# **P5200A - High Voltage Differential Probe 50 MHz**

**Specifications:**

| **CAT II** | **Single-Phase AC Loads** | **Appliances or portable tools** |
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| Measurement Category  **CAT ||** | Working Voltage  **1000V** | Transient Voltage  **6000V** | Test Source-Impedance  **12 Ohms** | Working Current  **83.3A** | Transient Current  **500A** |
| --- | --- | --- | --- | --- | --- |

* Attenuation: 50X / 500X
* Bandwidth: 50 MHz
* Differential Input Impedance: 10 MΩ || 2 pF
* Input Impedance between each Input and Ground: 5 MΩ || 4 pF
* Common Mode Voltage: ±1300 V
* Safety Voltage Rating: 1000V
* CAT Voltage Rating: ||
* Maximum Rated Input Voltage (each side rated to ground): 1000 V CAT II
* Maximum Differential Input Voltage
  + 500X: ± 1300 V
  + 50X: ± 130 V
* Up to 6000 V Differential (DC + pk AC)
* Up to 2300 V Common (RMS)
* Typical CMRR:
  + - DC: >80 dB
    - 100 kHz: >60 dB
    - 3.2 MHz: >30 dB
    - 50 MHz: >26 dB
* Overrange Indicator
* Safety Certified
* Switchable Attenuation
* Switchable Bandwidth Limit
* **Price: $ 1339.50**

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##### **Applications**

* Floating Measurements
* Switching Power Supply Design
* Motor Drive Design
* Electronic Ballast Design
* CRT Display Design
* Power Converter Design and Service
* Power Device Evaluation

**Design Approch:**

**Steps:**

1. **First Evaluation**
2. Requirement Building
3. Paper Design by 27/Jan 2023
4. **Second Evaluation**
5. Simulation
6. Prototype
7. PCB design by 17/Feb 2023
8. **Third Evaluation**
9. Assembling
10. Testing and Calibration 17/March 2023
11. **Final Evaluation**
12. Bugs and Fixing
13. Model Ready 10/April 2023

**Concept:**

**What we what in our design(our requirements)**

Basic gain accuracy of better than 1%.

• Input impedance above 1 MΩ with parallel capacitance under 5 pF.

• Input voltage range suitable for measuring 230 V +15% mains,It should be safe to connect to considerably higher voltages

• A bandwidth of at least 25 MHz

• DC and 50/60 Hz common-mode rejection ratio (CMRR) of 60 dB or better (1/1,000)

Differential Probe contains A matched pair of input attenuators followed by a classic three op-amp differential instrumentation amplifier.

* an attenuator
* a buffer stage
* a difference amplifier stage.

The gain of Circuit is given by multiplying the gain of each of these stages.

* First, Choose the **Input Attenuation** ratio so that the maximum operating voltage will be attenuated and within the input common-mode range.
* In the **buffer stage** we have an instrumentation amplifier that can be programmed with a single resistor (Rd)
  + If Rd is open, circuit gain=1 i/p signal of a multi-hundred volt.
  + If Rd is close gain=10, can measure differential signals of 10Volt
* **Difference Amplifier** convert the differential signal into a single-ended ground referenced one. Gain=2 so that overall differential gain instrument amp.. =1/100 or 1/10

**Design of Input attenuator:**

For this stage, we need a pair of input attenuators capable of safely withstanding mains voltages, with a high input impedance, each with a gain of 1/200 matched to better than 0.1% and with a bandwidth of at least 50 MHz.

**Design of Instrumentation Amplifier:**

We need three Om Amp instrumentation amplifiers. These have very high input impedance, common mode gain of 1 independent of resistor matching, and differential mode gain programmable via just one resistor.

**Power Supply**

**Construction:**

For this, we need PCB, input sockets, BNC output connector, power switch, and LED indicators

**Assembling**

**Testing and calibration**

A high voltage differential probe is a type of electrical test instrument that is used to measure high voltage differences between two points in an electrical circuit. It is typically used in conjunction with an oscilloscope to allow for the visualization of voltage waveforms and other electrical signals. The probe consists of a pair of high voltage probes that are connected to a differential amplifier, which amplifies the voltage difference between the two probes and sends the amplified signal to the oscilloscope for display. High voltage differential probes are useful for measuring voltage signals in high voltage electrical systems, such as power transmission and distribution systems. They are also useful for testing and debugging high voltage electrical devices and circuits.

A high voltage differential probe typically consists of a pair of high voltage probes, a differential amplifier, and a cable that connects the probe to an oscilloscope. The high voltage probes are made of conductive material, such as copper or brass, and are insulated to protect the user from the high voltage being measured. The probes are connected to the differential amplifier, which amplifies the voltage difference between the two probes and sends the amplified signal to the oscilloscope for display.

The differential amplifier is designed to reject common-mode signals, which are signals that are present on both probes and cancel each other out when the voltage difference is measured. This allows the probe to accurately measure the voltage difference between the two points in the circuit being tested, even in the presence of high levels of common-mode noise.

The probe also typically has safety features built in, such as overvoltage protection, to protect the user and the instrument from damage in the event of an accidental electrical overload.

**Possible ways of Current/Voltage Sensing/ current Transformer**

There are several ways to sense current or voltage in an electrical circuit, including:

1. Current transformer (CT): A current transformer is a type of transformer that is used to measure the current flowing in an electrical circuit. It consists of a primary winding, a secondary winding, and a core, which is typically made of iron or other magnetic material. The primary winding is connected in series with the circuit being measured, and the secondary winding is used to measure the current flowing through the primary winding. The current in the secondary winding is proportional to the current in the primary winding, but is typically much lower, making it easier to measure.
2. Rogowski coil: A Rogowski coil is a type of current sensor that consists of a single, continuous, helical winding of wire. It is typically used to measure alternating current (AC) and is often used in conjunction with a differential amplifier to amplify the signal.
3. Hall effect sensor: A Hall effect sensor is a type of transducer that uses the Hall effect to measure the magnetic field strength of a current-carrying conductor. It consists of a semiconductor device that produces a voltage proportional to the magnetic field strength.
4. Shunt resistor: A shunt resistor is a type of current sensor that consists of a resistor connected in parallel with the circuit being measured. The voltage drop across the resistor is proportional to the current flowing through the circuit, and can be measured using a voltmeter or other electrical measurement device.
5. Voltage transformer (VT): A voltage transformer, also known as a potential transformer, is a type of transformer that is used to measure the voltage in an electrical circuit. It consists of a primary winding, a secondary winding, and a core, which is typically made of iron or other magnetic material. The primary winding is connected in parallel with the circuit being measured, and the secondary winding is used to measure the voltage across the primary winding. The voltage in the secondary winding is proportional to the voltage in the primary winding, but is typically much lower, making it easier to measure.

**Survey of Current/Voltage Measurement Techniques**

There are several techniques for measuring current and voltage in electrical circuits, including:

1. **Direct measurement:** This method involves placing a sensor directly in the circuit being measured to directly sense the current or voltage. Examples of sensors used for direct measurement include current transformers, Rogowski coils, Hall effect sensors, and shunt resistors.
2. **Indirect measurement:** This method involves measuring an electrical quantity that is related to the current or voltage being measured, such as power or resistance. The current or voltage can then be calculated using the measured quantity and Ohm's law or other electrical laws. Examples of quantities that can be measured indirectly include power (using a wattmeter), resistance (using an ohmmeter), and impedance (using an LCR meter).
3. **Oscilloscope measurement:** An oscilloscope is a type of electronic test instrument that is used to visualize electrical signals. It can be used to measure the voltage and/or current of a circuit by displaying the waveform of the signal on a screen.
4. **Multimeter measurement:** A multimeter is a type of electronic test instrument that can be used to measure a variety of electrical quantities, including voltage, current, resistance, and continuity. Multimeters are often used to measure DC and AC voltage and current, and can also be used to measure resistance, continuity, and other quantities.
5. **Data acquisition system measurement:** A data acquisition system is a type of electronic system that is used to measure and record electrical signals. It typically consists of sensors, amplifiers, and a computer or other data storage device. Data acquisition systems are often used to measure and record electrical signals over a long period of time, or to measure signals that are too fast or too slow to be measured using other methods.

**Isolated Probe**

An isolated probe is an electrical test instrument that is used to measure voltage or other electrical quantities in a circuit while electrically isolating the measurement circuitry from the circuit being measured. This is useful in situations where the circuit being measured is at a different voltage potential than the measurement circuitry, or where there is a risk of electrical shock or damage to the measurement equipment.

Isolated probes typically use transformer isolation or optocoupler isolation to electrically isolate the measurement circuitry from the circuit being measured. Transformer isolation uses a transformer to transfer the measurement signal between the measurement circuitry and the circuit being measured, while optocoupler isolation uses an optocoupler, which is a type of electronic component that uses a light-emitting diode (LED) and a photodetector to transfer the measurement signal.

Isolated probes are commonly used in high voltage and/or high current measurement applications, as well as in hazardous or explosive environments where electrical isolation is necessary for safety.

**Why isolation is necessary in electrical instruments**

There are several reasons why electrical isolation is necessary in some electrical instruments:

1. Safety: Electrical isolation is often used to protect the user and the instrument from electrical shock or other electrical hazards. This is particularly important in situations where the circuit being measured is at a different voltage potential than the measurement circuitry, or where there is a risk of electrical shock or damage to the measurement equipment.
2. Accuracy: Electrical isolation can also help to improve the accuracy of measurements by eliminating the effects of ground loops and other common-mode voltage errors that can distort the measurement signal.
3. EMI/RFI: Electrical isolation can also help to reduce the effects of electromagnetic interference (EMI) and radio frequency interference (RFI) on the measurement signal, which can improve the stability and accuracy of the measurement.
4. Protection of measurement equipment: Electrical isolation can also help to protect the measurement equipment from damage due to overvoltage or other electrical transients in the circuit being measured.
5. Compatibility with hazardous or explosive environments: Electrical isolation is also necessary in some hazardous or explosive environments, where electrical isolation is necessary to prevent ignition or other safety risks.

**A probe's attenuation factor (i.e. 1X, 10X, 100X) is the amount by which the probe reduces the amplitude of the oscilloscope's input signal. A 1X probe doesn't reduce or attenuate the input signal while a 10X probe reduces the input signal to 1/10th of the signal's amplitude at the scope input.**