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Tektronix 485 repair

Fig. 1 Tektronix 485. 2 channel, 350MHz oscilloscope.

Some time ago my colleague gave me a faulty TEK 485 oscilloscope.

<u>Symptoms:</u>
Bright, blue mains fuse explosion after pressing the POWER button.

Repair:

I started from downloading the manual from :
" http://bama.edebris.com/manuals/tek/ ".

The brightness and loudness of the fuse explosion suggested that the failure was somewhere in the mains powered part of the power supply circuit (when the fuse blows off after few seconds or minutes, failure in the low voltage circuitry is more probable).

I started with removing the L1825 choke to isolate the inverter circuit and avoid further damages while checking (Fig.3).
I connected the oscilloscope to the 230V mains supply.
The fuse has been blown off that time also. Then I removed the RT1821 and RT1822 thermistors to determine if the failure was in the mains-bridge part or in the filter part. When I powered up the instrument, nothing bad happened, so I started tracking the filter part. I found that the electrolytic capacitor C1823 had no internal short indeed but it started conducting the current when more than 40V had been applied to it's terminals. I replaced both C1822 and C1823 capacitors with new 470uF/250V snap-in capacitors.

Fig. 2 One of these capacitors is faulty

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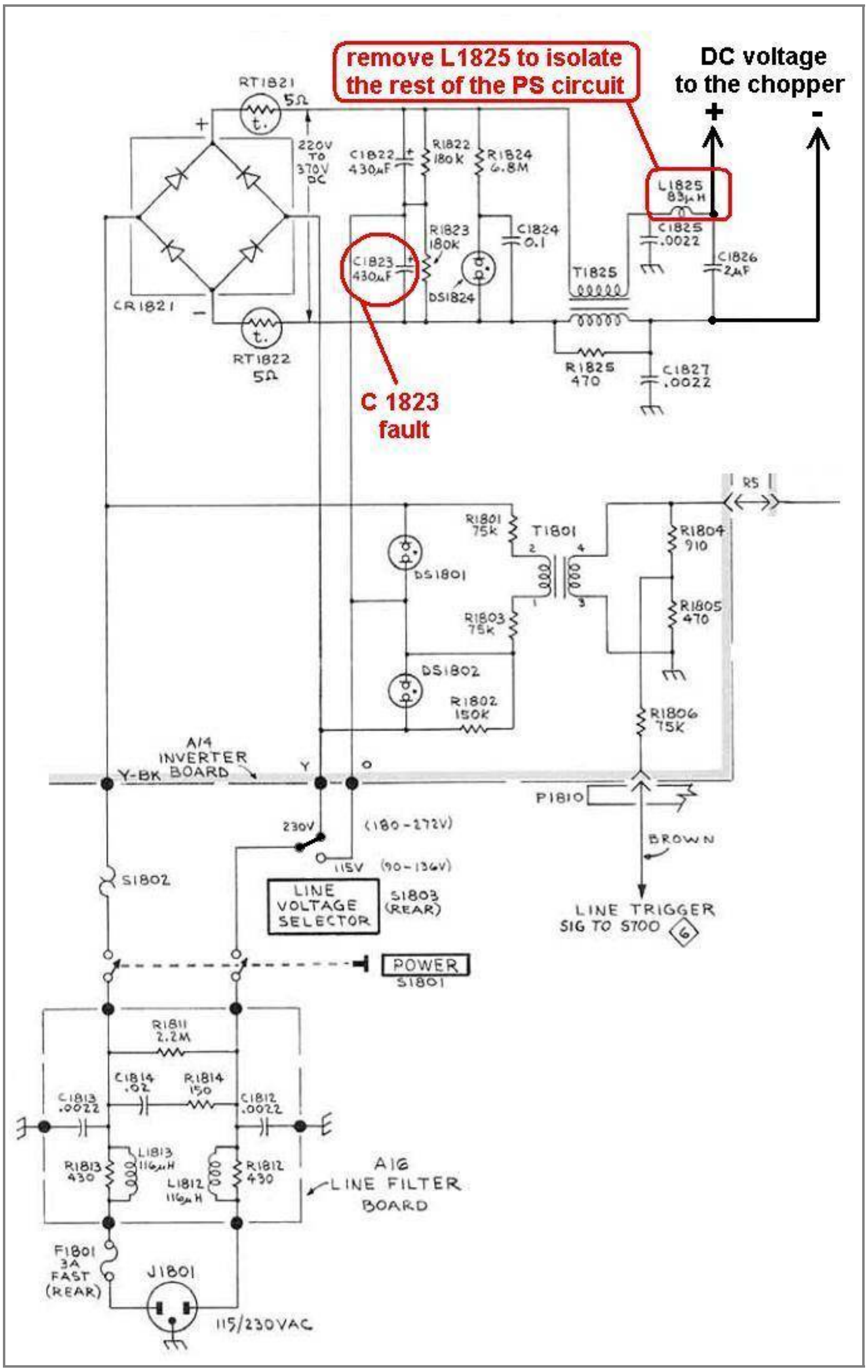

Fig. 3 Mains power supply (partial)

I went further with my investigation. The inverter circuit needed to be checked (Fig.4)

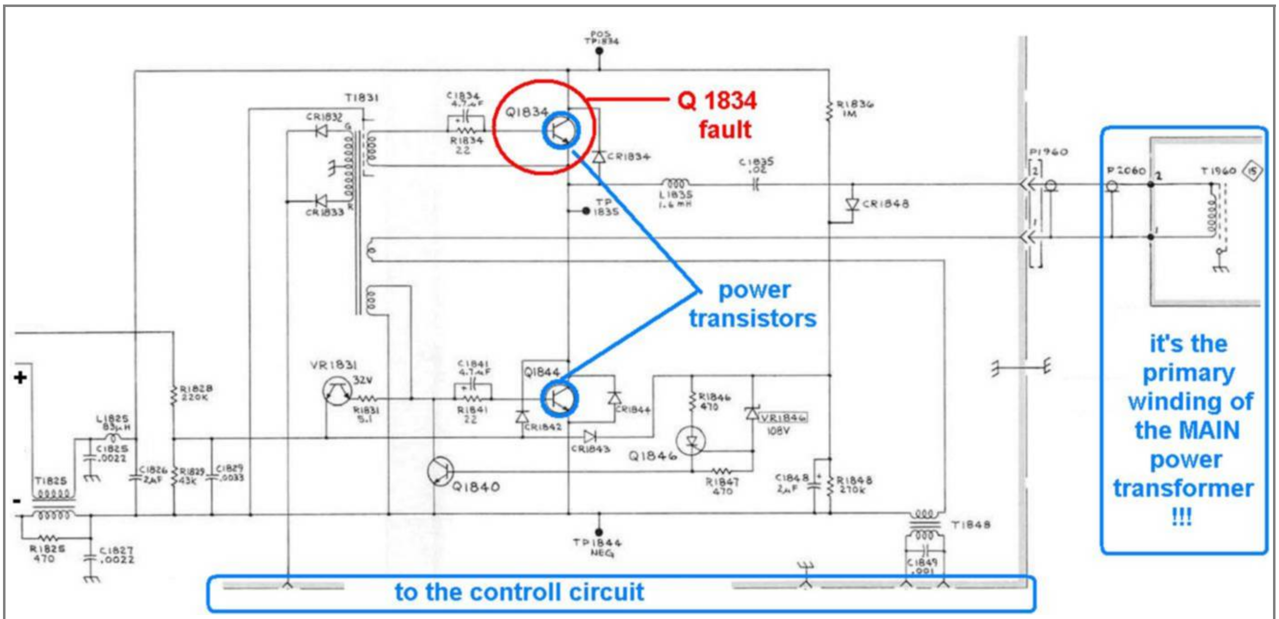

Fig. 4 The inverter circuitry

I started with checking the power transistors to make sure if everything is working correctly.
I tested them using the “diode check” multimeter's function and they seemed to be OK, but I decided to measure the hFE additionally.

Q1834 and Q1844 are power transistors in TO-3 metal housing. The TEK marking of these transistors is “151-0368-00” and it's the MJ13015 type indeed. To my surprise the Q1834 has hFE of about 2 and Q1844 has hFE of 10 (it should have 12...40 according the catalog data).

After some considerations I decided to use the BUX48A transistor, having similar parameters.
The fact that Q1834 and Q1844 transistors had NO damaged junctions, suggested that there are no serious damages in the surrounding circuitry.

Free Notes On Electronics

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I connected the 230V 200W light bulb in series with oscilloscope's mains power supply. I turned the power on and the scope ran properly. I left the scope running for few hours to check the power supply part. Success :)

The next issue:

The brushless motor fan placed on the scope's back had not started after powering on.
After some investigation it became obvious that the friction on the bearings have increased after 35 years of intensive usage. An important note should be placed here: the TEK 485, TEK 465, TEK 475 and similar, compact oscilloscopes need the cooling fan very much. It's reported that vertical stage output IC's can suffer overheat damage when the airflow is not provided.

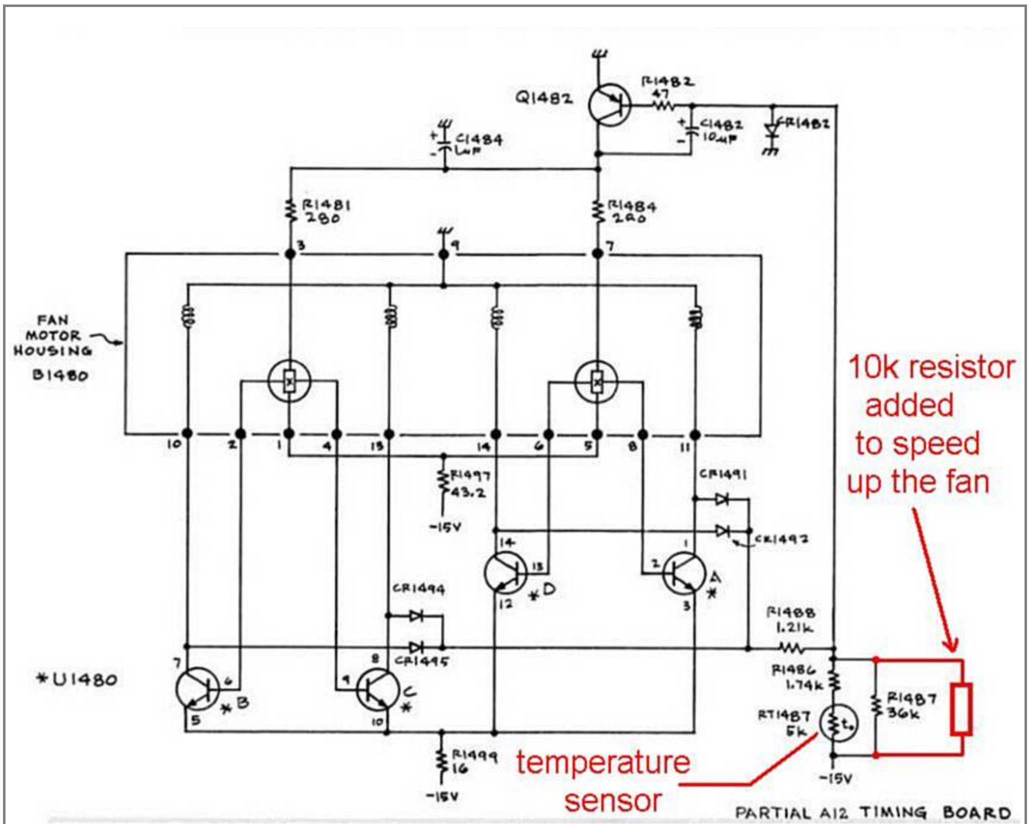

Fig. 5 Fan circuitry

Unfortunately, the SIEMENS- manufactured brushless fan is located in a VERY difficult to reach place. Tektronix engineers used a thermistor to increase the fan efficiency when there is hot inside (Fig.5). I thought it would be good idea to fool the circuit to see the increased temperature. I used an external potentiometer to find the optimal resistor value (R=10kΩ). Now the fan is working in a very reliable way.

One more repair had to be made.
The three lamps ('x1', 'x10', 'x100') showing actual V/div position were blanked. Let's look at Fig.6.

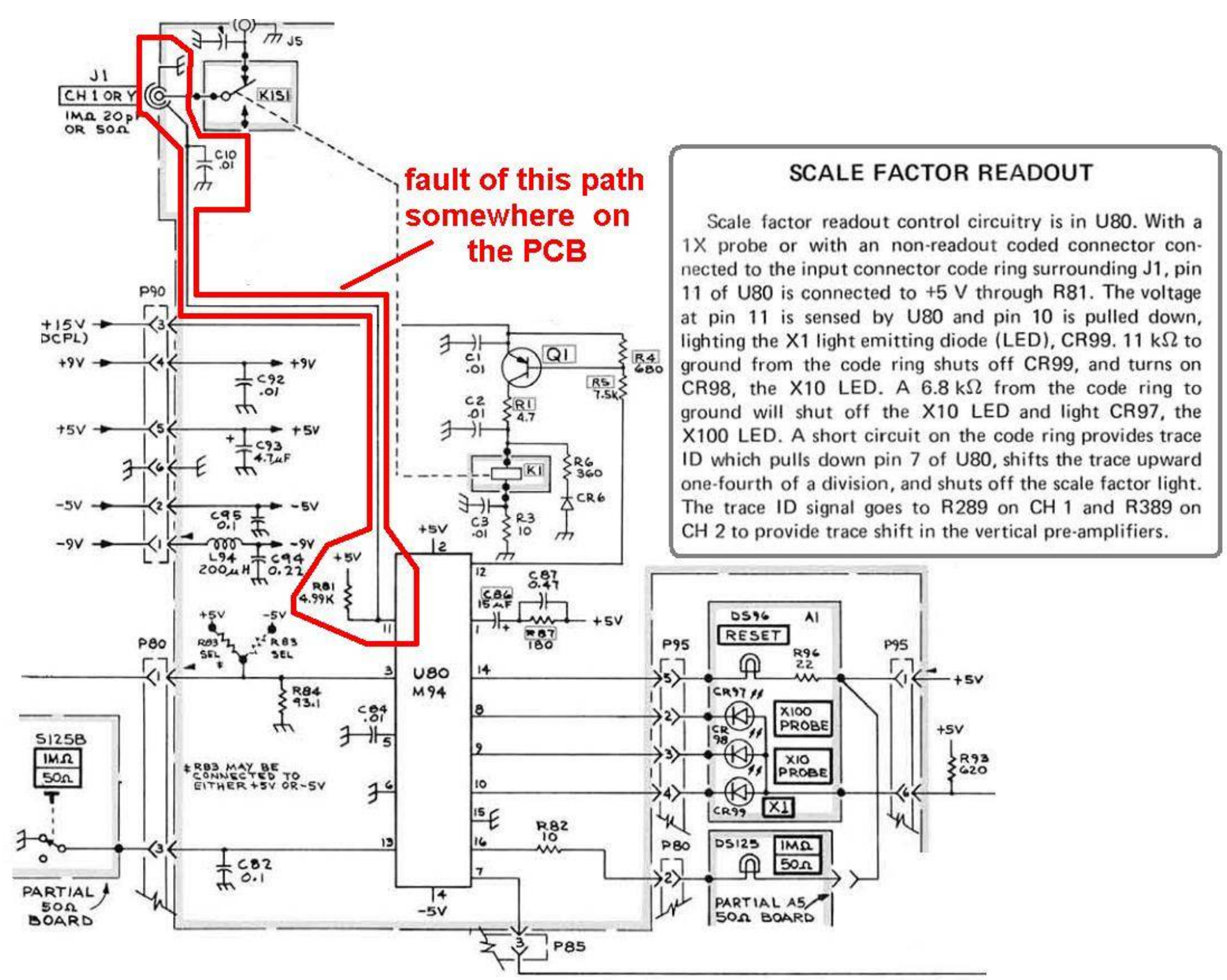

Fig. 6 Probe readout circuitry

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10:1 and 100:1 probes are connecting the ring to the GND through specified value resistor Rp built into the connector. The voltage on the sensing ring is equal to:

$$U_{sensing\_ring} = 5V*(Rp/Rp+5k\Omega)$$

The U80 custom IC is a threshold discriminator. The displayed V/div LED mark depends of the voltage on the BNC connector's sensing ring. I checked the voltage on the sensing ring and it was about 180mV. My first thought was that U80 is faulty, so I put the IC from the socket. I measured the ring's potential once again and obtained 180mV. I removed C10 from PCB, unsoldered connections to the BNC socket sensing ring. I measured the R81 value, the result was : 4,99kΩ. I checked everything I could and concluded, that there must be some leakage somewhere on the PCB.
I must admit that I had no idea what to do. I decided to use the 'brutal force' technique. Without the U80 in the socket I applied +4V from the bench power supply to the sensing ring. To my surprise the probe readout function started to work properly!

The scope was working, but I had to do some performance tests. I checked all the knobs and regulators. I checked the performance using low frequency oscillator and scope's internal calibrator.
Last step was to check the pulse response of the vertical deflection system. I used the TEK 284 pulse generator having about 60ps of slope rise time and 200mV of pulse amplitude.

Now some screen shots of test waveforms:

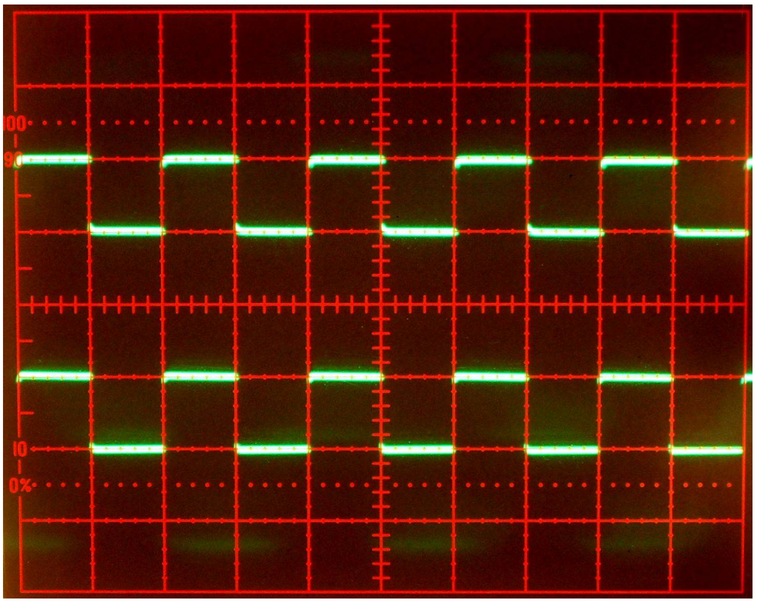

Fig. 7 Low freq. test:1kHz, 5Vpp square wave applied ;
TEK485 : vertical: 5V/div , horizontal: 0,5ms/div

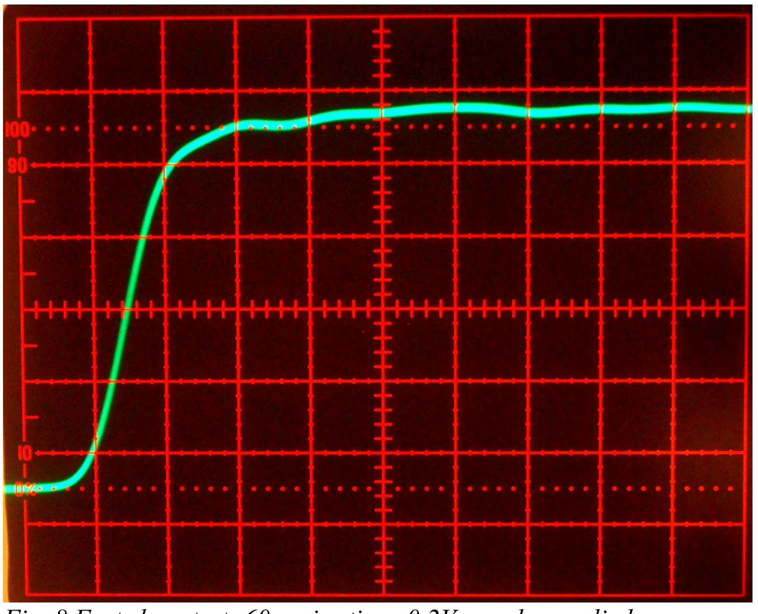

Fig. 8 Fast slope test: 60ps rise time, 0,2Vpp pulse applied ;
TEK485: vertical: <0,2V/div , horizontal:1ns/div

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Fig. 9 Tektronix 485 working

ANY. COMMENTS. AND. SUGGESTIONS. ARE. WELCOMED.