CLAIMS

1. A probe blade for a probe system configured to electrically test a device under test (DUT), the probe blade comprising:

a dielectric blade body defined by a dielectric blade body material, wherein the dielectric blade body includes a blade-mounting region and a probe-mounting region and defines a first blade side and an opposed second blade side;

a probe operatively attached to the probe-mounting region, wherein the probe includes a probe tip configured to electrically contact the DUT;

a force electrically conductive trace that extends on the first blade side, between the blade-mounting region and the probe-mounting region, wherein the force electrically conductive trace is in electrical communication with the probe within the probe-mounting region;

a sense electrically conductive trace that extends on the first blade side between the blade-mounting region and the probe-mounting region; and

an electrically conductive guard layer that extends on the opposed second blade side;

wherein the probe blade is configured to provide a Kelvin electrical connection with the DUT.

2. The probe blade of claim 1, wherein a probe-proximate end of the sense electrically conductive trace is shorted to a probe-proximate end of the force electrically conductive trace within the probe-mounting region, wherein the sense electrically conductive trace is spaced apart from the force electrically conductive trace along a remainder of a length of the force electrically conductive trace, and further wherein the Kelvin electrical connection is a quasi-Kelvin electrical connection.

3. The probe blade of claim 1, wherein the probe is a first probe that includes a first probe tip, wherein the probe blade includes a second probe that is operatively attached to the probe-mounting region and includes a second probe tip configured to electrically contact the DUT, wherein the sense electrically conductive trace is in electrical communication with the second probe within the probe-mounting region, and further wherein the Kelvin electrical connection is a true Kelvin electrical connection.

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4. The probe blade of claim 3, wherein the first probe tip and the second probe tip are configured to electrically contact a single contact pad of the DUT, and further wherein a distance between the first probe tip and the second probe tip is less than a corresponding width of the single contact pad of the DUT.

5. The probe blade of any of claims 3-4, wherein a distance between the first probe tip and the second probe tip is less than a blade thickness of the probe blade.

6. The probe blade of claim 3, wherein the first probe and the second probe taper toward one another as they extend away from the probe blade to facilitate electrical contact of both the first probe tip and the second probe tip with a single contact pad of the DUT.

7. The probe blade of any of claims 3-6, wherein at least one of the first probe and the second probe is oriented at a probe extension angle relative to a corresponding one of the first blade side and the second blade side, wherein the probe extension angle is at least 0 degrees and at most 20 degrees.

8. The probe blade of any of claims 3-7, wherein the force electrically conductive trace includes a first trace extension region, which is defined on an attachment surface of the probe blade, wherein the sense electrically conductive trace includes a second trace extension region, which is defined on the attachment surface, wherein the first probe is operatively attached to the first trace extension region, and further wherein the second probe is operatively attached to the second trace extension region.

9. The probe blade of claim 8, wherein the attachment surface extends between the first blade side and the second blade side of the probe blade.

10. The probe blade of any of claims 3-6, wherein:

(i) the first probe tip of the first probe is relatively proximate a side of the first probe that faces toward the second probe when compared to a side of the first probe that faces away from the second probe; and

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(ii) the second probe tip of the second probe is relatively proximate a side of the second probe that faces toward the first probe when compared to a side of the second probe that faces away from the first probe.

11. The probe blade of any of claims 1-10, wherein the probe blade includes an alignment structure configured to engage with a blade holder when the probe blade is received within a blade-receiving region of the blade holder.

12. The probe blade of claim 11, wherein the alignment structure includes a notch that extends into the probe blade and is configured to receive a region of the blade holder to facilitate consistent alignment between the probe blade and the blade holder.

13. The probe blade of any of claims 11-12, wherein the alignment structure includes a protrusion that extends from an edge region of the probe blade and is configured to extend around a region of the blade holder to facilitate consistent alignment between the probe blade and the blade holder.

14. The probe blade of any of claims 1-13, wherein the probe blade further includes a clearance region that extends away from the probe and is shaped to provide additional clearance for the probe to contact the DUT.

15. The probe blade of any of claims 1-14, wherein the opposed second blade side defines a second side surface area, and further wherein the electrically conductive guard layer defines a guard layer surface area that is at least 50% of the second side surface area.

16. The probe blade of any of claims 1-15, wherein the dielectric blade body material differs from an electrically conductive probe body material of the probe.

17. The probe blade of any of claims 1-16, wherein the dielectric blade body is an at least partially L-shaped dielectric blade body.

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18. A blade holder, comprising:

the probe blade of any of claims 1-17, wherein the blade holder is configured to separably and operatively attach the probe blade to a probe system;

an electrically conductive holder housing that defines:

(i) a blade-receiving region configured to receive the blade-mounting region of the probe blade;

(ii) an electrical connection region configured to receive a plurality of electrical connections;

(iii) a housing-mounting region configured to operatively attach the electrically conductive holder housing to the probe system; and

(iv) an at least partially enclosed housing volume that extends between the blade-receiving region and the electrical connection region;

a blade-contacting structure at least partially positioned within the blade-receiving region, wherein the blade-contacting structure includes a force blade contact, which is configured to electrically contact the force electrically conductive trace, and a sense blade contact, which is configured to electrically contact the sense electrically conductive trace;

a ground electrical connection to the electrical connection region, wherein the ground electrical connection is in electrical communication with the electrically conductive holder housing;

a force electrical connection within the electrical connection region, wherein the force electrical connection is electrically isolated from the electrically conductive holder housing;

a force conductor that extends within the housing volume, is electrically isolated from the electrically conductive holder housing, and electrically interconnects the force electrical connection with the force blade contact;

a sense electrical connection to the electrical connection region, wherein the sense electrical connection is electrically isolated from both the electrically conductive holder housing and the force electrical connection; and

a sense conductor that extends within the housing volume, is electrically isolated from both the electrically conductive holder housing and the force conductor, and electrically interconnects the sense electrical connection with the sense blade contact.

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19. The blade holder of claim 18, wherein the blade-contacting structure is a biased blade-contacting structure configured to operatively retain the probe blade within the blade-receiving region.

20. The blade holder of any of claims 18-19, wherein the blade-contacting structure is configured to urge the electrically conductive guard layer into electrical contact with an internal surface of the blade-receiving region that is at least partially defined by the electrically conductive holder housing such that the electrically conductive guard layer is in electrical communication with the electrically conductive holder housing.

21. A probe system configured to electrically test a device under test (DUT), the probe system comprising:

a chuck that defines a support surface configured to support a substrate that includes the DUT;

a probe assembly that includes the blade holder of any of claims 18-20;

a manipulator configured to move the probe assembly relative to the support surface;

a signal generation and analysis assembly configured to:

(i) provide a force signal to the DUT via the probe assembly; and

(ii) receive a sense signal from the DUT via the probe assembly; and

an imaging device configured to collect an optical image of at least one of:

(i) at least one other component of the probe system; and

(ii) the DUT.

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22. A kit of components configured to be utilized with a probe assembly of a probe system, the kit comprising:

the probe blade of any of claims 1-17; and

a tool configured to facilitate insertion of the probe blade into a blade holder and removal of the probe blade from the blade holder, wherein the tool includes:

(i) a handle region configured to be gripped by a user of the tool;

(ii) a blade receptacle shaped to receive at least a region of the probe blade;

(iii) a bearing surface that at least partially defines the blade receptacle and is shaped to press against an edge region of the blade; and

(iv) a blade gripping structure configured to be selectively actuated by the user to grip the probe blade.

23. A probe blade for a probe system configured to electrically test a device under test (DUT), the probe blade comprising:

a dielectric blade body defined by a dielectric blade body material, wherein the dielectric blade body includes a blade-mounting region and a probe-mounting region;

a probe operatively attached to the probe-mounting region, wherein the probe includes a probe tip configured to electrically contact the DUT;

an electrically conductive trace that extends between the blade-mounting region and the probe-mounting region and is in electrical communication with the probe within the probe-mounting region; and

an alignment structure configured to engage with a blade holder when the probe blade is received within a blade-receiving region of the blade holder, wherein the alignment structure includes at least one of:

(i) a notch that extends into the probe blade and is configured to receive a region of the blade holder to facilitate consistent alignment between the probe blade and the blade holder; and

(ii) a protrusion that extends from an edge region of the probe blade and is configured to extend around a region of the blade holder to facilitate consistent alignment between the probe blade and the blade holder.

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24. A blade holder, comprising:

the probe blade of claim 23, wherein the blade holder is configured to separably and operatively attach the probe blade to a probe system;

an electrically conductive holder housing that defines:

(i) a blade-receiving region configured to receive the blade-mounting region of the probe blade;

(ii) an electrical connection region configured to receive a plurality of electrical connections;

(iii) a housing-mounting region configured to operatively attach the electrically conductive holder housing to the probe system; and

(iv) an at least partially enclosed housing volume that extends between the blade-receiving region and the electrical connection region;

a blade-contacting structure at least partially positioned within the blade-receiving region, wherein the blade-contacting structure includes a force blade contact, which is configured to electrically contact a force electrically conductive trace, and a sense blade contact, which is configured to electrically contact a sense electrically conductive trace;

a ground electrical connection to the electrical connection region, wherein the ground electrical connection is in electrical communication with the electrically conductive holder housing;

a force electrical connection within the electrical connection region, wherein the force electrical connection is electrically isolated from the electrically conductive holder housing;

a force conductor that extends within the housing volume, is electrically isolated from the electrically conductive holder housing, and electrically interconnects the force electrical connection with the force blade contact;

a sense electrical connection to the electrical connection region, wherein the sense electrical connection is electrically isolated from both the electrically conductive holder housing and the force electrical connection; and

a sense conductor that extends within the housing volume, is electrically isolated from both the electrically conductive holder housing and the force conductor, and electrically interconnects the sense electrical connection with the sense blade contact.

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25. A probe system configured to electrically test a device under test (DUT), the probe system comprising:

a chuck that defines a support surface configured to support a substrate that includes the DUT;

a probe assembly that includes the blade holder of claim 24;

a manipulator configured to move the probe assembly relative to the support surface;

a signal generation and analysis assembly configured to:

(i) provide a force signal to the DUT via the probe assembly; and

(ii) receive a sense signal from the DUT via the probe assembly; and

an imaging device configured to collect an optical image of at least one of:

(i) at least one other component of the probe system; and

(ii) the DUT.

26. A kit of components configured to be utilized with a probe assembly of a probe system, the kit comprising:

the probe blade of claim 23; and

a tool configured to facilitate insertion of the probe blade into a blade holder and removal of the probe blade from the blade holder, wherein the tool includes:

(i) a handle region configured to be gripped by a user of the tool;

(ii) a blade receptacle shaped to receive at least a region of the probe blade;

(iii) a bearing surface that at least partially defines the blade receptacle and is shaped to press against an edge region of the blade; and

(iv) a blade gripping structure configured to be selectively actuated by the user to grip the probe blade.

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27. A blade holder configured to separably and operatively attach a probe blade to a probe system, the blade holder comprising:

an electrically conductive holder housing that defines:

(i) a blade-receiving region configured to receive a blade-mounting region of the probe blade;

(ii) an electrical connection region configured to receive a plurality of electrical connections;

(iii) a housing-mounting region configured to operatively attach the electrically conductive holder housing to the probe system; and

(iv) an at least partially enclosed housing volume that extends between the blade-receiving region and the electrical connection region;

a blade-contacting structure at least partially positioned within the blade-receiving region, wherein the blade-contacting structure includes a force blade contact, which is configured to electrically contact a force electrically conductive trace of the probe blade, and a sense blade contact, which is configured to electrically contact a sense electrically conductive trace of the probe blade;

a ground electrical connection to the electrical connection region, wherein the ground electrical connection is in electrical communication with the electrically conductive holder housing;

a force electrical connection within the electrical connection region, wherein the force electrical connection is electrically isolated from the electrically conductive holder housing;

a force conductor that extends within the housing volume, is electrically isolated from the electrically conductive holder housing, and electrically interconnects the force electrical connection with the force blade contact;

a sense electrical connection to the electrical connection region, wherein the sense electrical connection is electrically isolated from both the electrically conductive holder housing and the force electrical connection; and

a sense conductor that extends within the housing volume, is electrically isolated from both the electrically conductive holder housing and the force conductor, and electrically interconnects the sense electrical connection with the sense blade contact.

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28. The blade holder of claim 27, wherein the force electrically conductive trace and the sense electrically conductive trace are positioned on a first blade side of the probe blade, wherein the probe blade further includes an electrically conductive guard layer positioned on a second blade side of the probe blade, and further wherein the blade-contacting structure is configured to urge the electrically conductive guard layer into electrical contact with an internal surface of the blade-receiving region that is at least partially defined by the electrically conductive holder housing such that the electrically conductive guard layer is in electrical communication with the electrically conductive holder housing.

29. A probe system configured to electrically test a device under test (DUT), the probe system comprising:

a chuck that defines a support surface configured to support a substrate that includes the DUT;

a probe assembly that includes the blade holder of claim 27;

a manipulator configured to move the probe assembly relative to the support surface;

a signal generation and analysis assembly configured to:

(i) provide a force signal to the DUT via the probe assembly; and

(ii) receive a sense signal from the DUT via the probe assembly; and

an imaging device configured to collect an optical image of at least one of:

(i) at least one other component of the probe system; and

(ii) the DUT.

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