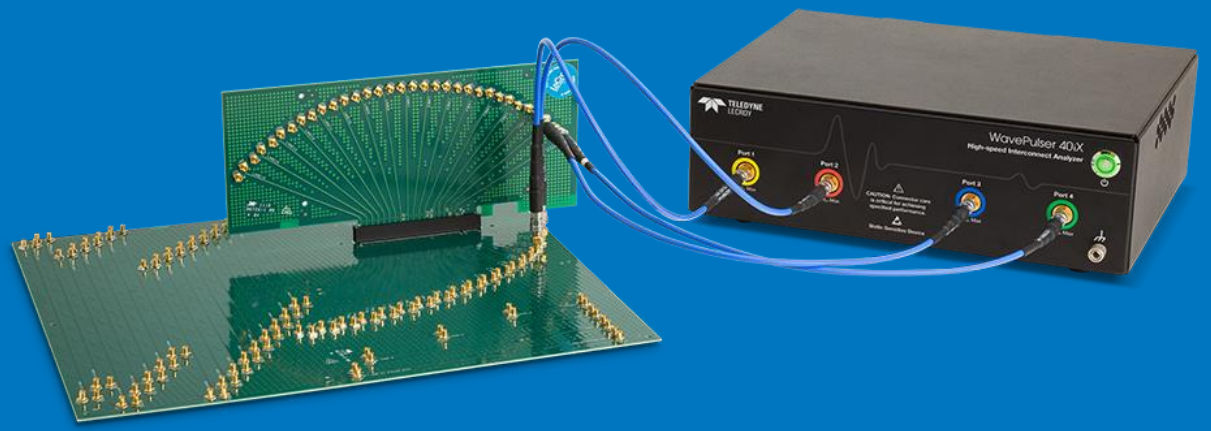
Advanced Calibration Techniques for WavePulser 40iX

High Speed Interconnect Analyzer

March-2020



Giuseppe Leccia
Business Development Manager

TELEDYNE LECROY
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Unmatched Characterization Insight

WavePulser 40iX: Testing in frequency and time domain

Time Domain

TDR

Frequency Domain

VNA

Deep Toolbox

(S-parameter de-embedding, Time Gating, Emulation
equalized eye-diagram and jitter analysis)

The combination of S-parameters (frequency domain) and Impedance Profile (time domain) in a single acquisition with a deep toolbox for simulation, emulation, de-embedding and time-gating provides:

Unmatched Characterization Insight

WavePulser 40iX in a nutshell

Testing in frequency and time in a single acquisition

DC to 40 GHz
Mixed-mode

S-parameters

Frequency Domain

Spatial Resolution < 1 mm
Differential and Common mode

Step and Impulse response
(rise time < 8.5 ps)
Impedance Profile

Time Domain

De-Embedding
Time Gating

Equalized eye-diagram
Jitter Analysis

Deep Toolbox

WavePulser 40iX
High Speed Interconnect Analyzer

Unmatched Characterization Insight

WavePulser 40iX three methods of calibration

1- Internal automatic calibration:

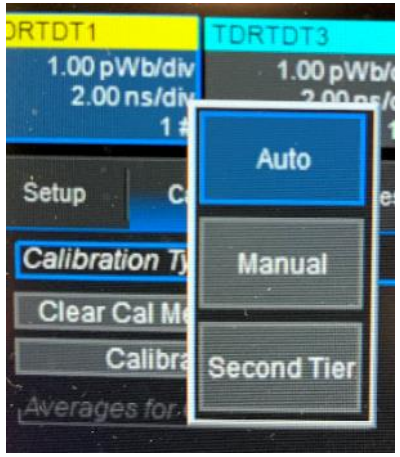
calibration standards built-in, automated, simple and fast.
Instant measurements from DC to 40 GHz

2- Manual calibration:

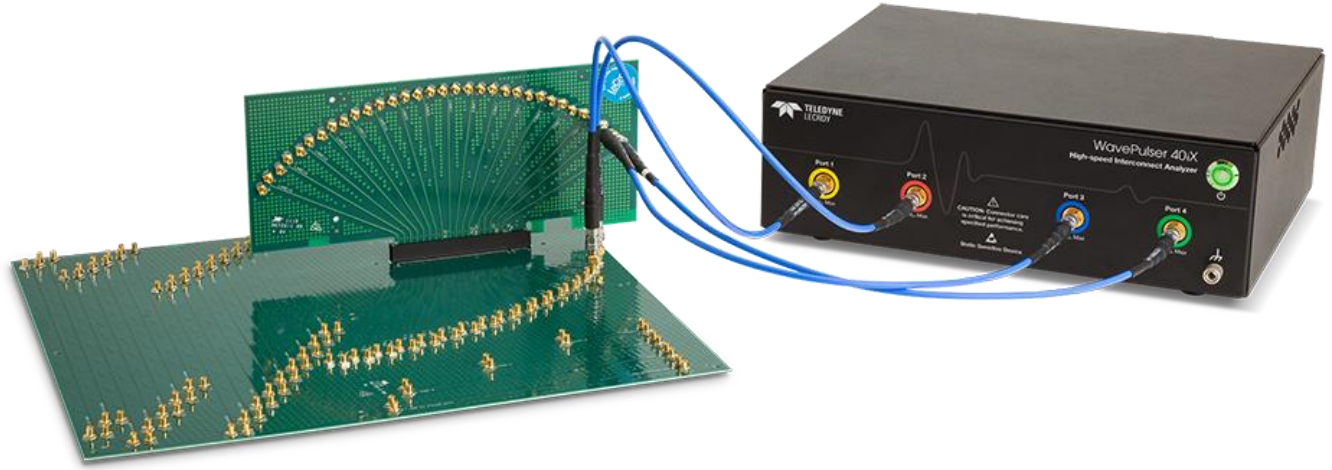
VNA-like calibration, using the cal kit included with the BUNDLE configuration, set any user defined reference plane

3- Second Tier calibration:

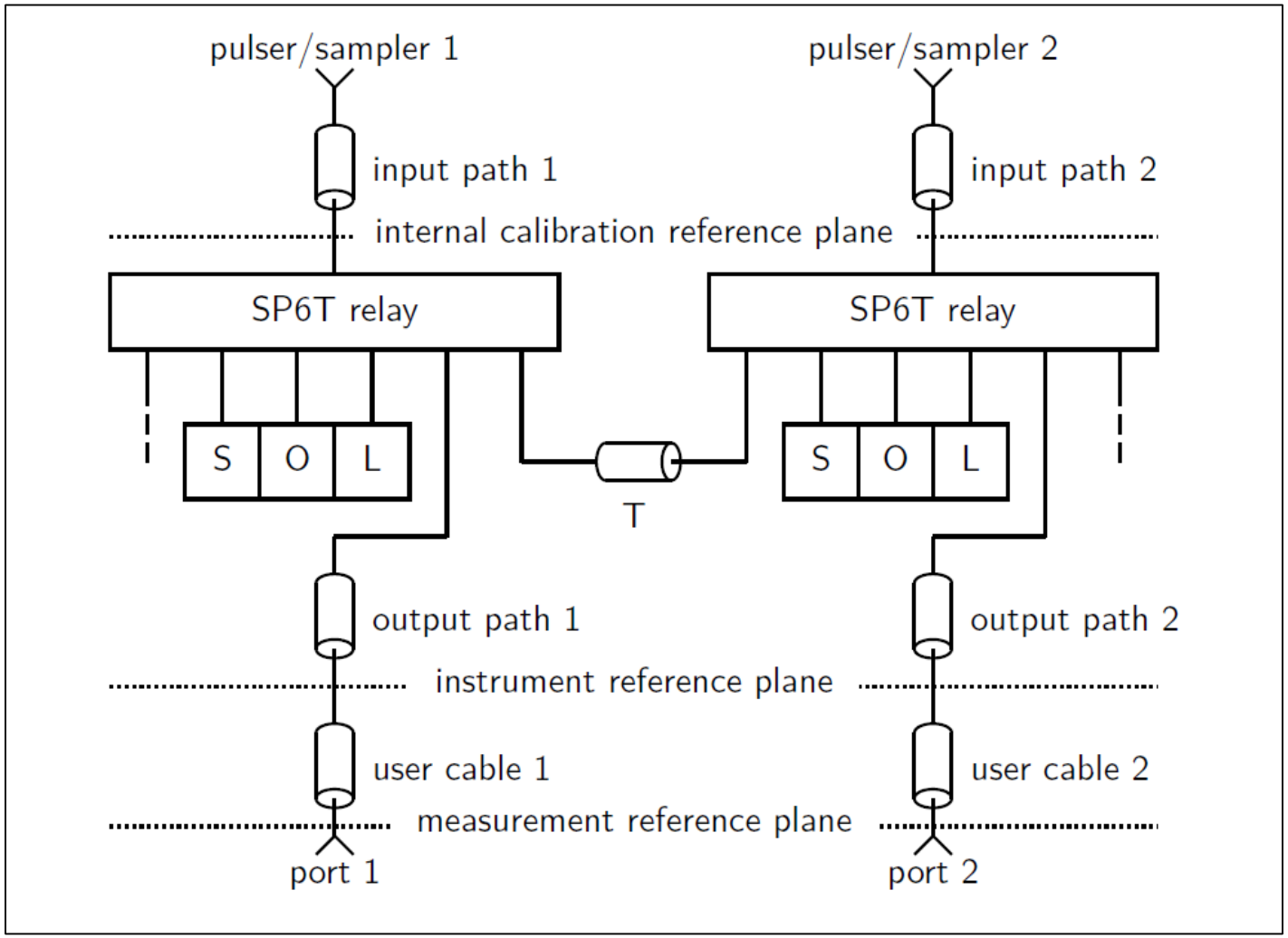
Combined the advantages of the manual calibration with the internal automatic calibration.
User can create a new factory calibration file without sending the unit to factory



High-speed Interconnect Analyzer: the ideal single tool for high-speed hardware designers and test engineers



Internal, Automatic Calibration



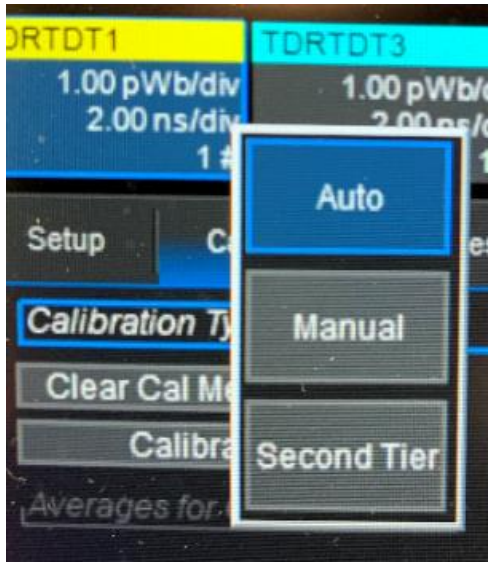
The internal WavePulser 40iX structures for two ports (simplified diagram)

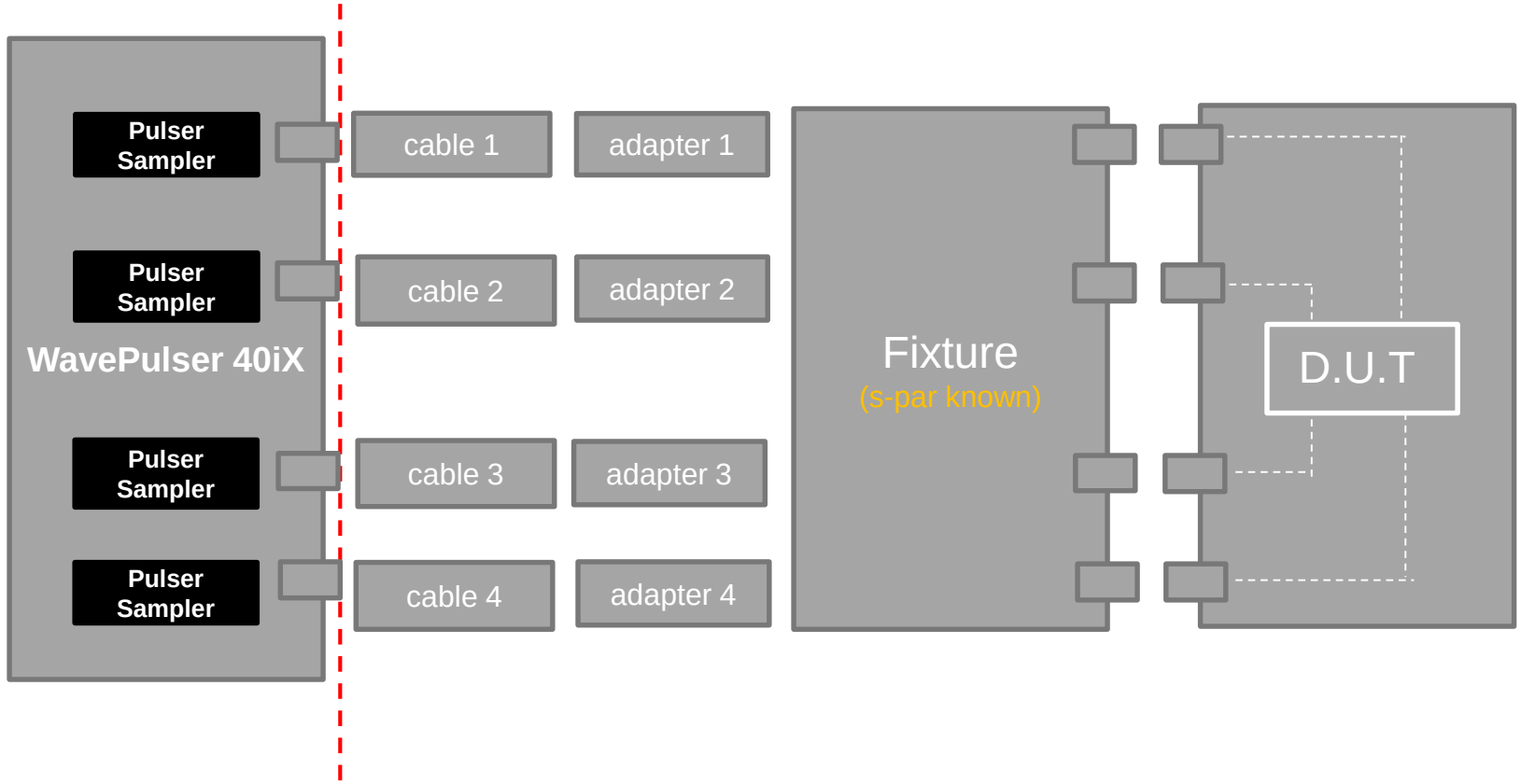
- WavePulser 40iX takes a radical and innovative approach to calibration
- Calibration standards are built-in (included in the standard unit): short-open-load-thru (SOLT)
- Automated, simple and fast calibration: connect to the DUT and press GO
- The measurement reference plane, which is the instrument reference plane, can be moved to the DUT after de-embedding:
  - user cables
  - user adapters
  - user test fixtures
- Calibrated DUT measurement obtained

Internal, Automatic Calibration Sequence

- Internal, Automatic Calibration
  - DC to 40GHz instant measure
- Calibration standards are built-in (included in the standard unit): short-open-load-thru (SOLT)
- WavePulser 40iX measures to DC, unlike the VNA, and DC is always desired in signal integrity measurements
- Baseline calibration step is added to the automatic sequence for higher accuracy at low frequency and DC

Internal, Automatic Calibration method





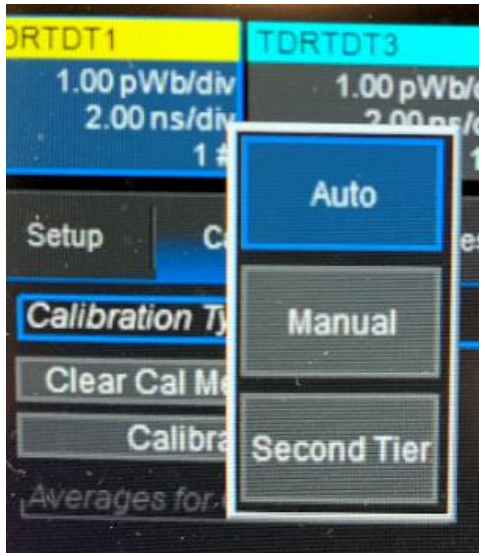
Automatic, quick and easy calibration:

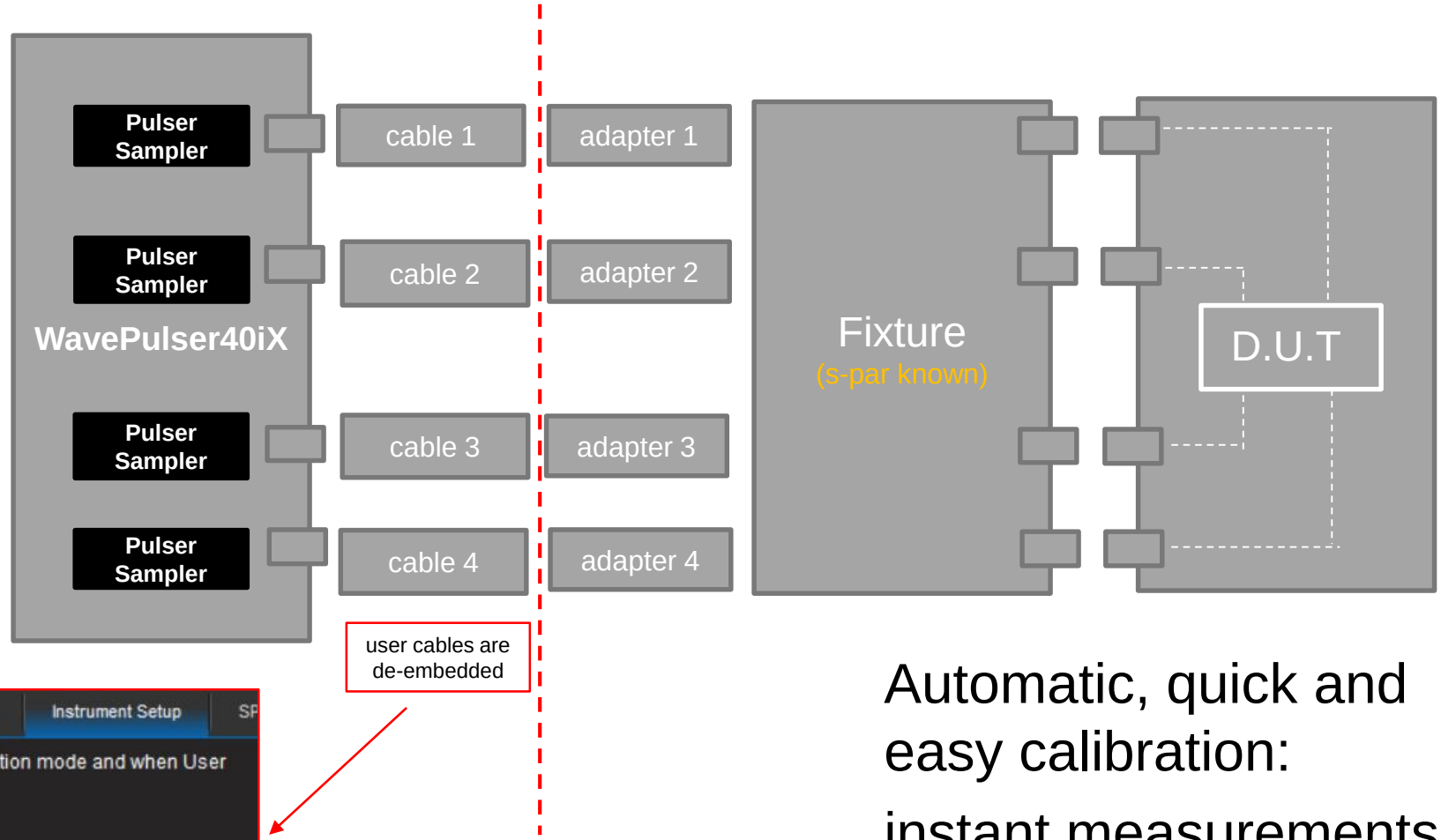
instant measurements

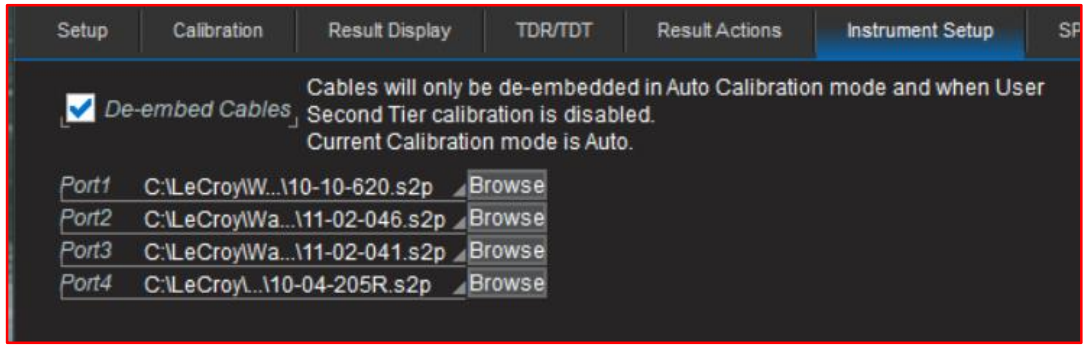
from DC to 40 GHz

Auto Calibration:
measurement reference plane
=
instrument reference plane

Internal, Automatic Calibration method





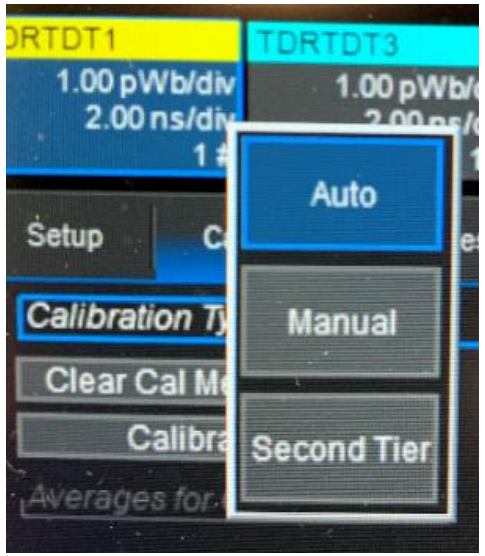


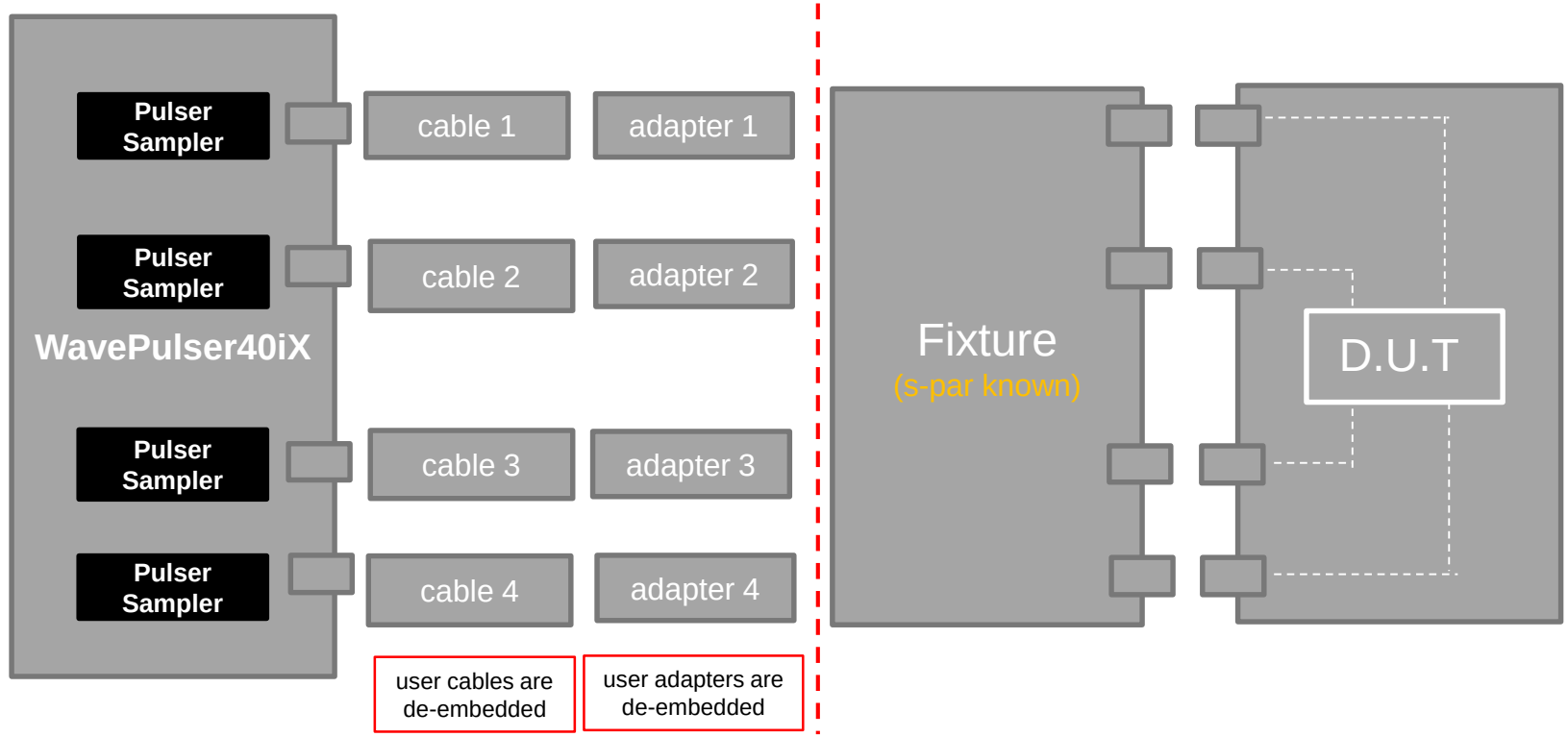
Auto Calibration:
measurement reference plane

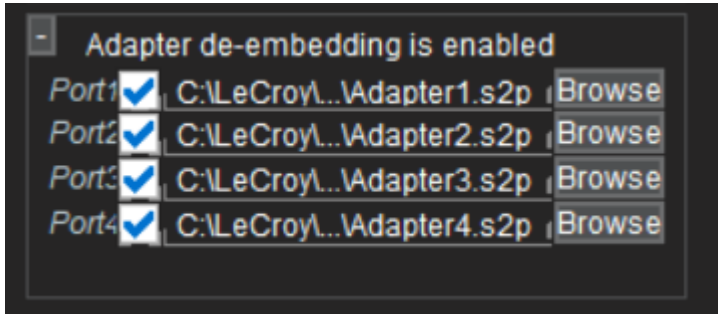
Automatic, quick and easy calibration:

instant measurements from DC to 40 GHz

Internal, Automatic Calibration method





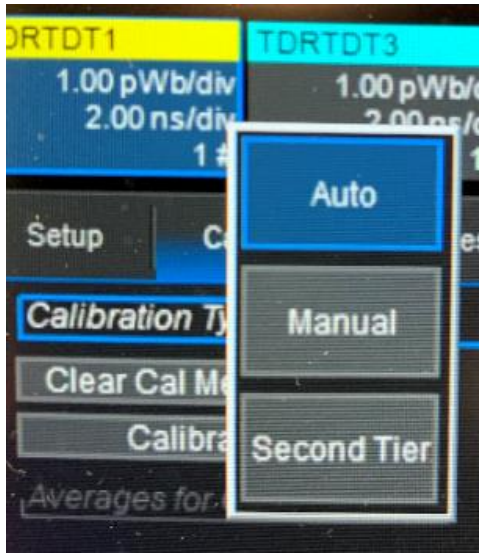


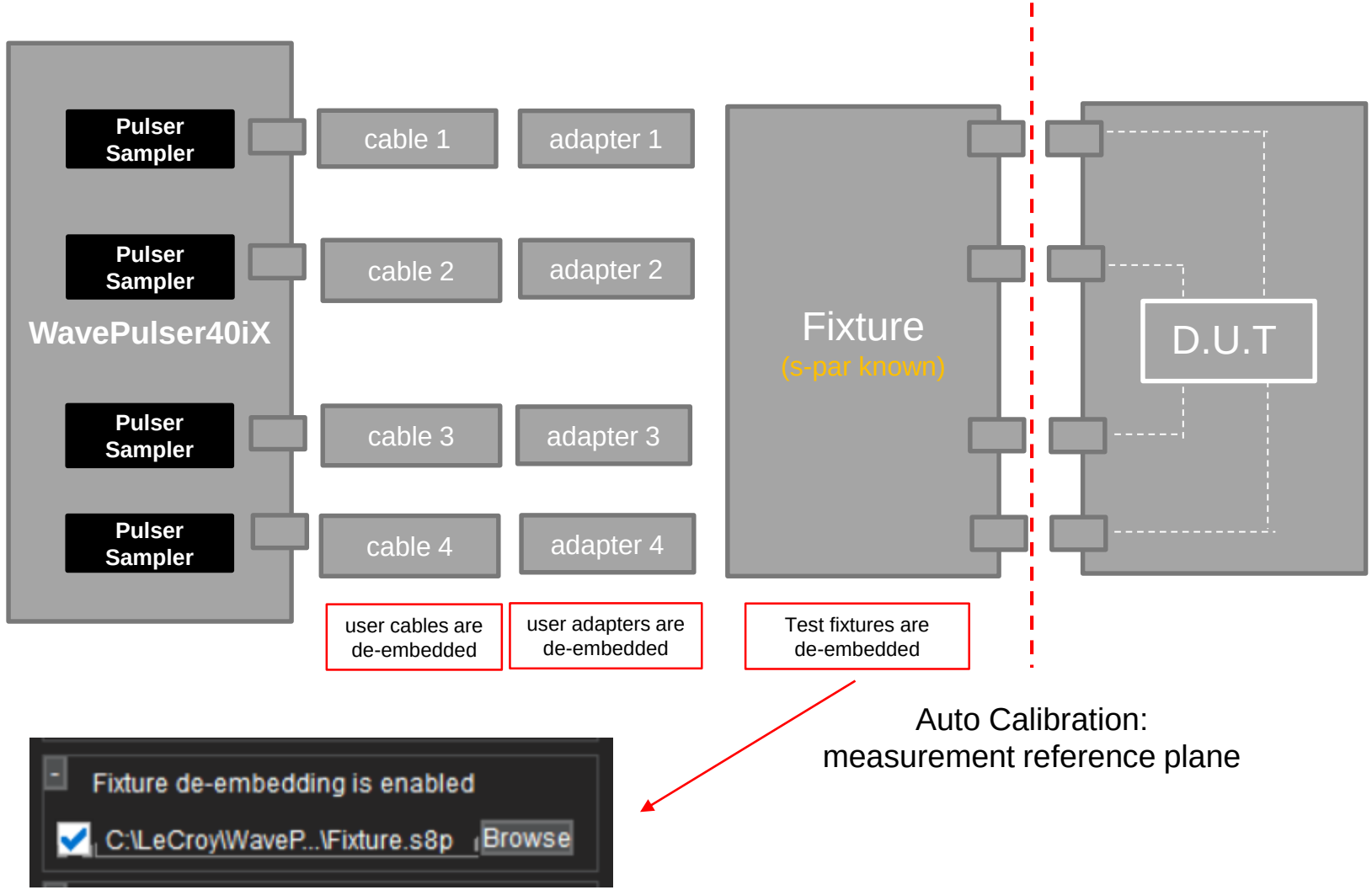
Auto Calibration:
measurement reference plane

Automatic, quick and easy calibration:

instant measurements from DC to 40 GHz

Internal, Automatic Calibration method



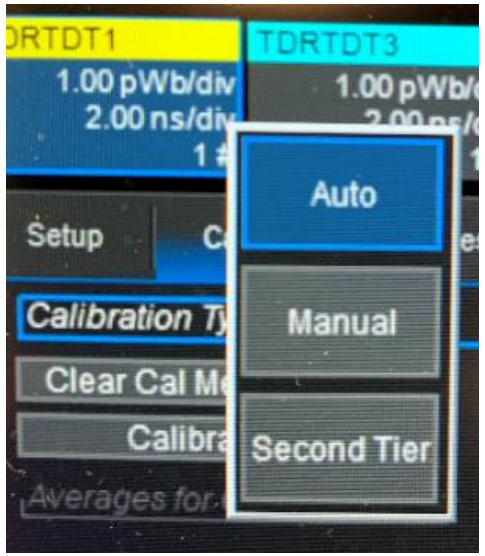


Automatic, quick and easy calibration:

instant measurements

from DC to 40 GHz

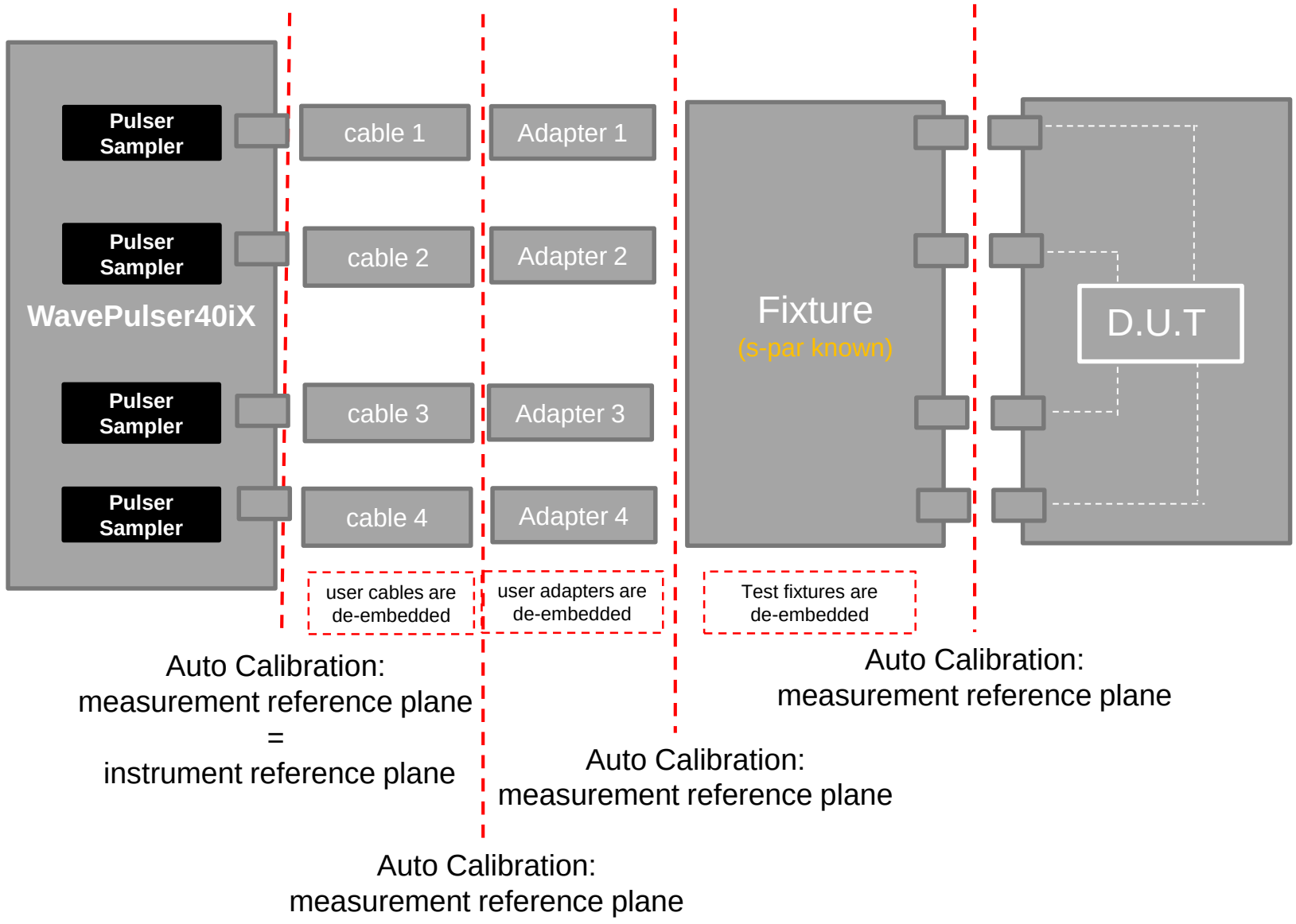
Internal, Automatic Calibration method



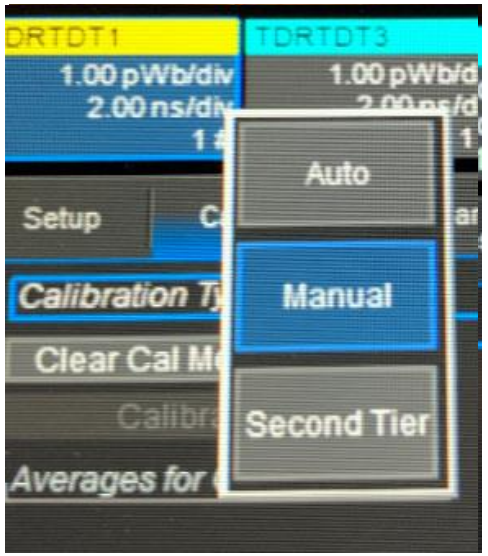
Automatic, quick and easy calibration:

instant measurements

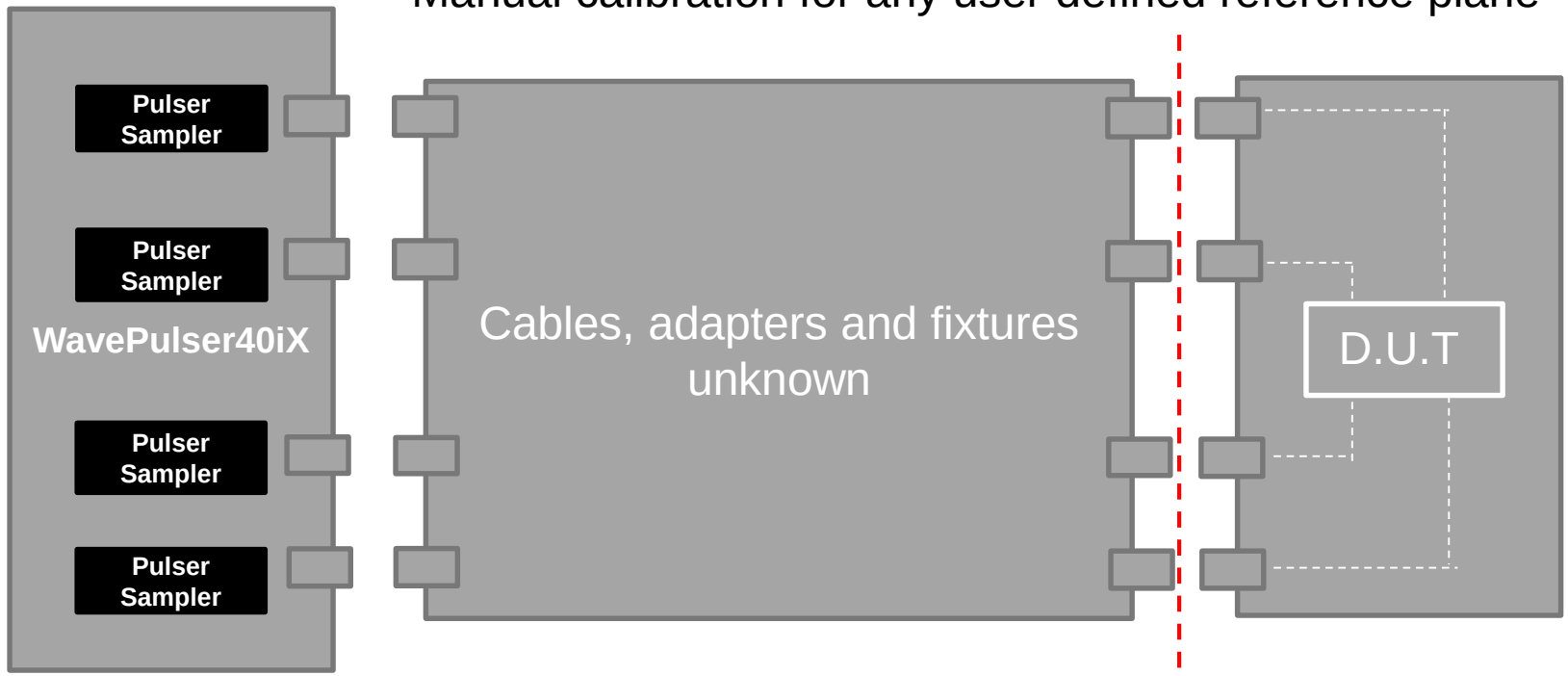
from DC to 40 GHz



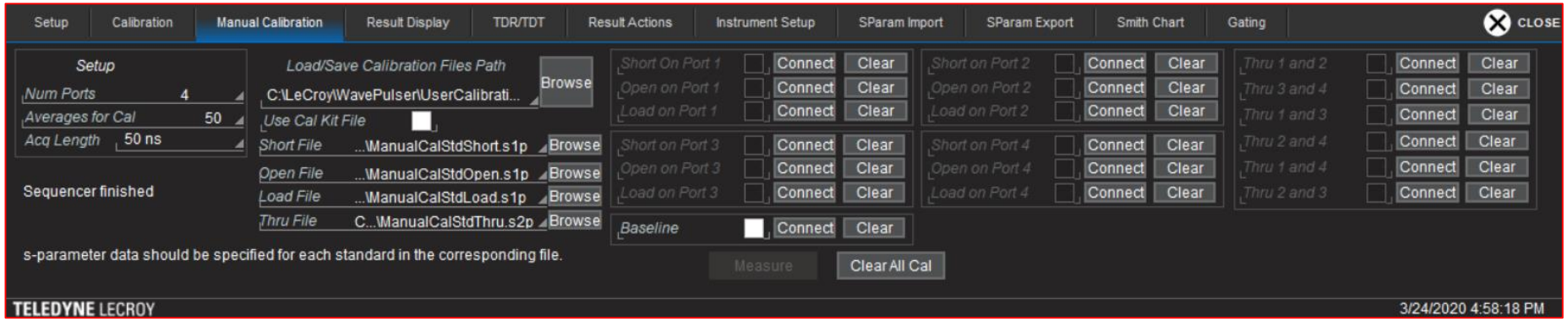
Manual calibration (VNA-like calibration) method



Manual calibration for any user defined reference plane

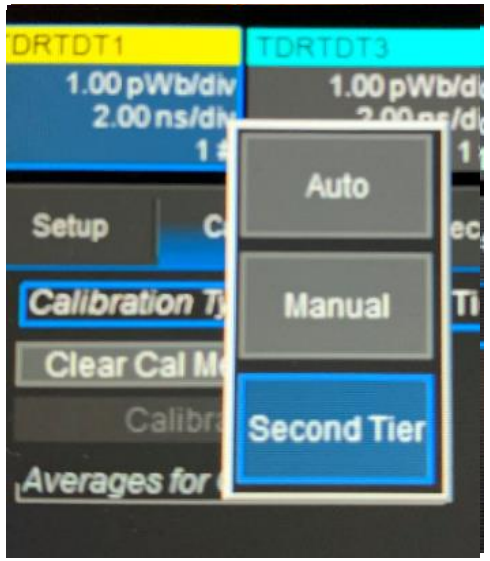


Manual calibration: measurement reference plane

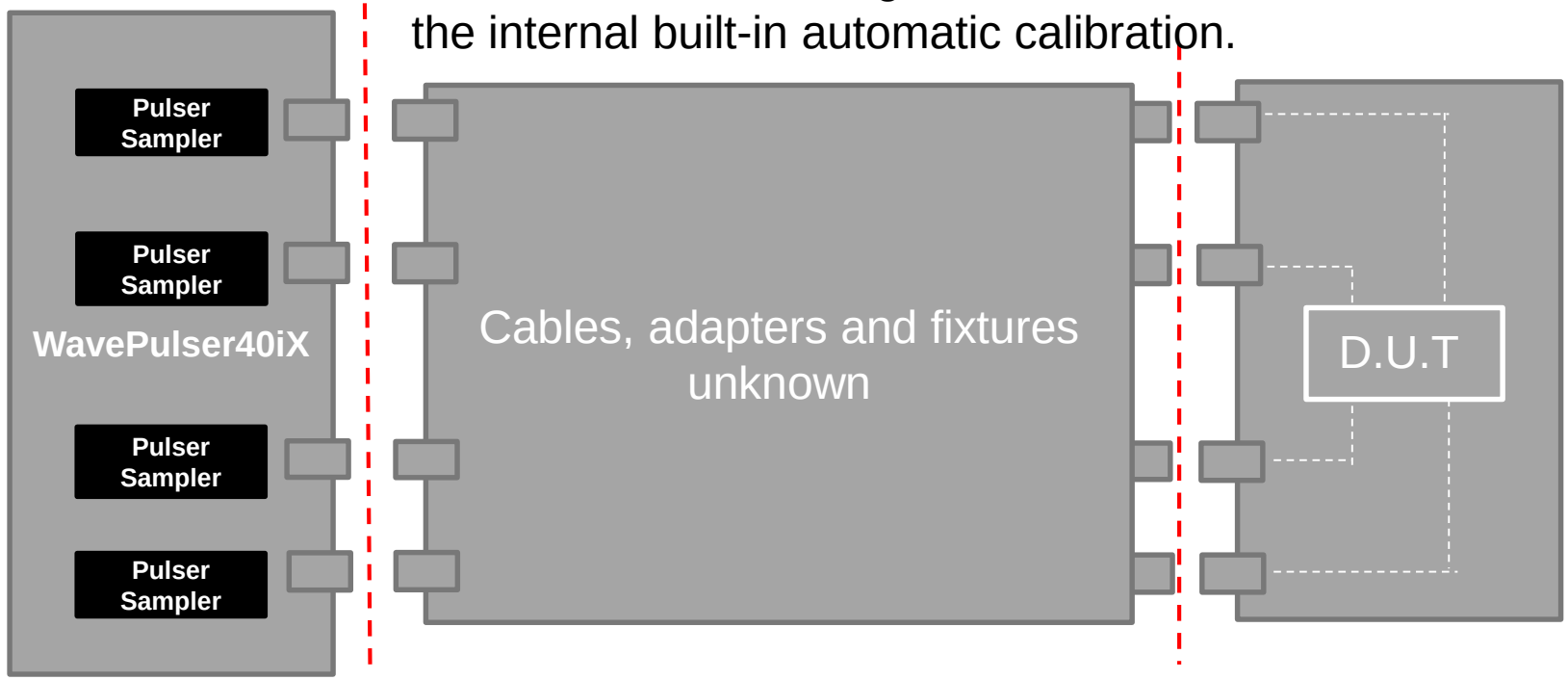


short-open-load-thru (SOLT) calibration kit

Second-tier calibration method



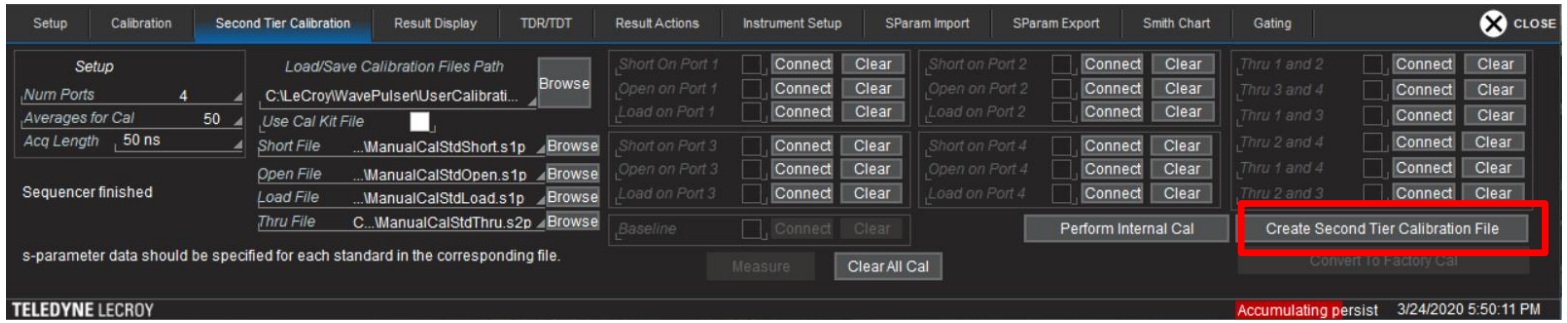
Combined the advantages of the manual calibration with the internal built-in automatic calibration.



the internal auto calibration takes care of drift and changes in pulse/sampler performance

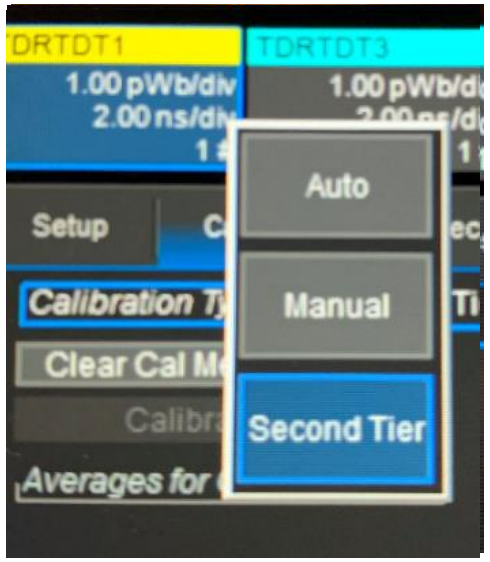
Auto Calibration:
measurement reference plane

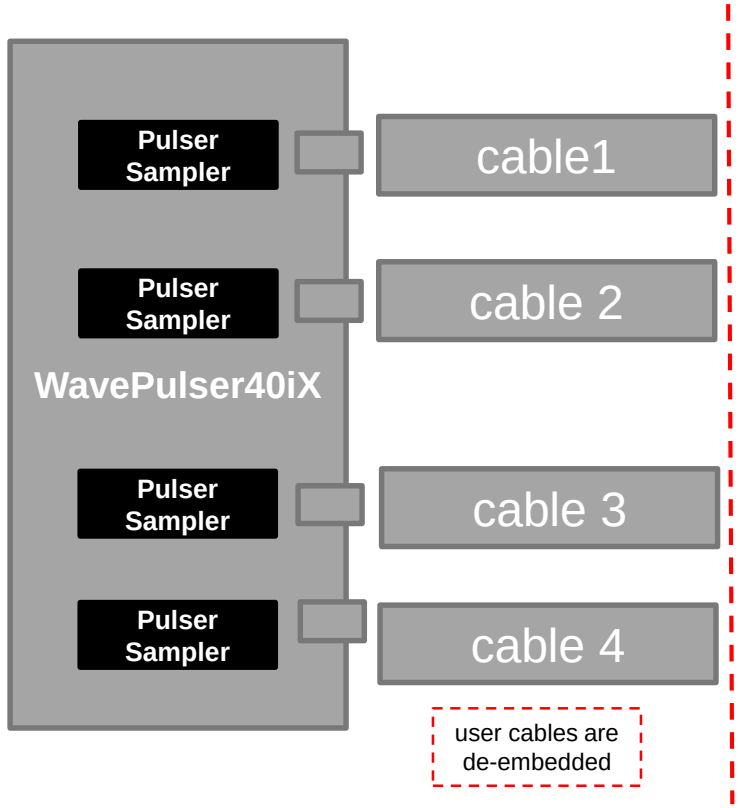
Manual calibration:
measurement reference plane

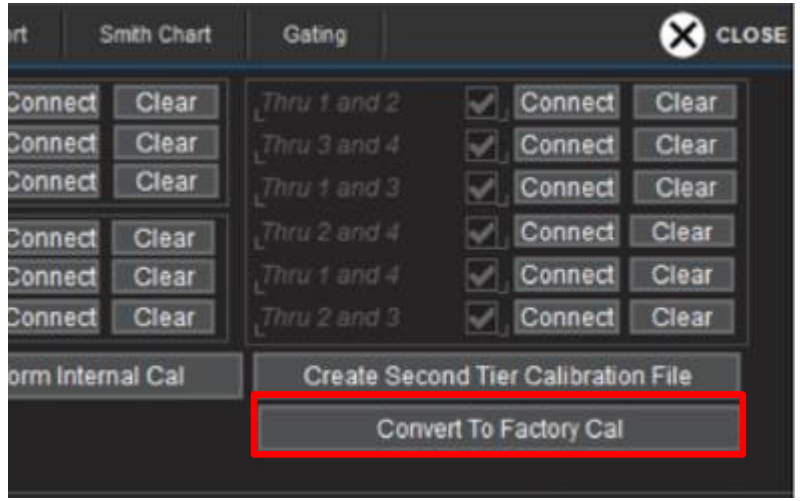


short-open-load-thru (SOLT) calibration kit

Second-tier calibration method: Create new factory Cal







On-site new factory calibration procedure without sending the unit back to factory

Auto Calibration:
measurement reference plane
=
Manual calibration:
measurement reference plane

short-open-load-thru (SOLT) calibration kit

Second-tier calibration method

Combined the advantages of the manual calibration with the internal built-in automatic calibration

Auto internal calibration takes care of drift and changes in pulse/sampler performance
Second-tier calibration is performing a de-embedding operation.

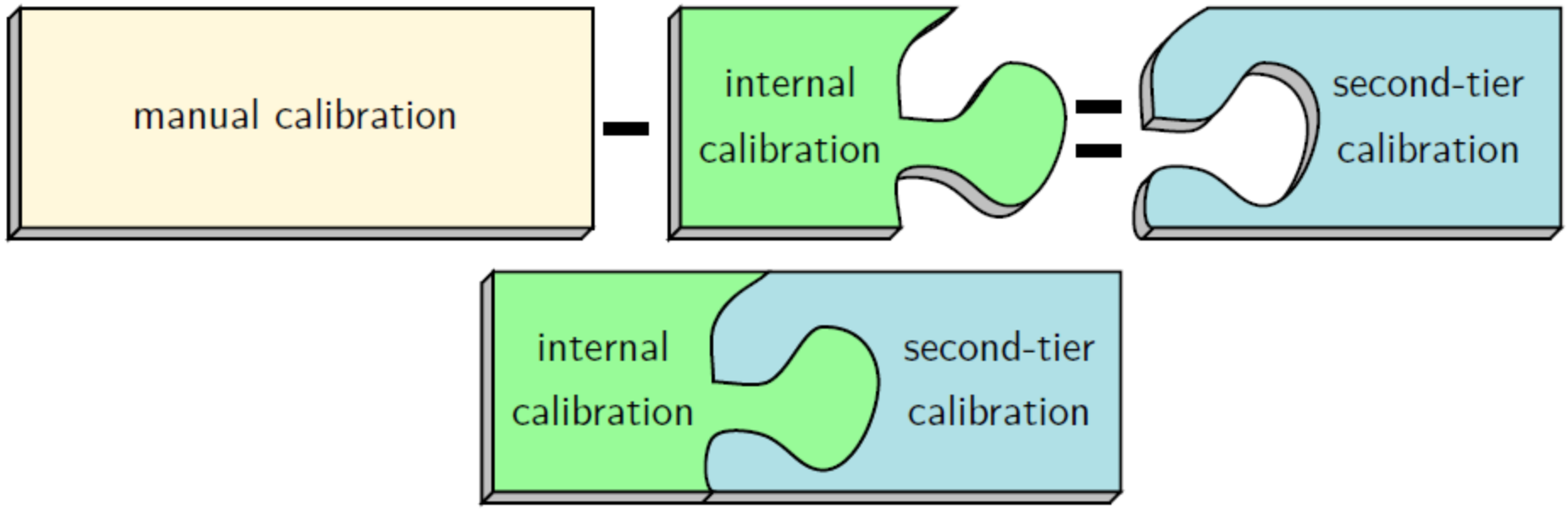


Figure 5: Stylistic view of second-tier calibration

WavePulser 40iX three methods of calibration

Internal, automatic calibration

WavePulser 40iX gives the user the advantage of taking measurements from DC to 40 GHz in minutes and frees the user from cumbersome and time consuming calibration of the instrument

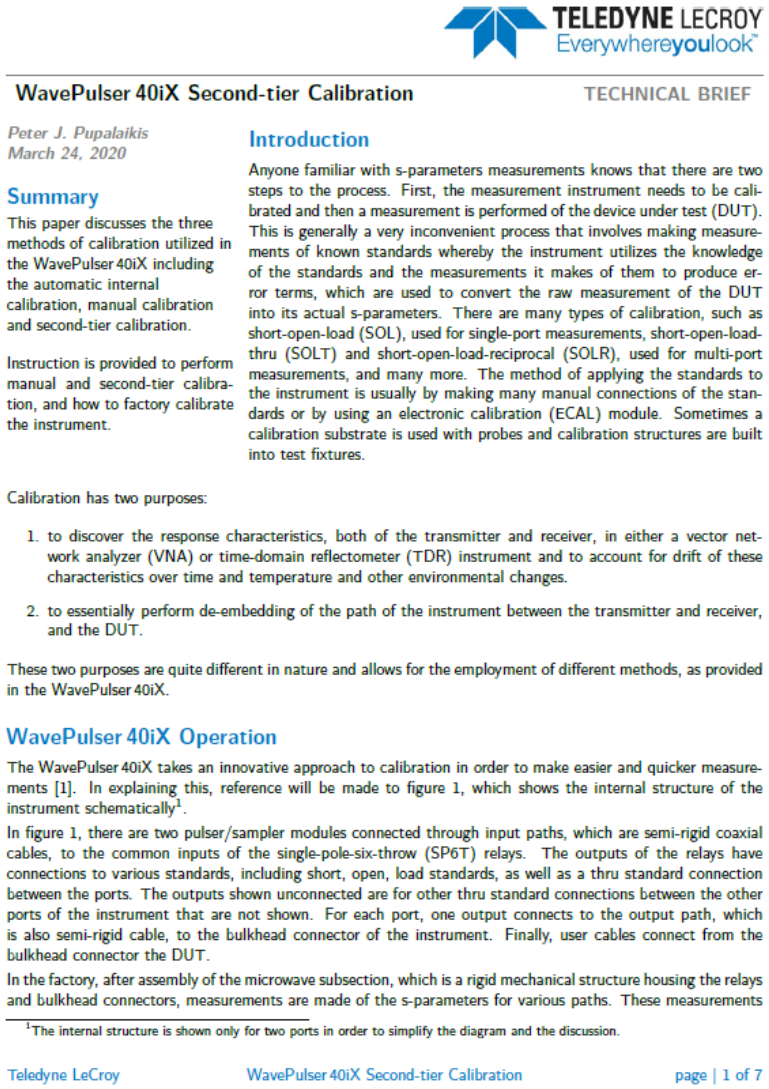
Manual calibration and second-tier calibration

Methods are provided within the instruments to perform manual calibrations when these are required and to apply these as second-tier calibrations so that the de-embedding effects of the manual calibration can always be used

Second-tier calibration and Convert to Factory Cal

Instruction has been provided for periodic factory recalibration of the instrument within sending the unit back to factory

To know more go to:
https://cdn.teledynelecroy.com/files/appnotes/second-tier-calibration.pdf



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WavePulser 40iX Second-tier Calibration TECHNICAL BRIEF

Peter J. Pupalaikis
March 24, 2020

Summary

This paper discusses the three methods of calibration utilized in the WavePulser 40iX including the automatic internal calibration, manual calibration and second-tier calibration.

Instruction is provided to perform manual and second-tier calibration, and how to factory calibrate the instrument.

Introduction

Anyone familiar with s-parameters measurements knows that there are two steps to the process. First, the measurement instrument needs to be calibrated and then a measurement is performed of the device under test (DUT). This is generally a very inconvenient process that involves making measurements of known standards whereby the instrument utilizes the knowledge of the standards and the measurements it makes of them to produce error terms, which are used to convert the raw measurement of the DUT into its actual s-parameters. There are many types of calibration, such as short-open-load (SOL), used for single-port measurements, short-open-load-thru (SOLT) and short-open-load-reciprocal (SOLR), used for multi-port measurements, and many more. The method of applying the standards to the instrument is usually by making many manual connections of the standards or by using an electronic calibration (ECAL) module. Sometimes a calibration substrate is used with probes and calibration structures are built into test fixtures.

Calibration has two purposes:

1. to discover the response characteristics, both of the transmitter and receiver, in either a vector network analyzer (VNA) or time-domain reflectometer (TDR) instrument and to account for drift of these characteristics over time and temperature and other environmental changes.
2. to essentially perform de-embedding of the path of the instrument between the transmitter and receiver, and the DUT.

These two purposes are quite different in nature and allows for the employment of different methods, as provided in the WavePulser 40iX.

WavePulser 40iX Operation

The WavePulser 40iX takes an innovative approach to calibration in order to make easier and quicker measurements [1]. In explaining this, reference will be made to figure 1, which shows the internal structure of the instrument schematically[1].

In figure 1, there are two pulser/sampler modules connected through input paths, which are semi-rigid coaxial cables, to the common inputs of the single-pole-six-throw (SP6T) relays. The outputs of the relays have connections to various standards, including short, open, load standards, as well as a thru standard connection between the ports. The outputs shown unconnected are for other thru standard connections between the other ports of the instrument that are not shown. For each port, one output connects to the output path, which is also semi-rigid cable, to the bulkhead connector of the instrument. Finally, user cables connect from the bulkhead connector the DUT.

In the factory, after assembly of the microwave subsection, which is a rigid mechanical structure housing the relays and bulkhead connectors, measurements are made of the s-parameters for various paths. These measurements

[1]The internal structure is shown only for two ports in order to simplify the diagram and the discussion.

Teledyne LeCroy WavePulser 40iX Second-tier Calibration page | 1 of 7