A method and apparatus for electrically coupling a slider to a controller circuit are disclosed. In one embodiment, a pre-amplifier with an integrated electrical connector (I-connector) may be connected via an electrical trace to a slider and via a head stack assembly flexible circuit to a control circuit. The pre-amplifier may have two parallel series of spring probe claws, two parallel series of contact pegs, two slots, or a slot and a rotary cam.
ELECTRICAL CONNECTION BETWEEN A SUSPENSION FLEXURE CABLE AND A HEAD STACK ASSEMBLY FLEXIBLE CIRCUIT

BACKGROUND INFORMATION

[0001] The present invention relates to magnetic disk drives. More specifically, the present invention relates to a method of electrically connecting the actuator and microactuator to a control circuit.

[0002] In the art today, different methods are utilized to improve recording density in hard disk drives. FIG. 1 provides an illustration of a typical disk drive. The typical disk drive has a head gimbal assembly (HGA) configured to read from and write to a magnetic hard disk 101. The HGA and the magnetic hard disk 101 are mounted to the base 102 of a main board 103. The disk 101 is rotated relative to the base 102 by a spindle motor 104. The HGA typically includes an actuator arm 105 and a suspension 106. The HGA supports and positions a magnetic read/write slider 107 above the magnetic hard disk 101. The slider may contain transducers to perform the read/write function. The HGA is rotated relative to the base 102 along the axis of a pivot bearing assembly 108 by an actuator frame 109. The actuator frame 109 contains an actuator coil 110 driven by a magnet 111. A relay flexible printed circuit 112 connects a board unit 113 to the transducer of the magnetic read/write slider 107. The signal from the transducer is amplified by the preamplifier 114 before being transmitted along the relay flexible printed circuit.

[0003] FIG. 2 provides one illustration of an actuator as practiced in the prior art. The suspension 106, which supports the slider 107, may include a flexure 201 attached to a base plate 202 that suspends a load beam 203 coupled to the slider 107. The slider 107 may be electronically coupled by electrical traces 204 that run along the suspension 106 and actuator arm 105 to an actuator board 205. The actuator board 205 runs the signals from the slider 107 through a pre-amplifier 114 before sending them through the relay flexible printed circuit 112. The electrical traces 204 may be coupled to the actuator board 205 by a set of termination pads 206 at the end of the electrical traces 204.

[0004] FIG. 3 provides one illustration of the electrical connection between the slider 107 and the relay flexible printed circuit 112 as practiced in the prior art. The electrical trace 204 coupled to the suspension 106 may electrically connect the slider 107 to the suspension 106. The termination pads 206 may be coupled to a set of contact pads 301 on the actuator board 205. The signal is then sent through a pre-amplifier to the relay flexible printed circuit 112.

[0005] In order to carry out previous methods of establishing an electrical connection, the flex cable on the suspension must be aligned properly to the pads of the actuator board 205. If soldering is used to connect the pads, the solder bump must be preliminarily formed on the pads for solder bonding. Laser or ultrasonic bonding can be prohibitively expensive and time consuming due to the necessary calibration work.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 provides an illustration of a typical disk drive.

[0007] FIG. 2 provides one illustration of an actuator as practiced in the prior art.

[0008] FIG. 3 provides one illustration of the electrical connection between the slider and the relay flexible printed circuit as practiced in the prior art.

[0009] FIG. 4 provides an illustration of one embodiment of an actuator with an electrical connection as constructed in the present invention.

[0010] FIG. 5 provides an illustration of one embodiment of the electrical connection as constructed in the present invention.

[0011] FIG. 6 provides an illustration one embodiment of a pre-amplifier with an I-connector.

[0012] FIG. 7 provides an illustration in a cross-section one embodiment of the pre-amplifier with I-connector as used in creating an electrical connection.

[0013] FIG. 8 provides an illustration in a side view of one embodiment of the electrical connection.

[0014] FIG. 9 provides an illustration in a top view of one embodiment of the electrical connection.

[0015] FIGS. 10a-d provide an illustration of alternate embodiments of the pre-amplifier with I-connector.

DETAILED DESCRIPTION

[0016] A method and apparatus for electrically coupling a slider to a controller circuit are disclosed. In one embodiment, a pre-amplifier with an integrated electrical connector (I-connector) may be connected via an electrical trace to a slider and via a head stack assembly flexible circuit to a control circuit. The pre-amplifier may have two parallel series of spring probe clamps, two parallel series of contact pegs, two slots, or a slot and a rotary cam.

[0017] FIG. 4 illustrates one embodiment of an actuator with an electrical connection as constructed in the present invention. The pre-amplifier 401 of the actuator board 205 may have a built in I-connector. The termination pads 206 of the electrical traces 204 may be directly connected to the pre-amplifier with I-connector 401. An alignment pin 402 extending up from the actuator board 205 may allow the pre-amplifier with I-connector 401 to be position. A screw 403 or other coupling device may be used to couple the I-connector to the actuator board 205.

[0018] FIG. 5 illustrates one embodiment of the electrical connection. The pre-amplifier with I-connector 401 may be coupled to an actuator board 205 by using an alignment pin 402 and a screw 403 or other coupling device. The termination pads 206 of the electrical traces 204 may be directly coupled to the pre-amplifier with I-connector 401. The head stack assembly flexible circuit 112 may be coupled to the pre-amplifier with I-connector 401 by a direct connection 501 or by terminating in a controller connection tab that connects to the pre-amplifier with I-connector.

[0019] FIG. 6 illustrates one embodiment of a pre-amplifier with an I-connector 401. Two parallel rows of spring probe clamps 601 may line the bottom of the pre-amplifier with I-connector 401. The spring probe clamps 601 may bend inwards towards the center of the pre-EXPRESS amplifier with I-connector 401. An alignment slot 602 may be used to align the pre-amplifier with I-connector 401 with the alignment pin 402. A screw hole 603 may allow the pre-amplifier with I-connector 401 to be coupled to the actuator board by a screw 403 or other coupling device.

[0020] FIG. 7 illustrates one embodiment of the pre-amplifier with I-connector 401 as used in creating an electrical connection. The pre-amplifier with I-connector 401 may be aligned to the actuator board 205 by an alignment...
pin extending up from the actuator arm 105 through the actuator board 205 and the alignment slot 602 of the pre-amplifier with 1-conector 401. The pre-amplifier with 1-conector 401 may then be coupled to the actuator board 205 and arm 105 by a screw 403 or other coupling device. The screw 403 or other coupling device may cause the spring probe claws 601 to be in contact with the contact pads 301 of the actuator board 205. The contact pads 301 may be electrically coupled to the head stack assembly flexible circuit 112.

4. The actuator circuit assembly of claim 2, further comprising:
at least one slider spring probe claw protruding from the pre-amplifier and pressure coupled to the at least one electrical trace termination pad; and
at least one controller spring probe claw protruding from the pre-amplifier and pressure coupled to an electrical actuator controller connection tab of the head stack assembly flexible circuit.

5. The actuator circuit assembly of claim 4, wherein the at least one slider spring probe claw and the at least one controller spring probe claw curve inward.

6. The actuator circuit assembly of claim 4, wherein the at least one slider spring probe claw and the at least one controller spring probe claw extend outward.

7. The actuator circuit assembly of claim 2, further comprising:
at least one slider contact peg protruding downward from the pre-amplifier and pressure coupled to the at least one electrical trace termination pad; and
at least one controller contact peg protruding downward from the pre-amplifier and pressure coupled to an electrical actuator controller connection tab of the head stack assembly flexible circuit.

8. The actuator circuit assembly of claim 1, further comprising:
a slider slot into which the at least one electrical trace termination pad is inserted; and
a controller slot into which the head stack assembly flexible circuit is inserted.

9. The actuator circuit assembly of claim 1, further comprising:
a slider rotary cam into which the at least one electrical trace termination pad is inserted; and
a controller slot into which the head stack assembly flexible circuit is inserted.

10. A head stack assembly, comprising:
an actuator arm to place a slider above a magnetic storage medium;
a control circuit to control the slider and the actuator arm;
at least one electrical trace termination pad electrically coupled to the slider;
a head stack assembly flexible circuit electrically coupled to the control circuit; and
a pre-amplifier with an integrated connector to electrically connect the at least one electrical trace termination pad to the head stack assembly flexible circuit.

11. The head stack assembly of claim 10, wherein the pre-amplifier is coupled to an actuator circuit board mounted on an actuator arm.

12. The head stack assembly of claim 11, wherein the pre-amplifier is coupled to the actuator circuit board by a fastener.

13. The head stack assembly of claim 11, further comprising:
at least one slider spring probe claw protruding from the pre-amplifier and pressure coupled to the at least one electrical trace termination pad; and
at least one controller spring probe claw protruding from the pre-amplifier and pressure coupled to an at least one electrical actuator controller connection tab of the head stack assembly flexible circuit.
14. The head stack assembly of claim 13, wherein the at least one slider spring probe claw and the at least one controller spring probe claw curve inward.

15. The head stack assembly of claim 13, wherein the at least one slider spring probe claw and the at least one controller spring probe claw extend outward.

16. The head stack assembly of claim 11, further comprising:
   at least one slider contact peg protruding downward from the pre-amplifier and pressure coupled to the at least one electrical trace termination pad; and
   at least one controller contact peg protruding downward from the pre-amplifier and pressure coupled to at least one electrical actuator controller connection tab of the head stack assembly flexible circuit.

17. The head stack assembly of claim 10, further comprising:
   a slider slot into which the at least one electrical trace termination pad is inserted; and
   a controller slot into which the head stack assembly flexible circuit is inserted.

18. The head stack assembly of claim 10, further comprising:
   a slider rotary cam into which the at least one electrical trace termination pad is inserted; and
   a controller slot into which the head stack assembly flexible circuit is inserted.

19. A hard disk drive, comprising:
   a magnetic storage medium to store data;
   a base to support the magnetic storage medium;
   an actuator arm to place a slider above a magnetic storage medium;
   a pivot to move the actuator arm in relation to the magnetic storage medium;
   a printed circuit board to control the slider and the actuator arm;
   at least one electrical trace termination pad electrically coupled to the slider;
   a head stack assembly flexible circuit electrically coupled to the control circuit; and
   a pre-amplifier with an integrated connector to electrically connect the at least one electrical trace termination pad to the head stack assembly flexible circuit.

20. The hard disk drive of claim 19, wherein the pre-amplifier is coupled to an actuator circuit board mounted on an actuator arm.

21. The hard disk drive of claim 20, wherein the pre-amplifier is coupled to the actuator circuit board by a fastener.

22. The hard disk drive of claim 20, further comprising:
   at least one slider spring probe claw protruding from the pre-amplifier and pressure coupled to at least one electrical trace termination pad; and
   at least one controller spring probe claw protruding from the pre-amplifier and pressure coupled to at least one electrical actuator controller connection tab of the head stack assembly flexible circuit.

23. The hard disk drive of claim 22, wherein the at least one slider spring probe claw and the at least one controller spring probe claw curve inward.

24. The hard disk drive of claim 22, wherein the at least one slider spring probe claw and the at least one controller spring probe claw extend outward.

25. The hard disk drive of claim 20, further comprising:
   at least one slider contact peg protruding downward from the pre-amplifier and pressure coupled to the at least one electrical trace termination pad; and
   at least one controller contact peg protruding downward from the pre-amplifier and pressure coupled to at least one electrical actuator controller connection tab of the head stack assembly flexible circuit.

26. The hard disk drive of claim 19, further comprising:
   a slider slot into which the at least one electrical trace termination pad is inserted; and
   a controller slot into which the head stack assembly flexible circuit is inserted.

27. The hard disk drive of claim 19, further comprising:
   a slider rotary cam into which the at least one electrical trace termination pad is inserted; and
   a controller slot into which the head stack assembly flexible circuit is inserted.

28. A method, comprising:
   electrically coupling at least one electrical trace termination pad to a slider;
   electrically coupling a head stack assembly flexible circuit to a control circuit; and
   electrically coupling the at least one electrical trace termination pad to the head stack assembly flexible circuit with a pre-amplifier with an integrated connector.

29. The method of claim 28, further comprising coupling the pre-amplifier to an actuator circuit board mounted on an actuator arm.

30. The method of claim 29, further comprising coupling the pre-amplifier to the actuator circuit board by a fastener.

31. The method of claim 29, further comprising:
   pressure coupling the pre-amplifier to the at least one electrical trace termination pad using at least one slider spring probe claw protruding from the pre-amplifier; and
   pressure coupling the pre-amplifier to at least one electrical actuator controller connection tab of the head stack assembly flexible circuit using at least one controller spring probe claw protruding from the pre-amplifier.

32. The method of claim 31, wherein the at least one slider spring probe claw and the at least one controller spring probe claw curve inward.

33. The method of claim 31, wherein the at least one slider spring probe claw and the at least one controller spring probe claw extend outward.

34. The method of claim 29, further comprising:
   pressure coupling the pre-amplifier to the at least one electrical trace termination pad using at least one slider contact peg protruding downward from the pre-amplifier; and
   pressure coupling the pre-amplifier to at least one electrical actuator controller connection tab of the head stack assembly flexible circuit using at least one controller contact peg protruding downward from the pre-amplifier.

35. The method of claim 28, further comprising:
   inserting the at least one electrical trace termination pad into a slider slot; and
   inserting the head stack assembly flexible circuit into a controller slot.

36. The method of claim 28, further comprising:
   inserting the at least one electrical trace termination pad into a slider rotary cam; and
   inserting the head stack assembly flexible circuit into a controller slot.