Aj-Simple-Scope

Technical Manual

www.ajoyraman.in

1. Introduction:

This is a brief manual containing relevant technical data required for understanding construction and use of the Aj-Simple-Scope unit.

This unit is designed to compliment the Aj-SigGen-PS and serve as a teaching aid for budding engineers, electronic enthusiasts and hobbyists.

This USB connected unit implements a microcontroller based 2-Channel Oscilloscope providing continuous sampling rates up to 100 ksps and 20 Msps using equivalent time sampling. Common DSO features such as spectrum analysis, waveform capture and data saving are provided. The input range is ± 12V with additional gain settings of X2 and X5. Trigger and sweep options are also provided.

2. Warning & Disclaimer:

All content provided in this document is for informational purposes only. The owner of this document makes no representations as to the accuracy or completeness of any information. The owner will not be liable for any errors or omissions in this information. The owner will not be liable for any losses, injuries, or damages from the display or use of this information including software.

3. Block Schematic and Function Description

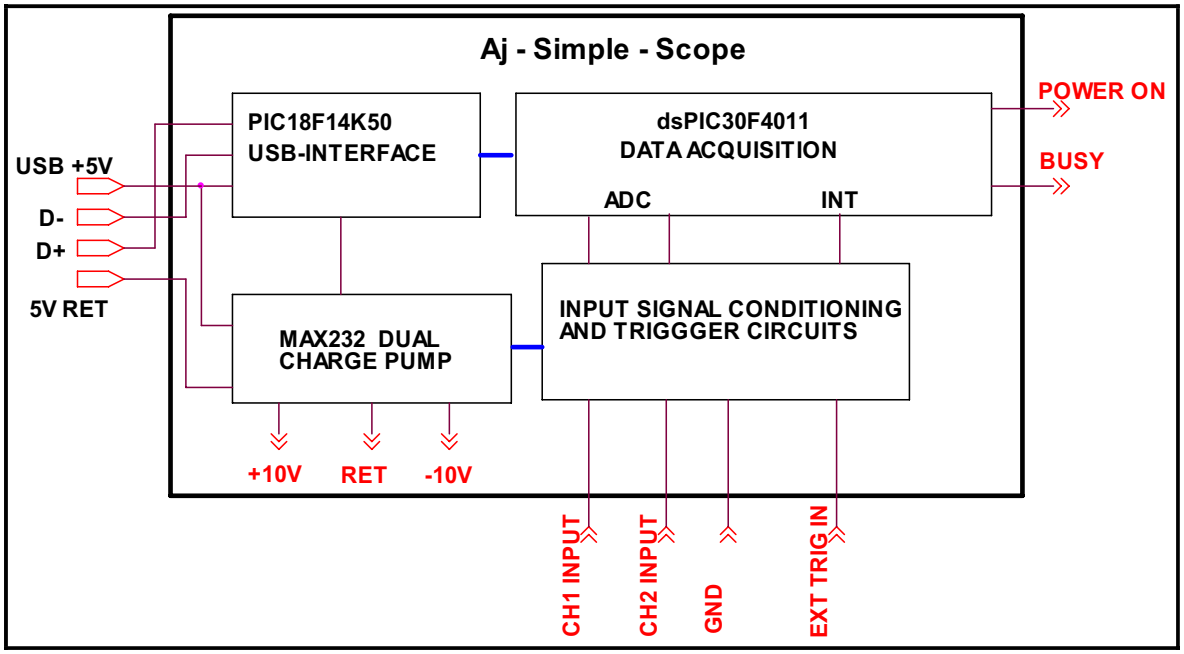


Figure 1, Aj-Simple-Scope simplified block schematic

Figure 1 shows the simplified block schematic of the system. For ease of portability the unit is powered and controlled from the USB port of a PC.

A PIC18F14K50 and dsPIC30F4011 microcontrollers are used to provide the functionality of the unit.

The first PIC microcontroller implements the following functions:

- Communicates with the host PC for enumeration as a USB to UART device
- Sets up the unit as a 200mA device
- Switches on power to the DC-DC converter
- Acts as a USB communication interface to the second PIC

The second PIC microcontroller implements the main Oscilloscope Functions

- Analog to Digital conversion of the CH1 and CH2 signal conditioned inputs at the required sampling rates
- Trigger interrupt handling
- Responding to serial commands from PIC1 and sending back the acquired data.
- A Busy signal is also generated

The dual-charge pump circuitry of the MAX232 is used as a DC-DC converter to provide a nominal ± 10V to all the analog circuitry.

4. Software on the PC Host:

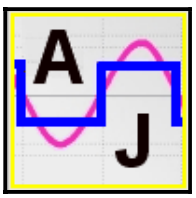


Figure 2, Aj-Simple-Scope Icon

A Visual Basic .Net 2.0 based GUI program is used to control the functions of the Aj-Simple-Scope. An Aj_Scope.exe along with associated ZedGraph.dll and USB driver files has been tested for compatibility with Windows XP and Windows 7 with .net 2.0.

5. GUI:

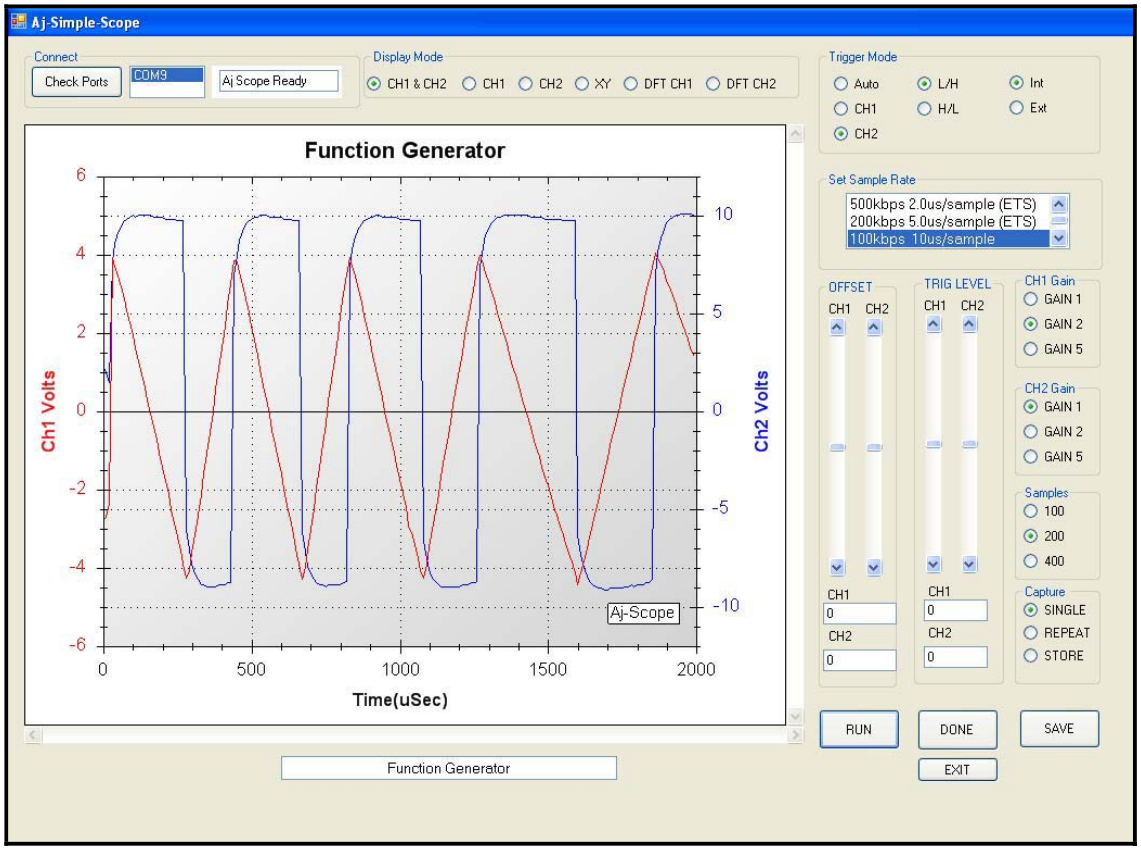


Figure 3, GUI

The GUI based Windows software on the Host PC permits checking for available COM ports and connecting to the port on which the hardware is connected.

Once connected the hardware unit responds with a ready signal.

Display and trigger modes, sampling rate, channel gains, channel offset trigger offset and number of samples can be set using the simple controls.

The RUN button initiates the signal capture single, repetitive or over-plotted.

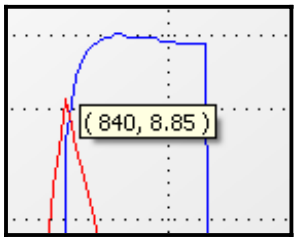


Figure 4, Mouse cursor data display

Values of data at the mouse cursor are automatically displayed.

The waveform caption can be entered and the figure stored as an image file.

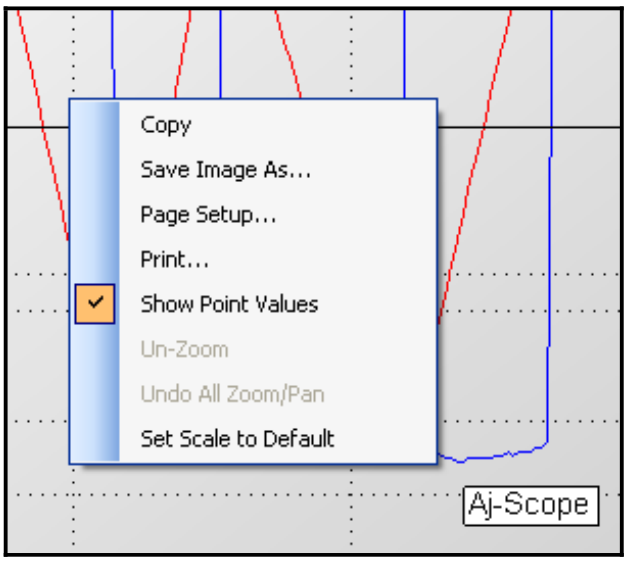


Figure 5, Image zoom, copy, print and save modes

Data can be stored in a .csv file using the SAVE option. Further processing can be carried out in MS EXCEL.

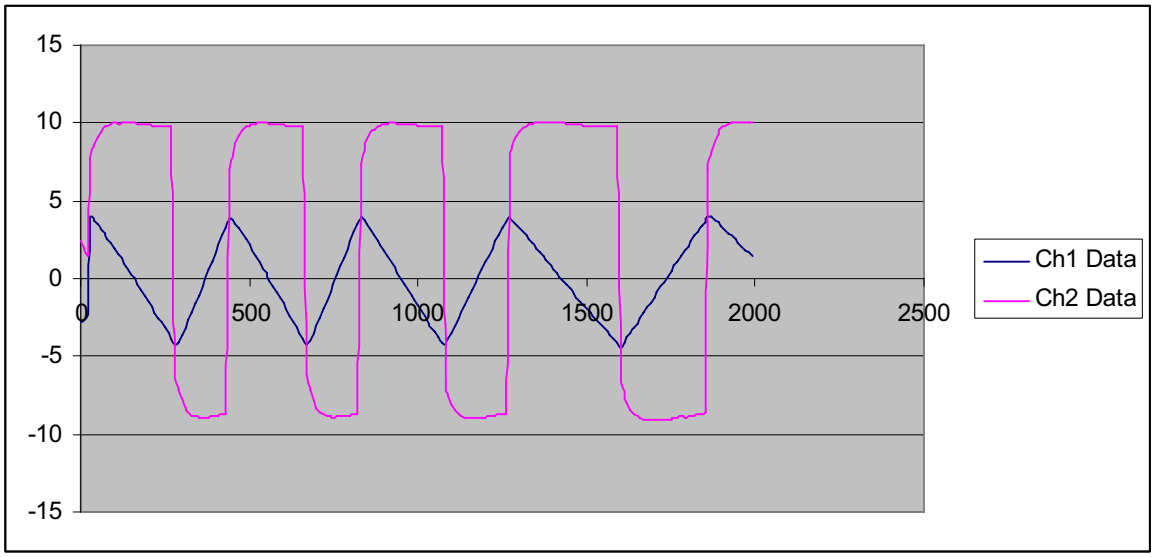


Figure 6, Plot in EXCEL based on saved data

A DFT (discrete furrier transform) can be carried out to show the frequency spectrum of captured waveforms.

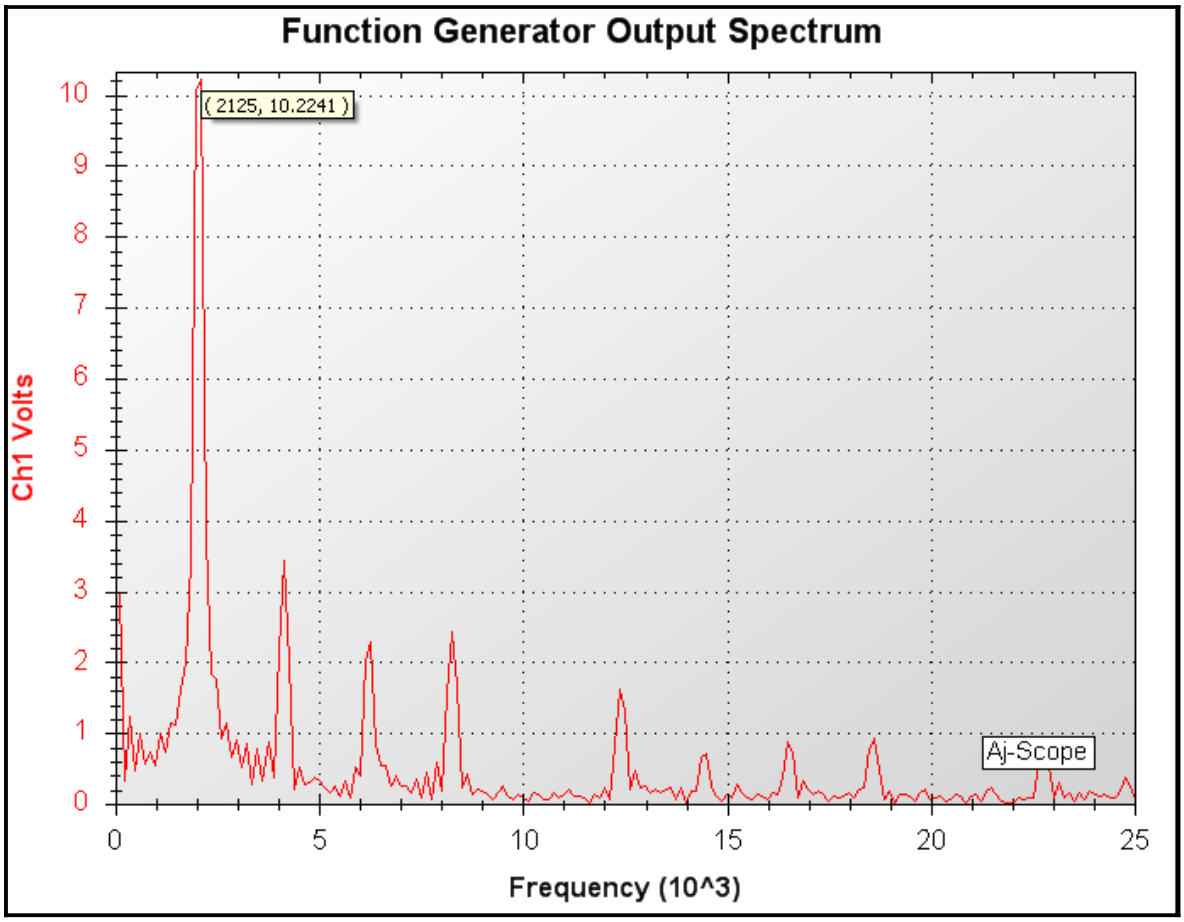


Figure 7, Spectrum Display

Finally an EXIT button is provided to close the program and exit.

6. Aj-Simple-Scope Unit, Front and Rear Panels:

Figure 8, Showing Aj-Simple-Scope Unit

Figure 9, Front panel showing connectors and LED's

Figure 10, Rear panel showing USB connector and Reset switch

7. Circuit Diagrams:

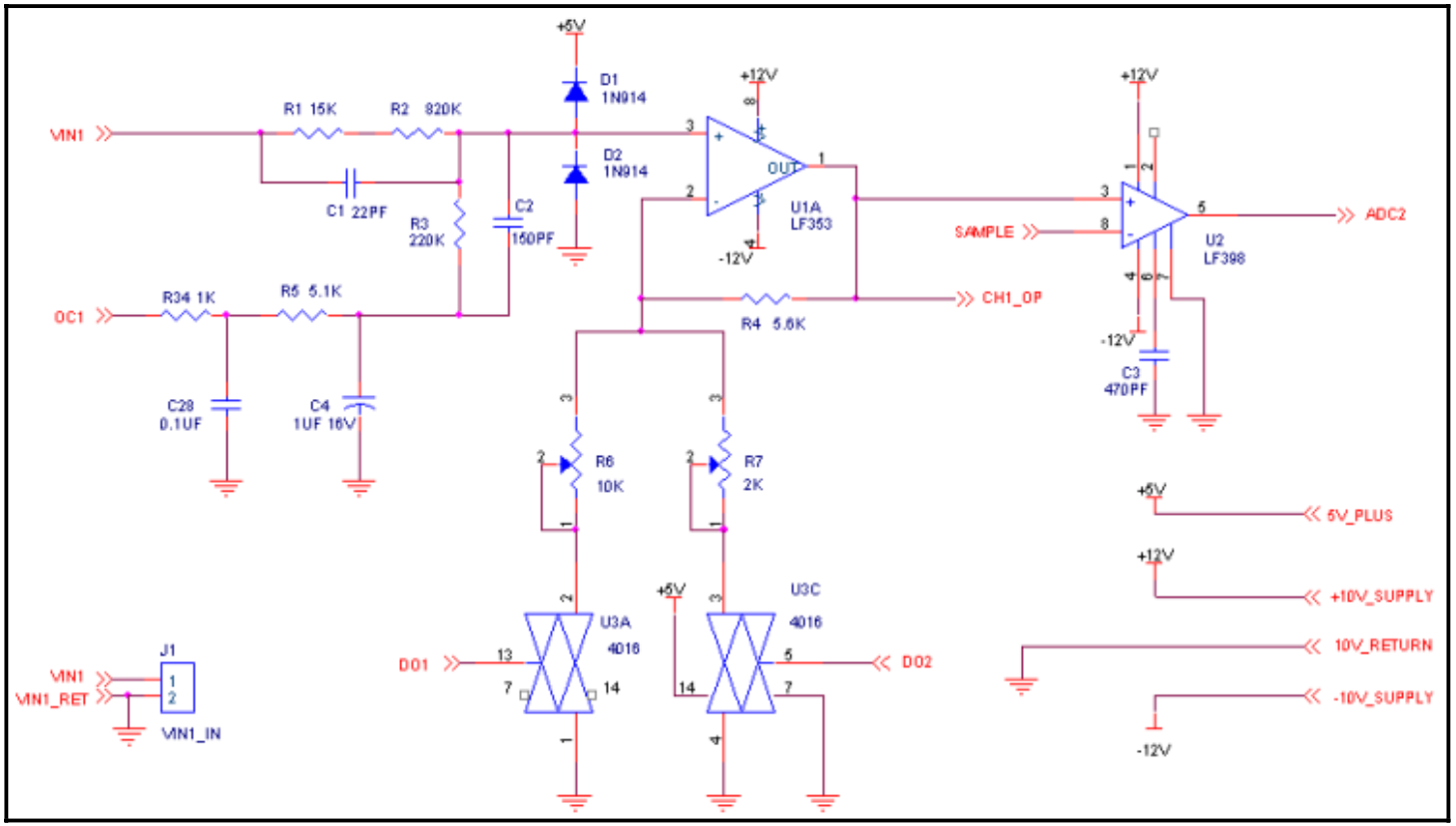


Figure 11, CH1 signal conditioner circuitry

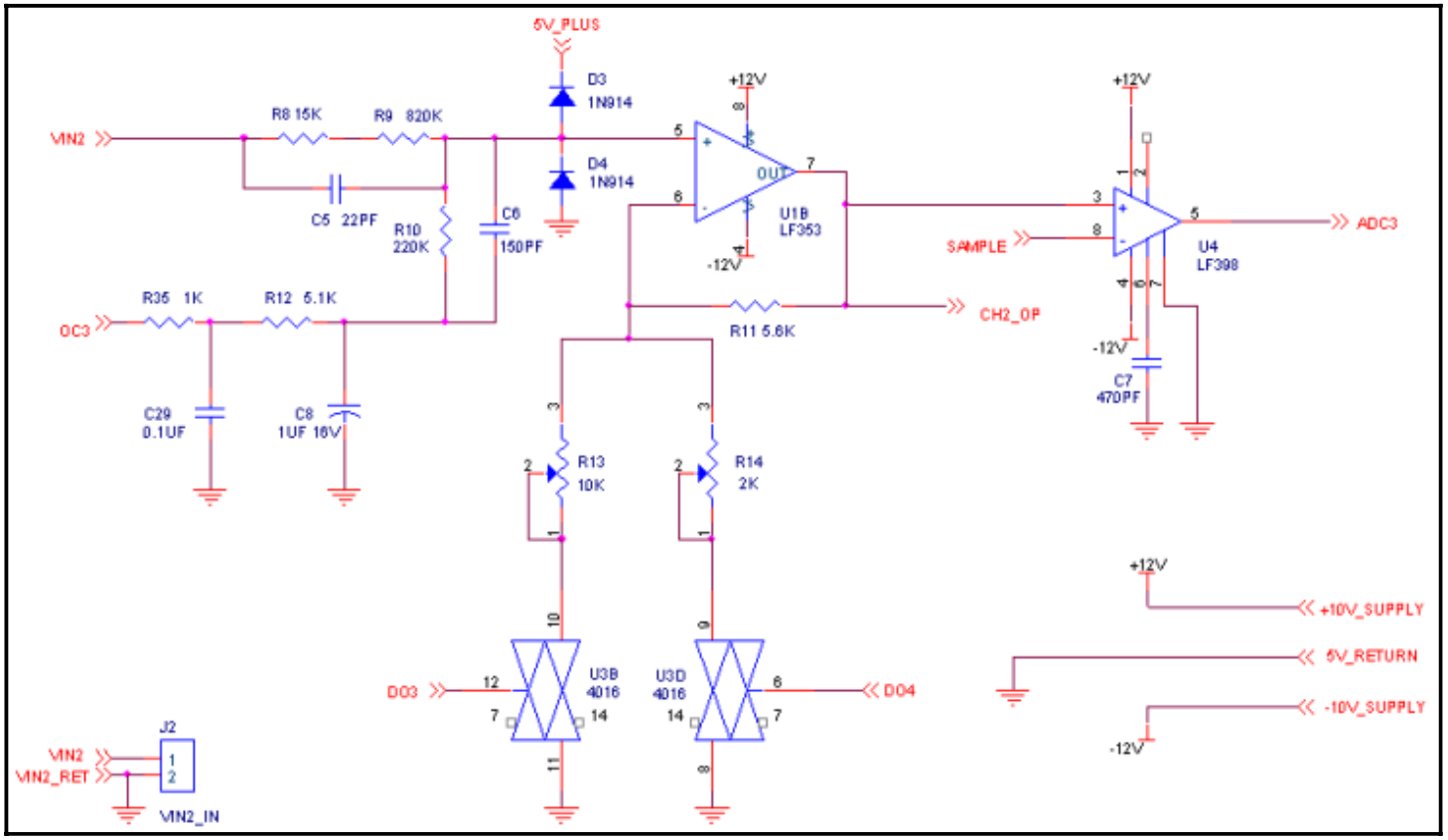


Figure 12, CH2 signal conditioner circuitry

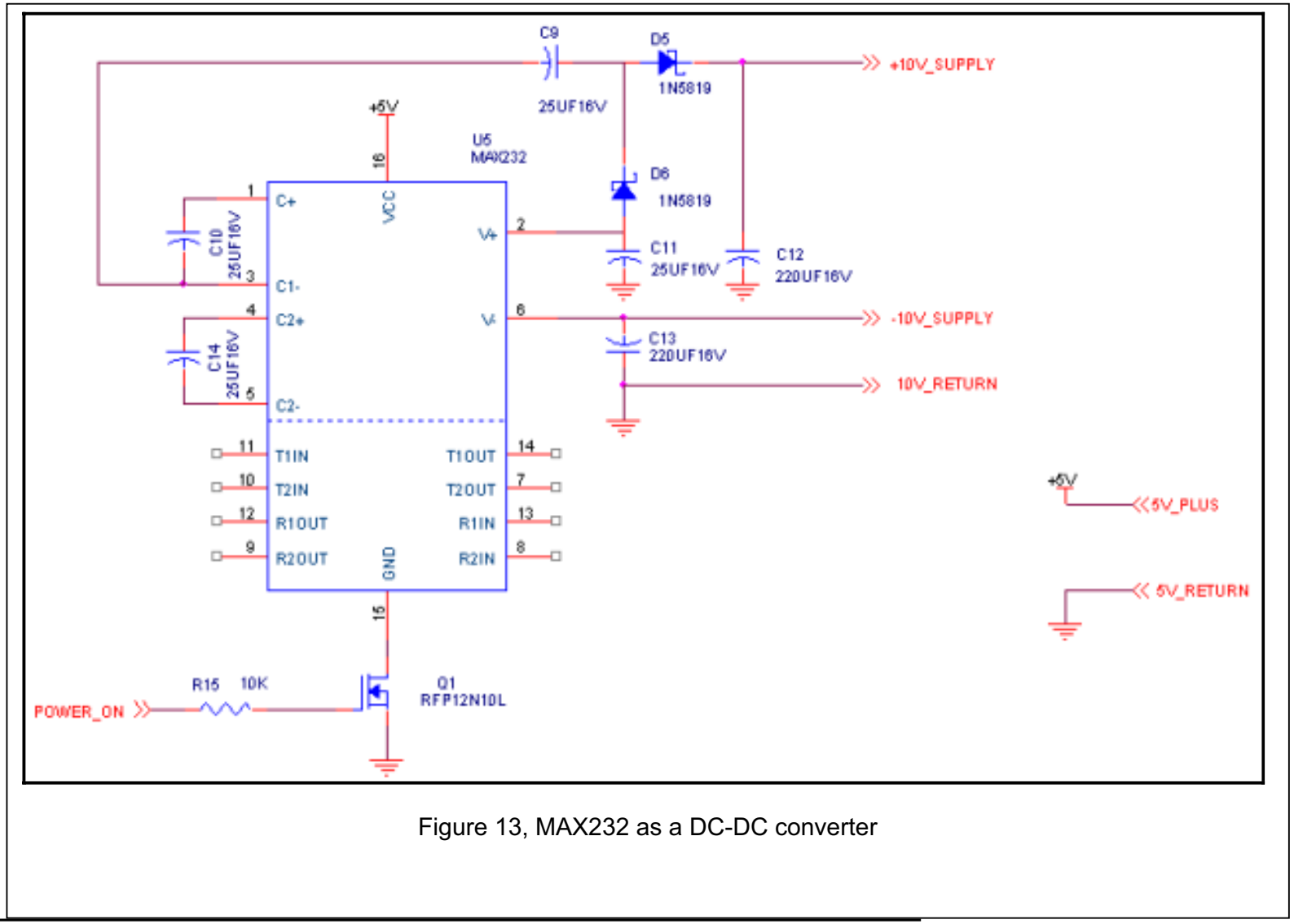


Figure 13, MAX232 as a DC-DC converter

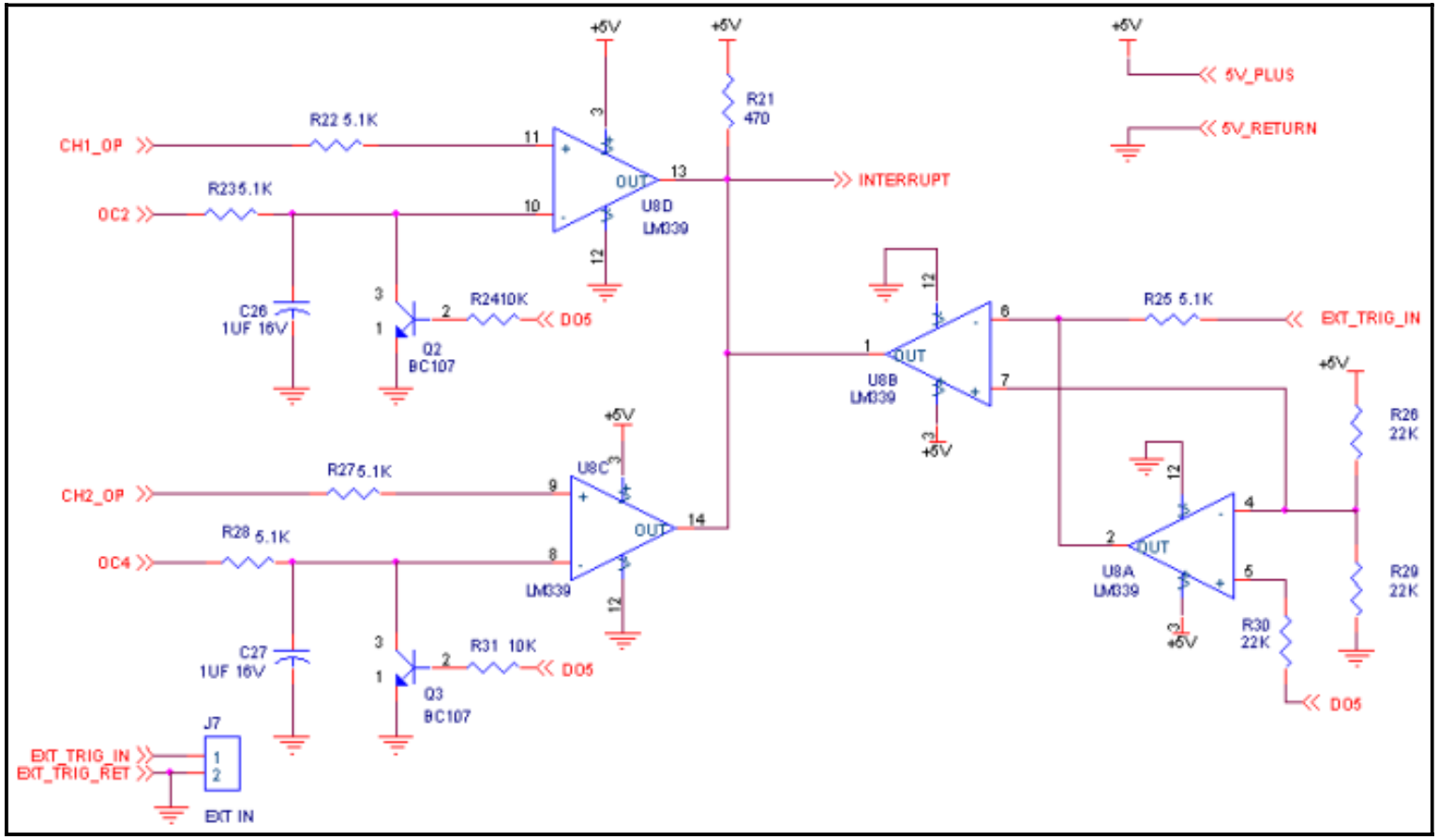


Figure 14, Trigger circuitry

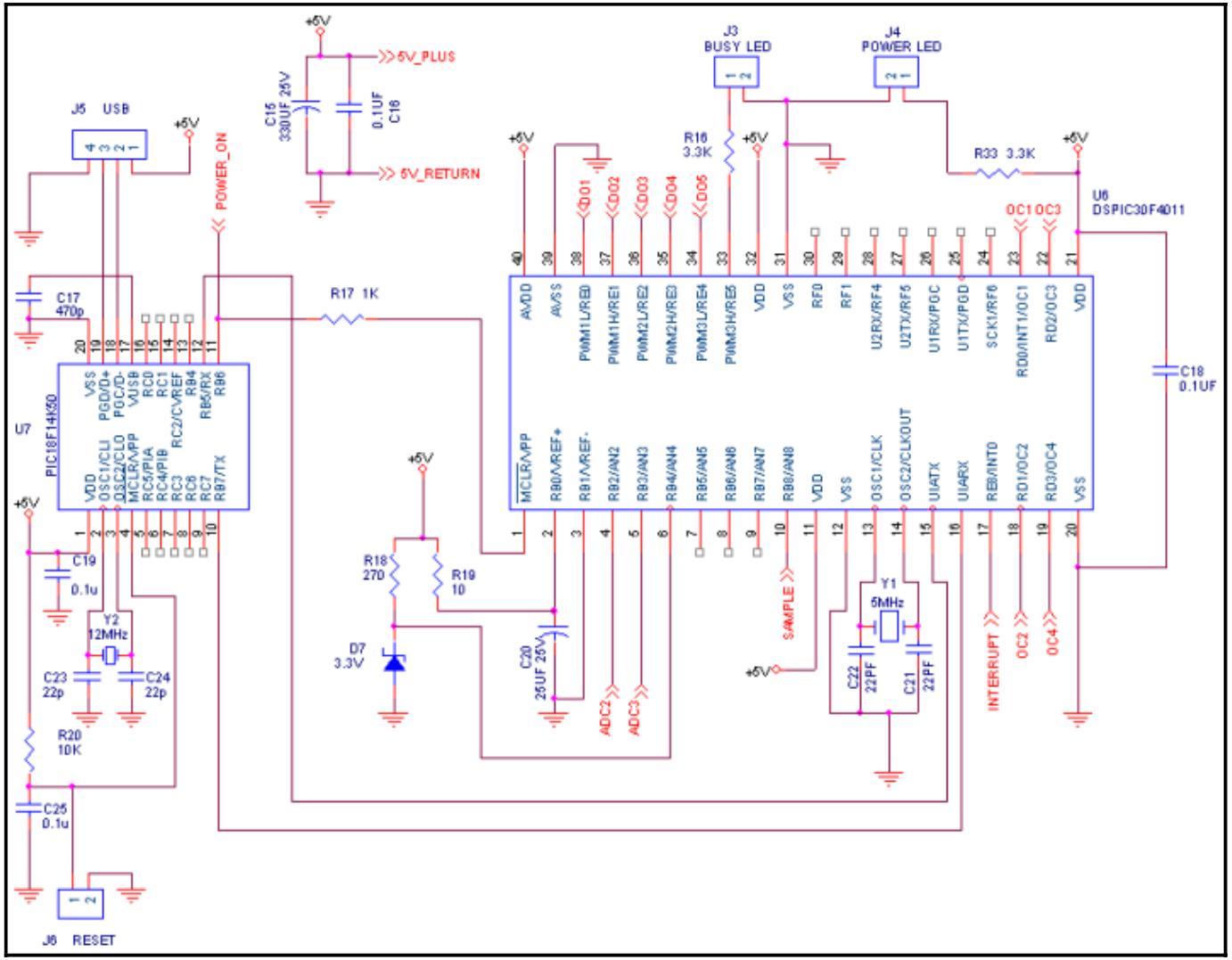


Figure 15. Processor circuitry

8. Bill of materials

Aj-Simple-Scope BILL OF MATERIALS COST

Item	Quantity	Reference	Part	Cost INR	Extended Cost	
1	4	C1,C5,C21,C22	22PF	0.50	2.00	
2	2	C6,C2	150PF	0.50	1.00	
3	2	C7,C3	470PF	0.50	1.00	
4	4	C4,C8,C26,C27	1UF 16V	1.50	6.00	
5	4	C9,C10,C11,C14	25UF16V	1.50	6.00	
6	2	C12,C13	220UF16V	2.50	5.00	
7	1	C15	330UF 25V	4.50	4.50	
8	4	C16,C18,C28,C29	0.1UF	1.00	4.00	
9	1	C17	470p	0.50	0.50	
10	2	C19,C25	0.1u	1.00	2.00	
11	1	C20	25UF 25V	2.50	2.50	
12	2	C23,C24	22p	0.50	1.00	
13	4	D1,D2,D3,D4	1N914	0.40	1.60	
14	2	D5,D6	1N5819	1.00	2.00	
15	1	D7	3.3V	1.00	1.00	
16	1	J1	VIN1 IN	10.00	10.00	
17	1	J2	VIN2 IN	10.00	10.00	
18	1	J3	BUSY LED	1.00	1.00	
19	1	J4	POWER LED	1.00	1.00	
20	1	J5	USB	8.00	8.00	
21	1	J6	RESET	4.00	4.00	
22	1	J7	EXT IN	10.00	10.00	
23	1	Q1	RFP12N10L	51.00	51.00	
24	2	Q2,Q3	BC107	7.00	14.00	
25	2	R8,R1	15K	0.20	0.40	
26	2	R9,R2	820K	0.20	0.40	
27	2	R10,R3	220K	0.20	0.40	
28	2	R11,R4	5.6K	0.20	0.40	
29	7	R5,R12,R22,R23,R25,R27,R28	5.1K	0.20	1.40	
30	6	R15,R20,R24,R31	10K	0.20	1.20	
31	2	R6,R13	10K TRIMPOT	18.00	36.00	
32	2	R14,R7	2K TRIMPOT	18.00	36.00	
33	2	R16,R33	3.3K	0.20	0.40	
34	3	R17,R34,R35	1K	0.20	0.60	
35	1	R18	270	0.20	0.20	
36	1	R19	10	0.20	0.20	
37	1	R21	470	0.20	0.20	
38	3	R26,R29,R30	22K	0.20	0.60	
39	1	U1	LF353	5.00	5.00	
40	2	U4,U2	LF398	45.00	90.00	
41	1	U3	CD4016	25.00	25.00	
42	1	U5	MAX232	30.00	30.00	
43	1	U6	DSPIC30F4011	450.00	450.00	
44	1	U7	PIC18F14K50	230.00	230.00	
45	1	U8	LM339	40.00	40.00	
46	1	Y1	5MHz	5.00	5.00	
47	1	Y2	12MHz	5.00	5.00	
48	1	PCB	Aj_Simple-Scope	200.00	200.00	
49	1	ENCLOSURE	GIANTA 1916	215.00	215.00	
			TOTAL COST INR		1,522.50	
			TOTAL COST $		27.68	

9. Printed Circuit Boards :

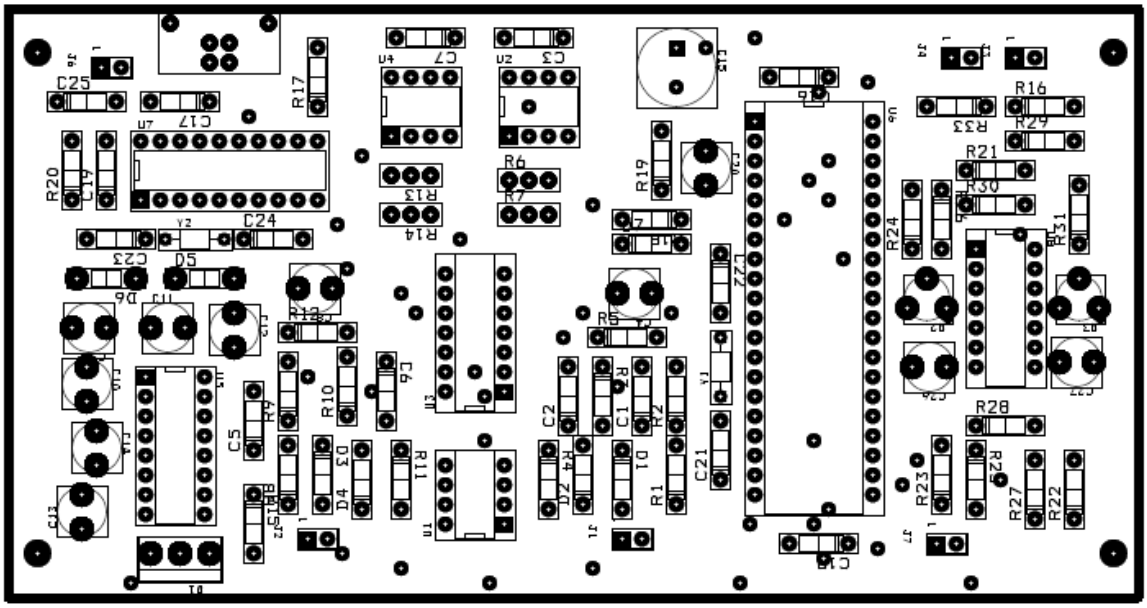


Figure 16, Component Layout

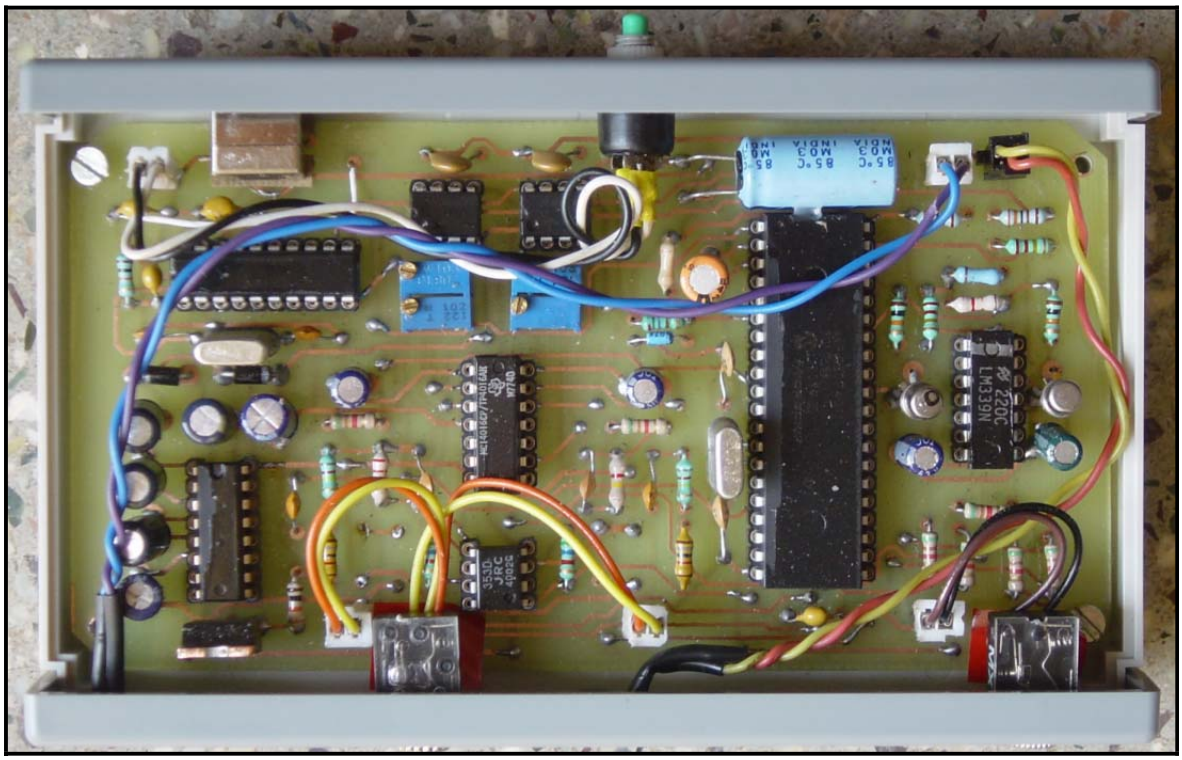


Figure 17, Wired PCB top view

10. Appendices

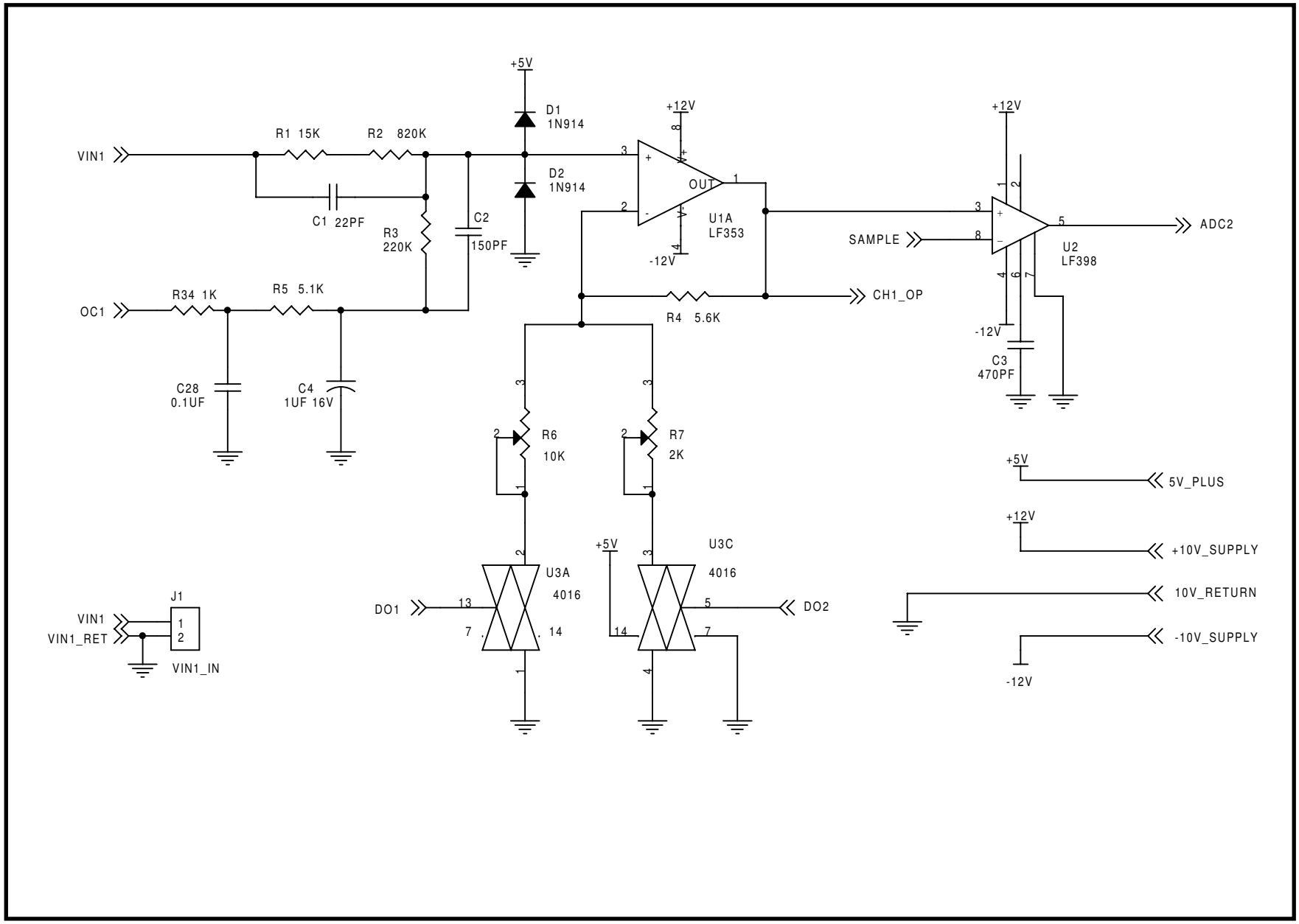
- CH1 Input Circuit
- CH2 Input Circuit
- MAX232 Dual Charge Pump Circuit
- Trigger Circuit
- Processor Circuit
- Component layout
- PCB 1:1 A4 Top mirrored
- PCB 1:1 A4 Bottom

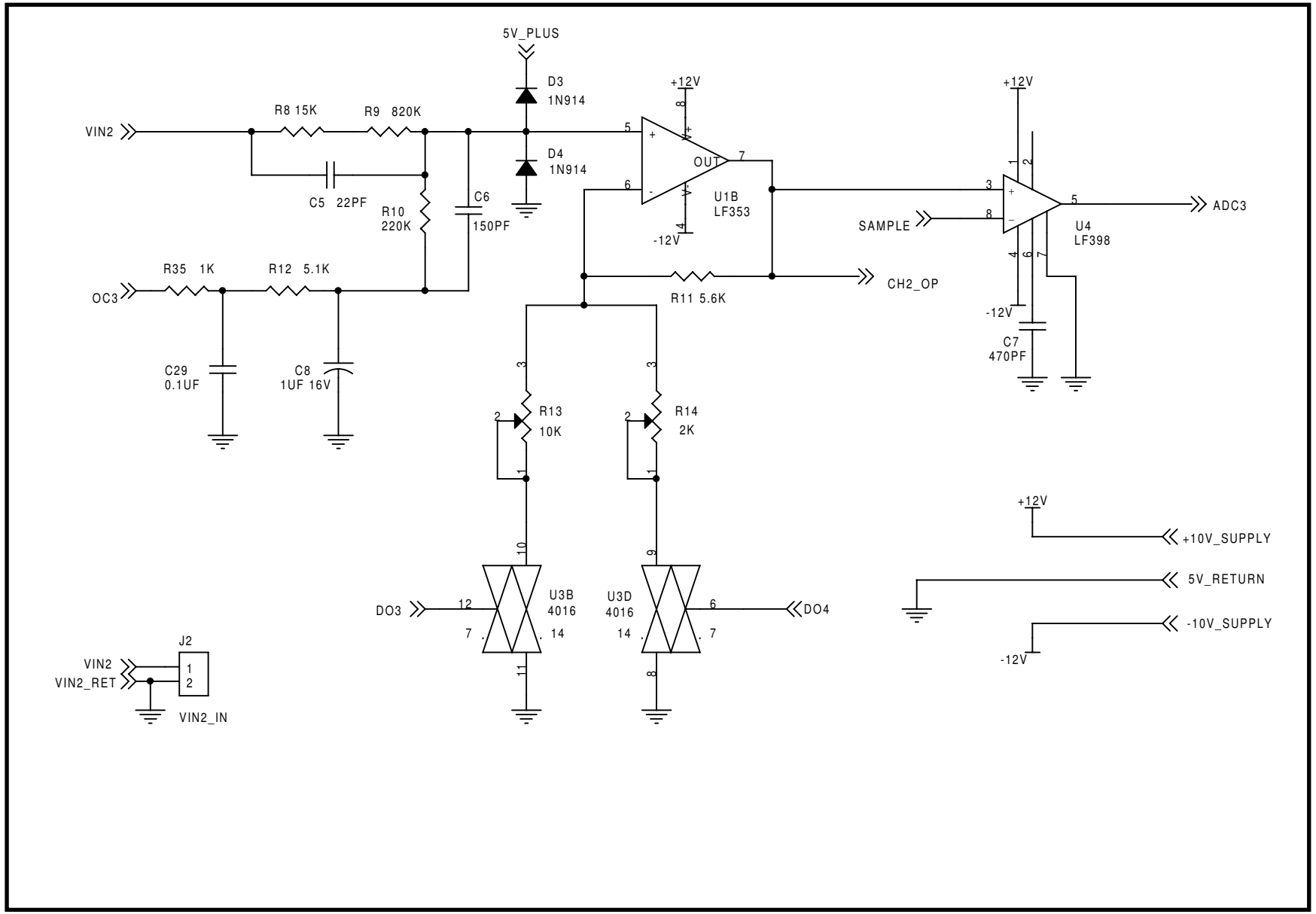
11. Summary

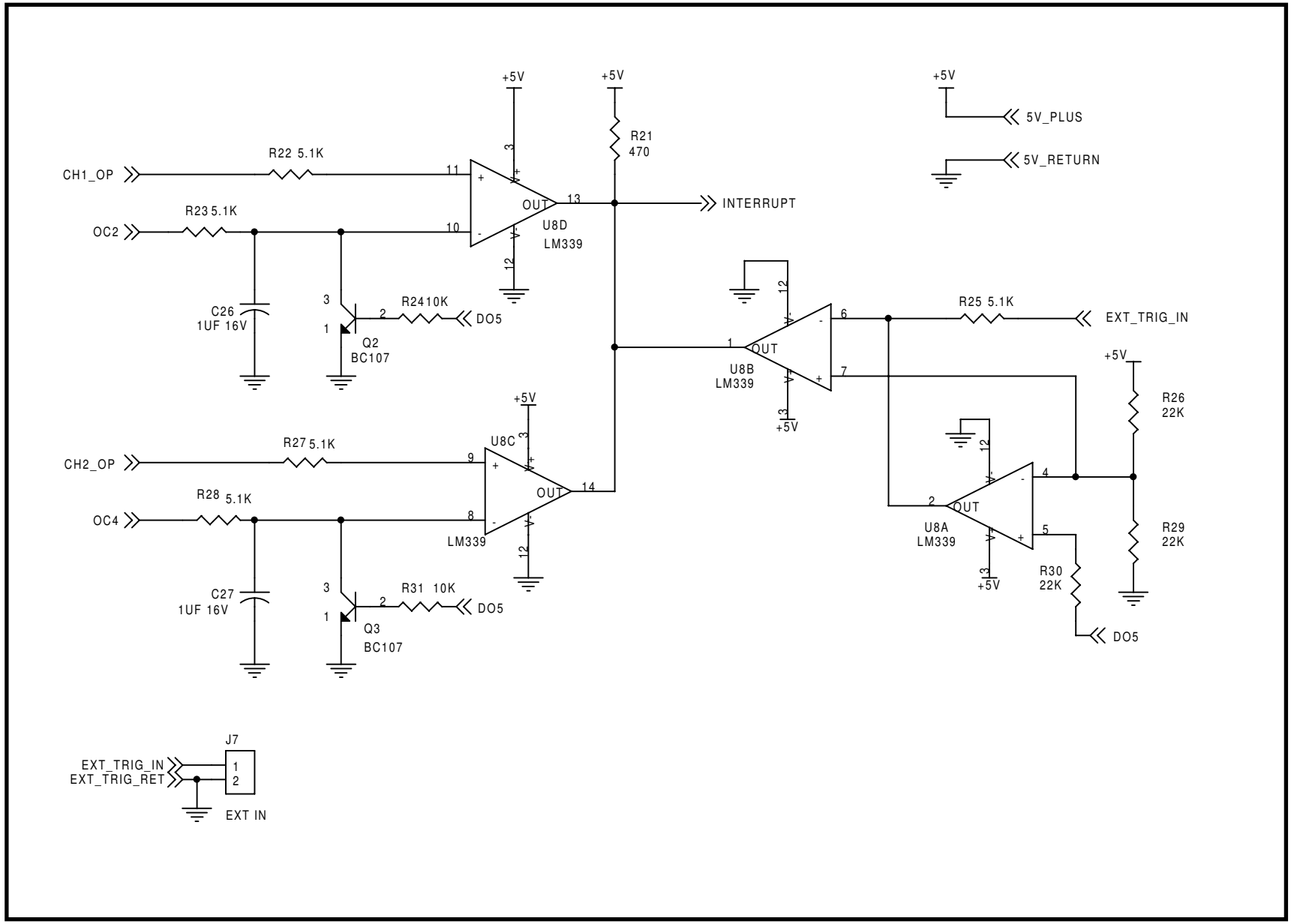
This document provides essential information for fabrication and operation of the Aj-Simple-Scope unit.

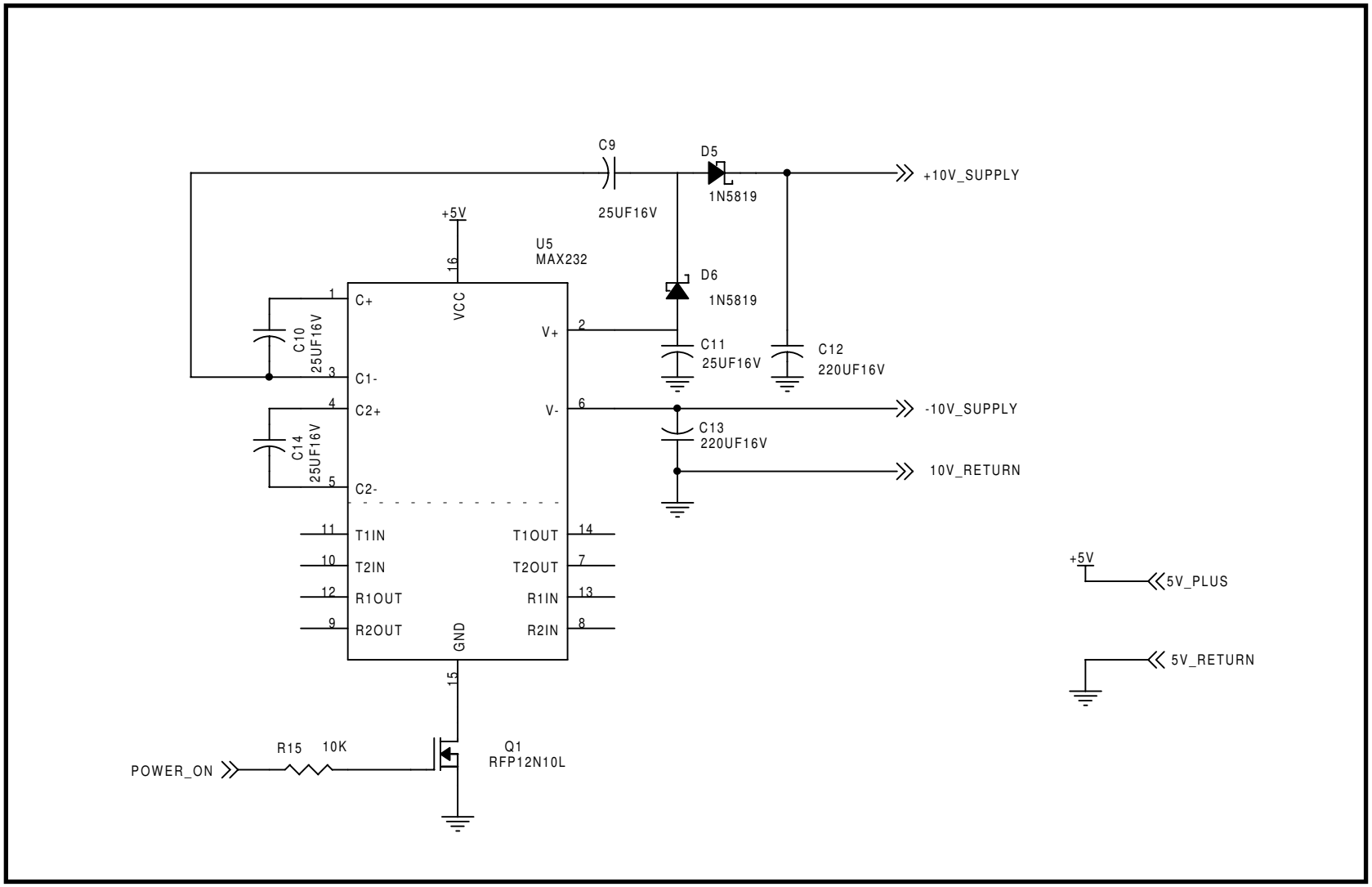
Software can be downloaded from my website http://www.ajoyraman.in

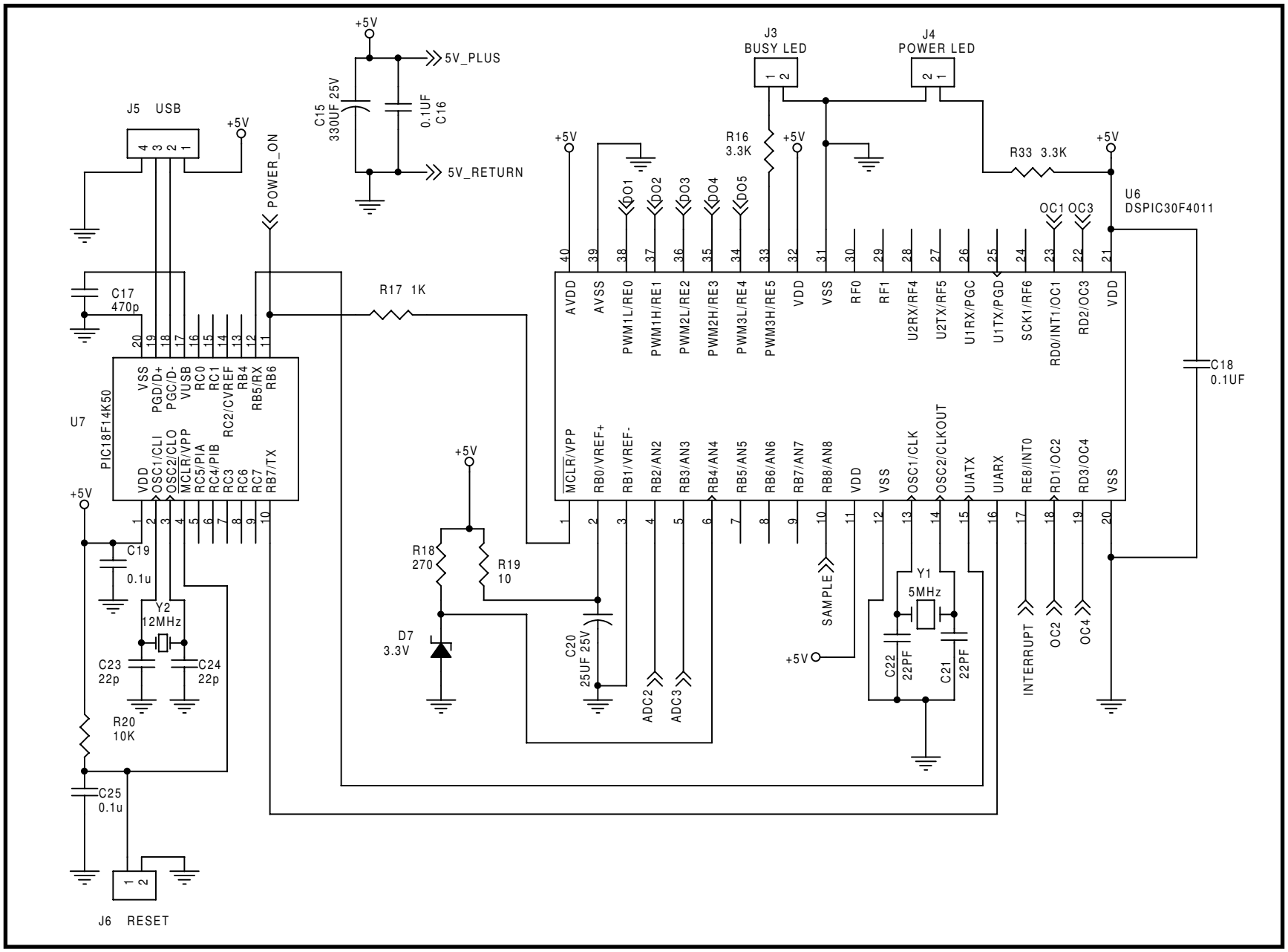
Address any doubts and clarifications to me at ajoyraman@gmail.com

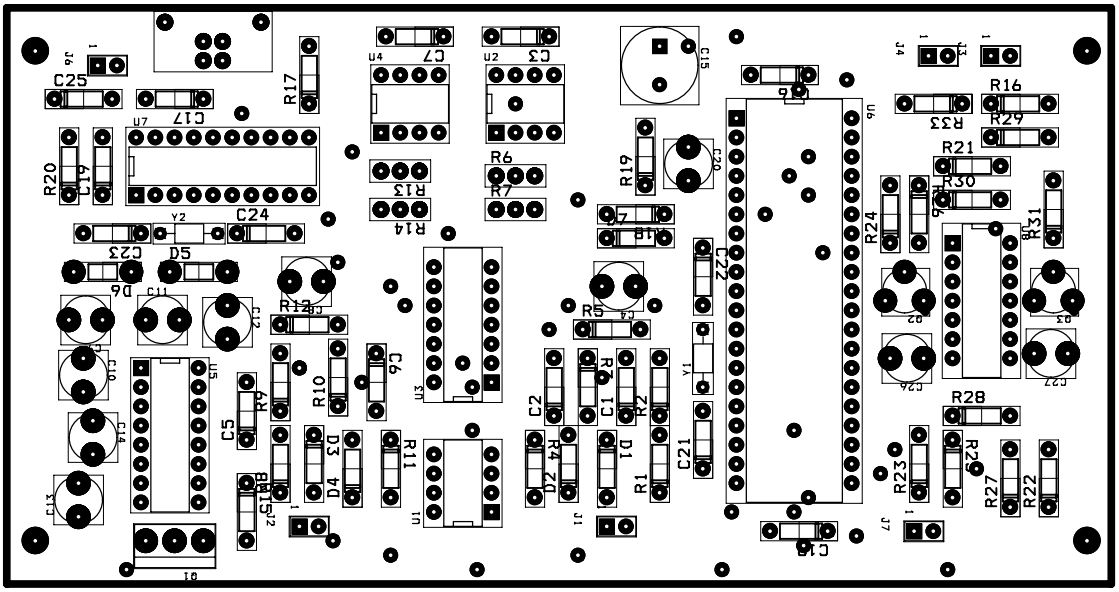

+5V
D1
1N914
D2
1N914
+12V
VIN1
R1 15K
R2 820K
C1 22PF
R3
220K
C2
150PF
U1A
LF353
OUT
-12V
OC1
R34 1K
R5 5.1K
C28
0.1UF
C4
1UF 16V
R4 5.6K
CH1_OP
SAMPLE
U2
LF398
ADC2
C3
470PF
R6
10K
R7
2K
U3A
4016
U3C
4016
DO1
DO2
J1
VIN1
VIN1_RET
VIN1_IN
5V_PLUS
+10V_SUPPLY
10V_RETURN
-10V_SUPPLY


5V_PLUS
D3
1N914
D4
1N914
VIN2
R8 15K
R9 820K
C5 22PF
R10
220K
C6
150PF
+12V
U1B
LF353
OUT
-12V
R35 1K
R12 5.1K
OC3
C29
0.1UF
C8
1UF 16V
R11 5.6K
CH2_OP
SAMPLE
U4
LF398
ADC3
C7
470PF
R13
10K
R14
2K
DO3
U3B
4016
U3D
4016
DO4
+10V_SUPPLY
5V_RETURN
-10V_SUPPLY
J2
VIN2
VIN2_RET
VIN2_IN


+5V
+5V
+5V
5V_PLUS
5V_RETURN
R21
470
CH1_OP
R22 5.1K
OC2
R23 5.1K
INTERRUPT
U8D
LM339
OUT
C26
1UF 16V
R2410K
DO5
Q2
BC107
R25 5.1K
EXT_TRIG_IN
U8B
LM339
R26
22K
CH2_OP
R27 5.1K
U8C
OC4
R28 5.1K
LM339
U8A
LM339
R29
22K
R30
22K
C27
1UF 16V
R31 10K
Q3
BC107
J7
EXT_TRIG_IN
EXT_TRIG_RET
EXT IN

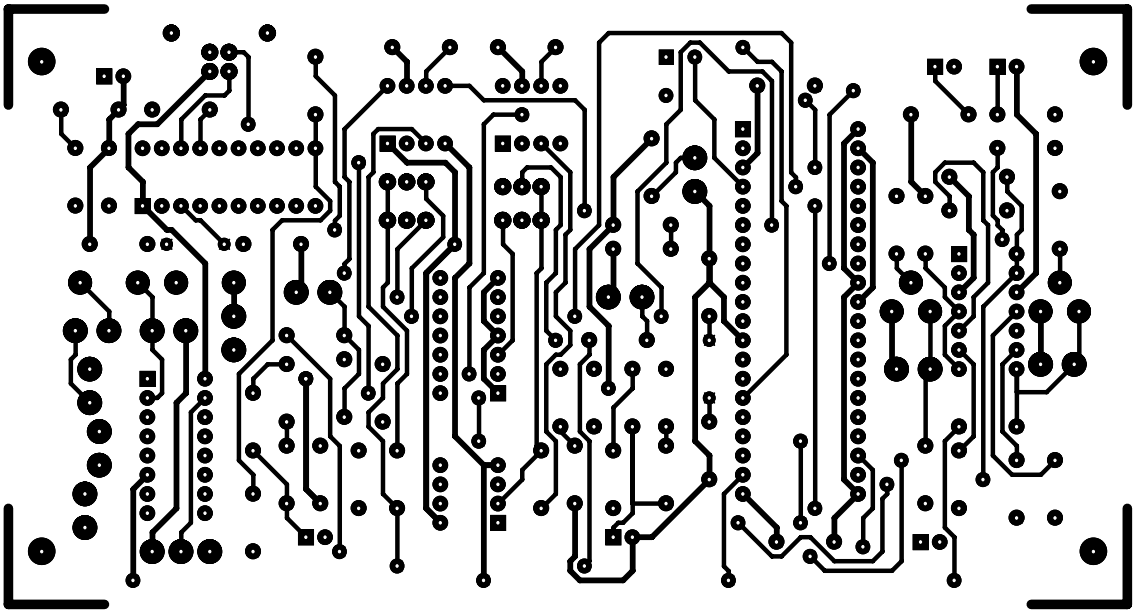

C9
25UF16V
D5
1N5819
+10V_SUPPLY
+5V
U5
MAX232
16
VCC
D6
1N5819
1
C+
C10
25UF16V
3
C1-
2
V+
C11
25UF16V
C12
220UF16V
4
C2+
C14
25UF16V
5
C2-
6
V-
-10V_SUPPLY
C13
220UF16V
10V_RETURN
11
T1IN
T1OUT
14
10
T2IN
T2OUT
7
12
R1OUT
R1IN
13
9
R2OUT
R2IN
8
GND
15
+5V
5V_PLUS
5V_RETURN
R15
10K
POWER_ON
Q1
RFP12N10L


+5V
5V_PLUS
C15
330UF 25V
0.1UF
C16
5V_RETURN
J5 USB
POWER_ON
J3
BUSY LED
J4
POWER LED
R16
3.3K
R33 3.3K
U6
DSPIC30F4011
C17
470p
R17 1K
C18
0.1UF
U7
PIC18F14K50
C19
0.1u
Y2
12MHz
C23
22p
C24
22p
R20
10K
C25
0.1u
J6 RESET
R18
270
R19
10
D7
3.3V
C20
25UF 25V
ADC2
ADC3
SAMPLE
Y1
5MHz
C22
22PF
C21
22PF
INTERRUPT
OC1
OC2
OC3
OC4



DRILL CHART				
SYM	DIAM	TOL	QTY	NOTE
×	0.028		48	
+	0.034		130	
◇	0.037		12	
⊠	0.038		96	
⊞	0.056		6	
⊕	0.065		12	
○	0.100		35	
△	0.110		4	
TOTAL			343	

DRILL CHART				
SYM	DIAM	TOL	QTY	NOTE
×	0.028		48	
+	0.034		130	
◇	0.037		12	
⊠	0.038		96	
⊞	0.056		6	
⊕	0.065		12	
○	0.100		35	
△	0.110		4	
	TOTAL		343	



DRILL CHART				
SYM	DIAM	TOL	QTY	NOTE
×	0.028		48	
+	0.034		130	
◇	0.037		12	
⊠	0.038		96	
⊞	0.056		6	
⧾	0.065		12	
○	0.100		35	
△	0.110		4	
TOTAL			343	