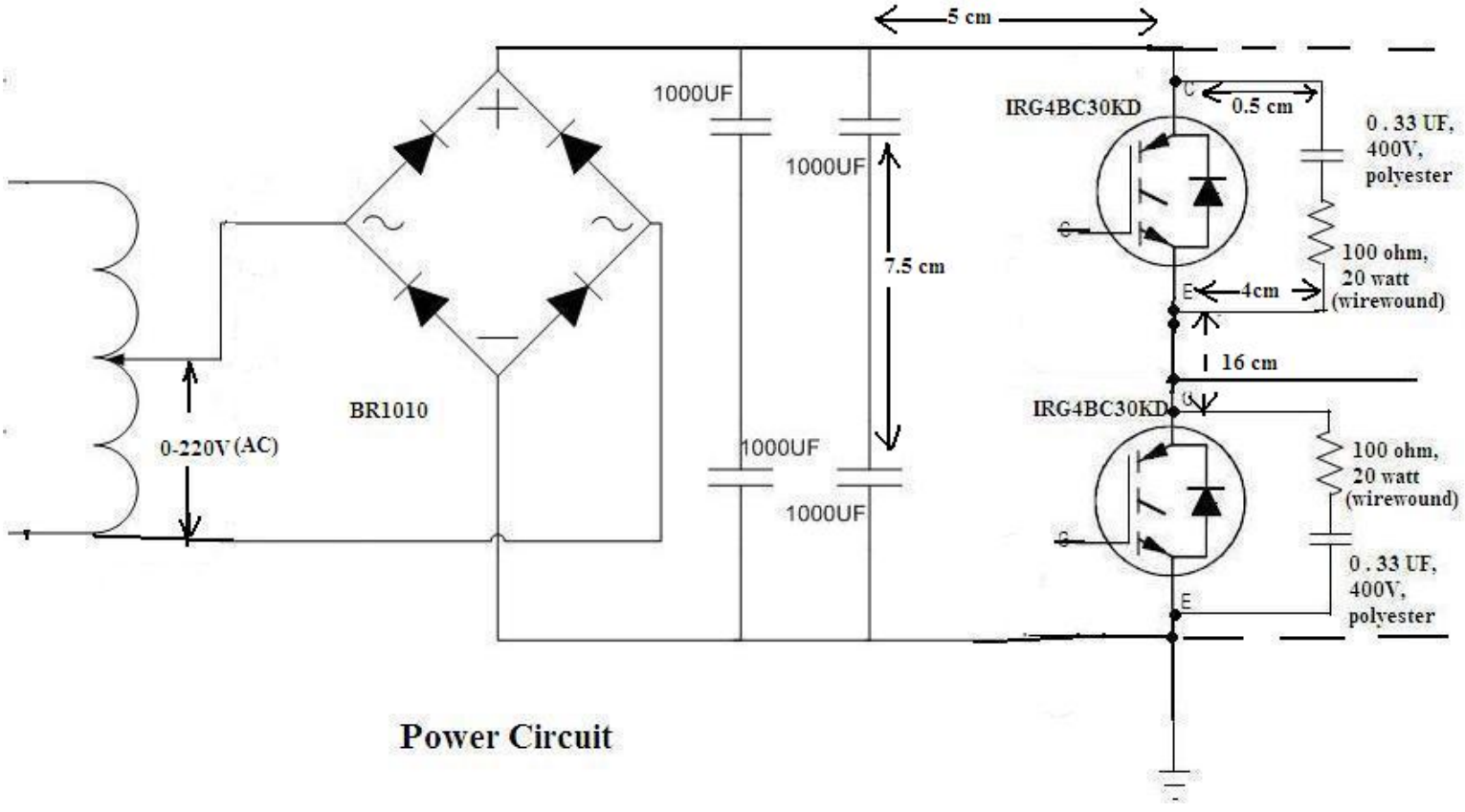
Burning (turned to a wire) IGBTs in a three phase inverter bridge

Problem: First the SPWM(sinusoidal PWM) signal is activated in microcontroller. PWM switching frequency is 2 KHz. It is then fed to the gate of the IGBTs**(IRG4BC30KD IGBT,which has a 600v Vce, I=28A and internal diode)** of the inverter bridge circuit using the IR2110 as gate driver . Then the DC rectified voltage is increased and fed to the three phase inverter. The voltage across each phase is checked with multimeter (BK PRECISION-Model no: Test Bench 391A).A balance 3-phase voltage is shown but the multimeter is making a buzzer sound similar to continuity test, though the function switch of the multimeter is not set at continuity measurement. After the line voltage across each phase has reached 90 volt, suddenly two branch of the inverter bridge burns (the high and low IGBTs, become a short: collector to emitter R = 0). This cant be caused by over current, because no load is connected across the inverter, and the IGBT are rated for 28A @ 25ºC.

Query:a) Distance between the upper and lower IGBT in a branch of inverter is 16 cm. Details is shown in figure. Will that cause problem?

b) An RC series circuit is added as snubber for each IGBT.The capacitance is 0.33 UF (polyester type) and the resistance is 100 ohm (wire wound type).Detail is in figure. Is that correct?

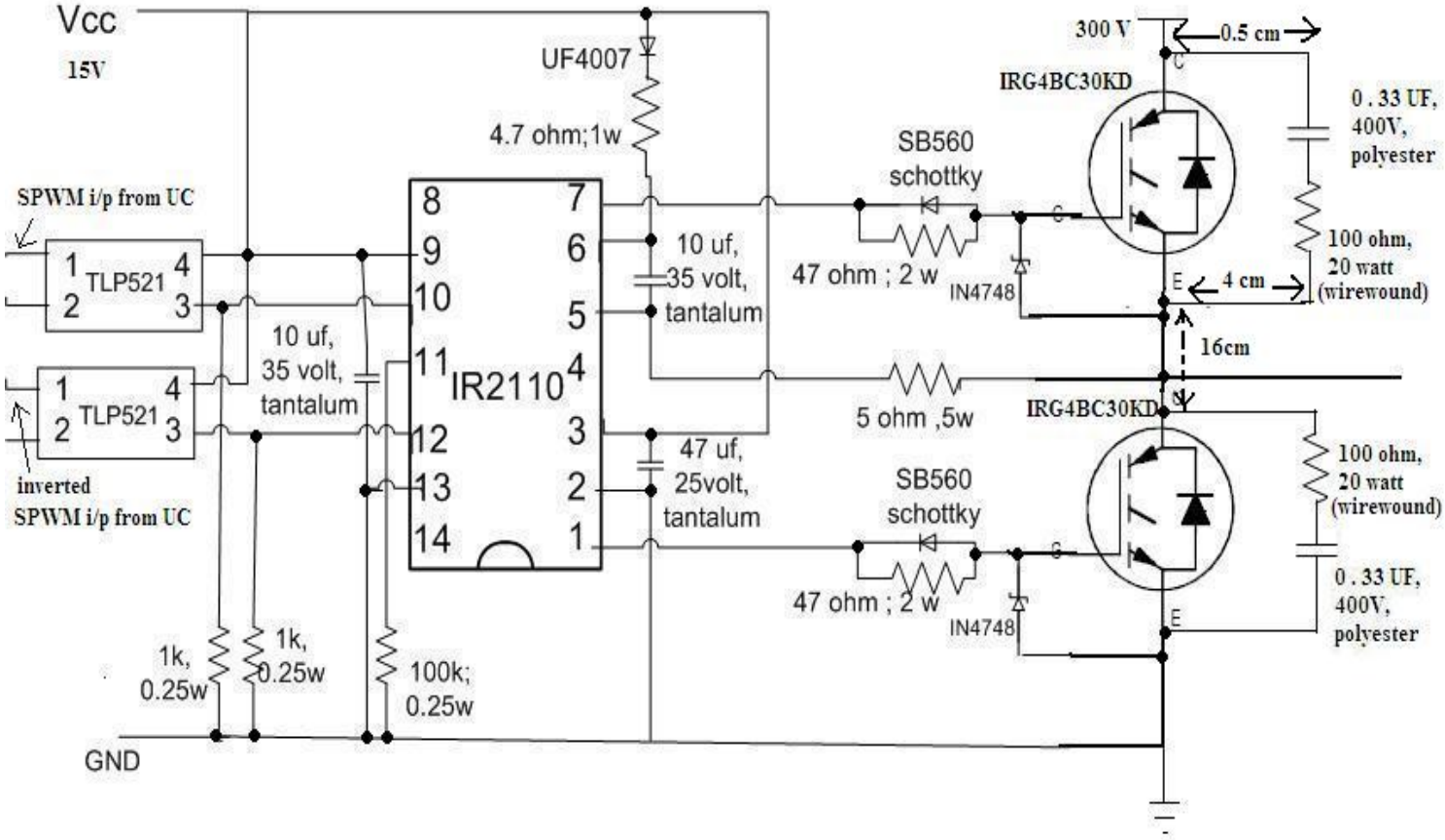
Circuit Description : The DC 300v bus voltage is obtained by rectifying 220v 1-ph with rectifier(BR1010). There are two number of 1000uF electrolytic capacitors in series at the output terminals of the rectifier circuit , and two number of 1000uF electrolytic capacitors in series at the input terminals of the inverter boards. That means a DC bus capacitance of equivalent value 1000 UF is there between rectifier and inverter. The 15v source for the IR2110 gate drivers, uses a step down transformer connected to single phases, a rectifier some filtering capacitors and a LM7815.



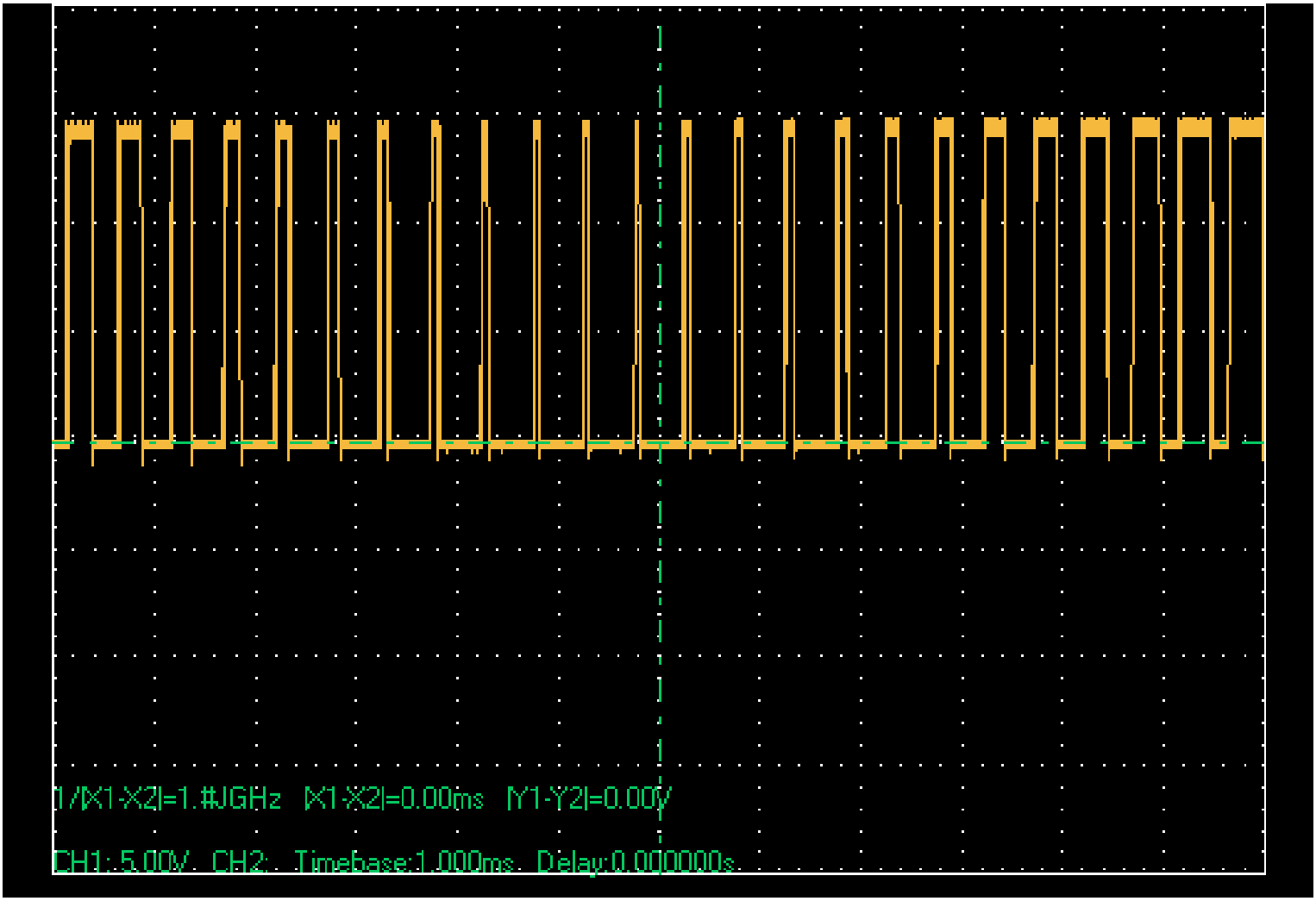
Power Circuit

The three-phase inverter bridge circuit uses the IR2110 as gate driver for the IRG4BC30KD IGBT,which has a 600v Vce, I=28A and internal diode . The charge gate resistor is 47ohm and for discharge a SB560 Schottky diode is placed. Between the emitters and gates of the IGBTs there is a clamping 18v zener diode. There is a snubber circuit across each IGBT with capacitance of 0.33uF, 400V polyester capacitor and 100 ohm, 20 Watt wire-wound resistance. There is a 47uF tantalum capacitor at the Vcc and Com for decoupling and a 10uF tantalum capacitors at the Vss and Vdd inputs of the IR2110. The bootstrap capacitor is a 10uF tantalum. Bootstrap diode is UF4007 and bootstrap resistance is 4.7 ohm. The operating frequency is 2 kHz. The circuit is opto-isolated by a TLP521-1, Power and drive circuit grounds are coupled. The circuit for one branch is shown in the next figure:

Inverter Board Half bridge circuit:



SPWM(sinusoidal PWM) input to the gate of IGBT: It is obtained by disconnecting the IGBT from the driver circuit and connecting the Vs pin (PIN 5)to ground. Then the prop of DSO is connected to the terminal of driver which was going to the gate of IGBT and the ground of the prop is connected to the driver ground. Note the magnitude of each pulse is 15 volt. Switching Period, Ts (Ton+Toff) is near 500 microsec. Or switching frequency is 2 KHz.



3-phase inverter circuit: An RC series circuit is added as snubber for each IGBT **(IRG4BC30KD IGBT,which has a 600v Vce, I=28A and internal diode)**. The capacitance is 0.33 UF (polyester type) and the resistance is 100 ohm (wire wound type). Distance between the upper and lower IGBT in a branch of inverter is 16 cm. Distance between two branch is 6 cm.