ModularEEG v1.1.0 - Bill of Materials

Digital board

Qty	Value	Package	Parts											
Capacitors														
1	27pF C0G	C-5	C102											
2	Cxtal	C-5	C115	C116										
3	10nF X7R	C-5	C108	C113	C119									
7	100nF X7R	C-5	C110	C111	C114	C117	C121	C124	C125	C131				
6	220nF 5%	C-5	C103	C104	C105	C106	C107	C109						
2	1µF tantalum	EL25B	C122	C123										
6	10µF tantalum	EL25B	C101	C120	C126	C127	C128	C129						
3	47µF tantalum	EL25B	C112	C118	C130									
Resistors														
1	100R	R-10	R111											
12	470R	R-10	R107	R114	R115	R116	R117	R118	R119	R120	R121	R122	R124	R128
5	1k	R-10	R125	R126	R127	R129	R130							
6	7.5k	R-10	R104	R106	R109	R110	R112	R113						
1	9k1	R-10	R103											
3	10k	R-10	R101	R105	R123									
1	15k	R-10	R102											
Discrete Semiconductors														
3	1N5818	D-12,5	D101	D103	D104									
1	LED 5mm	LED5	D102											
Integrated Circuits														
2	6N139	DIL-08	IC103	IC104										
1	7805	78XXL_S	IC107											
1	AT90S4433P	DIL-28/3	IC102											
1	MAX232	DIL-16	IC106											
1	TL431CLP	TO92-CLP	IC101											
1	TMV0505S	TMADCDC	IC105											
Miscellaneous Parts														
1	7.3728MHz	HC49/S	X101											
3	22µH	R-12,5	L101	L102	L103									
1	PINHD-2X5	2X05	J101											
1	PINHD-2X17	2X17	J102											

Analog board

Qty	Value	Package	Parts											
Capacitors														
2	10pF C0G	C-5	C209	C210										
4	100pF C0G	C-5	C204	C205	C206	C207								
6	1nF X7R	C-5	C212	C216	C222	C224	C232	C233						
2	10nF X7R	C-5	C202	C203										
2	33nF 5%	C-5	C234	C236										
12	100nF X7R	C-5	C208	C211	C214	C215	C217	C218	C219	C223	C225	C226	C227	C230
2	220nF 5%	C-5	C231	C235										
4	1µF film	C-10	C220	C221	C228	C229								
1	47µF tantalum	EL25B	C213											
1	47µF tan 1ohm	ES-5	C201											
Resistors														
1	100R	R-10	R240											
2	1k	R-10	R220	R222										
16	2k2	R-10	R201	R202	R203	R204	R205	R206	R207	R208	R209	R210	R211	R212
			R214	R215	R216	R217								
2	8.2k	R-10	R229	R234										
6	10k	R-10	R218	R219	R232	R237	R238	R239						
2	15k	R-10	R228	R233										
4	100k	R-10	R221	R225	R230	R235								
1	200k	R-10	R213											
6	1M	R-10	R223	R224	R226	R227	R231	R236						
Discrete Semiconductors														
4	BC547	TO92	Q205	Q206	Q207	Q208								
4	BC557	TO92	Q201	Q202	Q203	Q204								
Integrated Circuits														
2	INA114P	DIL-08	IC202	IC203										
4	TLC277P	DIL-08	IC201	IC204	IC205	IC206								
Miscellaneous Parts														
3	20k	S64Y	P201	P202	P203									
1	PINHD-2X17	2X17	J201											
170														

ModularEEG v1.1.0 - ordering information

All prices as of September 2002.

Color key:

See notes below.

No part is selected.

See distributor-specific notes below..

Not available. Prices given are estimates.

							Reichelt				RS Components					Reichelt								RS Components							
Value	**Package**	**Qty D**	**Qty A**	**Qty D+A**	**Qty D+2A**	**Part requirements and notes**	**Part no.**	**Unit Price**	**Min Qty**	**?**	**Part no.**	**Unit Price**	**Min Qty**	**?**			**Qty D**	**Qty A**	**Qty D+A**	**Qty D+2A**	**Price D**	**Price A**	**Price D+A**	**Price D+2A**	**Qty D**	**Qty A**	**Qty D+A**	**Qty D+2A**	**Price D**	**Price A**	**Price D+A**	**Price D+2A**
Capacitors																**Capacitors**																
10pF C0G	C-5		2	2	4	100V, 5mm pitch,C0G	Kerko-500 10p	0,07	1		N/A	0,1	5			10pF C0G		2	2	4		0,14	0,14	0,28		5	5	5		0,5	0,5	0,5
Cxtal C0G	C-5	2		2	2	5mm pitch, C0G. **See notes.**	Kerko-500 56p	0,07	1	1	N/A	0,1	5	1		Cxtal C0G	2		2	2	0,14		0,14	0,14	5		5	5	0,5		0,5	0,5
100pF C0G	C-5		4	4	8	100V, 5mm pitch, C0G	Kerko-500 100p	0,07	1		N/A	0,1	5			100pF C0G		4	4	8		0,28	0,28	0,56		5	5	10		0,5	0,5	1
1nF X7R	C-5		6	6	12	200V, 5mm pitch, X7R	X7R-5 1,0n	0,07	1		298-9028	0,14	5			1nF X7R		6	6	12		0,42	0,42	0,84		10	10	15		1,4	1,4	2,1
10nF X7R	C-5	3	2	5	7	100V, 5mm pitch, X7R	X7R-5 10n	0,07	1		264-4832	0,16	5			10nF X7R	3	2	5	7	0,21	0,14	0,35	0,49	5	5	5	10	0,8	0,8	0,8	1,6
33nF 5%	C-5		2	2	4	5%, 5mm pitch, max 3.5mm wide	N/A	0,1	1		312-1504	0,082	10			33nF 5%		2	2	4		0,2	0,2	0,4		10	10	10		0,82	0,82	0,82
100nF X7R	C-5	8	12	20	32	50V, 5mm pitch, X7R	X7R-5 100n	0,12	1		264-4876	0,205	5			100nF X7R	8	12	20	32	0,96	1,44	2,4	3,84	10	15	20	35	2,05	3,075	4,1	7,175
220nF 5%	C-5	6	2	8	10	5%, 5mm pitch, max 3.5mm wide	N/A	0,2	1		312-1475	0,139	10			220nF 5%	6	2	8	10	1,2	0,4	1,6	2	10	10	10	10	1,39	1,39	1,39	1,39
1µF film	C-10		4	4	8	5% tolerance, 10mm pitch	MKH100-10 1,0µ	0,3	1		298-0188	0,349	5			1µF film		4	4	8		1,2	1,2	2,4		5	5	10		1,745	1,745	3,49
1µF tantalum	EL25B	2		2	2	35V, 2.5mm pitch	TANTAL 1,0/35	0,15	1		N/A	0,2	1			1µF tantalum	2		2	2	0,3		0,3	0,3	2		2	2	0,4		0,4	0,4
10µF tantalum	EL25B	6		6	6	16V, 2.5mm pitch	TANTAL 10/16	0,22	1		N/A	0,2	1			10µF tantalum	6		6	6	1,32		1,32	1,32	6		6	6	1,2		1,2	1,2
47µF tantalum	EL25B	3	1	4	5	> 6.3V, 2.5mm pitch	TANTAL 47/6,3	0,33	1		N/A	0,3	1			47µF tantalum	3	1	4	5	0,99	0,33	1,32	1,65	3	1	4	5	0,9	0,3	1,2	1,5
47µF tan 1ohm	ES-5		1	1	2	> 6.3V, 5mm pitch, ESR = 0.8 - 1.2 ohm	N/A	3	1		N/A	3	1			47µF tan 1ohm		1	1	2		3	3	6		1	1	2		3	3	6
Resistors																**Resistors**																
100R	R-10	1	1	2	3	1% metal film, 0.25W, 10mm pitch	METALL 100	0,08	1		148-269	0,044	10			100R	1	1	2	3	0,08	0,08	0,16	0,24	10	10	10	10	0,44	0,44	0,44	0,44
470R	R-10	12		12	12	1% metal film, 0.25W, 10mm pitch	METALL 470	0,08	1		148-427	0,044	10			470R	12		12	12	0,96		0,96	0,96	20		20	20	0,88		0,88	0,88
1k	R-10	5	2	7	9	1% metal film, 0.25W, 10mm pitch	METALL 1,00K	0,08	1		148-506	0,044	10			1k	5	2	7	9	0,4	0,16	0,56	0,72	10	10	10	10	0,44	0,44	0,44	0,44
2k2	R-10		16	16	32	1% metal film, 0.25W, 10mm pitch	METALL 2,20K	0,08	1		148-584	0,044	10			2k2		16	16	32		1,28	1,28	2,56		20	20	40		0,88	0,88	1,76
7.5k	R-10	6		6	6	1% metal film, 0.25W, 10mm pitch	METALL 7,50K	0,08	1		148-708	0,044	10			7.5k	6		6	6	0,48		0,48	0,48	10		10	10	0,44		0,44	0,44
8.2k	R-10		2	2	4	1% metal film, 0.25W, 10mm pitch	METALL 8,20K	0,08	1		148-714	0,044	10			8.2k		2	2	4		0,16	0,16	0,32		10	10	10		0,44	0,44	0,44
9k1	R-10	1		1	1	1% metal film, 0.25W, 10mm pitch	METALL 9,10K	0,08	1		148-720	0,044	10			9k1	1		1	1	0,08		0,08	0,08	10		10	10	0,44		0,44	0,44
10k	R-10	3	6	9	15	1% metal film, 0.25W, 10mm pitch	METALL 10,0K	0,08	1		148-736	0,044	10			10k	3	6	9	15	0,24	0,48	0,72	1,2	10	10	10	20	0,44	0,44	0,44	0,88
15k	R-10	1	2	3	5	1% metal film, 0.25W, 10mm pitch	METALL 15,0K	0,08	1		148-770	0,044	10			15k	1	2	3	5	0,08	0,16	0,24	0,4	10	10	10	10	0,44	0,44	0,44	0,44
100k	R-10		4	4	8	1% metal film, 0.25W, 10mm pitch	METALL 100K	0,08	1		148-972	0,044	10			100k		4	4	8		0,32	0,32	0,64		10	10	10		0,44	0,44	0,44
200k	R-10		1	1	2	1% metal film, 0.25W, 10mm pitch	METALL 200K	0,08	1		149-054	0,044	10			200k		1	1	2		0,08	0,08	0,16		10	10	10		0,44	0,44	0,44
1M	R-10		6	6	12	1% metal film, 0.25W, 10mm pitch	METALL 1,00M	0,08	1		149-228	0,044	10			1M		6	6	12		0,48	0,48	0,96		10	10	20		0,44	0,44	0,88
Discrete Semiconductors																**Discrete Semiconductors**																
1N5818	D-12,5	3		3	3	Any 1A schottky should work.	1N 5818	0,06	1		348-5505	0,12	1			1N5818	3		3	3	0,18		0,18	0,18	3		3	3	0,36		0,36	0,36
BC547	TO92		4	4	8	TO92	BC 547B	0,05	1		348-9399	0,043	1			BC547		4	4	8		0,2	0,2	0,4		4	4	8		0,172	0,172	0,344
BC557	TO92		4	4	8	TO92	BC 557B	0,05	1		348-9456	0,043	1			BC557		4	4	8		0,2	0,2	0,4		4	4	8		0,172	0,172	0,344
LED 5mm	LED5	1		1	1	Any LED		0,3	1			0,3	1			LED 5mm	1		1	1	0,3		0,3	0,3	1		1	1	0,3		0,3	0,3
Integrated Circuits																**Integrated Circuits**																
6N139	DIL-08	2		2	2	Optocoupler	6N139	0,69	1		303-135	1,18	1			6N139	2		2	2	1,38		1,38	1,38	2		2	2	2,36		2,36	2,36
7805	78XXL_S	1		1	1	5V regulator, >= 500mA. Size TO220	µA 7805	0,28	1		633-026	0,575	1			7805	1		1	1	0,28		0,28	0,28	1		1	1	0,575		0,575	0,575
AT90S4433P	DIL-28/3	1		1	1	**Will be replaced by ATmega8 soon.**	AT 90S4433 PDIP	7,5	1		N/A	7,5	1			AT90S4433P	1		1	1	7,5		7,5	7,5	1		1	1	7,5		7,5	7,5
INA114AP	DIL-08		2	2	4	Low-power precision inamp	INA 114AP	7,85	1	2	311-524	7,86	1			INA114AP		2	2	4		15,7	15,7	31,4		2	2	4		15,72	15,72	31,44
MAX232	DIL-16	1		1	1	RS232 tranceiver	MAX 232 CPE	1	1	3	225-8510	1,74	1			MAX232	1		1	1	1		1	1	1		1	1	1,74		1,74	1,74
TL431CLP	TO92-CLP	1		1	1	Adjustable voltage reference	TL 431 ACLP	0,3	1		267-9995	0,39	1			TL431CLP	1		1	1	0,3		0,3	0,3	1		1	1	0,39		0,39	0,39
TLC277P	DIL-08		4	4	7	Dual precision opamp	TLC 277 DIP	1,65	1		428-464	1,785	1			TLC277P		4	4	7		6,6	6,6	11,55		4	4	7		7,14	7,14	12,5
TMV0505S	TMADCDC	1		1	1	5Vin-5Vout 10% SIP7, 3kV iso	N/A	10	1		192-0826	10,7	1	3		TMV0505S	1		1	1	10		10	10	1		1	1	10,7		10,7	10,7
Miscellaneous Parts																**Miscellaneous Parts**																
20k	S64Y		3	3	6	Multi-turn trimpot, 64Y footprint	64Y-20K	0,64	1		154-2448	1,476	1			20k		3	3	6		1,92	1,92	3,84		3	3	6		4,428	4,428	8,856
22µH	R-12,5	3		3	3	SRF > 13MHz, Imax > 285mA, 12.5mm pitch	SMCC 22µ	0,19	1		191-0526	0,225	10			22µH	3		3	3	0,57		0,57	0,57	10		10	10	2,25		2,25	2,25
7.3728MHz	HC49/S	1		1	1	HC49 or equivalent package.	7,3728-HC49U-S	0,49	1	1	311-811	1,23	1	1		7.3728MHz	1		1	1	0,49		0,49	0,49	1		1	1	1,23		1,23	1,23
PINHD-2X17	2X17	1	1	2	3	2x17 pin-header / ribbon cable connector	STIFTL. 2X17G	0,21	1					2		PINHD-2X17	1	1	2	3	0,21	0,21	0,42	0,63								
PINHD-2X5	2X05	1		1	1	2x5 pin-header / ribbon cable connector	STIFTL. 2X17G	0,21	1					2		PINHD-2X5	1		1	1	0,21		0,21	0,21								
Sockets																**Sockets**																
8-pin socket	DIL-08	2	6	8	14		GS 8	0,03	1		Very expensive					8-pin socket	2	6	8	14	0,06	0,18	0,24	0,42								
16-pin socket	DIL-16	1		1	1		GS 16	0,04	1		since minimum					16-pin socket	1		1	1	0,04		0,04	0,04								
28-pin socket	DIL-28	1		1	1	7.68mm wide.	GS 14	0,04	2	4	order is 50 pieces.					28-pin socket	2		2	2	0,08		0,08	0,08								
Socket strip	SIL-20					Can be useful...					267-7400	0,55	5			Socket strip																

Notes

Crystal and loading capacitors (Cxtal)
The crystal's loading capacitors must be chosen appropriately. Set Cxtal = (Cload - Cstray) * 2
Cload (crystal loading capacitance) is given in the crystal data sheet. Cstray is stray capacitance on the PCB + microcontroller. Estimate Cstray = 3 - 5pF.

47uF 1 ohm capacitor
This capacitor is hard to locate in through-hole form (unless you order from Newark) You can replace it with an SMD type.
Mount an SMD like this: Solder the negative end to its pad. Have the positive end land on the ground plane. Scrape off the solder mask
in front of the positive end and solder.
Also note that any ESR = 0.8 ohm to 1.2 ohm is acceptable.

Microcontroller
The AT90S4433 is "not recommended for new designs" which is industry-speak for "we are not going to manufacture this part for much longer".
The replacement is the ATmega8. However, it has a problem associated with it:
ADC channels 5 and 6 are only 8 bit, while the EEG board is designed with 10 bit resolution in mind. (Channels 1 - 4 are ok though.)

TLC277 amplifier
In a four channel EEG setup (two amplifier boards), you only mount IC201 on **one** board.

DCDC converter
TMV0505S is not available in many places. It can be replaced with NMV0505SA. This converter has a rather high output voltage (6-7 V) at very light loads.
Therefore, when building the digital board, mount all parts except the microcontroller. Turn on the power and measure the voltage in the +5V/3 net, e.g. at IC103 pin 8.
The voltage should be LESS than 6V. If not, you must reduce the value of R127 (near the LED), in order to present the DCDC converter with a higher load.

Pin headers
These are fairly expensive at RS (order code 531-942, you need 17x2 + 17x2 + 3x2 = 74 pins total) so try to find them elsewhere.
You need 2.54mm pitch double-row headers or equialent connectors, for ribbon cable. The ribbon cable can be made from an old floppy-drive cable.

Socket strip
Instead of soldering wires directly to the PCB's you can solder in socket strips which you have cut into suitable lengths.
Then insert the wires into the sockets without soldering, during the testing phase. This way you do not risk breaking the wires before putting everything securely in a box.
(Then you should solder them in.) 0.5mm diameter single-strand wire is suitable.

Reichelt notes

1) Crystal loading capacitance is 32pF so Cxtal = 56pF (estimate Cstray = 4pF)
2) Higher grade is available: INA114BP which costs €13.60. Note that for this application this is hardly needed.
3) The MAX232 listed does not have ESD protected I/O pins. Protected type has part no MAX232 ECPE and costs€4.80.
4) Two 14-pin sockets

RS components notes

Prices were calculated from SEK to Euros by dividing by ten but at the time of writing 1 EUR = 9 SEK. Also, VAT is not included.

1) Crystal loading capacitance is 7pF so Cxtal = 10pF (estimate Cstray = 5 pF)
2) Avoid buying these parts from here. They are more expensive than they need to be.
3) TMV0505S is replaced by NMV0505SA

Newark Electronics notes

1) Crystal loading capacitance is 20pF so Cxtal = 33pF (estimate Cstray = 4pF)
2) The part has 2.5mm lead pitch - bend to 5mm
3) The part has 5mm lead pitch rather than 10mm. C220 can be mounted two ways. The lower placement (seen PCB layout) is the correct one.
4) This part may be replaced with a small aluminium electroytic. Part no 18C4465 for $0.063
5) **Digital board capacitors** can be replaced by an aluminium electrolytics. This may degrade noise immunity. (Probably not). Part no 18C4469 for $0.147
6) ESR=1.2 Ohm. Can be replaced with an ESR=1.0 Ohm type. Part no 87F5155 for $4.78
7)
8)
9) Higher grade INA114BP is available. Part no 35C1716 for $12.08
10) A cheaper alternative is MAX232 CPE that lacks ESD protection. Part no 34C3833 for $2.91
11) TMV0505S is replaced by NMV0505SA

Digi-Key notes

1) Carbon resistor for possibly improved ESR protection
2) Can be replaced with the newer generation ATMEGA8-16PI-ND $6.33 see**Microcontroller** note above.
3) Higher grade: INA114BP-ND $10.28
4) Or S2212-17-ND tin $1.77 - a special order item