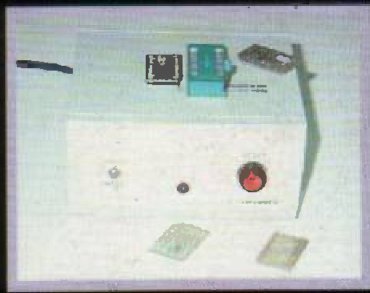
ETI
ELECTRONICS TODAY INTERNATIONAL

ETI 'EPROMMER' EPROM PROGRAMMER



With Personality Modules

THE UNIVERSAL SERIAL BUS

A RIVAL FOR RS232?

SWITCH TUNED SIGNAL GENERATOR

No Calibration Needed

PLUS

Are Your Lights On? - Car Headlight Warning

Speed Controlling DC Motors - Trial and Success

Peak-Reading VU Meter - Aims for 100%

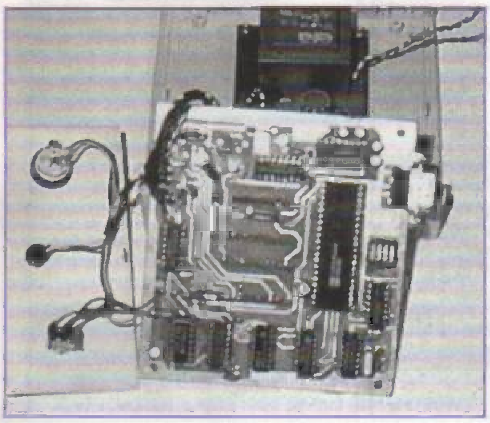
9 770142 722153 07
FOR ENTHUSIASTS BY ENTHUSIASTS NEXUS
Vol 26 Issue: 7 20 June 1997 £2.50
USA $4.95

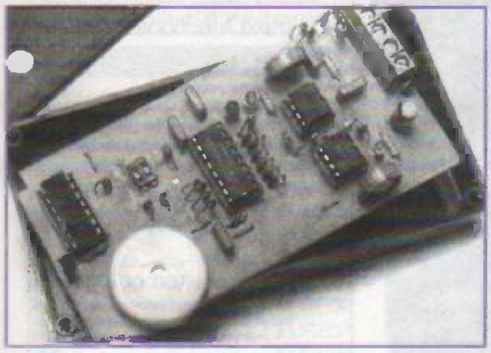
Contents

Volume 26 No.7

Features & Projects

Next Issue 18th July 1997





Regulars

SATELLITE POWER SUPPLY REPAIR KITS

ALBA	CODE
SAT660	SATPSU2

AMSTRAD	CODE
SRD510, SRD520, SRD540, SRD550	SATPSU3
SRDR45	
SRD500	SATPSU4
SRX320, SRX340, SRX345, SRX350	SATPSU5
SRX100	SATPSU6
SRD600	SATPSU14
SAT250, SR950, SRD700, SRD950,	SATPSU16
SRX1002, SRX2001, SRX301,	
SRX501, SRX502	
SRD2000	SATPSU18

BRITISH TELECOM	CODE
SVS300	SATPSU17

BUSH	CODE
IRD150	SATPSU12
IRD155	SATPSU19

CHURCHILL	CODE
D3MAC DECODER	SATPSU7

ECHOSTAR	CODE
SR5500 EARLY PSU WITH ADJ	SATPSU12
6500, SR7700, SR8700	SATPSU13

FERGUSON	CODE
SRD 5, SRD16	SATPSU1
SRV1	SATPSU2
SRDE4	SATPSU11

FINLUX	CODE
SR5700	SATPSU12

GOODMANS	CODE
ST700	SATPSU1

GRUNDIG	CODE
STR1	SATPSU1
GIRD200, FIRD3000	SATPSU2

MANHATTAN	CODE
850, 950	SATPSU1

MASPRO	CODE
SRE250S/1, SRE350S/1	SATPSU1
SRE250S, SRE350S, SRE450S	SATPSU2

MIMTEC	CODE
SOPRENSON TYPE PSU ONLY	SATPSU15

NETWORK	CODE
9000, 9200	SATPSU2

NOKIA	CODE
SAT1500	SATPSU2

PACE	CODE
PRD800, PRD900, PSR800, PSR900	SATPSU1
MRD920, SS9000, SS9010, SS9200,	SATPSU2
SS9210, SS9220	
D100, D150,	SATPSU6
MSS100	SATPSU8
APOLLO, MSS200, MSS300	SATPSU9
MSS500, MSS1000	SATPSU10

PHILIPS	CODE
STU802/05M	SATPSU1
STU801	SATPSU2

THOMSON	CODE
SRS4	SATPSU2

TOSHIBA	CODE
SAT99, TU-SDU200	SATPSU1

CODE	PRICE	CODE	PRICE	CODE	PRICE	CODE	PRICE
SATPSU1	650p	SATPSU6	650p	SATPSU11	835p	SATPSU16	730p
SATPSU2	650p	SATPSU7	650p	SATPSU12	1735p	SATPSU17	850p
SATPSU3	650p	SATPSU8	730p	SATPSU13	3125p	SATPSU18	1175p
SATPSU4	650p	SATPSU9	900p	SATPSU14	3135p	SATPSU19	650p
SATPSU5	650p	SATPSU10	1230p	SATPSU15	77.5p		

PACE SATELLITE TUNERS

MODELS	CODE	PRICE
PRD800, MSS200 (2GHZ) (221-2077062)	TUNER01	1650p
PRD900, MSS500, MSS1000 (2Ghz) (221-2177012)	TUNER02	1650p

PACE SWITCH MODE TRANSFORMERS

MODELS	CODE	PRICE
PACE9000	PACE9000	800p
PACEPRD800, PRD900	PRD800	550p

SATMETER

THE SATMETER IS A PROFESSIONAL PORTABLE SATELLITE STRNGTH METER DESIGNED FOR THE INSTALLATION AND MAINTENANCE OF SATELLITE TV SYSTEMS. THE SATMETER CAN BE USED AS STAND ALONE METER WITH POWERING THE LNB AS WELL AS IN LOOP. THROUGH OPERATION WITH SATELLITE RX POWERING THE LNB.

ACOUSTICAL SIGNAL: ON SIGNAL STRENGTH
INPUT IMPEDENENCE: 75 Ohm
MAX.INPUT SIGNAL: -10 DBM

LED INDICATOR: VERTICAL/HORIZONTAL
POWER AMPLIFIER: 18 DB

FREQUENCY RANGE: 900 TO 2050 MHZ
DETECTION RANGE: -60 TO -10 DBM

ORDER CODE: TOOL 22 PRICE: 8500p

SATELLITE LNB'S

MAKE & MODEL	ORDER CODE	PRICE	MAKE & MODEL	ORDER CODE	PRICE
Cambridge AE22/AE5 0.8dB standard 10.95-II.70 GHz Gold Range	LNB1	2160p	Cambridge AE7 Twin O/P H+V Both Enhanced	LNB7	4000p
Cambridge AE14 Universal LNB 10.7-11.7/11.7-12.75 GHz	LNB2	2500p	Cambridge AE2 Dual O/P H-V Separate Enhanced	LNB8	3550p
Cambridge AE21/AE5 Single O/P Switching LNB 1.0dB Standard	LNB3	2050p	Grundig Super Universal 'Anis' 10.7-12.75 GHz 0.8dB	LNB9	2600p
Cambridge AE19/AE6 Single O/P Switching LNB 1.0dB Enhanced	LNB4	2050p	Grundig Universal 'Anis' 10.7-12.75 GHz 1.0dB	LNB10	2250p
Cambridge AE23/AE12 0.8dB Enhanced 10.7-11.8GHz Gold Range	LNB5	2160p	Cambridge AE1 Twin O/P H+V Both Standard	LNB11	4000p
Cambridge AE8 Dual O/P H-V Separate Enhanced	LNB6	4000p			

FUSES

	TIME LAG (20MM)		QUICK BLOW (20MM)	
CURRENT RATING	ORDER CODE	PRICE	ORDER CODE	PRICE
100mA	FUSE36	75p	FUSE37	60P
160mA	FUSE01	75p	FUSE17	60p
250mA	FUSE02	75p	FUSE18	60p
315mA	FUSE03	75p	FUSE19	60p
400mA	FUSE04	75p	FUSE20	60p
500mA	FUSE05	75p	FUSE21	60p
630mA	FUSE06	75p	FUSE22	60p
800mA	FUSE07	60p	FUSE23	60p
IA	FUSE08	60p	FUSE24	60p
1.25A	FUSE09	60p	FUSE25	60p
1.6A	FUSE10	60p	FUSE26	60p
2A	FUSE11	50p	FUSE27	60p
2.5A	FUSE12	50p	FUSE28	60p
3.15A	FUSE13	55p	FUSE29	50p
4A	FUSE14	55p	FUSE30	50p
5A	FUSE15	60p	FUSE31	50p
6.3A	FUSE16	60p	FUSE32	50p

CERAMIC PLUG TOP

CURRENT RATING	ORDER CODE	PRICE
3A	FUSE33	100p
5A	FUSE34	100p
13A	FUSE35	100p

20mm CERAMIC TIME LAG

CURRENT RATING	ORDER CODE	PRICE
6.3A	FUSE38	100p
8A	FUSE39	100p
10A	FUSE40	100p
3.15A	FUSE41	85p
4A	FUSE42	85p
5A	FUSE43	85p

38mm CERAMIC TIME LAG

CURRENT RATING	ORDER CODE	PRICE
10A	FUSE48	815P

32mm CERAMIC SLOW BLOW

CURRENT RATING	ORDER CODE	PRICE
8A	FUSE44	185P
10A	FUSE45	185p
15A	FUSE46	185p
20A	FUSE47	210p

NB.
ALL FUSES ARE MADE IN THE UK AND FULLY MEET BS4265 & BS1362 SAFETY STANDARDS AND SHOULD NOT BE COMPARED WITH CHEAP IMPORTED TYPES.

****ALL THE ABOVE PRICES ARE FOR PACKS OF 10 FUSES****

TRANSISTORS

PART	PRICE
AC125	30P
AC126	30P
AC127	30P
AC128K	40P
AC141K	45P
AC176	22P
ACY18	48P
ACY19	48p
AD149	60P
AF125	50P
AF139	30P
BC107	8P
BC108	8P
BC109	8P
BC109C	10P
BC140	20P
BC142	20P
BC143	20P
BC147	8P
BC149	8P
BC159	8p
BC160	30P
BC171	10P
BC172	10P
BC177	14P
BC178	14P
BC179	14P
BC182	7P
BC182L	7P
BC183	7P
BC183L	7P
BC184	7P
BC184L	7P
BC212	7P
BC212L	7P
BC213	7P
BC213L	7P
BC214	7P
BC214L	7P
BC237	7P
BC238	7P
BC239	7P
BC300	20P
BC301	20P
BC302	20P
BC303	20P
BC304	25P
BC327	7P
BC328	7P
BC337	7P
BC338	7P
BC441	28P
BC446	8P
BC477	18P
BC516	22P
BC537	25P
BC546	8P
BC547	8P
BC548	8P
BC549	8p
BC550	8P
BC556	8P
BC557	7P
BC558	8P
BC559	8P
BC560	8P
BC637	20P
BC639	20P
BC640	20P
BCY33	200P
BCY34	200P
BCY70	16P
BCY71	16P
BCY72	16P
BD115	30P
BD124P	50P
BD131	25P
BD132	25P
BD133	50P
BD135	20P
BD136	20P
BD137	20P
BD138	20P
BD139	20P
BD140	20P
BD144	90P
BD157	38P
BD166	30P
BD175	30P
BD177	30P
BD179	32P
BD181	45P
BD182	60P
BD184	60P
BD187	30P
BD201	33P
BD202	38P
BD203	42P
BD204	42P
BD222	31P
BD225	31P
BD232	31P
BD233	30P
BD234	32P
BD235	28P
BD236	30P
BD237	21P
BD238	24P
BD239	30P
BD240	40P
BD241A	40P
BD243A	50P
BD244	50P
BD245	50P
BD246A	50P
BD265	45P
BD267	45P
BD269	45P
BD278	50P
BD311	100P
BD314	100P
BD315	150P
BD317	150P
BD331	40P
BD332	40P
BD361	60P
BD362	60P
BD370	30P
BD371	30P
BD410	50P
BD433	28P
BD434	30P
BD435	31P
BD436	30P
BD437	28P
BD438	36P
BD439	40P
BD440	40P
BD441	40P
BD533	50P
BD534	38P
BD535	38P
BD536	38P
BD537	40P
BD538	40P
BD643	50P
BD645	50P

PART	PRICE
BD647	50P
BD649	50P
BD675	40P
BD676	40P
BD677	38P
BD678	40P
BD679	40P
BD680	40P
BD681	45P
BD682	45P
BD705	50P
BD707	50P
BD709	50P
BD711	50P
BD736	50P
BD826	50P
BD828	50P
BD839	55P
BD897	50P
BD899	50P
BD977	50P
BDX33	60P
BDX37	100P
BDX44	100P
BDX47	75P
BDX54C	75P
BDX62C	150P
BDX63C	175P
BDX64C	175P
BDX65	80P
BDX66C	175P
BDX67C	275P
BDX71	70P
BDX77	175P
BDX87C	175P
BDX88C	150P
BDW24	55P
BDW93	50P
BDW94	50P
BDY29	225P
BDY56	225P
BDY58	500P
BDY90	125P
BDY92	100P
BF137	35P
BF167	30P
BF181	18P
BF183	20P
BF195	7P
BF199	8P
BF200	16P
BF225	30P
BF240	16P
BF245	25P
BF254	15P
BF255	12P
BF256	18P
BF257	18P
BF259	18P
BF262	25P
BF270	18P
BF273	15P
BF311	21P
BF336	20P
BF337	20P
BF338	20P
BF362	30P
BF367	13P
BF371	17P
BF421	18P
BF422	21P
BF423	25P
BF455	12P
BF458	19P
BF462	50P
BF471	28P
BF472	28P
BF479	30P
BF494	16P
BF495	16P
BF595	16P
BF596	16P
BF615	30P
BF617	30P
BF760	40P
BF763	40P
BF870	22P
BF871	22P
BF960	38P
BF961	35P
BF964	38P
BFQ232	75P
BFQ252A	60P
BFR90	85P
BFR91	99P
BFT43	30P
BFX29	20P
BFX84	20P
BFX85	20P
BFX87	15P
BFX88	15P
BFX89	60P
BFY50	14P
BFY51	24P
BFY52	14P
BFY56	25P
BFY64	25P
BFY90	45P
BLY48	85P
BR100	14P
BR103	37P
BR303	85P
BSX20	15P
BU105	80P
BU108	100P
BU109	80P
BU110	90P
BU111	100P
BU124	60P
BU125	100P
BU126	65P
BU128	125P
BU133	125P
BU137	150P
BU180	100P
BU184	100P
BU204	65P
BU205	70P
BU206	100P
BU207	150P
BU208	70P
BU208A	75P
BU208AT	200P
BU208B	200P
BU208D	130P
BU209	90P
BU225	120P
BU226	120P
BU312	90P
BU325	55P
BU326A	75P
BU406	60P
BU406D	85P
BU407	55P
BU407D	75P
BU408	60P
BU408D	75P

PART	PRICE
BU409	85P
BU412	175P
BU413	175P
BU414B	250P
BU415A	170P
BU426A	70P
BU433	120P
BU500	100P
BU500D	225P
BU505	90P
BU505D	90P
BU505DF	90P
BU506	100P
BU506D	70P
BU506DF	120P
BU508A	70P
BU508AF	95P
BU508APH	80P
BU508D	90P
BU508DF	115P
BU508DR	130P
BU508V	110P
BU508VF	100P
BU526	75P
BU536	100P
BU546	125P
BU603	125P
BU606D	225P
BU608D	120P
BU626	120P
BU705	130P
BU706DF	175P
BU706F	150P
BU724A	100P
BU801	70P
BU806	70P
BU807	60P
BU807F	75P
BU808DF	300P
BU810	110P
BU824	450P
BU826	120P
BU826A	160P
BU902	110P
BU903	110P
BU910	80P
BU912	100P
BU920	100P
BU922	110P
BU930	130P
BU932	175P
BU941	250P
BU2508A	130P
BU2508AF	130P
BU2508D	130P
BU2508DF	150P
BU2520AF	225P
BU2520DF	225P
BU2525A	325P
BU2525AF	325P
BU2527AF	400P
BUF405A	200P
BUH315	200P
BUH15D	250P
BUH515	200P
BUH515D	250P
BUH517	275P
BUH517D	175P
BUH715	425P
BUV93	375P
BUK444/ 500B	200P
BUK444/ 800B	200P
BUK445/ 600B	200P
BUK446/ 800B	400P
BUK455/ 600B	200P
BUK456/	200P
BUW81A	150P
BUR51	1900P
BUR52	1900P
BUS11A	200P
BUS12A	200P
BUS14A	500P
BUS23	225P
BUS48A	175P
BUT11A	55P
BUT11AF	55P
BUT12	80P
BUT13	310P
BUT18	80P
BUT18AF	80P
BUT30V	1700P
BUT56A	100P
BUT76A	80P
BUT90	1300P
BUT92	1200P
BUV18	650P
BUV20	650P
BUV21	400P
BUV23	475P
BUV24	350P
BUV25	110P
BUV26	150P
BUV27	125P
BUV28	110P
BUV37	175P
BUV46A	75P
BUV47	120P
BUV48A	175P
BUV48AF	325P
BUV48C	250P
BUV50	425P
BUV61	100P
BUV70	200P
BUV90	175P
BUZ30A	475P
BUW11A	200P
BUW1AF	225P
BUW12	125P
BUW12A	150P
BUW12F	250P
BUW13A	200P
BUW32A	500P
BUW48	550P
BUW49	550P
BUW50	400P
BUZ73AF	60P
BUW84	75P
BUW85	85P
BUX10	150P
BUX11	200P
BUX12	150P
BUX20	350P
BUX21	450P
BUX22	450P
BUX23	900P
BUX32	175P
BUX37	200P
BUX39	450P
BUX40	210P
BUX41	200P
BUX42	200P
BUX47A	200P

PART	PRICE
BUX48A	150P
BUX55	800P
BUX80	180P
BUX81	160P
BUX84	50P
BUX85	50P
BUX86	30P
BUX87	50P
BUX98A	350P
BUY18S	150P
BUY47	150P
BUY57	125P
BUY69A	200P
BUY71	250P
BUZ10	65P
BUZ11	200P
BUZ11A	175P
BUZ14	550P
BUZ20	225P
BUZ21	250P
BUZ24	350P
BUZ25	450P
BUZ32	125P
BUZ36	800P
BUZ44A	525P
BUZ45A	800P
BUZ50B	500P
BU53A	800P
BUZ71	75P
BUZ71AF	100P
BUZ72A	100P
BUZ72AF	100P
BUZ73A	150P
BUZ76A	110P
BUZ80	200P
BUZ80AF	200P
BUZ83	200P
BUZ90A	180P
BUZ91A	400P
BY448	20P
BYT11	25P
C106D	28P
CQY80	40P
IRF120	225P
IRF130	475P
IRF140	550P
IRF230	550P
IRF240	425P
IRF250	375P
IRF330	600P
IRF340	325P
IRF350	750P
IRF450	650P
IRF10	150P
IRF520	150P
IRF530	150P
IRF540	200P
IRF610	150P
IRF611	150P
IRF620	160P
IRF630	150P
IRF640	350P
IRF642	200P
IRF650	200P
IRF710	150P
IRF720	150P
IRF730	150P
IRF740	150P
IRF820	150P
IRF830	160P
IRF840	150P
IRF9140	1000P
IRF9510	150P
IRF9511	150P
IRF9520	150P
IRF9530	400P
IRF9531	200P
IRF9540	300P
IRF9541	200P
IRF9610	150P
IRF9620	150P
IRF9622	200P
IRF9630	325P
IRF9640	375P
IRFD9220	100P
IRFBC30	200P
IRFBC40	400P
IRFP140	250P
IRFP150	300P
IRFP240	300P
IRFP250	400P
IRFP350	325P
IRFP450	400P
IRFP460	775P
IRFP9140	1450P
IRFP9240	500P
IRFPC50	600P
IRFRC20	250P
IRFZ20	65P
IRFZ42	275P
IRFZ44	275P
MJ900	200P
MJ10001	200P
MJ1001	200P
MJ2501	200P
MJ2955	55P
MJ3000	100P
MJ3001	100P
MJ4032	175P
MJ4035	175P
MJ4502	300P
MJ10012	300P
MJ11015	250P
MJ11016	300P
MJ11032	800P
MJ11033	800P
MJ15003	250P
MJ15004	300P
MJ15015	250P
MJ15016	350P
MJ15022	250P
MJ15023	400P
MJ15024	400P
MJ15025	700P
MJE29A	30P
MJE30A	30P
MJE210	70P
MJE340	25P
MJE350	80P
MJE520	30P
MJE2955T	65P
MJE3055T	65P
MJE13004	100P
MJE13005	60P
MJE13007	100P
MJE13009	100P
MJE15028	200P
MJE15029	200P
MJE15030	250P
MJE15031	400P
MJE18004	125P
MJF18004	175P
MJF18204	350P
MPSA05	15P
MPSA06	15P
MPSA10	15P
MPSA13	15P

PART	PRICE
MPSA14	15P
MPSA20	15P
MPSA42	15P
MPSA43	15P
MPSA44	40P
MPSA55	12P
MPSA56	12P
MPSA70	15P
MPSA92	20P
MPSA93	20P
MPSU10	200P
MPSU45	550P
MPSU56	400P
MPSU60	350P
MR510	35P
MR856	36P
OC28	350P
OC29	250P
OC35	350P
OC36	250P
OC45	50P
OC200	180P
R2008B	100P
R2010B	100P
S2000A3	175P
S2000AF	175P
S2055A	175P
S2055AF	200P
S2530A	100P
S2800M	72P
TIP29	15P
TIP29A	22P
TIP29C	25P
TIP29E	40P
TIP30	25P
TIP30C	25P
TIP31A	22P
TIP31C	27P
TIP32	24P
TIP32A	21P
TIP32C	28P
TIP33	50P
TIP33C	60P
TIP34	65P
TIP34C	60P
TIP35C	65P
TIP36C	65P
TIP42A	20P
TIP41C	22P
TIP42A	20P
TIP42C	22P
TIP47	40P
TIP48	40P
TIP50	60P
TIP51	80P
TIP52	80P
TIP54	85P
TIP102	70P
TIP105	65P
TIP106	65P
TIP107	65P
TIP110	40P
TIP111	40P
TIP112	35P
TIP112H	50P
TIP115	30P
TIP116	30P
TIP117	30P
TIP120	37P
TIP121	35P
TIP122	30P
TIP125	30P
TIP126	40P
TIP127	35P
TIP130	30P
TIP131	30P
TIP132	30P
TIP136	40P
TIP137	65P
TIP162	110P
TIP141	65P
TIP143	75P
TIP145	50P
TIP146	70P
TIP147	80P
TIP150	90P
TIP151	60P
TIP2955	50P
TIP3055	50P
TIPL760	100P
TIPL762A	200P
TIPL763A	200P
TIPL791A	80P
TIS61	15P
TIS90	15P
TIS93	20P
ZTX107	11P
ZTX108	11P
ZTX109	12P
ZTX212	20P
ZTX300	10P
ZTX301	16P
ZTX302	10P
ZTX303	20P
ZTX304	10P
ZTX320	20P
ZTX501	13P
ZTX502	10P
ZTX503	18P
ZTX504	25P
2N696	26P
2N697	22P
2N698	40P
2N78	22P
2N914	28P
2N918	30P
2N930	18P
2N1131	28P
2N1132	28P
2N1304	350P
2N1305	225P
2N1613	24P
2N1711	24P
2N1893	30P
2N2102	50P
2N2218A	24P
2N2219	24P
2N2221	23P
2N2222	23P
2N2243	40P
2N2369	15P
2N2484	15P
2N2646	40P
2N2894	50P
2N2904	20P
2N2905	20P
2N2906	18P
2N2907	18P
2N3019	28P
2N3053	18P
2N3054	40P
2N3055	38P
2N3055H	50P
2N3439	40P
2N3440	45P
2N3441	175P
2N3442	85P

PART	PRICE
2N3553	100P
2N3585	650P
2N3702	9P
2N3703	9P
2N3704	9P
2N3705	9P
2N3706	9P
2N3707	9P
2N3710	12P
2N3711	12P
2N3771	85P
2N3772	90P
2N3773	100P
2N3792	150P
2N3799	18P
2N3819	29P
2N3820	70P
2N3823	40P
2N3866	110P
2N3903	11P
2N3906	11P
2N3924	375P
2N3958	375P
2N4031	25P
2N4033	25P
2N4036	29P
2N4220	175P
2N4347	130P
2N4391	60P
2N4392	50P
2N4393	55P
2N4399	200P
2N4401	12P
2N4403	12P
2N4416	120P
2N4420	75P
2N4427	75P
2N4920	50P
2N4922	30P
2N4923	30P
2N5038	175P
2N5061	20P
2N5088	20P
2N5109	100P
2N5116	175P
2N5154	150P
2N5160	600P
2N5179	40P
2N5192	50P
2N5241	500P
2N5245	45P
2N5294	30P
2N5296	30P
2N5320	50P
2N5322	55P
2N5401	10P
2N5416	40P
2N5448	12P
2N5457	45P
2N5458	55P
2N5460	55P
2N5461	75P
2N5462	45P
2N5484	55P
2N5551	12P
2N5671	350P
2N5672	400P
2N5680	55P
2N5884	175P
2N5886	325P
2N6031	250P
2N6049	55P
2N6059	150P
2N6098	50P
2N6099	45P
2N6107	40P
2N6109	40P
2N6211	400P
2N6248	150P
2N6284	250P
2N6287	225P
2N6292	40P
2N6385	120P
2N6403	160P
2N6427	25P
2N6476	250P
2N6488	90P
2N6491	90P
2N6547	300P
2N6609	375P
2N6660	375P
2N6675	175P
2N6678	225P
4N35	50P

RECTIFIER DIODES

BY127	8P
BY133	8P
BY164	40P
BY179	35P
BY184	32P
BY206	11P
BY207	20P
BY227	19P
BY228	28P
BY298	15P
BY299	18P
BY329-1200	150P
BY448	20P
BYT11	25p
BYT13-1000	30P
BYV96E	25P
BYW96E	36P
BYX10	15P
BYX55/600	25P
OA47	10P
OA91	10P
IN4001	3P
IN4002	3P
IN4003	3P
IN4004	3P
IN4005	3P
IN4006	3P
IN4007	4P
IN4148	2P
IN5400	9P
IN5401	8P
IN5402	8P
IN5403	8P
IN5404	8P
IN5405	11P
IN5406	12P
IN5407	12P
IN5408	12P
RGP10	25P
RGP15	25P
RGP30	16P
SKE4F2/06	60P
SKE4F2/08	80P
SKE4F2/10	100P
SR2M	60P

TRANSISTORS

PART	PRICE
I.C. SOCKETS	
8 PIN	4P
14 PIN	5P
16 PIN	6P
18 PIN	9P
20 PIN	10P
22 PIN	12P
24 PIN	13P
28 PIN	13P
40 PIN	15P
ZENER DIODES	
400m	WATT
2V7 TO 39V	5P
1.3	WATT
2V7 TO 39V	9P
VOLTAGE REGULATORS	
7805	25P
7806	25P
7808	25P
7812	25P
7815	25P
7818	25P
7824	25P
7905	25P
7906	30P
7908	30P
7912	30P
7915	30P
7918	30P
7924	30P
78L05	24P
78L08	24P
78L12	24P
78L15	24P
78L18	24P
78L24	24P
79L05	35P
79L08	35P
79L12	35P
79L15	35P
LM309K	100P
LM317T	100P
LM323K	350P
78H09KC	800P
79H12KC	700P
79HGKC	800P
L.E.D.'s 3mm	
RED	5p
YELLOW	8p
GREEN	8p
5mm	
RED	5p
YELLOW	8p
GREEN	8p
RECTANGULAR LED's	
5mm x 2.5mm	
RED	5p
YELLOW	8p
GREEN	8p
BRIDGE RECTIFIER	
W005	16p

PART	PRICE
1A/50V	
W01	18p
1A/100V	
WO2	19p
1A/200V	
W04	21p
LA/400V	
W06	23p
LA/600V	
W08	28p
1A/800V	
BR81D	33p
2A/100V	
BR82D	33p
2A/200V	
BR84D	37p
2A/400V	
BR86D	43p
2A/600V	
BR88D	43p
2A/800V	
BR32	43p
2A/200V	
BR34	43p
2A/400V	
BR36	44p
2A/600V	
BR62	80p
6a/200V	
BR64	72p
6A/400V	
BR251	150p
25A/100V	
BR252	165p
24A/200V	
BR254	185p
25A/400V	
BR2156	200p
25A/600V	
BR258	240p
25A/800V	
BR351	185p
35V/100V	
BR352	200p
35V/200V	
BR354	220p
35V/400V	
BR356	230p
35V/600V	
BR358	260p
35V/800V	
BY164	40p
1.5A/100V	
BY176	40p
1.5A/800V	
TRIACS	
TIC206D	60p
4A/400V	
TIC225D	69p
6A/400V	
TIC226D	68p
8A/400V	
TIC235D	85p
12A/400V	
TIC246D	105p
16A/400V	
TIC253D	190p
20A/400V	
TIC263D	205p
25A/400V	
THYRISTORS	
2N5061	20p
0.8A/60V	

PART	PRICE
TIC116C	59p
8A/300V	
TIC116D	70p
8A/400V	
TIC126D	75p
12A/400V	
TIC126M	90p
12A/600V	
C106D	28p
4A/400V	
BR103	37p
BR303	85p
BT106	180p
BT119	100p
17088	200p
17089	200p
17127	200p
15/80H	230p
15/85R	230p
SG 264	800p
SG613	1500p
COMPUTER IC's	
Z80ACPU	100p
Z80ADMA	200p
Z80ACTC	140p
Z80ASIO-1	210p
Z80ASIO-2	210p
75107	65p
75110	75p
75113	100p
75122	110p
75154	100p
75162	700p
75182	95p
75183	95p
75195	185p
2114	150p
2532	200p
26LS32	.75p
2716	100p
2732	200p
2732A	220p
2764	150p
27C64	200p
27128	150p
27256-25	150p
27512	300p
4116	40p
4164-15	80p
4164-12	90p
41256-15	80p
41256-12	100p
41256-10	110p
41464-12	150p
6116	80p
6264-10	210p
62256-12	300p
6502A	360p
65C02	930p
6522	280p
6800	210p
6802	220p
6803	500p
6808	500p
6809	500p
6810	150p
6818	380p
6821	130p
6840	290p
6845	200p
6850	90p
74F244	35p
8085A	300p
8086	500p
8088	480p

PART	PRICE
8156	300p
8224	240p
8226	240p
8250	750p
8251	200p
8253	160p
8257	220p
8271	340p
8279	270p
8283	400p
8284	440p
8287	260p
8288	650p
82C206PLCC	500p
8748	700p
8755	800p
8T26	95p
8T28	110p
CMOS IC's	
4000	13p
4001	13p
4002	13p
4006	34p
4007	13p
4009	20p
4010	21p
4011	13p
4012	13p
4013	19p
4014	32p
4016	18p
4018	30p
4019	28p
4020	33p
4021	36p
4022	36p
4023	13p
4024	25p
4025	13p
4026	60p
4027	18p
4028	29p
4029	34p
4030	17p
4032	52p
4033	60p
4034	76p
4035	42p
4038	46p
4040	30p
4041	36p
4042	30p
4043	36p
4045	72p
4046	42p
4047	45p
4048	26p
4049	18p
4050	20p
4051	38p
4052	35p
4053	35p
4054	53p
4055	52p
4056	52p
4060	40p
4063	52p
4066	20p
4067	120p
4068	13p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p

PART	PRICE
4075	13p
4076	42p
4077	13p
4078	13p
4081	13p
4082	13p
4085	36p
4086	30p
4089	75p
4093	18p
4094	44p
4094	58p
4098	50p
4099	42p
4501	26p
4502	36p
4504	35p
4505	80p
4506	58p
4507	30p
4508	67p
4510	32p
4511	30p
4512	38p
4514	65p
4515	65p
4516	36p
4517	100p
4518	36p
4519	28p
4520	36p
4521	86p
4526	38p
4527	41p
4528	38p
4529	65p
4532	48p
4553	140p
4555	29p
4556	36p
4557	140p
4583	60p
4584	30p
4585	40p
40103	120p
40105	140p
40106	35p
40107	50p
40110	170p
40114	180p
40160	55p
40161	55p
40174	48p
40192	48p
40193	48p
40194	58p
40257	120p
74 SERIES	
7400	20p
7401	16p
7402	18p
7403	20p
7404	35p
7405	10p
7406	30p
7407	30p
7408	25p
7409	20p
7413	30p
7414	45p
7416	32p
7417	32p
7420	20p
7421	25p
7425	15p

PART	PRICE
7430	25p
7437	28p
7438	30p
7442	38p
7447	60p
7450	22p
7451	10p
7454	25p
7473	25p
7481	90p
7482	60p
7485	25p
7489	75p
7493	35p
7495	48p
74132	42p
74141	55p
74145	70p
74157	45p
74160	50p
74HC SERIES	
74HC03	14p
74HC08	18p
74HC10	20p
74HC11	14p
74HC14	28p
74HC20	19p
74HC27	20p
74HC51	20p
74HC73	24p
74HC74	24p
74HC76	28p
74HC77	35p
74HC85	33p
74HC86	29p
74HC107	28p
74HC123	35p
74HC125	32p
74HC126	33p
74HC132	33p
74HC133	33p
74HC137	52p
74HC138	33p
74HC147	42p
74HC153	32p
74HC154	90p
74HC157	34p
74HC158	34p
74HC160	44p
74HC161	44p
74HC162	44p
74HC163	44p
74HC164	44p
74HC165	56p
74HC166	60p
74HC174	38p
74HC175	38p
74HC190	46p
74HC192	53p
74HC193	41p
74HC194	46p
74HC195	46p
74HC221	80p
74HC238	55p
74HC240	48p
74HC241	47p
74HC242	55p
74HC243	60p
74HC245	48p
74HC251	25p
74HC257	40p
74HC259	52p
74HC273	42p
74HC280	61p
74HC283	61p

SERVICE AIDS

DESCRIPTION	VOLUME	CODE	PRICE
VIDEO HEAD CLEANER	75ML	SP01	180p
VIDEO HEAD CLEANER	200ML	SP27	250p
SWITCH CLEANER	176ML	SP02	180p
SUPER 40	400ML	SP15	250p
SILICONE GREASE	200ML	SP03	210p
FREEZE IT	170ML	SP04	320p
FREEZE IT	400ML	SP16	600p
FOAM CLEANER	400ML	SP05	200p
ANTI STATIC	200ML	SP06	190p
AEROKLEANE	200ML	SP07	220p
AERO DUSTER	150ML	SP08	310p
AERO DUSTER	400ML	SP17	550p
PLASTIC SEAL	200ML	SP09	250p
GLASS CLEANER	250ML	SP10	160p
COLDKLENE	250ML	SP13	230p

DESCRIPTION	VOLUME	CODE	PRICE
EXCEL POLISH 80	250ML	SP18	150p
ADHESIVE 120	400ML	SP19	190p
LABEL REMOVER 130	200ML	SP20	240p
REFURB 140	400ML	SP21	240p
TUBE SILICON GREASE	50 GRAMMES	SP11	220p
TUBE TUBE SILICON SEALANT WHITE	75ML	SP22	280p
TUBE SILICON SEALANT CLEAR	75ML	SP23	280p
TUBE HEAT SINK COMPUND	25 GRAMMES	SP12	150p
DRIVE CLEANER	200ML	SP24	150P
SCREEN CLEANER	200ML	SP25	150p
COMPUTER CARE KIT		SP26	2100p
ANTI STATIC FOAM CLEANER	400ML	SP28	175p
AIR DUSTER	400ML	SP29	450p

ALL THE ABOVE ITEMS ARE MANUFACTURED BY SERVISOL

IF YOU PURCHASE MORE THAN ONE SERVISOL PRODUCT POSTAGE & PACKING WILL BE CHARGED AS FOLLOWS:

300P FOR 5 CANS

450p FOR MORE THAN 5 CANS

GRANDATA LTD

K.P. HOUSE, UNIT 15, POP IN COMMERCIAL CENTRE, SOUTHWAY, WEMBLEY, MIDDLESEX, ENGLAND HA9 0HB

Telephone: 0181-900 2329 Fax: 0181-903 6126

OPEN Monday to Saturday.

Times: Mon-Fri 9.00-5.30 Sat 9.00-2.00

PLEASE PHONE US FOR TYPE NOT LISTED HERE AS WE ARE HOLDING 30,000 ITEMS AND QUOTATIONS ARE GIVEN FOR LARGE QUANTITIES

Please send £1 P&P and VAT at 17.5%. Govt, Colleges, etc. Orders accepted. Please allow 7 days for delivery. Prices quoted are subject to stock availability and may be changed without notice.

TV and video parts sold are replacement parts.

Access & Visa Card accepted

WE STOCK TV AND VIDEO SPARES, JAPANESE TRANSISTORS AND TDA SERIES. PLEASE RING US FOR FURTHER INFORMATION.

ETI
ELECTRONICS
TODAY INTERNATIONAL

News...

Mobile Phone Call for Recycling

The Association of European Telecommunications and Professional Electronics Industry (ECTEL) in conjunction with British Telecommunications (BT) is running a pilot scheme to encourage the recycling of mobile phones on the basis of "take-back", where manufacturers offer to take back and recycle items once users have finished with them.

The idea is that technology is moving so fast that new "state of the art" equipment can be overtaken quickly by newer ones, creating obsolescence and a problem of waste management. The issue of waste electronic equipment is gradually being considered by Governments and industry is being encouraged to take a lead in establishing what is "technically possible and economically sensible". A Government spokesman said: "We need to establish how much electronic equipment is gong into the waste stream and the extent of its potential environmental impact. We must also define the equipment to be considered and decide which categories should be earmarked as priorities for recovery. This should help to establish a methodology for the recycling of electronic equipment."

Under the scheme, owners of old mobile phones will be invited to return them to their nearest BT communication centre, on the understanding that they will be disposed of in an environmentally friendly way. The aim is to establish if there is a real consumer interest in the recycling of phones and whether "take-back" is an environmentally and economically viable solution for small electronic products.

Users can take used mobile phones and batteries to the following contact points:

Atlas (Northern Ireland, Cumbria, South and West Scotland) 01387 251010; Tyne Tees Telecom (North East) 0191 232 4536; JWE Foneshops (Yorkshire and North Midlands) 0990 130130; Landalow (East and North Scotland 01738 633674; Midland Phones (West Midlands) 01384 572144; Phoneline (Thames Valley) 01753 553553 Crown Talk (Midlands) 01203 447844; Keeping You In Touch (Greater Manchester, Lancs and North Cheshire) 0161 848 0599; Uplands (South Wales and South West) 0800 240000 Phone The World (South Coast) 01489 577770; Radiophone (Cambs and Norfolk) 01603 434000; National Radiofone (Milton Keynes and Northants) 01933 402202; Moco (Kent and West London) 0800 371214; Straight Talk (South London) 0800 171819. ECTEL can be contacted at 01753 500074.

Users interested in the scheme can contact their nearest BT shop for information.

In April, leading recycling experts from the Department of the Environment, industry and local government have addressed a conference on the implications for industry of recent packaging recovery legislation. Legislation covering a gamut of materials, from card to batteries, is gradually placing greater obligations on manufacturers and users to recycle used materials.

Matchbox-sized recharger for in-car use

Travelling users of computer and other equipment are constantly on the guard against unwanted power-failures caused by their batteries running out while in use. Small chargers that can be connected via a car's 12V supply are becoming more popular. The NOTEpower 75i inverter by Merlin Equipment (shown) converts the car's 12 volts to 230 VAC mains. Specifically designed by a computer manufacturer for operating small appliances, the NOTEpower 75i plugs into that mainstay of portable electrical appliances, the car's cigar lighter socket. Output is sent to the appliance's own power supply "brick" using a standard cable provided.

The NOTEpower 75i can also be used to power peripherals such as bubblejet printers for a complete mobile workstation. Designed to be more than 90 percent efficient, it is also fully overload and overheat protected, and stated by its makers to be smaller, lighter and easier to use than any other on the market at present. It also features a battery alarm to warn if the vehicle battery is low and turn of the invertor to allow the car to re-start. So you will not have to substitute a dead computer with an immobile car.

Other useful applications include running chargers for camcorders, small power tools and other equipment that can run on mobile 230 volt AC power. The NOTEpower 75i is CE approved for electrical interference and safety. The retail price is £86 ex VAT and carriage. This is a top-end example of a useful class of power add-on.

For information contact Merlin Equipment, Unit 1, Hithercroft Court, Lupton Road, Hithercroft Industrial Estate, Wallingford, Oxon OX10 9BT. Tel. 01491 824333 fax 01492 824466.

Rockwell bring in 56 Kbps analogue modem chip

The K56Plus modem technology from Rockwell provides data transfer rates of up to 56,000 bps across standard telephone lines. Faster transfer rates are now in greater demand, particularly from Internet users wanting high speed connection.

One advantage of the K56Plus technology is the availability of higher speed of transmission without the extra expense of ISDN installation. The Rockwell technology has already received the support of over 300 Internet Service Providers (ISPs) and comms equipment manufacturers. K56Plus crosses the gap between analogue and digital comms; where existing analogue modems normally assume an analogue connection at both ends of the communications, K56Plus assumes that one end is a purely digital connection - which tends to be the case for corporate users and ISPs.

For the user accessing the Internet or a large central computer site from a K56Plus modem, the upstream part of the dialogue, mainly keystrokes and mouse commands, flows at the conventional rate of 33.6 Kbps, and the downstream conversation, frequently Web pages loaded with graphics, sound, video and other large data files, can be downloaded at the higher 56.6 Kpbs rate. Time and cost are reduced, a significant factor as the Net access grows more congested.

Rockwell have used a new encoding method that reduces the analogue noise that has hitherto restricted data rates to 33.6Kbps when employed with a K56Plus modem to dial into a digital connection. K56Plus products will be upgradeable to the expected new ITU standard, say distributor Telecom Design Communications, and compatibility should be ensured by Rockwell's very large existing modem manufacturer and user base.

This may be as fast an analogue modems get - until technology springs another surprise.

Information from TDC Ltd., Stroudley Road, Basingstoke, Hants RG24 8FN. Tel 01256 332800 Fax 01256 332810.

OVERSEAS READERS

To call UK telephone numbers, replace the initial 0 with your local overseas access code plus the digits 44.

MODSMODSMODSMODSMODSMODS

CampLight (October 1996): for future constructors: Electrovalue, who supply the magnetic core, have moved. The new address is Unit 5, Beta Way, Thorpe Industrial Park, Egham, Surrey TW20 8RE Tel 01784 433604. Overseas mail order customers please write to Electrovalue for ordering information. (And the coil-winding wire is 0.20 mm insulated copper.)

PIC Programmer (Vol 26 issue 6): for a non-DIY copy of the 'PIC devices programmed' table on page 40 of last month's issue, please send your address to Lynn at Nexus House (see page 74).

Test and measurement catalogue

Keithley Instruments have published their 1997 test and measurement catalogue and reference guide. The 300-page catalogue includes DMMs, electrometers, precision sources, voltmeters, picoammeters, ohmmeters, source-measure units, power supplies, switch systems, semiconductor characterisation systems, a new line of miniaturised measurement modules and more. The guid includes application examples to help design a test system, selector guides to compare important specifications and complete product specifications.

Specially featured in the colour section is the model 2400 digital sourcemeter, the fastest system instrument offered by Keithley to date, a high-speed test solution for large volume component manufacturers.

The catalogue is available in print or on CD rom from Keithley Instruments, The Minster, 58 Portman Road, Reading, Berks RG30 1EA. Tel 0118 9575666 fax 0118 9596469.

Nevada Catalogue

Nevada's 1997 hobby communications catalogue is available now to anyone who sends an A4 stamped self-addressed envelope to Nevada, 189 London,Road, North End, Portsmouth, Hants PO2 9AE. Radio enthusiasts will find antenna equipment, scanning receivers, transceivers, airband and marine radios, filters, packet radio equipment, TVI filters, Morse equipment and many more things for the radio shack. Their showroom in Portsmouth is also open to the public.

DIFFERENTIAL THERMOSTAT KIT Perfect for heat recovery, solar systems, boiler efficiency etc. Two sensors will operate a relay when a temp difference (adjustable) is detected. All components and pcb. £29 ref LOT93

MAGNETIC RUBBER TAPE Selfadhesive 10 metre reel, 8mm wide perfect for all sorts of applications! £15 ref LOT87

MAINS POWER SAVER UK made plug in unit, fitted inseconds, can reduce your energy consumption by 15%. Works with fridges, soldering irons, conventional bulbs etc. Max 2A rating. £9 each ref LOT71, pack of 10 £69 ref LOT72

YUASHA SEALED LEAD ACID Batteries, ex equipment but ok bargain price just £5.99 each ref YA1. 100 or more £3.50 each.

DC TO DC CONVERTERS

DRM58 input 10-40vdc output 5v 8A £15 DRM128 input 17-40vdc output 12v 8A £18 DRM158 input 20-40vdc output 15v 8A £18 DRM248 input 29-40vdc output 24v 8A £12 DRS123 input 17-40vdc output 12v 3A £10 DRS153 input 20-40vdc output 15v 3A £20 DRS243 input 29-40vdc output 24v 3A £8

HITACHI LM225X LCD SCREENS 270x150mm, standard 12 way connector, 640x200 dots, tec spec sheet. £15 each ref LM2

VARIABLE CAPACITORS Dual gang, 60x33x45mm, reduction gearing, unknown capacity but probably good quality (military spec) general purpose radio tuner. £9 ref VC1

ELECTRONIC FLASH PCB Small pcb fitted with components including a flash tube. Just connect 12vdc and it flashes, variable speed potentiometer. £6 ref FLS1

THIEF PROOF PEN! Amazing new ball point pen fitted with a combination lock on the end that only you know! £2.49 ref TP2

JUMBO BI COLOUR LEDS PCB with 15 fitted also 5 giant seven segment displays (55mm) £8 ref JUM1

HOME DECK CLEARANCE These units must be cleared! leads, a n infra red remote qwerty keyboard and receiver, a standard UHF modulator, a standard 1200/75 BT approved modem and loads of chips, capacitors, diodes, resistors etc all for just £10 ref BAR33.

6.8MW HELIUM NEON LASERS New units, £65 ref LOT33

COINSLOT TOKENS You may have a use for these? mixed bag of 100 tokens £5 ref LOT20

PORTABLE X RAY MACHINE PLANS Easy to construct plans on a simple and cheap way to build a home X-ray machine! Effective device, X-ray sealed assemblies, can be used for experimental purposes. Not a toy or for minors! £6/set. Ref F/XP1.

TELEKINETIC ENHANCER PLANS Mystify and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing phychic phenomenon. £4/set Ref F/TKE1.

ELECTRONIC HYPNOSIS PLANS & DATA This data shows several ways to put subjects under your control. Included is a full volume reference text and several construction plans that when assembled can produce highly effective stimuli. This material must be used cautiously. It is for use as entertainment at parties etc only, by those experienced in its use. £15/set. Ref F/EH2.

GRAVITY GENERATOR PLANS This unique plan demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship out of simple materials and without any visible means- cause it to levitate. £10/set Ref F/GRA1.

WORLDS SMALLEST TESLA COIL/LIGHTENING DISPLAY GLOBE PLANS Produces up to 750,000 volts of discharge, experiment with extraordinary HV effects, 'Plasma in a jar', St Elmo's fire, Corona, excellent science project or conversation piece. £5/set Ref F/BTC1/LG5.

COPPER VAPOUR LASER PLANS Produces 100mw of visible green light. High coherency and spectral quality similar to Argon laser but easier and less costly to build yet far more efficient. This particular design was developed at the Atomic Energy Commision of NEGEV in Israel. £10/set Ref F/CVL1.

VOICE SCRAMBLER PLANS Minature solid state system turns speech sound into indecipherable noise that cannot be understood without a second matching unit. Use on telephone to prevent third party listening and bugging. £6/set Ref F/VS9.

PULSED TV JOKER PLANS Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound! works on FM too! DISCRETION ADVISED. £8/set Ref F/TJ5.

BODYHEAT TELESCOPE PLANS Highly directional long range device uses recent technology to detect the presence of living bodies, warm and hot spots, heat leaks etc. Intended for security, law enforcement, research and development, etc. Excellent security device or very interesting science project. £8/set Ref F/BHT1.

BURNING, CUTTING CO2 LASER PLANS Projects an invisible beam of heat capable of burning and melting materials over a considerable distance. This laser is one of the most efficient, converting 10% input power into useful output. Not only is this device a workhorse in welding, cutting and heat processing materials but it is also a likely candidate as an effective directed energy beam weapon against missiles, aircraft, ground-to-ground, etc. Particle beams may very well utilize a laser of this type to blast a channel in the atmosphere for a high energy stream of neutrons or other particles. The device is easily applicable to burning and etching wood, cutting, plastics, textiles etc £12/set Ref F/LC7.

MYSTERY ANTI GRAVITY DEVICE PLANS Uses simple concept. Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or science project. £6/set Ref F/ANT1K.

FRUIT POWERED CLOCK Just add a fresh orange, tomato, banana or any other fruit plug in the probes and the clock works! £9.95 ref SC154

DYNAMO FLASHLIGHT Interesting concept, no batteries needed just squeeze the trigger for instant light apparently even works under water in an emergency although we haven't tried it yet! £6.99 ref SC152

ULTRASONIC BLASTER PLANS Laboratory source of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquides. Many cleaning uses for PC boards, jewliery, coins, small parts etc. £6/set Ref F/ULB1.

ULTRA HIGH GAIN AMP/STETHOSCOPIC MIKE/ SOUND AND VIBRATION DETECTOR PLANS Ultrasensitive device enables one to hear a whole new world of sounds. Listen through walls, windows, floors etc. Many applications shown, from law enforcement, nature listening, medical heartbeat, to mechanical devices. £6/set Ref F/HGA7

WOLVERHAMPTON ELECTRONICS STORE NOW OPEN IN WORCESTER ST TEL 01902 22039

ANTI DOG FORCE FIELD PLANS Highly effective circuit produces time variable pulses of accoustical energy that dogs cannot tolerate £6/set Ref F/DOG2

LASER BOUNCE LISTENER SYSTEM PLANS Allows you to hear sounds from a premises without gaining access. £12/set Ref F/LLIST1

LASER LIGHT SHOW PLANS Do it yourself plans show three methods. £6 Ref F/LLS1

PHASOR BLAST WAVE PISTOL SERIES PLANS Handheld, has large transducer and battery capacity with external controls. £6/set Ref F/PSP4

INFINITY TRANSMITTER PLANS Telephone line grabber/ room monitor. The ultimate in home/office security and safety! simple to use! Call your home or office phone, push a secret tone on your telephone to access either: A) On premises sound and voices or B) Existing conversation with break-in capability for emergency messages. £7 Ref F/TELEGRAB.

BUG DETECTOR PLANS Is that someone getting the goods on you? Easy to construct device locates any hidden source of radio energy! Sniffs out and finds bugs and other sources of bothersome interference. Detects low, high and UHF frequencies. £5/set Ref F/BD1.

ELECTROMAGNETIC GUN PLANS Projects a metal object a considerable distance-requires adult supervision £5 ref F/EML2.

ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND! £5/set Ref F/EMA1.

PARABOLIC DISH MICROPHONE PLANS Listen to distant sounds and voices, open windows, sound sources in 'hard to get or hostile premises. Uses satellite technology to gather distant sounds and focus them to our ultra sensitive electronics. Plans also show an optional wireless link system. £8/set ref F/PM5

2 FOR 1 MULTIFUNCTIONAL HIGH FREQUENCY AND HIGH DC VOLTAGE, SOLID STATE TESLA COIL AND VARIABLE 100,000 VDC OUTPUT GENERATOR PLANS Operates on 9-12vdc, many possible experiments. £10 Ref F/HVM7/TCL4.

MEGA LED DISPLAYS PCB fitted with 5 seven segment displays each measuring 55 x 38mm. £5 ref LED5.

MOD TRANSMITTING VALVES 5J180E £80 ref LOT112

SWITCHED MODE PSU'S 244 watt, +5 32A, +12 6A, -5 0.2A, -12 0.2A. There is also an optional 3.3v 25A rail available. 120/240v I/P. Cased, 175x80x145mm. IEC inlet Suitable for PC use (6 d/drive connectors 1 m/board). £15 ref LOT135

HYDROGEN FUEL CELL PLANS There is a lot of interest in using Hyrogen as the fuel of the future. Hydrogen is easy to produce using chemicals and surplus solar generated electricity. It is also easy to store with little or no loss Hyrogen fuel cells are designed to store hydrogen and weight for weight will hold twice as much energy as a full petrol tank. Our plans give you loads of information on Hyrogen production, storage and practical plans to build your own Hydrogen fuel cell! you will need access to a well equiped workshop for this but full construction details and drawings are included. Ful cell plans £9 ref HY1

VIDEO PROCESSOR UNITS?/6v 10AH BATTS/24V 8A TX Not too sure what the function of these units is but they certainly make good strippers! Measures 390X320X120mm, on the front are controls for screen speed, scan delay, scan mode, loads of connections on the rear, Inside 2 x 6v 10AH sealed lead acid batts, pcb's and a 8A? 24v torroidial transformer (mains in), sold as seen, may have one or two broken knobs etc due to poor storage. £15.99 ref VP2

RETRON NIGHT SIGHT Recognition of a standing man at 300m in 1/4 moonlight, hermatically sealed, runs on 2 AA batteries, 80mm F1.5 lens, 20mw infrared laser included. £325 ref RETRON

MAKE YOUR OWN CHEWING GUM KIT Everything you need to make real chewing gum, even the bowl and tree sap from the Sapodilla tree £7.99 ref SC190

MINI FM TRANSMITTER KIT Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but easily changed to cover 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £9 Ref 1001.

3-30V POWER SUPPLY KIT Variable, stabilized power supply for lab use. Short circuit protected, suitable for profesional or amateur use 24v 3A transformer is needed to complete the kit. £14 Ref 1007.

1 WATT FM TRANSMITTER KIT Supplied with piezo electric mic. 8-30vdc. At 25-30v you will get nearly 2 watts! £15 ref 1009.

FM/AM SCANNER KIT Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160mhz on both AM and FM. Built in 5 watt amplifier, inc speaker. £18 ref 1013.

3 CHANNEL SOUND TO LIGHT KIT Wireless system, mains operated, separate sensitivity adjustment for each channel, 1,200 w power handling, microphone included. £17 Ref 1014.

4 WATT FM TRANSMITTER KIT Small but powerful FM transmitter, 3 RF stages, microphone and audio preamp included. £24 Ref 1028.

STROBE LIGHT KIT Adjustable from 1-60 hz (a lot faster than conventional strobes). Mains operated. £17 Ref 1037.

COMBINATION LOCK KIT 9 key, programmable, complete with keypad, will switch 2A mains. 9v dc operation. £13 ref 1114.

PHONE BUG DETECTOR KIT This device will warn you if somebody is eavesdropping on your line. £9 ref 1130.

ROBOT VOICE KIT Interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

TELEPHONE BUG KIT Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £12 Ref 1135.

3 CHANNEL LIGHT CHASER KIT 800 watts per channel, speed and direction controlssupplied with 12 LEDS (you can fit triacs instead to make kit mains, not supplied) 9-12vdc £17 ref 1026.

12V FLOURESCENT LAMP DRIVER KIT Light up 4 foot tubes from your car battery! 9v 2a transformer also required. £8 ref 1069.

HELPING HANDS Perfect for those fiddly jobs that need six hands, 6 ball and socket joints, magnifier, £7.99 ref YO57A

VOX SWITCH KIT Sound activated switch ideal for making bugging tape recorders etc, adjustable sensitivity. £10 ref 1073.

PREAMP MIXER KIT 3 input mono mixer, sep bass and treble controls plus individual level controls, 18vdc, input sens 100mA. £15 ref 1052.

SOUND EFFECTS GENERATOR KIT Produces sounds ranging from bird chips to sirens. Complete with speaker, add sound effects to your projects for just £9 ref 1045.

15 WATT FM TRANSMITTER (BUILT) 4 stage high power, preamp required 12-18vdc, can use ground plane, yagi or open dipole. £69 ref 1021.

HUMIDITY METER KIT Builds into a precision LCD humidity meter, 9 ic design, pcb, lcd display and all components included. £29

PC TIMER KIT Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configeration is 286, VGA, 4.1,640k, serial port, hard drive with min 100k free. £24.99

MAGNETIC MARBLES They have been around for a number of years but still give rise to curiosity and amazement. A pack of 12 is just £3.99 ref GI/R20

NICKEL PLATING KIT Professional electroplating kit that will transform rusting parts into showpieces in 3 hours! Will plate onto steel, iron, bronze, gunmetal, copper, welded, silver soldered or brazed joints. Kit includes enough to plate 1,000 sq inches. You will also need a 12v supply, a container and 2 12v light bulbs. £45 ref NIK39.

Minature adjustable timers, 4 pole c/o output 3A 240v,
HY1230S, 12vDC adjustable from 0-30 secs. £4.99
HY1260M, 12vDC adjustable from 0-60 mins. £4.99
HY2405S, 240v adjustable from 0-5 secs. £4.99
HY24060m, 240v adjustable from 0-60 mins. £6.99

BUGGING TAPE RECORDER Small voice activated recorder, uses micro cassette complete with headphones. £28.99 ref MAR29P1.

POWER SUPPLY fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

COMPOSITE VIDEO KIT. Converts composite video into separate H sync, V sync, and video. 12v DC £12.00 REF: MAG8P2.

FUTURE PC POWER SUPPLIES These are 295x135x60mm, 4 drive connectors 1 mother board connector, 150watt, 12v fan, iec inlet and on/off switch. £12 Ref EF6.

VENUS FLY TRAP KIT Grow your own carnivorous plant with this simple kit £3 ref EF34

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

ROCK LIGHTS Unusual things these, two pieces of rock that glow when rubbed together! belived to cause rain! £3 a pair Ref EF29.

3' by 1' AMORPHOUS SOLAR PANELS 14.5v, 700mA 10 watts, aluminium frame, screw terminals, £55 ref MAG45.

ELECTRONIC ACCUPUNCTURE KIT Builds into an electronic version instead of needles! good to experiment with. £9 ref 7P30

SHOCKING COIL KIT Build this little battery operated device into all sorts of things, also gets worms out of the ground! £9 ref 7P36.

HIGH POWER CATAPULTS Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 miles per hour! Range of over 200 metres! £8.99 ref R/9.

COMPAQ POWER SUPPLIES WITH 12V DC FANS Ex equipment psu's, some ok some not but worth it for the fan alone! probably about 300 watt PC unit with IEC input. £3.50 each ref CQ1

BALLON MANUFACTURING KIT British made, small blob blows into a large, longlasting balloon, hours of fun! £3.99 ref GI/E99R

9-0-9V 4A TRANSFORMERS, chassis mount. £7 ref LOT19A.

MEGA LED DISPLAYS Build your self a clock or something with these mega 7 seg displays 55mm high, 38mm wide. 5 on a pcb for just £4.99 ref LOT16 or a bumper pack of 50 displays for just £29 ref LOT17.

SOLID STATE RELAYS

CMP-DC-200P 3-32vdc operation, 0-200vdc 1A £2.50
SMT20000/3 3-24vdc operation, 28-280vac 3A £4.50

BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX . BN3 5QT. (ESTABLISHED 50 YEARS).

MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £3.50 P&P PLUS VAT.

24 HOUR SERVICE £4.50 PLUS VAT.

OVERSEAS ORDERS AT COST PLUS £3.50

(ACCESS, VISA, SWITCH, AMERICAN EXPRESS)

'phone orders : 01273 203500

FAX 01273 323077

E-mail bull@pavilion.co.uk

FREE COLOUR CATALOGUE WITH EVERY ORDER

WE BUY SURPLUS STOCK FOR CASH

SURPLUS STOCK LINE 0802 660335

Catching

The Universal Serial Bus

The USB is a new standard providing a single interface protocol for PC peripherals. It could take over from RS232 and other standards - if it gets support from hardware manufacturers. Will it be a long wait, or will there be three along in a minute? Asks Robin Abbott.

The Universal Serial Bus (USB) is a new standard for interfacing peripherals to a computer at transfer rates in excess of 1 megabyte per second. It is intended to be flexible, inexpensive, easy to use, easily expandable and sufficiently defined to allow any kind of peripheral to be connected and remain compatible with other devices connected to the bus. The bus standard has been sponsored by Compaq, Digital Equipment Corporation, IBM, Intel, Microsoft, NEC and Northern Telecom - an impressive list of names whichever way you look at it!

In this article we will look at the USB bus from the viewpoint of its capability and benefits to the user, and we will also look in some detail at its operation, although it is worth noting that much of the functionality of the bus at the lower level protocols - electrical and signalling - will be available in integrated form and therefore removed from the direct concern of anyone actually implementing it.

The need for USB

Why do we need a new protocol for addressing peripherals? Let us consider a typical medium- to high-end PC. For the sake of example I have chosen to consider my own PC, which is used for software and hardware development as well as word processing, data analysis, accounting, and games. This PC is Pentium-based and has the following peripherals:

- A keyboard and mouse for input
- A gamepad/joystick for games
- A colour inkjet printer.
- A laser printer which is used in place of the ink jet for high speed output.
- A scanner, used for OCR, photocopying and incorporating photographs in documents.
- Speakers used for sound output.
- An internal modem.
- An internal ZIP drive used for backup
- An internal CD-ROM
- External development peripherals, including a PIC programmer, an eprom programmer, and the FED PIC Basic development system.

This PC is shown in figure 1, which includes a view of the internal cards required to support all these devices. Note that the following physical data standards are used in this system:

- An RS232 serial interface (COM1) is used for the mouse.
- An RS232 serial interface (COM2) is used for the development peripherals, which are connected through a simple data switch
- The joystick is connected on a standard PC games port.
- A SCSI interface is used for the scanner.
- A slightly different SCSI interface is used for the ZIP drive. Note that two SCSI cards are required, because the particular scanner in use does not operate correctly on a standard SCSI interface.
- A parallel printer port is used for the inkjet and laser printers. As the PC has only one printer port, and as no further slots are available for additional printer port expansion cards, an external printer switch is required.
- The modem is internal, emulates a standard serial port (COM4) and, because of the way interrupts are used in the PC, cannot be used at the same time as the development peripherals.
- The keyboard is connected to the PC on a standard PC keyboard interface.
- The speakers are connected on a standard analogue output from an internal sound card.
- The CD-ROM is connected on an internal E-IDE interface.

Once the power cables are thrown in, this adds up to a grand total of 18 different cables and 9 different physical interface

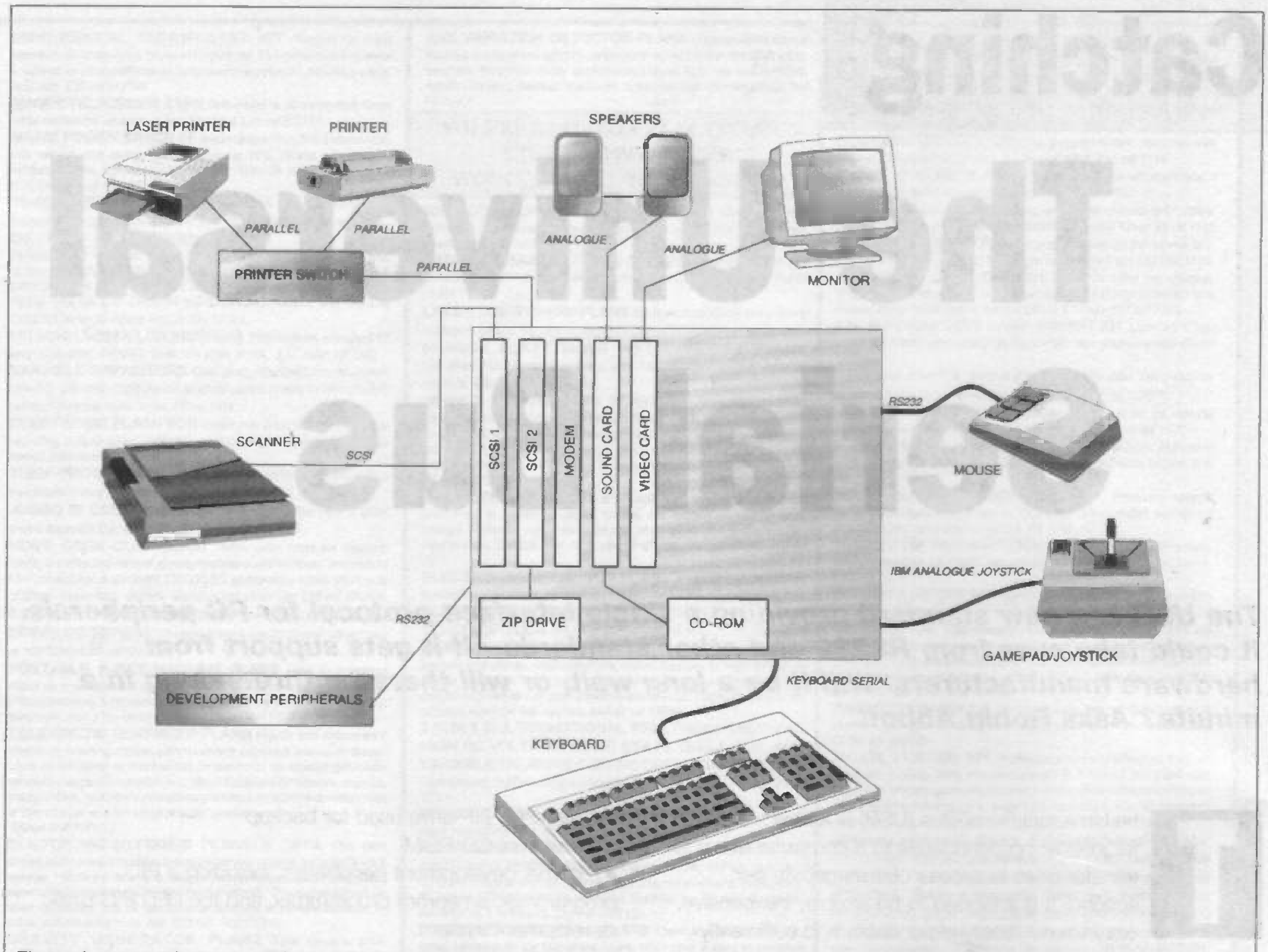


Figure 1: connections on a PC used for development and games

standards required to connect and power all the peripherals - which are a fairly standard set for a busy professional or semi-professional personal computer.

Switching between printers requires not only a selection on the PC, but also manual switching. If this is forgotten, the current print command has to be cancelled and submitted again once the printer switch is in the correct position.

There are four different expansion cards required (two SCSI, a modem and a sound card), which occupy all the ISA slots on the motherboard, so that future expansion using this type of PC bus slot is not possible. Setting up these cards to ensure that there was no clash on the I/O port addresses used by the sound card and the second SCSI interface caused considerable problems, as they both clashed with the first SCSI card which was already installed. If you are not yourself a PC owner, ask anyone who is - they will almost certainly have a similar story to tell.

Another issue is that of interrupts. In a typical PC there are 15 interrupts available for peripheral devices, a number of which are reserved for internal operation, and in my PC all the remaining interrupts have been used. Although well-behaved applications and cards can share interrupts, this is not always possible, and in practice I have rarely found it possible to install two peripherals on one interrupt.

The Bus

The Universal serial bus (USB) system is intended to overcome some of these problems. The USB is a new interface standard which provides the following features:

- Removal of the limit to the expansion capability of a PC due to a limited number of expansion slots.
- Allows simple expansion of a PC with common low-level software drivers.
- Powering of peripheral devices via the USB cable.
- Up to 127 devices may be served per USB host connection.
- "Hot swapping" - devices may be connected, disconnected, reset, and power cycled while the host PC is in use.
- Operation for simple low bandwidth devices at 1.5Mb/s.
- Operation at up to 12Mb/s for other devices, including audio and compressed video.
- Reduction in cabling.
- Reduction in different type of cables.
- Cabling is simple, physically flexible, low cost 4-core cable.
- Up to 5m distance per cable run.
- The electrical signalling allows the PC to place all peripherals on the USB into a suspended low power state. This is used for "green" energy saving systems.
- Automatic assignment of addresses to devices, together with software interrupt polling requires no user intervention for device set-up.

The universal serial bus is not intended as a LAN, or to provide networking services, but purely as a local connection facility to a single host PC.

The topology of a complete USB system is illustrated in figure 2 . The root hub is the host PC. All data transfers are performed between the root hub and devices on the USB

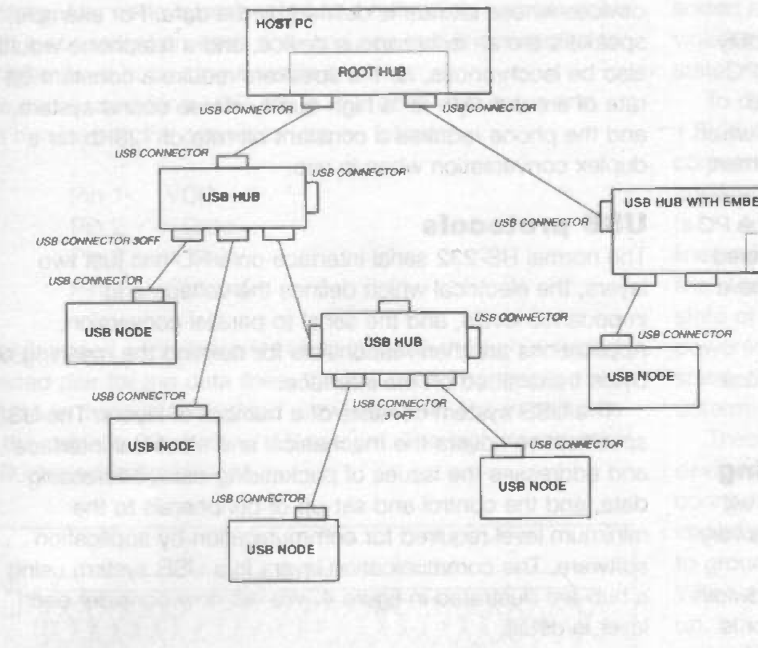


Figure 2: topology of a complete USB system

network, and devices on the USB network do not communicate directly with each other. There is only ever one root hub. A USB node (also known as a function) is a device which uses the USB to communicate to the host PC, so our USB nodes are the keyboard, the mouse, the printer, and so on.

The devices shown as hubs are special USB equipments which provide one port towards the host PC, but several downstream ports to which further hubs or USB nodes may be connected. This allows a treelike connection of USB nodes, and has the advantage that unplugging a device from the hub does not affect any other devices connected to it. It is envisaged that in practice hubs will normally form part of an equipment. For example, a keyboard may contain a hub device as well as a USB node for the keyboard itself. The hub on the keyboard now allows a mouse and gamepad to be directly plugged into it. This is called an embedded hub.

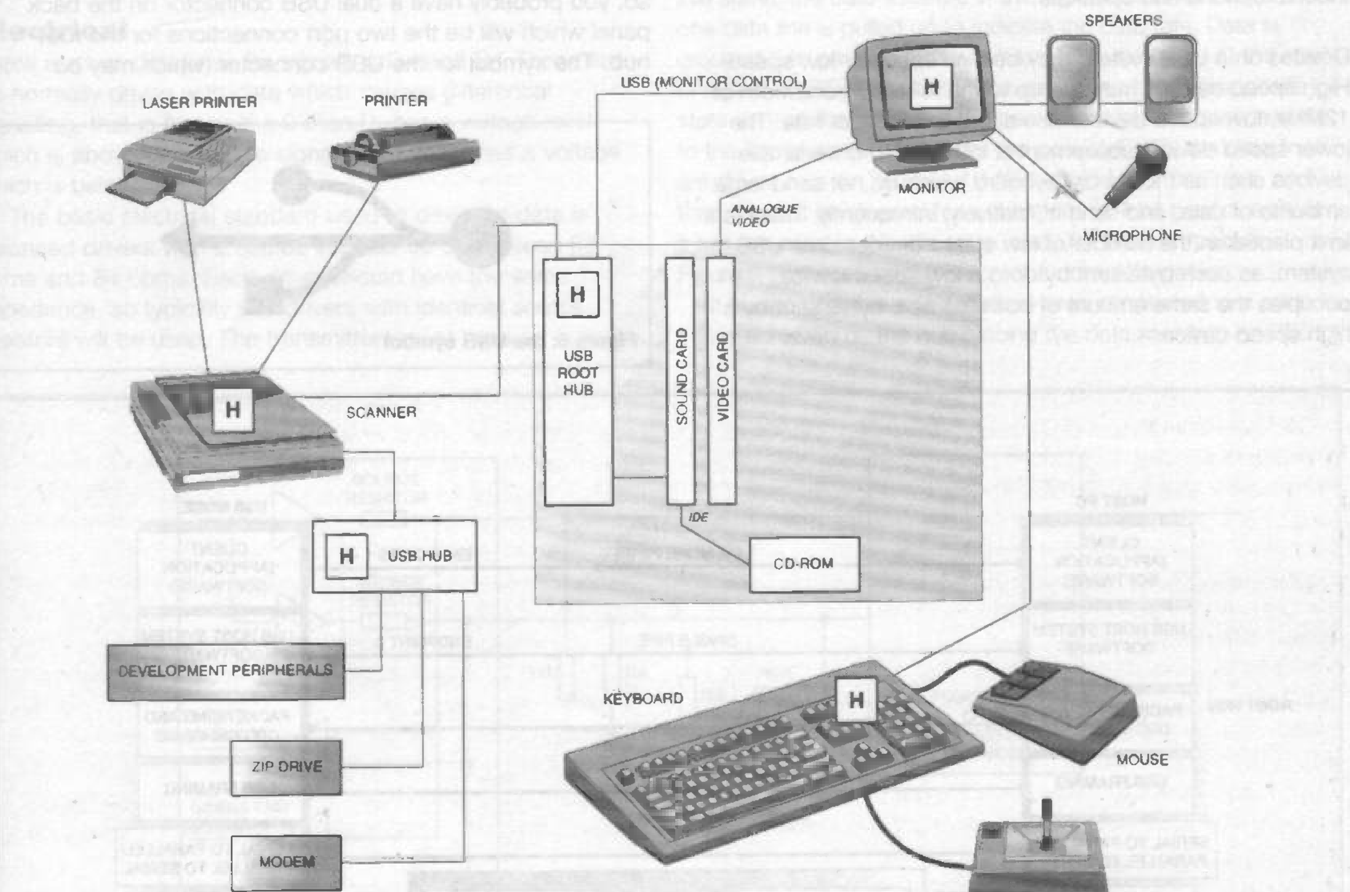


Figure 3: connections on a PC used for development and games, interfaced using the USB system

We can now redraw figure 1 to show how the example PC and all its connections can now be interconnected using the USB system (figure 3). The keyboard is an embedded hub, and the other hub connections are used for the mouse and the game pad. The monitor is a hub for the speakers and microphone (note that in figure 3 we now have the capability for monitor control which was not present in the original PC configuration). The scanner operates as a hub for the two printers, and also operates as a hub for a special hub to which the other peripherals (the modem, ZIP drive and development peripherals) are connected.

Note that we now have considerably less cabling to the PC (as well as this, many of these functions will also be powered from the USB, eliminating some power cables), and we have removed three expansion cards - the USB root hub is implemented on the motherboard.

There are a number of peripherals that are unlikely to use the USB system:

CD-ROMs intended for internal mounting

Disk drives - internal disk drives, and external hard disks will not use the USB system because they have a continuous very high bandwidth requirement when they are in use.
Monitor video data. This has a very high continuous bandwidth requirement (up to tens of megahertz), and as the monitor is usually located close to the PC system unit then the usual SVGA connector can be employed. However, control of the monitor from the PC can use the USB system, and in our example we have shown the monitor as a hub used to connect the microphone and speakers.

Devices on a USB system may be high speed or low speed. High speed devices may use up to the full USB bandwidth of 12MHz, low speed devices use a 1.5MHz transfer rate. The lower speed device requirement is intended to drive simple devices such as mouse or keyboard which do not send large amounts of data, and send it (relatively) infrequently. There is a limit placed on the number of low speed devices on a USB system, as each byte sent by or to a low speed device occupies the same amount of bus time as 8 bytes sent by a high speed device.

Devices on a USB system are either asynchronous, or isochronous. Asynchronous devices generate or receive data as required. For example, the keyboard and the mouse are asynchronous devices. Isochronous devices are defined as devices whose bit rate is defined by the data. For example, speakers are an isochronous device, and a telephone would also be isochronous, as the speakers require a constant bit rate of around 1Mb for a high quality stereo sound system, and the phone requires a constant bit rate of 128Kb for a duplex conversation when in use.

USB protocols

The normal RS-232 serial interface on a PC has just two layers, the electrical which defines the voltage and impedance levels, and the serial to parallel conversion. Applications are then responsible for defining the meaning of bytes transmitted on the interface.

The USB system consists of a number of layers. The USB specification covers the mechanical and electrical interface and addresses the issues of packetising data, addressing data, and the control and set-up of peripherals to the minimum level required for communication by application software. The communication layers in a USB system using a hub are illustrated in figure 4. We will now consider each layer in detail.

Mechanical

The USB plug is normally supplied moulded to a cable. If you have a PC manufactured within the last 12 months or so, you probably have a dual USB connector on the back panel which will be the two port connections for the root hub. The symbol for the USB connector (which may be

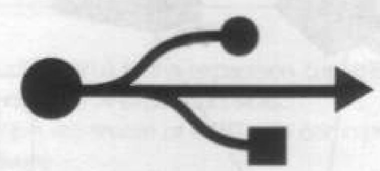


Figure 5: the USB symbol

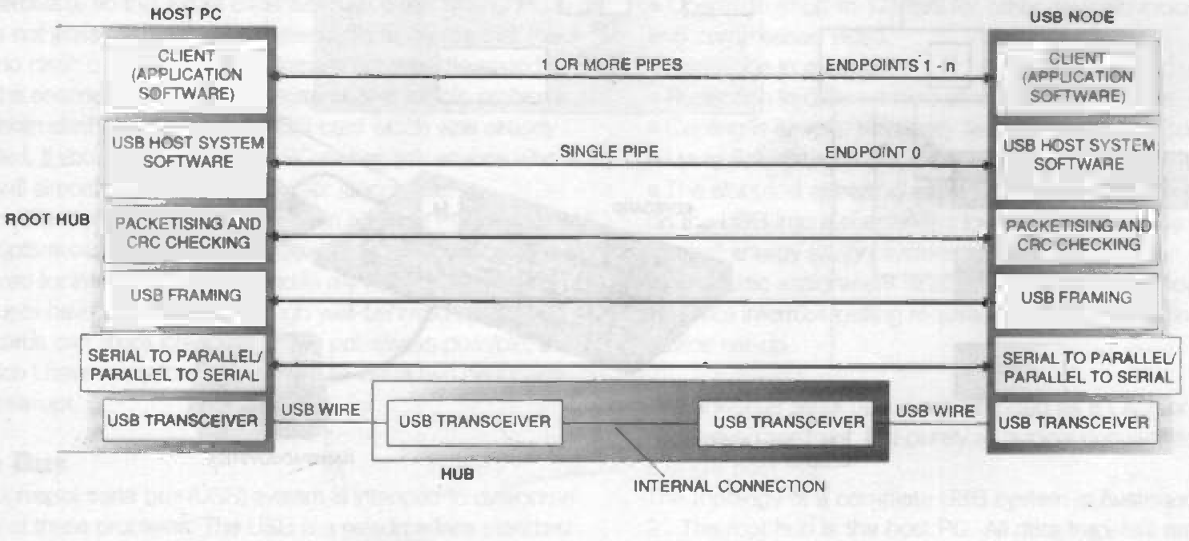


Figure 4: USB protocol layers (system using hub). Hub communications to the host are now shown

printed alongside it) is illustrated in figure 5. The connectors are unique for upstream and downstream ports on a hub, and so it is impossible to create loops within a USB system which would almost certainly cause failure of the USB system. Any node is connected to a hub using a single cable with a connector on each end, and any hub is connected to a higher level hub using a single cable.

The cable used for a USB link is four-core. The cores and pin numbers in the connector are as follows:

Pin 1	VCC
Pin 2	- Data
Pin 3	+ Data
Pin 4	Ground

A high speed connection (12MHz) is made through shielded twisted pair for the data lines, the low speed connection may be made through unshielded untwisted pair. The impedance of the cable is 90 ohms +/-15 percent. The high speed cable is illustrated in figure 6.

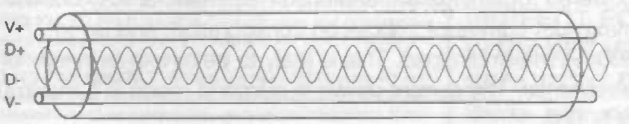


Figure 6: USB cable

Electrical

There are two data lines for signalling D+ and D-. These are be normally driven with data which causes differential signalling, that is to signal a 0 then D- has a voltage level which is above D+, and to signal a 1 then D- has a voltage which is below D+.

The basic electrical standard used to drive the data is balanced drivers with a source impedance of between 58 ohms and 84 ohms. Each driver should have the same impedance, so typically two drivers with identical source resistors will be used. The transmitters must have an output swing of greater than 2.8V into a 15k load, and must be capable of being switched off.

The receivers are balanced and must switch with an input differential of 200mV. Each data line must also have a single ended receiver to enable the device to detect differential violations (where both data lines are switched to the same state), to allow for additional switching.

To differentiate between a high and low data rate device 1.5k pull-up resistors are used. See figure 7 which shows complete USB transceivers for high speed and low speed applications implemented in a USB node, or in a port on a hub. A high speed device has a pull-up resistor on the D+ line and a low speed device has a pull-up resistor on the D- line. The drivers have pull-down resistors of 15k. In the idle state of the line (when the USB peripheral device is not powered, and the downstream driver is in a high impedance state), the pull-down and pull-up resistors may be used to determine the bit rate by the hub.

These resistors may also be used to determine when a device is connected to a hub port. With no device connected to a port, its transmission drivers will be in a high impedance state, and the two data lines will both be pulled to ground. This is called a 'single ended 0' state (or SE0). When a device is connected to the port, it will be powered up, but its transmission drivers will be in a high impedance state. Therefore the pull-up resistor on the device's upstream port will pull one of the data lines high. This may be detected by the hub's downstream port.

When no packets are being sent (when the USB is in the idle state), the data lines are in the high impedance state, and one data line is pulled up to indicate the data rate. Data is grouped into packets for transmission on the USB. At the start of a packet (SOP), the data lines are driven into the opposite state so that the first bit of the packet holds the opposite state to the idle state. At the end of the packet (EOP), the data lines are driven to a single ended 0 for a period of 2 bit times, and then the bus is released for a minimum of 1 bit period, so that it has returned to the idle state ready for the next packet. Figure 8 illustrates transmission of a complete packet.

It is also possible to reset all devices connected to a port; this is achieved by the hub placing the data lines into an SE0

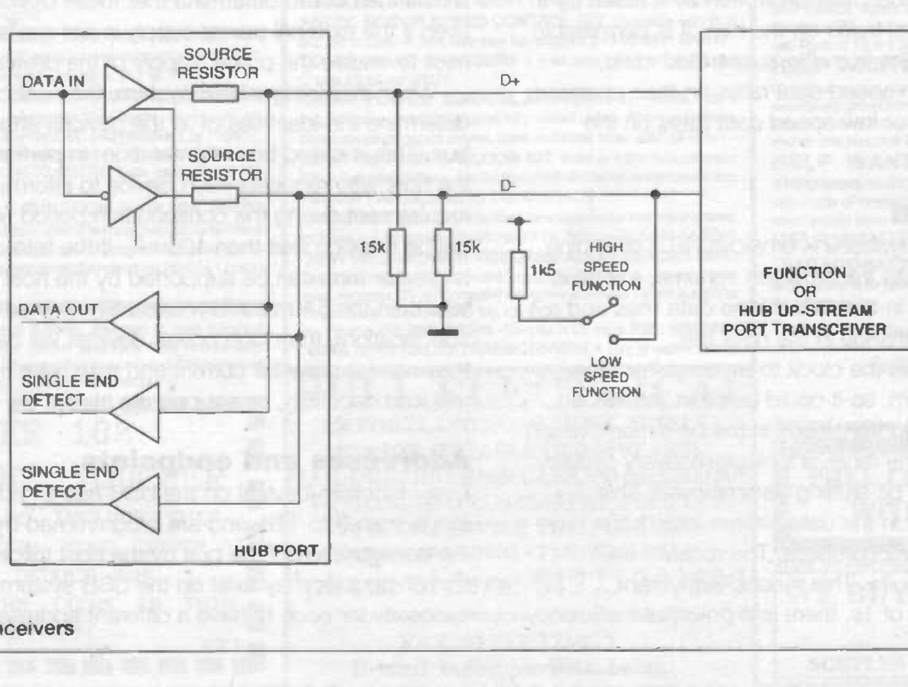


Figure 7: USB tranceivers

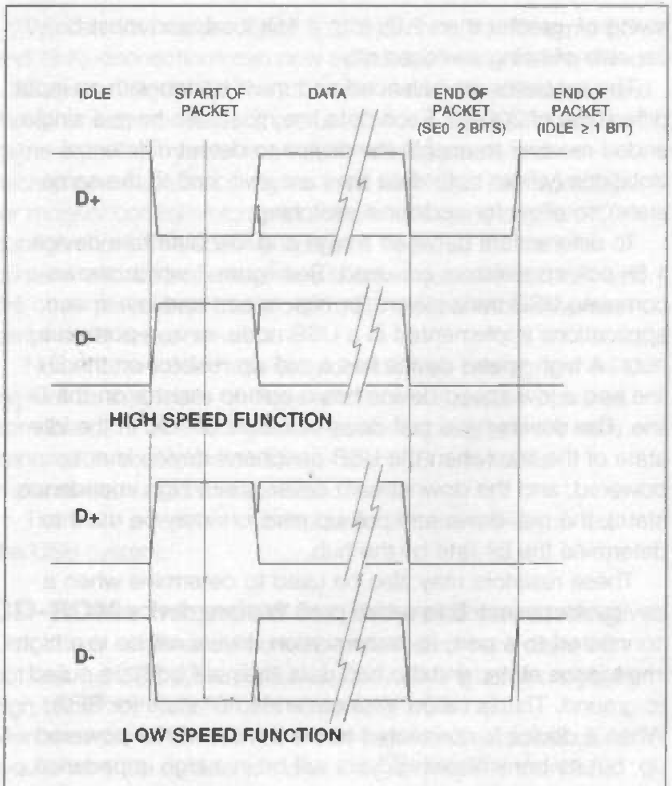


Figure 8: complete packet

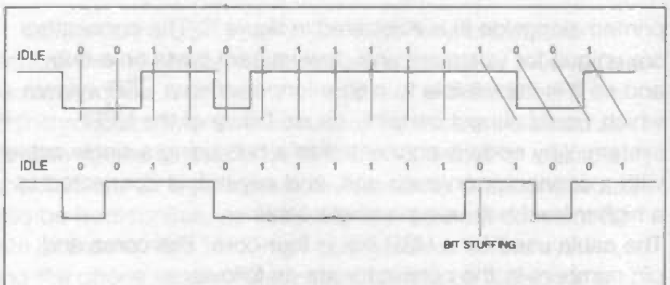


Figure 9: transmission of bit stream using NRZI with bit stuffing

state for a period of 10ms. All devices which see this state should then act as if they have just been connected to the bus.

Normally at least one packet will be sent on the bus every millisecond. If the USB is idle for more than 3ms, all devices may enter a suspend state. In the suspend state devices should power down and use less than 500uA current. However they do not have to do this, and may continue to draw power as required for monitoring functions. For example, if the host PC enters a low power state due to lack of keyboard or mouse activity, then it may suspend the bus by placing it into the idle state for more than 3ms. However, the keyboard and mouse must remain fully available to detect user key presses or mouse movements to wake the PC from its low-power state. To do this they may draw the current they require to perform this task.

Once suspended, devices may be woken by a reset, by a resume state, or by normal traffic on the bus. It is permissible to take up to 20ms to wake from the suspended state.

All hubs must use high speed data rates on their upstream port, and may allow high or low speed data rates on the downstream port.

Data transmission

The data sent over the physical link employs NRZI encoding with bit-stuffing. In this data transmission scheme, a 0 bit is represented by a change in the state of the data lines and a 1 bit is represented by no change in the data line.

The receiver determines the clock to be used from the transitions in the bit stream, so it could be seen that a long series of 1s will result in no transitions in the bit stream, which would be disastrous for the receiver's clock-recovery circuitry. To prevent this problem, "bit stuffing" is employed. This technique inserts a '0' bit in the data stream if six 1 bits have been seen, prior to the NRZI process. The receiver then removes the 0 bit after six 1s. This means that when transmitting a long series of 1s, there is a potential inefficiency of 14 percent in the data, however, if this is a problem then higher levels of the software are expected to employ data compression to optimise out this inefficiency.

The complete transmission process is shown in figure 9 which illustrates the transmission of a bit stream.

The USB power distribution system

The USB systems allows distribution of power to attached peripherals. The nominal supply voltage is 5V, but devices must operate with a power supply as low as 4.75V when drawing full current. The maximum current consumption of all loads powered together is 5A, and any one peripheral may draw a maximum current of 100mA on configuration, and up to 500mA maximum load. This is likely to be ample for nearly all peripherals. The current drawn in suspend mode is a maximum of 500uA.

Looking again at our example PC, the following peripherals may be powered from the USB:

- Keyboard.
- Mouse
- Gamepad
- Speakers.
- Modem.
- High capacity floppy drive
- External development peripherals.

Clearly the scanner and printers will require their own power supplies, as power drawn by these devices may be tens of watts. This type of device is known as a self powered device. It is expected that even self powered devices will still power their USB circuitry from the USB power distribution system. This allows the host to determine that these devices are present even if the external power supply is not available, or allows the host to enable the power supply of the device remotely.

When initialising a USB system, the host controller must determine the identities of all the devices attached to the USB bus. This is called bus enumeration. In performing this function, the host also requests each device to inform it of its current requirement during the configuration period (when each device will be drawing less than 100mA). If the total requested current is greater than can be supported by the host (which may be less than the 5A maximum capability defined by the USB specification), then high power devices will be informed that they cannot draw full current and may have to operate with reduced capability, or not operate at all.

Addresses and endpoints

Every function (device) on the USB has an address. Addresses range from 0 to 128, and are programmed by the host during the configuration of the bus by the host following power up, up to 127 devices may exist on the USB system without the necessity for each to have a different address set up by the

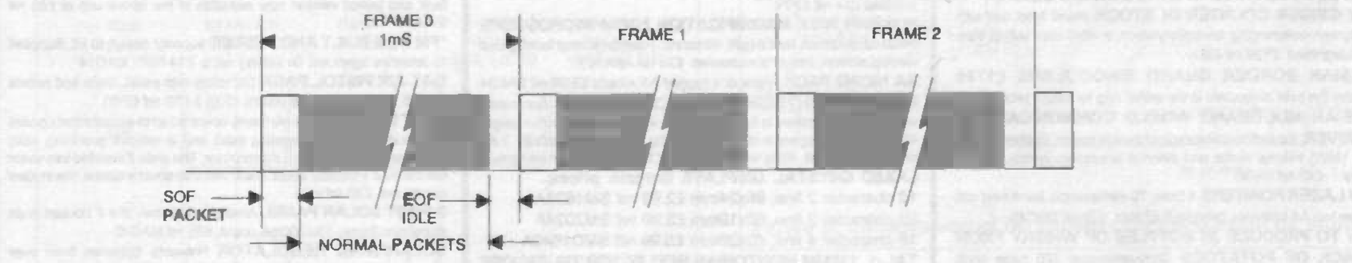


Figure 10: USB 1 millisecond frame structure

user - anyone who has tried to set up expansion cards in a PC and has to worry about setting the address and interrupt number of the card will appreciate how much of a benefit this can be !

A function may have a number of endpoints. An endpoint is an internal address within the function which allows the controlling software to address packets to different internal functions of a single USB function. For example, a combined scanner/printer may have an endpoint for the scanner and an endpoint for the printer within a single USB address to allow the host software to treat the single device as two independent functions. A device may have up to 16 endpoint addresses. Endpoint address 0 is the controlling endpoint which is used by the host software to set up all devices on the USB system, and cannot be used by the application.

Packetising

Data to be sent on to the USB is divided into packets, the maximum size of which is around 8kbits - at 12MHz this takes around 700us to transmit on the bus. Data is transmitted on the bus Least Significant Bit (LSB) first. Most data transfers are in bytes, however, some bit fields transmitted in headers are not aligned on a byte boundary.

The USB host divides time into 1ms frames, Every 1ms the host sends a special packet, the start of which (the SOP bit) is accurately timed. At the end of each frame there is a guard time during which no data is sent, and during which time hubs on the USB system electrically disconnect any active transmitters. This ensures that the bus is idle for the SOF. This is illustrated in figure 10. These frame packets are not sent when the bus is suspended.

A packet is delimited by the SOP and EOP markers on the data lines as described above.

A packet always starts with a synchronising pattern which is sent as seven 0s followed by a 1 - this represents the byte 80 hex. This is used to enable the receiver's clock synchronisation circuitry to recover the clock. Following the synchronisation pattern the first bit of the packet is sent on the bus.

The format of the various USB packets is shown in figure 11.

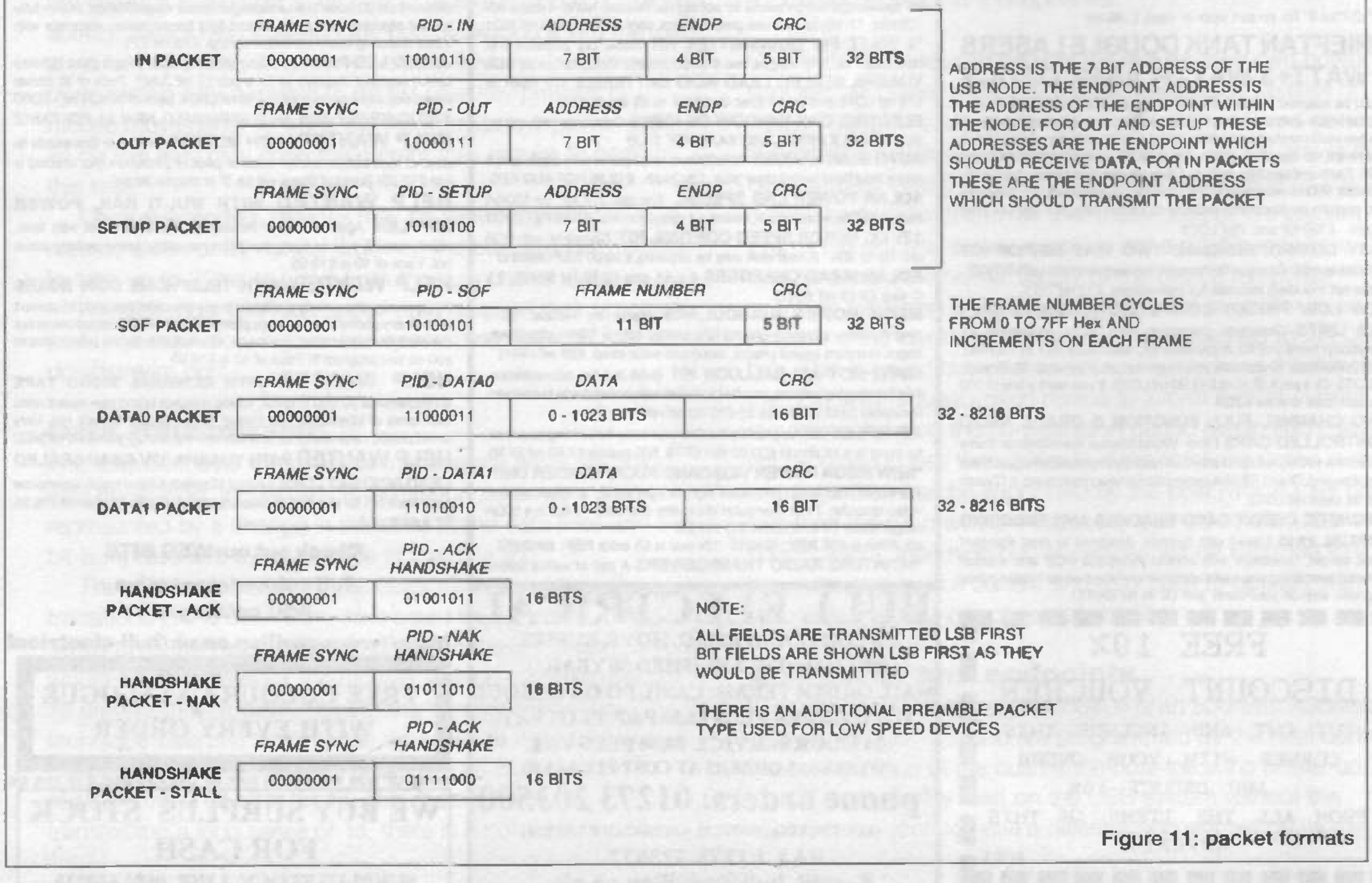


Figure 11: packet formats

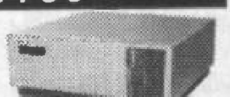
Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

LOW COST PC's -



SPECIAL BUY 'AT 286'

40Mb HD + 3Mb Ram

LIMITED QUANTITY only of these 12Mhz HI GRADE 286 systems Made in the USA to an industrial specification, the system was designed for *total reliability*. The compact case houses the mother-board, PSU and EGA video card with single 5¼" 1.2 Mb floppy disk drive & Integral 40Mb hard disk drive to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee. *Ready to Run!*
Order as HIGRADE 286 **ONLY £129.00** (E)

Optional Fitted extras: VGA graphics card	£29.00
1.4Mb 3½" floppy disk drive (instead of 1.2 Mb)	£19.95
Wordperfect 6.0 for Dos - when 3½" FDD option ordered	£22.50
NE2000 Ethernet (thick, thin or twisted) network card	£29.00

LOW COST 486DX-33 SYSTEM

Limited quantity of this 2nd user, supurb small size desktop unit. Fully featured with standard simm connectors 30 & 72 pin. Supplied with keyboard, 4 Mb of RAM, SVGA monitor output, 256k cache and integral 120 Mb IDE drive with single 1.44 Mb 3.5" floppy disk drive. Fully tested and guaranteed. *Fully expandable*
Many other options avaiable - call for details. only **£399.00** (E)

FLOPPY DISK DRIVES 3½" - 8"

5¼" or 3½" from only £18.95 !

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are *BRAND NEW* or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3½" supported on your PC).

3½" Panasonic JU363/4 720K or equivalent RFE	£24.95(B)
3½" Mitsubishi MF355C-L. 1.4 Meg. Laptops only	£25.95(B)
3½" Mitsubishi MF355C-D. 1.4 Meg. Non laptop	£18.95(B)
5¼" Teac FD-55GFR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5¼" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£29.95(B)
5¼" BRAND NEW Mitsubishi MF501B 360K	£22.95(B)
Table top case with integral PSU for HH 5¼" Flopp or HD	£29.95(B)
8" Shugart 800/801 8" SS refurbished & tested	£195.00(E)
8" Shugart 810 8" SS HH *Brand New*	£195.00(E)
8" Shugart 851 8" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" double sided *NEW*	£275.00(E)
Mitsubishi M2896-63-02U 8" DS slimline *NEW*	£285.00(E)
Dual 8" cased drives with integral power supply 2 Mb	£499.00(E)

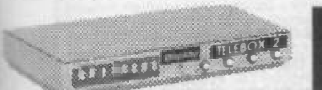
HARD DISK DRIVES

End of line purchase scoop! *Brand new* NEC D2246 8" 85 Mbyte drive with industry standard SMD interface, replaces Fujitsu equivalent model. Full manual. Only £299.00 or 2 for £525.00 (E)

3½" FUJI FK-309-26 20mb MFM I/F RFE	£59.95(C)
3½" CONNER CP3024 20 mb IDE I/F (or equiv.)RFE	£59.95(C)
3½" CONNER CP3044 40mb IDE I/F (or equiv.)RFE	£69.00(C)
3½" RODIME RO3057S 45mb SCSI I/F (Mac & Acorn)	£69.00(C)
3½" WESTERN DIGITAL 850mb IDE I/F *Brand New*	£185.00(C)
5¼" MINISCRIBE 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5¼" SEAGATE ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5¼" CDC 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
5¼" HP 9754B 850 Mb SCSI RFE tested	£89.00(C)
5¼" HP C3010 2 Gbyte SCSI *differential* RFE tested	£195.00(C)
8" FUJITSU M2322K 160Mb SMD I/F RFE tested	£195.00(E)
Hard disc controllers for MFM , IDE, SCSI, RLL etc. from	£16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER
CABLE COMPATIBLE

The TELEBOX is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD etc. The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. TELEBOX MB covers virtually all television frequencies VHF and UHF including the HYPERBAND as used by most cable TV operators. A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop computer video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

TELEBOX ST for composite video input type monitors	£36.95
TELEBOX STL as ST but fitted with integral speaker	£39.50
TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95

For overseas PAL versions state 5.5 or 6 mHz sound specification.
*For cable / hyperband reception Telebox MB should be connected to a cable type service. Shipping code on all Teleboxe's is (B)

DC POWER SUPPLIES

Virtually every type of power supply you can imagine.Over 10,000 Power Supplies Ex Stock Call for info / list.

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

6,000,000 items EX STOCK

For *MAJOR* SAVINGS - CALL FOR SEMICONDUCTOR HOTLIST

VIDEO MONITOR SPECIALS

One of the highest specification monitors you will ever see - At this price - Don't miss it!!

Mitsubishi FA3415ETKL 14" SVGA Multisync colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including IBM PC's in CGA, EGA, VGA & SVGA modes, BBC, COMMODORE (including Amiga 1200), ARCHIMEDES and APPLE. Many features: Etched faceplate, text switching and LOW RADIATION MPR specification. Fully guaranteed, supplied in EXCELLENT little used condition.

Tilt & Swivel Base £4.75 **Only £119** (E) Order as MITS-SVGA
VGA cable for IBM PC included.
External cables for other types of computers CALL

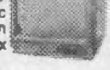
As New - Used on film set for 1 week only!!
15" 0.28 SVGA 1024 x 768 res. colour monitors.
Swivel & tilt etc. Full 90 day guarantee. £145.00 (E)

Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors. Good SH condition - from £299 - CALL for info

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 Khz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £95** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite 15.625 Khz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13½" x 12" x 11". Good used condition. **Only £125** (E)



20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & *optional* sound input. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc.In EXCELLENT little used condition with full 90 day guarantee.

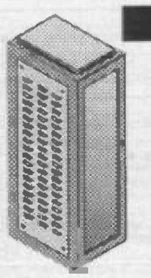
20"....£135 22"....£155 26"....£185 (F)

SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
2kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
IBM 8230 Type 1, Token ring base unit driver	£950
IBM 53F5501 Token Ring ICS 20 port lobe modules	£750
IBM MAU Token ring distribution panel 8228-23-5050N	£95
AIM 501 Low distortion Oscillator 9Hz to 330Khz, IEEE	£550
Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£6500
HP1650B Logic Analyser	£3750
HP3781A Pattern generator & HP3782A Error Detector	£POA
HP APOLLO RX700 system units	£950
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP3081A Industrila workstation c/w Barcode swipe reader	£175
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP7580A A1 8 pen HPGL high speed drum plotter	£1850
EG+G Brookdeal 95035C Precision lock in amp	£650
View Eng. Mod 1200 computerised inspection system	£POA
Ling Dynamics 2kW programmable vibration test system	£POA
Computer controlled 1056 x 560 mm X Y table & controller	£1425
Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Fiskers 45KVA 3 ph On Line UPS - New batts Dec.1995	£9500
ICI R5030UV34 Cleanline ultrasonic cleaning system	£POA
Mann Tally MT645 High speed line printer	£2200
Intel SBC 486/133SE Multibus 486 system. 8Mb Ram	£1200
Zeta 3220-05 A0 4 pen HPGL *fast* drum plotters	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. New	£550
Fujitsu M3041R 600 LPM band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Perkin Elmer 2998 Infrared spectrophotometer	£POA
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager!)	£950
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
TAYLOR HOBSON Tallysurf amplifier / recorder	£750
System Video 1152 PAL waveform monitor	£485
Test Lab - 2 mtr square quietised acoustic test cabinets	£300
Kenwood 9601 PAL Vectorscope - NEW	£650

Please call for further details on the above items

19" RACK CABINETS



Superb quality 6 foot 40U
Virtually New, Ultra Smart
Less than Half Price!

Top quality 19" rack cabinets made in UK by Optima Enclosures Ltd. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the most versatile we have ever sold. Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays.
Overall dimensions are: 77½" H x 32½" D x 22" W. Order as:

OPT Rack 1 Complete with removable side panels.	£335.00 (G)
OPT Rack 2 Rack, Less side panels	£225.00 (G)

32U - High Quality - All steel RakCab

Made by Eurocraft Enclosures Ltd to the highest possible spec, rack features all steel construction with removable side, front and back doors. Front and back doors are hinged for easy access and all are lockable with five secure 5 lever barrel locks. The front door is constructed of double walled steel with a 'designer style' smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to take the heaviest of 19" rack equipment. The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A mains distribution panel internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin switched utility socket. Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvres. The top panel may be removed for fitting of integral fans to the sub plate etc. Other features include: fitted castors and floor levelers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in excellent, slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W. (64" H x 25" D x 23¾" W)

Sold at LESS than a third of makers price !!

A superb buy at only £195.00 (G)

Over 1000 racks - 19" 22" & 24" wide 3 to 44 U high. Available from stock !! Call with your requirements.

TOUCH SCREEN SYSTEM

The ultimate in 'Touch Screen Technology' made by the experts - *MicroTouch* - but sold at a price below cost !! System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to an electronic controller PCB. The controller produces a standard serial RS232 or TTL output which continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an incredible matrix resolution of 1024 x 1024 positions over the entire screen size !! A host of available translation software enables direct connection to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc etc. Imagine using your finger with 'Windows', instead of a mouse !! (a driver is indeed available !) *The applications for this amazing product are only limited by your imagination!!* Complete system including Controller, Power Supply and Data supplied at an incredible price of only: **£145.00** (B)
Full MICROTOUCH software support pack and manuals for IBM compatible PC's £29.95 RFE - Tested

LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with 2 Mbytes of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) memory. Full data and driver disks supplied. RFE. Fully tested and guaranteed. Windows compatible. £59.95(A1)
Half length 8 bit memory upgrade cards for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.
Order as: XT RAM UG. 256k. £34.95 *or* 512k £39.95 (A1)

SIMM SPECIALS

1 MB x 9 SIMM 9 chip 120ns	Only	£16.50 (A1)
1 MB x 9 SIMM 3 chip 80 ns £19.50	or 70ns	£22.95 (A1)
1 MB x 9 SIMM 9 chip 80 ns £21.50	or 70ns	£23.75 (A1)
4 MB 70 ns 72 pin SIMM *-with parity-*	Only	£95.00 (A1)

INTEL 486-DX33 CPU £55.00 INTEL 486-DX66 CPU £69.00 (A1)
FULL RANGE OF CO-PROCESSOR'S EX STOCK - CALL FOR £££

FANS & BLOWERS

EPSON DO412 40x40x20 mm 12v DC	£7.95	10 / £65
PAPST TYPE 612 60x60x25 mm 12v DC	£8.95	10 / £75
MITSUBISHI MMF-D6D12DL 60x60x25 mm 12v DC	£4.95	10 / £42
MITSUBISHI MMF-08C12DM 80x80x25 mm 12v DC	£5.25	10 / £49
MITSUBISHI MMF-09B12DH 92x92x25 mm 12v DC	£5.95	10 / £53
PANCAKE 12-3.5 92x92x18 mm 12v DC	£7.95	10 / £69

EX-EQUIP AC fans. ALL TESTED 120 x 120 x 38 mm specify 110 or 240 v £6.95. 80 x 80 x 38 mm - specify 110 or 240 v £5.95
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240v NEW £79.95
Shipping on all fans (A). Blowers (B). *50,000 Fans Ex Stock CALL*

Issue 13 of *Display News* now available - send large SAE - PACKED with bargains!

DISPLAY -ELECTRONICS-

ALL MAIL & OFFICES
Open Mon-Fri 9.00-5:30
Dept ET. 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

LONDON SHOP
Open Mon - Sat 9:00 - 5:30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
Nr.Thornton Heath & Selhurst Park SR Rail Stations

NEW **DISTEL©**
The Original
FREE On line Database
Info on 20,000 + stock items!
RETURNING SOON !

ALL ☎ ENQUIRIES
0181 679 4414
FAX 0181 679 1927

SWITCH MasterCard VISA EST 25 YEARS

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks etc acknowledged. © Display Electronics 1996. E & O.E. 06/6

OUT	First packet of a host to function transaction. Packet includes address of function and the address of the endpoint.
IN	First packet of a function to host transaction. Packet includes address of the function and the address of the endpoint which is generating data.
SOF	Start of frame, followed by the 11 bit frame number. This is the packet sent every 1ms.
SETUP	This is used in setting up the function by the host bus enumeration software.
DATA0	Data packet. Followed by up to 1023 bytes of data in 8 bit form.
DATA1	Data packet. (See below for details of how DATA0 and DATA1 packets are used). Followed by up to 1023 bytes of data in 8 bit form.
ACK	Acknowledgement by receiver that the packet was received without errors.
NAK	Receiver cannot accept data.
STALL	Indicates that an endpoint is stalled, for example this may be sent to indicate that a device has been unable to process all the data sent to it as yet.
PRE	Preamble - used for communication to low speed devices.

Note that the fields of the packet do not line up on 8-bit boundaries; for example, the 7 bits of the address in an OUT packet are followed immediately by the 4 bits of the endpoint address. These packets are also known in the specification as tokens.

The first four bits sent are the PID. This stands for packet identity, and is a 4-bit code (the upper four bits of the PID byte are the same 4-bit code, but inverted providing a simple check on the code). The types of PID available are shown in the table above.

Addresses are seven bits in length, endpoint addresses are four bits in length.

CRC checking is applied to the longer of the packets. The CRC check is either five bits long or 16 bits long dependant on the packet type. The CRC check is intended to ensure that the packet has been received correctly without errors.

Sending and receiving data

Data transfers always occur between the host and an endpoint on a function with a specific address. This unique address to which data is transferred is called a pipe. A pipe may be a stream pipe or a message pipe. A message pipe contains data in a defined structure, a stream pipe contains unstructured data such as sound information for speakers or from a microphone.

Data transfers are always based on a multi way packet transfer and are always initiated by the host - it is not possible for any function on a USB system to send data autonomously. The direction of transfer is indicated by the host sending either an IN or an OUT packet. The IN packet is a request to the function from the host to send the host some data in one or more packets, the OUT packet is a request to the function to send the host some data in one or more packets. Following the IN or OUT packet the function or the host respectively send a DATA packet, following each data packet the receiving end of the USB transaction sends an ACK (or NAK or STALL if there is a problem), and then the next packet may be sent. The initial packet sent is a DATA0 packet, the next packet is a DATA1 packet and then back to DATA0, the packet types toggle between DATA0 and DATA1 throughout the data transfer.

When the function is receiving data it may return an ACK packet if the data was received without error, a NAK packet if the function was temporarily unable to receive data, and a STALL packet if there is a problem with the function which requires resetting from the host.

An example of an occasion when a STALL packet may be sent would be if a watchdog circuit timed out.. A watchdog circuit in a microprocessor based system is usually based on a resettable monostable, the software must keep resetting the monostable, if it fails to do so due to a software failure or unexpected external event then the monostable times out and produces a hardware reset or non-maskable interrupt. If a watchdog time-out occurred in the function the function may send STALL packets in response to any query by the host, and may then be reset and initialised by the host, and can continue operation.

An interrupt transaction occurs to a special type of endpoint called an interrupt endpoint. Interrupt endpoints are normally polled by the host on a regular basis. If the endpoint has data then it sends it using the interrupt endpoint when it is polled. It is usual that there is only a small amount of interrupt data, if larger amounts are to be sent the interrupt packet may identify the need for the large data transfer which can be transferred at the request of the host at a later time.

An example of interrupt data may be a keyboard which returns a keycode when a new key is pressed. Thus the endpoints on a keyboard may be:

Endpoint 0, which is always used for USB management control.
Endpoint 1 which may be used to control the state of the keyboard - for example in setting LED's on the keyboard.
Endpoint 2 an interrupt endpoint used to send the keycode of a key which is pressed.

Transfer to an isochronous endpoint is achieved without the handshake packet, the host issues an IN or OUT packet and then the DATA packet is sent. Only DATA0 packets are used. As an illustration of bus bandwidth required by an isochronous device, consider a stereo microphone which employs audio compression to achieve a bandwidth requirement of 50Kbits/s per channel. This will require a packet size of 12.5 bytes per millisecond. By the time that the size of the IN packet, the header and CRC on the DATA packet, and the SOP and EOP states, are taken into account this device will use about 170bits during the frame, or around 1.5 percent of the USB bandwidth at 12MHz.

Connecting and disconnecting USB functions

When a USB function is attached to a hub the hub detects its presence by the change in electrical levels (as described above in the section on the electrical interface of the bus).

TELNET

8 CAVANS WAY,
BINLEY INDUSTRIAL ESTATE,
COVENTRY CV3 2SF
Tel: 01203 650702
Fax: 01203 650773
Mobile: 0860 400683

(Premises situated close to Eastern-by-pass in Coventry with easy access to M1, M6, M40, M42, M45 and M69)

OSCILLOSCOPES

Beckman 9020 - 20MHz - Dual Channel £150
Cossor 3102 - 60MHz Dual Channel £250
Gould 1602 – 20 MHz D.S.O. with printer (cursors) £1150
Gould OS 245A/250/255/300/3000/3351/4000 .... from £125
Hameg 203/203-5 - 20MHz - Dual Channel .... from £150
Hewlett Packard 180A/180C/181A/182C .... from £200
Hewlett Packard 1740A, 1741A, 17744A, 100MHz dual ch .... from £350
Hewlett Packard 54100D - 1GHz Digitizing £2995
Hewlett Packard 54501A - 100MHz - Digitizing 4 channel £1750
Hewlett Packard 54602A - 150MHz - 4 channel £1750
Hitachi V650F – 60 MHz Dual Channel £350
Hitachi VC6265 – 100 MHz Digital Storage (AS NEW) GPIB £2250
Hitachi V152F/V302B/V302F/V353F/V550B/V650F .... from £125
Intron 2020 – 20 MHz Digital Storage (NEW) £650
Iwatsu SS 5710/SS 5702 - 20MHz .... from £125
Kikusui COS 6100 – 100MHz, 5 Channel, 12 Trace £475
Kikusui 5100 - 100MHz - Dual Channel £350
Meguro - MSO 1270A - 20 MHz Digital Storage (NEW) £650
National VP5703A - 100MHz - Digital Storage £750
Nicolet 310 - L.F. D.S.O with twin Disc Drive £550
Nicolet 3091 – L.F. D.S.O £900
Panasonic VP5741A - 100 MHz D.S.O. with Digital readout - waveform analysis - TV Signal Analysis Function - G.P.I.B. £1995
Philips PM 3211/PM 3212/PM 3214/PM 3217/PM 3234/PM 3240/PM 3243/PM 3244/PM 3261/ PM 3262/PM 3263/PM 3540 .... from £125
Philips PM 3295A - 400MHz Dual Channel £1750
Scopex 14D-15 - 15MHz - Dual Channel £100
Tektronix 434 - 25MHz - 2 Channel, Analogue Storage £250
Tektronix 454 - 150MHz - 2 Channel £400
Tektronix 468 - 100MHz - D.S.O. £750
Tektronix 2213 – 60MHz Dual Channel £425
Tektronix 2215 60MHz dual trace £450
Tektronix 2235 - 100MHz-Dual trace £800
Tektronix 2236 - 100MHz Dual Channel with Counter/Timer £995
Tektronix 2335 Dual trace 100MHz (portable) £750
Tektronix 2445 150 MHz - 4 Channel £1250
Tektronix 2445A - 150MHz - 4 Channel £1650
Tektronix 2465 - 350MHz - 4 channels £2500
Tektronix 2225 – 50MHz dual ch £450
Tektronix 455 - 50MHz Dual Channel £350
Tektronix 464/466 – 100MHz An storage .... from £350
Tektronix 465/465B – 100MHz dual ch .... from £350
Tektronix 475/475A - 200MHz/250MHz Dual Channel .... from £475
Tektronix 485 - 350MHz- 2 channel £900
Tektronix 5403 - 60MHz - 2 or 4 Channel .... from £250
Tektronix 7313, 7603, 7613, 7623, 7633, 100MHz 4 ch .... from £300
Tektronix 7704 – 250MHz 4 ch .... from £650
Tektronix 7904 – 500MHz .... from £850
Tektronix 7934 500MHZ with storage .... from £1000
Trio CS-1022 - 20MHz - Dual Channel £125

Other scopes available too

SPECIAL OFFER
HITACHI V212 - 20 MHZ DUAL TRACE £180
HITACHI V222 - 20 MHZ DUAL TRACE + ALTERNATE MAGNIFY £200

SPECTRUM ANALYSERS

Advantest 4131 - 10KHz - 3.5GHz (G.P.I.B) £5000
Ando AC8211 - Spectrum Analyser 1.7GHz £3000
Eaton/Alltech 757 - 10KHz – 22 GHz £2750
Hewlett Packard 3580A – -5Hz-50KHz £995
Hewlett Packard 3709B - Constellation Analyser with 15709A High Impedance Interface (As New) £5750
Hewlett Packard 182T with 8559A (10MHz – 21GHz) £3750
Hewlett Packard 35601A - Spectrum Analyser Interface £1000
Hewlett Packard 3585A - 40MHz Spectrum Analyser £5000
Hewlett Packard 141T + 8552B + 8555A - (10MHz – 18GHz) £1600
Hewlett Packard 3562A Dual Channel Dynamic Sig. Analyser £7500
Hewlett Packard 8505A - Network Analyser 500KHz – 1300MHz £3950
Hewlett Packard 853A + 8558B - 0.1 to 1500MHz £3250
Hewlett Packard 182T + 8558B - 0.1 to 1500MHz £2750
Hewlett Packard 8565A - 0.01-22GHz £3750
Hewlett Packard 8754A - Network Analyser 4-1300MHz £2500
Marconi 2370 – 110MHz £995
Marconi 2371 – 30KHz - 200MHz £1250
Meguro MSA 4901 - 1-300 GHz (AS NEW) £1995
Meguro MSA 4912 - 1-1 GHz (AS NEW) £3000
Polrad 641-1 – 10MHz – 18GHz £1500
Rohde & Schwarz – SWOB 5 Polyskop 0.1 – 1300MHz £2500
Takeda Riken 4132 - 1.0GHz Spectrum Analyser £2750
Tektronix 7L18 with 7603 mainframe (1.5-60GHz with external mixers) £2000

MISCELLANEOUS

Adret 740A - 100KHz-1120MHz Synthesised Signal Generator £2000
ANRITSU ME 462B DF/3 Transmission Analyser £3000
Danbridge JP30A - 30KV Insulation Tester £1500
Anritsu MG642A Pulse Pattern Generator £1500
Dranetz 626 - AC/DC - Multifunction Analyser £850
EIP 331 – Frequency counter 18GHz £700
Farnell AP70-30 Power Supply (0-70v/30A) Auto Ranging £750
Farnell TSV 70 MkII Power Supply (70V-5A or 35V-10A) £200
Farnell DSG-1 - Synthesised Signal Generator £125
Flure 5100A - Calibrator £2500
Flure 5101B - Calibrator with Tape Deck £4000
Flure 5100B - Calibrator £3500
Guildline 9152 - T12 Battery Standard Cell £550
Heiden 1107 – 30V-10A Programmable Power Supply (IEEE) £650
Hewlett Packard 331A - Distortion Analyser £300
Hewlett Packard 333A - Distortion Analyser £300
Hewlett Packard 3336C - Synthesised Signal Generator (10Hz-21MHz) £1000
Hewlett Packard 3437A System voltmeter £350
Hewlett Packard 3456A Digital voltmeter £850
Hewlett Packard 3438A Digital multimeter £200
Hewlett Packard 3711A/3712A/3791B/3793B Microwave Link Analyser £2250
Hewlett Packard 3776A - PCM Terminal Test Set .... £POA
Hewlett Packard 3325A - 21MHz Synthesiser/Function Gen £1500
Hewlett Packard 3488A - HP - 1B Switch control unit (various Plug-ins available) £650
Hewlett Packard 334A - Distortion Analyser £300
Hewlett Packard 339A - Distortion Measuring Set £1500
Hewlett Packard 3455A 61/2 Digit M/Meter (Autocal) £750
Hewlett Packard 3478A - Multimeter (5½ Digit) + HP-1B £550
Hewlett Packard 3776A - PCM Terminal Test Set .... £P.O.A.
Hewlett Packard 3779A/3779C - Primary Mux Analyser .... from £600
Hewlett Packard 436A + Sensor .... from £1000
Hewlett Packard 4275A - LCR Meter (Multi-Frequency) £3950
Hewlett Packard 4338A - Millionmeter (As New) £2000
Hewlett Packard 4342A - 'Q' Meter £995
Hewlett Packard 4952A - Protocol Analyser (with interfaces) £2500
Hewlett Packard 4953A - Protocol Analyser £2750
Hewlett Packard 432A – Power Meter (with 478A Sensor) £275
Hewlett Packard 435A or B Power Meter (with 8481A/8484A) .... from £750
Hewlett Packard 4271B - L.C.R. Meter (Digital) £900
Hewlett Packard 4279A - 1MHz, C-V Meter £6500
Hewlett Packard 4948A - (TIMS) Transmission impairment M/Set £2000
Hewlett Packard 4972A - Lan Protocol Analyser £2000
Hewlett Packard 5420A Digital Signal Analyser £350
Hewlett Packard 5335A - 200MHz High Performance Systems Counter £600
Hewlett Packard 5314A - (NEW) 100MHZ Universal Counter £250
Hewlett Packard 5183 - Waveform Recorder £2250
Hewlett Packard 5238A Frequency Counter 100MHz £250
Hewlett Packard 5370A - 100MHz Universal Timer/Counter £450
Hewlett Packard 5385A Frequency Counter - 1GHz - (HP1B) with OPTS 001/003/004/005 .... £995
Hewlett Packard 6034 - 60v-10a System Power Supply £1500
Hewlett Packard 6253A Power Supply 20V-3A Twin £200
Hewlett Packard 6181C D.C. current source £150
Hewlett Packard 6255A Power Supply 40V - 1.5A Twin £200
Hewlett Packard 6266B Power Supply 40V-5A £220
Hewlett Packard 6271B Power Supply 60V-3A £225
Hewlett Packard 6034A - O-60V-10A System P.S.U. £1500
Hewlett Packard 7475A - 6 Pen Plotter £250
Hewlett Packard 7550A - 8 Pen Plotter A3/A4 .... £450

HEWLETT PACKARD 6261B
Power Supply 20v-50A £450 ***Discount for Quantities***

Hewlett Packard 8349B - Microwave Broad Band Amplifier £3500
Hewlett Packard 83555A - Millimeter - Wave Source Module 33-50GHz £4250
Hewlett Packard 8015A - 50MHz Pulse Generator £750
Hewlett Packard 8403A - Modulator £500
Hewlett Packard 8405A - Vector Voltmeter £500
Hewlett Packard 8165A - 50 MHZ Programmable Signal Source £1650
Hewlett Packard 8350B - Sweep Oscillator Mainframe (various Plug-ins available) extra £2650
Hewlett Packard 8152A - Optical Average Power Meter £1250
Hewlett Packard 8158B - Optical Attenuator (OPTS 002 + 011) £1100
Hewlett Packard 83554A - Wave Source Module 26.5 to 40 GHz £3500
Hewlett Packard 8620C Sweep oscillator mainframe £400
Hewlett Packard 8684A 5.4GHz to 12.5GHz Sig-Gen £2750
Hewlett Packard 8620C Sweep oscillator mainframe .... from £250
Hewlett Packard 8750A Storage normaliser £375
Hewlett Packard 8903A - Audio Analyser (20Hz – 100KHz) £2600
Hewlett Packard 8958A - Cellular Radio Interface £4000
Hewlett Packard 8901A - Modulation Analyser £3400
Hewlett Packard P382A Variable Attenuator £250
Hewlett Packard 1630D - Logic Analyser (43 Channels) £650
Hewlett Packard 16500A - Fitted with 16510A/16515A/16530A/16531A - Logic Analyser £4000
Hewlett Packard 11729B - Carrier Noise Test Set £2000
Krohn-Hite 2200 Lin/Log Sweep Generator £995
Krohn-Hite 4024A Oscillator £250
Krohn-Hite 5200 Sweep, Function Generator £350
Krohn-Hite 6500 Phase Meter £250
Marconi 2019 - 80KHz-1040MHz Synthesised Sig. Gen £1850
Marconi 2019A - 80KHz - 1040MHz - Synthesised Signal Generator £1950
Marconi 2022A - 10KHz-1GHz AM/FM Signal Generator £2000
Marconi 2432A 500MHz digital freq. meter £200
Marconi 2610 - True RMS Voltmeter £850
Marconi 2871 Data Comms Analyser £2000
Philips PM 5167 10MHz function gen £400
Philips 5190 L.F. Synthesiser (G.P.I.B.) £800
Philips PM5519 - TV Pattern Generator £350
Philips PM5667 - Vectorscope £500
Philips PM6652 - 1.5GHz Programmable High Resolution Timer/Counter £900
Philips PM6670 - 120MHz High Resolution Universal Counter £350
Philips PM6673 - 120MHz High Resolution Universal Counter £350
Prema 4000 - 6 1/2 Digit Multimeter (NEW) £450
Racal 1992 - 1.3GHz Frequency Counter £800
Racal Dana 9081/9082 Synth. sig. gen. 520MHz .... from £500
Racal Dana 9084 Synth. sig. gen. 104MHz £450
Racal Dana 9303 R/F Level Meter & Head £650
Racal Dana 9917 UHF frequency meter 560MHz £175
Racal Dana 9302A R/F millivoltmeter (new version) £375
Racal Dana 9082 Synthesised am/fm sig gen (520MHz) £500
Racal 9085 Low Distortion Oscillator .... £POA
Racal 9301A - True RMS R/F Millivoltmeter £300
Racal 9921 - 3GHz Frequency Counter £450
Rohde & Schwarz AMF 2 - TV Demodulator £1250
Rohde & Schwarz LFM 2 - 60 Mhz Group Delay Sweep Gen £1600
Rohde & Schwarz SMFP2 - 1GHz Radio Comms T/Set £2500
Rohde & Schwarz UPSF 2 - Video Noise Meter £1400
Rohde & Schwarz URE - RMS Voltmeter (10Hz-25MHz) £500
Rohde & Schwarz - Scud Radio Code Test Set £300
Rohde & Schwarz SUF 2 Noise Generator £300
Rohde & Schwarz UPGS - Psophometer £150
Rohde & Schwarz SMDU - 15Hz to 525MHz Signal Gen (FM & AM) £500
Schaffner NSG 203A Line Voltage Variation Simulator £950
Schaffner NSG 222A Interferance Simulator £850
Schaffner NSG 223 Interferance Generator £850
Schaffner WSG 431 Electrostatic Discharge Simulator £1250
Schlumberger 4923 Radio Code Test Set £950
Schlumberger 4031 - 1GHz Radio Comms Test Set £7000
Schlumberger 2720 1250 MHz Frequency Counter £500
Schlumberger 7060/7065/7075 Multimeters .... from £350
Solartron 1250 - Freq. Response Analyser £2500
Stanford Research DS 340 - 15 MHz Syntesized Function (NEW) and arbitrary waveform generator £1200
Systron Donner 6030 - Microwave Frequency Counter (26.5 GHz) £2500
Telequipment CT71 Curve Tracer £250
Tektronix TM5003 + AFG 5101 Arbitrary Function Gen. £1750
Tektronix 1240 Logic Analyser £750
Tektronix DAS9100 – Series Logic Analyser £500
Tektronix – Plug-ins – many available such as SC504, SW503, SG502, PG508, FG504, FG503, TG501, TR503 + many more .... £POA
Tektronix 577 Curve Tracer £1150
Tektronix AM503 + TM501 + P6302 - Current Probe Amplifier £995
Tektronix PG506 + TG501 + SG503 + TM503 - Oscilloscope Calibrator £1995
Tektronix AA5001 & TM 5006 M/F - Programmable Distortion Analyser £2500
Tektronix 577 - Curve Tracer £1150
Time 9811 Programmable Resistance £600
Time 9814 Voltage Calibrator £750
Toellner7720 - Programmable 10 MHz Function Gen (AS NEW) £700
Valhalla Scientific - 2724 Programmable Resistance Standard .... £P.O.A.
Wayne Kerr 3245 - Precision Inductance Analyer £3250
Wayne Kerr 4210 - LCR Meter £600
Wayne Kerr 4225 - LCR Bridge £600
Wayne Kerr 6425 - Precision Component Analyser £275
Wayne Kerr 8905 - Precision LCR Meter £850
Wavetek 171 - Synthesised Function Generator £250
Wavetek 172B Programmable Sig Source (0.0001HZ-13MHZ) .... £P.O.A.
Wavetek 184 - Sweep Generator - 5MHz £250
Wavetek 3010 – 1- 1GHz Signal Generator £1250
Wiltron 6620S - Programmable Sweep Generator (3.6 - 6.5GMZ) £650

MANY MORE ITEMS AVAILABLE –
SEND LARGE S.A.E. FOR LIST OF EQUIPMENT
ALL EQUIPMENT IS USED –
WITH 30 DAYS GUARANTEE.
PLEASE CHECK FOR AVAILABILITY BEFORE
ORDERING – CARRIAGE & VAT TO BE ADDED
TO ALL GOODS

The hub notifies the host of the attachment (recall that the host PC has a hub itself - the root hub). The host then enables the port on the hub and addresses the peripheral on that port using the USB default address, the host then assigns an address to the peripheral and establishes control pipe 0. From this point onwards the peripheral can be set up from the host and then used by application software. It is likely that in most implementations of the host, then the host will set up all USB devices during the boot up sequence of the host, applications may then run at a later time and will have the USB peripherals which they address immediately available.

Connection of a hub requires the hub to be initialised, and then each port of the hub to be initialised in order.

Disconnection of a function or hub is also recognised by the change in electrical levels. The hub notifies the host which removes all records referring to the hub or function, and notifies any application software of the removal.

Implementing the USB interface

Those readers who have studied this article in detail will probably have realised that providing a USB interface on a peripheral is considerably more complex than interfacing to earlier standards, such as RS232 or the parallel port. On the other hand, the problem of interfacing to USB is likely to become crucial if it becomes widely accepted, and in this case it is likely that microcontrollers will increasingly become available with USB ports, and with USB application software provided as standard.

The first decision to be made is whether the peripheral will contain an embedded hub, or whether it will simply consist of a USB function. It is likely that most non-commercial users will implement peripherals without embedded hubs, and rely on the commercial manufacturers to produce either dedicated hubs, or peripherals with embedded hubs and multiple downstream ports.

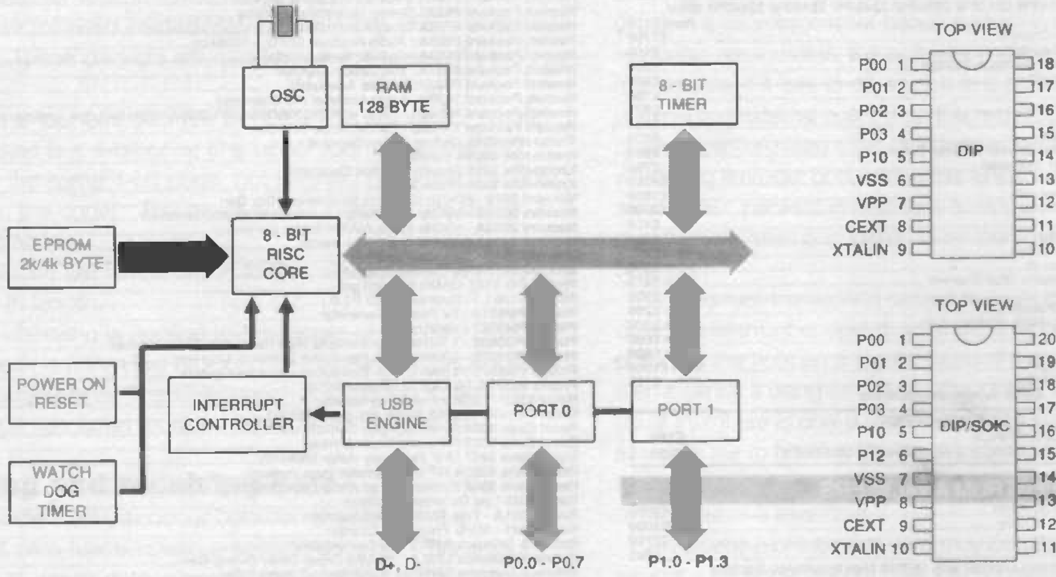


Figure 12: Cypress USB microcontroller (low speed peripheral) - block diagram

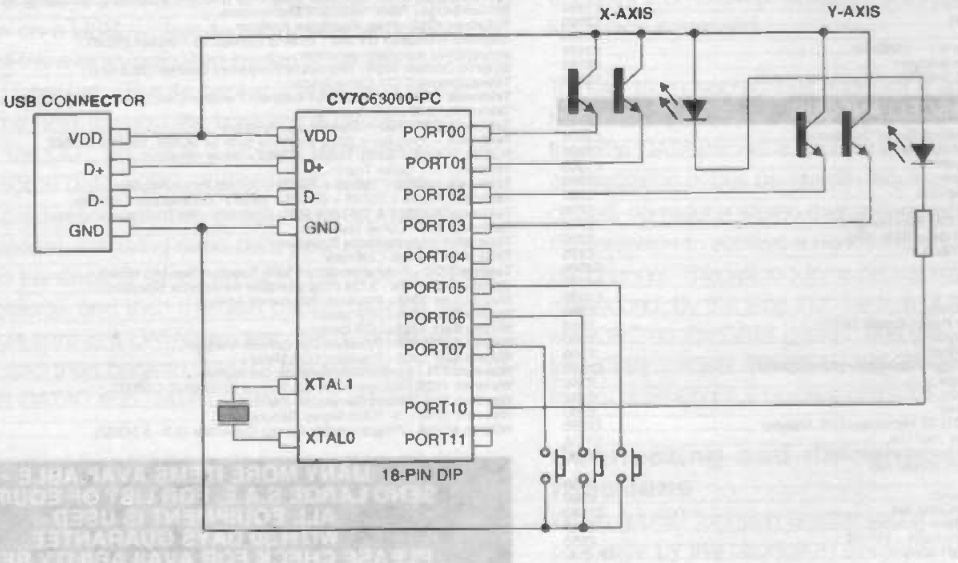


Figure 13: mouse with a Cypress microcontroller

Given the relative complexity of the USB it is hardly surprising that the only support chips currently available or planned are based on microcontrollers, we will take a look at two series of planned microcontrollers from Intel and from Cypress. It is likely that mask programmed microcontrollers like these will become available for specific applications such as keyboard and mouse functions, these chips are likely to be available at very low cost.

Implementing a peripheral device

The CY7C63x00 series are USB microcontrollers designed for peripherals operating using low speed USB. The series is intended to be fully available by the end of 1997 with full production now. The block diagram of this device is shown in figure 12. The smaller devices offer 10 in/out pins, and the larger devices offer 16 in/out pins. The USB transceiver is on chip, and the chips offer 128 byte of ram and 2K or 4K of eprom. As an example of the use of one of these microcontrollers, figure 13 shows a mouse implemented using one of the Cypress ics using Cypress's promotional literature As can be seen in this circuit, there is very little to a USB device implemented using a controller such as this.

Anyone used to using the PIC series of microcontrollers would have little problem using these devices. There is an on chip timer generating 128us and 1.024ms interrupts. The device supports USB suspend mode directly, which can be woken up by USB interrupt or external interrupts. Interrupt sources are the timer, external action, or USB endpoint actions. The device has two endpoints, endpoint 0 is capable of receive and transmit, endpoint 1 is capable of transmit only, data is loaded into the endpoint FIFO register, and will be transmitted automatically by the microcontroller on receipt of an IN packet. The microcontroller will generate an interrupt on receipt of a packet to endpoint 0. The microcontroller has a risc core, and supports Immediate, direct, and indexed addressing modes.

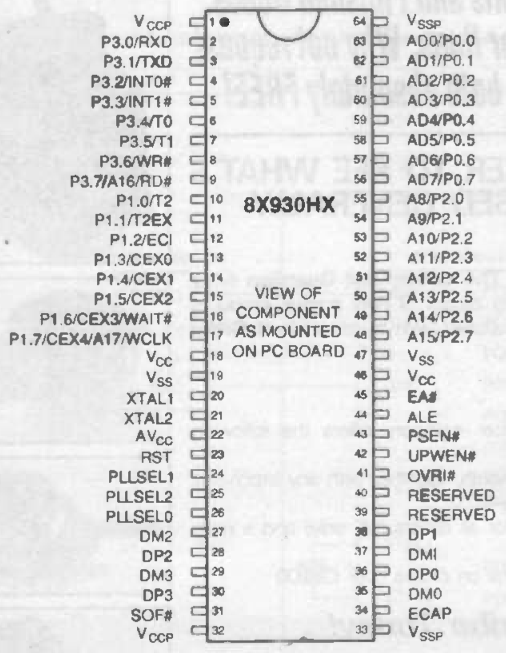


Figure 14: 8 x 930Hx USB hub/peripheral controller pin-out (64 pin package)

Implementing a Hub

The 8x930Hx microcontroller from Intel is a complete hub peripheral controller which offers one upstream port, an internal hub, and three external downstream ports. All the ports have internal USB transceivers. The internal embedded controller has three endpoint buffers of 16 bytes, and a configurable 1Kbyte buffer, this will allow endpoint 0 and control functions on the 16 byte buffers with large scale data transfer on the 1K buffer. The device has 1Kbyte of internal ram, and up to 16Kbyes of rom, although it is possible to use external eprom/ram up to a total of 256Kbytes. This particular device offers operation at up to 12Mbps. The controller is available in a 64 pin package - the pin out is shown in figure 14, and this is clearly a non-trivial device!
This device is code compatible with the 8051 series of microcontrollers.

The future of USB

The USB is a new interface standard. To become accepted and widely used a standard must be supported by suppliers of equipment which may use it. One only has to look at the Betamax video tape standard, or the IBM Micro-Channel architecture for bus interfacing, to see that good ideas can fail to conquer the market if they have insufficent third party support.

It seems unlikely that USB will be supported until it is widely available on host PCs. This is because suppliers of peripherals will want a market which is not limited to people who have purchased new PCs in the last year or so. This could be achieved if add-on USB host cards become widely available for those that do not have USB on the motherboard, but a quick scan of the computer magazines showed a distinct dearth of such cards available at time of writing. A number of PCs are advertised with dual USB ports, and I found that many new PCs which are not advertised with USB ports are in fact supplied with them. However, when I phoned three PC suppliers, only one could actually tell me what USB stood for and for what it is used!

The first peripherals likely to use USB are the higher bandwidth complex devices such as printers and scanners where the cost of the USB interface is not significant in comparison to the overall cost of the device. For simpler devices such as keyboards and mice, it seems unlikely that USB will be cost competitive with the cheapest devices which are currently available, and it will take some time for USB chipsets for these applications to be widely available and cost competitive. I spent some time scanning advertisements in several PC magazines, but I was unable to find a single peripheral which used the USB.

In conclusion, the attractions of USB are such that if the system starts to become widely available on peripherals as well as on PCs, then it will snowball, becoming the de facto interfacing standard. In the longer term as the application ics become more widely available I hope to be able to bring the readers of ETI an example interface using the USB.

The USB standard

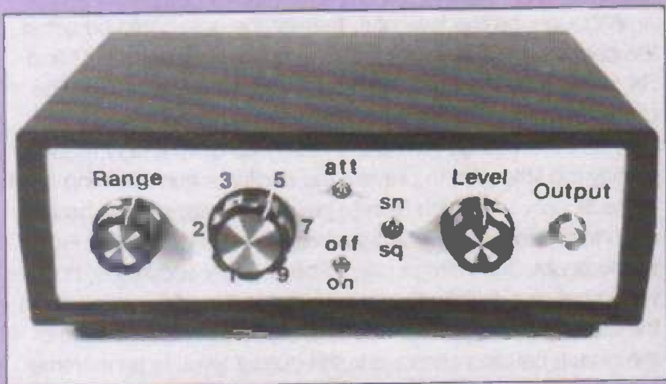
The current issue of the USB standard is available on the internet from the USB implementors forum at: http://teleport.com/~USB, on on email at USB@FES.FM.INTEL./COM. The author is prepared to supply copies of the USB specification in Microsoft Word 6.0 (and above) format. Please send an SAE and £3.00 to Robin Abbott, 60 Walkford Way, Christchurch, Dorset, BH23 5QG mail order only.

AF generator Switch tuned

Robert Penfold's design for an audio frequency signal generator has switch controlled tuning rather than the continuous type. Covering a range of 10 hertz to 100 kilohertz, no calibration is needed once the unit is finished.

A conventional audio frequency signal generator typically covers a range of 20 Hertz to 200 kilohertz in four ranges, with continuously variable tuning over each range. A unit of this type represents a fairly straightforward project for the home conductor to build, but it can be difficult to get the finished generator accurately calibrated. Matters are made more difficult by the fact that the scaling is decidedly non-linear unless a difficult to obtain anti-log potentiometer is used for the tuning control. Even then, accurate linear scaling is not guaranteed, and producing an accurate scale can be difficult. In fact it is not possible at all, unless you have access to either a frequency meter or another signal generator that is accurately calibrated.

This audio generator covers a range of 10 Hertz to 100 kilohertz, but it has switch controlled tuning rather than the continuous variety. On the lowest of its four ranges it provides output frequencies of 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, and 100 Hertz. The other three ranges provide output frequencies at 10, 100, and 1000 times these frequencies. The advantage of using switch controlled tuning is that there is no calibration to contend with once the unit has been completed. You just switch on and dial up the required frequencies using the two frequency control switches. Close tolerance components in the critical parts of the circuit ensure that the accuracy of the output frequencies is reasonably good. The actual error will very somewhat from one frequency to the next, but in general the output frequency will be within five percent of the required figure, and in many cases the error will be under one percent. This is



more than adequate for most purposes, including most frequency response testing.

Obviously it is not possible to set any desired frequency using this method of frequency control, but in practice you do not often need to set odd output frequencies such as 876 Hertz. However, it is only fair to point out that this generator is not suitable for testing filters that have either a very narrow passband or provide a very narrow "notch." It is well suited to most general audio testing, such as checking the frequency responses of tone controls and RIAA preamplifiers, voltage gain measurement, and so on.

Good quality sine and squarewave output signals are provided at a maximum output voltage of about three volts peak-to-peak. The squarewave signal has rise and fall times of well under one microsecond, and is free from overshoot and ringing effects. An attenuator switch can be set to reduce the output level by about 40dB, and a continuously variable attenuator is also provided. Power is obtained from an internal nine volt battery and the unit is therefore fully portable.

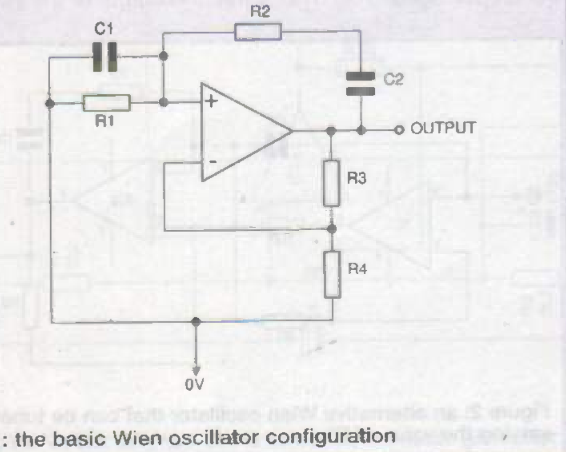
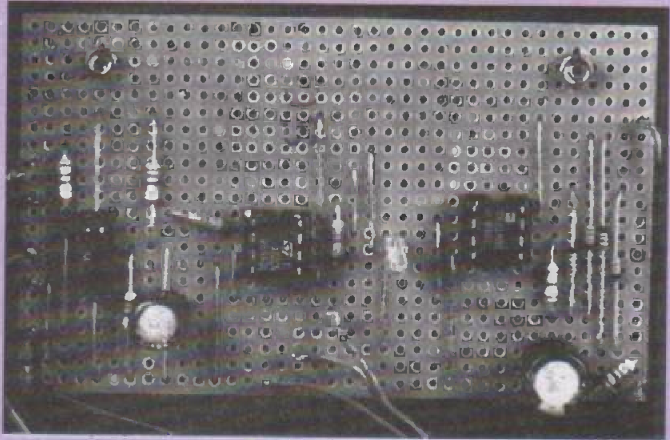


Figure 1: the basic Wien oscillator configuration

Sinewave Generation

Audio signal generators are almost invariably based on a Wien oscillator which produces the sinewave signal. The squarewave signal is then produced from the sinewave signal using a clipping amplifier. The basic circuit for a Wien oscillator is shown in figure1. The Wien network consists of R1, R2, C1, and C2, and it is connected so that it provides positive feedback over the operational amplifier.

At a certain frequency the Wien network will produce a phase shift of zero degrees, and the circuit will oscillate at this frequency provided the voltage gain of the amplifier fractionally more than compensates for the losses through the Wien network. Conventionally, C1=C2 and R1=R2, but the circuit



will operate if the two resistors and the two capacitors are not of equal value. Assuming that they are, a voltage gain of approximately three must be provided by the amplifier in order to produce oscillation.

Although, on the face of it, the voltage gain could be set at the correct level by giving negative feedback resistors R3 and R4 suitable values, in practice this will not work properly. The circuit will provide a high quality sinewave output signal provided the voltage gain is set very accurately. It only requires slightly too little gain to prevent the oscillator from working at all, or fractionally too much gain to produce a clipped and badly distorted output signal. Using a preset resistor for R3 or R4 would enable the voltage gain to be set very accurately, but this would not give satisfactory results in practice. Any variations in the loading on the output would tend to upset the balance of the circuit, causing changes in the output level. In an extreme case the oscillator could stall completely. Where a variable output frequency is required it is normally obtained by using a dual gang potentiometer for R1 and R2. The matching of the two gangs is never perfect, and this means that the precise voltage gain needed to sustain oscillation will vary somewhat from one setting of the tuning control to another.

The only practical way of stabilising the output level is to use some form of automatic gain control (agc) circuit. There is more than one way of achieving this, but by far the most common is to use one of the self-heating thermistors that are designed specifically for this application. Unlike an ordinary thermistor, a self- heating type is contained in an evacuated glass envelope that largely isolates it from the ambient temperature. Passing a small current through one of these components results in it rising in temperature, which in turn causes its resistance to fall. In a Wien oscillator the thermistor is connected in place of R3.

Initially the resistance of the thermistor is quite high, which gives high voltage gain through the amplifier and strong oscillation. This strong oscillation produces a heavy flow of current through the thermistor, which results in the thermistor heating up. The thermistor's resistance therefore drops and produces weaker oscillation. In fact it normally results in oscillation ceasing, and the thermistor starting to cool off again. Its resistance then rises again and quite strong oscillation occurs once more. This process continues a few times with the circuit gradually settling down and oscillating gently.

As with any form of automatic gain control, this system relies on a form of negative feedback action. If the circuit oscillates more strongly for some reason, the amount of current through the thermistor increases and the gain of the circuit is reduced. Conversely, if the level of oscillation reduces, the current flow through the thermistor reduces and the gain of the circuit is increased. Any change in output level is therefore counteracted by a suitable change in the voltage gain of the amplifier. Obviously some variations in the output level will occur, since the thermistor will not quite fully compensate for any change in the amplitude of the output signal. However, under normal loading the circuit will keep the output level within a fraction of a decibel of its unloaded level. In the case of a variable frequency Wien oscillator the stabilisation also maintains a virtually constant output amplitude over the full audio range.

Single resistor tuning

Life would be easier if the frequency of a Wien oscillator could be varied via just one of the resistors in the Wien network. A switch tuned audio generator would then only need one set of precision resistors. Also, an ordinary single pole switch would suffice, which would give a considerable cost saving over a multi-way two pole type.

It is actually possible to tune a Wien oscillator via one of the resistors in the Wien network, but it produces practical difficulties. The gain needed to just sustain oscillation varies greatly if the value of one resistor is altered. Although one might expect the automatic gain control to compensate for these variations in gain, in reality the variations are so great that normal thermistor stabilisation can not cope adequately. In fact it is difficult to produce an output stabilisation circuit that can cope adequately with both variations in loading and changing losses through the Wien network.

One way around this problem is to use the alternative Wien oscillator configuration of figure2 (the "Brokaw" configuration). In this circuit the positive feedback is once again provided by a Wien network which consists of R1, R2, C1, and C2. This time there is a slight change in that R1 is returned to the virtual earth formed at the non- inverting input of IC1, rather than to the zero volt earth rail. Whether it is returned to the true earth or a virtual earth makes no difference to the operation of the Wien oscillator, and the circuit therefore oscillates normally. The negative feedback circuit of this design is much more complex than the simple two resistor network of the basic Wien oscillator. R4 and R5 form what at first appears to be an ordinary negative feedback network, but R4 is returned to the output of IC1 and not to the earth rail. IC1 operates as a non-inverting amplifier, and its voltage gain is controlled by the ratio of R3 to R1. The input signal for this amplifier comes from the output of the Wien network, and as we have already seen, R1 is actually part of this network.

When considering the operation of this circuit you need to bear in mind that any increase in the value of R1 will reduce the output frequency, but it will also produce stronger oscillation. The input signal to the inverting amplifier is taken from the output of the Wien network, and this is of course in-phase with the output signal. This means that the output of the inverting

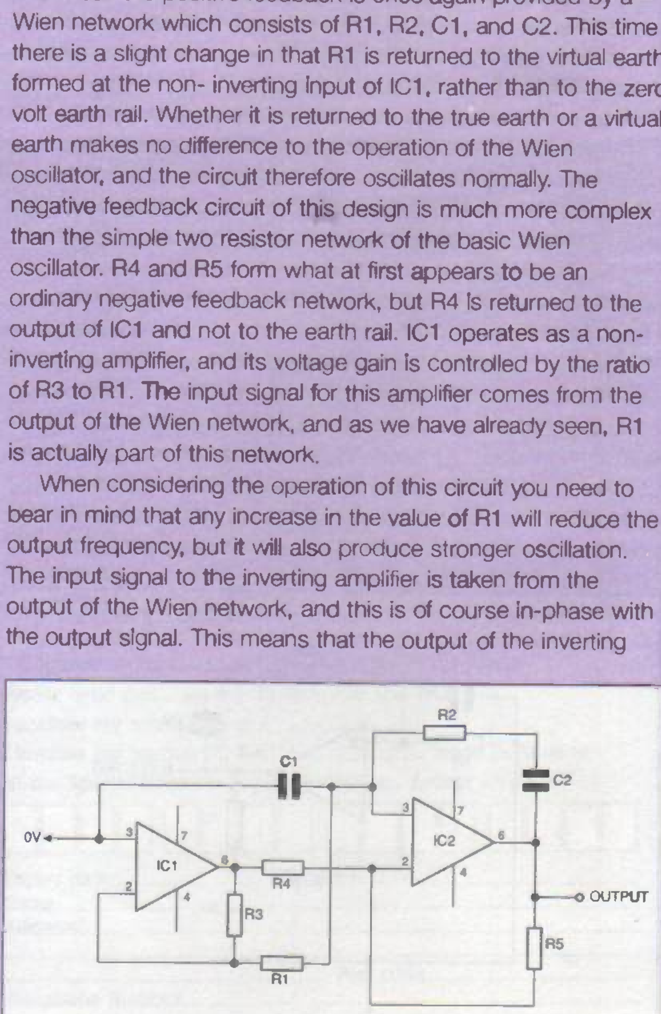


Figure 2: an alternative Wien oscillator that can be tuned by varying the value of R1

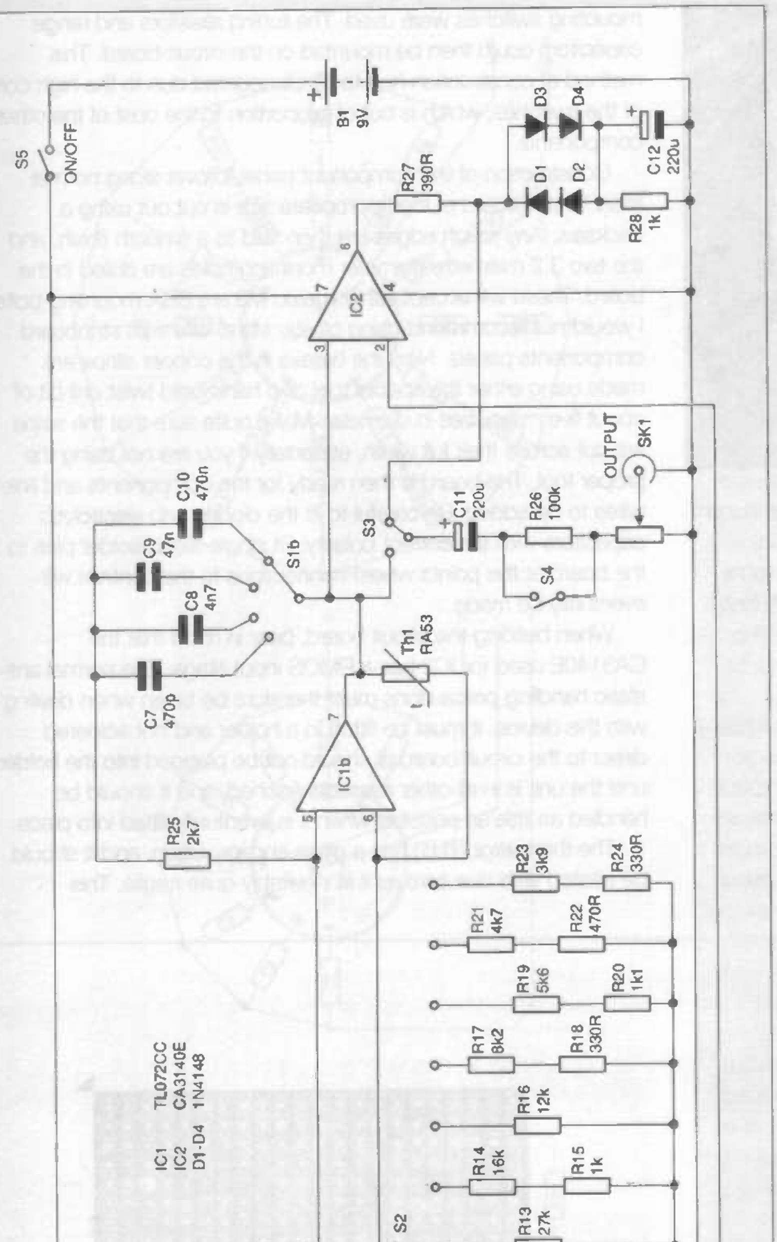


Figure 3: the circuit diagram of the switch tuned audio generator

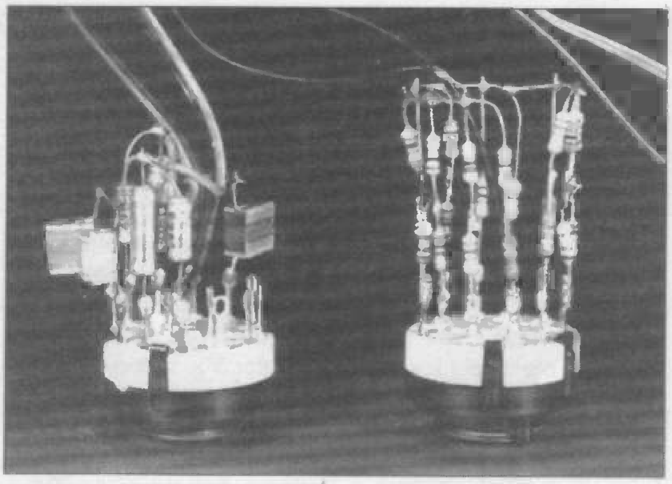
amplifier is out-of-phase with the output signal. IC2 operates as an inverting amplifier to this signal, with R4 and R5 acting as the negative feedback network. This further inversion means that the output signal from IC1 boosts the output signal from IC2.The stronger the output from IC1, the greater the boost.

Increasing the value of R1 produces stronger oscillation, but it also produces reduced voltage gain from IC1 and a weaker output signal from this amplifier. This produces a reduction in the boost to the output level of the oscillator. The stronger oscillation is therefore counteracted by the reduced boost to the output level, and wide variations in the value of R1 produce no significant change in the output level. The circuit still requires automatic gain control to compensate for variations in output loading, etc. This can be provided in the normal way by using a thermistor in place of R5. It is possible to cover a wide frequency span by altering the value of R1, but the scaling is extremely non- linear. This is not really of any consequence in the present application where R1 is a series of fixed resistors rather than a potentiometer.

Circuit operation

The circuit diagram for the switch tuned audio generator appears in figure 3. IC1 is used in the Wien oscillator, and with the only exception that the circuit is powered from a single supply rail, it uses exactly the same configuration as the circuit of figure 2. R1, R2, and C2 produce a centre-tap on the supply rails that is used for biasing purposes. R5 to R24 are the range resistors which give the circuit its basic repertoire of 12 output frequencies. It is inevitable that some rather odd values are requires, and most of the tuning resistances are made up from two resistors connected in series. There are four sets of capacitors in the Wien network (C3 to C10) and these provide the circuit with its four frequency ranges. S1 is the frequency control and S2 is the range switch. Th1 is the self-heating thermistor which stabilises the output level.

Sinewave to squarewave conversion is provided by IC2 which is an operational amplifier used open-loop and in the non-inverting mode. The high voltage gain of IC1 results in a heavily clipped output signal that is a squarewave of reasonable quality. However, the wave shape is improved by the diode clipping circuit based on D1 to D4, and this circuit also reduces the peak-to-peak output level of the squarewave generator to one that is comparable to the output level of the sinewave oscillator. The required output signal is selected via S3, and C11 couples the output from S3 to the attenuator circuit.VR1 is the variable attenuator, and S4 is the attenuator switch.VR1 receives the full output level when S4 is closed, but R26 introduces losses of about 40dB (that is, it reduces the output level by a factor of 100) when S4 is open. It is easier to set very low output levels when S4 is set to attenuate the output signal. Due to the 20 percent tolerance rating of VR1, the attenuation provided by R26 may not be precisely 40dB.



Power is obtained from a nine volt battery (B1), and the current consumption of the circuit is about 10 milliamps. A PP3 size battery is just about adequate to power the circuit, but a higher capacity battery would be a better choice if the unit is likely to be used for long periods.

Construction

Details of the stripboard component panel are provided in figure 4 (component layout) and figure 5 (copper side view). The board measures 37 holes by 22 copper strips. Construction of the board is very straight forward since the majority of the components are hard wired to the switches. Construction would be slightly easier and the finished unit would be somewhat neater if printed circuit mounting switches were used. The tuning resistors and range capacitors could then be mounted on the circuit board. This method of construction had to be discounted due to the high cost of the switches, which is out of proportion to the cost of the other components.

Construction of the component panel follows along normal lines. First a board of the appropriate size is cut out using a hacksaw. Any rough edges are then filed to a smooth finish, and the two 3.2 millimetre diameter mounting holes are drilled in the board. These will accept either metric M3 are 6BA mounting bolts. I would not recommend using plastic stand-offs with stripboard components panels. Next the breaks in the copper strips are made using either the special tool or a hand-held twist drill bit of about five millimetres in diameter. Make quite sure that the strips are cut across their full width, especially if you are not using the proper tool. The board is then ready for the components and link-wires to be added. Be careful to fit the diodes and electrolytic capacitors with the correct polarity. Fit single-sided solder pins to the board at the points where connections to the controls will eventually be made.

When building the circuit board, bear in mind that the CA3140E used for IC2 has a PMOS input stage. The normal anti-static handling precautions must therefore be taken when dealing with this device. It must be fitted in a holder and not soldered direct to the circuit board. It should not be plugged into the holder until the unit is in all other respects finished, and it should be handled as little as possible when it is eventually fitted into place.

The thermistor (TH1) has a glass encapsulation, and it should be treated with due care as it is inevitably quite fragile. This

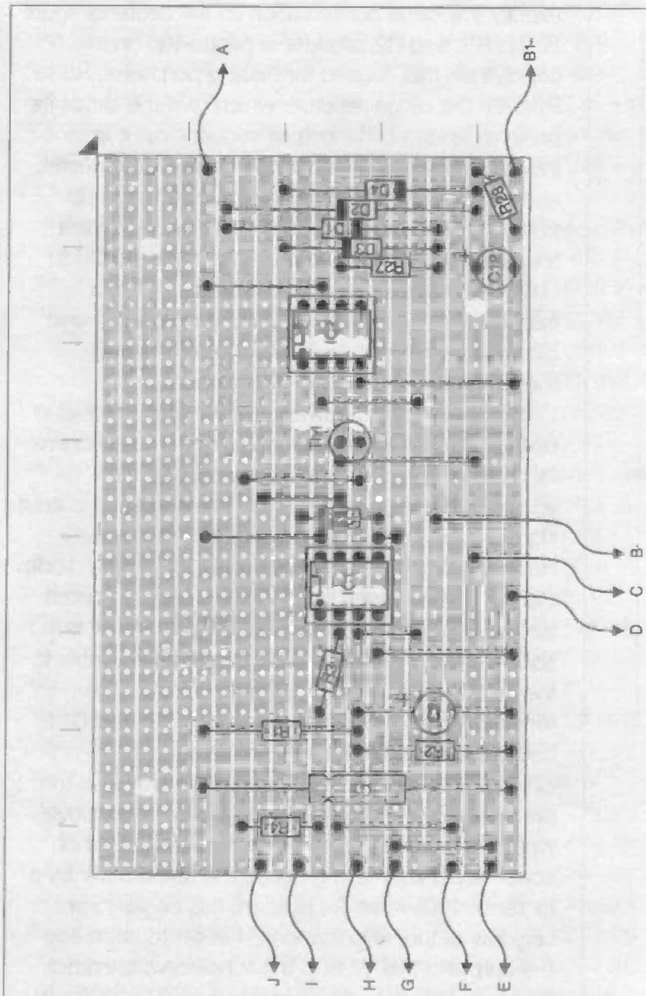


Figure 4: the component layout for the stripboard panel

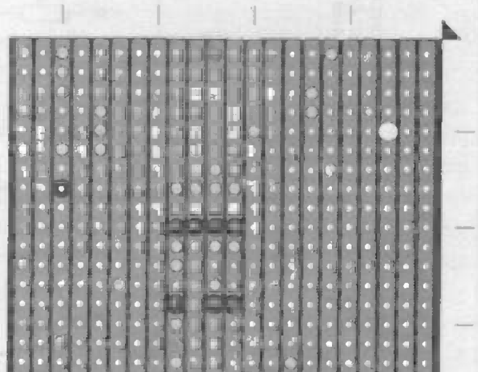


Figure 5: the underside view of the stripboard panel

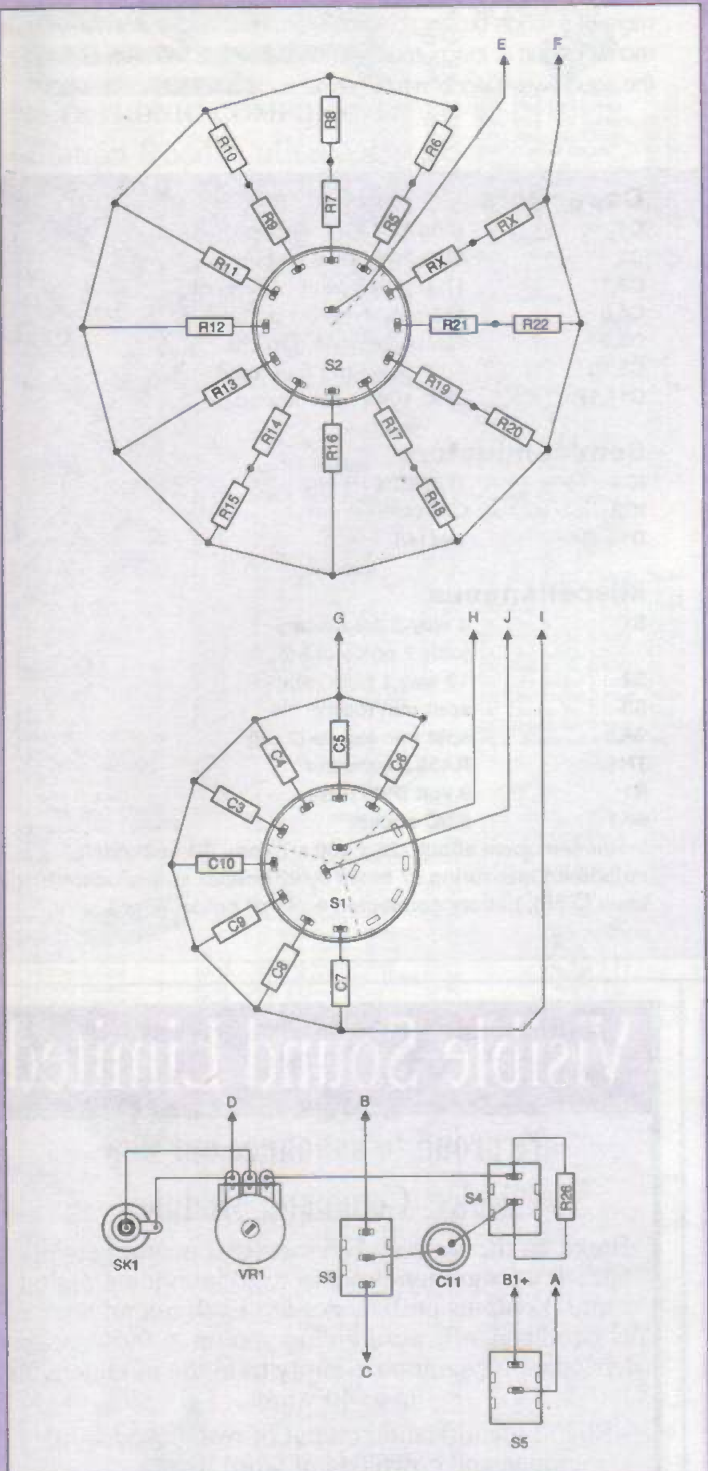
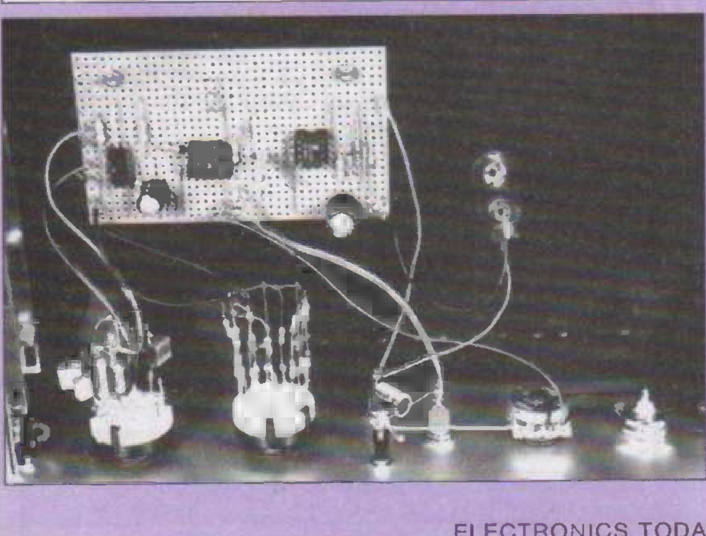


Figure 6: details of the hard wiring (use in conjunction with figure 4)



component seems to be sold as both the RA53 and as the R53, but it is suitable for use in this circuit in either guise. It is quite an expensive component, and it is worth checking in a few component catalogues to find the best price as there seems to be significant variations from one catalogue to another. Inexpensive bead and rod thermistors are not suitable for use in this circuit; only a self-heating type will work in this application.

Hard wiring

As already pointed out, a substantial number of the components are mounted on the controls. Details of all the hard wiring are shown in figure6, which should be used in conjunction with figure 4. Provided you go about things in the right way this wiring is reasonably easy to complete. S1 is a standard four way three pole rotary switch, but in this case one pole is left unused. It is a good idea to fit the range capacitors to S1 and the tuning resistors to S2 before these two switches are mounted on the front panel of the case. Start by doing any necessary trimming of the leadout wires, and then "tin" the ends of the leadout wires and the tags of the switches. Before adding the components to a switch it must be fixed in place on the work-top. All that is needed is a generous blob of Bostik Blu-Tack or Plasticine. The switch is then easily repositioned as you work your way around the tags.

In order to obtain good frequency accuracy the tuning resistors must be close tolerance components, as must most of the other resistors in the circuit. In fact I would recommend using 1 percent tolerance resistors throughout the circuit. Ideally the range capacitors would also have a tolerance rating of 1 percent, but it might be difficult to obtain suitable components having values of 47n and 470n. Capacitors having a tolerance of 5 percent are readily available in these values though, and should give good results. The tolerance rating indicates a maximum error, and in practice the actual error is likely to be considerably less. Due to stray capacitance in the circuit the output frequencies might be fractionally low on the highest frequency range. Perfectionists can replace each 470pF range capacitor with a 390pF capacitor in parallel with a 68pF type.

It is a good idea to connect long flying leads to the pole tags of S1 and S2 before mounting these switches in the case. Once they are in position it can be difficult to gain access to the pole tags as they are shielded by the tuning resistors and range capacitors. The remaining hard wiring is very straight forward and should present no real difficulties. The general layout used for this project is not critical, but it is always a good idea to avoid too much criss-crossing of the connecting wires. The prototype is housed in a plastic instrument case which has aluminium front and rear panels, but a much smaller case could be used if greater portability is required. However, make sure that you choose a case that can accommodate all the controls and the output socket on its front panel.

Testing, testing...

If you have access to suitable test equipment, use this to check that the unit is providing the correct output waveforms, frequencies, and output levels. Note that the sinewave peak-to-peak output voltage will be slightly higher than the squarewave peak-to-peak output potential. The quality of the squarewave output signal inevitably reduces slightly at high frequencies, but it should be reasonable even at the highest output frequency of 100 kilohertz. In the absence of suitable test equipment the output can be monitored using an amplifier and loudspeaker, are even a crystal earphone will suffice. This will enable the basic function of the unit to be verified, but bear in mind that apart from 10 kilohertz, the output frequencies on the highest range are beyond the limits of human hearing. The sinewave signal has a very distinctive "pure" sound, whereas the squarewave signal is more of a rough buzzing sound. The difference between the two is more obvious at low output frequencies where the harmonics of the squarewave signal are largely at audible frequencies.

PARTS LIST

for the Switch Tuned AF Generator

Resistors

(All 0.6W 1 percent metal film)

R1,2	2k2 (2 off)
R3,4,25	2k7 (3 off)
R5	390k
R6	22k
R7	180k
R8	10k
R9	100k
R10	6k8
R11	68k
R12	47k
R13	27k
R14	16k
R15	1k
R16	12k
R17	8k2
R18, 24	330R
R19	5k6
R20	1k1
R21	4k7
R22	470R
R23	3k9
VR1	1k lin carbon rotary

Capacitors

C1	100u 10V axial electro
C2	470u 10V radial electro
C3,7	470p polystyrene 1 percent
C4,8	4n7 polystyrene 1 percent
C5,9	47n polyester 5 percent
C6,10	470n polyester 5 percent
C11,12	220u 10V radial electro

Semiconductors

IC1	TL072CN
IC2	CA3140E
D1 - D4	1N4148

Miscellaneous

S1	4 way 3 pole rotary (only 2 poles used)
S2	12 way 1 pole rotary
S3	spdt min toggle
S4,5	spst min toggle (2 off)
TH1	RA53 thermistor
B1	9 volt (PP3 size)
SK1	BNC socket

Instrument case about 225 x 180 x 70mm, 0.1 inch pitch stripboard measuring 37 holes by 22 copper strips, control knob (3 off), battery connector, 8-pin dil holder (2 off), wire, solder, etc.

New generation PC processors FROM MAJOR MANUFACTURERS

Intel introduces "next level" with the Pentium II processor

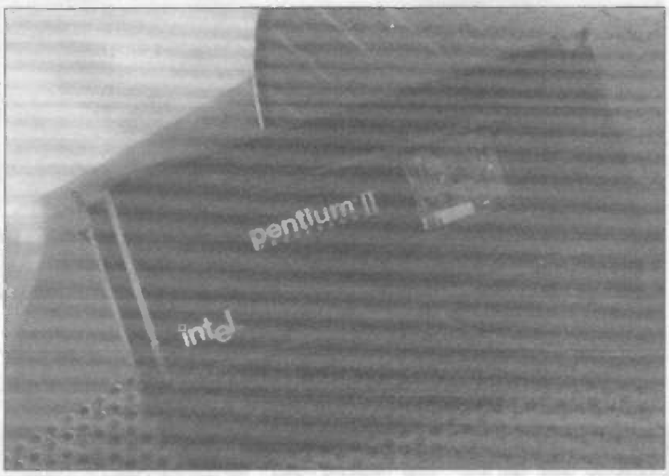
The Intel Corporation has introduced a new generation of Pentium processors, the Pentium II processor. The new device, which has been introduced at speeds of 300, 266 and 233 megahertz, combines Intel's advanced Pentium Pro processor with the capabilities of its MMX (tm) media enhancement technology. MMX, which has been added to the Pentium II to enhance performance for audio, video and graphics applications as well as speed up data encryption and compression, was originally developed primarily for the games market (which has driven so much popular computer development) but, to give an example, can also be used to allow a PC to do most of the work of a modem so that the modem itself becomes just a low cost interface to the telephone line. (Though the PC cannot do much else at the same time.) The 7.5-million transistor processor core is based on Intels P6 architecture, and is manufactured on .35-micron process technology with a new packaging method.

The new processor is provided in a new style of package, the Single Edge Contact cartridge. This incorporates the processor itself, plus 512KB of level 2 cache unified for code and data. The L2 cache is made from industry-sourced static ram, and runs at half processor speed on its own bus, while the system bus (used for memory of I/O requests) runs at 66MHz. Consequently, the Pentium II at 266 MHz can achieve around three times the peak bus bandwidth of the highest speed Pentium processor system, which runs one bus at a peak of 66MHz. (This feature is referred to as dual independent bus architecture).

L2 cache performance has a major impact on overall system performance, and running the L2 cache bus at half processor speed would be difficult to achieve if the cache and the processor itself were both separately mounted on the motherboard. No doubt Intel intend to use this new packaging method to permit further advances in power for further processor generations. Another advantage for Intel may be that the cartridge processor makes a break from standard motherboards, compelling users to choose between Intel-specific motherboards and competing types.

The processor core has 32KB of non-blocking L1 cache running at processor speed, divided as 16KB data and 16KB instructions, also a vital feature for performance.

The new processor also has the Pentium Pro's features of dynamic execution, which executes instructions ahead of time when possible. A 12 stage pipeline is used, with a two level adaptive branch prediction mechanism to reduce the probability

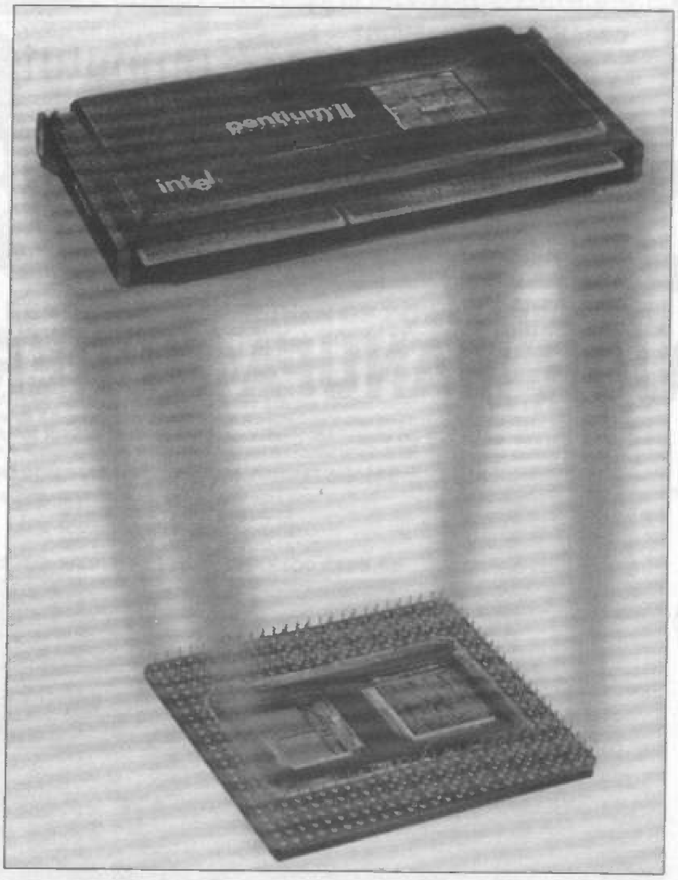


of there being a clock cycle when the processor is wasting time.

Dynamic Execution incorporates the two concepts of "out of order" and "speculative execution", effectively eliminating the constraint of linear instruction sequencing between the traditional "fetch" and "execute" phases of instruction execution. Up to three instruction can be decoded per clock cycle. Considered conceptually, the decoded instructions are put into a dataflow graph, which can hold up to 40 instructions; these are executed from the graph when their operands are available (versus instruction order). Up to four instructions can be executed per clock cycle.

Intel's MMX Technology incorporates 57 instructions oriented to highly parallel operations with multimedia and communications type data. These instructions use a technique known as SIMD (single instruction, multiple data) to crunch several bytes in the same way, delivering better multimedia and comms performance. The Pentium II processor can execute two MMX instructions at a time.

Multi processor systems are also catered for. The Pentium II system bus supports up to eight outstanding bus requests (four per processor), allowing more parallel operation between processors and I/O, as well as supporting smooth performance scaling to a two-processor system. The GTL+ electrical signalling of the system bus will assist the migration of this bus to higher frequencies as DRAM technologies with higher performances reach the market. The GTL+ bus will provide "glueless" (no additional chip logic required) support for two processors, giving cost-effective SMP (symmetric multi-processor) solutions.



The Pentium II's write-combining technology, which combines multiple writes to one region of memory (for example, a video controller frame buffer) declared as WC type in a single burst write operation, can be used to get very high graphics I/O performance

Testing and fault-monitoring features include built-in self-test, providing single stuck-at fault coverage of the microcode and large PLAs, as well as testing of the Instruction cache, data cache, Translation Lookaside Buffers and roms. There is a standard test access port and boundary scan architecture mechanism (a growing test technique which is becoming a new industrial standard).

The 266- and 233-MHz Pentium II processors are already available in desktop systems from more than a dozen leading computer manufacturers, and the 300-MHz version will be appearing in workstations after the middle of 1997.

A new high end processor from AMD

Flash memory leaders AMD are also releasing a new PC microprocessor in 1997. In April AMD introduced the AMD-K6(tm) 233, 200 and 166 MHz processors, its 6th generation processors with MMX technology. AMD's view is that Intel's product strategy is to encourage PC makers away from the current motherboard and processor technology (Socket 7) to its unique daughter board technology, or single edge card (SEC). "These new technologies do not offer direct benefits to the PC manufacturer, or necessarily to the user. This strategy ties manufacturers deeper into Intel, as it moves to propriety chip sets for the Pentium II. Intels's market strategy also requires different processors for 16-bit and 32-bit software."

The AMD-K6 is a single chip solution for 16-bit and 32-bit software. Importantly, the AMD-K6 maintains Socket 7 compatibility and therefore allows manufacturers to develop new, more powerful PCs using the current infrastructure, (motherboards, casing, power supplies etc), allowing cost saving.

Perhaps because AMD are not the company setting the standard for PCs, their strategy seems to be to aim for technological advantages in certain areas. For example, comparing the cache size, the level 1 cache on the AMD-K6 processor is 32K instruction and 32K data. AMD say that they have cut the number of transistors required for random logic compared with the Intel Pentium processors, and have used the space on the chip thus saved to incorporate a larger level 1 cache. In addition, they have concentrated on maximising the cache hits by using a very large branch prediction table.

The relevance of the branch prediction table is that if the instruction cache is loaded with a series of instructions from memory, these will be able to be accessed very rapidly for as long as the software does not branch outside the instructions in the cache. As soon as there is a branch requiring an instruction not in the cache, the processor has to wait while the extra instructions are fetched. The branch prediction table is a means of determining the likely direction of the branch, and thus having the instructions ready when they are required. As a comparison, the AMD-K6 has 8192 branch history table entries, as compared with 512 in the Intel Pentium Pro.

There are several other areas in particular where AMD's top of the range processors are aiming to offer features that will be an advantage to some users. One of these is that the AMD-K6 processor will plug into the widely-used Socket-7, often referred to as the Pentium bus connection. By comparison, Intel's Pentium II processor plugs into a proprietary slot, which will mean that new motherboard designs will be required. Some PC manufacturers may find it advantageous to offer comparable performance without changing motherboard designs.

The other competitive edge offered by the AMD-K6 processor is that the delay when switching from 32-bit to16-bit instructions is less than with the Pentium Pro. What this means in practice is that when running an operating system such as Windows 95, which incorporates 16-bit code as well as 32-bit code, the AMD-K6 processor has significant speed advantages. An operating system such as Windows NT, which is exclusively 32-bit, will not show such differences between the two processors.

Nevertheless, a comparison between an AMD-K6 processor running at 200 MHz and an Intel Pentium Pro processor running at 200 MHz, both running the Windows

	Market Segment	Operating System	Applications
Pentium* II processor	Business Desktop, Uni/Dual Workstation, Uni/Dual Server	Windows NT* Windows* 95, UNIX*	Business Apps, Multimedia & Communications Workstation Apps
Pentium* Pro processor	Business Desktop, Workstation, Server	Windows NT Windows 95, UNIX	32-Bit Business Apps, Professional Apps Workstation Apps
Pentium* processor with MMX™ Technology	Home, Mobile, Business Desktop	Windows 95	Business Apps, Consumer Apps Multimedia & Communications
Pentium* processor	Home, Mobile, Business Desktop	Windows 95, Windows 3.1	Consumer, 16-Bit Business Apps

*Other brands and names are the property of their respective owners.

NT operating system, shows according to AMD's figures, a speed advantage to the AMD-K6. It is therefore possible that PC manufacturers offering machines specifically for use with Windows '95 may prefer to use the AMD-K6 processor for this purpose.

The AMD-K6 processor is almost a risc machine in some respects. x86 instructions are translated into risc-86 instructions then executed. In some cases the x86 instruction results in zero risc-86 instructions. This raises the question as to whether a K6 native code running even faster would be possible.

Another interesting technological step taken in the manufacture of the AMD-K6 processor is that instead of connecting to the chip by using bond-wires welded to pads round the edge of the chip, solder bumps on the chip are used to bond it upside-down into the package, taking connections from all over the chip. This saves some chip area, gets the signals in and out faster, and improves thermal performance.

*Below: A selection from comparison figures issued to AMD in May 1997. *Data shown are estimates based on industry publications and derived from reports that Pentium II is based on Pentium Pro. Pentium II is not publicly available at time of writing. Final product features may vary from estimates shown.*

Processor features	AMD-K6 200MHz	*Pentium II	Pentium Pro	Pentium with MMX (P556)
x86 decoders	2 sophisticated 1 long, 1 vector	1sophisticated 2 simple	1 sophisticated 1 simple	1 sophisticated 1 simple
Branch history table entries	8192	512	512	258
Branch prediction accuracy	95 percent	90 percent	90 percent	75-80 percent
L1 instruction and data cache	32k + 32K	16K + 16K	8K + 8K	16K + 16K
Processor bus	Socket 7 66MHz	Pentium Pro 66MHz	Pentium Pro 66MHz	Socket 7 66MHz
Latency (smaller is better)	2 clock	5-7 clock	5-7 clock	2 clock

Features EDWIN NC

System Features

- Complete End-to-End CAE/CAD system
- Simultaneous Schematic and Layout generation
- Automatic front and back annotation
- Intuitive hierarchical menu structure
- Mouse or keyboard commend activation
- Macro operations
- Real-time display of: ratsnest, active nodes, single line or true trace width
- On-line help
- Auto reconnect
- Full Integration of Schematic and Layout
- Automatic file backup
- User definable text sizes
- DXF in and output
- Screen hardcopy
- Library viewer with editing possibility
- Switching on/off possibility for tool and scroll bars
- Visible schematic and PCB symbols by editing
- Monochrome mode for better print resolution
- Bitmap support, for loading logos, documentation, etc. Can be used in hierarchical as well as in simple schematic or PCB design
- Maximum number of nets: 16,000
- Maximum number of nodes: 32,000
- Maximum number of bend points: 64,000
- Maximum number of connections: 64,000
- Maximum number of symbols: 32,000
- Maximum number of components: 32,000
- Maximum number of multi-segment traces: 32,000, with a total of 64,000 trace segments
- ANSI/IEC libraries

Schematic Capture

- Up to 100 schematic sheets
- Up to 64" x 64" sheet size
- Industry standard sheet sizes
- Rotate, scale and mirror symbols
- Real-time dragging of components and wires
- Automatic package and pin assignment
- Orthogonal and free mode manual routing
- Automatic bus annotation
- Block save, load, move and delete
- Direct access to mixed mode simulation
- Autorouting of connections
- Merging and splitting of nets possibility
- Definable line width, also for bus-lines
- Swapping of component positions
- Automatic component renumbering by swapping

PCB Layout

- 32 layers (28 route layers, 2 silk-screen layers (front and back), 2 soldemask layers (front and back))
- User definable trace sizes
- User definable pads
- Curved traces
- 1 mil grid resolution - Fine grid 10 micron
- SMT, fine line, analog support
- Component repeat, rotate and mirror
- Component "move by name"
- Component, gate and pin swap
- Automatic component renaming
- Trace repeat
- On-line, multi-layer routing with automatic via insertion
- Pin-to-pin, free or 45 degree routing
- Change segment side and width, trace side and width
- Fast interactive generation of ground planes with user definable cross-hatch or solid fill
- Automatic ground plane with thermal relief insertion
- Automatic DRC with user specified parameters
- Electrical connectivity checking
- Linear rotation of symbols
- Gerber input read and use possibility
- Built-in interface for Spectra 6.0, Max route 6.0 and Arizona Autorouter
- Bitmap functions (logos, drawings, ...)
- Sophisticated database viewer

Mixed Mode Simulation

- AC analysis (Frequency domain)
- DC analysis (Linear/non-linear)
- TD analysis (Time domain)
- Diagram generator
- Dynamic parameter definition of active and passive components
- Output graphs displayed on screen, hardcopy or placed on schematic
- Oscilloscope function
- DLL based analog/digital simulation primitives, modelling language and library creation tools
- Built-in model generator for discrete devices

Please Note: Some of the above are ONLY provided on the De Luxe 3 Version.
EdSpice and Thermal Analysis are available as bolt-on extras. See previous page.

YES! Please Rush Me My EDWINNC Program.

Swift Designs Ltd., Business & Technology Centre, Bessemer Drive, Stevenage, Herts. SG1 2DX
Tel 01438 310133 Fax 01438 722751

Name: ....

Address: .... Postcode: ....

Tel.: (Day) .... (Evening) .... Version Required: Basic De Luxe 1 2 3 (please circle)

I enclose £ .00 + p.p. £5 UK (p.p. £10.00 Outside UK)

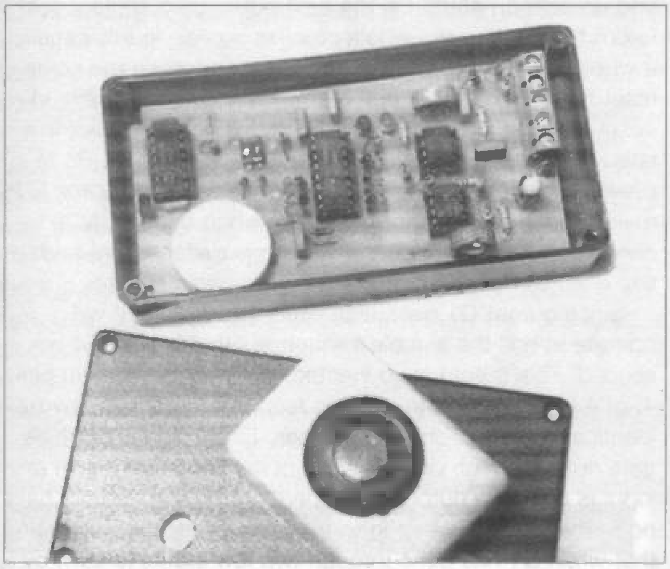
Cheque/P.O./Credit Card: Visa/Access/Mastercard:

No.: | | | | | | | | | | | | | | | | Expiry Date: | | | | Signature:

Please allow 10–15 days for delivery.

Are Your Lights On?

Keep on the light side of the law with Terry Balbirnie's after-dark warning



Have you ever driven off in the dark without switching on the car headlights? If you are honest, you will probably admit that you have done so at some time or other. If you were lucky, you were alerted by other motorists flashing their lights or by noticing the lights on other cars. If you weren't so lucky you might have caused an accident or been stopped by the police.

Overview

This circuit provides an audible warning when the headlights need to be switched on. The sound is only given while the ignition key is turned and will stop as soon as the headlights are operated. The warning takes the form of two rapid high-pitched bleeps given every so often. The signal is discrete and enables the motorist to disregard it when, for example, the engine is left running with only the sidelights on. It is also distinctive and will be easily heard above other noises inside the car.

At the end of construction, the light level at which the unit needs to operate will be set to individual requirements. The time between sets of bleeps is also adjustable to one of three periods - 1 minute, 2 minutes and 4 minutes approximately.

Providing it is dark enough, the first signal will be given as soon as the ignition is switched on. This ensures that a warning is obtained at the first opportunity. Of course, it may be dark enough inside the garage or in an enclosed car park to operate the unit while it is still light outside. Although a signal would be given under such circumstances, this is not thought to be a problem and the effect is simply ignored.

The circuit comprises two parts. The first is housed in a small plastic box and contains the light sensor. This is placed so as to respond to the light outside. The other section contains the rest of the circuit including the buzzer. This will probably be mounted out of sight under the dashboard. The connection between the two parts is made

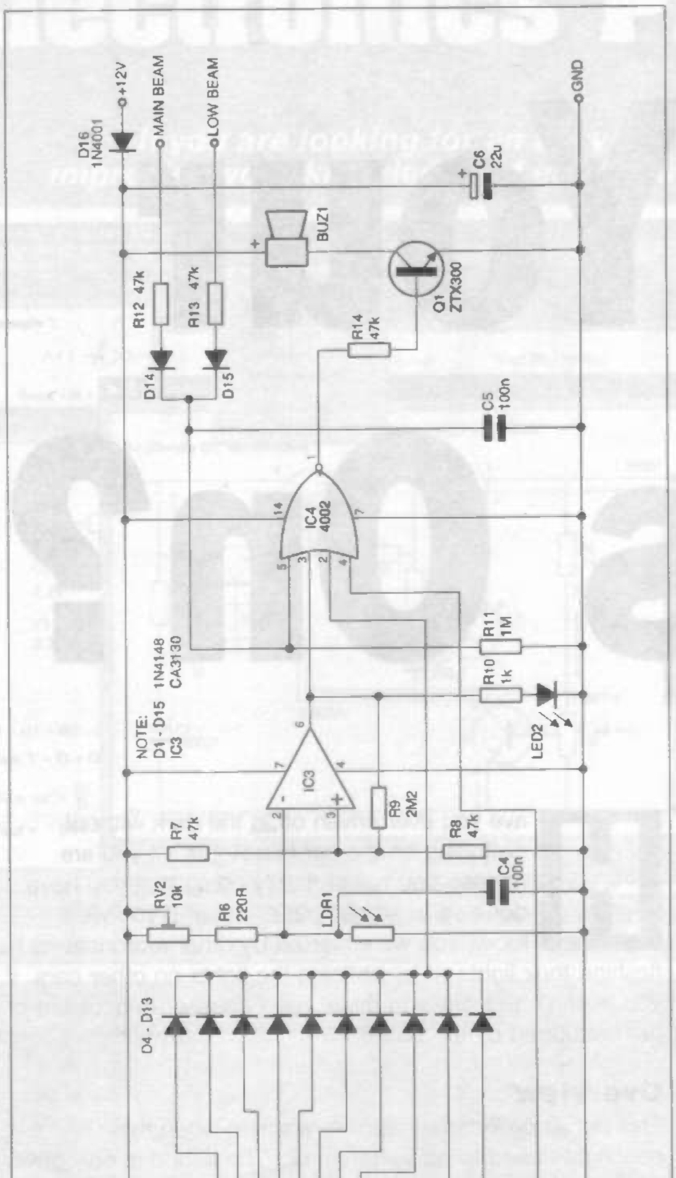


Figure 1: The circuit of the lights-off bleeper

using light-duty twin wire. Connections will also need to be made to the 12V supply and to the lighting circuits. Details for doing this are given later. The unit draws current only while the ignition is switched on and since it requires only a few milliamps, it imposes a negligible load on the car system.

How it works

The circuit for the Lights Needed Bleeper is shown in figure 1. IC1 is a timer integrated circuit configured as an astable. Thus, as long as it receives a supply, it will provide a string of pulses at the output, pin 3. The rate at which these are given depends on the values of resistors R1, R2, R3, preset potentiometer RV1 and capacitor C1. With those specified, RV1 may be used to adjust the rate between about 4 and 11 per second. For the purpose of explanation, assume that it has been set to provide eight pulses per second.

These pulses are applied to the clock input, pin 10, of 12-stage binary counter, IC2. Its outputs, Q1 to Q12, then go high in various combinations to record, in binary, the total number of pulses registered. Table 1 shows the state of IC2 outputs over the first six and last six pulses. It would be very difficult showing the entire truth table because it would have 4096 lines! It will be seen that output Q1 goes high every second pulse, Q2 every four pulses and so. It will also be noted that, starting from the beginning, output Q3 goes high on the fourth pulse, Q4 would do so on the eighth one, etc. By the same reasoning, the final output, Q12 would go high on 2048 counts and all outputs would end up high on 4095. On the next pulse, all outputs would return to zero and the whole process repeat. In this circuit, a whole cycle is not allowed to happen because the i.c. is reset to begin a further one prematurely by making pin 11 (reset input) high momentarily. More will be said about this later. The reset pin is normally kept low via resistor, R4 to prevent possible false resetting. Additionally, capacitor, C3 makes pin 11 go high for an instant when the supply is connected (that is, when the ignition is switched on) and this ensures that the count will always begin at zero.

Since output Q1 goes high every two pulses, it will operate at half the astable frequency - that is about 4 per second. This output is connected to one of the inputs, pin 4, of 4-input NOR gate, IC4. (in fact, this ic contains two identical gates but only one of them is used here). A NOR gate output is high only when all of its inputs are low. If any input is high, the output must therefore be low and will have no further effect. Referring to the truth table, it will be seen that when Q1 has gone through two low states (shown by asterisks), outputs Q3 to Q12 go high in various ways until the device has performed a complete cycle or has been reset. Note that output Q2 is not used. A high condition at any output Q3 to Q12 will allow this state to pass via one or more of diodes D4 to D13 and hence to another NOR gate input, IC4 pin 2. The output, pin 1 will therefore be kept low. Assume for the moment that the remaining NOR gate inputs, pins 3 and 5, are also low (this will be the case when it is sufficiently dark and when the lights are switched off). IC4 output, pin 1, will then give two pulses (shown by the asterisks) at the beginning of the cycle then remain off until the next one.

Seeing the light

The light sensor comprises light-dependent resistor, LDR1, and this works in conjunction with operational amplifier, IC3.

The resistance of an LDR rises as the amount of light falling on its sensitive surface falls. The LDR forms the lower arm of a potential divider with resistor R6 and preset RV2 in the upper one. The voltage at IC3 pin 2 (the inverting input) will therefore rise as the light level falls. If the voltage at the inverting input is less than that at the non-inverting one (pin 3) the output, pin 6, will be high. In other cases it will be low. The non-inverting input, pin 3, receives a fixed voltage equal to one-half that of the supply (nominally 6V) due to the further potential divider consisting of equal-value resistors, R7 and R8. With suitable adjustment to RV2, the voltage at pin 2 will be less than that at pin 3 during daylight hours and pin 6 will be high. As it becomes darker, the voltage at pin 2 will rise above that at pin 3 so pin 6 will go low. Note that variations in supply voltage will have no effect on the operating point since the voltages at both inputs will rise or fall in sympathy. Their relative conditions will therefore remain unchanged. Resistor R9 applies a little positive feedback to the system and sharpens the switching action. The logic state of IC3 pin 6 is connected to another NOR gate input, IC4 pin 3. During daytime, therefore, IC4 output can never be high.

Beam me up

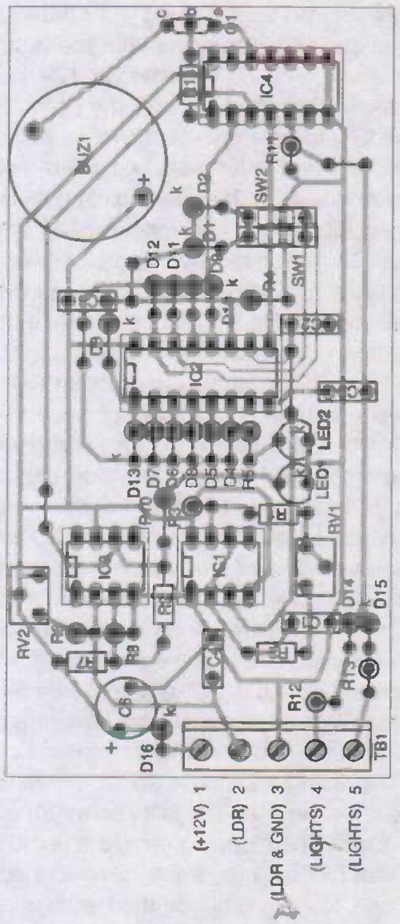
The fourth NOR gate input, pin 5, receives a feed from the headlight circuit. Due to the logistics of wiring this part up later, it will probably be easier to gain access to the main and low-beam circuits separately. If either headlamp filament is on, a high state will pass via either R12 and D14 or R13 and D15. As the dip switch is moved between the positions in the course of driving, there could be a brief period when neither filament is on. This would present a momentary low input to IC4 and allow the output to go high if there happened to be low states at the other three inputs. To prevent this effect, capacitor C5 will be charged when either filament is on. When the dip-switch changes over, the capacitor will maintain the high state for sufficient time to allow the other filament to take over. With the headlights on, it is therefore impossible for IC4 output to be high. During periods when all IC4 inputs are low (dim light conditions, headlights off and at the times shown by the asterisks in Table 1), pin 1 will go high. Current will then flow into the base of transistor, Q1, with current limited by resistor R14. The buzzer will then bleep.

Q12	Q11	Q10	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1
0	0	0	0	0	0	0	0	0	0	0	0*
0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	1	0*
0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	1	0	1
1	1	1	1	1	1	1	1	1	0	1	0
1	1	1	1	1	1	1	1	1	0	1	1
1	1	1	1	1	1	1	1	1	1	0	0
1	1	1	1	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1	1	1	1

Time settings

Imagine both switches SW1 and SW2 are off for the moment. Counting will continue until pin 1 (Q12) goes high whereupon diode D3 will apply a reset pulse to IC2 pin 11 and a new cycle will begin. This takes some 4 minutes.

Figure 2: the component layout



Switches SW1 and SW2 provide options to reset IC2 when pin 14 (Q10) or pin 15 (Q11) goes high by allowing a reset pulse to flow through diode D1 or D2 as appropriate. The timings will then be about 1 or 2 minutes.

A signal is derived from IC2 pin 6 (Q3 output) for testing and setting-up purposes. This allows current to flow through red light emitting diode LED1 each time it goes high with the current limited by resistor R5. Since this output pulses at one-eighth clock frequency, the LED will flash at about once per second which is easy to monitor. A signal is also obtained at the output of op-amp, IC3. This causes green light-emitting diode LED2 to glow under the "bright" condition. Here, R10 limits the operating current. This LED simplifies the setting-up of the operating light level at the end of construction.

Construction

The PCB component layout is shown in figure 2. Begin by soldering the four ic sockets in position. Add the 5-section piece of PCB screw terminal block, TB1, the four link wires and the twin dil switches SW1/SW2. Solder the resistors and capacitors. C6 is an electrolytic type - check the polarity. Add the diodes and transistor - there are 16 diodes and care must be taken to observe the orientation of all of them. Solder the LEDs close to the PCB using minimum heat to prevent damage. Complete the circuit panel by soldering the buzzer in place - the polarity is clearly marked on the body.

Basic test

The circuit panel may be tested using a 9V battery before installing it in the car. Note, however, that the buzzer will be much quieter than when used with the car 12V system. Insert all the ics into their sockets with the correct orientation. CMOS can be static-sensitive - it helps to touch something earthed (such as a water tap) before handling the pins. Adjust both presets to approximately mid-travel and switch SW1 on (for one- minute timing).

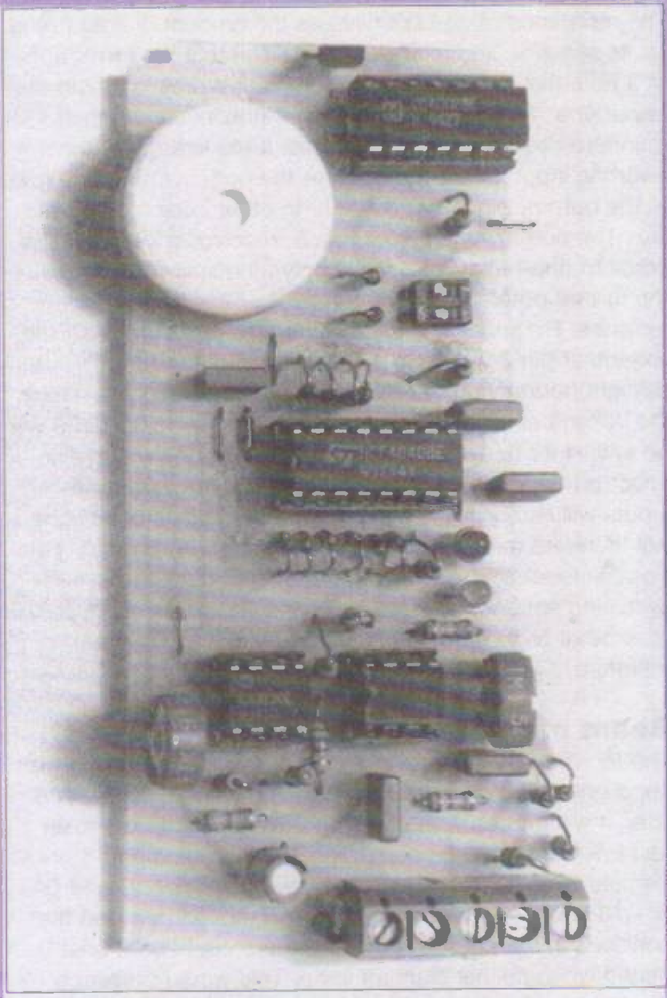
Refer to figure 3. Attach the 9V battery connectors to positions 1 (positive) and 3 (negative) and secure the LDR wires temporarily to terminal block positions 2 and 3. Connect the battery - the buzzer may make a sound. Check that the red LED is flashing and adjust RV1 until it operates once per second. This does not need to be done very accurate but a timing of one second will result in the operating times mentioned earlier. Note also that this setting also alters the buzzer on time. Providing there is sufficient light reaching the LDR, the green LED will be on. If necessary, adjust RV2 until it is. Place a piece of Plasticine or Blu-Tak over the LDR window so that the LED swtiches off. The buzzer should now sound with double bleeps given every one minute or so (with a clock rate of exactly 1 pulse per second it would actually be 64 seconds). Switch SW1 off and SW2 on - the timing should now double to about 2 minutes. Finally, switch both SW1 and SW2 off. The timing should be about 4 minutes.

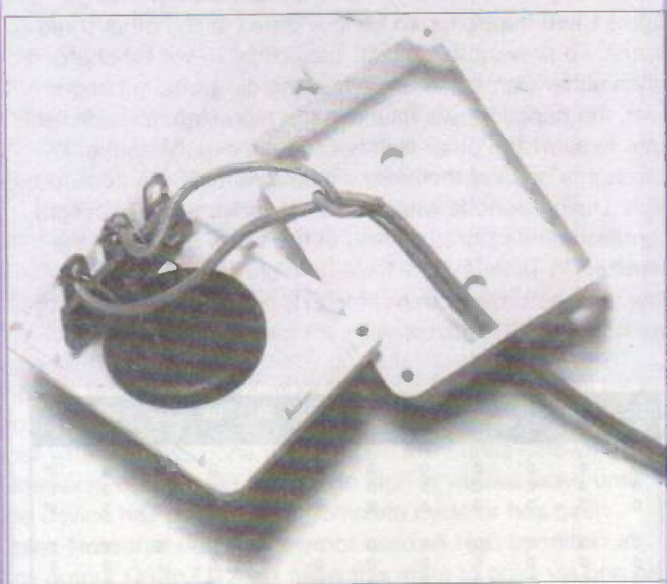
Remove the covering from the LDR so that the green LED operates again. The bleeping should stop. Cover the LDR again so that bleeping resumes. Inter-connect either of terminals 4 or 5 to 1 (to simulate the headlights being on) - the bleeping should again stop.

Making contact

Before mounting the circuit panel inside the box, drill two holes in the side close to the terminal block position. These should be large enough to accommodate all six wires passing through (terminal 3 carries two wires). If the circuit panel is a tight fit inside the box, no mounting holes are needed. If you need to file off corners so that it will go inside, do this after having removed the ics Also, take care not to damage any tracks on the underside. To prevent vibration, place thin pieces of plastic foam on the base of the box and above the circuit panel avoiding the area of the buzzer. Measure the position of the hole in the buzzer and drill a hole in the lid to correspond with it so that the sound will pass through.

Prepare the sensor box by drilling a hole of sufficient size in the lid for a large grommet through which the LDR will be secured (see photograph). Alternatively, a tight hole could be made in the plastic and the LDR held in position using a little quick-setting epoxy resin adhesive. If this method is used, the window of the LRD should be made level with the face of the case. Mount a piece of tag strip on the lid inside and solder the LDR wires to this. If there is any chance of them touching, sleeve them using short pieces of insulation stripped from connecting wire. Drill a hole for the twin wire which will lead from the light sensor to the main unit. Measure sufficient wire to interconnect the





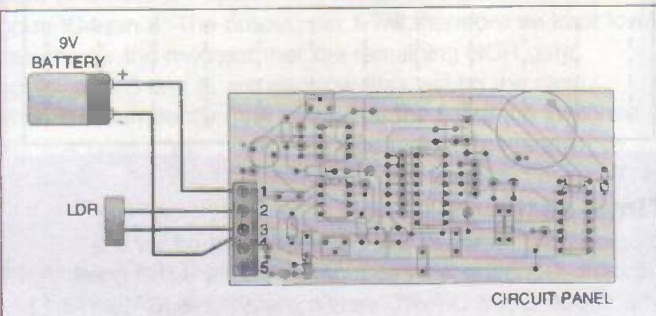


Figure 3: basic checking circuit

PARTS LIST for Are Your Lights On?

Resistors

R1, R2	330k
R3	5k6
R4, R11	1M
R5, R10	1k
R6	220R
R7, R8, R12, R13	47k
R9	2M2
RV1	1M
RV2	10k
LDR1	ORP12 light dependent resistor

Capacitors:

C1, C4, C5	100n min. metallised polyester, 5mm pin spacing
C2, C3	47n min. metallised polyester, 5mm pin spacing
C6	22u 16V radial electrolytic

Semiconductors:

D1-D15	1N4148
D16	1N4001
LED1	3mm red LED
LED2	3mm green LED
Q1	ZTX300
IC1	7555 low-power timer
IC2	4040 12-stage counter
IC3	CA3130 op-amp
IC4	4002 dual quad NOR gate

Miscellaneous

SW1, SW2	Dual dil SPST switches
BUZ1	PCB mounting buzzer 12V 5mA dc operation.
TB1	5-way PCB mounting

screw terminal block - 5mm spacing.
2 off 8-pin dil sockets, 14-pin dil socket, 16-pin dil socket. Tag strip. Plastic box for circuit panel, small plastic box for light sensor. 9V battery and connectors for testing. Auto-type wire and snap-lock connectors as required.

two sections. Light-duty twin wire such as loudspeaker type would be suitable. Pass one end through the hole and, leaving some slack, tie a knot in it to provide strain relief. Solder the wires to the LDR tags. Route the wire back to the main unit position but do connect it up yet.

Car connections

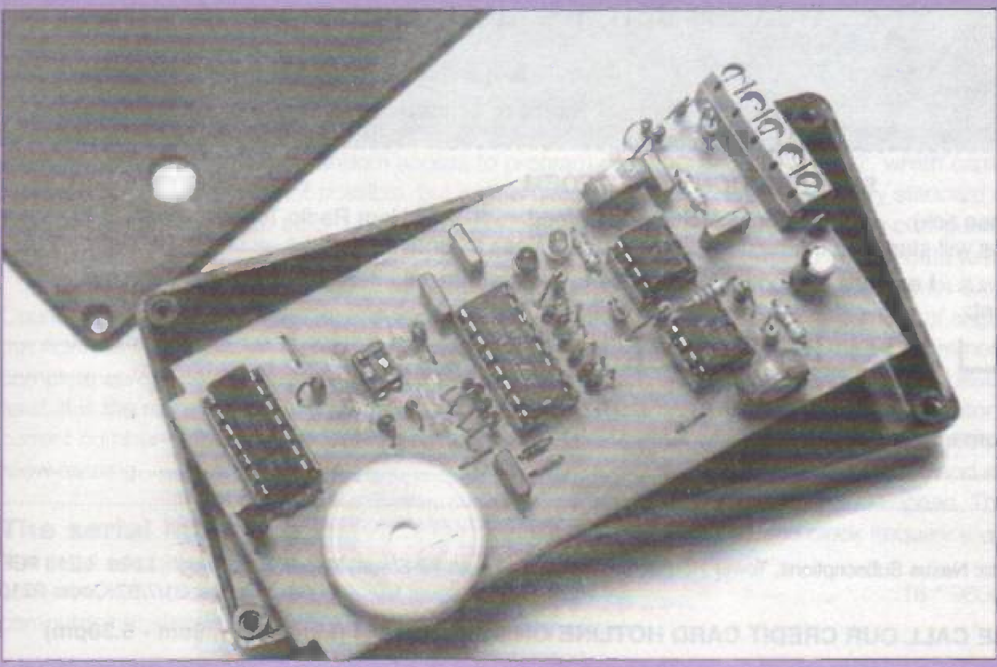
Check how you will gain access to the connections which need to be made to the car wiring. One must be made to a wire which is live only when the ignition is switched on. It is essential that this is on the outlet side of a low-value fuse. A ground (earth) connection (which may usually be made to an existing earth point) and connections to the wires leading to both filaments of one of the headlights. In some older cars, the headlights are not fused. If this is the case, include line fuse holders in each wire close to the connections and insert a low-value (say 3A) fuse.in each. Connections to existing wires may be conveniently made using "snap lock" connectors which avoids having to break wires.

This additional wiring must of proper automotive type and a rubber grommet must be used wherever it needs to pass through a hole in metal.

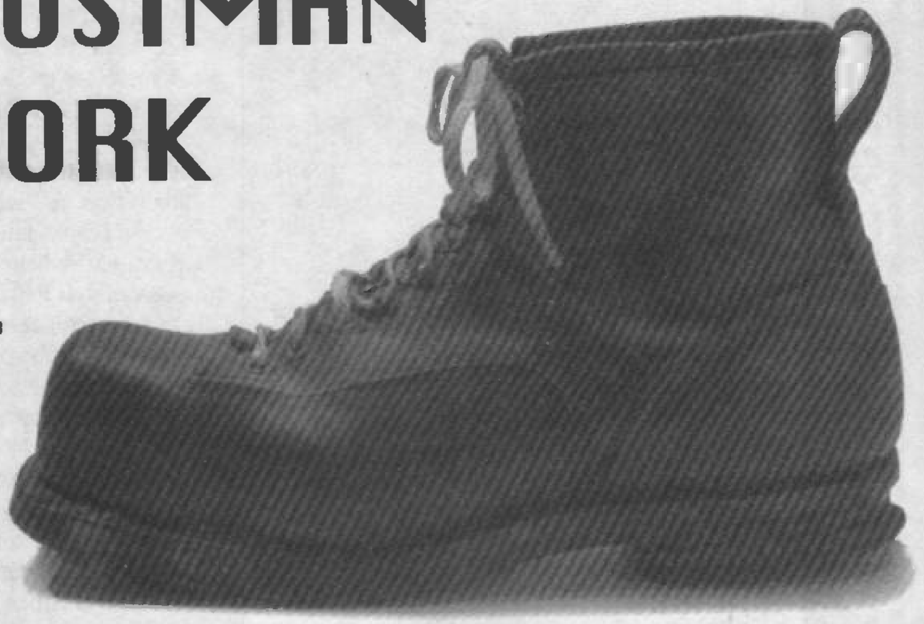
Run the wires back to the unit and connect them to the terminal block in the following way: Terminal 1 to the +12V feed, Terminal 2 to one sensor wire, Terminal 3 to the earth connection and the other sensor wire, Terminals 4 and 5 to the lighting circuits. Attach the lid on the main unit box and secure it in position.

Assemble the sensor unit and decide on a suitable location for it. Some experimentation will be needed to find the best one. Make checks in lighting conditions rather brighter than the required switching point. If the sensor is placed so that direct light falls on its sensitive surface, such as in the corner of the windscreen, it will be found that RV2 needs to be adjusted almost to the zero resistance end of its track. If such adjustment is difficult, it will be found helpful to restrict the amount of light reaching the LDR by, for example, using translucent plastic or by partially covering it with PVC tape. If no rubber grommet was used, the sensor box could be stuck to window glass using two self-adhesive pads of the type normally used to attach the interior mirror, making sure, of course, that it is clear of your field of view. Self-adhesive pads are readily available from car accessory shops. In the prototype unit, the sensor was placed behind a grill so that it could not be seen. This automatically restricts the light reaching it and makes for easy adjustment to RV2. Do not place it where shadows will be cast on the sensitive surface by items inside the car since this will cause false operation.

Test the unit under actual conditions. Re-adjust the timing if necessary. Over a period of use, set RV2 to provide a warning at the required brightness level and set the operating time as required.



LET THE POSTMAN DO THE WORK



SUBSCRIBE... AND SAVE UP TO £9

ACORN ARCHIMEDES WORLD
13 issues
UK: WAS £48.75, NOW £39.75. YOU SAVE £9.
Europe: £60.50, Overseas: £62.50, USA: $100.00

HAM RADIO TODAY
13 issues
UK: WAS £32.50, NOW £29.00, YOU SAVE £3.50.
Europe: £39.50, Overseas: £41.50, USA: $66.00

E.T.I.
13 issues
UK: WAS £30.55, NOW £27.00, YOU SAVE £3.55,
Europe: £40.00, Overseas: £41.80, USA: $64.00

Now this just has to be a good deal! Not only will you save a considerable amount of money, but your postman will also deliver the next 13 issues of your favourite electronics magazine directly to your door- with no fuss, no hassle, and no future price increases.

So go on, subscribe now, save your shoe leather, and up to 70p per issue.

Here's why YOU should subscribe to either ETI, Ham Radio Today or Acorn Archimedes World:
- FREE home delivery in the UK.
- A saving of up to £9 a year.
- Price protection- you won't pay any more if the cover price goes up.
- Guarantee receiving every issue.

This is one deal where you really can't lose.

REMEMBER, it's always cheaper to subscribe!

All savings are based upon buying the same number of issues from your newsagent. UK only.

SUBSCRIPTION ORDER FORM

YES, I would like to subscribe to (please tick): ☐ Acorn Archimedes World ☐ Ham Radio Today ☐ E.T.I.
for the next 13 issues (all subscriptions will start with the next available issue, unless extending).
The total value of my order is £..................I enclose a cheque/PO payable to 'Nexus Special Interests', or please debit my Access/Visa/Mastercard/AMEX account:
Card No: |_|_|_|_| |_|_|_|_| |_|_|_|_| |_|_|_|_| Expiry........../..........
Signature..

Your Details:
Name: Mr/Mrs/Miss Initial:............Surname:..
Address:..
....Post Code:..........................
Tel no:..

Please return, together with your payment, to: Nexus Subscriptions, Tower House, Sovêreign Park, Lathkill Street, Market Harborough, Leics LE16 9EF
Offer closes: 31/7/97 Code: 0210

TO ORDER BY PHONE, PLEASE CALL OUR CREDIT CARD HOTLINE ON 01858-435344 (Mon to Fri, 9am - 5.30pm)

☐ Please tick this box if you do not wish to receive information from other companies

"Eprommer" Eprom Programmer with Personality Modules

Keith Wardill's versatile Eprom Programmer uses a PC serial port and a set of six "Personality Modules" to connect a wide range of eproms up to 64KB.

This Eprom Programmer connects to a computer serial port, and will program and read most eproms up to 64 kilobytes now available. To avoid complex switching to cope with different eprom configurations in use, the Programmer uses a plug-in 'Personality Module' for each type of eprom. This module makes the correct pin connections, sets the programming voltage (Vpp), and determines the program pulse duration.

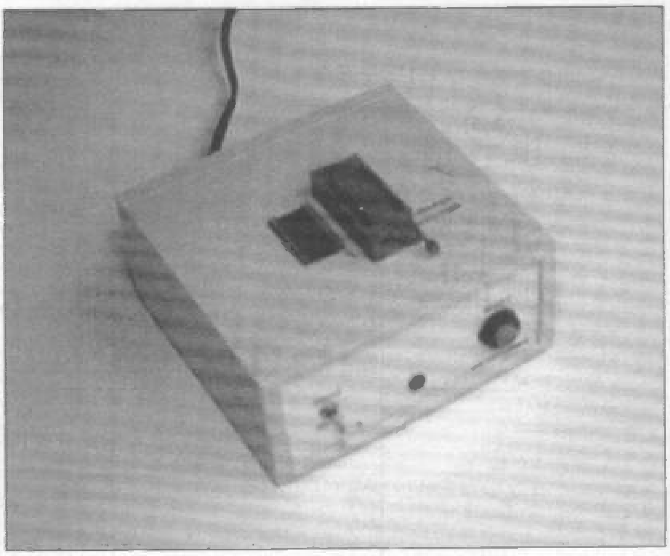
Operating protocol

The Programmer is designed to answer with a data byte when it receives a data byte. In PROGRAM mode, the data to be programmed to a particular address is sent to the Programmer, written to the eprom, and then the Programmer will read the programmed data back and send it to the host computer. By doing this, the software on the host can check if the eprom is correctly programmed before carrying on. In READ mode, a dummy byte is sent to the Programmer, which prompts the Programmer to read a byte of eprom data and transmit it to the host computer. Note that random access to program or read specific addresses is not possible, but as it is usual to program or read the entire eprom in one go, this is not really a handicap.

After PROGramming or READing, the eprom Address Counter is incremented. If the reset switch is pressed to zero the Address Counter, then by repeatedly sending data the complete eprom can be stepped through and programmed or read. It is the responsibility of the host computer to send the correct number of programming bytes, or dummy bytes to allow reading.

The serial interface

The serial computer interface (figure 1) uses a MAX232 RS232 converter, IC1, to convert serial RS232 levels to and from the computer into standard TTL for the Programmer.



The Transmit and Receive Data signals are connected to a 6402 UART, IC2, which carries out serial\\parallel conversion. This is an industry standard device, and is easy to use because it can be configured by connections to its pins, rather than writing control data to it from a CPU. In this application, it is set up to operate with 8 bits, no parity, and 2 stop bits. This ic also has a number of status and handshake signals, which are used by the Programmer as described later.

The Transmit and Receive clocks are generated by the 2.4576MHz crystal oscillator IC3C/D. Dual binary divider IC4 divides the output to produce four clock outputs. The UART has an internal divider, and requires a clock which is 16 times the required Baud speed. Thus, if it is to operate at 9600 Baud, the clock frequency will be:

$$16 * 9600 = 153600 \text{ Hz}.$$

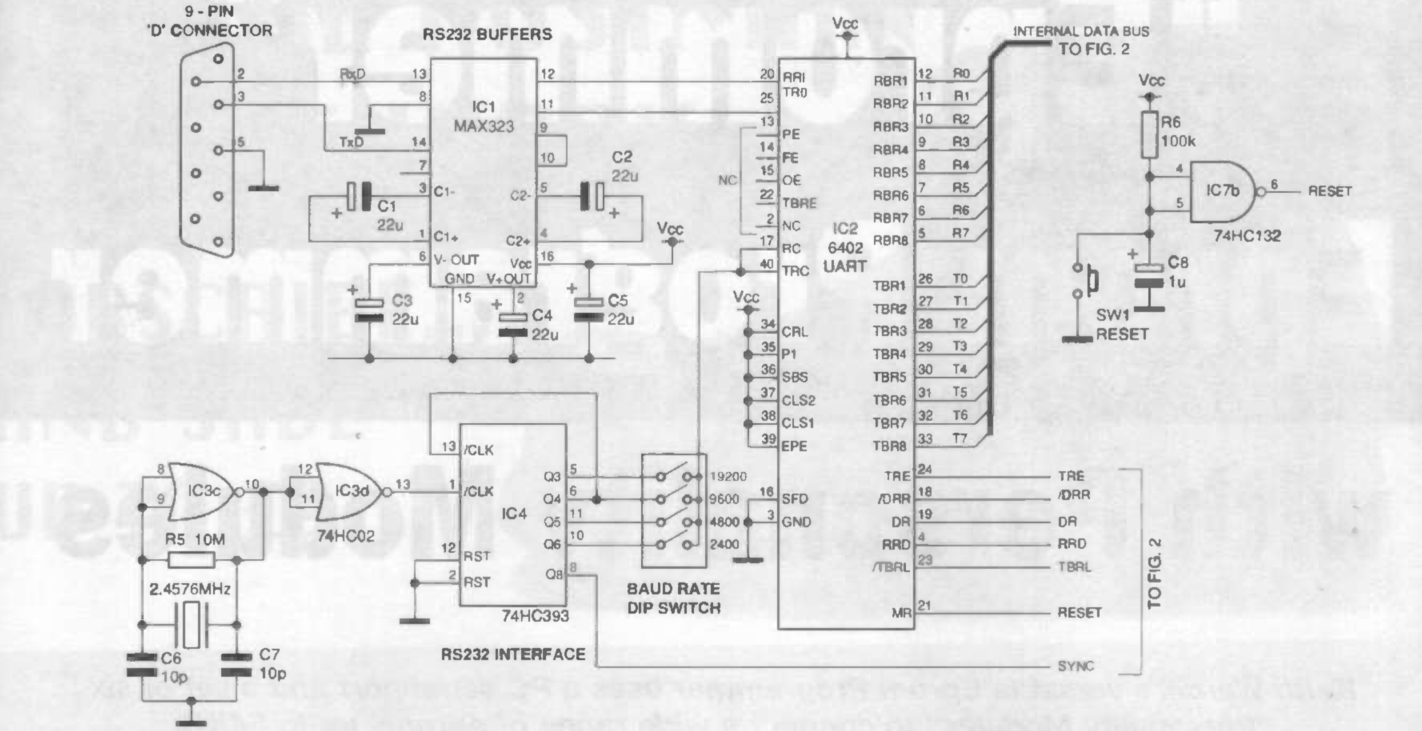


Figure 1: the Eprom Programmer serial interface circuit

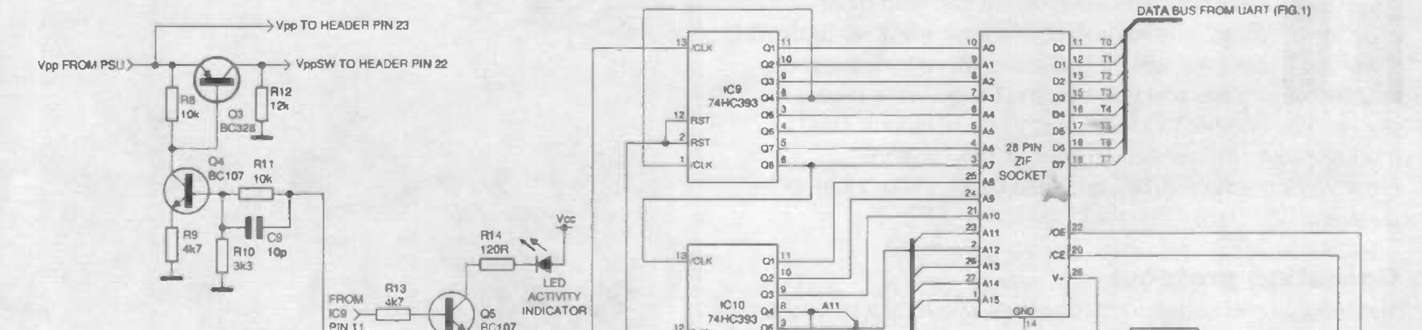


Figure 2: the Eprom Programmer control circuit

The divided outputs available correspond to Baud rates of 2400, 4800, 9600 and 19200, selected by a dip switch. Normally, the highest speed can be used, unless a long cable is used to connect the Programmer to the computer. Note that no RS232 handshakes, software or hardware are used, so the cable for the computer connection need only be a simple three core type, carrying Tx and Rx Data, and Ground.

The divider IC4 also provides a sync signal of 9600 Hz to the Programmer Control.

The Reset Circuit around NAND gate IC7B provides a switch-on reset, by means of C8, and a manual reset, with SW1. This resets the eprom address counter, as well as the UART.

Programmer control

In the Programmer Control section (figure 2), many of the pins, such as the Data pins D0-D7, and Address pins A0 to A10 and A12, are the same on most eproms. Unfortunately as eproms have increased in size over the years, manufacturers have been forced to use other pins on the eproms for different purposes. Table 1 shows the pin functions of the 27XX series, which differ from eprom to eprom: these are pins 1, 20, 22, 23, 26 and 27. The appropriate connections to these pins are made via the Personality Module.

PROGRAM mode

(In the following, note that /Q means 'not Q'.) To program most eproms, a programming voltage (Vpp) is applied to the appropriate pin, then a program pulse, usually negative going of 1 millisecond duration is applied. The exceptions are the 2716, which requires a positive going 50ms pulse, and the 2732, which requires a negative going 50ms pulse.

IC5A, IC5B and IC6B generate the program pulse. Until data is received by the UART, its DR (Data Ready) output on pin 19 is low, keeping D-Type flip-flop IC5A In its 'set' state, so its Q output is high, and the /Q is low. The high Q output keeps IC6B in its 'reset' state. It also maintains TR1 in the Power Supply in the 'on' state. If TR1 is on, then R17A and B are effectively short-circuited, and the Vpp output of the PSU is held at +5V by R15/R16. (It also keeps IC8 reset, but more about this later.) Let us assume that a connection exists between pins 16 and 17 of the Personality Module, so the 9600 Hz sync signal is applied to pin 13 of IC6B.

Before any WRITE operation, the reset button must be pressed to set the address counters to zero. The 'D' input of IC5A (pin 2) is pulled low when switched to 'PROG'. When a data byte is received, DR goes high, and the next positive edge of the sync signal at IC5A clock input will set the Q output of IC5A low, releasing the 'reset' on IC6B (and IC8). Q1 in the PSU is switched off, so Vpp rises to a level determined by R17A and B, and Rp on the Personality Module.

Counter IC6B will now count negative going edges of the sync signal. After 8 edges, the Q4 output of IC6B goes high, and on the 10th edge, Q2 also goes high (reference to the Timing Diagram, figure 3, will make this clear). This causes the /Q output on pin 8 of IC5B to go low, and the Q output on pin 9 to go high. The /Q output is applied to the DRR (Data Ready Reset) input on pin 18 of the UART. This resets DR, allowing the UART to accept a new data byte. Since DR has gone low, IC5A will be forced into its 'set' state, and the circuit will now be in its original state, with Vpp switched back to +5V.

Table 1: Eprom pin functions

EPROM	1	20	22	23	26	27
	R W	R W	R W	R W	R W	R W
2716	X	0 - [1]	0 - 5V	5 - 25Vpp	5 - 5	X
2732A	X	0 - [2]	0 - 21Vpp	A11	5 - 5	X
2764	5 -21Vpp	0 - 0	0 - 5V	A11	X	+5 - [3]
2764A	5 - 12.5Vpp	0 - 0	0 - 5V	A11	X	+5 - [3]
27128	5 - 21Vpp	0 - 0	0 - 5V	A11	A13	+5 - [3]
27128A	5 - 12.5Vpp	0 - 0	0 - 5V	A11	A13	+5 - [3]
27256	5 - 12.5Vpp	0 - [3]	0 - 5V	A11	A13	A14
27256A	5 - 12.6Vpp	0 - [3]	0 - 5V	A11	A13	A14
27512	A15	0 - [3]	0 - 12.5Vpp	A11	A13	A14

[1] POSITIVE GOING TTL 50mS +/-10%

[2] NEGATIVE GOING TTL 50mS +/-10%

[3] NEGATIVE GOING TTL 1mS +/-5%

X DON'T CARE - NOT CONNECTED

NOTE THAT 2716 AND 2732 ARE 24 PIN DEVICES. THE PIN NUMBERS GIVEN ASSUME THAT A 28 PIN SOCKET IS IN USE, AND THE EPROM IS FITTED SO THAT DEVICE PIN 1 IS IN SOCKET PIN 3. HENCE PINS 1,2,27,AND 28 ARE NOT USED

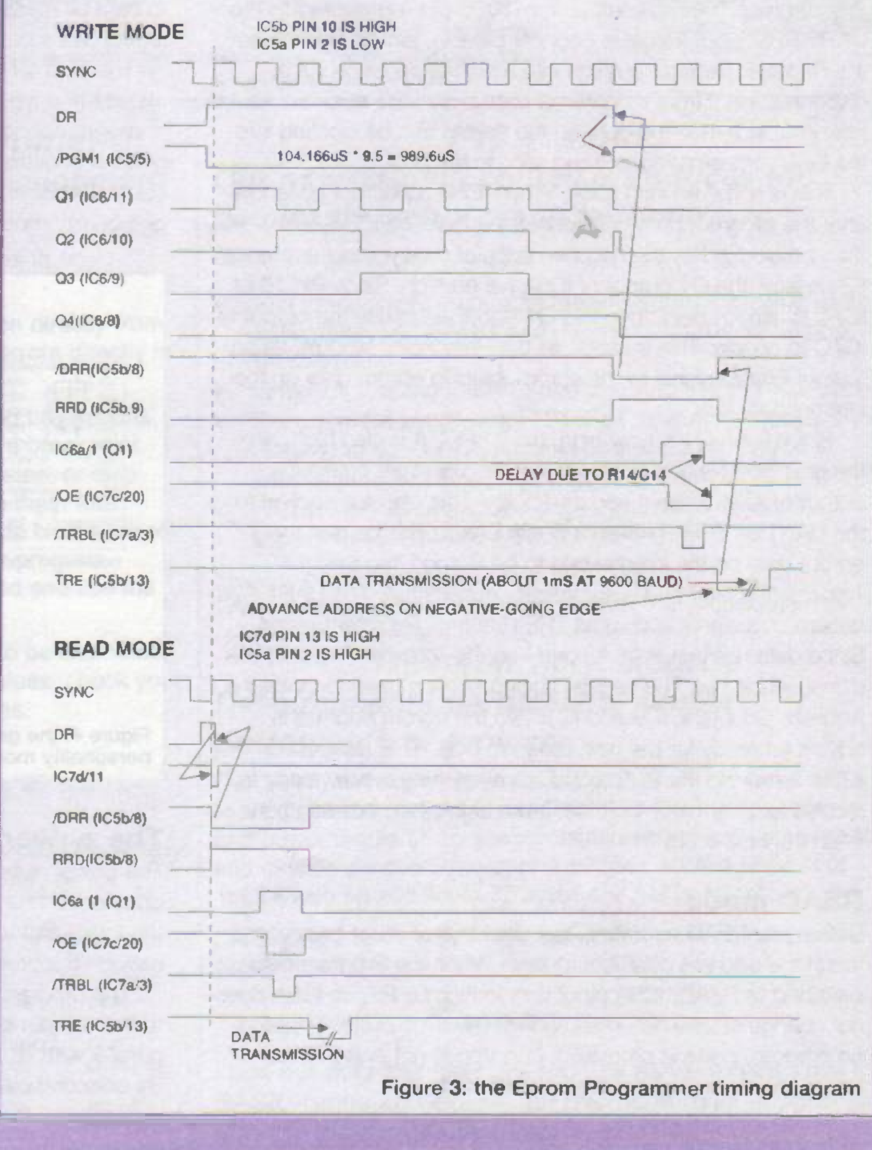


Figure 3: the Eprom Programmer timing diagram

The timing diagram in figure 3 will shows that after IC5A changed state, IC6B effectively counted $9^1/_2$ periods of the sync signal, then IC5A reverted to its original state. Since the period of the sync signal is 1/9600 seconds, or slightly more than 104us, then dividing this by 9.5 gives a time interval of slightly more than 989 us. We need 1 ms for the program pulse, but the eprom tolerance is 5 percent, so 989 us is sufficient. Hence a negative going program pulse is produced at pin 5 of IC5A, connected to the Personality Module as PGM1. A positive going pulse appears also at IC5A pin 6, and is connected as PGM2. This is also inverted and gated by IC3B, to produce a negative going PGM3. This is used for 2732 and 27512 eproms.

To produce the 50 ms pulse required for the 2716/2732 eproms, the sync signal is divided by 50 by IC8, connected to divide by 25 and 2, producing a sync/50 clock with a period just over 5.2ms. Now the program pulse period will be 9.5 x 5.2 = 49.48ms. To select the appropriate period for the programming pulse, both the sync signal and sync/50 are fed to pins 16 and 18 respectively of the Personality Module. Depending on which eprom is to be programmed, the appropriate connection to Personality Module pin 17 is made, thence to IC6B pin 13. If you intend never to program 2716 or 2732 eproms, then IC8 can be omitted, and a permanent link made between pins 16 and 17 of the Personality Module.

Several other signals are also derived from the control circuit: After the programming pulse has finished, the Programmer must transmit the programmed data back to the host computer as a check, and to inform it that the next data byte can be sent to the Programmer. The high output from IC5B pin 9 is applied to the UART RRD input (Receive Register Disable, pin 4). This forces the Receiver Register outputs into a high impedance state, disconnecting it from the internal data bus. If the eprom output is now enabled, then the data on the eprom can be clocked into the UART transmit register and sent to the host.

This is achieved with IC6A. When IC5B /Q output goes low after the program pulse, it releases the reset on IC6A, which will then be clocked by the negative edge of the sync pulse. Hence 52 us later, the Q1 output of IC6A will go high. Since Pin 10 of IC7C is already high, then this Q1 signal will cause the output of IC7C to go low. This is used, via the Personality Module, as an Output Enable signal to the eprom, placing eprom data on the internal data bus.

Since IC6A Q1 is now high, pin 2 of IC7A is also high, and the next positive half-cycle of the sync signal will cause the output of IC7A to be a negative pulse. This signal is applied to the UART as TRBL (Transmit Buffer Load). This causes the eprom data on the internal bus to be latched into the UART Transmit Register and automatically transmitted. The UART also generates a signal known as TRE (Transmit Register Empty). Since data has just been loaded into the Transmit Register, this signal will be low. The negative going edge is used to clock the Address Counters, IC9 and IC10, so the eprom address is advanced ready for the next program byte. TRE also resets IC5B, removing the RRD signal, so everything is now ready to receive another byte. TRE will return high when the data has been transmitted by the UART

READ mode

Before any READ operation, the reset button must be pressed to set the address counters to zero. When the Programmer is switched to READ, IC5A pin 2 is held high by R7, so IC5A does not change state when clocked with the sync pulse. Therefore no program pulse is produced, and Vpp is not switched on, hence the eprom will not be programmed.

IC7D pin 13 is also pulled high by R7. When a data byte is received the DR signal from the UART is applied to IC7 pin 12. It is inverted and 'sets' IC5B, producing the DRR, RRD and OE signals as described for programming. This will place the eprom data on the internal bus, and transmit it back to the computer as described above.

To provide some indication of what is happening, an LED is driven by one of the outputs of the address counter, to indicate that the counter is incrementing during programming and reading.

The personality modules

The 'personality modules' (figure 4) consist of small double-sided PCBs which plug into a 24-pin dil socket, and make the appropriate connections for a particular eprom. It also carries Rp, the programming resistor for the programming voltage. The PCB layouts for the standard 27XX range are given: obviously if you don't need all of them, just make the one(s) you require. Table 2 shows the connections to be made on the Personality Modules for most of the standard eproms. Note that some eproms are available with different programming voltages, notably the 2764, which is available with 21V or 12.5V programing voltages. Usually those types with an 'A' suffix are 12.5V types. Make sure that you fit the correct values for Rp to provide the appropriate programming voltage.

It is not essential to use the personality module PCBs as given: I originally used ic sockets, soldering small wire links on the top side of the socket to make the connections. This turned out to be a bit messy and fragile, so I opted for the PCBs. Maybe the reader has a better idea.

The pins for the PCBs were made from standard office staples (the type used to staple paper together). Any PCB 'through' connections are made with short wire links. The general construction is shown in Figure 4. After making all the connections, and ensuring that Rp was the correct value, the personality modules were given a coat of protective varnish.

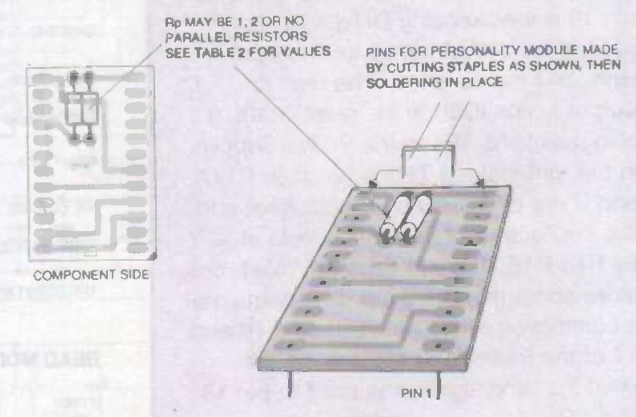


Figure 4: the general construction and component layout of the personality modules

The power supply

The power supply (figure 5) uses a simple voltage doubler/rectifier to produce a stabilised +5V supply via IC12 for the logic, and a higher voltage, which is regulated by IC13 to provide the programming voltage, Vpp.

The programming voltage is determined by the ratio of R15 to the resistor chain R16 and the value of R17A and B in parallel with Rp, which is mounted on the personality module. By selecting different values for Rp, then Vpp can be set as

From the Microcontroller Professionals:

Program PIC Microcontrollers:

We now have 3 programmers for PIC's !

Original - This is our original programmer for 16C5X, 16C55X,16C6X, 16C7x, 16C8x, 16F8X devices.
Price : £40 for the kit, or £50 ready built.

Serial - This programmer programs the newest PIC devices in a single 40 pin multi-width ZIF socket. Will program: 16C55X, 16C6X, 16C7X, 16C8x, 16F8X, 12C508, 12C509, PIC 14000. Also In-Circuit programming.
Price : £40 for the kit, or £50 ready built.

Introductory - This programmer is intended for the smaller user, or newcomer to PIC's. Will program 8 pin and 18 pin devices : 16C55X, 16C61, 16C62X, 16C71, 16C71X, 16C8X, 16F8X, 12C508, and 12C509.
Price £22 for the kit (not available ready built).

Note : All our programmers operate on a PC, using a standard RS232 serial interface (COM1, 2, 3, or 4). No hard to handle parallel cable swapping ! All programmers are supplied with full instructions, Windows programming software, MPASM, MPSIM and PICDE - the Windows based PIC assembler environment. (offers all features of PICDESIM below without the simulator).

PIC BASIC

FED's PIC BASIC products - straightforward, capable, powerful, rapid development.

In a Windows Development Environment our modules need no assembler or UV eraser to program your PIC's, and operate from a serial link to your PC.

The 16C74 module features - 8k EEPROM, up to 2000 lines of BASIC, 27 lines of programmable I/O, 8 A/D inputs, Interrupt driven serial RS232 interface, Peripheral I^2C bus interface, LCD display driver routines, up to 178 bytes for variables and stack, extendible with optional external ram and all the standard 16C74 features.

Compiler - The FED PIC BASIC compiler for the 16C74. It produces hex code to program your 16C74 directly with no need for external EEPROM. Compatible with the EEPROM versions of PIC 16C74 BASIC modules - develop on an EEPROM based module then compile and program your PIC chips directly.

16C57 Module Kit (8k EEPROM, 4MHz) £27.00, Pre-built £33.00
16C57 Module Kit (8k EEPROM, 10MHz) £31.00, Pre-built £37.00
16C74 Module Kit (8k EEPROM, 4MHz) £35.00, Pre-built £42.00
16C74 Module Kit (8k EEPROM, 20MHz) £40.00, Pre-built £46.00
16C84 chip programmed with BASIC - £25.00
Compiler - £60.00, or £50.00 when ordered with a module

Forest Electronic Developments
10 Holmhurst Avenue, Christchurch,
Dorset, BH23 5PQ. http://www.ibmpcug.uk/~gmwarner/fed.htm
01425-270191 (Voice/Fax)

Prices are inclusive, please add £3.00 for P&P and handling to each order. Cheques/POs payable to Forest Electronic Developments, or phone with credit card details. Serial Cables - £7.50.

Windows Based PIC Development:

PICDESIM - the Windows based development environment.

PICDESIM allows you to develop your PIC projects in one Windows program.

Incorporate multiple files, view help file information directly from the code, edit within the project, build, and track errors directly in the source, then simulate.

Simulator allows addressed, conditional and timed breakpoints, follow your code in the source editor window, set a breakpoint directly in the code. Run your program, or single step, or step over subroutines. Track variable values and trace them for display on the Trace Analyser. Input stimuli include clocks, direct values and asynchronous serial data. Profile your program - examine frequently called routines which are timed and use the information to optimise out bottle necks.

Trace Analyser allows any register or port value to be examined in analogue (graphical), waveform, or numeric values, check your program directly against your predicted waveforms.

Runs up to 50 times faster than MPSIM !

NEW ! - 32 bit version allows full use of Windows '95 and Windows NT 4.0 facilities.

Cost £30.00, or £25.00 for existing and new purchasers of any of our programmers. Please specify Windows 3.1, or Windows '95 (32 bit) versions of PICDESIM.

PIC's

PIC16C74/JW Erasable	20MHz	£24.00	PIC16C556 (14 bit versn 16C56)		£4.50
PIC16C74-04P OTP	4MHz	£8.00	PIC16C74-20P OTP	20MHz	£11.00
PIC16C57-04P OTP	4MHz	£5.00	PIC16C57-10P OTP	10MHz	£6.00
PIC16C84-04P	4MHz	£6.00	PIC16C84-10P	10MHz	£8.00
PIC16F84-04P	4MHz	£7.00	PIC12C508-04P OTP	4MHz	£2.20
PIC14000-04P OTP	4MHz	£10.00	PIC14000/JW	Erasable	£23.00
PIC12C508-04P OTP	4MHz	£2.70	**Ask about other chips!**		

PIC Training

Our new training course introduces PIC's painlessly with a practical emphasis.

Our training package includes

- Full introductory manual to the PIC series including use of assembler, peripherals and interrupts for the 12 bit and 14 bit controllers.
- Video introducing the PIC, and showing use of PICDESIM
- Development board with PIC16F84, and all components required to develop 3 practical projects, including LED driving, handling delays and serial communications to a PC.
- PICDESIM - the Windows based Simulator (see left)
- Microchip MPSIM and MPASM programs

Training Course £80.00
Training Course with pre-built Introductory PIC programmer £99.00

Development Boards

Development boards allow simple prototyping of projects.

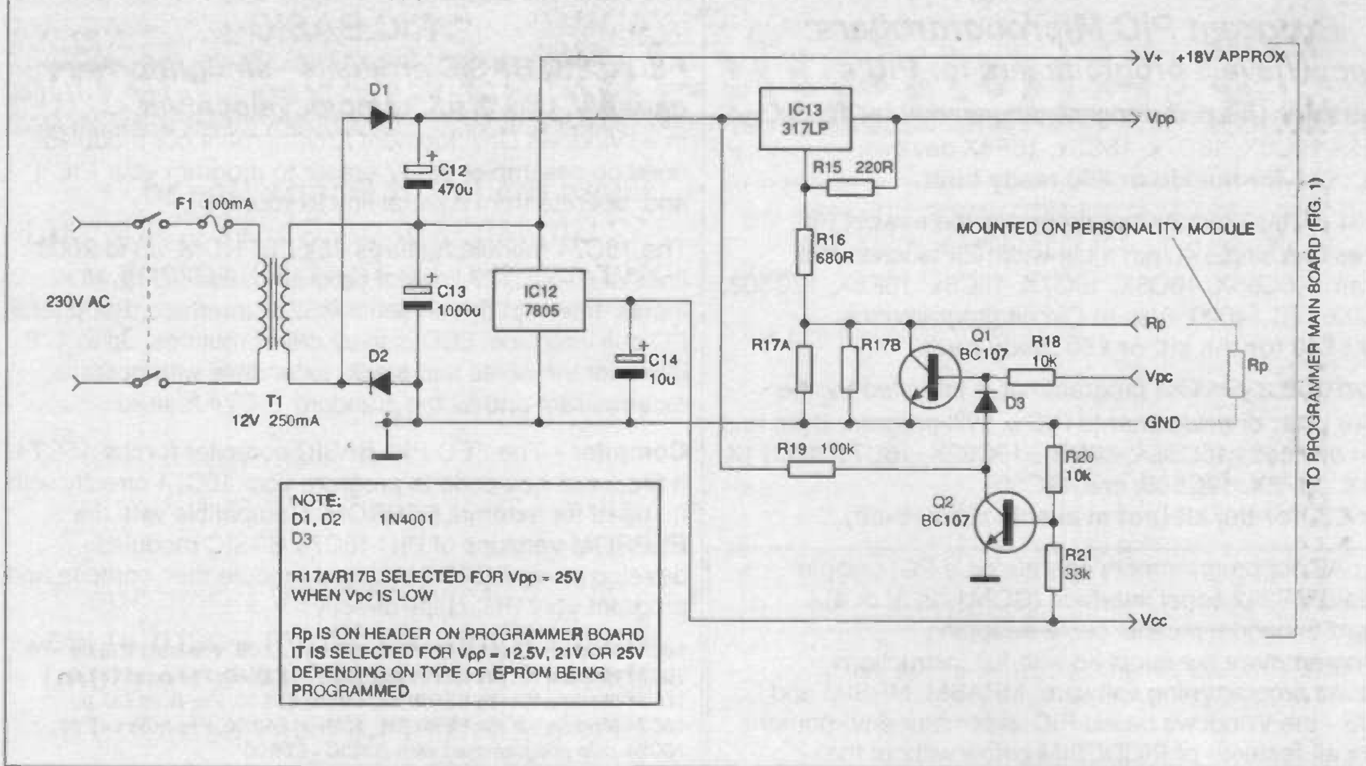
Our 18 pin development board includes a simple serial interface to a PC, 18 pin socket for any 18 pin device, 4MHz resonator and power regulator components. All instructions components, and circuits supplied. Includes a 16F84 - 10MHz version of 16C84 with an additional 32 bytes of RAM for programs.

Development board with all components for serial inteface, power supply, oscillator and 16F84 device £20.00.

Coming soon...

Look out over the next few months as we expand our PIC BASIC range and extend our microcontroller support to another major manufacturer.

Figure 5: the Eprom Programmer power supply



required for a particular eprom. Resistor values for the common programming voltages of +12.5, +21V and +25V are given in Table 2. Use 1 percent or 2 percent resistors.

Unfortunately, because of the different functions of various pins as mentioned earlier, the programming voltage must be switched between Vpp when programming, to +5V when reading. (Just to make life difficult, the 2732 and 27512 are different) This is done with IC13 and Q1. If Q1 is on, then R17A and B and Rp are effectively short-circuited and the output of IC13 is determined by the ratio of R15 to R16. (+5V). The Programming Pulse is applied to the base of Q1. When high (in the Read Mode), Q1 is on, and the output of IC13 is +5V. When the Program Pulse goes low (Program Mode), Q1 is off, so the output voltage of IC2 is determined by Rp.

A further complication is caused by the differing requirements of the Output Enable (pin 22 of the eprom) during reading and programming. Due to lack of pins, the programming voltage is applied to the OE pin of the 27512, so it must be high during programming, and 0V to read. The other eproms only require logic 0 or 1. To do this, Vpp is switched by Q3 and Q4. When the level from IC5A pin 6 is high (programming), then Q4 is switched on, pulling the base of TR3 low, and switching it on to apply Vpp to the Personality Module, and thence to the appropriate eprom pin.

A final power problem is that Vcc to 27256 and 27512 eproms, normally +5V, must be increased to +6.2V during programming. This is done with IC11 and Q6. The negative going 1 ms programming pulse on pin 15 of the Personality Modules for these eproms is connected to pin 11, so that Q4 is switched off during programming, and the output from IC11 will rise to 6.2 volts, determined by R3\R4. When Q6 is switched on, during Read Mode, then R3 is effectively short-circuited, and the output of IC11 is +5V. For those eproms which normally only require +5V during both Read and Program modes, then the connection to Q6, via the Personality Module pin 11, is taken to +5V, ensuring IC11 output is always at +5V.

Table 2: pin connections for Personality Modules. Note: "3K3//5K6" means 3k3 resistor in parallel with 5k6 resistor. Some Eproms are available with different program voltages. The value of Rp connected between pins 12 and 16 should be selected accordingly where both values are given. The values of R17A and B on the PSU are 10K//5K6

EPROM 2716

PIN		PIN	FUNCTION
3	→	24	+5V Vcc
4	→	23	Vpp (+25V)
5	→	20	OE
6	→	13	CE & PGM PULSE
18	→	19	50mS PULSE
Rp	—		Vpp SET BY R17A & B

EPROM 2732

PIN		PIN	FUNCTION
3	→	24	+5V Vcc
4	→	7	A11
5	→	22	Vpp (+21V)
6	→	14	CE & PGM PULSE
18	→	19	50mS PULSE
12	—	16	39k // 22k

EPROM 2764

PIN		PIN	FUNCTION
1	→	23	Vpp
2	→	15	PGM PULSE
4	→	7	A11
5	→	20	OE
6	→	12	CE
11	→	24	+5V Vcc
17	→	18	1mS PULSE
12	Rp	16	39k // 22k (21V TYPE)
12	Rp	16	3k3 //5k6 12.5V TYPE)

EPROM 27128

PIN		PIN	FUNCTION
1	→	23	Vpp (+12.5V)
2	→	15	PGM PULSE
3	→	10	A13
4	→	7	A11
5	→	20	OE
6	→	12	CE
11	→	24	+5V Vcc
17	→	18	1mS PULSE
12	Rp	16	3k3 //5k6

EPROM 27256

PIN		PIN	FUNCTION
1	→	23	Vpp (+12.5V)
2	→	9	A14
3	→	10	A13
4	→	7	A11
5	→	20	OE
6	→	14	PGM PULSE
11	→	15	+6.2V/+5V Vcc
17	→	18	1mS PULSE
12	Rp	16	3k3 //5k6

EPROM 27512

PIN		PIN	FUNCTION
1	→	8	A15
2	→	9	A14
3	→	10	A13
4	→	7	A11
5	→	22	OE/ Vpp 9+12.5V)
6	→	14	PGM PULSE
11	→	15	+6.2V/+5V Vcc
17	→	18	1mS PULSE
12	Rp	16	3k3 //5k6

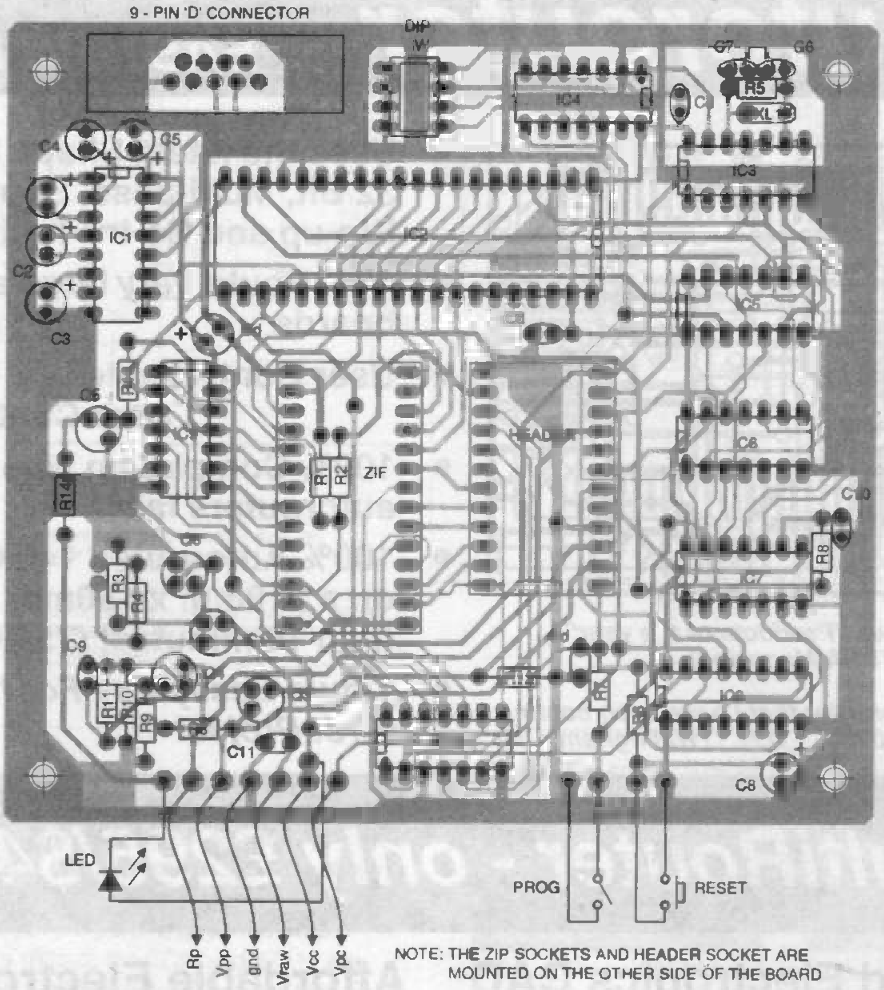


Figure 6: the component layout of the main board

Mechanical construction

The main PCB layout is double-sided (figure 6): this normally requires through-hole plating to connect one side of the board to the other. This is virtually impossible to do if you make the board yourself (as I do), and the board expensive to have made. To get round this, some of the 'through' connections are made by soldering the IC sockets on both sides of the PCB. I strongly recommend that good quality turned-pin IC sockets are used. These stand slightly clear of the PCB when fitted, and it is possible, with a steady hand, to solder to pads on the component side of the board under the sockets, and on the 'copper' side of the board, creating a through connection. Figure 7 shows how this may be done. Be warned: a steady hand, good eye, and small, hot soldering iron is essential for this. It is possible to do without the ic sockets, and solder directly to the pins of the ics, but this is not recommended because testing and replacement is difficult (or impossible).

There are also a number of through connections made by wire links soldered on both sides of the PCB, and also a number of the resistors and capacitors are soldered on both sides. The through links are shown on figure 8, the component layout, by an 'X'. Fit all these links first, because some are under IC sockets, followed by the other components, the ic sockets, and the crystal. A small blob of glue gives added security for the crystal. Check carefully to see which components require soldering on both sides of the PCB.

The eprom socket should ideally be a zero insertion force (ZIF) type, although a normal good quality ic socket can be used if you don't anticipate a lot of use. This socket, and also the 24 pin socket for the personality module, are fitted on the 'copper' side of the board. This is so that the sockets protrude through matching holes cut in the case when the PCB is mounted, allowing you to insert and remove the eprom and personality module. Figure 8 shows these mechanical details.

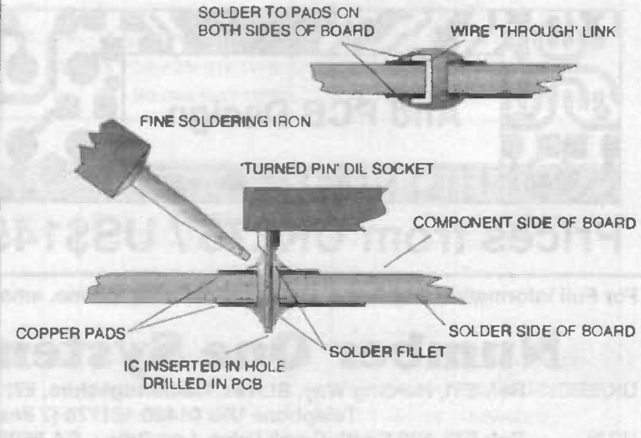


Figure 7: Eprom Programmer - soldering the "through" connections

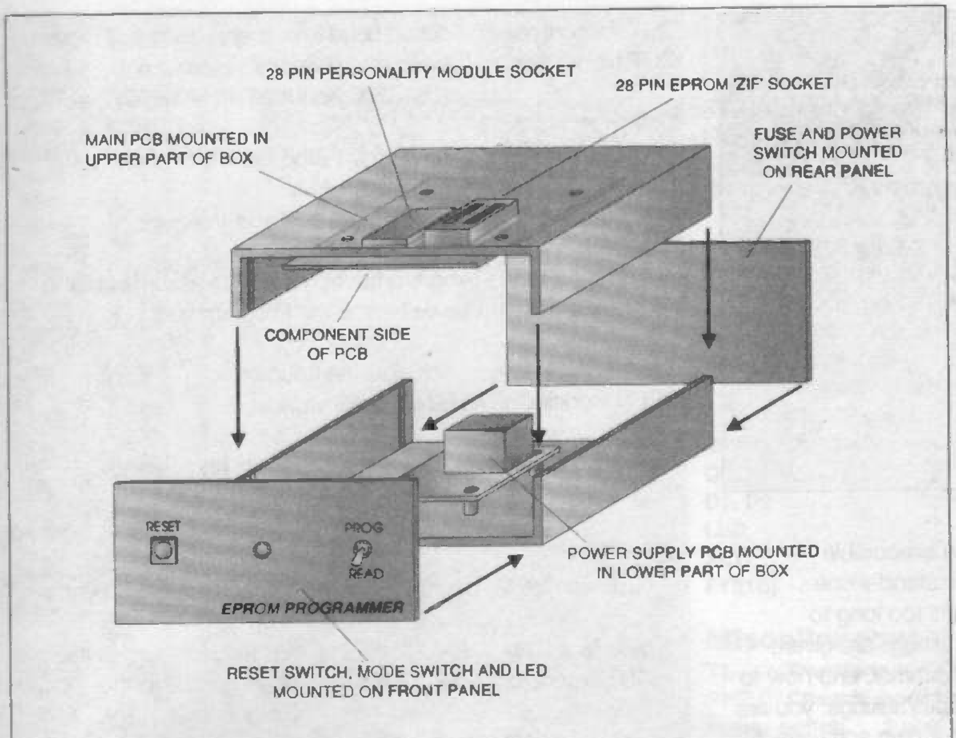


Figure 6: Eprom Programmer - general construction

Once again, some care is necessary to fit these sockets because they require soldering on both sides.

The PSU presents no special difficulties: it is a single-sided board (figure 9), and no through connections are required. Observe the polarities of the diodes and electrolytic capacitors when fitting them. Check also that no 'whiskers' of copper remain around the connections to cause short circuits. It is wise to check operation of the PSU before connecting to the main board. See under 'Testing'

It is difficult to give mechanical design instructions for the box, since not everyone can lay hands on the same box, or has the same skills. However, Figure 8 shows how the original was mounted in its box. Holes were cut in the appropriate place in the top of the box, and the PCB mounted with plastic spacers so the ZIF socket protruded through the hole, and the 9 pole D-type RS232 connector protruded through a hole cut in the rear panel. If you have problems finding plastic spacers, short pieces cut from a plastic ballpoint pen barrel are ideal.

The Reset Switch, Mode Switch and Mode LED are mounted on the front panel, connected to the PCB with short lengths of multicore wire. I used a piece of flat cable as this keeps things tidy. The power switch and fuse are mounted on the rear panel, and the power cable is routed through a notch cut in the edge of the rear panel.

The PSU was bolted into the base of the box, again using short M3 bolts and plastic spacers.

Testing

Connect 230V AC to the PSU, and switch on, taking great care not to touch the high voltage points - **230V AC is lethal! This is a mains construction - if you do not have mains construction experience, seek the assistance of someone who does.**

With a voltmeter, check the +5V supply is available. If so, connect the voltmeter between ground and the output of IC13 (Vpp). If +5v is applied to the Vpc input (R18) using a short piece of wire, then Q1 should switch on, and the Vpp output should be +5V. If the Vpc input is now taken to ground, Q1 should be off, and Vpp should be +25V. This is determined by the values of R17A and B in parallel. If it differs by more than 0.2 volt, switch off and disconnect the 230V AC and adjust the values of R17A and B. When all these voltages appear OK, switch off the power, connect the main PCB without inserting the ics, and switch back on. Check that +5V is available on the appropriate pin of any IC socket. If it is not, switch off and **disconnect** the power and look for the probable short-circuit on the main PCB.

When all is well, insert the ics. If you have access to an oscilloscope, then the oscillator can be checked, as can the Baud rate divisor. If the UART is not fitted, then a link between pins 24 and 17 of the UART socket connects a clock signal to the address counters for checking at the eprom socket. Don't forget A11, A13, A14 and A15 are connected via the personality module.

Operation of the Vcc Switch, Q6/IC11 is checked by monitoring the eprom Vcc on pin 28 of the ZIF socket. Connecting pin 11 of the Personality Module to +5V (pin 24), should switch on Q6, so pin 28 of the eprom should be +5v. Remove the connection, and it should rise to +6.2 volts.

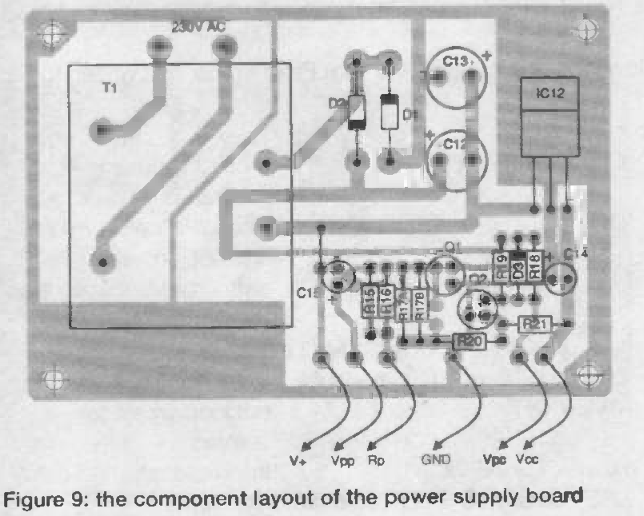


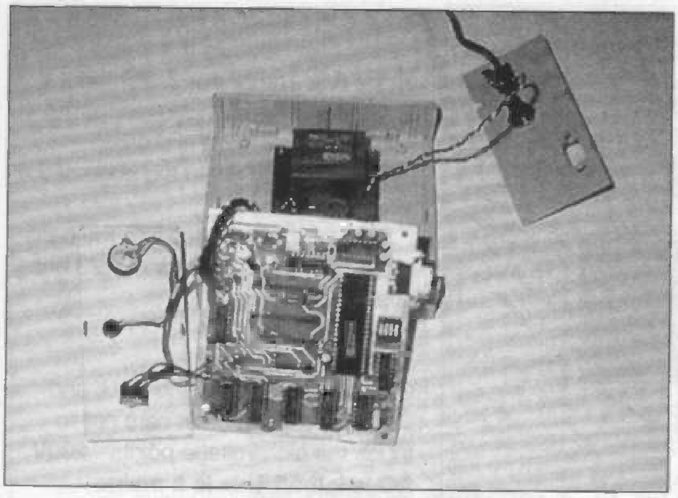
Figure 9: the component layout of the power supply board

Conclusion

The Programmer is not restricted to use on an IBM compatible PC. There is no reason why it should not be used on any machine with a serial port, providing the user can produce the appropriate software. I have tested the prototype with an Atari ST machine, as well as 386/486/Pentium based PCs running at various speeds.

Software

Because the Programmer responds to a byte, and returns a byte, it is not possible just to use a simple terminal program and transmit a data file to the Programmer. The software must be able to check that each byte has been received and acted on by getting a response. The original software was written in QBasic supplied with the later versions of DOS. The problem



here is that it is not possible to compile an executable program, although it can be done with the stand-alone versions of QBasic. The full QBasic listing is too long to reproduce here. However, two annotated listings are given: these show how to write data to the Programmer, and how to Read data. These are very much 'bare-bones' listings: you are encouraged to expand these and write your own software: it really is not difficult. An executable program in Visual Basic 3 for use with Windows 3.1 or Windows 95 has been developed, plus a small application which sends a selected number of bytes to check the operation of the Programmer on a 'one-shot' basis, and to confirm the operation of the address counter.

Programming the Programmer

The following addresses apply to standard PCs, and can be declared as constants.

Constant Name	Port COM2	Port COM1	Function
txport	&H2F8	&H3F8	Tx Buffer
rxport	&H2F8	&H3F8	Rx Buffer
intenreg	&H2F9	&H3F9	Interrupt Enable Reg.
intident	&H2FA	&H3FA	Interrupt Identification
linecont	&H2FB	&H3FB	Line Control

In the following description the actual program instructions are shown in bold type. &HFF is the QBasic convention for showing hexadecimal data, in this case hex FF. The following variables must be initialised in your program:

workfile %	integer containing the active filenumber.
Byte %	integer containing the databyte.
workfile$	string variable containing the name of a file.
counter&	long integer used as an index.
programmersize&	size of the eprom in use in bytes
available = 4	interrupt bit mask for RxData

Port Setup

Before using the Programmer, your program should set up the PC port to be used to match the UART settings. This requires a divisor to be loaded to set the baud rate (in this case, 9600 baud), and the appropriate stop bits, parity and handshakes must be set:

```
OUT linecont, &H80    set up baud rate: enable baud rate divisors
OUT txport, &HC       baud rate division
                      (1843200/baudrate*16 = &H0C)
OUT intenreg, &H0
OUT linecont, 3       no parity, 1 stop bit, 8 bits/char,
                      no handshakes
OUT intenreg, 1       enable data available interrupt
```

Writing data to the Programmer from file (this assumes that a file of data exists to be written to the Programmer):

```
counter& = 1              'initialize the counter
OPEN workfile$ FOR BINARY AS workfile %

'Now loop until all the data is read from file and sent to
Programmer.

do
  GET workfile %, counter, byte %  'QBASIC reads 2 bytes
                                   from file
  byte % = byte % AND &HFF         'so reduce it to 1 byte
  OUT txport, byte %               'then send it to the
                                   Programmer

'now wait until the Programmer echoes the data

do                                 'wait for 'data available'
                                   interrupt
  TIMER ON                         'switch timeout watchdog
                                   on
  ready = INP(intident) AND available
LOOP UNTIL (ready = available)
TIMER OFF                          'exit when data received

  counter& = counter& + 1          'increment the counter
loop until counter& > Programmersize&   'and loop if not
                                   completed
close workfile %                   'close the file when
                                   finished
```

Reading data from Programmer to file: if data is received by the PC, it sets a bit in the Interrupt Identification Register. The Read process enters a loop until this bit is set, then reads the waiting byte of data and writes it to file.

```
  counter& = 1                     'initialize the counter
  OPEN workfile$ FOR RANDOM AS workfile % LEN = 1
  FIELD #workfile %, 1 AS databyte$

'Now loop until all data read from Programmer and written to file.

do
  OUT txport, &HFF                 'prompt programmer to
                                   return data
  DO                               'loop until 'data available'
                                   interrupt occurs.
    TIMER ON                       'switch timeout watchdog
                                   on
    ready = INP(intident) AND available
  LOOP UNTIL (ready = available)
  TIMER OFF                        'exit loop when data
                                   received
  rxbyte % = INP(rxport)           'then read returned data
  LSET databyte$ = LEFT$(MKI$(rxbyte %), 1)
```

PARTS LIST for the Eprommer

Resistors

All 0.25 Watt 5%

R1, R8, R11, R17A, R18, R20	10k
R2, R21	33k
R3	100R
R4	470R
R5	10M
R6, R19	100k
R7, R9, R13	4k7
R10	3k3
R12	12k
R14	120R
R15	220R
R16	680R
R17B	5k6
Rp	See Text

Capacitors

C1, C2, C3, C4, C5	22uF 35V radial electro (Maplin AT56L)
C6, C7, C9	10pF ceramic (Maplin WX44X)
C8	1uF 63V radial electro (Maplin AT73Q)
C10	150pF ceramic (Maplin WX58N)
C11, Cd 1- 3	100nF polyester (Maplin DT98G)
C12	470uF 25V radial electro (Maplin AT51F)
C13	1000uF 25V radial electro (Maplin AT52G)
Cd 4	47uF 16V radial electro (Maplin AT39N)

Semiconductors

IC1	Max 232CPE (Maplin FD92A)
IC2	6402 uart (Maplin QQ04E)
IC3	74HC02 quad 2 I/P NOR (Maplin UB01B)
IC4, IC6, IC9, IC10	74HC393 dual binary divider (Maplin AE60Q)
IC5	74HC74 dual 'D'-type flip flop (Maplin UB19V)
IC7	74HC132 quad 2 I/P NAND Schmitt (If difficult to obtain, use 74HC00) (Maplin UB00A)
IC8	74HC390 dual divide 2/5 (Maplin UB84F)
IC11	74L05 voltage regulator (Maplin AV02C)
IC12	78M05CV (Maplin QL28F)
IC13	317LP voltage regulator (Maplin AV26D)
Q1, Q2, Q4, Q5, Q6	BC107 (Maplin QB31J)
Q3	BC328 (Maplin QB69A)
D1, D2	1N4001 (Maplin QL73Q)
LED	Red LED (Maplin UK48C)
XL1	2.4576 MHz crystal (Maplin FY81C)

Miscellaneous

T1	Transformer 230Vac/ 12Vac - 250mA (Maplin YN14Q)
F1	Chassis mount fuse holder 100mA (Maplin RX96E)
Power switch	2 pole on-off (Maplin FH04E)
Mode switch	1 pole 2-position (Maplin FH04E)
Reset switch	Momentary push to make (Maplin FF98G)
Serial connector	9 pin 'D' type plug PCB mount (Maplin FG66W)
Baud rate switch	4 pole dip switch (Maplin JH08J)

14-pin I/C sockets (7 off) use 'turned pin' type (Maplin FJ64U)
16-pin I/C sockets (2 off) (Maplin FJ65U)
24-pin I/C socket for target cable (Maplin FJ67X)
40-pin I/C socket (Maplin FJ69A)
28-pin ZIF socket for eproms (Maplin FT14Q)

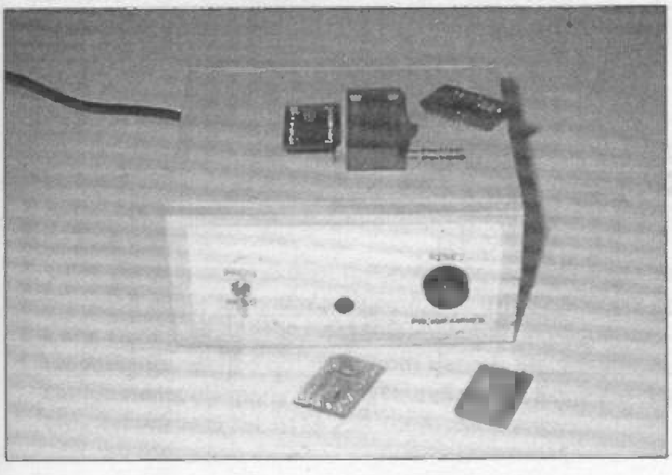
Box	(HxWxD) 6.5 x 13 x 13 cms

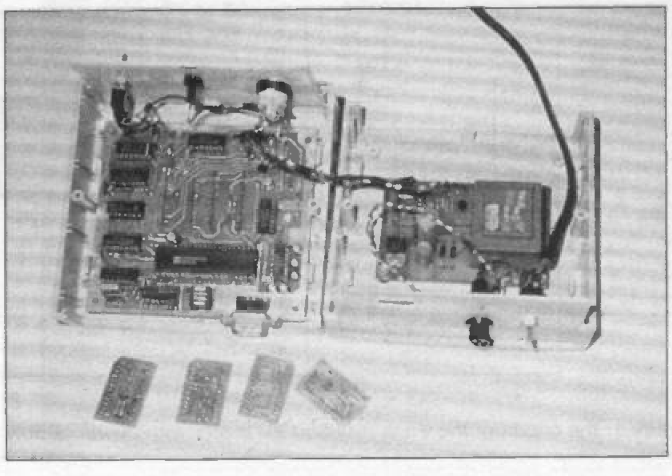
```
                                  'convert number to a 1-
                                  char string
   PUT #workfile %                'and put it in the file
   counter& = counter& + 1        'increment the counter
loop until counter& > Programmersize&    'and loop if not
completed
close workfile %                  'close the file when
                                  finished
```

Any data may be sent to the Programmer as a prompt in Read mode (I used FF). It may also be worth noting that if the Programmer fails to return a byte for any reason, this routine will stay in the loop forever waiting for data. You should include a check on the Timer value, and exit after a short period, noting this is a Timeout Error. The remainder of the program is left up to you.

Software

A disk containing the Eprommer software is available from Forest Electronic Developments, 10 Holmehurst Ave., Christchurch, Dorset BH23 5PQ, priced £5 inclusive of post and packing. A kit may be available in the future - please enquire at FED at the address above.





Peak Reading VU Meter

Tony Sercombe's peak-reading VU meter combats momentary overloads in your audio system.

VU or volume unit meters, were first used in the early days of broadcasting, principally in the United States. These early versions suffered many drawbacks. They consisted of a basic moving coil meter, with a diode, and perhaps resistor in series, simply connected across the signal path. They thus did little more than indicate the average value of the signal. The main problems with such a simple system were an inability to follow the signal levels accurately, poor frequency response, and a tendency to indicate a different level for differing programme contents of the same level. Another point is that other than the 0 dBm or 100 percent scale marking, levels could not easily be read.

At that time these meters were used in the UK also, but in the early 1930s attempts were made to improve matters, and the PPM or peak programme meter, was developed. This represented a great step forward. These meters had active electronics driving them. To begin with, they used variable slope [gain] pentode valves, and a right-hand mechanical zero system, so that an increase in signal was indicated as the valve gain reduced, being pulled up by the hair-spring. Modern PPMs use the conventional left-hand zero system, and solid state electronics.

The PPM has many advantages over the VU meter. Perhaps the most significant is that the circuit is logarithmic in nature and thus imitates the response of the human ear. This allows the scale to be marked in a linear fashion. The scale covers a range of 28 dB, or 25 times, and can be read over its entire length quite easily. The meter itself is specially designed to have a very fast response, or attack, an the electronics provide a slow decay or fallback of about 1 second. This has been the standard in this country and the majority of Europe for many years. Lately the LED column has become popular, however, many technicians find they suffer a degree of eye strain with this system, and still prefer the PPM.

A professional PPM attempts to indicate .5 Hz at 20 kHz, and to do this they have become very expensive, particularly as a stereo pair, and so are probably well beyond the pocket of most enthusiasts.

Between the extremes

This present circuit is intended to fall somewhere between these two extremes. It uses a VU meter movement, but has a fast response time and good frequency response beyond the audio bandwidth of 20 Hz to 20 kHz. The circuit is linear, in theory making the scale accurate. However, the point of real interest is the 0 dBm or 100 percent mark on the scale, which will be the reference point adjusted to in use.

The circuit uses two single ics and one dual ic per channel. The first stage is a TL071 connected as an inverting amplifier with a gain of approximately 6 dB, or two times. The 22k preset enables the basic sensitivity to be set. If somewhat more gain is required, the value of the feedback resistor from pin 6 to pin 2 may be increased. The input resistor should not be reduced much in value, otherwise the circuit being monitored may be loaded unduly by the meter. The resistor from pin 3 to ground goes some way to reducing the offset voltage, and should have the same value as the input resistor. The output of the amplifier is connected to the input of a full wave rectifier. Full wave rectification is needed because the level of the signal in one half of the waveform may exceed that in the other, and therefore could be missed using a half wave system. With all the resistors of equal value , the rectifier operates broadly by inverting a positive signal twice, with D1 off and D2 on, and with negative inputs it inverts it once, with D1 on and D2 off, to provide a positive output.

The output of the rectifier is fed, via a further diode, to a buffer amplifier. The purpose of this is to provide a very high input impedance, and to supply out put current from a very low impedance source. Because the input is at high impedance, a capacitor may be connected to ground. This has the effect of delaying the signal voltage decay after large peaks. Since the impedance is very high and the input current tiny, a large value resistor is needed to shunt the capacity. By this means, the decay time is controlled. The diode is used to prevent the decay voltage from dissipating through the previous circuit. The resistor at pin 6 of the buffer is simply to give the meter some protection, and should be

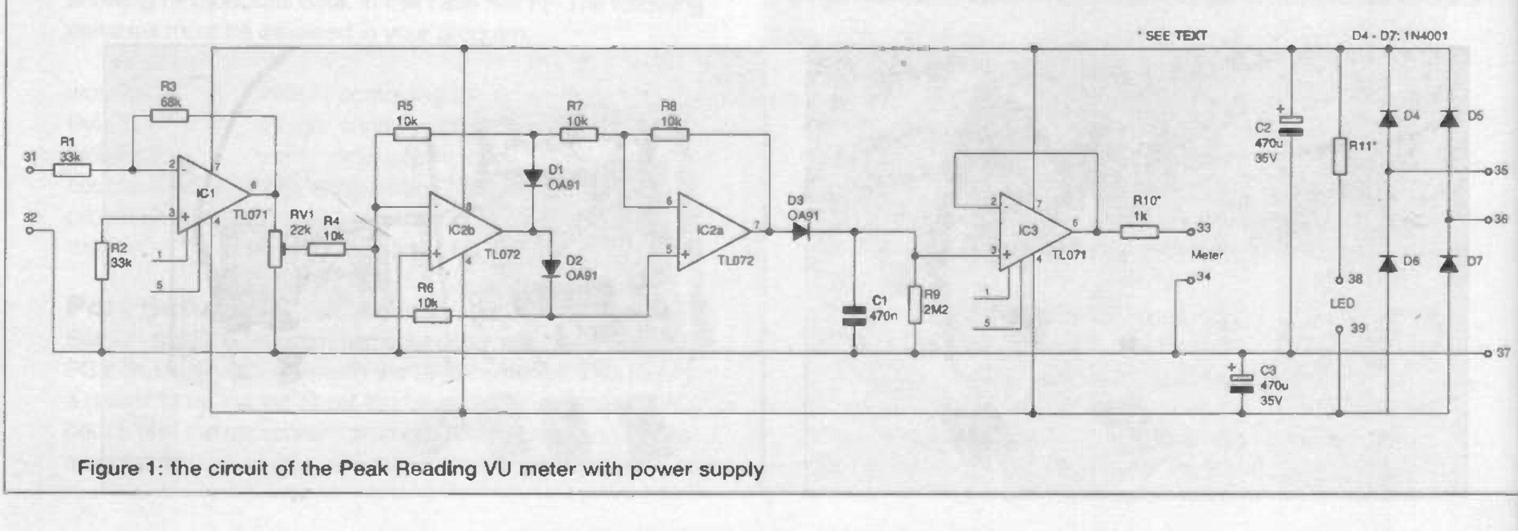


Figure 1: the circuit of the Peak Reading VU meter with power supply

adjusted to suit the movement, as should the values of the decay components. If the meter has a tendency to fall back too quickly, the capacitor may be increased to about 1 uF. It is recommended that if a stereo pair are to be constructed, that polyester type capacitors are used, since the tolerance of the electrolytic variety is such that they might have to be selected to give equal decay times. If it falls too slowly, the resistor value may be reduced by a small amount to adjust for this. No standard reference voltage is given, since it is assumed that this will differ, depending on the equipment to be monitored; however, a reference level of about .75 of the maximum to be used should be chosen and set by VR1 to 0 dBm or 100 percent on the scale.

Linearity

Although the drive circuitry is essentially linear, there exists a degree of non-linearity at the diode output. Since VU meters first came into being, they have been very simple instruments, simple a diode and sometimes a resistor as already mentioned, in serious with the meter. The scale calibration has historically taken this into account. Of course, this is only a half-wave rectifier, and thus ignores the other half of the signal, adding another limitation to the system. The reason why it is included in the present circuit is to bring the calibration to equality, and isolate the decay components, as already stated.

The next, and perhaps most practical point to note, is that the main importance of the scale is for setting steady tone. The main ponit of interest is the 0 dBm or 100 percent marking, and a slight overswing of the pointer on peaks here should be what is aimed for. The calibration cannot be used in the same way as a PPM - the diode specified will introduce a non-linear characteristic at the start of conduction, but in this case it is only around the -18/20 dB point on the scale, which is 10 times below peak, and of little importance in practical terms. Once the reference level of 0 dBm has been established, any signal below that must be within the dynamic range of the circuit being monitored anyway. The voltage drop across a germanium diode is in the order of 2/300 millivolts, which is absorbed by the previous circuitry

It is perhaps worth mentioning here that many VU meter movements are damped in much the same way as the traditional moving coil panel meter. This causes a VU meter to rise, or attach, a little more slowly. It is better to obtain an undamped movement if possible. A simple check for this is to gently rock the meter from side to side. The pointer should move by a few mil each time. However, an undamped meter will exhibit a degree of overshoot. That is to say, if a steady tone is applied, the pointer will rise quickly, and then settle back a small amount to a steady value. This is probably the best in use, since any overshoot will be taken up in controlling the levels anyway. The prototype instrument has been built into an audio mixer as an "aux send" level monitor, however, as described here it is intended as a stand-alone unit, and to this end a suitable power supply circuit is shown. If this is constructed, the proper care should be taken with mains supply connections, as mains voltages can be very dangerous, and all work and any adjustments, apart from the level setting preset, must be carried out without the power supply connected.

The choice of enclosure is left to the constructor; it could, for example, be used as a master monitor in a home studio, in which case it could be built into a separate free-standing case and so be transportable.

All components, except the meter movements, may be obtained either from Maplin Electronics (01702 554000) or Cirkit Distribution (01992 448899). Suitable analogue movements may be obtained from Henry's Electronic Components (formerly Henry's Radio) at 404 Edgware Road London W2 1ED Tel. 0171 723 1008.

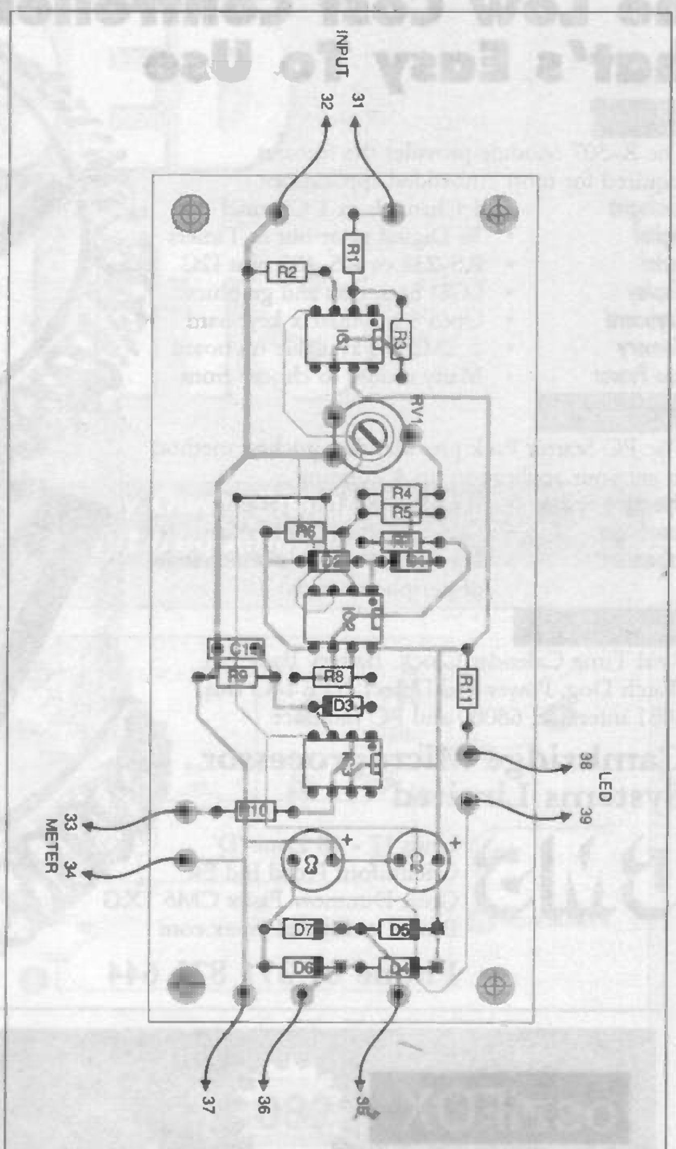


Figure 2: the component overlay and connections

PARTS LIST for the VU Meter

Resistors

R1,R2	33k
R3	68k
R4 to R8	10k
R9	2M2*
R10	1k0*
RV1	22k

Capacitors

C1	470n*

Semiconductors

D1 to D3	0A90/91
IC1, IC3	TL071
IC2	TL072

Miscellaneous

VU meter movement/s as required

*Adjust on test

Power supply section

R11	to suit LED and supply
C2, C3	470 uF
D4 to D7	1N4001
LED1	Red LED
TR1	Mains transformer pri: 6-0-6V to 10-V-10V

Switch, fuse as required.

SPICED CIRCUITS

Circuit simulation with software, by Owen Bishop.
This month, part 3 - More about frequency.

We begin by analysing the circuit in part 2 (ETI Issue 5, 1997), which some readers may have recognised as a band-pass filter of the multiple feedback type (figure 1). The netlist is entered either by typing it in, or by using Geseca, as described in part 2. When specifying the voltage generator, set its amplitude to 100mV (a greater amplitude might saturate the op amp) and its frequency to 1kHz (see later). The problem was to investigate the frequency-dependent behaviour of the circuit.

Using a signal generator and an oscilloscope with a breadboarded version of the circuit, you can sweep the generator frequency over a given range, using a sine-wave signal, and watch the changing signal amplitude on the oscilloscope. A simulator program such as SpiceAge plots output amplitude against frequency to obtain the frequency response. To make interpretation easier, we can elect to have the results plotted on logarithmic scales. For the first run of this analysis, where we have no idea of the possible result, we select a wide range, say from 1Hz to 1MHz (figure 2). The plot has a sharply peaked pass-band, centre frequency 531Hz, rolling off symmetrically on either side. Note that it does not matter to what value we originally set the frequency of the generator, as the frequency response test sweeps it over the specified range, irrespective of its nominal value.

The operation of the circuit is based on feedback. We have two feedback loops, each containing a filter. The C1/R1 combination is a high-pass filter and the C2/R2 combination is a low-pass filter. High-frequency and low-frequency signals passing through the op amp are fed back to the inverting (-) input where they act to cancel out the signal coming from the generator. Only signals of intermediate frequency can pass. Taken as a simple high-pass filter, the C1/C2 combination has a cut-off frequency of 0.5piRC = 4813Hz. This is the frequency at which the power of the output signal has been reduced to half the input power. This happens when the output voltage amplitude is 3dB below the input amplitude, so this is sometimes known as the -3dB point. For the low-pass filter C2/C3, the -3dB point is 0.5piRC = 60Hz. The responses of the two filters overlap, as in figure 3 and we can see why the pass-band is so narrow, for the frequency at the -3dB point of the high-pass filter is higher than that of the low-pass filter. The location of the peak would be

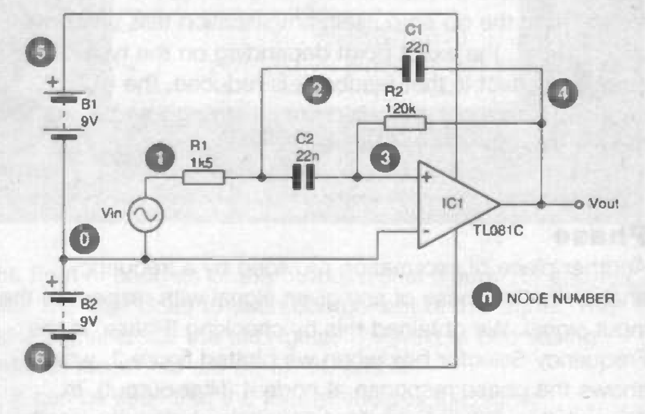


Figure 1: last month's Problem - the filter circuit

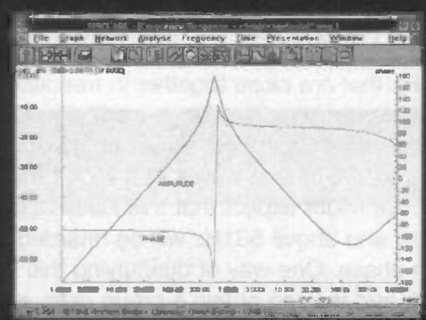


Figure 2: a Bode plot of the frequency response of figure 1

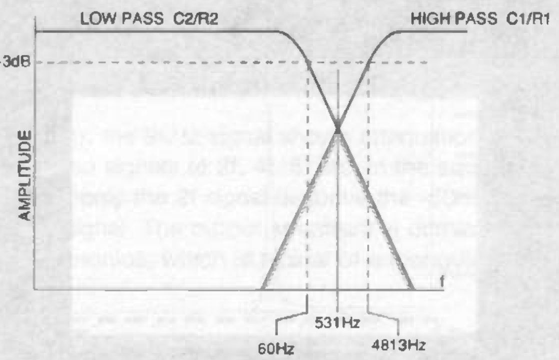


Figure 3: overlapping responses of the low-pass and high-pass sections of figure 1 produce a sharply peaked band-pass response

expected to come half-way between the two -3dB points, but this is a mean on a logarithmic scale, the geometric mean. Instead of adding them and dividing by 2, we multiply them and take the square root:

Centre frequency = Square root of (4823 x 60) = 538Hz

This agrees well with the curve plotted in figure 2. We can use the cross-hairs to measure roll-off. For example, place the cross-hairs on the curve with the vertical cross-hair exactly on 10Hz. Read the corresponding decibel figure, which is -47.3. Now move the cross-hairs further up the curve to 80Hz. This is 10Hz doubled three times, a span of 3 octaves. The dB value at this point on the curve is -29.57. So the amplitude has increased by 17.73dB per 3 octaves, or about 6dB per octave. This is a typical figure for the roll-off of a single stage RC filter.

Similarly, the portion of the curve above the pass-band shows a roll off of -6dB/octave. There is a slight increase of response above about 1MHz. This is due to the frequency response of the op amp itself; amplification falls off above about 1MHz, the exact point depending on the type of op amp. The effect is that feedback is reduced, the high frequencies are not cancelled out as strongly as before, so there is an upturn in response.

Phase

Another piece of information provided by a frequency analysis is the phase of any given signal with respect to the input signal. We obtained this by checking 'Phase' in the Frequency Selector box when we plotted figure 2, which shows the phase response at node 4 (filter output). In general, it is -90 degrees for frequencies below the centre frequency, and +90 degrees for frequencies above it. There is a sharp 180 degree change in frequency at centre frequency. Sudden changes in frequency are bound to mean abrupt changes in the timing of signals. Signals around 531Hz that are close together in frequency may show big difference of phase. Since most signals we produce in everyday life are not pure sine waves, but consist of a mixture of sine waves of a wide range of frequencies, we might expect that this leads to distortion. Signals below and above 531Hz will be retarded or advanced in phase. One way of quantifying this is known as Group Delay, and we can obtain a group delay analysis by checking Group Delay in the Frequency Selector box. The curve (figure 4) shows both positive and negative delay.

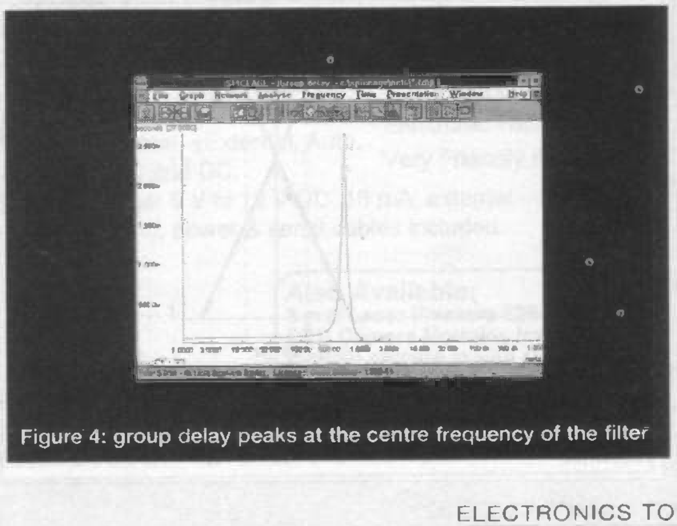


Figure 4: group delay peaks at the centre frequency of the filter

While delay may have its uses in other circuits, it plays havoc with a signal of mixed frequencies, and is a disadvantage of this kind of filter. But perhaps this is being unfair to the filter. Usually we set the cut-off point of the low-pass section to be higher than that of the high-pass section. This results in a wider pass-band (figure 5). Phase lag decreases gradually and fairly evenly from -90 degrees to about -180 degrees. The phase curve falls below the scale at the centre frequency, but is plotted 180 degrees higher up the scale above the cut-off point. This is a continuous fall, not an abrupt reversal, and a plot of group delay shows only a gradual variation in delay throughout the frequency range.

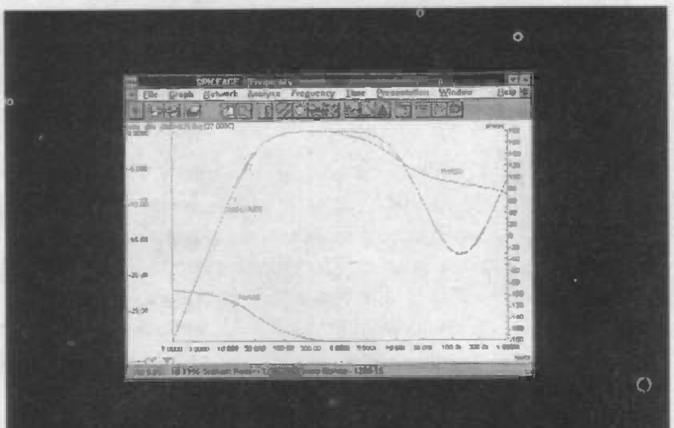


Figure 5: exchanging R1 and R2 makes the pass-band much wider

Fourier

We continue by using last month's problem circuit to illustrate another important aspect of frequency response. The basis of the Fourier analysis is the fact that any periodic signal, or whatever shape, can be analysed into a number of sine waves of different frequencies and amplitudes. If f is the frequency of the original signal, the fundamental, the frequencies of its other constituent sine waves, the harmonics, are f, 2f, 3f, 4f, and so on. Sometimes one or more of the harmonics may have zero amplitude. We may, for example, find that only the odd-numbered harmonics are present. After you have processed a signal in SpiceAge, you may carry out a Fourier analysis to find out what sine-wave components it has and what are their amplitudes.

To obtain the signal, we use another major kind of Spice analysis, the Transient Analysis. In this analysis the voltage generator (one or more), and current generators (if any) are put to work feeding their outputs into the circuit and the resultant voltage at all the nodes and currents through all the branches are calculated at specified time-intervals. For example, since our generator has a frequency of 1kHz, and we would like to follow the action of the circuit for 10 cycles of the generator, we click on Time, then on Sweep Times and set the Start time to 0, Stop time to 10m (milliseconds) and the Step time to 10u (microseconds). This gives us 1000 sampling times during the run. We can then plot the voltage at one or more nodes. Figure 6 shows output voltage from time 0. The 1kHz signal has an initial bias superimposed on it as the capacitors gradually acquire their charges. To eliminate this stage, return to Sweep Times and amend Start and Stop times to 10ms and 20ms

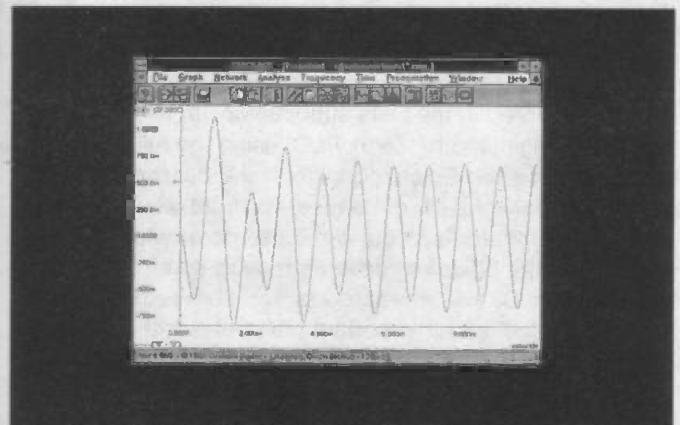


Figure 6: a Transient analysis shows how filter output varies in time

generator line, and re-run the Transient analysis (figure 8) to plot both input and output signals. The square wave input is clearly seen and we can see an output signal of larger amplitude, but what has become of the 'squareness'? The Fourier analysis of the input (figure 9) demonstrates what we mean when we say that a square wave is rich in harmonics. We have cut out the noise by holding the minimum dB level to -50dB and are not plotting phase. The 1kHz signal dominates and the next strongest signals are the odd harmonics at 3f, 5f, 7f, 9f and so on. There are also even harmonics, but at considerably lower amplitudes.

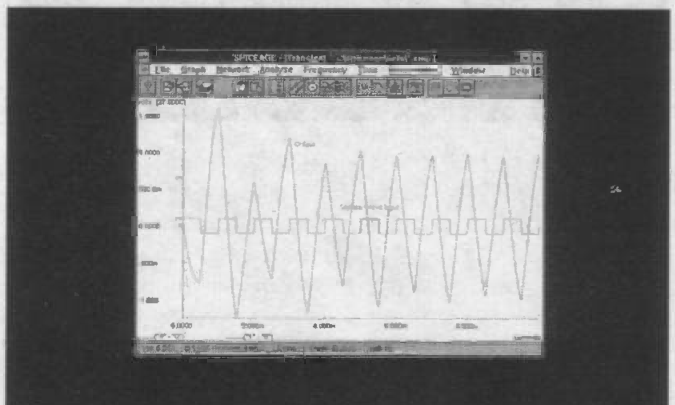


Figure 8: transient analyses of input and output demonstrate what the filter does to a square-wave signal

respectively. Re-run the Transient Analysis to obtain 10 reasonably stable oscillations. Having done this, clicking on Fourier produces a plot of the spectral composition of the signal. It is similar to what we could produce by using a Spectrum Analyser.

The analysis (figure 7) shows its strongest component at 1kHz, as expected. But distortion has introduced signals at other frequencies. The next strongest signal is at 500Hz, but this is -45dB down on the 1kHz signal. This means that its amplitude is only about 0.000032 of the main output signal, so we can ignore it. This particular component is probably due to the initial oscillations that have not completely died away. The other signals shown by a multitude of vertical lines really represent a continuous spectrum of 'signals' and probably all of them are due to approximations in the calculations. In short, they are mathematical noise. Usually we put a -60dB Hold on the minimum of the decibel scale to eliminate this noise from the display.

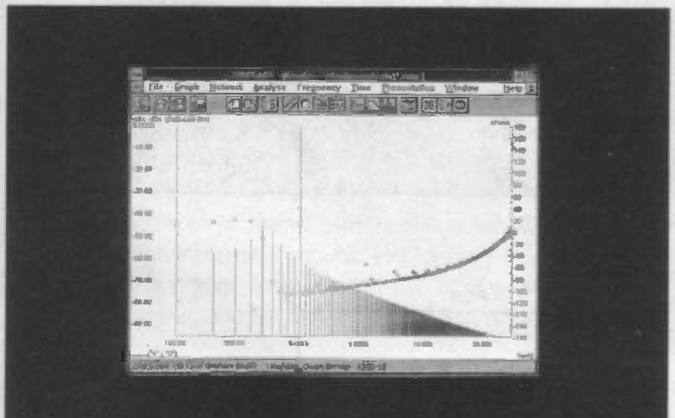


Figure 7: a Fourier analysis of the signal of figure 6 shows a peak at 531Hz, a hint of early oscillation, and mathematical noise

The Fourier analysis also displays the phase of the signals, using small square symbols. In figure 7 the phase of the 1kHz output signal is +9.81 degrees. Owing to the way the analysis is calculated, this is with respect to the input plus 90 degrees, so at 1kHz the output is 99.81 degrees ahead of the input, as already shown in figure 2.

Square waves

Pure sine waves are instructive but now for something more exciting! Amend the netlist to Ex=square on the

The Fourier analysis of the output signal (figure 10) shows what the filter does to each component of the signal. The 1kHz signal is still the strongest. The next in decreasing order of amplitude are 3f, 5f, 7f, and 9f.

It can be seen that the filter attenuates the higher frequencies more strongly. For example the 1kHz signal is amplified from 127mV to 850m, a gain of over 6 times. By contrast the higher harmonics are reduced more and more as frequency increases. The 5kHz signal, originally at -14.2dB has been reduced to 31.0dB, an attenuation of -16.8dB.

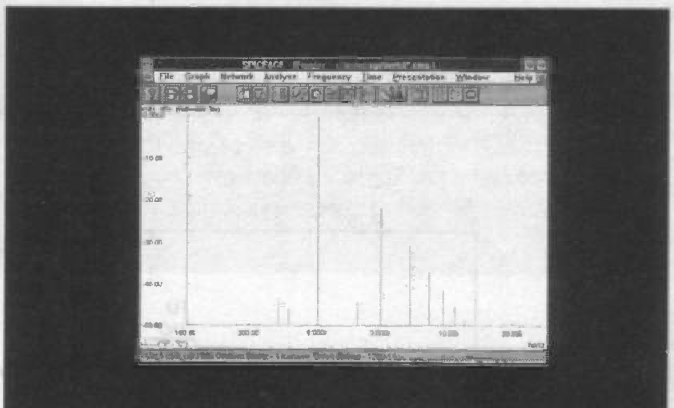


Figure 9: Fourier analysis of the square-wave input

Further along, the 9kHz signal shows attenuation of -22dB. There are also signals at 2f, 4f, 6f etc. in the square wave, but of these only the 2f signal is above the -50dB level in the filtered signal. The output spectrum is dominated by the odd harmonics, which is typical of a triangular wave.

Exploding netlists

If you re-load the netlist used in Part 1 (ETI issue 3 1997), which included a BC548BP transistor, you can explode it

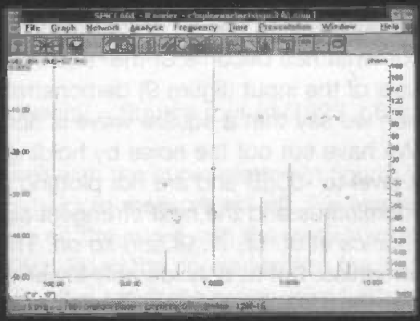


Figure 10: Fourier analysis of the output, for comparison with figure 9. The constituent signals have a complicated phase relationship

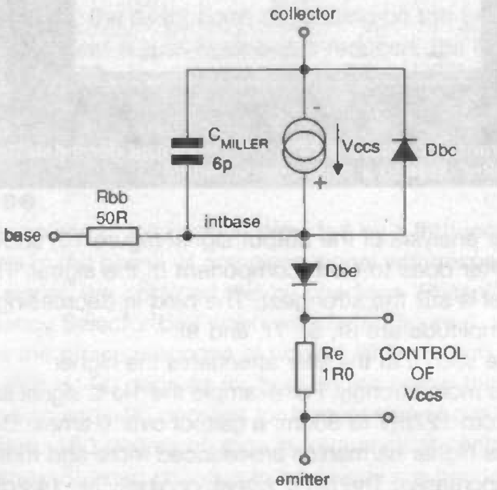


Figure 11: the 'npn' transistor model is basic but quick-running

by clicking on Netlist and then Explode. The transistor is normally specified in the netlist solely by its model name and its netlist connections. Exploding calls up more detail from a file stored in the Nets subdirectory. In this case the file is one originated by Zetex PLC, using the full Spice format. As in other Spice model files, the description consists simply of a list of parameters and their values. What the computer is to do with these parameters is decided by the Spice software. Parameters include such quantities as IS, the saturation current, here with the value 1.3×10^{-14}A. Another important parameter is the forward current gain, BF, which equals 400 in this transistor. Altogether Spice has 40 parameters for specifying a bipolar junction transistor. The BC548BP model specifies only 22 of these, the remainder of the parameters being given default values when a simulation is run. Thus the transistor is represented by a set of equations with 40 parameters to put into them. A model such as this gives a highly accurate representation of the transistor, but at the cost of taking an appreciable time to evaluate. If the netlist includes several transistors, it may take too long to run.

An alternative way of modelling a complex component is to represent it by a netlist of simpler components. Models of this kind are stored as .lib files and their netlist is incorporated into the main netlist wherever they are named. One such is the cheap-and-cheerful 'npn' model (figure 11), which is perfectly good enough for non-critical modelling. We leave the reader to discover how it operates. At least it runs very fast!

Problems

Set up the circuits of figure 12 on a breadboard or simulator: (a) is an amplifier which needs improving; find out what is wrong with it and do what you can to correct it. (b) is a precision voltage regulator; how precise is it?

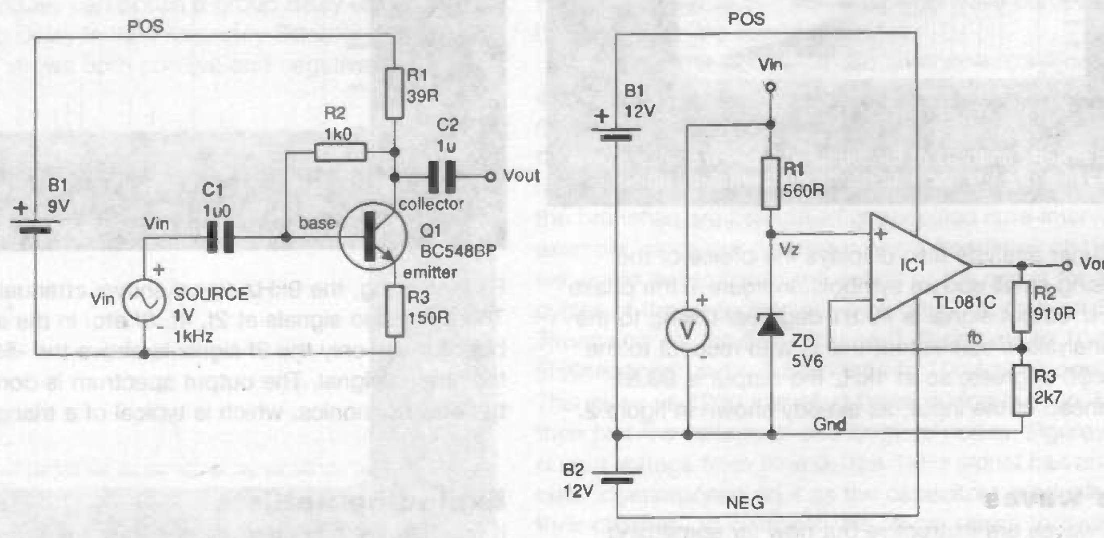
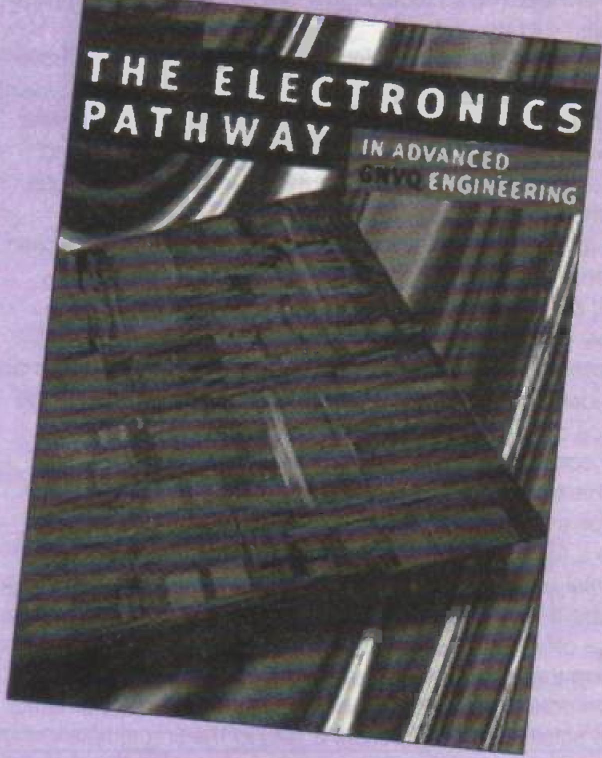


Figure 12: two more problem circuits

REVIEWS

The Electronic Pathway in Advanced GNVQ Engineering
Barry Lewis and Tim Strickland
Price £16.99 ISBN 0 3334 9914 4 P/b
Macmillan Press Basingstoke 1996



This practical textbook covers the Advanced GVNQ Optional Units 11 (Electrical Principles) 13 (Electronics) 19 (Microelectronic Systems) and 9 (Communications Engineering), which between them contain many of the most important topics in basic electronics - to illustrate, the chapter headings run through DC circuits, capacitance, electro-magnetism, AC circuits, semiconductors diodes and transistors, power supplies, amplifiers, digital electronics, information transmissions (comms), microelectronics and test meters (including oscilloscopes).

The book starts with DC circuits, covering Ohms Law, series and parallel circuits, power dissipation, and so on. It has a good explanation of resistor colour codes, including five-band resistors, and goes on to describe other resistor components such as pots and light-dependent resistors. The text does not avoid advanced concepts - by page 23 we have Kirchoff's Laws - but there are practical experiments to demonstrate, and detailed circuit calculations to help make things clear. By page 31, you are learning Thevinin's Theorem and Norton's Theorem, and when you have completed this, you have a better than average understanding of DC circuits. Matched attenuators, bias networks, and the like are treated matter-of-factly. Chapter 2 covers capacitors equally well. There are examples, with detailed illustrations of individual types of capacitors showing the structure and the dielectric, with the relevant formulae.

Each section also has "guided examples", showing how calculations are applied to practical circuits. At the end of the sections there are sample questions to test your knowledge.

Subsequent sections include Semiconductors, Power Supplies, and Amplifiers (with a selection of op-amp building blocks). The important aspects of combinational and sequential logic circuits are covered, and there is a substantial section on information transmission, which includes radio modulation systems and fibre optics. Section 10 covers machine code programming, and section 11 covers test equipment.

The basics of electronics are presented clearly in this book, with understandable explanations throughout, even for topics which are easily made confusing. The authors have aimed for clarity and a down-to-earth approach without sacrificing detail. I would have appreciated this book in my first year at university, and yet it would also be useful to a complete novice.

If you want to learn about electronics at this level, I recommend this book - it is good enough to read for interest, not only to help with gaining GNVQs. The text makes nothing more complicated than it has to be, and will appeal to practical engineering people who want to make things work.

Satellite Projects Handbook
Price £14.99 ISBN 0 7506 2406 X P/b
ButterworthHeinemann/Newnes Oxford 1996

This book has been written by Lawrence Harris, who has worked in a satellite ground station, sending commands and receiving data from British scientific satellites. Clearly he has maintained a personal interest in the subject in his spare time as well, and he relates his experiences of satellite monitoring with various types of equipment.

The first five chapters talk about satellites in general, experiences of launching and operating a particular satellite, and various current satellites in detail: what they are for, the frequencies on which they transmit, and other information such as amateur radio retransmissions of shuttle communications. There are pictures received from weather and survey satellites to whet your appetite.

Chapter 6 begins the practical project side of this book, describing the basic hardware and terminology, and the basics of setting up a personal ground station. The author suggests starting with a simple station to receive UOSAT2, for which in his experience a simple and inexpensive dipole will suffice, though he suggests a crossed dipole for better reception of the circularly polarised signal. A simple scanner will receive UOSAT2 telemetry and data as an introduction to satellite receiving.

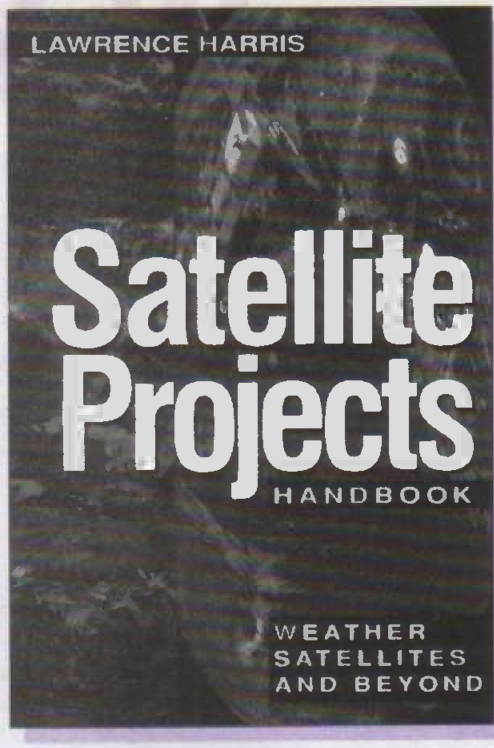
Chapter 7 covers the reception of weather satellite data. The necessary specification for the various parts is covered.

Kits are mentioned as a good way to build up equipment, but circuits and designs are not given. It must be said that the title may be a little misleading to project constructors: this is not a "project" book - it is a handbook for the electronics and radio enthusiast who already understands the principles but has not dealt with satellite reception before. Personally, I would have liked to see some practical circuits.

Subsequent chapters deal with the decoding of weather satellite images, including a fair amount about the necessary computer equipment, although much of this will be familiar to those readers of ETI who are more computer-oriented. There are pointers on how you might understand and use weather satellite data once it has been converted to a picture: monitoring hurricanes and looking at thermal ocean currents are among the suggestions.

Of course, there is more to satellite monitoring than simply receiving weather pictures from known spacecraft. Chapter 10 talks about listening for new or unfamiliar signals and identifying the source - with a warning: sometimes the source of an apparent satellite signal can be the clock of your computer.

This book is not a reference source for information on microwave and UHF reception. Assuming that you already have a fair knowledge of general electronics and at least a minimal acquaintance with rf, then this book tells you how to go about receiving satellite signals and how to start making sense of what you receive. There are useful appendices, and I found the one on Kepler elements of particular interest. I have noticed Kepler orbital elements specified for amateur radio satellites, but Appendix 3 here is the first simple explanation I have seen of how to use these figures to calculate where the satellite will be at a given time.



Although developments move faster than any book publication can, much of the information here will probably be relevant for years to come. If you want to monitor satellite transmissions but do not know much about how to make a start, this is a good handbook.

Construction Authors

If you have designed and built any kind of electronics gadget for yourself, your home, your friends or your business, it may be suitable for publication in ETI.

Read on!

You may have a one-off project you would like to share; you may be a regular constructor with a new design you are especially pleased with, or you may be a pro designer trying out ideas and looking for feedback.

Your ideas may be simple or complex, analogue or digital, computer-related or rooted in tradition; elaborately cased or (in some cases) not cased at all.
You may be a private hobbyist, an engineer of advanced standing, or a student. You may be yourself and a soldering iron, a club or a business.

ETI is looking for original project design for publication. "Original" simply means that you have designed the project for a particular purpose or to a general specification, and have worked out how you want to do it for yourself. You can be applying well-known and established techniques, or using the latest components in new applications, as long as the final result is your own design.

For further details of authors' fees and how to write up a project for publication, please write to ETI for our Potted Project Production information sheet at PPP, ETI Nexus House, Boundary Way, Hemel Hempstead Herts HP2 7ST. A self-addressed envelope is always a help, but not a necessity.

WRITE FOR ETI!

Much as we like all mod cons, project authors do not have to produce CAD output, professionally drafted plans or Shakespearean prose.

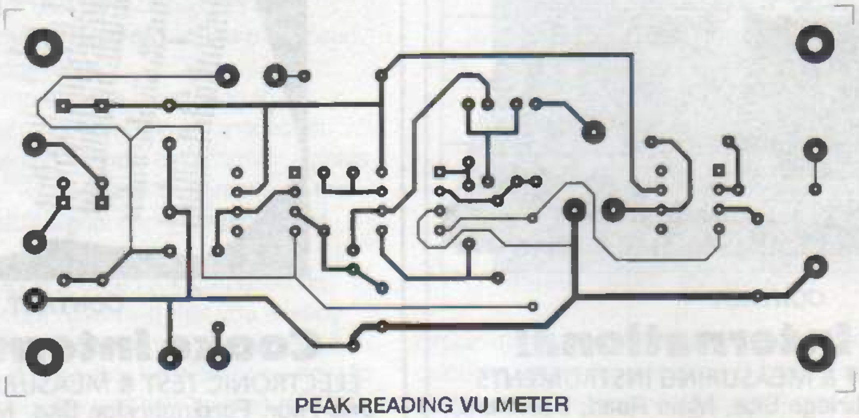
ETI's mission is to publish projects and "how to" articles. ETI does not buy news items or short feature articles from outside contributors.

ETI commissions a small number of full length feature articles from experienced independent contributors only.

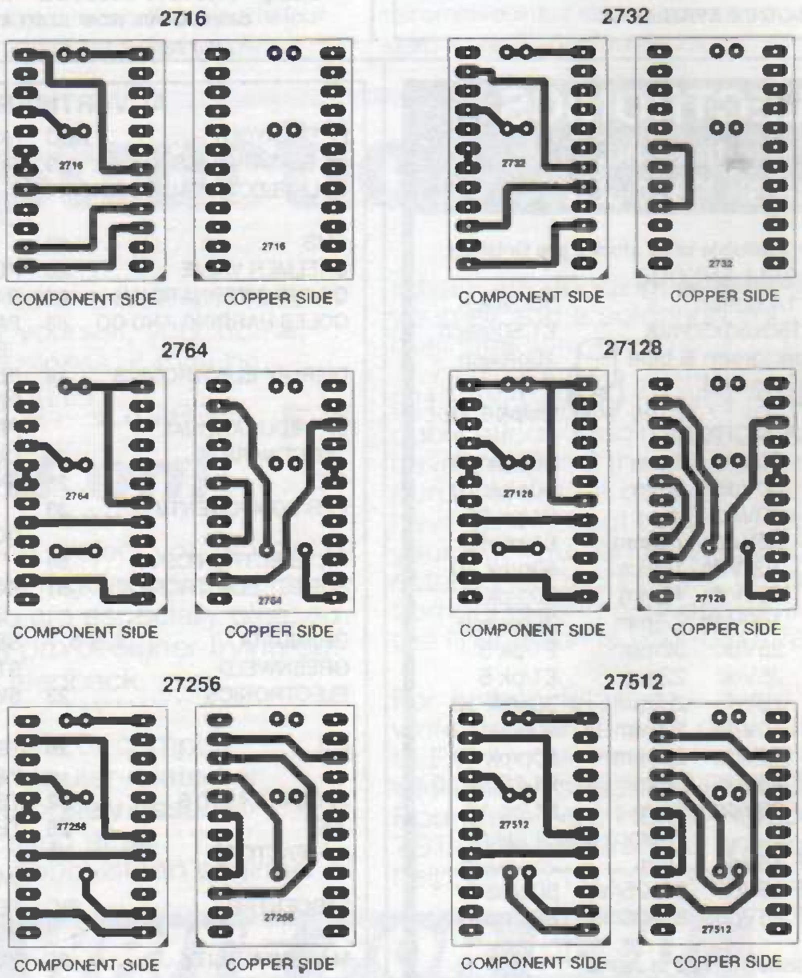
ADVERTISERS INDEX

ETI
ELECTRONICS
TODAY INTERNATIONAL
TOMORROW'S TECHNOLOGY TODAY

FOILS FOR THIS ISSUE



PEAK READING VU METER



EPROMMER: THE PERSONALITY MODULES

ETI Classified

Andy Forder
01442 66551

Send your requirements to:
ETI Classified Department, Nexus, Nexus House, Boundary Way, Hemel Hempstead, HP2 7ST
Lineage: 75p per word (+ VAT) (minimum 15 words)
Semi display: (minimum 2.5cms)
£10.50 + VAT per single column centimetre

Ring for information on series bookings/discounts.
All advertisements in this section must be pre-paid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

FOR SALE

Veronica KITS — 88-108MHz FM TRANSMITTERS

Professional PLL transmitter, Stereo Coder, and Compressor/Limiter kits licensable in the U.K. Also very stable VFO transmitter kits. Prices from under £10 and a 'Ready Built' service is available. Contact us for a free brochure including prices and more detailed information.

18 Victoria St, Queensbury, BRADFORD, BD13 1AR
Tel 01274 816200 Email veronica@legend.co.uk

SWC SCIENTIFIC WIRE COMPANY

ENAMELLED COPPER WIRE
TINNED WIRE SILVER
PLATED COPPER WIRE
SOLDER EUREKA WIRE
NICKEL CHROME WIRE
BRASS WIRE LI TZ WIRE
BIFILAR WIRE MANGANIN
WIRE TEFZEL WIRE NICKEL
SAE BRINGS LIST 18 RAVEN RD LONDON E18 1HW
FAX 0181 559 1114

£50 BT INSTRUMENT FOR ONLY £7.50

We refer to the BT insulation tester and multi-meter with which you can read insulation directly in megohms, AC volts up to 230, 4 ranges of DC volts up to 500, 3 ranges of milliamps and one 5A range and 3 ranges of resistance. These are in perfect condition, have had very little use, if any, tested and fully guaranteed. Complete with leads and prods £7.50, Order Ref 7.5P4. Carrying case which will take small tools as well, £2 extra. Postage £3 unless your order is £25 and over.

J & N Factors
Dept ETI, Pilgrim Works, Stairbridge Lane, Bolney, Sussex, RH17 5PA
Telephone: (01444) 881965

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220/240V AC 50/60
OUTPUT 0-260V

	Price	P&P	
PANEL MOUNTING			
0.5KVA 2.5 amp max	£33.00	£6.00	(£45.83 inc VAT)
1KVA 5 amp max	£45.25	£7.00	(£61.39 inc VAT)
SHROUDED			
0.5KVA 2.5 amp max	£34.00	£6.00	(£47.00 inc VAT)
1KVA 5 amp max	£46.25	£7.00	(£62.57 inc VAT)
2KVA 10 amp max	£65.00	£8.50	(£86.36 inc VAT)
3KVA 15 amp max	£86.50	£3.50	(£111.63 inc VAT)
5KVA 25 amp max	£150.00 Plus Carriage & VAT		
10KVA 45 amp max	£300.00 Plus Carriage & VAT		
6KVA 3 PHASE Star	£205.00 Plus Carriage & VAT		

Buy direct from the Importers. Keenest prices in the country

COMPREHENSIVE RANGE OF TRANSFORMERS-LT-ISOLATION & AUTO
(110-240V Auto transfer either cased with American socket and mains lead of open frame type. Available for immediate delivery.

WIDE RANGE OF XENON FLASHTUBES
Write/Phone your enquires

ULTRA VIOLET BLACK LIGHT BLUE FLUORESCENT TUBES

4ft 40 watt £14.00 (callers only)	(£16.45 inc VAT)
2ft 20 watt £9.00 (callers only)	(£10.58 inc VAT)
12in 8 watt £4.80 + 75p p&p	(£6.52 inc VAT
9in 6 watt £3.96 + 50p p&p	(£5.24 inc VAT)
6in 4 watt £3.96 + 50p p&p	(£5.24 inc VAT)

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes £6.05 + £1.40 p&p (£8.75 inc VAT)
The above Tubes are 3500/4000 angst. (350-400um) ideal for detecting security markings, effects lighting & Chemical applications.
Other Wave Lengths of U.V. TUBE available for Germicidal & Photo Sensitive applications. Please telephone your enquiries.

400 WATT BLACK LIGHT BLUE UV LAMP
GES Mercury Vapour lamp suitable for use with a 400W P.F. Balast
Only £38.00 + £4.00 p&p (£49.35 inc VAT)

12V D.C. BILGE PUMPS
500 GPH 15ft head 3 amp £19.98
1750 GPH 15ft head 9 amp £34.55
Also now available 24V D.C. 1750 GPH 15ft head 5 amp £35.55. All designed to be used submerged. PRICES INCLUDE P&P & VAT

SUPER HY-LIGHT STROBE KIT
Designed for Disco, Theatrical uses etc.
Approx 16 joules. Adjustable speed £50.00 + £3.00 p&p (62.28 inc VAT)
Case and reflector £24.00 + £3.00 p&p (£31.73 inc VAT)
SAE for further details including Hy-Light and industrial Strobe Kits.

5KVA ISOLATION TRANSFORMER
As New Ex-equipment fully shrouded Line Noise Suppression, Ultra Isolation Transformer with terminal covers and Knock-out cable entries. Primary 120/240V Secondary 120/240V 50/60 Hz. .005 pF Capacitance. Size L.37 x W.19 x H.16cm Weight 42 Kilos. PRICE **£120.00 +VAT** ex-warehouse. Carriage on request

24V DC SIEMENS CONTACTOR
Type 3TH8022 DB 2 x NO and 2 x NC 230V AC 10A contacts Screw or Din Rail fixing. Size H 120 x W 45 x 0.75mm. Brand New Price £7.63 incl. P&P and VAT.

240V AC WESTOOL SOLENIODS
TT2 Mod 1 flat. 1 MAx stroke 1/4 in. Base mounting 1/2in. stroke 5lbs pull approx. TT6 Mod 1 Flat. 2 Max stroke 1/8 in. Front mounting 1/2in. Front mounting 1/2 in. stroke 15lbs pull approx. Price incl. p&p & VAT. TT2 £5.88, TT6 £8.81. SERIES 400 £7.64.

AXIAL COOLING FAN
230V AC 120mm square x 38mm 3 blade 10 watt Low Noise fan. Price £7.29 incl. P&P and VAT. Other voltages and sizes available from stock. Please telephone your enquiries.

INSTRUMENT CASE
Brand new Manuf. by Imhof L31 x H18 x 19cm deep. Removeable front and rear panel for easy assembly of components. Grey finish complete with case feet. PRICE £16.45 INCL. P&P &VAT 2 off £28.20 inclusive.

SEWING MACHINE MOTOR
Brand new 220/240v AC/DC SEW-TRIC 2 lead Brush Motor. Size L. 100mm x H. 70mm x W.55mm. Spindle. 1/4in. dia x 1in. long. £14.10 incl. P&P & VAT

GEARED MOTORS
71 RPM 20lb inch torque reversable 115V AC input including capacitor and transformer for 240V AC operation.
Price inc VAT & p&p £27.73

SOLID STATE EHT UNIT
Input 230/240V AC, Output approx 15KV. Producing 0mm spark. Built-in 10 sec timer. Easily modified for 20sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.81 inc VAT) NMS

EPROM ERASURE KIT
Build your own EPROM ERASURE for a fraction of the price of a made-up unit kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit £15.00 + £2.00 p&p (£19.98 inc VAT)

WASHING MACHINE WATER PUMP
Brand new 240V AC, fan cooled. Can be used for a variety of purposes. Inlet 1½in. outlet 1 in. dia. Price includes p&p & VAT. £11.20 each or 2 for £20.50 inclusive.

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
TEL 0181-995 1560 FAX 0181-995 0549
ACCOUNT CUSTOMERS MIN, ORDER £10
Open Monday/Friday
Ample Parking Space

TELEPHONE BUGGING?

"STOP IT NOW!!" WITH THE NEW BUG X *TERMINATOR*.

Blocks all phone taps & telecorders, keeps phone calls and fax's private.
For details send a S.A.E. or Tel/Fax: Write for details with S.A.E. to: F.K.Electronics services, Northgate house, St. Marys Place, Newcastle Upon Tyne, NE1 7PN.
Tel: 0191 4601706
Fax: 0191 4601707.

Professional AUDIO TRANSFORMERS

FREE 16 PAGE CATALOG AVAILABLE
Fax Toll-Free 0800-96-7106
SESCOM, INC. sescom@anv.net
2100 WARD DR., HENDERSON, NV 89015
Tech Line 702-565-3993 (weekdays 8 am - 4 pm PST)
Office 702-565-3400 Fax 702-565-4828

TRANSFORMERS

VVT Variable Voltage Technology Ltd

TRANSFORMERS
For valve and transistor circuits
HT Filament chokes high & low voltage
Standard and custom design
large and small quantities
Unit 24E, Samuel Whites Estate, Medina Road, Cowes, Isle of Wight PO31 7LP
Tel 01983 280592 Fax 01983 280593

PLANS

ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teslas, surveillance devices, pyrotechnics and com-puter graphics tablet. 150 projects. For catalogue, SAE to Plancentre Publications, Unit 7, Old Wharf Industrial Estate, Dymock Road, Ledbury, Herefordshire, HR8 2HS.

ELECTRONIC VALVES

WILSON VALVES
(PROP JIM FISH G4MH)
Over 50,000 valves stocked,
2000 different types,
vintage, military, audio, etc.
Fast service. Send SAE for list
VALVES WANTED FOR CASH
28 Banks Avenue, Golcar, Huddersfield, West Yorks HD7 4LZ
Tel: 01484 654650
Fax: 01484 655699

WANTED

TURN YOUR SURPLUS TRANSISTORS, ICS ETC INTO CASH immediate settlement.
We also welcome the opportunity to quote for complete factory clearance
Contact:
COLES-HARDING & CO
Unit 58, Queens Road, Wisbech, Cambs PE13 7PQ
BUYERS OF SURPLUS INVENTORY ESTABLISHED OVER 20 YEARS
Tel: 01945 584188 Fax: 01945 475216

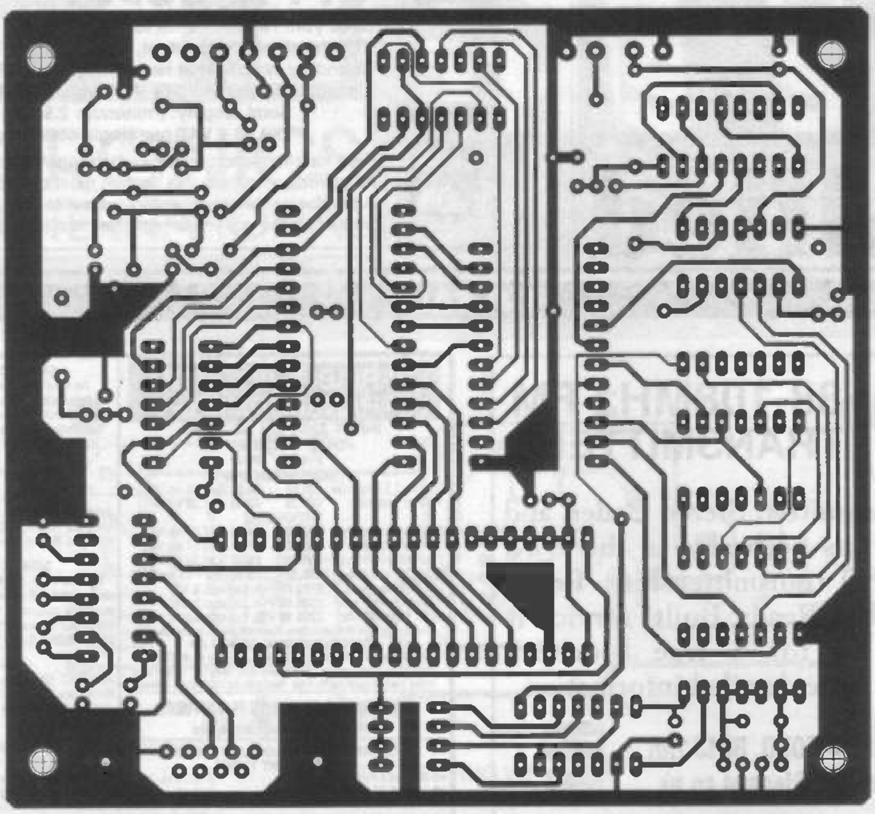
FAX your advert to us on 01442 66998

PRINTED CIRCUIT BOARDS

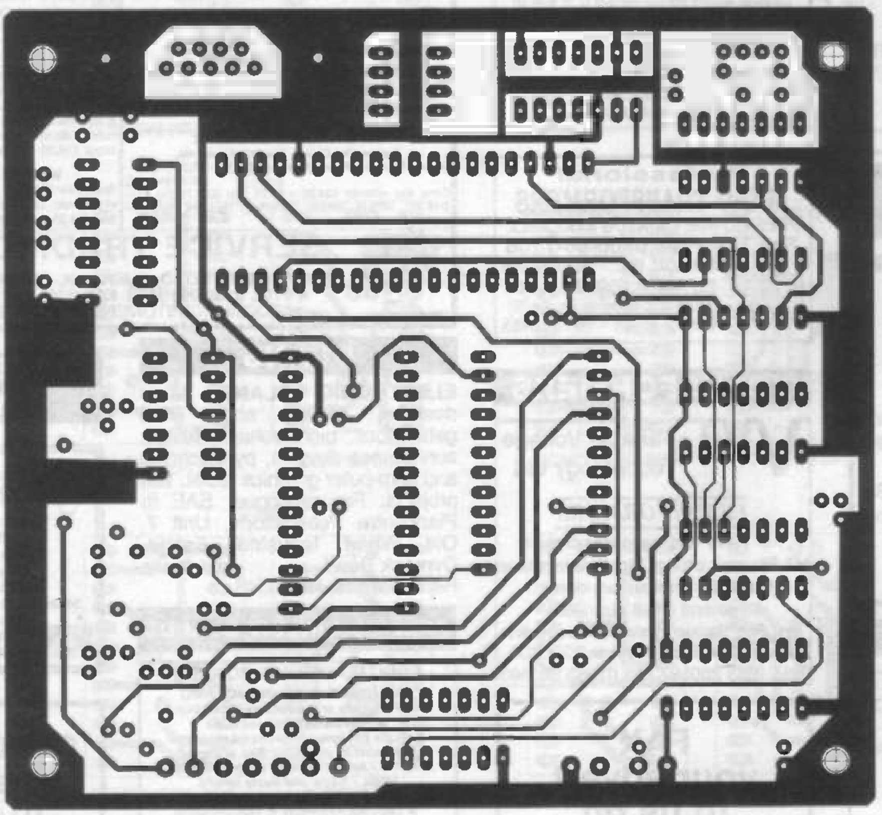
PRINTED CIRCUIT BOARDS
Designed & Manufactured
- *Prototype or Production Quantities*
- *Fast turnaround available*
- *PCBs Designed from circuit diagrams*
- *Almost all computer files accepted*
  Easy PC / Aries / VuTrax / Cadstar Gerber / HPGL / !Draw and many others.
- *Fast International service*
- *Contract Assembly & Test available*

TELEPHONE 01232 473533
INTERNATIONAL +44 1232 473533
agar Circuits
FAX - 01232 473533
Email - agar@argonet.co.uk
36 WOODCOT AVENUE, BELFAST BT5 5JA

Call Our Friendly Sales Team on 01442 66551 & ask for details

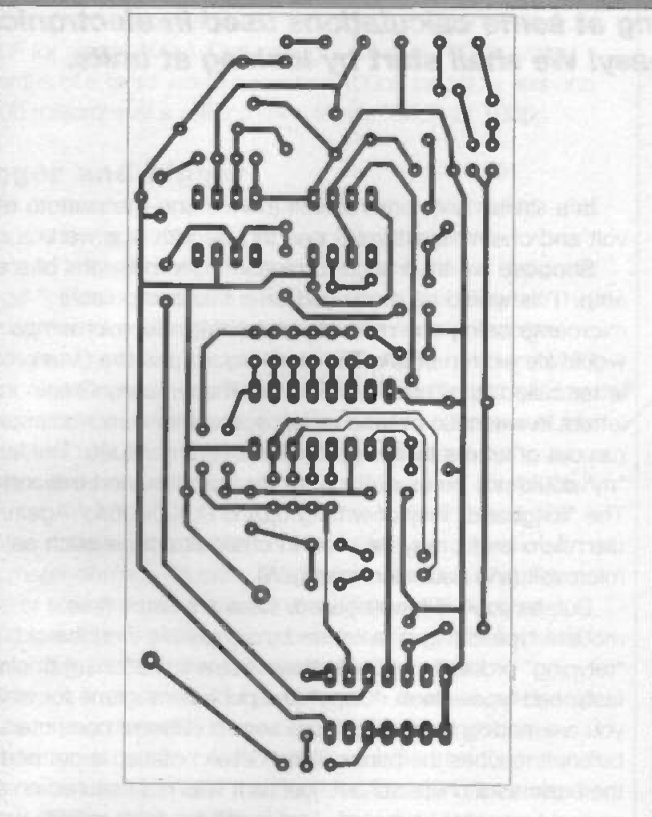


EPROMMER: THE MAIN BOARD TRACK SIDE

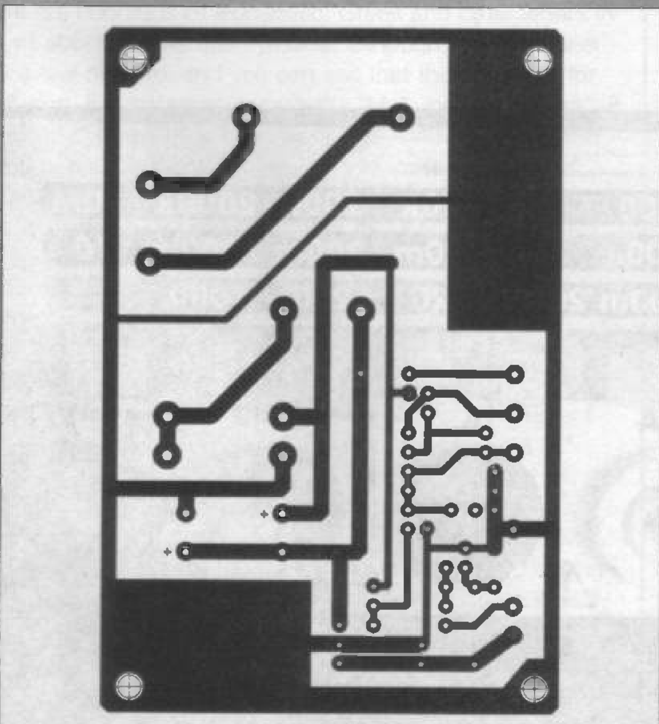


EPROMMER: THE MAIN BOARD COMPONENT SIDE

FOILS FOR THIS ISSUE



ARE YOUR LIGHTS ON?



EPROMMER: THE POWER SUPPLY BOARD

ETI ELECTRONICS TODAY INTERNATIONAL PCB Service

ETI can supply printed circuit boards for most of our current projects - see the list below for boards available. For recent boards not listed, check the constructional article for an alternative supplier.

Please use this order form or a copy of it. Check that all relevant information is filled in, including the Unit Order Code, and that you have signed the form if sending a credit card number. Overseas customers please add postage appropriate to the number of units you are ordering. Make cheques/POs/money orders, in £ sterling only, payable to Nexus Special Interest Limited. Please allow 28 days for delivery. Access/Visa orders may be made on 01442 66551 (ask for Readers Services).

Only boards listed here are available from our PCB Service. For past issues of magazines, copy articles or binders, please see the admin panel (page 75) or contact Readers Services (see below) for information.

Terms of trade

Terms strictly payment with order. We cannot supply credit orders, but will supply a proforma invoice if requested. Proforma orders will not be processed until payment is received. All boards are manufactured from the foils that appear in the ETI Foils Pages for the appropriate issue. Please check that our foils are suitable for the component packages you intend to use before ordering as we cannot supply modified boards or replace boards that have been modified or soldered. Boards are only supplied in the listed units. Sorry, we cannot break units. Prices and stock may be altered without prior notice. Prices and stock listed in this issue supersede prices and stock appearing in any previous issue. ETI, Nexus Special Interests and their representatives shall not be liable for any loss or damage suffered howsoever arising out of or in connection with the supply of printed circuit boards or other goods or services by ETI, Nexus Special Interests or their representatives other than to supply goods or services offered or refund the purchaser any money paid in respect of goods not supplied.

Name and Issue of project	Unit code	Price
ETI Issue 7 1997		
Eprommer - main board (double sided)	E797/1	£13.32
Eprommer - PSU board	E797/2	£5.64
Eprommer - personality modules (double sided):	E797/3	
Any ONE module board		£5.09
Any two modules		£7.90
Any three modules		£11.85
Any four modules		£15.80
Any five modules		£19.75
All six modules		£23.70

Please specify which Eprom modules you require. Modules are for 2716, 2732, 2764, 27128, 27256 or 27512. One order code/overseas postal charge applies whether a selection or all six personality module boards are ordered.

Are Your Lights On?	E/797/4	£5.09
Peak Reading VU Meter	E/797/5	£5.09

Please supply:

Quantity	Project	Unit Order Code	Price	Total price

Prices are inclusive of post and packing in the UK

Overseas Post and Packing (if applicable): Add £1 per unit

Name ....

Address ....

....

....

....

I enclose payment of £ .... (cheque/PO/money order in £ Sterling only) to:

PCB Service, READERS SERVICES DEPARTMENT, Nexus Special Interests Ltd., Nexus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST UK.

Signature: ....Card expiry date ....

Practically Speaking

BY TERRY BALBIRNIE

Over the next few months we shall be looking at some calculations used in electronics. Don't be put off - the maths is quite easy! We shall start by looking at units.

Beginners - and not only beginners - in electronics are often confused by the number of abbreviations - usually standard scientific symbols - in use. For instacne, on any multi-tester there are milliamp and microamp scales, and there may be a millivolt scale as well as volt scales, and so on.

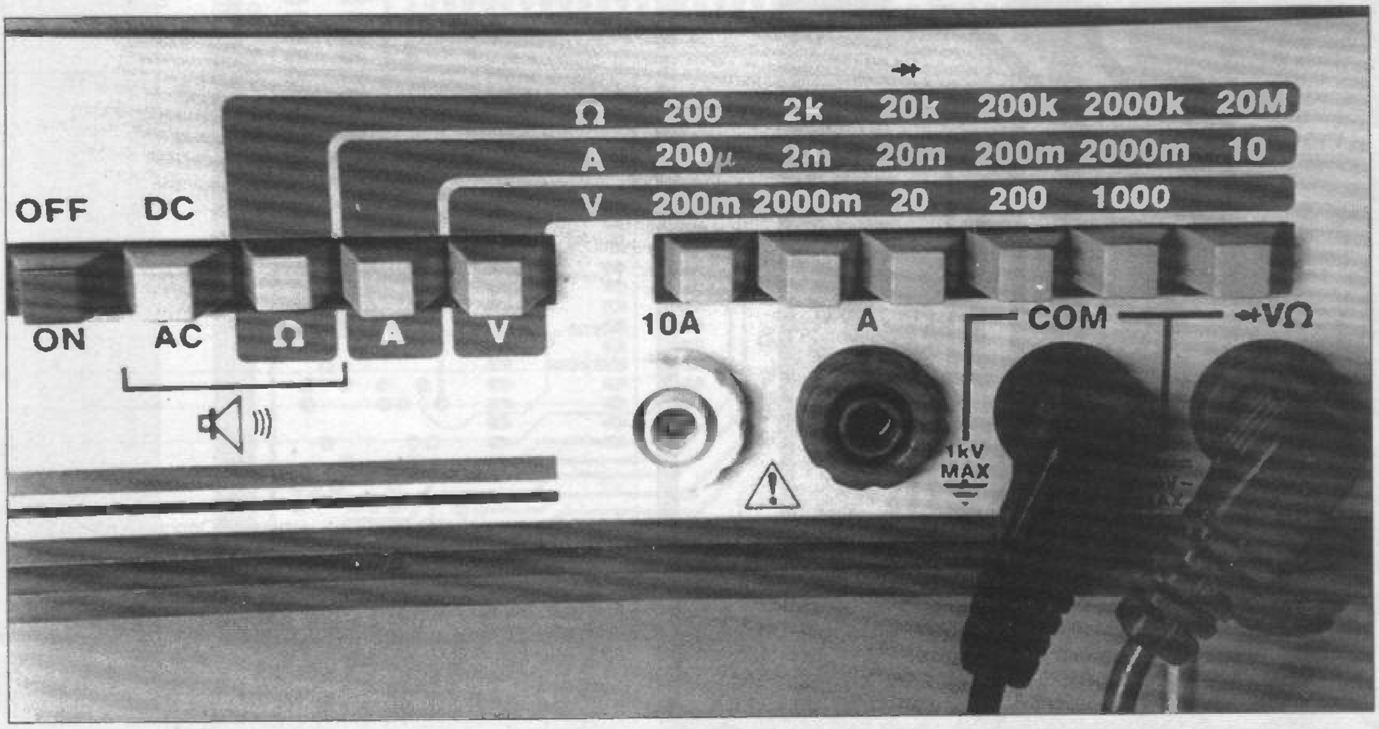
The reason for this complication is that the measurements need to span a very wide range of values, and the use of prefixes like milli (one thousandth) and micro (one millionth) makes life much easier and avoids a lot of zeros. Some examples will make this clear. Suppose, in making a check on a circuit, we measure a current of four amps (written 4A). This would be measured on the 0-10A scale (many amateur muti-testers do not have one of these, but many professional models do). Suppose, at some other time we measured a current of five thousandths of an amp. This would be measured on a milliamp scale - 1 milliamp being one-thousandth of an amp. This is written "5mA" because it is much quicker and more straightforward than writing 0.005A - and there is not the risk of "losing" zeros in reading or writing it. And please note! These "value signs" are case-sensitive - "m" is not the same thing as "M" - but we will come to that below.

In a similar way, one millivolt (mV) is one-thousandth of a volt and one milliwatt (mW) one thousandth of a watt.

Suppose we then need to measure six millionths of a an amp. This would be measured on a microamp scale - 1 microamp being one millionth of an amp. Six microamps would be written 6(μ)A. The prefix micro μ is the Greek letter called "mu" and is used - like many, many Greek letters in scientific notation - because otherwise we simply run out of letters to designate the different values. The letter "m" could not be used for both thousandths and millionths. The "longhand" way of writing 6μA is 0.000006A. Again, the micro prefix may be used in other situations such as microvolt (μV) and microwatt (μW).

But, as you will have noticed, there is a catch here - modern typesetting is faster and more reliable than the old "retyping" process - but still shares some limitations with old-fashioned typewriters!. "Copy" (the publishers' name for what you are reading here) may "hop" several different computers before it reaches the printer - and Greek notation is not part of the basic ascii character set, just as it was not featured on a normal typewriter keyboard. Ascii is still the most reliable way of "moving" copy without inviting unwanted transformations - so authors and publishers still use substitute letters for Greek

Ohm, amp and volt scales on a popular type of multi-meter



notation. The most well-known ones are "u" for "µ" and "R" for "Ω" (ohms).

We sometimes use prefixes to divide a unit into even smaller parts. This is best illustrated by capacitor values. The standard unit of capacitance, the farad, is generally too large for everyday use. A 1F capacitor is not needed very often. It is much more usual to use millionths, thousand-millionths and millionth-millionths of a farad. The prefix for a thousand-millionth is nano (n) and for a millionth-millionth, pico (p). Thus, a capacitor having a value of 100 millionths of a farad would be written 100(µ)F or 100uF (or simply 100u). One having a value of 100 thousand-millionths of a farad would be written 100nF (or 100n) and one of 100 millionths of a millionth of a farad, 100pF, or 100p.

Bigger and bigger

Other prefixes are used to scale units up. In electronics, this is usually by factors of one thousand and one million. One thousand is given the prefix "kilo-" and one million the prefix "mega-". This is familiar in everyday life as the kilogram (1000 grams), the kilometre (1000 metres) and even someone earning megabucks! It is particularly convenient when talking about resistance values. Remembering that the symbol for the ohm is "Ω" or (informally) "R", a 10-ohm resistor would be written 10R. However, it is common to use resistor values of thousands or millions of ohms. Ten thousand ohms ("ten kilohms" - not "ten kilo-ohms") is written 10kR or just 10k, and ten million ohms, 10MR or just 10M ("ten megohms", not "ten mega-ohms"). To carry this further, a resistor having a value of four thousand and seven hundred (4,700) ohms would be written 4.7k, and one of six million eight hundred thousand (6,800,00) ohms would be written 6.8M.

There is a clever way of avoiding the decimal point and that is to use the prefix in place of it. For example, in a parts list you may find 4k7 or 6M8 specified for the values of the resistors above. A resistor of value 4.7 ohms may be written 4R7 or 4Ω7, and so on.

No mixing!

There are hundreds of alphabetic, Greek and other letters in use as abbreviations and symbols, although you may meet only a few of them, and you can see that there is room for confusion. For instance, if you write "Ma", instead of "mA", it could be read by the unwary as "mega-metres-per-second" (a unit of acceleration), instead of "milliamps" as required. Whereas "S" means "siemens" (a unit of conductance), "s" means "seconds" (the most commonly used unit of time in electronics) - an "ms" is a "millisecond", but an "mS" is a "milliseimens". "k" means "kilo" (one-thousandth) but to confuse matters further, a computing "digital thousandth" is 1024 , written "K" and is still called a "kilo-" (as in a "kilobyte", 1024 bytes). The whole field of computing is still ambiguous as to abbreviations, but "B" is most consistent for "bytes", and "bit" for "bits". But in a different field "K" also stands for "Kelvin", a specialised measure of temperature. And "m", as everyone knows, also means "metre", as in "mm" for "millimetre". So it is wise to be wary.

Fortunately, not many of these notations clash in meaning in a disasterous way, but there is one where wariness is really important. The high voltage needed for a TV picture tube is several thousand volts (kV) and in scientific research voltages of several million may be used (MV). An LED may consume 20 milliwatts (20mW) but a power station may generate 2000 megawatts (2000MW). So you will see that it is vital not to mix up your "m" with your "M"!

Around the Corner

As you will see from our Contents page, the ETI PCB Service is back this month after a period of absence. This gives us great pleasure, because we know that although a lot of constructors make their own boards, there are always some of you who are unable to for one reason or another - lack of basic equipment, lack of somewhere suitable to set it up of just lack of time in the busy world of today - and would like the opportunity to buy ready-made boards for projects.

This gives us even more pleasure because, during that dark few years known by everyone in the UK as "the Recession" - which our governers, past and present, tell us is behind us now - there were many kinds of shake-out in businesses, including the entire electronics industry, and one of them was the need for suppliers to hold less stock. This affected the ability of our suppliers to make large batches of board at an economic price, and our ability to keep stock.

Now we have a new arrangement and a new supplier and we hope that our service will be helpful to many readers. Of course, as these things happen, we start with one rather unusual package this month - including the Eprommer personality modules, tiny double-sided optional PCBS - which we decided in the end to offer on a pick-and-mix basis. But no, we won't be doing liquorice allsorts next month.

I would like to thank our new suppliers, and I would also like to thank our old suppliers, who provided us with a fine service and still make boards for us when we need long runs. The "recession" only affected the cash flow, not the quality.

Bear essentials

Swindon-based part-time adventurer and explorer David Hempleman-Adams and fellow adventurer Rune Gjeldnes from Norway were presented with two custom-programmed "Minder" pagers by Blick Telefusion Communications Ltd. of Swindon to accompany them on their unsupported walk to the North Pole.

The four preprogrammed pager messages were: "Stop", "Lunch", "Emergency" and "Bear".

The two travellers are travelling some distance apart for safety reasons. The pagers pass essential information between them. On the face of it, these messages contain 75 percent of all the information needed for survival in the modern world - never mind the Arctic. But what is the fourth essential? Our consultant says that the answer is obvious - but is he right? The Editor welcomes suggestions, of course.

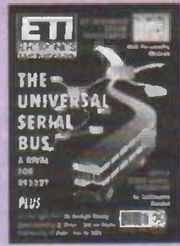
Last Month's Competition Winners

The lucky winners of last month's Swift Designs competition (skilful as well as lucky, of course) are Mr. K Mitchell of Loughton and Mr. L Hadden of Ballygawley. Mr. Mitchell wins a copy of EDWin NC Deluxe 3 along with Thermal Analysis and EDSpice simulation. Mr. Hadden wins our runner-up prize of EDWin NC Basic. Congratulations and we hope that both readers enjoy many happy hours in CAD country.

Next Month...

Volume 26 no. 8 of Electronics Today International will be in your newsagent on 18th July 1997 ... Douglas Clarkeson will be chasing intelligent robots (or maybe they will be chasing him) ... as valve hifi, radio and and amplifier equipment becomes evermore popular , Peter Kenyon has designed a portable Value Characteristic Tester for identifying and matching valves ... If you can never find the tiles, the cards and the dice for the family word games, try Electronic A-Z for your letters of the alphabet ... Terry Balbirnie's Brake Light Checker is a safety feature for your car ... If you are thinking of doing Electronics at college, we look at some of the country's leading departments ... all the regulars, and more.

Contents are in preparation but are subject to space and availability.



Published by
Nexus Special Interests Limited
Nexus House, Boundary Way,
Hemel Hempstead, Herts HP2 7ST
Tel: 01442 66551
Fax: 01442 66998

EDITORIAL

Editor
Helen Armstrong

Administration Assistant
Lynn Bugden

Consultant
Andrew Armstrong

PRODUCTION

Designer
Dan Sturges

Technical Illustrator
John Puczynski

Production Executive (Copy control)
Marie Quilter

Printed By
Wiltshire Ltd., Bristol

Origination by
Ebony, Liskeard

SALES

Advertisement Manager
Andrew Forder
01442 66551 x331

Group Sales Manager
Jason Wollington

MANAGEMENT

Divisional Managing Director
John Bridges

Business Manager
Stuart Cooke

Circulation Manager
William Pearson

Marketing Manager
Jason Doran

Copy Sales Manager
David Pagendam

SUBSCRIPTIONS

UK:Orders 01858 435344
Enquiries 01858 435322
USA: Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA9005-45009
USA. For VISA/Mastercard orders phone: (310) 375 6258. Fax: (310) 375 0548. Pacific Time: 9am - 9pm weekdays 10am - 6pm weekends

REAOERS SERVICES
Back issues(last 12 months) £3.05 per issue if available. Older issues: photocopies of whole articles often available. Write to The Photocopy Service, Readers Services Department, at Nexus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST.
Binders for ETI: £7.50 each including UK post and packing. Overseas please add £1.50. Cheques to Nexus Special Interest at Nexus House, or phone VISA/Mastercard orders to Readers Services Department 01442 66551

FOR ENTHUSIASTS BY ENTHUSIASTS

NEXUS

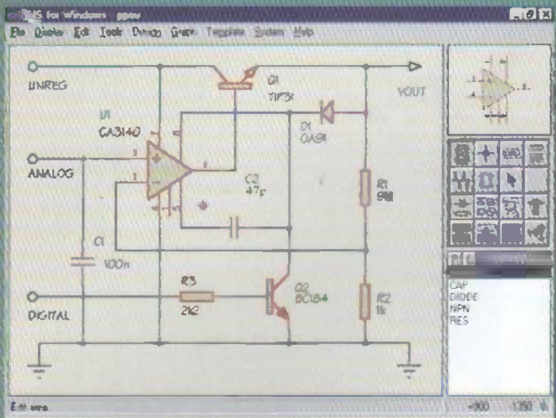
ISSN 0142-7229

PROTEUS

The IV th Generation

Schematic Capture

NEW Version IV



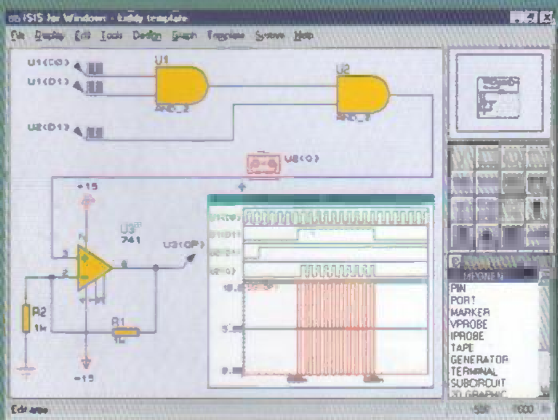
●Produces attractive schematics like you see in the magazines. ●Netlist, Parts List & ERC reports. ●Hierarchical Design. ●Full support for buses including bus pins. ●Extensive component/model libraries. ●Advanced Property Management. ●Seamless integration with simulation and PCB design.

New Features

Component Auto-Placer
Pinswap/Gateswap Optimizer
Background Regeneration of Power Planes
Enhanced Autorouting with Tidy Pass
Full Control of Schematic Appearance
Extensive New Component Libraries

Available in 5 levels - prices from £295 to £1875 + VAT.
Call now for further information & upgrade prices.

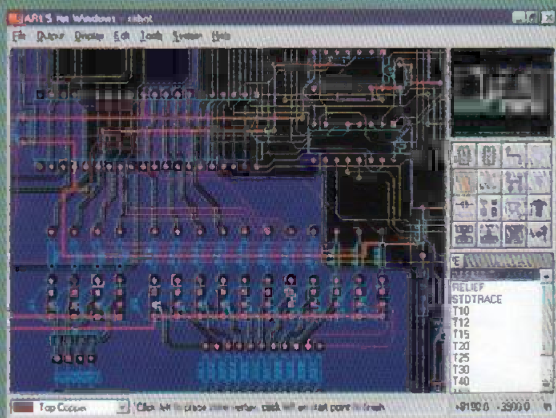
Simulation



●Non-Linear & Linear Analogue Simulation. ●Event driven Digital Simulation with modelling language. ●Partitioned simulation of large designs with multiple analogue & digital sections. ●Graphs displayed directly on the schematic.

PCB Design

NEW Version IV



●Automatic Component Placement. ●Rip-Up & Retry Autorouter with tidy pass. ●Pinswap/Gateswap Optimizer & Backannotation. ●32 bit high resolution database. ●Full DRC and Connectivity Checking. ●Shape based gridless power planes. ●Gerber and DXF Import capability.

"PROTEUS is particularly good with its rip-up-and-retry autorouter"

EWW January 1997

Labcenter Electronics

Write, phone or fax for your free demo disk, or ask about our full evaluation kit.
Tel: 01756 753440. Fax: 01756 752857. EMAIL: info@labcenter.co.uk
53-55 Main St, Grassington. BD23 5AA. WWW: http://www.labcenter.co.uk

Fully interactive demo versions available for download from our WWW site.
Call for educational, multi-user and dealer pricing - new dealers always wanted.
Prices exclude VAT and delivery. All manufacturer's trademarks acknowledged.


BRAND NEW!
PCB-POOL®
ALREADY OVER 2000 MEMBERS IN GERMANY
TRIED & TRUSTED STRAIGHT FROM GERMANY
1 Eurocard
+ Tooling
+ Photoplots
+ V.A.T.
=
£49
CONTOUR ?
ANY !
ANY FORMAT, ANY OUTLINE
NO PREMIUM !
INDUSTRY QUALITY
MULTILAYER ?
NO PROBLEM !
FREE
ON YOUR FIRST ORDER
(only as long as stock lasts)
NO. OF DRILLS ?
NO LIMITS !
NO INCREASE IN COSTS FOR INCREASE IN DRILLS !
Pay more ?
NO !
ALL IN ONE PRICE
incl.
Tooling
Photoplots
V.A.T.
SERIE XXS
10 board POOL only £ 25
20 board POOL only £ 19
30 board POOL only £ 16
40 board POOL only £ 14
50 board POOL only £ 12
Eurocard + Soldermask + Position print
Beta LAYOUT
Beta LAYOUT Ltd.
IRELAND
PCB-Brokerage
6 College Grove
Ennis - Co. Clare
My adress/Fax number
Fax/send back
Send/ fax me the PCB-POOL® participation requirements.
Please send me the PREVUE-DISC free of charge.
get connected
INFO: ++353 (0) 65 66500 FAX 66514
FAX on Demand 66515
EURO File-Transfer 66520
analog BBS 66516
isdn BBS 66518
pcbpool@betalayout.ie
http://www.pcb-pool.com
We accept
German Office
Beta LAYOUT GmbH
PCB-Brokerage
Feldstraße 2
65326 Aarbergen