovery state after restart.
    - Delete recovery state after optimizer finished.
- Static constructor added to script class which loads the settings from
the registry (this is used when calling the script class from e.g.:
CPython over pythonnet).
- GuiCalibrationConfig, GuiSlidingLoadConfig and GuiVerificationConfig
improved (browse dialog file filter).
- Dialog New Calibration Config improved (Optional Standards renamed to
Isolation Calibration).
- Slot Chamfer added to connector model (METAS Standard Computer).
- GuiSplitButtonVnaParameterSetUp improved:
  - Reference Receiver added.
  - Test and Reference Receivers added.
- GuiJournalEditor improved:
  - Reference Receiver added.
- VnaData improved:
  - IsOnlySwitchTerms read-only property added.
  - IsSParamDataAndSwitchTerms read-only property added.
  - IsSParamDataAndReferenceReceiver read-only property added.
  - IsSParamDataReferenceReceiverAndSwitchTerms read-only property added.
- VnaParameter improved:
  - IsSwitchTerm read-only property added.
  - VnaParameter.SwitchTerms method added.
  - VnaParameter.SParameterMatrixAndReferenceReceiver method added.
  - VnaParameter.SParameterMatrixReferenceReceiverAndSwitchTerms method
improved (parameter order changed).
  - VnaParameter.TestAndReferenceReceivers method added.
  - VnaParameter.ParameterMatrixFromVnaData method improved.
  - VnaParameter.Info method improved.
- Convert.Object2SParamData and Convert.Object2VnaData methods added.

==
VNA Tools V2.2.6 (2.2.7220.27700) - 08.10.2019
==

- Bug in HP8510C, HP8751A, HP87xx drivers fixed (buffer size when reading
trace data or instrument state set to 1024 kByte).
- Default buffer size when reading a byte array increased to 16 kBytes
(old VisaNS value was 16 kBytes, new Ivi.Visa value was 1 kBytes).
- AlmemoLogger driver improved (works with A809 and A2890-9).
- VnaToolsRealTime class improved and VnaToolsRealTimeCOM2 class added.
The following methods were added:
  - ListCollectionItems
  - LoadCollectionItemAsSParamData
  - SaveSParamDataCollectionAsBinary
  - SaveSParamDataCollectionAsCovarianceText
  - NewVerificationConfig
  - LoadVerificationConfig
  - SaveVerificationConfig
- VerificationConfigCOM and VerificationConfigStdCOM classes added.
- Script class improved. The following methods were added to support data
collections:
  - ListCollectionItems
  - LoadCollectionItemAsSParamData
  - LoadCollectionItemAsVnaData
  - SaveSParamDataCollectionAsBinary
  - SaveSParamDataCollectionAsCovarianceText
  - SaveVnaDataCollectionAsBinary
  - SaveVnaDataCollectionAsCovarianceText

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==================================================
VNA Tools V2.2.5 (2.2.7200.25240) - 18.09.2019
==================================================


- Uses improved METAS UncLib V2.2.5:
  - Bug when loading read-only files fixed (FileAccess mode set to Read).
  - DoubleHelper class improved:
    - IsLessOrApproximatelyEqual method added.
    - IsGreaterOrApproximatelyEqual method added.
  - Interpolation improved (uses IsLessOrApproximatelyEqual).
- Agilent ENA driver improved (multiport supported added).
- Error message of setting up VNA improved (inner exception message
added).
- Juroshek calibration Zr bug (VNA Zr != calibration standard defintions
Zr) fixed.
- Bug in measurement series fixed (transmission S-parameter series).
- Databased standard: error message added in case the data file does not
exist.
- Waveguide bug fixed (uses DoubleHelper.IsLessOrApproximatelyEqual).


==================================================
VNA Tools V2.2.4 (2.2.7172.23772) - 21.08.2019
==================================================


- Uses improved METAS UncLib V2.2.4:
  - Bug in the algorithm solving a nonlinear least squares problem with
linear (bound) constraints using the Levenberg-Marquardt fixed. Details:
The Jacobian matrix is not manipulated anymore to achieve the boundaries,
the algorithm takes care about. --> smaller residuals at the point of the
solution.
  - Performance of interpolation improved.
  - Interpolation improved (PolyFitData x shifted to -xx, avoids matrix
is singular, higher accuracy).
  - Fatal error message added: same internal uncertainty id.
- Data Explorer improved:
  - Passivity Check added.
  - Bug in method SameFrequencyPoints fixed (uses
DoubleHelper.IsApproximatelyEqual).
  - Performance of method CommonFrequencyPoints improved (uses
DoubleHelper.Union).
  - Transforms.PreProcessFreqList improved (numerical problems fixed).
- Console output of optimization calibration improved:
  - Standard numbering changed (start from 01).
- NationalInstruments.VisaNS replaced by Ivi.Visa:
  - Metas.Instr.VisaExtensions.VisaNS.MessageBasedSessionNS class added
(replaces the superseded NationalInstruments.VisaNS.MessageBasedSession
class).
  - Works with the following IO libraries:
    - National Instruments VISA
    - Keysight IO Libraries Suite
    - Rohde & Schwarz VISA (requires National Instruments VISA)
- Sweep timeout increased from 30 minutes to 120 minutes.
- Performance of method UpdateView (GuiJournal) improved.
- SParamTools improved (check for same frequency points and not only for
same number of frequency points).
- Bug in SParamTools.ShuntImpedance fixed.
- Bug in RemoveDependenciesFromDataset2 fixed.
- Fatal error fixed in ComputeLinearity fixed (same ids, double rounding
problem).
- Write complete error message to console (background worker).
```

- IronPython 2.7.7 replaced by IronPython 2.7.9
- Show stack size during start up.
- Stack size changed to 16 MB.


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=================================================
VNA Tools V2.2.3 (2.2.7062.28513) - 03.05.2019
=================================================
```

- Uses improved METAS UncLib V2.2.3:
  - Python wrapper improved.
  - Optimizers improved (CSRDot for weighting without covariance and support for HugeMatrix added).
  - OptimizerLevenbergMarquardt and OptimizerTrustRegion use Cholesky decomposition to compute weighting matrix.
- The noise characterization wizard tries to perform the measurements like that:
  1. Set same start and stop frequency (in linear sweep mode) and check if span frequency is zero. If the span frequency is zero the noise measurements are performed in this mode. That's the case for all HP, Agilent and Keysight VNAs.
  2. If the span frequency was not zero the measurements are performed in CW mode. That's the case for Anritsu VNAs and Rohde Schwarz ZNA, ZNB, ZVA, ZVB and so on.
  3. If the VNA doesn't supported the CW mode (with multiple measurement points) the measurements are done with a slightly different (0.001 Hz) start and stop frequency in linear sweep mode. That's the case for the Rohde Schwarz ZVC, ZVM, ZVK, ZVR and ZVRE. The reason for that is that the firmware of those VNAs are not supporting setting the same start and stop frequency.
- Noise characterization improved:
  - Workaround for Anritsu VNAs added (a CW entry will be coerced to the nearest point in the linear frequency list).
- Store debug information of optimization calibration improved:
  - Report progress.
  - Remove old existing files.
  - Standard numbering changed (start from 01).
- Primary female open standard added.
- DC resistance and variable DC resistance properties added to primary offset/flush short standard.
- Support for sub folders added for the following database entries:
  - VNA Device
  - Cable
  - Connector
  - DUT Uncertainty
  - Logger Device
- Performance of VNAData2Struct.m improved.
- Bug in Journal Editor fixed (inside measurement series experiment --> no error correction until end experiment).


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=================================================
VNA Tools V2.2.2 (2.2.6997.19301) - 27.02.2019
=================================================
```

- Uses improved METAS UncLib V2.2.1:
  - Python wrapper added.
- Agilent ENA driver modified (allow Keysight and Agilent as identification string, bug fixed).
- Database / Calibration Standard editor bug fixed (new ID for calibration standards with different file path).
- SParamTools.Interpolation uses NumLib.Interpolation2 (quadratic).

- VnaDataTools.Interpolation uses NumLib.Interpolation2 (quadratic).
- Metas.Vna.Data.SignalProcessing.Transforms uses NumLib.Interpolation2 (quadratic).
- GuiMaterialParamDataGraph.InterploateData uses NumLib.Interpolation2 (quadratic).
- SParamTools.SplineInterpolation added.
- VnaDataTools.SplineInterpolation added.
- Script.SplineInterpolation added.
- ThreePortTools.ComputeThreePort improved (use all equations s11, s21, 12 and s22 from all 3 calibration standards).

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=================================================
VNA Tools V2.2.1 (2.2.6956.17676) - 17.01.2019
=================================================
```

- Support for material parameters added. The following algorithms are supported:
  - Nicholson-Ross-Weir
  - NIST Iterative
  - New Non-Iterative
  - Direct
- Data Explorer improved:
  - Auto set up parameter matrix added to graph.
  - Bug in GuiXYPlotAdvanced fixed (GetUncNumberAndDescription method and second Y-axis).
  - Bug in GuiXYPlot fixed (xyCursor.GetCurrentIndex < 0).
- Time domain improved:
  - Compute gating improved (shift frequency domain data to -meanGroupDelay if abs(meanGroupDelay) > 2 * stdGroupDelay).
  - Mag log property added to graph and table in time domain.
- Unwrap method modified (linear fit to DC):
  - Phase should start at DC between +90 deg and -270 deg for a negative slope.
  - Phase should start at DC between -90 deg and +270 deg for a positive slope.

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=================================================
VNA Tools V2.2.0 (2.2.6908.27056) - 30.11.2018
=================================================
```

- Support for mixed-mode S-parameters added.

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=================================================
VNA Tools V2.1.1 (2.1.6908.24816) - 30.11.2018
=================================================
```

- Uses improved METAS UncLib V2.1.5:
  - UncNumber (LinProp, MCProp and DistProp) improved:
    - Tan method improved.
    - Sinh, Cosh, Tanh methods improved.
  - Complex improved:
    - Sin, Cos, Tan methods improved.
    - Sinh, Cosh, Tanh methods improved.
- Data Explorer improved:
  - Changing the x-axis scale will auto scale the y-axis to the visible part.
  - Changing the x-axis scale in one plot will change the x-axis scale in all other plots (except Cartesian).
- Support added for Touchstone V2.0 file format.
- Touchstone file format support improved:

- New data line for each matrix row added when number of ports is
greater than 2.
    - Formatting improved (padding).
    - Port assignment added (comment line).
    - Assembly name and version added (comment line).
    - Creation date added (comment line).
- DataCovarText file format improved:
    - Assembly name and version added (comment line).
    - Creation date added (comment line).
- New Databased Standard Wizard improved (Source Ports added).
- Create Databased Standard added to content menu of Data Explorer.
- Fit Calibration Standard Model added to content menu of Data Explorer.
- Tabular page called Cal Std Model Fit removed from VNA Tools. It's now
part of the content menu of the Data Explorer.
- Measurement series added with experiment a several DUT measurements.
- Measurement series dialog remembers old settings.
- Global Root Path renamed to Root Path.
- Label Root Path not visible (Data Explorer and VNA Tools).
- Browse button not visible for Root Path (Data Explorer and VNA Tools).

==
VNA Tools V2.1.0 (2.1.6876.16039) - 29.10.2018
==

- Uses improved METAS UncLib V2.1.4:
  - Integrate method added to NumLib class.
  - SplineInterpolation added to NumLib class.
  - Bug fixed (deserialize a generic type from an older version).
- Data Explorer improved:
  - Bug in compare VnaParameters fixed (VnaReceiverType.one).
  - GuiVnaParameter improved (disable Port when VnaReceiverType.one is
selected).
- CmcTools improved (exceptions added):
  - Calibration Config must be two-port calibration.
  - First port of calibration config must be port 1.
  - Second port of calibration config must be port 2.
  - VNA Error Terms must be two-port calibration.
  - First port of VNA error terms must be port 1.
  - Second port of VNA error terms must be port 2.
- VNA Characterize Noise improved:
  - Default VNA Mode: Linear frequency with same start and stop
frequency.
  - If not supported CW VNA Mode.
- SParamTools.Interpolation uses NumLib.SplineInterpolation2.
- SParamTools.InterpolationReImMP uses NumLib.Interpolation2 (linear).
- VnaDataTools.Interpolation uses NumLib.SplineInterpolation2.
- VnaDataTools.InterpolationReImMP uses NumLib.Interpolation2 (linear).
- Metas.Vna.Data.SignalProcessing.Transforms uses
NumLib.SplineInterpolation2.
- PostProcessTimeDomainData improved (uses NumLib.Integrate for mode low
pass step).
- BeginExperimentJournalItem modified (default experiment type changed to
statistical).

```
==================================================
VNA Tools V2.0.4 (2.0.6814.27933) - 28.08.2018
==================================================


- Uses improved METAS UncLib V2.1.0:
  - Atan2 improved (Atan2(0, 0) --> 0, Atan2(NaN, x) --> NaN and Atan2(x,
NaN) --> NaN, sensitivities in all cases).
  - NonLinearEig method added to LinProp/UncLinAlg class.
  - Solve over-determined non-linear Eigenvalue problem improved (smaller
residuals):
    - new: over-determined non-linear system --> determined non-linear
system --> determined linear system
    - old: over-determined non-linear system --> over-determined linear
system --> determined quadratic system --> determined linear system.
- Data Explorer improved:
  - Legend added to Graph.
  - XY plot improved (show single point).
  - Cartesian plot improved (frequency information added).
  - MultiSelectTreeView HighDPI bug fixed (uses
TextRenderer.MeasureText).
- Measurement series with different VNA settings (e.g.: source power)
added.
- Port assignment column added to calibration config.
- Bug in renaming measurement journal item fixed (.vdatb extension).
- Bug when opening a vnalog, calcfg or vercfg file from command line or
windows explorer fixed.


==================================================
VNA Tools V2.0.3 (2.0.6785.14432) - 30.07.2018
==================================================


- Agilent ENA and PNA drivers improved (set byte order to normal).
- Anritsu ShockLine driver added.
- AnritsuAutocalOverShockLine driver added.
- Metas.Instr.Driver.Vna.AnritsuVectorStar.dll renamed to
Metas.Instr.Driver.Vna.Anritsu.dll.
- TestVna High DPI bug fixed.
- CmcCalculationMode (min, mean, max) added to Database / CMC Entry
(default: min).
- VnaErrorTermsCalibrationFile added to Database / CMC Entry (default:
none --> ideal VNA).
- Raw data in CmcTools are set to Port Zr of the VNA and not changed to
Port Zr of the VNA (using SParamTools.ChangeZr) --> ideal VNA error terms
in all cases.
- Fatal error fixed in ComputeLinearity fixed (same ids when measurement
level is NaN).
- Non leaky mask of error terms for a new configuration of an
optimization calibration.
- Time gating dialog improved: Conv enabled (without item Time Domain) in
frequency domain.
- Time gating dialog bug fixed (minimum value of time span set to 100
ps).
- InterpolationReImMP added to SParamTools and VnaDataTools.
- InterpolationMagPhase added to SParamTools and VnaDataTools.
- Atan2 improved (sensitivities in all cases).
```

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==================================================
VNA Tools V2.0.2 (2.0.6732.13864) - 07.06.2018
==================================================


- On Wafer Offset Short Standard added.


==================================================
VNA Tools V2.0.1 (2.0.6724.25834) - 31.05.2018
==================================================


- .NET target version changed to V4.5.
- Support for vdatb files as raw data added.
- New switch term format (vdatb).
- Examples modified (new switch term format).
- Custom VNA Parameter Setup improved.
- Support for CITI files improved.
- Support for VNA Data Covariance Text files (*.vdatcv) added.
- Support for S-Parameter Data Collection Covariance Text files
(*.scolcv) added.
- Support for VNA Data Collection Covariance Text files (*.vcolcv) added.
- Support for S-Parameter Data Collection Binary files (*.scolb) added.
- Support for VNA Data Collection Binary files (*.vcolb) added.
- Support for ZIP files (*.zip) added.
- Save Collection As .. added to content menu of the Data Explorer.
- Check Connector Parameters added.
- Reciproc and OptReciproc methods added to Script class.
- MATLAB support improved.


==================================================
VNA Tools V2.0.0 (2.0.6667.33608) - 03.04.2018
==================================================


- Tool Tips added.
- Support for PDF files with embedded data files added to Data Explorer.
- Data Explorer improved: Open file menu item added to content menu.
- Number of Points added to VNA Device Characterize Noise dialog added
(before 801 points per frequency point was used).
- VNA Settings: default value of Zr changed to 50 Ohm.
- Journal VNA Settings: Zr enabled when no VNA session is open.


==================================================
VNA Tools V1.9.2 (1.9.6621.25325) - 16.02.2018
==================================================


- Time Domain added:
  - Frequency Domain to Time Domain
  - Time Gating


==================================================
VNA Tools V1.9.1 (1.9.6563.29785) - 20.12.2017
==================================================


- Data Explorer improved:
  - Auto Refresh
  - Auto Update Panel
  - Sort Selected Items
  - Update Icon Status
- Optimization calibration improved: up to 65535 objective functions.
- Interpolation improved: check if interpolation order out of range -->
NaN.
```

- LookUpId improved: return guid as string if not found.
- Improved time scale axis in Data Logger.
- ReplaceLaTeXCharacters method added. Fix bug with special characters,
e.g.: Omega.
- High DPI improved.

==
VNA Tools V1.9.0 (1.9.6491.14270) - 09.10.2017
==

- Uses METAS UncLib V1.9.0.
- Data Explorer improved:
  - Show reference impedance (Zr info) in column headers of GuiVnaTable.
  - ReIm, MP format added to graph and table (reflection: real and
imaginary parts, transmission: magnitude and phase).
  - Time format for phase delay and group delay added to table.
- Debug mode added to error correction (stores R, V, D and C uncertainty
influences for each measurement).
- Transmission connector repeatability added.
- CreateDatabaseStandard method added to script class.
- VNA Settings System Zr is read only.
- Complex reference impedance is not allowed for a VNA device.
- Metas.Vna.RealTime.COM.dll improved:
  - Evaluation key added which expires after 90 days.
  - VerificationToolsCOM class added with NormalizedError method.
  - Transmission uncertainty added for connector repeatability.
- Waveguide example added, see '08_Waveguide_Example_WR10'.
- On-Wafer example added, see '09_OnWafer_Example_GGB_CS-5'.
- Bug in GuiXYPlot fixed (BackgroundWorker).
- Bug in FindParameterIndex in VnaData class fixed (convert switch term
to S-parameter).
- Bug in drivers fixed (VISA Dispose added).

==
VNA Tools V1.8.6 (1.8.6430.18695) - 09.08.2017
==

- Data Explorer improved:
  - Z-parameter and Y-parameter data added:
    - VnaDataConv.Z_Parameter : Z-parameter
    - VnaDataConv.Y_Parameter : Y-parameter
    - VnaDataConv.Impedance   : Impedance (only reflection parameters,
other ports are terminated with an ideal load)
    - VnaDataConv.Admittance : Y-parameter(only reflection parameters,
other ports are terminated with an ideal load)
  - Conversion mode VSWR moved to magnitude format.
- LRRM calibration added.
- Agilent Model Standard improved:
  - Magnitude uncertainty added for Agilent model standard (open or
short).
  - Transmission uncertainty added for Agilent model standard (delay
thru).
- Bug in optimization calibration fixed (switch terms with noise,
linearity and drift).
- Bug in calibration cache fixed (do not add uncompress data to cache).

```
==================================================
VNA Tools V1.8.5 (1.8.6400.24590) - 10.07.2017
==================================================


- Bugs in GuiXYPlot fixed (ProcessSpecialValues, MoveCursorSafe).


==================================================
VNA Tools V1.8.4 (1.8.6400.16000) - 10.07.2017
==================================================


- Unknown series inductance and unknown capacitance calibration standards
added.
- Bugs in GuiCable, GuiConnector and GuiDUTUncertainty fixed.
- Bug in GuiXYPlot fixed (move cursor to NaN).


==================================================
VNA Tools V1.8.3 (1.8.6395.15968) - 05.07.2017
==================================================


- Database: Uncertainties are labeled with (k = 1) or (k = 2).
- Cable Transmission Stability is now one-way (Ct) and not two-way
(Ct*Ct).
- Cable Symmetry Stability is now one-way (Cs).
- Noise Floor (db rms) with k = 1.
- Characterization of noise floor changed:
  - new: 20*log10(max(std(syx_re), std(syx_im))
  - old: mean(20*log10(syx - mean(sxy)))
- Show uncertainty budget for cursors added.
- Cursors are coupled between plots.
- Verification added to VNA Tools.
- Agilent Model Standard extended for Waveguide.
- LHKM TRL LRL improved (choosing the eigenvalue for the unknown
reflection).
- Bug in save frequency list fixed.
- Logger Device added to Database and Journal.
- Reset states of step attenuator after measurement series has completed.
- On wafer line standard improved: frequency independent conductivity,
relative permittivity and tan delta added.


==================================================
VNA Tools V1.8.2 (1.8.6297.14029) - 29.03.2017
==================================================


- Uses METAS UncLib V1.8.2.
- Database / CMC Entry editor added.
- CMC Tools added to content menu of Data Explorer.
- Different hash algorithms to compute checksums.
- IronPython 2.7.7 used in Script editor.
- Bug in compute waveguide offset fixed.
- Database tab page order changed.


==================================================
VNA Tools V1.8.1 (1.8.6262.24056) - 22.02.2017
==================================================


- Uses METAS UncLib V1.8.1:
  - Chain Rule improved (faster).
  - LinAlg improved (Dot_invA_B and Dot_A_invB added).
  - Complex division improved.
- Parallelization of SParamTools (Cascade and Decascade).
```

- LHKM TRM LRL support for multiple lines added.
- Switched Error Terms normalized to 1.
- Helper methods added for Metas.Vna.RealTime.COM.dll.
- Metas.Instr.Driver.Logger.dll added.
- Rohde & Schwarz cables added.

==
VNA Tools V1.8.0 (1.8.6198.18768) - 20.12.2016
==

- Uses METAS UncLib V1.8.0.
- .NET target version changed to V4.0.
- High DPI scaling supported.
- Icons replaced with High DPI Icons.
- Bug with cursors fixed in XYPlot.

==
VNA Tools V1.7.10 (1.7.6177.29900) - 29.11.2016
==

- Support for waveguide standards with ratio not equal to two added
(simulation data updated).
- Bug in Journal Editor fixed. Add Measurement / Custom.
- Bug in RohdeSchwarz_ZNx_ZVx driver fixed: VnaParameter2String "S101" --
> "S1001".
- Clear cache method added.
- CmcTables supports specifying VNA Device.

==
VNA Tools V1.7.9 (1.7.6102.30094) - 28.09.2016
==

- Bugs in Metas.Vna.RealTime.dll fixed.
- Context menu for changing time stamp format added to header cell of the
time stamp column.
- DirectoryInfoExtensions added. Used to get directories and files
natural sorted by name.

==
VNA Tools V1.7.8 (1.7.6094.23660) - 07.09.2016
==

- Bugs in Metas.Vna.RealTime.COM.dll fixed.
- VnaToolsGuiCOM class added.
- Support for waveguide standards with ratio not equal to two added.
- Simulation data not yet updated.

==
VNA Tools V1.7.7 (1.7.6087.19110) - 31.08.2016
==

- User settings are stored to registry:
'HKEY_CURRENT_USER\Software\METAS\VNA Tools'.
- Metas.Vna.RealTime improved.

```
=================================================
VNA Tools V1.7.6 (1.7.6082.14268) - 26.08.2016
=================================================


- Data Explorer and VNA Tools: set root path from command prompt added.
- Remove small influences option added to optimization calibration.
- ECal renamed to ECU (Electronic Calibration Unit).
- Metas.Vna.RealTime.dll added.
- Metas.Vna.RealTime.COM.dll added.


=================================================
VNA Tools V1.7.5 (1.7.6022.29592) - 29.06.2016
=================================================


- Uses METAS UncLib V1.7.0.


=================================================
VNA Tools V1.7.4 (1.7.6005.16561) - 21.06.2016
=================================================


- Simple Line standard added.
- On-Wafer Line standard added.
- DUT Uncertainty added (can be used to represent on-wafer crosstalk).


=================================================
VNA Tools V1.7.3 (1.7.5989.15887) - 25.05.2016
=================================================


- Compress other frequency influences added for optimization calibration
over all frequency points.
- Show Journal Info in Unc Budget added.
- RemoveSmallUncInfluencesLimit changed from 1e-8 to 1e-7.


=================================================
VNA Tools V1.7.2 (1.7.5952.18825) - 19.04.2016
=================================================


- Error Model Zr bugs fixed:
  - Use Cable Zr for non-waveguide measurements.
  - Use Connector Zr for non-waveguide measurements.
  - Use VNA Zr for Drift for non-waveguide measurements.
- Shift reference plane:
  - Z_Y_Polynom added.
  - SParamTools: PolyFitZandY, PolyValZandY and MeanZandYPolynom added.
  - CalibrationTools: ComputeFitandMeanZ0andGamma using the Z_Y_Polynom
added.
- Copper Mountain Planar VNA driver added.


=================================================
VNA Tools V1.7.1 (1.7.5924.24352) - 21.03.2016
=================================================


- LHKM_TRL_LRL calibration added.
- LHKM_TRM_LRM calibration added.
- Bug (weighting with covariance) in optimization calibration fixed.
- Optimization calibration improved:
  - Variables of the calibration standards are stored in the calb file.
  - ComputeZ0andGamma method added.
```

```
==================================================
VNA Tools V1.7.0 (1.7.5883.24145) - 09.02.2016
==================================================


- New drift model: drift of ideal VNA.
- Symmetry drift added.
- Cable reflection stability added.
- Cable symmetry stability added.


==================================================
VNA Tools V1.6.5 (1.6.5854.25873) - 11.01.2016
==================================================


- Unknown Load calibration standard improved:
  - Fit uncertainty changed (random ID).


==================================================
VNA Tools V1.6.4 (1.6.5820.31869) - 08.12.2015
==================================================


- Unknown Load calibration standard improved:
  - Fit frequency added.
  - Fit uncertainty added.


==================================================
VNA Tools V1.6.3 (1.6.5813.20164) - 01.12.2015
==================================================


- User Weight Table added in standard description.
- Add Series Impedance and Shunt Admittance to SParamTools.
- Add Unknown Load as calibration standard.


==================================================
VNA Tools V1.6.2 (1.6.5801.18094) - 20.11.2015
==================================================


- More information during start up.
- Measure run time of VNA Tools.
- Upgrade Settings problem fixed.
- Add IronPython.Modules.dll.


==================================================
VNA Tools V1.6.1 (1.6.5777.20096) - 26.10.2015
==================================================


- Bug in new version 2 of calb fixed.
- Performance improvements.


==================================================
VNA Tools V1.6.0 (1.6.5773.34394) - 22.10.2015
==================================================


- New version 2 of sdatb and vdatb:
  - Smaller uncompressed file size.
  - GZIP not needed.
  - Faster loading and saving of files.
```

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=================================================
VNA Tools V1.5.4 (1.5.5764.15746) - 13.10.2015
=================================================


- Complete rewrite of all GUI editors.
- Drag and drop support improved.
- Split View added.
- VNA Device added to measurement journal file.
- .NET target version changed to V3.5.


=================================================
VNA Tools V1.5.3 (1.5.5743.23902) - 22.09.2015
=================================================


- Bug in Agilent_8720_53_Series driver fixed.
- Alglib uses Intel MKL for Cholesky decomposition.
- Faster optimization calibration.


=================================================
VNA Tools V1.5.2 (1.5.5730.25433) - 15.09.2015
=================================================


- Experiment uncertainties:
    - Add support for independent S-parameters, e.g.: 2 one port
components measured at the same time.
- LHKM calibration added.


=================================================
VNA Tools V1.5.1 (1.5.5697.15735) - 07.08.2015
=================================================


- Improved Data Explorer:
    - Set as Root Path in content menu.
    - Root Path is expanded.
    - Add Plot Font Dialog.
    - Decascade changed. Now all four cases are supported.
    - No autoscale when setting interaction mode to none. Autoscale when
unchecking zoom button.
    - Bugs in PlotCartesian fixed.
- Covariance tab page in calibration standard editor.
- Renaming measurement journal item added.
- Import measurement in journal ignores time stamp of file.
- Add measurement: trigger cont when sweep is complete and file dialog is
shown.
- Bug in GuiJournalCableConnectorTable fixed.
- Bug in Waveguide Offset Short Standard fixed (length offset).
- Bug in Database / VNA Device / Update Linearity Plot fixed
(SetYRange(NaN, NaN)).
- Bug in compute noise factor fixed. Do not under estimate the
uncertainty if meas ifbw is smaller than spec_ifbw.
- New linearity model. The linearity is discretized in 0.02 dB steps over
all receiver values. The discretion points are correlated with the 10
neighbor points.
- Width offset and height offset added to waveguide shim section.
- Add Waveguide Connector Offset class which use COMSOL simulation data
- Add Anritsu 3650A, 3651A, 3652A, 3653A, 3654D calibration kits.
- Add Anritsu 3656B and 3659 calibration kits.
- Add 0.8 mm connector.
- Add Anritsu standard cables.
- Add Anritsu Autocal.
```

- First version of Agilent_8720_53_Series driver based on the HP8753D driver.

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==================================================
VNA Tools V1.5.0 (1.5.5595.21600) - 27.04.2015
==================================================
```

- Improved Data Explorer:
    - New possibility to expand Windows shortcuts (links) to drives, directories, files and files with sub items
    - New Folder dialog added,
    - New Shortcut dialog added,
    - the cursor label in the tabular page graph shows now to which trace it's locked to.
    - Show properties in content menu of Data Explorer added.
- Primary Airline Standard and Primary Offset Short Standard changed. Ideal line section for propagation constant has zero length now. This is needed to couple offset shorts with different length.
- Covariance for experiment uses n - 1.
- Statistics: dof = n - 1 for coverage factor.
- Bug in time stamp of user comment fixed.
- Bugs in calibration standard fit for 2 ports fixed:
    - Offset Loss (Anritsu and Rohde Schwarz models) is divided by factor two for two-ports.
    - Offset Delay (Anritsu model) has the correct unit now.
- Offset Loss (Anristu model) is fitted now.
- Equivalent Source Match Palmer added.
- Support for MMS4 DSD files (read only) integrated.
- Measurement Journal / Custom Cable and Custom Connector Plots added.
- VNA Device / Noise, Linearity and Drift Plots added.
- Database / Cable and Connector Plots added.
- Comments field in all calibration standard database items added.
- VNA Device / Noise Characterization added.
- Color for user comments in Journal editor changed (light cyan).
- Load and Save VNA Graph Settings added.
- Waveguide Shim Standard and Waveguide Offset Short Standard added.
- Uncertainty interpolation changed.
- Obsolete Tools tabular page removed.
- Support for Rohde & Schwarz ZVK (RohdeSchwarz_ZVC_M_R driver) added.
- Support for Keysight ENA E5080A (Agilent_PNA_Series driver) added.
- New Logo for VNA Tools II and Data Explorer.
- Strong names for all assemblies except driver and example assemblies.
- Digital signed installers.

```
==================================================
VNA Tools V1.4.0 (1.4.5403.29510) - 20.10.2014
==================================================
```

- CITI files with Mag Phase uncertainties supported.
- DC and HF conductivity for primary calibration standards.
- Optimization calibration supports different user weights for reflection and transmission.
- Unknown Reflection Calibration Standard added (passive).
- Unknown Line Calibration Standard added (S11 = ?, S22 = ?, S21 = S12 = e^(-(g1*f^0.5 + g2*f)).
- Juroshek calibration added for splitter characterization.
- METAS VNA Tools II help file added.

```
================================================
VNA Tools V1.3.2 (1.3.5238.16528) - 05.05.2014
================================================


- Data Explorer improved:
    - content menu for post-processing of data,
    - supports to show error terms of calibration binary files (*.calb),
    - colored icons in file explorer and
    - norm to value or to value and uncertainty.
- New primary airline and offset short standard in database.
- Optimization calibration can optimize all frequencies at once. This is
needed when calibration standards are used with unknown parameters which
are constant over frequency.
- It supports the following VNA's: Agilent ENA, PNA, Anritsu VectorStar,
Hewlett Packard 8510C, 8751A, 8753D and Rohde &amp; Schwarz ZNB, ZNC,
ZVA, ZVB, ZVT, ZVC, ZVM, ZVR.


================================================
VNA Tools V1.2.1 (1.2.5042.15584) - 28.10.2013
================================================


- Multiport support in VNA drivers.
- Compute error correction for new measurements only if error correction
configuration is saved and calibration file exists.
- New Cable Connector Table in Journal Editor and Measurement Series to
support multiport measurements.
- TRL calibration works no right. Allows offset delay for thru connection
and definition for high reflect, used to choose the right square root.
- New Graph Custom Set Up dialog which allows to configure the
parameters.
- Norm in graph is not changed if number of measurements change.
- Metas.Vna.Matlab is now part of the installer.


================================================
VNA Tools V1.1.2 (1.1.4881.16734) - 13.05.2013
================================================


- sdatcv file specification. New ASCII file format.
- Covariance view for visualizing the covariance or correlation
  - between S-parameters at a single frequency point or
  - between all frequency points for a single S-parameter.
- Cartesian view for visualizing S-parameter in a complex plane.
- New wizards improve the usability of VNA Tools II.
  - New Project helps creating a new project.
  - New Databased Standard helps creating a new calibration standard in
the database.
- New linearity model improves the measurement model.
- New Tools: Change Port Assignment and Data Converter.
- Metas.Vna.Matlab provides some functions to interact with VNA Tools II
from MATLAB, e.g.: load and save sdatb files.
```

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================================================
VNA Tools V0.9.1 (0.9.4617.19294) - 22.08.2012
================================================


- New drift model with correlation.
- More information in the measurement journal.
- Round up uncertainties in the data explorer.
- Bug fixes.


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Michael Wollensack METAS
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