TH2851 Series

Ultra-High-Frequency Precision Impedance Analyzer — Technical & Applications Guide

This guide is the deep-dive companion to the TH2851 Series datasheet. It explains how the platform's automatic-balancing-bridge design achieves 130 MHz precision impedance measurement, walks through each of its five test modes with worked context, and covers the optional dielectric-constant and magnetic-permeability analysis packages in full — including the underlying measurement principles and formulas. For a one-page overview and ordering information, see the TH2851 Series datasheet.



Model	Test frequency	Basic accuracy	Impedance range	Fastest test speed
TH2851-015	10Hz – 15MHz	0.08%	25mΩ – 40MΩ	2.5 ms
TH2851-030	10Hz – 30MHz	0.08%	25mΩ – 40MΩ	2.5 ms
TH2851-050	10Hz – 50MHz	0.08%	25mΩ – 40MΩ	2.5 ms
TH2851-080	10Hz – 80MHz	0.08%	25mΩ – 40MΩ	2.5 ms
TH2851-130	**10Hz – 130MHz**	**0.08%**	**25mΩ – 40MΩ**	**2.5 ms**

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2 Platform highlights — bridge technology & accuracy

Every model in the TH2851 Series is built on the same measurement core: a wideband, auto-zeroing automatic-balancing-bridge with a **four-terminal-pair** test configuration. This combination is what lets the platform hold **0.08% basic accuracy** across a 25mΩ – 40MΩ impedance range from 10 Hz all the way up to 130 MHz — a span where reflection-based impedance analyzers and network analyzers typically lose accuracy well before reaching the same frequency ceiling.

Why four-terminal-pair matters

Each of the four connections — H_{CUR}, H_{POT}, L_{POT}, L_{CUR} — carries its own shield, driven so that stray capacitance to ground and lead-inductance coupling are cancelled rather than measured as part of the device under test. This is what keeps low-impedance readings (down to 25mΩ) meaningful at frequencies where ordinary two- or three-terminal connections would be dominated by fixture parasitics.

Automatic level control (ALC)

The built-in ALC function continuously adjusts the drive signal so the AC level actually appearing across the device under test matches the level you set — not just the level at the source — which keeps measurements consistent on low-impedance parts where source loading would otherwise shift the effective test level.

Accuracy across the frequency range

Peak accuracy is highest at low-to-mid frequency and widens gradually as the platform reaches its outer frequency limits — this is normal for any wideband impedance-measurement bridge and is specified explicitly rather than left as a single blanket number:

Test frequency	Peak accuracy
1kHz – 1MHz	0.08% (typical ≤ ±0.045%)
2MHz	0.5%
10MHz	1%
130MHz	5.0%

> **Reading the table:** the 015/030/050/080 models share this same accuracy curve up to their respective frequency ceiling — the 5.0% figure at 130MHz applies only to the TH2851-130, since it is the only model that reaches that frequency.

Five selectable speed / accuracy levels

Every measurement mode lets you trade test speed for averaging depth, point by point:

Level	1 — Fast	2	3	4	5 — Precision
Typical time	2.5 ms	10 ms	40 ms	80 ms	400 ms

> **In practice:** use level 1 for production-line sorting where throughput matters most, and level 5 when characterizing a component's true performance for R&D or incoming-inspection reference data.

Why a bridge instrument instead of a network analyzer?

RF reflection-based impedance analyzers and vector network analyzers extract impedance indirectly, from a reflection-coefficient measurement referenced to a fixed system impedance (typically 50Ω) — a method that works well deep into the GHz range but loses precision as the device under test's impedance moves away from that reference, particularly at the low-impedance, low-loss end of the passive-component range. The TH2851's automatic-balancing-bridge measures impedance directly, which is what allows it to hold 0.08% accuracy on parts from 25mΩ up to 40MΩ — a range and precision combination reflection-based methods are not designed to match, even though their frequency ceiling is often higher.

3 Interface & operation modes

The TH2851 replaces the small monochrome or segment displays typical of older bridge instruments with a 10.1" capacitive touch screen (1280×800) running on a Windows-based platform. Mouse, keyboard, LAN, VGA and HDMI are all supported directly, so the instrument can be operated at the bench exactly as shown on screen, or extended to an external monitor for a lab workstation setup.



10.1" touch display with eight quick-select parameter buttons along the left edge

- **Single-screen layout** — test parameters, sorting parameters, sorting results and function selections all fit on one screen without crowding.
- **Four measurement parameters** displayed and freely reassigned at once (e.g. |Z|, θz, R, X simultaneously).
- **Eight quick-select buttons** on the left edge switch between eight saved sets of test parameters with one touch.
- Full **SCPI** command set and **LabVIEW** compatibility for building automated test programs around the same instrument.

Five test modes, one platform

The same measurement core is shared across five distinct modes, each covered in more depth over the following pages:

Mode	What it's for	See
Point measurement	Single-frequency reading of up to four parameters at once — the default bench workflow	§4
List sweep	Up to 1,601 points with independently configured frequency, level and bias, each sorted separately	§4
Graphic sweep	Up to 4 channels × 4 curves plotted live against frequency, level or bias	§5
Equivalent circuit analysis	Fits a measured impedance curve to one of 7 standard R-L-C models	§6
Crystal oscillator analysis	Resonant/anti-resonant frequency and Q-factor extraction for piezoelectric devices	§7

File management & connectivity

Because the platform runs on a Windows-based OS rather than dedicated embedded firmware, setup files, screen captures and logged measurement data can be saved directly to a USB drive or across the LAN interface in standard formats, without a proprietary export step. The same connectivity — LAN, USB Device, RS-232C, GPIB — is what a SCPI or LabVIEW test program uses to drive the instrument remotely, so the manual and automated workflows share the same underlying interface.

4 Point measurement & list sweep

Point measurement

The default working mode: set a test frequency, AC level and (optionally) DC bias, and the instrument continuously updates up to four selected parameters — for example |Z|, θz, R and X — in large, colour-coded digits. This is the fastest way to characterize a single device under test, verify a calibration standard, or confirm a fixture connection before running a more complex sweep.



Point measurement display: four parameters, each with its own reference/math offset

- Each of the four displayed parameters carries its own **Math** (relative) and **Ref** (reference) offset, independent of the others.
- AC/DC monitor readouts (I_{AC}, V_{AC}) confirm the actual signal level reaching the device under test, useful when verifying ALC behaviour on low-impedance parts.
- Trigger mode, averaging count, OSC level and AC-range can all be changed from the same softkey column without leaving the measurement screen.

List sweep — up to 1,601 points

List sweep steps the instrument through a table of up to 1,601 independently defined test points. Unlike a simple logarithmic or linear frequency sweep, every point in the list can have its own frequency, AC voltage or current, and DC bias voltage or current — and every point can carry its own averaging count and pass/fail sort limits.

List sweep parameter	Detail
Points	Up to 1,601, each independently defined
Per-point settings	Measurement parameter, test frequency, AC voltage/current, DC bias voltage/current, averaging count
Sorting	Each point can be sorted (pass/fail) independently of the others

Typical use: characterizing a component's behaviour at a specific, non-uniform set of frequencies — for example the handful of frequencies called out in a customer specification — without wasting sweep time on points that aren't part of the acceptance criteria.

5 Graphic sweep

Graphic sweep plots impedance parameters continuously against a swept stimulus — frequency, AC level or DC bias — so trends, resonances and out-of-family behaviour are visible at a glance rather than inferred from a table of numbers.



Graphic sweep display: live curve plotted against a segmented frequency sweep

- **4 channels**, each showing up to **4 curves** — 16 curves in total across the display.
- **14 split-screen layouts** for arranging channels and curves — from a single full-screen curve to four channels shown simultaneously.
- Sweep types: **logarithmic**, **linear**, or **segmented** — 2 to 1,601 points per sweep.
- Each window can be configured with its own scanning conditions, independent of the others.

Segmented scanning

Segmented scanning lets you define several frequency segments within a single sweep cycle, each with its own level and offset, and skip the frequency ranges between them entirely. This is the practical answer to a common problem: testing a crystal resonator's nominal resonance, anti-resonance and any spurious response frequencies without wasting sweep time — and screen resolution — on the irrelevant frequencies in between.

Curve sorting & comparison

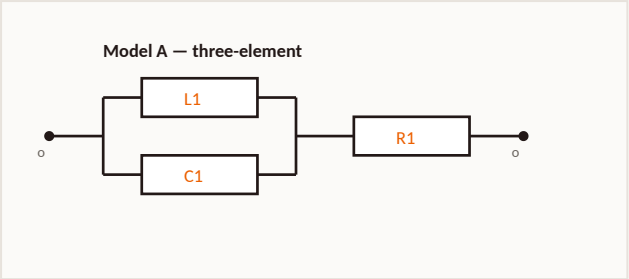
Curve sorting applies pass/fail judgement to some or all of a scanned curve's region — the standard way to screen resonance curves, such as filtering piezoelectric elements by their resonance frequency shape rather than a single-point reading.

Curve trajectory comparison overlays multiple measurement runs in the same coordinate system — either several different devices under different conditions, or repeated measurements of the same device to check repeatability — with the value at any chosen frequency point calculated for every curve at once.

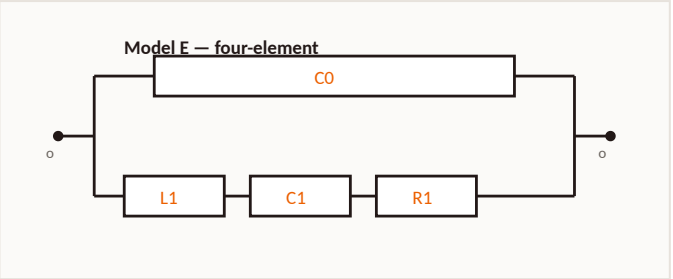
> **Graphic sweep vs. list sweep:** reach for graphic sweep when you need to see a curve's overall shape — resonances, roll-off, out-of-family behaviour — and for list sweep (§4) when you already know the exact frequencies that matter and want a numeric pass/fail result at each one. The two share the same underlying sweep engine, so a list sweep's point definitions can be reused as a graphic sweep's segments and vice versa.

6 Equivalent circuit analysis

Real components rarely behave as a single ideal R, L or C — a real inductor has winding resistance and self-capacitance, a real capacitor has equivalent series resistance and inductance. Equivalent circuit analysis fits the impedance curve actually measured on the TH2851 to one of **7 standard models** — 4 three-element and 3 four-element topologies — so a component's parasitic behaviour can be described with a small set of physically meaningful values instead of a raw curve.



Illustrative — L1 & C1 in parallel, in series with R1 (used for high-leakage-inductance parts)



Illustrative — C0 in parallel with L1, C1, R1 in series (used for resonators)

Model	Elements	Typical fitting object
A	Three-element — L1 & C1 in parallel, R1 in series with the pair	High-leakage-inductance components
B	Three-element — C1 in parallel with (L1 series R1)	Inductive resistors
C	Three-element — L1 in parallel with (C1 series R1)	High-resistance-value resistors
D	Three-element — L1, C1, R1 all in series	Capacitors
E	Four-element — C0 in parallel with (L1, C1, R1 in series)	Resonators
F	Four-element — R0 in series with (L1 parallel C1 parallel R1)	Inductance equivalent series resistance
G	Four-element — R0, L1 in series, with C1 & R1 in parallel across the output	Capacitors

Workflow: the fitted curve can be compared directly against the measured curve on screen, refined with user-entered starting parameters, and exported as a plain TXT file for use outside the instrument.

7 Crystal oscillator (piezoelectric) analysis

Crystal oscillator analysis measures and calculates the key parameters engineers need when characterizing quartz crystals and other piezoelectric devices: **resonant frequency**, **anti-resonant frequency** and **quality factor**. The same analysis extends to other piezoelectric components — ceramic filters, notch filters, discriminators, transformers, high-power ultrasonic generators, transducers/vibrators, surface-acoustic-wave devices and electro-acoustic devices — reporting static capacitance, loss, resonant/anti-resonant frequencies and mechanical coupling coefficient as applicable.

> **Why it matters:** pairing this with segmented scanning (§5) means a crystal's nominal and spurious response frequencies can be characterized in one setup, without sweeping — or waiting on — irrelevant frequency ranges.

Crystal oscillator analysis and equivalent circuit analysis (§6) describe the same physical device from two angles: a quartz crystal's electrical behaviour is exactly what the four-element **Model E** resonator topology (C0 in parallel with L1-C1-R1) represents, so the resonant/anti-resonant frequencies and Q-factor reported here can be cross-checked against — or used to seed — a Model E curve fit for the same device.

7 Cursor analysis

Every curve — whether from a graphic sweep, equivalent-circuit fit or crystal-oscillator analysis — can carry up to **10 cursors**, including a reference cursor, each with an excitation value (X-axis) and a response value (Y-axis). Cursors are used to read exact values, locate specific points automatically, and compute statistics without leaving the graphic display.

What cursors can do

- Read measured values as absolute numbers or relative to a reference point
- Adjust the sweep range and rescale the Y-axis directly from cursor values
- Compute statistics across the curve for the region a cursor is placed in

Cursor search conditions

- **Max / min** — the highest and lowest values on the curve
- **Peak / valley** — nearest peak or valley to the left/right of the cursor, or multiple peak-valley values at once
- **Target** — the target value closest to the cursor, to its left/right, or multiple target values

> **Typical use:** place the reference cursor at a component's nominal resonant frequency, then use peak/valley search to confirm the actual measured peak falls within an acceptable offset — a quick repeatability check without setting up a full curve-sorting limit line.

8 Interfaces & rear panel

All interfaces below are standard on every TH2851 model — there is no cut-down interface configuration across the series.



Rear panel — TH2851-130 shown; layout is identical across all five models

PC / automation: RS-232C, USB Host, USB Device, LAN, GPIB

Production line: HANDLER interface for bin/sort output

Display & peripherals: HDMI, VGA, USB 3.0 ×2, USB 2.0 ×2

Audio: headphone and microphone jacks (Windows platform)

Power: IEC power inlet with in-line fuse; rating printed alongside

Handler — outputs bin/sorting results to automatic handling equipment on a production line.

Device — USB Device port for PC communication.

RS-232C — serial PC communication.

GPIB — IEEE-488 interface for automated test systems.

USB 3.0 / HDMI — high-speed storage and external-display output.

VGA / USB 2.0 / LAN — external monitor, peripherals and network connection.

Headphone / microphone jacks — standard 3.5mm audio, part of the Windows-based platform.

Power inlet & fuse rating table — printed rating covers both 110V/60Hz and 220V/50Hz operation; confirm the fitted fuse matches your supply before switching on.

> **Before switching on:** confirm the fuse rating shown on the rear-panel label matches your local supply voltage and frequency, and that the power cord's protective grounding conductor is connected — both are called out directly on the chassis.

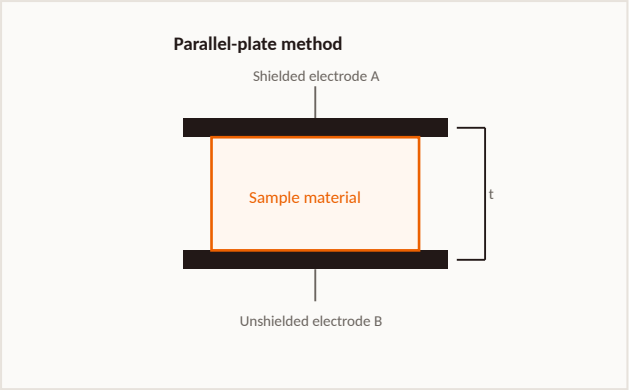
Interfaces at a glance

RS232C	USB Host	USB Device	LAN	GPIB	HANDLER	VGA	HDMI
standard	standard	standard	standard	standard	standard	standard	standard

SCPI command set and LabVIEW compatibility included on every model.

9 Option — dielectric constant analysis

With the TH26077 test fixture and dielectric-constant analysis software, a TH2851 measures the dielectric constant and dissipation factor of solid dielectric materials — plastics, ceramics and similar insulating materials — using the parallel-plate method, which eliminates stray capacitance from the result.



Illustrative — material sample held between shielded electrode A and unshielded electrode B

Configuration

Item	Mandatory
TH2851 main unit	Yes
TH26077 test fixture	Yes
Dielectric-constant test software	Yes

Basic parameters

Test frequency	DC – 30MHz
Measured parameters	Capacitance (C), dissipation factor (D), dielectric constant (εr', εr'')
Test principle	Parallel-plate measurement
Zeroing	Open circuit, short circuit

Electrode	Sample diameter	Sample thickness
Shielded electrode A1	40mm – 56mm	≤10mm
Shielded electrode A2	10mm – 56mm	≤10mm

Dielectric constant formula

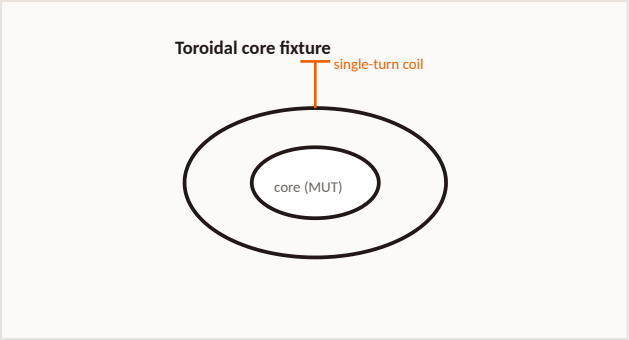
$$\varepsilon r = (ta \times Cp) / (A \times \varepsilon 0) = (ta \times Cp) / (\pi \times (d/2)^2 \times \varepsilon 0)$$

`Cp`	equivalent parallel capacitance measured by the instrument (F)	`d`	diameter of the test electrode — A1: 38×10^{-3} m · A2: 5×10^{-3} m
`ta`	average thickness of the sample material (m)	`ε0`	permittivity of free space, 8.854×10^{-12} F/m
`A`	area of the test electrode within the shielded electrode (m^2)		

Once activated, the software lets you select dielectric-constant parameters directly on the TH2851 touch interface for single measurement, list sweep or curve sweep — the same three workflows used for standard impedance measurement.

10 Option — magnetic permeability analysis

With the TH26086 adapter base, TH26088 test fixture and magnetic-permeability test software, a TH2851 measures the complex magnetic permeability of toroidal magnetic materials — ferrite, amorphous cores and similar components — using a single-turn toroidal coil fixture that avoids magnetic flux leakage and needs no extra winding wire.



Illustrative — toroidal sample inside the single-turn coil fixture

Configuration

Item	Mandatory
TH2851 main unit	Yes
TH26086 adapter base	Yes
TH26088 test fixture	Yes
Magnetic-permeability test software	Yes
TH26086_CAL calibration kit	Yes

> **Note:** TH26086 is mandatory when ordering TH26088 — without the adapter base, the permeability fixture cannot measure accurately.

Item	Spec
TH26086 test frequency	DC – 130MHz · max voltage ±42V peak (AC+DC) · 0–40°C
TH26088 test frequency	1kHz – 1GHz
Small components	Height ≤3mm · inner diameter ≥3.1mm · outer diameter ≤8mm
Large components	Height ≤8.5mm · inner diameter ≥5mm · outer diameter ≤20mm

Effective permeability (μ'e, μ''e)

Measured by winding the core with a single turn inside the sealed toroidal fixture and reading the inductance at the winding's terminals:

$$\mu'_e = (\ell \times L_{eff}) / (\mu_0 \times N^2 \times A) \qquad \mu''_e = (\ell \times (R_{eff} - R_W)) / (\mu_0 \times N^2 \times \omega \times A)$$

- L_{eff} — inductance of the toroidal winding
- R_{eff} — equivalent resistance incl. core loss and line resistance
- R_W — line (winding) resistance
- N — number of turns
- ℓ — average magnetic-path length of the core (m)
- A — cross-sectional area of the toroidal core (m²)
- ω — angular frequency, 2πf
- μ_0 — permeability of free space, $4\pi\times10^{-7}$ H/m

Relative permeability

$$\mu_r = [(Z'_m - Z'_{sm}) \times 2\pi] / [j\omega\mu_0 h \cdot \ln(c/b)] + 1$$

- Z'_m — impedance measured without the core
- Z'_{sm} — impedance measured with the core in place
- h, c, b — sample height, outer diameter, inner diameter

11 Full technical specifications

Parameter	TH2851-015	TH2851-030	TH2851-050	TH2851-080	TH2851-130
Display	10.1" TFT LCD, 1280×800, capacitive touch screen, Windows-based UI				
Reading resolution	6 digits				
AC parameters	Cp/Cs, Lp/Ls, Rp/Rs, |Z|, |Y|, R, X, G, B, θ, D, Q, VAC, IAC				
DC parameters	VDC, IDC, DCR				
Test frequency range	10Hz–15MHz	10Hz–30MHz	10Hz–50MHz	10Hz–80MHz	10Hz–130MHz
Frequency resolution	1 mHz				
Frequency tolerance	±0.0005% (typical, 5–40°C)				
AC voltage	5mV – 2Vrms (1mV resolution)				
AC current	50μA – 20mArms (10μA resolution)				
DC bias voltage	0 – ±40V (1mV resolution)				
DC bias current	0 – ±100mA (40μA resolution)				
Test terminal configuration	Four-terminal pair				
Output impedance	25Ω / 100Ω				
Impedance range	25mΩ – 40MΩ (±10% accuracy)				
Test speed (5 levels)	1: 2.5ms · 2: 10ms · 3: 40ms · 4: 80ms · 5: 400ms				
Peak accuracy	0.08% typical (≤ ±0.045%) at 1kHz–1MHz · 0.5% at 2MHz · 1% at 10MHz · 5.0% at 130MHz				
List sweep	Up to 1,601 points, independently averaged and sorted per point — frequency, AC voltage/current, DC bias voltage/current				
Graphic sweep	4 channels × 4 curves (16 curves total), 14 split-screen layouts; logarithmic, linear or segmented sweep, 2–1,601 points				
Equivalent circuit analysis	7 models — 4× three-element, 3× four-element; exportable as TXT				
Crystal oscillator analysis	Resonant/anti-resonant frequency, quality factor, static capacitance and loss (piezoelectric devices)				
Cursor analysis	Up to 10 cursors per curve incl. reference cursor; max/min, peak/valley and target search				
Sorting	10-bin LCR sorting; each scan-mode curve sorted independently				
Interface	RS232C, USB Host, USB Device, LAN, GPIB, HANDLER, VGA, HDMI				
Power-on warm-up	60 minutes				
Input voltage	100–120VAC / 198–242VAC selectable, 47–63Hz				
Power consumption	Max 150VA				
Dimensions (W×H×D)	428 × 220 × 325 mm				
Weight	14.5 kg				

Optional dielectric-constant (§9) and magnetic-permeability (§10) analysis packages require the fixtures and software listed in their respective sections and are not included in the specifications above.

12 Accessories & contact

Every TH2851 ships fully calibrated with the standard fixtures and reference standards below. The optional fixtures extend the same platform into SMD, magnetic-ring, bolt-capacitor and materials-analysis work — talk to your Techmize contact or authorized distributor about fixture selection or custom mounting requirements.

Standard accessories

Item	Description
—	EU power cable (Schuko, CEE 7/7)
TH26047A	Four-terminal-pair test fixture
TH26005D	Four-terminal-pair test fixture
TH26082A	100Ω standard component (calibration reference)
TH26010	Gold-plated short-circuit board
TH26061D_P1	Calibration kit
AR05TTS1000N	Chip resistor (calibration reference)

Optional test fixtures & software

Item	Description
TH26007A	Magnetic-ring (toroidal) test fixture — DC–120MHz
TH26008A	SMD component test fixture — DC–120MHz
TH26009B	SMD component test clamp — DC–15MHz
TH26048B	Four-terminal-pair test fixture, axial/radial leaded parts — DC–13MHz
TH26062A	Four-terminal-pair test fixture, large DC-link film capacitors — DC–100kHz
TH26063	Four-terminal-pair test fixture, bolt & DC-link capacitors — DC–100kHz
TH26108C	Four-terminal-pair chip test fixture — DC–40MHz
TH26077	Dielectric test fixture — DC–30MHz (see §9)
TH26086	Four-terminal-pair to 7mm adapter base — DC–130MHz (see §10)
TH26088	Magnetic-permeability test fixture — 1kHz–1GHz (see §10)
TH26086_CAL	7mm-fixture calibration kit

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