Aim instruments

# I-prober 520 positional current probe


Unique technology enabling current measurement in PCB tracks

bandwidth of DC to 5MHz, dynamic range of 10mA to 20A pk-pk

useable with any normal oscilloscope, safety rated to 300V Cat II

investigates waveforms in any conductor including ground planes

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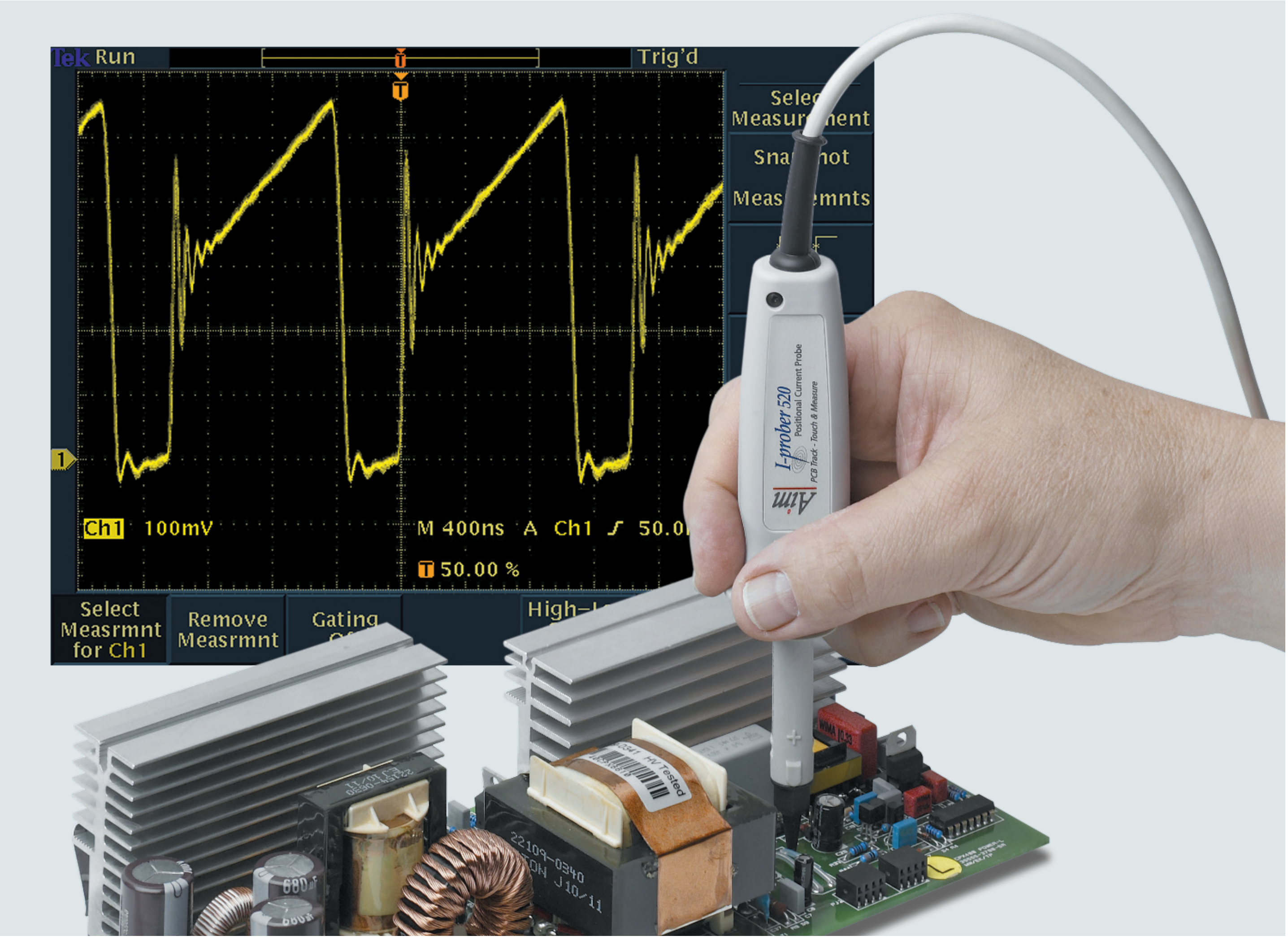
# Aim I-prober 520 - a breakthrough in current measurement technology !




Aim instruments
*Applied Innovative Metrology*

*I-prober 520*
Positional Current Probe
*PCB Track - Touch & Measure*

## *A technology breakthrough*

The I-prober 520 achieves something radically new.

It can observe and measure currents in PCB tracks and other conductors where conventional current probes can't be used. This includes captive wires into components, the legs of integrated circuits, and PCB ground planes.

Conventionally, current can only be measured by either breaking the circuit to insert a shunt resistor, or by surrounding the conductor by a loop of magnetic material as in a standard current probe.

The I-prober 520 enables currents, from dc up to 5MHz, to be observed and measured simply by placing its insulated tip onto the conductor.

### Key Features

- Current measurement from insulated probing of conductor
- Suitable for observation and measurement of current in PCB tracks, component leads and ground planes
- Wide dynamic range of 10mA to 20A peak to peak
- Wide bandwidth of DC to 5MHz
- Low noise figure equivalent to <6mA rms at full bandwidth
- Safety rated to 300V Cat II (600V Cat I)
- Suitable for connection to any oscilloscope
- High accuracy general purpose H-field probe
- Converts to standard 'closed magnetic circuit' current probe

### Unique Capabilities

- No requirement to break or surround the conductor
- Observe and measure currents in PCB tracks directly
- Minimal disturbance to circuit conditions through very low insertion impedance and stray capacitance
- Useable in confined and difficult to access spaces
- Measures current into surface mount components, IC legs and short component leads
- Can observe currents flowing within ground planes
- Useable on high voltage conductors and in high temperature areas

# Observe & measure currents in PCB tracks, captive component leads & ground planes

## *Current measurement techniques*

True measurement of current requires the circuit to be broken and a current measurement device inserted (e.g. a shunt that converts current to voltage). However, breaking the circuit is impractical in many circumstances and, in the case of PCB tracks, may be impossible.

### Closed magnetic circuit current measurement

DC capable current probes do not measure current, they measure field density. Current flowing through a conductor creates an H field which is directly proportional to the current.

If a conductor is surrounded by a closed magnetic circuit of high Mu material the whole of the field is 'captured' by the magnetic circuit and the field density can be scaled to represent current.

Conventional current probes achieve this by concentrating the field into a gap within a loop of high Mu material. The field is then measured by a field sensor inserted into the gap, often a Hall effect device.

Alternatively ac current can be measured by transformer action whereby the loop of magnetic material creates a one turn primary from the conductor that is enclosed. Hybrid devices use a field sensor for dc and low frequencies plus a transformer for higher frequencies.

Normally the probe provides a method of mechanically splitting the magnetic circuit to enable the conductor to be inserted. The position of the conductor within the loop has relatively little effect upon the measurement.

### PCB track current measurement

Measuring current in a PCB track presents particular difficulties because it normally not possible either to break the track or to enclose it within a magnetic circuit. Typically engineers have to guess at the current flowing in a track from voltage measurements made in other parts of the circuit.

As electronic design moves towards ever higher densities, development omits the "bread board" stage and goes straight to PCB design. The inability to observe and measure currents in a circuit under development can pose a serious problem for engineers.

## *The technology behind the I-prober 520*

### The principle of a positional current probe

To make a quantitative measurement of current from the field that it generates requires that a known proportion of that field is measured.

Conventional current probes achieve this by concentrating the whole of the field within a loop of high Mu material, and measuring it using transformer action or a field sensor within a gap.

By contrast, the positional current probe must measure a known proportion of the field by positioning the sensor at a known distance from the conductor. If this distance and the sensor size can both be made very small, then a large and predictable proportion of the field can be captured.

### The Fluxgate Magnetometer - updating an established principle

The I-prober 520 uses the well established principle of a fluxgate magnetometer to measure field.

Conventional fluxgate magnetometers are relatively large with bandwidths limited to a few kHz. They are typically used for precision measurement of fields within geophysics and bio-electromagnetics.

By contrast, the sensor within the I-prober 520 uses a patented miniature fluxgate magnetometer of sub-millimetre size incorporating a highly advanced core material.

This enables it to use an excitation frequency of several tens of MHz resulting in a sensor with a bandwidth of dc to 5MHz combined with low noise and wide dynamic range.

## *Making PCB current measurement a reality*

The concept of a positional current probe is not entirely new. However, previous attempts have been physically large and suitable only for measuring high currents at low bandwidth.

The high excitation frequency miniature sensor within the I-prober 520 provides it with levels of positional accuracy, sensitivity, bandwidth and dynamic range that are superior to anything previously achieved by several orders of magnitude.

***In consequence, the Aim I-prober 520 is the first and only probe that can be used to measure currents from amps down to milliamps at frequencies from DC up to MHz, making practical measurement of PCB track currents a reality.***

## *Minimal circuit disturbance*

With many high frequency switching circuits and high bandwidth signal paths, inserting even a short loop of wire into the track path can change the inductance sufficiently to alter the circuit performance.

Unlike a conventional current probe, the I-prober 520 has an extremely low insertion impedance and negligible stray capacitance.

This enables current observations and measurements to be made without disturbance to the circuit.

## *The I-prober 520 in use*

The magnitude of the signal from a positional current probe is critically related to its position relative to the conductor. The size of the conductor (e.g. the width of a PCB track) also has a significant effect.

This means that the sensitivity of the I-prober has to be adjusted to match the track width when quantitative measurements are required. A calibrator within the control box enables sensitivity adjustment in conjunction with a calibration graph.

The measurement result will also include other field effects present at the tip of the probe and not just that coming from the current through the conductor. This may include DC effects from adjacent magnetised components and from the earths magnetic field, plus AC effects from transformers and other field radiating sources.

Current in adjacent tracks, or tracks on the opposite side of the PCB will also affect the measurement.

There are solutions to these potential problems. The unwanted DC can be nulled out by observing the measurement without power to the circuit, whilst AC interference can be attenuated using bandwidth filters. The I-prober control box includes a wide range DC offset control and switchable filters.

Nevertheless, the use of the I-prober 520 requires interpretation based upon a proper understanding of circuits and systems. It is a tool for the professional engineer.

## Closed-loop current measurement

Whereas the primary purpose of the I-prober 520 is as a positional current probe, the are many circumstances where current measurements can be made in the conventional way by enclosing the conductor.


To increase its overall usefulness, the I-prober 520 is supplied with a clip-on toroid assembly which converts it into a closed magnetic circuit probe for measuring current in a wire.

The toroid is open until the probe is attached, allowing insertion of the wire without disconnection.

The wide bandwidth, dynamic range and low noise of the probe are retained but higher accuracy, repeatability and unwanted field rejection are achieved.


## Measurement of electromagnetic field

The very small size of the field sensor within the I-prober 520 gives it some unique capabilities when used to measure magnetic fields.

The variation of field with position can be accurately determined enabling the precise source of fields to be located and their variation in space measured.

A switch on the control box re-scales the output voltage to measure in Teslas or in amps per metre.

### Example Applications

- Inductor optimisation in switching circuits
- Efficiency evaluation ???
- Investigation of non-optimum ground planes
- Observation of current flow into reactive components
- Investigation of short circuit current flow paths
- Detection of interfering magnetic fields
- Elimination of ground loop currents

### GENERAL SPECIFICATIONS (All Modes)

**Output Signal**

| | |
|---|---|
| Maximum Output: | ± 10V . |
| Oscilloscope Input: | Suitable for an input impedance of 1MΩ in parallel with < 30pF. |
| Trace Position: | Wide range DC offset control within control box. |

**Safety**

| | |
|---|---|
| Max. Circuit Voltage | 300V Cat II (on AC line circuits).<br>600V (on uncategorised secondary circuits inside equipment). |
| Max. Tip Temperature | 150ºC maximum allowable temperature at probe tip. |
| Conformance | Complies with EN61010-1 & EN61010-031 |

**Bandwidth Control**

| Switch Position | Full | 500kHz | 2Hz |
|---|---|---|---|
| Nominal Bandwidth: | DC to 5MHz | DC to 500kHz | DC to 2Hz |
| Risetime: | <70ns | 700ns | 175ms |
| Aberrations: | <±5% | <±1% | <±1%. |
| Noise (Typical)*: | 6mA rms | 3mA rms | 1.5mA rms |

* This is the noise level for current measurement using the Toroid attachment. For PCB track measurement the equivalent noise will depend upon the track width and gain setting but will be similar to the Toroid measurement figure for a track width of 0.5mm.

**HF Performance (bandwidth switch at Full)**

| | |
|---|---|
| Propagation Delay | 60ns typical (to 10%). |
| Bandwidth: | DC to 5MHz (small signal) |
| Slew Rate: | 15A/µs (equivalent). |

**Overload Indication**

| | |
|---|---|
| Indicator Threshold: | Indicator LED within control box will light if output voltage exceeds ± 10V or if large magnetic fields cause the system to saturate. |

**Power Source**

| | |
|---|---|
| Power Supply: | 5.2V at up to 5 watts from AC line adaptor (supplied). |

**Mechanical**

| | |
|---|---|
| Probe Dimensions | 155mm x 38mm x 28mm max; 2.8mm x 1.8mm at tip |
| Cable Length | 2m from probe tip to output BNC |

**EMC**

| | |
|---|---|
| Conformance | Complies with EN61326 |

### MAGNETIC FIELD MEASUREMENT (Mode = Field)

| | |
|---|---|
| Scaling Factor: | 250µT (or 200A/m) per Volt. |
| Accuracy and Linearity: | ±3% |
| Maximum Field: | ±2·5mT (2000A/m). |

### CURRENT MEASUREMENT USING TOROID (Mode = Wire)

| | |
|---|---|
| Scaling Factor: | 1 Amp per Volt. |
| Accuracy and Linearity: | ±5% |
| Current Range: | ±10mA to ±10A (DC + peak) |
| Max. Wire Diameter: | 3.5mm (unbroken) or 6mm (end fed) |

### CURRENT MEASUREMENT IN PCB TRACKS (Mode = PCB Track)

| | |
|---|---|
| Scaling Factor: | Adjustable to 1 Amp per Volt for track widths 0·2mm to 3.5mm (0·007" to 0·14") and 2 Amp per volt for track widths 3mm to 6.5mm (0·125" to 0·25") using Calibrator and compensation graph. |
| Sensor Spacing: | 0.7mm distance from sensor to PCB track set by probe design. |
| Calibrator: | Built-in calibrator within the control box providing an AC or DC calibration current through a 0.5mm track. |

*Accuracy specifications apply for the temperature range 18ºC to 28ºC after one hour warm-up. Thurlby Thandar Instruments Ltd. operates a policy of continuous development and reserves the right to alter specifications without prior notice.*

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