Quartz Crystal Thickness Monitor
Model 12161
Instruction Manual

SPI Supplies Division of **STRUCTURE PROBE, INC.**

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WARRANTY

The SPI Supplies unit you have purchased is guaranteed to be free of defects in workmanship on the day of shipment. This warranty covers parts and labor for a period of one year, excluding shipping charges or consumables. Breakage of glassware is specifically excluded from this warranty.

Proper use of your unit, according to this instruction manual, should result in trouble -free operation. Any improper use of the SPI Supplies unit through modifications or unresaonable operating procedures will void this warranty.

DISCLAIMER

SPI Supplies instruments are designed for simplicity of insstallation and operation. This manual provides full and complete information in both these areas. SPI Supplies therfore assumes no liability or responsibility of any kind for damage or injury resulting from incorrect installation or operation of the machine. if questions arise , call SPI Supplies TOLL-FREE at 800-2424-SPI (USA only). FAX at 1-610-436-5755 or EMail at SPI2SPI@2SPI.com for assistance.

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INSTRUCTIONS FOR USE

A. General Description
B. Operation

1. General Description

The SPI –MODULE QUARTZ THICKNESS MONITOR operates by monitoring the frequency of a quartz crystal when loaded with evaporation material deposited onto the crystal. The frequency shift is related to the mass of the material deposited. Calibration of the thickness then depends upon: the thickness , the area of the crystal that is exposed (fixed by the design of the crystal holder)_and the density of the material being deposited.

When using the equipment , it is always assumed that the source to the crystal and source to the subtrate distances are the same, and it must be remembered that the thickness of the coatings (from a point source) will be inversely proportional to the square of the these distances. If these do differ , a constant can be applied to the real density of the material being deposited to compensate accordingly, i.e. the ratio of the squares of the distances.

The front panel of the instrument comprises of a four digit LED display calibrated in nanometers (10 angstroms = 1 nanometer), main power switch and three thumbwheel switches for selection of the density
The zero knob is used to zero the display before commencing the deposition process.

2. Operation

It is assumed that the vacuum system has been evacuated and is ready for use.

(I) Switch on the main power switch.
(II) Dial in the density of the evaporant or sputtered material.
(III) Use the "zero" adjustment to set the display to "OO.O" .
(IV) Commence deposition process.

3. Additional Notes

(I) Typical density values for the materials shown are:

Gold	19.4 g/cc
Gold/1.85 %Palladium	18.0 g/cc
Platinum	22.1 g/cc
Silver	10.5 g/cc
Nickel	08.3 g/cc
Aluminum	02.6 g/cc
Carbon	02.2 g/cc

(II) Quartz Crystal

The crystal is a 5 MHz "AT" cut plano convex quartz crystal operating in parallel resonance. It will function normally until the total thickness of the deposited material causes the oscillation frequency to be outside the range of the measuring system. At this point , which corresponds to about 11 microns of aluminum or 2 microns of gold, the digits on the display will no longer alter during deposition. The crystal must then be changed. This is simply done by unscrewing the top plate of the crystal holder.

DETAILS OF THE QUARTZ CRYSTAL THICKNESS MONITOR

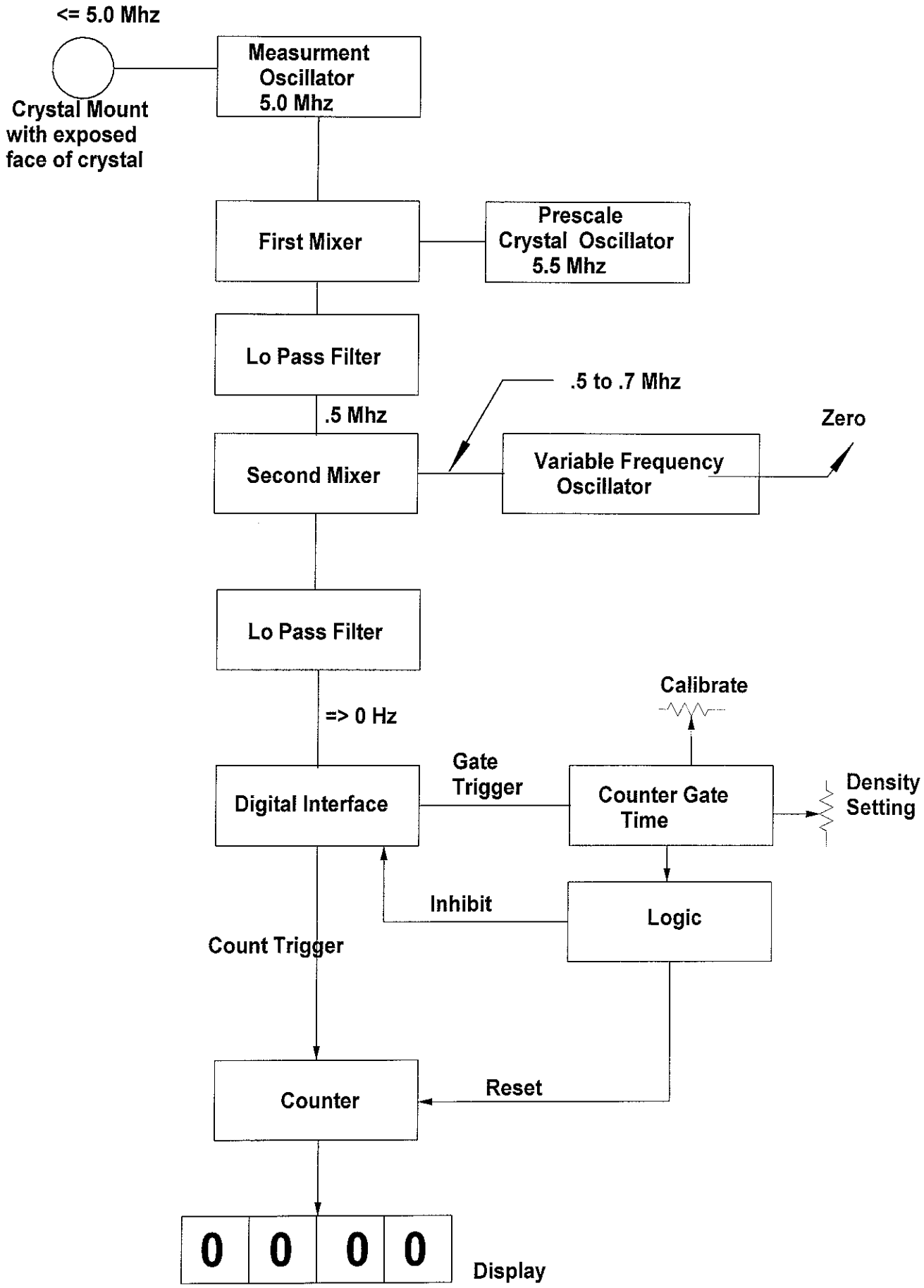
FUNCTION: To measure the thickness of the layer of gold or other metals being deposited during sputtering by measuring the shift in frequency of a quartz crystal being electrically excited to mechanical vibrations.

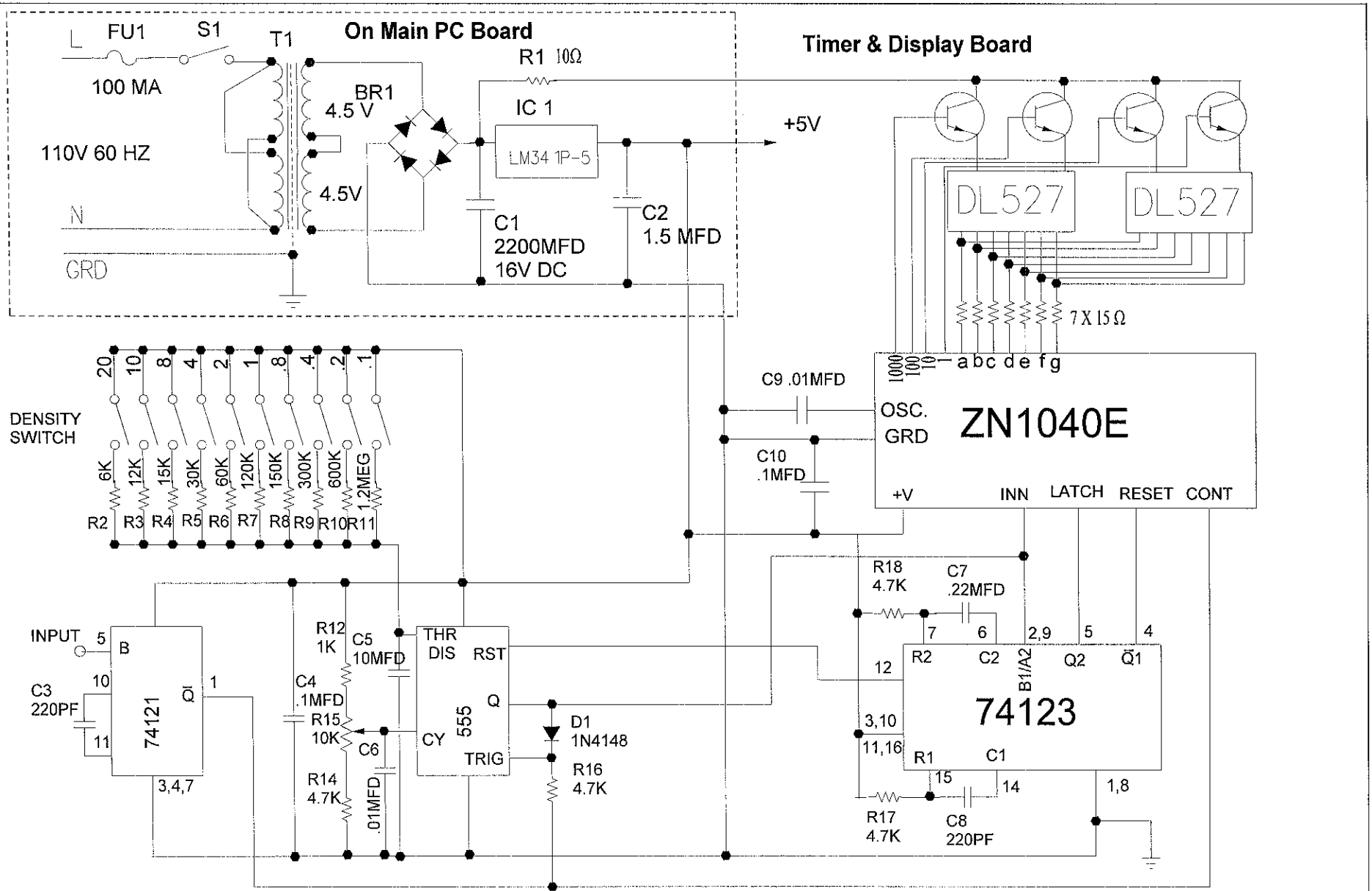
THEORY: the frequency of oscillation of the quartz crystal is a function of the elasticity of the material and the mass. The deposition of gold on an exposed face of the crystal adds to the mass of the vibrating system. This lowers the frequency of oscillation. Knowing the relationship between the change in frequency to the change in mass, we can measure the change in frequency to get the change in mass. From knowing the physical dimensions of the exposed area and the density of the material being deposited we can calculate the thickness of the deposited layer. This constant factor is obtained by using an appropriate gate time for enabling the counter to count the signal from the second mixer. This constant can be changed to account for the different density of different materials. With the density switch set at 4.0, the gate of time of the counter is set for 200 milliseconds (ms). This means that a pulse or cycle must occur within 200 ms for the counter to receive a count . There is an inverse relationship between the density switch setting and the gate time; hence , 2.0 on the switch would be 400 ms gate time and 8.0 on the density switch would be 100 ms gate time. The higher the density of the material being deposited the greater the mass for a given thickness of the deposit; hence, the larger the frequency shift of the crystal oscillator. This higher frequency presented to the counter must indicate the same thickness, therefore, the time the counter can count must be made shorter (shorter gate time = higher density material).

METHOD: The initial frequency of the measurement oscillator (produced by the quartz crystal) was chosen to be 5.0 Megahertz (Mhz). This signal is mixed in the first mixer with a fixed frequency prescale oscillator of 5.5Mhz. The output of the first mixer is filtered to obtain the difference frequency initially being .5Mhz. This signal is then sent to a second mixer and mixed with a variable frequency oscillator ranging from .5Mhz to .7Mhz. The output of this mixer is filtered to obtain the difference frequency. This signal is then sent to the counter.

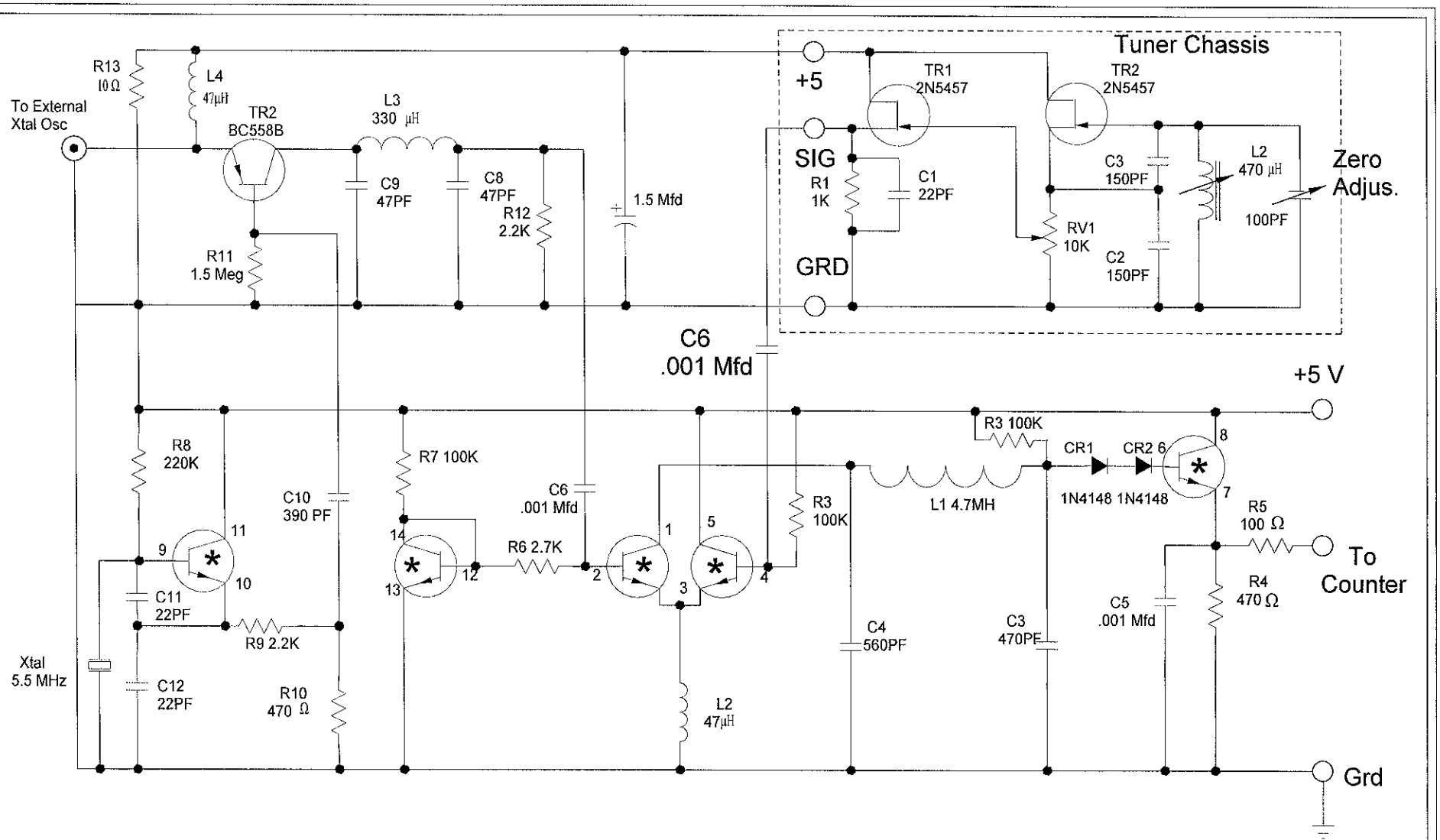
Prior to starting sputtering, the frequency of the variable oscillator is varied until the output of the second mixer is zero frequency thus indicating "0000" on the counter readout. As the sputtering proceeds, the output of the second mixer will change with the change in frequency of the measurement oscillator.
This will counted by the counter . A constant factor is applied at the counter to change the differential frequency to nanometers of thickness (this accounts for the dimensions and the density of the material.

Block Diagram of QCTM

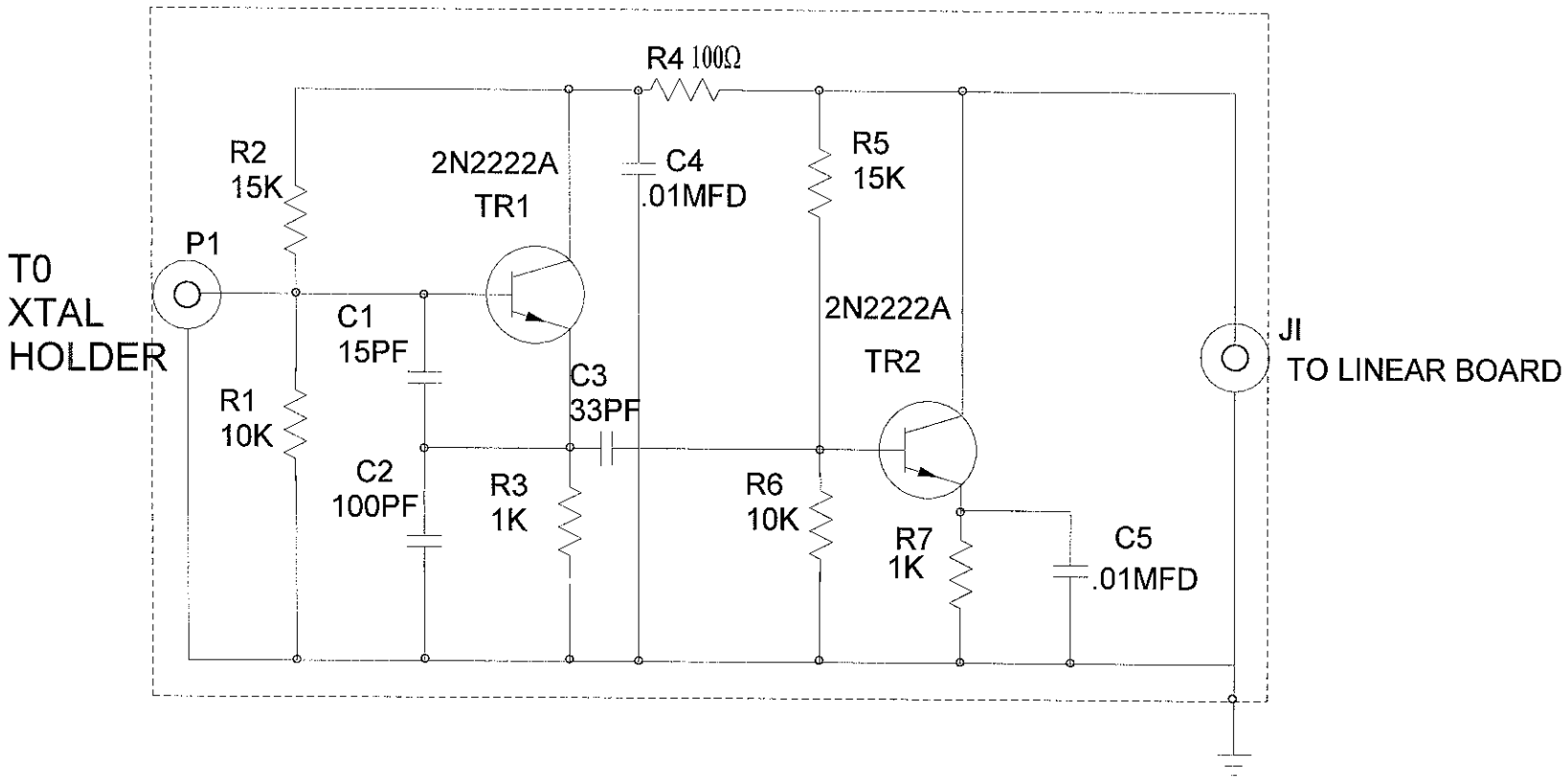




DWG.NO.	QCTM_102
DESC.	POWER SUPPLY & COUNTER BOARD
DATE	10/18/01
DRAWN BY	A L M
REV. NO.	



DWG.NO.	QCTM 100
DESC.	Main PC Board
DATE	10/17/01 DRAWN BY ALM REV. NO.



EXTERNAL OSCILLATOR

DWG.NO.	QCTM__101
DESC.	External Oscillator SPI Part 12161-XL
DATE 10/18/01	DRAWN BY A L M REV. NO.