TOYO

PinProbe® M1
5G (FR1) UE OTA Production Test Solution
PRODUCT BROCHURE

INTRODUCTION
The OTA testing of 5G cellphones undergoing mass production is facing unprecedented challenges. The number of antennas and frequency bands under test has increased extensively. The higher frequency bands used by 5G make OTA testing even more difficult. All of these challenges lead to a much longer test time, a more complicated procedure for NPI, and a higher cost. The PinProbe M1 is an innovative solution that provides almost 6 times higher efficiency with a considerably lower cost.

The PinProbe M1 is able to test all the wireless functions of the 5G UE, including 5G FR1, LTE, WiFi 2.4G/4.9G/5.8G, Bluetooth, and GPS.

- HIGH EFFICIENCY: 6 times faster speed, Multi-DUT parallel testing
- AUTOMATIC NPI: 20 mins procedure for New Product Introduction (NPI)
- COST SAVING: 6-channel VSG/VSA (non-signaling) option; considerable cost saving on test equipment
- WIDE APPLICATIONS: 5G FR1, LTE, WiFi (2.4G~5.8G), Bluetooth and GPS; 600M~6GHz (7.2GHz option)
- HIGH CONFIDENCE: Test results monotonically correlated with TRP from big chambers
- HIGH RELIABILITY: On-line system self-check
- CUSTOMIZABILITY: Options available upon customer's request

KEY FEATURES INCLUDE: 6 TIMES HIGHER EFFICIENCY, MULTI-DUT PARALLEL TESTING
The PinProbe M1 can test up to 6 DUTs at the same time. By using the unique design monotonically correlated with TRP from of the probe antennas and absorbers, interferences between the DUTs are minimized to achieve a true parallel test. Working with a 6 channel VSG/VSA, The PinProbe M1 shows 6 times higher efficiency with very little extra cost.

Table 1 illustrates the data collected on a production line. PinProbe M1 finishes a test of 6 DUTs in 25 seconds during which the conventional solution only tests one DUT.

TEST TIME (UNIT: S)							
	Existing	PinProbe M1 Test System					
Num of DUTs	1 DUT	1	2	3	4	5	6
Time	~25	20.2	24.9	24.9	25.7	25.9	25.6

- 20 Tx & 52 Rx tested for one DUT
- DUT has 4 antennas
- 1 DUT ~ 6 DUTs tested in PinProbe M1. It takes 25.6s to test 6 DUTs while the existing system takes 25s to test one DUT

Table 1: Test Times

TEST RESULTS MONOTONICALLY CORRELATED WITH TRP TEST
Test data from the production line test solution only makes sense if that data can be correlated monotonically with the TRP/TIS test from big chambers. This has been a difficult challenge for a long time, especially for the higher frequencies and multi-antenna DUTs.

The PinProbe M1 measures the antenna under test in the reactive near field with the specially designed probe antenna, and reconstructs the far-field radiation results based on aperture coupling theory. Please see *Figure 1.*

Test results show a monotonical correlation with TRP measured in the large chamber for all frequency bands, see *Figure 2.*

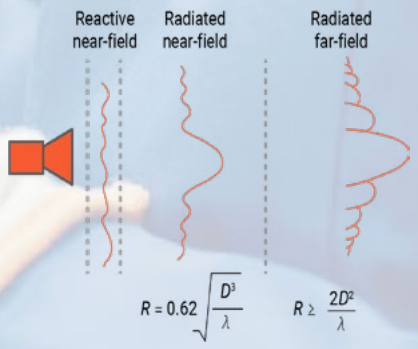

Figure 1: Aperture Coupling Theory

CONSIDERABLE COST SAVING
The PinProbe M1 is optimized for higher efficiency with a 6-channel VSG/VSA (see *Figure 3* on the right and *Figure 4* below), which features

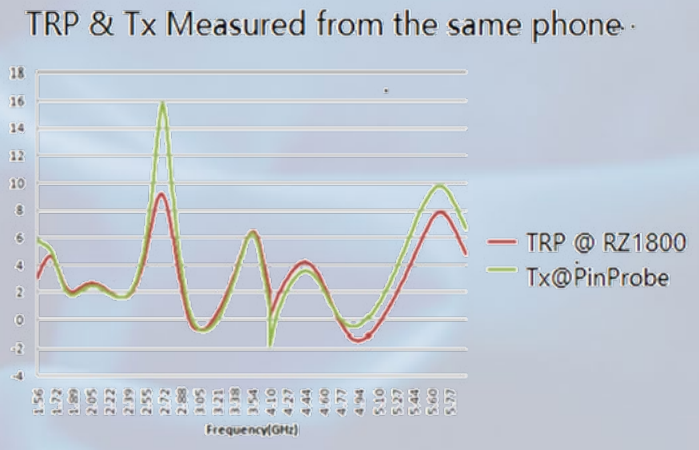

Figure 2: Correlation Analysis

wideband arbitrary signal generation, vector signal receiving, and analysis.

It is compatible with a wide variety of signals, such as 5G NR sub-6GHz, LTE, LTE-V2X, NB-IoT, Cat-M, V2X 802.11p, WLAN, and Bluetooth. It also supports the six channel Tx or Rx parallel test.

Figure 3: 6-channel VSG/VSA

To achieve the same test capacity, a few (2 or 3) pieces of conventional test equipment are required. But with only a single 6-Channel VSG/VSA, the PinProbe M1 saves the customer a considerable amount of funds and still presents 6X higher efficiency.

The Interface of the VSG/VSA is open for the program. The customer has more flexibility to generate and analyze the signals wanted.

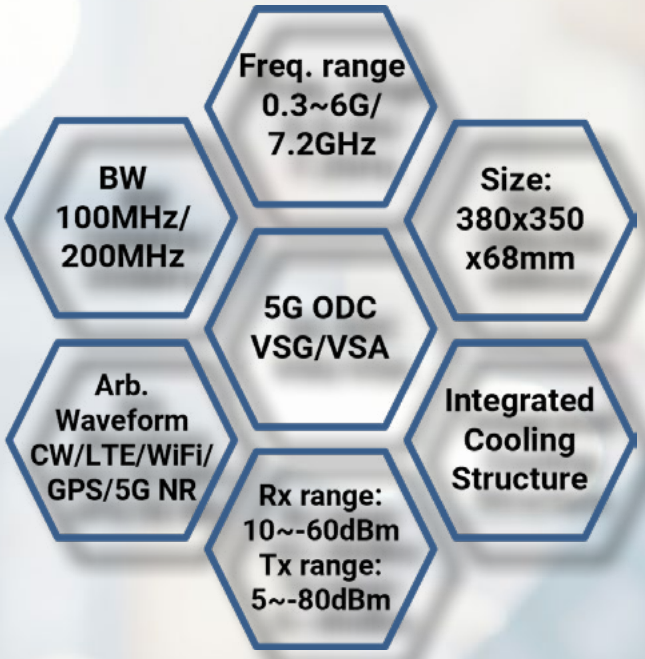

Figure 4: 6-channel VSG/VSA Features

AUTOMATIC NPI PROCEDURE

The New Product Introduction (NPI) process can be time consuming, sometimes taking weeks. The PinProbe M1 reduces the NPI process to 20 minutes (see *Figure 5*).

For a new cellphone, PinProbe scans a flat surface first, which is about the same area and is parallel to the cellphone, then determines test points for each antenna.

This NPI procedure is accomplished automatically through software, which saves a considerable amount of effort for test engineers. The NPI software is open for modification to adapt to the customer's experience. We partner with customers to make the NPI procedure as easy and smooth as possible.

LONG-LIFETIME EPP ABSOBERS

The PinProbe test box is equipped with patented Expanded Polypropylene (EPP) absorbers. The EPP material is a type of

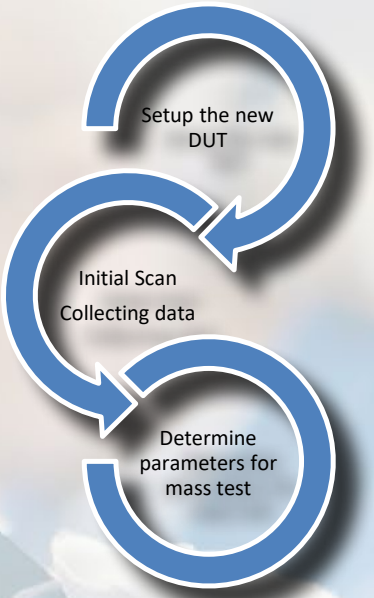

Figure 5: NPI Work Flow

lightweight closed porous foam, which is characterized by its hardness, solvent-resistance, and safety to the environment. It is also high strength, in-deformable, and heat-resistant. See *Table 2* and *Figures 6 & 7*.

The EPP absorber exhibits good absorbing performance for the electromagnetic wave within a small space, providing a low reflection environment, reduce the test uncertainty and improve test accuracy.

AUTOMATIC TEST PROCESS AND ONLINE SELF-CHECK

Once the NPI procedure is finished, the automatic mass test is straightforward much like conventional test systems. The PinProbe M1 has an online self-check function (see *Figure 8*) to ensure its proper working condition. Signals delivered to a self-check antenna are looped back through each probe antenna to check if the signal paths are good or
not. Users get alarmed immediately if any failure occurs.

All hardware interfaces are open to customers to ensure friendly user experiences.

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REFLECTIVITY AT NORMAL INCIDENCE					
model	**0.5 GHz**	**1 GHz**	**2 GHz**	**4 GHz**	**8 GHz**
VPP-200		-27 dB	-40 dB	-40 dB	-50 dB
VPP-230		-30 dB	-40 dB	-40 dB	-50 dB
VPC-300	-30 dB	-35 dB	-40 dB	-45 dB	-50 dB
VPP-300	-30 dB	-40 dB	-45 dB	-50 dB	-50 dB
VPP-450	-30 dB	-45 dB	-50 dB	-55 dB	-50 dB
VPP-600	-40 dB	-50 dB	-50 dB	-50 dB	-50 dB

Table 2: Absorber Matrix

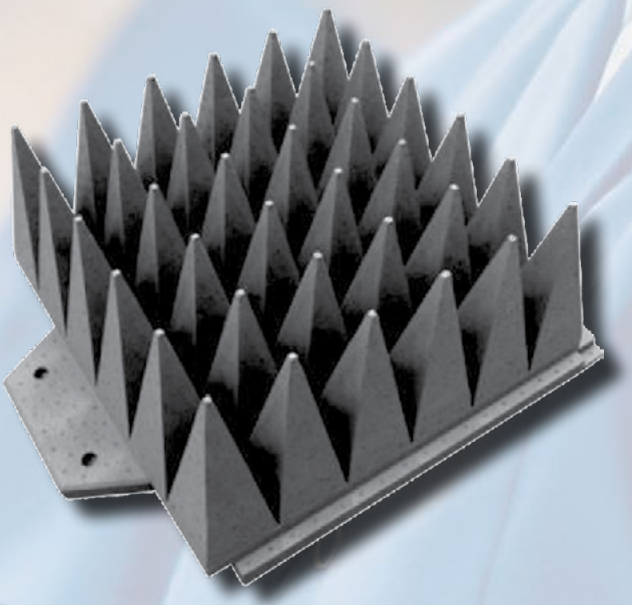


Figure 6: VPC-300

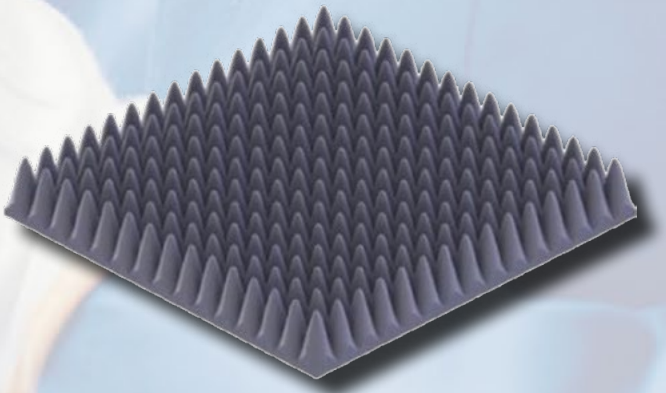


Figure 7: VPC-600

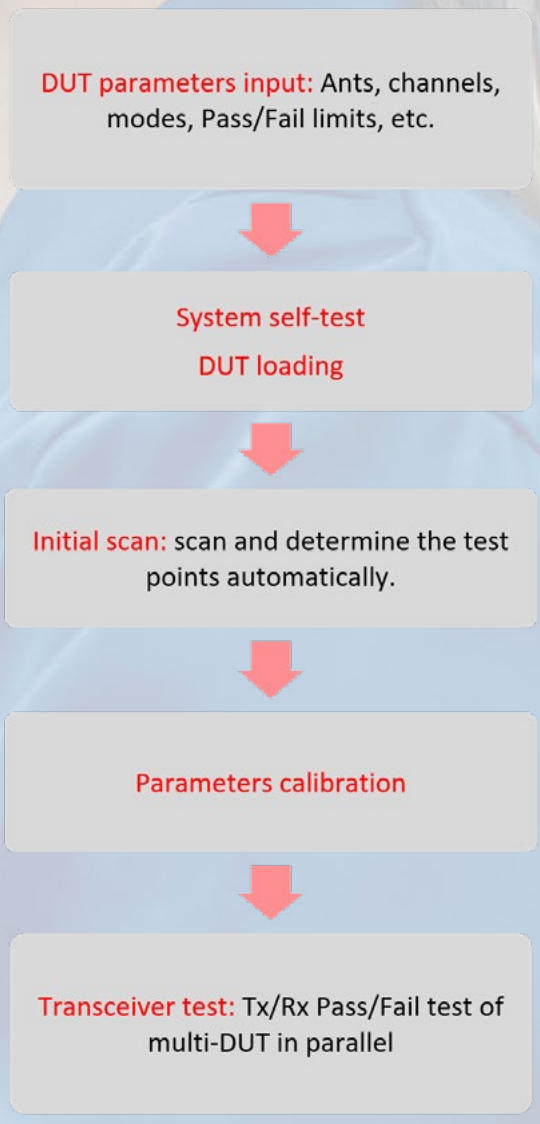
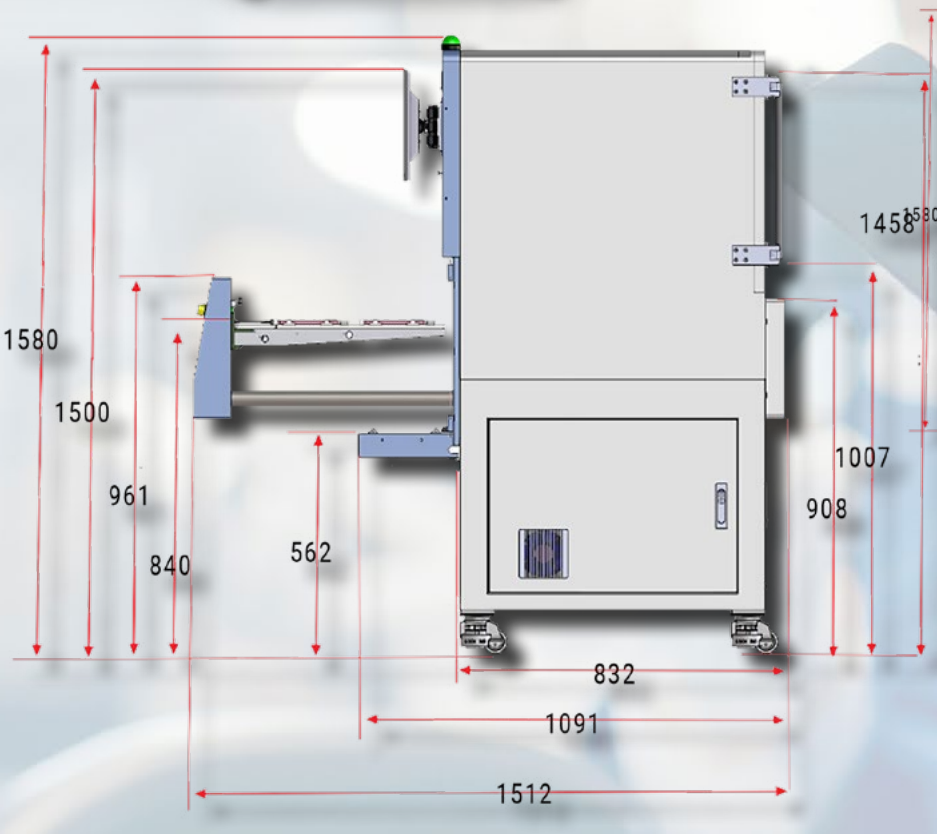
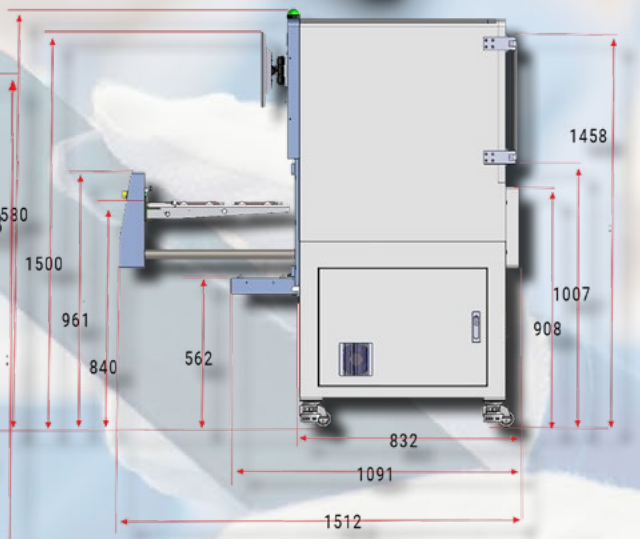


Figure 8: Automatic Test Process

MECHANICAL FEATURES

- Compliant with production line, safety, and stability requirements
- Designed for safety: Fool-proof design is for anticollision and avoiding bodily injury
- Designed for ergonomics: The height of the operation platform is 960mm. This satisfys the ergonomic standing posture requirement of most female or male operators, and there is enough room under the operating platform to clear legs and knees





MODULAR STRUCTURE, EASY MAINTENANCE

- Automatic self-test; fast trouble-shooting
- System maintenance; the electrical and antennas maintenance ports are on the rear, and can be accessed conveniently
- Fast scanning for RF links quality; by measuring the path loss between probe antennas and the communication antenna, test engineers can identify a broken link quickly, then replace parts and fix the problem immediately
- Mechanical maintenance; the cylinder maintenance ports are on both sides of PinProbe. An engineer can adjust the control valve of the cylinder to change the operation speed

MAXSIGN: FAST PROFESSIONAL MANUFACTURING OTA TEST SOFTWARE

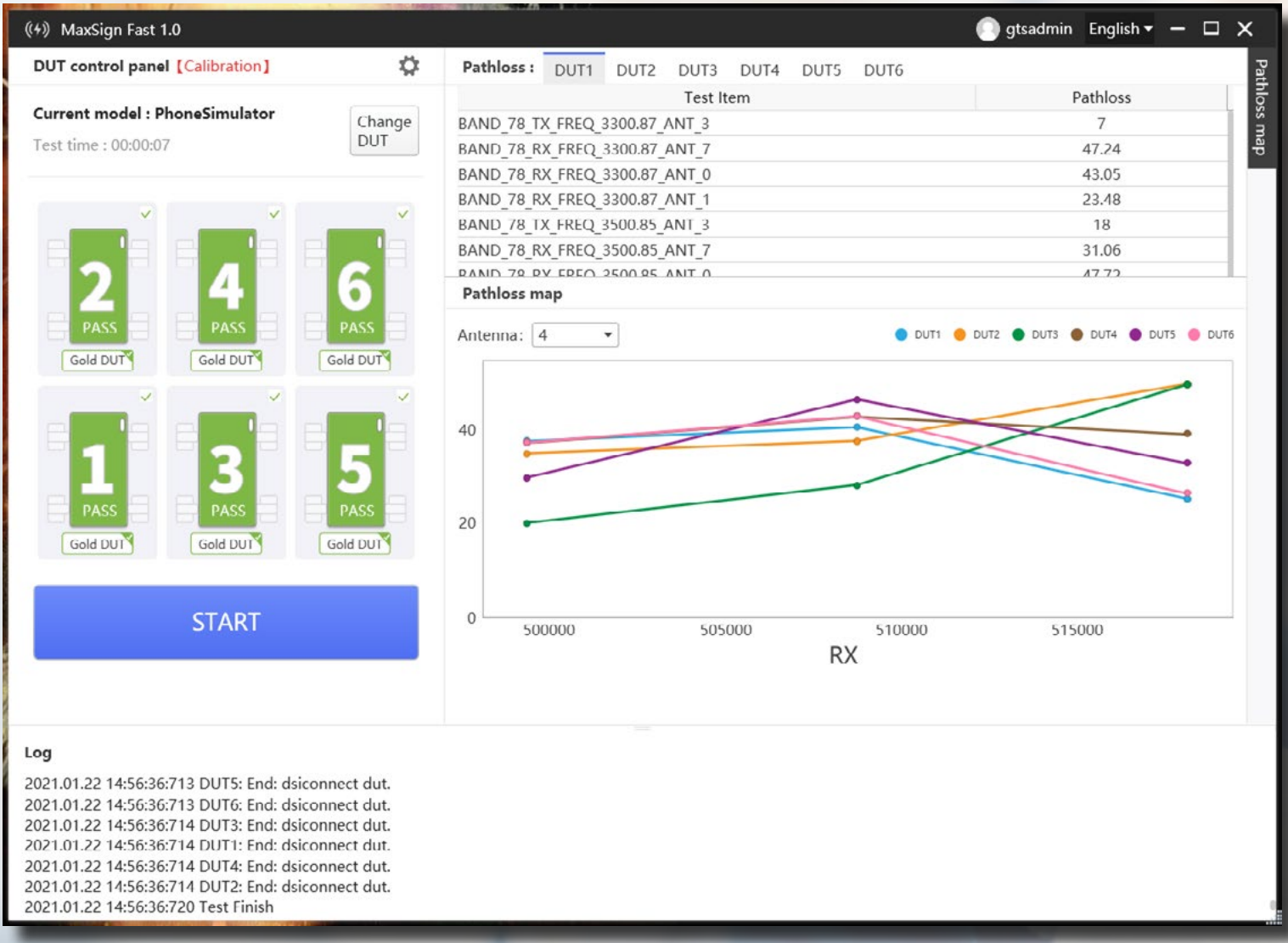
The MaxSign-Fast software is developed based on the Microsoft.NET Framework 4.0 platform, and is a non-signalling OTA test software for the production line.

MaxSign-Fast has many features, such as high-test efficiency, short new DUT importing time, flexible configuration, smooth test processes, stable operation, simple & friendly GUI and compliance with manufacturing standards. This software fully satisfies mass-production test requirements.

The MaxSign Autotest software was developed in partnership with GTS, and the software can cover a variety of tests, including passive antenna, SISO, or MIMO for 3G/4G/5G, Wi-Fi, BT, V2X, and GNSS.

MaxSign Auto also provides a result analysis and comparison tool dedicated to automotive testing, which can be used to analyze and compare many kinds of test results on a common computer, including:

- Automatic NPI, path loss calibration
- 6-DUTs parallel test
- Ready to test UE with Qualcomm chipset. Open to work with other chipsets.
- Checks and views DUT antenna positions, path loss calibration data and test data.
- Supports GTS' 6-channel VSG/VSA and firmware upgrade.
- Manages raw test data and log files. Traces the test process.
- Self-check function



TECHNICAL SPECIFICATIONS		
General	Functions	RF test, UE performance fast scan
	Typical applications	Production test for wireless UE
	DUT types	Small multi-antenna UE(cellphone, smart watch, PDA, etc.)
	Test methodology	Radiated aperture near field plane scan
	Frequency range	600MHz~6GHz/7.2GHz(optional)
	Bandwidth	100MHz/200MHz(optional)
	Major tests	RF spec: Tx/Rx
	Shielding	≥70dB
	Measurement distance	≤50mm
DUT	Max. DUT quantity	6
	Max. antenna array size	200mm×100mm×100mm (L×W×H)
	Max. loading	5kg
Probe Antenna	Quantity	6
	Scan accuracy	0.1mm
Absorobe	Base material	EPP (Expanded polypropylene)
	Height	60mm
	Absorbing rate	≥10dB
Chamber	Exterior dimensions	1091mm×882mm×1580mm (L×W×H)
	Door size	870mm×400mm (W×H)
	Weight	420kg

PINPROBE SYSTEM HARDWARE	
Shielding Chamber	Including shielding box, door, interface module, RF cables, and communication cables
Electrical Control Module	Including electrical cards, and sliding table mechanism
Pneumatic control Module	Cylinder and it's control units
RF Switch Module	1 to 6 RF switching
Probe Antenna	0.6-6GHz × 6
Communication Antenna	0.6-6GHz × 1

SERVICE & SUPPORT	
System calibration	One free calibration at system delivery
Maintenance	Free for the first year
Software upgrade	Free for the first year

PINPROBE SOFTWARE	
Scanning Module	Including inner motion module's 2D scanning control , instrument control, switch control and DUT control, etc.
Positioning Module	Including inner motion module's positioning control , instrument control and DUT control, etc.
Calibration Module	Test data calibration, display and report generation

INSTRUMENTS SUPPORTED (OPTIONAL)	
Vector Signal Analyzer	General signal receiving and measurement instruments
Vector Signal Source	General arbitrary signal generator
CMW100	R&S production test set
MT8870A	Anritsu production test set

TOYO TOYOTech

47623 Lakeview Blvd, Fremont, CA 94538
Phone: 510-438-9548 | E-mail: info@toyotechus.com
http://www.toyotechus.com

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