PSoC Design Challenge 2002
Project No: 248
LCR Meter
Abstract

The LCR Meter measures the characteristics of a passive component. It has the following features:

- Measures the capacitance, inductance, resistance, quality factor, dissipation factor and phase angle of a component's impedance
- Displays the real part (resistance), the imaginary part (capacitance or inductance) and one selectable third result at the same time
- Resistance range: from 100.0mΩ (resolution 0.1mΩ) to 1.000MΩ
- Capacitance range: from 100.0pF (resolution 0.1pF) to 10.00mF
- Inductance range: from 10.00uH (resolution 10nH) to 10.00mH
- Some results from non-exhaustive accuracy test: error of 0.07% at 10nF, 0.16% at 10kΩ, 2.4% at 100uH
- Stimulus frequency ranges from 50Hz to 10kHz in 195 user-selectable, crystal-controlled discrete steps
- Stimulus AC amplitude is selectable from three different values: 250mV, 500mV, 1V
- Stimulus DC bias can be set internally to 2V or externally to any voltage up to 50V
- The resistive and reactive parts of either a series or a parallel equivalent circuit can be displayed
- Four-wire measurement interface compensates for test setup contact resistance
- Two-wire measurement interface included additionally
- Guarded measurement eliminates parasitic capacitances between measurement path and ground
- Shielded cables between the LCR meter and the component under test can be used without disturbing the measurement, thus eliminating the parasitic capacitance between probe cables
- Measured capacitance can be offset to 0 to compensate for additional parasitic capacitance in the test setup
- Measurement terminals are protected against hard short-circuits to external voltage sources up to +/- 12V
- Uses a large, low-cost LCD display for providing a maximum of information at the same time
- Rotary encoder provides easy user interface
- Small keyboard additionally provides fast access to three parameters
- RS232 interface sends measurement results and can be used to set up measurement parameters
- Accuracy mainly determined by only a few precision resistors, calibration only necessary for a secondary function

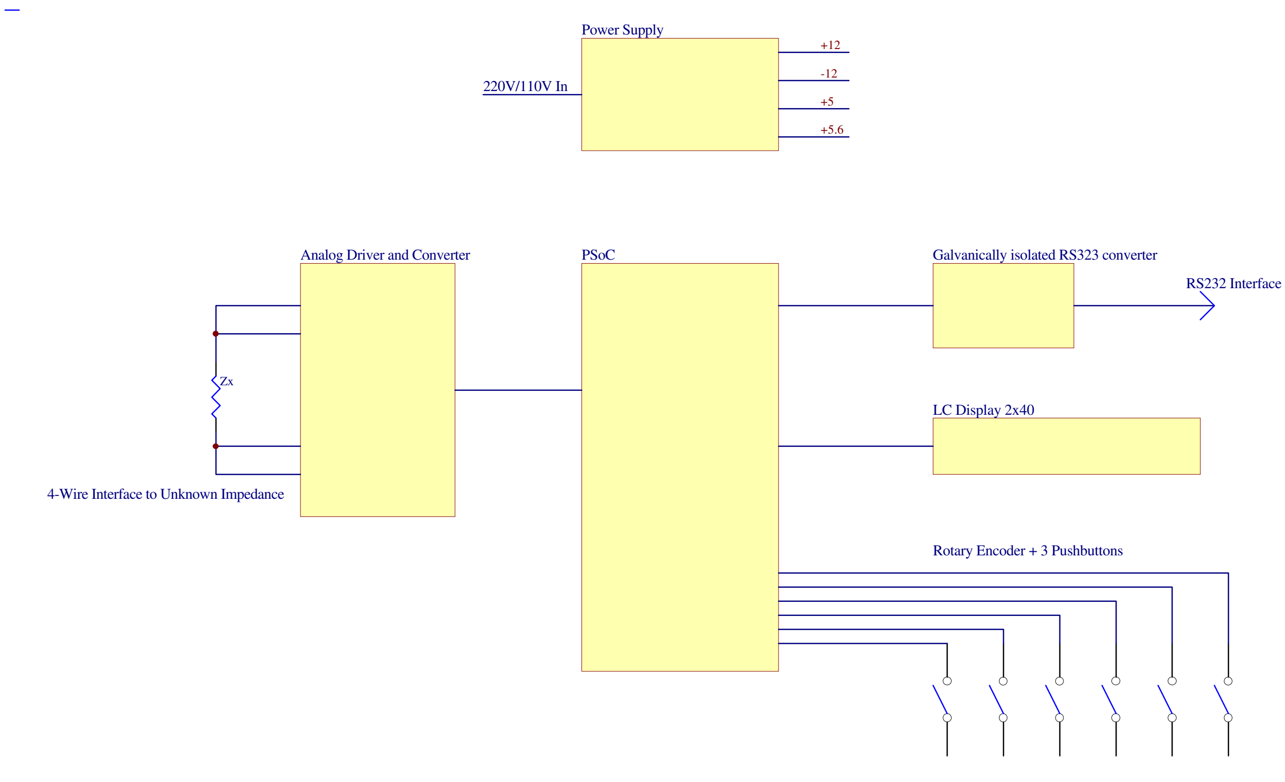


Figure 1: Coarse block diagram

The circuit is composed of the following blocks:

- Power supply: provides four different voltages
- PSoC with supporting hardware
- Analog driver and converter: includes an anti-aliasing filter, buffer amplifier which generates the stimulus voltage, an input amplifier which converts the current through the component under test to a voltage, and an impedance converter to drive the PSoC analog inputs.
- An LC display which is directly connected to the PSoC
- A rotary encoder and keyboard which are connected to the PSoC through a debouncing circuit
- A galvanically isolated RS232 interface

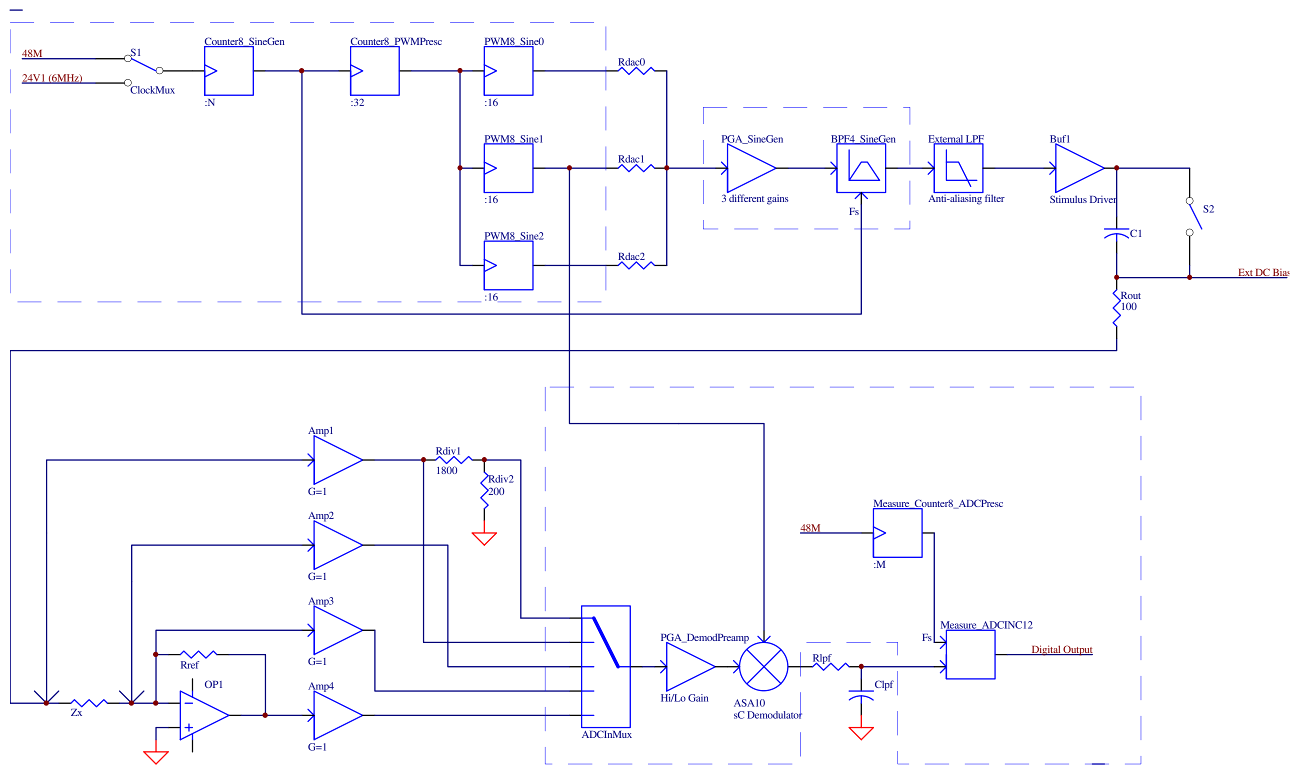
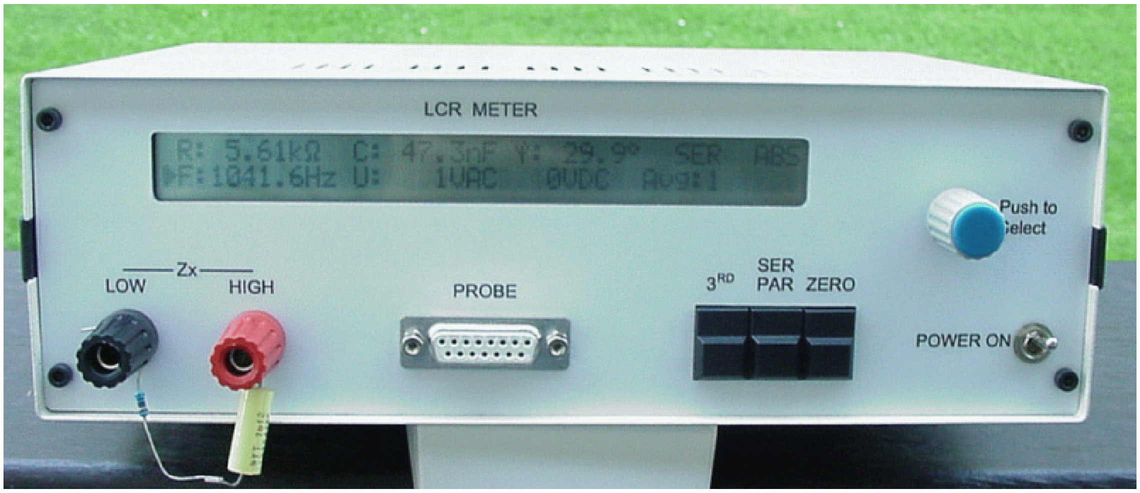


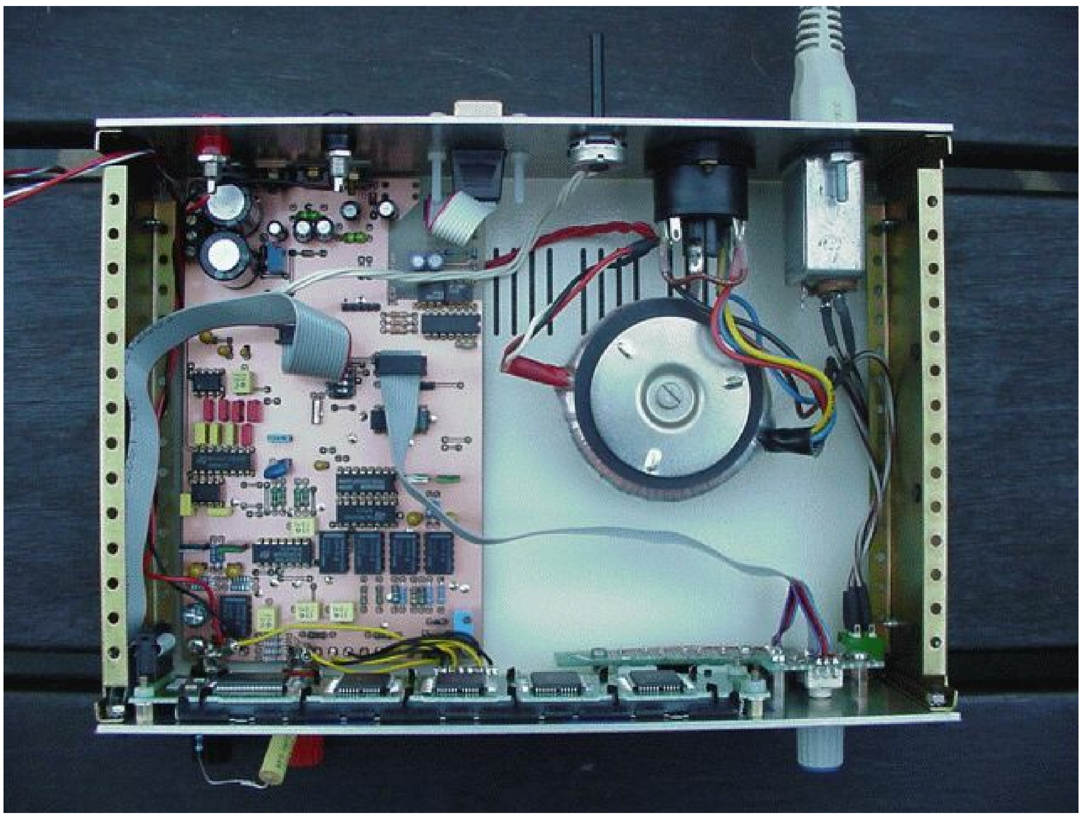
Figure 2: Measurement block diagram. Everything inside the dashed lines is located in the PSoC

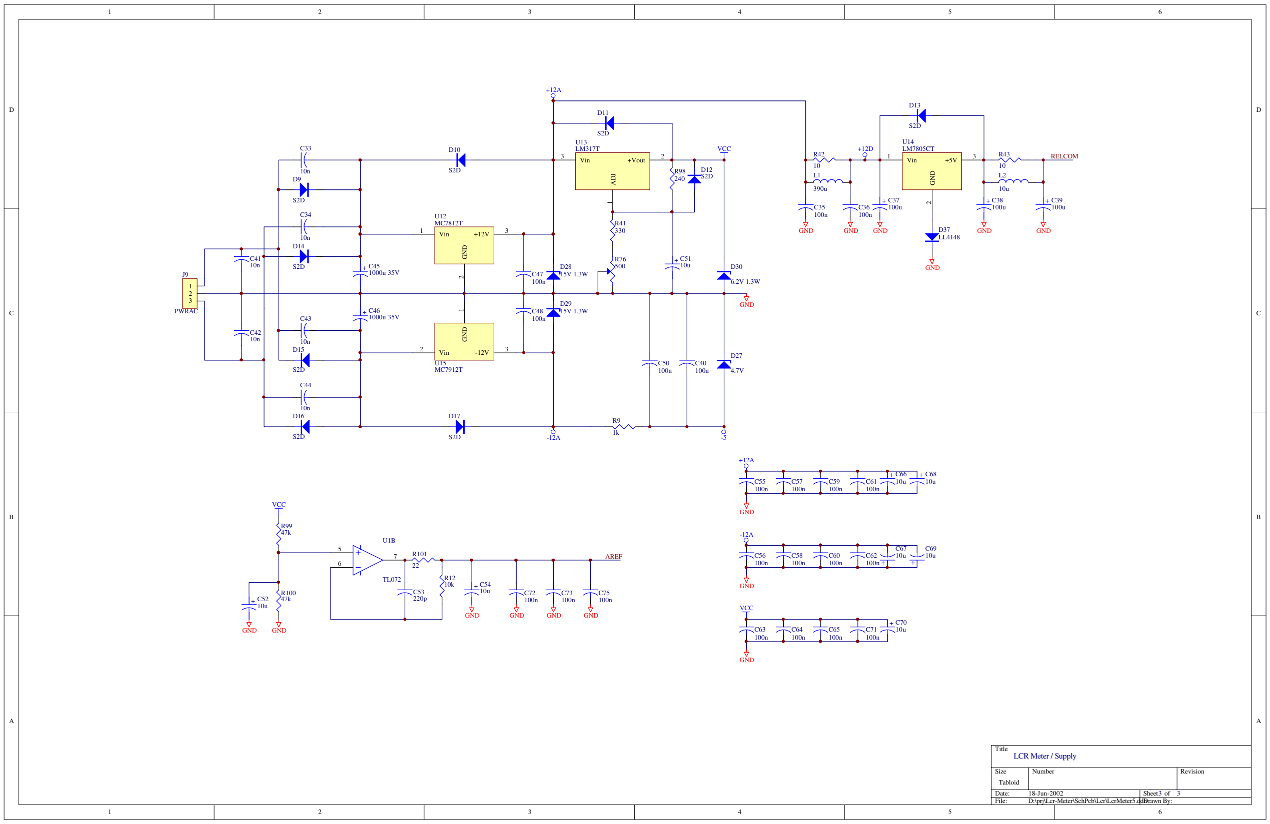
The upper part of the diagram is the stimuls generator. Counter8_SineGen, Counter8_PWMPresc, the three PWM generators and the three resistors Rdac0..Rdac2 generate a piecewise approximated sine wave (four different amplitude levels). The bandpass filter BPF4_SineGen, together with the external anti-alising filter transform the approximated sinewave into a low-distortion sinewave. The frequency of the sinewave is determined by setting the dividing ration of Counter8_SineGen, the amplitude is set by the gain of PGA_SineGen. The buffer amplifier Buf1 drives the component under test, Zx.

The operational amplifier OP1 forms together with a selectable reference resistor Rref (selected by a set of relays) a current-to-voltage converter. The voltage across the reference resistor is fed into the PSoC through the two impedance converters Amp3 and Amp4. Additionally, the voltage across the component under test is measured seperatly and also fed into the PSoC (four-wire measurement). In order to increase the measurement range, the drive voltage is divided by Rdiv1 and Rdiv2 and the gain of the amplifier driving the demodulator ASA10 is adjusted if necessary. The demodulator's local oscillator input is driven by the square wave output of a PWM generator, which has the same frequency as the stimulus sine wave. The phase difference between the stimulus signal and the local oscillator input signal is set by selecting the phases of two PWM generators among two differnt sets. Two phase shifts are used, 0 and 90 degrees, as it is necessary to determine the real and imaginary parts of the component's impedance.

The demodulator is filtered by an RC lowpass in order to avoid a signal with fast-rising edges at the input of the ADC. The ADC is clocked with a frequency generated by the Measure_Counter8_ADCPresc which is adjusted in such a way that the ratio between the integration time of the ADC and the period of the stimulus sine wave is always an integer.


LCR METER
R: 5.61kΩ C: 47.3nF
SER ABS
F:1041.6Hz U: 1VAC 0VDC Avg:1
Push to
Zx
LOW
HIGH
PROBE
3RD
SER
PAR
ZERO
POWER ON

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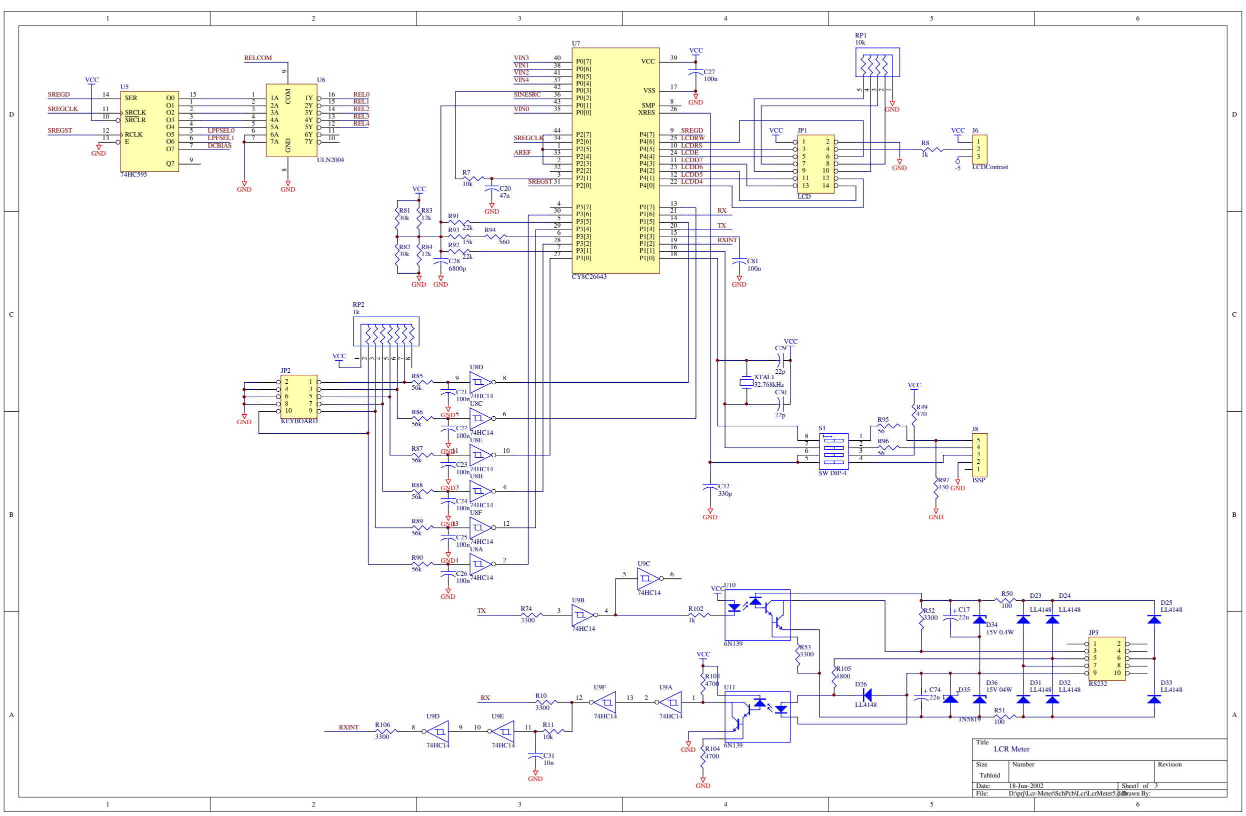
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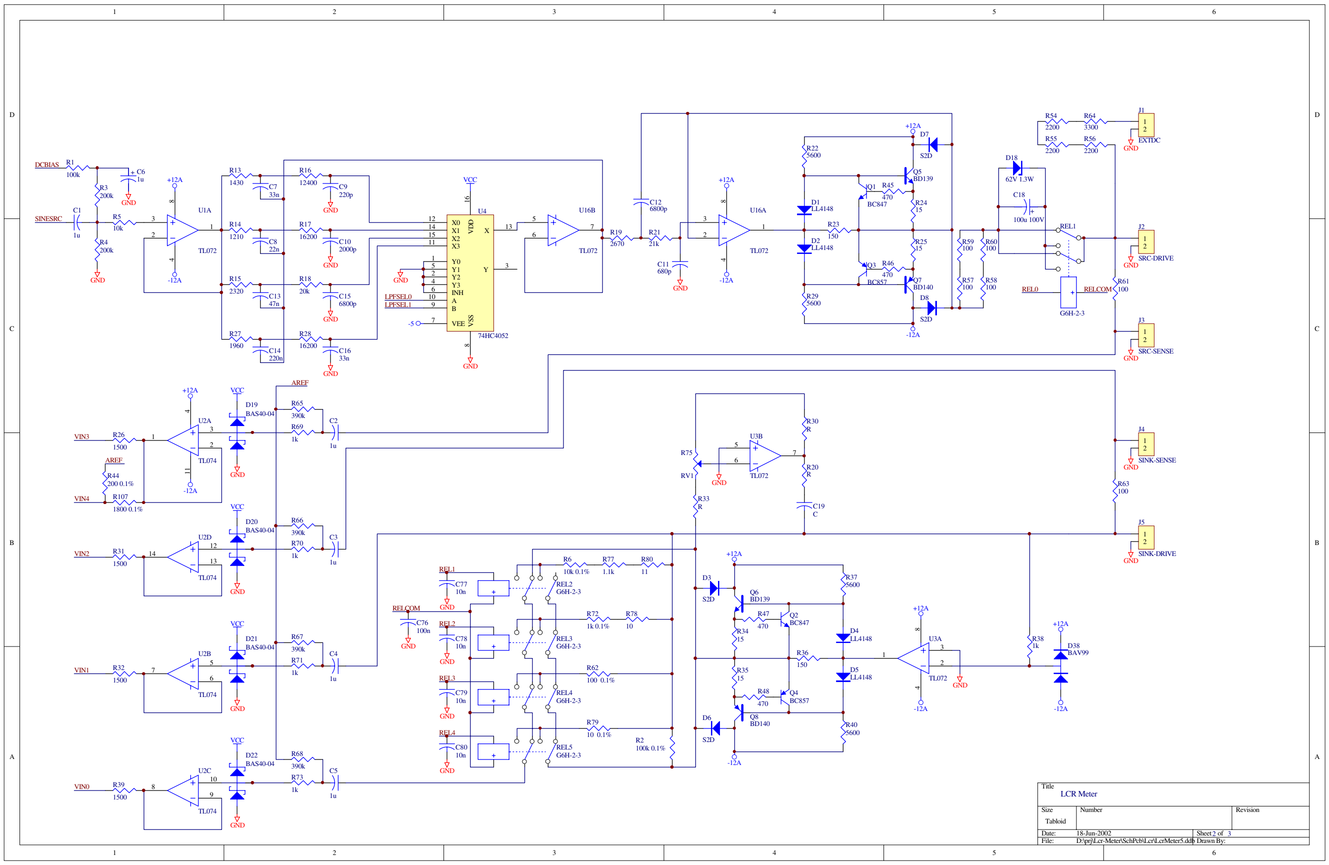

DCBIAS
SINESRC
VIN0
VIN1
VIN2
VIN3
VIN4
AREF
LPFSEL0
LPFSEL1
RELCOM
REL0
REL1
REL2
REL3
REL4
74HC4052
TL072
TL074
EXTDC
SRC-DRIVE
SRC-SENSE
SINK-SENSE
SINK-DRIVE
G6H-2-3
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