Data Acquisition System
(a PC-compatible, True-RMS DVM)

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VIII semester, E&C

Test & Measurement needs

- Ease of use
- Ability to store and visualize data
- High accuracy and large dynamic range
- Basic signal processing support
- Field measurement storage
- Low cost

Features

- Easy-to-use Menu Driven Interface
- High resolution (six digits)
- PC Interface
  - Logged Mode
  - Slave Mode
- True-RMS measurement
- 128 Reading Non-volatile Memory

Features

- Different Averaging modes supported
- Auto-ranging support
- Analog-like Bar graph mode
- Minimum-Maximum mode
- 16x2 backlit LCD display

Design Issues

- Analog Front-end Design
  - Attenuator
    - Attenuate applied voltage to within the ADC's dynamic range (512 mV)
    - Provide protection against high voltage and ESD
  - True RMS-to-DC Converter
  - Coupling selector
    - Chooses between direct input voltage and RMS-to-DC converted voltage

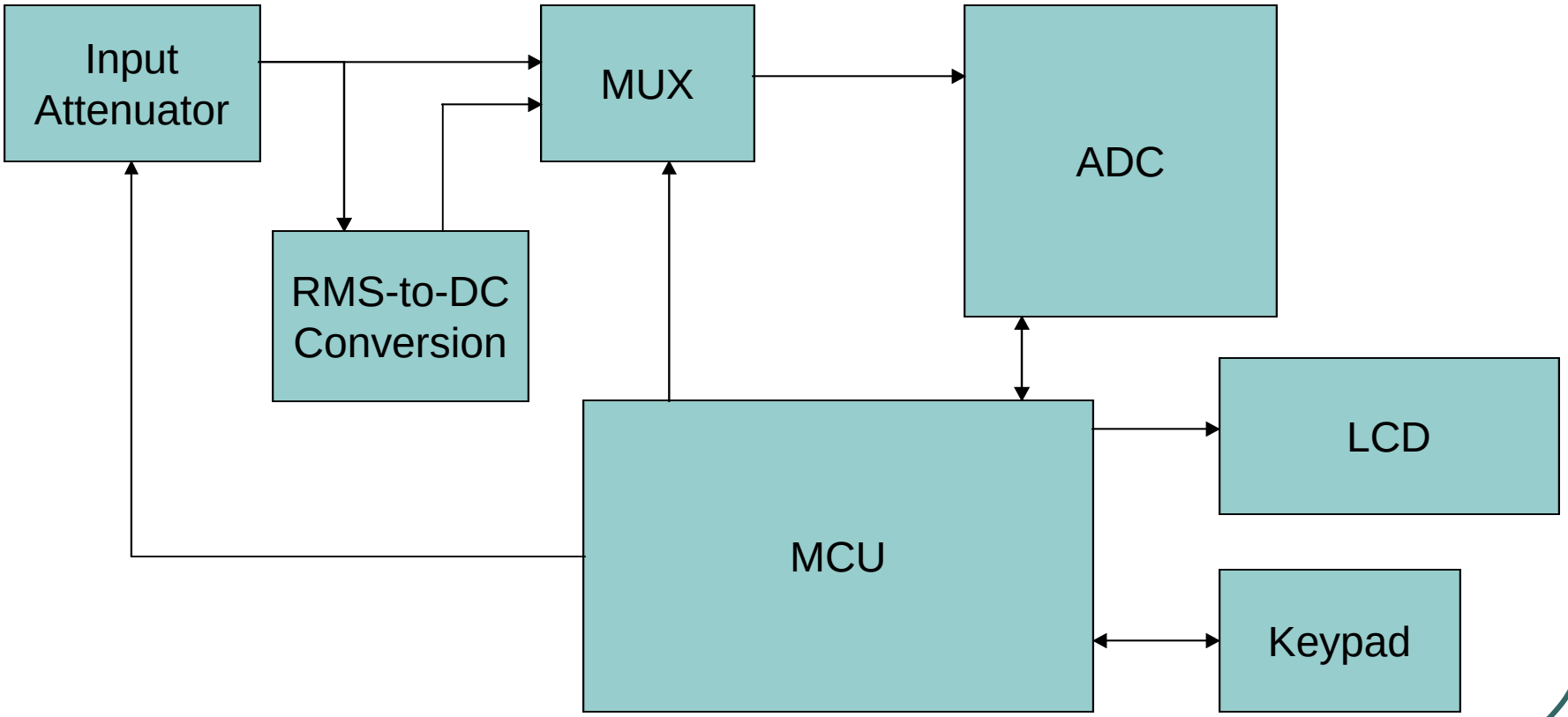
Design Issues

- ADC
  - Easy-to-use Serial Interface (SPI)
  - 50/60 Hz Line Noise Rejection
  - Conversion rate of 13 readings/sec.
  - Noise at Input
    - Use of a ground-plane on the PCB
    - Separation of Analog and Digital sections
    - Liberal power-supply decoupling at each chip

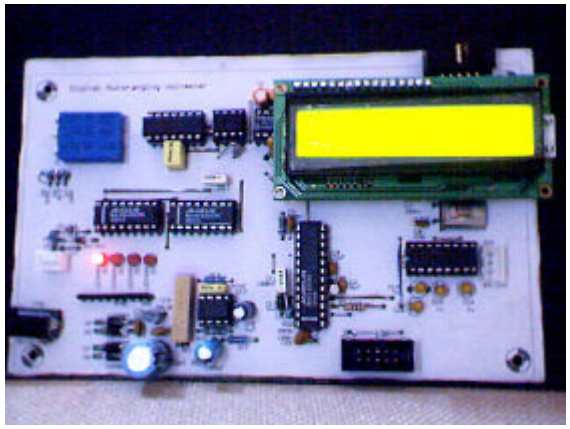
Design Issues

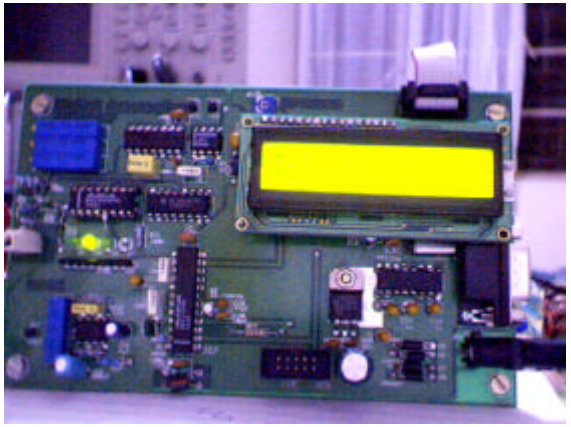
- Microprocessor
  - Ease of Programming
  - Large onboard memory
    - 8k Flash program memory
    - 512 bytes EEPROM
    - 512 bytes SRAM
  - 32 bidirectional I/O ports
  - SPI and RS-232 support

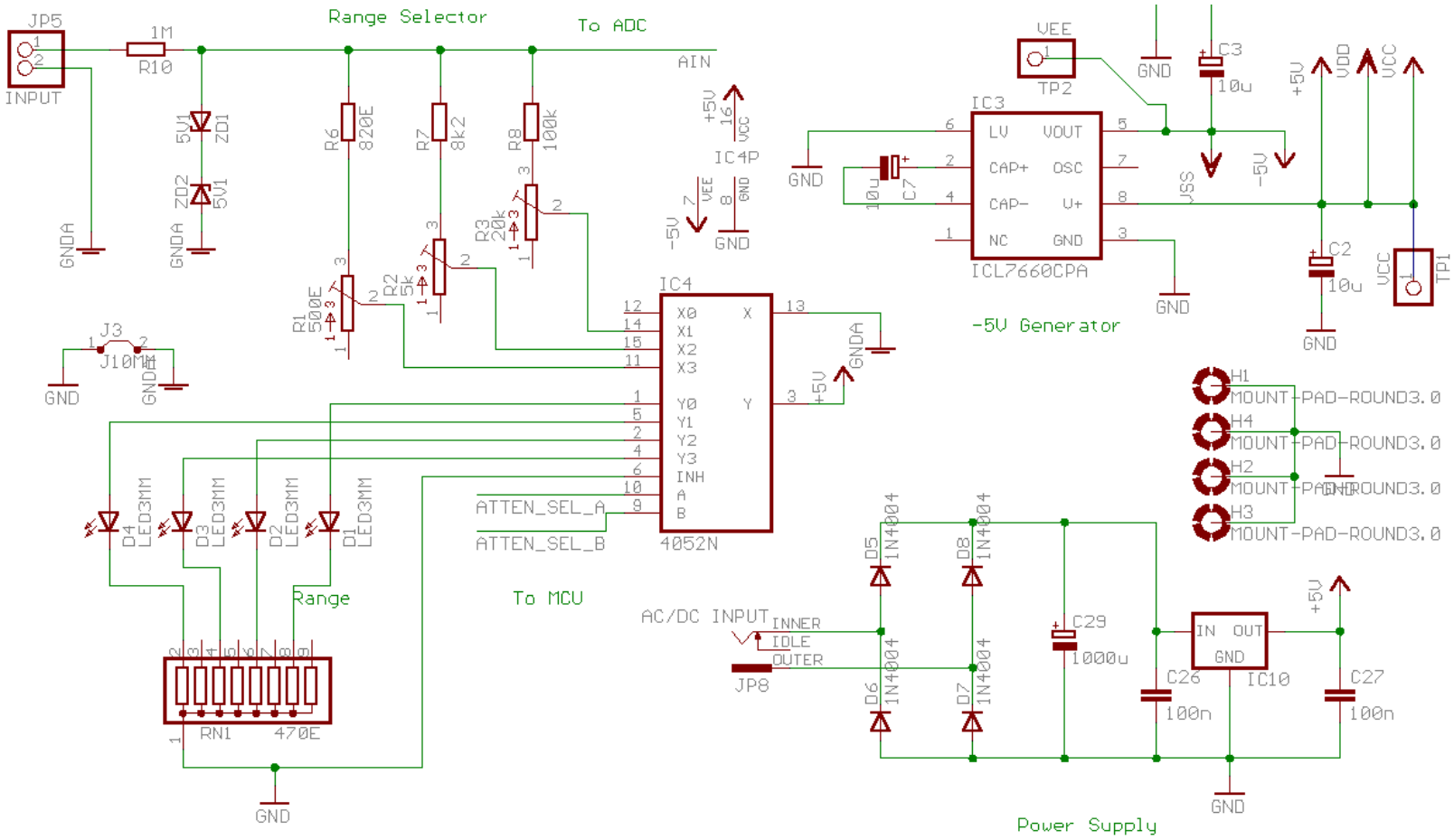
Block Diagram

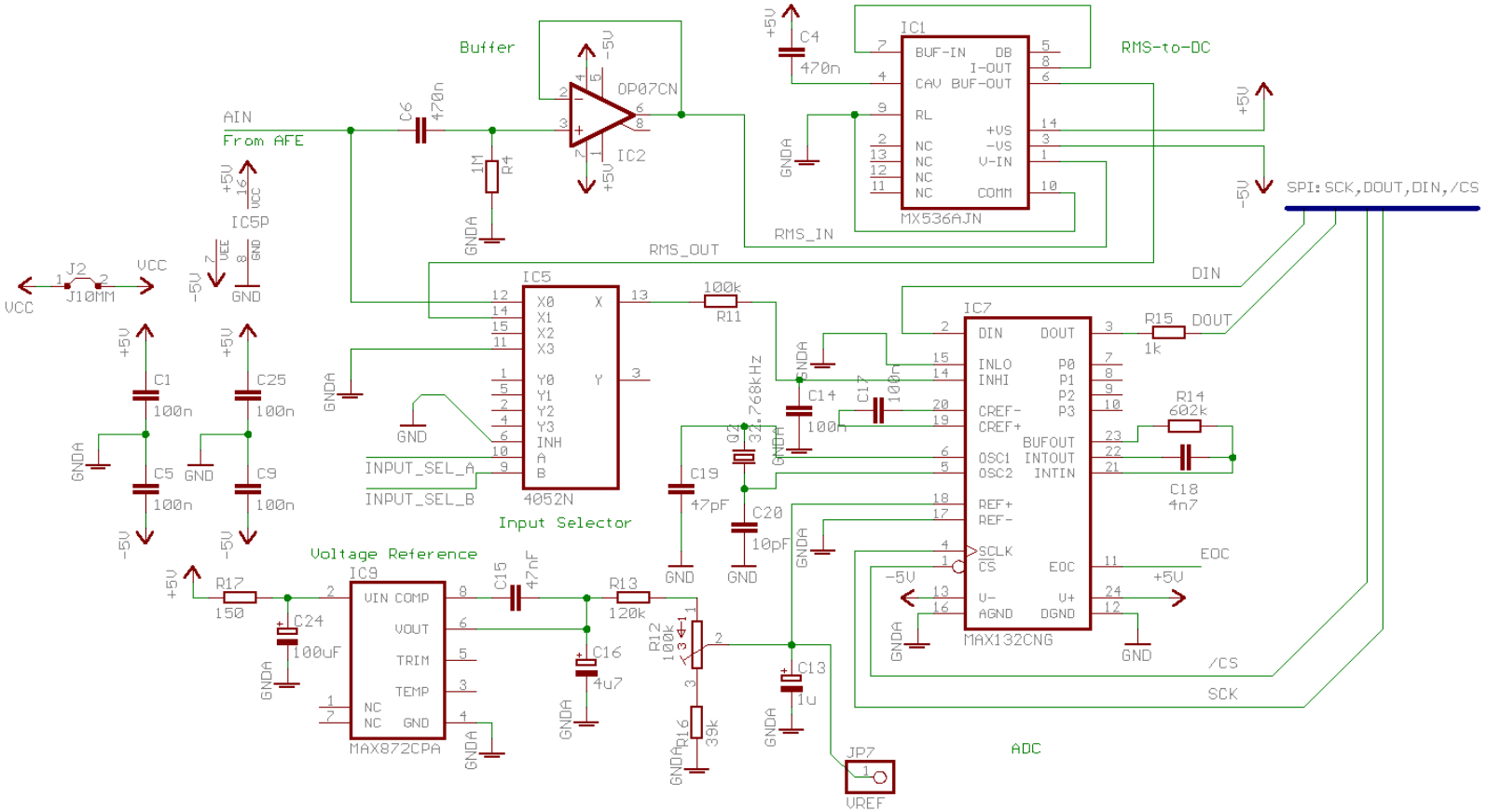


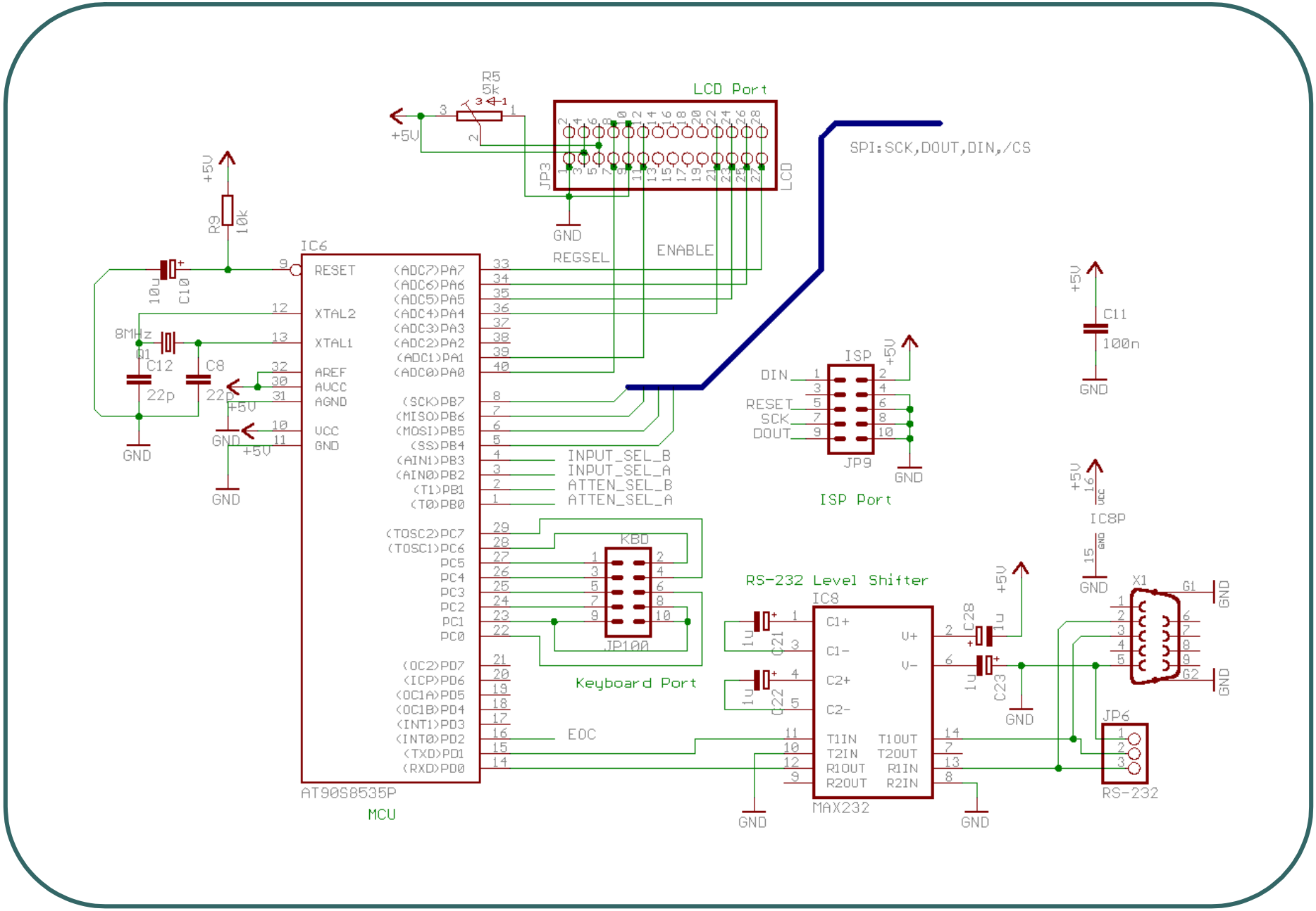
Schematics and Board Layout



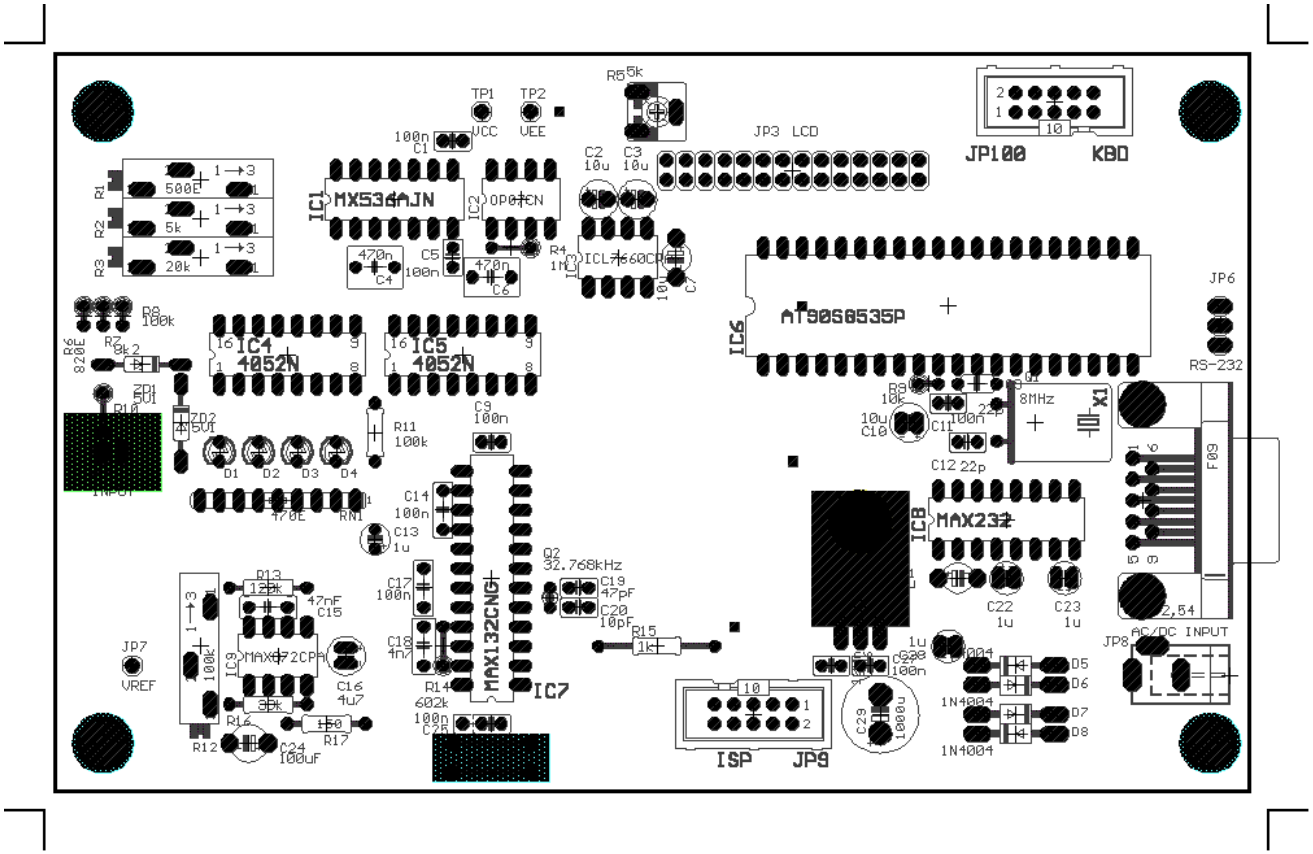



Range Selector
To ADC
AIN
JP5
INPUT
1M
R10
5V1
ZD1
ZD2
GNDA
R6
820E
R7
8k2
R8
100k
R3
20k
R2
5k
R1
500E
IC4P
+5V
VCC
VEE
GND
-5V
IC4
X0
X1
X2
X3
Y0
Y1
Y2
Y3
INH
A
B
X
Y
4052N
ATTEN_SEL_A
ATTEN_SEL_B
J3
J10MM
D4 LED3MM
D3 LED3MM
D2 LED3MM
D1 LED3MM
Range
RN1
470E
To MCU
VEE
TP2
C3
10u
IC3
LV
VOUT
CAP+
OSC
CAP-
V+
NC
GND
ICL7660CPA
C7
C2
VSS
VDD
VCC
TP1
-5V Generator
H1
H4
H2
H3
MOUNT-PAD-ROUND3.0
AC/DC INPUT
INNER
IDLE
OUTER
JP8
D5 IN4004
D8 IN4004
D6 IN4004
D7 IN4004
C29
1000u
IN
OUT
IC10
C26
100n
C27
100n
Power Supply

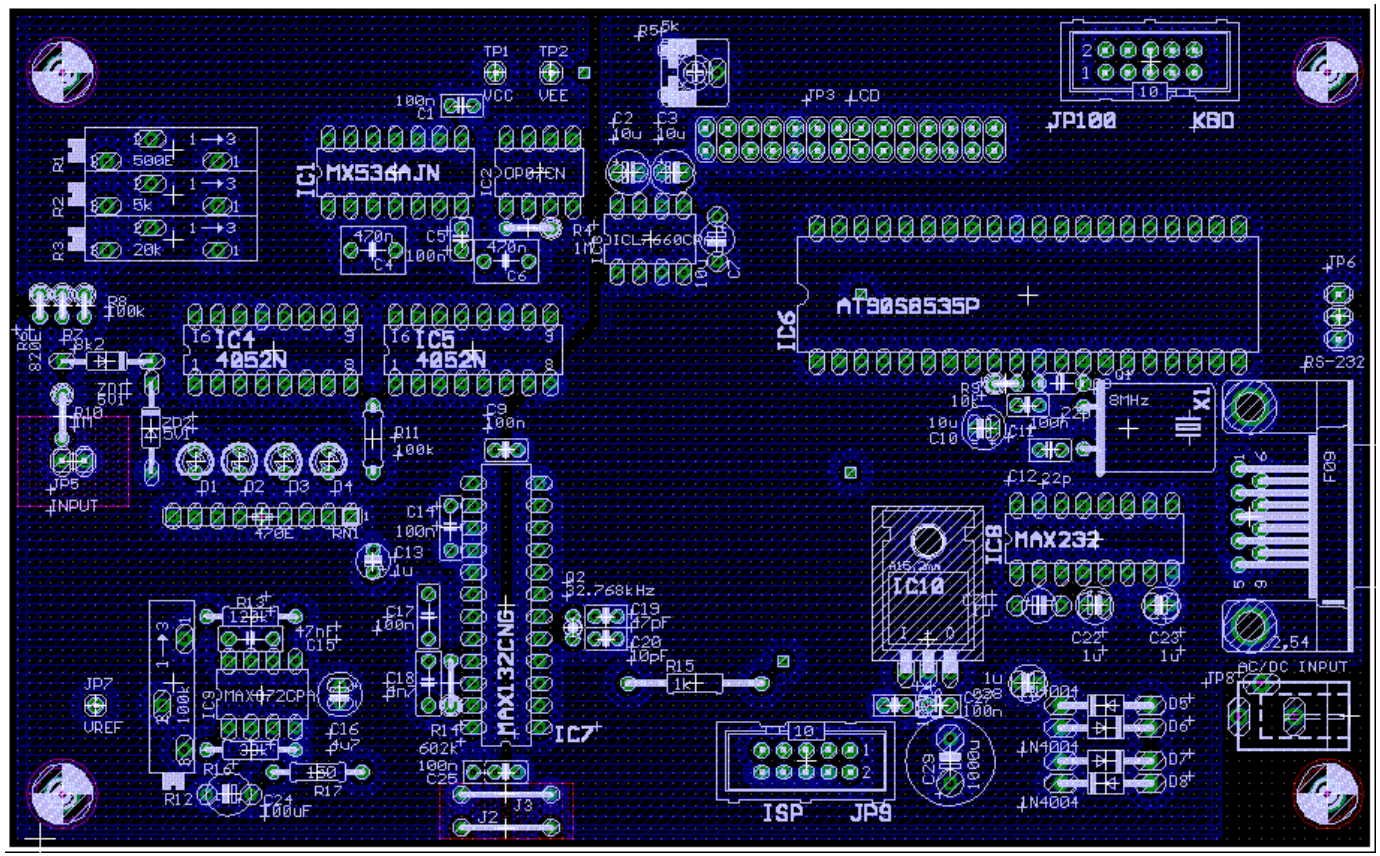

Buffer
OP07CN
IC2
AIN
From AFE
C6
470n
1M
R4
GNDA
+5V
-5V
C4
470n
IC1
BUF-IN
DB
I-OUT
CAV
BUF-OUT
RL
+VS
NC
-VS
V-IN
NC
NC
COMM
MX536AJN
RMS-to-DC
RMS_IN
RMS_OUT
SPI: SCK,DOUT,DIN,/CS
DIN
DOUT
J2
J10MM
VCC
GND
IC5P
VCC
VEE
GND
IC5
X0
X1
X2
X3
Y0
Y1
Y2
Y3
INH
A
B
X
Y
4052N
100k
R11
INPUT_SEL_A
INPUT_SEL_B
Input Selector
C1
100n
C5
100n
C25
100n
C9
100n
IC7
DIN
DOUT
INLO
INHI
CREF-
CREF+
OSC1
OSC2
REF+
REF-
SCLK
CS
V-
AGND
P0
P1
P2
P3
BUFOUT
INTOUT
INTIN
EOC
V+
DGND
MAX132CNG
R15
1k
R14
602k
C18
4n7
C14
100n
C17
100n
G2
32.768kHz
C19
47pF
C20
10pF
Voltage Reference
IC9
VIN
COMP
VOUT
TRIM
TEMP
NC
NC
GND
MAX872CPA
R17
150
C24
100uF
C15
47nF
R13
120k
C16
4u7
R12
100k
R16
39k
C13
1u
JP7
VREF
ADC
/CS
SCK

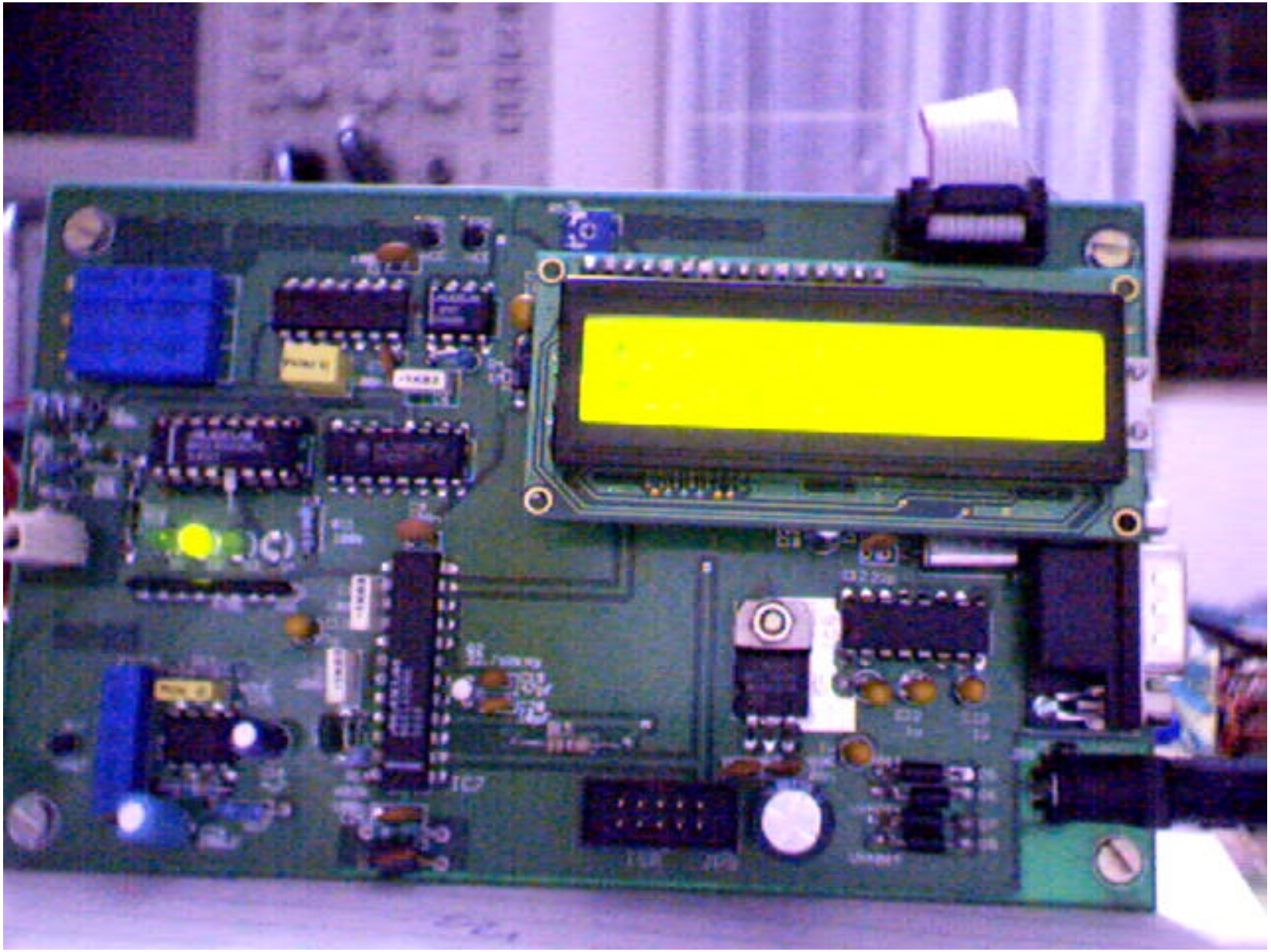

LCD Port
SPI:SCK,DOUT,DIN,/CS
R5
5k
+5V
JP3
LCD
GND
REGSEL
ENABLE
IC6
R9
10k
10u
C10
RESET
XTAL2
XTAL1
AREF
AVCC
AGND
VCC
GND
8MHz
Q1
C12
22p
C8
22p
(ADC7)PA7
(ADC6)PA6
(ADC5)PA5
(ADC4)PA4
(ADC3)PA3
(ADC2)PA2
(ADC1)PA1
(ADC0)PA0
(SCK)PB7
(MISO)PB6
(MOSI)PB5
(SS)PB4
(AIN1)PB3
(AIN0)PB2
(T1)PB1
(T0)PB0
INPUT_SEL_B
INPUT_SEL_A
ATTEN_SEL_B
ATTEN_SEL_A
(TOSC2)PC7
(TOSC1)PC6
PC5
PC4
PC3
PC2
PC1
PC0
(OC2)PD7
(ICP)PD6
(OC1A)PD5
(OC1B)PD4
(INT1)PD3
(INT0)PD2
(TXD)PD1
(RXD)PD0
EOC
AT90S8535P
MCU
KBD
JP100
Keyboard Port
ISP
DIN
RESET
SCK
DOUT
JP9
ISP Port
C11
100n
IC8P
RS-232 Level Shifter
IC8
C1+
C1-
C2+
C2-
V+
V-
T1IN
T2IN
R1OUT
R2OUT
T1OUT
T2OUT
R1IN
R2IN
C21
C22
C28
C23
1u
MAX232
X1
JP6
RS-232

Parts Layout (Silkscreen)

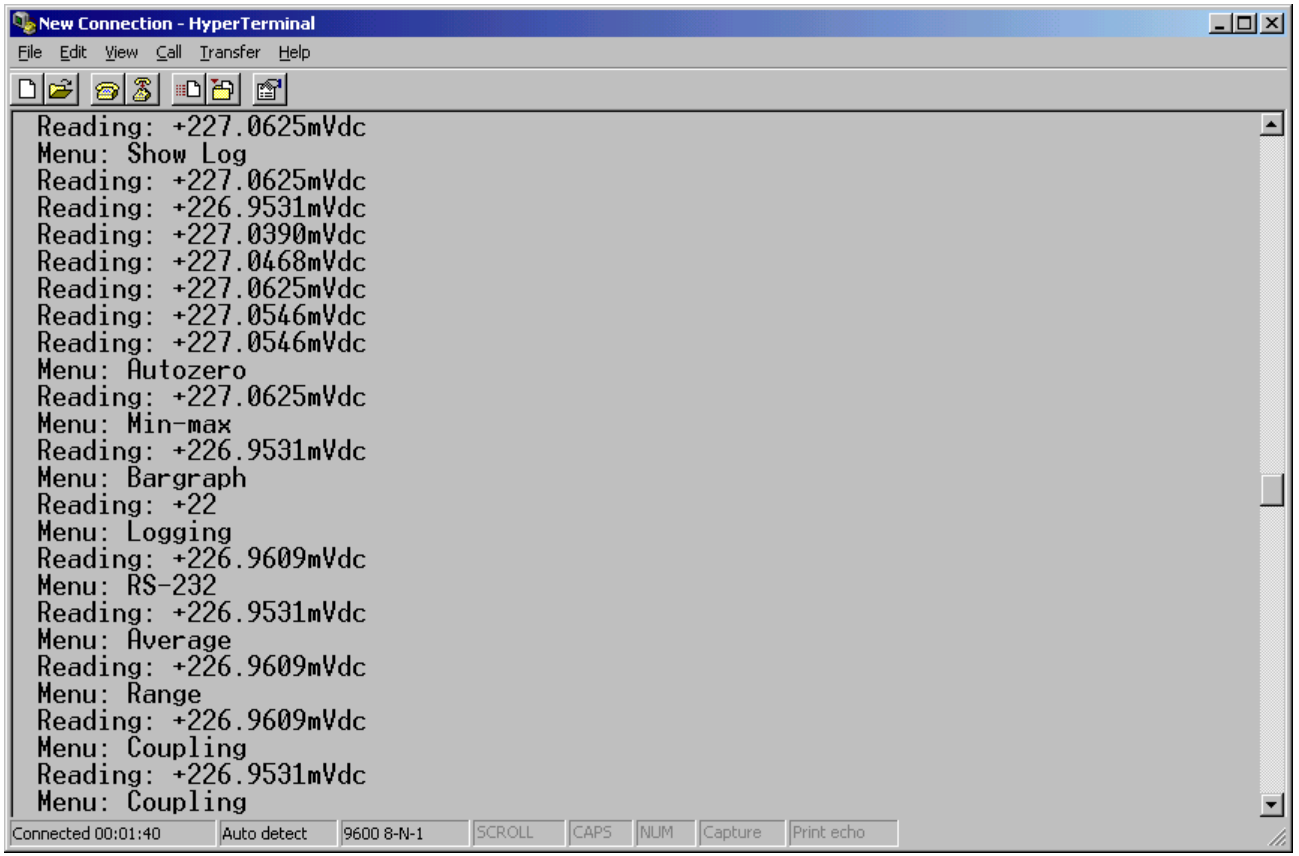


Ground Plane Layer





RS-232 Slave Mode Operation



Comparison with the Tektronix TX-1

- Tektronix TX-1
  - 4½ - digit accuracy
  - 10 field measurements may be stored
  - Cost : US$ 275
- Our DVM
  - 6 – digit accuracy
  - Up to 128 measurements
  - Cost : < Rs.2,000

Applications

- High-resolution bench top DVM
  - With Data logging facility
- Field (service) measurements
  - As a stand-alone, reliable instrument
- Battery-charge monitor
  - Measurement over time
- Input Device for Data Analysis software

Questions?

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