Tera Ohm Meter

Background

A client had been manufacturing various versions of this instrument for over 20 years. The design in production had been designed several years before, but still incorporated manual wiring, with critical components soldered directly to switches to minimize parasitic electrical leakage. The client produced two similar instruments, but the electronics for each was unique.

System Overview

Bolton Engineering took the basic instrument concept, re-engineered it using modern components, and implemented it on a single standard FR-4 circuit board. The new design incorporated a microcontroller that generated the programmable power supply reference voltage, and set the input transimpedance amplifier gain using high-isolation reed relays. The design eliminated a high-cost precision analog multiplier required to normalize the meter output to the applied programmable voltage by performing the multiplication in the time domain using a microcomputer generating PWM signal and an inexpensive analog switch.

A variety of circuit board guard techniques were used to isolate the pA-sensitive input amplifier from the on-board 1100V power supply. The guards surrounding the high-voltage power supply were implemented as inter-digitated plated slots to prevent leakage current through the bulk circuit board material. Other guard rings were placed surrounding the input transimpedance amplifier and range switches on both sides of the board.

The new design allowed the two instruments to be manufactured using a single board design, by adding a strap to select different microcontroller programs and by selectively populating two of the three applied voltage range switches:

- A lower cost instrument with five preset applied voltages.
- A premium instrument with a programmable applied voltage in 10V steps.

Results

- Reduced instrument cost by two-thirds.
- Implemented 7 full scale ranges ranging from 20 MegOhms ($2x10^7$ Ohms) to 200 TeraOhms ($2x10^{14}$ Ohms)
- Implemented programmable power supply, from 10V to 1100V, in 10V steps.
- Reduced part count by half.
- Simplified system wiring.
- Microcontroller and firmware eliminated many precision, single-sourced components.
- Implemented design so that two different instruments were produced off a single board design.

Project Scope

Bolton Engineering was responsible for designing the schematics, prototyping and testing the circuitry, writing microcontroller firmware, designing the circuit board, and writing documentation.

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