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2021

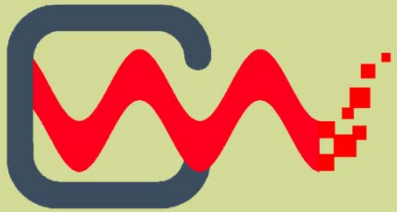
Best Practice of Production Testing for mmWave IC and modules

Wang Zi

Gubo Technologies

TestConX中国 China

Virtual ▪ October 26-29, 2021



Abstract

- 随着毫米波技术发展和应用场景的不断丰富，毫米波测试需求的多样性和复杂性也在不断增加。毫米波的量产测试面临诸多挑战，已有的量产设备不能兼顾性能和成本的需要。如何结合标准仪表和毫米波分离器件，提供定制化的毫米波测试系统以及包括分选仪的空口（OTA）设计，数据分析在内的完整测试解决方案已经成为行业重要需求。孤波依托自研的专业自动化测试软件平台以及积累的行业经验，为毫米波量产测试提供标准测试方案，帮助客户实现了性能和成本的平衡。

- With the development of mmWave technology and the increasing applications' scenarios, the diversity and complexity of millimeter wave testing requirements are also increasing. Current mass production testing of mmWave faces many challenges, and existing mainstream ATE cannot meet the needs of performance and cost. This requires a combination of standard instrumentation and mmWave discrete devices to provide customized complete test solutions for mmWave test systems – which includes over the air (OTA) designs in a standard handler. With years of accumulated industry experience in automated test and standard software platform, Gubo seeks to provide a standard test solution for mmWave mass production testing to help customers achieve a balance of performance and cost.

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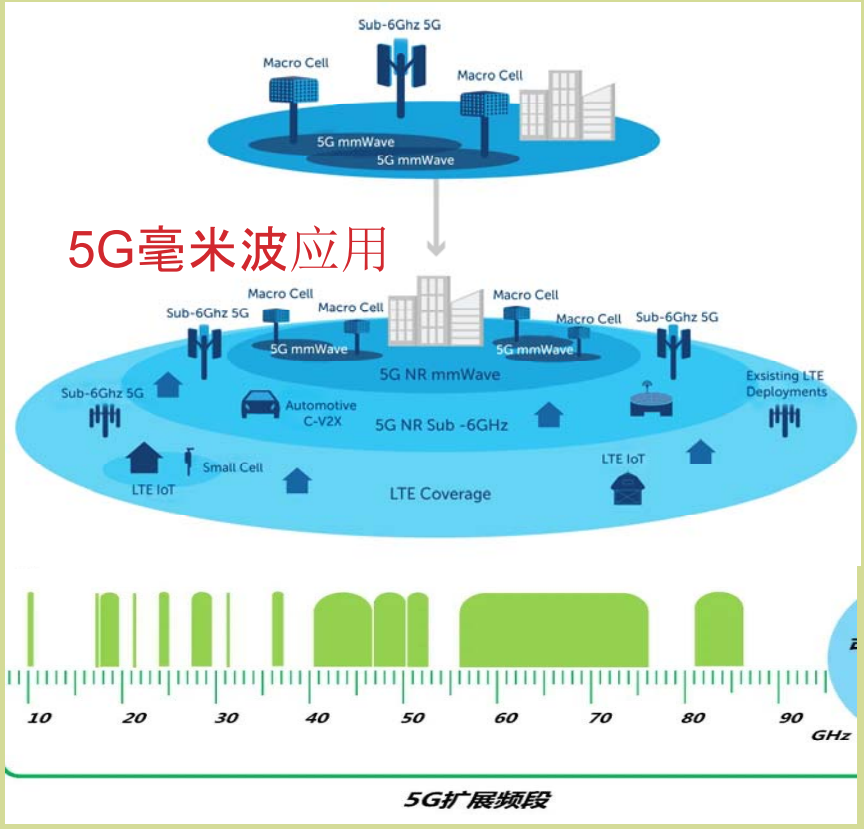
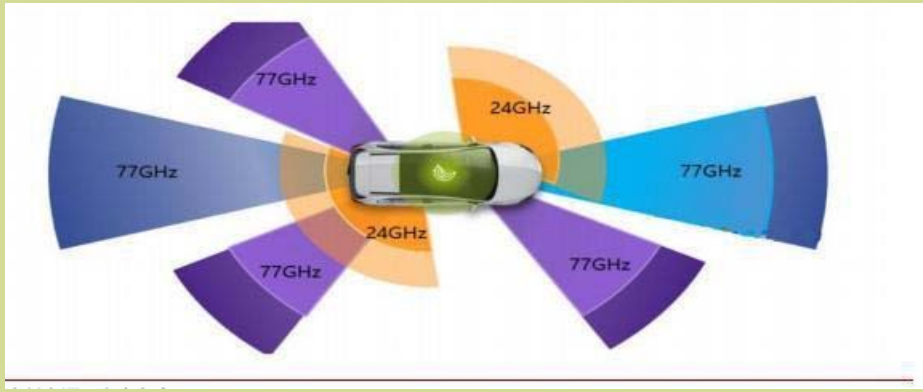
- mmWave Application Scenarios
- Test Challenges for mmWave
- Features for mmWave Product
- Practice 1: Test list consideration for mass production
- Practice 2: Tester Selection
- Practice 3: Socket Selection
- Practice 4: Design considerations for Loadboard and Docking
- How to Quickly Build a Customized ATE

mmWave Application Scenarios



汽车毫米波雷达



24 GHz Radar (shared spectrum)	77 GHz Radar (dedicated spectrum)	79 GHz Radar (dedicated spectrum)
200 MHz Bandwidth 1.5 m Resolution	600 MHz Bandwidth 0.5 m Resolution	4 GHz Bandwidth 0.1 m Resolution

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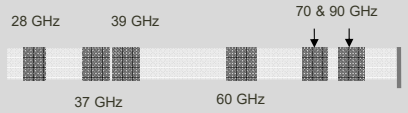
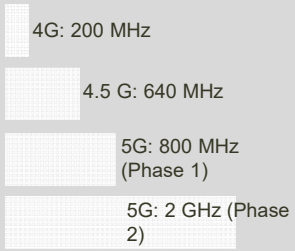
Test Challenges for mmWave

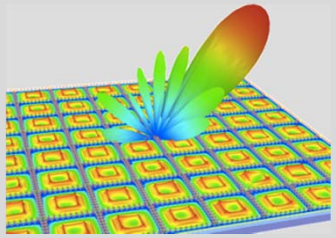
Multi-Standard / Multi-Band Coverage



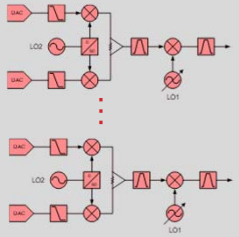
Ultra-wide Bandwidths



Antenna Arrays and Beamforming Validation

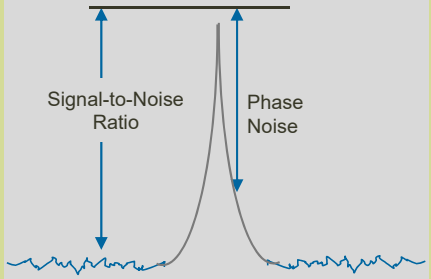


Channel Scaling for MIMO / CA

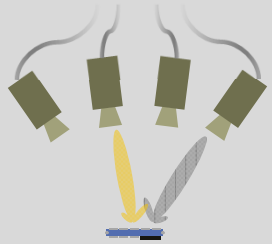


2 – 128 MIMO channels

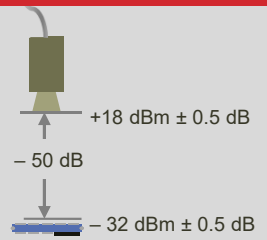
OTA Performance



Spatial Dependence of Measurements



Calibrated Air Interfaces and Chambers



Near field / Far Field

Total Cost of Test

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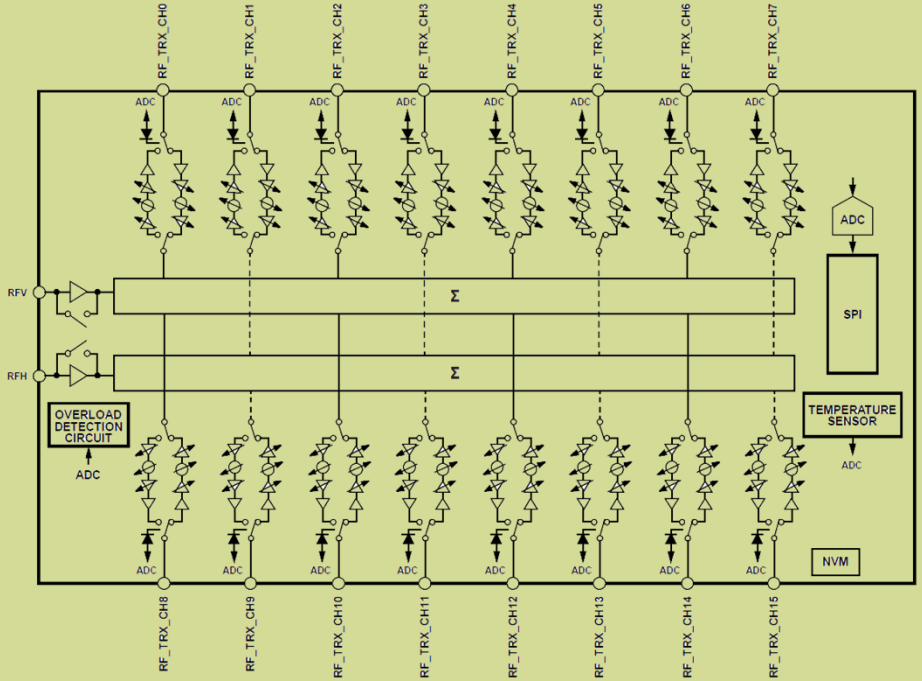
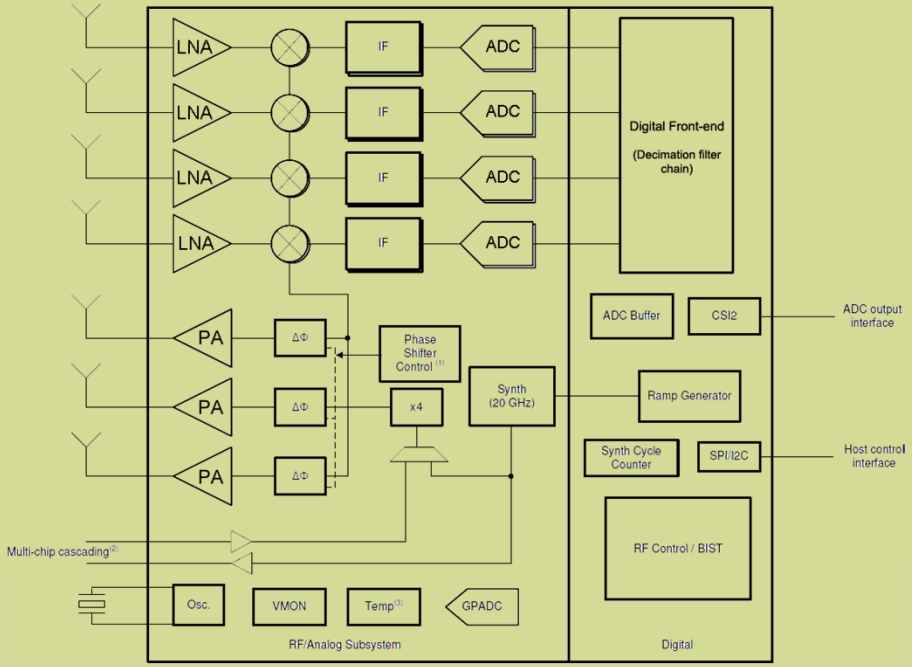
Features for mmWave Product



5G mmWave Beamformer



FMCW Transceiver

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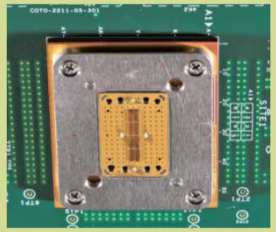
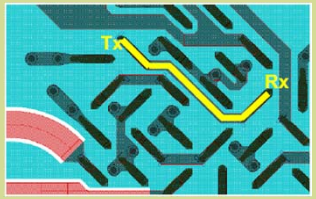
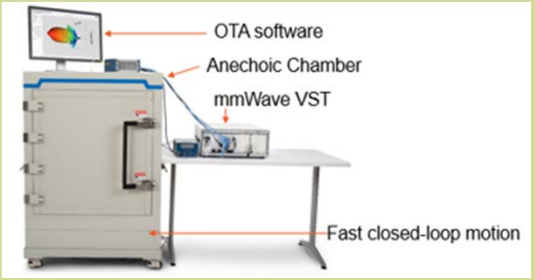
Practice 1: How to determine the test list for mass production



Probe Head Loopback

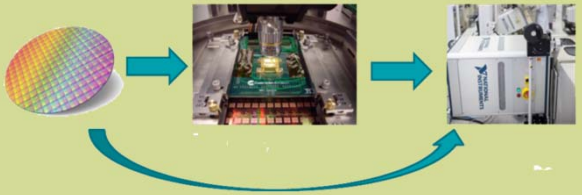
- Pros: Does not need high number of channels and minimal space transformation. High/Low temperature test capability.
- Cons: No access to die by tester and depends upon r the DUT to know if it fails; and routing requires no crossing





Final Test (No Wafer Test)

- Pros: Reduces cost by no need any test step which reduces process time
- Cons: If the yield is low, a lot of packaged parts are thrown away, costing more than doing wafer test



OTA Test

HIGHLIGHTS
- Dramatically cut validation test time of 5G mmWave OTA devices
- Test narrowband (CW) and wideband (5G NR) signals with the same setup
- Run TX/RX tests without external switches
- Fast, detailed test results including 3D power and modulation quality (EVM)

ADVANTAGES
- 5x to 10x faster measurement times with patented position control
- Direct Par-Field and Compact Antenna Test Range in a single chamber

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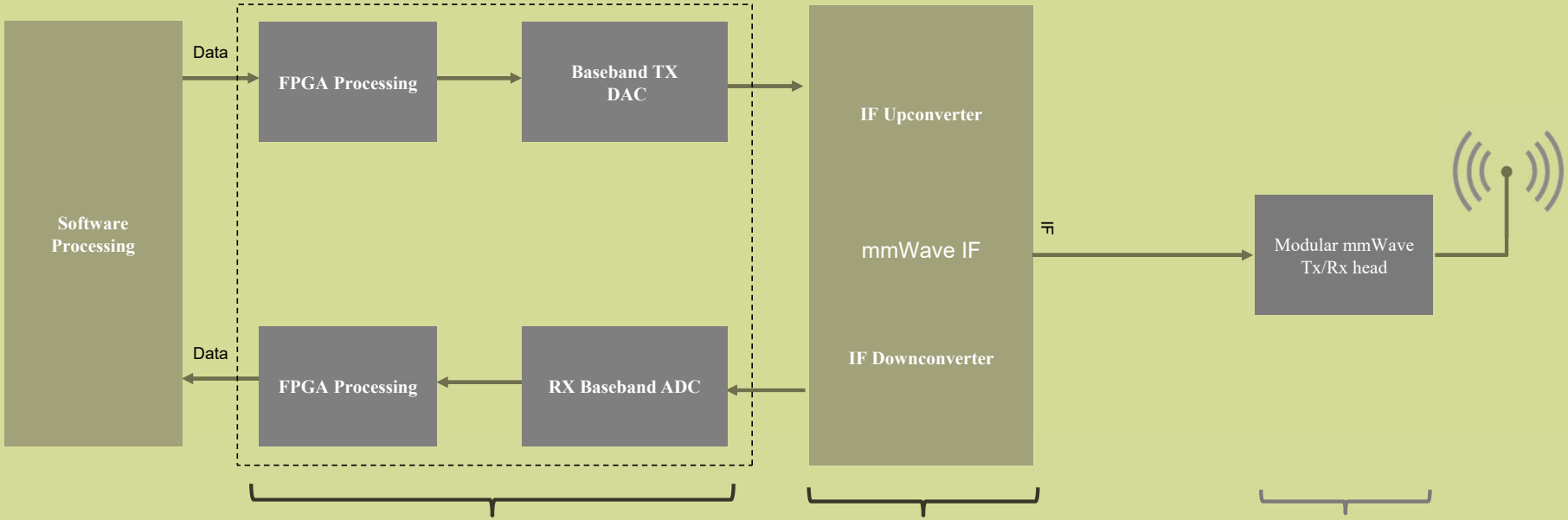
System Architecture for mmWave Mass Production



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Practice 2: What kind of Tester to Choose

mmWave Switch（ SPNT ）
Port Expansion

FLEXIBLE mmWAVE DESIGN

mmWave frequency coverage delivered through modular up/downconverter head

喇叭天线 毫米波开关 毫米波射频头 本振 基带 中频

BROAD Frequency Coverage

5.1 GHz to 7.125 GHz WLAN coverage,
5-21 GHz and remote head configuration with
support for 28 GHz / 39 GHz 5G, 70 GHz, 60GHz GHz

Multi Channel IF-RF
Multi Channel RF-RF

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Practice 2: What kind of Tester to Choose

PLATFORM

- "Customer knows best"
- Customizable solution
- Open, vibrant ecosystem
- Customer designs

自动化 Automation → 测试速度 Speed Test → 量产完成性 HVM

精度 Accuracy → 可扩展性 Scalable → 定制化 Customize

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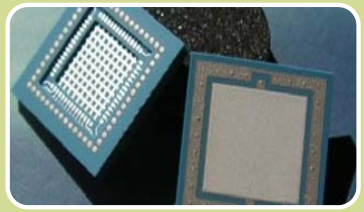
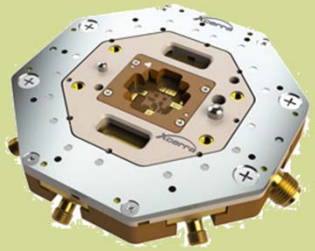
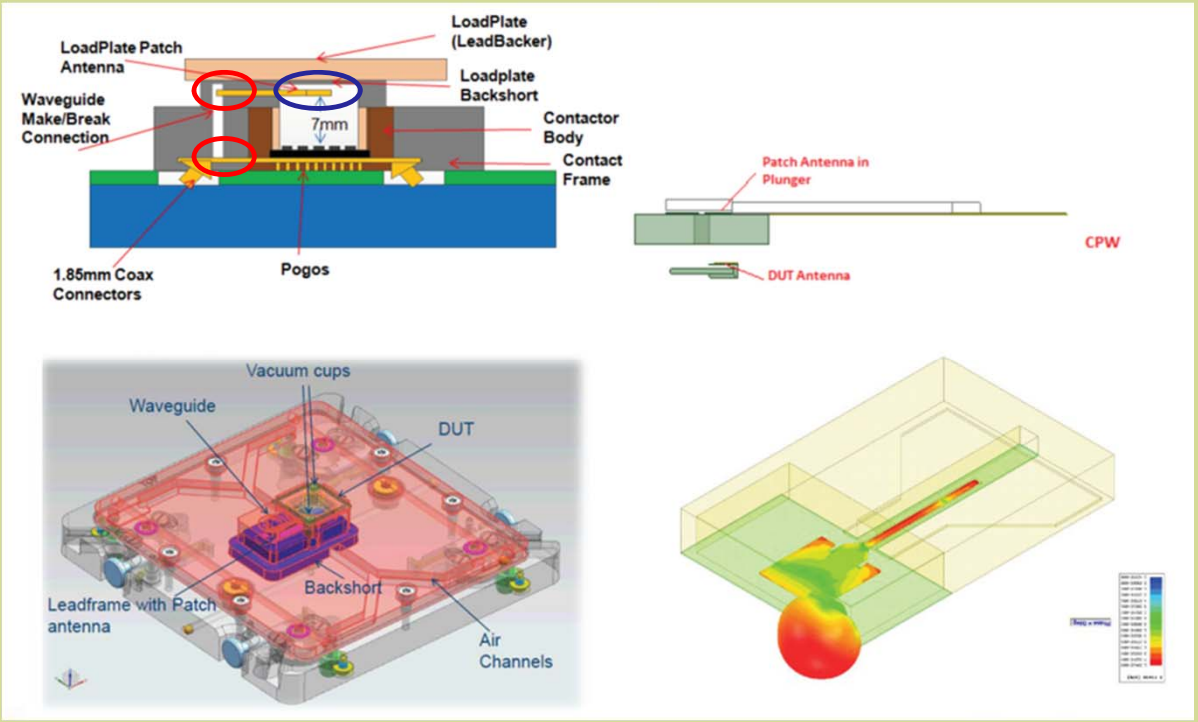
Practice 3: What kind of Socket to Choose

Uniform radiated RF performance on all elements







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Practice 4: How to Design Loadboard and Docking

IMPROVED SIGNAL INTEGRITY

Reduction of signal path provides improved performance over conventional wafer probe approaches

PROBE CARD LOADING OPTIONS

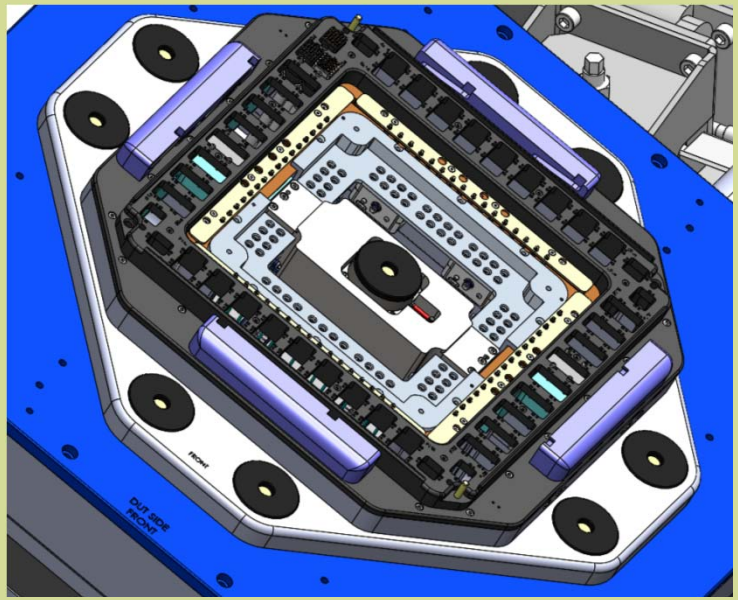
Support for top-load and bottom-load probe card loading

PROBE CARD DEVELOPMENT GUIDE

New Direct Dock probe card development guide available

CUSTOMIZABLE BRIDGE BEAM MATING

Adaptable bridge beam mating structure on probe card based on contact technology, pin count, DUT size, and site count



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How to Quickly Build a Customized ATE

- 功能特点 Functional features
  - 芯片测试各阶段调试及代码转换工具，如寄存器、Pattern、测试定义导入等

    Debugging and code conversion tools at all stages for chip test. e.g., registers, patterns, test plan import, etc.
  - 自动化测试流程快速编写及高效执行

    Automated test flow programming and execution
  - 测试IP功能开发、调试及管理

    Test IP functional development, debugging and management
  - 测试代码各阶段复用及执行

    Test codes reuse for all stages
  - 硬件抽象及快速自定义设备添加管理

    Rapid HW abstraction for customization device management

Gubo has a complete solution (OneTest) to help realize the vision of automated testing from Lab setup to ATE HVM that enable shorter time-to-market for the customer.

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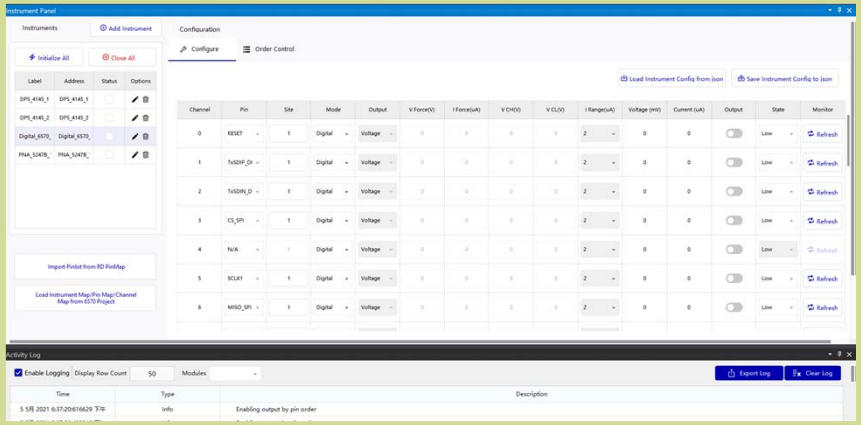
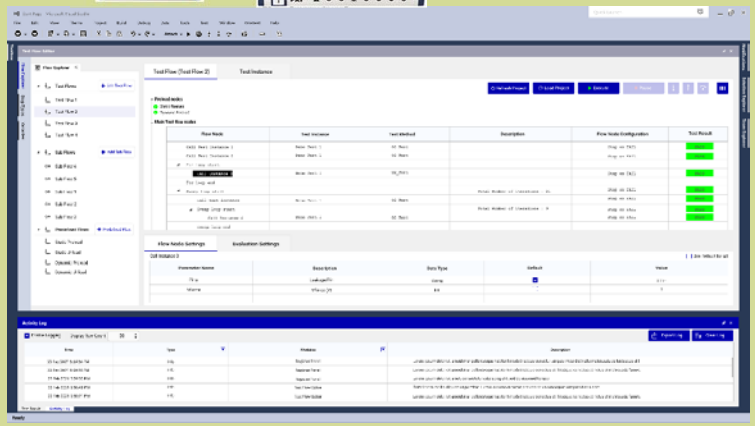
New Product Import based on DIY ATE

- Problem Description

Different kinds of third-party equipment are usually used for system integration as the traditional test equipment can not meet the needs of mmWave production testing. However, it is difficult to realize the software development and hardware maintenance.



- OneTest provides the integration and management for hardware and optimizes the test efficiency



User-friendly ATE Development Environment

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