Probe Station Applications – Testing High Frequency Devices

ADVANCED TECHNOLOGY FOR RESEARCH & INDUSTRY

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- SCOPE: How to configure a wafer probe station for high frequency applications.

Probe stations can be utilised to test and characterise devices for a wide range of applications. One such application of interest is the testing of high frequency (HF) devices. High frequency probing applications are also commonly referred to as radio frequency (RF), or microwave (MW) depending on the application and the frequency ranges to be tested. The frequency bandings typically used when discussing HF probing are shown in the table below:

IEEE Band	Wavelength	Frequency Range (GHz)	Explanation and notes
MF	1 km – 100 m	0.0003 – 0.003	Medium Frequency
HF	100 m – 10 m	0.003 – 0.03	High Frequency
VHF	10 m – 1 m	0.03 – 0.3	Very High Frequency
UHF	1 m – 30 cm	0.3 – 1	Ultra High Frequency
L band	30 cm – 15 cm	1 – 2	Long wave
S band	15 cm – 7.5 cm	2 – 4	Short wave
C band	7.5 cm – 3.75 cm	4 – 8	Compromise between S and X
X band	3.75 cm – 2.5 cm	8 – 12	X for crosshairs, used in WW2 for fire control
K_u band	2.5 cm – 1.67 cm	12 – 18	Kurz-under
K band	1.67 cm – 1.11 cm	18 – 27	Kurz (German for short)
K_a band	1.11 cm – 7.5 mm	27 – 40	Kurz-above
V band	7.5 mm – 4 mm	40 – 75	
W band	4 mm – 2.73 mm	75 – 110	As W follows V in the alphabet
mm	2.73 mm – 1 mm	110 – 300	Millimetre, sometimes called the G band

These are the bandings defined by the IEEE but some applications and industries use different nomenclature and different frequency groupings. For instance the frequency range 3 – 30 GHz can be referred to as Super High Frequency (SHF) and the range 30 – 300 GHz as Extremely High Frequency (EHF). This EHF range is sometimes also referred to as the millimetre range (mm). When working above 300 GHz the application is then termed Terahertz and is beyond the scope of what we will discuss here.

In order to work with any of the frequency bands listed above the probe station should not require many changes in how it is manufactured. In reality the basic components included will not be that different from a standard probe system, but some of the specifics will need to be customised to your application requirements as is explained below.

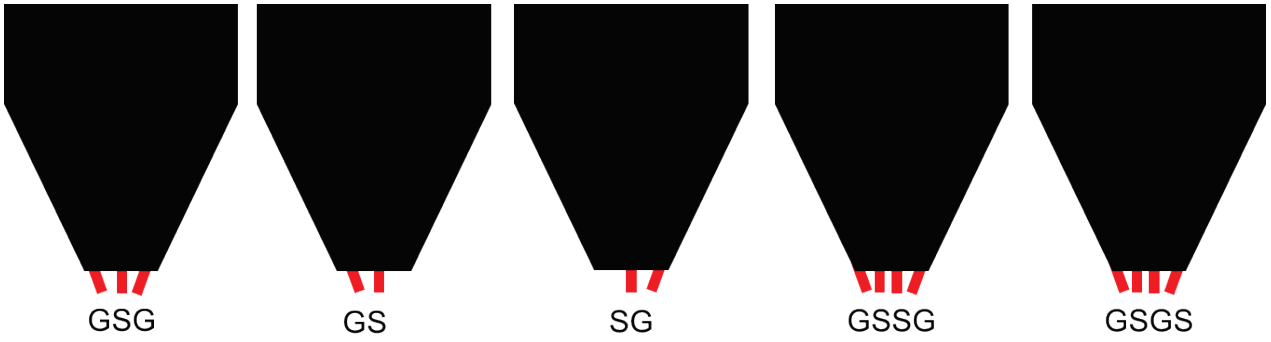
High quality HF and RF probing solutions look to minimise sources of movement, drift and noise, although this is true of most probing applications. To achieve this, the probe station requires the mechanics and bases used in the system to be vibration free. The Probe System for Life (PS4L) from SemiProbe allows the easy integration of rigid high quality components to meet this requirement.

The simplest addition to a bench-top probe station is to include a vibration isolation table, this helps to remove interference from the surrounding environment. Further reduction in vibration can be achieved by using a HF suitable platen. The platen is used to hold the manipulators, tuners and other extension modules in a probe system and in HF probing applications these are typically larger and made of steel or are steel plated. In most systems these will have tapped mounting holes to allow the manipulators to be bolted into place or will allow magnetic fixing of the manipulators.

For an RF system, the manipulators need to be able provide the highest levels of precision, rigidity and stability. This high level of stability is achieved by using a firm base that can either be bolted or magnetically fixed to the platen. The manipulators must also be able to accommodate the increased weight of the additional cables, probes and tuners required for the RF probing.

The probes on the HF probe system can be set up in a variety of configurations for applying the signal to your DUT. What you will need depends on the specifics and the requirements of your application. The most common configuration is ground-signal-ground (GSG) but others such as ground-signal (GS) and signal-ground (SG) are often used as are

GSSG and GSGS (ground-signal-signal-ground and ground-signal-ground-signal). Diagrams of these are shown in the image below:



Beyond using individual probes to characterise your device, RF probe cards are also available from a variety of suppliers and can be easily incorporated into the probe system. Often these will include calibration options that can be integrated into the RF system.

The wafer chucks used to hold the device under test (DUT) will have vacuum control to allow the substrate to be securely held. In addition these HF chucks have the ability to hold two calibration substrates or a calibration substrate and a contact substrate.

A further consideration to make when configuring an RF or microwave probe station is to ensure that the probe cables that you use are suitable for the frequency range you need to work with. As with the probes and probe cards a number of manufacturers are available and all can be incorporated into a SemiProbe PS4L.

Finally, when planning your RF probing setup it is important to consider the instrumentation you will be using to run your test protocol. Being able to interface with these is crucial to producing a RF probe system otherwise no RF probing will be possible. Typically the instrumentation and analysers are purchased separately from the probe station but compatibility between the two is essential.

Probing at high frequencies will always be more challenging than a DC probing application but provided the right equipment and instrumentation has been specified during the design and development process then there is no reason that accurate measurements cannot be achieved. The PS4L from SemiProbe is an ideal choice of platform when choosing an RF probe station due to its innate flexibility and continuous upgrade path. The PS4L can grow and shift with your probing requirements as they evolve without needing to purchase a whole new system.